

Appendix K – Desktop Hydrogeological Study – Highway 401 Power Dam Bridge Replacement



FINAL REPORT

Desktop Hydrogeological Study – Highway 401 Power Dam Bridge Replacement

G.W.P 4092-19-00

Township of South Stormont, Ontario

Presented to:

Ministry of Transportation
Eastern Region
1355 John Counter Blvd.
Kingston, ON
K7K 0E5

Project No. 201979404

November 14, 2023

\\\\EGNYTEDRIVE\\MH CLOUD\\PROJ\\2020\\201979404-MTO-HIGHWAY 401 POWER
DAM DRIVE\\08. WORKING\\ENVIRONMENTAL\\04. GEO-
ENVIRONMENTAL\\DESKTOP HYDROG\\201979404_DESKTOP HYDROG_
POWERDAM_FINAL.DOCX

Executive Summary

Morrison Hershfield Ltd (MH) was retained by the Ministry of Transportation Ontario (MTO) to complete a desktop hydrogeological study for the proposed bridge replacement at Highway 401 and Power Dam Road interchange in the Township of South Stormont, Ontario.

The desktop hydrogeological study was carried out to determine the existing geological and hydrogeological conditions of the study area, evaluation of the potential need for groundwater dewatering, potential groundwater impacts associated with the adjacent landfill to the project limits, and potential impacts on nearby receptors of the planned work.

The topography at the existing Highway 401/Power Dam Drive intersection slopes gently southward towards South Raisin River located, approximately 600 m south of the Site, and the St. Lawrence River located approximately 3.5 kilometers (km) south of the Site.

The surficial geology is described as till comprised of stone-poor, sandy silt to silty sand-textured till on Paleozoic terrain. The southern part of the study area has fine-textured glaciomarine deposits comprising silt, clay, minor sand, and gravel (Ontario Geological Survey, 2003). The study area is located on the Bobcaygeon Formation within the Simcoe Group and is made up of limestone, with minor shales in the upper part (Ontario Geological Survey, 2011). According to the WWIS, the average depth to bedrock within the study area is found to be about 37m.

According to Ontario Source Protection Information Atlas, the project area comes under the Highly Vulnerable Aquifer (HVA) zone and with a vulnerability score of 6. The proposed project might require excavation associated with civil works including installing new culverts, construction of new retaining walls, foundation underpinning, and utility service trenches. Additional dewatering operations will likely not be required. If water taking at rates between 50,000 liters and 400,000 liters per day is possible upon further evaluation, EASR registration is recommended.

Contaminants from sources like fill material of unknown quality, auto garage, waste generation, metal fabrication, and historic diesel spills could be possibly mobilized due to construction. Overall, the risk of mobilization of existing contaminant sources for this project exists. An additional consideration is required during the detailed-designing stages. However, the desktop study at the preliminary stage determines minimal temporary and residual effects on the groundwater quantity (i.e., well yields) resulting from the project.

No significant impact on ecology is determined at this stage. Further details are presented in the Natural Sciences, Fish and Fish Habitat Existing Conditions and Preliminary Impact Assessment Report prepared by MH under the same retainer.

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1. INTRODUCTION

Morrison Hershfield Limited (MH) completed a desktop hydrogeological study for the proposed bridge replacement at Highway 401 and Power Dam Road interchange in the Township of South Stormont, Ontario. The project site is shown in Figure 1, in Appendix A.

The project in general includes:

- The replacement of Bridge Site 13X-180/BO that carries Power Dam Drive over Highway 401.
- Developing a long-term plan for the interchange
- Establishing the footprint for the future widening of Highway 401 to six lanes

The desktop hydrogeological study was carried out to determine the existing hydrogeological conditions, evaluation of the potential need for groundwater dewatering, potential groundwater impacts associated with the adjacent activities to the project limits, and potential impacts on nearby receptors of the planned work.

1.1 Study Area

The Highway 401 Power Dam Bridge and Interchange is in the Township of South Stormont, within the United Counties of Stormont, Dundas and Glengarry. The Township of South Stormont is on the north shore of the St. Lawrence River.

For this study, the land containing all the alternative alignments is considered as the Site. The study area is defined as comprising lands within 500 m of the Site. The Site and the desktop hydrogeological study area are shown in Figure 1, in Appendix A.

Highway 401 is a four-lane divided rural freeway at the Power Dam Road interchange. The land use in the area is a combination of farmland, undeveloped wooded land, residential properties, and limited commercial properties along the local roads.

1.2 Scope of Work

The purpose of this groundwater study is to assess groundwater resources and determine and mitigate impacts associated with the proposed Highway 401 Power Dam Bridge and interchange project. The groundwater study will be carried out as per Section 3.3 of the *“Environmental Reference for Highway Design, June 2009”*, and as such incorporates the following elements: 1) establishment of a study area; 2) compilation and assessment of background information such as geological and topographic mapping, water well records, geological information, published hydrogeological, water resources studies, and geotechnical studies; 3) hydrogeological assessment and determination of significance; and 4) assessment of impacts

2. METHODS

This section describes the methods used in this study. Specifics to the project, including dates, specific data sources, and specific details of the chosen methodology are included as part of the results.

2.1 Background Data Review

Background data review was conducted in accordance with industry-standard practices using readily available information from federal, provincial, municipal, and other sources of information. The following is a non-exhaustive list of key data sources:

- Rideau Valley Source Protection Authority Assessment Reports
- MECP Water Well Information System (WWIS, MOE, 2012).
- Geology Ontario (maps published by the Ontario Geological Survey).
- Google Earth (for quick reference topographic and land use information).
- MECP Source Protection Information Atlas

The background review included analysis as necessary to develop an overall understanding of the hydrogeological setting within the study area including local aquifer systems, water table depth, groundwater flow direction, groundwater recharge discharge areas, and highly vulnerable aquifers. The background review also includes the review of groundwater quality data (if available) and a high-level review of land uses within the study for the potential contaminating sources which could pose an impact on the groundwater quality.

2.2 Site Reconnaissance

MH staff conducted a windshield survey of the study area on April 28, 2022. Site inspection involved observation of existing local hydrogeological conditions, where visible from the public right-of-way. Site reconnaissance photos are shown in Appendix B.

2.3 Impact Assessment

Groundwater impacts are generally assessed based on calculated or estimated drawdown of the water table/potentiometric surface, and on calculated or estimated changes in volumetric flow (such as loss of base flow to local streams). Other types of impacts (from ground vibration, spills, etc.) are assessed on a qualitative basis based on a professional judgment unless otherwise stated. The impact assessment is made by considering the impacts of these project-induced calculated or estimated hydrogeological effects on the following potential receptors:

- Wells and Aquifers.
- Actual or Potential Contamination.
- Surface water.
- Structures.
- Ecology.

All receptors identified within the study areas were determined through the review of the available background data.

3. EXISTING CONDITIONS

3.1 Background Report Review

No existing groundwater reports were available for the study area.

3.2 Physiography and Topography

The study area ranges in elevation from approximately 70 to 80 meters above sea level (masl). The topography at the existing Highway 401/Power Dam Drive intersection slopes gently southward towards South Raisin River located, approximately 600 m south of the Site, and the St. Lawrence River located approximately 3.5 kilometers (km) south of the Site. There are no water bodies within the study area. Drainage on the roads and surrounding areas are collected by roadside ditches and drains. No catch basins or manhole covers were observed in the study area during site reconnaissance.

3.3 Geology

According to “The Physiography of Southern Ontario” (Chapman and Putman, 1984), the study area falls within the Lancaster Flats.

In the southern part of Glengarry County, for about 10 km back from St. Lawrence, lies a lowland in which the till plain has been buried under water-laid deposits leaving exposed only the stony crests of a few drumlins and ridges. The water-laid materials range from clay to very fine sand in much the same as they do on the margins of the Winchester clay plain. The soils are generally poorly drained and have rather deep black surface soils underlain by rusty, mottled subsoils (Chapman and Putnam, 1984). As provided in Appendix A, the surficial geology is described as Till comprised of stone-poor, sandy silt to silty sand-textured till on Paleozoic terrain. The southern part of the study area has fine-textured glaciomarine deposits comprising silt, clay, minor sand, and gravel (Ontario Geological Survey, 2003).

The study area is located on the Bobcaygeon Formation within the Simcoe Group and is made up of limestone, with minor shales in the upper part (Ontario Geological Survey, 2011).

According to the WWIS, the average depth to bedrock is found to be about 37 m.

3.4 Hydrogeology

3.4.1 Aquifers and Groundwater Flow

According to WWIS, the aquifer depths in the study area range from 6m to 22m. The deeper wells were found to be present majorly in the northern quadrant of the study area, which is also at a higher slope. The inferred local groundwater direction is likely southerly towards the St. Lawrence River.

3.4.2 Water Well Records

A review of the Ministry of the Environment, Conservation, and Parks (MECP, 2021) Water Well Information System (WWIS) database was conducted for all water supply wells within a 500 m radius of the project area. The Ministry of the Environment, Conservation, and Parks (MECP) Water Well Information System (WWIS) database were queried for records of water supply wells within 500 m of the Site (MECP, 2020). A total of nineteen (19) water supply well records were identified, including seventeen (17) domestic, one (1) commercial, and one (1) livestock. The well installation dates range from 1970 to 2017. The wells around the study area have varied pumping demands and consists of both shallow and deep-water wells.

The map of MECP water well locations is provided in Figure 3 in Appendix B. It is noted that the margin of error of the locations of MECP well records ranges from 100 to 300 meters.

According to the MECP Source Water Protection online mapping (<http://www.applications.ene.gov.on.ca/swp/en/index.php>), there are no Well Head Protection Areas (WHPA) located within or in the vicinity (within a 1 km radius) of the study area.

3.5 Source Water Protection

The project site falls under the Raisin Region Source Protection Region. The Ontario Clean Water Act, 2006 identifies four types of vulnerable areas as part of source protection assessment as discussed below.

A wellhead protection area (WHPA) – It is the area around the wellhead that contributes source water to a drinking water system (i.e., a municipal well). A WHPA shows where groundwater is coming from to supply a municipal well, and how fast it is traveling through the ground toward the well (Cataraqui Source Protection Authority).

According to the MECP Source Water Protection online mapping (<http://www.applications.ene.gov.on.ca/swp/en/index.php>, accessed February 2022), there are no Wellhead Protection Areas (WHPA) located within or in the vicinity (within a 1 km radius) of the study area.

Intake Protection Zone (IPZ) – A zone established around a surface water intake of drinking water as prescribed in the Technical Rules: Clean Water Act, 2006.

According to Source Protection Information Atlas, IPZ does not apply to the study area.

Highly Vulnerable Aquifer (HVA) – Aquifers are considered vulnerable based on factors like depth from the ground level, type/characteristics of soil, and rock material surrounding it.

According to Ontario Source Protection Information Atlas, the selected southern region project area comes under the HVA zone, with a vulnerability score of 6. This

means that the water in the region can move relatively faster from the ground to the aquifer and is more vulnerable to contamination.

Significant Groundwater Recharge Area (SGRA) – In the SGRA, a significantly large amount of water reaches the aquifer from the ground surface. Changes to this recharge capacity affect both the quantity and quality of water in the region.

According to Ontario Source Protection Information Atlas, a small southwestern parcel of the study area comes under the SGRA zone.

The map showing source water protection details, as obtained from the Source Protection Information Atlas (accessed on June 5, 2022) is provided in Appendix A.

3.6 Potential Contamination Source

Based on the COS completed by MH in March 2022, four potentially contaminating activities and four areas of potential environmental concern (APECs) were identified in the vicinity of the project area including unknown quality of imported fill (within the project area), Fix Auto Cornwall garage (16892 Atchison Road), West Front Construction, Rosedale Mechanical Ltd. (16900 Atchison Road), and multiple historic diesel spills was identified as potential sources of contamination. The figure showing these PCAs/APECs is provided in Appendix A.

4. CONSTRUCTION DEWATERING AND PERMITS

In areas where fine-textured soil like clay retains water, seepage would be minimal, and the retained water is removed with the soil. According to WWIS, the average depth of groundwater table in the study area is 16m below the ground surface and is not shallow. The detailed design of the recommended plan is not available at the time of this report. Dewatering might not be required depending on the scope of work and excavation depths. These identifications are based on the well record review, desktop research, and visual observations. A detailed EASR/PTTW evaluation to confirm the hydrogeological condition is necessary during the detailed design process.

Under *O. Reg. 63/16*, the following types of water-taking activities must be registered in the Environmental Activity and Sector Registry (EASR), an online self-registration system implemented by the Ministry of the environmental, Conservation and Parks (MECP):

- surface water takings that are more than 50,000 liters per day (L/day) and are for road construction purposes that meet specified criteria about the purpose, rate, or location of the water taking; and
- construction site dewatering involving more than 50,000 L/day and less than 400,000 L/day of groundwater and/or stormwater.

For such takings, a Permit-To-Take-Water (PTTW) is not required, but the EASR registration must be carried out by the contractor undertaking the work. The registered water taking must continue to meet the criteria set out in *O. Reg. 63/16* and the water taker must comply with the operational requirements including obtaining the required water taking plan and discharge plan, where applicable, notifying local authorities, and reporting water taking amounts.

5. IMPACT ASSESSMENT AND MITIGATION MEASURES

5.1 Potential Impacts on Water Wells and Mitigation Measures

5.1.1 Water Levels and Well Yields

As an introduction to this topic, it is well known that well yields can be negatively affected by the temporary or permanent lowering of the groundwater level in aquifers. Temporary groundwater level lowering is typically associated with construction dewatering when excavations are pumped to keep them dry and safe for workers. Permanent groundwater level lowering is commonly associated with permanent topographic changes, such as when deep rock cuts are blasted for highway construction. Permanent groundwater level lowering can also result from permanent major groundwater takings (for irrigation, industry, etc.), and drainage at sumps (in mines, quarries, etc.) and foundations. Permanent groundwater level lowering may also be associated with reduced recharge of aquifers caused by development and associated increased imperviousness.

Most of the wells in the study area are bedrock wells with an average depth of 37 mbgs and with inner diameter of ~0.16m. There are around 6 shallow water wells with depths less than 15 m bgs. Water levels were approximately found to range from 6.4 m bgs (Well ID: 5804438) to 23m bgs (Well ID: 5802751). Although the wells are not shallow, many of them have a layer of sand and limestone above the bedrock which might aid seepage and require dewatering. A private water well monitoring program shall be developed and implemented by the Contractor to ensure that the dewatering activities are not negatively impacting the potable water wells.

The Ontario Water Resources Act (OWRA) provides that all water users whose supplies are interrupted shall be provided an alternate source. If a water well interference complaint is received by MTO, the Contractor, or through other channels (i.e., the MNR or MECP), and the complaint concerns water well within 500 m of the construction project, then the Contractor shall carry out the following actions:

1. Immediately provide an interim potable water supply (within 12 hours).
2. Notify the MECP of the complaint (if they are not already aware).
3. Retain a qualified professional to conduct a site investigation, determine the cause and provide recommendations to correct the problem.
4. If it is found that the water well interference resulted from the project, the water supply will be restored to its original condition, or better.

However, the desktop study at the preliminary stage determines minimal temporary and residual effects on the groundwater quantity (i.e., well yields) resulting from the project.

5.1.2 Well Water Quality

Water quality in aquifers and wells can be negatively affected by introduced contaminant sources, mobilization of existing contaminant sources, and groundwater movement. During construction, introduced contaminant sources may include degraded surface water caused by poor erosion and sediment control, degraded surface water caused by the interaction of stormwater with muck piles (pieces of blasted rock), fuel, and chemical spills from construction equipment, and chemicals introduced into the ground during blasting. The risk of aquifer and well contamination due to these possible sources of contamination must be managed through proper construction practices and mitigation measures as set out in Section 5.

If actual contamination is present in soil and/or groundwater in close vicinity of the groundwater dewatering locations (if determined needed), depending on the radius of the impacts created by the construction dewatering activities, there is a potential for contamination migration during construction dewatering. Detailed evaluation of potential impacts to groundwater and mitigation measures shall be conducted during the detail design stage when the groundwater dewatering locations and pumping rates can be determined.

Following construction, improper use of road de-icing materials may also result in impairment of groundwater quality in previously undeveloped areas.

Overall, so long as proper construction practices are used there will be minimal temporary and residual effects on the groundwater quality resulting from the project.

5.2 Potential Impacts on Surface Water

5.2.1 Flow Amounts

There is a small waterbody/pond present outside the 500m study area boundary in the southwest region. The South Raisin River creek runs in the southeastern portion of the study area. No significant impacts in terms of the quantity of water present in surface water features are anticipated.

5.2.2 Water Quality

Water quality in surface water may be affected by changes in the rate of groundwater discharge, by changes in the quality of groundwater discharge, or by contaminants introduced by way of a dewatering system.

To maintain the quality of groundwater, alternatives with proximity to contaminant sources should be evaluated in detail.

5.3 Potential Impacts on Structures

Structures can be affected by settlement caused by soil consolidation related to groundwater level lowering. Generally, this is a concern where structures are founded on thick clay deposits, which are permanently dewatered (by under-draining, for example). There are no significant deposits of clay close to the proposed design. Limited dewatering of the bedrock is not anticipated to result in any significant consolidation of soils. There is a small strip of residential structures about 200m from the in the vicinity of the alignments. Therefore, potential impacts to the structures within the study area is unlikely. Further evaluation shall be conducted when the groundwater dewatering locations and rates (if determined needed) are determined during the detail design stage.

5.4 Potential Impacts on Ecology

There are no Provincially Significant Wetlands or Areas of Natural and Scientific Interest (ANSI) located within the study area. Therefore, no significant impacts on the local ecological system are anticipated. Details regarding the ecological existing conditions and potential impacts can be found in the Natural Sciences Existing Conditions and Impact Assessment Report and Fish and Fish Habitat Existing Conditions Report prepared by MH issued under a separate cover.

6. CLOSURE

We trust the above meets your current requirements. Should you have any comments, questions, or require additional information, please do not hesitate to contact the undersigned.

Respectfully submitted,
Morrison Hershfield Limited

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7. LIMITATIONS AND USE

This report has been prepared for the exclusive use of Ministry of Transportation (MTO), by Morrison Hershfield Limited (Morrison Hershfield). Morrison Hershfield hereby disclaims any liability or responsibility to any person or party, other than MTO, for any loss, damage, expense, fines, or penalties which may arise from the use of any information or recommendations contained in this report by a third party.

The report, which specifically includes all tables, figures and appendices is based on data and information collected during investigations conducted by Morrison Hershfield and is based solely on the conditions of the site at the time of the investigation, supplemented by historical information and data obtained by Morrison Hershfield as described in this report.

Morrison Hershfield has exercised professional judgment in collecting and analyzing the information and formulating recommendations based on the results of the study. The services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to this study. No other warranty or representation, either expressed or implied, as to the accuracy of the information or recommendations included or intended in this report.

8. REFERENCES

- Raisin Region Conservation Authority. Raisin-South Nation Source Protection Area, Drinking Water Source Protection.
- Chapman, L.J. and Putnam, D.F., 1984. The Physiography of Southern Ontario, Ontario Geological Survey, Special Volume 2.
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- Rideau Valley Source Protection Authority, Source Protection Plan

APPENDIX A: Figures



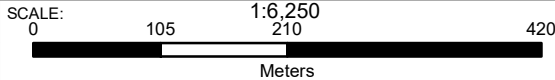
LEGEND

- Site Boundary
- Study Area (500 m Buffer)
- Land Information Ontario Data**
 - Watercourses
 - Waterbodies
- Transportation Network**
 - Expressway / Highway / Freeway
 - Arterial / Collector
 - Local Roads

NOTES:
- NDMNRF Raisin Region Conservation Authority



Coordinate System: NAD 1983 UTM Zone 18N
Sources: NDMNRF



TITLE:
Site Locality

PROJECT NO.: 201979404
Highway 401 at Power Dam Drive,
Bridge Replacement

DATE: April, 2022 **Figure 1**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



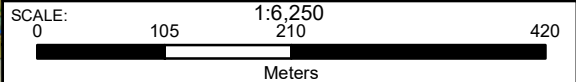
LEGEND

- Site Boundary
- Study Area (500 m Buffer)
- Land Information Ontario Data**
 - Watercourses
 - Waterbodies
 - Significant Ecological Area
 - Wooded Areas
- Transportation Network**
 - Expressway / Highway / Freeway
 - Arterial / Collector
 - Local Roads

NOTES:
- NDMNRF Raisin Region Conservation Authority



Coordinate System: NAD 1983 UTM Zone 18N
Sources: NDMNRF

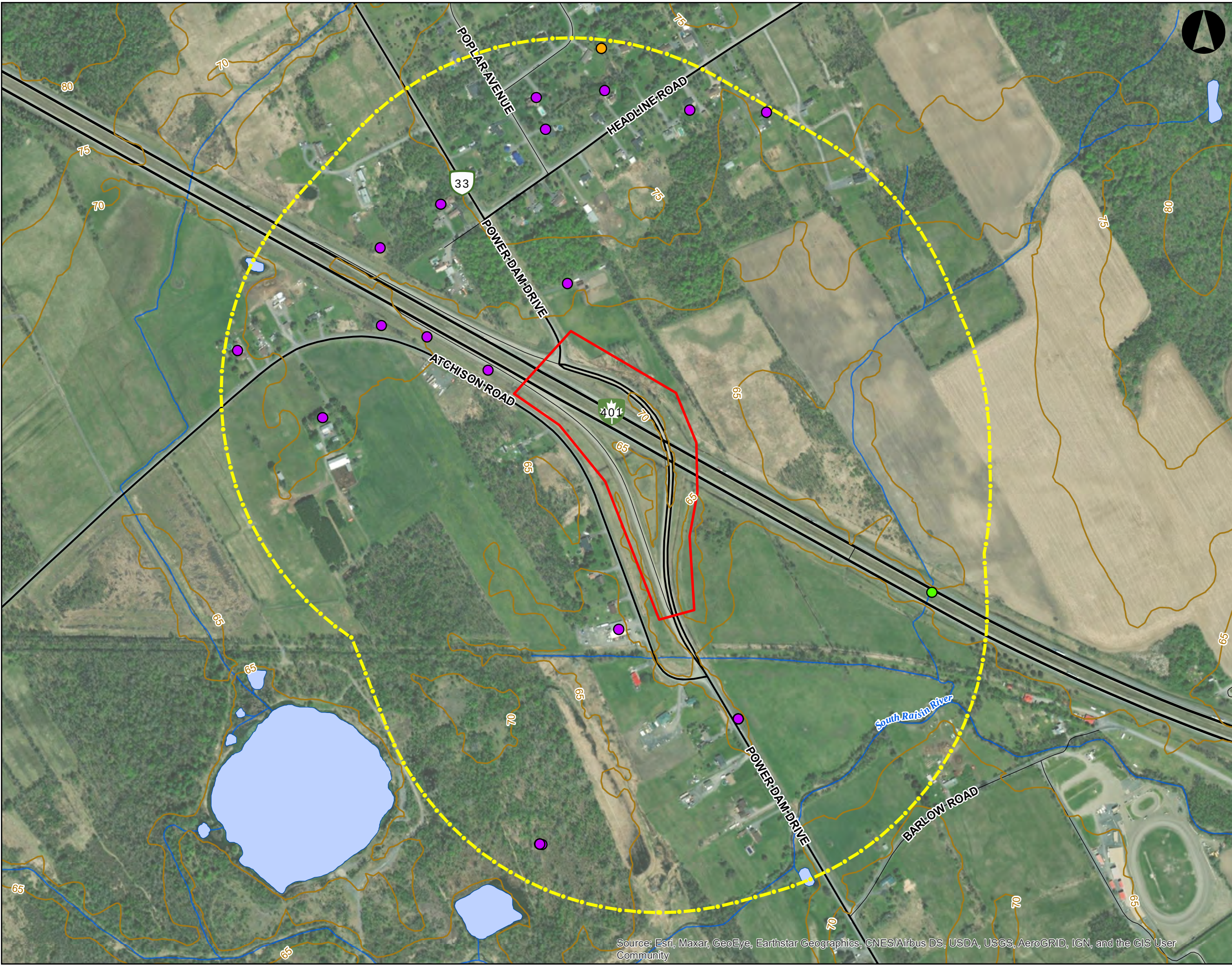


TITLE:
Waterbodies and Areas of Natural Significance

PROJECT NO.: 201979404
Highway 401 at Power Dam Drive, Bridge Replacement

DATE: April, 2022

Figure 2



LEGEND

Water Wells in Provincial System (WWIS)

- Commerical
- Domestic
- Livestock

Site Boundary

Study Area (500 m Buffer)

Land Information Ontario Data

- Topographic Contour (mASL)
- Watercourses
- Waterbodies

Transportation Network

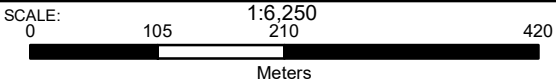
- Expressway / Highway / Freeway
- Arterial / Collector
- Local Roads

NOTES:

- NDMNRF Raisin Region Conservation Authority



Coordinate System: NAD 1983 UTM Zone 18N
Sources: NDMNRF



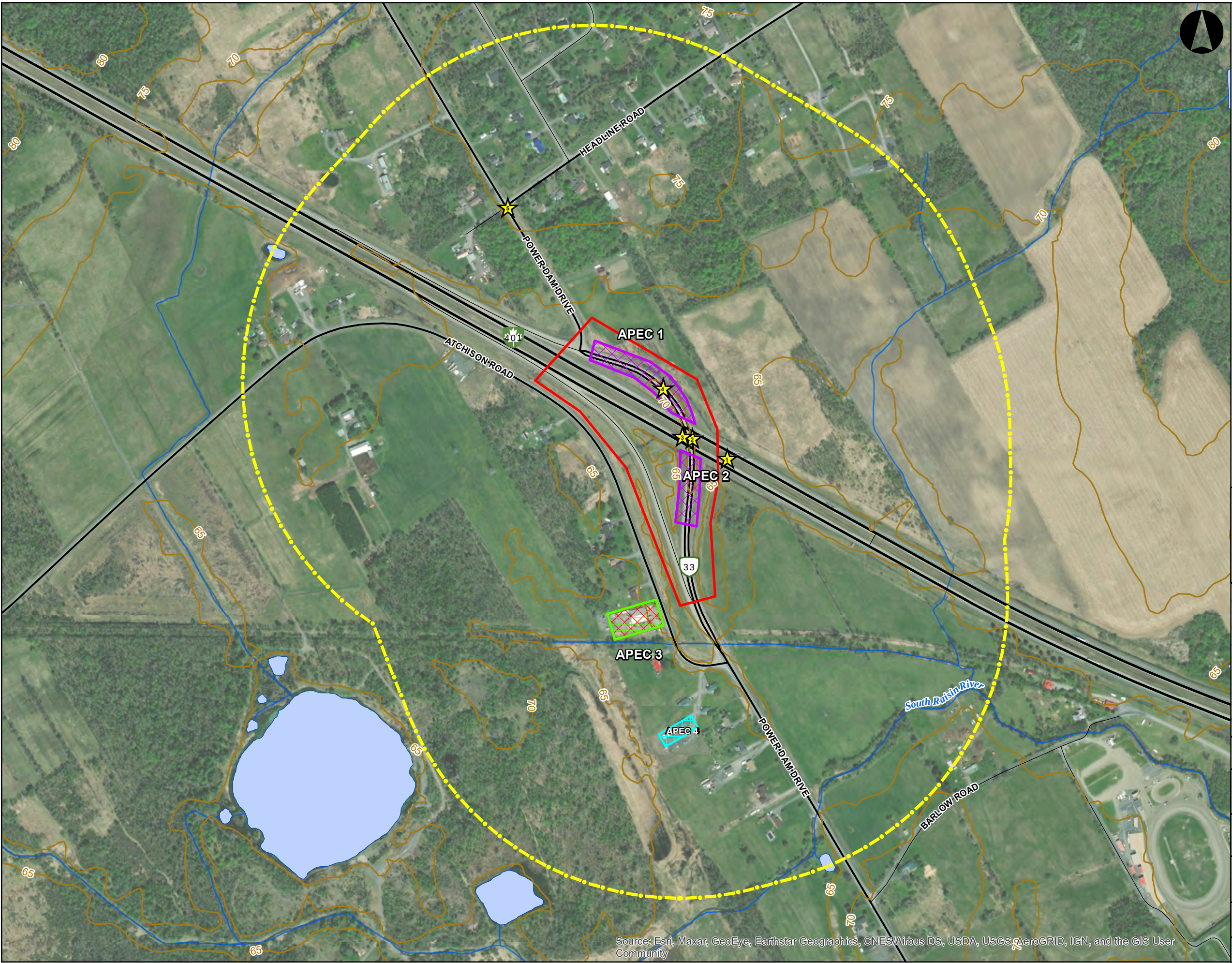
TITLE:
Topography and WWIS Locations

PROJECT NO.: 201979404
Highway 401 at Power Dam Drive,
Bridge Replacement

DATE: April, 2022

Figure 3

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



LEGEND

- ★ Spill Locations
- Study Area (500 m)
- Site Boundary

Potentially Contaminating Activities

- PCA #10: Commercial Autobody Shop
- PCA #30: Importation of Fill Material of Unknown Quality
- PCA #58: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of bio soils and soil conditioners
- PCA #34: Metal Fabrication

Land Information Ontario Data

- Topographic Contour (mASL)
- Watercourses
- Waterbodies

Transportation Network

- Expressway / Highway / Freeway
- Arterial / Collector
- Local Roads

NOTES:

- NDMNRF Raisin Region Conservation Authority

1:500,000

Coordinate System: NAD 1983 UTM Zone 18N
Sources: NDMNRF

MORRISON HERSHFIELD

SCALE: 0 105 1:6,250 210 420

Meters

TITLE:

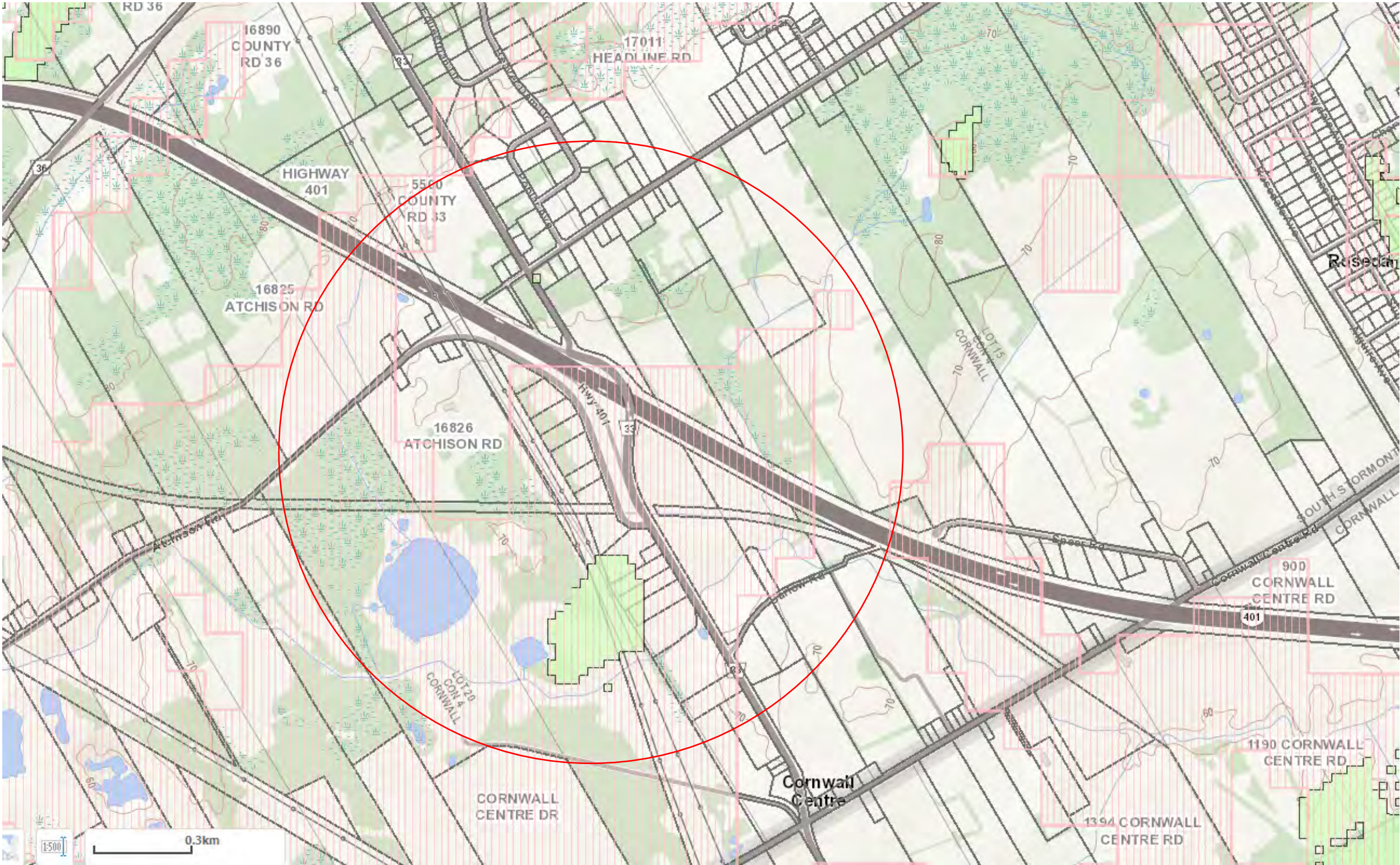
Potentially Contaminating Activities

PROJECT NO.: 201979404
Highway 401 at Power Dam Drive,
Bridge Replacement

DATE: April, 2022

Figure 4

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Legend

-  Approximate Study Area
-  Highly Vulnerable Aquifers
-  Significant Groundwater Recharge Area



Project Name:

**Desktop Hydrogeological Study
– Highway 401 Power Dam
Bridge Replacement**



Drawing Title:

**Source Water Protection Details
for the study area**

Scale:

N.T.S.

Project No:

201979404

Drawing No:

5

Department:

Environmental

Date:

June 2022

L:\proj\2124077\Drawings\Location Plans\Template.pdf Source: Ontario Geological Survey, 2022



Legend

- Approximate Study Area
- 5b Till
- Fine-Textured Glaciomarine Deposits
- Coarse-Textured Glaciomarine Deposits



Project Name:

Desktop Hydrogeological Study – Highway 401 Power Dam Bridge Replacement




MORRISON HERSHFIELD

Drawing Title:

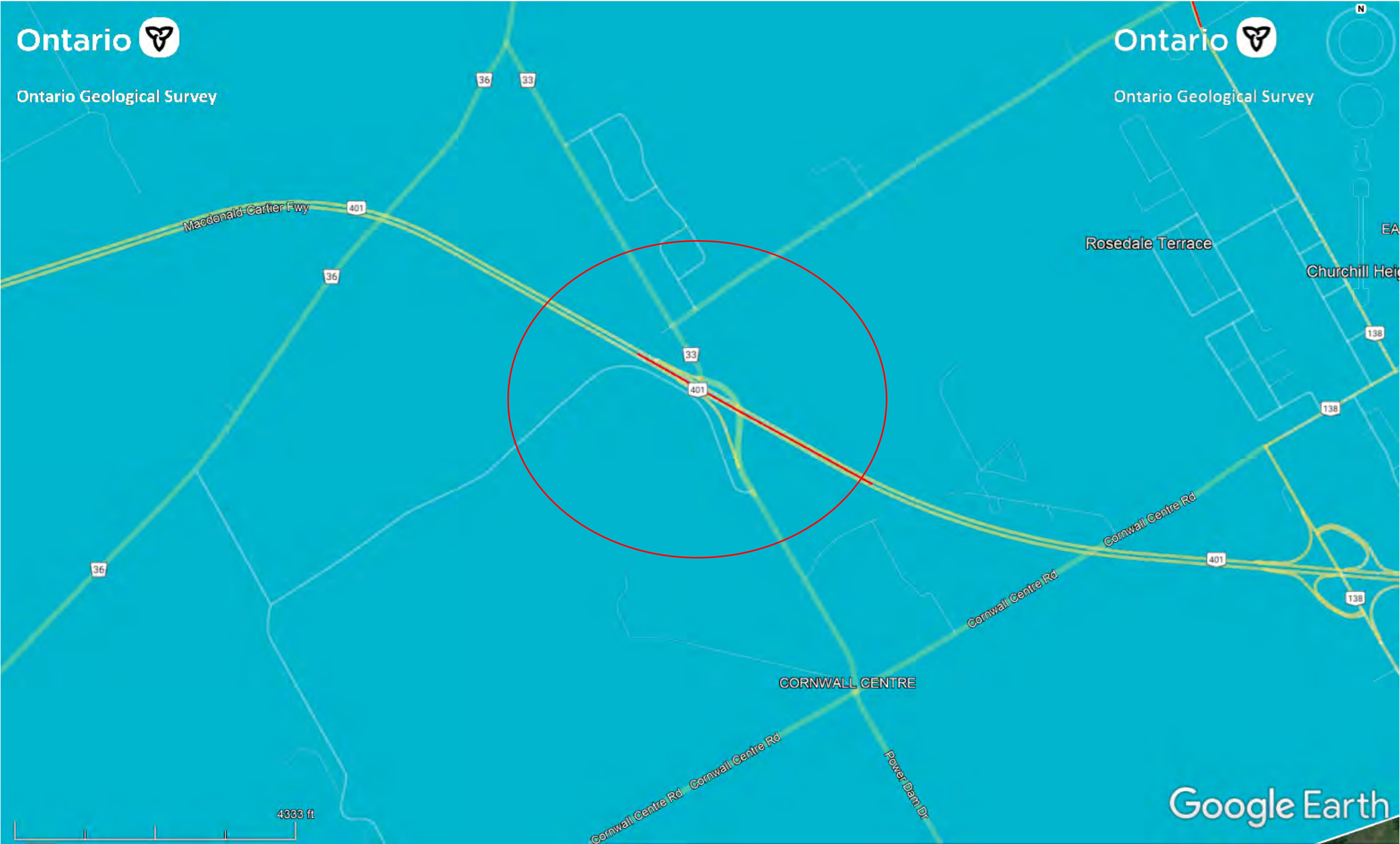
Surficial Geology Map

Scale:

N.T.S.

Project No:	Drawing No:
201979404	6
Department:	Date:
Environmental	June 2022

L:\proj\2124077\Drawings\Location Plans\Template.pdf
Source: Ontario Geological Survey, 2022



Legend

-  Approximate Study Area
-  Limestone, dolostone, shale, arkose, sandstone Ottawa Group; Simcoe Group Shadow Lake Formation



Project Name:

**Desktop Hydrogeological Study
– Highway 401 Power Dam
Bridge Replacement**



Drawing Title:

Bedrock Geology Map

Scale:

N.T.S.

Project No:

201979404

Drawing No:

7

Department:

Environmental

Date:

June 2022

APPENDIX B: Site Reconnaissance Photos



Photo #1 Rosedale Mechanical



Photo #2 Rosedale Mechanical



Photo #3 Fix Auto Collision Cornwall



Photo #4 Residential houses
and roadside ditches





Photo #5 Truck yard



Photo #6 Barn with horses



Photo #7
Farmlands

Appendix L – Highway Drainage and Hydrology Report



MORRISON HERSHFIELD now



Stantec

FINAL REPORT

Preliminary Highway Drainage and Hydrology Report

Highway 401 / Power Dam Drive Interchange

Agreement No. 4019-E-0023

Assignment No. 4

G.W.P. 4092-19-00

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January 21, 2025

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1. INTRODUCTION

Morrison Hershfield Limited has been retained by the Ministry of Transportation (MTO) to complete the Class Environmental Assessment (EA) and Preliminary Design for a new interchange at Highway 401 and Power Dam Drive near Cornwall, Ontario, including the preparation of a Preliminary Design Report (PDR) and a Transportation Environmental Study Report (TESR).

As part of the Class EA process, Morrison Hershfield evaluated a long-list and short-list of design alternatives and selected a single diamond interchange as the technically preferred alternative (TPA) to carry forward into preliminary design. The decision matrix for the evaluation of alternatives is found in **APPENDIX A**.

Morrison Hershfield completed preliminary design of drainage and stormwater management (SWM) for the technically preferred alternative, including hydrologic and hydraulic analysis of existing and proposed conditions and preliminary sizing of required culverts, ditches, and stormwater management to support the new interchange. Climate change considerations have been included as per Provincial Engineering Memorandum #2016-14.

2. EXISTING CONDITIONS

The Highway 401 and Power Dam Drive interchange is located just north-west of Cornwall, Ontario in the municipalities of South Stormont and the United Counties of Stormont, Dundas, and Glengarry. The intersection is within the jurisdiction of the Raisin River Conservation Authority (RRCA). The project limits extend 1.5 kilometers east and west and 750 meters north and south of the interchange, as presented in **Exhibit 1**.

The existing interchange only allows traffic to exit Highway 401 Eastbound to Power Dam Drive southbound and to enter Highway 401 in the westbound direction. The proposed project aims to improve vehicle access between Highway 401 and Power Dam Drive by replacing the existing bridge along Power Dam Drive over Highway 401 and replacing the existing partial interchange with a full interchange. These modifications will impact the existing drainage systems for the interchange.

Highway 401 is a divided 4-lane highway separated by a grass-lined median with a posted speed limit of 100 km/h. The bridge over Highway 401 has two lanes of traffic divided by a raised-curb median with a posted speed limit of 80 km/h.

The following background reports/maps were reviewed:

- Power Dam Drive Overpass Construction Drawings (1968)
- Proctor and Redfern Group (1984), South Branch Raisin River Flood and Fill Line Mapping, Raisin River Conservation Authority
- MTO (2014 & 2018), OSIM Inspection Form
- MTO (2021), Highway 401 Corridor Maps
- Dillon (2021), Culvert Hydrology Report, Highway 401 Culvert Replacement
- MTO (2021), Structural Culvert Replacement Contract Drawings
- Ainley (2021), Culvert Replacement and Rehabilitation Contract Drawings (100%)
- Ainley (2022), Gravity Pipe Analysis Memorandum
- Golder (2022), Geotechnical Report

The project site is within the Raisin River watershed. Flows from the project area outlet to the South Raisin River through ditches and culverts. The South Branch of the Raisin River (South Raisin River) is located south of Highway 401. It eventually joins the Main Branch of the Raisin River, which outlets to Lake St. Francis (St. Lawrence River).

Drainage along Highway 401 is conveyed east and west via roadside ditches and culverts to the watercourses. Drainage along Power Dam Drive overpass is captured by catch basins and conveyed through culverts to roadside ditches along Highway 401. The existing drainage system for the interchange includes 15 culverts, 9 catch basins, and roadside ditches. **Exhibit 1** presents a map of the existing culverts. Existing culverts and storm outlets within the project limits are identified in **Table 1**.

The study background and the field investigations conducted by the MH teams are discussed in **Sections 2.1 to 2.6**.

Table 1: Existing Culverts and Drainage Infrastructure

Crossing ID	Drainage Asset ID (DAID)	Watercourse	Highway/Road No.
EC01	CV-0401-011160	Local Drainage	Highway 401 - Emergency Turnaround
EC02	31X-0334/C0	Tributary of SBRR	Highway 401 - All Lanes
EC03	CV-0401-000462	Local Drainage	Highway 401 - Eastbound Lanes
EC04	CV-0401-011161	Local Drainage	Power Dam Drive
EC05	CV-0401-000147	Local Drainage	Highway 401 - Eastbound Lanes
EC06	CV-0401-011166	Local Drainage	Highway 401 - Westbound Lanes
EC07	CV-0401-000463	Local Drainage	Highway 401 - Offramp
EC08	CV-0401-000464	Local Drainage	Power Dam Drive
EC09	CV-0401-011163	Storm Outlet	Power Dam Drive
EC10	CV-0401-011162	Storm Sewer	Power Dam Drive
EC11	CV-0401-011165	Storm Outlet	Power Dam Drive
EC12	CV-0401-011164	Storm Sewer	Power Dam Drive
EC13	CV-0401-000617	Storm Outlet	Power Dam Drive
EC14	CV-0401-000618	Storm Outlet	Power Dam Drive
EC15	CV-0401-011167	Storm Outlet	Power Dam Drive
EC16	CV-0401-001323	Storm Outlet	Power Dam Drive
EC17	Municipal	Tributary of SBRR	Power Dam Drive
EC18	Municipal	Tributary of SBRR	Atchison Road
EC19	CV-0401-011169	Tributary of SBRR	Highway 401 - Westbound Lanes
EC20	CV-0401-000148	Tributary of SBRR	Highway 401 - Eastbound Lanes
EC21	CV-0401-000149	Local Drainage	Highway 401 - All Lanes
EC22	CV-0401-000150	Tributary of SBRR	Highway 401 - Eastbound Lanes
EC23	CV-0401-011170	Tributary of SBRR	Highway 401 - Westbound Lanes

2.1 South Raisin River Floodplain Mapping

The Proctor and Redfern Group developed floodplain mapping for the RRCA for the South Raisin River in February 1984. The floodplain is located outside of the study area and is not anticipated to be impacted by any of the proposed intersection configurations.

2.2 Unnamed Watercourses / Drains

Two unnamed drains cross Highway 401 via structural culverts: one approximately 750 meters west of the intersection (Culvert EC02) and one approximately 700 meters east of the interchange (Culverts EC22 and EC23). Both flow from north to south. A third unnamed drain crosses west to east under Power Dam Drive, approximately 450 meters south of the interchange (Culverts EC17 and EC18). While the OMAFRA Agriculture Information Atlas (AgMaps) identifies these drains as having municipal drain status, the Drainage Superintendent for the Township of South Stormont has confirmed that they have no record of an engineer's report for any of these drains and do not consider any of them to hold municipal status (see **APPENDIX C** for communications with the local Drainage Superintendent). The three crossings can be seen in **Exhibit 1**.

2.3 MTO Gravity Pipe Analysis Memorandum

The Gravity Pipe Analysis memorandum prepared by Ainley provides the design for culverts along Highway 401 within the Township of South Stormont and the City of Cornwall, of which only one culvert is within the study area: EC07. The memorandum recommends the replacement of culvert EC07, a centerline culvert under the Highway 401 EB off-ramp located within limits of this study. Ainley used either the Rational Method or SWMHYMO (depending on catchment size) to determine the peak flow for each culvert. The hydraulic design was completed using CulvertMaster. It should be noted that the catchment area for culvert EC07 in the memorandum includes the area west of culvert EC01. However, the proposed ditch inlet to culvert EC02 from the Culvert Hydrology Report prepared by Dillon Consulting (Section 2.4) will remove the area west of culvert EC01 from the catchment area of culvert EC07, providing an over-estimate of flow to culvert EC07. The report recommends the existing 610 mm CSP culvert be replaced with a 600 mm steel or concrete culvert. The other culverts included in the memorandum are not within the scope of this project.

The Ainley Tender Drawings (2021) detail the culvert replacements described in the Ainley memorandum. In addition to the culverts presented in the Ainley memorandum, the drawings note 13 other culverts and 10 catch basins at the Highway 401/Power Dam Drive interchange. Most culverts are recommended for cleanout, and two culverts (EC21 and EC22) are recommended for concrete repair and cleanout. A summary of the culvert recommendations is provided in **Table 2**. Works under the Ainley contract began in 2023.

2.4 MTO Culvert Hydrology Report

The culvert hydrology report prepared by Dillon Consulting for MTO is part of a project to replace a series of structural culverts along Highway 401 near the project site. The report focused on the replacement of a structural culvert under Highway 401 approximately 800 meters west of the interchange (EC02). The structural culvert is along an unnamed tributary of the South Raisin River, running under the divided highway and emergency vehicle turnaround in the median. A second non-structural culvert (EC01) runs perpendicular to and above the structural culvert conveying drainage in the grassy ditch between the highway lanes. Dillon conducted a field investigation and determined the existing culvert EC02 is 3.65 meters in width, 1.85 meters in height, and 63 meters in length. Dillon used peak flows developed by WSP (using Visual Otthymo 2) to conduct hydraulic analysis with HEC-RAS. The report recommended the existing culvert be replaced with a 3.6 m x 2.4 m box culvert.

The corresponding MTO contract drawings to the Dillon Report (2021) detail the culvert replacement, as well as the relocation of the non-structural culvert. The drawings show the non-structural culvert will outlet into the structural culvert in the proposed configuration, rather than passing drainage over and through the emergency vehicle turnaround. The culvert replacement work began in 2023 and is expected to be completed in 2024.

Table 2: Existing Culvert Cleanout, Repair, and Replacement Ongoing Work

HIGHWAY 401/POWER DAM DRIVE INTERCHANGE EXISTING CULVERT TABLE														
Culvert No.	Ainley Culvert ID	Ainley Sewer ID	Drainage Asset ID (DAID)	Roadway	Location	Station	Culvert Type	Existing Size (Ainley), mm	Proposed Size (Ainley), mm	Existing Size (MH), mm	Existing Length (Ainley), m	Proposed Length (Ainley), m	Estimated Depth to Pipe (Ainley), m	Culvert Action (Ainley)
EC01*	-	-	CV-0401-011160	Hwy 401	Median Turnaround	17+914	CSP	450	500		14.07	15	1	Replacement
EC02*	-	-	31X-0334/C0	Hwy 401	WBL and EBL	17+914	OFCB	3650 x 1850	3600 x 2700	-	63	73.2	3	Replacement
EC03	30	-	CV-0401-000462	Hwy 401	EBL	18+495	SPCSP	900	900	-	30.66	31	1.5	Trenchless Replacement
EC04	-	-	CV-0401-011161	Power Dam Dr.	Intersection N of highway	-	CSP	750 (est.)	-	-	-	-	-	-
EC05	35	-	CV-0401-000147	Hwy 401	EBL	18+767	NRFO	1220 x 1220	-	900 X 1200	24.34	-	1	Clean out
EC06	36	-	CV-0401-011166	Hwy 401	WBL	18+767	NRFO	1220 x 1220	-	900 X 1200	23.74	-	1	Clean out
EC07	37	-	CV-0401-000463	Hwy 401	W-N/S Ramp (I/C 786)	18+770	CSP	610	600	-	18.94	19	2.5	Open Cut Replacement
EC08	38	-	CV-0401-000464	Power Dam Dr.	Centreline	18+872	SPCSP	750	-	-	38.62	-	3	Clean out
EC09	31	SSS7	CV-0401-011163	Power Dam Dr.	SBL	18+665	CSP	305	-	-	10.68	-	NA	Clean out
EC10	32		CV-0401-011162	Power Dam Dr.	South of SBL	18+672	CSP	305	-	-	15.85	-	NA	Clean out
EC11	34	SSS8	CV-0401-011165	Power Dam Dr.	South of SBL	18+735	CSP	305	-	-	15.24	-	NA	Clean out
EC12	33		CV-0401-011164	Power Dam Dr.	SBL	18+735	CSP	305	-	-	7.93	-	NA	Clean out
EC13	39	SSS9	CV-0401-000617	Power Dam Dr.	NBL	18+880	CSP	305	-	-	18.9	-	NA	Clean out
EC14	40	SSS10	CV-0401-000618	Power Dam Dr.	NBL	18+900	CSP	305	-	-	10.97	-	NA	Clean out
EC15	41	SSS11	CV-0401-011167	Power Dam Dr.	SBL	18+895	CSP	300	-	-	8.53	-	3	Clean out
EC16	42	SSS12	CV-0401-001323	Power Dam Dr.	NBL	18+955	CSP	305	-	-	12.8	-	-	Clean out
EC17	-	-	-	Power Dam Dr.	Atchison Rd. Intersection	-	CSP	-	-	1200	NA	-	-	-
EC18	-	-	-	Atchison Rd	West of C17	-	CSP	-	-	1800	NA	-	-	-
EC19	-	-	CV-0401-011169	Hwy 401	WBL	18+990	Concrete	-	-	1500 X 1200	NA	-	-	-
EC20	-	-	CV-0401-000148	Hwy 401	EBL	19+010	Concrete	-	-	1500 X 1200	NA	-	-	-
EC21**	43	-	CV-0401-000149	Hwy 401	WBL and EBL	19+200	Concrete	1800 X 1800	NRFO	1700 X 1300	22.58	-	0.75	Concrete Repair & Clean out
EC22**	47	-	CV-0401-000150	Hwy 401	EBL	19+350	NRFO	1800 x1800	-	1200 X 800	22.58	-	-	Concrete Repair & Clean out
EC23**	-	-	CV-0401-011170	Hwy 401	WBL	19+340		-	-	1000 X 1000	-	-	-	-

* Culverts EC01 and EC02 characteristics are from the Culvert Hydrology Report, Highway 401 Culvert Replacement, Site No 31X-0334/C0, WP 4112-13-01 (Dillon, 2021.)

** Culverts EC21, EC22, and EC23 sizes are from 2019 MTO Survey.

2.5 Geotechnical Report

The Geotechnical Report, prepared by Golder, is a preliminary foundation investigation for the construction of the new bridge over Highway 401. A soil profile in the report indicated clayey silt (till) overlain by firm to stiff clay then very stiff clay (consistent with OMAFRA AgMaps soil mapping shown in **Exhibit 4** and discussed in **Section 5.1**). The investigation found that the soil in the project site has high potential for steel corrosion and low potential for sulphate attack. The report recommends silt fences and erosion control blankets during the construction phase to improve water quality. All recommendations from the geotechnical report shall be incorporated into the drainage design.

2.6 Field Investigations and Preliminary Recommendations

MH conducted a field investigation on November 3rd, 2021, to inspect drainage elements within the study area and identify immediate causes of poor drainage of Highway 401. Anecdotal reports by neighbouring residents of poor drainage are a suspected cause of rapid deterioration of the highway pavement under the Power Dam Drive bridge. This understanding will inform the ultimate drainage design with any proposed re-aligned highway, structures, or ramp configurations.

The investigation found many of the culverts and ditches within the study area were not functioning as designed, resulting in standing water on both sides of many culverts. MH also inspected the drainage of the bridge over Highway 401. MH found the number of catch basin inlets to be sufficient, but the outlet leads appeared to be either buried or in very poor condition. Interim recommendations provided in the field investigations memo include cleaning out ditches, culverts, and catch basin leads that have been heavily sedimented to promote drainage along the site. The following list indicates the structures to be cleaned out:

- CV-0401-000464
- CV-0401-000463
- CV-0401-011167
- CV-0401-000618
- CV-0401-000617
- CV-0401-011165
- CV-0401-011164
- CV-0401-011163

All of the above culverts were identified for clean-out or replacement as part of the work done by Ainley Group, slated for 2023. The full results of the field investigation are provided in **APPENDIX B**. As per correspondence with MTO found in **APPENDIX C**, soil and water testing is excluded from the scope of the preliminary design and should be completed during detailed design.

3. DRAINAGE DESIGN CRITERIA

The drainage and SWM design is based on the following standards and manuals:

- Highway Drainage Design Standards (MTO 2008);
- Drainage Management Manual (MTO 1997);
- Gravity Pipe Design Guidelines (MTO 2014);
- Implementation of the Ministry's Climate Change Consideration in the Design of Highway Drainage Infrastructure (PEM DSCO #2016-13);
- Environmental Guide for Erosion and Sediment Control during Construction of Highway Projects (MTO, 2015);
- Canadian Highway Bridge Design Code (CSA, 2006);
- Stormwater Management Planning and Design Manual (MECP, 2003); and
- A Guide for Engineers working under the Drainage Act in Ontario, Publication 852 (OMAFRA, 2018).

Criteria for the various elements of the drainage design has been organized in the following subsections:

- Culverts – **Section 3.1**;
- Stormwater Management – **Section 3.2**;
- Ditches – **Section 3.3**; and,
- Storm Sewers – **Section 3.4**.

3.1 Culverts

Design criteria for the existing/proposed culverts is summarized in the following subsections.

3.1.1 Design Flows

The design flow is defined by the classification of the road the culvert crosses. Road classifications were determined using the Ontario Road Network (ORN). **Table 3** summarizes the design flow requirements for watercourse culverts and drainage culverts per the *Highway Drainage Design Standards* (HDDS) (MTO 2008).

Table 3: HDDS Design Flow Requirements for Watercourse and Drainage Culverts

Road Class	Design Flow Return Period (yrs)			
	Watercourse Culvert		Drainage Culvert	
	Minor Flow	Major Flow ¹	Minor Flow ²	Major Flow ²
Freeways, Highway Ramps, and Urban Arterials	N/A	50	10	100
Rural Arterials and Collectors	N/A	25	10	100

¹Used in calculation of HW/D and freeboard

²Used in calculation of freeboard

3.1.2 Check Flood

The Canadian Highway Bridge Design Code (CHBDC) (2014) stipulates that culverts shall be designed to withstand a check flood without endangering the integrity of the structure or causing embankment failure. Per Section 1.9.1.3 of CHBDC, the check flood return period shall be, at a minimum, twice the return period of the design flow. HDDS WC-1 describes the same check, although called check flow for scour. HDDS requirements are more stringent and will therefore be carried forward for use on this project, as detailed in **Section 3.1.3**.

3.1.3 Check Flow for Scour (Erosion)

HDDS stipulate that culverts along watercourses should be designed to withstand a check flow greater than the design flow without embankment or structural failure. **Table 4** summarizes the check flow for each road class. Flows resulting from the scour analysis are not to overtop the edge of the travelled lane, though they are not subjected to freeboard, clearance, or flow depth restrictions. The velocity at the outlet of the culvert under these conditions must be 2 m/s or less to prevent excessive erosion, otherwise erosion protection may be required.

Table 4: Check Flow Requirements for Watercourse Culverts

Road Class	Check Flow
Freeways and Urban Arterials	130% of the 100-Year Flow
Rural Arterials and Collectors	115% of the 100-Year Flow

3.1.4 Freeboard

Freeboard at watercourse culverts is defined by the HDDS as the vertical distance between the upstream water surface elevation and the lowest point on the road profile at the edge of the travelled lane. For a drainage culvert, it is the vertical distance between the upstream water surface elevation and the top of subgrade. **Table 5** summarizes the freeboard requirements as specified in HDDS WC-7 and SD-13 for watercourse and drainage culverts, respectively.

Table 5: Minimum Freeboard Requirements for Watercourse and Drainage Culverts

Culvert Type	Minimum Freeboard	
	Minor	Major
Watercourse	N/A	1.0 m
Drainage	0.3 m	0 m

3.1.5 Headwater Depth

Headwater Depth (HW) is the vertical distance from the upstream invert elevation to the upstream water surface elevation of the culvert. A HW/D ratio equal to or less than 1.0 indicates that the headwater elevation is either at or below the culvert obvert. **Table 6** summarizes the HDDS WC-7 criteria for maximum allowable HW/D ratio.

Table 6: HW/D Requirements for Watercourse and Drainage Culverts

Culvert Type	Maximum HW/D
Watercourse	1.5
Drainage	N/A

3.1.6 Minimum Culvert Size

HDDS WC-8 specifies minimum culvert sizes for maintenance access. **Table 7** provides a summary of the minimum size criteria. This is applicable for both watercourse and drainage culverts.

Table 7: Minimum Culvert Sizes

Road Class	Minimum Culvert Size (mm)
Highways, Urban Arterials, & Highway Ramps	800 (circular, elliptical, & arch) 900 (box)
Rural Arterials & Collectors	600 (circular, elliptical, & arch) 900 (box)
Local Roads & Private Entrances	400 (length < 10 m) 500 (length > 10 m)

3.1.7 Depth of Cover

Culvert design is governed by the minimum required depth of cover above the culvert. The depth of cover is the difference between the top elevation of the road and the crown elevation of the culvert. Cover depth shall be in accordance with the CSPI Handbook of Steel Drainage & Highway Construction Products (2017) and/or OCPA Concrete Pipe Design Manual. Based on these two references, the minimum cover depth would be 0.3 m and 0.6 m for CSP and concrete, respectively.

3.1.8 Fish Passage Requirements

Culverts within fish habitat must be designed according to fish passage requirements, following MTO Highway Drainage Design Standards (2008) Section WC-12. As such, the culvert substrate and native substrate must have a depth of at least 0.3 m and 0.1 m, respectively, therefore the total embedment must be at least 0.4 m. The maximum velocity through the culvert for the 2-Year Return Period Flows should not exceed the natural velocity of the channel, or 0.8 m/s, for a sufficient depth (0.3 m) to allow for fish passage. The water depth in the culvert should be consistent with the depths upstream and downstream of the culvert, and be at least 0.3 m. The culvert's headwater elevation should be outlet controlled.

Fish habitat is present within the project limits as summarized in **Table 8**, as well as in adjacent ditches and watercourses. Culverts EC02, EC17, EC18, EC22, and EC23 are located on fish-bearing watercourses. Culvert EC02 is being replaced in 2024; for hydrology and hydraulics analyses, refer to Culvert Hydrology Report, Highway 401 Culvert Replacement (Dillon, 2021). Fish passage requirements apply to these culverts. Additional details are provided in the *Fish and Fish Habitat Existing Conditions and Impact Assessment Report* (Morrison Hershfield, 2023). Note that culvert EC02 is being replaced in 2024; for details on this culvert, refer to Culvert Hydrology Report, Highway 401 Culvert Replacement (Dillon, 2021).

Table 8: Fish Habitat within Project Limits

MH Culvert ID	Fish Habitat
EC02	Direct
EC17	Direct
EC18	Direct
EC22	Direct
EC23	Direct

Table 9: Existing Culvert Design Criteria

Culvert ID		Roadway	Road Classification	Fish Passage Design Required	Return Period (Year)			Freeboard (m)		HW/D (Major)
					Minor Design Flow (yr)	Major Design Flow (yr)	Check Flow for Scour	Minor	Major	
Watercourse Culverts	EC17	Power Dam Drive	Rural Arterial	Yes	N/A	25	115% of 100-yr	N/A	≥1	≤1.5
	EC18	Atchison Road	Rural Collector	Yes	N/A	25	115% of 100-yr	N/A	≥1	≤1.5
	EC22	Freeway	Provincial Highway	Yes	N/A	50	130% of 100-yr	N/A	≥1	≤1.5
	EC23	Freeway	Provincial Highway	Yes	N/A	50	130% of 100-yr	N/A	≥1	≤1.5
Drainage Culverts	EC1	Freeway ⁽¹⁾	Provincial Highway	No	10	100	N/A	0.3	N/A	N/A
	EC3	Freeway	Provincial Highway	No	10	100	N/A	0.3	N/A	N/A
	EC4	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC5	Freeway	Provincial Highway	No	10	100	N/A	0.3	N/A	N/A
	EC6	Freeway	Provincial Highway	No	10	100	N/A	0.3	N/A	N/A
	EC7	Freeway Ramp	Provincial Highway	No	10	100	N/A	0.3	N/A	N/A
	EC8	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC9	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC10	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC11	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC12	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC13	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC14	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC15	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC16	Power Dam Drive	Rural Arterial	No	10	100	N/A	0.3	N/A	N/A
	EC19	Freeway	Provincial Highway	No	10	100	N/A	0.3	N/A	N/A
	EC20	Freeway	Provincial Highway	No	10	100	N/A	0.3	N/A	N/A
	EC21	Freeway	Provincial Highway	No	10	100	N/A	0.3	N/A	N/A

(1) This culvert is located under an emergency vehicle turn-around

3.1.9 Climate Change

MTO undertook a study with the University of Waterloo to investigate trends in the historical rainfall to account for climate changes (Soulis, Princz, & Wong, 2015). A trend has been identified and incorporated into the MTO IDF Curve Lookup online tool (Provincial Engineering Memorandum, PEM DSCO #2016-14).

According to the PEM DSCO #2016-14 policy for climate change, MTO drainage infrastructure should be designed with considerations for climate change. The infrastructure should meet performance standards for the entire design life of the structure. Key considerations are summarized as follows:

- The design must satisfy both the start and end life design constraints for the range of the return periods from 2- to 100-year.
- Design continues to be in accordance with the MTO Drainage Design Standards.
- Designers shall apply future rainfall values for the year corresponding to the end of the Design Service Life of the structure in the design for conveyance, erosion, scour, and stormwater management components.
- The design for fish passage shall meet the low flow requirements at the present and future flow conditions.

In accordance with the climate change considerations given above, both the start (2023) and the end life design (2098) rainfall values, assuming a 75-year design life for CSP structures, are obtained from the MTO IDF Curve Lookup V3.0 online tool.

3.2 Stormwater Management

In Ontario, the design of stormwater management (SWM) best management practices (BMPs) is outlined in the Ministry of the Environment, Conservation and Parks (MECP) “Stormwater Management Planning and Design Manual” (SWMPDM, 2003). BMPs are needed to mitigate impacts of the project on the water balance (infiltration), water quality (TSS removal), erosion, and water quantity (peak flow/flood level) control. Per the SWMPDM, post-development peak flows should not exceed those from pre-development values.

In general, a SWM approach should follow the hierarchy of BMPs. The SWMPDM recommends that BMPs be considered in order of preference as follows and detailed in subsequent subsections:

- Source Controls
- Conveyance Controls
- End-of-Pipe Controls

3.2.1 Source and Conveyance Controls

Source and conveyance controls that will be considered for this project site and will provide the required SWM benefits will include (enhanced) grassed swales, vegetated filter strips, and natural buffer strips (Table 1.3 of the SWMPDM).

Opportunities for source and conveyance-type BMPs exist in swales along the highway and connecting roadways that provide drainage for the roadways. Enhanced swales with rock check dams would be most suitable stormwater management control structures for the current project.

3.2.2 End-of-Pipe Controls

Given the rural setting, including presence of ditches/swales along the roadways and multiple outlets, end-of-pipe facilities are not considered appropriate for application on this project and are not recommended.

3.3 Ditches

As stipulated in HDDS SD-3 Section 3.4 and SD-9 Section 3, ditches shall be designed as outlined below:

- There is no flow spread onto the shoulder/travel line during conveyance of flows up to and including the major system design flow (100-year);
- A freeboard of at least 0.3m should be provided from the HGL to top of subgrade associated with conveyance of the minor event (10-year), with a depth no greater than 1m;
- As a desirable standard, 100-year flow extent shall not extend beyond the ROW, and at a minimum will not increase existing extent of flooding;
- Ditch lining shall be designed to resist erosion during events up to and including the major system design flow (100-year), with velocities not exceeding 1.5m/s unless reinforcement is used; and
- Physical parameters as per SD-9 Section 3.2.

Where required for stormwater management, ditches shall be designed as enhanced grass swales per Section 4.8.2 of TRCA/CVC's Low Impact Development Stormwater Management Planning and Design Guide (2010), including:

- Maximum flow velocity limited to 0.5 m/s and flow depth limited to 100 mm during conveyance of the 4-hour 25-mm Chicago storm event, with check dams as required;
- Bottom width between 0.75 and 3 m; and
- Side slopes no steeper than 2.5:1.

3.4 Storm Sewers

Storm sewer systems shall be designed in accordance with HDDS SD-1 to SD-8, including:

- Provide capacity for the design flow, defined as the 10-year and 100-year return period flow for minor system and major system design, respectively, for highway, arterial, and collector roads (SD1) or as per municipal design standards for municipal road drainage;
- Limit flow spread onto travel lanes of a highway and depth of flow at the edge of the travel lanes as per SD3 or as per municipal design standards for municipal road drainage;
- Design inlets in accordance with SD-5, SD-6, and SD-7, with a maximum distance of 150 m between inlets or less as determined by SD-3;
- Design the storm sewer system in accordance with minimum pipe diameter, minimum velocity, maximum maintenance hole spacing, and minimum slope of lateral sewers as per SD-4; and
- Design inlets at highway sag points in accordance with SD-6.

4. PROPOSED CONDITIONS

The drainage pattern at the study area is generally from north-west to south-east. Under existing conditions, fifteen (15) culverts service the roadway network and external areas, including twelve (12) culverts crossing Highway 401, two (2) crossing Power Dam Drive and one (1) crossing Atchison Road (**Exhibit 1**, Existing Culverts). The drainage from all culverts discharges to an Unnamed Drain at multiple outlets and ultimately to the South Raisin River. Runoff from roadways drains via sheet flow and is collected and conveyed with typical roadside ditches to culverts at low points.

The Technically Preferred Alternative (TPA) for the proposed interchange is presented in **Exhibit 6**. The overall north-west to south-east drainage pattern will remain the same for the proposed conditions. Locally, drainage patterns will change where culverts and ditches are shifting to accommodate the new roadway alignment. **Exhibit 7** shows the roadway drainage with the proposed culverts. Hydrologic analysis for the TPA is presented in **Section 5**.

A total of twelve (12) culverts have been designed to service the ultimate alignment. Highway 401 will be widened, and Power Dam Drive will be realigned to accommodate the N-W, N-E, S-W and S-E ramps, conflicting with the current location of some existing culverts as shown on **Exhibit 7**. Therefore most existing culverts must be removed, realigned, or extended to allow for the reconstruction of the interchange. Four (4) new culverts, three (3) replacements and three (3) extensions will be needed to drain the proposed interchange. Two (2) existing culverts will remain as-is. Culverts EC01 and EC02 are being removed and replaced, respectively, as part of an existing contract and are excluded from this analysis. Design criteria for the proposed culverts are summarized in Error! Reference source not found.. Hydraulic analysis for the culverts is presented in **Section 6**.

Roadway drainage will be provided via enhanced grassed swales located on both sides of the roadways. The trapezoidal swales are proposed to service Highway 401, highway ramps, and Power Dam Drive, with bottom width of 1.0m, 3:1 side slope, varying depths, and tie-in to the road shoulder and original ground. The stormwater management approach is discussed in **Section 7**.

The proposed interchange will be implemented using a phased approach with “interim” and “ultimate” conditions. During interim conditions, only ramps to the west of Power Dam Drive (Power Dam to Westbound 401 and Eastbound 401 to Power Dam) will be constructed. Culverts PC24 and PC25 service the ultimate alignment and may not need to be constructed during the interim phase. Culverts PC19, PC20, PC21, PC22, and PC23 should be replaced / extended as part of the future widening planned for this section of Highway 401 such that they can accommodate the ultimate configuration of the Power Dam Drive interchange, including all ramps.

5. HYDROLOGY

The methodology for the hydrology calculations completed to support preliminary culvert design is presented in **Section 5.1**. Peak flow estimates for existing and proposed culverts are provided in **Section 5.2** and **Section 5.3**, respectively.

5.1 Methodology

The MTO Drainage Management Manual (1997) states the Rational Method is applicable for watershed drainage areas < 100 ha. All culverts within the project limits have rural drainage areas below 100 ha and thus the Rational Method is considered acceptable for estimation of peak flows at each culvert. The Rational Method equation is presented below (Equation 1).

$$Q = \frac{CiA}{360}$$

Equation 1: Rational Method

Where: Q = flow rate calculated using Rational Method (m³/s)

C = weighted runoff coefficient

i = rainfall intensity (mm/hr)

A = catchment area (ha)

Catchment areas draining to each culvert were delineated using the Ontario Digital Elevation Model (ODEM) obtained from Land Information Ontario's (LIO) GeoHub website.

The weighted runoff coefficient is calculated using land cover, slope, and soil type, and runoff coefficient values from MTO Drainage Management Manual (DMM) Design Chart (DC) 1.07, which uses soil texture to differentiate between soil types. Soil textures within the project limits were estimated using OMAFRA AgMaps soil mapping and include Loam and Clay Loam (as shown in **Exhibit 4**). The slope range for each catchment was calculated using LIO's ODEM. A summary of the values used to estimate the composite runoff coefficient for each catchment is provided in **Table 10**.

Table 10: Runoff Coefficients of Existing Land Uses

Land Use	Slope (%)	Runoff Coefficient	
		Loam	Clay Loam
Cultivated	0-5	0.35	0.55
Grassed	0-5	0.28	0.40
Impervious	0-5	0.88	0.95
Industrial (Light)	0-5	0.65	0.80
Lake and Wetland	0-5	0.05	0.05
Open Space*	0-5	0.73	0.80
Residential	0-5	0.33	0.40
Woodland	0-5	0.25	0.35

*Calculated from curve number (per HEC-HMS Technical Reference Manual, Open space, fair condition with 50-75% grass cover)

Intensity-frequency-duration (IDF) data was estimated using rainfall data obtained from the MTO IDF Curve Lookup Tool. To account for climate change, both the 2023 and 2098 IDF equations were extracted.

Time of Concentration (T_c) was computed using the Bransby-Williams Method (for catchments with a runoff coefficient > 0.4) and Airport Method (for catchments with a runoff coefficient < 0.4). Catchments with an estimated $T_c < 10$ minutes were rounded up to 10 minutes to avoid overestimation of flow intensity in accordance with standard industry practice.

5.2 Existing Conditions

Runoff generated by the project area and upstream catchments is conveyed via ditches, culverts, and watercourses to the outlet at the southeast edge of the project area to the unnamed drain, tributary to the South Raisin River. **Figure 1** below shows the five outlets from the study area to the South Raisin River, and drainage areas for each outlet. Refer to **Exhibit 2** for a detailed drainage mosaic.

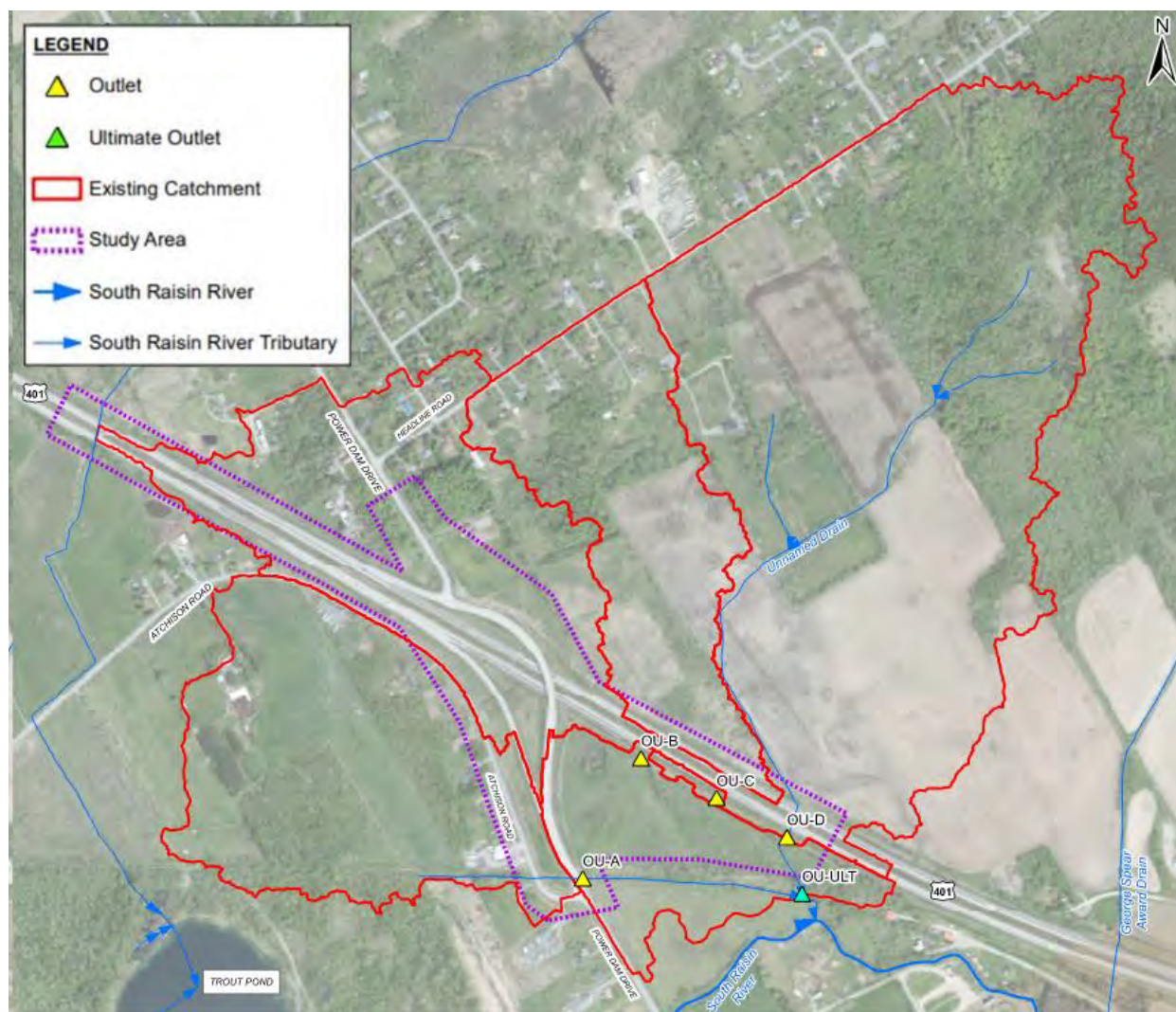


Figure 1: South Raisin River Outlet Locations and Drainage Areas

A summary of the hydrologic calculations for the drainage area to each existing culvert is provided in **Table 11**. Detailed calculations are provided in **APPENDIX D**. As per the MTO Drainage Management Manual (1997), the runoff coefficient was increased by 10%, 20%, and 25% for the 25-, 50-, and 100-Year return period design flow calculations, respectively.

Table 11: Summary of Existing Catchment Hydrology

Culvert	Catchment	Area	Runoff Coefficient	Tc	Rainfall Intensity (mm/hr)						Design Flow (L/s)					
ID	ID	(ha)	2-year	(min)	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year
EC17	ES-17	29.11	0.43	37	32.7	42.4	48.8	56.9	62.8	68.7	1127	1462	1681	1960	2164	2367
EC18	ES-18	27.49	0.42	35	33.5	43.4	50.0	58.3	64.3	70.4	1076	1397	1606	1872	2067	2261
EC22	ES-22	77.63	0.37	92	18.1	23.3	26.7	31.1	34.3	37.5	1445	1863	2140	2491	2744	3000
EC23	ES-23	76.73	0.37	92	18.1	23.3	26.7	31.1	34.3	37.5	1417	1826	2097	2442	2689	2941
EC03	ES-03	1.57	0.56	33	34.5	44.8	51.5	60.1	66.3	72.6	84	108	125	145	160	176
EC04	ES-04	10.62	0.33	68	21.4	27.7	31.8	37.0	40.8	44.6	209	270	310	361	397	435
EC05	ES-05	1.89	0.59	10	75.9	99.0	114.1	133.3	147.3	161.3	234	305	351	410	453	497
EC06	ES-06	1.01	0.61	10	75.9	99.0	114.1	133.3	147.3	161.3	130	170	196	229	253	277
EC07	ES-07	4.98	0.51	46	28.9	37.4	43.0	50.1	55.3	60.5	202	262	301	351	388	424
EC08	ES-08	8.35	0.52	48	28.0	36.2	41.6	48.5	53.6	58.6	340	441	507	591	652	713
MH09/ MH10	ES-09/10	0.06	0.86	10	75.9	99.0	114.1	133.3	147.3	161.3	11	14	16	19	21	23
EC11	ES-11	0.17	0.90	10	75.9	99.0	114.1	133.3	147.3	161.3	32	42	48	56	62	68
MH13	ES-13	0.07	0.95	10	75.9	99.0	114.1	133.3	147.3	161.3	13	18	20	24	26	29
MH14	ES-14	0.02	0.95	10	75.9	99.0	114.1	133.3	147.3	161.3	4	5	6	7	7	8
MH15	ES-15	0.11	0.95	10	75.9	99.0	114.1	133.3	147.3	161.3	22	28	32	38	42	46
MH16	ES-16	0.06	0.93	10	75.9	99.0	114.1	133.3	147.3	161.3	11	15	17	20	22	24
EC19	ES-19	21.24	0.33	86	18.8	24.3	27.9	32.4	35.7	39.1	371	479	550	640	705	771
EC20	ES-20	22.14	0.35	86	18.8	24.3	27.8	32.4	35.7	39.1	400	516	592	690	760	831
EC21	ES-21	22.01	0.36	63	22.0	28.5	32.7	38.1	42.0	45.9	483	625	717	835	921	1007
EC03	ES-03	1.57	0.56	33	34.5	44.8	51.5	60.1	66.3	72.6	84	108	125	145	160	176
EC04	ES-04	10.62	0.33	68	21.4	27.7	31.8	37.0	40.8	44.6	209	270	310	361	397	435
EC05	ES-05	1.89	0.59	10	75.9	99.0	114.1	133.3	147.3	161.3	234	305	351	410	453	497
EC06	ES-06	1.01	0.61	10	75.9	99.0	114.1	133.3	147.3	161.3	130	170	196	229	253	277

5.3 Proposed Conditions

The Technically Preferred Alternative (TPA) for the proposed interchange is shown in **Exhibit 6**. The proposed interchange will result in an increase in imperviousness of the project area from 30.7% to 37.5%, as shown in **Table 12**. New impervious surfaces include the widened Highway 401, the addition of highway ramps, and modifications to Power Dam Drive and Atchison Road. Impact of the project on subcatchments within the project limits and associated imperviousness values are shown in **Table 12**. No impacts to the South Raisin River Floodplain are anticipated.

Table 12: Pre- and Post-development Subcatchments within Project Limits and Imperviousness Values

Outlet	Area (ha)		Imperviousness (%)	
	EX	PR	EX	PR
OU-A	0.7	0.5	29.0	28.0
OU-B	13.1	15.3	32.5	36.3
OU-C	1.0	0.6	28.8	36.9
OU-D	1.4	1.7	36.6	42.1
OU-Ultimate	2.9	2.4	20.7	43.6
Total	19.1	20.6	30.7	37.5

The drainage system proposed to service the interchange is shown schematically in **Exhibit 7**. Pre- and post-development land cover is shown in **Exhibit 3** and **Exhibit 8**, respectively.

Culverts EC02, EC03, and EC18 currently servicing Highway 401 and Atchison Road will be repurposed to service the proposed interchange. EC02 will be replaced in 2024; its drainage area is not affected by the interchange works. None of the culverts to be retained are addressed by the Ainley memo and remediation/replacement works currently underway (detailed in **Section 2**).

Culverts PC19 and PC20 are recommended to be extended by approximately 25 m and culvert PC21 by approximately 20 m to accommodate the widening of Highway 401 and the new ramps.

Replacement culverts PC17, PC22, and PC23 are required to achieve hydraulic design criteria (freeboard and headwater depth). The existing culverts at these locations have insufficient capacity. See **Section 6.2** for results of the hydraulic analysis.

Four (4) new ramp culverts are proposed to service the new road alignment. Culvert PC07 is proposed under W- N/S off-ramp, PC04 is proposed on N/S-W on-ramp, PC24 is proposed on E- N/S off-ramp, and PC25 is proposed on N/S-E on-ramp. Highway 401 culverts EC01, EC05, EC06 and EC08 are recommended to be removed as they won't be required to service the proposed road alignment.

According to the design criteria outlined in **Section 3.1.9**, the culvert designs must account for climate change by satisfying the present conditions, as well as those predicted for the end of their service life. When compared to the 2023 values, the 2098 IDF equations result in higher estimated flow rates and have been carried forward for use for the design of the culverts as per climate change requirements described in **Section 3.1.9**. A summary of the hydrologic results for the drainage area to each proposed culvert is provided in **Table 14**. Detailed calculations are provided in **APPENDIX D**.

Table 13: Proposed Culvert Design Criteria

Culvert ID		Proposed Road Class	Fish Passage Design Required	Return Period			Freeboard (m)		HW/D (Major)	Min. Size (mm)
				Minor Design Flow (yr)	Major Design Flow (yr)	Check Flow for Scour	Minor	Major		
Watercourse Culverts	EC18	Rural Arterial	Yes	N/A	25	115% of 100-yr	N/A	1.0	1.5	600
	PC17	Rural Collector	Yes	N/A	25	115% of 100-yr	N/A	1.0	1.5	600
	PC23	Freeway	Yes	N/A	50	130% of 100-yr	N/A	1.0	1.5	800
	PC22	Freeway	Yes	N/A	50	130% of 100-yr	N/A	1.0	1.5	800
Drainage Culverts	EC03	Freeway	No	10	100	N/A	0.3	N/A	N/A	800
	PC07	Freeway	No	10	100	N/A	0.3	N/A	N/A	800
	PC25	Freeway	No	10	100	N/A	0.3	N/A	N/A	800
	PC04	Freeway	No	10	100	N/A	0.3	N/A	N/A	800
	PC24	Freeway	No	10	100	N/A	0.3	N/A	N/A	800
	PC19	Freeway	No	10	100	N/A	0.3	N/A	N/A	800
	PC20	Freeway	No	10	100	N/A	0.3	N/A	N/A	800
	PC21	Freeway	No	10	100	N/A	0.3	N/A	N/A	800

Table 14: Summary of Proposed Catchment Hydrology

Culvert ID	A (ha)	C	Tc (min)	Rainfall Intensity (mm/hr)						Design Flow (L/s)					
				2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year
EC18	27.49	0.42	36	33	43	50	58	64	70	1069	1387	1595	2046	2464	2808
PC17	29.06	0.42	37	33	42	49	57	62	68	1112	1442	1814	2308	2661	2918
PC23	77.02	0.37	93	18	23	27	31	34	37	1417	1826	2097	2686	3227	3675
PC22	77.92	0.37	93	18	23	27	31	34	37	1445	1863	2139	2739	3291	3748
EC03	1.57	0.78	33	35	45	52	60	66	73	75	97	112	144	173	197
PC07	4.86	0.53	44	29	38	44	51	56	62	211	274	315	404	486	554
PC25	9.1	0.44	58	24	30	35	41	45	49	264	341	392	502	604	687
PC04	11.33	0.35	70	21	27	31	36	40	44	232	299	344	440	529	603
PC24	13.63	0.39	81	20	25	29	34	37	41	286	369	424	543	652	743
PC19	22.51	0.37	86	19	24	28	33	36	39	440	567	651	834	1002	1142
PC20	24.27	0.39	85	19	24	28	33	36	39	493	636	730	935	1123	1280
PC21	21.57	0.36	66	22	28	32	37	41	45	463	599	687	881	1059	1206

6. HYDRAULIC ANALYSIS

Methodology for the hydraulic analysis is presented in **Section 6.1**. Invert elevations were not available for the existing culverts, so the hydraulic performance of existing culverts could therefore not be analyzed. It is recommended that a survey of existing culvert inverts is completed to allow for verification of hydraulic performance of existing culverts as part of the detailed design phase and evaluation of hydraulic impact of the proposed system. Results from evaluation of hydraulic performance of the proposed culverts are presented in **Section 6.2**. Hydraulic analysis for proposed ditches is provided in **Section 6.3**.

6.1 Methodology

HY-8 was used to complete the hydraulic analysis for the proposed culverts. The material of three of the four new culverts proposed were assumed to be CSP and one CSPA. Gravity pipe design, including soil and water sampling should be completed as part of detailed design to select a suitable culvert material. Culverts were sized using the criteria detailed in **Section 3.1** and **Table 9**.

6.2 Proposed Culverts

Proposed culverts are summarized in **Table 15**. Considering compatibility with the preliminary interchange design and conclusions from condition assessments detailed in **Section 2.1** and **Section 2.2**, an action has been recommended for each culvert, as summarized below:

- Four (4) culverts will no longer be required and should be removed, including Culvert EC01 to be removed as part of an existing contract;
- Three (3) culverts are minimally impacted by proposed works and can remain, including Culvert EC02 to be replaced as part of an existing contract;
- Three (3) culverts should be extended under Highway 401 to accommodate new ramps and widened Highway 401;
- Three (3) culverts require replacement due to insufficient capacity; and
- Four (4) new culverts are required under new highway ramps.

Each culvert proposed to service the proposed interchange has been assigned a unique “proposed conditions” ID (“PC##”). Characteristics of proposed culverts are shown in **Table 15**, including size, invert elevations, length, and slope. Where a proposed culvert replaces an existing culvert, the size of the associated existing culvert is also shown. The invert elevations of culverts were assumed in the absence of existing survey and should be confirmed during through survey during detailed design.

It is important to note that the generally flat topography within the study area and existing road profiles along Highway 401 and Power Dam Drive constrain the size of culverts and limit how much freeboard can be achieved.

It should also be noted that Culvert EC18 under Atchison Road was found to have insufficient capacity to meet MTO design criteria. However, the proposed plan does not involve works in the vicinity of this culvert. Therefore, replacement of this culvert is not included as part of this project.

Table 15: Proposed Culvert Characteristics

Culvert ID	Culvert Action	Size (mm)		Inv. Elev. (m) ¹		Embedment depth (m)	Proposed length (m)	Slope (%)
		Existing	Proposed	Inlet	Outlet			
EC18	Remain	1800	-	61.70		0.60	22.70	0.80
PC17	Replace	1200	2700 X 1200	61.77	61.70	0.30	27.18	0.25
PC23	Replace	1000 X 1000	2400 X 1500	62.11	61.96	0.30	29.38	0.52
PC22	Replace	1200 X 800	2400 X 1500	61.94	61.76	0.30	34.76	0.52
EC03	Remain	900	-	65.13	64.81	-	31.00	1.04
PC07	New	-	1240 X 840	63.55	63.49	0.35	14.35	0.41
PC25	New	-	800	63.20	63.07	-	18.84	0.68
PC04	New	-	800	65.06	64.89	-	31.32	0.54
PC24	New	-	800	63.31	63.13	-	24.96	0.72
PC19	Extend	1500 X 1200	-	62.50	62.45	0.30	71.53	0.07
PC20	Extend	1500 X 1200	-	62.45	62.40	0.30	71.82	0.07
PC21	Extend	1700 X 1300	-	62.20	62.00	0.30	69.36	0.29

1. Approximate invert elevations based on DEM and to be confirmed as part of detailed design.

Hydraulic performance of proposed culverts was analyzed in HY-8. Results of HY-8 analysis and level of compliance with design criteria outlined in **Section 3.1** are shown in **Table 16**. Detailed HY-8 model output for each culvert is included in **APPENDIX E**.

As shown in **Table 16**, all proposed drainage culverts achieve freeboard and HW/D requirements described in **Section 3.1.5** and **Table 11**.

Watercourse culverts all achieve the HW/D requirement as well, however none of the watercourse culverts achieve at least 1.0 m of freeboard. In the case of Culverts EC18 and EC18, the difference in elevation between the channel invert and edge of driving lane is less than 1.4 m. At Culverts EC23 and EC22 under Highway 401, that difference is less than 1.9m. The shallow depth of cover makes it very difficult to achieve the 1.0 m freeboard criteria without significantly oversizing these culverts. Despite not achieving the freeboard criteria, the proposed culverts will provide an improvement compared to existing drainage conditions.

It is important to note that peak flows to these culverts are calculated using the rational method, which is considered a conservative method of estimate peak flows in rural subwatersheds. Further, peak flows accounts for projected climate change impacts and represents flow estimates to the year 2098. The exact channel inverts are estimates based on DEM and should be confirmed at detailed design. Opportunities for raising the roadway profile should also be considered as part of future Highway 401 widening works in order to increase freeboard and improved roadway drainage along this section of Highway 401.

Proposed culvert sizes shown in **Table 15** are the minimum culvert sizes that meet the design criteria outlined in **Section 3.1.6** and **Table 11** (with the exception of the freeboard criteria for watercourse culverts). Upsizing the culverts from the minimum designs in **Table 15** by one size is recommended to allow for future culvert rehabilitation that may eventually be needed long-term.

It is recommended that existing ditches and culverts are surveyed so that performance of existing and proposed culverts can be evaluated more accurately during detailed design. This evaluation should aim to replicate existing flooding conditions, including gathering anecdotal information on seasonal flooding and ponding, operation and maintenance records, and consider impacts of culverts in series, including culverts installed by members of the public under illegitimate recreational trails.

Table 16: Proposed Culvert HY-8 Hydraulic Results

Culvert ID		Design Flow	Total Discharge (m ³ /s)	Headwater (HW) (m)		Outlet Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)	Cover Depth (m)	Freeboard (m)	HW/D	Freeboard Criteria Met ¹	HW/D Criteria Met ²
				Elevation	Depth								
Watercourse Culverts	EC18	Major (25-yr)	2.05	63.31	1.01	0.77	1.54	1.05	0.07	0.26	0.56	No	Yes
	PC17	Major (25-yr)	2.31	62.95	0.89	0.81	1.06	1.09	0.47	0.49	0.33	No	Yes
	PC23	Major (50-yr)	3.23	63.47	1.06	0.94	1.42	1.18	0.68	0.82	0.70	No	Yes
	PC22	Major (50-yr)	3.29	63.31	1.07	0.95	1.44	1.19	0.59	0.72	0.71	No	Yes
Drainage Culverts	EC03	Minor (10-yr)	0.11	65.43	0.31	0.19	1.14	0.47	0.32	0.92	0.34	Yes	N/A
		Major (100-yr)	0.20	65.54	0.42	0.26	1.34	0.56	0.32	0.81	0.46	Yes	N/A
	PC07	Minor (10-yr)	0.31	64.32	0.42	0.30	0.93	0.64	0.28	0.35	0.34	Yes	N/A
		Major (100-yr)	0.55	64.64	0.74	0.41	1.33	0.75	0.28	0.03	0.59	Yes	N/A
	PC25	Minor (10-yr)	0.39	63.75	0.67	0.37	1.69	3.40	0.89	1.14	0.69	Yes	N/A
		Major (100-yr)	0.69	64.05	0.98	0.51	2.06	4.09	0.89	0.84	1.06	Yes	N/A
	PC04	Minor (10-yr)	0.34	65.64	0.58	0.35	1.61	3.25	2.74	2.96	0.73	Yes	N/A
		Major (100-yr)	0.60	65.90	0.84	0.47	1.96	3.91	2.74	2.70	1.05	Yes	N/A
	PC24	Minor (10-yr)	0.42	63.96	0.65	0.39	1.73	3.48	1.35	1.50	0.81	Yes	N/A
		Major (100-yr)	0.74	64.26	0.95	0.52	2.12	4.17	1.35	1.20	1.19	Yes	N/A
	PC19	Minor (10-yr)	0.65	63.41	0.61	0.27	1.62	4.01	0.61	0.91	0.51	Yes	N/A
		Major (100-yr)	1.14	63.64	0.84	0.39	1.95	4.77	0.61	0.67	0.70	Yes	N/A
	PC20	Minor (10-yr)	0.73	63.40	0.65	0.29	1.68	4.16	0.52	0.77	0.54	Yes	N/A
		Major (100-yr)	1.28	63.65	0.90	0.42	2.03	4.94	0.52	0.52	0.75	Yes	N/A
	PC21	Minor (10-yr)	0.69	63.02	0.52	0.26	1.59	4.09	0.89	1.37	0.40	Yes	N/A
		Major (100-yr)	1.21	63.23	0.73	0.37	1.91	4.86	0.89	1.16	0.56	Yes	N/A

¹ Minimum freeboard criteria presented in Table 13 and Section 3.1.4

² Maximum HW/D of 1.5 only applicable for culverts along watercourses per Section 3.1.5

6.2.1 Erosion Protection

The performance of applicable proposed culverts at watercourses during conveyance of the Check Flow for Scour storms was analyzed according to the requirements detailed in **Section 3.1.3**. A summary of the scour analysis results is provided below in **Table 17**.

Table 17: Scour Analysis for 2098 Check Scour Storm (HY-8)

ID	Total Discharge (m ³ /s)	Headwater Elevation (m)	Outlet Velocity (m/s)
EC18 ¹	3.23	63.64	1.87
PC17 ¹	3.36	63.53	1.38
PC23 ²	4.78	64.42	1.77
PC22 ²	4.87	64.09	1.79

¹ 115% of 100-Year Return Period

² 130% of 100-Year Return Period

Using the criteria presented in **Section 3.1.3**, none of the watercourse culverts require outlet erosion protection based on its outlet velocity (<2 m/s). Although drainage culverts have no erosion protection requirements per the MTO HDDS (2008), it is recommended to provide erosion protection in the form of inlet and outlet riprap aprons for drainage culverts with high outlet velocities (>2 m/s).

6.2.2 Fish Passage

Culverts EC18, PC17, PC23 and PC22 are located in direct fish habitat and are therefore subject to fish passage requirements per **Section 3.1.8**. The design flow for these requirements is the result of the 2-Year storm. The results of the hydraulic analysis completed using HY-8 for the proposed fish passage culverts are provided in **Table 18**.

Table 18: HY-8 Results from 2023 2-Year Storm (Fish Passage)

ID	Total Discharge (m ³ /s)	Outlet Depth (m)	Outlet Velocity (m/s)
EC18	1.06	0.56	1.07
PC17	1.11	0.57	0.72
PC23	1.42	0.65	0.91
PC22	1.44	0.65	0.92

At the detailed design stage, calculation of the natural channel velocity downstream of the culverts, establishment of site-specific fish passage design criteria (e.g., velocity < 0.8 m/s, depth > 0.3m), and modelling of substrate depth should be completed to verify if flow passage design requirements are achieved or if further analysis/design is required.

6.3 Proposed Ditches

The proposed interchange will be serviced by ditches, which should be designed according to the criteria detailed in **Section 3.3**. A proposed ditch with longitudinal slope of at least 0.5%, minimum bottom width of 1m, and maximum side slopes of 3:1 would have sufficient capacity to convey the largest estimated peak flow within the project limits (100-year peak flow of 3.29 m³/s at PC22), as shown in **Table 16** within a normal flow depth of 0.8 m. Rock check dams should be incorporated as necessary to achieve enhanced treatment runoff and accounted for in flow-depth calculations. A typical design is included in **Figure 2** below.

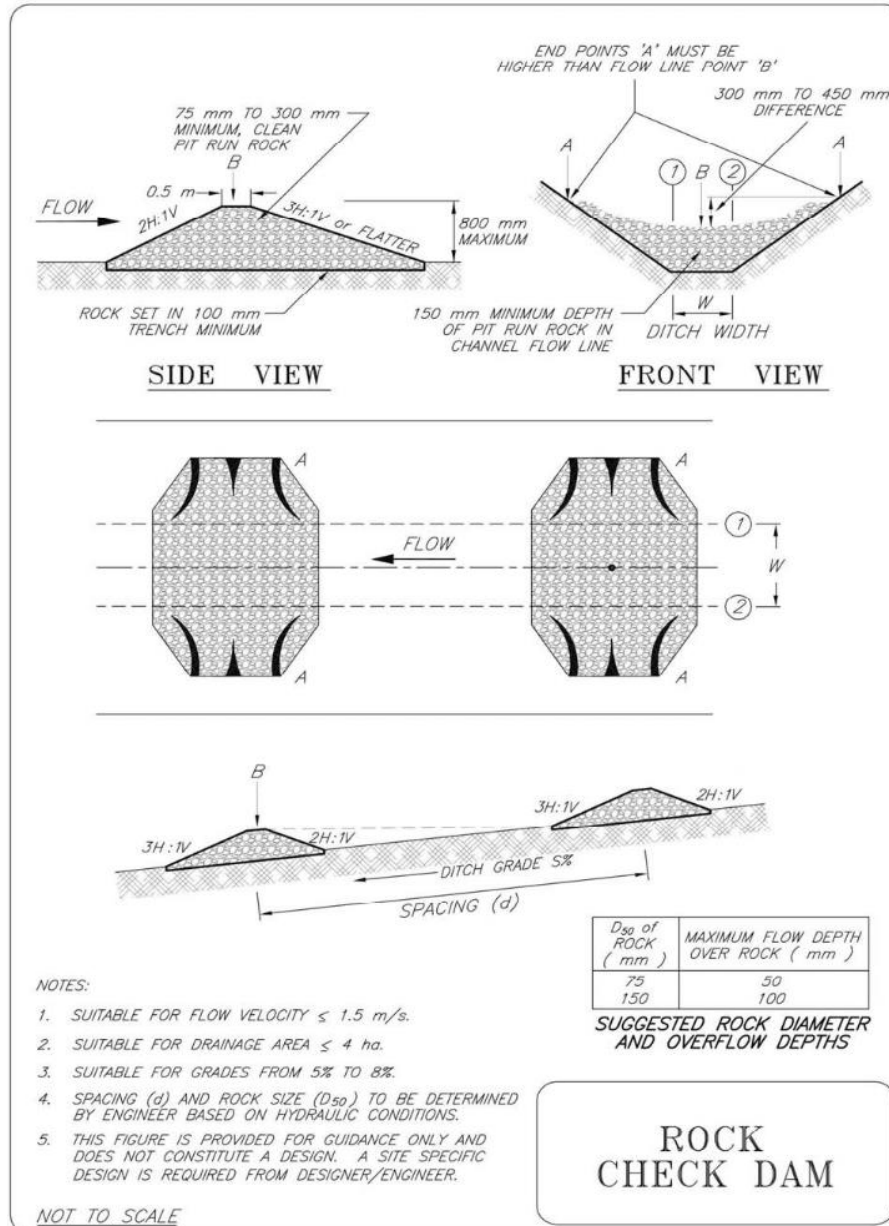


Figure 2: Rock Check Dam Typical Detail -- BMP26 from ESC Guide (MTO, 2015)

7. STORMWATER MANAGEMENT

Stormwater management (SWM) supporting the proposed interchange is required as detailed in **Section 3.2**. Details are provided in the following subsections, as summarized below:

- Methodology used for completion of SWM calculations is presented in **Section 7.1**;
- Modeling results from PCSWMM are presented in **Section 7.2**; and
- Enhanced grass swale design is presented in **Section 7.3**.

7.1 Methodology

The study area was modelled using PCSWMM in both the existing and proposed conditions to estimate the increase in peak flow from pre- to post-development. The study area was divided into five lumped catchments, each representing runoff contributing to one of the five existing stormwater outlets from the project limits. The outlets are summarized below, described in more detail in **Section 5.2**, and shown graphically in **Exhibit 2** and **Exhibit 7** for existing and proposed conditions, respectively:

- Runoff from the southwest quadrant along the Atchison Road and Power Dam Drive is conveyed east through outlet OU-A;
- Runoff from the majority of the project area, including Highway 401, Power Dam Drive Road, and some of the surrounding municipal roads, woodland, and private property in the north, is conveyed southeast through outlet OU-B;
- Runoff from rural subcatchments in the northeast quadrant containing woodland, and private property is conveyed south through outlet OU-C and OU-D respectively;
- A small subcatchment at the southeast quadrant conveys flows from OU-A, OU-C, OU-C and OU-D to the ultimate outlet OU-Ultimate through ditches and unnamed drain.

The slopes, lengths, runoff coefficients, and time of concentrations for the lumped catchments were estimated using the methodology described in **Section 5.1**. SCS Type II storm hyetographs were generated for 2-, 5-, 10-, 25-, and 100-year events using the MTO IDF Curve lookup tool. Per the MTO Drainage Management Manual (1997), a design storm duration of 6 hours was selected as this is greater than twice the largest time of concentration of 1.5 hours (OU-D).

Composite imperviousness of each catchment area was calculated using the look-up values in **Table 19** and the PCSWMM “Spatial Weighting” tool. All the catchment areas have >20% imperviousness and were therefore modeled using the “STANHYD” runoff method. The Horton infiltration method was used to estimate the infiltration for all catchment areas. Maximum and minimum infiltration rates of 76.2 and 13.2 mm/hr and a decay constant of 4.14 hr⁻¹ were used, which are typical for modelling practice in the Ottawa area (City of Ottawa, 2012).

Table 19: Lookup Table for Imperviousness by Land Use

Land Use	Imperviousness (%)
Industrial	50
Woodland	5
Pasture	5
Cultivated	5
Residential	30
Sand and Gravel	95
Landfill	5
Lakes and Wetland	5
Open Space	50
Impervious	100

7.2 Results

Table 20 summarizes the change in imperviousness between pre- and post-development scenarios. **Table 21** presents peak flows between the pre- and post-development scenarios and the required storage volumes to maintain peak flow rates from the existing condition. Detailed PCSWMM output, including figures showing the increase in peak flow for each lumped catchment, are presented in **APPENDIX F**.

Table 20: Change in Imperviousness between Pre- and Post-Development

Outlet	Area (ha)		Imperviousness (ha)		Imperviousness (%)	
	EX	PR	EX	PR	EX	PR
OU-A	0.7	0.5	0.19	0.15	29.0	28.0
OU-B	13.1	15.3	4.26	5.55	32.5	36.3
OU-C	1.0	0.6	0.30	0.22	28.8	36.9
OU-D	1.4	1.7	0.53	0.72	36.6	42.1
OU-Ultimate	2.9	2.4	0.60	1.06	20.7	43.6
Total	19.1	20.6	5.88	7.71	30.7	37.5

Table 21: Stormwater Storage Volume Requirements

Outlet	Max. Total Inflow (m ³ /s)			Storage Volume Required (m ³)		
	2023 EX ¹	2098 EX ¹	2098 PR	Proposed Works ²	Climate Change ³	Combined ⁴
OU-A	0.08	0.09	0.07	N/A ⁵	N/A ⁵	N/A ⁵
OU-B	1.27	1.38	1.73	488	316	804
OU-C	0.13	0.14	0.13	N/A ⁵	N/A ⁵	N/A ⁵
OU-D	0.23	0.25	0.38	162	40	201
OU-Ultimate	0.22	0.24	0.50	320	49	369
Total	1.92	2.10	2.81	969	406	1374

¹ To separate the SWM requirement resulting from proposed interchange works and climate change, release rates were calculated for both 2023 and 2098 IDF scenarios.

² Represents the fraction of the quantity control volume requirement resulting from new impervious surfaces associated with the proposed works.

³ Represents the fraction of the quantity control volume requirement associated with mitigating the impact of climate change on peak flows.

⁴ Represents the total quantity control requirement for the project, considering both new impervious surfaces associated with the proposed works and the increase in peak flows due to climate change.

⁵ Reduction in peak flow due to reduction in drainage area.

As shown, in total, the proposed development results in an increase in imperviousness from 30.7% to 37.5%, which requires 969 m³ of on-site detention to limit runoff to pre-development rates. Considering the effect of climate change on peak flows, a volume of 1,374 m³ is required to attenuate post-development, 2098 peak flows to pre-development, 2023 rates. It is recommended that storage is provided within enhanced grass swales. Further discussion of SWM upstream of each outlet and conceptual enhanced grass swale design is provided in **Section 7.3**.

Enhanced swales are to be designed and constructed in accordance with the Low Impact Development Guidelines (TRCA, 2010) and the MECP SWM Planning and Design Manual (2003).

7.3 Swale Design

Enhanced grass swales along the highway and ramps are proposed to provide enhanced treatment of runoff and quantity control. Enhanced grass swales are vegetated open channels with rock check dams designed to convey, treat, and attenuate (slow down) stormwater runoff. These stormwater BMPs will provide filtration of sediment, evapotranspiration, and infiltration of stormwater for water balance benefits, and reduction of erosion at the outlets.

Quantity control of runoff will be achieved by detaining and drawing down runoff upstream of check dams. Spacing of check dams is based on height of the check dam and slope of the swale. As shown in **Figure 3**, check dams should be spaced such that the toe of each check dam is at the elevation of the downstream check dam's crest, to maximize storage provided by the system. Per guidance from STEP (Sustainable Technologies Evaluation Program), check dam height should be calculated based on the on-site design infiltration rate and are typically allowed up to a height of 0.6 m. Larger check dams will achieve storage requirements with greater spatial efficiency.

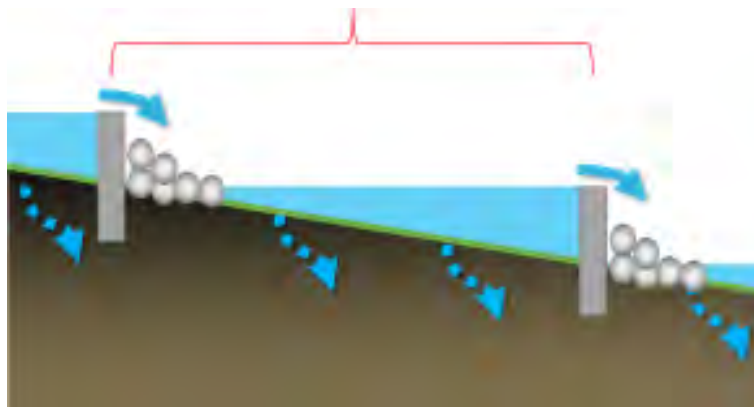


Figure 3: Check Dam Spacing Methodology (STEP 2023)

Assuming a longitudinal slope of 0.5%, bottom width of 1m, side slopes of 3:1, and a check dam height of 0.5m, a single check dam will provide 62.5 m³ of storage over a length of 100 m. Conceptual layout of enhanced grass swales is provided in **Table 22** to demonstrate that sufficient ditch length is available to provide the storage volume requirement.

While storage volume is not required for Catchments OU-A and OU-C (due to a reduction in peak runoff flow), any storage provided within these catchments may offset volume requirements for other catchments, provided that potential impacts to the downstream receiver are mitigated with no additional risk to property or infrastructure.

Table 22: Proposed Enhanced Grass Swales

Outlet	Storage Volume Required (m ³)	Number of Check Dams Required	Required Enhanced Grass Swale Storage		Available Enhanced Grass Swale Storage	
			Length (m)	Volume (m ³)	Length (m)	Volume (m ³)
OU-A	N/A	N/A	N/A	N/A	N/A	N/A
OU-B	804	13	1286	804	3962	2476
OU-C	N/A	N/A	N/A	N/A	N/A	N/A
OU-D	201	3	322	201	141	88
OU-Ultimate	369	6	590	369	836	522
Total	1374	22	2199	1374	4939	3087

8. CONCLUSIONS AND RECOMMENDATIONS

Morrison Hershfield Limited was retained by MTO to complete the Class EA and Preliminary Design for the new interchange of Highway 401 and Power Dam Drive. The study area consists of the provincially owned Highway 401 ROW, the municipal overpass crossing of Power Dam Drive, and surrounding municipal roads of Atchison Rd in the SW quadrant. Stormwater is conveyed from the project limits through a rural ditch and culvert system. In total, there are 15 existing culverts within the limits of the project, of which, three (3) are municipal assets and 12 are owned by MTO. An unnamed, intermittent-flow watercourse flows through the project limits. Indirect and direct fish habitat is present within the project limits.

Through the Class EA process, a diamond interchange was selected as the TPA and a preliminary drainage and SWM design was completed. The proposed works increase the imperviousness of the project area from 30.7% to 37.5% (from 5.9 ha to 7.7 ha impervious area) for total areas of 19.1 ha (existing conditions) and 20.6 ha (proposed conditions) respectively, and include the following impacts to drainage and stormwater management:

- Removal of four (4) culverts no longer required, installation of four (4) new culverts, replacement of (3) culverts, and extension of three (3) culverts;
- SWM required via enhanced grass swales to provide MOECP “Enhanced” (80% TSS Removal) treatment of runoff and “post to pre” quantity control (to maintain pre-development flow rates).
- 1,450 m³ of storage is required to attenuate peak flows to pre-development, 2023 rates, considering both the impact of new impervious areas and climate change on peak flows. It is feasible to provide this quantity control volume in approximately 2.5 km of enhanced grass swales upstream of check dams.

It is recommended that due consideration be given to the following during subsequent phases of the project:

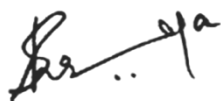
- Design of proposed culverts should appropriately consider fish passage and erosion protection requirements;
- Proposed culvert sizing should consider upsizing for future culvert rehabilitation long-term particularly for those culverts crossing Highway 401;
- A survey of existing culverts should be completed as part of detailed design to allow for hydraulic analysis of existing culverts and evaluation of impact of the proposed design;
- Culverts PC19, PC20, PC21, PC22, and PC23 should be replaced / extended as part of the future widening planned for this section of Highway 401 such that they can accommodate the ultimate configuration of the Power Dam Drive interchange, including all ramps.

9. CLOSURE

We trust that this report is sufficient for your current requirements. Please contact the undersigned with any questions or clarifications.

Sincerely,

Morrison Hershfield Limited



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Water Resources Designer



Karine Bertrand, P.Eng.
Senior Water Resources Engineer



Karyn Cornfield, M.Sc., P.Eng.
Drainage and Hydrology Lead

10. REFERENCES

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MTO (April 2014). Gravity Pipe Design Guidelines.

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LEGEND

- Existing Culvert
- CB Structure
- Existing Catchbasin Lead
- StudyLimit
- South Raisin River
- South Raisin River Tributary

NOTE:
The location of existing culverts were estimated based on data/information available on google map and previous Sample Assignment. They need to be confirmed.



Coordinate System: NAD 1983 UTM Zone 18N
Sources: MNR



SCALE: 1:4,736.76
Meters 0 50 100 200 300

TITLE: **Existing Culvert**

PROJECT NO.: 201979404
Highway 401 / Power Dam Drive Interchange

DATE: February 2024 **Exhibit 1**



LEGEND



Study Limit



Existing Subcatchment

Land Use



Cultivated



Grassed



Impervious



Industrial



Lake/ Wetland



Residential



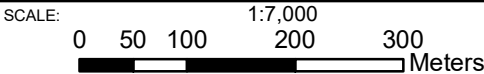
Woodland



Coordinate System: NAD 1983 CSRS UTM Zone 18N
Sources: MNR, MTO, OFAT, RRCA



MORRISON HERSHFIELD

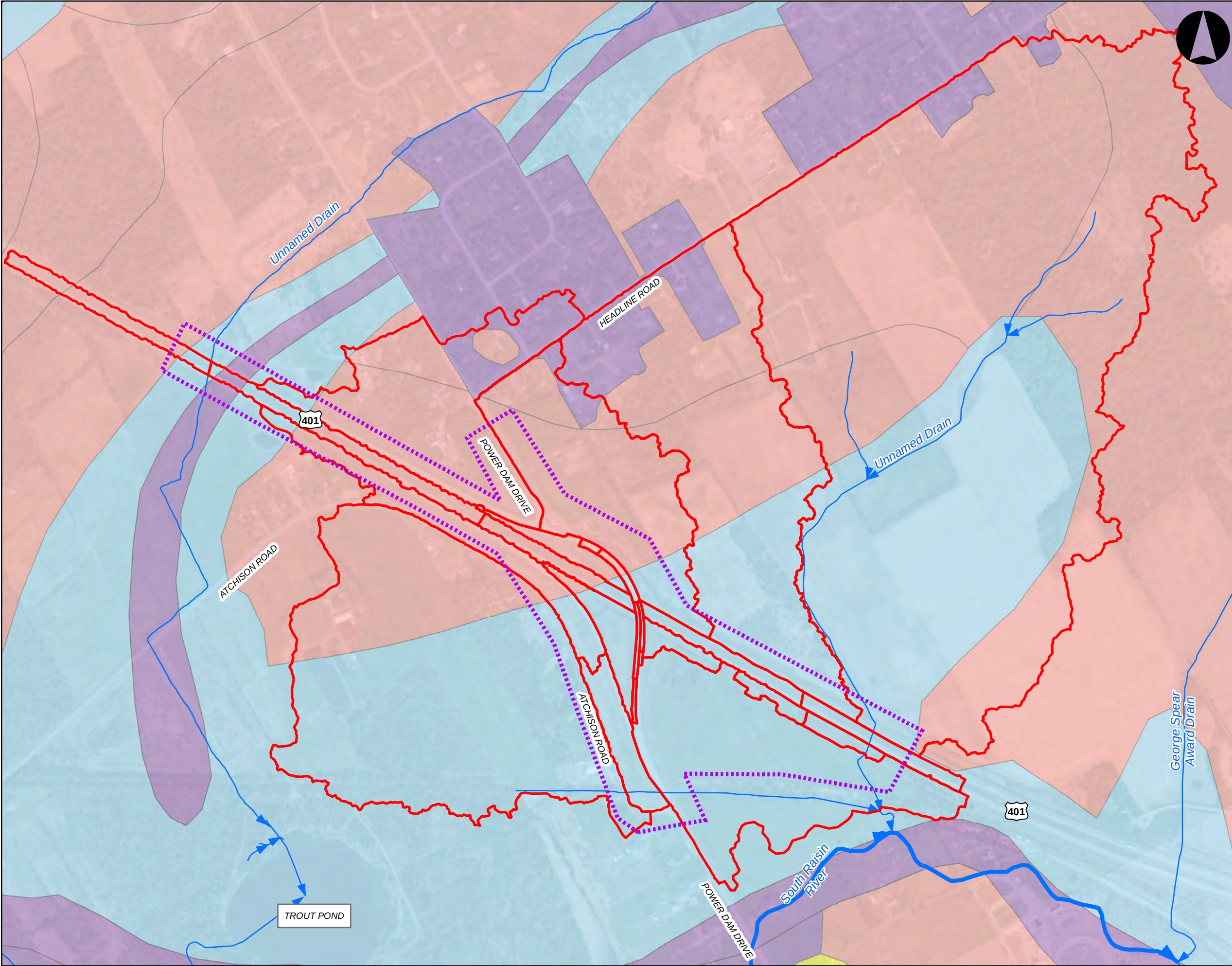


TITLE:
**Existing Conditions
Land Use**

PROJECT NO.: 201979400
Highway 401 / Power Dam Drive Interchange

DATE: **November 2023**

Exhibit 3



LEGEND

- StudyLimit
- Existing Subcatchment
- South Raisin River
- South Raisin River Tributary

Soil Texture

- Unknown
- Clay (CL)
- Gravelly Sand Loam (GSL)
- Loam (L)



Coordinate System: NAD 1983 UTM Zone 18N
Sources: MNR, OMFARA

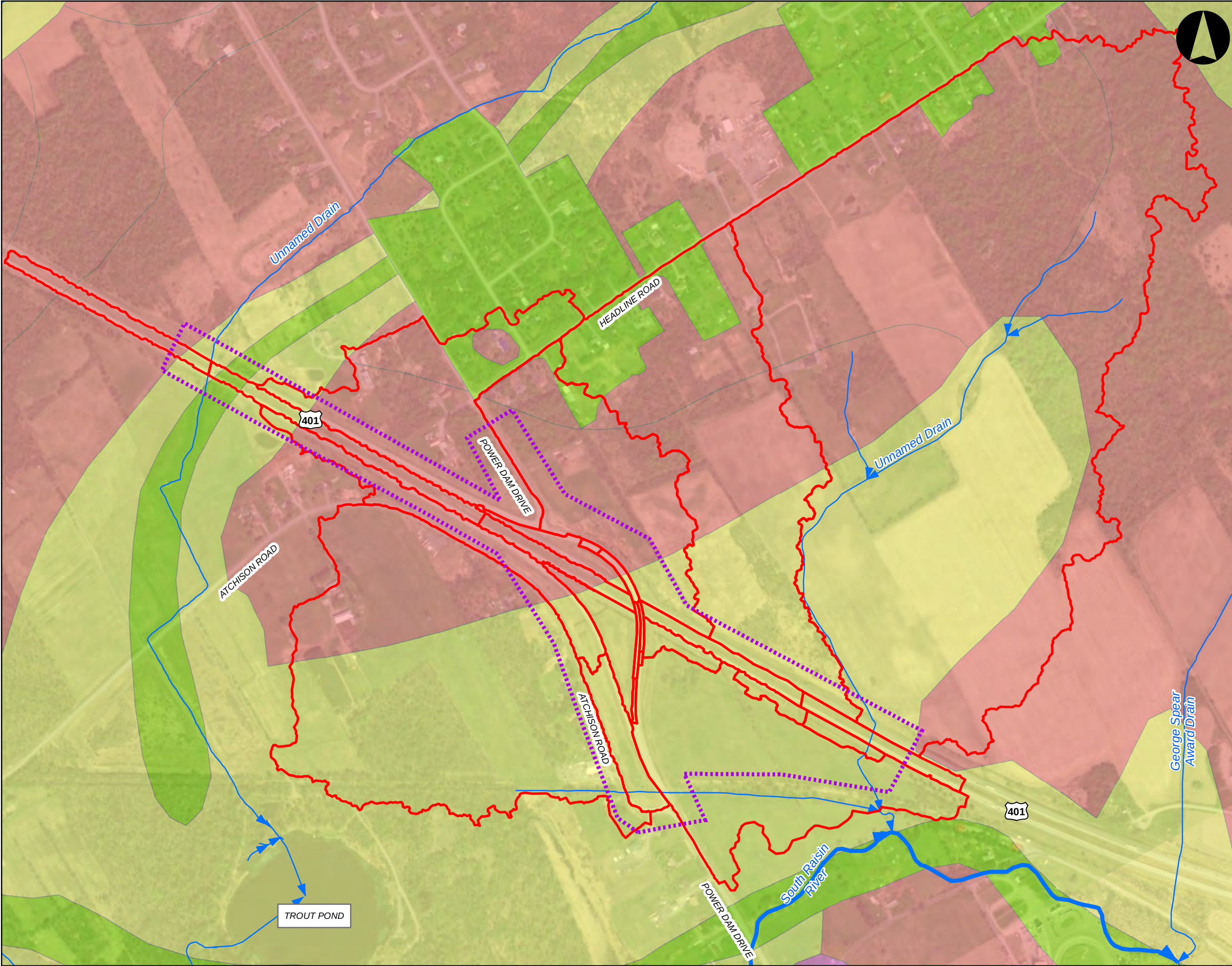


SCALE: 1:7,000
Meters 0 50 100 200 300

TITLE: **Soil Texture**

PROJECT NO.: 201979404
Highway 401 / Power Dam Drive Interchange

DATE: **November 2023** **Exhibit 4**



LEGEND

- StudyLimit
- Existing Subcatchment
- South Raisin River
- South Raisin River Tributary

Hydrological Soil Group

- Unidentified
- A
- B
- C
- D



Coordinate System: NAD 1983 UTM Zone 18N
Sources: MNR



SCALE: 1:7,000
Meters 0 50 100 200 300

TITLE: **Hydrological Soil Group**

PROJECT NO.: 201979404
Highway 401 / Power Dam Drive Interchange

DATE: **November 2023** **Exhibit 5**



Scale: 1:5,000

TROUT POND

POWER DAM DRIVE

ATCHISON ROAD

POWER DAM DRIVE

HEADLINE ROAD

ATCHISON ROAD

Unnamed Drain

Unnamed Drain

South Raisin River

George Spear Award Drain

LEGEND

- StudyLimit
- Proposed Roads
- South Raisin River
- South Raisin River Tributary
- South Raisin River Floodplain (RRCA)

1:500,000

Coordinate System: NAD 1983 UTM Zone 18N
Sources: MNR, MTO, OFAT, RRCA

MORRISON HERSHFIELD

SCALE: 1:7,000

Meters

TITLE:

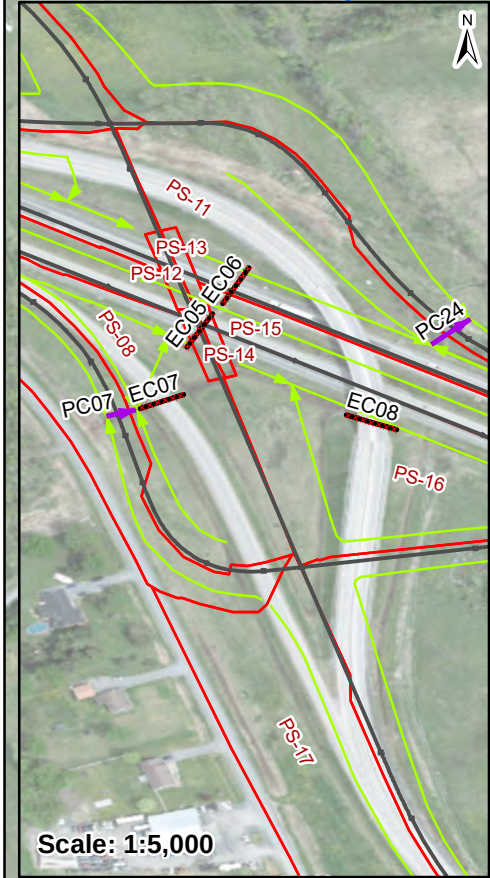
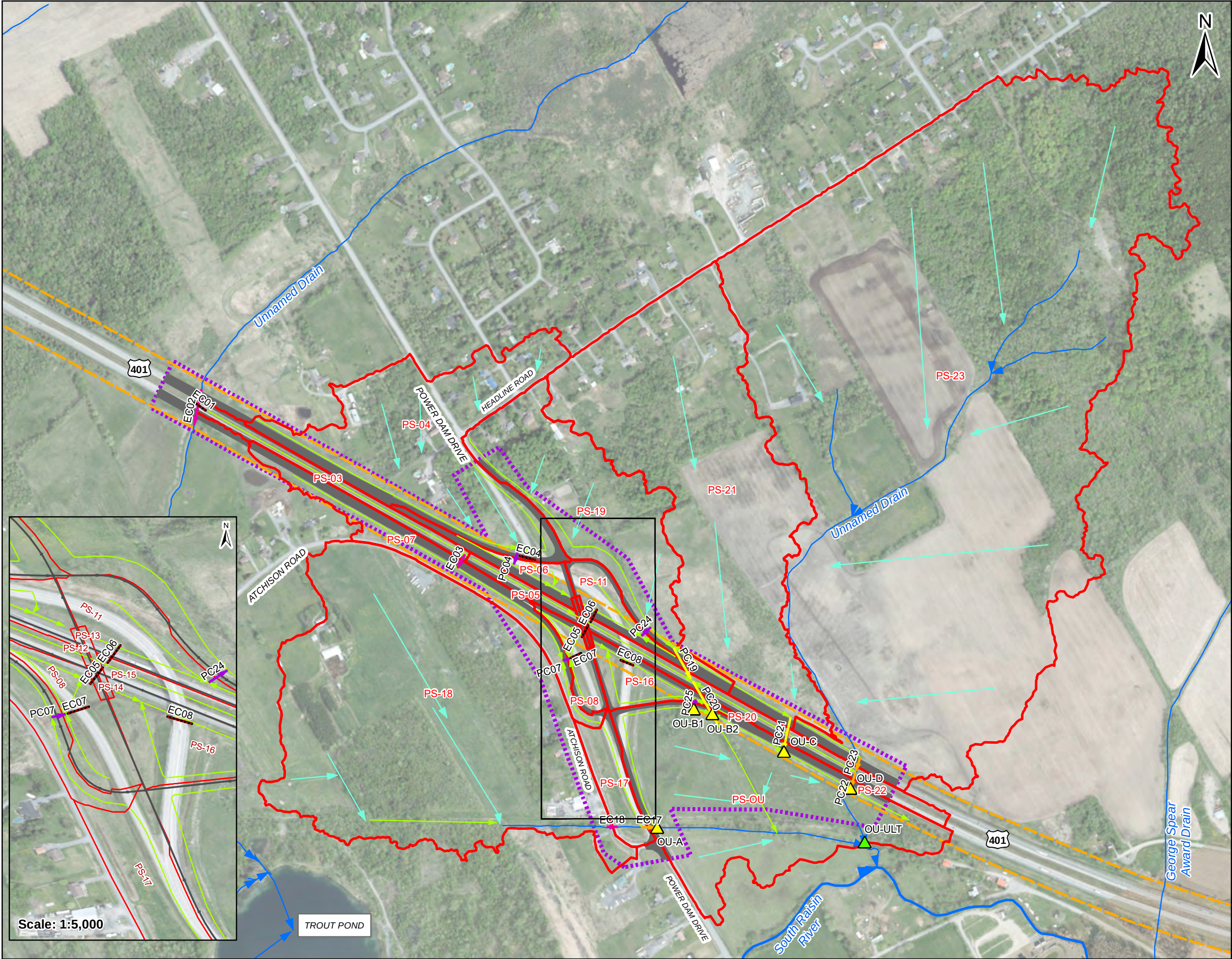
**Proposed Conditions
Technically Preferred Alternative**

PROJECT NO.: 201979404

Highway 401 / Power Dam Drive Interchange

DATE: **February 2024**

Exhibit 6



LEGEND

Outlet

- Individual
- Ultimate

Proposed Culverts

- Extend
- New
- Remain
- Remove
- Replace

Sheet flow

Proposed Ditch

Proposed Roads

MTO Right of Way

South Raisin River

South Raisin River Tributary

Proposed Subcatchments

StudyLimit

1:500,000

Coordinate System: NAD 1983 UTM Zone 18N
Sources: MNR, MTO, OFAT, RRCA

SCALE: 1:7,000

TITLE:

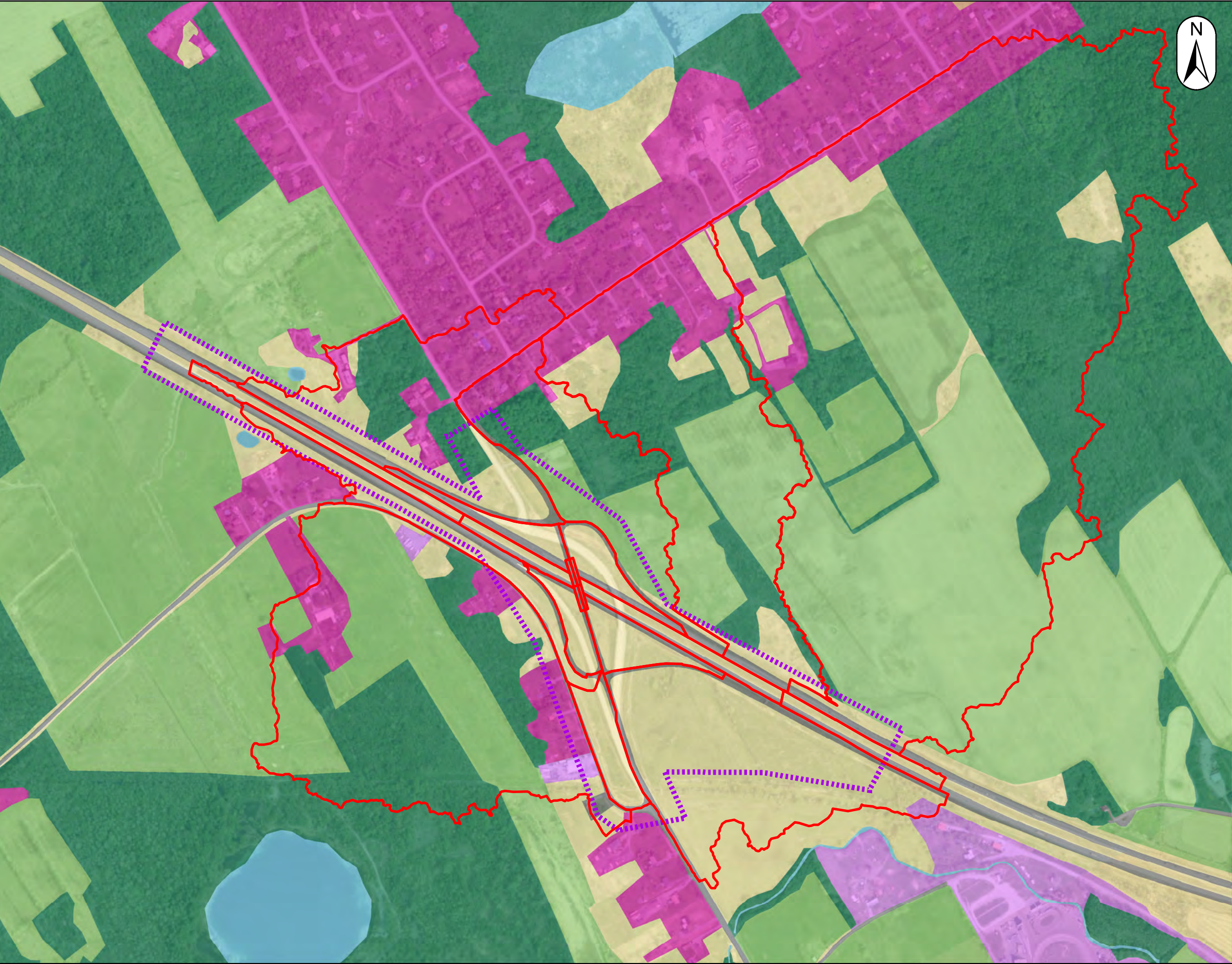
**Proposed Conditions
Drainage Mosaic**

PROJECT NO.: 201979404

Highway 401 / Power Dam Drive Interchange

DATE: February 2024

Exhibit 7



LEGEND

Study Limit

Proposed Subcatchments

Land Use

Cultivated

Grassed

Impervious

Industrial

Lake/ Wetland

Open Space

Residential

Woodland



Coordinate System: NAD 1983 CSRS UTM Zone 18N
Sources: MNR, MTO, OFAT, RRCA

MORRISON HERSHFIELD

SCALE: 1:7,000
0 50 100 200 300 Meters

TITLE:
**Proposed Conditions
Land Use**

PROJECT NO.: 201979400
Highway 401 / Power Dam Drive Interchange

DATE: February 2024

Exhibit 8

APPENDIX A: Design Alternatives Decision Matrix

GWP 4092-23-00 Highway 401 and Power Dam Drive Interchange
Short List Evaluation Matrix

135 PoorGood ✖ Disadvantage✔ Advantage			Do Nothing		Alternative 3		Alternative 5		Alternative 6		Alternative 8	
Category	Sub-Category	Criteria		Score		Score		Score		Score		Score
Alternative Schematic												
Alternative Description			NO DESIGN ALTERNATIVE, THE REPLACEMENT STRUCTURE WOULD BE IN THE SAME LOCATION WITH THE SAME RAMP CONNECTIONS		BRIDGE WEST OF EXISTING, SKEW ANGLE 35°, PARCLO AB		STRAIGHT BRIDGE SLIGHTLY EAST OF EXISTING, SKEW ANGLE 60°, PARCLO B2 NORTH OF BRIDGE, DIAMOND SOUTH OF BRIDGE		BRIDGE WEST OF EXISTING, SKEW ANGLE 60°, PARCLO B2		BRIDGE WEST OF EXISTING, SKEW ANGLE 41°, SINGLE DIAMOND INTERCHANGE	
TRANSPORTATION (50%)	Interchange Operations (60%)	LOS / Total Delay (60%)	North Intersection (AM/PM): 4.9 / 5.8, A / A South Intersection (AM/PM): 0.2 / 0.2, A / A	5	North Intersection (AM/PM): 4.5 / 4.6, A / A South Intersection (AM/PM): 2.8 / 3.6, A / A	5	North Intersection (AM/PM): 4.5 / 4.6, A / A South Intersection (AM/PM): 2.8 / 3.6, A / A	5	North Intersection (AM/PM): 4.4 / 4.3, A / A South Intersection (AM/PM): 2.3 / 3.2, A / A	5	North Intersection (AM/PM): 6.9 / 7.2, A / A South Intersection (AM/PM): 2.6 / 3.4, A / A	5
		Municipal Road Impacts (30%)	✖ No Impact, That is no improvement to current alignment, or new access to Highway 401	1	- Realignment of Power Dam Drive on both sides of Highway 401 to eliminate the jog. - Design Speed exceeds existing 80km/hr.	5	- Realignment of Power Dam Drive on both sides of Highway 401 to eliminate the jog. - Design Speed is consistent at 70 km/hr.	2	- Realignment of Power Dam Drive on both sides of Highway 401 to eliminate the jog. - Design Speed exceed 80km/hr.	5	- Realignment of Power Dam Drive on both sides of Highway 401 to eliminate the jog. - Design Speed exceeds 80km/hr.	4
		Accommodation Active Transportation (10%)	✖ No AT provided	1	✔ AT can be accommodated on the west side of Power Dam Drive. ✖ 2 high risk potential conflict areas ✖ 1 moderate risk potential conflict area	3	✔ AT can be accommodated on either side of Power Dam Drive. ✖ 1 moderate risk potential conflict area	4	✔ AT can be accommodated on either side of Power Dam Drive. ✖ 1 Moderate risk potential conflict areas	4	✔ AT can be accommodated on either side of Power Dam Drive. ✖ 2 Moderate risk potential conflict areas	4
	Interchange Geomeotry (40%)	Ramp Geometry (30%)	- 1 controlled intersections - 1 right turn (may be upgraded to free flow) (N-W) - W-N movement is not accommodated	1	- Parclo interchange is a common configuration found on MTO highways - 2 controlled intersections (off / On ramps) - 4 right turn (may be upgraded to free flow) (S-E, S-W, W-N, E-N) - 4 left turn movements (N-E, W-N, E-N, S-W)	4	- 2 controlled intersections (off / on ramps) - 4 right turns (may be upgraded to free flow) (S-E, N-W, E-S, W-S) - 4 left turn movements (N-E, W-N, E-N, S-W) - "button hook" ramp configuration on north side with exit parallel to the highway is atypical ✖ Does not meet sightline requirements for vehicles that have exited 401 westbound are need to turn left onto Power Dam drive	1	- 2 controlled intersections (off / on ramps) - 4 right turns (may be upgraded to free flow) (S-E, N-W, E-S, W-N) - 4 left turn movements (N-E, W-N, E-N, W-S) - "button hook" ramp configuration on north side with exit parallel to the highway is atypical ✖ Does not meet sightline requirements for vehicles that have exited 401 westbound are need to turn left onto Power Dam drive	1	- Diamond interchange is a common configuration found on MTO highways - 2 controlled intersections (off / on ramps) - 4 right turns (may be upgraded to free flow) (S-E, N-W, E-N, W-S) - 4 left turn movements (N-E, W-N, E-S, S-W)	4
		Structure Layout (40%)	✖ Curvilinear alignment presents challenges for construction and maintenance of future structure. Construction of new bridge on existing alignment involves more complicated staging and/or closure of Power Dam Drive	1	✔ Straight Structure, simpler for design and construction - New structure length approximately 124m, adding complexity with structure material selection and span lengths. - 35 degrees skewe	2	✔ Straight Structure. - New structure length approximately 68m - 60 degrees skewe	4	✔ Curvilinear alignment. Structure may be constructed as a straight structure. - New structure length approximately 76m - 60 degrees skewe	4	✔ Straight Structure. - New structure length approximately 97m, adding complexity to structure and foundation design - 41 degrees skewe	3
		Conflicts with vehicles and active transportation due to Turning and Weaving (20%)	No change from today. Existing north intersection is within a curvilinear section of Power Dam Drive and the WB on-ramp which creates speed differential issues.	1	All turning movements are accommodated through the interchange ramps/intersections and good sightlines for active transportation crossings	5	Poor sightlines for WB traffic exiting Highway 401 at the Power Dam Drive intersection to view oncoming traffic and cyclists/pedestrians.	1	Poor sightlines for WB traffic exiting Highway 401 at the Power Dam Drive intersection to view oncoming traffic and cyclists/pedestrians..	1	All turning movements are accommodated through the interchange ramps/intersections, and good sightlines for active transportation crossings.	5
		Future Interchange Needs (10%)	No additional ramp connections from the existing configuration	1	Full interchange can be constructed. Significant change in geometry of existing ramps should they be the only ones reinstated, with full interchange constructible at a later date.	3	Similar geometry to existing ramps to and from the west. Ramps connecting to and from the east can be constructed at a later date	4	Similar geometry to existing north ramp terminal, with changes to south terminal. Ramps connecting to and from the east can be constructed at a later date	3	Similar geometry to existing ramps to and from the west. Ramps connecting to and from the east can be constructed at a later date	4
	Transportation Weighted Sum		1.22		2.10		1.70		1.95		2.14	

GWP 4092-23-00 Highway 401 and Power Dam Drive Interchange
Short List Evaluation Matrix

1 3 5 PoorGood ✖ Disadvantage✔ Advantage			Do Nothing		Alternative 3		Alternative 5		Alternative 6		Alternative 8	
Category	Sub-Category	Criteria		Score		Score		Score		Score		Score
ENVIRONMENTAL (30%)	Natural Environment (40%)	Fisheries Impacts (30%)	✔ No potential impacts	5	One area of interaction with direct fish habitat at Culvert C17- likely minimal impacts so long as culvert modifications due to road width/alignment are not required. Existing culvert C22 &23 not required with new EB off ramp on the east side of realigned Power Dam Drive. Second location includes culvert C22/23 where direct fish habitat was identified - culvert extension likely required due to widening for new EB on-ramp.	4	Two interactions with direct fish habitat (refer to previous note for C17 under alternative 3) including: likely minimal impacts so long as culvert modifications due to road width/alignment are not required. Second location includes culvert C22/23 where direct fish habitat was identified - culvert extension likely required due to widening for new EB on-ramp.	3	Same fish habitat interactions as Alternative 5 including: Two interactions with direct fish habitat (refer to previous note for C17 under alternative 3) including: likely minimal impacts so long as culvert modifications due to road width/alignment are not required. Second location includes culvert C22/23 where direct fish habitat was identified - culvert extension likely required due to widening for new EB on-ramp.	3	Same fish habitat interactions as Alternative 5 & 6 including: Two interactions with direct fish habitat (refer to previous note for C17 under alternative 3) including: likely minimal impacts so long as culvert modifications due to road width/alignment are not required. Second location includes culvert C22/23 where direct fish habitat was identified - culvert extension likely required due to widening for new EB on-ramp.	3
		Impacts to Wildlife and Wildlife Habitat (30%)	✔ No potential impacts	5	✔ No impact to forested area in the northwest quadrant along Power Dam Drive (potential Species at Risk bat habitat) - moderate impact to Species at Risk bird habitat (Eastern Meadowlark) in the southeast quadrant.	3	- Low impact to forested area in the northwest quadrant along Power Dam Drive which may be Species at Risk bat habitat. - moderate impact to Species at Risk bird habitat (Eastern Meadowlark) in the southeast quadrant.	2	- Low impact to forested area in the northwest quadrant along Power Dam Drive which may be Species at Risk bat habitat. - moderate impact to Species at Risk bird habitat (Eastern Meadowlark) in the southeast quadrant.	2	- Low impact to forested area in the northwest quadrant along Power Dam Drive which may be Species at Risk bat habitat. - low impact to Species at Risk bird habitat (Eastern Meadowlark) in the southeast quadrant.	3
		Water Resources / Drainage Impacts (40%)	✔ No increase in imperviousness ✖ No improvement to existing drainage issues (filled in ditches, damaged culverts) causing deterioration of road surface on Hwy 401. ✖ Existing culverts under Power dam Drive Overpass, Hwy 401 EB offramp to S-Power Dam Drive and at Power Dam Drive and the 401WB Onramp are in poor condition requiring replacement in the short to medium term. - No impacts to the floodplain.	2	✔ Low increase in imperviousness ✖ Relocation of at least one cross-culvert under Hwy 401 is likely required ✖ Poor opportunity to improve existing pavement drainage issues by reinstating and/or widening ditches on south side of the highway ✖ A new structural culvert may be required where drainage combines under the proposed EB on-ramp. - Existing cross-culverts will need to be extended or replaced. - No impacts to the floodplain.	2	✔ Good opportunity to improve existing pavement drainage issues by reinstating and/or widening ditches on south side of the highway ✖ High increase in imperviousness ✖ A new structural culvert may be required where drainage combines under the proposed EB on-ramp. - Existing cross-culverts will need to be extended or replaced. - No impacts to the floodplain.	3	✖ Poor opportunity to improve existing pavement drainage issues by reinstating and/or widening ditches on south side of the highway. ✖ A new structural culvert may be required where drainage combines under the proposed EB on-ramp. - Moderate increase in imperviousness - Existing cross-culverts will need to be extended or replaced. - No impacts to the floodplain.	3	✔ Good opportunity to improve existing pavement drainage issues by reinstating and/or widening ditches on south side of the highway ✖ Relocation of at least one cross-culvert under Hwy 401 is anticipated ✖ A new structural culvert may be required where drainage combines under the proposed EB on-ramp. - Moderate increase in imperviousness - Existing cross-culverts will need to be extended or replaced. - No impacts to the floodplain.	3
	Social / Economic / Cultural Environment (60%)	Permanent Property Impacts (80%)	✔ No impacts	5	Total additional property required: ~2.87 ha. Access to lands north and south of Highway are maintained however this alternative has the largest property impact	1	Total additional property required: ~2.43 ha - New entrance will be required for property north of highway on Power Dam Drive	2	Total additional property required: ~1.88 ha - New entrance will be required for property north of highway on Power Dam Drive	3	Total additional property required: ~0.55 ha - New entrance will be required for property north of highway on Power Dam Drive	4
		Impacts to Agriculture Lands and Operations (10%)	✔ No potential impacts	5	✖ High impact (removal) to existing agricultural lands and disruption to on-going farm operations within the northeast and southeast quadrants.	1	✖ High impact (removal) to existing agricultural lands and disruption to on-going farm operations within the northeast and southeast quadrants.	1	✖ High impact (removal) to existing agricultural lands and disruption to on-going farm operations within the northeast and southeast quadrants.	1	- Moderate impact (removal) to existing agricultural lands and disruption to on-going farm operations within the northeast and southeast quadrants.	3
		Impacts to Archaeological Resources (10%)	✔ No potential impacts	5	✖ Archaeological potential within two quadrants, will require Stage 2 AA. Largest area of potentially undisturbed lands impacted.	2	✖ Archaeological potential within two quadrants, will require Stage 2 AA. Large area of potentially undisturbed lands impacted.	2	✖ Archaeological potential within two quadrants, will require Stage 2 AA. Moderate amount of potentially undisturbed lands impacted.	3	✖ Archaeological potential within two quadrants, will require Stage 2 AA. Smallest area of potentially undisturbed lands impacted.	4
	Environmental Weighted Sum		1.36		0.55		0.67		0.83		1.06	
COST & CONSTRUCTABILITY (20%)	Cost (70%)	Construction Costs, including interchange and local road impacts (100%)	Cost is lowest as it is only to replace the structure Parametric cost Estimate \$15M	5	-Power Dam Dr. Realignment total length of 800 m - 4 ramps; total length of 1425m - 4 SCL Hwy. 401 speed change lanes; total length of 2,000m - Intersection at Atchison Road reconstruction - Structure length 124 m Parametric Cost Estimate \$30M	2	-Power Dam Dr. Realignment total length of 900 m - 4 ramps; total length of 1100m - 4 SCL Hwy. 401 speed change lanes; total length of 2,000m - Atchison Road intersection reconstruction -Structure length 68m Parametric Estimate \$23M	3	-Power Dam Dr. Realignment total length of 900 m - 4 ramps; total length of 925m - 4 SCL Hwy. 401 speed change lanes; total length of 2,000m - Atchison Road intersection reconstruction - Structure length 76 m Parametric Estimate \$24M	4	-Power Dam Dr. Realignment total length of 900 m - 4 ramps; total length of 1000m - 4 SCL Hwy. 401 speed change lanes; total length of 2,000m - no impacts to Atchison Road intersection - Structure length 97m Parametric Estimate \$26M	2
	Constructability (30%)	Potential Utility Conflicts (60%)	✔ No Conflict	5	Impacts to Hydro line north and south of the highway with new ramp terminals. Up to 4 existing poles impacted Gas crossing under the realigned Power Dam Drive, W-N/S and N/S-E ramps Impact to buried Bell Cable south of the structure	3	Larger impact to Hydro line north of the highway with 2 poles requiring relocation Gas crossing under and W-N/S, N/S-E ramps and Power Dam drive (on existing alignment) No Impact to buried Bell Cable south of the structure	3	Larger impact to Hydro line north of the structure. Up to 4 existing poles impacted Gas crossing under the realigned Power Dam Drive, E-N/S and N/S-E ramps Impact to buried Bell Cable south of the structure	3	2-3 hydro poles impacted north of the highway Gas crossing under the realigned Power Dam Drive, E-N/S and N/S-E ramps Impact to buried Bell Cable south of the structure	3
		Construction Impacts (40%)	Replacing the bridge on the existing alignment results in closure of the crossing and ramps during construction. Ramps are able to remain open.	5	WB on ramp and Power Dam Drive south of the 401would likely see intermittent long term closures to facilitate construction. No impacts to Headline road and moderate impacts to Atchison Rd intersection for paving tie ins	1	New bridge location would result in largest realignment of Power Dam Drive but also shortest structure. Bridge, ramps and sideroads would be closed	3	Ramp construction will result in intermittent long term closure along Power Dam Drive. Existing bridge can remain in service where required during construction. Short term impacts to Atchison Raod durng reconstruction of intersection.	4	Lease impact to existing roads and structure, however longer structure. Atchicons Road intersection not imapcted.	2
	Cost & Constructability Weighted Sum		1.00		0.41		0.60		0.76		0.44	
TOTAL SCORE (OUT OF 5)			3.58		3.06		2.97		3.54		3.64	

GWP 4092-23-00 Highway 401 and Power Dam Drive Interchange
Short List Evaluation Matrix

1 3 5 Poor Good ✖ Disadvantage ✔ Advantage			Do Nothing	Score	Alternative 3	Score	Alternative 5	Score	Alternative 6	Score	Alternative 8	Score
Category	Sub-Category	Criteria										
ALTERNATIVE RANK			2		4		5		3		1	

APPENDIX B: Field Investigation and Interim Measures Memo

MEMORANDUM



TO: Brad Hewton, P.Eng.

FROM: Justin Philippi, P. Eng.

PROJECT No.: 21979404

RE: Existing Drainage Assessment, Hwy 401 and
Power Dam Drive Interchange

DATE: 2/8/2022

REVISED 4/26/2022

X:\PROJ\2020\201979404-MTO-HIGHWAY 401 POWER DAM DRIVE\08. WORKING\DRAINAGE\06. DELIVERABLES\01. FIELD INVESTIGATION MEMO\03 - MTO COMMENTS ON FIELD INVESTIGATION MEMO AND INTERIM MEASURES\201979404 - DRAINAGE MEMO INTERIM MEASURES.DOCX

On November 3, 2021, Frank Hendriksen and I completed a field investigation at this project site to inspect the drainage elements for detailed design and to attempt to identify any immediate causes of poor drainage of the roadway (Hwy 401), that has caused lower pavement performance and frequent repairs. A copy of these photos are included in the attached appendix.

Our site visit occurred four days after the last significant rainfall event.

When walking the site became clear that there appear to be a sufficient number of drainage structures to convey runoff but most of them are not functioning as designed. This appears to be the leading cause of the poor drainage performance. Standing water was encountered across the project site. Most culverts and ditches had standing water on both the upstream and downstream sides. Many of the ditches across the project site have very little relief and most appear to be filled with silt / sediment that further impedes drainage. We observed that an informal ATV or other recreational off-road vehicle trail (will refer to ATV for simplicity) had been established along the east side of Power Dam Drive from the intersection with Atchison Road to Hwy 401, and eastward along Hwy 401 to an unknown location beyond the project limits. This trail has significantly undermined the drainage structures in this area. Ditches have been rutted and filled with sediment, leading to ponding and flow obstructions throughout this side of the project area.

With the exception of the cross-highway box culverts (two sets of two culverts on a skew angle crossing Hwy 401 from North to South on either side of Power Dam Drive) which are in good to very good condition, the other culverts conveying drainage across the project site are in poor to very poor condition. Many are heavily corroded, most have deformed inlets and outlets, none have headwalls or outlet treatments such as riprap to maintain flow, and several were partially filled with sediment, limiting their conveyance capacity. This includes culverts:

- CV-0401-011161
- CV-0401-011163
- CV-0401-011165
- CV-0401-000463
- CV-0401-000464
- CV-0401-000617
- CV-0401-000618
- CV-0401-011167

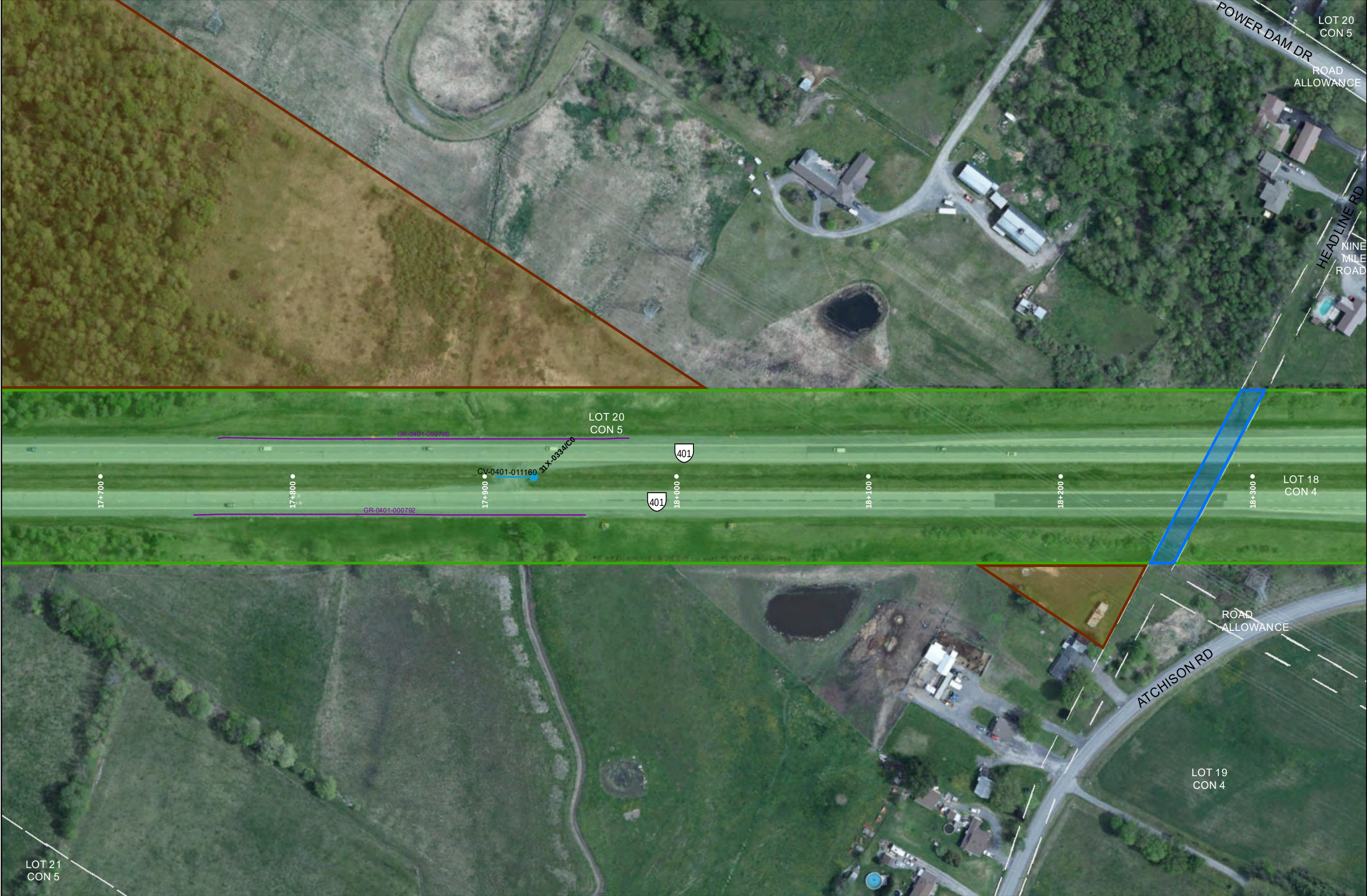
The bridge deck appears to have a sufficient number of catch basin inlets, however, most of the outlet leads could not be located. They appear to have been buried in the embankment over time. Where existing leads were located, they were found to be in a failed condition; often little more than pieces of heavily rusted metal that disintegrated when uncovered.

The receiving ditch could only be inspected at Hwy 401. This ditch appears to be overgrown; and the conveyance capacity from this point to the confluence with the South Raisin River could not be inspected. The drainage path from this site follows approximately 270 m south-east in a ditch to its confluence with another watercourse (Unnamed Drain) that flows eastward approximately 250 m to the South Raisin River. The flow path and any obstructions along this watercourse could not be inspected. From aerial photography, it appears that the ponding issues extend along the approximately 500 m watercourse to the confluence with the South Raisin River. This ditch is shown in Figures 28, 38, 39, 41 and 42 in the attached appendix, and marked in the maps below.

We understand there are existing maintenance contracts currently underway in this project area. Some of the recommendations indicated below have been proposed under these other contracts; however at the time of the site visit, they had not yet been undertaken. The primary recommendations for the interim improvement of the drainage in this area are:

- Clean out, regrade and stabilize the ditches along this area. This includes the ditch approximately 180 m east of Power Dam Drive which receives flows from this entire area and drains to the South Raisin River. The drain has become heavily overgrown. The conveyance capacity cannot be determined in the current condition but appears to be impeded. This is indicated in red on Figure 2.
- Eliminate ATV traffic through this area
- Clean out the following culverts
 - o under Power Dam Drive on the South side of Hwy 401 (CV—0401-000464)
 - o Under the exit ramp from EB 401 to SB Power Dam Drive (CV-0401-000463) (this culvert is proposed to be replaced by open cut under another contract)
 - o Clean out and daylight CB leads from the CBs on the bridge deck and embankment of Power Dam Drive (all of these CBs and leads are recommended for cleanout under another contract):
 - CV-0401-01167
 - CV0401-000618
 - CV-0401-000617
 - CV-0401-011165
 - CV-0401-011164
 - CV-0401-011163

While these measures may not solve all the drainage issues in this area, they should permit the existing structures to function more efficiently and convey stormwater to the outlet more effectively, while a long-term solution is designed. In particular, the maintenance of the downstream drain conveying flows from the south side of Hwy 401 to the South Raisin River will offer long term improvement for current and future interchange designs.



Drainage Inventory

- Catch Basin
- Ditch Inlet
- Manhole

- Culvert
- Sewer
- Outlet

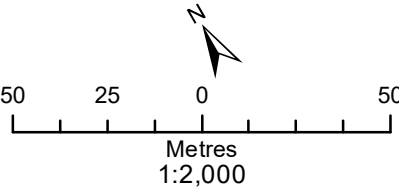
Guideway Inventory

Structural Inventory

- Bridge
- Structural Culvert
- Sign Structure
- Retaining Wall
- Ferry Dock

Title Records

- Road Closing
- Controlled Access Highway
- Designated, Not Owned
- King's Highway
- Owned, Not Designated
- Limited Interest
- Geographic Townships
- Lots & Concessions

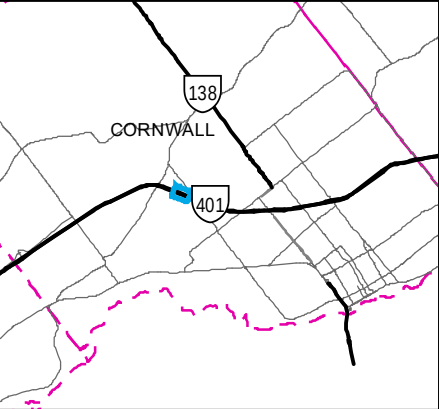


Produced by: East Region Geomatics Section

Sources: MTO, LIO

Projection: Lmabert Conformal Conic
Datum: North American Datum 1983
Date: August 14, 2021

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Transportation (MTO) shall not be liable in any way for the use of, or reliance upon, this map or any information on this map





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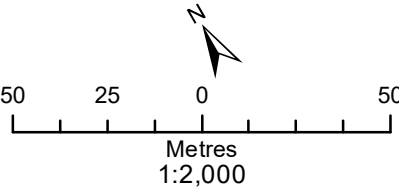
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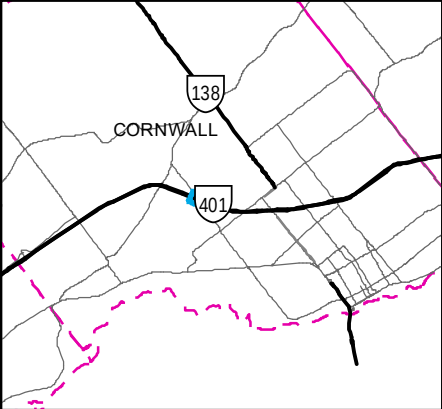


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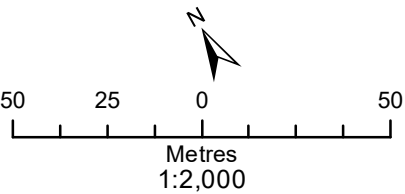
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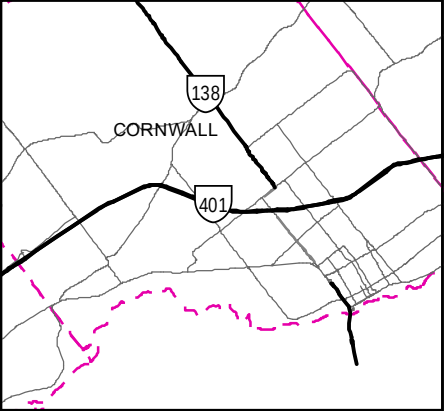




Figure 1: Ponding south of Hwy 401 near Culvert C7



Figure 2: Ponding south of Hwy 401 near Culvert C7



Figure 3: Drain between C17 and C18 flowing well (Atchinson Road and Power Dam Drive)



Figure 4: Ditch leading to C17 Culvert under Power Dam Drive



Figure 5: Inlet of Culvert C17 under Power Dam Drive, 1200 mm, good condition, 350 mm water depth



Figure 6: Outlet of C17 and CB lead at Atchinson Road



Figure 7: Damage to drainage ditch near outlet of C17



Figure 8: Damage to Drainage Ditch. Ponding caused by tire tracks from ATV



Figure 9: Ponding along Power Dam Drive caused by tire tracks from Figure 7, 8



Figure 10: Ponding along Power Dam Drive caused by tire tracks from Figure 7, 8



Figure 11: Full ditch along east side of Power Dam Drive embankment, South of Hwy 401



Figure 12: Daylighted CB outlet (SSC10/C14)



Figure 13: Daylighted CB outlet (SSC10/C14)



Figure 14: Daylighted CB outlet (SSC9/C13)



Figure 15: Seepage from CB outlet (SSC9/C13)



Figure 16: Ponding on DS side of C8, ruts caused by ATV limit drainage



Figure 17: Ponding on DS side of C8, ruts caused by ATV limit drainage



Figure 18: C8 outlet, rusted, mostly embedded, poor flow



Figure 19: C8 outlet, rusted, mostly embedded, poor flow



Figure 20: Area south of Hwy 401 just East of Power Dam Drive



Figure 21: Disconnected Deck Drain outlet S-E side of Power Dam Drive



Figure 22: Inlet of C8, partially blocked, ponding observed



Figure 23: Ponding upstream of C8 (S-W of Hwy 401 and Power Dam Dr)



Figure 24: Damage to Hwy 401 EB under Power Dam Drive



Figure 25: Ponding at DS outlet of C5 and confluence of C7 South of Hwy 401



Figure 26: Ponding in area between Hwy 401, Hwy 401 off-ramp and Power Dam Dr.



Figure 27: Culvert C5



Figure 28: Limited ditch on south side of Hwy 401 from exit ramp to C5



Figure 29: Downstream / outlet of C7 (Hwy 401 offramp)



Figure 30: Road surface wear and upstream ponding of Culvert C7 (Hwy 401 offramp)



Figure 31: Culvert C7 inlet



Figure 32: Culvert C7



Figure 33: Culvert C7 Outlet



Figure 34: Outlet of SSC15 - CB Lead from Power Dam W side



Figure 35: SSC 11 - C15, CB on Power Dam west side



Figure 36: SSC10, C14 - CB inlet and lead; Power Dam Drive Northbound



Figure 37: SSC9, C13, CB and Lead Power Dam Drive Northbound



Figure 38: Drainage area West of Power Dam Drive, South of Hwy 401



Figure 39: Drainage area East of Power Dam Drive, South of Hwy 401



Figure 40: C19-C20 carrying flows across Hwy 401 (south side)



Figure 41: Downstream of C20 leading to municipal drain (ultimate receiver of this drainage area)



Figure 42: Downstream of C20 leading to municipal drain (ultimate receiver of this drainage area)



Figure 43: C19



Figure 44: South side of Hwy 401, ditches compromised by ATV tracks causing interference with drainage



Figure 45: South side of Hwy 401, ditches compromised by ATV tracks causing interference with drainage



Figure 46: South side of Hwy 401, ditches compromised by ATV tracks causing interference with drainage



Figure 47: C4 - Culvert under Power Dam Drive on North side of Hwy 401, with ponding



Figure 48: SSC7 - CB (x2) and lead to South side of Power Dam Drive



Figure 49: SSC8, CB (x2) and lead to south side of Power Dam Drive



Figure 50: SSC8, CB (x2) and lead to south side of Power Dam Drive



Figure 51: Outlet area of SSC7; no outlet could be located, but wet soil conditions encountered.



Figure 52: CB and SSC7, with wet area below. No outlet could be observed.

APPENDIX C: Correspondence

Shravya Mookalera

From: Kris St. Thomas <kris@southstormont.ca>
Sent: Wednesday, May 24, 2023 3:18 PM
To: Karine Bertrand
Subject: RE: Power Dam Drive Municipal Drain

Good after Karine

This is not a municipal drain. I think it may be an award drain but we can not find any paperwork to verify. Please feel to reach out with any more questions.

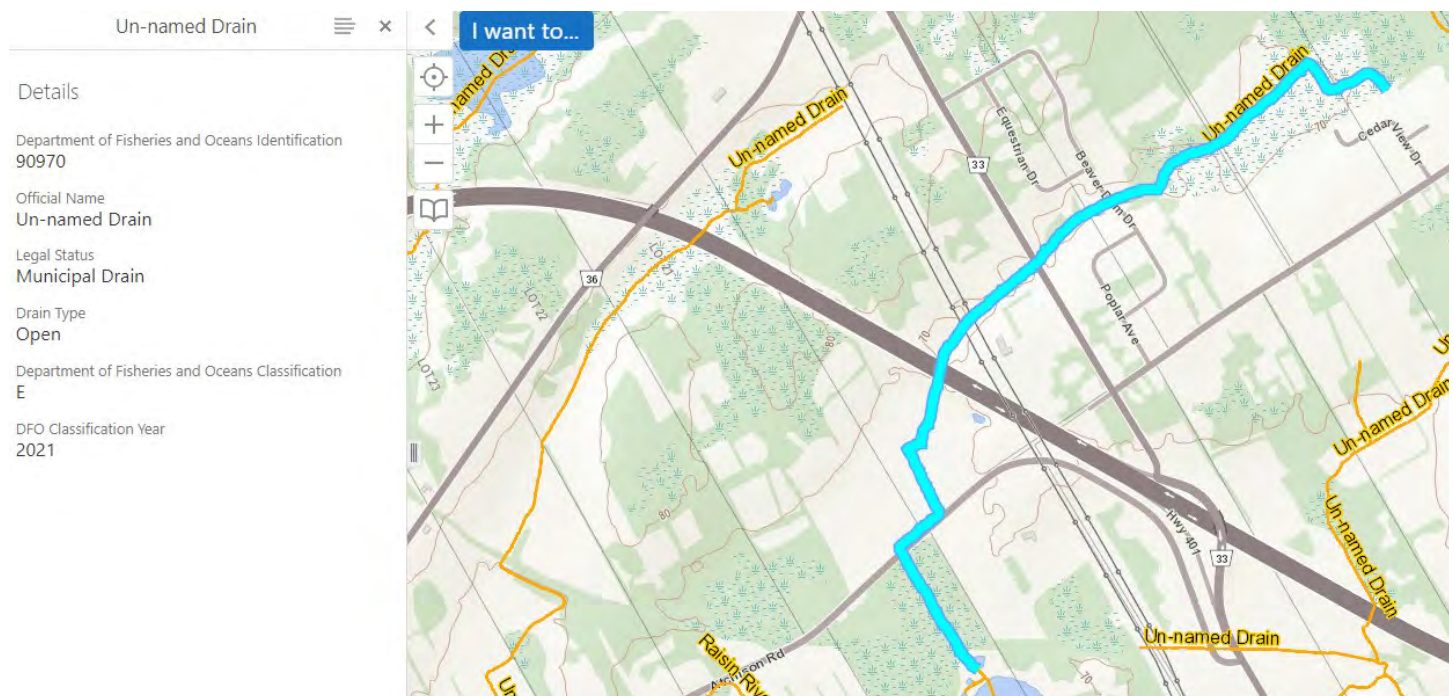
Kris St Thomas

From: Karine Bertrand <KBertrand@morrisonhershfield.com>
Sent: Tuesday, May 23, 2023 8:28 AM
To: Kris St. Thomas <kris@southstormont.ca>
Subject: RE: Power Dam Drive Municipal Drain

Hello Kris,

Following your previous correspondence with Justin Philippi, I am continuing additional work on the same project, and would like to confirm the status of an additional drain, shown in the image below.

Like the two other unnamed drains Justin inquired about, this drain is listed as a “municipal drain” per OMAFRA. Can you confirm and provide any reports if available?



Thank you,

Karine Bertrand, P.Eng. (She/Her)

Senior Engineer, Water Resources



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Direct: 613 739 2910 x1022217

Mobile: 613 791 8737

morrisonhershfield.com

From: Kris St. Thomas <kris@southstormont.ca>

Sent: March 21, 2022 12:57

To: Justin Philippi <JPhilippi@morrisonhershfield.com>

Cc: Mustafa Sasal <MSasal@morrisonhershfield.com>

Subject: RE: (Automatic Reply) Thank you for contacting the Township of South Stormont

Good afternoon

I have reviewed my files and this is not a Municipal drain.

We do not have any reports pertaining to it.

Our roads dept. has changed a couple of culverts on this drain. When we have no reports we always change like for like.

If you require any more assistance please feel free to reach out.

Kris St. Thomas

From: Justin Philippi <JPhilippi@morrisonhershfield.com>

Sent: March 8, 2022 2:55 PM

To: Kris St. Thomas <kris@southstormont.ca>

Cc: Mustafa Sasal <MSasal@morrisonhershfield.com>

Subject: RE: (Automatic Reply) Thank you for contacting the Township of South Stormont

Hi Kris,

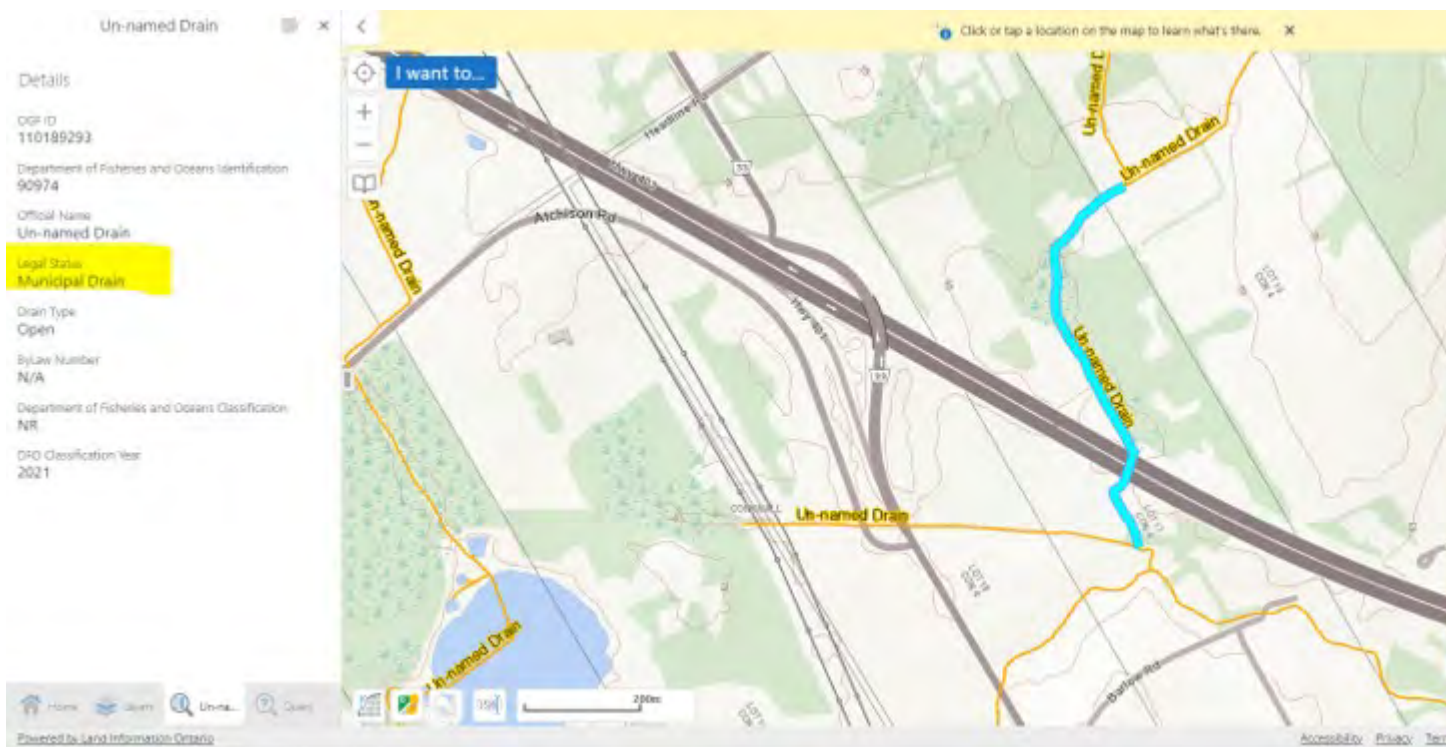
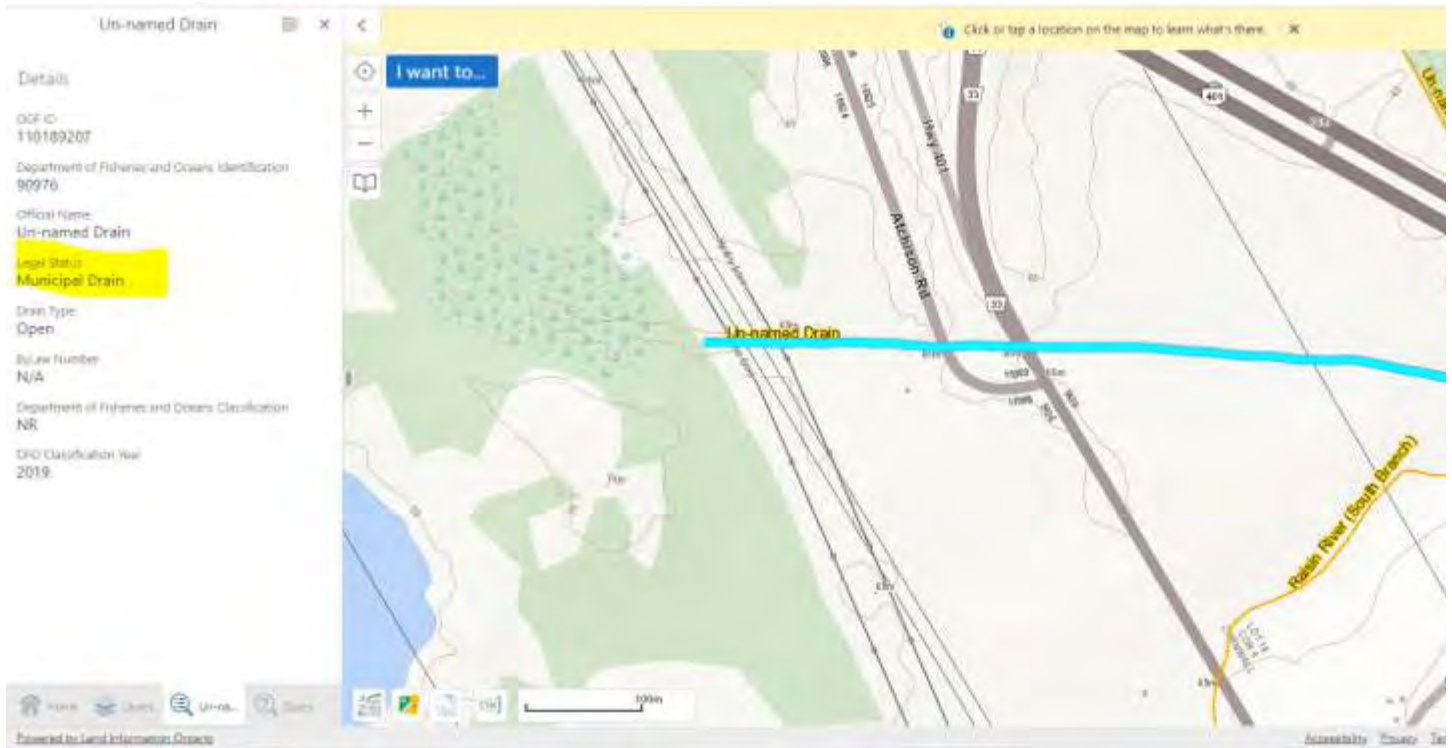
Would you be able to elaborate. I understood the unnamed drain in the first screenshot below to be classified as a municipal drain by OMAFRA on their AG Map tool.

If there is no engineers report does the township have any reports, designs, or modelling for it or for the drain indicated in the second image below?

I know the crossing of the first drain at Power Dam Drive has a recently replaced culvert; is there any chance there would be a H&H report to support that renewal?

Thank you for your help,

Justin



Justin Philippi, M.Sc., P.Eng.
 Senior Engineer, Water Resources - Infrastructure Ottawa
 Office: [613 739 2910](tel:6137392910) ext 1022312
 Mobile: [343-987-8790](tel:343-987-8790)
JPhilippi@morrisonhershfield.com

UPCOMING LEAVE NOTICE: I will be away on a parental leave starting March 12 to April 17.
 During this time I will not be available.
 Please contact Karyn Cornfield (kcornfield@morrisonhershfield.com) with any project related question or issues.

From: Kris St. Thomas <kris@southstormont.ca>
Sent: March 7, 2022 01:39
To: Justin Philippi <JPhilippi@morrisonhershfield.com>
Subject: RE: (Automatic Reply) Thank you for contacting the Township of South Stormont

Good Morning Justin

Sorry for the delay in responding.
This is not a Municipal drain, therefore I have no engineers report.
If you require any more assistance please feel free to reach out.

kris

From: Justin Philippi <JPhilippi@morrisonhershfield.com>
Sent: February 28, 2022 9:50 AM
To: Kris St. Thomas <kris@southstormont.ca>
Cc: Mustafa Sasal <MSasal@morrisonhershfield.com>
Subject: FW: (Automatic Reply) Thank you for contacting the Township of South Stormont

Hello Kris,

I sent the message below to you last week. I spoke with the administrator in the office last Friday, and she mentioned you were working as lead hand last week. When you've got the backlog cleared, would you be able to get back to me on any availability of an engineers report or other information on this drain near Power Dam Drive and Hwy 401.

Thanks,
Justin Philippi

Justin Philippi, M.Sc., P.Eng.
Senior Engineer, Water Resources - Infrastructure Ottawa
Office: [613 739 2910 ext 1022312](tel:6137392910)
Mobile: [343-987-8790](tel:343-987-8790)
JPhilippi@morrisonhershfield.com

From: noreply@esolutionsgroup.ca <noreply@esolutionsgroup.ca>
Sent: February 23, 2022 12:40
To: Justin Philippi <JPhilippi@morrisonhershfield.com>
Subject: (Automatic Reply) Thank you for contacting the Township of South Stormont

This message is to confirm receipt of your recent email to the Township of South Stormont.

Thank you,

Township of South Stormont

Your Name:

Justin Philippi

Subject:

Engineers Report on Unnamed Municipal Drain

Your Message:

Hello Kris, I'm a consulting engineer working on a project for MTO at the Power Dam Drive exit of Hwy 401. We're looking at drainage conditions in the area and have identified an unnamed municipal drain as part of the catchment / receiving watercourse of our project area. I am hoping you have an engineers report related to this drain that can assist us in our analysis and design.

I've attached an image from OMAFRA with the location and OGF ID number.

I would appreciate if you could respond to let me know this message has been received, and to discuss any follow up question you may have.

Thank you kindly,

Justin Philippi, M.Sc., P.Eng.
Senior Engineer, Water Resources - Infrastructure Ottawa
Office: 613 739 2910 ext 1022312
Mobile: 343-987-8790
JPhilippi@morrisonhershfield.com

Shravya Mookalera

From: Ag Info <ag.info.omafra@ontario.ca>
Sent: Monday, May 29, 2023 2:48 PM
To: Karine Bertrand
Subject: FW: Municipal / Award Drain Identification

Follow Up Flag: Follow up
Flag Status: Completed

Hello Karine,

Thank you for your inquiry. In speaking with our drainage program coordinator they have advised that in order for a drain to be a drain under the Drainage Act, it must have been initiated by petition and followed the Drainage Act process including the passing of a municipal by-law. If the local municipality that is responsible for the drain does not have a by-law adopting an engineer's report, then it is likely either not a drain or there is no record to support that it is a drain.

There are two (2) causes for the situation of drains showing on AgMaps but are not municipal drains:

1. Some of these drains originate from OMAFRA's paper maps from the 80's and 90's, but 2.) most of these drains came from the early days when the federal Department of Fisheries and Oceans contracted the local conservation authorities (CA) to map and classify drains.

If the local municipality determines that certain sections of drains on AgMaps is not a drain under the Drainage Act, they can notify OAMFRA formally and we can update the constructed drain layer.

I hope this information has been helpful. If you have any further questions please feel free to reach out to our drainage program coordinator directly at:

Timothy R. Brook, M.Sc., P.Eng.
Ministry of Agriculture, Food and Rural Affairs
Drainage Program Coordinator
Phone: 519-766-3651
Email: timothy.brook@ontario.ca

The Agricultural Information Contact Centre (AICC) takes pride in responding to farm, agri-business and rural business inquiries in a timely fashion. We want to provide you with the best service possible, and in order to help us accomplish this, we would ask that you please take 1-2 minutes to complete our [customer satisfaction survey](#).

Sincerely,

Kyle Dearlove | Team Lead
Information & Client Support Unit (ICSU), Business Services Branch
Ministry of Agriculture, Food and Rural Affairs
1 Stone Road West, 4NE | Guelph | ON | N1G 4Y2
Toll Free: 1-877-424-1300 | TTY: 1-855-696-2811
Website: www.ontario.ca/OMAFRA

Please Note: As part of providing [accessible customer service](#), please let me know if you have any accommodation needs or require communication supports or alternate formats.

From: Karine Bertrand <KBertrand@morrisonhershfield.com>

Sent: Thursday, May 25, 2023 11:25 AM

To: Ag Info <ag.info.omafra@ontario.ca>

Subject: Municipal / Award Drain Identification

CAUTION -- EXTERNAL E-MAIL - Do not click links or open attachments unless you recognize the sender.

Hello,

My name is Karine Bertrand, I'm a consulting engineer working on a project for MTO in the township of South Stormont, near Cornwall, at the interchange between Highway 401 and Power Dam Drive.

I have a question regarding the legal status of unnamed drains in the project area.

While looking at drainage conditions in the area, we identified three (3) unnamed drains that Ag Maps lists as having "municipal drain" legal status (see figure below). However, the township's drainage superintendent (Kris St. Thomas, South Stormont) maintains that these are not municipal drains and that they (South Stormont) have no engineer's reports on file. They suspect they may be Award drains; but again, do not have any reports on file to confirm.

Does OMAFRA have an information source that would confirm the legal status of these drains, or can OMAFRA explain why they are listed as having "municipal drain" legal status in Ag Maps, contrary to the opinion of the local drainage superintendent?



Thank you,
Karine

Karine Bertrand, P.Eng. (She/Her)
Senior Engineer, Water Resources



200-2932 Baseline Road | Ottawa, ON K2H 1B1
Direct: 613 739 2910 x1022217
Mobile: 613 791 8737
morrisonhershfield.com

Shravya Mookalera

From: Brad Hewton
Sent: Monday, May 3, 2021 10:43 AM
To: Karyn Cornfield
Subject: RE: 401 Power Dam

Confirmed this removes gravity pipe requirements

From: Brad Hewton
Sent: Monday, May 3, 2021 10:42 AM
To: Karyn Cornfield <KCornfield@morrisonhershfield.com>
Subject: FW: 401 Power Dam

See below. if they remove existing culverts what will that mean? I assume this removes gravity pipe testing as well but will confirm

From: Brake, David (MTO) <Dave.Brake@ontario.ca>
Sent: Monday, May 3, 2021 10:39 AM
To: Brad Hewton <BHewton@morrisonhershfield.com>
Subject: RE: 401 Power Dam

Melissa suggested this morning that we will likely not require the culvert inspection report.

A paving/drainage contract is currently under design by the in-house group for the section of the 401 from Moulinette easterly to Boundary Road, which overlaps our study.

I am trying to confirm the scope of that contract before we issue the work order as it make take care of most of the culverts (at least along the 401).

I have added to wording to the Phase 2 foundation section that notes the contract and the need to coordinate our future investigations to avoid a contractor issue. It shouldn't be an issue for the phase 1.

Once I confirm the culvert information, I will likely remove an wording related to the inspections, testing and reports. Do you have a sense on what the cost was for these inspections and the resulting reports?

Dave

David Brake

Project Manager
Ministry of Transportation | Design and Engineering | Project Delivery East
Work 613-545-4221
Mobile 613-893-3031
David.Brake@ontario.ca



From: Brad Hewton <BEHewton@morrisonhershfield.com>
Sent: Monday, May 03, 2021 10:29 AM
To: Brake, David (MTO) <Dave.Brake@ontario.ca>
Subject: RE: 401 Power Dam

CAUTION -- EXTERNAL E-MAIL - Do not click links or open attachments unless you recognize the sender.

Fair, as long as it's clear we're scoping that and it would be confirmed in future phases.

From: Brad Hewton <BEHewton@morrisonhershfield.com>
Sent: Friday, April 30, 2021 3:14 PM
To: Brake, David (MTO) <Dave.Brake@ontario.ca>
Subject: 401 Power Dam

CAUTION -- EXTERNAL E-MAIL - Do not click links or open attachments unless you recognize the sender.

Table below has our unofficial numbers (still need final vetting but generally there). I added the sample assignment ones to show the differences.

Category	Total	Original from SA2	Difference
Highway Engineering	\$ 326,900.00	\$ 233,900.00	\$ 93,000.00
Traffic Engineering	\$ 64,360.00	\$ 56,960.00	\$ 7,400.00
Bridge Engineering	\$ 145,000.00	\$ 125,800.00	\$ 19,200.00
Drainage and Hydrology Engineering	\$ 156,700.00	\$ 43,200.00	\$ 113,500.00
Geotechnical	\$ 170,355.00	\$ 9,250.00	\$ 161,105.00
Foundations	\$ 127,975.00	\$ 30,830.71	\$ 97,144.29
Electrical Engineering	\$ 35,900.00	\$ 29,700.00	\$ 6,200.00
Environmental Services	\$ 296,615.00	\$ 150,665.00	\$ 145,950.00
Archaeological Services	\$ 6,350.00	\$ 6,350.00	\$ -
Built Heritage Services	\$ 5,545.00	\$ 5,545.00	\$ -
Waste Management Services	\$ 17,100.00	\$ 17,100.00	\$ -
Surveys	\$ -	\$ 7,900.00	\$ (7,900.00)
Value Engineering / Risk Assessment	\$ -	\$ -	\$ -
Total Sum	\$ 1,159,040.71	\$ 717,200.71	\$ 441,840.00

A few items to note, in no particular order:

1. Pavements will come down a bit. They scoped investigation work for that drainage concern that Bruce identified. I clarified it's not needed but haven't got a revised price yet. Don't think it's huge, but it's something.
2. Both pavement and foundations fees are for both Phase 1 and 2.
3. Schedule changed from 13 months in our schedule estimation form to 19, impacts across all disciplines.
4. Addition of interchange and extended investigation limits, as previously discussed. biggest impact of expanded study limits is enviro and drainage
5. Some enviro addition include Noise and Air. Not big ticket but noted nonetheless
6. For drainage, a few things to note where it differs from the sample assignment on top of schedule include
 - Added ESCORA
 - Culvert inspection and reporting
 - Localized drainage issue assessment
 - Gravity Pipe testing 3 seasons including lab testing and analysis

- Addition of interchange and larger study limits than SA adds to area of investigation and hydraulics as well as existing and proposed culvert sites

I assume you'll want to discuss next week, let me know what works best for you and I'll sort out my schedule.

Thanks,
Brad

***Schedule Notice:** with the ongoing stay at home order and remote learning for children, my schedule will be variable for the coming weeks. I will respond to all e-mail and meetings as quickly as possible.*

BRAD HEWTON, P.ENG
Manager, Roads and Highways Ottawa
bhewton@morrisonhershfield.com



200-2932 Baseline Road | Ottawa, ON K2H 1B1 Canada
Cell: 613 884 6083 | Office: 613 739 2910 x1022292
morrisonhershfield.com
Please consider the environment before printing this message

APPENDIX D: Hydrology

CULVERTS -- Flow for Existing 2021																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Culvert	Subcatchment	Area	Cumulative Area	Runoff Coefficient						AC						Cumulative AC						Runoff Coefficient -- Cumulative Area						Upstream Area for Flowpath	Individual Flowpath	Individual Slope**	Cumulative Flowpath	Cumulative Slope	Bransby Williams	Airport	Tc	Cumulative Tc	Rainfall Intensity (mm/hr)						Design Flow (L/s)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
ID	ID	(ha)	(ha)	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year										ID	m	%	m	%	(min)	(min)	(min)	(min)	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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EC18	ES-18	27.49	27.49	0.42	0.42	0.42	0.46	0.51	0.53	11.57	11.57	11.57	12.73	13.89	14.47	11.57	11.57	11.57	12.73	13.89	14.47	0.42	0.42	0.42	0.46	0.51	0.53		769	0.6	769	0.6	35	75	35	35	33.5	43.4	50.0	58.3	64.3	70.4	1076	1397	1606	2060	2480	2827																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
EC17	ES-17	1.62	29.11	0.52	0.52	0.52	0.57	0.62	0.65	11.57	0.84	0.84	0.84	0.92	1.01	1.05	12.41	12.41	11.57	12.73	13.65	14.90	15.52	0.43	0.43	0.43	0.46	0.51	0.53	EC18	42	0.5	812	0.6	37	76	37	37	32.7	42.4	48.8	58.9	62.8	68.7	1127	1462	1681	2156	2596	2955																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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EC03	ES-03	1.57	1.57	0.56	0.56	0.56	0.61	0.67	0.69	0.87	0.87	0.87	0.96	1.04	1.09	0.87	0.87	0.87	0.96	1.04	1.09	0.56	0.56	0.56	0.61	0.67	0.69		563	0.7	563	0.7	33	48	33	33	34.5	44.8	51.5	60.1	66.3	72.6	84	108	125	145	160	176																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
EC07	ES-07	3.41	4.98	0.49	0.49	0.49	0.53	0.58	0.61	1.65	1.65	1.65	1.82	1.98	2.06	2.52	2.52	2.52	2.77	3.03	3.15	0.51	0.51	0.51	0.56	0.61	0.63	EC03	294	0.5	857	0.6	46	66	46	46	28.9	37.4	43.0	50.1	55.3	60.5	80	242	301	351	388	424																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
EC11	ES-11	0.17	0.17	0.90	0.90	0.90	0.99	1.08	1.13	0.15	0.15	0.15	0.15	0.17	0.18	0.19	0.15	0.15	0.15	0.17	0.18	0.19	0.90	0.90	0.90	0.99	1.08	1.13		122	3.0	122	3.0	7	5	7	10	75.9	99.0	114.1	133.3	147.3	161.3	32	42	48	62	75	85																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
MH09/MH10	ES-09/10	0.06	0.06	0.86	0.86	0.86	0.95	1.03	1.08	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.06	0.86	0.86	0.86	0.95	1.03	1.08		40	2.6	40	2.6	3	4	3	10	75.9	99.0	114.1	133.3	147.3	161.3	11	14	16	21	25	28																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
EC06	ES-06	0.78	1.01	0.53	0.53	0.53	0.58	0.64	0.66	0.41	0.41	0.41	0.46	0.50	0.52	0.62	0.62	0.62	0.68	0.74	0.77	0.61	0.61	0.61	0.67	0.73	0.77	EC11	56	1.1	178	2.4	9	16	9	10	75.9	99.0	114.1	133.3	147.3	161.3	130	170	196	252	303	346																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
EC05	ES-05	0.89	1.89	0.55	0.55	0.55	0.61	0.66	0.69	0.49	0.49	0.49	0.54	0.59	0.61	1.11	1.11	1.11	1.22	1.33	1.39	0.59	0.59	0.59	0.64	0.70	0.73	EC06	14	1.1	192	2.3	9	18	9	10	75.9	99.0	114.1	133.3	147.3	161.3	234	305	351	451	544	621																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
MH15	ES-15	0.11	0.11	0.95	0.95	0.95	1.04	1.14	1.19	0.10	0.10	0.10	0.11	0.12	0.13	0.10	0.10	0.10	0.11	0.12	0.13	0.95	0.95	0.95	1.04	1.14	1.19		142	2.9	142	2.9	8	4	8	10	75.9	99.0	114.1	133.3	147.3	161.3	22	28	32	42	50	57																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
EC08	ES-08	1.37	8.35	0.47	0.47	0.47	0.52	0.57	0.59	0.65	0.65	0.65	0.71	0.78	0.81	0.10	0.10	0.10	0.11	0.12	0.13	0.52	0.52	0.52	0.58	0.63	0.66	EC07	82	0.5	939	0.6	48	68	48	48	28.0	36.2	41.6	48.5	53.6	58.6	340	441	507	650	782	891																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
EC04	ES-04	10.62	10.62	0.33	0.33	0.33	0.36	0.40	0.41	3.50	3.50	3.50	3.86	4.21	4.38	3.50	3.50	3.50	3.86	4.21	4.38	0.33	0.33	0.33	0.36	0.40	0.41		566	0.7	566	0.7	27	68	68	68	21.4	27.7	31.8	37.0	40.8	44.6	209	270	310	397	477	543																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
EC19	ES-19	10.62	21.24	0.34	0.34	0.34	0.37	0.41	0.42	3.60	3.60	3.60	3.96	4.32	4.58	7.10	7.10	7.10	7.81	8.53	8.88	0.33	0.33	0.33	0.37	0.40	0.42	EC04	333	0.6	899	0.6	41	86	86	86	18.8	24.3	27.9	32.0	35.7	39.1	371	479	550	704	846	964																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
EC20	ES-20	0.90	22.14	0.62	0.62	0.62	0.68	0.74	0.77	0.55	0.55	0.55	0.61	0.67	0.69	7.66	7.66	7.66	8.43	9.19	9.57	0.35	0.35	0.35	0.38	0.42	0.43	EC19	25	0.5	924	0.6	42	86	86	86	18.8	24.3	27.8	32.4	35.7	39.1	400	516	592	759	912	1039																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						

CULVERTS -- Flow for Proposed 2098																																																		
Culvert	Subcatchment	Area	Cumulative Area	Runoff Coefficient						AC						Cumulative AC						Runoff Coefficient -- Cumulative Area						Upstream Area for Flowpath	Individual Flowpath	Individual Slope**	Cumulative Flowpath	Cumulative Slope	Bransby Williams	Airport	Tc	Cumulative Tc	Rainfall Intensity (mm/hr)						Design Flow (L/s)							
ID	ID	(ha)	(ha)	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	ID	m	%	m	%	(min)	(min)	(min)	(min)	2-Year	5-Year	10-year	25-Year	50-Year	100-Year	2-Year	5-Year	10-year	25-Year	50-Year	100-Year		
OU-A																																																		
EC18	PS-18	27.49	27.49	0.42	0.42	0.42	0.46	0.50	0.52	11.52	11.52	11.52	12.67	13.82	14.40	11.52	11.52	11.52	12.67	13.82	14.40	0.42	0.42	0.42	0.46	0.50	0.52		PS-18	786.72	0.61	786.72	0.61	36	73	36	36	33.4	43.4	49.9	58.1	64.2	70.2	1069	1387	1595	2046	2464	2808	
PC17	PS-17	1.57	29.06	0.49	0.49	0.49	0.54	0.59	0.62	0.77	0.77	0.77	0.85	0.93	0.97	12.29	12.29	13.44	14.67	15.33	15.36	0.42	0.42	0.46	0.50	0.53	0.53			45.55	832.27	0.60		37	75	37	37	32.6	42.2	48.6	56.6	62.5	68.4	1112	1442	1814	2308	2661	2918	
OU-B																																																		
EC03	PS-03	1.57	1.57	0.50	0.50	0.50	0.55	0.60	0.62	0.78	0.78	0.78	0.86	0.94	0.98	0.78	0.78	0.78	0.86	0.94	0.98	0.50	0.50	0.50	0.55	0.60	0.62			570.79	0.75	570.79	0.75	33	52	33	33	34.6	44.9	51.6	60.2	66.5	72.7	75	97	112	144	173	197	
PC07	PS-07	3.29	4.86	0.55	0.55	0.55	0.60	0.66	0.69	1.80	1.80	1.80	1.98	2.16	2.25	2.58	2.58	2.58	2.84	3.10	3.23	0.53	0.53	0.53	0.58	0.64	0.66	PS-03	274.40	0.52	845.19	0.68	44	61	44	44	29.4	38.2	43.9	51.1	56.4	61.7	211	274	315	404	486	554		
	PS-08	1.00	7.44	0.52	0.52	0.52	0.57	0.62	0.65	0.52	0.52	0.52	0.57	0.62	0.65	3.10	3.10	3.10	3.41	3.72	3.88	0.42	0.42	0.42	0.46	0.50	0.52	PS-07	223.92	0.98	1069.11	0.74	53	80	53	53	25.6	33.2	38.1	44.4	49.0	53.6	221	286	329	421	507	578		
	PS-14	0.04	0.04	0.95	0.95	0.95	1.04	1.14	1.18	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.95	0.95	0.95	1.04	1.14	1.18		111.06	2.15	111.06	2.15	8	4	8	10	75.9	99.0	114.1	133.3	147.3	161.3	7	10	11	14	17	20		
	PS-15	0.03	0.03	0.86	0.86	0.86	0.94	1.03	1.07	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.86	0.86	0.86	0.94	1.03	1.07		43.99	1.03	43.99	1.03	4	5	4	10	75.9	99.0	114.1	133.3	147.3	161.3	5	7	8	10	13	14		
PC25	PS-16	1.59	9.10	0.54	0.54	0.54	0.60	0.65	0.68	0.87	0.87	0.87	0.95	1.04	1.08	4.03	4.03	4.03	4.43	4.83	5.04	0.44	0.44	0.44	0.49	0.53	0.55	PS-08	111.06	0.50	1180.18	0.72	58	82	58	58	23.5	30.5	35.0	40.7	44.9	49.1	264	341	392	502	604	687		
	PS-05	0.68	0.68	0.51	0.51	0.51	0.56	0.61	0.63	0.34	0.34	0.34	0.38	0.41	0.43	0.34	0.34	0.34	0.38	0.41	0.43	0.51	0.51	0.51	0.56	0.61	0.63		44.24	0.52	44.24	0.52	3	16	3	10	75.9	99.0	114.1	133.3	147.3	161.3	72	94	108	139	167	191		
PC04	PS-04	11.33	11.33	0.35	0.35	0.35	0.38	0.42	0.44	3.95	3.95	3.95	4.35	4.74	4.94	3.95	3.95	3.95	4.35	4.74	4.94	0.35	0.35	0.35	0.38	0.42	0.44		563.01	0.57	563.01	0.57	28	70	70	70	21.1	27.3	31.3	36.4	40.2	43.9	232	299	344	440	529	603		
	PS-06	0.88	12.21	0.62	0.62	0.62	0.68	0.74	0.77	0.55	0.55	0.55	0.60	0.65	0.68	4.50	4.50	4.50	4.95	5.40	5.62	0.37	0.37	0.37	0.41	0.44	0.46	PS-04	120.91	0.50	683.92	0.56	34	76	76	76	20.3	26.2	30.1	35.0	38.6	42.2	254	328	376	482	579	660		
	PS-12	0.04	0.04	0.88	0.88	0.88	0.97	1.06	1.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.88	0.88	0.88	0.97	1.06	1.10		570.79	0.75	570.79	0.75	47	19	47	47	28.1	36.4	41.9	48.8	53.8	58.9	3	4	4	5	6	7			
	PS-13	0.04	0.04	0.74	0.74	0.74	0.81	0.89	0.92	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.74	0.74	0.74	0.81	0.89	0.92		45.12	0.50	45.12	0.5000	4	10	4	10	75.9	99.0	114.1	133.3	147.3	161.3	6	7	8	11	13	15		
PC24	PS-11	1.34	13.63	0.52	0.52	0.52	0.57	0.62	0.65	0.70	0.70	0.70	0.77	0.84	0.87	5.26	5.26	5.26	5.78	6.31	6.57	0.39	0.39	0.39	0.42	0.46	0.48	PS-06	127.00	0.50	810.93	0.55	40	81	81	81	19.6	25.3	29.0	33.8	37.2	40.7	286	369	424	543	652	743		
PC19	PS-19	8.89	22.51	0.35	0.35	0.35	0.39	0.42	0.44	3.11	3.11	3.11	3.42	3.73	3.89	8.37	8.37	8.37	9.21	10.04	10.46	0.372	0.37	0.37	0.41	0.45	0.46	PS-11	59.33	0.50	870.26	0.54	41	86	86	86	18.9	24.4	28.0	32.6	35.9	39.3	440	567	651	834	1002	1142		
PC20	PS-20	1.09	24.27	0.59	0.59	0.59	0.65	0.71	0.74	0.64	0.64	0.64	0.71	0.77	0.80	9.35	9.35	9.35	10.29	11.22	11.69	0.39	0.39	0.39	0.42	0.46	0.48	PS-19	24.34	0.50	894.60	0.54	42	85	85	85	19.0	24.5	28.1	32.7	36.0	39.4	493	636	730	935	1123	1280		
OU-C																																																		
PC21	PS-21	21.57	21.57	0.36	0.36	0.36	0.39	0.43	0.45	7.72	7.72	7.72	8.49	9.27	9.65	7.72	7.72	7.72	8.49	9.27	9.65	0.36	0.36	0.36	0.39	0.43	0.45		869.57	1.24	869.57	1.24	35	66	66	66	21.6	27.9	32.0	37.3	41.1	45.0	463	599	687	881	1059	1206		
OU-D																																																		
PC23	PS-23	77.02	77.02	0.37	0.37	0.37	0.41	0.44	0.46	28.42	28.42	28.42	31.26	34.10	35.53	28.42	28.42	28.42	31.26	34.10	35.53	0.37	0.37	0.37	0.41	0.44	0.46		1650.01	1.15	1650.01	1.15	59	93	93	93	17.9	23.1	26.6	30.9	34.1	37.2	1417	1826	2097	2686	3227	3675		
PC22	PS-22	0.90	77.92	0.62	0.62	0.62	0.69	0.75	0.78	0.56	0.56	0.56	0.62	0.67	0.70	28.98	28.98	28.98	31.88	34.78	36.23	0.37	0.37	0.37	0.41	0.45	0.46	PS-23	9.54	0.50	1659.55	1.14	60	93	93	93	17.9	23.1	26.6	30.9	34.1	37.2	1445	1863	2139	2739	3291	3748		
OU-ULT																																																		
PS-OU		13.15	175.08	0.45	0.45	0.45	0.50	0.54	0.56	5.92	5.92	5.92	6.51	7.10	7.40	68.30	68.30	69.45	76.28	82.53	85.37	0.39	0.39	0.40	0.44	0.47	0.49	PS-22	116.752	0.50	1776.30	1.10	59	95	95	95	17.7	22.8	26.2	30.4	33.5	36.7	3352	4320	5045	6450	7685	8694		

CN* Calculation (Existing Lumped Subcatchments)

Highway 401/ Power Dam Drive Interchange

Hydrologic Analysis

Soil group was determined based on the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Soils GIS database provided by the City of Ottawa (HYDRO1

$$S = \frac{25400}{CN_{AMCIII}} - 254$$

S = Soil storage (mm)

$$Q = \frac{(P - I_a)^2}{P + S - I_a}$$

Q = Runoff from the area (mm)

P = Total rainfall for 100yr return period (mm)

Ia = Initial abstraction (mm):

$$I_a = 0.2S$$

$$S^* = \frac{(P - I_{a_{measured}})^2}{Q} + I_a - P$$

S* = New soil storage based on measured Ia value for the study area

CN* for AMCII is calculated from new storage value:

$$CN^*_{AMCII} = f(S^*, CN^*_{AMCII})$$

CN* Calculation

Subcatchment ID	CN	CN	CN*		AMCIII		Total		Ia	
	AMCII	AMCIII	AMCII	AMCIII	S (mm)	S* (mm)	Rainfall (mm)	Q (mm)	computed (mm)	input (mm)
OU-A	79	90	76	89	27.2	32.2	76.8	51.6	5.4	2.7
OU-B	73	87	69	84	38.3	46.6	76.8	44.5	7.7	3.8
OU-C	73	86	67	84	40.3	49.4	76.8	43.3	8.1	4.0
OU-D	72	86	66	83	42.4	52.3	76.8	42.2	8.5	4.2
OU-Ultimate	82	91	79	91	24.0	26.0	76.8	54.0	4.8	3.6

CN* Calculation (Proposed Lumped Subcatchments)

Highway 401/ Power Dam Drive Interchange

Hydrologic Analysis

Soil group was determined based on the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Soils GIS database provided by the City of Ottawa (HYDRO1 attribute)

$$S = \frac{25400}{CN_{AMCIII}} - 254$$

S = Soil storage (mm)

$$Q = \frac{(P - I_a)^2}{P + S - I_a}$$

Q = Runoff from the area (mm)

P = Total rainfall for 100yr return period (mm)

I_a = Initial abstraction (mm):

$$I_a = 0.2S$$

$$S^* = \frac{(P - I_{a_{measured}})^2}{Q} + I_a - P$$

S* = New soil storage based on measured I_a value for the study area

CN* for AMCII is calculated from new storage value:

$$CN^*_{AMCII} = f(S^*, CN^*_{AMCII})$$

CN* Calculation

Subcatchment ID	CN	CN	CN*		AMCIII		Total		I _a	
	AMCII	AMCIII	AMCII	AMCIII	S	S*	Rainfall	Q	computed	input
					(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
OU-A	79	90	76	89	27.2	32.0	82.2	56.6	5.4	2.7
OU-B	72	86	66	83	42.4	51.9	82.2	46.8	8.5	4.2
OU-C	73	86	68	84	40.3	49.0	82.2	48.0	8.1	4.0
OU-D	72	86	66	83	42.4	51.9	82.2	46.8	8.5	4.2
OU-Ultimate	83	92	80	91	22.4	24.2	82.2	60.3	4.5	3.4

APPENDIX E: Hydraulics

HY-8 Culvert Analysis Report

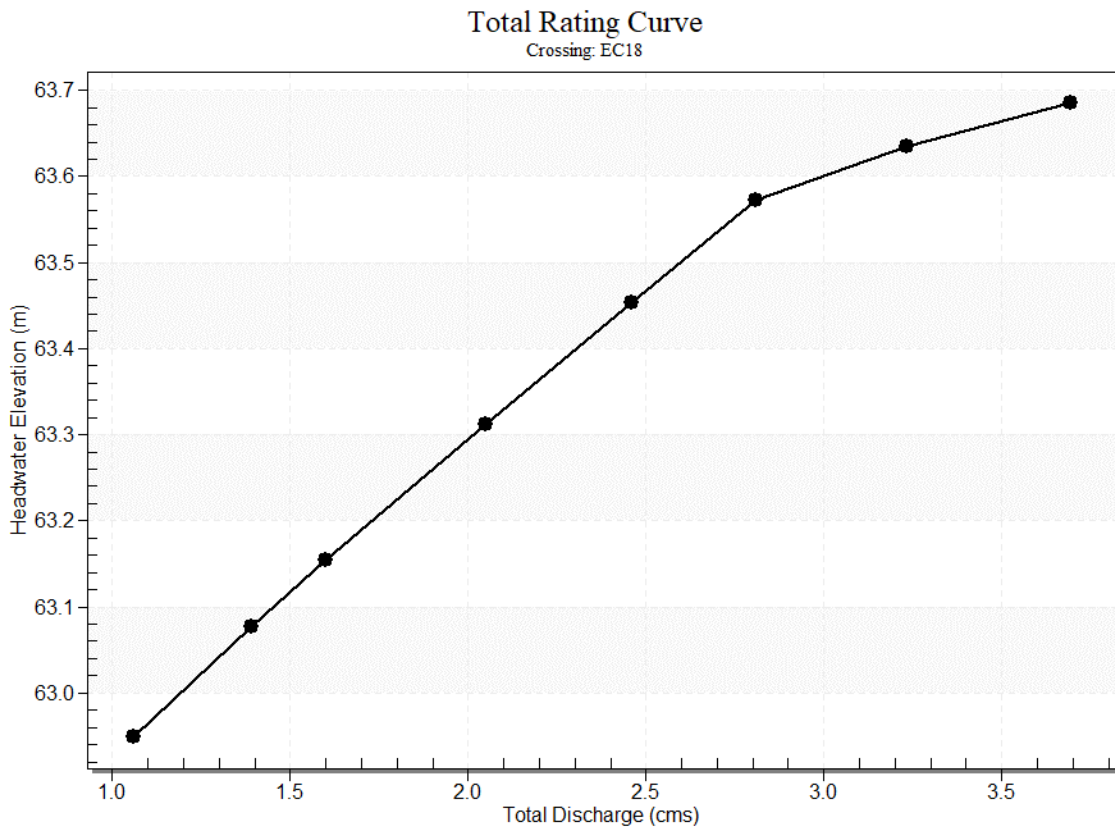
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: EC18

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	EC18 Discharge (cms)	Roadway Discharge (cms)	Iterations
62.95	2-yr	1.06	1.06	0.00	1
63.08	5-yr	1.39	1.39	0.00	1
63.15	10-yr	1.60	1.60	0.00	1
63.31	25-yr	2.05	2.05	0.00	1
63.45	50-yr	2.46	2.46	0.00	1
63.57	100-yr	2.81	2.81	0.00	13
63.64	115%	3.23	2.96	0.27	7
63.57	Overtopping	2.80	2.80	0.00	Overtopping

Rating Curve Plot for Crossing: EC18



Culvert Data: EC18

Table 1 - Culvert Summary Table: EC18

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	1.06 cms	1.06 cms	62.95	0.63	0.64 9	3- M 1t	0.48	0.3 3	0.5 6	0.56	1.07	0.89
5-yr	1.39 cms	1.39 cms	63.08	0.76	0.77 7	3- M 1t	0.58	0.4 0	0.6 4	0.64	1.24	0.95
10- yr	1.60 cms	1.60 cms	63.15	0.83	0.85 4	3- M 1t	0.64	0.4 4	0.6 8	0.68	1.34	0.99
25- yr	2.05 cms	2.05 cms	63.31	0.98	1.01 3	3- M 2t	0.77	0.5 1	0.7 7	0.77	1.54	1.05
50- yr	2.46 cms	2.46 cms	63.45	1.11	1.15 3	3- M 2t	0.91	0.5 8	0.8 4	0.83	1.72	1.10
100- yr	2.81 cms	2.81 cms	63.57	1.24	1.27 3	3- M 2t	1.08	0.6 3	0.8 9	0.89	1.87	1.14
115 %	3.23 cms	2.96 cms	63.64	1.30	1.33 6	3- M 2t	1.20	0.6 5	0.9 5	0.94	1.87	1.18

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

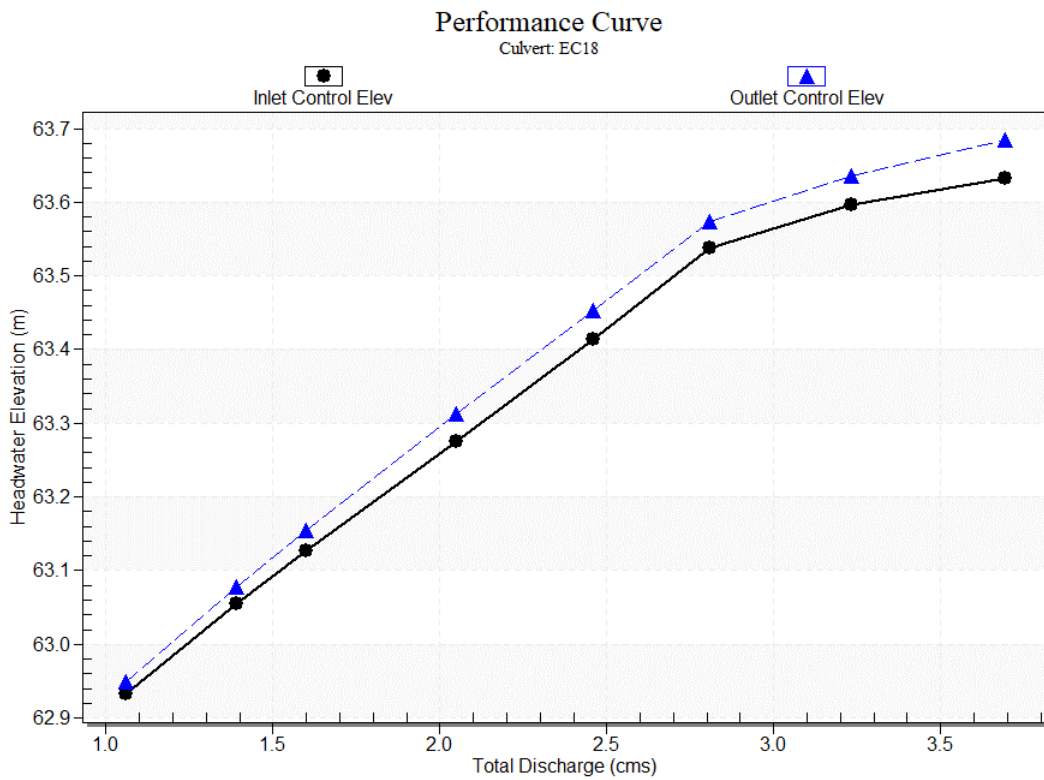
Inlet Elevation (invert): 62.30 m,

Outlet Elevation (invert): 62.12 m

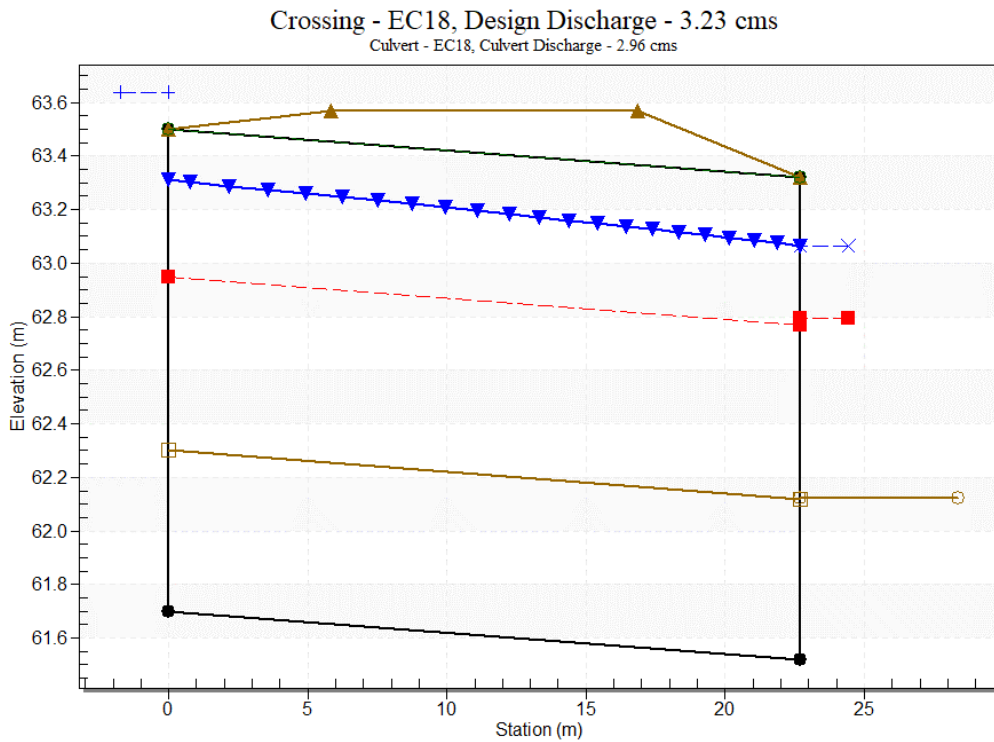
Culvert Length: 22.70 m,

Culvert Slope: 0.0079

Culvert Performance Curve Plot: EC18



Water Surface Profile Plot for Culvert: EC18



Site Data - EC18

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 61.70 m

Outlet Station: 22.70 m

Outlet Elevation: 61.52 m

Number of Barrels: 1

Culvert Data Summary - EC18

Barrel Shape: Circular

Barrel Diameter: 1800.00 mm

Barrel Material: Corrugated Steel

Embedment: 600.00 mm

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting ($K_e=0.9$)

Inlet Depression: None

Tailwater Data for Crossing: EC18

Table 2 - Downstream Channel Rating Curve (Crossing: EC18)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
1.06	62.68	0.56	0.89	16.52	0.47
1.39	62.76	0.64	0.95	18.80	0.48
1.60	62.80	0.68	0.99	20.10	0.48
2.05	62.89	0.77	1.05	22.56	0.49
2.46	62.96	0.83	1.10	24.54	0.49
2.81	63.01	0.89	1.14	26.07	0.50
3.23	63.07	0.94	1.18	27.78	0.50

Tailwater Channel Data - EC18

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (1:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0300

Channel Invert Elevation: 62.12 m

Roadway Data for Crossing: EC18

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 63.57 m

Roadway Surface: Paved

Roadway Top Width: 11.03 m

HY-8 Culvert Analysis Report

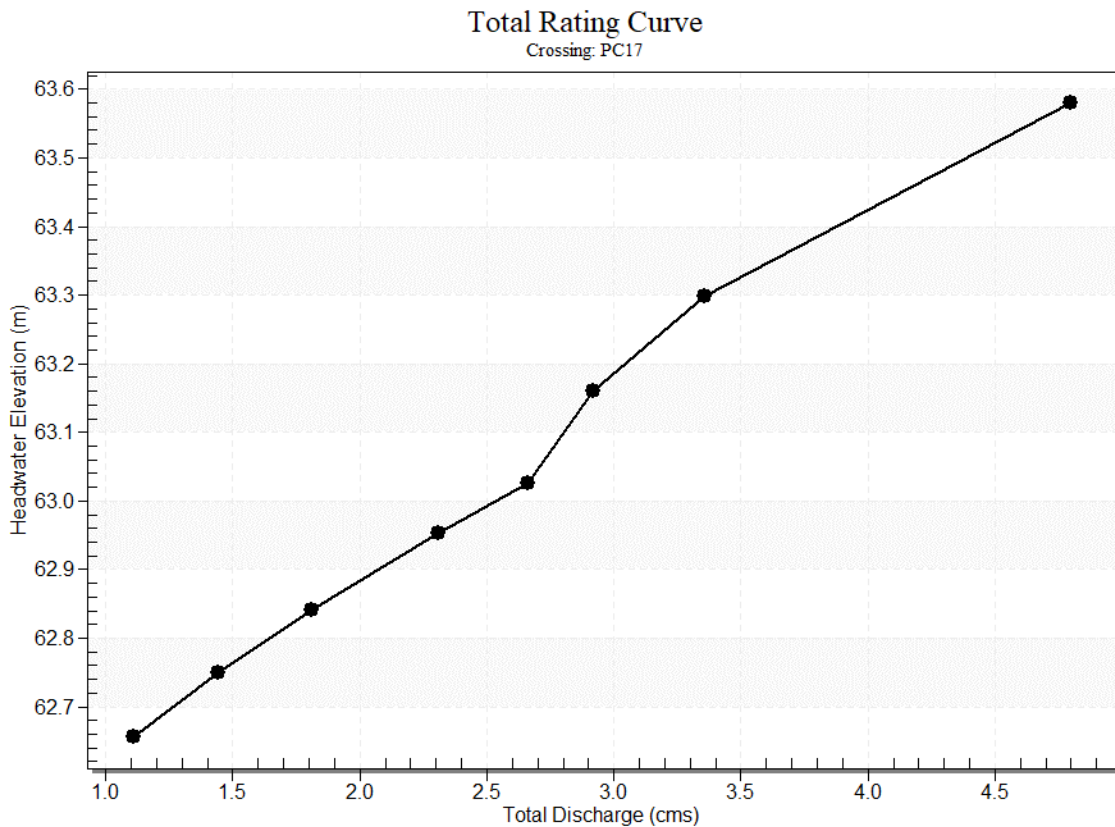
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC17

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC17 Discharge (cms)	Roadway Discharge (cms)	Iterations
62.66	2-yr	1.11	1.11	0.00	1
62.75	5-yr	1.44	1.44	0.00	1
62.84	10-yr	1.81	1.81	0.00	1
62.95	25-yr	2.31	2.31	0.00	1
63.03	50-yr	2.66	2.66	0.00	1
63.16	100-yr	2.92	2.92	0.00	1
63.30	115%	3.36	3.36	0.00	1
63.44	Overtopping	3.79	3.79	0.00	Overtopping

Rating Curve Plot for Crossing: PC17



Culvert Data: PC17

Table 1 - Culvert Summary Table: PC17

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	1.11 cms	1.11 cms	62.66	0.44	0.59 7	3- M 1t	0.51	0.2 6	0.5 7	0.57	0.72	0.90
5-yr	1.44 cms	1.44 cms	62.75	0.52	0.68 9	3- M 1t	0.59	0.3 1	0.6 5	0.65	0.82	0.96
10- yr	1.81 cms	1.81 cms	62.84	0.61	0.78 2	3- M 1t	0.68	0.3 6	0.7 2	0.72	0.93	1.02
25- yr	2.31 cms	2.31 cms	62.95	0.71	0.89 3	3- M 1t	0.80	0.4 2	0.8 1	0.81	1.06	1.09
50- yr	2.66 cms	2.66 cms	63.03	0.78	0.96 5	3- M 2t	0.87	0.4 6	0.8 6	0.86	1.14	1.13
100- yr	2.92 cms	2.92 cms	63.16	0.83	1.10 1	4- FF f	0.90	0.4 9	0.9 0	0.90	1.20	1.15
115 %	3.36 cms	3.36 cms	63.30	0.92	1.23 8	4- FF f	0.90	0.5 4	0.9 0	0.96	1.38	1.20

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

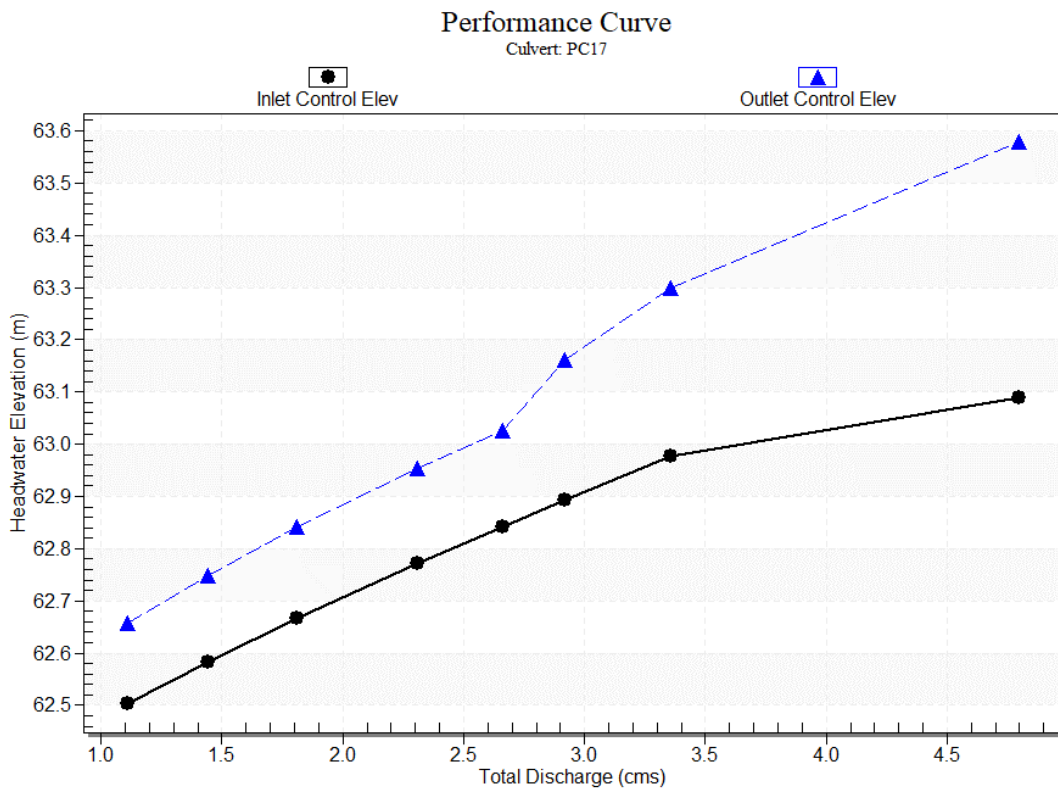
Inlet Elevation (invert): 62.06 m,

Outlet Elevation (invert): 62.00 m

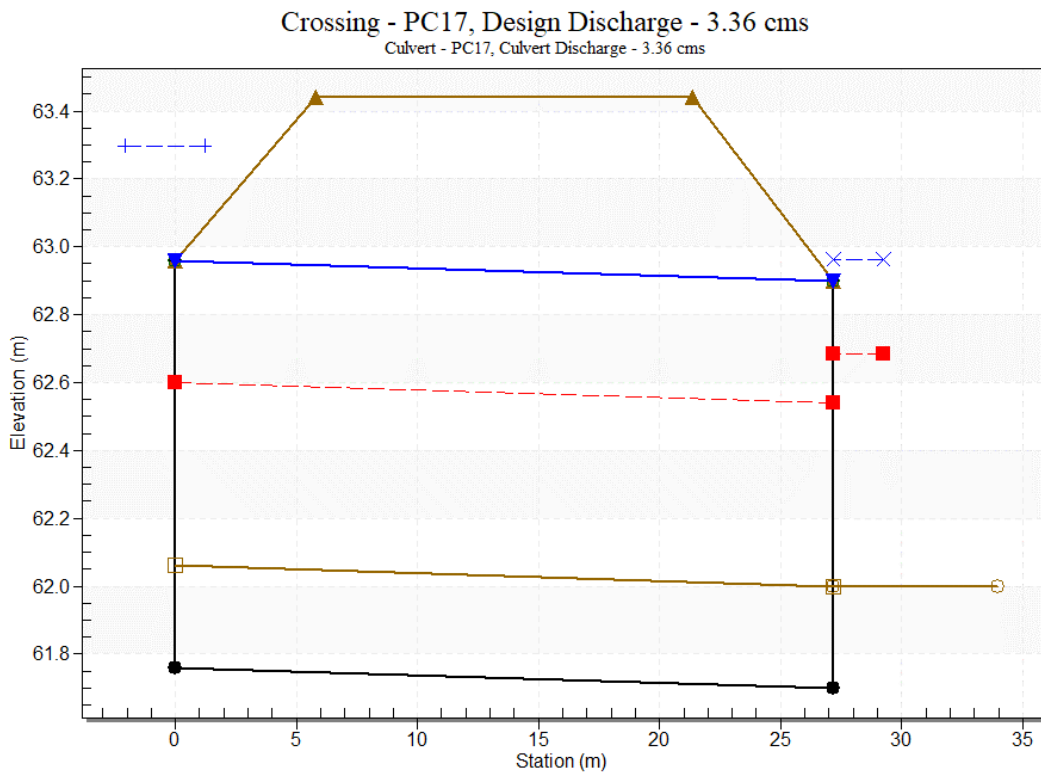
Culvert Length: 27.18 m,

Culvert Slope: 0.0022

Culvert Performance Curve Plot: PC17



Water Surface Profile Plot for Culvert: PC17



Site Data - PC17

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 61.76 m

Outlet Station: 27.18 m

Outlet Elevation: 61.70 m

Number of Barrels: 1

Culvert Data Summary - PC17

Barrel Shape: Concrete Box

Barrel Span: 2700.00 mm

Barrel Rise: 1200.00 mm

Barrel Material: Concrete

Embedment: 300.00 mm

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: PC17

Table 2 - Downstream Channel Rating Curve (Crossing: PC17)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
1.11	62.57	0.57	0.90	16.89	0.47
1.44	62.65	0.65	0.96	19.12	0.48
1.81	62.72	0.72	1.02	21.29	0.48
2.31	62.81	0.81	1.09	23.84	0.49
2.66	62.86	0.86	1.13	25.43	0.49
2.92	62.90	0.90	1.15	26.53	0.50
3.36	62.96	0.96	1.20	28.26	0.50

Tailwater Channel Data - PC17

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (.:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0300

Channel Invert Elevation: 62.00 m

Roadway Data for Crossing: PC17

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 63.44 m

Roadway Surface: Paved

Roadway Top Width: 15.59 m

HY-8 Culvert Analysis Report

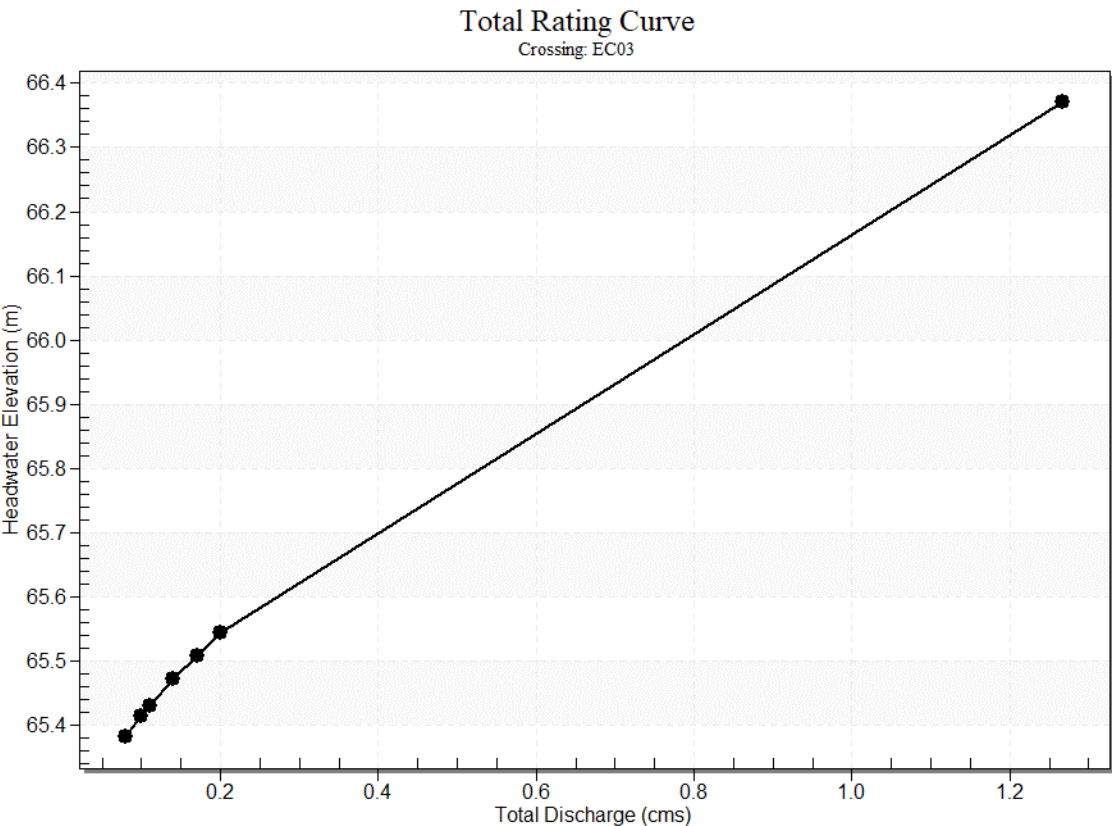
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: EC03

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	EC03 Discharge (cms)	Roadway Discharge (cms)	Iterations
65.38	2-yr	0.08	0.08	0.00	1
65.42	5-yr	0.10	0.10	0.00	1
65.43	10-yr	0.11	0.11	0.00	1
65.47	25-yr	0.14	0.14	0.00	1
65.51	50-yr	0.17	0.17	0.00	1
65.54	100-yr	0.20	0.20	0.00	1
66.35	Overtopping	1.20	1.20	0.00	Overtopping

Rating Curve Plot for Crossing: EC03



Culvert Data: EC03

Table 1 - Culvert Summary Table: EC03

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	0.08 cms	0.08 cms	65.38	0.23	0.25 8	2- M 2c	0.17	0.1 6	0.1 6	0.14	1.04	0.43
5-yr	0.10 cms	0.10 cms	65.42	0.26	0.29 0	2- M 2c	0.19	0.1 8	0.1 8	0.16	1.11	0.46
10- yr	0.11 cms	0.11 cms	65.43	0.27	0.30 5	2- M 2c	0.20	0.1 9	0.1 9	0.17	1.14	0.47
25- yr	0.14 cms	0.14 cms	65.47	0.31	0.34 7	2- M 2c	0.23	0.2 1	0.2 1	0.20	1.22	0.51
50- yr	0.17 cms	0.17 cms	65.51	0.35	0.38 4	2- M 2c	0.25	0.2 4	0.2 4	0.22	1.28	0.54
100- yr	0.20 cms	0.20 cms	65.54	0.38	0.41 9	2- M 2c	0.27	0.2 6	0.2 6	0.24	1.34	0.56

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

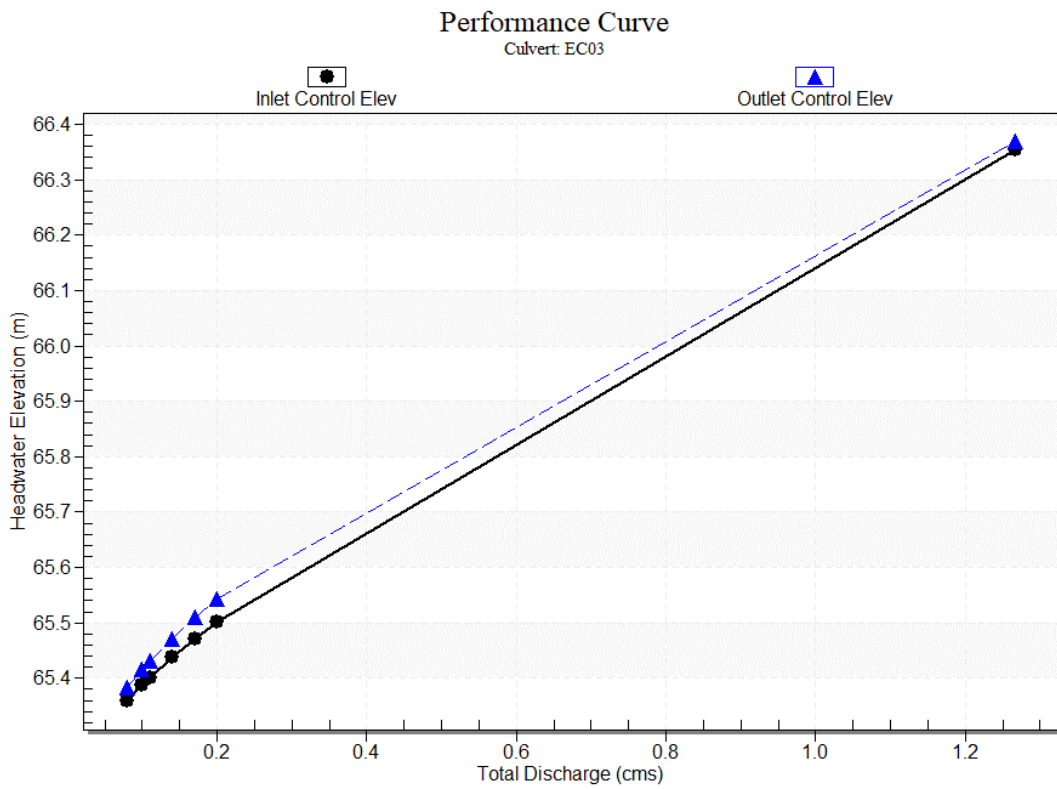
Inlet Elevation (invert): 65.12 m,

Outlet Elevation (invert): 64.81 m

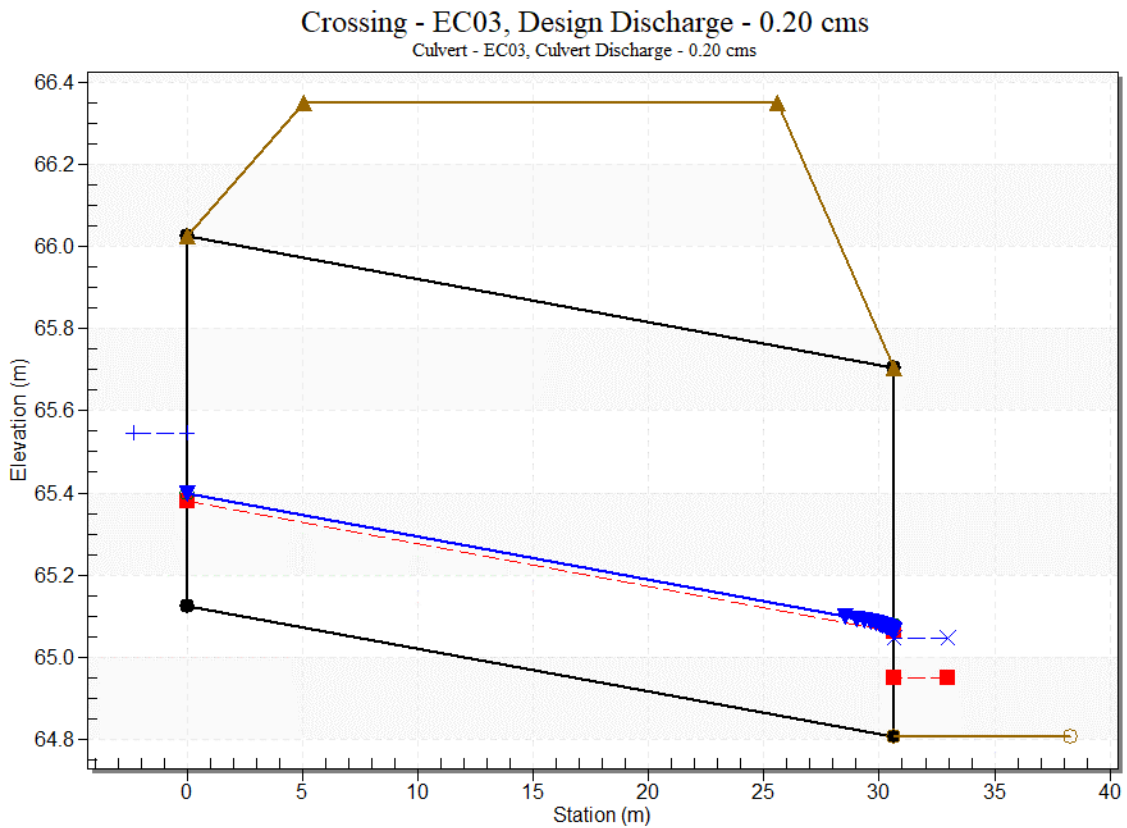
Culvert Length: 30.64 m,

Culvert Slope: 0.0104

Culvert Performance Curve Plot: EC03



Water Surface Profile Plot for Culvert: EC03



Site Data - EC03

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 65.12 m

Outlet Station: 30.64 m

Outlet Elevation: 64.81 m

Number of Barrels: 1

Culvert Data Summary - EC03

Barrel Shape: Circular

Barrel Diameter: 900.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting ($K_e=0.9$)

Inlet Depression: None

Tailwater Data for Crossing: EC03

Table 2 - Downstream Channel Rating Curve (Crossing: EC03)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
0.08	64.95	0.14	0.43	4.26	0.40
0.10	64.97	0.16	0.46	4.83	0.40
0.11	64.98	0.17	0.47	5.09	0.41
0.14	65.00	0.20	0.51	5.82	0.41
0.17	65.03	0.22	0.54	6.46	0.42
0.20	65.05	0.24	0.56	7.06	0.42

Tailwater Channel Data - EC03

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (1:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0300

Channel Invert Elevation: 64.81 m

Roadway Data for Crossing: EC03

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 66.35 m

Roadway Surface: Paved

Roadway Top Width: 20.53 m

HY-8 Culvert Analysis Report

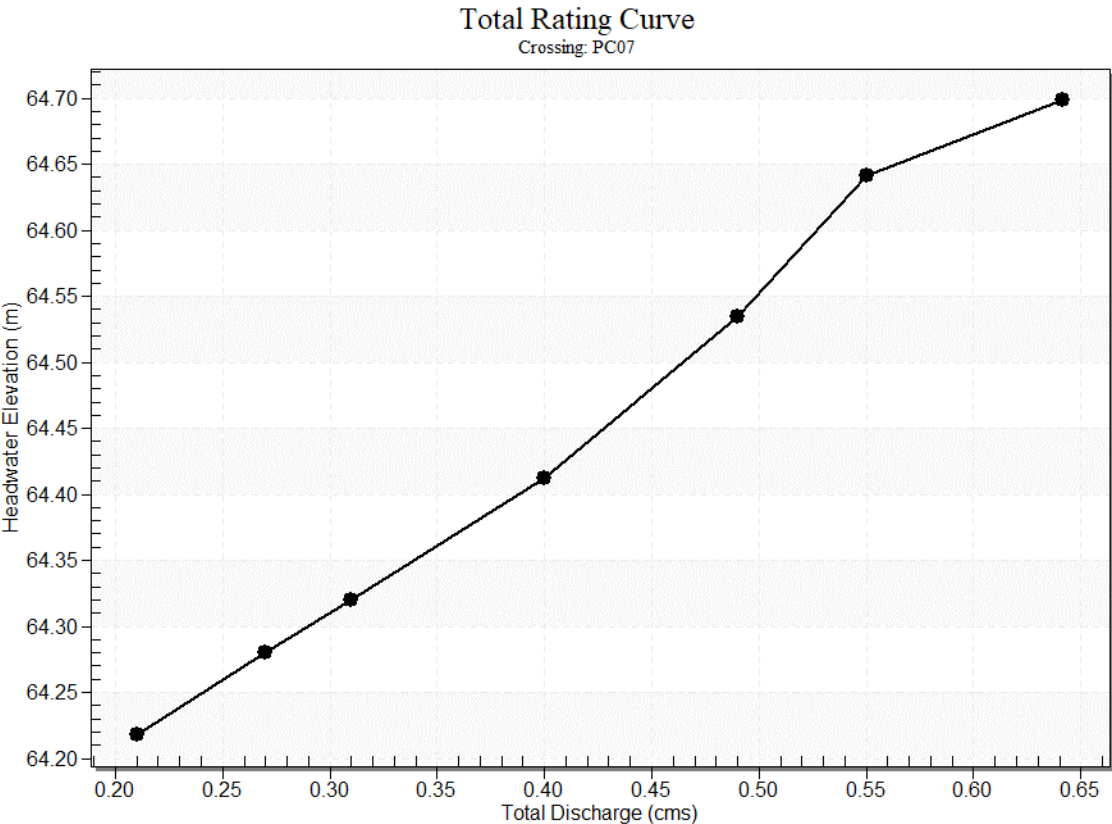
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC07

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC07 Discharge (cms)	Roadway Discharge (cms)	Iterations
64.22	2-yr	0.21	0.21	0.00	1
64.28	5-yr	0.27	0.27	0.00	1
64.32	10-yr	0.31	0.31	0.00	1
64.41	25-yr	0.40	0.40	0.00	1
64.53	50-yr	0.49	0.49	0.00	1
64.64	100-yr	0.55	0.55	0.00	1
64.67	Overtopping	0.56	0.56	0.00	Overtopping

Rating Curve Plot for Crossing: PC07



Culvert Data: PC07

Table 1 - Culvert Summary Table: PC07

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	0.21 cms	0.21 cms	64.22	0.27	0.31 8	3- M 2t	0.30	0.1 5	0.2 5	0.25	0.75	0.57
5-yr	0.27 cms	0.27 cms	64.28	0.33	0.38 0	3- M 2t	0.38	0.1 7	0.2 8	0.28	0.86	0.61
10- yr	0.31 cms	0.31 cms	64.32	0.36	0.42 0	3- M 2t	0.49	0.1 9	0.3 0	0.30	0.93	0.64
25- yr	0.40 cms	0.40 cms	64.41	0.44	0.51 2	3- M 2t	0.49	0.2 2	0.3 5	0.35	1.08	0.68
50- yr	0.49 cms	0.49 cms	64.53	0.52	0.63 4	7- M 2t	0.49	0.2 6	0.3 8	0.38	1.23	0.72
100- yr	0.55 cms	0.55 cms	64.64	0.57	0.74 2	7- M 2t	0.49	0.2 8	0.4 1	0.41	1.33	0.75

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

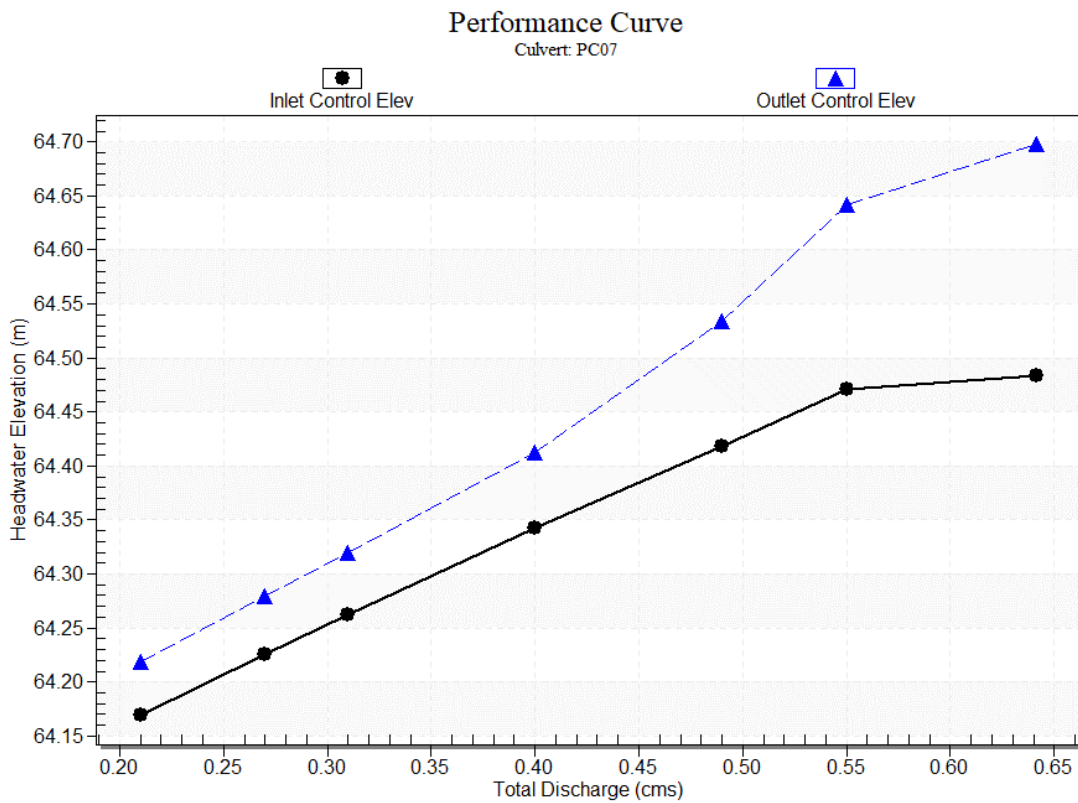
Inlet Elevation (invert): 63.90 m,

Outlet Elevation (invert): 63.84 m

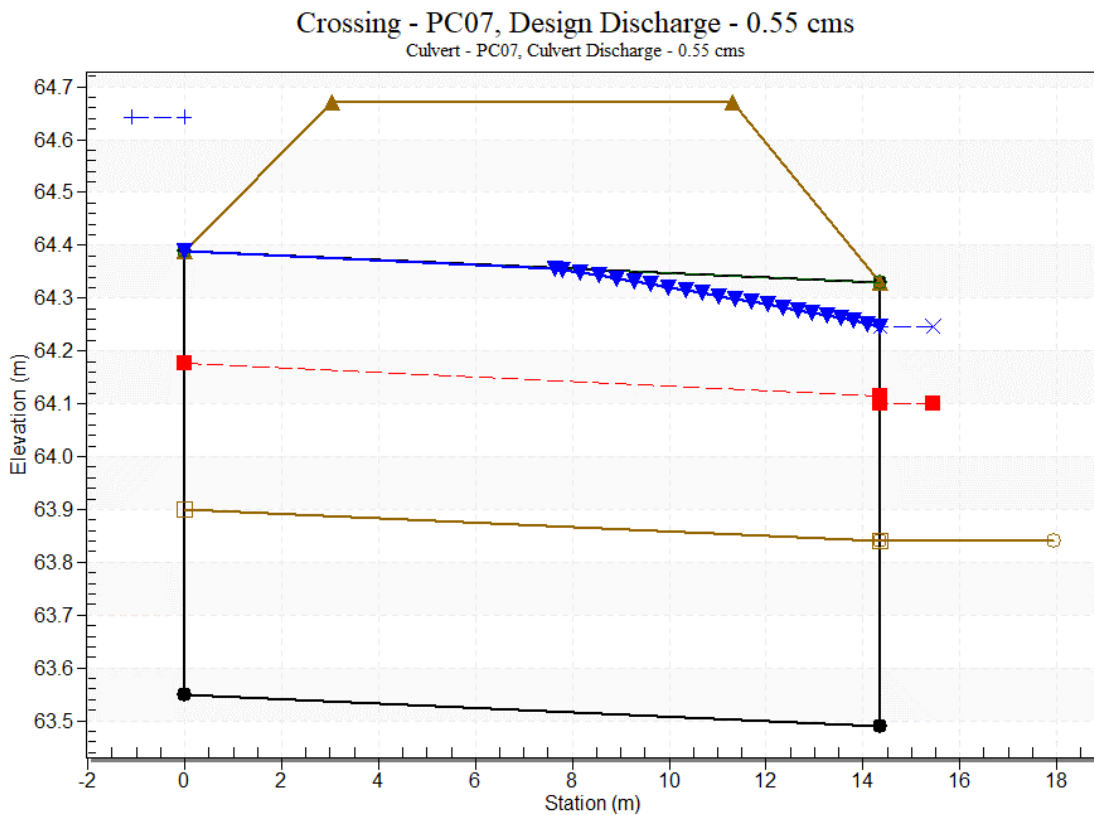
Culvert Length: 14.35 m,

Culvert Slope: 0.0042

Culvert Performance Curve Plot: PC07



Water Surface Profile Plot for Culvert: PC07



Site Data - PC07

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 63.55 m

Outlet Station: 14.35 m

Outlet Elevation: 63.49 m

Number of Barrels: 1

Culvert Data Summary - PC07

Barrel Shape: Pipe Arch

Barrel Span: 1199.38 mm

Barrel Rise: 838.20 mm

Barrel Material: Steel or Aluminum

Embedment: 350.00 mm

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting ($K_e=0.9$)

Inlet Depression: None

Tailwater Data for Crossing: PC07

Table 2 - Downstream Channel Rating Curve (Crossing: PC07)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
0.21	64.09	0.25	0.57	7.24	0.42
0.27	64.12	0.28	0.61	8.28	0.43
0.31	64.14	0.30	0.64	8.90	0.43
0.40	64.19	0.35	0.68	10.16	0.44
0.49	64.22	0.38	0.72	11.27	0.45
0.55	64.25	0.41	0.75	11.95	0.45

Tailwater Channel Data - PC07

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (1:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0300

Channel Invert Elevation: 63.84 m

Roadway Data for Crossing: PC07

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 64.67 m

Roadway Surface: Paved

Roadway Top Width: 8.25 m

HY-8 Culvert Analysis Report

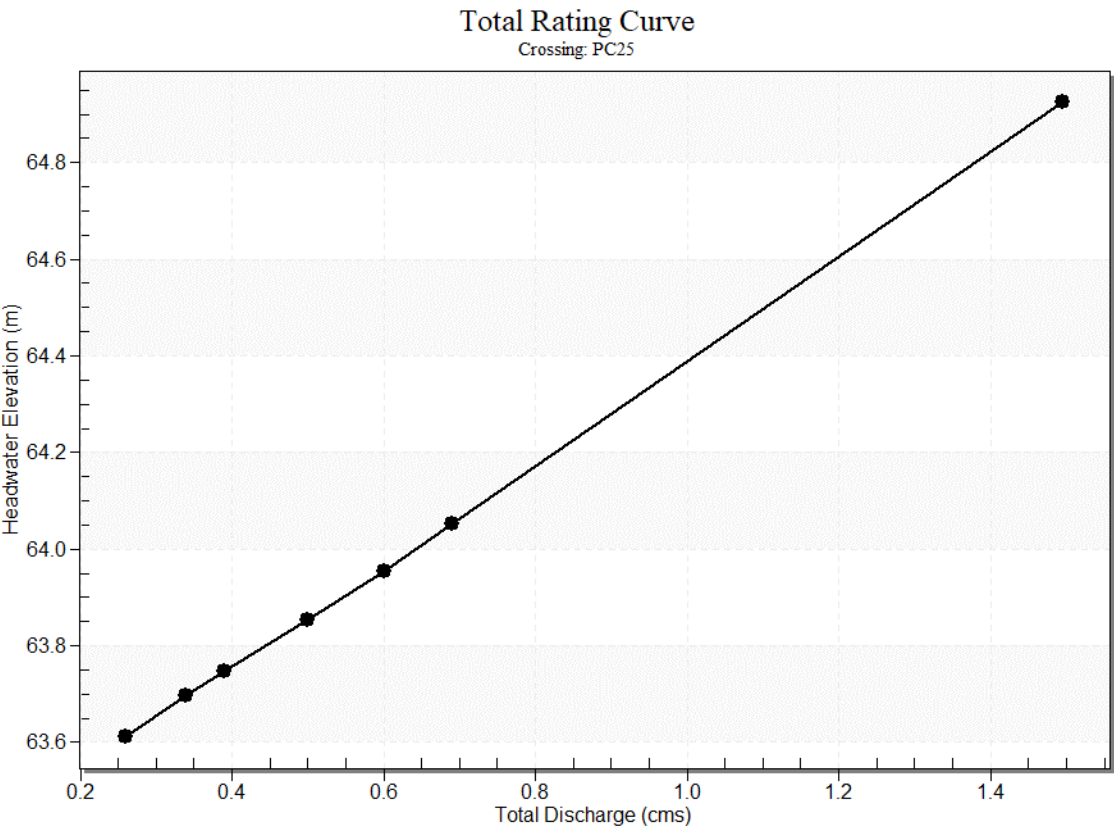
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC25

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC25 Discharge (cms)	Roadway Discharge (cms)	Iterations
63.61	2-yr	0.26	0.26	0.00	1
63.70	5-yr	0.34	0.34	0.00	1
63.75	10-yr	0.39	0.39	0.00	1
63.85	25-yr	0.50	0.50	0.00	1
63.95	50-yr	0.60	0.60	0.00	1
64.05	100-yr	0.69	0.69	0.00	1
64.89	Overtopping	1.37	1.37	0.00	Overtopping

Rating Curve Plot for Crossing: PC25



Culvert Data: PC25

Table 1 - Culvert Summary Table: PC25

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	0.26 cms	0.26 cms	63.61	0.46	0.54 0	7- H2 c	- 0.30	0.3 0	0.3 0	0.08	1.49	2.97
5-yr	0.34 cms	0.34 cms	63.70	0.53	0.62 4	7- H2 c	- 0.30	0.3 5	0.3 5	0.09	1.61	3.25
10- yr	0.39 cms	0.39 cms	63.75	0.58	0.67 5	7- H2 c	- 0.30	0.3 7	0.3 7	0.10	1.69	3.40
25- yr	0.50 cms	0.50 cms	63.85	0.68	0.78 2	7- H2 c	- 0.30	0.4 3	0.4 3	0.11	1.83	3.69
50- yr	0.60 cms	0.60 cms	63.95	0.77	0.88 1	7- H2 c	- 0.30	0.4 7	0.4 7	0.12	1.96	3.91
100- yr	0.69 cms	0.69 cms	64.05	0.86	0.98 1	7- H2 c	- 0.30	0.5 1	0.5 1	0.13	2.06	4.09

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

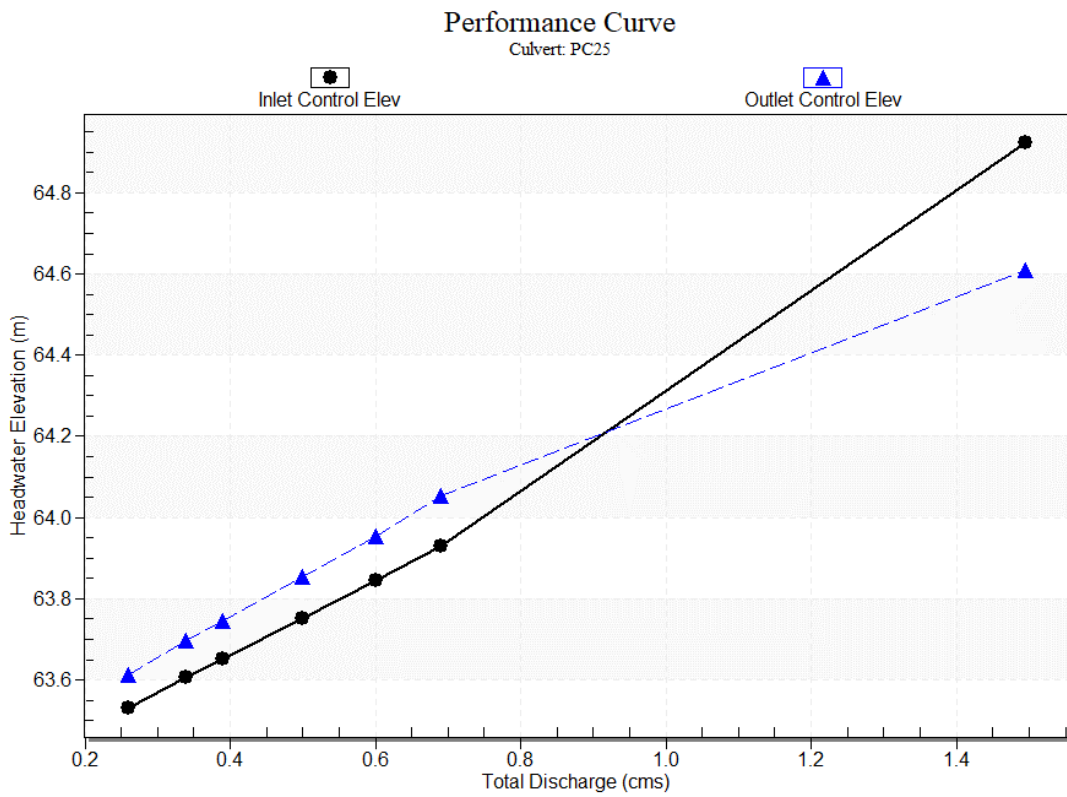
Inlet Elevation (invert): 63.07 m,

Outlet Elevation (invert): 63.07 m

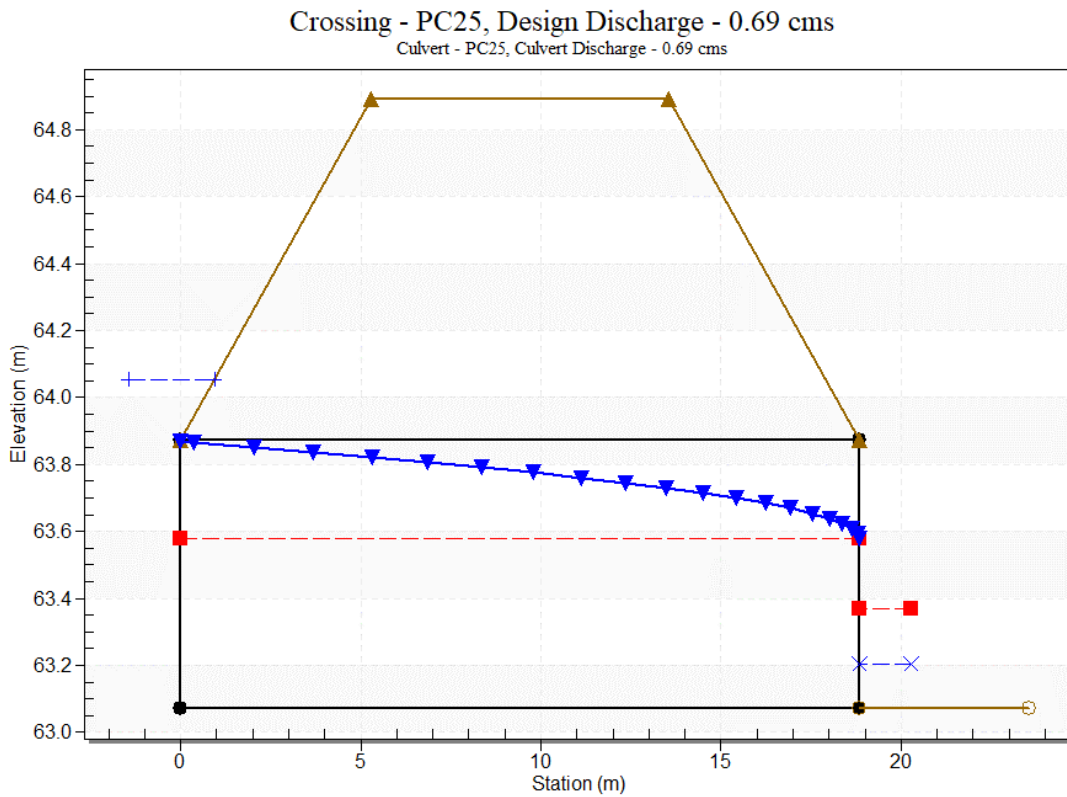
Culvert Length: 18.84 m,

Culvert Slope: 0.0000

Culvert Performance Curve Plot: PC25



Water Surface Profile Plot for Culvert: PC25



Site Data - PC25

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 63.07 m

Outlet Station: 18.84 m

Outlet Elevation: 63.07 m

Number of Barrels: 1

Culvert Data Summary - PC25

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting ($K_e=0.9$)

Inlet Depression: None

Tailwater Data for Crossing: PC25

Table 2 - Downstream Channel Rating Curve (Crossing: PC25)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
0.26	63.15	0.08	2.97	2.24	3.65
0.34	63.16	0.09	3.25	2.62	3.73
0.39	63.17	0.10	3.40	2.83	3.77
0.50	63.18	0.11	3.69	3.26	3.84
0.60	63.20	0.12	3.91	3.62	3.89
0.69	63.21	0.13	4.09	3.92	3.93

Tailwater Channel Data - PC25

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (┐:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0030

Channel Invert Elevation: 63.07 m

Roadway Data for Crossing: PC25

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 64.89 m

Roadway Surface: Paved

Roadway Top Width: 8.25 m

HY-8 Culvert Analysis Report

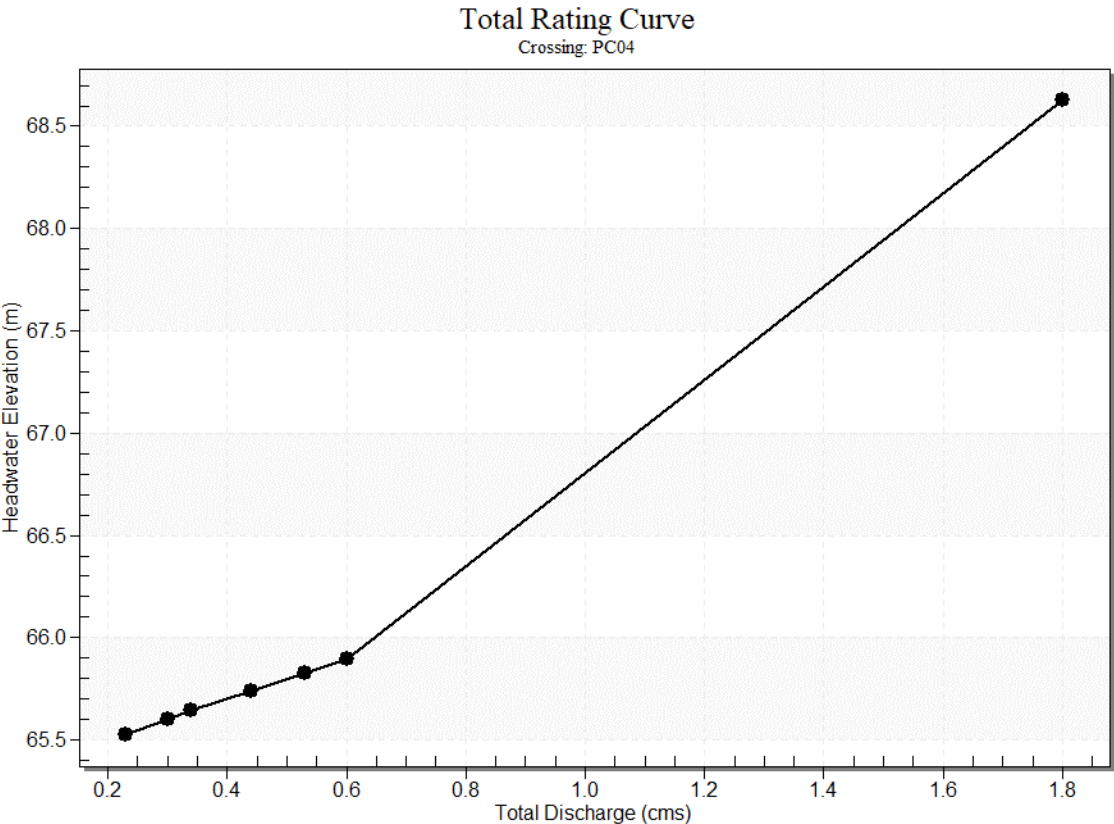
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC04

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC04 Discharge (cms)	Roadway Discharge (cms)	Iterations
65.53	2-yr	0.23	0.23	0.00	1
65.60	5-yr	0.30	0.30	0.00	1
65.64	10-yr	0.34	0.34	0.00	1
65.74	25-yr	0.44	0.44	0.00	1
65.83	50-yr	0.53	0.53	0.00	1
65.90	100-yr	0.60	0.60	0.00	1
68.60	Overtopping	1.72	1.72	0.00	Overtopping

Rating Curve Plot for Crossing: PC04



Culvert Data: PC04

Table 1 - Culvert Summary Table: PC04

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	0.23 cms	0.23 cms	65.53	0.42	0.46 8	2- M 2c	0.37	0.2 8	0.2 8	0.07	1.43	2.84
5-yr	0.30 cms	0.30 cms	65.60	0.49	0.54 4	2- M 2c	0.43	0.3 3	0.3 3	0.08	1.55	3.11
10- yr	0.34 cms	0.34 cms	65.64	0.53	0.58 5	2- M 2c	0.47	0.3 5	0.3 5	0.09	1.61	3.25
25- yr	0.44 cms	0.44 cms	65.74	0.62	0.68 3	2- M 2c	0.56	0.4 0	0.4 0	0.10	1.75	3.53
50- yr	0.53 cms	0.53 cms	65.83	0.71	0.77 0	2- M 2c	0.66	0.4 4	0.4 4	0.11	1.87	3.75
100- yr	0.60 cms	0.60 cms	65.90	0.77	0.83 9	7- M 2c	0.80	0.4 7	0.4 7	0.12	1.96	3.91

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

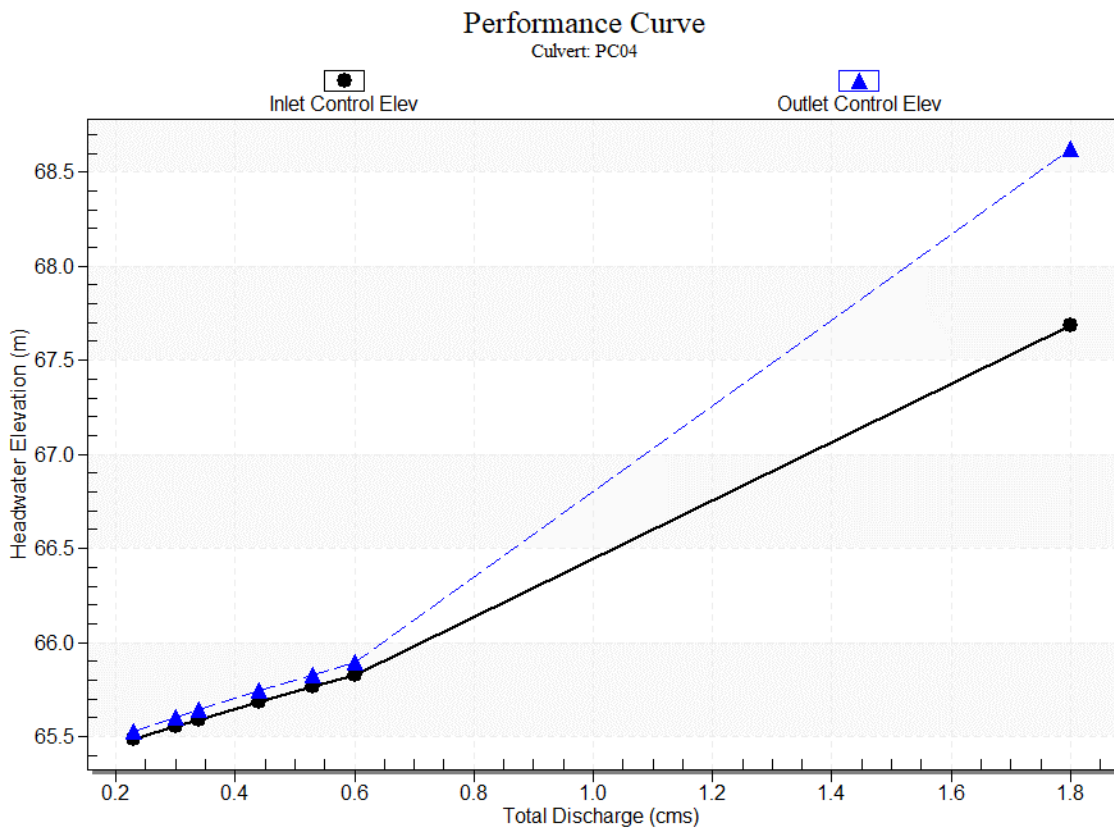
Inlet Elevation (invert): 65.06 m,

Outlet Elevation (invert): 64.89 m

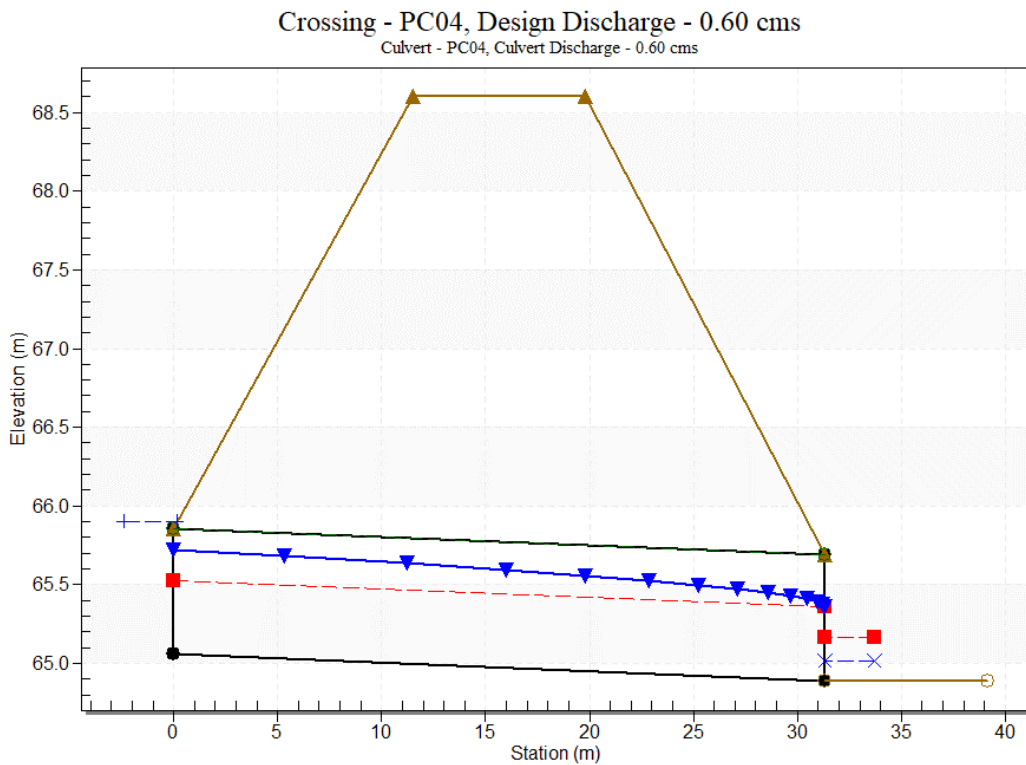
Culvert Length: 31.32 m,

Culvert Slope: 0.0054

Culvert Performance Curve Plot: PC04



Water Surface Profile Plot for Culvert: PC04



Site Data - PC04

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 65.06 m

Outlet Station: 31.32 m

Outlet Elevation: 64.89 m

Number of Barrels: 1

Culvert Data Summary - PC04

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting ($K_e=0.9$)

Inlet Depression: None

Tailwater Data for Crossing: PC04

Table 2 - Downstream Channel Rating Curve (Crossing: PC04)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
0.23	64.96	0.07	2.84	2.08	3.61
0.30	64.97	0.08	3.11	2.43	3.69
0.34	64.98	0.09	3.25	2.62	3.73
0.44	64.99	0.10	3.53	3.03	3.80
0.53	65.00	0.11	3.75	3.38	3.85
0.60	65.01	0.12	3.91	3.62	3.89

Tailwater Channel Data - PC04

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (┐:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0030

Channel Invert Elevation: 64.89 m

Roadway Data for Crossing: PC04

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 68.60 m

Roadway Surface: Paved

Roadway Top Width: 8.26 m

HY-8 Culvert Analysis Report

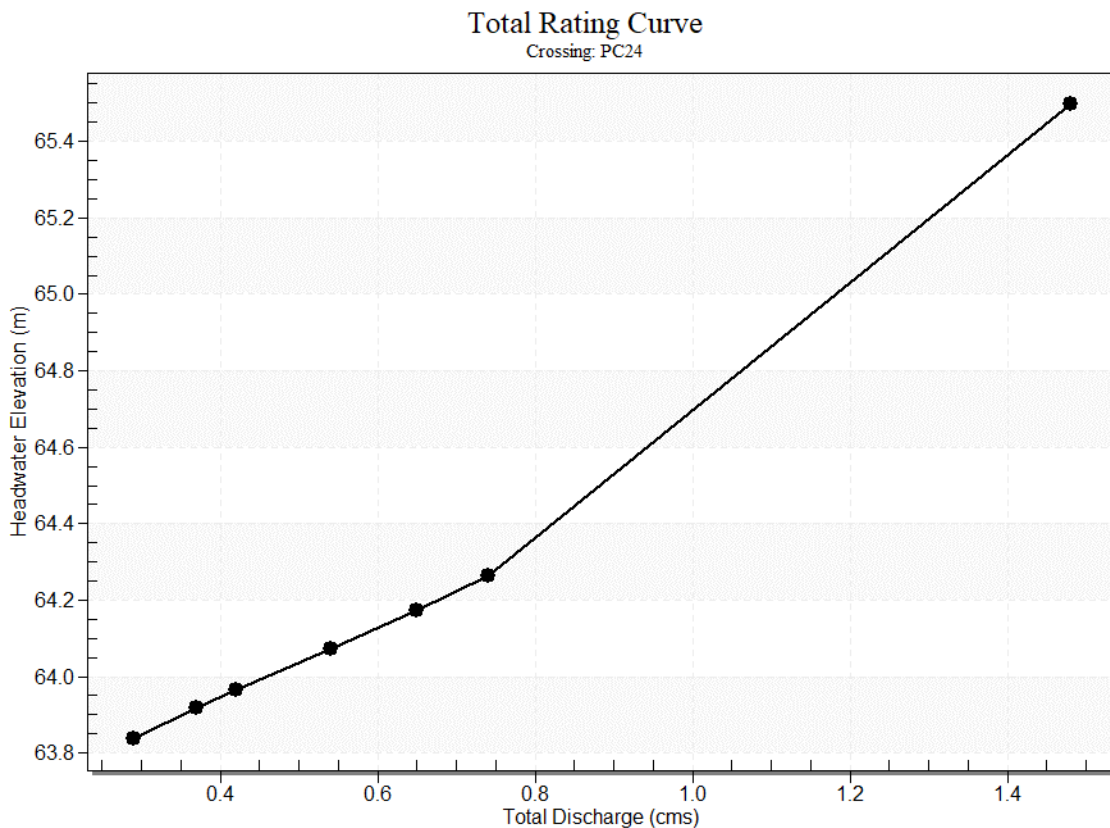
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC24

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC24 Discharge (cms)	Roadway Discharge (cms)	Iterations
63.84	2-yr	0.29	0.29	0.00	1
63.92	5-yr	0.37	0.37	0.00	1
63.96	10-yr	0.42	0.42	0.00	1
64.07	25-yr	0.54	0.54	0.00	1
64.17	50-yr	0.65	0.65	0.00	1
64.26	100-yr	0.74	0.74	0.00	1
65.46	Overtopping	1.35	1.35	0.00	Overtopping

Rating Curve Plot for Crossing: PC24



Culvert Data: PC24

Table 1 - Culvert Summary Table: PC24

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	0.29 cms	0.29 cms	63.84	0.48	0.52 7	2- M 2c	0.39	0.3 2	0.3 2	0.08	1.54	3.08
5-yr	0.37 cms	0.37 cms	63.92	0.56	0.60 6	2- M 2c	0.45	0.3 6	0.3 6	0.09	1.66	3.34
10- yr	0.42 cms	0.42 cms	63.96	0.61	0.65 3	2- M 2c	0.49	0.3 9	0.3 9	0.10	1.73	3.48
25- yr	0.54 cms	0.54 cms	64.07	0.71	0.76 2	2- M 2c	0.59	0.4 4	0.4 4	0.12	1.88	3.78
50- yr	0.65 cms	0.65 cms	64.17	0.82	0.86 3	7- M 2c	0.80	0.4 9	0.4 9	0.13	2.02	4.01
100- yr	0.74 cms	0.74 cms	64.26	0.91	0.95 3	7- M 2c	0.80	0.5 2	0.5 2	0.14	2.12	4.17

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

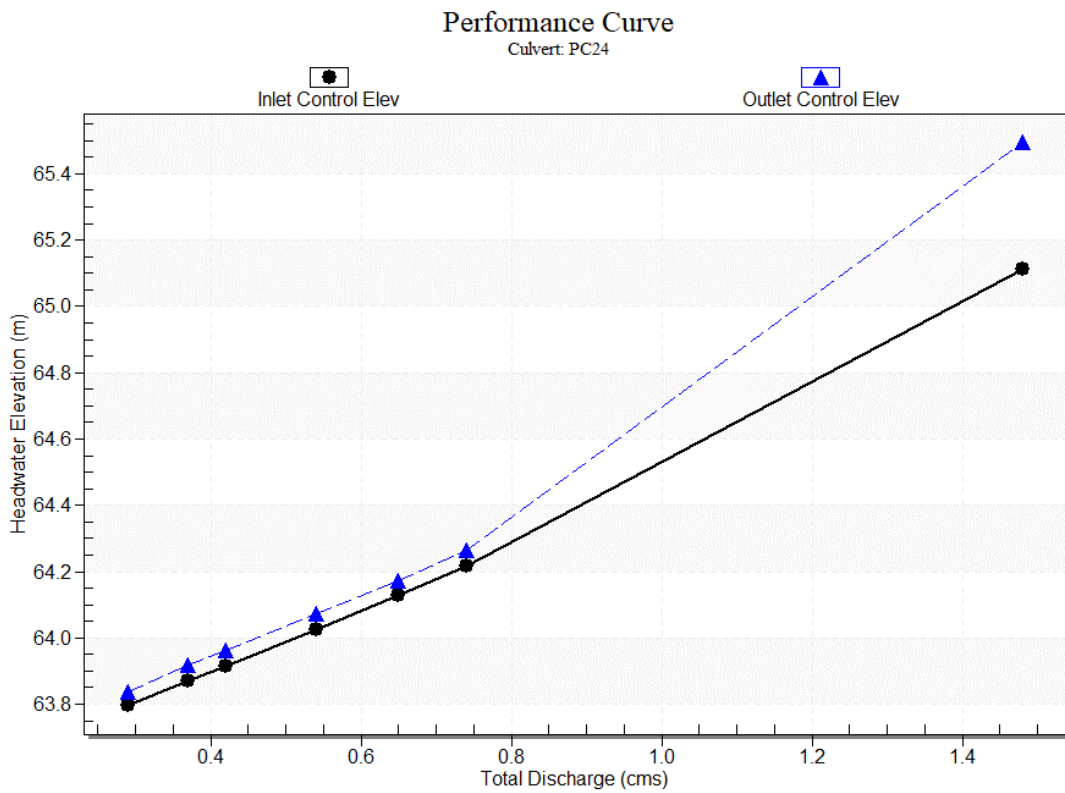
Inlet Elevation (invert): 63.31 m,

Outlet Elevation (invert): 63.13 m

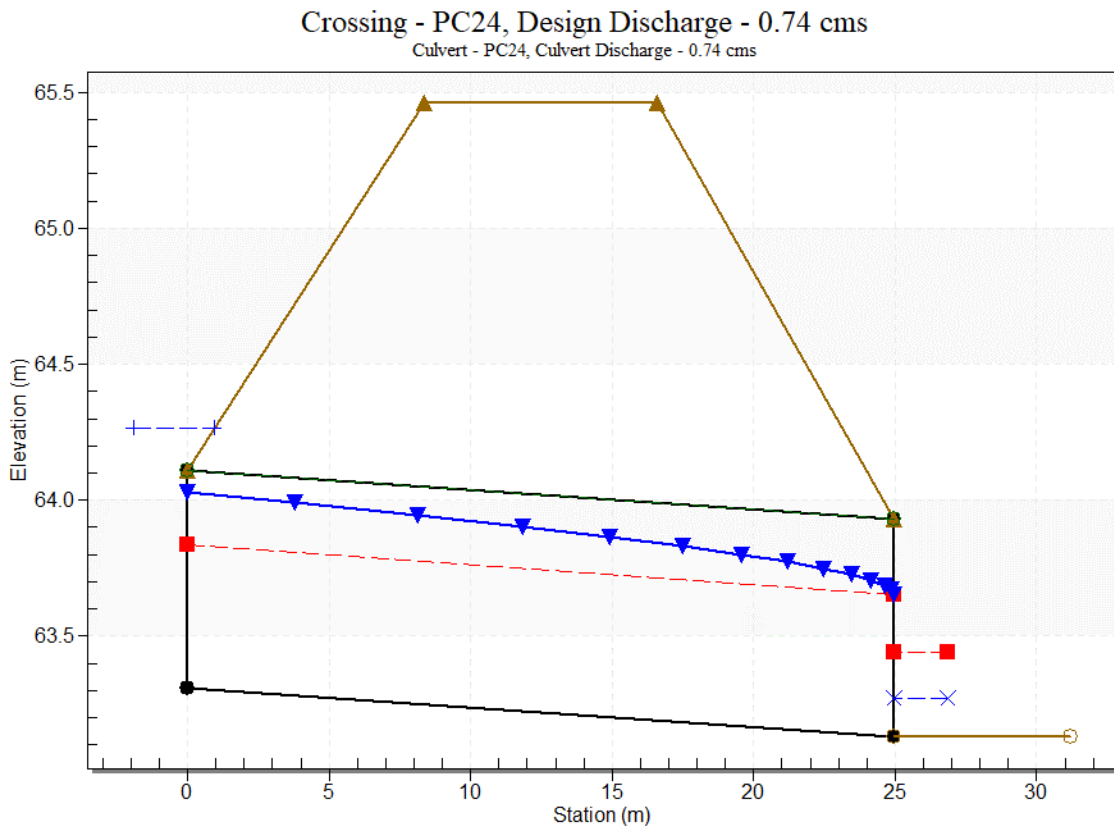
Culvert Length: 24.96 m,

Culvert Slope: 0.0072

Culvert Performance Curve Plot: PC24



Water Surface Profile Plot for Culvert: PC24



Site Data - PC24

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 63.31 m

Outlet Station: 24.96 m

Outlet Elevation: 63.13 m

Number of Barrels: 1

Culvert Data Summary - PC24

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting ($K_e=0.9$)

Inlet Depression: None

Tailwater Data for Crossing: PC24

Table 2 - Downstream Channel Rating Curve (Crossing: PC24)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
0.29	63.21	0.08	3.08	2.38	3.68
0.37	63.22	0.09	3.34	2.75	3.75
0.42	63.23	0.10	3.48	2.95	3.79
0.54	63.25	0.12	3.78	3.41	3.86
0.65	63.26	0.13	4.01	3.79	3.91
0.74	63.27	0.14	4.17	4.08	3.95

Tailwater Channel Data - PC24

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (┐:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0030

Channel Invert Elevation: 63.13 m

Roadway Data for Crossing: PC24

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 65.46 m

Roadway Surface: Paved

Roadway Top Width: 8.26 m

HY-8 Culvert Analysis Report

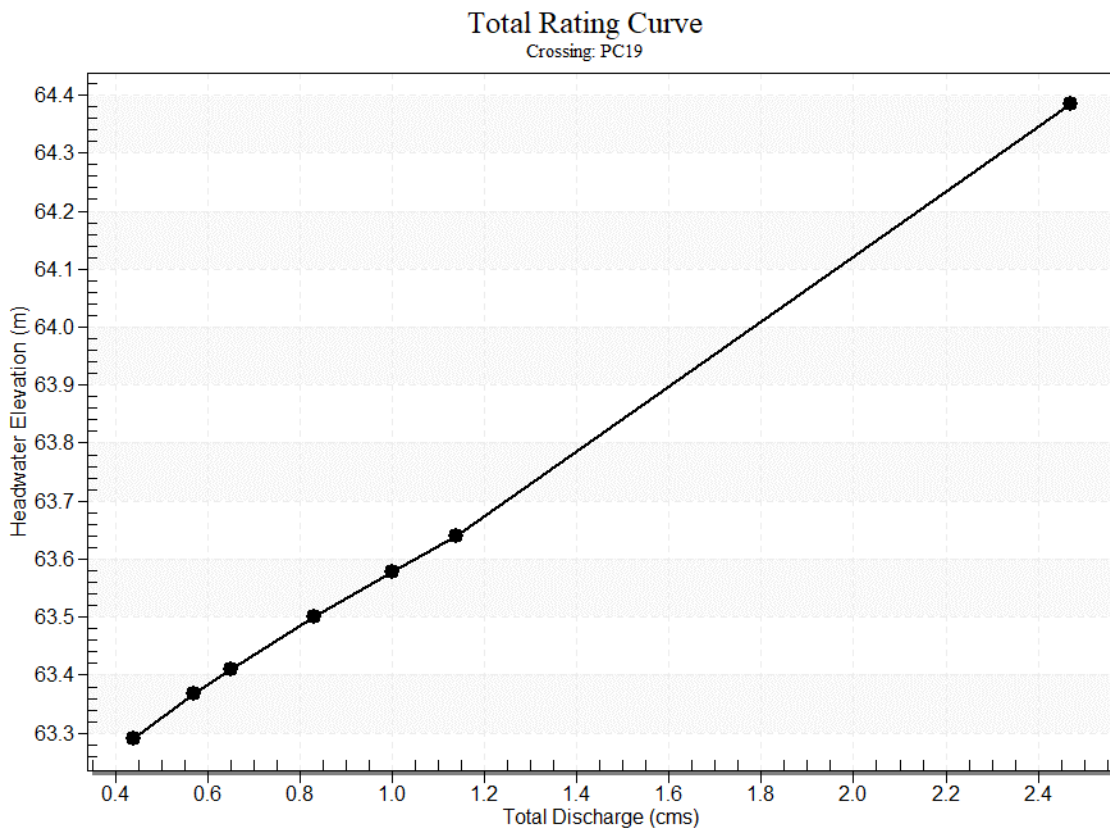
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC19

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC19 Discharge (cms)	Roadway Discharge (cms)	Iterations
63.29	2-yr	0.44	0.44	0.00	1
63.37	5-yr	0.57	0.57	0.00	1
63.41	10-yr	0.65	0.65	0.00	1
63.50	25-yr	0.83	0.83	0.00	1
63.58	50-yr	1.00	1.00	0.00	1
63.64	100-yr	1.14	1.14	0.00	1
64.32	Overtopping	2.13	2.13	0.00	Overtopping

Rating Curve Plot for Crossing: PC19



Culvert Data: PC19

Table 1 - Culvert Summary Table: PC19

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	0.44 cms	0.44 cms	63.29	0.35	0.49 1	2- M 2c	0.60	0.2 1	0.2 1	0.10	1.42	3.53
5-yr	0.57 cms	0.57 cms	63.37	0.42	0.56 7	2- M 2c	0.71	0.2 5	0.2 5	0.12	1.55	3.84
10- yr	0.65 cms	0.65 cms	63.41	0.46	0.61 0	2- M 2c	0.77	0.2 7	0.2 7	0.13	1.62	4.01
25- yr	0.83 cms	0.83 cms	63.50	0.54	0.70 1	2- M 2c	0.90	0.3 1	0.3 1	0.15	1.76	4.33
50- yr	1.00 cms	1.00 cms	63.58	0.61	0.77 9	2- M 2c	0.90	0.3 6	0.3 6	0.16	1.87	4.58
100- yr	1.14 cms	1.14 cms	63.64	0.66	0.83 9	2- M 2c	0.90	0.3 9	0.3 9	0.18	1.95	4.77

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

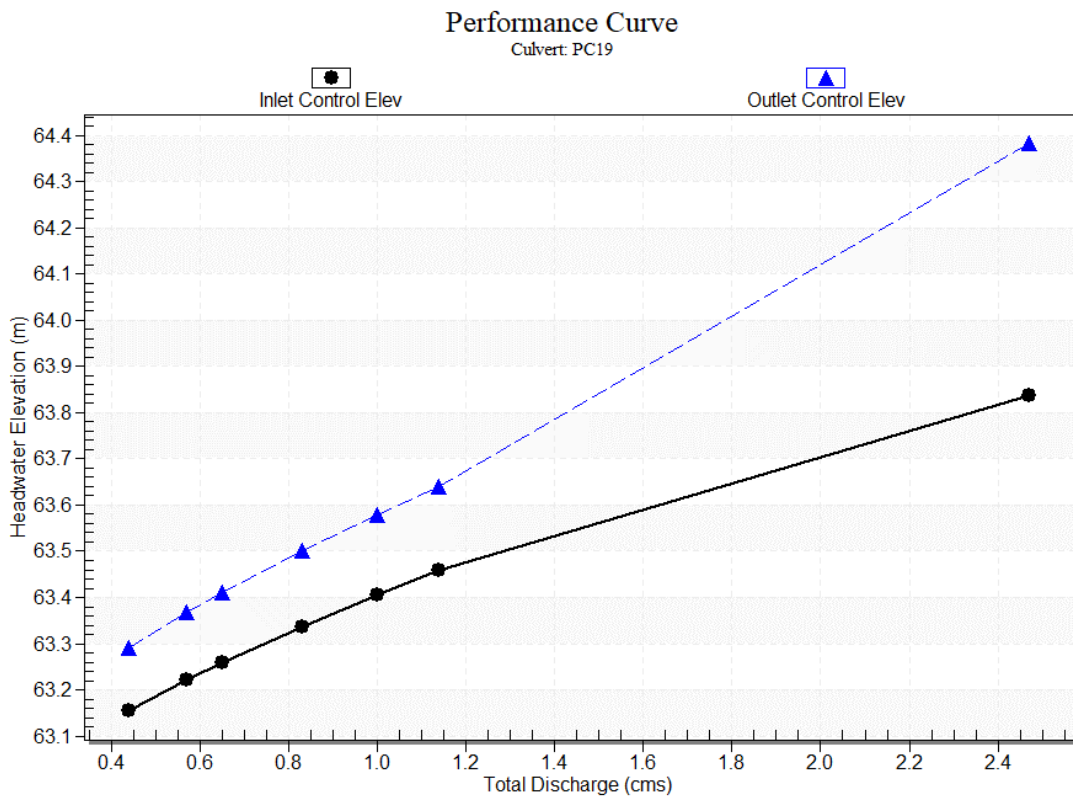
Inlet Elevation (invert): 62.80 m,

Outlet Elevation (invert): 62.75 m

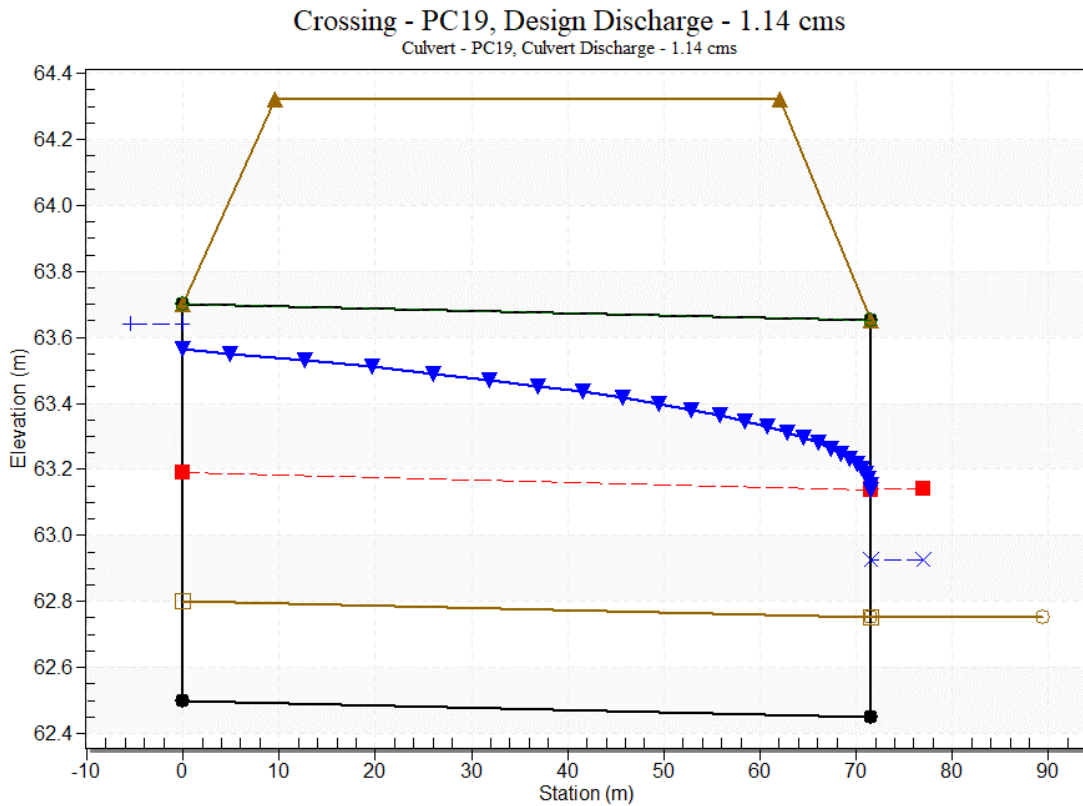
Culvert Length: 71.53 m,

Culvert Slope: 0.0007

Culvert Performance Curve Plot: PC19



Water Surface Profile Plot for Culvert: PC19



Site Data - PC19

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 62.50 m

Outlet Station: 71.53 m

Outlet Elevation: 62.45 m

Number of Barrels: 1

Culvert Data Summary - PC19

Barrel Shape: Concrete Box

Barrel Span: 1500.00 mm

Barrel Rise: 1200.00 mm

Barrel Material: Concrete

Embedment: 300.00 mm

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: PC19

Table 2 - Downstream Channel Rating Curve (Crossing: PC19)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
0.44	62.85	0.10	3.53	3.03	3.80
0.57	62.87	0.12	3.84	3.52	3.87
0.65	62.88	0.13	4.01	3.79	3.91
0.83	62.90	0.15	4.33	4.35	3.98
1.00	62.91	0.16	4.58	4.83	4.03
1.14	62.93	0.18	4.77	5.19	4.07

Tailwater Channel Data - PC19

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (1:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0030

Channel Invert Elevation: 62.75 m

Roadway Data for Crossing: PC19

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 64.32 m

Roadway Surface: Paved

Roadway Top Width: 52.50 m

HY-8 Culvert Analysis Report

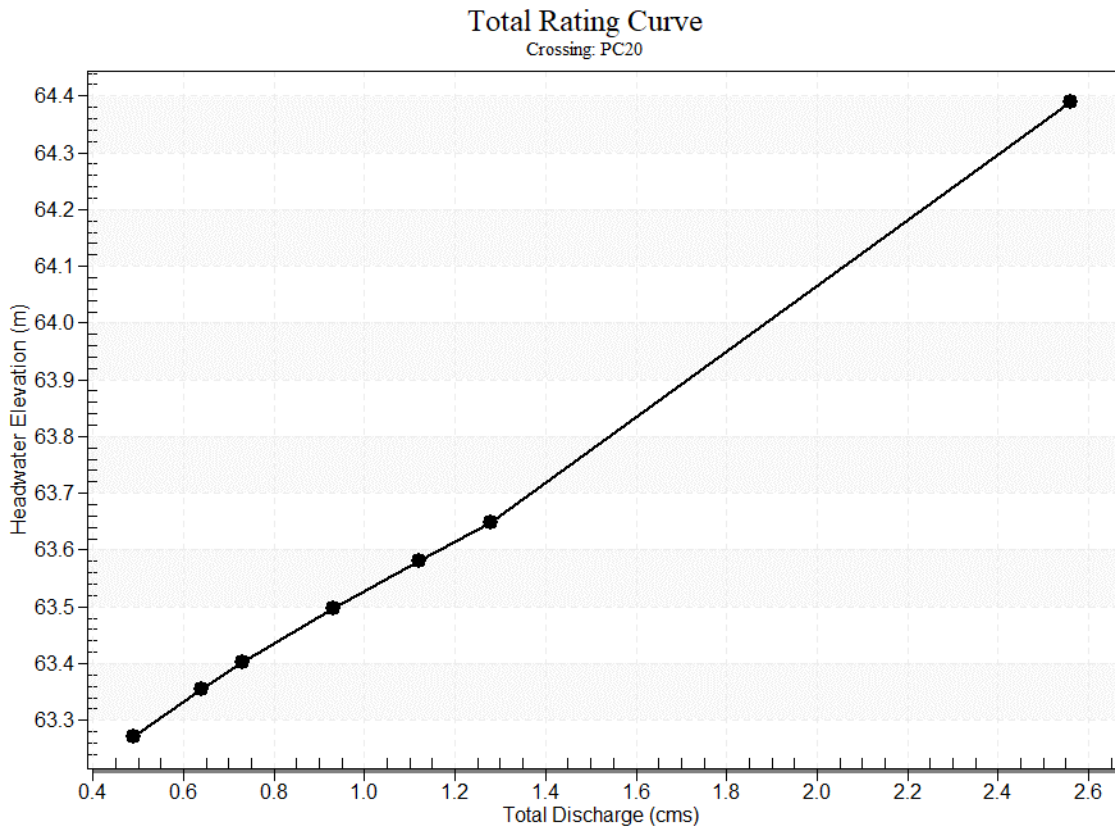
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC20

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC20 Discharge (cms)	Roadway Discharge (cms)	Iterations
63.27	2-yr	0.49	0.49	0.00	1
63.36	5-yr	0.64	0.64	0.00	1
63.40	10-yr	0.73	0.73	0.00	1
63.50	25-yr	0.93	0.93	0.00	1
63.58	50-yr	1.12	1.12	0.00	1
63.65	100-yr	1.28	1.28	0.00	1
64.32	Overtopping	2.19	2.19	0.00	Overtopping

Rating Curve Plot for Crossing: PC20



Culvert Data: PC20

Table 1 - Culvert Summary Table: PC20

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	0.49 cms	0.49 cms	63.27	0.38	0.52 2	2- M 2c	0.64	0.2 2	0.2 2	0.11	1.47	3.66
5-yr	0.64 cms	0.64 cms	63.36	0.45	0.60 6	2- M 2c	0.76	0.2 6	0.2 6	0.13	1.61	3.99
10- yr	0.73 cms	0.73 cms	63.40	0.49	0.65 2	2- M 2c	0.83	0.2 9	0.2 9	0.14	1.68	4.16
25- yr	0.93 cms	0.93 cms	63.50	0.58	0.74 8	2- M 2c	0.90	0.3 4	0.3 4	0.16	1.83	4.48
50- yr	1.12 cms	1.12 cms	63.58	0.65	0.83 1	2- M 2c	0.90	0.3 8	0.3 8	0.17	1.94	4.74
100- yr	1.28 cms	1.28 cms	63.65	0.71	0.89 8	2- M 2c	0.90	0.4 2	0.4 2	0.19	2.03	4.94

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

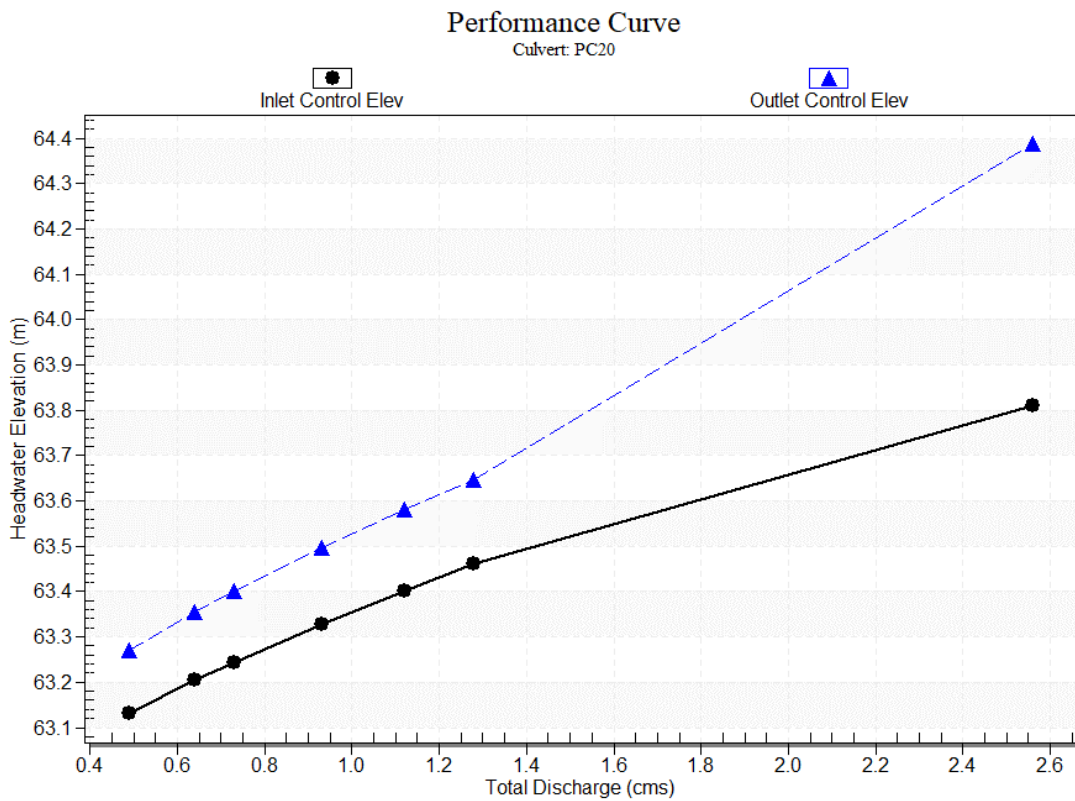
Inlet Elevation (invert): 62.75 m,

Outlet Elevation (invert): 62.70 m

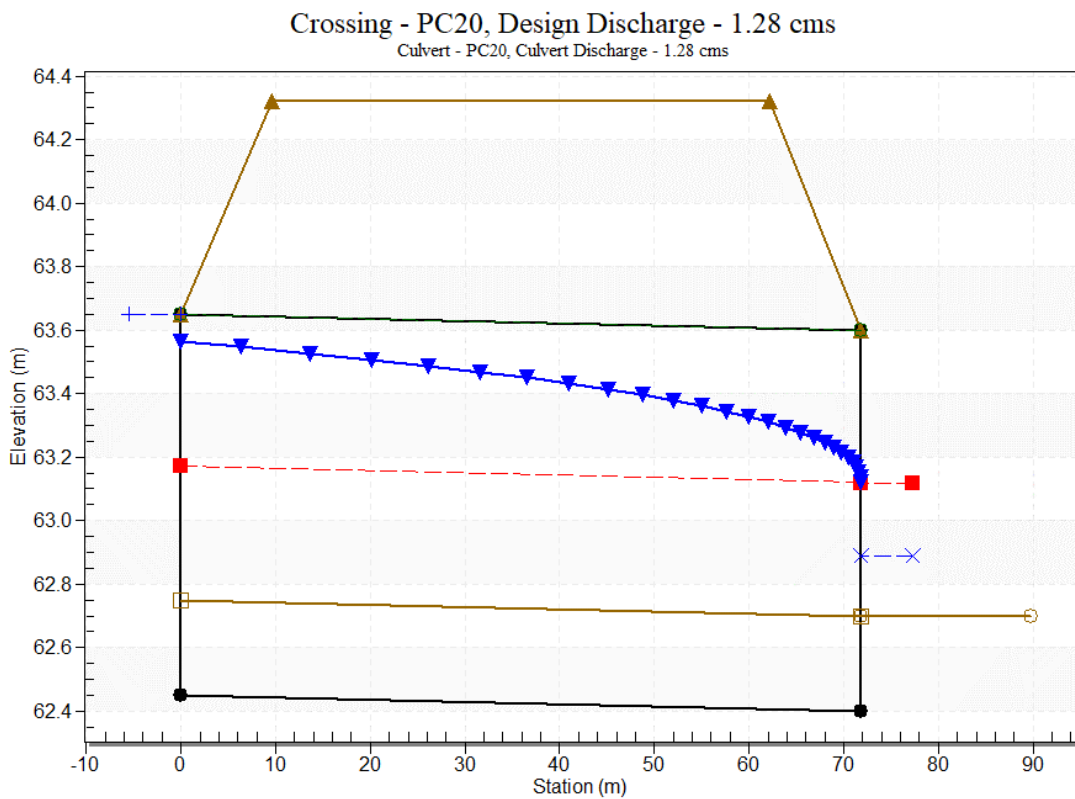
Culvert Length: 71.82 m,

Culvert Slope: 0.0007

Culvert Performance Curve Plot: PC20



Water Surface Profile Plot for Culvert: PC20



Site Data - PC20

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 62.45 m

Outlet Station: 71.82 m

Outlet Elevation: 62.40 m

Number of Barrels: 1

Culvert Data Summary - PC20

Barrel Shape: Concrete Box

Barrel Span: 1500.00 mm

Barrel Rise: 1200.00 mm

Barrel Material: Concrete

Embedment: 300.00 mm

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: PC20

Table 2 - Downstream Channel Rating Curve (Crossing: PC20)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
0.49	62.81	0.11	3.66	3.23	3.83
0.64	62.83	0.13	3.99	3.76	3.91
0.73	62.84	0.14	4.16	4.05	3.94
0.93	62.86	0.16	4.48	4.64	4.01
1.12	62.87	0.17	4.74	5.14	4.06
1.28	62.89	0.19	4.94	5.54	4.10

Tailwater Channel Data - PC20

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (1:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0030

Channel Invert Elevation: 62.70 m

Roadway Data for Crossing: PC20

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 64.32 m

Roadway Surface: Paved

Roadway Top Width: 52.50 m

HY-8 Culvert Analysis Report

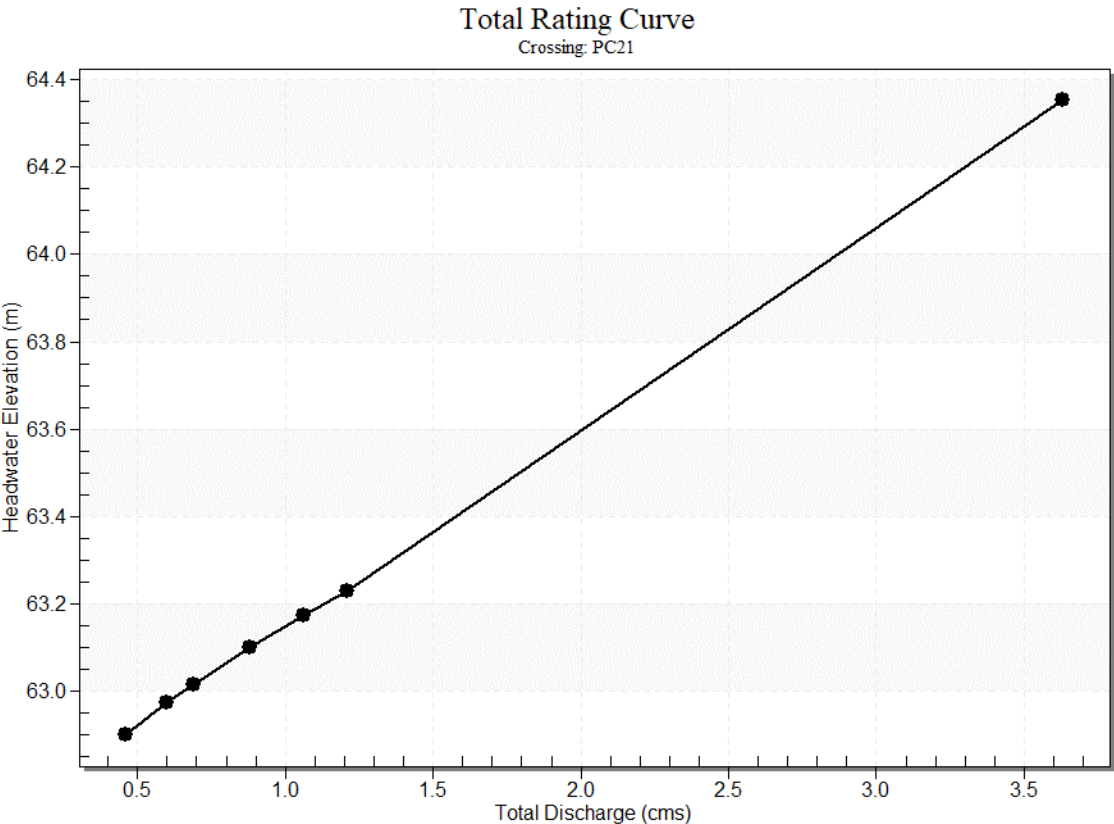
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC21

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC21 Discharge (cms)	Roadway Discharge (cms)	Iterations
62.90	2-yr	0.46	0.46	0.00	1
62.97	5-yr	0.60	0.60	0.00	1
63.02	10-yr	0.69	0.69	0.00	1
63.10	25-yr	0.88	0.88	0.00	1
63.17	50-yr	1.06	1.06	0.00	1
63.23	100-yr	1.21	1.21	0.00	1
64.30	Overtopping	3.38	3.38	0.00	Overtopping

Rating Curve Plot for Crossing: PC21



Culvert Data: PC21

Table 1 - Culvert Summary Table: PC21

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	0.46 cms	0.46 cms	62.90	0.33	0.40 1	2- M 2c	0.36	0.2 0	0.2 0	0.11	1.38	3.59
5-yr	0.60 cms	0.60 cms	62.97	0.40	0.47 2	2- M 2c	0.43	0.2 3	0.2 3	0.12	1.51	3.91
10- yr	0.69 cms	0.69 cms	63.02	0.44	0.51 6	2- M 2c	0.47	0.2 6	0.2 6	0.13	1.59	4.09
25- yr	0.88 cms	0.88 cms	63.10	0.52	0.59 9	2- M 2c	0.55	0.3 0	0.3 0	0.15	1.72	4.41
50- yr	1.06 cms	1.06 cms	63.17	0.58	0.67 2	2- M 2c	0.61	0.3 4	0.3 4	0.17	1.83	4.67
100- yr	1.21 cms	1.21 cms	63.23	0.63	0.73 0	2- M 2c	0.67	0.3 7	0.3 7	0.18	1.91	4.86

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

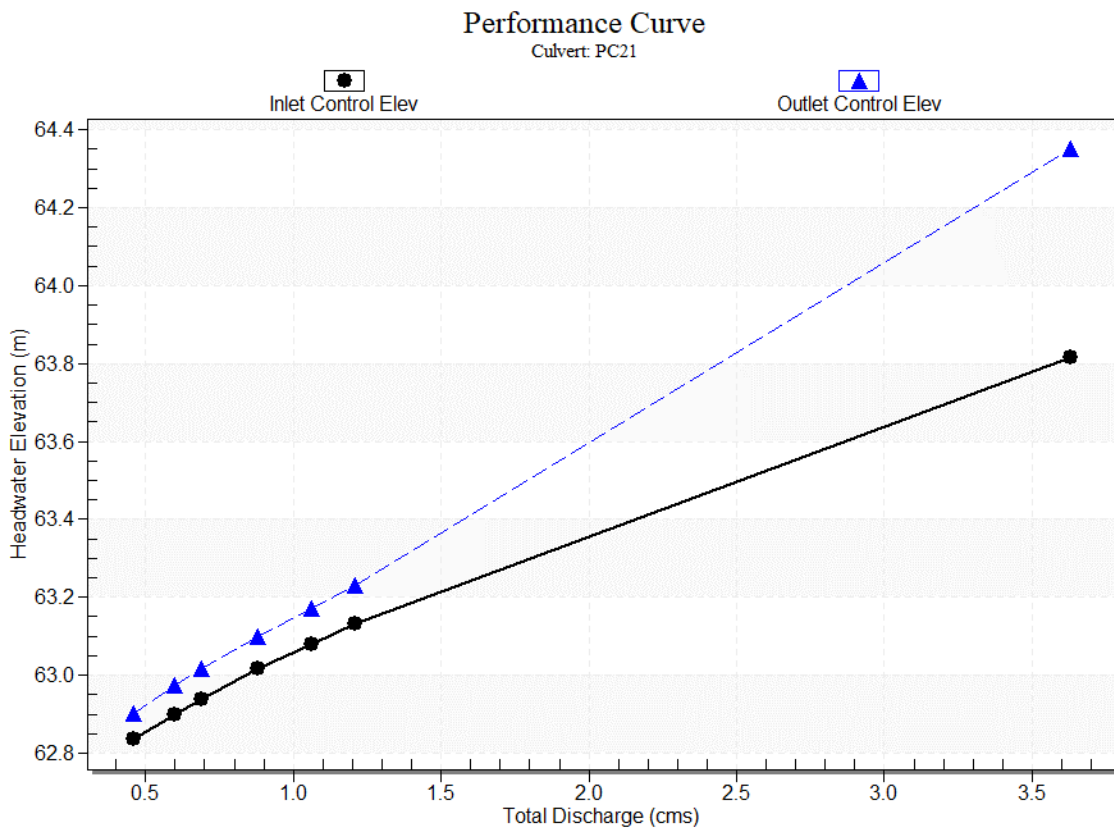
Inlet Elevation (invert): 62.50 m,

Outlet Elevation (invert): 62.30 m

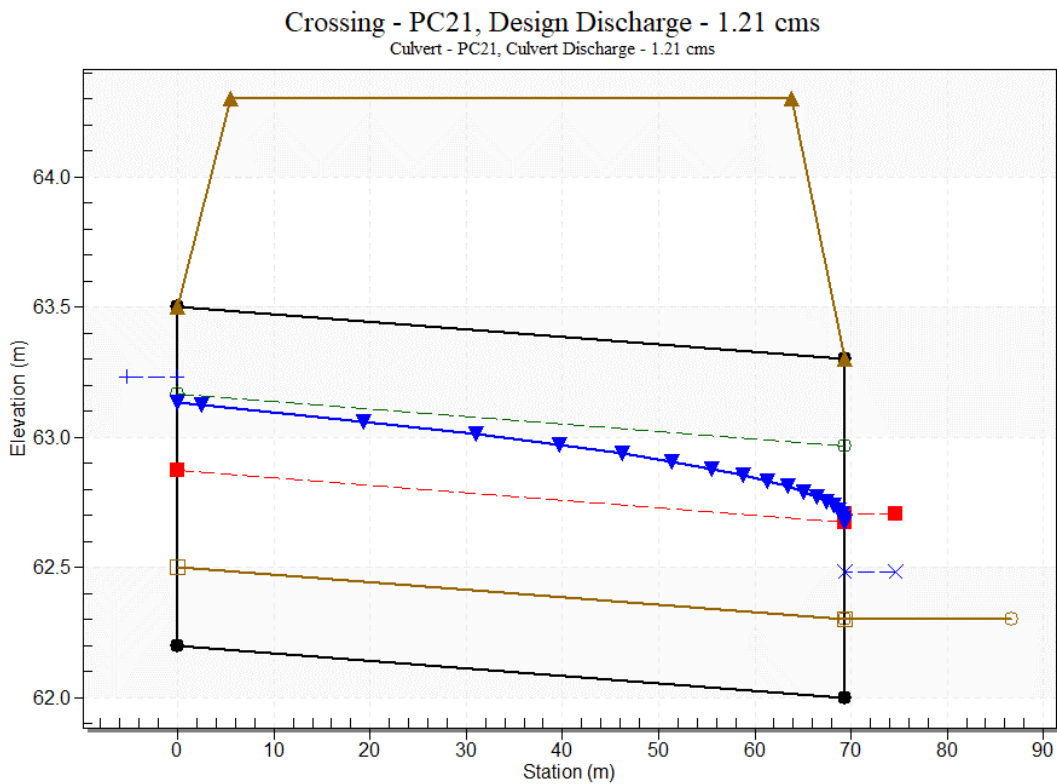
Culvert Length: 69.36 m,

Culvert Slope: 0.0029

Culvert Performance Curve Plot: PC21



Water Surface Profile Plot for Culvert: PC21



Site Data - PC21

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 62.20 m

Outlet Station: 69.36 m

Outlet Elevation: 62.00 m

Number of Barrels: 1

Culvert Data Summary - PC21

Barrel Shape: Concrete Box

Barrel Span: 1700.00 mm

Barrel Rise: 1300.00 mm

Barrel Material: Concrete

Embedment: 300.00 mm

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: PC21

Table 2 - Downstream Channel Rating Curve (Crossing: PC21)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
0.46	62.41	0.11	3.59	3.11	3.81
0.60	62.42	0.12	3.91	3.62	3.89
0.69	62.43	0.13	4.09	3.92	3.93
0.88	62.45	0.15	4.41	4.50	4.00
1.06	62.47	0.17	4.67	4.99	4.05
1.21	62.48	0.18	4.86	5.37	4.09

Tailwater Channel Data - PC21

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (1:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0030

Channel Invert Elevation: 62.30 m

Roadway Data for Crossing: PC21

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 64.30 m

Roadway Surface: Paved

Roadway Top Width: 58.31 m

HY-8 Culvert Analysis Report

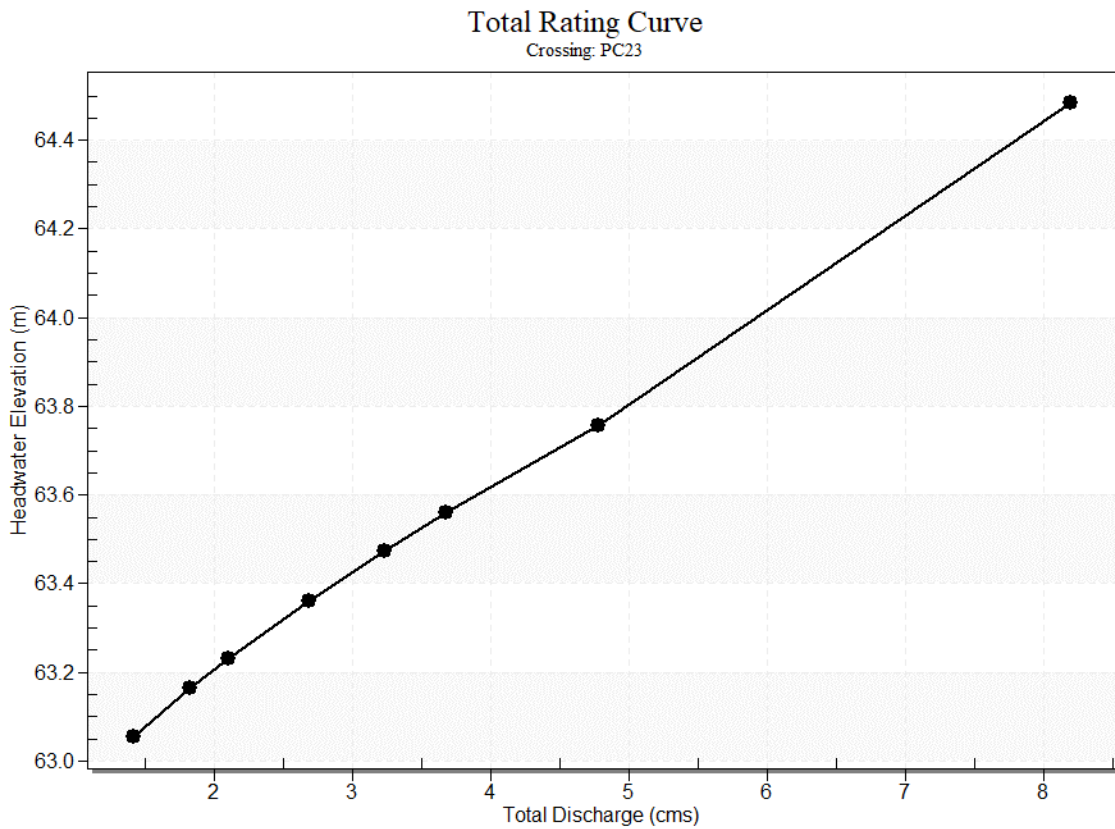
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC23

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC23 Discharge (cms)	Roadway Discharge (cms)	Iterations
63.06	2-yr	1.42	1.42	0.00	1
63.16	5-yr	1.83	1.83	0.00	1
63.23	10-yr	2.10	2.10	0.00	1
63.36	25-yr	2.69	2.69	0.00	1
63.47	50-yr	3.23	3.23	0.00	1
63.56	100-yr	3.67	3.67	0.00	1
63.76	130%	4.78	4.78	0.00	1
64.29	Overtopping	6.50	6.50	0.00	Overtopping

Rating Curve Plot for Crossing: PC23



Culvert Data: PC23

Table 1 - Culvert Summary Table: PC23

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	1.42 cms	1.42 cms	63.06	0.56	0.64 5	3- M 1t	0.49	0.3 3	0.6 5	0.65	0.91	0.96
5-yr	1.83 cms	1.83 cms	63.16	0.66	0.75 4	3- M 1t	0.57	0.3 9	0.7 3	0.73	1.05	1.02
10- yr	2.10 cms	2.10 cms	63.23	0.73	0.82 0	3- M 1t	0.62	0.4 3	0.7 8	0.78	1.13	1.06
25- yr	2.69 cms	2.69 cms	63.36	0.85	0.95 2	3- M 1t	0.73	0.5 0	0.8 7	0.87	1.29	1.13
50- yr	3.23 cms	3.23 cms	63.47	0.96	1.06 3	3- M 1t	0.82	0.5 7	0.9 4	0.94	1.42	1.18
100- yr	3.67 cms	3.67 cms	63.56	1.05	1.14 9	3- M 1t	0.89	0.6 2	1.0 0	1.00	1.53	1.22
130 %	4.78 cms	4.78 cms	63.76	1.26	1.34 6	7- M 1t	1.05	0.7 4	1.1 2	1.12	1.77	1.31

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

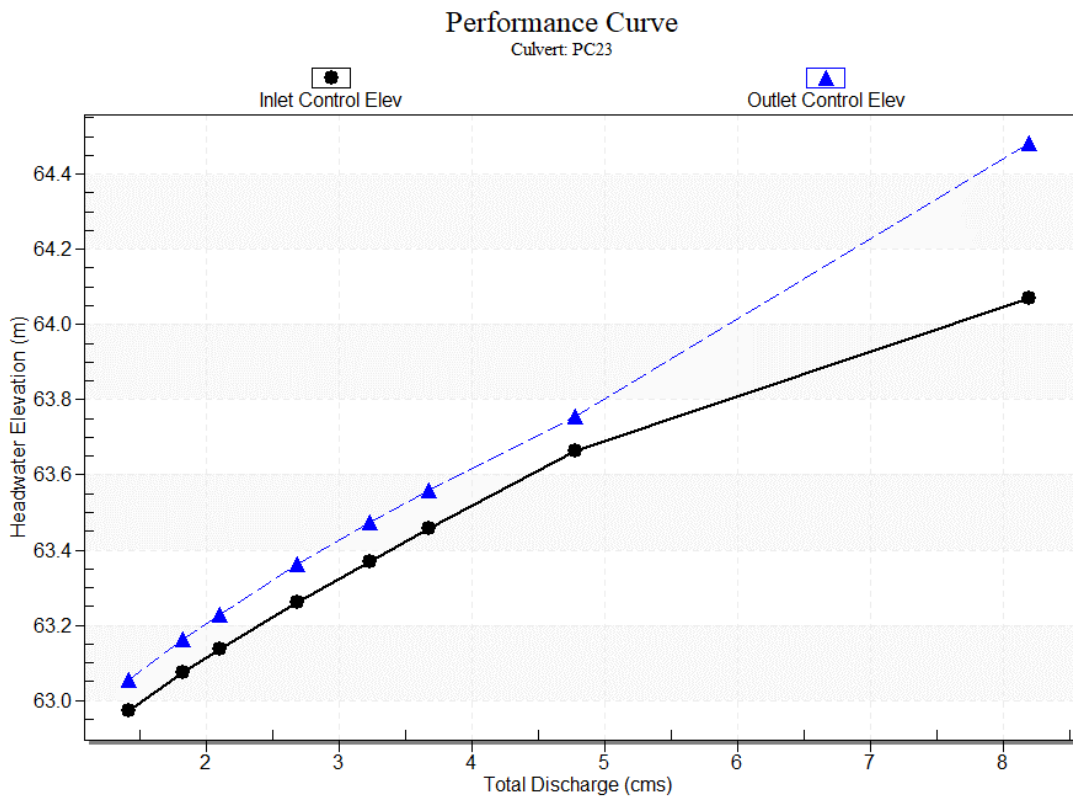
Inlet Elevation (invert): 62.41 m,

Outlet Elevation (invert): 62.26 m

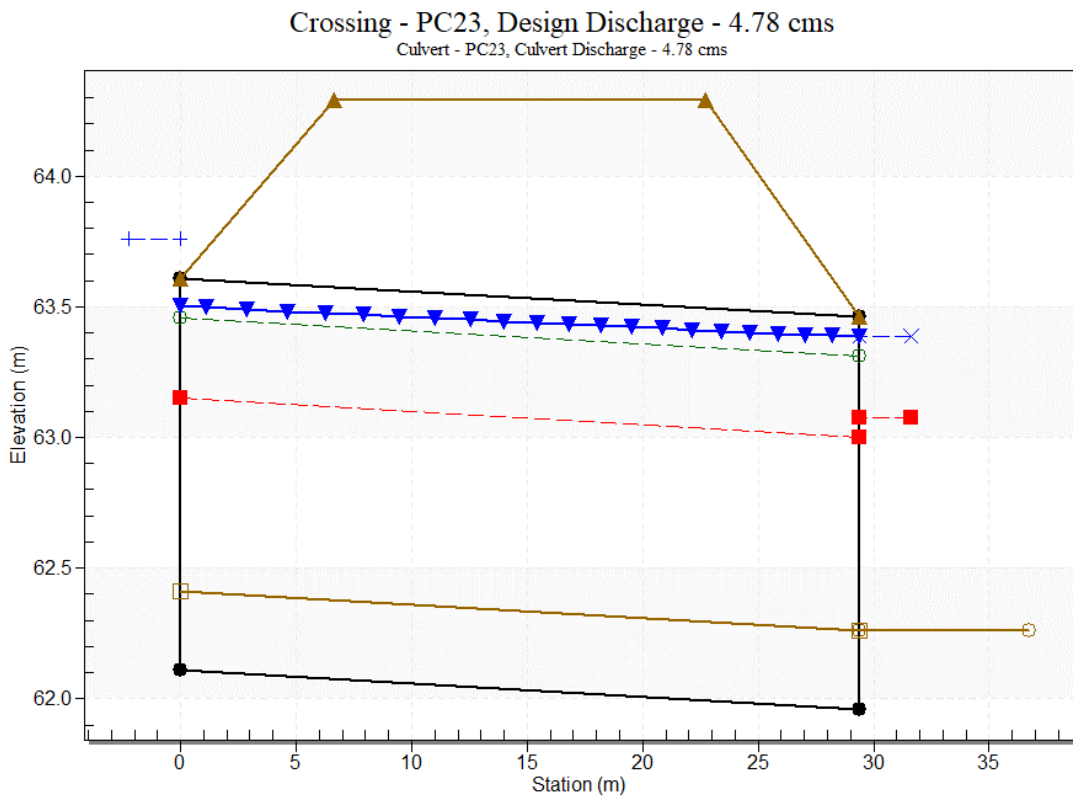
Culvert Length: 29.38 m,

Culvert Slope: 0.0051

Culvert Performance Curve Plot: PC23



Water Surface Profile Plot for Culvert: PC23



Site Data - PC23

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 62.11 m

Outlet Station: 29.38 m

Outlet Elevation: 61.96 m

Number of Barrels: 1

Culvert Data Summary - PC23

Barrel Shape: Concrete Box

Barrel Span: 2400.00 mm

Barrel Rise: 1500.00 mm

Barrel Material: Concrete

Embedment: 300.00 mm

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: PC23

Table 2 - Downstream Channel Rating Curve (Crossing: PC23)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
1.42	62.91	0.65	0.96	18.98	0.48
1.83	62.99	0.73	1.02	21.38	0.48
2.10	63.04	0.78	1.06	22.80	0.49
2.69	63.13	0.87	1.13	25.54	0.49
3.23	63.20	0.94	1.18	27.76	0.50
3.67	63.26	1.00	1.22	29.43	0.50
4.78	63.38	1.12	1.31	33.07	0.51

Tailwater Channel Data - PC23

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (.:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0300

Channel Invert Elevation: 62.26 m

Roadway Data for Crossing: PC23

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 64.29 m

Roadway Surface: Paved

Roadway Top Width: 16.10 m

HY-8 Culvert Analysis Report

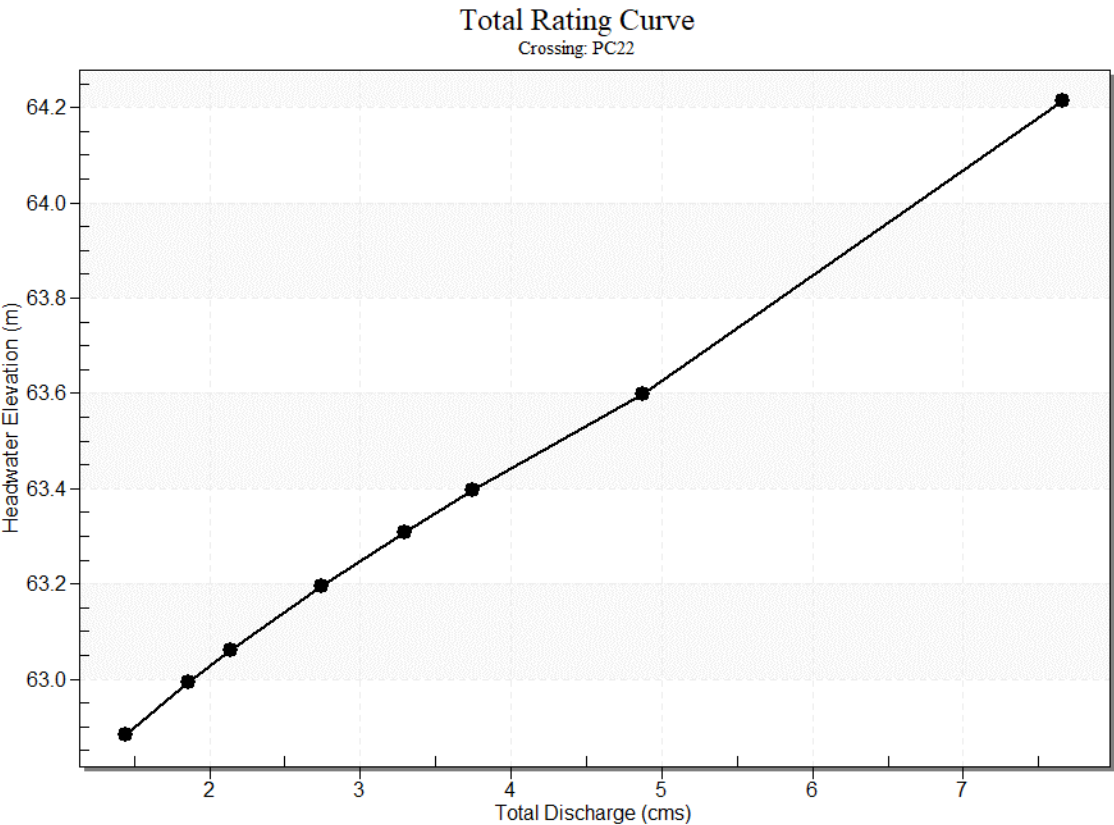
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: PC22

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	PC22 Discharge (cms)	Roadway Discharge (cms)	Iterations
62.88	2-yr	1.44	1.44	0.00	1
62.99	5-yr	1.86	1.86	0.00	1
63.06	10-yr	2.14	2.14	0.00	1
63.20	25-yr	2.74	2.74	0.00	1
63.31	50-yr	3.29	3.29	0.00	1
63.40	100-yr	3.75	3.75	0.00	1
63.60	130%	4.87	4.87	0.00	1
64.03	Overtopping	6.10	6.10	0.00	Overtopping

Rating Curve Plot for Crossing: PC22



Culvert Data: PC22

Table 1 - Culvert Summary Table: PC22

Disc harg e Nam es	Total Disc harg e (cms)	Culv ert Disc harg e (cms)	Head water Eleva tion (m)	Inle t Con trol Dep th (m)	Out let Con trol Dep th (m)	Fl o w Ty pe	Nor mal Dep th (m)	Crit ical De pth (m)	Ou tle t De pth (m)	Tail water r Dept h (m)	Outl et Vel ocit y (m/ s)	Tail water r Velo city (m/s)
2-yr	1.44 cms	1.44 cms	62.88	0.57	0.64 4	3- M 1t	0.49	0.3 3	0.6 5	0.65	0.92	0.96
5-yr	1.86 cms	1.86 cms	62.99	0.67	0.75 4	3- M 1t	0.58	0.3 9	0.7 3	0.73	1.06	1.03
10- yr	2.14 cms	2.14 cms	63.06	0.73	0.82 1	3- M 1t	0.63	0.4 3	0.7 8	0.78	1.14	1.07
25- yr	2.74 cms	2.74 cms	63.20	0.86	0.95 6	3- M 1t	0.73	0.5 1	0.8 8	0.88	1.30	1.14
50- yr	3.29 cms	3.29 cms	63.31	0.97	1.06 9	3- M 1t	0.82	0.5 8	0.9 5	0.95	1.44	1.19
100- yr	3.75 cms	3.75 cms	63.40	1.06	1.15 8	3- M 1t	0.90	0.6 3	1.0 1	1.01	1.55	1.23
130 %	4.87 cms	4.87 cms	63.60	1.27	1.35 9	7- M 1t	1.06	0.7 5	1.1 3	1.13	1.79	1.31

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

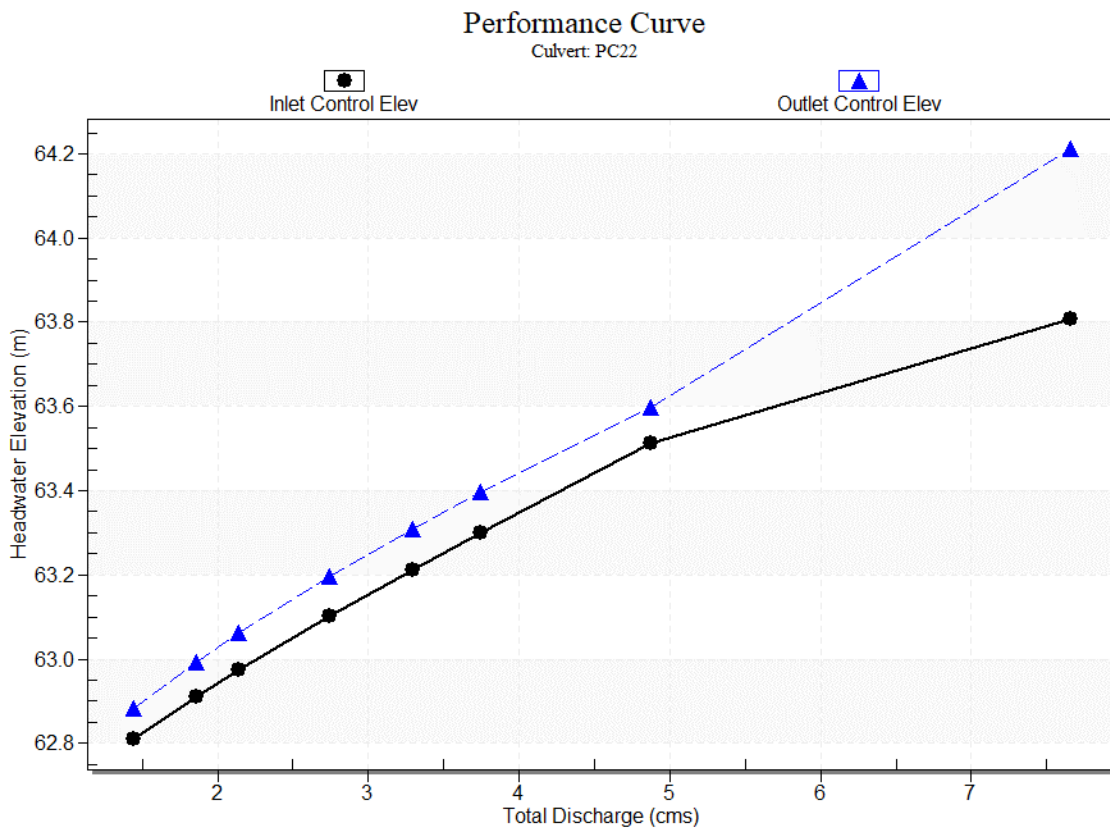
Inlet Elevation (invert): 62.24 m,

Outlet Elevation (invert): 62.06 m

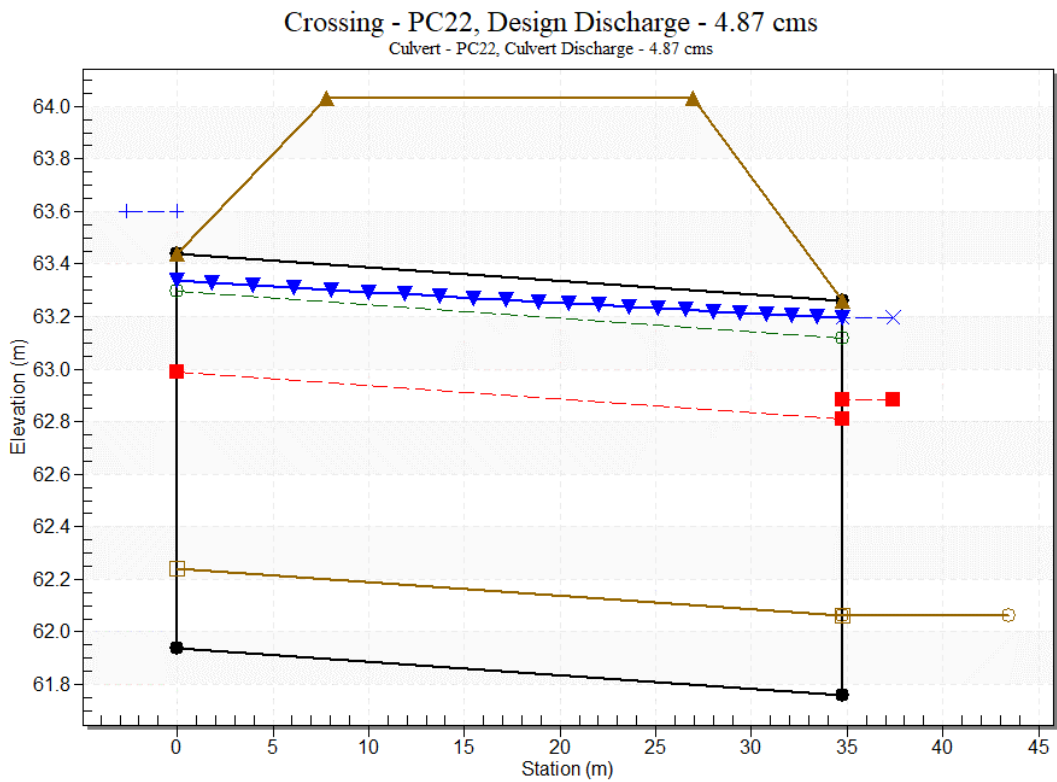
Culvert Length: 34.76 m,

Culvert Slope: 0.0052

Culvert Performance Curve Plot: PC22



Water Surface Profile Plot for Culvert: PC22



Site Data - PC22

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 61.94 m

Outlet Station: 34.76 m

Outlet Elevation: 61.76 m

Number of Barrels: 1

Culvert Data Summary - PC22

Barrel Shape: Concrete Box

Barrel Span: 2400.00 mm

Barrel Rise: 1500.00 mm

Barrel Material: Concrete

Embedment: 300.00 mm

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: PC22

Table 2 - Downstream Channel Rating Curve (Crossing: PC22)

Flow (cms)	Water Surface Elev (m)	Velocity (m/s)	Depth (m)	Shear (Pa)	Froude Number
1.44	62.71	0.65	0.96	19.15	0.48
1.86	62.79	0.73	1.03	21.58	0.48
2.14	62.84	0.78	1.07	23.01	0.49
2.74	62.94	0.88	1.14	25.77	0.50
3.29	63.01	0.95	1.19	28.00	0.50
3.75	63.07	1.01	1.23	29.69	0.50
4.87	63.19	1.13	1.31	33.36	0.51

Tailwater Channel Data - PC22

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 1.00 m

Side Slope (H:V): 2.00 (.:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0300

Channel Invert Elevation: 62.06 m

Roadway Data for Crossing: PC22

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 64.03 m

Roadway Surface: Paved

Roadway Top Width: 19.15 m

Hydraulic Analysis Report

Project Data

Project Title: Power Dam Drive

Project Date: Monday, February 5, 2024

Project Units: SI Units (Metric)

Channel Analysis: Channel Analysis

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 3.0000 m/m

Side Slope 2 (Z2): 3.0000 m/m

Channel Width 1.00 m

Longitudinal Slope: 0.0050 m/m

Manning's n: 0.0350

Flow 3.2900 cms

Result Parameters

Depth 0.8073 m

Area of Flow 2.7627 m²

Wetted Perimeter 6.1061 m

Hydraulic Radius 0.4525 m

Average Velocity 1.1908 m/s

Top Width 5.8440 m

Froude Number: 0.5528

Critical Depth 0.6099 m

Critical Velocity 1.9065 m/s

Critical Slope: 0.0177 m/m

Critical Top Width 4.66 m

Calculated Max Shear Stress 39.5686 N/m²

Calculated Avg Shear Stress 22.1754 N/m²

APPENDIX F: Lumped Hydrology (PCSWMM)

PCSWMM Lumped Model Results - Existing Conditions (2023)

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.3)

Element Count

Number of rain gages 1
Number of subcatchments ... 5
Number of nodes 5
Number of links 0
Number of pollutants 0
Number of land uses 0

Raingage Summary

Name	Data Source	Data Type	Recording Interval
SCS_Type_II_76.8mm	SCS_Type_II_76.8mm	INTENSITY	6 min.

Subcatchment Summary

Name	Area	Width	%Imperv	%Slope	Rain Gage
OUTlet					
OUT-A	0.66	26.01	29.00	0.3800	SCS_Type_II_76.8mm
OU-A					
OUT-B	13.10	111.75	32.50	0.5900	SCS_Type_II_76.8mm
OU-B					
OUT-C	1.03	53.74	28.80	0.2500	SCS_Type_II_76.8mm
OU-C					
OUT-D	1.44	80.25	36.60	0.5200	SCS_Type_II_76.8mm
OU-D					
OUT-Ultimate	2.90	45.11	20.70	0.4400	SCS_Type_II_76.8mm
OU-Ultimate					

Node Summary

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
OU-A	OUTFALL	62.23	0.00	0.0	
OU-B	OUTFALL	0.00	0.00	0.0	
OU-C	OUTFALL	0.00	0.00	0.0	
OU-D	OUTFALL	62.16	0.00	0.0	
OU-Ultimate	OUTFALL	60.65	0.00	0.0	

Analysis Options

Flow Units CMS

Process Models:

Rainfall/Runoff YES
RDII NO
Snowmelt NO
Groundwater NO
Flow Routing NO
Water Quality NO
Infiltration Method HORTON
Surcharge Method EXTRAN
Starting Date 06/29/2023 00:00:00
Ending Date 06/30/2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00

	Volume	Depth
Runoff Quantity Continuity	hectare-m	mm
Total Precipitation	1.469	76.800
Evaporation Loss	0.000	0.000
Infiltration Loss	0.929	48.556
Surface Runoff	0.532	27.807
Final Storage	0.009	0.494
Continuity Error (%)	-0.074	

	Volume	Volume
Flow Routing Continuity	hectare-m	10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.532	5.325
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.532	5.325
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

Subcatchment Runoff Summary

Perv	Total	Total	Total	Total	Total	Imperv
Runoff	Runoff	Precip	Peak Runoff	Runoff	Evap	Runoff
		Runoff	Runoff	Coeff		

Subcatchment	mm	10^6 ltr	mm CMS	mm	mm	mm	mm
OUT-A			76.80	0.00			
8.33	30.23	0.20	0.08	0.394	0.00	46.21	21.90
OUT-B			76.80	0.00	0.00	48.33	24.47
3.51	27.98	3.67	1.27	0.364			
OUT-C			76.80	0.00	0.00	46.06	21.75
8.64	30.39	0.31	0.13	0.396			
OUT-D			76.80	0.00	0.00	38.92	27.64
9.80	37.44	0.54	0.23	0.488			
OUT-Ultimate			76.80	0.00	0.00	55.78	15.62
5.13	20.75	0.60	0.22	0.270			

Analysis begun on: Mon Feb 12 09:41:30 2024
 Analysis ended on: Mon Feb 12 09:41:30 2024
 Total elapsed time: < 1 sec

[TITLE]
;;Project Title/Notes

[OPTIONS]

;;Option Value
FLOW_UNITS CMS
INFILTRATION HORTON
FLOW_ROUTING DYNWAVE
LINK_OFFSETS ELEVATION
MIN_SLOPE 0
ALLOW_PONDING NO
SKIP_STEADY_STATE NO

START_DATE 6/29/2023
START_TIME 00:00:00
REPORT_START_DATE 6/29/2023
REPORT_START_TIME 00:00:00
END_DATE 6/30/2023
END_TIME 00:00:00
SWEEP_START 1/1
SWEEP_END 12/31
DRY_DAYS 0
REPORT_STEP 00:01:00
WET_STEP 00:05:00
DRY_STEP 00:05:00
ROUTING_STEP 5
RULE_STEP 00:00:00

INERTIAL_DAMPING PARTIAL
NORMAL_FLOW_LIMITED BOTH
FORCE_MAIN_EQUATION H-W
VARIABLE_STEP 0.75
LENGTHENING_STEP 0
MIN_SURFAREA 0
MAX_TRIALS 8
HEAD_TOLERANCE 0
SYS_FLOW_TOL 5
LAT_FLOW_TOL 5
MINIMUM_STEP 0.5
THREADS 8

[EVAPORATION]

;;Data Source Parameters
;;-----
CONSTANT 0.0
DRY_ONLY NO

[RAINGAGES]

;;Name Format Interval SCF Source
;;-----
SCS_Type_II_76.8mm INTENSITY 0:06 1.0 TIMESERIES SCS_Type_II_76.8mm

[SUBCATCHMENTS]

;;Name Rain Gage Outlet Area %Imperv Width %
Slope CurbLen SnowPack
;;-----
OUT-A SCS_Type_II_76.8mm OU-A 0.658 29 26.01 0.38

OUT-B SCS_Type_II_76.8mm OU-B 13.104 32.5 111.75 0.59
0
OUT-C SCS_Type_II_76.8mm OU-C 1.029 28.8 53.74 0.25
0
OUT-D SCS_Type_II_76.8mm OU-D 1.441 36.6 80.25 0.52
0
OUT-Ultimate SCS_Type_II_76.8mm OU-Ultimate 2.895 20.7 45.11 0.44
0

[SUBAREAS]

;;Subcatchment N-Imperv N-Perv S-Imperv S-Perv PctZero RouteTo
PctRouted
;;-----
OUT-A 0.013 0.25 1.57 4.67 0 OUTLET
OUT-B 0.013 0.25 1.57 4.67 0 OUTLET
OUT-C 0.013 0.25 1.57 4.67 0 OUTLET
OUT-D 0.013 0.25 1.57 4.67 0 OUTLET
OUT-Ultimate 0.013 0.25 1.57 4.67 0 OUTLET

[INFILTRATION]

;;Subcatchment Param1 Param2 Param3 Param4 Param5
;;-----
OUT-A 76.2 13.2 4.14 7 0
OUT-B 76.2 13.2 4.14 7 0
OUT-C 76.2 13.2 4.14 7 0
OUT-D 76.2 13.2 4.14 7 0
OUT-Ultimate 76.2 13.2 4.14 7 0

[OUTFALLS]

;;Name Elevation Type Stage Data Gated Route To
;;-----
OU-A 62.232 FREE NO
OU-B 0 FREE NO
OU-C 0 FREE NO
OU-D 62.159 FREE NO
OU-Ultimate 60.653 FREE NO

[TIMESERIES]

;;Name Date Time Value
;;-----
;SCS_Type_II_10.6mm design storm, total rainfall = 10.6 mm, rain interval = 6 minutes, rain units = mm/hr.
SCS_Type_II_10.6mm 0:00 0.47253
SCS_Type_II_10.6mm 0:06 0.48003
SCS_Type_II_10.6mm 0:12 0.48003
SCS_Type_II_10.6mm 0:18 0.48003
SCS_Type_II_10.6mm 0:24 0.48003
SCS_Type_II_10.6mm 0:30 0.48003
SCS_Type_II_10.6mm 0:36 0.49203
SCS_Type_II_10.6mm 0:42 0.51603
SCS_Type_II_10.6mm 0:48 0.54004
SCS_Type_II_10.6mm 0:54 0.56404
SCS_Type_II_10.6mm 1:00 0.58804
SCS_Type_II_10.6mm 1:06 0.61804
SCS_Type_II_10.6mm 1:12 0.65404
SCS_Type_II_10.6mm 1:18 0.69005
SCS_Type_II_10.6mm 1:24 0.72605

SCS_Type_II_10.6mm	1:30	0.76205
SCS_Type_II_10.6mm	1:36	0.81005
SCS_Type_II_10.6mm	1:42	0.87006
SCS_Type_II_10.6mm	1:48	0.93006
SCS_Type_II_10.6mm	1:54	0.99007
SCS_Type_II_10.6mm	2:00	1.05007
SCS_Type_II_10.6mm	2:06	1.15208
SCS_Type_II_10.6mm	2:12	1.29609
SCS_Type_II_10.6mm	2:18	1.4401
SCS_Type_II_10.6mm	2:24	1.5841
SCS_Type_II_10.6mm	2:30	1.72811
SCS_Type_II_10.6mm	2:36	3.57624
SCS_Type_II_10.6mm	2:42	7.12847
SCS_Type_II_10.6mm	2:48	11.46526
SCS_Type_II_10.6mm	2:54	20.56186
SCS_Type_II_10.6mm	3:00	14.27194
SCS_Type_II_10.6mm	3:06	2.84419
SCS_Type_II_10.6mm	3:12	2.50217
SCS_Type_II_10.6mm	3:18	2.16014
SCS_Type_II_10.6mm	3:24	1.81812
SCS_Type_II_10.6mm	3:30	1.4761
SCS_Type_II_10.6mm	3:36	1.26608
SCS_Type_II_10.6mm	3:42	1.18808
SCS_Type_II_10.6mm	3:48	1.11007
SCS_Type_II_10.6mm	3:54	1.03207
SCS_Type_II_10.6mm	4:00	0.95406
SCS_Type_II_10.6mm	4:06	0.89406
SCS_Type_II_10.6mm	4:12	0.85206
SCS_Type_II_10.6mm	4:18	0.81005
SCS_Type_II_10.6mm	4:24	0.76805
SCS_Type_II_10.6mm	4:30	0.72605
SCS_Type_II_10.6mm	4:36	0.69005
SCS_Type_II_10.6mm	4:42	0.66004
SCS_Type_II_10.6mm	4:48	0.63004
SCS_Type_II_10.6mm	4:54	0.60004
SCS_Type_II_10.6mm	5:00	0.57004
SCS_Type_II_10.6mm	5:06	0.55054
SCS_Type_II_10.6mm	5:12	0.53854
SCS_Type_II_10.6mm	5:18	0.52953
SCS_Type_II_10.6mm	5:24	0.51753
SCS_Type_II_10.6mm	5:30	0.50853
SCS_Type_II_10.6mm	5:36	0.49653
SCS_Type_II_10.6mm	5:42	0.48753
SCS_Type_II_10.6mm	5:48	0.47553
SCS_Type_II_10.6mm	5:54	0.46653

;SCS_Type_II_35.4mm design storm, total rainfall = 35.4 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_35.4mm	0:00	1.57808
SCS_Type_II_35.4mm	0:06	1.60312
SCS_Type_II_35.4mm	0:12	1.60312
SCS_Type_II_35.4mm	0:18	1.60312
SCS_Type_II_35.4mm	0:24	1.60312
SCS_Type_II_35.4mm	0:30	1.60312
SCS_Type_II_35.4mm	0:36	1.6432
SCS_Type_II_35.4mm	0:42	1.72336
SCS_Type_II_35.4mm	0:48	1.80352

SCS_Type_II_35.4mm	0:54	1.88367
SCS_Type_II_35.4mm	1:00	1.96383
SCS_Type_II_35.4mm	1:06	2.06402
SCS_Type_II_35.4mm	1:12	2.18426
SCS_Type_II_35.4mm	1:18	2.30449
SCS_Type_II_35.4mm	1:24	2.42473
SCS_Type_II_35.4mm	1:30	2.54496
SCS_Type_II_35.4mm	1:36	2.70527
SCS_Type_II_35.4mm	1:42	2.90566
SCS_Type_II_35.4mm	1:48	3.10605
SCS_Type_II_35.4mm	1:54	3.30644
SCS_Type_II_35.4mm	2:00	3.50684
SCS_Type_II_35.4mm	2:06	3.8475
SCS_Type_II_35.4mm	2:12	4.32844
SCS_Type_II_35.4mm	2:18	4.80937
SCS_Type_II_35.4mm	2:24	5.29031
SCS_Type_II_35.4mm	2:30	5.77125
SCS_Type_II_35.4mm	2:36	11.94328
SCS_Type_II_35.4mm	2:42	23.8064
SCS_Type_II_35.4mm	2:48	38.28963
SCS_Type_II_35.4mm	2:54	68.66885
SCS_Type_II_35.4mm	3:00	47.6629
SCS_Type_II_35.4mm	3:06	9.49851
SCS_Type_II_35.4mm	3:12	8.35629
SCS_Type_II_35.4mm	3:18	7.21406
SCS_Type_II_35.4mm	3:24	6.07183
SCS_Type_II_35.4mm	3:30	4.92961
SCS_Type_II_35.4mm	3:36	4.22824
SCS_Type_II_35.4mm	3:42	3.96773
SCS_Type_II_35.4mm	3:48	3.70723
SCS_Type_II_35.4mm	3:54	3.44672
SCS_Type_II_35.4mm	4:00	3.18621
SCS_Type_II_35.4mm	4:06	2.98582
SCS_Type_II_35.4mm	4:12	2.84555
SCS_Type_II_35.4mm	4:18	2.70527
SCS_Type_II_35.4mm	4:24	2.565
SCS_Type_II_35.4mm	4:30	2.42473
SCS_Type_II_35.4mm	4:36	2.30449
SCS_Type_II_35.4mm	4:42	2.2043
SCS_Type_II_35.4mm	4:48	2.1041
SCS_Type_II_35.4mm	4:54	2.00391
SCS_Type_II_35.4mm	5:00	1.90371
SCS_Type_II_35.4mm	5:06	1.83858
SCS_Type_II_35.4mm	5:12	1.79851
SCS_Type_II_35.4mm	5:18	1.76845
SCS_Type_II_35.4mm	5:24	1.72837
SCS_Type_II_35.4mm	5:30	1.69831
SCS_Type_II_35.4mm	5:36	1.65823
SCS_Type_II_35.4mm	5:42	1.62817
SCS_Type_II_35.4mm	5:48	1.5881
SCS_Type_II_35.4mm	5:54	1.55804

;SCS_Type_II_40.2mm design storm, total rainfall = 40.2 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_40.2mm	0:00	1.79205
SCS_Type_II_40.2mm	0:06	1.8205
SCS_Type_II_40.2mm	0:12	1.8205

SCS_Type_II_40.2mm	0:18	1.8205
SCS_Type_II_40.2mm	0:24	1.8205
SCS_Type_II_40.2mm	0:30	1.8205
SCS_Type_II_40.2mm	0:36	1.86601
SCS_Type_II_40.2mm	0:42	1.95703
SCS_Type_II_40.2mm	0:48	2.04806
SCS_Type_II_40.2mm	0:54	2.13908
SCS_Type_II_40.2mm	1:00	2.23011
SCS_Type_II_40.2mm	1:06	2.34389
SCS_Type_II_40.2mm	1:12	2.48043
SCS_Type_II_40.2mm	1:18	2.61697
SCS_Type_II_40.2mm	1:24	2.7535
SCS_Type_II_40.2mm	1:30	2.89004
SCS_Type_II_40.2mm	1:36	3.07209
SCS_Type_II_40.2mm	1:42	3.29965
SCS_Type_II_40.2mm	1:48	3.52721
SCS_Type_II_40.2mm	1:54	3.75478
SCS_Type_II_40.2mm	2:00	3.98234
SCS_Type_II_40.2mm	2:06	4.36919
SCS_Type_II_40.2mm	2:12	4.91534
SCS_Type_II_40.2mm	2:18	5.46149
SCS_Type_II_40.2mm	2:24	6.00764
SCS_Type_II_40.2mm	2:30	6.55379
SCS_Type_II_40.2mm	2:36	13.56271
SCS_Type_II_40.2mm	2:42	27.03439
SCS_Type_II_40.2mm	2:48	43.48145
SCS_Type_II_40.2mm	2:54	77.97988
SCS_Type_II_40.2mm	3:00	54.12567
SCS_Type_II_40.2mm	3:06	10.78645
SCS_Type_II_40.2mm	3:12	9.48934
SCS_Type_II_40.2mm	3:18	8.19224
SCS_Type_II_40.2mm	3:24	6.89513
SCS_Type_II_40.2mm	3:30	5.59803
SCS_Type_II_40.2mm	3:36	4.80156
SCS_Type_II_40.2mm	3:42	4.50573
SCS_Type_II_40.2mm	3:48	4.2099
SCS_Type_II_40.2mm	3:54	3.91407
SCS_Type_II_40.2mm	4:00	3.61824
SCS_Type_II_40.2mm	4:06	3.39068
SCS_Type_II_40.2mm	4:12	3.23138
SCS_Type_II_40.2mm	4:18	3.07209
SCS_Type_II_40.2mm	4:24	2.9128
SCS_Type_II_40.2mm	4:30	2.7535
SCS_Type_II_40.2mm	4:36	2.61697
SCS_Type_II_40.2mm	4:42	2.50318
SCS_Type_II_40.2mm	4:48	2.3894
SCS_Type_II_40.2mm	4:54	2.27562
SCS_Type_II_40.2mm	5:00	2.16184
SCS_Type_II_40.2mm	5:06	2.08788
SCS_Type_II_40.2mm	5:12	2.04237
SCS_Type_II_40.2mm	5:18	2.00824
SCS_Type_II_40.2mm	5:24	1.96272
SCS_Type_II_40.2mm	5:30	1.92859
SCS_Type_II_40.2mm	5:36	1.88308
SCS_Type_II_40.2mm	5:42	1.84894
SCS_Type_II_40.2mm	5:48	1.80343
SCS_Type_II_40.2mm	5:54	1.7693

```

;SCS_Type_II_46.8mm design storm, total rainfall = 46.8 mm, rain interval = 6
minutes, rain units = mm/hr.
SCS_Type_II_46.8mm      0:00      2.08627
SCS_Type_II_46.8mm      0:06      2.11939
SCS_Type_II_46.8mm      0:12      2.11939
SCS_Type_II_46.8mm      0:18      2.11939
SCS_Type_II_46.8mm      0:24      2.11939
SCS_Type_II_46.8mm      0:30      2.11939
SCS_Type_II_46.8mm      0:36      2.17237
SCS_Type_II_46.8mm      0:42      2.27834
SCS_Type_II_46.8mm      0:48      2.38431
SCS_Type_II_46.8mm      0:54      2.49028
SCS_Type_II_46.8mm      1:00      2.59625
SCS_Type_II_46.8mm      1:06      2.72871
SCS_Type_II_46.8mm      1:12      2.88766
SCS_Type_II_46.8mm      1:18      3.04662
SCS_Type_II_46.8mm      1:24      3.20557
SCS_Type_II_46.8mm      1:30      3.36452
SCS_Type_II_46.8mm      1:36      3.57646
SCS_Type_II_46.8mm      1:42      3.84139
SCS_Type_II_46.8mm      1:48      4.10631
SCS_Type_II_46.8mm      1:54      4.37123
SCS_Type_II_46.8mm      2:00      4.63616
SCS_Type_II_46.8mm      2:06      5.08652
SCS_Type_II_46.8mm      2:12      5.72234
SCS_Type_II_46.8mm      2:18      6.35816
SCS_Type_II_46.8mm      2:24      6.99397
SCS_Type_II_46.8mm      2:30      7.62979
SCS_Type_II_46.8mm      2:36      15.78942
SCS_Type_II_46.8mm      2:42      31.47287
SCS_Type_II_46.8mm      2:48      50.62019
SCS_Type_II_46.8mm      2:54      90.78254
SCS_Type_II_46.8mm      3:00      63.01197
SCS_Type_II_46.8mm      3:06      12.55736
SCS_Type_II_46.8mm      3:12      11.0473
SCS_Type_II_46.8mm      3:18      9.53723
SCS_Type_II_46.8mm      3:24      8.02717
SCS_Type_II_46.8mm      3:30      6.51711
SCS_Type_II_46.8mm      3:36      5.58988
SCS_Type_II_46.8mm      3:42      5.24548
SCS_Type_II_46.8mm      3:48      4.90108
SCS_Type_II_46.8mm      3:54      4.55668
SCS_Type_II_46.8mm      4:00      4.21228
SCS_Type_II_46.8mm      4:06      3.94736
SCS_Type_II_46.8mm      4:12      3.76191
SCS_Type_II_46.8mm      4:18      3.57646
SCS_Type_II_46.8mm      4:24      3.39102
SCS_Type_II_46.8mm      4:30      3.20557
SCS_Type_II_46.8mm      4:36      3.04662
SCS_Type_II_46.8mm      4:42      2.91415
SCS_Type_II_46.8mm      4:48      2.78169
SCS_Type_II_46.8mm      4:54      2.64923
SCS_Type_II_46.8mm      5:00      2.51677
SCS_Type_II_46.8mm      5:06      2.43067
SCS_Type_II_46.8mm      5:12      2.37769
SCS_Type_II_46.8mm      5:18      2.33795

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SCS_Type_II_46.8mm	5:24	2.28496
SCS_Type_II_46.8mm	5:30	2.24522
SCS_Type_II_46.8mm	5:36	2.19224
SCS_Type_II_46.8mm	5:42	2.1525
SCS_Type_II_46.8mm	5:48	2.09952
SCS_Type_II_46.8mm	5:54	2.05978

;SCS_Type_II_5.9mm design storm, total rainfall = 5.9 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_5.9mm	0:00	0.26301
SCS_Type_II_5.9mm	0:06	0.26719
SCS_Type_II_5.9mm	0:12	0.26719
SCS_Type_II_5.9mm	0:18	0.26719
SCS_Type_II_5.9mm	0:24	0.26719
SCS_Type_II_5.9mm	0:30	0.26719
SCS_Type_II_5.9mm	0:36	0.27387
SCS_Type_II_5.9mm	0:42	0.28723
SCS_Type_II_5.9mm	0:48	0.30059
SCS_Type_II_5.9mm	0:54	0.31395
SCS_Type_II_5.9mm	1:00	0.3273
SCS_Type_II_5.9mm	1:06	0.344
SCS_Type_II_5.9mm	1:12	0.36404
SCS_Type_II_5.9mm	1:18	0.38408
SCS_Type_II_5.9mm	1:24	0.40412
SCS_Type_II_5.9mm	1:30	0.42416
SCS_Type_II_5.9mm	1:36	0.45088
SCS_Type_II_5.9mm	1:42	0.48428
SCS_Type_II_5.9mm	1:48	0.51768
SCS_Type_II_5.9mm	1:54	0.55107
SCS_Type_II_5.9mm	2:00	0.58447
SCS_Type_II_5.9mm	2:06	0.64125
SCS_Type_II_5.9mm	2:12	0.72141
SCS_Type_II_5.9mm	2:18	0.80156
SCS_Type_II_5.9mm	2:24	0.88172
SCS_Type_II_5.9mm	2:30	0.96187
SCS_Type_II_5.9mm	2:36	1.99055
SCS_Type_II_5.9mm	2:42	3.96773
SCS_Type_II_5.9mm	2:48	6.38161
SCS_Type_II_5.9mm	2:54	11.44481
SCS_Type_II_5.9mm	3:00	7.94382
SCS_Type_II_5.9mm	3:06	1.58309
SCS_Type_II_5.9mm	3:12	1.39271
SCS_Type_II_5.9mm	3:18	1.20234
SCS_Type_II_5.9mm	3:24	1.01197
SCS_Type_II_5.9mm	3:30	0.8216
SCS_Type_II_5.9mm	3:36	0.70471
SCS_Type_II_5.9mm	3:42	0.66129
SCS_Type_II_5.9mm	3:48	0.61787
SCS_Type_II_5.9mm	3:54	0.57445
SCS_Type_II_5.9mm	4:00	0.53104
SCS_Type_II_5.9mm	4:06	0.49764
SCS_Type_II_5.9mm	4:12	0.47426
SCS_Type_II_5.9mm	4:18	0.45088
SCS_Type_II_5.9mm	4:24	0.4275
SCS_Type_II_5.9mm	4:30	0.40412
SCS_Type_II_5.9mm	4:36	0.38408
SCS_Type_II_5.9mm	4:42	0.36738

SCS_Type_II_5.9mm	4:48	0.35068
SCS_Type_II_5.9mm	4:54	0.33398
SCS_Type_II_5.9mm	5:00	0.31729
SCS_Type_II_5.9mm	5:06	0.30643
SCS_Type_II_5.9mm	5:12	0.29975
SCS_Type_II_5.9mm	5:18	0.29474
SCS_Type_II_5.9mm	5:24	0.28806
SCS_Type_II_5.9mm	5:30	0.28305
SCS_Type_II_5.9mm	5:36	0.27637
SCS_Type_II_5.9mm	5:42	0.27136
SCS_Type_II_5.9mm	5:48	0.26468
SCS_Type_II_5.9mm	5:54	0.25967

;SCS_Type_II_51.6mm design storm, total rainfall = 51.6 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_51.6mm	0:00	2.30025
SCS_Type_II_51.6mm	0:06	2.33676
SCS_Type_II_51.6mm	0:12	2.33676
SCS_Type_II_51.6mm	0:18	2.33676
SCS_Type_II_51.6mm	0:24	2.33676
SCS_Type_II_51.6mm	0:30	2.33676
SCS_Type_II_51.6mm	0:36	2.39518
SCS_Type_II_51.6mm	0:42	2.51201
SCS_Type_II_51.6mm	0:48	2.62885
SCS_Type_II_51.6mm	0:54	2.74569
SCS_Type_II_51.6mm	1:00	2.86253
SCS_Type_II_51.6mm	1:06	3.00858
SCS_Type_II_51.6mm	1:12	3.18383
SCS_Type_II_51.6mm	1:18	3.35909
SCS_Type_II_51.6mm	1:24	3.53435
SCS_Type_II_51.6mm	1:30	3.7096
SCS_Type_II_51.6mm	1:36	3.94328
SCS_Type_II_51.6mm	1:42	4.23537
SCS_Type_II_51.6mm	1:48	4.52747
SCS_Type_II_51.6mm	1:54	4.81956
SCS_Type_II_51.6mm	2:00	5.11166
SCS_Type_II_51.6mm	2:06	5.60822
SCS_Type_II_51.6mm	2:12	6.30925
SCS_Type_II_51.6mm	2:18	7.01027
SCS_Type_II_51.6mm	2:24	7.7113
SCS_Type_II_51.6mm	2:30	8.41233
SCS_Type_II_51.6mm	2:36	17.40885
SCS_Type_II_51.6mm	2:42	34.70086
SCS_Type_II_51.6mm	2:48	55.81201
SCS_Type_II_51.6mm	2:54	100.09357
SCS_Type_II_51.6mm	3:00	69.47474
SCS_Type_II_51.6mm	3:06	13.84529
SCS_Type_II_51.6mm	3:12	12.18035
SCS_Type_II_51.6mm	3:18	10.51541
SCS_Type_II_51.6mm	3:24	8.85047
SCS_Type_II_51.6mm	3:30	7.18553
SCS_Type_II_51.6mm	3:36	6.1632
SCS_Type_II_51.6mm	3:42	5.78348
SCS_Type_II_51.6mm	3:48	5.40375
SCS_Type_II_51.6mm	3:54	5.02403
SCS_Type_II_51.6mm	4:00	4.64431
SCS_Type_II_51.6mm	4:06	4.35221

SCS_Type_II_51.6mm	4:12	4.14775
SCS_Type_II_51.6mm	4:18	3.94328
SCS_Type_II_51.6mm	4:24	3.73881
SCS_Type_II_51.6mm	4:30	3.53435
SCS_Type_II_51.6mm	4:36	3.35909
SCS_Type_II_51.6mm	4:42	3.21304
SCS_Type_II_51.6mm	4:48	3.06699
SCS_Type_II_51.6mm	4:54	2.92095
SCS_Type_II_51.6mm	5:00	2.7749
SCS_Type_II_51.6mm	5:06	2.67997
SCS_Type_II_51.6mm	5:12	2.62155
SCS_Type_II_51.6mm	5:18	2.57774
SCS_Type_II_51.6mm	5:24	2.51932
SCS_Type_II_51.6mm	5:30	2.4755
SCS_Type_II_51.6mm	5:36	2.41708
SCS_Type_II_51.6mm	5:42	2.37327
SCS_Type_II_51.6mm	5:48	2.31485
SCS_Type_II_51.6mm	5:54	2.27104

;SCS_Type_II_54mm design storm, total rainfall = 54 mm, rain interval = 6 minutes,
rain units = mm/hr.

SCS_Type_II_54mm	0:00	2.40723
SCS_Type_II_54mm	0:06	2.44544
SCS_Type_II_54mm	0:12	2.44544
SCS_Type_II_54mm	0:18	2.44544
SCS_Type_II_54mm	0:24	2.44544
SCS_Type_II_54mm	0:30	2.44544
SCS_Type_II_54mm	0:36	2.50658
SCS_Type_II_54mm	0:42	2.62885
SCS_Type_II_54mm	0:48	2.75113
SCS_Type_II_54mm	0:54	2.8734
SCS_Type_II_54mm	1:00	2.99567
SCS_Type_II_54mm	1:06	3.14851
SCS_Type_II_54mm	1:12	3.33192
SCS_Type_II_54mm	1:18	3.51533
SCS_Type_II_54mm	1:24	3.69873
SCS_Type_II_54mm	1:30	3.88214
SCS_Type_II_54mm	1:36	4.12669
SCS_Type_II_54mm	1:42	4.43237
SCS_Type_II_54mm	1:48	4.73805
SCS_Type_II_54mm	1:54	5.04373
SCS_Type_II_54mm	2:00	5.34941
SCS_Type_II_54mm	2:06	5.86907
SCS_Type_II_54mm	2:12	6.6027
SCS_Type_II_54mm	2:18	7.33633
SCS_Type_II_54mm	2:24	8.06997
SCS_Type_II_54mm	2:30	8.8036
SCS_Type_II_54mm	2:36	18.21856
SCS_Type_II_54mm	2:42	36.31485
SCS_Type_II_54mm	2:48	58.40791
SCS_Type_II_54mm	2:54	104.74909
SCS_Type_II_54mm	3:00	72.70612
SCS_Type_II_54mm	3:06	14.48926
SCS_Type_II_54mm	3:12	12.74688
SCS_Type_II_54mm	3:18	11.0045
SCS_Type_II_54mm	3:24	9.26212
SCS_Type_II_54mm	3:30	7.51974

SCS_Type_II_54mm	3:36	6.44986
SCS_Type_II_54mm	3:42	6.05248
SCS_Type_II_54mm	3:48	5.65509
SCS_Type_II_54mm	3:54	5.25771
SCS_Type_II_54mm	4:00	4.86032
SCS_Type_II_54mm	4:06	4.55464
SCS_Type_II_54mm	4:12	4.34066
SCS_Type_II_54mm	4:18	4.12669
SCS_Type_II_54mm	4:24	3.91271
SCS_Type_II_54mm	4:30	3.69873
SCS_Type_II_54mm	4:36	3.51533
SCS_Type_II_54mm	4:42	3.36249
SCS_Type_II_54mm	4:48	3.20965
SCS_Type_II_54mm	4:54	3.05681
SCS_Type_II_54mm	5:00	2.90397
SCS_Type_II_54mm	5:06	2.80462
SCS_Type_II_54mm	5:12	2.74348
SCS_Type_II_54mm	5:18	2.69763
SCS_Type_II_54mm	5:24	2.63649
SCS_Type_II_54mm	5:30	2.59064
SCS_Type_II_54mm	5:36	2.52951
SCS_Type_II_54mm	5:42	2.48365
SCS_Type_II_54mm	5:48	2.42252
SCS_Type_II_54mm	5:54	2.37667

;SCS_Type_II_58.8mm design storm, total rainfall = 58.8 mm, rain interval = 6
minutes, rain units = mm/hr.

SCS_Type_II_58.8mm	0:00	2.62121
SCS_Type_II_58.8mm	0:06	2.66282
SCS_Type_II_58.8mm	0:12	2.66282
SCS_Type_II_58.8mm	0:18	2.66282
SCS_Type_II_58.8mm	0:24	2.66282
SCS_Type_II_58.8mm	0:30	2.66282
SCS_Type_II_58.8mm	0:36	2.72939
SCS_Type_II_58.8mm	0:42	2.86253
SCS_Type_II_58.8mm	0:48	2.99567
SCS_Type_II_58.8mm	0:54	3.12881
SCS_Type_II_58.8mm	1:00	3.26195
SCS_Type_II_58.8mm	1:06	3.42838
SCS_Type_II_58.8mm	1:12	3.62809
SCS_Type_II_58.8mm	1:18	3.8278
SCS_Type_II_58.8mm	1:24	4.02751
SCS_Type_II_58.8mm	1:30	4.22722
SCS_Type_II_58.8mm	1:36	4.4935
SCS_Type_II_58.8mm	1:42	4.82636
SCS_Type_II_58.8mm	1:48	5.15921
SCS_Type_II_58.8mm	1:54	5.49206
SCS_Type_II_58.8mm	2:00	5.82491
SCS_Type_II_58.8mm	2:06	6.39076
SCS_Type_II_58.8mm	2:12	7.18961
SCS_Type_II_58.8mm	2:18	7.98845
SCS_Type_II_58.8mm	2:24	8.7873
SCS_Type_II_58.8mm	2:30	9.58614
SCS_Type_II_58.8mm	2:36	19.83799
SCS_Type_II_58.8mm	2:42	39.54284
SCS_Type_II_58.8mm	2:48	63.59973
SCS_Type_II_58.8mm	2:54	114.06012

SCS_Type_II_58.8mm	3:00	79.16889
SCS_Type_II_58.8mm	3:06	15.77719
SCS_Type_II_58.8mm	3:12	13.87994
SCS_Type_II_58.8mm	3:18	11.98268
SCS_Type_II_58.8mm	3:24	10.08542
SCS_Type_II_58.8mm	3:30	8.18816
SCS_Type_II_58.8mm	3:36	7.02318
SCS_Type_II_58.8mm	3:42	6.59047
SCS_Type_II_58.8mm	3:48	6.15777
SCS_Type_II_58.8mm	3:54	5.72506
SCS_Type_II_58.8mm	4:00	5.29235
SCS_Type_II_58.8mm	4:06	4.9595
SCS_Type_II_58.8mm	4:12	4.7265
SCS_Type_II_58.8mm	4:18	4.4935
SCS_Type_II_58.8mm	4:24	4.26051
SCS_Type_II_58.8mm	4:30	4.02751
SCS_Type_II_58.8mm	4:36	3.8278
SCS_Type_II_58.8mm	4:42	3.66137
SCS_Type_II_58.8mm	4:48	3.49495
SCS_Type_II_58.8mm	4:54	3.32852
SCS_Type_II_58.8mm	5:00	3.1621
SCS_Type_II_58.8mm	5:06	3.05392
SCS_Type_II_58.8mm	5:12	2.98735
SCS_Type_II_58.8mm	5:18	2.93742
SCS_Type_II_58.8mm	5:24	2.87085
SCS_Type_II_58.8mm	5:30	2.82092
SCS_Type_II_58.8mm	5:36	2.75435
SCS_Type_II_58.8mm	5:42	2.70442
SCS_Type_II_58.8mm	5:48	2.63785
SCS_Type_II_58.8mm	5:54	2.58793

;SCS_Type_II_63.6mm design storm, total rainfall = 63.6 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_63.6mm	0:00	2.83519
SCS_Type_II_63.6mm	0:06	2.88019
SCS_Type_II_63.6mm	0:12	2.88019
SCS_Type_II_63.6mm	0:18	2.88019
SCS_Type_II_63.6mm	0:24	2.88019
SCS_Type_II_63.6mm	0:30	2.88019
SCS_Type_II_63.6mm	0:36	2.95219
SCS_Type_II_63.6mm	0:42	3.0962
SCS_Type_II_63.6mm	0:48	3.24021
SCS_Type_II_63.6mm	0:54	3.38422
SCS_Type_II_63.6mm	1:00	3.52823
SCS_Type_II_63.6mm	1:06	3.70824
SCS_Type_II_63.6mm	1:12	3.92426
SCS_Type_II_63.6mm	1:18	4.14027
SCS_Type_II_63.6mm	1:24	4.35629
SCS_Type_II_63.6mm	1:30	4.5723
SCS_Type_II_63.6mm	1:36	4.86032
SCS_Type_II_63.6mm	1:42	5.22034
SCS_Type_II_63.6mm	1:48	5.58037
SCS_Type_II_63.6mm	1:54	5.94039
SCS_Type_II_63.6mm	2:00	6.30042
SCS_Type_II_63.6mm	2:06	6.91246
SCS_Type_II_63.6mm	2:12	7.77651
SCS_Type_II_63.6mm	2:18	8.64057

SCS_Type_II_63.6mm	2:24	9.50463
SCS_Type_II_63.6mm	2:30	10.36868
SCS_Type_II_63.6mm	2:36	21.45742
SCS_Type_II_63.6mm	2:42	42.77082
SCS_Type_II_63.6mm	2:48	68.79154
SCS_Type_II_63.6mm	2:54	123.37115
SCS_Type_II_63.6mm	3:00	85.63165
SCS_Type_II_63.6mm	3:06	17.06513
SCS_Type_II_63.6mm	3:12	15.01299
SCS_Type_II_63.6mm	3:18	12.96086
SCS_Type_II_63.6mm	3:24	10.90872
SCS_Type_II_63.6mm	3:30	8.85658
SCS_Type_II_63.6mm	3:36	7.5965
SCS_Type_II_63.6mm	3:42	7.12847
SCS_Type_II_63.6mm	3:48	6.66044
SCS_Type_II_63.6mm	3:54	6.19241
SCS_Type_II_63.6mm	4:00	5.72438
SCS_Type_II_63.6mm	4:06	5.36435
SCS_Type_II_63.6mm	4:12	5.11234
SCS_Type_II_63.6mm	4:18	4.86032
SCS_Type_II_63.6mm	4:24	4.6083
SCS_Type_II_63.6mm	4:30	4.35629
SCS_Type_II_63.6mm	4:36	4.14027
SCS_Type_II_63.6mm	4:42	3.96026
SCS_Type_II_63.6mm	4:48	3.78025
SCS_Type_II_63.6mm	4:54	3.60024
SCS_Type_II_63.6mm	5:00	3.42023
SCS_Type_II_63.6mm	5:06	3.30322
SCS_Type_II_63.6mm	5:12	3.23121
SCS_Type_II_63.6mm	5:18	3.17721
SCS_Type_II_63.6mm	5:24	3.10521
SCS_Type_II_63.6mm	5:30	3.0512
SCS_Type_II_63.6mm	5:36	2.9792
SCS_Type_II_63.6mm	5:42	2.92519
SCS_Type_II_63.6mm	5:48	2.85319
SCS_Type_II_63.6mm	5:54	2.79918

;SCS_Type_II_68.4mm design storm, total rainfall = 68.4 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_68.4mm	0:00	3.04916
SCS_Type_II_68.4mm	0:06	3.09756
SCS_Type_II_68.4mm	0:12	3.09756
SCS_Type_II_68.4mm	0:18	3.09756
SCS_Type_II_68.4mm	0:24	3.09756
SCS_Type_II_68.4mm	0:30	3.09756
SCS_Type_II_68.4mm	0:36	3.175
SCS_Type_II_68.4mm	0:42	3.32988
SCS_Type_II_68.4mm	0:48	3.48476
SCS_Type_II_68.4mm	0:54	3.63964
SCS_Type_II_68.4mm	1:00	3.79451
SCS_Type_II_68.4mm	1:06	3.98811
SCS_Type_II_68.4mm	1:12	4.22043
SCS_Type_II_68.4mm	1:18	4.45275
SCS_Type_II_68.4mm	1:24	4.68506
SCS_Type_II_68.4mm	1:30	4.91738
SCS_Type_II_68.4mm	1:36	5.22714
SCS_Type_II_68.4mm	1:42	5.61433

SCS_Type_II_68.4mm	1:48	6.00153
SCS_Type_II_68.4mm	1:54	6.38872
SCS_Type_II_68.4mm	2:00	6.77592
SCS_Type_II_68.4mm	2:06	7.43415
SCS_Type_II_68.4mm	2:12	8.36342
SCS_Type_II_68.4mm	2:18	9.29269
SCS_Type_II_68.4mm	2:24	10.22196
SCS_Type_II_68.4mm	2:30	11.15123
SCS_Type_II_68.4mm	2:36	23.07684
SCS_Type_II_68.4mm	2:42	45.99881
SCS_Type_II_68.4mm	2:48	73.98336
SCS_Type_II_68.4mm	2:54	132.68218
SCS_Type_II_68.4mm	3:00	92.09442
SCS_Type_II_68.4mm	3:06	18.35306
SCS_Type_II_68.4mm	3:12	16.14605
SCS_Type_II_68.4mm	3:18	13.93903
SCS_Type_II_68.4mm	3:24	11.73202
SCS_Type_II_68.4mm	3:30	9.52501
SCS_Type_II_68.4mm	3:36	8.16982
SCS_Type_II_68.4mm	3:42	7.66647
SCS_Type_II_68.4mm	3:48	7.16311
SCS_Type_II_68.4mm	3:54	6.65976
SCS_Type_II_68.4mm	4:00	6.15641
SCS_Type_II_68.4mm	4:06	5.76921
SCS_Type_II_68.4mm	4:12	5.49817
SCS_Type_II_68.4mm	4:18	5.22714
SCS_Type_II_68.4mm	4:24	4.9561
SCS_Type_II_68.4mm	4:30	4.68506
SCS_Type_II_68.4mm	4:36	4.45275
SCS_Type_II_68.4mm	4:42	4.25915
SCS_Type_II_68.4mm	4:48	4.06555
SCS_Type_II_68.4mm	4:54	3.87195
SCS_Type_II_68.4mm	5:00	3.67836
SCS_Type_II_68.4mm	5:06	3.55252
SCS_Type_II_68.4mm	5:12	3.47508
SCS_Type_II_68.4mm	5:18	3.417
SCS_Type_II_68.4mm	5:24	3.33956
SCS_Type_II_68.4mm	5:30	3.28148
SCS_Type_II_68.4mm	5:36	3.20404
SCS_Type_II_68.4mm	5:42	3.14596
SCS_Type_II_68.4mm	5:48	3.06852
SCS_Type_II_68.4mm	5:54	3.01044

;SCS_Type_II_7.8mm design storm, total rainfall = 7.8 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_7.8mm	0:00	0.34771
SCS_Type_II_7.8mm	0:06	0.35323
SCS_Type_II_7.8mm	0:12	0.35323
SCS_Type_II_7.8mm	0:18	0.35323
SCS_Type_II_7.8mm	0:24	0.35323
SCS_Type_II_7.8mm	0:30	0.35323
SCS_Type_II_7.8mm	0:36	0.36206
SCS_Type_II_7.8mm	0:42	0.37972
SCS_Type_II_7.8mm	0:48	0.39738
SCS_Type_II_7.8mm	0:54	0.41505
SCS_Type_II_7.8mm	1:00	0.43271
SCS_Type_II_7.8mm	1:06	0.45478

SCS_Type_II_7.8mm	1:12	0.48128
SCS_Type_II_7.8mm	1:18	0.50777
SCS_Type_II_7.8mm	1:24	0.53426
SCS_Type_II_7.8mm	1:30	0.56075
SCS_Type_II_7.8mm	1:36	0.59608
SCS_Type_II_7.8mm	1:42	0.64023
SCS_Type_II_7.8mm	1:48	0.68438
SCS_Type_II_7.8mm	1:54	0.72854
SCS_Type_II_7.8mm	2:00	0.77269
SCS_Type_II_7.8mm	2:06	0.84775
SCS_Type_II_7.8mm	2:12	0.95372
SCS_Type_II_7.8mm	2:18	1.05969
SCS_Type_II_7.8mm	2:24	1.16566
SCS_Type_II_7.8mm	2:30	1.27163
SCS_Type_II_7.8mm	2:36	2.63157
SCS_Type_II_7.8mm	2:42	5.24548
SCS_Type_II_7.8mm	2:48	8.4367
SCS_Type_II_7.8mm	2:54	15.13042
SCS_Type_II_7.8mm	3:00	10.502
SCS_Type_II_7.8mm	3:06	2.09289
SCS_Type_II_7.8mm	3:12	1.84122
SCS_Type_II_7.8mm	3:18	1.58954
SCS_Type_II_7.8mm	3:24	1.33786
SCS_Type_II_7.8mm	3:30	1.08618
SCS_Type_II_7.8mm	3:36	0.93165
SCS_Type_II_7.8mm	3:42	0.87425
SCS_Type_II_7.8mm	3:48	0.81685
SCS_Type_II_7.8mm	3:54	0.75945
SCS_Type_II_7.8mm	4:00	0.70205
SCS_Type_II_7.8mm	4:06	0.65789
SCS_Type_II_7.8mm	4:12	0.62698
SCS_Type_II_7.8mm	4:18	0.59608
SCS_Type_II_7.8mm	4:24	0.56517
SCS_Type_II_7.8mm	4:30	0.53426
SCS_Type_II_7.8mm	4:36	0.50777
SCS_Type_II_7.8mm	4:42	0.48569
SCS_Type_II_7.8mm	4:48	0.46362
SCS_Type_II_7.8mm	4:54	0.44154
SCS_Type_II_7.8mm	5:00	0.41946
SCS_Type_II_7.8mm	5:06	0.40511
SCS_Type_II_7.8mm	5:12	0.39628
SCS_Type_II_7.8mm	5:18	0.38966
SCS_Type_II_7.8mm	5:24	0.38083
SCS_Type_II_7.8mm	5:30	0.3742
SCS_Type_II_7.8mm	5:36	0.36537
SCS_Type_II_7.8mm	5:42	0.35875
SCS_Type_II_7.8mm	5:48	0.34992
SCS_Type_II_7.8mm	5:54	0.3433

;SCS_Type_II_70.2mm design storm, total rainfall = 70.2 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_70.2mm	0:00	3.1294
SCS_Type_II_70.2mm	0:06	3.17908
SCS_Type_II_70.2mm	0:12	3.17908
SCS_Type_II_70.2mm	0:18	3.17908
SCS_Type_II_70.2mm	0:24	3.17908
SCS_Type_II_70.2mm	0:30	3.17908

SCS_Type_II_70.2mm	0:36	3.25855
SCS_Type_II_70.2mm	0:42	3.41751
SCS_Type_II_70.2mm	0:48	3.57646
SCS_Type_II_70.2mm	0:54	3.73542
SCS_Type_II_70.2mm	1:00	3.89437
SCS_Type_II_70.2mm	1:06	4.09306
SCS_Type_II_70.2mm	1:12	4.33149
SCS_Type_II_70.2mm	1:18	4.56992
SCS_Type_II_70.2mm	1:24	4.80836
SCS_Type_II_70.2mm	1:30	5.04679
SCS_Type_II_70.2mm	1:36	5.36469
SCS_Type_II_70.2mm	1:42	5.76208
SCS_Type_II_70.2mm	1:48	6.15946
SCS_Type_II_70.2mm	1:54	6.55685
SCS_Type_II_70.2mm	2:00	6.95423
SCS_Type_II_70.2mm	2:06	7.62979
SCS_Type_II_70.2mm	2:12	8.58351
SCS_Type_II_70.2mm	2:18	9.53723
SCS_Type_II_70.2mm	2:24	10.49096
SCS_Type_II_70.2mm	2:30	11.44468
SCS_Type_II_70.2mm	2:36	23.68413
SCS_Type_II_70.2mm	2:42	47.20931
SCS_Type_II_70.2mm	2:48	75.93029
SCS_Type_II_70.2mm	2:54	136.17381
SCS_Type_II_70.2mm	3:00	94.51796
SCS_Type_II_70.2mm	3:06	18.83604
SCS_Type_II_70.2mm	3:12	16.57094
SCS_Type_II_70.2mm	3:18	14.30585
SCS_Type_II_70.2mm	3:24	12.04076
SCS_Type_II_70.2mm	3:30	9.77566
SCS_Type_II_70.2mm	3:36	8.38482
SCS_Type_II_70.2mm	3:42	7.86822
SCS_Type_II_70.2mm	3:48	7.35162
SCS_Type_II_70.2mm	3:54	6.83502
SCS_Type_II_70.2mm	4:00	6.31842
SCS_Type_II_70.2mm	4:06	5.92103
SCS_Type_II_70.2mm	4:12	5.64286
SCS_Type_II_70.2mm	4:18	5.36469
SCS_Type_II_70.2mm	4:24	5.08652
SCS_Type_II_70.2mm	4:30	4.80836
SCS_Type_II_70.2mm	4:36	4.56992
SCS_Type_II_70.2mm	4:42	4.37123
SCS_Type_II_70.2mm	4:48	4.17254
SCS_Type_II_70.2mm	4:54	3.97385
SCS_Type_II_70.2mm	5:00	3.77515
SCS_Type_II_70.2mm	5:06	3.646
SCS_Type_II_70.2mm	5:12	3.56653
SCS_Type_II_70.2mm	5:18	3.50692
SCS_Type_II_70.2mm	5:24	3.42744
SCS_Type_II_70.2mm	5:30	3.36784
SCS_Type_II_70.2mm	5:36	3.28836
SCS_Type_II_70.2mm	5:42	3.22875
SCS_Type_II_70.2mm	5:48	3.14927
SCS_Type_II_70.2mm	5:54	3.08967

;SCS_Type_II_75.6mm design storm, total rainfall = 75.6 mm, rain interval = 6 minutes, Rain units = mm/hr.

SCS_Type_II_75.6mm	0:00	3.37013
SCS_Type_II_75.6mm	0:06	3.42362
SCS_Type_II_75.6mm	0:12	3.42362
SCS_Type_II_75.6mm	0:18	3.42362
SCS_Type_II_75.6mm	0:24	3.42362
SCS_Type_II_75.6mm	0:30	3.42362
SCS_Type_II_75.6mm	0:36	3.50921
SCS_Type_II_75.6mm	0:42	3.68039
SCS_Type_II_75.6mm	0:48	3.85158
SCS_Type_II_75.6mm	0:54	4.02276
SCS_Type_II_75.6mm	1:00	4.19394
SCS_Type_II_75.6mm	1:06	4.40791
SCS_Type_II_75.6mm	1:12	4.66469
SCS_Type_II_75.6mm	1:18	4.92146
SCS_Type_II_75.6mm	1:24	5.17823
SCS_Type_II_75.6mm	1:30	5.435
SCS_Type_II_75.6mm	1:36	5.77736
SCS_Type_II_75.6mm	1:42	6.20532
SCS_Type_II_75.6mm	1:48	6.63327
SCS_Type_II_75.6mm	1:54	7.06122
SCS_Type_II_75.6mm	2:00	7.48917
SCS_Type_II_75.6mm	2:06	8.21669
SCS_Type_II_75.6mm	2:12	9.24378
SCS_Type_II_75.6mm	2:18	10.27087
SCS_Type_II_75.6mm	2:24	11.29795
SCS_Type_II_75.6mm	2:30	12.32504
SCS_Type_II_75.6mm	2:36	25.50599
SCS_Type_II_75.6mm	2:42	50.84079
SCS_Type_II_75.6mm	2:48	81.77108
SCS_Type_II_75.6mm	2:54	146.64872
SCS_Type_II_75.6mm	3:00	101.78857
SCS_Type_II_75.6mm	3:06	20.28496
SCS_Type_II_75.6mm	3:12	17.84563
SCS_Type_II_75.6mm	3:18	15.4063
SCS_Type_II_75.6mm	3:24	12.96697
SCS_Type_II_75.6mm	3:30	10.52764
SCS_Type_II_75.6mm	3:36	9.0298
SCS_Type_II_75.6mm	3:42	8.47347
SCS_Type_II_75.6mm	3:48	7.91713
SCS_Type_II_75.6mm	3:54	7.36079
SCS_Type_II_75.6mm	4:00	6.80445
SCS_Type_II_75.6mm	4:06	6.3765
SCS_Type_II_75.6mm	4:12	6.07693
SCS_Type_II_75.6mm	4:18	5.77736
SCS_Type_II_75.6mm	4:24	5.4778
SCS_Type_II_75.6mm	4:30	5.17823
SCS_Type_II_75.6mm	4:36	4.92146
SCS_Type_II_75.6mm	4:42	4.70748
SCS_Type_II_75.6mm	4:48	4.4935
SCS_Type_II_75.6mm	4:54	4.27953
SCS_Type_II_75.6mm	5:00	4.06555
SCS_Type_II_75.6mm	5:06	3.92647
SCS_Type_II_75.6mm	5:12	3.84088
SCS_Type_II_75.6mm	5:18	3.77668
SCS_Type_II_75.6mm	5:24	3.69109
SCS_Type_II_75.6mm	5:30	3.6269
SCS_Type_II_75.6mm	5:36	3.54131

SCS_Type_II_75.6mm	5:42	3.47712
SCS_Type_II_75.6mm	5:48	3.39153
SCS_Type_II_75.6mm	5:54	3.32733

;SCS_Type_II_76.8mm design storm, total rainfall = 76.8 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_76.8mm	0:00	3.42362
SCS_Type_II_76.8mm	0:06	3.47797
SCS_Type_II_76.8mm	0:12	3.47797
SCS_Type_II_76.8mm	0:18	3.47797
SCS_Type_II_76.8mm	0:24	3.47797
SCS_Type_II_76.8mm	0:30	3.47797
SCS_Type_II_76.8mm	0:36	3.56491
SCS_Type_II_76.8mm	0:42	3.73881
SCS_Type_II_76.8mm	0:48	3.91271
SCS_Type_II_76.8mm	0:54	4.08661
SCS_Type_II_76.8mm	1:00	4.26051
SCS_Type_II_76.8mm	1:06	4.47788
SCS_Type_II_76.8mm	1:12	4.73873
SCS_Type_II_76.8mm	1:18	4.99958
SCS_Type_II_76.8mm	1:24	5.26042
SCS_Type_II_76.8mm	1:30	5.52127
SCS_Type_II_76.8mm	1:36	5.86907
SCS_Type_II_76.8mm	1:42	6.30381
SCS_Type_II_76.8mm	1:48	6.73856
SCS_Type_II_76.8mm	1:54	7.1733
SCS_Type_II_76.8mm	2:00	7.60805
SCS_Type_II_76.8mm	2:06	8.34712
SCS_Type_II_76.8mm	2:12	9.39051
SCS_Type_II_76.8mm	2:18	10.4339
SCS_Type_II_76.8mm	2:24	11.47729
SCS_Type_II_76.8mm	2:30	12.52068
SCS_Type_II_76.8mm	2:36	25.91084
SCS_Type_II_76.8mm	2:42	51.64779
SCS_Type_II_76.8mm	2:48	83.06903
SCS_Type_II_76.8mm	2:54	148.97648
SCS_Type_II_76.8mm	3:00	103.40426
SCS_Type_II_76.8mm	3:06	20.60695
SCS_Type_II_76.8mm	3:12	18.1289
SCS_Type_II_76.8mm	3:18	15.65084
SCS_Type_II_76.8mm	3:24	13.17279
SCS_Type_II_76.8mm	3:30	10.69474
SCS_Type_II_76.8mm	3:36	9.17313
SCS_Type_II_76.8mm	3:42	8.60796
SCS_Type_II_76.8mm	3:48	8.0428
SCS_Type_II_76.8mm	3:54	7.47763
SCS_Type_II_76.8mm	4:00	6.91246
SCS_Type_II_76.8mm	4:06	6.47771
SCS_Type_II_76.8mm	4:12	6.17339
SCS_Type_II_76.8mm	4:18	5.86907
SCS_Type_II_76.8mm	4:24	5.56474
SCS_Type_II_76.8mm	4:30	5.26042
SCS_Type_II_76.8mm	4:36	4.99958
SCS_Type_II_76.8mm	4:42	4.7822
SCS_Type_II_76.8mm	4:48	4.56483
SCS_Type_II_76.8mm	4:54	4.34746
SCS_Type_II_76.8mm	5:00	4.13008

SCS_Type_II_76.8mm	5:06	3.98879
SCS_Type_II_76.8mm	5:12	3.90184
SCS_Type_II_76.8mm	5:18	3.83663
SCS_Type_II_76.8mm	5:24	3.74968
SCS_Type_II_76.8mm	5:30	3.68447
SCS_Type_II_76.8mm	5:36	3.59752
SCS_Type_II_76.8mm	5:42	3.53231
SCS_Type_II_76.8mm	5:48	3.44536
SCS_Type_II_76.8mm	5:54	3.38015

;SCS_Type_II_82.2mm design storm, total rainfall = 82.2 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_82.2mm	0:00	3.66435
SCS_Type_II_82.2mm	0:06	3.72251
SCS_Type_II_82.2mm	0:12	3.72251
SCS_Type_II_82.2mm	0:18	3.72251
SCS_Type_II_82.2mm	0:24	3.72251
SCS_Type_II_82.2mm	0:30	3.72251
SCS_Type_II_82.2mm	0:36	3.81557
SCS_Type_II_82.2mm	0:42	4.0017
SCS_Type_II_82.2mm	0:48	4.18782
SCS_Type_II_82.2mm	0:54	4.37395
SCS_Type_II_82.2mm	1:00	4.56007
SCS_Type_II_82.2mm	1:06	4.79273
SCS_Type_II_82.2mm	1:12	5.07192
SCS_Type_II_82.2mm	1:18	5.35111
SCS_Type_II_82.2mm	1:24	5.6303
SCS_Type_II_82.2mm	1:30	5.90948
SCS_Type_II_82.2mm	1:36	6.28174
SCS_Type_II_82.2mm	1:42	6.74705
SCS_Type_II_82.2mm	1:48	7.21236
SCS_Type_II_82.2mm	1:54	7.67768
SCS_Type_II_82.2mm	2:00	8.14299
SCS_Type_II_82.2mm	2:06	8.93402
SCS_Type_II_82.2mm	2:12	10.05078
SCS_Type_II_82.2mm	2:18	11.16753
SCS_Type_II_82.2mm	2:24	12.28428
SCS_Type_II_82.2mm	2:30	13.40104
SCS_Type_II_82.2mm	2:36	27.7327
SCS_Type_II_82.2mm	2:42	55.27927
SCS_Type_II_82.2mm	2:48	88.90982
SCS_Type_II_82.2mm	2:54	159.45139
SCS_Type_II_82.2mm	3:00	110.67487
SCS_Type_II_82.2mm	3:06	22.05587
SCS_Type_II_82.2mm	3:12	19.40358
SCS_Type_II_82.2mm	3:18	16.75129
SCS_Type_II_82.2mm	3:24	14.09901
SCS_Type_II_82.2mm	3:30	11.44672
SCS_Type_II_82.2mm	3:36	9.81812
SCS_Type_II_82.2mm	3:42	9.21321
SCS_Type_II_82.2mm	3:48	8.6083
SCS_Type_II_82.2mm	3:54	8.0034
SCS_Type_II_82.2mm	4:00	7.39849
SCS_Type_II_82.2mm	4:06	6.93317
SCS_Type_II_82.2mm	4:12	6.60746
SCS_Type_II_82.2mm	4:18	6.28174
SCS_Type_II_82.2mm	4:24	5.95602

SCS_Type_II_82.2mm	4:30	5.6303
SCS_Type_II_82.2mm	4:36	5.35111
SCS_Type_II_82.2mm	4:42	5.11845
SCS_Type_II_82.2mm	4:48	4.88579
SCS_Type_II_82.2mm	4:54	4.65314
SCS_Type_II_82.2mm	5:00	4.42048
SCS_Type_II_82.2mm	5:06	4.26925
SCS_Type_II_82.2mm	5:12	4.17619
SCS_Type_II_82.2mm	5:18	4.10639
SCS_Type_II_82.2mm	5:24	4.01333
SCS_Type_II_82.2mm	5:30	3.94353
SCS_Type_II_82.2mm	5:36	3.85047
SCS_Type_II_82.2mm	5:42	3.78067
SCS_Type_II_82.2mm	5:48	3.68761
SCS_Type_II_82.2mm	5:54	3.61781

;SCS_Type_II_9mm design storm, total rainfall = 9 mm, rain interval = 6 minutes,
rain units = mm/hr.

SCS_Type_II_9mm	0:00	0.40121
SCS_Type_II_9mm	0:06	0.40757
SCS_Type_II_9mm	0:12	0.40757
SCS_Type_II_9mm	0:18	0.40757
SCS_Type_II_9mm	0:24	0.40757
SCS_Type_II_9mm	0:30	0.40757
SCS_Type_II_9mm	0:36	0.41776
SCS_Type_II_9mm	0:42	0.43814
SCS_Type_II_9mm	0:48	0.45852
SCS_Type_II_9mm	0:54	0.4789
SCS_Type_II_9mm	1:00	0.49928
SCS_Type_II_9mm	1:06	0.52475
SCS_Type_II_9mm	1:12	0.55532
SCS_Type_II_9mm	1:18	0.58589
SCS_Type_II_9mm	1:24	0.61646
SCS_Type_II_9mm	1:30	0.64702
SCS_Type_II_9mm	1:36	0.68778
SCS_Type_II_9mm	1:42	0.73873
SCS_Type_II_9mm	1:48	0.78967
SCS_Type_II_9mm	1:54	0.84062
SCS_Type_II_9mm	2:00	0.89157
SCS_Type_II_9mm	2:06	0.97818
SCS_Type_II_9mm	2:12	1.10045
SCS_Type_II_9mm	2:18	1.22272
SCS_Type_II_9mm	2:24	1.34499
SCS_Type_II_9mm	2:30	1.46727
SCS_Type_II_9mm	2:36	3.03643
SCS_Type_II_9mm	2:42	6.05248
SCS_Type_II_9mm	2:48	9.73465
SCS_Type_II_9mm	2:54	17.45818
SCS_Type_II_9mm	3:00	12.11769
SCS_Type_II_9mm	3:06	2.41488
SCS_Type_II_9mm	3:12	2.12448
SCS_Type_II_9mm	3:18	1.83408
SCS_Type_II_9mm	3:24	1.54369
SCS_Type_II_9mm	3:30	1.25329
SCS_Type_II_9mm	3:36	1.07498
SCS_Type_II_9mm	3:42	1.00875
SCS_Type_II_9mm	3:48	0.94252

SCS_Type_II_9mm	3:54	0.87628
SCS_Type_II_9mm	4:00	0.81005
SCS_Type_II_9mm	4:06	0.75911
SCS_Type_II_9mm	4:12	0.72344
SCS_Type_II_9mm	4:18	0.68778
SCS_Type_II_9mm	4:24	0.65212
SCS_Type_II_9mm	4:30	0.61646
SCS_Type_II_9mm	4:36	0.58589
SCS_Type_II_9mm	4:42	0.56041
SCS_Type_II_9mm	4:48	0.53494
SCS_Type_II_9mm	4:54	0.50947
SCS_Type_II_9mm	5:00	0.48399
SCS_Type_II_9mm	5:06	0.46744
SCS_Type_II_9mm	5:12	0.45725
SCS_Type_II_9mm	5:18	0.44961
SCS_Type_II_9mm	5:24	0.43942
SCS_Type_II_9mm	5:30	0.43177
SCS_Type_II_9mm	5:36	0.42158
SCS_Type_II_9mm	5:42	0.41394
SCS_Type_II_9mm	5:48	0.40375
SCS_Type_II_9mm	5:54	0.39611

[REPORT]
;;Reporting Options
INPUT YES
CONTROLS NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]
Subcatch OUT-A WDT
Subcatch OUT-B WDT
Subcatch OUT-C WDT
Subcatch OUT-D WDT
Subcatch OUT-Ultimate WDT
Node OU-A WDT
Node OU-D WDT
Node OU-Ultimate WDT

[MAP]
DIMENSIONS 514153.27595 4989095.9442 515745.94505 4990035.3618
UNITS Meters

[COORDINATES]
;;Node X-Coord Y-Coord
;;-----
OU-A 515106.896 4989171.986
OU-B 515207.966 4989389.503
OU-C 515349.476 4989313.937
OU-D 515476.265 4989244.925
OU-Ultimate 515505.186 4989138.928

[VERTICES]
;;Link X-Coord Y-Coord
;;-----

[POLYGONS]		
;;Subcatchment	X-Coord	Y-Coord
;;-----	-----	-----
OUT-A	514994.576	4989336.571
OUT-A	514967.537	4989410.841
OUT-A	514971.045	4989413.102
OUT-A	514972.162	4989414.984
OUT-A	514972.118	4989418.164
OUT-A	514968.789	4989422.714
OUT-A	514968.96	4989430.53
OUT-A	514971.929	4989432.208
OUT-A	514977.12	4989433.027
OUT-A	514981.002	4989435.146
OUT-A	514982.551	4989437.586
OUT-A	514984.734	4989435.79
OUT-A	514987.984	4989424.018
OUT-A	514990.369	4989420.403
OUT-A	514990.778	4989415.812
OUT-A	514991.222	4989414.765
OUT-A	514996.173	4989403.199
OUT-A	514998.358	4989396.405
OUT-A	514998.004	4989391.008
OUT-A	514999.992	4989389.017
OUT-A	515004.12	4989380.145
OUT-A	515008.368	4989368.395
OUT-A	515008.156	4989363.838
OUT-A	515013.173	4989354.199
OUT-A	515015.118	4989344.255
OUT-A	515013.996	4989339.91
OUT-A	515018.862	4989335.887
OUT-A	515019.779	4989328.804
OUT-A	515024.12	4989324.145
OUT-A	515029.551	4989307.577
OUT-A	515034.379	4989295.405
OUT-A	515034.369	4989290.759
OUT-A	515032.79	4989286.704
OUT-A	515034.43	4989282.589
OUT-A	515033.99	4989281.246
OUT-A	515033.762	4989281.223
OUT-A	515034.159	4989280.195
OUT-A	515047.827	4989239.032
OUT-A	515065.293	4989201.632
OUT-A	515088.153	4989171.536
OUT-A	515090.103	4989168.969
OUT-A	515105.097	4989149.23
OUT-A	515098.746	4989144.382
OUT-A	515093.984	4989143.144
OUT-A	515088.12	4989139.008
OUT-A	515083.163	4989138.645
OUT-A	515058.539	4989179.525
OUT-A	515045.549	4989203.128
OUT-A	515030.375	4989238.9
OUT-A	515016.648	4989270.379
OUT-A	515004.711	4989304.368
OUT-A	514994.576	4989336.571
OUT-B	515145.645	4989520.1
OUT-B	515170.36	4989506.48

OUT-B	515175.936	4989503.071
OUT-B	515176.824	4989498.847
OUT-B	515181.937	4989496.963
OUT-B	515183.401	4989493.426
OUT-B	515189.339	4989488.153
OUT-B	515179.123	4989465.726
OUT-B	515202.43	4989454.571
OUT-B	515225.478	4989438.005
OUT-B	515234.979	4989436.195
OUT-B	515244.32	4989429.841
OUT-B	515261.295	4989419.06
OUT-B	515263.104	4989417.063
OUT-B	515285.388	4989407.075
OUT-B	515289.851	4989405.119
OUT-B	515304.611	4989395.859
OUT-B	515314.391	4989390.964
OUT-B	515323.045	4989387.288
OUT-B	515328.939	4989384.758
OUT-B	515337.905	4989378.809
OUT-B	515349.262	4989369.372
OUT-B	515350.072	4989369.189
OUT-B	515350.049	4989368.965
OUT-B	515350.243	4989368.767
OUT-B	515352.273	4989367.608
OUT-B	515356.324	4989366.349
OUT-B	515357.335	4989364.718
OUT-B	515359.436	4989363.518
OUT-B	515353.654	4989335.244
OUT-B	515348.755	4989337.898
OUT-B	515308.768	4989362.912
OUT-B	515306.822	4989363.191
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OUT-B	515289.823	4989373.848
OUT-B	515287.485	4989378.167
OUT-B	515284.669	4989377.804
OUT-B	515278.346	4989379.393
OUT-B	515275.292	4989381.973
OUT-B	515272.347	4989382.394
OUT-B	515269.497	4989385.522
OUT-B	515265.121	4989388.146
OUT-B	515258.972	4989389.998
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OUT-B	515249.167	4989396.192
OUT-B	515247.936	4989400.962
OUT-B	515239.994	4989402.019
OUT-B	515235.551	4989406.577
OUT-B	515229.111	4989408.136
OUT-B	515226.173	4989411.199
OUT-B	515215.219	4989415.245
OUT-B	515208.496	4989420.177
OUT-B	515205.258	4989420.147
OUT-B	515200.709	4989415.82
OUT-B	515199.487	4989408.316
OUT-B	515191.627	4989399.737
OUT-B	515188.655	4989402.112
OUT-B	515183.339	4989403.291

OUT-B	515177.088	4989406.983
OUT-B	515171.905	4989407.897
OUT-B	515166.847	4989412.518
OUT-B	515155.276	4989419.109
OUT-B	515148.5	4989419.755
OUT-B	515145.175	4989421.998
OUT-B	515139.326	4989423.705
OUT-B	515136.526	4989428.464
OUT-B	515112.054	4989442.305
OUT-B	515107.932	4989444.016
OUT-B	515103.155	4989442.284
OUT-B	515096.905	4989445.049
OUT-B	515093.705	4989450.469
OUT-B	515089.459	4989448.606
OUT-B	515086.685	4989442.113
OUT-B	515079.784	4989439.581
OUT-B	515073.035	4989429.372
OUT-B	515052.843	4989428.675
OUT-B	515053.961	4989439.748
OUT-B	515046.697	4989441.077
OUT-B	515044.272	4989412.83
OUT-B	515042.065	4989389.227
OUT-B	515035.774	4989389.055
OUT-B	515035.705	4989388.825
OUT-B	515035.607	4989388.5
OUT-B	515034.992	4989369.793
OUT-B	515033.562	4989364.566
OUT-B	515033.497	4989338.631
OUT-B	515031.661	4989330.577
OUT-B	515034.485	4989312.622
OUT-B	515033.701	4989310.427
OUT-B	515029.551	4989307.577
OUT-B	515024.12	4989324.145
OUT-B	515019.779	4989328.804
OUT-B	515018.862	4989335.887
OUT-B	515013.996	4989339.91
OUT-B	515015.118	4989344.255
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OUT-B	515008.156	4989363.838
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OUT-B	515004.12	4989380.145
OUT-B	514999.992	4989389.017
OUT-B	514998.004	4989391.008
OUT-B	514998.358	4989396.405
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OUT-B	514990.778	4989415.803
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OUT-B	514987.984	4989424.009
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OUT-B	514982.551	4989437.577
OUT-B	514981.002	4989435.136
OUT-B	514977.12	4989433.017
OUT-B	514971.929	4989432.208
OUT-B	514968.96	4989430.52
OUT-B	514968.789	4989422.714
OUT-B	514972.118	4989418.154
OUT-B	514972.162	4989414.974

OUT-B	514971.045	4989413.092
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OUT-B	514965.69	4989403.447
OUT-B	514960.358	4989401.779
OUT-B	514957.746	4989397.257
OUT-B	514954.346	4989401.381
OUT-B	514951.541	4989408.575
OUT-B	514947.995	4989413.008
OUT-B	514947.735	4989417.791
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OUT-B	514938.873	4989429.153
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OUT-B	514933.142	4989428.069
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OUT-B	514542.072	4989751.753
OUT-B	514535.11	4989755.767
OUT-B	514512.357	4989768.98
OUT-B	514499.696	4989776.333
OUT-B	514454.035	4989802.849
OUT-B	514385.281	4989842.775
OUT-B	514384.378	4989851.404
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OUT-B	514375.174	4989859.2
OUT-B	514355.229	4989865.255
OUT-B	514345.551	4989871.577
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OUT-B	514325.295	4989908.2
OUT-B	514327.551	4989909.577
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OUT-B	514303.435	4989926.349
OUT-B	514299.301	4989925.438
OUT-B	514292.402	4989930.427
OUT-B	514289.862	4989934.887
OUT-B	514280.939	4989935.966
OUT-B	514277.755	4989941.781
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OUT-B	514247.12	4989985.124
OUT-B	514251.551	4989981.577
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OUT-B	514317.551	4989948.577
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OUT-B	514369.552	4989952.123
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OUT-B	514408.164	4989932.189
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OUT-B	514838.761	4989713.192
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OUT-B	515023.827	4989627.527
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OUT-C	515441.502	4989356.086
OUT-C	515440.996	4989351.019
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OUT-C	515450.057	4989342.081
OUT-C	515458.164	4989337.189
OUT-C	515460.607	4989334.632
OUT-C	515466.55	4989332.576
OUT-C	515471.268	4989329.405
OUT-C	515467.173	4989319.955
OUT-C	515461.358	4989313.772
OUT-C	515460.937	4989309.847
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OUT-C	515456.065	4989308.352
OUT-C	515357.335	4989364.718
OUT-C	515356.324	4989366.349
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OUT-C	515179.123	4989465.726
OUT-C	515189.339	4989488.153
OUT-C	515183.401	4989493.426
OUT-C	515181.937	4989496.963
OUT-C	515176.824	4989498.847
OUT-C	515175.936	4989503.071
OUT-C	515170.36	4989506.48
OUT-C	515281.963	4989444.979
OUT-D	515366.874	4989328.094
OUT-D	515366.858	4989328.092
OUT-D	515353.654	4989335.244
OUT-D	515359.436	4989363.518
OUT-D	515456.065	4989308.352
OUT-D	515456.531	4989308.087
OUT-D	515458.551	4989307.577
OUT-D	515460.937	4989309.847
OUT-D	515461.358	4989313.772

OUT-D	515467.173	4989319.955
OUT-D	515471.268	4989329.405
OUT-D	515466.55	4989332.576
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OUT-D	515590.812	4989260.316
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OUT-D	515581.346	4989243.782
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OUT-D	515623.13	4989219.156
OUT-D	515629.23	4989215.256
OUT-D	515635.314	4989214.34
OUT-D	515639.346	4989210.372
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OUT-D	515667.551	4989196.577
OUT-D	515660.984	4989185.144
OUT-D	515656.551	4989172.577
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OUT-D	515619.983	4989190.008
OUT-D	515614.13	4989194.156
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OUT-D	515597.335	4989202.815
OUT-D	515594.229	4989203.255
OUT-D	515560.982	4989220.007
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OUT-D	515518.11	4989244.133
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OUT-Ultimate	515430.529	4989259.261
OUT-Ultimate	515408.292	4989272.557
OUT-Ultimate	515387.807	4989282.625
OUT-Ultimate	515370.272	4989293.414
OUT-Ultimate	515361.205	4989298.006
OUT-Ultimate	515357.443	4989300.803
OUT-Ultimate	515357.173	4989301.005
OUT-Ultimate	515347.506	4989303.99

OUT-Ultimate	515340.681	4989310.483
OUT-Ultimate	515334.038	4989311.891
OUT-Ultimate	515324.694	4989317.9
OUT-Ultimate	515314.265	4989321.142
OUT-Ultimate	515307.187	4989328.329
OUT-Ultimate	515307.229	4989328.94
OUT-Ultimate	515271.932	4989348.415
OUT-Ultimate	515265.858	4989351.75
OUT-Ultimate	515262.08	4989352.597
OUT-Ultimate	515248.444	4989360.941
OUT-Ultimate	515248.48	4989361.293
OUT-Ultimate	515199.289	4989388.304
OUT-Ultimate	515175.735	4989394.01
OUT-Ultimate	515157.697	4989395.614
OUT-Ultimate	515130.026	4989395.96
OUT-Ultimate	515108.697	4989392.616
OUT-Ultimate	515103.333	4989390.408
OUT-Ultimate	515098.659	4989387.653
OUT-Ultimate	515077.199	4989381.154
OUT-Ultimate	515072.985	4989358.506
OUT-Ultimate	515070.137	4989340.526
OUT-Ultimate	515069.753	4989313.444
OUT-Ultimate	515074.481	4989278.726
OUT-Ultimate	515083.848	4989247.26
OUT-Ultimate	515105.369	4989184.797
OUT-Ultimate	515120.298	4989158.9
OUT-Ultimate	515104.988	4989149.603
OUT-Ultimate	515104.966	4989149.403
OUT-Ultimate	515090.103	4989168.969
OUT-Ultimate	515088.153	4989171.536
OUT-Ultimate	515065.293	4989201.632
OUT-Ultimate	515047.827	4989239.032
OUT-Ultimate	515034.159	4989280.195
OUT-Ultimate	515033.762	4989281.223
OUT-Ultimate	515033.99	4989281.246
OUT-Ultimate	515034.43	4989282.589
OUT-Ultimate	515032.79	4989286.704
OUT-Ultimate	515034.369	4989290.759
OUT-Ultimate	515034.379	4989295.405
OUT-Ultimate	515030.167	4989306.024
OUT-Ultimate	515029.551	4989307.577
OUT-Ultimate	515033.701	4989310.427
OUT-Ultimate	515034.485	4989312.622
OUT-Ultimate	515031.661	4989330.577
OUT-Ultimate	515033.497	4989338.631
OUT-Ultimate	515033.562	4989364.566
OUT-Ultimate	515034.992	4989369.793
OUT-Ultimate	515035.607	4989388.5
OUT-Ultimate	515035.774	4989389.055
OUT-Ultimate	515041.633	4989389.215
OUT-Ultimate	515042.065	4989389.227
OUT-Ultimate	515044.272	4989412.83
OUT-Ultimate	515044.404	4989414.373
OUT-Ultimate	515046.697	4989441.077
OUT-Ultimate	515053.961	4989439.748
OUT-Ultimate	515052.843	4989428.675
OUT-Ultimate	515073.035	4989429.372

OUT-Ultimate	515079.784	4989439.581
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OUT-Ultimate	515089.459	4989448.606
OUT-Ultimate	515093.705	4989450.469
OUT-Ultimate	515096.905	4989445.049
OUT-Ultimate	515103.155	4989442.284
OUT-Ultimate	515107.932	4989444.016
OUT-Ultimate	515112.054	4989442.305
OUT-Ultimate	515136.526	4989428.464
OUT-Ultimate	515139.326	4989423.705
OUT-Ultimate	515145.175	4989421.998
OUT-Ultimate	515148.5	4989419.755
OUT-Ultimate	515155.276	4989419.109
OUT-Ultimate	515166.847	4989412.518
OUT-Ultimate	515171.905	4989407.897
OUT-Ultimate	515177.088	4989406.983
OUT-Ultimate	515183.339	4989403.291
OUT-Ultimate	515188.655	4989402.112
OUT-Ultimate	515191.627	4989399.737
OUT-Ultimate	515199.487	4989408.316
OUT-Ultimate	515200.709	4989415.82
OUT-Ultimate	515205.258	4989420.147
OUT-Ultimate	515208.496	4989420.177
OUT-Ultimate	515215.219	4989415.245
OUT-Ultimate	515226.173	4989411.199
OUT-Ultimate	515229.111	4989408.136
OUT-Ultimate	515235.369	4989406.621
OUT-Ultimate	515235.551	4989406.577
OUT-Ultimate	515239.994	4989402.019
OUT-Ultimate	515247.936	4989400.962
OUT-Ultimate	515249.167	4989396.192
OUT-Ultimate	515253.745	4989394.77
OUT-Ultimate	515258.972	4989389.998
OUT-Ultimate	515265.121	4989388.146
OUT-Ultimate	515269.497	4989385.522
OUT-Ultimate	515272.347	4989382.394
OUT-Ultimate	515275.292	4989381.973
OUT-Ultimate	515278.346	4989379.393
OUT-Ultimate	515284.669	4989377.804
OUT-Ultimate	515287.485	4989378.167
OUT-Ultimate	515289.823	4989373.848
OUT-Ultimate	515296.929	4989368.955
OUT-Ultimate	515301.416	4989367.512
OUT-Ultimate	515303.755	4989366.759
OUT-Ultimate	515305.077	4989365.221
OUT-Ultimate	515306.822	4989363.191
OUT-Ultimate	515308.768	4989362.912
OUT-Ultimate	515348.755	4989337.898
OUT-Ultimate	515366.858	4989328.092
OUT-Ultimate	515366.874	4989328.094
OUT-Ultimate	515517.13	4989244.039
OUT-Ultimate	515518.11	4989244.133
OUT-Ultimate	515520.11	4989242.135
OUT-Ultimate	515530.13	4989238.156
OUT-Ultimate	515560.982	4989220.007
OUT-Ultimate	515594.229	4989203.255
OUT-Ultimate	515597.335	4989202.815

OUT-Ultimate	515599.346	4989204.673
OUT-Ultimate	515601.484	4989204.511
OUT-Ultimate	515602.097	4989203.576
OUT-Ultimate	515600.8	4989200.695
OUT-Ultimate	515601.984	4989199.009
OUT-Ultimate	515614.13	4989194.156
OUT-Ultimate	515619.983	4989190.008
OUT-Ultimate	515634.874	4989183.899
OUT-Ultimate	515643.972	4989177.998
OUT-Ultimate	515656.551	4989172.577
OUT-Ultimate	515673.551	4989164.577
OUT-Ultimate	515669.679	4989158.449
OUT-Ultimate	515666.551	4989144.577
OUT-Ultimate	515659.595	4989145.511
OUT-Ultimate	515658.191	4989144.913
OUT-Ultimate	515588.017	4989178.949
OUT-Ultimate	515513.396	4989216.566
OUT-Ultimate	515447.964	4989251.288

[SYMBOLS]
;;Gage X-Coord Y-Coord
;;-----

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.3)

Element Count

Number of rain gages 6
Number of subcatchments ... 5
Number of nodes 5
Number of links 0
Number of pollutants 0
Number of land uses 0

Raingage Summary

Name	Data Source	Data Type	Recording Interval
SCS_Type_II_40.2mm	SCS_Type_II_40.2mm	INTENSITY	6 min.
SCS_Type_II_51.6mm	SCS_Type_II_51.6mm	INTENSITY	6 min.
SCS_Type_II_58.8mm	SCS_Type_II_58.8mm	INTENSITY	6 min.
SCS_Type_II_68.4mm	SCS_Type_II_68.4mm	INTENSITY	6 min.
SCS_Type_II_75.6mm	SCS_Type_II_75.6mm	INTENSITY	6 min.
SCS_Type_II_82.2mm	SCS_Type_II_82.2mm	INTENSITY	6 min.

Subcatchment Summary

Name	Area	Width	%Imperv	%Slope	Rain Gage
Outlet					
OUT-A	0.66	26.01	29.00	0.3800	SCS_Type_II_82.2mm
OU-A					
OUT-B	13.10	111.75	32.50	0.5900	SCS_Type_II_82.2mm
OU-B					
OUT-C	1.03	53.74	28.80	0.2500	SCS_Type_II_82.2mm
OU-C					
OUT-D	1.44	80.25	36.60	0.5200	SCS_Type_II_82.2mm
OU-D					
OUT-Ultimate	2.90	45.11	20.70	0.4400	SCS_Type_II_82.2mm
OU-Ultimate					

Node Summary

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
OU-A	OUTFALL	62.23	0.00	0.0	
OU-B	OUTFALL	62.79	0.00	0.0	
OU-C	OUTFALL	62.32	0.00	0.0	

OU-D	OUTFALL	62.16	0.00	0.0
OU-Ultimate	OUTFALL	60.65	0.00	0.0

Analysis Options

Flow Units CMS
Process Models:
Rainfall/Runoff YES
RDII NO
Snowmelt NO
Groundwater NO
Flow Routing NO
Water Quality NO
Infiltration Method HORTON
Surcharge Method EXTRAN
Starting Date 06/29/2023 00:00:00
Ending Date 06/30/2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00

	Volume	Depth
Runoff Quantity Continuity	hectare-m	mm
Total Precipitation	1.572	82.200
Evaporation Loss	0.000	0.000
Infiltration Loss	0.974	50.932
Surface Runoff	0.590	30.837
Final Storage	0.009	0.494
Continuity Error (%)	-0.077	

	Volume	Volume
Flow Routing Continuity	hectare-m	10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.590	5.905
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.590	5.905
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

Subcatchment Runoff Summary

Perv	Total	Total	Total	Total	Total	Total	Imperv
Runoff	Runoff	Runoff	Precip	Runoff	Evap	Infil	Runoff
Subcatchment	mm	10^6 ltr	mm	mm	mm	mm	mm
mm	mm	10^6 ltr	CMS	Coeff	mm	mm	mm
OUT-A			82.20	0.00	0.00	47.91	23.47
10.46	33.94	0.22	0.09	0.413			
OUT-B			82.20	0.00	0.00	50.85	26.23
4.64	30.87	4.04	1.38	0.376			
OUT-C			82.20	0.00	0.00	47.72	23.31
10.82	34.13	0.35	0.14	0.415			
OUT-D			82.20	0.00	0.00	40.15	29.63
12.00	41.63	0.60	0.25	0.506			
OUT-Ultimate			82.20	0.00	0.00	58.48	16.74
6.71	23.45	0.68	0.24	0.285			

Analysis begun on: Mon Feb 12 09:34:45 2024
 Analysis ended on: Mon Feb 12 09:34:45 2024
 Total elapsed time: < 1 sec

PCSWMM Lumped Model Results - Existing Conditions (2098)

[TITLE]
;;Project Title/Notes

[OPTIONS]

;;Option Value
FLOW_UNITS CMS
INFILTRATION HORTON
FLOW_ROUTING DYNWAVE
LINK_OFFSETS DEPTH
MIN_SLOPE 0
ALLOW_PONDING NO
SKIP_STEADY_STATE NO

START_DATE 6/29/2023
START_TIME 00:00:00
REPORT_START_DATE 6/29/2023
REPORT_START_TIME 00:00:00
END_DATE 6/30/2023
END_TIME 00:00:00
SWEEP_START 1/1
SWEEP_END 12/31
DRY_DAYS 0
REPORT_STEP 00:01:00
WET_STEP 00:05:00
DRY_STEP 00:05:00
ROUTING_STEP 5
RULE_STEP 00:00:00

INERTIAL_DAMPING PARTIAL
NORMAL_FLOW_LIMITED BOTH
FORCE_MAIN_EQUATION H-W
VARIABLE_STEP 0.75
LENGTHENING_STEP 0
MIN_SURFAREA 0
MAX_TRIALS 8
HEAD_TOLERANCE 0
SYS_FLOW_TOL 5
LAT_FLOW_TOL 5
MINIMUM_STEP 0.5
THREADS 8

[EVAPORATION]

;;Data Source Parameters

;;-----
CONSTANT 0.0
DRY_ONLY NO

[RAINGAGES]

;;Name Format Interval SCF Source
;;-----
SCS_Type_II_40.2mm INTENSITY 0:06 1.0 TIMESERIES SCS_Type_II_40.2mm
SCS_Type_II_51.6mm INTENSITY 0:06 1.0 TIMESERIES SCS_Type_II_51.6mm
SCS_Type_II_58.8mm INTENSITY 0:06 1.0 TIMESERIES SCS_Type_II_58.8mm
SCS_Type_II_68.4mm INTENSITY 0:06 1.0 TIMESERIES SCS_Type_II_68.4mm
SCS_Type_II_75.6mm INTENSITY 0:06 1.0 TIMESERIES SCS_Type_II_75.6mm
SCS_Type_II_82.2mm INTENSITY 0:06 1.0 TIMESERIES SCS_Type_II_82.2mm

[SUBCATCHMENTS]

;;Name Rain Gage Outlet Area %Imperv Width %
Slope CurbLen SnowPack
;;-----

OUT-A SCS_Type_II_82.2mm OU-A 0.658 29 26.01 0.38
0
OUT-B SCS_Type_II_82.2mm OU-B 13.104 32.5 111.75 0.59
0
OUT-C SCS_Type_II_82.2mm OU-C 1.029 28.8 53.74 0.25
0
OUT-D SCS_Type_II_82.2mm OU-D 1.441 36.6 80.25 0.52
0
OUT-Ultimate SCS_Type_II_82.2mm OU-Ultimate 2.895 20.7 45.11 0.44
0

[SUBAREAS]

;;Subcatchment N-Imperv N-Perv S-Imperv S-Perv PctZero RouteTo
PctRouted
;;-----

OUT-A 0.013 0.25 1.57 4.67 0 OUTLET
OUT-B 0.013 0.25 1.57 4.67 0 OUTLET
OUT-C 0.013 0.25 1.57 4.67 0 OUTLET
OUT-D 0.013 0.25 1.57 4.67 0 OUTLET
OUT-Ultimate 0.013 0.25 1.57 4.67 0 OUTLET

[INFILTRATION]

;;Subcatchment Param1 Param2 Param3 Param4 Param5
;;-----
OUT-A 76.2 13.2 4.14 7 0
OUT-B 76.2 13.2 4.14 7 0
OUT-C 76.2 13.2 4.14 7 0
OUT-D 76.2 13.2 4.14 7 0
OUT-Ultimate 76.2 13.2 4.14 7 0

[OUTFALLS]

;;Name Elevation Type Stage Data Gated Route To
;;-----
OU-A 62.232 FREE NO
OU-B 62.79 FREE NO
OU-C 62.32 FREE NO
OU-D 62.159 FREE NO
OU-Ultimate 60.653 FREE NO

[TIMESERIES]

;;Name Date Time Value
;;-----

;;SCS_Type_II_10.6mm design storm, total rainfall = 10.6 mm, rain interval = 6 minutes, Rain units = mm/hr.

SCS_Type_II_10.6mm 0:00 0.47253
SCS_Type_II_10.6mm 0:06 0.48003
SCS_Type_II_10.6mm 0:12 0.48003
SCS_Type_II_10.6mm 0:18 0.48003
SCS_Type_II_10.6mm 0:24 0.48003
SCS_Type_II_10.6mm 0:30 0.48003
SCS_Type_II_10.6mm 0:36 0.49203
SCS_Type_II_10.6mm 0:42 0.51603

SCS_Type_II_10.6mm	0:48	0.54004
SCS_Type_II_10.6mm	0:54	0.56404
SCS_Type_II_10.6mm	1:00	0.58804
SCS_Type_II_10.6mm	1:06	0.61804
SCS_Type_II_10.6mm	1:12	0.65404
SCS_Type_II_10.6mm	1:18	0.69005
SCS_Type_II_10.6mm	1:24	0.72605
SCS_Type_II_10.6mm	1:30	0.76205
SCS_Type_II_10.6mm	1:36	0.81005
SCS_Type_II_10.6mm	1:42	0.87006
SCS_Type_II_10.6mm	1:48	0.93006
SCS_Type_II_10.6mm	1:54	0.99007
SCS_Type_II_10.6mm	2:00	1.05007
SCS_Type_II_10.6mm	2:06	1.15208
SCS_Type_II_10.6mm	2:12	1.29609
SCS_Type_II_10.6mm	2:18	1.4401
SCS_Type_II_10.6mm	2:24	1.5841
SCS_Type_II_10.6mm	2:30	1.72811
SCS_Type_II_10.6mm	2:36	3.57624
SCS_Type_II_10.6mm	2:42	7.12847
SCS_Type_II_10.6mm	2:48	11.46526
SCS_Type_II_10.6mm	2:54	20.56186
SCS_Type_II_10.6mm	3:00	14.27194
SCS_Type_II_10.6mm	3:06	2.84419
SCS_Type_II_10.6mm	3:12	2.50217
SCS_Type_II_10.6mm	3:18	2.16014
SCS_Type_II_10.6mm	3:24	1.81812
SCS_Type_II_10.6mm	3:30	1.4761
SCS_Type_II_10.6mm	3:36	1.26608
SCS_Type_II_10.6mm	3:42	1.18808
SCS_Type_II_10.6mm	3:48	1.11007
SCS_Type_II_10.6mm	3:54	1.03207
SCS_Type_II_10.6mm	4:00	0.95406
SCS_Type_II_10.6mm	4:06	0.89406
SCS_Type_II_10.6mm	4:12	0.85206
SCS_Type_II_10.6mm	4:18	0.81005
SCS_Type_II_10.6mm	4:24	0.76805
SCS_Type_II_10.6mm	4:30	0.72605
SCS_Type_II_10.6mm	4:36	0.69005
SCS_Type_II_10.6mm	4:42	0.66004
SCS_Type_II_10.6mm	4:48	0.63004
SCS_Type_II_10.6mm	4:54	0.60004
SCS_Type_II_10.6mm	5:00	0.57004
SCS_Type_II_10.6mm	5:06	0.55054
SCS_Type_II_10.6mm	5:12	0.53854
SCS_Type_II_10.6mm	5:18	0.52953
SCS_Type_II_10.6mm	5:24	0.51753
SCS_Type_II_10.6mm	5:30	0.50853
SCS_Type_II_10.6mm	5:36	0.49653
SCS_Type_II_10.6mm	5:42	0.48753
SCS_Type_II_10.6mm	5:48	0.47553
SCS_Type_II_10.6mm	5:54	0.46653

;SCS_Type_II_35.4mm design storm, total rainfall = 35.4 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_35.4mm	0:00	1.57808
SCS_Type_II_35.4mm	0:06	1.60312

SCS_Type_II_35.4mm	0:12	1.60312
SCS_Type_II_35.4mm	0:18	1.60312
SCS_Type_II_35.4mm	0:24	1.60312
SCS_Type_II_35.4mm	0:30	1.60312
SCS_Type_II_35.4mm	0:36	1.6432
SCS_Type_II_35.4mm	0:42	1.72336
SCS_Type_II_35.4mm	0:48	1.80352
SCS_Type_II_35.4mm	0:54	1.88367
SCS_Type_II_35.4mm	1:00	1.96383
SCS_Type_II_35.4mm	1:06	2.06402
SCS_Type_II_35.4mm	1:12	2.18426
SCS_Type_II_35.4mm	1:18	2.30449
SCS_Type_II_35.4mm	1:24	2.42473
SCS_Type_II_35.4mm	1:30	2.54496
SCS_Type_II_35.4mm	1:36	2.70527
SCS_Type_II_35.4mm	1:42	2.90566
SCS_Type_II_35.4mm	1:48	3.10605
SCS_Type_II_35.4mm	1:54	3.30644
SCS_Type_II_35.4mm	2:00	3.50684
SCS_Type_II_35.4mm	2:06	3.8475
SCS_Type_II_35.4mm	2:12	4.32844
SCS_Type_II_35.4mm	2:18	4.80937
SCS_Type_II_35.4mm	2:24	5.29031
SCS_Type_II_35.4mm	2:30	5.77125
SCS_Type_II_35.4mm	2:36	11.94328
SCS_Type_II_35.4mm	2:42	23.8064
SCS_Type_II_35.4mm	2:48	38.28963
SCS_Type_II_35.4mm	2:54	68.66885
SCS_Type_II_35.4mm	3:00	47.6629
SCS_Type_II_35.4mm	3:06	9.49851
SCS_Type_II_35.4mm	3:12	8.35629
SCS_Type_II_35.4mm	3:18	7.21406
SCS_Type_II_35.4mm	3:24	6.07183
SCS_Type_II_35.4mm	3:30	4.92961
SCS_Type_II_35.4mm	3:36	4.22824
SCS_Type_II_35.4mm	3:42	3.96773
SCS_Type_II_35.4mm	3:48	3.70723
SCS_Type_II_35.4mm	3:54	3.44672
SCS_Type_II_35.4mm	4:00	3.18621
SCS_Type_II_35.4mm	4:06	2.98582
SCS_Type_II_35.4mm	4:12	2.84555
SCS_Type_II_35.4mm	4:18	2.70527
SCS_Type_II_35.4mm	4:24	2.565
SCS_Type_II_35.4mm	4:30	2.42473
SCS_Type_II_35.4mm	4:36	2.30449
SCS_Type_II_35.4mm	4:42	2.2043
SCS_Type_II_35.4mm	4:48	2.1041
SCS_Type_II_35.4mm	4:54	2.00391
SCS_Type_II_35.4mm	5:00	1.90371
SCS_Type_II_35.4mm	5:06	1.83858
SCS_Type_II_35.4mm	5:12	1.79851
SCS_Type_II_35.4mm	5:18	1.76845
SCS_Type_II_35.4mm	5:24	1.72837
SCS_Type_II_35.4mm	5:30	1.69831
SCS_Type_II_35.4mm	5:36	1.65823
SCS_Type_II_35.4mm	5:42	1.62817
SCS_Type_II_35.4mm	5:48	1.5881

SCS_Type_II_35.4mm 5:54 1.55804

;SCS_Type_II_40.2mm design storm, total rainfall = 40.2 mm, rain interval = 6 minutes, Rain units = mm/hr.

SCS_Type_II_40.2mm	0:00	1.79205
SCS_Type_II_40.2mm	0:06	1.8205
SCS_Type_II_40.2mm	0:12	1.8205
SCS_Type_II_40.2mm	0:18	1.8205
SCS_Type_II_40.2mm	0:24	1.8205
SCS_Type_II_40.2mm	0:30	1.8205
SCS_Type_II_40.2mm	0:36	1.86601
SCS_Type_II_40.2mm	0:42	1.95703
SCS_Type_II_40.2mm	0:48	2.04806
SCS_Type_II_40.2mm	0:54	2.13908
SCS_Type_II_40.2mm	1:00	2.23011
SCS_Type_II_40.2mm	1:06	2.34389
SCS_Type_II_40.2mm	1:12	2.48043
SCS_Type_II_40.2mm	1:18	2.61697
SCS_Type_II_40.2mm	1:24	2.7535
SCS_Type_II_40.2mm	1:30	2.89004
SCS_Type_II_40.2mm	1:36	3.07209
SCS_Type_II_40.2mm	1:42	3.29965
SCS_Type_II_40.2mm	1:48	3.52721
SCS_Type_II_40.2mm	1:54	3.75478
SCS_Type_II_40.2mm	2:00	3.98234
SCS_Type_II_40.2mm	2:06	4.36919
SCS_Type_II_40.2mm	2:12	4.91534
SCS_Type_II_40.2mm	2:18	5.46149
SCS_Type_II_40.2mm	2:24	6.00764
SCS_Type_II_40.2mm	2:30	6.55379
SCS_Type_II_40.2mm	2:36	13.56271
SCS_Type_II_40.2mm	2:42	27.03439
SCS_Type_II_40.2mm	2:48	43.48145
SCS_Type_II_40.2mm	2:54	77.97988
SCS_Type_II_40.2mm	3:00	54.12567
SCS_Type_II_40.2mm	3:06	10.78645
SCS_Type_II_40.2mm	3:12	9.48934
SCS_Type_II_40.2mm	3:18	8.19224
SCS_Type_II_40.2mm	3:24	6.89513
SCS_Type_II_40.2mm	3:30	5.59803
SCS_Type_II_40.2mm	3:36	4.80156
SCS_Type_II_40.2mm	3:42	4.50573
SCS_Type_II_40.2mm	3:48	4.2099
SCS_Type_II_40.2mm	3:54	3.91407
SCS_Type_II_40.2mm	4:00	3.61824
SCS_Type_II_40.2mm	4:06	3.39068
SCS_Type_II_40.2mm	4:12	3.23138
SCS_Type_II_40.2mm	4:18	3.07209
SCS_Type_II_40.2mm	4:24	2.9128
SCS_Type_II_40.2mm	4:30	2.7535
SCS_Type_II_40.2mm	4:36	2.61697
SCS_Type_II_40.2mm	4:42	2.50318
SCS_Type_II_40.2mm	4:48	2.3894
SCS_Type_II_40.2mm	4:54	2.27562
SCS_Type_II_40.2mm	5:00	2.16184
SCS_Type_II_40.2mm	5:06	2.08788
SCS_Type_II_40.2mm	5:12	2.04237

SCS_Type_II_40.2mm	5:18	2.00824
SCS_Type_II_40.2mm	5:24	1.96272
SCS_Type_II_40.2mm	5:30	1.92859
SCS_Type_II_40.2mm	5:36	1.88308
SCS_Type_II_40.2mm	5:42	1.84894
SCS_Type_II_40.2mm	5:48	1.80343
SCS_Type_II_40.2mm	5:54	1.7693

;SCS_Type_II_46.8mm design storm, total rainfall = 46.8 mm, rain interval = 6 minutes, Rain units = mm/hr.

SCS_Type_II_46.8mm	0:00	2.08627
SCS_Type_II_46.8mm	0:06	2.11939
SCS_Type_II_46.8mm	0:12	2.11939
SCS_Type_II_46.8mm	0:18	2.11939
SCS_Type_II_46.8mm	0:24	2.11939
SCS_Type_II_46.8mm	0:30	2.11939
SCS_Type_II_46.8mm	0:36	2.17237
SCS_Type_II_46.8mm	0:42	2.27834
SCS_Type_II_46.8mm	0:48	2.38431
SCS_Type_II_46.8mm	0:54	2.49028
SCS_Type_II_46.8mm	1:00	2.59625
SCS_Type_II_46.8mm	1:06	2.72871
SCS_Type_II_46.8mm	1:12	2.88766
SCS_Type_II_46.8mm	1:18	3.04662
SCS_Type_II_46.8mm	1:24	3.20557
SCS_Type_II_46.8mm	1:30	3.36452
SCS_Type_II_46.8mm	1:36	3.57646
SCS_Type_II_46.8mm	1:42	3.84139
SCS_Type_II_46.8mm	1:48	4.10631
SCS_Type_II_46.8mm	1:54	4.37123
SCS_Type_II_46.8mm	2:00	4.63616
SCS_Type_II_46.8mm	2:06	5.08652
SCS_Type_II_46.8mm	2:12	5.72234
SCS_Type_II_46.8mm	2:18	6.35816
SCS_Type_II_46.8mm	2:24	6.99397
SCS_Type_II_46.8mm	2:30	7.62979
SCS_Type_II_46.8mm	2:36	15.78942
SCS_Type_II_46.8mm	2:42	31.47287
SCS_Type_II_46.8mm	2:48	50.62019
SCS_Type_II_46.8mm	2:54	90.78254
SCS_Type_II_46.8mm	3:00	63.01197
SCS_Type_II_46.8mm	3:06	12.55736
SCS_Type_II_46.8mm	3:12	11.0473
SCS_Type_II_46.8mm	3:18	9.53723
SCS_Type_II_46.8mm	3:24	8.02717
SCS_Type_II_46.8mm	3:30	6.51711
SCS_Type_II_46.8mm	3:36	5.58988
SCS_Type_II_46.8mm	3:42	5.24548
SCS_Type_II_46.8mm	3:48	4.90108
SCS_Type_II_46.8mm	3:54	4.55668
SCS_Type_II_46.8mm	4:00	4.21228
SCS_Type_II_46.8mm	4:06	3.94736
SCS_Type_II_46.8mm	4:12	3.76191
SCS_Type_II_46.8mm	4:18	3.57646
SCS_Type_II_46.8mm	4:24	3.39102
SCS_Type_II_46.8mm	4:30	3.20557
SCS_Type_II_46.8mm	4:36	3.04662

SCS_Type_II_46.8mm	4:42	2.91415
SCS_Type_II_46.8mm	4:48	2.78169
SCS_Type_II_46.8mm	4:54	2.64923
SCS_Type_II_46.8mm	5:00	2.51677
SCS_Type_II_46.8mm	5:06	2.43067
SCS_Type_II_46.8mm	5:12	2.37769
SCS_Type_II_46.8mm	5:18	2.33795
SCS_Type_II_46.8mm	5:24	2.28496
SCS_Type_II_46.8mm	5:30	2.24522
SCS_Type_II_46.8mm	5:36	2.19224
SCS_Type_II_46.8mm	5:42	2.1525
SCS_Type_II_46.8mm	5:48	2.09952
SCS_Type_II_46.8mm	5:54	2.05978

;SCS_Type_II_5.9mm design storm, total rainfall = 5.9 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_5.9mm	0:00	0.26301
SCS_Type_II_5.9mm	0:06	0.26719
SCS_Type_II_5.9mm	0:12	0.26719
SCS_Type_II_5.9mm	0:18	0.26719
SCS_Type_II_5.9mm	0:24	0.26719
SCS_Type_II_5.9mm	0:30	0.26719
SCS_Type_II_5.9mm	0:36	0.27387
SCS_Type_II_5.9mm	0:42	0.28723
SCS_Type_II_5.9mm	0:48	0.30059
SCS_Type_II_5.9mm	0:54	0.31395
SCS_Type_II_5.9mm	1:00	0.3273
SCS_Type_II_5.9mm	1:06	0.344
SCS_Type_II_5.9mm	1:12	0.36404
SCS_Type_II_5.9mm	1:18	0.38408
SCS_Type_II_5.9mm	1:24	0.40412
SCS_Type_II_5.9mm	1:30	0.42416
SCS_Type_II_5.9mm	1:36	0.45088
SCS_Type_II_5.9mm	1:42	0.48428
SCS_Type_II_5.9mm	1:48	0.51768
SCS_Type_II_5.9mm	1:54	0.55107
SCS_Type_II_5.9mm	2:00	0.58447
SCS_Type_II_5.9mm	2:06	0.64125
SCS_Type_II_5.9mm	2:12	0.72141
SCS_Type_II_5.9mm	2:18	0.80156
SCS_Type_II_5.9mm	2:24	0.88172
SCS_Type_II_5.9mm	2:30	0.96187
SCS_Type_II_5.9mm	2:36	1.99055
SCS_Type_II_5.9mm	2:42	3.96773
SCS_Type_II_5.9mm	2:48	6.38161
SCS_Type_II_5.9mm	2:54	11.44481
SCS_Type_II_5.9mm	3:00	7.94382
SCS_Type_II_5.9mm	3:06	1.58309
SCS_Type_II_5.9mm	3:12	1.39271
SCS_Type_II_5.9mm	3:18	1.20234
SCS_Type_II_5.9mm	3:24	1.01197
SCS_Type_II_5.9mm	3:30	0.8216
SCS_Type_II_5.9mm	3:36	0.70471
SCS_Type_II_5.9mm	3:42	0.66129
SCS_Type_II_5.9mm	3:48	0.61787
SCS_Type_II_5.9mm	3:54	0.57445
SCS_Type_II_5.9mm	4:00	0.53104

SCS_Type_II_5.9mm	4:06	0.49764
SCS_Type_II_5.9mm	4:12	0.47426
SCS_Type_II_5.9mm	4:18	0.45088
SCS_Type_II_5.9mm	4:24	0.4275
SCS_Type_II_5.9mm	4:30	0.40412
SCS_Type_II_5.9mm	4:36	0.38408
SCS_Type_II_5.9mm	4:42	0.36738
SCS_Type_II_5.9mm	4:48	0.35068
SCS_Type_II_5.9mm	4:54	0.33398
SCS_Type_II_5.9mm	5:00	0.31729
SCS_Type_II_5.9mm	5:06	0.30643
SCS_Type_II_5.9mm	5:12	0.29975
SCS_Type_II_5.9mm	5:18	0.29474
SCS_Type_II_5.9mm	5:24	0.28806
SCS_Type_II_5.9mm	5:30	0.28305
SCS_Type_II_5.9mm	5:36	0.27637
SCS_Type_II_5.9mm	5:42	0.27136
SCS_Type_II_5.9mm	5:48	0.26468
SCS_Type_II_5.9mm	5:54	0.25967

;SCS_Type_II_51.6mm design storm, total rainfall = 51.6 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_51.6mm	0:00	2.30025
SCS_Type_II_51.6mm	0:06	2.33676
SCS_Type_II_51.6mm	0:12	2.33676
SCS_Type_II_51.6mm	0:18	2.33676
SCS_Type_II_51.6mm	0:24	2.33676
SCS_Type_II_51.6mm	0:30	2.33676
SCS_Type_II_51.6mm	0:36	2.39518
SCS_Type_II_51.6mm	0:42	2.51201
SCS_Type_II_51.6mm	0:48	2.62885
SCS_Type_II_51.6mm	0:54	2.74569
SCS_Type_II_51.6mm	1:00	2.86253
SCS_Type_II_51.6mm	1:06	3.00858
SCS_Type_II_51.6mm	1:12	3.18383
SCS_Type_II_51.6mm	1:18	3.35909
SCS_Type_II_51.6mm	1:24	3.53435
SCS_Type_II_51.6mm	1:30	3.7096
SCS_Type_II_51.6mm	1:36	3.94328
SCS_Type_II_51.6mm	1:42	4.23537
SCS_Type_II_51.6mm	1:48	4.52747
SCS_Type_II_51.6mm	1:54	4.81956
SCS_Type_II_51.6mm	2:00	5.11166
SCS_Type_II_51.6mm	2:06	5.60822
SCS_Type_II_51.6mm	2:12	6.30925
SCS_Type_II_51.6mm	2:18	7.01027
SCS_Type_II_51.6mm	2:24	7.7113
SCS_Type_II_51.6mm	2:30	8.41233
SCS_Type_II_51.6mm	2:36	17.40885
SCS_Type_II_51.6mm	2:42	34.70086
SCS_Type_II_51.6mm	2:48	55.81201
SCS_Type_II_51.6mm	2:54	100.09357
SCS_Type_II_51.6mm	3:00	69.47474
SCS_Type_II_51.6mm	3:06	13.84529
SCS_Type_II_51.6mm	3:12	12.18035
SCS_Type_II_51.6mm	3:18	10.51541
SCS_Type_II_51.6mm	3:24	8.85047

SCS_Type_II_51.6mm	3:30	7.18553
SCS_Type_II_51.6mm	3:36	6.1632
SCS_Type_II_51.6mm	3:42	5.78348
SCS_Type_II_51.6mm	3:48	5.40375
SCS_Type_II_51.6mm	3:54	5.02403
SCS_Type_II_51.6mm	4:00	4.64431
SCS_Type_II_51.6mm	4:06	4.35221
SCS_Type_II_51.6mm	4:12	4.14775
SCS_Type_II_51.6mm	4:18	3.94328
SCS_Type_II_51.6mm	4:24	3.73881
SCS_Type_II_51.6mm	4:30	3.53435
SCS_Type_II_51.6mm	4:36	3.35909
SCS_Type_II_51.6mm	4:42	3.21304
SCS_Type_II_51.6mm	4:48	3.06699
SCS_Type_II_51.6mm	4:54	2.92095
SCS_Type_II_51.6mm	5:00	2.7749
SCS_Type_II_51.6mm	5:06	2.67997
SCS_Type_II_51.6mm	5:12	2.62155
SCS_Type_II_51.6mm	5:18	2.57774
SCS_Type_II_51.6mm	5:24	2.51932
SCS_Type_II_51.6mm	5:30	2.4755
SCS_Type_II_51.6mm	5:36	2.41708
SCS_Type_II_51.6mm	5:42	2.37327
SCS_Type_II_51.6mm	5:48	2.31485
SCS_Type_II_51.6mm	5:54	2.27104

;SCS_Type_II_54mm design storm, total rainfall = 54 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_54mm	0:00	2.40723
SCS_Type_II_54mm	0:06	2.44544
SCS_Type_II_54mm	0:12	2.44544
SCS_Type_II_54mm	0:18	2.44544
SCS_Type_II_54mm	0:24	2.44544
SCS_Type_II_54mm	0:30	2.44544
SCS_Type_II_54mm	0:36	2.50658
SCS_Type_II_54mm	0:42	2.62885
SCS_Type_II_54mm	0:48	2.75113
SCS_Type_II_54mm	0:54	2.8734
SCS_Type_II_54mm	1:00	2.99567
SCS_Type_II_54mm	1:06	3.14851
SCS_Type_II_54mm	1:12	3.33192
SCS_Type_II_54mm	1:18	3.51533
SCS_Type_II_54mm	1:24	3.69873
SCS_Type_II_54mm	1:30	3.88214
SCS_Type_II_54mm	1:36	4.12669
SCS_Type_II_54mm	1:42	4.43237
SCS_Type_II_54mm	1:48	4.73805
SCS_Type_II_54mm	1:54	5.04373
SCS_Type_II_54mm	2:00	5.34941
SCS_Type_II_54mm	2:06	5.86907
SCS_Type_II_54mm	2:12	6.6027
SCS_Type_II_54mm	2:18	7.33633
SCS_Type_II_54mm	2:24	8.06997
SCS_Type_II_54mm	2:30	8.8036
SCS_Type_II_54mm	2:36	18.21856
SCS_Type_II_54mm	2:42	36.31485
SCS_Type_II_54mm	2:48	58.40791

SCS_Type_II_54mm	2:54	104.74909
SCS_Type_II_54mm	3:00	72.70612
SCS_Type_II_54mm	3:06	14.48926
SCS_Type_II_54mm	3:12	12.74688
SCS_Type_II_54mm	3:18	11.0045
SCS_Type_II_54mm	3:24	9.26212
SCS_Type_II_54mm	3:30	7.51974
SCS_Type_II_54mm	3:36	6.44986
SCS_Type_II_54mm	3:42	6.05248
SCS_Type_II_54mm	3:48	5.65509
SCS_Type_II_54mm	3:54	5.25771
SCS_Type_II_54mm	4:00	4.86032
SCS_Type_II_54mm	4:06	4.55464
SCS_Type_II_54mm	4:12	4.34066
SCS_Type_II_54mm	4:18	4.12669
SCS_Type_II_54mm	4:24	3.91271
SCS_Type_II_54mm	4:30	3.69873
SCS_Type_II_54mm	4:36	3.51533
SCS_Type_II_54mm	4:42	3.36249
SCS_Type_II_54mm	4:48	3.20965
SCS_Type_II_54mm	4:54	3.05681
SCS_Type_II_54mm	5:00	2.90397
SCS_Type_II_54mm	5:06	2.80462
SCS_Type_II_54mm	5:12	2.74348
SCS_Type_II_54mm	5:18	2.69763
SCS_Type_II_54mm	5:24	2.63649
SCS_Type_II_54mm	5:30	2.59064
SCS_Type_II_54mm	5:36	2.52951
SCS_Type_II_54mm	5:42	2.48365
SCS_Type_II_54mm	5:48	2.42252
SCS_Type_II_54mm	5:54	2.37667

;SCS_Type_II_58.8mm design storm, total rainfall = 58.8 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_58.8mm	0:00	2.62121
SCS_Type_II_58.8mm	0:06	2.66282
SCS_Type_II_58.8mm	0:12	2.66282
SCS_Type_II_58.8mm	0:18	2.66282
SCS_Type_II_58.8mm	0:24	2.66282
SCS_Type_II_58.8mm	0:30	2.66282
SCS_Type_II_58.8mm	0:36	2.72939
SCS_Type_II_58.8mm	0:42	2.86253
SCS_Type_II_58.8mm	0:48	2.99567
SCS_Type_II_58.8mm	0:54	3.12881
SCS_Type_II_58.8mm	1:00	3.26195
SCS_Type_II_58.8mm	1:06	3.42838
SCS_Type_II_58.8mm	1:12	3.62809
SCS_Type_II_58.8mm	1:18	3.8278
SCS_Type_II_58.8mm	1:24	4.02751
SCS_Type_II_58.8mm	1:30	4.22722
SCS_Type_II_58.8mm	1:36	4.4935
SCS_Type_II_58.8mm	1:42	4.82636
SCS_Type_II_58.8mm	1:48	5.15921
SCS_Type_II_58.8mm	1:54	5.49206
SCS_Type_II_58.8mm	2:00	5.82491
SCS_Type_II_58.8mm	2:06	6.39076
SCS_Type_II_58.8mm	2:12	7.18961

SCS_Type_II_58.8mm	2:18	7.98845
SCS_Type_II_58.8mm	2:24	8.7873
SCS_Type_II_58.8mm	2:30	9.58614
SCS_Type_II_58.8mm	2:36	19.83799
SCS_Type_II_58.8mm	2:42	39.54284
SCS_Type_II_58.8mm	2:48	63.59973
SCS_Type_II_58.8mm	2:54	114.06012
SCS_Type_II_58.8mm	3:00	79.16889
SCS_Type_II_58.8mm	3:06	15.77719
SCS_Type_II_58.8mm	3:12	13.87994
SCS_Type_II_58.8mm	3:18	11.98268
SCS_Type_II_58.8mm	3:24	10.08542
SCS_Type_II_58.8mm	3:30	8.18816
SCS_Type_II_58.8mm	3:36	7.02318
SCS_Type_II_58.8mm	3:42	6.59047
SCS_Type_II_58.8mm	3:48	6.15777
SCS_Type_II_58.8mm	3:54	5.72506
SCS_Type_II_58.8mm	4:00	5.29235
SCS_Type_II_58.8mm	4:06	4.9595
SCS_Type_II_58.8mm	4:12	4.7265
SCS_Type_II_58.8mm	4:18	4.4935
SCS_Type_II_58.8mm	4:24	4.26051
SCS_Type_II_58.8mm	4:30	4.02751
SCS_Type_II_58.8mm	4:36	3.8278
SCS_Type_II_58.8mm	4:42	3.66137
SCS_Type_II_58.8mm	4:48	3.49495
SCS_Type_II_58.8mm	4:54	3.32852
SCS_Type_II_58.8mm	5:00	3.1621
SCS_Type_II_58.8mm	5:06	3.05392
SCS_Type_II_58.8mm	5:12	2.98735
SCS_Type_II_58.8mm	5:18	2.93742
SCS_Type_II_58.8mm	5:24	2.87085
SCS_Type_II_58.8mm	5:30	2.82092
SCS_Type_II_58.8mm	5:36	2.75435
SCS_Type_II_58.8mm	5:42	2.70442
SCS_Type_II_58.8mm	5:48	2.63785
SCS_Type_II_58.8mm	5:54	2.58793

;SCS_Type_II_63.6mm design storm, total rainfall = 63.6 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_63.6mm	0:00	2.83519
SCS_Type_II_63.6mm	0:06	2.88019
SCS_Type_II_63.6mm	0:12	2.88019
SCS_Type_II_63.6mm	0:18	2.88019
SCS_Type_II_63.6mm	0:24	2.88019
SCS_Type_II_63.6mm	0:30	2.88019
SCS_Type_II_63.6mm	0:36	2.95219
SCS_Type_II_63.6mm	0:42	3.0962
SCS_Type_II_63.6mm	0:48	3.24021
SCS_Type_II_63.6mm	0:54	3.38422
SCS_Type_II_63.6mm	1:00	3.52823
SCS_Type_II_63.6mm	1:06	3.70824
SCS_Type_II_63.6mm	1:12	3.92426
SCS_Type_II_63.6mm	1:18	4.14027
SCS_Type_II_63.6mm	1:24	4.35629
SCS_Type_II_63.6mm	1:30	4.5723
SCS_Type_II_63.6mm	1:36	4.86032

SCS_Type_II_63.6mm	1:42	5.22034
SCS_Type_II_63.6mm	1:48	5.58037
SCS_Type_II_63.6mm	1:54	5.94039
SCS_Type_II_63.6mm	2:00	6.30042
SCS_Type_II_63.6mm	2:06	6.91246
SCS_Type_II_63.6mm	2:12	7.77651
SCS_Type_II_63.6mm	2:18	8.64057
SCS_Type_II_63.6mm	2:24	9.50463
SCS_Type_II_63.6mm	2:30	10.36868
SCS_Type_II_63.6mm	2:36	21.45742
SCS_Type_II_63.6mm	2:42	42.77082
SCS_Type_II_63.6mm	2:48	68.79154
SCS_Type_II_63.6mm	2:54	123.37115
SCS_Type_II_63.6mm	3:00	85.63165
SCS_Type_II_63.6mm	3:06	17.06513
SCS_Type_II_63.6mm	3:12	15.01299
SCS_Type_II_63.6mm	3:18	12.96086
SCS_Type_II_63.6mm	3:24	10.90872
SCS_Type_II_63.6mm	3:30	8.85658
SCS_Type_II_63.6mm	3:36	7.5965
SCS_Type_II_63.6mm	3:42	7.12847
SCS_Type_II_63.6mm	3:48	6.66044
SCS_Type_II_63.6mm	3:54	6.19241
SCS_Type_II_63.6mm	4:00	5.72438
SCS_Type_II_63.6mm	4:06	5.36435
SCS_Type_II_63.6mm	4:12	5.11234
SCS_Type_II_63.6mm	4:18	4.86032
SCS_Type_II_63.6mm	4:24	4.6083
SCS_Type_II_63.6mm	4:30	4.35629
SCS_Type_II_63.6mm	4:36	4.14027
SCS_Type_II_63.6mm	4:42	3.96026
SCS_Type_II_63.6mm	4:48	3.78025
SCS_Type_II_63.6mm	4:54	3.60024
SCS_Type_II_63.6mm	5:00	3.42023
SCS_Type_II_63.6mm	5:06	3.30322
SCS_Type_II_63.6mm	5:12	3.23121
SCS_Type_II_63.6mm	5:18	3.17721
SCS_Type_II_63.6mm	5:24	3.10521
SCS_Type_II_63.6mm	5:30	3.0512
SCS_Type_II_63.6mm	5:36	2.9792
SCS_Type_II_63.6mm	5:42	2.92519
SCS_Type_II_63.6mm	5:48	2.85319
SCS_Type_II_63.6mm	5:54	2.79918

;SCS_Type_II_68.4mm design storm, total rainfall = 68.4 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_68.4mm	0:00	3.04916
SCS_Type_II_68.4mm	0:06	3.09756
SCS_Type_II_68.4mm	0:12	3.09756
SCS_Type_II_68.4mm	0:18	3.09756
SCS_Type_II_68.4mm	0:24	3.09756
SCS_Type_II_68.4mm	0:30	3.09756
SCS_Type_II_68.4mm	0:36	3.175
SCS_Type_II_68.4mm	0:42	3.32988
SCS_Type_II_68.4mm	0:48	3.48476
SCS_Type_II_68.4mm	0:54	3.63964
SCS_Type_II_68.4mm	1:00	3.79451

SCS_Type_II_68.4mm	1:06	3.98811
SCS_Type_II_68.4mm	1:12	4.22043
SCS_Type_II_68.4mm	1:18	4.45275
SCS_Type_II_68.4mm	1:24	4.68506
SCS_Type_II_68.4mm	1:30	4.91738
SCS_Type_II_68.4mm	1:36	5.22714
SCS_Type_II_68.4mm	1:42	5.61433
SCS_Type_II_68.4mm	1:48	6.00153
SCS_Type_II_68.4mm	1:54	6.38872
SCS_Type_II_68.4mm	2:00	6.77592
SCS_Type_II_68.4mm	2:06	7.43415
SCS_Type_II_68.4mm	2:12	8.36342
SCS_Type_II_68.4mm	2:18	9.29269
SCS_Type_II_68.4mm	2:24	10.22196
SCS_Type_II_68.4mm	2:30	11.15123
SCS_Type_II_68.4mm	2:36	23.07684
SCS_Type_II_68.4mm	2:42	45.99881
SCS_Type_II_68.4mm	2:48	73.98336
SCS_Type_II_68.4mm	2:54	132.68218
SCS_Type_II_68.4mm	3:00	92.09442
SCS_Type_II_68.4mm	3:06	18.35306
SCS_Type_II_68.4mm	3:12	16.14605
SCS_Type_II_68.4mm	3:18	13.93903
SCS_Type_II_68.4mm	3:24	11.73202
SCS_Type_II_68.4mm	3:30	9.52501
SCS_Type_II_68.4mm	3:36	8.16982
SCS_Type_II_68.4mm	3:42	7.66647
SCS_Type_II_68.4mm	3:48	7.16311
SCS_Type_II_68.4mm	3:54	6.65976
SCS_Type_II_68.4mm	4:00	6.15641
SCS_Type_II_68.4mm	4:06	5.76921
SCS_Type_II_68.4mm	4:12	5.49817
SCS_Type_II_68.4mm	4:18	5.22714
SCS_Type_II_68.4mm	4:24	4.9561
SCS_Type_II_68.4mm	4:30	4.68506
SCS_Type_II_68.4mm	4:36	4.45275
SCS_Type_II_68.4mm	4:42	4.25915
SCS_Type_II_68.4mm	4:48	4.06555
SCS_Type_II_68.4mm	4:54	3.87195
SCS_Type_II_68.4mm	5:00	3.67836
SCS_Type_II_68.4mm	5:06	3.55252
SCS_Type_II_68.4mm	5:12	3.47508
SCS_Type_II_68.4mm	5:18	3.417
SCS_Type_II_68.4mm	5:24	3.33956
SCS_Type_II_68.4mm	5:30	3.28148
SCS_Type_II_68.4mm	5:36	3.20404
SCS_Type_II_68.4mm	5:42	3.14596
SCS_Type_II_68.4mm	5:48	3.06852
SCS_Type_II_68.4mm	5:54	3.01044

;SCS_Type_II_7.8mm design storm, total rainfall = 7.8 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_7.8mm	0:00	0.34771
SCS_Type_II_7.8mm	0:06	0.35323
SCS_Type_II_7.8mm	0:12	0.35323
SCS_Type_II_7.8mm	0:18	0.35323
SCS_Type_II_7.8mm	0:24	0.35323

SCS_Type_II_7.8mm	0:30	0.35323
SCS_Type_II_7.8mm	0:36	0.36206
SCS_Type_II_7.8mm	0:42	0.37972
SCS_Type_II_7.8mm	0:48	0.39738
SCS_Type_II_7.8mm	0:54	0.41505
SCS_Type_II_7.8mm	1:00	0.43271
SCS_Type_II_7.8mm	1:06	0.45478
SCS_Type_II_7.8mm	1:12	0.48128
SCS_Type_II_7.8mm	1:18	0.50777
SCS_Type_II_7.8mm	1:24	0.53426
SCS_Type_II_7.8mm	1:30	0.56075
SCS_Type_II_7.8mm	1:36	0.59608
SCS_Type_II_7.8mm	1:42	0.64023
SCS_Type_II_7.8mm	1:48	0.68438
SCS_Type_II_7.8mm	1:54	0.72854
SCS_Type_II_7.8mm	2:00	0.77269
SCS_Type_II_7.8mm	2:06	0.84775
SCS_Type_II_7.8mm	2:12	0.95372
SCS_Type_II_7.8mm	2:18	1.05969
SCS_Type_II_7.8mm	2:24	1.16566
SCS_Type_II_7.8mm	2:30	1.27163
SCS_Type_II_7.8mm	2:36	2.63157
SCS_Type_II_7.8mm	2:42	5.24548
SCS_Type_II_7.8mm	2:48	8.4367
SCS_Type_II_7.8mm	2:54	15.13042
SCS_Type_II_7.8mm	3:00	10.502
SCS_Type_II_7.8mm	3:06	2.09289
SCS_Type_II_7.8mm	3:12	1.84122
SCS_Type_II_7.8mm	3:18	1.58954
SCS_Type_II_7.8mm	3:24	1.33786
SCS_Type_II_7.8mm	3:30	1.08618
SCS_Type_II_7.8mm	3:36	0.93165
SCS_Type_II_7.8mm	3:42	0.87425
SCS_Type_II_7.8mm	3:48	0.81685
SCS_Type_II_7.8mm	3:54	0.75945
SCS_Type_II_7.8mm	4:00	0.70205
SCS_Type_II_7.8mm	4:06	0.65789
SCS_Type_II_7.8mm	4:12	0.62698
SCS_Type_II_7.8mm	4:18	0.59608
SCS_Type_II_7.8mm	4:24	0.56517
SCS_Type_II_7.8mm	4:30	0.53426
SCS_Type_II_7.8mm	4:36	0.50777
SCS_Type_II_7.8mm	4:42	0.48569
SCS_Type_II_7.8mm	4:48	0.46362
SCS_Type_II_7.8mm	4:54	0.44154
SCS_Type_II_7.8mm	5:00	0.41946
SCS_Type_II_7.8mm	5:06	0.40511
SCS_Type_II_7.8mm	5:12	0.39628
SCS_Type_II_7.8mm	5:18	0.38966
SCS_Type_II_7.8mm	5:24	0.38083
SCS_Type_II_7.8mm	5:30	0.3742
SCS_Type_II_7.8mm	5:36	0.36537
SCS_Type_II_7.8mm	5:42	0.35875
SCS_Type_II_7.8mm	5:48	0.34992
SCS_Type_II_7.8mm	5:54	0.3433

;SCS_Type_II_70.2mm design storm, total rainfall = 70.2 mm, rain interval = 6 minutes, rain units = mm/hr

SCS_Type_II_70.2mm	0:00	3.1294
SCS_Type_II_70.2mm	0:06	3.17908
SCS_Type_II_70.2mm	0:12	3.17908
SCS_Type_II_70.2mm	0:18	3.17908
SCS_Type_II_70.2mm	0:24	3.17908
SCS_Type_II_70.2mm	0:30	3.17908
SCS_Type_II_70.2mm	0:36	3.25855
SCS_Type_II_70.2mm	0:42	3.41751
SCS_Type_II_70.2mm	0:48	3.57646
SCS_Type_II_70.2mm	0:54	3.73542
SCS_Type_II_70.2mm	1:00	3.89437
SCS_Type_II_70.2mm	1:06	4.09306
SCS_Type_II_70.2mm	1:12	4.33149
SCS_Type_II_70.2mm	1:18	4.56992
SCS_Type_II_70.2mm	1:24	4.80836
SCS_Type_II_70.2mm	1:30	5.04679
SCS_Type_II_70.2mm	1:36	5.36469
SCS_Type_II_70.2mm	1:42	5.76208
SCS_Type_II_70.2mm	1:48	6.15946
SCS_Type_II_70.2mm	1:54	6.55685
SCS_Type_II_70.2mm	2:00	6.95423
SCS_Type_II_70.2mm	2:06	7.62979
SCS_Type_II_70.2mm	2:12	8.58351
SCS_Type_II_70.2mm	2:18	9.53723
SCS_Type_II_70.2mm	2:24	10.49096
SCS_Type_II_70.2mm	2:30	11.44468
SCS_Type_II_70.2mm	2:36	23.68413
SCS_Type_II_70.2mm	2:42	47.20931
SCS_Type_II_70.2mm	2:48	75.93029
SCS_Type_II_70.2mm	2:54	136.17381
SCS_Type_II_70.2mm	3:00	94.51796
SCS_Type_II_70.2mm	3:06	18.83604
SCS_Type_II_70.2mm	3:12	16.57094
SCS_Type_II_70.2mm	3:18	14.30585
SCS_Type_II_70.2mm	3:24	12.04076
SCS_Type_II_70.2mm	3:30	9.77566
SCS_Type_II_70.2mm	3:36	8.38482
SCS_Type_II_70.2mm	3:42	7.86822
SCS_Type_II_70.2mm	3:48	7.35162
SCS_Type_II_70.2mm	3:54	6.83502
SCS_Type_II_70.2mm	4:00	6.31842
SCS_Type_II_70.2mm	4:06	5.92103
SCS_Type_II_70.2mm	4:12	5.64286
SCS_Type_II_70.2mm	4:18	5.36469
SCS_Type_II_70.2mm	4:24	5.08652
SCS_Type_II_70.2mm	4:30	4.80836
SCS_Type_II_70.2mm	4:36	4.56992
SCS_Type_II_70.2mm	4:42	4.37123
SCS_Type_II_70.2mm	4:48	4.17254
SCS_Type_II_70.2mm	4:54	3.97385
SCS_Type_II_70.2mm	5:00	3.77515
SCS_Type_II_70.2mm	5:06	3.646
SCS_Type_II_70.2mm	5:12	3.56653
SCS_Type_II_70.2mm	5:18	3.50692
SCS_Type_II_70.2mm	5:24	3.42744
SCS_Type_II_70.2mm	5:30	3.36784
SCS_Type_II_70.2mm	5:36	3.28836

SCS_Type_II_70.2mm	5:42	3.22875
SCS_Type_II_70.2mm	5:48	3.14927
SCS_Type_II_70.2mm	5:54	3.08967

;SCS_Type_II_75.6mm design storm, total rainfall = 75.6 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_75.6mm	0:00	3.37013
SCS_Type_II_75.6mm	0:06	3.42362
SCS_Type_II_75.6mm	0:12	3.42362
SCS_Type_II_75.6mm	0:18	3.42362
SCS_Type_II_75.6mm	0:24	3.42362
SCS_Type_II_75.6mm	0:30	3.42362
SCS_Type_II_75.6mm	0:36	3.50921
SCS_Type_II_75.6mm	0:42	3.68039
SCS_Type_II_75.6mm	0:48	3.85158
SCS_Type_II_75.6mm	0:54	4.02276
SCS_Type_II_75.6mm	1:00	4.19394
SCS_Type_II_75.6mm	1:06	4.40791
SCS_Type_II_75.6mm	1:12	4.66469
SCS_Type_II_75.6mm	1:18	4.92146
SCS_Type_II_75.6mm	1:24	5.17823
SCS_Type_II_75.6mm	1:30	5.435
SCS_Type_II_75.6mm	1:36	5.77736
SCS_Type_II_75.6mm	1:42	6.20532
SCS_Type_II_75.6mm	1:48	6.63327
SCS_Type_II_75.6mm	1:54	7.06122
SCS_Type_II_75.6mm	2:00	7.48917
SCS_Type_II_75.6mm	2:06	8.21669
SCS_Type_II_75.6mm	2:12	9.24378
SCS_Type_II_75.6mm	2:18	10.27087
SCS_Type_II_75.6mm	2:24	11.29795
SCS_Type_II_75.6mm	2:30	12.32504
SCS_Type_II_75.6mm	2:36	25.50599
SCS_Type_II_75.6mm	2:42	50.84079
SCS_Type_II_75.6mm	2:48	81.77108
SCS_Type_II_75.6mm	2:54	146.64872
SCS_Type_II_75.6mm	3:00	101.78857
SCS_Type_II_75.6mm	3:06	20.28496
SCS_Type_II_75.6mm	3:12	17.84563
SCS_Type_II_75.6mm	3:18	15.4063
SCS_Type_II_75.6mm	3:24	12.96697
SCS_Type_II_75.6mm	3:30	10.52764
SCS_Type_II_75.6mm	3:36	9.0298
SCS_Type_II_75.6mm	3:42	8.47347
SCS_Type_II_75.6mm	3:48	7.91713
SCS_Type_II_75.6mm	3:54	7.36079
SCS_Type_II_75.6mm	4:00	6.80445
SCS_Type_II_75.6mm	4:06	6.3765
SCS_Type_II_75.6mm	4:12	6.07693
SCS_Type_II_75.6mm	4:18	5.77736
SCS_Type_II_75.6mm	4:24	5.4778
SCS_Type_II_75.6mm	4:30	5.17823
SCS_Type_II_75.6mm	4:36	4.92146
SCS_Type_II_75.6mm	4:42	4.70748
SCS_Type_II_75.6mm	4:48	4.4935
SCS_Type_II_75.6mm	4:54	4.27953
SCS_Type_II_75.6mm	5:00	4.06555

SCS_Type_II_75.6mm	5:06	3.92647
SCS_Type_II_75.6mm	5:12	3.84088
SCS_Type_II_75.6mm	5:18	3.77668
SCS_Type_II_75.6mm	5:24	3.69109
SCS_Type_II_75.6mm	5:30	3.6269
SCS_Type_II_75.6mm	5:36	3.54131
SCS_Type_II_75.6mm	5:42	3.47712
SCS_Type_II_75.6mm	5:48	3.39153
SCS_Type_II_75.6mm	5:54	3.32733

;SCS_Type_II_76.8mm design storm, total rainfall = 76.8 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_76.8mm	0:00	3.42362
SCS_Type_II_76.8mm	0:06	3.47797
SCS_Type_II_76.8mm	0:12	3.47797
SCS_Type_II_76.8mm	0:18	3.47797
SCS_Type_II_76.8mm	0:24	3.47797
SCS_Type_II_76.8mm	0:30	3.47797
SCS_Type_II_76.8mm	0:36	3.56491
SCS_Type_II_76.8mm	0:42	3.73881
SCS_Type_II_76.8mm	0:48	3.91271
SCS_Type_II_76.8mm	0:54	4.08661
SCS_Type_II_76.8mm	1:00	4.26051
SCS_Type_II_76.8mm	1:06	4.47788
SCS_Type_II_76.8mm	1:12	4.73873
SCS_Type_II_76.8mm	1:18	4.99958
SCS_Type_II_76.8mm	1:24	5.26042
SCS_Type_II_76.8mm	1:30	5.52127
SCS_Type_II_76.8mm	1:36	5.86907
SCS_Type_II_76.8mm	1:42	6.30381
SCS_Type_II_76.8mm	1:48	6.73856
SCS_Type_II_76.8mm	1:54	7.1733
SCS_Type_II_76.8mm	2:00	7.60805
SCS_Type_II_76.8mm	2:06	8.34712
SCS_Type_II_76.8mm	2:12	9.39051
SCS_Type_II_76.8mm	2:18	10.4339
SCS_Type_II_76.8mm	2:24	11.47729
SCS_Type_II_76.8mm	2:30	12.52068
SCS_Type_II_76.8mm	2:36	25.91084
SCS_Type_II_76.8mm	2:42	51.64779
SCS_Type_II_76.8mm	2:48	83.06903
SCS_Type_II_76.8mm	2:54	148.97648
SCS_Type_II_76.8mm	3:00	103.40426
SCS_Type_II_76.8mm	3:06	20.60695
SCS_Type_II_76.8mm	3:12	18.1289
SCS_Type_II_76.8mm	3:18	15.65084
SCS_Type_II_76.8mm	3:24	13.17279
SCS_Type_II_76.8mm	3:30	10.69474
SCS_Type_II_76.8mm	3:36	9.17313
SCS_Type_II_76.8mm	3:42	8.60796
SCS_Type_II_76.8mm	3:48	8.0428
SCS_Type_II_76.8mm	3:54	7.47763
SCS_Type_II_76.8mm	4:00	6.91246
SCS_Type_II_76.8mm	4:06	6.47771
SCS_Type_II_76.8mm	4:12	6.17339
SCS_Type_II_76.8mm	4:18	5.86907
SCS_Type_II_76.8mm	4:24	5.56474

SCS_Type_II_76.8mm	4:30	5.26042
SCS_Type_II_76.8mm	4:36	4.99958
SCS_Type_II_76.8mm	4:42	4.7822
SCS_Type_II_76.8mm	4:48	4.56483
SCS_Type_II_76.8mm	4:54	4.34746
SCS_Type_II_76.8mm	5:00	4.13008
SCS_Type_II_76.8mm	5:06	3.98879
SCS_Type_II_76.8mm	5:12	3.90184
SCS_Type_II_76.8mm	5:18	3.83663
SCS_Type_II_76.8mm	5:24	3.74968
SCS_Type_II_76.8mm	5:30	3.68447
SCS_Type_II_76.8mm	5:36	3.59752
SCS_Type_II_76.8mm	5:42	3.53231
SCS_Type_II_76.8mm	5:48	3.44536
SCS_Type_II_76.8mm	5:54	3.38015

;SCS_Type_II_82.2mm design storm, total rainfall = 82.2 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_82.2mm	0:00	3.66435
SCS_Type_II_82.2mm	0:06	3.72251
SCS_Type_II_82.2mm	0:12	3.72251
SCS_Type_II_82.2mm	0:18	3.72251
SCS_Type_II_82.2mm	0:24	3.72251
SCS_Type_II_82.2mm	0:30	3.72251
SCS_Type_II_82.2mm	0:36	3.81557
SCS_Type_II_82.2mm	0:42	4.0017
SCS_Type_II_82.2mm	0:48	4.18782
SCS_Type_II_82.2mm	0:54	4.37395
SCS_Type_II_82.2mm	1:00	4.56007
SCS_Type_II_82.2mm	1:06	4.79273
SCS_Type_II_82.2mm	1:12	5.07192
SCS_Type_II_82.2mm	1:18	5.35111
SCS_Type_II_82.2mm	1:24	5.6303
SCS_Type_II_82.2mm	1:30	5.90948
SCS_Type_II_82.2mm	1:36	6.28174
SCS_Type_II_82.2mm	1:42	6.74705
SCS_Type_II_82.2mm	1:48	7.21236
SCS_Type_II_82.2mm	1:54	7.67768
SCS_Type_II_82.2mm	2:00	8.14299
SCS_Type_II_82.2mm	2:06	8.93402
SCS_Type_II_82.2mm	2:12	10.05078
SCS_Type_II_82.2mm	2:18	11.16753
SCS_Type_II_82.2mm	2:24	12.28428
SCS_Type_II_82.2mm	2:30	13.40104
SCS_Type_II_82.2mm	2:36	27.7327
SCS_Type_II_82.2mm	2:42	55.27927
SCS_Type_II_82.2mm	2:48	88.90982
SCS_Type_II_82.2mm	2:54	159.45139
SCS_Type_II_82.2mm	3:00	110.67487
SCS_Type_II_82.2mm	3:06	22.05587
SCS_Type_II_82.2mm	3:12	19.40358
SCS_Type_II_82.2mm	3:18	16.75129
SCS_Type_II_82.2mm	3:24	14.09901
SCS_Type_II_82.2mm	3:30	11.44672
SCS_Type_II_82.2mm	3:36	9.81812
SCS_Type_II_82.2mm	3:42	9.21321
SCS_Type_II_82.2mm	3:48	8.6083

SCS_Type_II_82.2mm	3:54	8.0034
SCS_Type_II_82.2mm	4:00	7.39849
SCS_Type_II_82.2mm	4:06	6.93317
SCS_Type_II_82.2mm	4:12	6.60746
SCS_Type_II_82.2mm	4:18	6.28174
SCS_Type_II_82.2mm	4:24	5.95602
SCS_Type_II_82.2mm	4:30	5.6303
SCS_Type_II_82.2mm	4:36	5.35111
SCS_Type_II_82.2mm	4:42	5.11845
SCS_Type_II_82.2mm	4:48	4.88579
SCS_Type_II_82.2mm	4:54	4.65314
SCS_Type_II_82.2mm	5:00	4.42048
SCS_Type_II_82.2mm	5:06	4.26925
SCS_Type_II_82.2mm	5:12	4.17619
SCS_Type_II_82.2mm	5:18	4.10639
SCS_Type_II_82.2mm	5:24	4.01333
SCS_Type_II_82.2mm	5:30	3.94353
SCS_Type_II_82.2mm	5:36	3.85047
SCS_Type_II_82.2mm	5:42	3.78067
SCS_Type_II_82.2mm	5:48	3.68761
SCS_Type_II_82.2mm	5:54	3.61781

;SCS_Type_II_9mm design storm, total rainfall = 9 mm, rain interval = 6 minutes,
rain units = mm/hr.

SCS_Type_II_9mm	0:00	0.40121
SCS_Type_II_9mm	0:06	0.40757
SCS_Type_II_9mm	0:12	0.40757
SCS_Type_II_9mm	0:18	0.40757
SCS_Type_II_9mm	0:24	0.40757
SCS_Type_II_9mm	0:30	0.40757
SCS_Type_II_9mm	0:36	0.41776
SCS_Type_II_9mm	0:42	0.43814
SCS_Type_II_9mm	0:48	0.45852
SCS_Type_II_9mm	0:54	0.4789
SCS_Type_II_9mm	1:00	0.49928
SCS_Type_II_9mm	1:06	0.52475
SCS_Type_II_9mm	1:12	0.55532
SCS_Type_II_9mm	1:18	0.58589
SCS_Type_II_9mm	1:24	0.61646
SCS_Type_II_9mm	1:30	0.64702
SCS_Type_II_9mm	1:36	0.68778
SCS_Type_II_9mm	1:42	0.73873
SCS_Type_II_9mm	1:48	0.78967
SCS_Type_II_9mm	1:54	0.84062
SCS_Type_II_9mm	2:00	0.89157
SCS_Type_II_9mm	2:06	0.97818
SCS_Type_II_9mm	2:12	1.10045
SCS_Type_II_9mm	2:18	1.22272
SCS_Type_II_9mm	2:24	1.34499
SCS_Type_II_9mm	2:30	1.46727
SCS_Type_II_9mm	2:36	3.03643
SCS_Type_II_9mm	2:42	6.05248
SCS_Type_II_9mm	2:48	9.73465
SCS_Type_II_9mm	2:54	17.45818
SCS_Type_II_9mm	3:00	12.11769
SCS_Type_II_9mm	3:06	2.41488
SCS_Type_II_9mm	3:12	2.12448

SCS_Type_II_9mm	3:18	1.83408
SCS_Type_II_9mm	3:24	1.54369
SCS_Type_II_9mm	3:30	1.25329
SCS_Type_II_9mm	3:36	1.07498
SCS_Type_II_9mm	3:42	1.00875
SCS_Type_II_9mm	3:48	0.94252
SCS_Type_II_9mm	3:54	0.87628
SCS_Type_II_9mm	4:00	0.81005
SCS_Type_II_9mm	4:06	0.75911
SCS_Type_II_9mm	4:12	0.72344
SCS_Type_II_9mm	4:18	0.68778
SCS_Type_II_9mm	4:24	0.65212
SCS_Type_II_9mm	4:30	0.61646
SCS_Type_II_9mm	4:36	0.58589
SCS_Type_II_9mm	4:42	0.56041
SCS_Type_II_9mm	4:48	0.53494
SCS_Type_II_9mm	4:54	0.50947
SCS_Type_II_9mm	5:00	0.48399
SCS_Type_II_9mm	5:06	0.46744
SCS_Type_II_9mm	5:12	0.45725
SCS_Type_II_9mm	5:18	0.44961
SCS_Type_II_9mm	5:24	0.43942
SCS_Type_II_9mm	5:30	0.43177
SCS_Type_II_9mm	5:36	0.42158
SCS_Type_II_9mm	5:42	0.41394
SCS_Type_II_9mm	5:48	0.40375
SCS_Type_II_9mm	5:54	0.39611

[REPORT]

;;Reporting Options
INPUT YES
CONTROLS NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

Subcatch	OUT-A	WDT
Subcatch	OUT-B	WDT
Subcatch	OUT-C	WDT
Subcatch	OUT-D	WDT
Subcatch	OUT-Ultimate	WDT
Node	OU-A	WDT
Node	OU-D	WDT
Node	OU-Ultimate	WDT

[MAP]

DIMENSIONS	514153.27595	4989095.9442	515745.94505	4990035.3618
UNITS	Meters			

[COORDINATES]

;;Node	X-Coord	Y-Coord
;;-----	-----	-----
OU-A	515106.896	4989172.005
OU-B	515207.966	4989389.503
OU-C	515349.476	4989313.937
OU-D	515476.265	4989244.925

OU-Ultimate 515505.186 4989138.928

[VERTICES]

;;Link X-Coord Y-Coord

;;-----

[POLYGONS]

;;Subcatchment X-Coord Y-Coord

;;-----

OUT-A 514994.576 4989336.571

OUT-A 514967.537 4989410.841

OUT-A 514971.045 4989413.102

OUT-A 514972.162 4989414.984

OUT-A 514972.118 4989418.164

OUT-A 514968.789 4989422.714

OUT-A 514968.96 4989430.53

OUT-A 514971.929 4989432.208

OUT-A 514977.12 4989433.027

OUT-A 514981.002 4989435.146

OUT-A 514982.551 4989437.586

OUT-A 514984.734 4989435.79

OUT-A 514987.984 4989424.018

OUT-A 514990.369 4989420.403

OUT-A 514990.778 4989415.812

OUT-A 514991.222 4989414.765

OUT-A 514996.173 4989403.199

OUT-A 514998.358 4989396.405

OUT-A 514998.004 4989391.008

OUT-A 514999.992 4989389.017

OUT-A 515004.12 4989380.145

OUT-A 515008.368 4989368.395

OUT-A 515008.156 4989363.838

OUT-A 515013.173 4989354.199

OUT-A 515015.118 4989344.255

OUT-A 515013.996 4989339.91

OUT-A 515018.862 4989335.887

OUT-A 515019.779 4989328.804

OUT-A 515024.12 4989324.145

OUT-A 515029.551 4989307.577

OUT-A 515034.379 4989295.405

OUT-A 515034.369 4989290.759

OUT-A 515032.79 4989286.704

OUT-A 515034.43 4989282.589

OUT-A 515033.99 4989281.246

OUT-A 515033.762 4989281.223

OUT-A 515034.159 4989280.195

OUT-A 515047.827 4989239.032

OUT-A 515065.293 4989201.632

OUT-A 515088.153 4989171.536

OUT-A 515090.103 4989168.969

OUT-A 515105.097 4989149.23

OUT-A 515098.746 4989144.382

OUT-A 515093.984 4989143.144

OUT-A 515088.12 4989139.008

OUT-A 515083.163 4989138.645

OUT-A 515058.539 4989179.525

OUT-A 515045.549 4989203.128

OUT-A 515030.375 4989238.9

OUT-A 515016.648 4989270.379

OUT-A 515004.711 4989304.368

OUT-A 514994.576 4989336.571

OUT-B 515145.645 4989520.1

OUT-B 515170.36 4989506.48

OUT-B 515175.936 4989503.071

OUT-B 515176.824 4989498.847

OUT-B 515181.937 4989496.963

OUT-B 515183.401 4989493.426

OUT-B 515189.339 4989488.153

OUT-B 515179.123 4989465.726

OUT-B 515202.43 4989454.571

OUT-B 515225.478 4989438.005

OUT-B 515234.979 4989436.195

OUT-B 515244.32 4989429.841

OUT-B 515261.295 4989419.06

OUT-B 515263.104 4989417.063

OUT-B 515285.388 4989407.075

OUT-B 515289.851 4989405.119

OUT-B 515304.611 4989395.859

OUT-B 515314.391 4989390.964

OUT-B 515323.045 4989387.288

OUT-B 515328.939 4989384.758

OUT-B 515337.905 4989378.809

OUT-B 515349.262 4989369.372

OUT-B 515350.072 4989369.189

OUT-B 515350.049 4989368.965

OUT-B 515350.243 4989368.767

OUT-B 515352.273 4989367.608

OUT-B 515356.324 4989366.349

OUT-B 515357.335 4989364.718

OUT-B 515359.436 4989363.518

OUT-B 515353.654 4989335.244

OUT-B 515348.755 4989337.898

OUT-B 515308.768 4989362.912

OUT-B 515306.822 4989363.191

OUT-B 515303.755 4989366.759

OUT-B 515296.929 4989368.955

OUT-B 515289.823 4989373.848

OUT-B 515287.485 4989378.167

OUT-B 515284.669 4989377.804

OUT-B 515278.346 4989379.393

OUT-B 515275.292 4989381.973

OUT-B 515272.347 4989382.394

OUT-B 515269.497 4989385.522

OUT-B 515265.121 4989388.146

OUT-B 515258.972 4989389.998

OUT-B 515253.745 4989394.77

OUT-B 515249.167 4989396.192

OUT-B 515247.936 4989400.962

OUT-B 515239.994 4989402.019

OUT-B 515235.551 4989406.577

OUT-B 515229.111 4989408.136

OUT-B 515226.173 4989411.199

OUT-B 515215.219 4989415.245

OUT-B 515208.496 4989420.177

OUT-B	515205.258	4989420.147
OUT-B	515200.709	4989415.82
OUT-B	515199.487	4989408.316
OUT-B	515191.627	4989399.737
OUT-B	515188.655	4989402.112
OUT-B	515183.339	4989403.291
OUT-B	515177.088	4989406.983
OUT-B	515171.905	4989407.897
OUT-B	515166.847	4989412.518
OUT-B	515155.276	4989419.109
OUT-B	515148.5	4989419.755
OUT-B	515145.175	4989421.998
OUT-B	515139.326	4989423.705
OUT-B	515136.526	4989428.464
OUT-B	515112.054	4989442.305
OUT-B	515107.932	4989444.016
OUT-B	515103.155	4989442.284
OUT-B	515096.905	4989445.049
OUT-B	515093.705	4989450.469
OUT-B	515089.459	4989448.606
OUT-B	515086.685	4989442.113
OUT-B	515079.784	4989439.581
OUT-B	515073.035	4989429.372
OUT-B	515052.843	4989428.675
OUT-B	515053.961	4989439.748
OUT-B	515046.697	4989441.077
OUT-B	515044.272	4989412.83
OUT-B	515042.065	4989389.227
OUT-B	515035.774	4989389.055
OUT-B	515035.705	4989388.825
OUT-B	515035.607	4989388.5
OUT-B	515034.992	4989369.793
OUT-B	515033.562	4989364.566
OUT-B	515033.497	4989338.631
OUT-B	515031.661	4989330.577
OUT-B	515034.485	4989312.622
OUT-B	515033.701	4989310.427
OUT-B	515029.551	4989307.577
OUT-B	515024.12	4989324.145
OUT-B	515019.779	4989328.804
OUT-B	515018.862	4989335.887
OUT-B	515013.996	4989339.91
OUT-B	515015.118	4989344.255
OUT-B	515013.173	4989354.199
OUT-B	515008.156	4989363.838
OUT-B	515008.368	4989368.395
OUT-B	515004.12	4989380.145
OUT-B	514999.992	4989389.017
OUT-B	514998.004	4989391.008
OUT-B	514998.358	4989396.405
OUT-B	514996.173	4989403.199
OUT-B	514990.778	4989415.803
OUT-B	514990.369	4989420.394
OUT-B	514987.984	4989424.009
OUT-B	514984.734	4989435.781
OUT-B	514982.551	4989437.577
OUT-B	514981.002	4989435.136

OUT-B	514977.12	4989433.017
OUT-B	514971.929	4989432.208
OUT-B	514968.96	4989430.52
OUT-B	514968.789	4989422.714
OUT-B	514972.118	4989418.154
OUT-B	514972.162	4989414.974
OUT-B	514971.045	4989413.092
OUT-B	514966.789	4989410.349
OUT-B	514965.69	4989403.447
OUT-B	514960.358	4989401.779
OUT-B	514957.746	4989397.257
OUT-B	514954.346	4989401.381
OUT-B	514951.541	4989408.575
OUT-B	514947.995	4989413.008
OUT-B	514947.735	4989417.791
OUT-B	514941.617	4989425.63
OUT-B	514940.948	4989428.324
OUT-B	514938.873	4989429.153
OUT-B	514933.734	4989428.403
OUT-B	514933.149	4989428.009
OUT-B	514933.142	4989428.069
OUT-B	514923.953	4989455.783
OUT-B	514911.112	4989484.398
OUT-B	514894.166	4989512.549
OUT-B	514879.513	4989535.703
OUT-B	514860.296	4989559.756
OUT-B	514836.067	4989581.524
OUT-B	514799.965	4989608.266
OUT-B	514730.078	4989646.297
OUT-B	514635.068	4989698.82
OUT-B	514542.072	4989751.753
OUT-B	514535.11	4989755.767
OUT-B	514512.357	4989768.98
OUT-B	514499.696	4989776.333
OUT-B	514454.035	4989802.849
OUT-B	514385.281	4989842.775
OUT-B	514384.378	4989851.404
OUT-B	514383.045	4989854.071
OUT-B	514375.174	4989859.2
OUT-B	514355.229	4989865.255
OUT-B	514345.551	4989871.577
OUT-B	514328.811	4989887.837
OUT-B	514324.995	4989892.999
OUT-B	514325.734	4989900.394
OUT-B	514328.185	4989904.576
OUT-B	514325.295	4989908.2
OUT-B	514327.551	4989909.577
OUT-B	514312.939	4989917.965
OUT-B	514310.746	4989922.771
OUT-B	514308.12	4989925.145
OUT-B	514303.435	4989926.349
OUT-B	514299.301	4989925.438
OUT-B	514292.402	4989930.427
OUT-B	514289.862	4989934.887
OUT-B	514280.939	4989935.966
OUT-B	514277.755	4989941.781
OUT-B	514270.357	4989944.382

OUT-B	514265.864	4989948.889
OUT-B	514257.984	4989950.353
OUT-B	514256.702	4989952.727
OUT-B	514254.219	4989954.133
OUT-B	514251.175	4989953.064
OUT-B	514250.322	4989953.266
OUT-B	514233.954	4989962.223
OUT-B	514225.67	4989966.756
OUT-B	514231.655	4989992.661
OUT-B	514239.72	4989987.954
OUT-B	514242.1	4989985.147
OUT-B	514247.12	4989985.124
OUT-B	514251.551	4989981.577
OUT-B	514254.218	4989982.134
OUT-B	514258.174	4989980.2
OUT-B	514270.984	4989970.009
OUT-B	514280.13	4989968.156
OUT-B	514288.929	4989961.955
OUT-B	514297.165	4989958.19
OUT-B	514300.984	4989954.009
OUT-B	514310.165	4989952.19
OUT-B	514317.551	4989948.577
OUT-B	514324.562	4989947.588
OUT-B	514330.119	4989948.009
OUT-B	514339.357	4989958.771
OUT-B	514346.325	4989960.329
OUT-B	514348.94	4989956.965
OUT-B	514356.983	4989952.008
OUT-B	514366.541	4989949.933
OUT-B	514369.552	4989952.123
OUT-B	514404.13	4989935.156
OUT-B	514408.164	4989932.189
OUT-B	514410.94	4989924.075
OUT-B	514417.219	4989926.133
OUT-B	514422.874	4989924.01
OUT-B	514424.28	4989924.297
OUT-B	514630.758	4989809.099
OUT-B	514816.871	4989704.104
OUT-B	514830.984	4989700.121
OUT-B	514837.52	4989705.407
OUT-B	514838.761	4989713.192
OUT-B	514831.682	4989724.722
OUT-B	514815.491	4989756.061
OUT-B	514783.382	4989809.201
OUT-B	514751.286	4989856.567
OUT-B	514739.921	4989870.346
OUT-B	514720.948	4989906.698
OUT-B	514753.886	4989930.118
OUT-B	514757.941	4989919.334
OUT-B	514774.126	4989890.757
OUT-B	514789.557	4989861.174
OUT-B	514823.184	4989805.026
OUT-B	514854.028	4989754.644
OUT-B	514872.485	4989724.064
OUT-B	514879.831	4989706.008
OUT-B	514880.611	4989695.216
OUT-B	514886.67	4989689.457

OUT-B	514903.297	4989687.237
OUT-B	514934.804	4989676.768
OUT-B	514970.861	4989659.281
OUT-B	514997.85	4989642.527
OUT-B	515023.827	4989627.527
OUT-B	515035.69	4989616.51
OUT-B	515047.306	4989603.736
OUT-B	515067.264	4989577.928
OUT-B	515078.133	4989561.637
OUT-B	515081.875	4989555.83
OUT-B	515145.645	4989520.1
OUT-C	515281.963	4989444.979
OUT-C	515441.502	4989356.086
OUT-C	515440.996	4989351.019
OUT-C	515448.69	4989346.737
OUT-C	515450.057	4989342.081
OUT-C	515458.164	4989337.189
OUT-C	515460.607	4989334.632
OUT-C	515466.55	4989332.576
OUT-C	515471.268	4989329.405
OUT-C	515467.173	4989319.955
OUT-C	515461.358	4989313.772
OUT-C	515460.937	4989309.847
OUT-C	515458.551	4989307.577
OUT-C	515456.531	4989308.087
OUT-C	515456.065	4989308.352
OUT-C	515357.335	4989364.718
OUT-C	515356.324	4989366.349
OUT-C	515352.273	4989367.608
OUT-C	515350.243	4989368.767
OUT-C	515350.049	4989368.965
OUT-C	515350.072	4989369.189
OUT-C	515349.262	4989369.372
OUT-C	515337.905	4989378.809
OUT-C	515328.939	4989384.758
OUT-C	515323.045	4989387.288
OUT-C	515314.391	4989390.964
OUT-C	515304.611	4989395.859
OUT-C	515289.851	4989405.119
OUT-C	515285.388	4989407.075
OUT-C	515263.104	4989417.063
OUT-C	515261.295	4989419.06
OUT-C	515244.32	4989429.841
OUT-C	515234.979	4989436.195
OUT-C	515225.478	4989438.005
OUT-C	515202.43	4989454.571
OUT-C	515179.123	4989465.726
OUT-C	515189.339	4989488.153
OUT-C	515183.401	4989493.426
OUT-C	515181.937	4989496.963
OUT-C	515176.824	4989498.847
OUT-C	515175.936	4989503.071
OUT-C	515170.36	4989506.48
OUT-C	515281.963	4989444.979
OUT-D	515366.874	4989328.094
OUT-D	515366.858	4989328.092
OUT-D	515353.654	4989335.244

OUT-D	515359.436	4989363.518
OUT-D	515456.065	4989308.352
OUT-D	515456.531	4989308.087
OUT-D	515458.551	4989307.577
OUT-D	515460.937	4989309.847
OUT-D	515461.358	4989313.772
OUT-D	515467.173	4989319.955
OUT-D	515471.268	4989329.405
OUT-D	515466.55	4989332.576
OUT-D	515460.607	4989334.632
OUT-D	515458.164	4989337.189
OUT-D	515450.057	4989342.081
OUT-D	515448.69	4989346.737
OUT-D	515440.996	4989351.019
OUT-D	515441.502	4989356.086
OUT-D	515501.66	4989322.567
OUT-D	515585.944	4989277.388
OUT-D	515605.076	4989267.181
OUT-D	515603.368	4989265.76
OUT-D	515595.984	4989265.144
OUT-D	515590.812	4989260.316
OUT-D	515588.12	4989251.008
OUT-D	515581.346	4989243.782
OUT-D	515580.391	4989240.708
OUT-D	515580.21	4989240.127
OUT-D	515623.13	4989219.156
OUT-D	515629.23	4989215.256
OUT-D	515635.314	4989214.34
OUT-D	515639.346	4989210.372
OUT-D	515650.982	4989204.009
OUT-D	515657.324	4989204.328
OUT-D	515659.412	4989200.437
OUT-D	515667.551	4989196.577
OUT-D	515660.984	4989185.144
OUT-D	515656.551	4989172.577
OUT-D	515643.972	4989177.998
OUT-D	515634.874	4989183.899
OUT-D	515619.983	4989190.008
OUT-D	515614.13	4989194.156
OUT-D	515601.984	4989199.009
OUT-D	515600.8	4989200.695
OUT-D	515602.097	4989203.576
OUT-D	515601.484	4989204.511
OUT-D	515599.346	4989204.673
OUT-D	515597.335	4989202.815
OUT-D	515594.229	4989203.255
OUT-D	515560.982	4989220.007
OUT-D	515530.13	4989238.156
OUT-D	515520.11	4989242.135
OUT-D	515518.11	4989244.133
OUT-D	515517.13	4989244.039
OUT-D	515366.874	4989328.094
OUT-Ultimate	515447.964	4989251.288
OUT-Ultimate	515435.439	4989258.198
OUT-Ultimate	515434.893	4989258.09
OUT-Ultimate	515430.529	4989259.261
OUT-Ultimate	515408.292	4989272.557

OUT-Ultimate	515387.807	4989282.625
OUT-Ultimate	515370.272	4989293.414
OUT-Ultimate	515361.205	4989298.006
OUT-Ultimate	515357.443	4989300.803
OUT-Ultimate	515357.173	4989301.005
OUT-Ultimate	515347.506	4989303.99
OUT-Ultimate	515340.681	4989310.483
OUT-Ultimate	515334.038	4989311.891
OUT-Ultimate	515324.694	4989317.9
OUT-Ultimate	515314.265	4989321.142
OUT-Ultimate	515307.187	4989328.329
OUT-Ultimate	515307.229	4989328.94
OUT-Ultimate	515271.932	4989348.415
OUT-Ultimate	515265.858	4989351.75
OUT-Ultimate	515262.08	4989352.597
OUT-Ultimate	515248.444	4989360.941
OUT-Ultimate	515248.48	4989361.293
OUT-Ultimate	515199.289	4989388.304
OUT-Ultimate	515175.735	4989394.01
OUT-Ultimate	515157.697	4989395.614
OUT-Ultimate	515130.026	4989395.96
OUT-Ultimate	515108.697	4989392.616
OUT-Ultimate	515103.333	4989390.408
OUT-Ultimate	515098.659	4989387.653
OUT-Ultimate	515077.199	4989381.154
OUT-Ultimate	515072.985	4989358.506
OUT-Ultimate	515070.137	4989340.526
OUT-Ultimate	515069.753	4989313.444
OUT-Ultimate	515074.481	4989278.726
OUT-Ultimate	515083.848	4989247.26
OUT-Ultimate	515105.369	4989184.797
OUT-Ultimate	515120.298	4989158.9
OUT-Ultimate	515104.988	4989149.603
OUT-Ultimate	515104.966	4989149.403
OUT-Ultimate	515090.103	4989168.969
OUT-Ultimate	515088.153	4989171.536
OUT-Ultimate	515065.293	4989201.632
OUT-Ultimate	515047.827	4989239.032
OUT-Ultimate	515034.159	4989280.195
OUT-Ultimate	515033.762	4989281.223
OUT-Ultimate	515033.99	4989281.246
OUT-Ultimate	515034.43	4989282.589
OUT-Ultimate	515032.79	4989286.704
OUT-Ultimate	515034.369	4989290.759
OUT-Ultimate	515034.379	4989295.405
OUT-Ultimate	515030.167	4989306.024
OUT-Ultimate	515029.551	4989307.577
OUT-Ultimate	515033.701	4989310.427
OUT-Ultimate	515034.485	4989312.622
OUT-Ultimate	515031.661	4989330.577
OUT-Ultimate	515033.497	4989338.631
OUT-Ultimate	515033.562	4989364.566
OUT-Ultimate	515034.992	4989369.793
OUT-Ultimate	515035.607	4989388.5
OUT-Ultimate	515035.774	4989389.055
OUT-Ultimate	515041.633	4989389.215
OUT-Ultimate	515042.065	4989389.227

OUT-Ultimate	515044.272	4989412.83
OUT-Ultimate	515044.404	4989414.373
OUT-Ultimate	515046.697	4989441.077
OUT-Ultimate	515053.961	4989439.748
OUT-Ultimate	515052.843	4989428.675
OUT-Ultimate	515073.035	4989429.372
OUT-Ultimate	515079.784	4989439.581
OUT-Ultimate	515086.685	4989442.113
OUT-Ultimate	515089.459	4989448.606
OUT-Ultimate	515093.705	4989450.469
OUT-Ultimate	515096.905	4989445.049
OUT-Ultimate	515103.155	4989442.284
OUT-Ultimate	515107.932	4989444.016
OUT-Ultimate	515112.054	4989442.305
OUT-Ultimate	515136.526	4989428.464
OUT-Ultimate	515139.326	4989423.705
OUT-Ultimate	515145.175	4989421.998
OUT-Ultimate	515148.5	4989419.755
OUT-Ultimate	515155.276	4989419.109
OUT-Ultimate	515166.847	4989412.518
OUT-Ultimate	515171.905	4989407.897
OUT-Ultimate	515177.088	4989406.983
OUT-Ultimate	515183.339	4989403.291
OUT-Ultimate	515188.655	4989402.112
OUT-Ultimate	515191.627	4989399.737
OUT-Ultimate	515199.487	4989408.316
OUT-Ultimate	515200.709	4989415.82
OUT-Ultimate	515205.258	4989420.147
OUT-Ultimate	515208.496	4989420.177
OUT-Ultimate	515215.219	4989415.245
OUT-Ultimate	515226.173	4989411.199
OUT-Ultimate	515229.111	4989408.136
OUT-Ultimate	515235.369	4989406.621
OUT-Ultimate	515235.551	4989406.577
OUT-Ultimate	515239.994	4989402.019
OUT-Ultimate	515247.936	4989400.962
OUT-Ultimate	515249.167	4989396.192
OUT-Ultimate	515253.745	4989394.77
OUT-Ultimate	515258.972	4989389.998
OUT-Ultimate	515265.121	4989388.146
OUT-Ultimate	515269.497	4989385.522
OUT-Ultimate	515272.347	4989382.394
OUT-Ultimate	515275.292	4989381.973
OUT-Ultimate	515278.346	4989379.393
OUT-Ultimate	515284.669	4989377.804
OUT-Ultimate	515287.485	4989378.167
OUT-Ultimate	515289.823	4989373.848
OUT-Ultimate	515296.929	4989368.955
OUT-Ultimate	515301.416	4989367.512
OUT-Ultimate	515303.755	4989366.759
OUT-Ultimate	515305.077	4989365.221
OUT-Ultimate	515306.822	4989363.191
OUT-Ultimate	515308.768	4989362.912
OUT-Ultimate	515348.755	4989337.898
OUT-Ultimate	515366.858	4989328.092
OUT-Ultimate	515366.874	4989328.094
OUT-Ultimate	515517.13	4989244.039

OUT-Ultimate	515518.11	4989244.133
OUT-Ultimate	515520.11	4989242.135
OUT-Ultimate	515530.13	4989238.156
OUT-Ultimate	515560.982	4989220.007
OUT-Ultimate	515594.229	4989203.255
OUT-Ultimate	515597.335	4989202.815
OUT-Ultimate	515599.346	4989204.673
OUT-Ultimate	515601.484	4989204.511
OUT-Ultimate	515602.097	4989203.576
OUT-Ultimate	515600.8	4989200.695
OUT-Ultimate	515601.984	4989199.009
OUT-Ultimate	515614.13	4989194.156
OUT-Ultimate	515619.983	4989190.008
OUT-Ultimate	515634.874	4989183.899
OUT-Ultimate	515643.972	4989177.998
OUT-Ultimate	515656.551	4989172.577
OUT-Ultimate	515673.551	4989164.577
OUT-Ultimate	515669.679	4989158.449
OUT-Ultimate	515666.551	4989144.577
OUT-Ultimate	515659.595	4989145.511
OUT-Ultimate	515658.191	4989144.913
OUT-Ultimate	515588.017	4989178.949
OUT-Ultimate	515513.396	4989216.566
OUT-Ultimate	515447.964	4989251.288

[SYMBOLS]		
;;Gage	X-Coord	Y-Coord
;;-----	-----	-----

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.3)

Element Count

Number of rain gages 3

Number of subcatchments ... 5

Number of nodes 5

Number of links 0

Number of pollutants 0

Number of land uses 0

Raingage Summary

Name	Data Source	Data Type	Recording Interval
SCS_Type_II_40.2mm	SCS_Type_II_40.2mm	INTENSITY	6 min.
SCS_Type_II_51.6mm	SCS_Type_II_51.6mm	INTENSITY	6 min.
SCS_Type_II_82.2mm	SCS_Type_II_82.2mm	INTENSITY	6 min.

Subcatchment Summary

Name	Area	Width	%Imperv	%Slope	Rain Gage
Outlet					
OUT-A	0.53	25.11	28.00	0.6000	SCS_Type_II_82.2mm
OU-A					
OUT-B	15.30	126.05	36.30	0.5810	SCS_Type_II_82.2mm
OU-B					
OUT-C	0.61	49.21	36.90	1.2400	SCS_Type_II_82.2mm
OU-C					
OUT-D	1.72	117.48	42.10	1.1400	SCS_Type_II_82.2mm
OU-D					
OUT-Ultimate	2.43	104.66	43.60	1.1000	SCS_Type_II_82.2mm
OU-Ultimate					

Node Summary

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
OU-A	OUTFALL	0.00	0.00	0.0	
OU-B	OUTFALL	0.00	0.00	0.0	
OU-C	OUTFALL	0.00	0.00	0.0	
OU-D	OUTFALL	0.00	0.00	0.0	
OU-Ultimate	OUTFALL	60.01	0.00	0.0	

Analysis Options

Flow Units CMS

Process Models:

Rainfall/Runoff YES

RDII NO

Snowmelt NO

Groundwater NO

Flow Routing NO

Water Quality NO

Infiltration Method HORTON

Surcharge Method EXTRAN

Starting Date 06/29/2023 00:00:00

Ending Date 06/30/2023 00:00:00

Antecedent Dry Days 0.0

Report Time Step 00:01:00

Wet Time Step 00:05:00

Dry Time Step 00:05:00

	Volume	Depth
Runoff Quantity Continuity	hectare-m	mm
-----	-----	-----
Total Precipitation	1.691	82.200
Evaporation Loss	0.000	0.000
Infiltration Loss	0.924	44.898
Surface Runoff	0.760	36.924
Final Storage	0.009	0.459
Continuity Error (%)	-0.098	

	Volume	Volume
Flow Routing Continuity	hectare-m	10^6 ltr
-----	-----	-----
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.760	7.605
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.760	7.605
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

Subcatchment Runoff Summary

	Total	Total	Total	Total	Total	Imperv
Deriv	Total	Total	Peak	Runoff		

Runoff	Runoff	Precip		Runon	Evap	Infil	Runoff
Subcatchment		Runoff	Runoff	Coeff			
mm	mm	10^6 ltr	mm	mm	mm	mm	mm
		CMS					

OUT-A			82.20	0.00	0.00	46.61	22.78
12.60	35.38	0.19	0.07	0.430			
OUT-B			82.20	0.00	0.00	47.94	29.43
4.43	33.86	5.18	1.73	0.412			
OUT-C			82.20	0.00	0.00	36.94	30.02
14.99	45.01	0.27	0.13	0.548			
OUT-D			82.20	0.00	0.00	34.27	34.25
13.37	47.63	0.82	0.38	0.579			
OUT-Ultimate			82.20	0.00	0.00	34.86	35.47
11.53	47.00	1.14	0.50	0.572			

Analysis begun on: Mon Feb 12 11:45:49 2024
 Analysis ended on: Mon Feb 12 11:45:49 2024
 Total elapsed time: < 1 sec

PCSWMM Lumped Model Results - Proposed Conditions (2098)

```

[TITLE]
;;Project Title/Notes

[OPTIONS]
;;Option      Value
FLOW_UNITS    CMS
INFILTRATION  HORTON
FLOW_ROUTING  DYNWAVE
LINK_OFFSETS  ELEVATION
MIN_SLOPE     0
ALLOW_PONDING NO
SKIP_STEADY_STATE NO

START_DATE     06/29/2023
START_TIME     00:00:00
REPORT_START_DATE 06/29/2023
REPORT_START_TIME 00:00:00
END_DATE       06/30/2023
END_TIME       00:00:00
SWEEP_START    01/01
SWEEP_END      12/31
DRY_DAYS       0
REPORT_STEP    00:01:00
WET_STEP       00:05:00
DRY_STEP       00:05:00
ROUTING_STEP   5
RULE_STEP      00:00:00

INERTIAL_DAMPING PARTIAL
NORMAL_FLOW_LIMITED BOTH
FORCE_MAIN_EQUATION H-W
VARIABLE_STEP    0.75
LENGTHENING_STEP 0
MIN_SURFAREA     0
MAX_TRIALS        8
HEAD_TOLERANCE   0.0015
SYS_FLOW_TOL     5
LAT_FLOW_TOL     5
MINIMUM_STEP     0.5
THREADS          14

[EVAPORATION]
;;Data Source  Parameters
;;-----
CONSTANT       0.0
DRY_ONLY       NO

[RAINGAGES]
;;Name      Format      Interval SCF      Source
;;-----
SCS_Type_II_40.2mm INTENSITY 0:06      1.0      TIMESERIES SCS_Type_II_40.2mm
SCS_Type_II_51.6mm INTENSITY 0:06      1.0      TIMESERIES SCS_Type_II_51.6mm
SCS_Type_II_82.2mm INTENSITY 0:06      1.0      TIMESERIES SCS_Type_II_82.2mm

[SUBCATCHMENTS]
;;Name      Rain Gage      Outlet      Area      %Imperv Width      %
Slope      CurbLen      SnowPack
;;-----

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OUT-A      SCS_Type_II_82.2mm OU-A      0.527      28      25.106      0.6
0
OUT-B      SCS_Type_II_82.2mm OU-B      15.297      36.3      126.048      0.581
0
OUT-C      SCS_Type_II_82.2mm OU-C      0.607      36.9      49.21      1.24
0
OUT-D      SCS_Type_II_82.2mm OU-D      1.716      42.1      117.478      1.14
0
OUT-Ultimate SCS_Type_II_82.2mm OU-Ultimate 2.426      43.6      104.662      1.1
0

[SUBAREAS]
;;Subcatchment N-Imperv N-Perv S-Imperv S-Perv PctZero RouteTo
PctRouted
;;-----
OUT-A      0.013      0.25      1.57      4.67      25      OUTLET
OUT-B      0.013      0.25      1.57      4.67      25      OUTLET
OUT-C      0.013      0.25      1.57      4.67      25      OUTLET
OUT-D      0.013      0.25      1.57      4.67      25      OUTLET
OUT-Ultimate 0.013      0.25      1.57      4.67      25      OUTLET

[INFILTRATION]
;;Subcatchment Param1 Param2 Param3 Param4 Param5
;;-----
OUT-A      76.2      13.2      4.14      7      0
OUT-B      76.2      13.2      4.14      7      0
OUT-C      76.2      13.2      4.14      7      0
OUT-D      76.2      13.2      4.14      7      0
OUT-Ultimate 76.2      13.2      4.14      7      0

[OUTFALLS]
;;Name      Elevation Type      Stage Data      Gated      Route To
;;-----
OU-A      0      FREE      NO
OU-B      0      FREE      NO
OU-C      0      FREE      NO
OU-D      0      FREE      NO
OU-Ultimate 60.01 FREE      NO

[TIMESERIES]
;;Name      Date      Time      Value
;;-----
;SCS_Type_II_40.2mm design storm, total rainfall = 40.2 mm, rain interval = 6
minutes, rain units = mm/hr.
SCS_Type_II_40.2mm 6/29/2023 0:00      1.79205
SCS_Type_II_40.2mm 6/29/2023 0:06      1.8205
SCS_Type_II_40.2mm 6/29/2023 0:12      1.8205
SCS_Type_II_40.2mm 6/29/2023 0:18      1.8205
SCS_Type_II_40.2mm 6/29/2023 0:24      1.8205
SCS_Type_II_40.2mm 6/29/2023 0:30      1.8205
SCS_Type_II_40.2mm 6/29/2023 0:36      1.86601
SCS_Type_II_40.2mm 6/29/2023 0:42      1.95703
SCS_Type_II_40.2mm 6/29/2023 0:48      2.04806
SCS_Type_II_40.2mm 6/29/2023 0:54      2.13908
SCS_Type_II_40.2mm 6/29/2023 1:00      2.23011
SCS_Type_II_40.2mm 6/29/2023 1:06      2.34389
SCS_Type_II_40.2mm 6/29/2023 1:12      2.48043

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SCS_Type_II_40.2mm	6/29/2023	1:18	2.61697
SCS_Type_II_40.2mm	6/29/2023	1:24	2.7535
SCS_Type_II_40.2mm	6/29/2023	1:30	2.89004
SCS_Type_II_40.2mm	6/29/2023	1:36	3.07209
SCS_Type_II_40.2mm	6/29/2023	1:42	3.29965
SCS_Type_II_40.2mm	6/29/2023	1:48	3.52721
SCS_Type_II_40.2mm	6/29/2023	1:54	3.75478
SCS_Type_II_40.2mm	6/29/2023	2:00	3.98234
SCS_Type_II_40.2mm	6/29/2023	2:06	4.36919
SCS_Type_II_40.2mm	6/29/2023	2:12	4.91534
SCS_Type_II_40.2mm	6/29/2023	2:18	5.46149
SCS_Type_II_40.2mm	6/29/2023	2:24	6.00764
SCS_Type_II_40.2mm	6/29/2023	2:30	6.55379
SCS_Type_II_40.2mm	6/29/2023	2:36	13.56271
SCS_Type_II_40.2mm	6/29/2023	2:42	27.03439
SCS_Type_II_40.2mm	6/29/2023	2:48	43.48145
SCS_Type_II_40.2mm	6/29/2023	2:54	77.97988
SCS_Type_II_40.2mm	6/29/2023	3:00	54.12567
SCS_Type_II_40.2mm	6/29/2023	3:06	10.78645
SCS_Type_II_40.2mm	6/29/2023	3:12	9.48934
SCS_Type_II_40.2mm	6/29/2023	3:18	8.19224
SCS_Type_II_40.2mm	6/29/2023	3:24	6.89513
SCS_Type_II_40.2mm	6/29/2023	3:30	5.59803
SCS_Type_II_40.2mm	6/29/2023	3:36	4.80156
SCS_Type_II_40.2mm	6/29/2023	3:42	4.50573
SCS_Type_II_40.2mm	6/29/2023	3:48	4.2099
SCS_Type_II_40.2mm	6/29/2023	3:54	3.91407
SCS_Type_II_40.2mm	6/29/2023	4:00	3.61824
SCS_Type_II_40.2mm	6/29/2023	4:06	3.39068
SCS_Type_II_40.2mm	6/29/2023	4:12	3.23138
SCS_Type_II_40.2mm	6/29/2023	4:18	3.07209
SCS_Type_II_40.2mm	6/29/2023	4:24	2.9128
SCS_Type_II_40.2mm	6/29/2023	4:30	2.7535
SCS_Type_II_40.2mm	6/29/2023	4:36	2.61697
SCS_Type_II_40.2mm	6/29/2023	4:42	2.50318
SCS_Type_II_40.2mm	6/29/2023	4:48	2.3894
SCS_Type_II_40.2mm	6/29/2023	4:54	2.27562
SCS_Type_II_40.2mm	6/29/2023	5:00	2.16184
SCS_Type_II_40.2mm	6/29/2023	5:06	2.08788
SCS_Type_II_40.2mm	6/29/2023	5:12	2.04237
SCS_Type_II_40.2mm	6/29/2023	5:18	2.00824
SCS_Type_II_40.2mm	6/29/2023	5:24	1.96272
SCS_Type_II_40.2mm	6/29/2023	5:30	1.92859
SCS_Type_II_40.2mm	6/29/2023	5:36	1.88308
SCS_Type_II_40.2mm	6/29/2023	5:42	1.84894
SCS_Type_II_40.2mm	6/29/2023	5:48	1.80343
SCS_Type_II_40.2mm	6/29/2023	5:54	1.7693

;SCS_Type_II_51.6mm design storm, total rainfall = 51.6 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_51.6mm	6/29/2023	0:00	2.30025
SCS_Type_II_51.6mm	6/29/2023	0:06	2.33676
SCS_Type_II_51.6mm	6/29/2023	0:12	2.33676
SCS_Type_II_51.6mm	6/29/2023	0:18	2.33676
SCS_Type_II_51.6mm	6/29/2023	0:24	2.33676
SCS_Type_II_51.6mm	6/29/2023	0:30	2.33676
SCS_Type_II_51.6mm	6/29/2023	0:36	2.39518

SCS_Type_II_51.6mm	6/29/2023	0:42	2.51201
SCS_Type_II_51.6mm	6/29/2023	0:48	2.62885
SCS_Type_II_51.6mm	6/29/2023	0:54	2.74569
SCS_Type_II_51.6mm	6/29/2023	1:00	2.86253
SCS_Type_II_51.6mm	6/29/2023	1:06	3.00858
SCS_Type_II_51.6mm	6/29/2023	1:12	3.18383
SCS_Type_II_51.6mm	6/29/2023	1:18	3.35909
SCS_Type_II_51.6mm	6/29/2023	1:24	3.53435
SCS_Type_II_51.6mm	6/29/2023	1:30	3.7096
SCS_Type_II_51.6mm	6/29/2023	1:36	3.94328
SCS_Type_II_51.6mm	6/29/2023	1:42	4.23537
SCS_Type_II_51.6mm	6/29/2023	1:48	4.52747
SCS_Type_II_51.6mm	6/29/2023	1:54	4.81956
SCS_Type_II_51.6mm	6/29/2023	2:00	5.11166
SCS_Type_II_51.6mm	6/29/2023	2:06	5.60822
SCS_Type_II_51.6mm	6/29/2023	2:12	6.30925
SCS_Type_II_51.6mm	6/29/2023	2:18	7.01027
SCS_Type_II_51.6mm	6/29/2023	2:24	7.7113
SCS_Type_II_51.6mm	6/29/2023	2:30	8.41233
SCS_Type_II_51.6mm	6/29/2023	2:36	17.40885
SCS_Type_II_51.6mm	6/29/2023	2:42	34.70086
SCS_Type_II_51.6mm	6/29/2023	2:48	55.81201
SCS_Type_II_51.6mm	6/29/2023	2:54	100.09357
SCS_Type_II_51.6mm	6/29/2023	3:00	69.47474
SCS_Type_II_51.6mm	6/29/2023	3:06	13.84529
SCS_Type_II_51.6mm	6/29/2023	3:12	12.18035
SCS_Type_II_51.6mm	6/29/2023	3:18	10.51541
SCS_Type_II_51.6mm	6/29/2023	3:24	8.85047
SCS_Type_II_51.6mm	6/29/2023	3:30	7.18553
SCS_Type_II_51.6mm	6/29/2023	3:36	6.1632
SCS_Type_II_51.6mm	6/29/2023	3:42	5.78348
SCS_Type_II_51.6mm	6/29/2023	3:48	5.40375
SCS_Type_II_51.6mm	6/29/2023	3:54	5.02403
SCS_Type_II_51.6mm	6/29/2023	4:00	4.64431
SCS_Type_II_51.6mm	6/29/2023	4:06	4.35221
SCS_Type_II_51.6mm	6/29/2023	4:12	4.14775
SCS_Type_II_51.6mm	6/29/2023	4:18	3.94328
SCS_Type_II_51.6mm	6/29/2023	4:24	3.73881
SCS_Type_II_51.6mm	6/29/2023	4:30	3.53435
SCS_Type_II_51.6mm	6/29/2023	4:36	3.35909
SCS_Type_II_51.6mm	6/29/2023	4:42	3.21304
SCS_Type_II_51.6mm	6/29/2023	4:48	3.06699
SCS_Type_II_51.6mm	6/29/2023	4:54	2.92095
SCS_Type_II_51.6mm	6/29/2023	5:00	2.7749
SCS_Type_II_51.6mm	6/29/2023	5:06	2.67997
SCS_Type_II_51.6mm	6/29/2023	5:12	2.62155
SCS_Type_II_51.6mm	6/29/2023	5:18	2.57774
SCS_Type_II_51.6mm	6/29/2023	5:24	2.51932
SCS_Type_II_51.6mm	6/29/2023	5:30	2.4755
SCS_Type_II_51.6mm	6/29/2023	5:36	2.41708
SCS_Type_II_51.6mm	6/29/2023	5:42	2.37327
SCS_Type_II_51.6mm	6/29/2023	5:48	2.31485
SCS_Type_II_51.6mm	6/29/2023	5:54	2.27104

;SCS_Type_II_58.8mm design storm, total rainfall = 58.8 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_58.8mm	6/29/2023	0:00	2.62121
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SCS_Type_II_58.8mm	6/29/2023	0:06	2.66282
SCS_Type_II_58.8mm	6/29/2023	0:12	2.66282
SCS_Type_II_58.8mm	6/29/2023	0:18	2.66282
SCS_Type_II_58.8mm	6/29/2023	0:24	2.66282
SCS_Type_II_58.8mm	6/29/2023	0:30	2.66282
SCS_Type_II_58.8mm	6/29/2023	0:36	2.72939
SCS_Type_II_58.8mm	6/29/2023	0:42	2.86253
SCS_Type_II_58.8mm	6/29/2023	0:48	2.99567
SCS_Type_II_58.8mm	6/29/2023	0:54	3.12881
SCS_Type_II_58.8mm	6/29/2023	1:00	3.26195
SCS_Type_II_58.8mm	6/29/2023	1:06	3.42838
SCS_Type_II_58.8mm	6/29/2023	1:12	3.62809
SCS_Type_II_58.8mm	6/29/2023	1:18	3.8278
SCS_Type_II_58.8mm	6/29/2023	1:24	4.02751
SCS_Type_II_58.8mm	6/29/2023	1:30	4.22722
SCS_Type_II_58.8mm	6/29/2023	1:36	4.4935
SCS_Type_II_58.8mm	6/29/2023	1:42	4.82636
SCS_Type_II_58.8mm	6/29/2023	1:48	5.15921
SCS_Type_II_58.8mm	6/29/2023	1:54	5.49206
SCS_Type_II_58.8mm	6/29/2023	2:00	5.82491
SCS_Type_II_58.8mm	6/29/2023	2:06	6.39076
SCS_Type_II_58.8mm	6/29/2023	2:12	7.18961
SCS_Type_II_58.8mm	6/29/2023	2:18	7.98845
SCS_Type_II_58.8mm	6/29/2023	2:24	8.7873
SCS_Type_II_58.8mm	6/29/2023	2:30	9.58614
SCS_Type_II_58.8mm	6/29/2023	2:36	19.83799
SCS_Type_II_58.8mm	6/29/2023	2:42	39.54284
SCS_Type_II_58.8mm	6/29/2023	2:48	63.59973
SCS_Type_II_58.8mm	6/29/2023	2:54	114.06012
SCS_Type_II_58.8mm	6/29/2023	3:00	79.16889
SCS_Type_II_58.8mm	6/29/2023	3:06	15.77719
SCS_Type_II_58.8mm	6/29/2023	3:12	13.87994
SCS_Type_II_58.8mm	6/29/2023	3:18	11.98268
SCS_Type_II_58.8mm	6/29/2023	3:24	10.08542
SCS_Type_II_58.8mm	6/29/2023	3:30	8.18816
SCS_Type_II_58.8mm	6/29/2023	3:36	7.02318
SCS_Type_II_58.8mm	6/29/2023	3:42	6.59047
SCS_Type_II_58.8mm	6/29/2023	3:48	6.15777
SCS_Type_II_58.8mm	6/29/2023	3:54	5.72506
SCS_Type_II_58.8mm	6/29/2023	4:00	5.29235
SCS_Type_II_58.8mm	6/29/2023	4:06	4.9595
SCS_Type_II_58.8mm	6/29/2023	4:12	4.7265
SCS_Type_II_58.8mm	6/29/2023	4:18	4.4935
SCS_Type_II_58.8mm	6/29/2023	4:24	4.26051
SCS_Type_II_58.8mm	6/29/2023	4:30	4.02751
SCS_Type_II_58.8mm	6/29/2023	4:36	3.8278
SCS_Type_II_58.8mm	6/29/2023	4:42	3.66137
SCS_Type_II_58.8mm	6/29/2023	4:48	3.49495
SCS_Type_II_58.8mm	6/29/2023	4:54	3.32852
SCS_Type_II_58.8mm	6/29/2023	5:00	3.1621
SCS_Type_II_58.8mm	6/29/2023	5:06	3.05392
SCS_Type_II_58.8mm	6/29/2023	5:12	2.98735
SCS_Type_II_58.8mm	6/29/2023	5:18	2.93742
SCS_Type_II_58.8mm	6/29/2023	5:24	2.87085
SCS_Type_II_58.8mm	6/29/2023	5:30	2.82092
SCS_Type_II_58.8mm	6/29/2023	5:36	2.75435
SCS_Type_II_58.8mm	6/29/2023	5:42	2.70442

SCS_Type_II_58.8mm	6/29/2023	5:48	2.63785
SCS_Type_II_58.8mm	6/29/2023	5:54	2.58793

;SCS_Type_II_68.4mm design storm, total rainfall = 68.4 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_68.4mm	6/29/2023	0:00	3.04916
SCS_Type_II_68.4mm	6/29/2023	0:06	3.09756
SCS_Type_II_68.4mm	6/29/2023	0:12	3.09756
SCS_Type_II_68.4mm	6/29/2023	0:18	3.09756
SCS_Type_II_68.4mm	6/29/2023	0:24	3.09756
SCS_Type_II_68.4mm	6/29/2023	0:30	3.09756
SCS_Type_II_68.4mm	6/29/2023	0:36	3.175
SCS_Type_II_68.4mm	6/29/2023	0:42	3.32988
SCS_Type_II_68.4mm	6/29/2023	0:48	3.48476
SCS_Type_II_68.4mm	6/29/2023	0:54	3.63964
SCS_Type_II_68.4mm	6/29/2023	1:00	3.79451
SCS_Type_II_68.4mm	6/29/2023	1:06	3.98811
SCS_Type_II_68.4mm	6/29/2023	1:12	4.22043
SCS_Type_II_68.4mm	6/29/2023	1:18	4.45275
SCS_Type_II_68.4mm	6/29/2023	1:24	4.68506
SCS_Type_II_68.4mm	6/29/2023	1:30	4.91738
SCS_Type_II_68.4mm	6/29/2023	1:36	5.22714
SCS_Type_II_68.4mm	6/29/2023	1:42	5.61433
SCS_Type_II_68.4mm	6/29/2023	1:48	6.00153
SCS_Type_II_68.4mm	6/29/2023	1:54	6.38872
SCS_Type_II_68.4mm	6/29/2023	2:00	6.77592
SCS_Type_II_68.4mm	6/29/2023	2:06	7.43415
SCS_Type_II_68.4mm	6/29/2023	2:12	8.36342
SCS_Type_II_68.4mm	6/29/2023	2:18	9.29269
SCS_Type_II_68.4mm	6/29/2023	2:24	10.22196
SCS_Type_II_68.4mm	6/29/2023	2:30	11.15123
SCS_Type_II_68.4mm	6/29/2023	2:36	23.07684
SCS_Type_II_68.4mm	6/29/2023	2:42	45.99881
SCS_Type_II_68.4mm	6/29/2023	2:48	73.98336
SCS_Type_II_68.4mm	6/29/2023	2:54	132.68218
SCS_Type_II_68.4mm	6/29/2023	3:00	92.09442
SCS_Type_II_68.4mm	6/29/2023	3:06	18.35306
SCS_Type_II_68.4mm	6/29/2023	3:12	16.14605
SCS_Type_II_68.4mm	6/29/2023	3:18	13.93903
SCS_Type_II_68.4mm	6/29/2023	3:24	11.73202
SCS_Type_II_68.4mm	6/29/2023	3:30	9.52501
SCS_Type_II_68.4mm	6/29/2023	3:36	8.16982
SCS_Type_II_68.4mm	6/29/2023	3:42	7.66647
SCS_Type_II_68.4mm	6/29/2023	3:48	7.16311
SCS_Type_II_68.4mm	6/29/2023	3:54	6.65976
SCS_Type_II_68.4mm	6/29/2023	4:00	6.15641
SCS_Type_II_68.4mm	6/29/2023	4:06	5.76921
SCS_Type_II_68.4mm	6/29/2023	4:12	5.49817
SCS_Type_II_68.4mm	6/29/2023	4:18	5.22714
SCS_Type_II_68.4mm	6/29/2023	4:24	4.9561
SCS_Type_II_68.4mm	6/29/2023	4:30	4.68506
SCS_Type_II_68.4mm	6/29/2023	4:36	4.45275
SCS_Type_II_68.4mm	6/29/2023	4:42	4.25915
SCS_Type_II_68.4mm	6/29/2023	4:48	4.06555
SCS_Type_II_68.4mm	6/29/2023	4:54	3.87195
SCS_Type_II_68.4mm	6/29/2023	5:00	3.67836
SCS_Type_II_68.4mm	6/29/2023	5:06	3.55252

SCS_Type_II_68.4mm	6/29/2023	5:12	3.47508
SCS_Type_II_68.4mm	6/29/2023	5:18	3.417
SCS_Type_II_68.4mm	6/29/2023	5:24	3.33956
SCS_Type_II_68.4mm	6/29/2023	5:30	3.28148
SCS_Type_II_68.4mm	6/29/2023	5:36	3.20404
SCS_Type_II_68.4mm	6/29/2023	5:42	3.14596
SCS_Type_II_68.4mm	6/29/2023	5:48	3.06852
SCS_Type_II_68.4mm	6/29/2023	5:54	3.01044

;SCS_Type_II_75.6mm design storm, total rainfall = 75.6 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_75.6mm	6/29/2023	0:00	3.37013
SCS_Type_II_75.6mm	6/29/2023	0:06	3.42362
SCS_Type_II_75.6mm	6/29/2023	0:12	3.42362
SCS_Type_II_75.6mm	6/29/2023	0:18	3.42362
SCS_Type_II_75.6mm	6/29/2023	0:24	3.42362
SCS_Type_II_75.6mm	6/29/2023	0:30	3.42362
SCS_Type_II_75.6mm	6/29/2023	0:36	3.50921
SCS_Type_II_75.6mm	6/29/2023	0:42	3.68039
SCS_Type_II_75.6mm	6/29/2023	0:48	3.85158
SCS_Type_II_75.6mm	6/29/2023	0:54	4.02276
SCS_Type_II_75.6mm	6/29/2023	1:00	4.19394
SCS_Type_II_75.6mm	6/29/2023	1:06	4.40791
SCS_Type_II_75.6mm	6/29/2023	1:12	4.66469
SCS_Type_II_75.6mm	6/29/2023	1:18	4.92146
SCS_Type_II_75.6mm	6/29/2023	1:24	5.17823
SCS_Type_II_75.6mm	6/29/2023	1:30	5.435
SCS_Type_II_75.6mm	6/29/2023	1:36	5.77736
SCS_Type_II_75.6mm	6/29/2023	1:42	6.20532
SCS_Type_II_75.6mm	6/29/2023	1:48	6.63327
SCS_Type_II_75.6mm	6/29/2023	1:54	7.06122
SCS_Type_II_75.6mm	6/29/2023	2:00	7.48917
SCS_Type_II_75.6mm	6/29/2023	2:06	8.21669
SCS_Type_II_75.6mm	6/29/2023	2:12	9.24378
SCS_Type_II_75.6mm	6/29/2023	2:18	10.27087
SCS_Type_II_75.6mm	6/29/2023	2:24	11.29795
SCS_Type_II_75.6mm	6/29/2023	2:30	12.32504
SCS_Type_II_75.6mm	6/29/2023	2:36	25.50599
SCS_Type_II_75.6mm	6/29/2023	2:42	50.84079
SCS_Type_II_75.6mm	6/29/2023	2:48	81.77108
SCS_Type_II_75.6mm	6/29/2023	2:54	146.64872
SCS_Type_II_75.6mm	6/29/2023	3:00	101.78857
SCS_Type_II_75.6mm	6/29/2023	3:06	20.28496
SCS_Type_II_75.6mm	6/29/2023	3:12	17.84563
SCS_Type_II_75.6mm	6/29/2023	3:18	15.4063
SCS_Type_II_75.6mm	6/29/2023	3:24	12.96697
SCS_Type_II_75.6mm	6/29/2023	3:30	10.52764
SCS_Type_II_75.6mm	6/29/2023	3:36	9.0298
SCS_Type_II_75.6mm	6/29/2023	3:42	8.47347
SCS_Type_II_75.6mm	6/29/2023	3:48	7.91713
SCS_Type_II_75.6mm	6/29/2023	3:54	7.36079
SCS_Type_II_75.6mm	6/29/2023	4:00	6.80445
SCS_Type_II_75.6mm	6/29/2023	4:06	6.3765
SCS_Type_II_75.6mm	6/29/2023	4:12	6.07693
SCS_Type_II_75.6mm	6/29/2023	4:18	5.77736
SCS_Type_II_75.6mm	6/29/2023	4:24	5.4778
SCS_Type_II_75.6mm	6/29/2023	4:30	5.17823

SCS_Type_II_75.6mm	6/29/2023	4:36	4.92146
SCS_Type_II_75.6mm	6/29/2023	4:42	4.70748
SCS_Type_II_75.6mm	6/29/2023	4:48	4.4935
SCS_Type_II_75.6mm	6/29/2023	4:54	4.27953
SCS_Type_II_75.6mm	6/29/2023	5:00	4.06555
SCS_Type_II_75.6mm	6/29/2023	5:06	3.92647
SCS_Type_II_75.6mm	6/29/2023	5:12	3.84088
SCS_Type_II_75.6mm	6/29/2023	5:18	3.77668
SCS_Type_II_75.6mm	6/29/2023	5:24	3.69109
SCS_Type_II_75.6mm	6/29/2023	5:30	3.6269
SCS_Type_II_75.6mm	6/29/2023	5:36	3.54131
SCS_Type_II_75.6mm	6/29/2023	5:42	3.47712
SCS_Type_II_75.6mm	6/29/2023	5:48	3.39153
SCS_Type_II_75.6mm	6/29/2023	5:54	3.32733

;SCS_Type_II_82.2mm design storm, total rainfall = 82.2 mm, rain interval = 6 minutes, rain units = mm/hr.

SCS_Type_II_82.2mm	6/29/2023	0:00	3.66435
SCS_Type_II_82.2mm	6/29/2023	0:06	3.72251
SCS_Type_II_82.2mm	6/29/2023	0:12	3.72251
SCS_Type_II_82.2mm	6/29/2023	0:18	3.72251
SCS_Type_II_82.2mm	6/29/2023	0:24	3.72251
SCS_Type_II_82.2mm	6/29/2023	0:30	3.72251
SCS_Type_II_82.2mm	6/29/2023	0:36	3.81557
SCS_Type_II_82.2mm	6/29/2023	0:42	4.0017
SCS_Type_II_82.2mm	6/29/2023	0:48	4.18782
SCS_Type_II_82.2mm	6/29/2023	0:54	4.37395
SCS_Type_II_82.2mm	6/29/2023	1:00	4.56007
SCS_Type_II_82.2mm	6/29/2023	1:06	4.79273
SCS_Type_II_82.2mm	6/29/2023	1:12	5.07192
SCS_Type_II_82.2mm	6/29/2023	1:18	5.35111
SCS_Type_II_82.2mm	6/29/2023	1:24	5.6303
SCS_Type_II_82.2mm	6/29/2023	1:30	5.90948
SCS_Type_II_82.2mm	6/29/2023	1:36	6.28174
SCS_Type_II_82.2mm	6/29/2023	1:42	6.74705
SCS_Type_II_82.2mm	6/29/2023	1:48	7.21236
SCS_Type_II_82.2mm	6/29/2023	1:54	7.67768
SCS_Type_II_82.2mm	6/29/2023	2:00	8.14299
SCS_Type_II_82.2mm	6/29/2023	2:06	8.93402
SCS_Type_II_82.2mm	6/29/2023	2:12	10.05078
SCS_Type_II_82.2mm	6/29/2023	2:18	11.16753
SCS_Type_II_82.2mm	6/29/2023	2:24	12.28428
SCS_Type_II_82.2mm	6/29/2023	2:30	13.40104
SCS_Type_II_82.2mm	6/29/2023	2:36	27.7327
SCS_Type_II_82.2mm	6/29/2023	2:42	55.27927
SCS_Type_II_82.2mm	6/29/2023	2:48	88.90982
SCS_Type_II_82.2mm	6/29/2023	2:54	159.45139
SCS_Type_II_82.2mm	6/29/2023	3:00	110.67487
SCS_Type_II_82.2mm	6/29/2023	3:06	22.05587
SCS_Type_II_82.2mm	6/29/2023	3:12	19.40358
SCS_Type_II_82.2mm	6/29/2023	3:18	16.75129
SCS_Type_II_82.2mm	6/29/2023	3:24	14.09901
SCS_Type_II_82.2mm	6/29/2023	3:30	11.44672
SCS_Type_II_82.2mm	6/29/2023	3:36	9.81812
SCS_Type_II_82.2mm	6/29/2023	3:42	9.21321
SCS_Type_II_82.2mm	6/29/2023	3:48	8.6083
SCS_Type_II_82.2mm	6/29/2023	3:54	8.0034

SCS_Type_II_82.2mm	6/29/2023	4:00	7.39849
SCS_Type_II_82.2mm	6/29/2023	4:06	6.93317
SCS_Type_II_82.2mm	6/29/2023	4:12	6.60746
SCS_Type_II_82.2mm	6/29/2023	4:18	6.28174
SCS_Type_II_82.2mm	6/29/2023	4:24	5.95602
SCS_Type_II_82.2mm	6/29/2023	4:30	5.6303
SCS_Type_II_82.2mm	6/29/2023	4:36	5.35111
SCS_Type_II_82.2mm	6/29/2023	4:42	5.11845
SCS_Type_II_82.2mm	6/29/2023	4:48	4.88579
SCS_Type_II_82.2mm	6/29/2023	4:54	4.65314
SCS_Type_II_82.2mm	6/29/2023	5:00	4.42048
SCS_Type_II_82.2mm	6/29/2023	5:06	4.26925
SCS_Type_II_82.2mm	6/29/2023	5:12	4.17619
SCS_Type_II_82.2mm	6/29/2023	5:18	4.10639
SCS_Type_II_82.2mm	6/29/2023	5:24	4.01333
SCS_Type_II_82.2mm	6/29/2023	5:30	3.94353
SCS_Type_II_82.2mm	6/29/2023	5:36	3.85047
SCS_Type_II_82.2mm	6/29/2023	5:42	3.78067
SCS_Type_II_82.2mm	6/29/2023	5:48	3.68761
SCS_Type_II_82.2mm	6/29/2023	5:54	3.61781

[REPORT]
;;Reporting Options
INPUT YES
CONTROLS NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]
Subcatch OUT-A WDT
Subcatch OUT-B WDT
Subcatch OUT-C WDT
Subcatch OUT-D WDT
Subcatch OUT-Ultimate WDT

[MAP]
DIMENSIONS 514153.03655 4989088.66635 515746.04445 4990035.71465
UNITS Meters

[COORDINATES]
;;Node X-Coord Y-Coord
;;-----
OU-A 515105.515 4989171.955
OU-B 515212.056 4989390.277
OU-C 515350.093 4989320.028
OU-D 515478.341 4989249.006
OU-Ultimate 515509.843 4989131.714

[VERTICES]
;;Link X-Coord Y-Coord
;;-----

[POLYGONS]
;;Subcatchment X-Coord Y-Coord
;;-----
OUT-A 514996.564 4989362.911

OUT-A	514996.558	4989362.93
OUT-A	514997.038	4989362.931
OUT-A	515000.822	4989368.117
OUT-A	515008.36	4989391.034
OUT-A	515012.397	4989400.67
OUT-A	515013.529	4989401.146
OUT-A	515013.557	4989401.17
OUT-A	515013.741	4989400.517
OUT-A	515039.607	4989321.906
OUT-A	515040.069	4989304.495
OUT-A	515055.127	4989256.697
OUT-A	515067.424	4989219.593
OUT-A	515078.217	4989195.282
OUT-A	515091.119	4989169.297
OUT-A	515105.691	4989149.191
OUT-A	515105.618	4989147.744
OUT-A	515104.551	4989148.577
OUT-A	515098.119	4989144.009
OUT-A	515093.984	4989143.144
OUT-A	515090.162	4989140.61
OUT-A	515072.387	4989173.035
OUT-A	515063.487	4989191.17
OUT-A	515052.574	4989212.132
OUT-A	515037.955	4989245.078
OUT-A	515030.045	4989268.713
OUT-A	515013.046	4989318.976
OUT-A	514996.564	4989362.911
OUT-B	514397.788	4989834.401
OUT-B	514397.774	4989834.397
OUT-B	514391.747	4989838.772
OUT-B	514385.422	4989841.426
OUT-B	514384.378	4989851.404
OUT-B	514383.045	4989854.071
OUT-B	514375.174	4989859.2
OUT-B	514352.605	4989866.631
OUT-B	514336.811	4989879.837
OUT-B	514328.346	4989888.372
OUT-B	514324.789	4989893.705
OUT-B	514325.734	4989900.394
OUT-B	514328.063	4989903.954
OUT-B	514328.053	4989905.19
OUT-B	514325.221	4989907.792
OUT-B	514326.924	4989910.317
OUT-B	514326.586	4989910.656
OUT-B	514326.098	4989911.145
OUT-B	514322.982	4989912.007
OUT-B	514312.939	4989917.965
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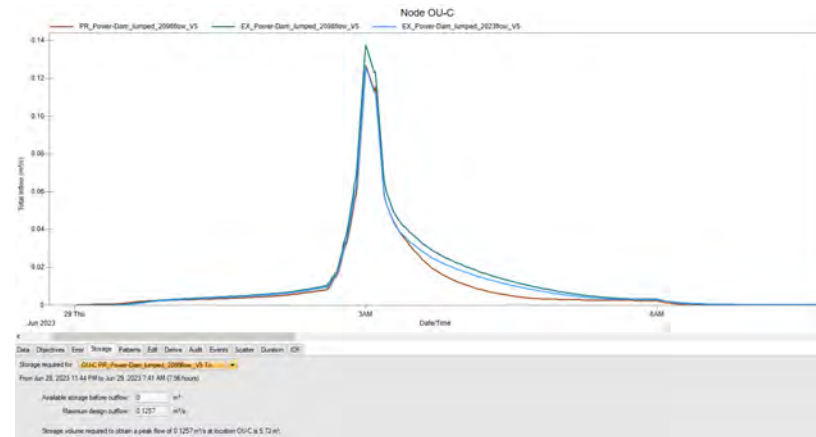
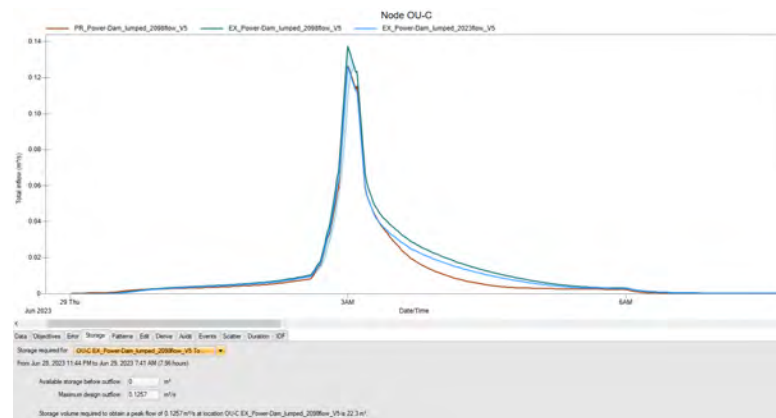
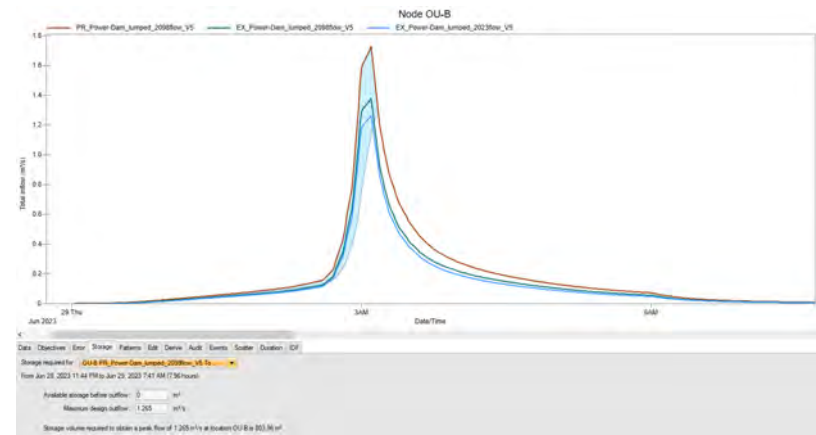
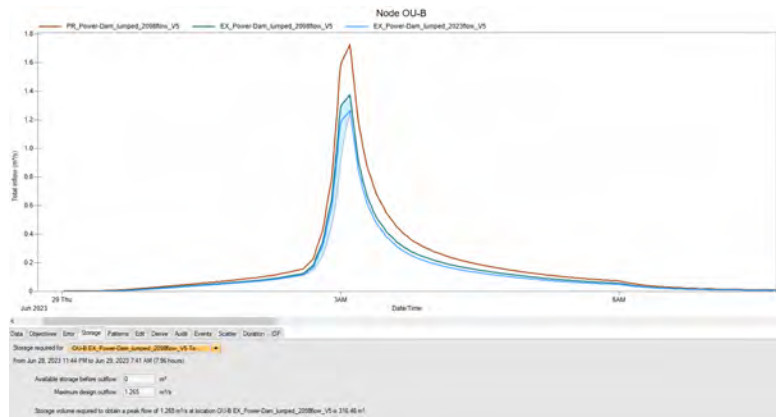
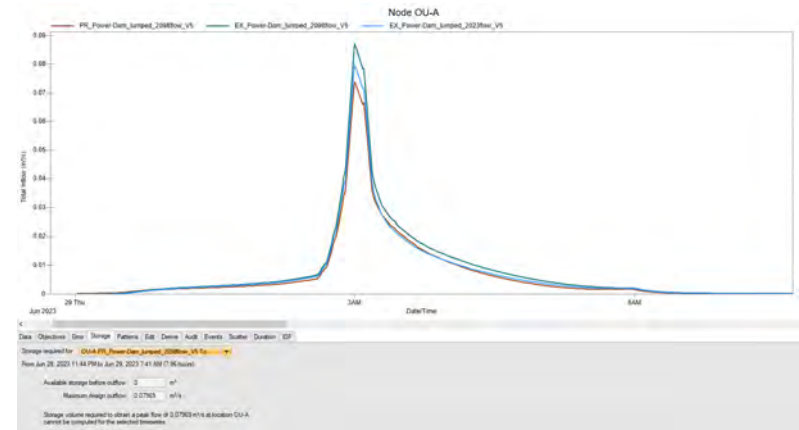
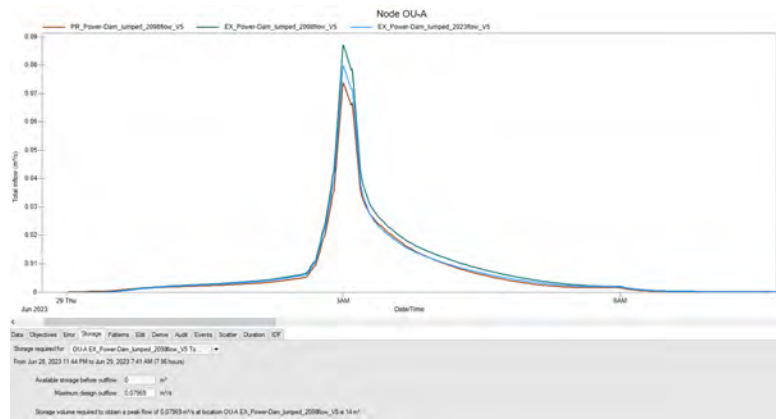
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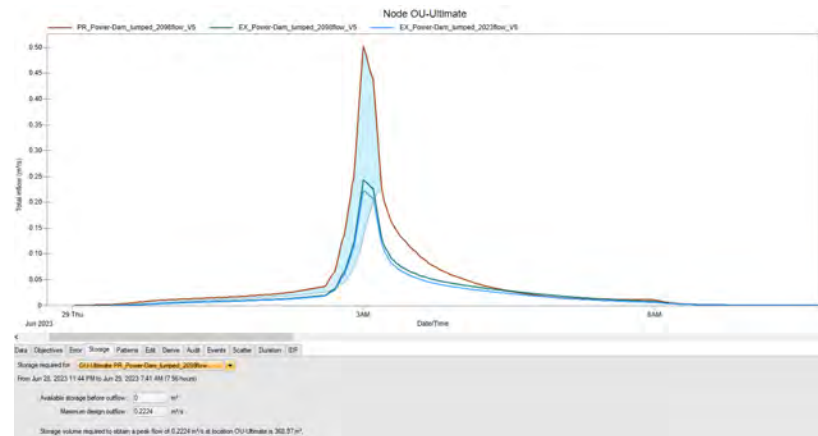
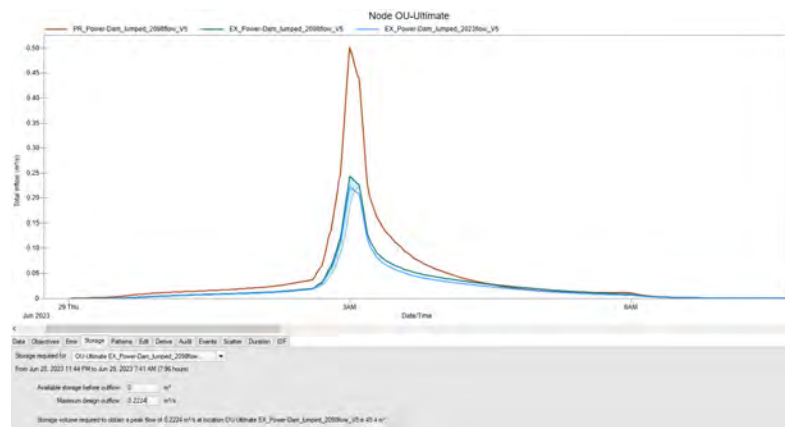
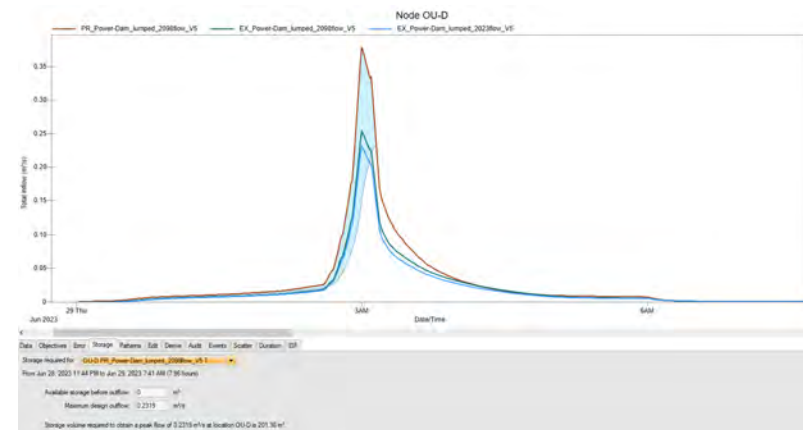
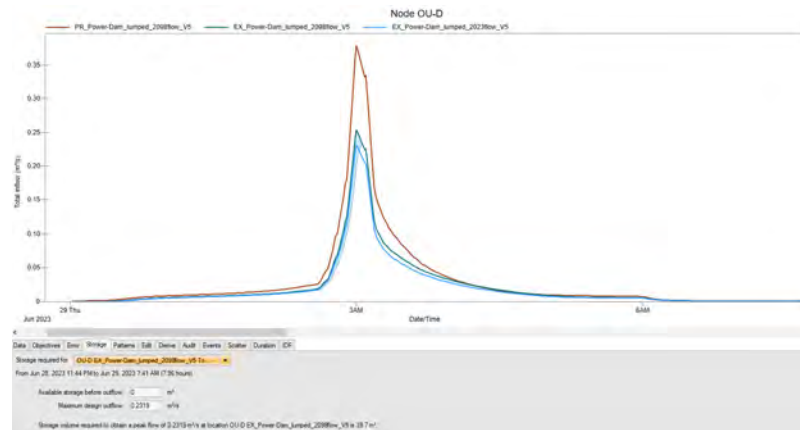
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Appendix M – Traffic Analysis Report, Preliminary Design and Environmental Assessment, Highway 401 at Power Dam Drive

Traffic Analysis Report

Preliminary Design and Environmental Assessment

Highway 401 at Power Dam Drive

Ministry of Transportation

Agreement No. 4019-E-0023, Assignment No. 4

G.W.P. 4092-19-00

Presented to:

Abdullah Anabtawi
Project Manager

Ministry of Transportation
1355 John Counter Boulevard
Kingston, ON
K7L 5A3

Project No. 201979402

June 22, 2023

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TRAFFIC REPORT 21062023.DOCX

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APPENDIX A: Model Calibration Report

APPENDIX B: Signal Warrant Analysis

1. INTRODUCTION

1.1 Purpose

This report reviews existing and projected Highway 401 operations, traffic volumes and characteristics; and documents the process and results of the Vissim micro-simulation analysis of three design alternatives of Bridge Site 013X-180 /BO (Highway 401 and Power Dam Drive Interchange IC 786).

1.2 Study Area

The study area for the purpose of modelling analysis of the Power Dam Road and Highway 401 interchange is 1.25 km north and 1.4 km south on Power Dam Road, and 5.6 km east and 16.5 km west on Highway 401. The model starts from McConnell Avenue east of Highway 401, ends on County Rd 14 / Dickinson Drive west of Highway 401, and includes three interchanges:

1. Brookdale Avenue (Highway 138) at Highway 401,
2. Power Dam Drive at Highway 401,
3. Moulinette Road (Highway 35) at Highway 401.

The extent of Power Dam Drive includes two intersections: Power Dam Drive at the Highway 401 westbound on-ramp (North Intersection), and Power Dam Drive and Highway 401 eastbound off-ramp (South Intersection).

The limits of the micro-simulation model are shown in **Figure 1-1**.



Figure 1-1: Study Area Simulation Limits

2. METHODOLOGY

2.1 Analysis Tool

The evaluation of traffic operations on the study area was conducted using Vissim 2020 micro-simulation software. Micro-simulation allows for detailed analysis of complicated traffic interactions.

2.2 Performance Measures

The following performance measures were used to evaluate the simulated traffic operations of the existing and future Vissim models:

Throughput: Volumes (used interchangeably with “throughput”) passing through Highway 401 sections in the eastbound and westbound directions, as well as traffic volumes travelling on Power Dam Road for the morning peak hour and the afternoon peak hour, were measured to evaluate the ability of the interchange design alternatives to process traffic through the study area.

Speed: Average speeds were evaluated over the length of Highway 401 study area in each direction.

Travel Time: Average simulated travel time was evaluated along the length of Highway 401. Real travel times were not available for the study area; however, a review of existing conditions using Google Maps’ “typical traffic” function show good / free-flow speeds through the study area. This is supported by anecdotal information provided by MTO traffic representatives during the project startup meeting.

3. EXISTING CONDITIONS

3.1 Model Development and calibration

This section provides a summary of the model development and calibration of the study area Vissim model. Full documentation can be found in the Calibration Report in **APPENDIX A**: Model calibration report include data used in simulation, data adjustment and balancing process, GEH, and Correlation between real and simulated volumes.

The model was developed using Vissim 2020 with Service Pack 14. The road network was constructed upon aerial imagery available within the Vissim software package.

The reference year for “existing conditions” was established as 2016 based on the most recent Highway 401 traffic Data. Data adjustment and balancing processes were employed to create a cohesive dataset for use in model calibration.

The model was calibrated to the following time periods:

- Weekday Morning Peak Period: 7 – 10 AM, representing the travel in the network during the peak morning hours.
- Weekday Evening Peak Period: 3 – 6 PM, representing the travel in the network during the peak evening hours.

3.1.1 Volume

Volume calibration is assessed using the GEH statistic to compare simulated values to real-world measurements. The GEH statistics in all time periods and directions were below 5.0 for 100% of data points, exceeding the typical standard of 85%. The Calibrated traffic volumes were used to forecast 2041 traffic volumes travelling through the study area corridors, which were then used to compare different design alternatives throughput.

3.1.2 Travel Time

Average hourly travel times for individual highway segments (interchange to interchange) were extracted from the model and used for the evaluation of the design alternatives.

Real-world travel time data was not available for the study area.

3.1.3 Speed

Average speeds are computed using travel times extracted from the model.

3.2 Model Results

The following subsections highlight the simulated traffic operations for the peak directions in each peak period, i.e., during the morning (7-10 AM) peak period, and the evening (3-6 PM) peak period.

3.2.1 Turning Movement Counts Power Dam Drive

Turning movements of Power Dam Drive at Highway 401 Ramps from MTO was used to calibrate traffic volumes traveling north and south of Power Dam Dr.

3.2.2 Highway 401 Eastbound Morning Peak Period

The following graphs shows the simulated operations for the eastbound direction, with respect to speed, travel time, and throughput during the morning peak hour (8-9 AM).

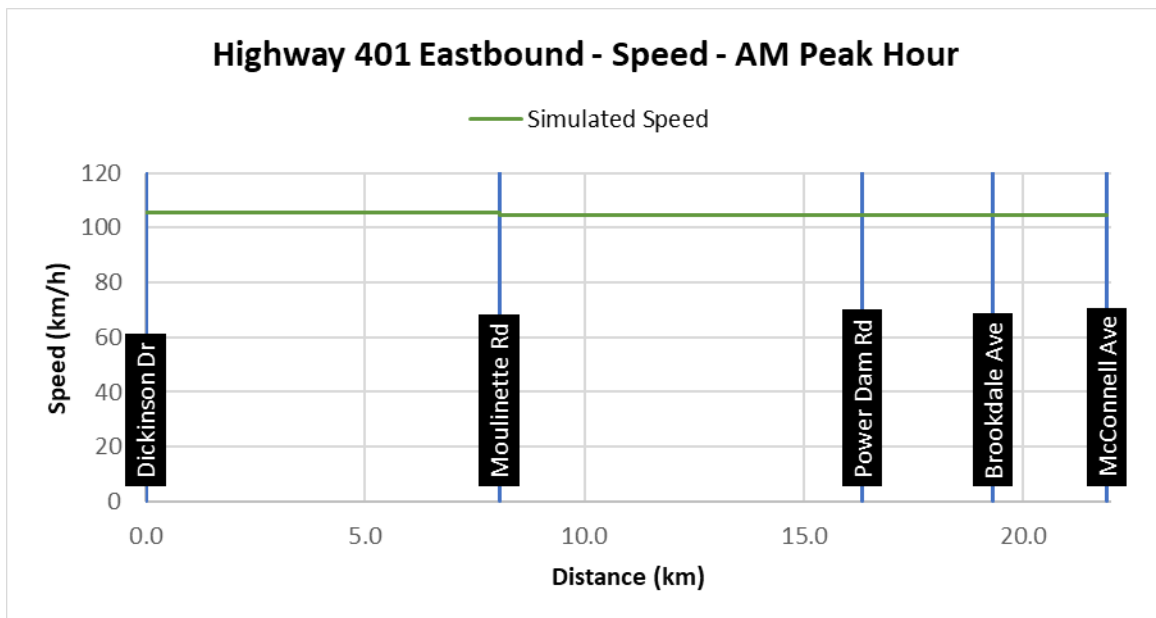


Figure 3-1: 2041 Simulated Speeds – AM Peak Hour – Eastbound

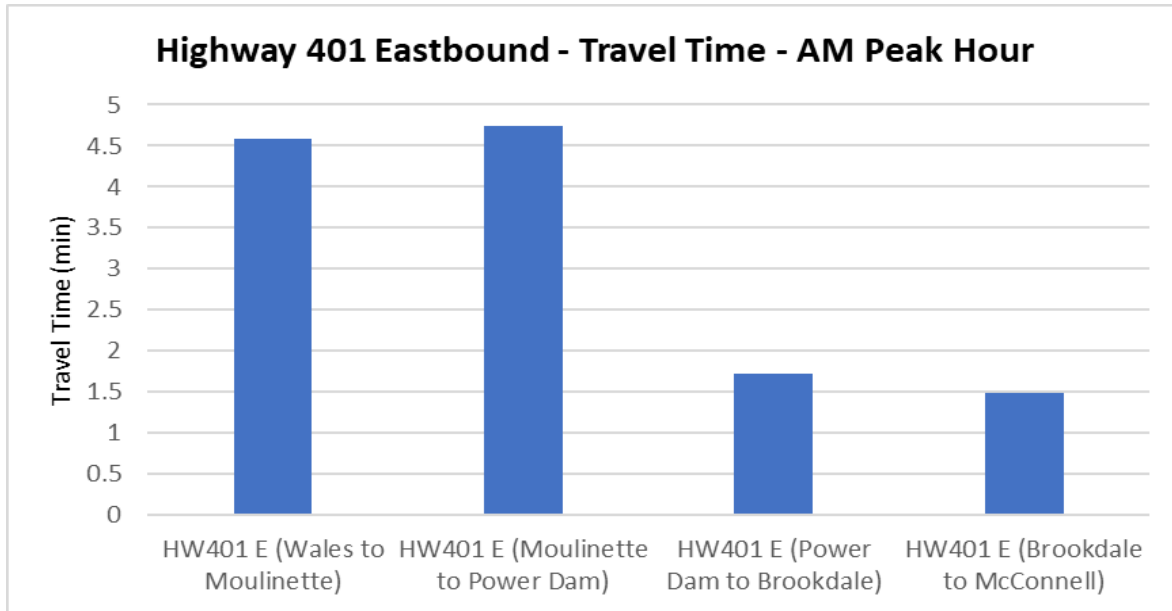


Figure 3-2: 2041 Simulated Travel Time by Highway Segment – AM Peak Hour – Eastbound

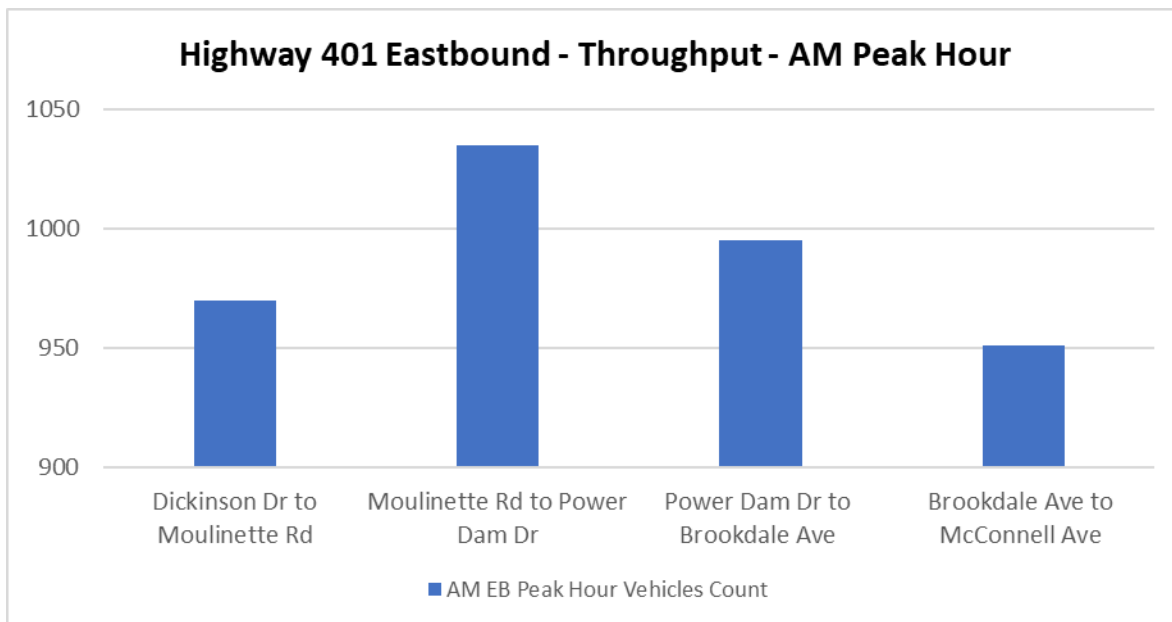


Figure 3-3: 2041 Simulated Volume Throughput by Highway Segment – AM Peak Hour – Eastbound

The speed and throughput graphs demonstrate low level of congestion in the eastbound direction of Highway 401. Free flow speed is observed on Highway 401 segments between Dickinson Drive and McConnell Avenue.

3.2.3 Highway 401 Westbound Evening Peak Period

The following graphs shows the simulated operations for the westbound direction, with respect to speed, travel time, and throughput during the evening peak hour (4-5 PM).

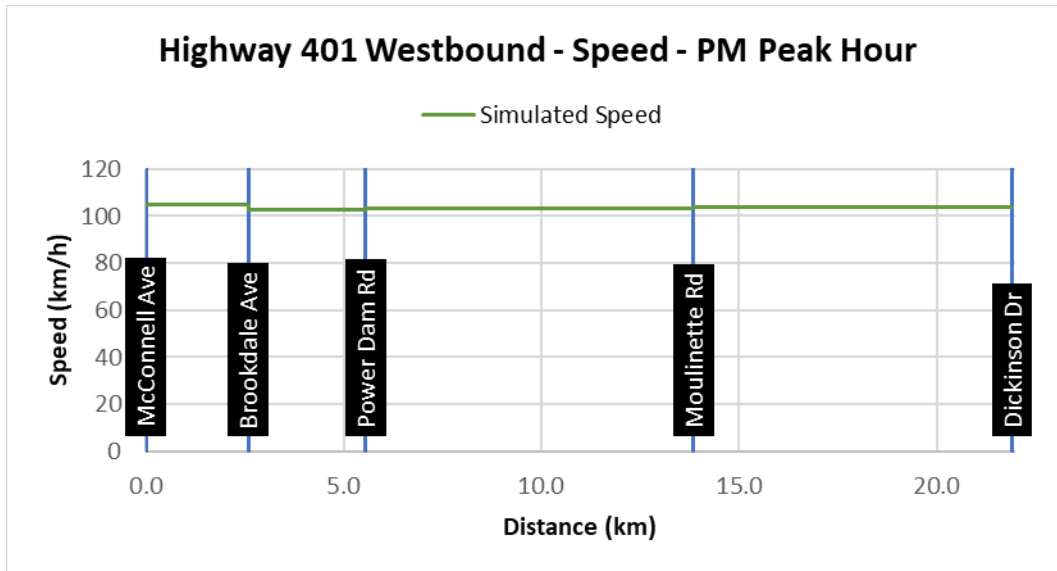


Figure 3-4: 2041 Simulated Speeds – PM Peak Hour – Westbound

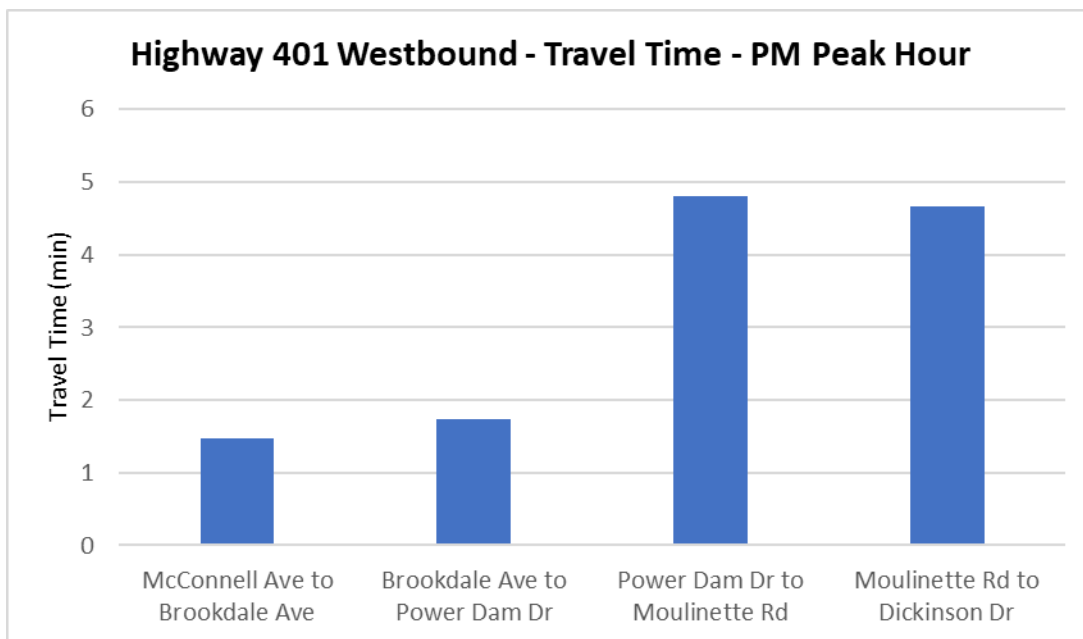


Figure 3-5: 2041 Simulated Travel Time by Highway Segment – PM Peak Hour – Westbound

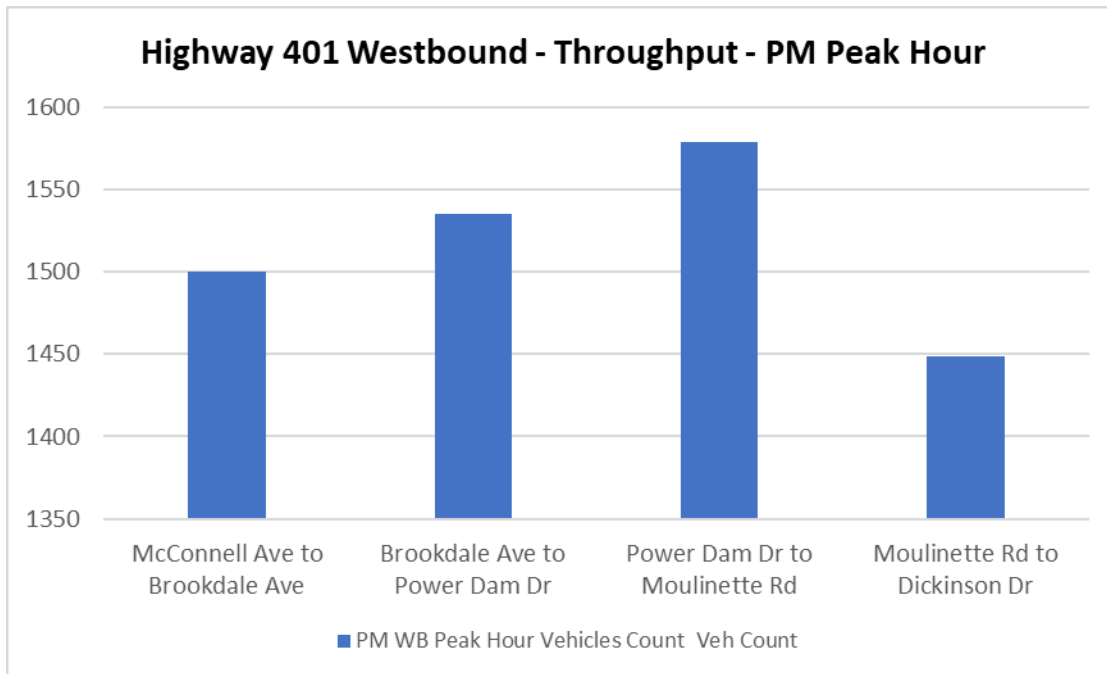


Figure 3-6: 2041 Simulated Volume Throughput by Highway Segment – PM Peak Hour – Westbound

The speed and throughput graphs demonstrate low level of congestion in the westbound direction of Highway 401. Highway segment between McConnell Avenue and Dickinson Drive show free flow speed behavior.

4. DESIGN ALTERNATIVES

Initially, a total of eight design alternatives had been developed for evaluation by Morrison Hershfield. Alternative selection process was conducted based on the following categories:

- i. Social / Natural Environment: including subcategory of Social and Community, Property Impacts, Watercourses / Fisheries, Vegetation Woodlots and Wildlife Habitat, and Water Resources
- ii. Cost / Staging: including subcategory of Cost, Staging Opportunities, and Utility Impacts
- iii. Transportation: including subcategory of Operational Performance, Geometry, Local Road Impacts, Structural Implications, Accommodation of Power Dam Drive Active Transportation
- iv. Key Advantages and disadvantages.

After the screening process, 3 alternatives were selected for Vissim micro-simulation analysis: Alternative 5 Straight Bridge - 60° Skew - Parclo B2 North of Bridge and Diamond South of Bridge; Alternative 6 Curved Bridge - 60° Skew - Parclo B2; and Alternative 8 Straight Bridge - 41° Skew - Single Diamond Interchange, shown in **Figure 4-1** through **Figure 4-3**.

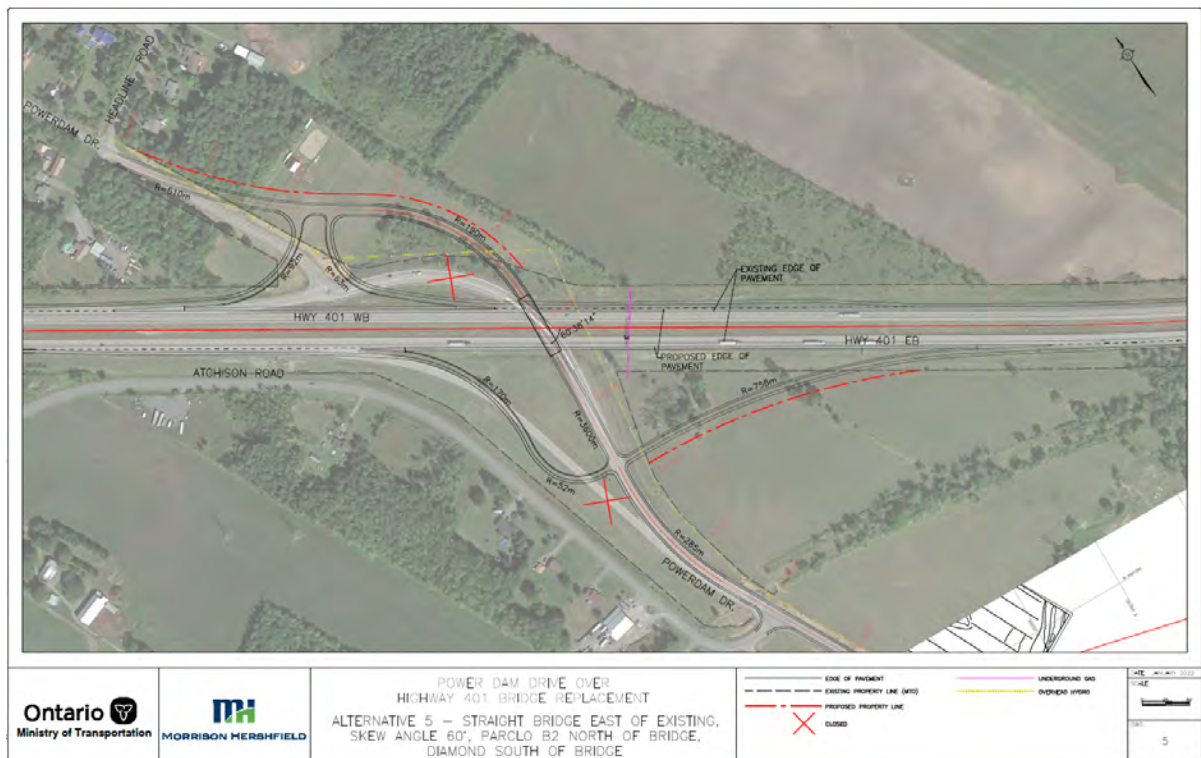


Figure 4-1: Alternative 5 Straight Bridge - 60° Skew - Parclo B2 North of Bridge and Diamond South of Bridge

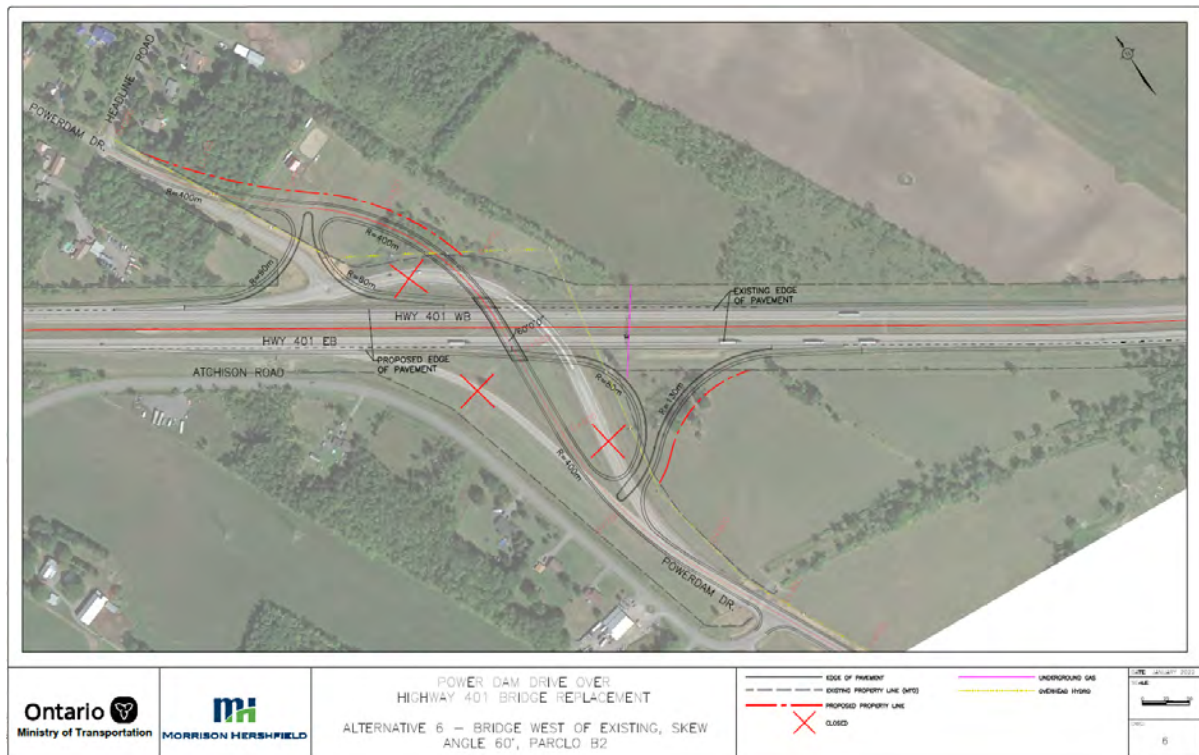


Figure 4-2: Alternative 6 Curved Bridge - 60° Skew - Parclo B2

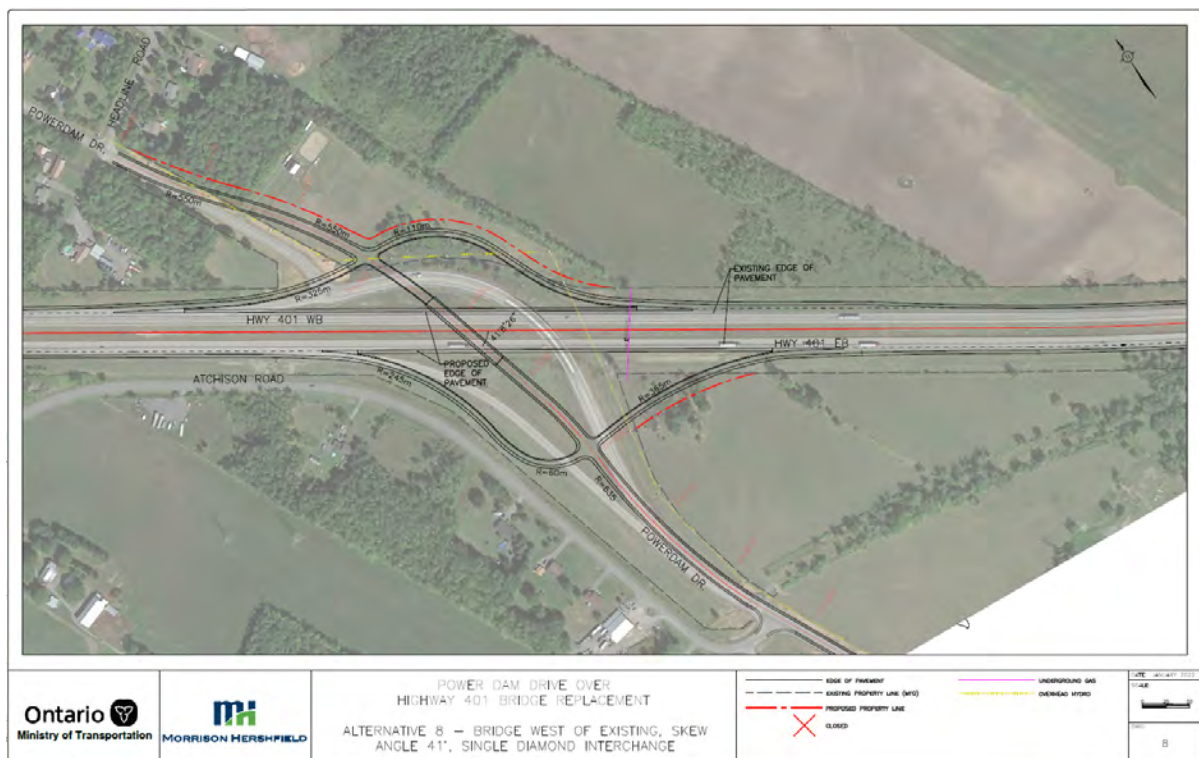


Figure 4-3: Alternative 8 Straight Bridge - 41° Skew - Single Diamond Interchange

5. DEVELOPMENT OF FUTURE DEMAND

The future demand, used in the micro-simulation analysis of the design alternatives, was developed using the following process:

- i. Baseline 2016 data adjustment and calibration as described in the Calibration Report presented in **APPENDIX A:**.
- ii. Count Data were extracted from MTO reports. Traffic counts were calibrated and balanced to represent 2016 baseline model.
- iii. 2016 Demand Data was extracted from EMME model provided by MTO.
- iv. 2041 Demand Data was extracted From EMME model provided by MTO.
- v. EMME extracted Matrixes were used as building blocks for origin-destination travel routes for 2016 baseline model.
- vi. Raw data from EMME was scaled and balanced with the calibrated 2016 baseline data to represent future demand matrices.
- vii. Traffic turning movements were produced using EMME – SOLA traffic assignment model of demand matrices of multi-class assignment for the study area for 2016 and 2041.
- viii. Each alternative was modeled using EMME – SOLA traffic assignment for traffic turning movement calculations extraction.

6. ANALYSIS OF DESIGN ALTERNATIVES

The following subsections highlight the simulated traffic operations of Highway 401 and Power Dam Drive Interchange design alternatives using projected data of the future year 2041 for the peak directions in each peak period, i.e., during the morning (7-10 AM) peak period, and the evening (3-6 PM) peak period.

6.1 Alternative 5

6.1.1 Eastbound Morning Peak Period

The following graphs shows the simulated operations for the eastbound direction, with respect to speed, travel time, and throughput during the morning peak hour (8-9 AM).

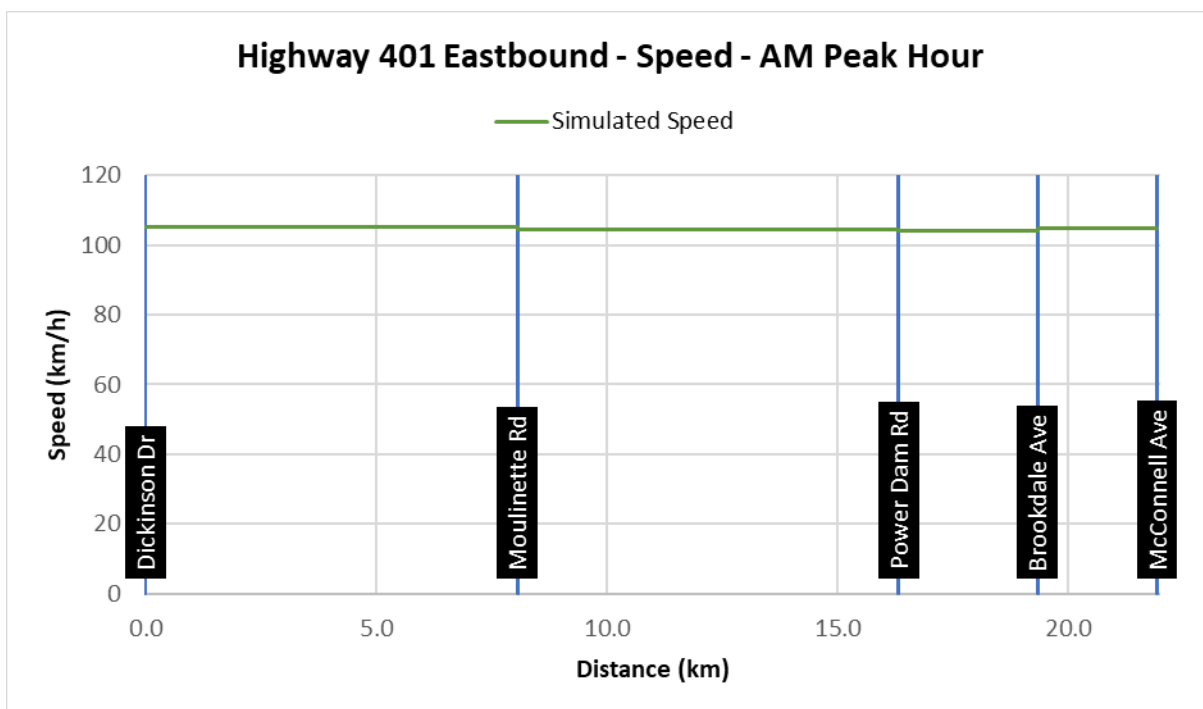


Figure 6-1: 2041 Alternative 5 Simulate Speeds - AM Peak Hour - Eastbound

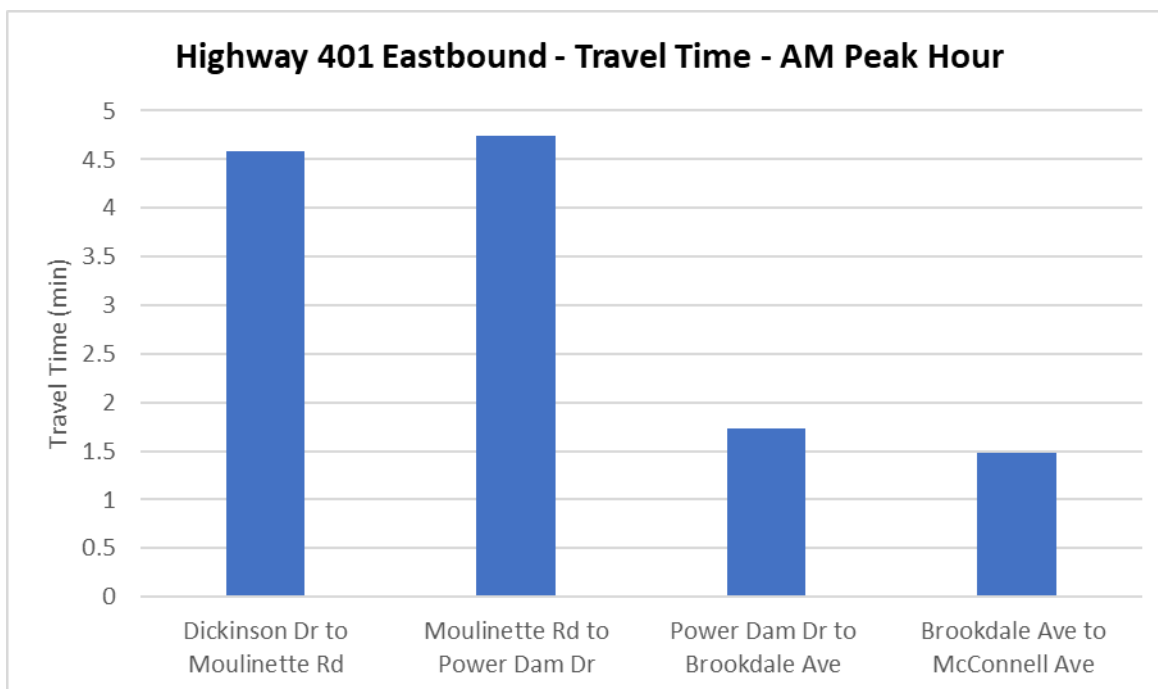


Figure 6-2: 2041 Alternative 5 Simulated Travel Time by Highway Segment – AM Peak Hour – Eastbound

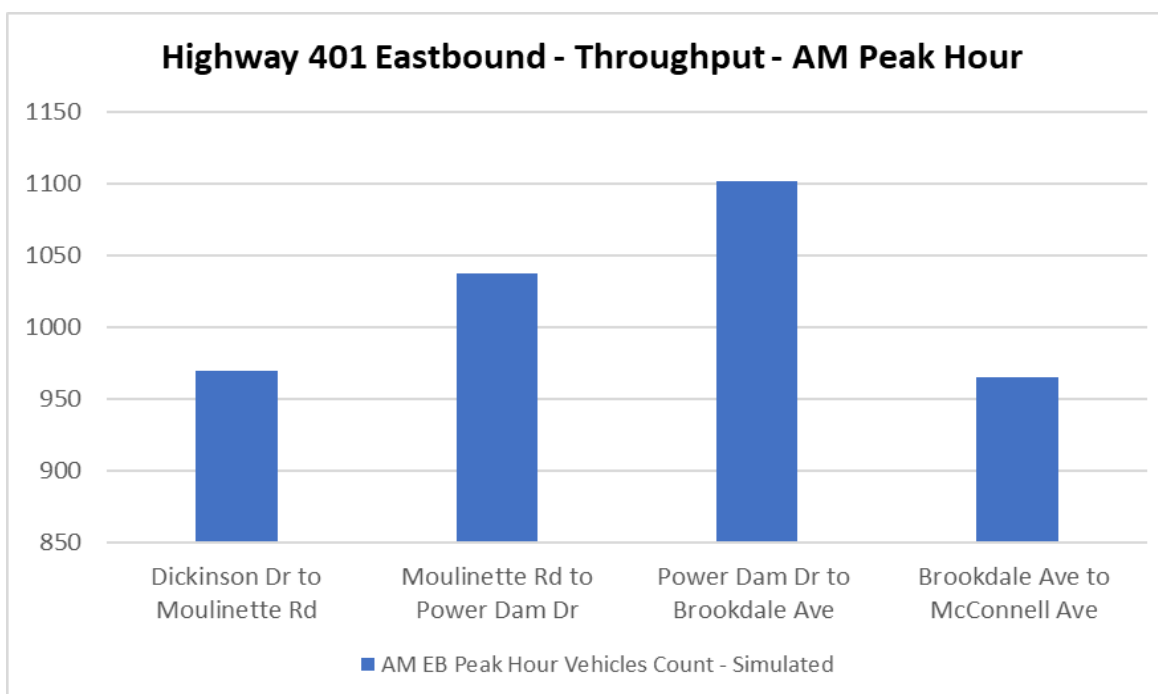


Figure 6-3: 2041 Alternative 5 Simulated Volume Throughput by Highway Segment – AM Peak Hour – Eastbound

6.1.2 Westbound Evening Peak Period

The following graphs show the simulated operations for the westbound direction, with respect to speed, travel time, and throughput during the evening peak hour (4-5 PM).

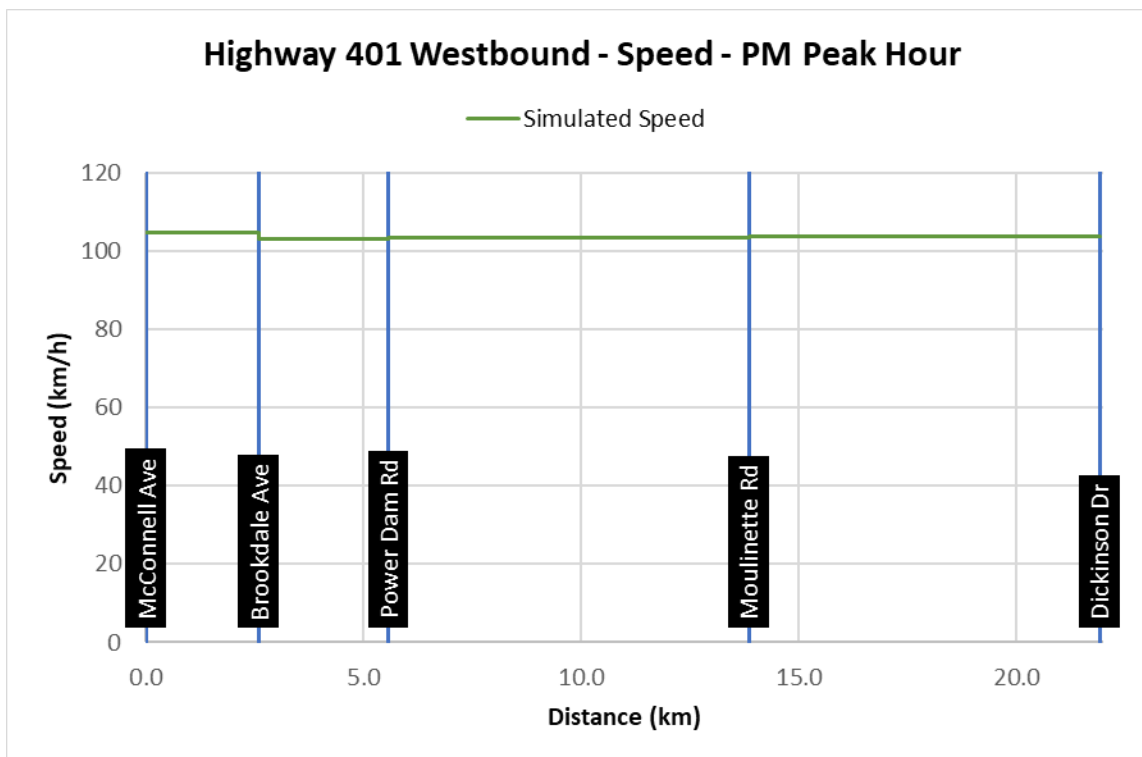


Figure 6-4: 2041 Alternative 5 Simulate Speeds - PM Peak Hour - Westbound

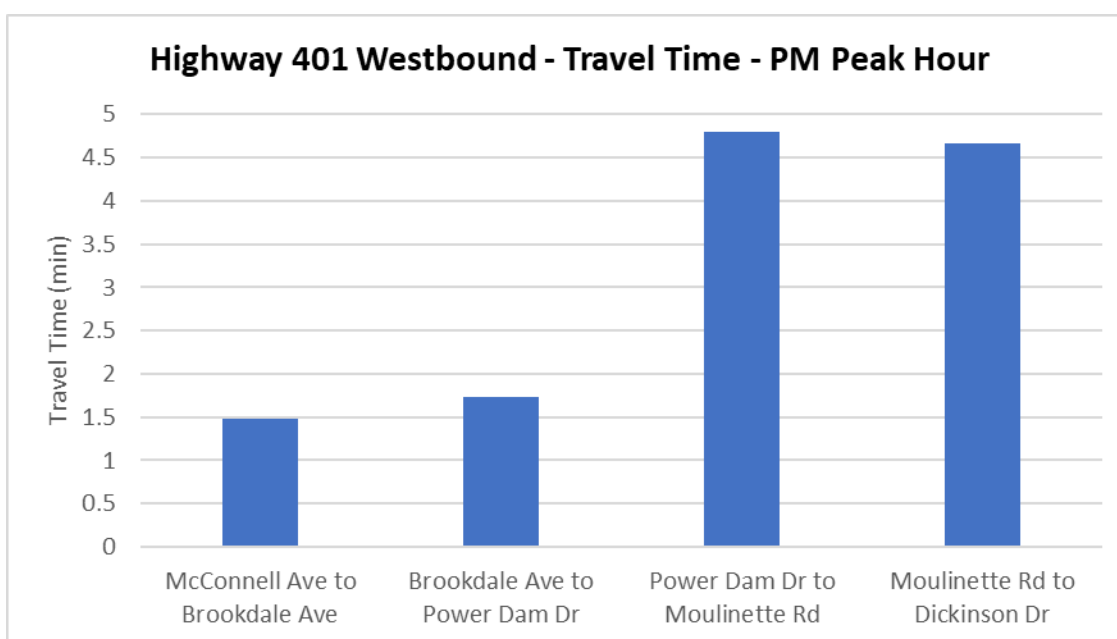


Figure 6-5: Alternative 5 Simulated Travel Time by Highway Segment – PM Peak Hour – Westbound

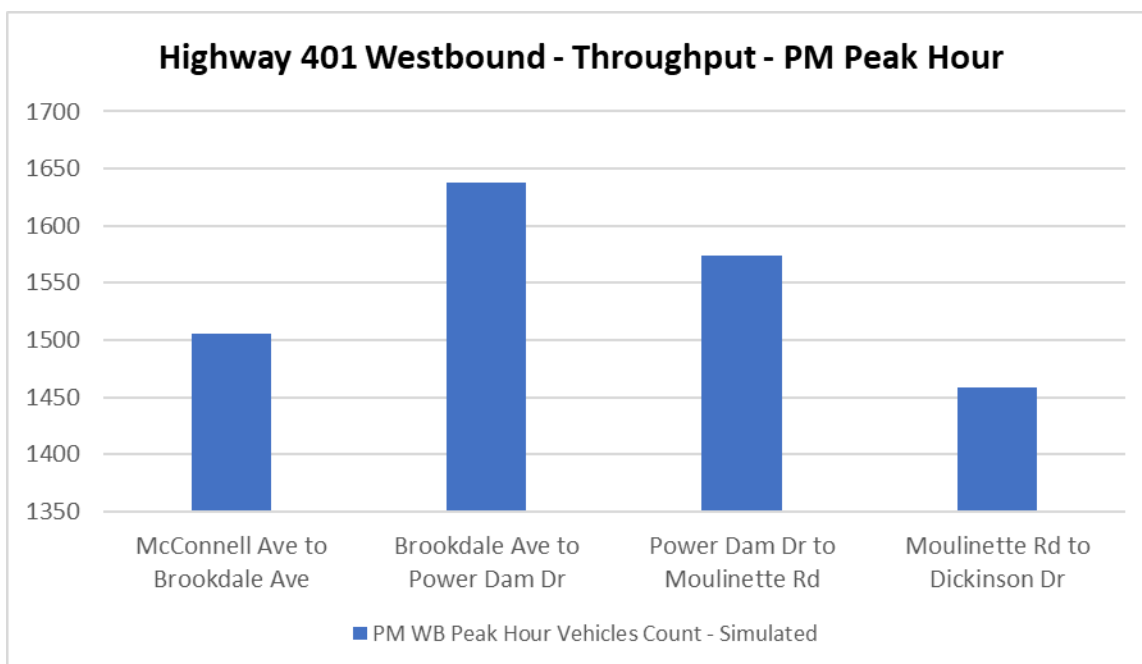


Figure 6-6: 2041 Alternative 5 Simulated Volume Throughput by Highway Segment – PM Peak Hour – Westbound

6.2 Alternative 6

6.2.1 Eastbound Morning Peak Period

The following graphs shows the simulated operations for the eastbound direction, with respect to speed, travel time, and throughput during the morning peak hour (8-9 AM).

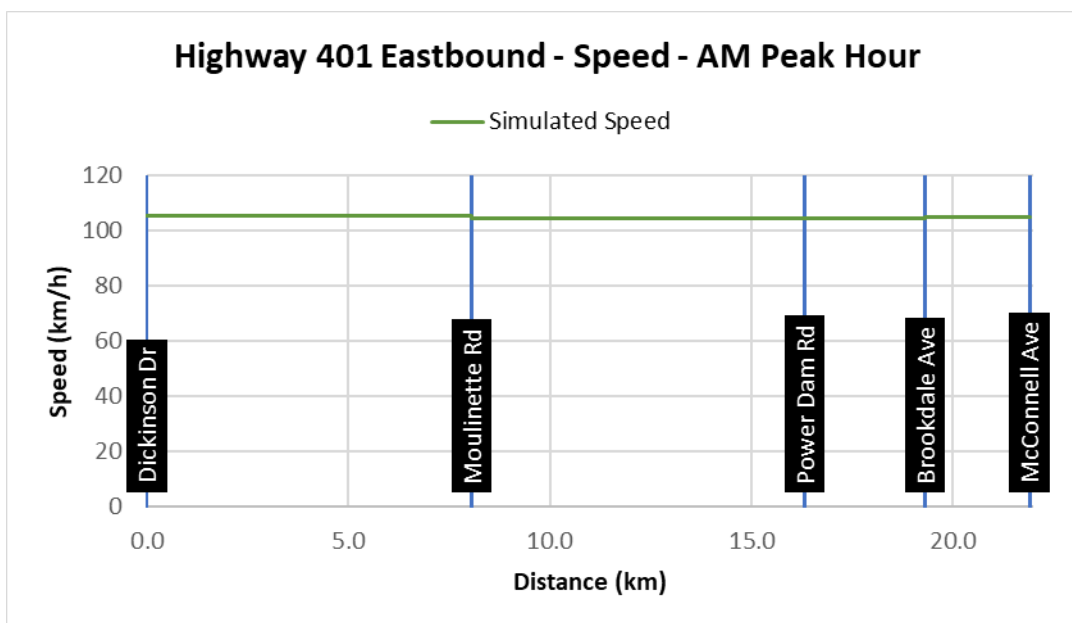


Figure 6-7: 2041 Alternative 6 Simulate Speeds - AM Peak Hour - Eastbound

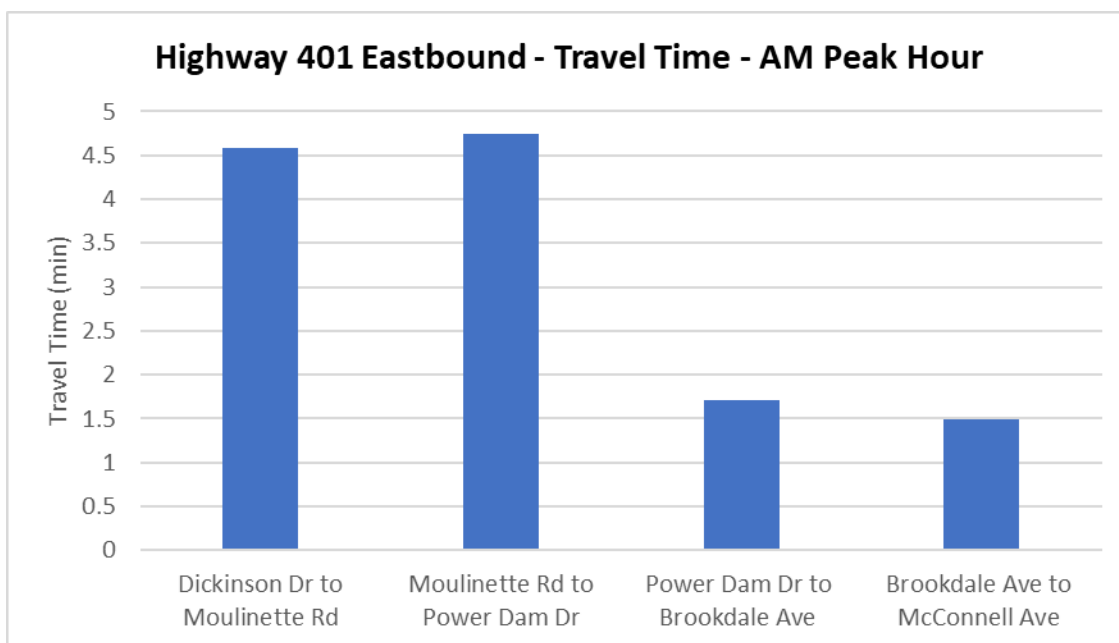


Figure 6-8: 2041 Alternative 6 Simulated Travel Time by Highway Segment – AM Peak Hour – Eastbound

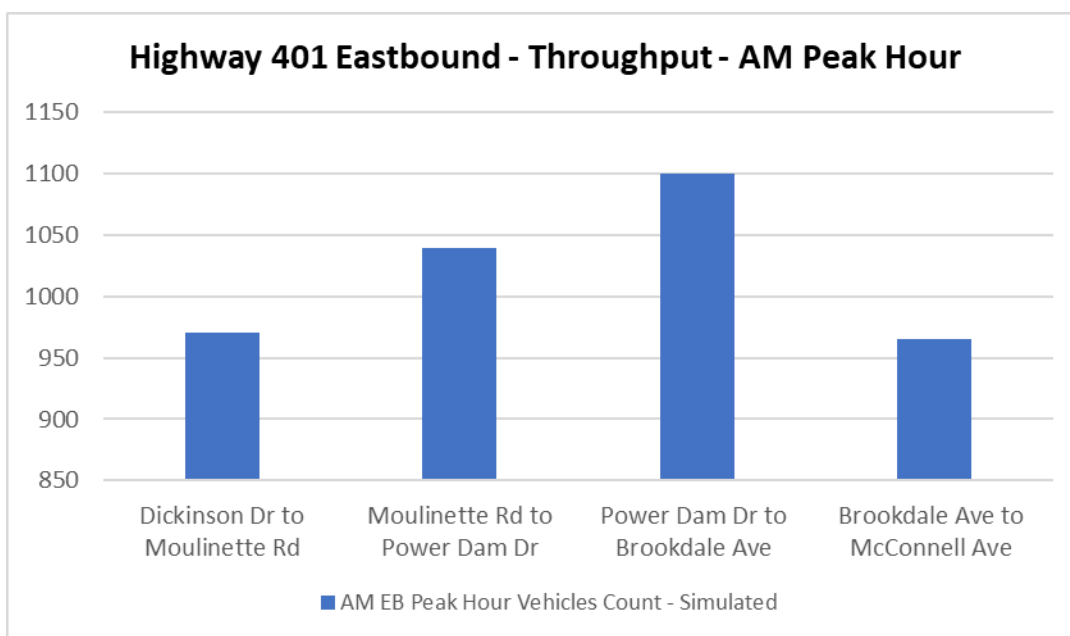


Figure 6-9: 2041 Alternative 6 Simulated Volume Throughput by Highway Segment – AM Peak Hour – Eastbound

6.2.2 Westbound Evening Peak Period

The following graphs show the simulated operations for the westbound direction, with respect to speed, travel time, and throughput during the evening peak hour (4-5 PM).

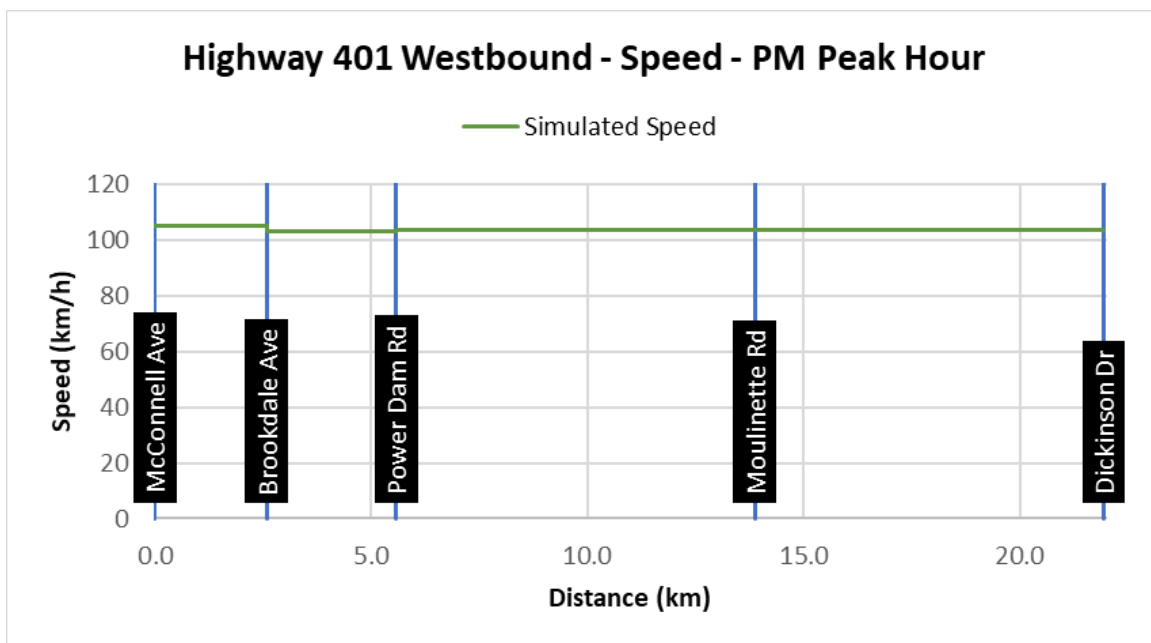


Figure 6-10: 2041 Alternative 6 Simulate Speeds - PM Peak Hour - Westbound

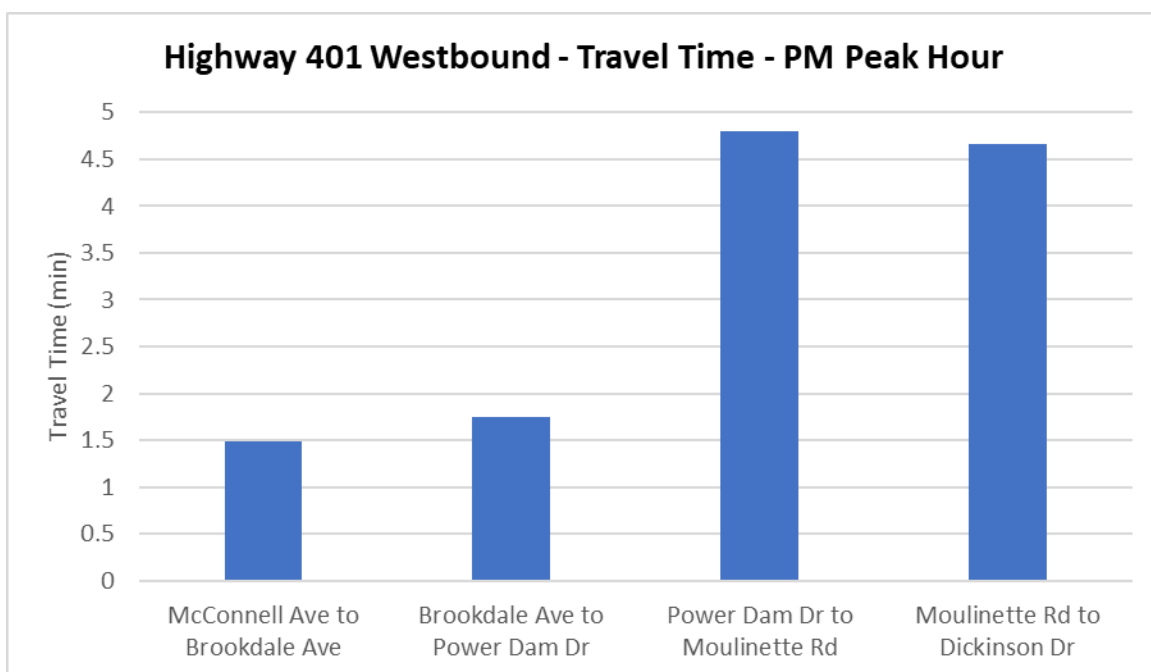


Figure 6-11: 2041 Alternative 6 Simulated Travel Time by Highway Segment – PM Peak Hour – Westbound

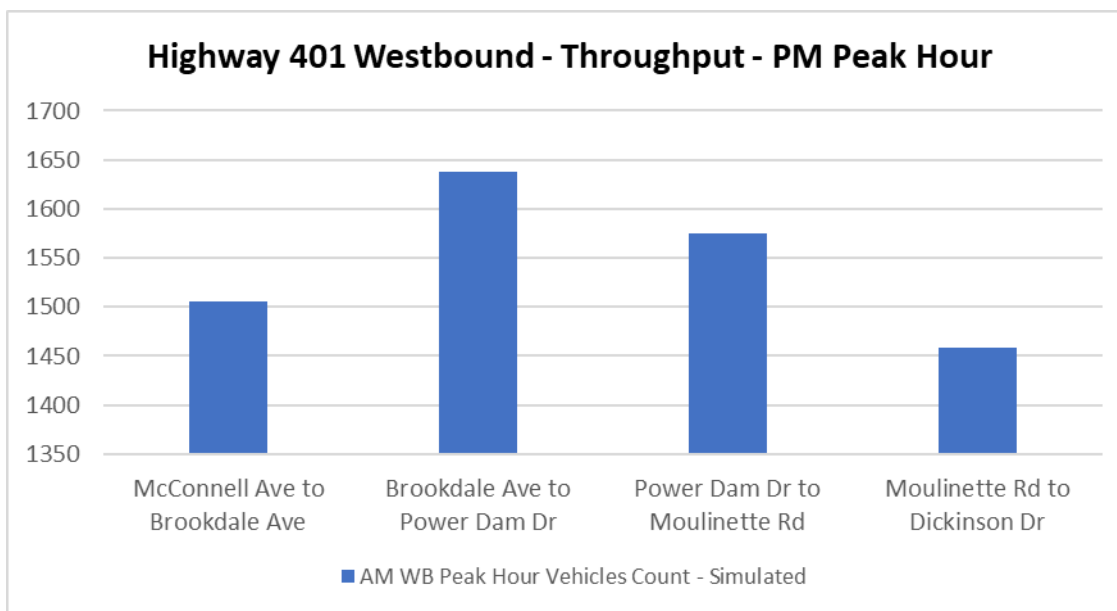


Figure 6-12: 2041 Alternative 6 Simulated Volume Throughput by Highway Segment – PM Peak Hour – Westbound

6.3 Alternative 8

6.3.1 Eastbound Morning Peak Period

The following graphs shows the simulated operations for the eastbound direction, with respect to speed, travel time, and throughput during the morning peak hour (8-9 AM).

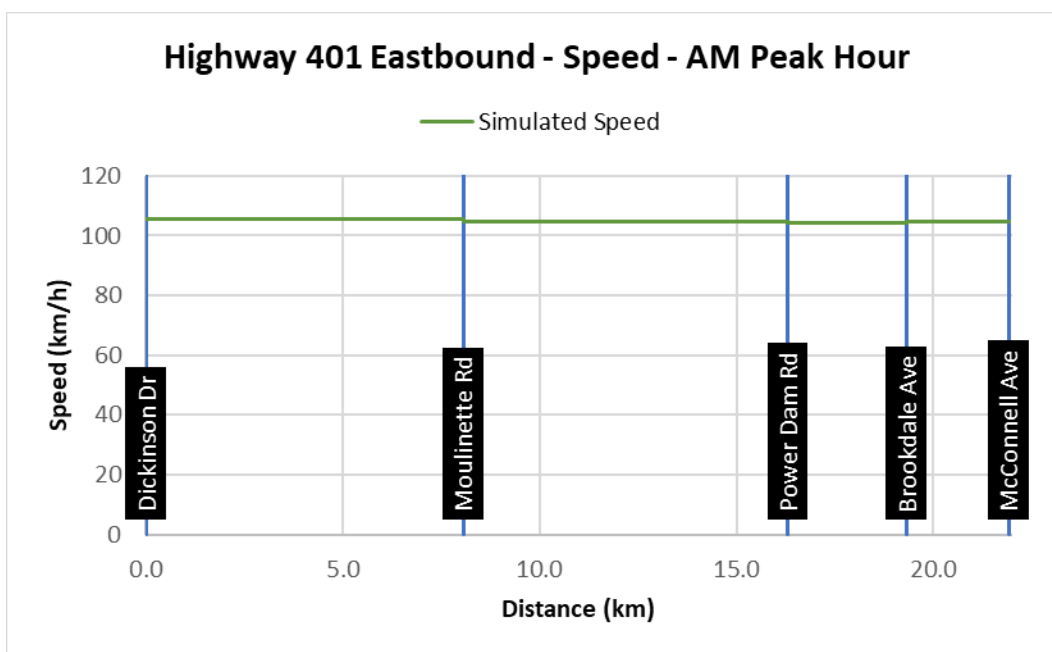


Figure 6-13: 2041 Alternative 8 Simulate Speeds - AM Peak Hour - Eastbound

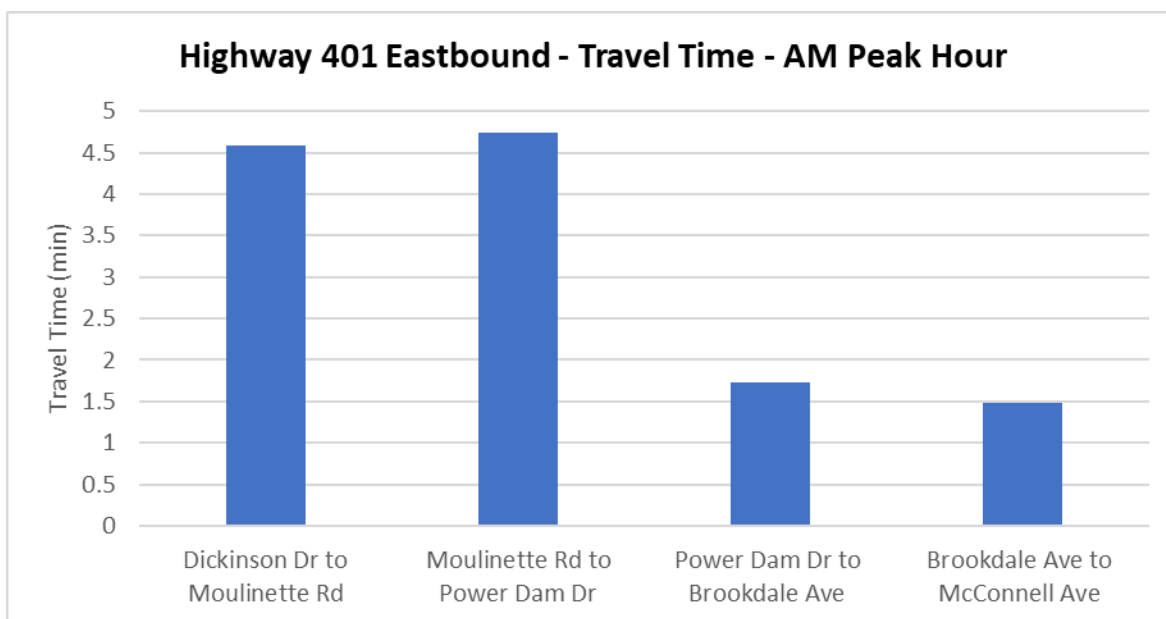


Figure 6-14: 2041 Alternative 8 Simulated Travel Time by Highway Segment – AM Peak Hour – Eastbound

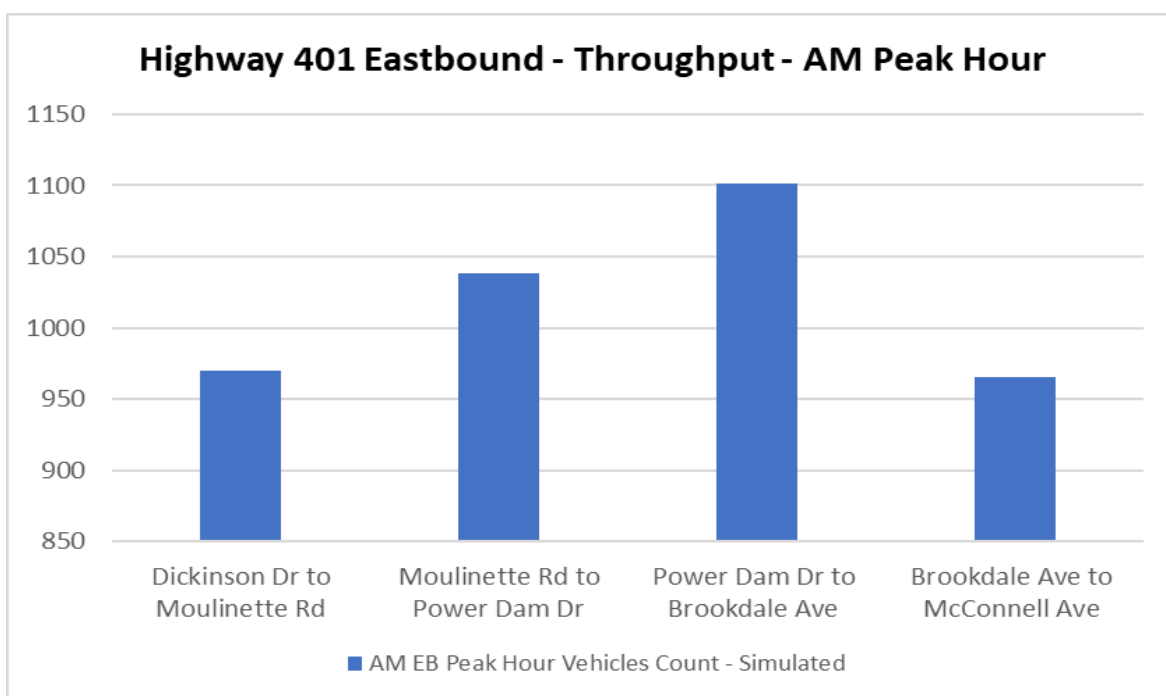


Figure 6-15: 2041 Alternative 8 Simulated Volume Throughput by Highway Segment – AM Peak Hour – Eastbound

6.3.2 Westbound Evening Peak Period

The following graphs show the simulated operations for the westbound direction, with respect to speed, travel time, and throughput during the evening peak hour (4-5 PM).

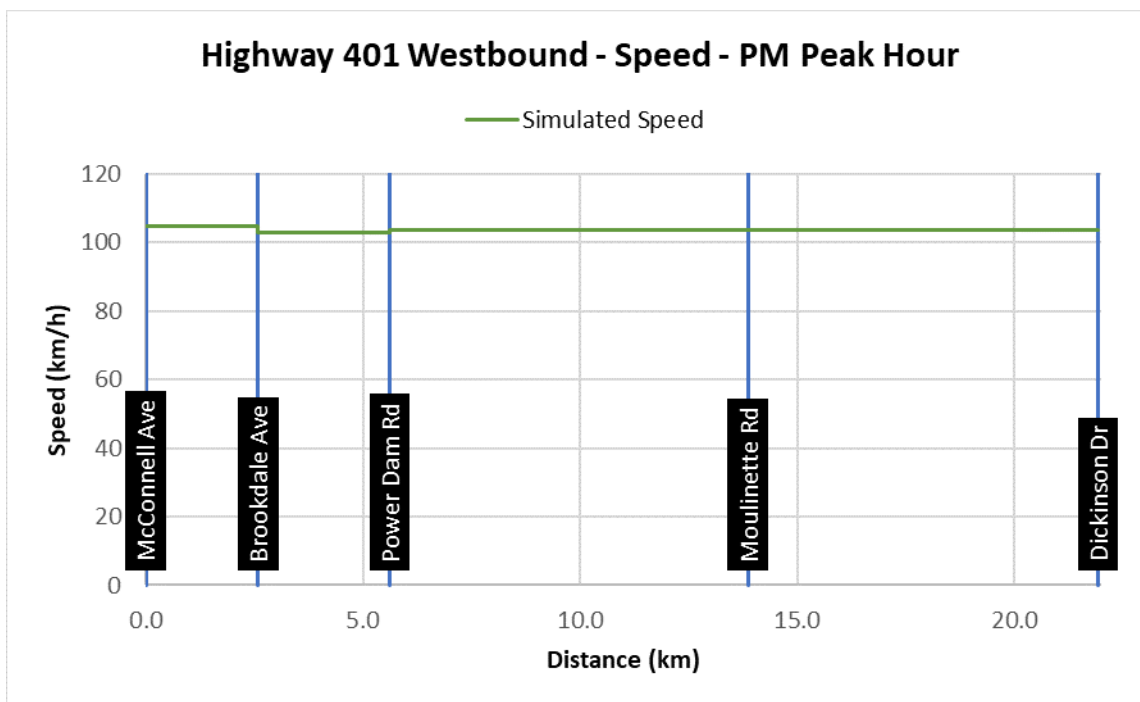


Figure 6-16: 2041 Alternative 8 Loops Simulate Speeds - PM Peak Hour - Westbound

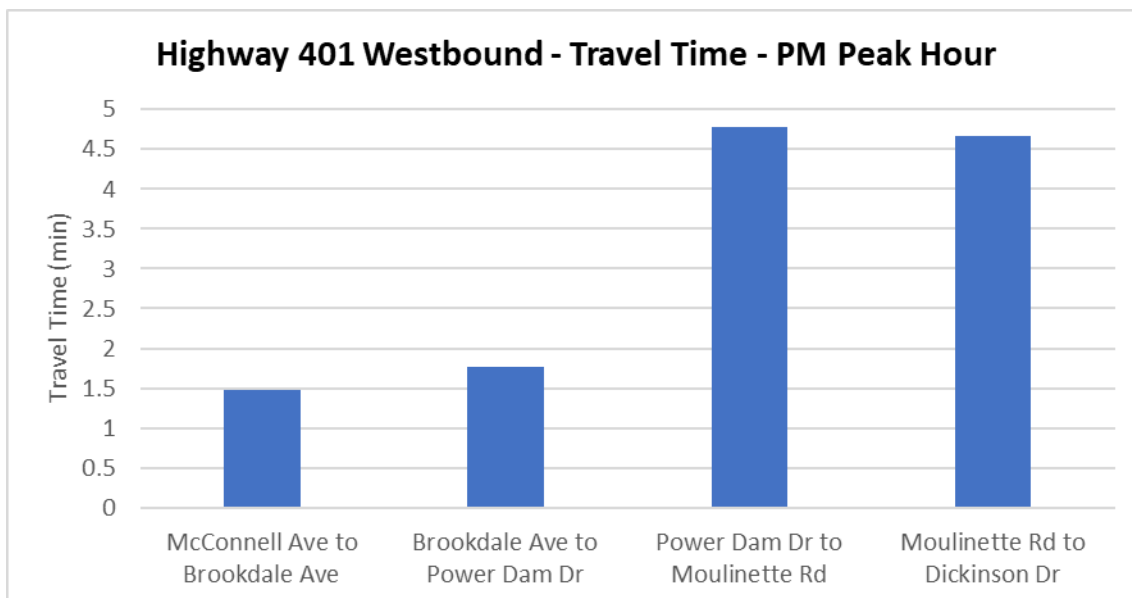


Figure 6-17: 2041 Alternative 8 Simulated Travel Time by Highway Segment – PM Peak Hour – Westbound

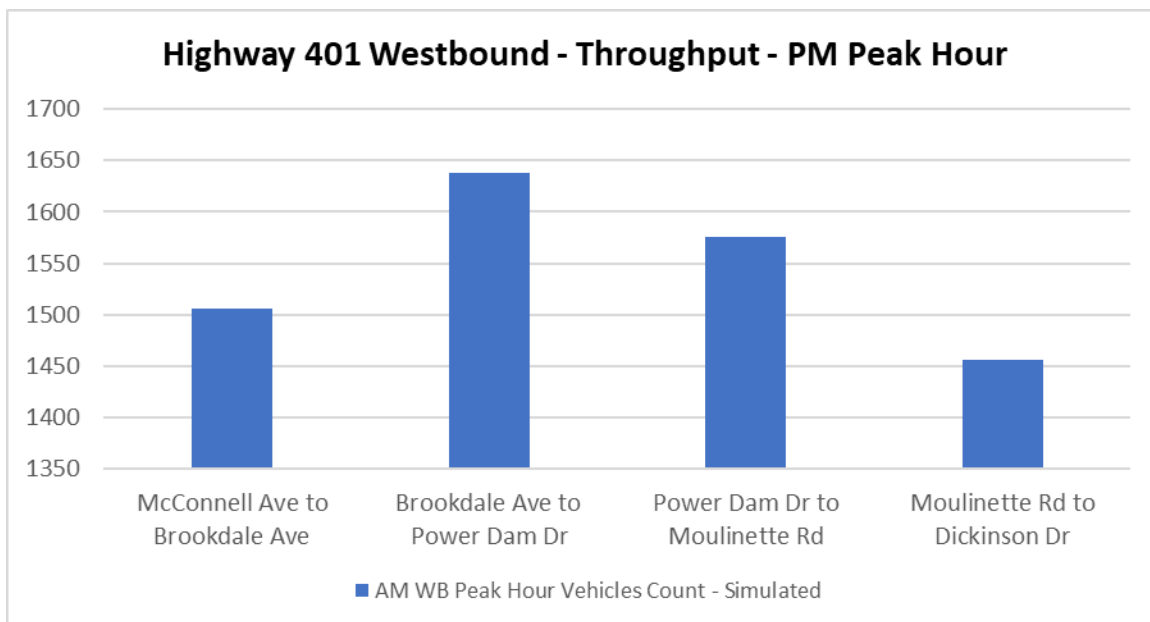


Figure 6-18: 2041 Alternative 8 Simulated Volume Throughput by Highway Segment – PM Peak Hour – Westbound

6.4 Power Dam Drive Intersections Operation Comparison

The following tables compare AM and PM peak hour Power Dam Drive intersections traffic operations with respect to volumes, traffic delay, and traffic movement level of service for 2041 future demand of all design alternatives on Power Dam Dr / Highway 401 Westbound Ramp, and Power Dam Dr / Highway 401 Eastbound Ramp.

Since this report is focused on forecasting future travel demand, it is important to consider uncertainties in traffic future demand analysis. Thus, an assumed traffic demand sensitivity of +20% growth was considered in the comparison.

The comparison is divided into two levels:

1. 2041 Traffic Demand - AM and PM Peak Hour (**Table 6-1 to Table 6-3**)
2. 2041 Traffic Demand + 20% - AM and PM Peak Hour (**Table 6-4 to Table 6-6**)

The analysis did not identify any significant operational concerns for any of the intersections, for any of the tested demand levels. Individual movement LOS ranged from A to C (primarily on the minor roadway); however, the overall intersection LOS was A during the AM and PM peak hours for all alternatives.

Table 6-1: 2041 Traffic Demand – AM and PM Peak Hour Volumes

Time	Direction	Movements	Power Dam Dr / Highway 401 Westbound Ramp				Power Dam Dr / Highway 401 Eastbound Ramp			
			Alt 0	Alt 5	Alt 6	Alt 8	Alt 0	Alt 5	Alt 6	Alt 8
AM	NB	NBL	22	23	23	23				
		NBT	55	17	17	17	77	23	23	23
		NBR					22	22	22	
	EB	EBL		68	68		16			16
		EBT								
		EBR		19	19		26	25		25
	SB	SBL					96	96	96	
		SBT	51	126	126	126	50	49	49	48
		SBR	5	13	13	13				
	WB	WBL				19			25	
		WBT								
		WBR				68			16	
	NB approach		77	40	40	40	77	45	45	45
	EB approach		0	87	87	0	26	41	0	41
	SB approach		56	139	139	139	50	145	145	144
	WB approach		0	0	0	87	0	0	41	0
	Intersection		133	266	266	266	153	231	231	230
PM	NB	NBL	30	33	33	33				
		NBT	114	56	56	56	144	51	51	51
		NBR					33	33	33	
	EB	EBL		91	91		38			38
		EBT								
		EBR		18	18		33	36		36
	SB	SBL					98	98	98	
		SBT	112	110	110	110	111	30	30	30
		SBR	9	11	11	11				
	WB	WBL				18			36	
		WBT								
		WBR				91			38	
	NB approach		144	89	89	89	144	84	84	84
	EB approach		0	109	109	0	33	74	0	74
	SB approach		121	121	121	121	111	128	128	128
	WB approach		0	0	0	109	0	0	74	0
	Intersection		265	319	319	319	288	286	286	286

Table 6-2: 2041 Traffic Demand – AM and PM Peak Hour Delay

Time	Direction	Movements	Power Dam Dr / Highway 401 Westbound Ramp				Power Dam Dr / Highway 401 Eastbound Ramp			
			Alt 0	Alt 5	Alt 6	Alt 8	Alt 0	Alt 5	Alt 6	Alt 8
AM	NB	NBL	0.1	1.1	1.0	1.1				
		NBT	0.0	0.2	0.1	0.4	0.0	0.1	0.1	0.1
		NBR						1.3	1.8	0.8
	EB	EBL		13.5	12.8			12.0		12.2
		EBT								
		EBR		11.9	11.8		0.8	11.2		11.3
	SB	SBL						1.2	0.1	1.0
		SBT	11.5	0.1	0.0	0.1	0.1	0.4	0.2	0.2
		SBR	11.6	0.1	4.2	0.1				
	WB	WBL				21.0			11.7	
		WBT								
		WBR				20.7			11.5	
	NB approach		0.0	0.7	0.6	0.8	0.0	0.7	0.9	0.4
	EB approach		0.0	13.1	12.6	0.0	0.8	11.5	0.0	11.6
	SB approach		11.5	0.1	0.4	0.1	0.1	0.9	0.1	0.7
	WB approach		0.0	0.0	0.0	20.7	0.0	0.0	11.7	0.0
	Intersection		4.9	4.5	4.4	6.9	0.2	2.8	2.3	2.6
PM	NB	NBL	0.1	0.8	0.7	0.7				
		NBT	0.1	0.3	0.2	0.4	0.1	0.1	0.1	0.1
		NBR						1.2	1.6	0.8
	EB	EBL		13.1	12.4			12.0		11.8
		EBT								
		EBR		12.8	11.5		1.0	11.9		11.8
	SB	SBL						1.0	0.1	0.7
		SBT	12.7	0.1	0.1	0.1	0.2	0.4	0.2	0.2
		SBR	11.8	0.0	0.0	0.0				
	WB	WBL				21.0			12.1	
		WBT								
		WBR				20.5			10.9	
	NB approach		0.1	0.4	0.3	0.5	0.1	0.5	0.7	0.4
	EB approach		0.0	13.0	12.2	0.0	1.0	12.0	0.0	11.8
	SB approach		12.6	0.1	0.1	0.1	0.2	0.9	0.1	0.6
	WB approach		0.0	0.0	0.0	20.6	0.0	0.0	11.5	0.0
	Intersection		5.8	4.6	4.3	7.2	0.2	3.6	3.2	3.4

Table 6-3: 2041 Traffic Demand – AM and PM Peak Hour LOS

Time	Direction	Movements	Power Dam Dr / Highway 401 Westbound Ramp				Power Dam Dr / Highway 401 Eastbound Ramp			
			Alt 0	Alt 5	Alt 6	Alt 8	Alt 0	Alt 5	Alt 6	Alt 8
AM	NB	NBL	A	A	A	A				
		NBT	A	A	A	A	A	A	A	A
		NBR						A	A	A
	EB	EBL		B	B			B		B
		EBT								
		EBR		B	B		A	B		B
	SB	SBL						A	A	A
		SBT	B	A	A	A	A	A	A	A
		SBR	B	A	A	A				
	WB	WBL				C			B	
		WBT								
		WBR				C			B	
	NB approach		A	A	A	A	A	A	A	A
	EB approach		A	B	B	A	A	B	A	B
	SB approach		B	A	A	A	A	A	A	A
	WB approach		A	A	A	C	A	A	B	A
	Intersection		A	A	A	A	A	A	A	A
PM	NB	NBL	A	A	A	A				
		NBT	A	A	A	A	A	A	A	A
		NBR						A	A	A
	EB	EBL		B	B			B		B
		EBT								
		EBR		B	B		A	B		B
	SB	SBL						A	A	A
		SBT	B	A	A	A	A	A	A	A
		SBR	B	A	A	A				
	WB	WBL				C			B	
		WBT								
		WBR				C			B	
	NB approach		A	A	A	A	A	A	A	A
	EB approach		A	B	B	A	A	B	A	B
	SB approach		B	A	A	A	A	A	A	A
	WB approach		A	A	A	C	A	A	B	A
	Intersection		A	A	A	A	A	A	A	A

Table 6-4: 2041 Traffic Demand + 20% – AM and PM Peak Hour Volumes

Time	Direction	Movements	Power Dam Dr / Highway 401 Westbound Ramp				Power Dam Dr / Highway 401 Eastbound Ramp			
			Alt 0	Alt 5	Alt 6	Alt 8	Alt 0	Alt 5	Alt 6	Alt 8
AM	NB	NBL	27	27	27	27				
		NBT	66	23	23	23	93	28	28	28
		NBR						26	26	26
	EB	EBL		86	86			22		22
		EBT								
		EBR		19	19		32	35		35
	SB	SBL						114	114	114
		SBT	61	150	150	150	61	54	54	54
		SBR	6	16	16	16				
	WB	WBL				19			35	
		WBT								
		WBR				86			22	
	NB approach		93	50	50	50	93	54	54	54
	EB approach		0	105	105	0	32	57	0	57
	SB approach		67	166	166	166	61	168	168	168
	WB approach		0	0	0	105	0	0	57	0
	Intersection		160	321	321	321	186	279	279	279
PM	NB	NBL	41	42	42	42				
		NBT	133	59	59	59	174	61	61	61
		NBR						39	39	39
	EB	EBL		105	105			40		40
		EBT								
		EBR		24	24		39	44		44
	SB	SBL						114	114	114
		SBT	133	132	132	132	133	42	42	42
		SBR	11	12	12	12				
	WB	WBL				24			44	
		WBT								
		WBR				105			40	
	NB approach		174	101	101	101	174	100	100	100
	EB approach		0	129	129	0	39	84	0	84
	SB approach		144	144	144	144	133	156	156	156
	WB approach		0	0	0	129	0	0	84	0
	Intersection		318	374	374	374	346	340	340	340

Table 6-5: 2041 Traffic Demand + 20% – AM and PM Peak Hour Delay

Time	Direction	Movements	Power Dam Dr / Highway 401 Westbound Ramp				Power Dam Dr / Highway 401 Eastbound Ramp			
			Alt 0	Alt 5	Alt 6	Alt 8	Alt 0	Alt 5	Alt 6	Alt 8
AM	NB	NBL	0.1	1.3	1.1	1.2				
		NBT	0.1	0.2	0.2	0.4	0.1	0.1	0.1	0.1
		NBR						1.5	2.2	1.1
	EB	EBL		14.3	13.6			12.5		12.5
		EBT								
		EBR		12.8	12.5		1.2	13.0		13.5
	SB	SBL						1.3	0.1	1.1
		SBT	11.7	0.1	0.0	0.1	0.1	0.4	0.3	0.3
		SBR	11.7	0.0	4.5	0.0				
	WB	WBL				22.1			13.4	
		WBT								
		WBR				21.8			11.5	
	NB approach		0.1	0.8	0.7	0.8	0.1	0.8	1.1	0.5
	EB approach		0.0	14.0	13.4	0.0	1.2	12.8	0.0	13.1
	SB approach		11.7	0.1	0.4	0.1	0.1	1.0	0.2	0.9
	WB approach		0.0	0.0	0.0	21.8	0.0	0.0	12.7	0.0
	Intersection		4.9	4.8	4.7	7.3	0.3	3.4	2.9	3.3
PM	NB	NBL	0.2	1.0	0.9	0.8				
		NBT	0.1	0.3	0.3	0.4	0.1	0.1	0.1	0.1
		NBR						1.2	1.6	0.8
	EB	EBL		13.6	12.7			13.2		12.7
		EBT								
		EBR		12.6	11.9		1.1	12.4		12.3
	SB	SBL						1.1	0.1	0.7
		SBT	13.1	0.1	0.1	0.1	0.2	0.4	0.2	0.3
		SBR	12.9	0.0	0.0	0.0				
	WB	WBL				21.7			12.4	
		WBT								
		WBR				21.0			11.6	
	NB approach		0.1	0.6	0.5	0.6	0.1	0.5	0.7	0.3
	EB approach		0.0	13.4	12.5	0.0	1.1	12.8	0.0	12.5
	SB approach		13.0	0.1	0.1	0.1	0.2	0.9	0.1	0.6
	WB approach		0.0	0.0	0.0	21.1	0.0	0.0	12.0	0.0
	Intersection		6.0	4.8	4.5	7.5	0.2	3.7	3.2	3.5

Table 6-6: 2041 Traffic Demand + 20% – AM and PM Peak Hour LOS

Time	Direction	Movements	Power Dam Dr / Highway 401 Westbound Ramp				Power Dam Dr / Highway 401 Eastbound Ramp			
			Alt 0	Alt 5	Alt 6	Alt 8	Alt 0	Alt 5	Alt 6	Alt 8
AM	NB	NBL	A	A	A	A				
		NBT	A	A	A	A	A	A	A	A
		NBR						A	A	A
	EB	EBL		B	B			B		B
		EBT								
		EBR		B	B		A	B		B
	SB	SBL						A	A	A
		SBT	B	A	A	A	A	A	A	A
		SBR	B	A	A	A				
	WB	WBL				C			B	
		WBT								
		WBR				C			B	
	NB approach		A	A	A	A	A	A	A	A
	EB approach		A	B	B	A	A	B	A	B
	SB approach		B	A	A	A	A	A	A	A
PM	WB approach		A	A	A	C	A	A	B	A
	Intersection		A	A	A	A	A	A	A	A
	NB	NBL	A	A	A	A				
		NBT	A	A	A	A	A	A	A	A
		NBR						A	A	A
	EB	EBL		B	B			B		B
		EBT								
		EBR		B	B		A	B		B
	SB	SBL						A	A	A
		SBT	B	A	A	A	A	A	A	A
		SBR	B	A	A	A				
	WB	WBL				C			B	
		WBT								
		WBR				C			B	
	NB approach		A	A	A	A	A	A	A	A
	EB approach		A	B	B	A	A	B	A	B
	SB approach		B	A	A	A	A	A	A	A
	WB approach		A	A	A	C	A	A	B	A
	Intersection		A	A	A	A	A	A	A	A

6.5 Signal Warrant Analysis

While the simulation analysis showed that the various intersection configurations performed well in unsignalized conditions, it was still necessary to verify the assumption that signalization was not required. Signal warrant analysis was performed for each ramp terminal configuration; the result summarized in **Table 6-7** indicate that signalization of these intersections is not justified. Supporting signal warrant calculations can be found in **APPENDIX B**.

Table 6-7: Summary of Signal Warrant Analysis

Alternative	Intersection	Warrant 1	Warrant 2	Warranted?
5	Westbound Ramp / Power Dam Dr	27%	20%	No
	Eastbound Ramp / Power Dam Dr	24%	21%	No
6	Westbound Ramp / Power Dam Dr	27%	20%	No
	Eastbound Ramp / Power Dam Dr	16%	21%	No
8	Westbound Ramp / Power Dam Dr	27%	18%	No
	Eastbound Ramp / Power Dam Dr	24%	21%	No

7. CONCLUSION

This report documents the traffic analysis of three alternative designs for a new interchange on Highway 401 at Power Dam Drive. The evaluation was conducted using Vissim micro-simulation software to assess future traffic operations for the 2041 planning horizon. An additional sensitivity scenarios was tested for each alternative with an additional 20% traffic growth applied to the 2041 demand forecasts.

The following conclusions can be made based on the results of the traffic analysis:

- With the 2041 projected traffic demand, the new interchange poses only marginal impacts to the mainline operations of Highway 401.
- All three alternative interchange configurations demonstrated very good performance:
 - o delays were marginal for all movements, and
 - o all movements exhibited LOS C or better, with overall intersection LOS A in all cases.
- The additional growth (+20%) in the sensitivity scenarios resulted in only small operational changes – all LOS values remained in the A-C range.
- Signal warrant analysis indicated that signalization is not warranted for any of the intersections.

There were no significant performance differences between the various interchange alternatives that could be identified for the 2041 planning horizon or for the sensitivity scenarios. Therefore, from a traffic performance perspective, no alternative can be conclusively identified as the preferred, nor can any alternative be eliminated as a candidate.

APPENDIX A: Model Calibration Report



MORRISON HERSHFIELD

DRAFT REPORT

Power Dam Drive Project

Traffic Modelling Calibration Report

Presented to:

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1355 John Counter Boulevard
Kingston, ON
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Project No. 201979402

October 20, 2022

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WORKING\TRAFFIC\REPORTS\201979404 - HWY 401 POWER DAM DR EA -
CALIBRATION REPORT.DOCX

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APPENDIX A: Asdf

1. INTRODUCTION

1.1 Purpose

The purpose of this report is to document the process and results of the calibration of the VISSIM micro-simulation model for the baseline 2016 morning and evening peak hour conditions. In addition, the calibrated model will be used in the development and analysis of future conditions and design alternatives of Bridge Site 013X-180 /BO (Power Dam Drive Interchange IC 786).

1.2 Study Area

The study area extends 5.6 km east and 16.5 km west of Power Dam interchange along Highway 401, and 1.5 km north and south Highway 401 along Power Dam Drive. Three interchanges are included within the study limits: Power Dam drive Interchange, Brookdale Avenue (Highway 138) interchange, and Moulinette Road (Highway 35) interchange.

The limits of the microsimulation model are shown in **Figure 1-1**.

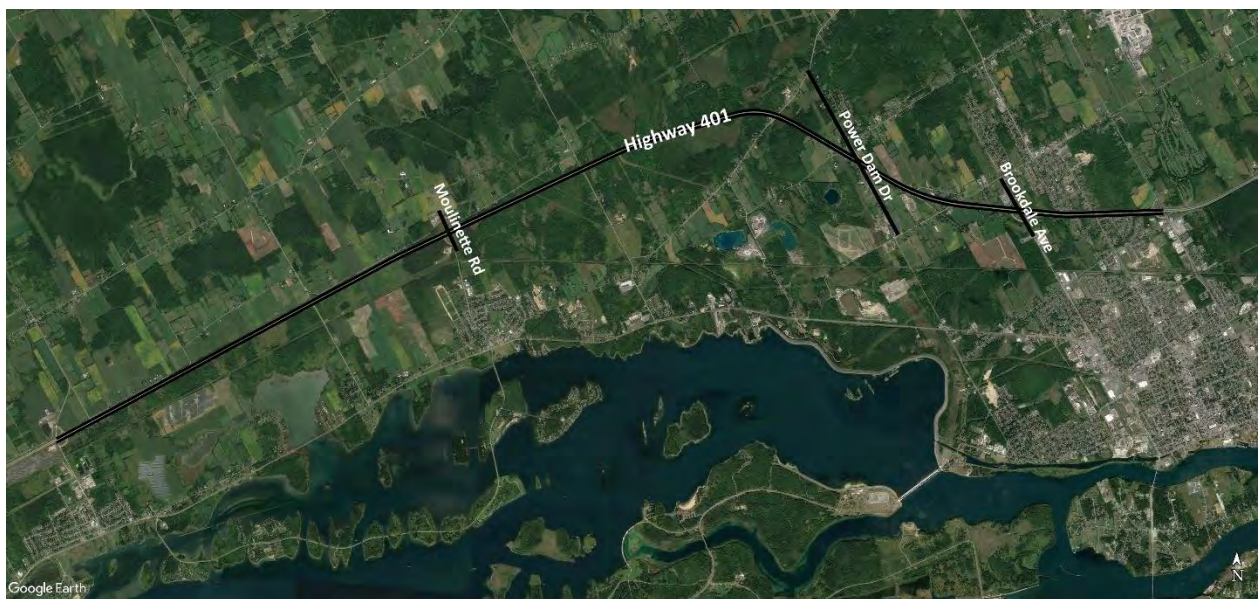


Figure 1-1: Study area simulation limits

2. MODEL INPUTS

2.1 Traffic Data

Mainline, ramp, and intersection count data was obtained to develop the base-year demand. Count locations and dates are summarized in **Table 2-1**.

Table 2-1: Traffic count inventory

Count Type	Location	Date
Mainline (HWY 401)	McConnel Ave to Brookdale Ave Brookdale Ave to Power Dam Dr Power Dam Dr to Moulinette Rd Moulinette Rd to Dickinson Dr	March 15, 2012; August 10 2016 March 15, 2012; August 10 2016 November 28, 2012; April 15 & October 16, 2013; April 1, 2014; August 10, 2016 March 15, 2012; August 10 2016
Ramps	Brookdale Ave WB off-ramp (61) N-W loop on-ramp (26) S-W direct on-ramp N-E direct on-ramp (25) S-E loop on-ramp (35) EB off-ramp (51) Power Dam Dr N/S - W on-ramp (16) EB off-ramp (53) Moulinette Rd WB off-ramp N/S - W on-ramp S/N - E on-ramp EB off-ramp	May 23, 2015 May 23, 2015 May 23, 2015 May 23, 2015 May 23, 2015 May 23, 2015 May 23, 2015 May 23, 2015 May 23, 2015 May 23, 2015 May 23, 2015
Intersections	Power Dam Dr and HWY 401 North Intersection Power Dam Dr and HWY 401 South Intersection	May 28, 2015 May 28, 2015

Classification data was used to establish a proportion of single-occupancy vehicles and heavy trucks within the traffic stream. The heavy vehicles data for Highway 401 was obtained from MTO Historical Data, and heavy vehicles count on Power Dam Dr was obtained from the intersections turning movement.

The vehicle compositions are summarized in **Table 2-2** and **Table 2-3**.

Table 2-2: Highway 401 vehicle composition

Location	Cars + Light Trucks	Heavy Trucks
McConnell Ave to Brookdale Ave	63.1%	36.9%
Brookdale Ave to Power Dam Dr	64.2%	35.8%
Power Dam Dr to Moulinette Rd	63.7%	36.3%
Moulinette Rd to Dickinson Dr	62.5%	37.5%

Table 2-3: Intersections vehicle composition

Location	Cars + Light Trucks	Heavy Trucks
Power Dam Dr and HWY 401 North Intersection		
Southbound AM Traffic	91.9%	8.1%
Southbound PM Traffic	91.5%	8.5%
Power Dam Dr and HWY 401 South Intersection		
Northbound AM Traffic	91.0%	9.0%
Northbound PM Traffic	95.8%	4.2%

2.2 Data Adjustment

The assembled count data was adjusted to account for variations in the month and year of their collection as follows:

- Count month was adjusted using seasonal adjustment factors corresponding to the “commuter tourist recreation” (CTR) travel pattern type identified for the study area from the Highways volume publication.
- Count year was adjusted using linear growth trends identified from the AADT values listed in the same publication by highway segment.
- The counts were adjusted to represent the second week of July 2016, the peak for the CTR pattern type.

Intersections counts were adjusted to account for annual traffic growth using linear average growth for Highway 401 used as part of the study area.

2.3 Balancing Process

The adjusted volume data was balanced to ensure conservation-of-flow through the study area and mitigate any congestion effects that may cause mainline counts to be lower than the actual demand. Ramp counts were held constant as they are less likely to be impacted by congestion.

For each hour in the morning and evening peak periods, an iterative process was applied: holding one mainline count constant and adding or subtracting on- and off-ramp volumes as necessary to compute the balanced counts for the other mainline locations and comparing them to their real count. The optimal set of balanced counts was that in which all the balanced mainline counts were equal to or greater than their respective real count. This process was conducted for both directions, with the resulting balanced volumes summarized in **Table 2-4** and **Table 2-5** for westbound and eastbound, respectively.

Table 2-4: Highway 401 balanced volumes - westbound

Westbound		AM peak period				PM peak period			
Location	Type	6:00 AM	7:00 AM	8:00 AM	9:00 AM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
McConnell to Brookdale	Mainline	401	567	539	537	1088	1113	982	797
off-ramp	Ramp	100	155	175	144	239	253	227	178
loop on-ramp	Ramp	127	166	158	171	270	283	269	195
on-ramp	Ramp	0	0	0	0	0	0	0	0
Brookdale to Power Dam	Mainline	428	578	522	564	1119	1143	1024	814
on-ramp	Ramp	36	55	39	34	51	61	53	30
Power Dam to Moulinette	Mainline	464	633	561	598	1170	1204	1077	844
off-ramp	Ramp	23	64	47	50	82	116	112	72
on-ramp	Ramp	27	42	46	47	49	32	32	14
Moulinette to Dickinson	Mainline	468	611	560	595	1137	1120	997	786

Table 2-5: Highway 401 balanced volumes - eastbound

Eastbound		AM peak period				PM peak period			
Location	Type	6:00 AM	7:00 AM	8:00 AM	9:00 AM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
McConnell to Brookdale	Mainline	550	712	766	708	817	948	958	927
on-ramp	Ramp	108	99	112	121	158	162	156	117
loop on-ramp	Ramp	56	72	72	76	71	69	79	74
off-ramp	Ramp	100	174	193	188	194	209	230	182
Brookdale to Power Dam	Mainline	486	715	775	699	782	926	953	918
off-ramp	Ramp	27	53	38	32	43	54	51	39
Power Dam to Moulinette	Mainline	513	768	813	731	825	980	1004	957
on-ramp	Ramp	73	125	88	52	55	71	59	40
off-ramp	Ramp	23	41	41	35	46	47	43	35
Moulinette to Dickinson	Mainline	463	684	766	714	816	956	988	952

Intersection's volumes were adjusted to ensure that on-ramp and off-ramp volumes are similar to those obtained from the Highway 401 Balancing process. The resulting AM and PM balanced volumes are summarized in **Table 2-6** through **Table 2-9**.

Table 2-6: Power Dam Dr and HWY 401 north intersection - AM balanced volumes

North Intersection		Southbound				Eastbound			
HOUR START	HOUR END	Right Turn to HW401		Left Turn to Power Dam		Right to Power Dam		Through to HW401	
		Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks
6:00 AM	7:00 AM	17	2	52	4	37	3	14	2
7:00 AM	8:00 AM	27	5	71	8	62	5	23	0
8:00 AM	9:00 AM	22	2	54	4	25	4	14	2
9:00 AM	10:00 AM	13	2	30	0	23	1	15	5

Table 2-7: Power Dam Dr and HWY 401 north intersection - PM balanced volumes

North Intersection		Southbound				Eastbound			
HOUR START	HOUR END	Right Turn to HW401		Left Turn to Power Dam		Right to Power Dam		Through to HW401	
		Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks
3:00 PM	4:00 PM	13	3	27	4	76	5	34	1
4:00 PM	5:00 PM	11	4	44	4	82	5	45	1
5:00 PM	6:00 PM	26	1	62	2	85	1	25	1
6:00 PM	7:00 PM	9	1	44	3	81	4	19	1

Table 2-8: Power Dam Dr and HWY 401 south intersection - AM balanced volumes

South Intersection		Southbound		Northbound		Eastbound	
HOUR START	HOUR END	Cars	Trucks	Cars	Trucks	Cars	Trucks
6:00 AM	7:00 AM	52	4	47	5	26	1
7:00 AM	8:00 AM	67	9	74	5	49	4
8:00 AM	9:00 AM	56	4	36	4	38	0
9:00 AM	10:00 AM	33	0	31	5	31	1

Table 2-9: Power Dam Dr and HWY 401 south intersection - PM balanced volumes

South Intersection		Southbound		Northbound		Eastbound	
HOUR START	HOUR END	Cars	Trucks	Cars	Trucks	Cars	Trucks
3:00 PM	4:00 PM	27	5	98	6	7	36
4:00 PM	5:00 PM	41	4	115	6	7	47
5:00 PM	6:00 PM	62	2	104	2	6	45
6:00 PM	7:00 PM	43	4	106	5	5	34

2.4 Assumptions and qualifications

The following is a list of assumptions that were necessary for the development and calibration of the micro-simulation model and qualifications for the use of this model for analysis of future traffic operations:

- It is assumed that the provided traffic data accurately reflect typical traffic conditions and is free of any effects caused by construction or incidents.
- The mainline, ramp and intersections count data is assembled from counts occurring on different weeks, seasons, and years. The balancing process attempts to produce a homogenized dataset.

2.5 Model Parameters

The model parameters used in the calibration of the micro-simulation model are summarized in **Table 2-10**.

Table 2-10: Model Parameter

Parameter	Value
Simulation resolution (steps/second)	10
Number of runs included in average	5
Wiedemann 99 parameters (HWY 401)	
CC0 – Standstill distance (m)	1.5
CC1 – Following distance (s)	0.9
CC2 – Longitudinal oscillation (m)	4
CC3 – Perception threshold for following (s)	-8
CC4 – Negative speed difference (m/s)	-0.35
CC5 – Positive speed difference (m/s)	0.35
CC6 – Influence speed on oscillation (m/s ²)	11.44
CC7 – Oscillation acceleration (m/s ²)	0.25
CC8 – Acceleration starting from standstill (m/s ²)	3.5
CC9 – Acceleration at 80 km/h (m/s ²)	1.5
Wiedemann 74 parameters (Power Dam Dr)	
Average standstill distance (m)	2
Additive part of safety distance (m)	2
Multiplicative part of safety distance (m)	3

3. MODEL CALIBRATION RESULTS

The calibration results in the following subsections compare the simulation outputs of volume to their respective real-world measurements for the morning and evening peak hours, 8 – 9 AM and 4 – 5 PM.

3.1 AM Peak hour

3.1.1 Volume

The real and simulated volumes for the morning peak hour, in the westbound direction are summarized and compared in **Table 3-1** and **Figure 3-1**. The GEH values for all mainline and ramp locations are less than 5.0 and both the R-squared value and slope of the regression line are approximately 1.0, indicating a high degree of match between the real and simulated volume data.

Table 3-1: Comparison of real and simulated volumes – AM peak hour – westbound

Westbound		AM Peak Hour 8 - 9 AM			
Location	Type	Real	Simulated	Difference	GEH
McConnell to Brookdale	Mainline	539	539	0	0.00
off-ramp	Ramp	175	173	-2	0.15
loop on-ramp	Ramp	158	158	0	0.00
on-ramp	Ramp	0	0	0	0.00
Brookdale to Power Dam	Mainline	522	525	3	0.13
on-ramp	Ramp	39	39	0	0.00
Power Dam to Moulinette	Mainline	561	567	6	0.25
off-ramp	Ramp	47	54	7	0.99
on-ramp	Ramp	46	46	0	0.00
Moulinette to Dickinson	Mainline	560	566	6	0.25
Percent of GEH values less than 5.0					100%

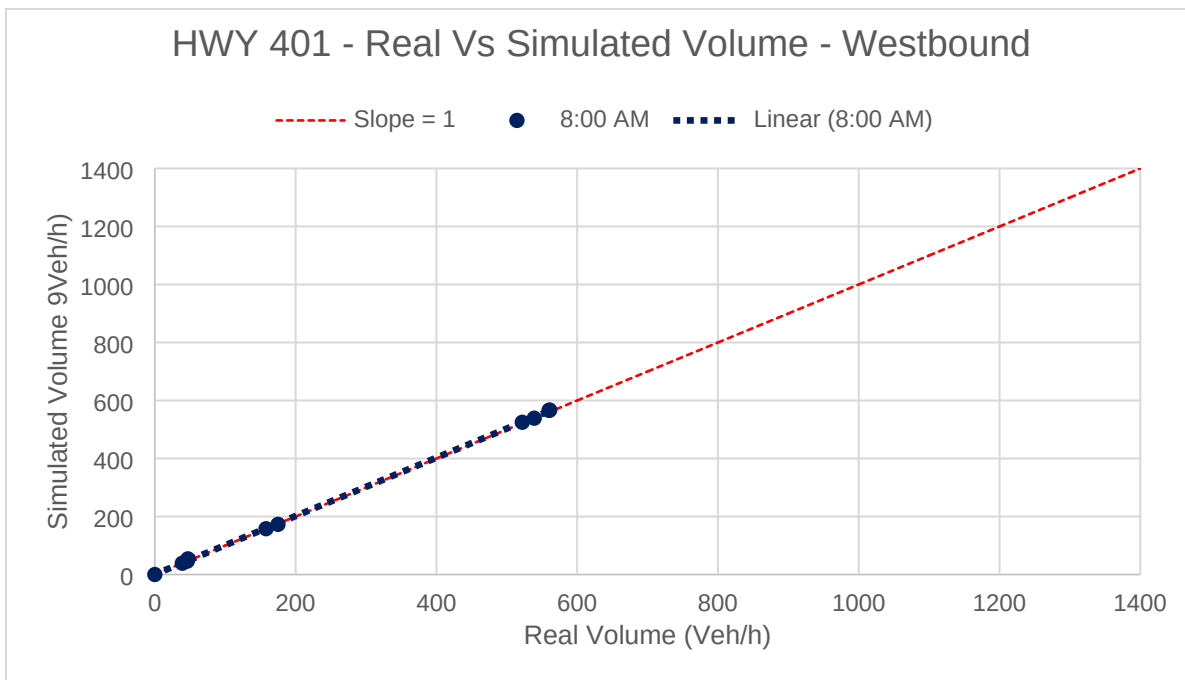


Figure 3-1: Correlation of real and simulated volumes – AM peak hour – westbound

In the eastbound direction, the real and simulated volumes for the morning peak hour are summarized and compared in **Table 3-2** and Figure 3-2. Eastbound is the peak direction of travel in the morning, and the calibration process did replicate the real volumes to a high degree; all GEH values are less than 5.0, and the slope and R-squared values are approximately 1.0.

Table 3-2: Comparison of real and simulated volumes – AM peak hour – eastbound

Eastbound		AM Peak Hour 8 - 9 AM			
Location	Type	Real	Simulated	Difference	GEH
McConnell to Brookdale	Mainline	766	763	-3	0.11
on-ramp	Ramp	41	43	2	0.31
loop on-ramp	Ramp	88	88	0	0.00
off-ramp	Ramp	813	804	-9	0.00
Brookdale to Power Dam	Mainline	38	41	3	0.48
off-ramp	Ramp	775	763	-12	0.43
Power Dam to Moulinette	Mainline	193	188	-5	0.36
on-ramp	Ramp	72	72	0	0.00
off-ramp	Ramp	112	112	0	0.00
Moulinette to Dickinson	Mainline	766	755	-11	0.40
Percent of GEH values less than 5.0					100%

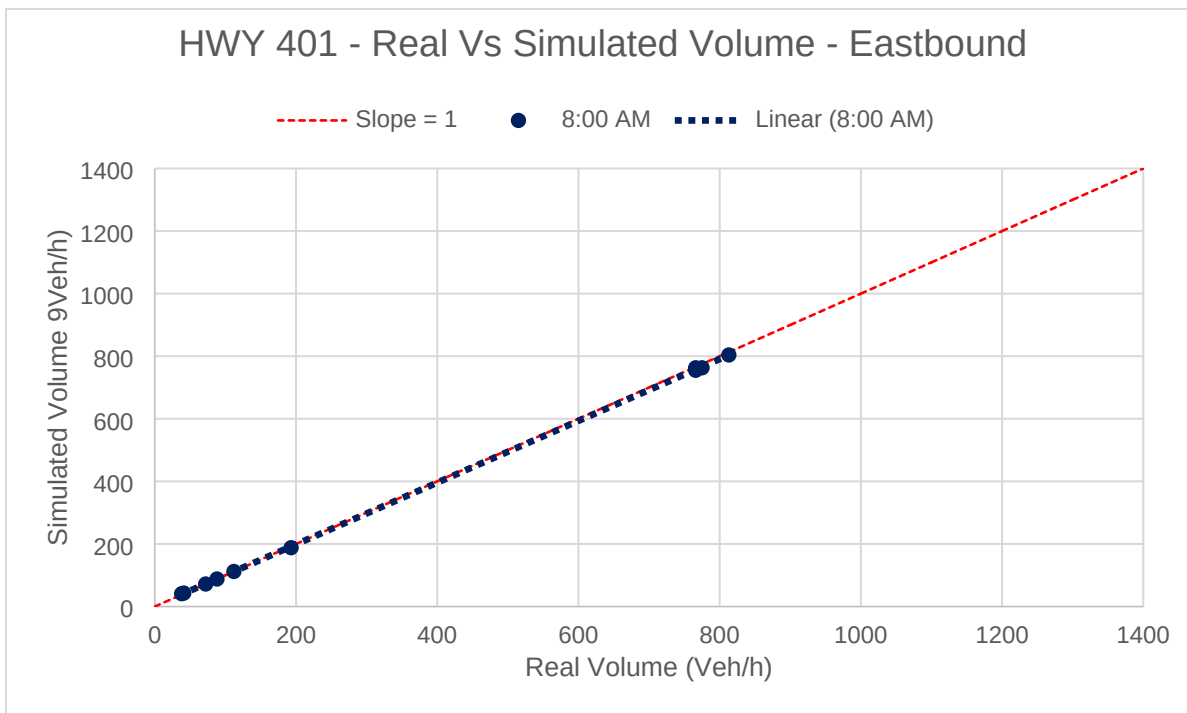


Figure 3-2: Correlation of real and simulated volumes – AM peak hour – eastbound

3.1.2 Travel Times

The simulated travel times for the westbound and eastbound during the morning peak hour are presented in **Figure 3-3** and **Figure 3-4**. Real travel times were not collected for the study area.

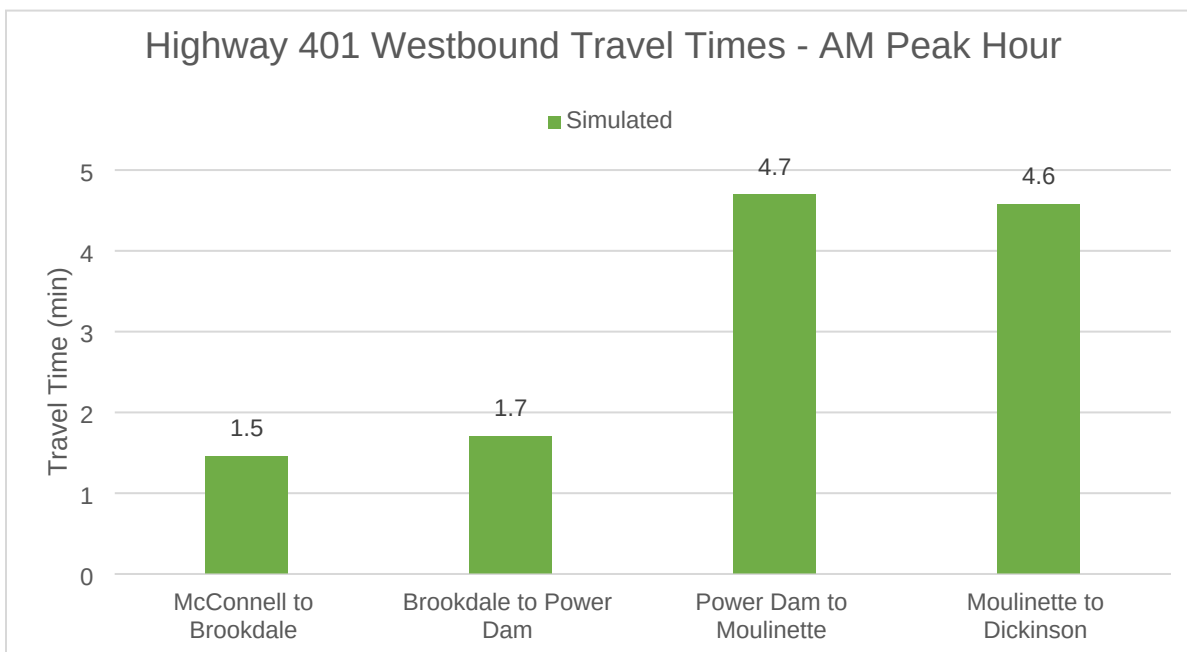


Figure 3-3: simulated travel time by highway segment – AM peak hour – westbound

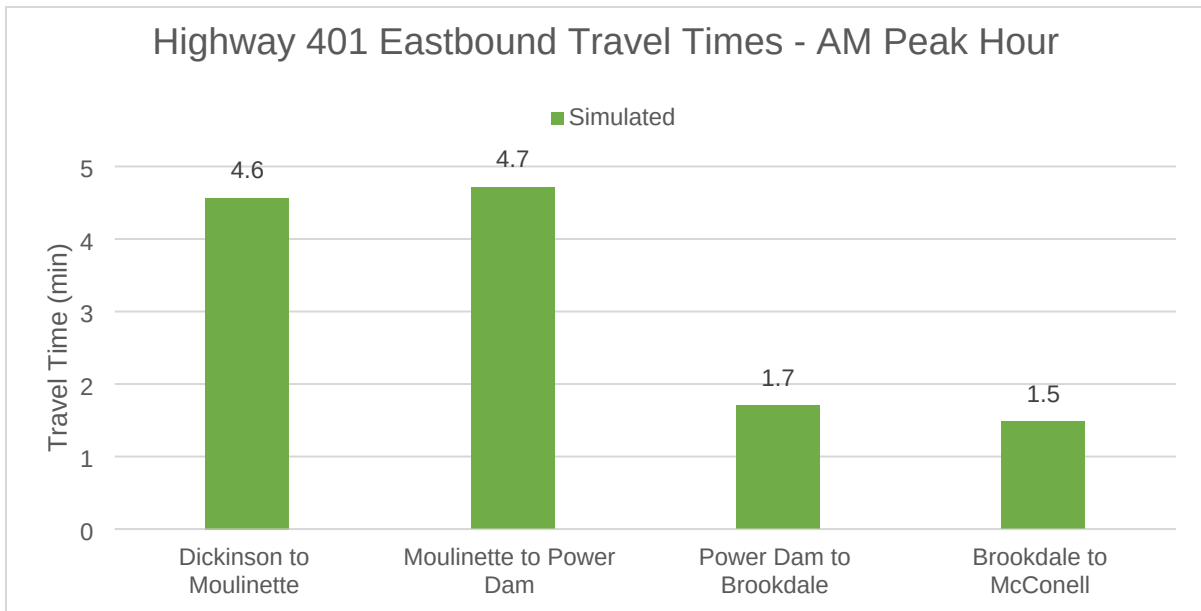


Figure 3-4: simulated travel time by highway segment – AM peak hour – eastbound

3.1.3 Speed

The simulated speeds during the morning peak hour are presented in **Figure 3-5** and **Figure 3-6**, for the westbound and eastbound directions, respectively. Both directions exhibit free-flow conditions throughout the study area and the model exhibit a high degree of compliance with the posted speed limit. Real speed data were not collected for the study area.

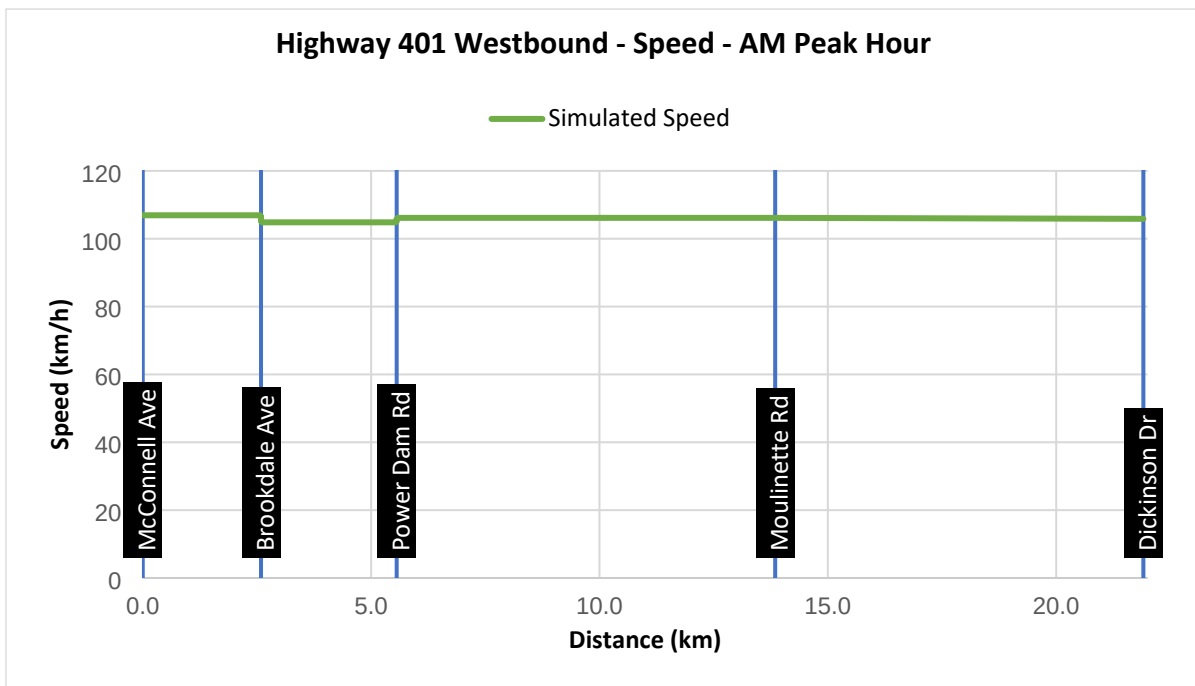


Figure 3-5: simulated speeds – AM peak hour – westbound

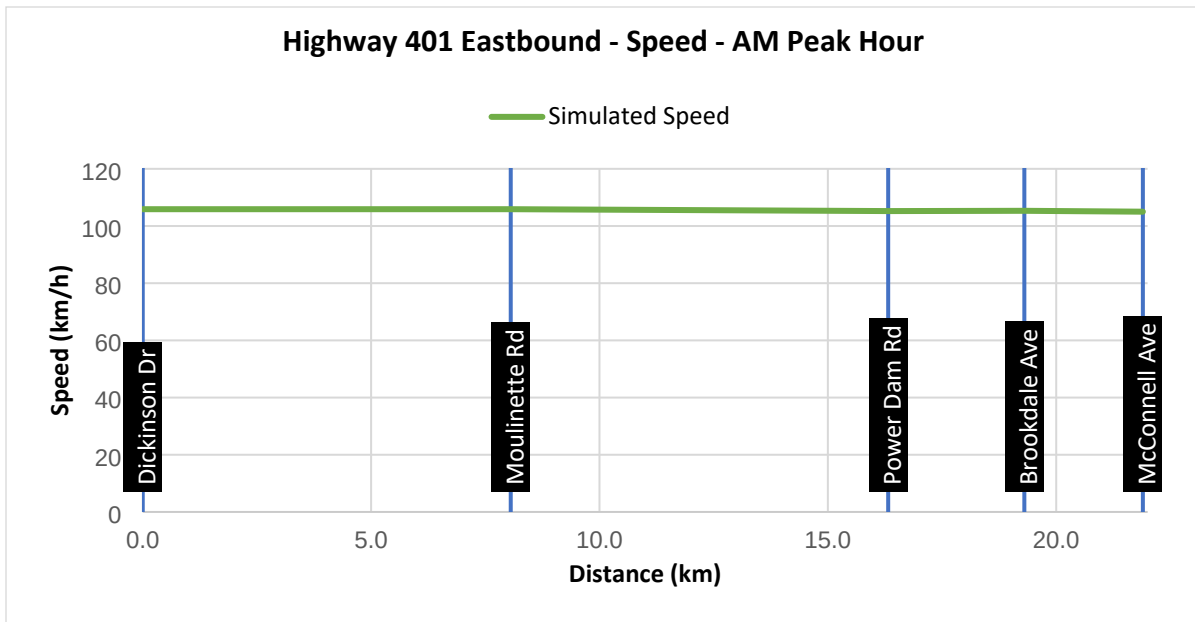


Figure 3-6: simulated speeds – AM peak hour – eastbound

3.2 PM Peak Hour

3.2.1 Volume

The real and simulated volumes for the afternoon peak hour, in the westbound direction are summarized and compared in **Table 3-3** and Figure 3-7. The GEH values for all mainline and ramp locations are less than 5.0 and both the R-squared value and slope of the regression line are approximately 1.0, indicating a high degree of match between the real and simulated volume data.

Table 3-3: Comparison of real and simulated volumes – PM peak hour – westbound

Westbound		PM Peak Hour 4 - 5 PM			
Location	Type	Real	Simulated	Difference	GEH
McConnell to Brookdale	Mainline	1113	1112	-1	0.03
off-ramp	Ramp	253	248	-5	0.32
loop on-ramp	Ramp	283	283	0	0.00
on-ramp	Ramp	0	0	0	0.00
Brookdale to Power Dam	Mainline	1143	1145	2	0.06
on-ramp	Ramp	61	57	-4	0.52
Power Dam to Moulinette	Mainline	1204	1200	-4	0.12
off-ramp	Ramp	116	111	-5	0.47
on-ramp	Ramp	32	32	0	0.00
Moulinette to Dickinson	Mainline	1120	1122	2	0.06
Percent of GEH values less than 5.0					100%

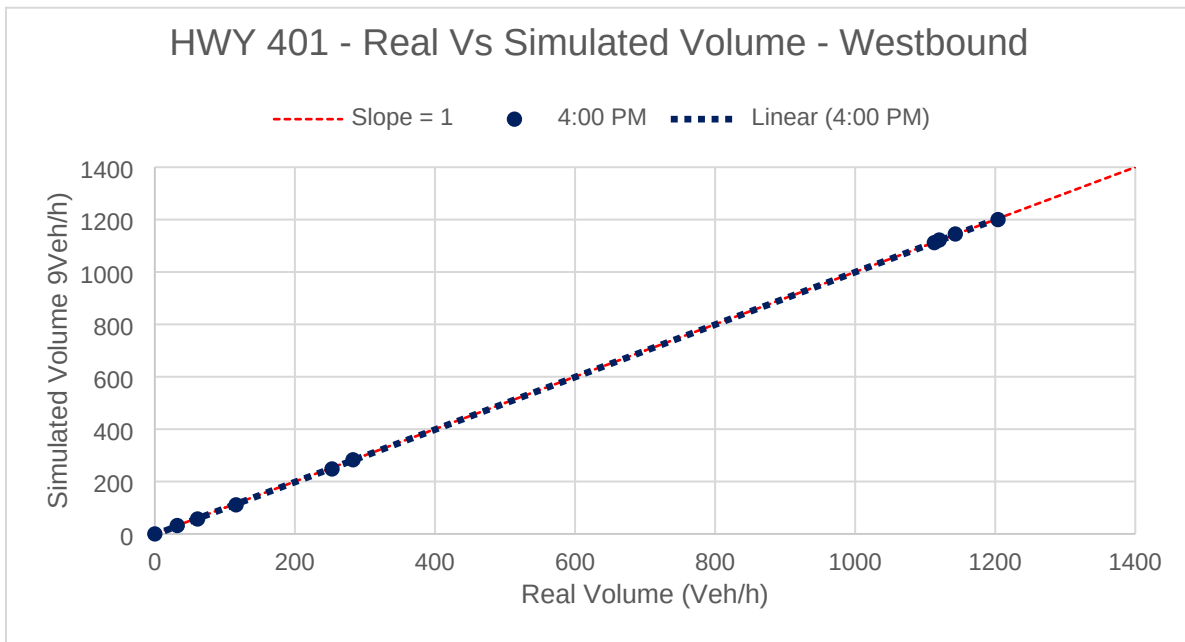


Figure 3-7: Correlation of real and simulated volumes – PM peak hour – westbound

In the eastbound direction, the real and simulated volumes for the afternoon peak hour are summarized and compared in **Table 3-4** and **Figure 3-8**. Eastbound is the peak direction of travel in the morning, but the calibration process did replicate the real volumes to a high degree; all GEH values are less than 5.0, and the slope and R-squared values are approximately 1.0.

Table 3-4: Comparison of real and simulated volumes – PM peak hour – eastbound

Eastbound		PM Peak Hour 4 - 5 PM			
Location	Type	Real	Simulated	Difference	GEH
McConnell to Brookdale	Mainline	956	949	-7	0.23
on-ramp	Ramp	47	48	1	0.15
loop on-ramp	Ramp	71	71	0	0.00
off-ramp	Ramp	980	967	-13	0.42
Brookdale to Power Dam	Mainline	54	57	3	0.40
off-ramp	Ramp	926	897	-29	0.96
Power Dam to Moulinette	Mainline	209	198	-11	0.77
on-ramp	Ramp	69	69	0	0.00
off-ramp	Ramp	162	162	0	0.00
Moulinette to Dickinson	Mainline	948	924	-24	0.78
Percent of GEH values less than 5.0					100%

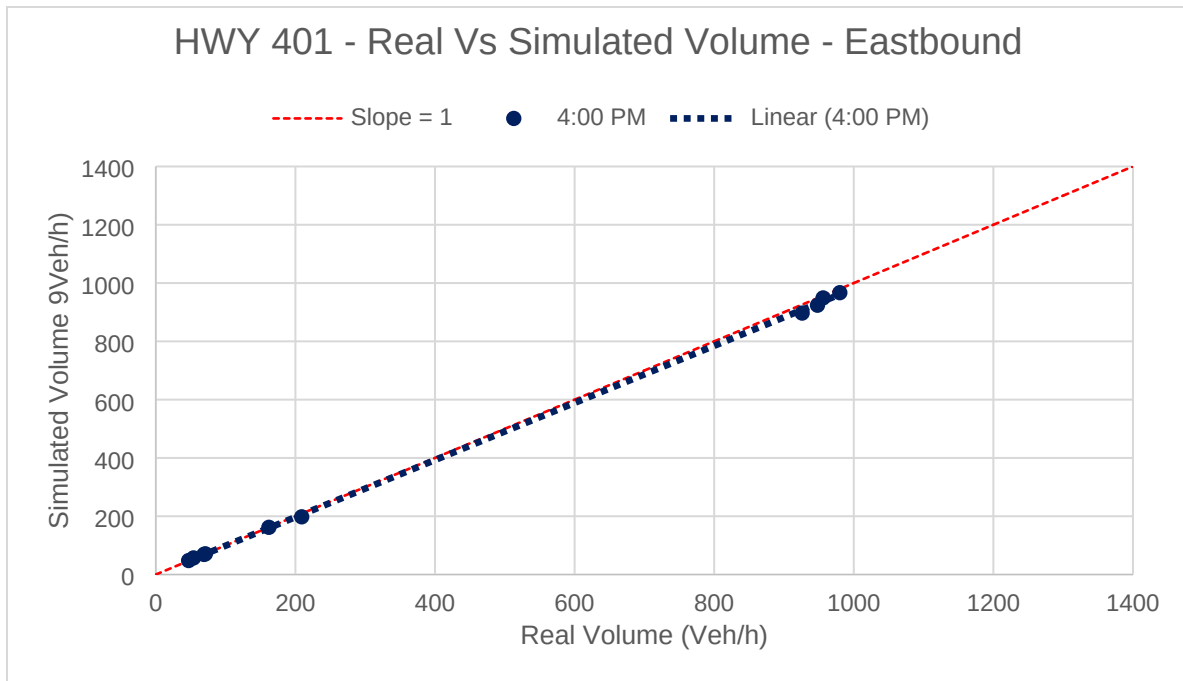


Figure 3-8: Correlation of real and simulated volumes – PM peak hour – eastbound

3.2.1 Travel Times

The simulated travel times for the westbound and eastbound during the afternoon peak hour are presented in **Figure 3-9** and **Figure 3-10**. Real travel times were not collected for the study area.

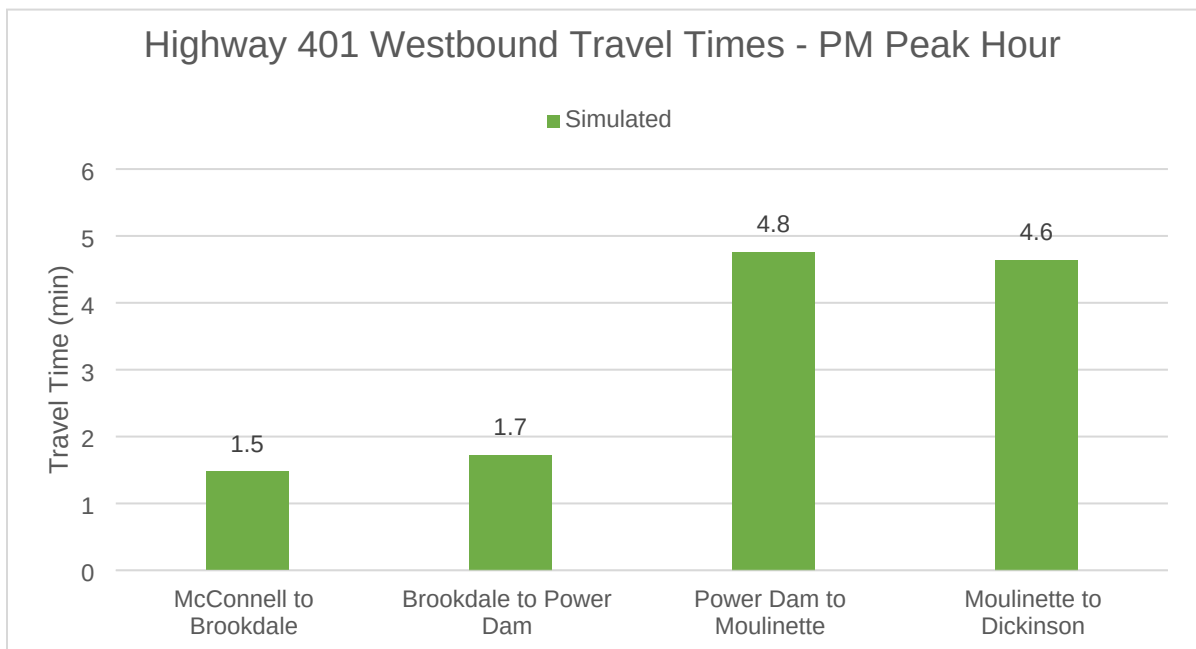


Figure 3-9: simulated travel time by highway segment – AM peak hour – westbound

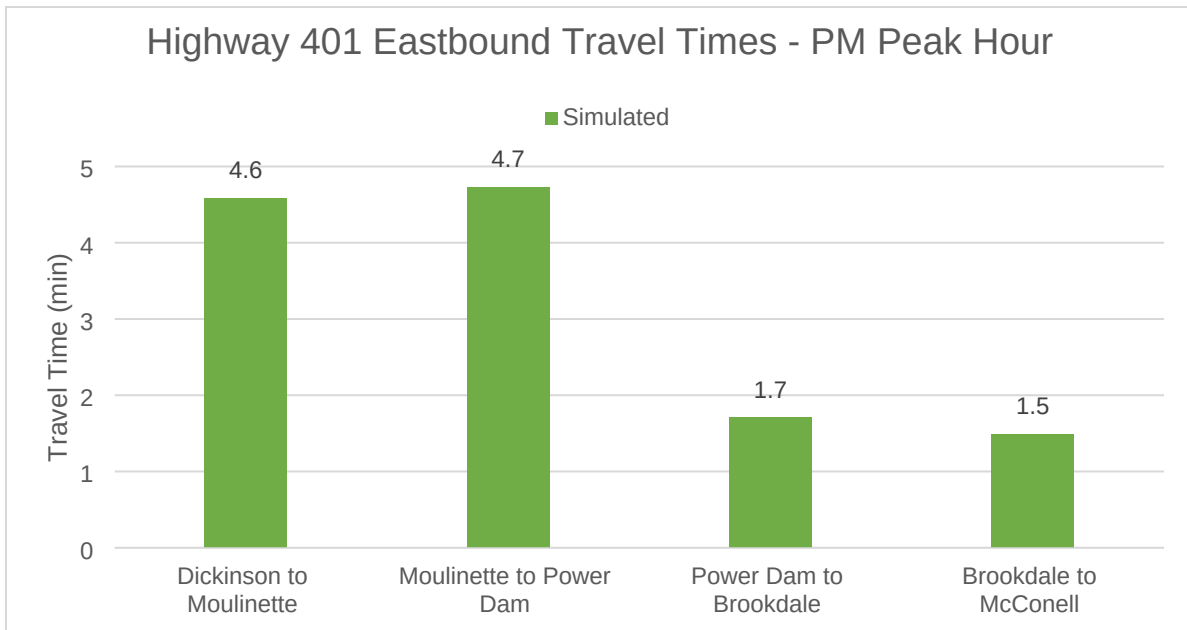


Figure 3-10: simulated travel time by highway segment – PM peak hour – eastbound

3.2.2 Speed

The simulated speeds during the afternoon peak hour are presented in Figure 3-11 and Figure 3-12, for the westbound and eastbound directions, respectively. Both directions indicate free-flow conditions throughout the study area and the model exhibit a high degree of compliance with the posted speed limit. Real speed data were not collected for the study area.

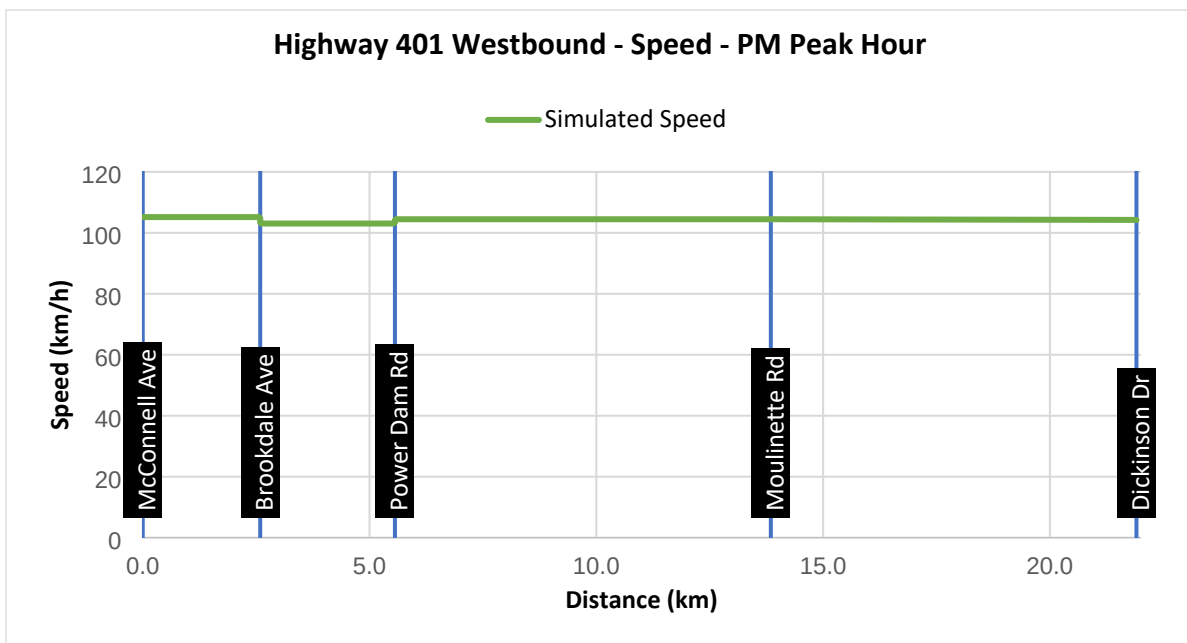


Figure 3-11: simulated speeds – PM peak hour – westbound

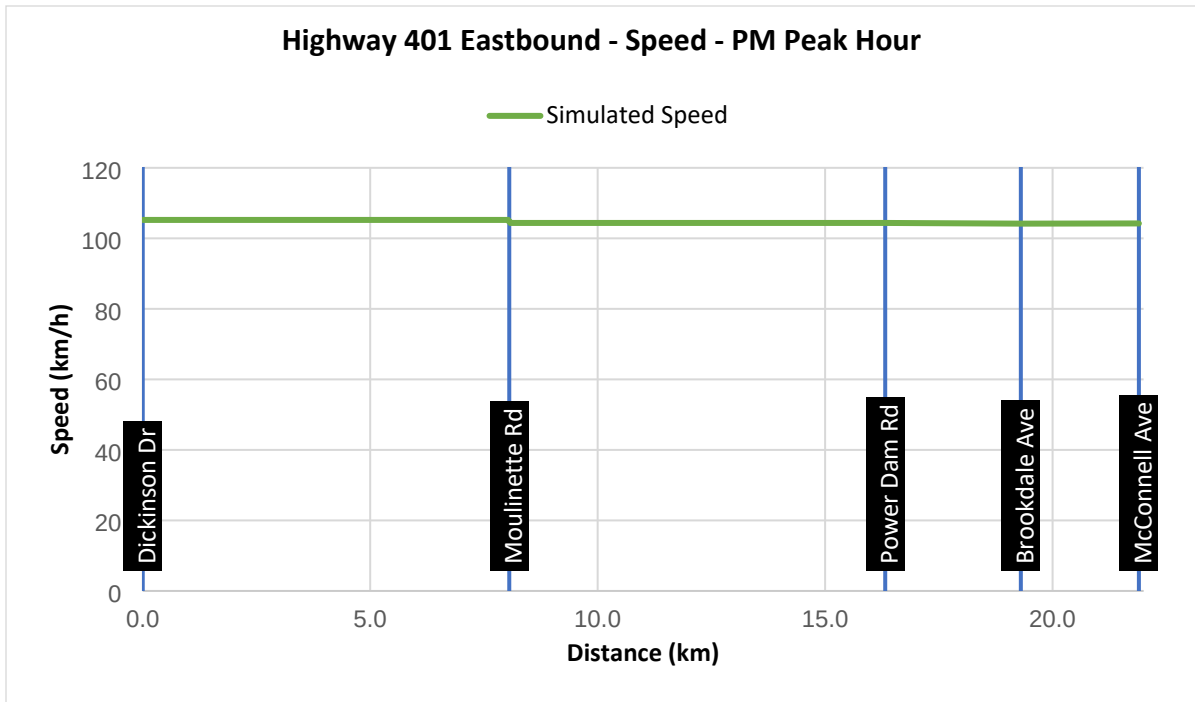


Figure 3-12: simulated speeds – PM peak hour – eastbound

4. CONCLUSION

This report has documented the calibration of the VISSIM micro-simulation model of the Highway 401 study area, for the morning and evening peak hours, with respect to the following performance measures:

- Volume – 100% of simulated volumes throughout the model have GEH values less than 5.0, exceeding the required 85%.
- Real travel times and speeds data were not collected; therefore, calibration of travel times and speed was not carried out.

Based on the above, the model is appropriately calibrated to the baseline 2016 traffic conditions and is suitable for developing and evaluating future traffic operations under various design alternatives.

APPENDIX B: Signal Warrant Analysis

Alternative 5

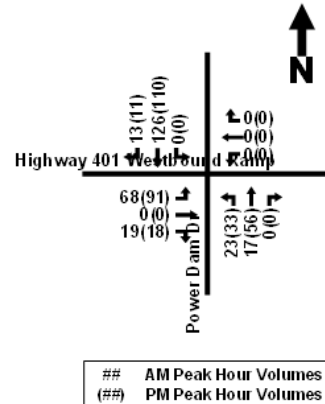
Signal Warrant Analysis (Justification 7) - Power Dam Dr/Highway 401 Westbound Ramp

Major Street:	Power Dam Dr
Minor Street:	Highway 401 Westbound Ramp
Comments:	

Number of Major Road Through Lanes (1-way):	1
Traffic Flow Conditions:	Free-Flow
Type of Intersection:	T
Pedestrians Crossing Major Road:	0

Warrant 1 - Minimum Vehicle Volume			
A - All Approaches		Sectional %	Entire %
Warrant Value:	480	30%	27%
Actual Approach Volume:	146		
B - Minor Street (Both Approaches)		Sectional %	
Warrant Value:	180	27%	
Actual Approach Volume:	49		

Warrant 2 - Delay to Cross Traffic			
A - Major Street (Both Approaches)		Sectional %	Entire %
Warrant Value:	480	20%	
Actual Approach Volume:	97		
B - Traffic Crossing Major Street		Sectional %	
Warrant Value:	50	80%	
Total Crossing Volume:	40		



Warrant Criteria:	Single Warrant	Are signals warranted?
Projected peak hour traffic volumes:	120%	NO

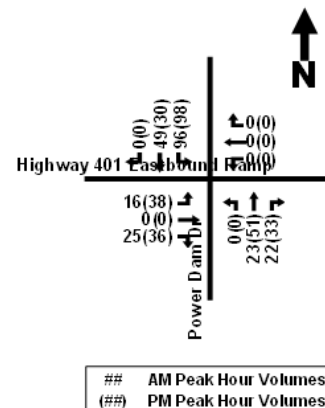
Signal Warrant Analysis (Justification 7) - Power Dam Dr/Highway 401 Eastbound Ramp

Major Street:	Power Dam Dr
Minor Street:	Highway 401 Eastbound Ramp
Comments:	

Number of Major Road Through Lanes (1-way):	1
Traffic Flow Conditions:	Free-Flow
Type of Intersection:	4-Leg
Pedestrians Crossing Major Road:	0

Warrant 1 - Minimum Vehicle Volume			
A - All Approaches		Sectional %	Entire %
Warrant Value:	480	27%	
Actual Approach Volume:	131		
B - Minor Street (Both Approaches)		Sectional %	
Warrant Value:	120	24%	
Actual Approach Volume:	29		

Warrant 2 - Delay to Cross Traffic			
A - Major Street (Both Approaches)		Sectional %	Entire %
Warrant Value:	480	21%	
Actual Approach Volume:	102		
B - Traffic Crossing Major Street		Sectional %	
Warrant Value:	50	28%	
Total Crossing Volume:	14		



Warrant Criteria:	Single Warrant	Are signals warranted?
Projected peak hour traffic volumes:	120%	NO

Alternative 6

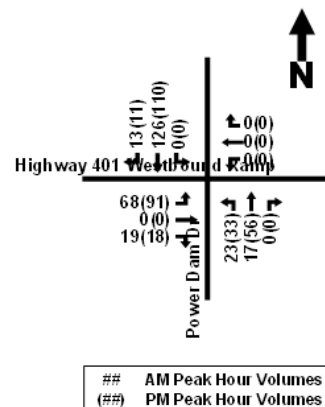
Signal Warrant Analysis (Justification 7) - Power Dam Dr/Highway 401 Westbound Ramp

Major Street:	Power Dam Dr
Minor Street:	Highway 401 Westbound Ramp
Comments:	

Number of Major Road Through Lanes (1-way):	1
Traffic Flow Conditions:	Free-Flow
Type of Intersection:	T
Pedestrians Crossing Major Road:	0

Warrant 1 - Minimum Vehicle Volume			
A - All Approaches		Sectional %	Entire %
Warrant Value:	480	30%	
Actual Approach Volume:	146		
B - Minor Street (Both Approaches)		Sectional %	
Warrant Value:	180	27%	
Actual Approach Volume:	49		

Warrant 2 - Delay to Cross Traffic			
A - Major Street (Both Approaches)		Sectional %	Entire %
Warrant Value:	480	20%	20%
Actual Approach Volume:	97		
B - Traffic Crossing Major Street		Sectional %	
Warrant Value:	50	80%	
Total Crossing Volume:	40		



Warrant Criteria:	Single Warrant	Are signals warranted?
Projected peak hour traffic volumes:	120%	NO

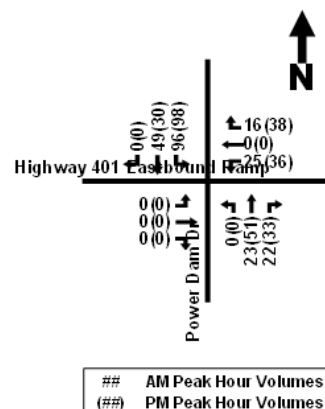
Signal Warrant Analysis (Justification 7) - Power Dam Dr/Highway 401 Eastbound Ramp

Major Street:	Power Dam Dr
Minor Street:	Highway 401 Eastbound Ramp
Comments:	

Number of Major Road Through Lanes (1-way):	1
Traffic Flow Conditions:	Free-Flow
Type of Intersection:	T
Pedestrians Crossing Major Road:	0

Warrant 1 - Minimum Vehicle Volume			
A - All Approaches		Sectional %	Entire %
Warrant Value:	480	27%	
Actual Approach Volume:	131		
B - Minor Street (Both Approaches)		Sectional %	
Warrant Value:	180	16%	
Actual Approach Volume:	29		

Warrant 2 - Delay to Cross Traffic			
A - Major Street (Both Approaches)		Sectional %	Entire %
Warrant Value:	480	21%	
Actual Approach Volume:	102		
B - Traffic Crossing Major Street		Sectional %	
Warrant Value:	50	30%	
Total Crossing Volume:	15		



Warrant Criteria:	Single Warrant	Are signals warranted?
Projected peak hour traffic volumes:	120%	NO

Alternative 8

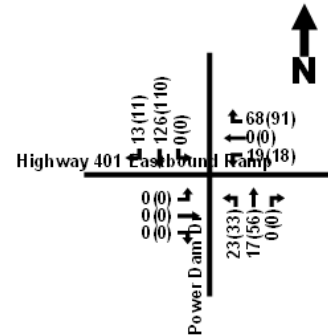
Signal Warrant Analysis (Justification 7) - Power Dam Dr/Highway 401 Eastbound Ramp

Major Street:	Power Dam Dr
Minor Street:	Highway 401 Eastbound Ramp
Comments:	

Number of Major Road Through Lanes (1-way):	1
Traffic Flow Conditions:	Free-Flow
Type of Intersection:	T
Pedestrians Crossing Major Road:	0

Warrant 1 - Minimum Vehicle Volume			
A - All Approaches		Sectional %	Entire %
Warrant Value:	480	30%	27%
Actual Approach Volume:	146		
B - Minor Street (Both Approaches)		Sectional %	
Warrant Value:	180	27%	
Actual Approach Volume:	49		

Warrant 2 - Delay to Cross Traffic			
A - Major Street (Both Approaches)		Sectional %	Entire %
Warrant Value:	480	20%	
Actual Approach Volume:	97		
B - Traffic Crossing Major Street		Sectional %	
Warrant Value:	50	18%	
Total Crossing Volume:	9		



##	AM Peak Hour Volumes
(##)	PM Peak Hour Volumes

Warrant Criteria:	Single Warrant	Are signals warranted?
Projected peak hour traffic volumes:	120%	NO

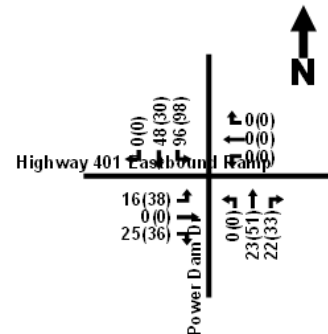
Signal Warrant Analysis (Justification 7) - Power Dam Dr/Highway 401 Eastbound Ramp

Major Street:	Power Dam Dr
Minor Street:	Highway 401 Eastbound Ramp
Comments:	

Number of Major Road Through Lanes (1-way):	1
Traffic Flow Conditions:	Free-Flow
Type of Intersection:	4-Leg
Pedestrians Crossing Major Road:	0

Warrant 1 - Minimum Vehicle Volume			
A - All Approaches		Sectional %	Entire %
Warrant Value:	480	27%	
Actual Approach Volume:	131		
B - Minor Street (Both Approaches)		Sectional %	
Warrant Value:	120	24%	
Actual Approach Volume:	29		

Warrant 2 - Delay to Cross Traffic			
A - Major Street (Both Approaches)		Sectional %	Entire %
Warrant Value:	480	21%	
Actual Approach Volume:	102		
B - Traffic Crossing Major Street		Sectional %	
Warrant Value:	50	28%	
Total Crossing Volume:	14		



##	AM Peak Hour Volumes
(##)	PM Peak Hour Volumes

Warrant Criteria:	Single Warrant	Are signals warranted?
Projected peak hour traffic volumes:	120%	NO

Appendix N – The Recommended Plan Preliminary Design Plates

HWY 401 - POWER DAM DRIVE RECOMMENDED DESIGN

GWP-XXXX-XX-XX
BOOK 1 OF 1

EASTERN REGION

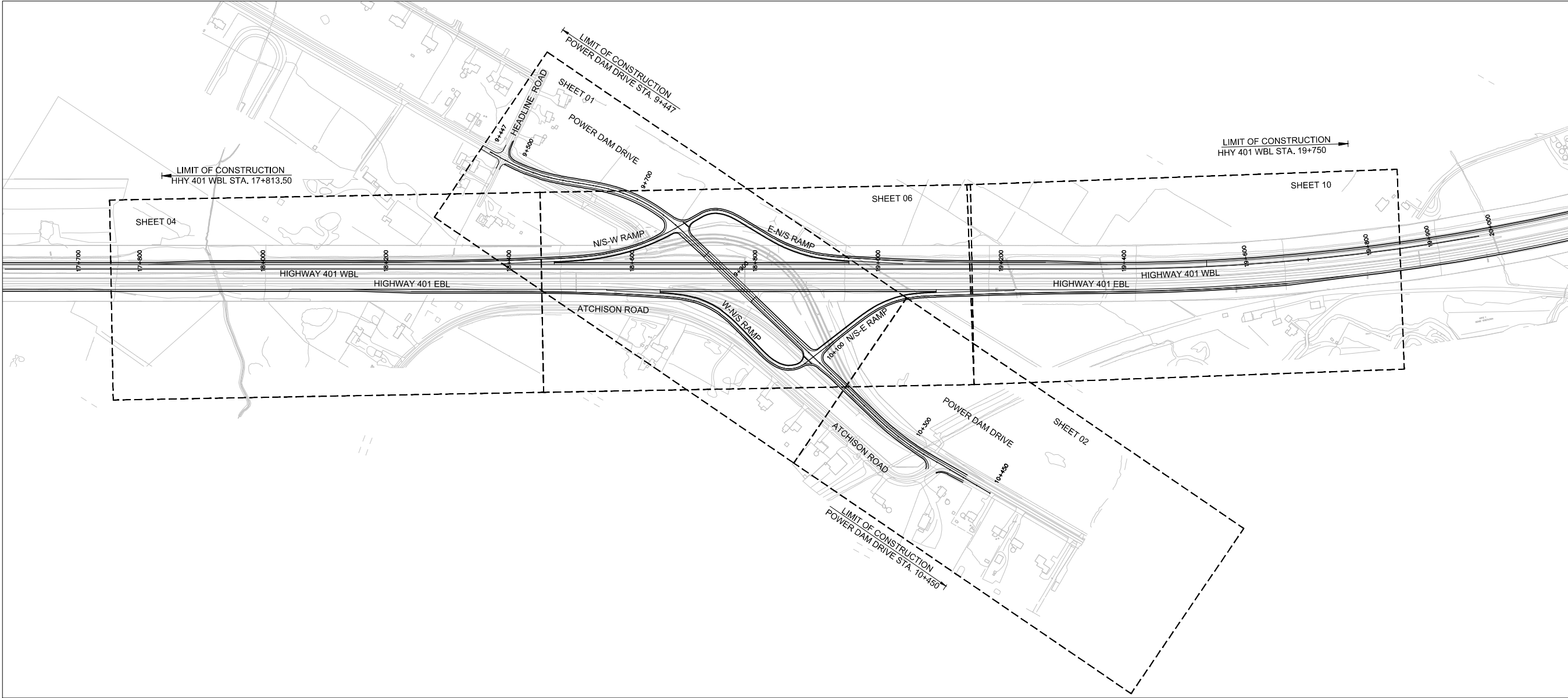
Ministry of Transportation



INDEX	
SHEET	DESCRIPTION
01	POWER DAM DRIVE PLAN STA. 9+447 - 10+150
02	POWER DAM DRIVE PLAN STA. 10+150 - 10+450
03	POWER DAM DRIVE PROFILE
04	HWY 401 PLAN WBL STA.17+813.5 - 18+450 EBL STA. 18+115 - 18+424.5

INDEX	
SHEET	DESCRIPTION
05	HWY 401 PROFILE WBL STA.17+813.5 - 18+450 EBL STA. 18+115 - 18+424.5
06	HWY 401 AND RAMP PLAN WBL STA.18+450- 19+150 EBL STA. 18+424.5 - 19+124.5
07	HWY 401 PROFILE WBL STA.18+450- 19+150 EBL STA. 18+424.5 - 19+124.5

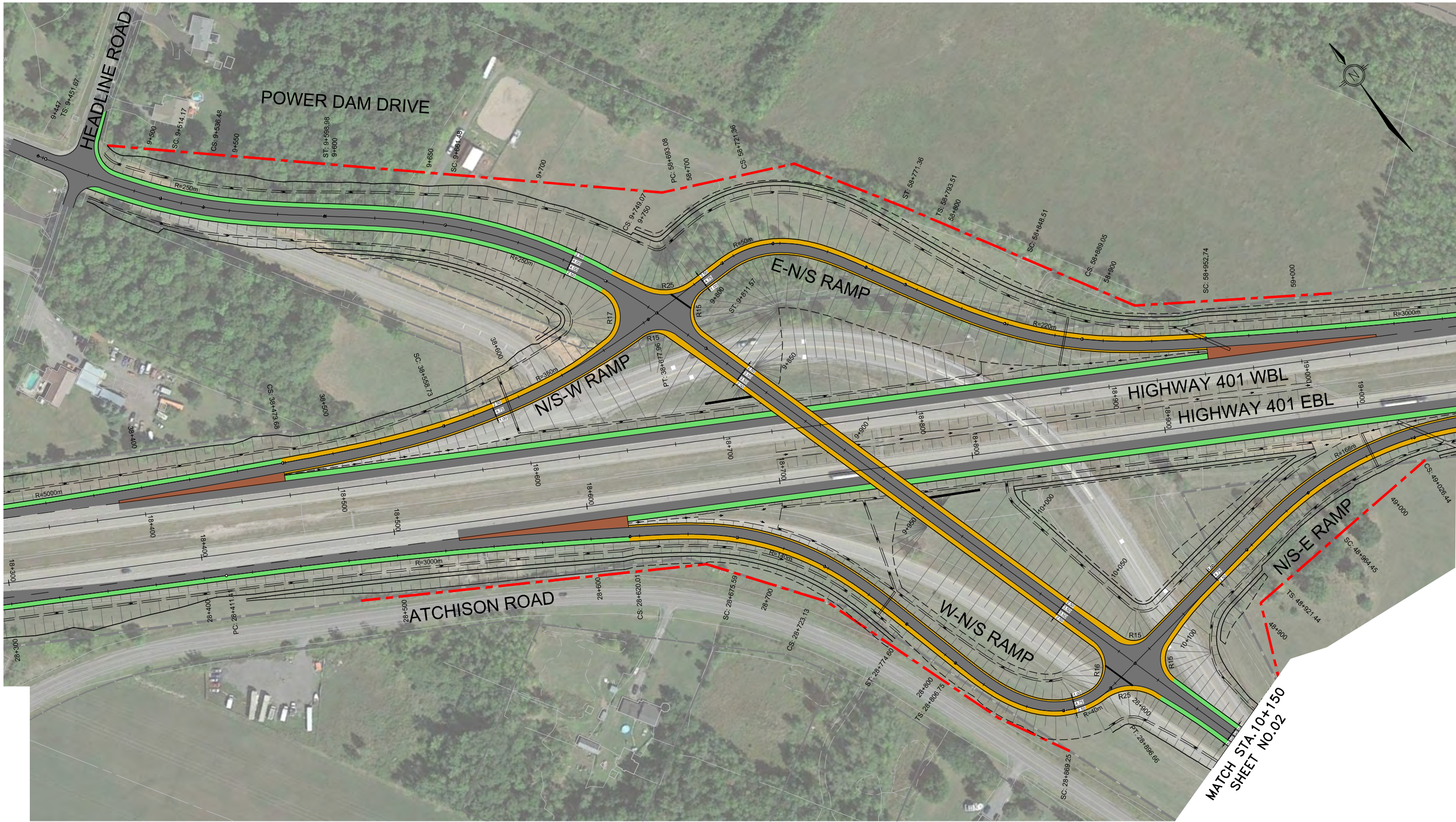
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SHEET	DESCRIPTION
08	N/S-W AND E-N/S RAMP PROFILE
09	W-N/S AND N/S-E RAMP PROFILES
10	HWY 401 PLAN WBL STA.19+150 - 19+400 EBL STA. 19+124.5 - 19+750
11	HWY 401 PROFILE WBL STA.19+150 - 19+400 EBL STA. 19+124.5 - 19+750
12 to 16	TYPICAL SECTIONS



POWER DAM DRIVE INTERCHANGE
RECOMMENDED DESIGN

KEY PLAN

METRIC DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN GWP-xxxx-xx-xx	DATE: JANUARY 2024
	SHEET



	TRAVEL LANES
	PAVED SHOULDER
	GRAVEL SHOULDER
	SIDEWALK / MEDIAN
	EDGE OF PAVEMENT
	EXISTING PROPERTY LINE
	PROPOSED PROPERTY LINE
	PROPOSED DITCH

POWER DAM DRIVE INTERCHANGE
RECOMMENDED DESIGN

POWER DAM DRIVE STA. 9+447 - 10+150

METRIC DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN	DATE: JANUARY 2024
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	SHEET 01

GWP-xxxx-xx-xx

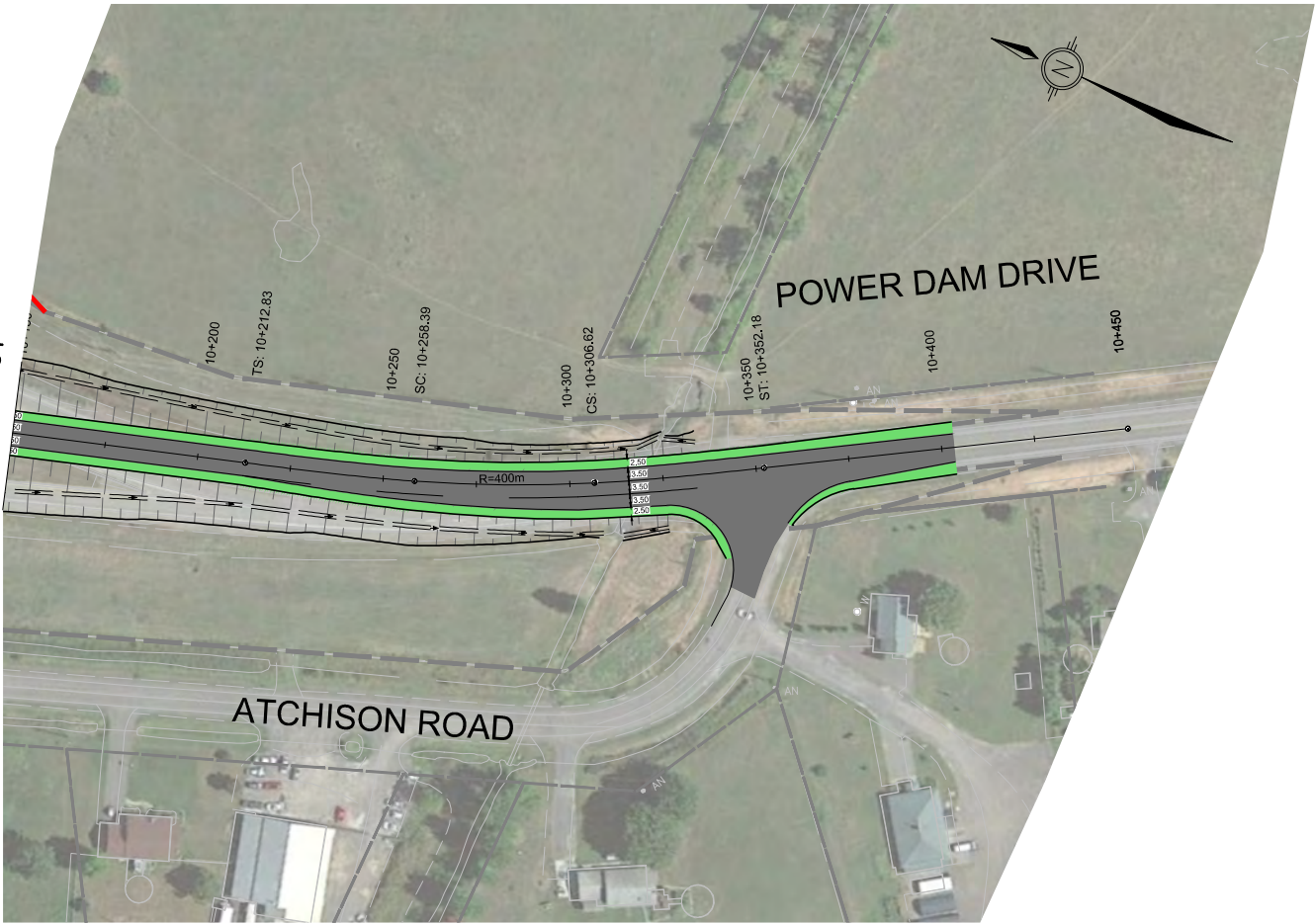


POWER DAM DRIVE INTERCHANGE
RECOMMENDED DESIGN

POWER DAM DRIVE STA. 10+150 - 10+450

- TRAVEL LANES
- PAVED SHOULDER
- GRAVEL SHOULDER
- SIDEWALK / MEDIAN
- EDGE OF PAVEMENT
- EXISTING PROPERTY LINE
- PROPOSED PROPERTY LINE
- PROPOSED DITCH

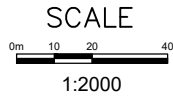
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

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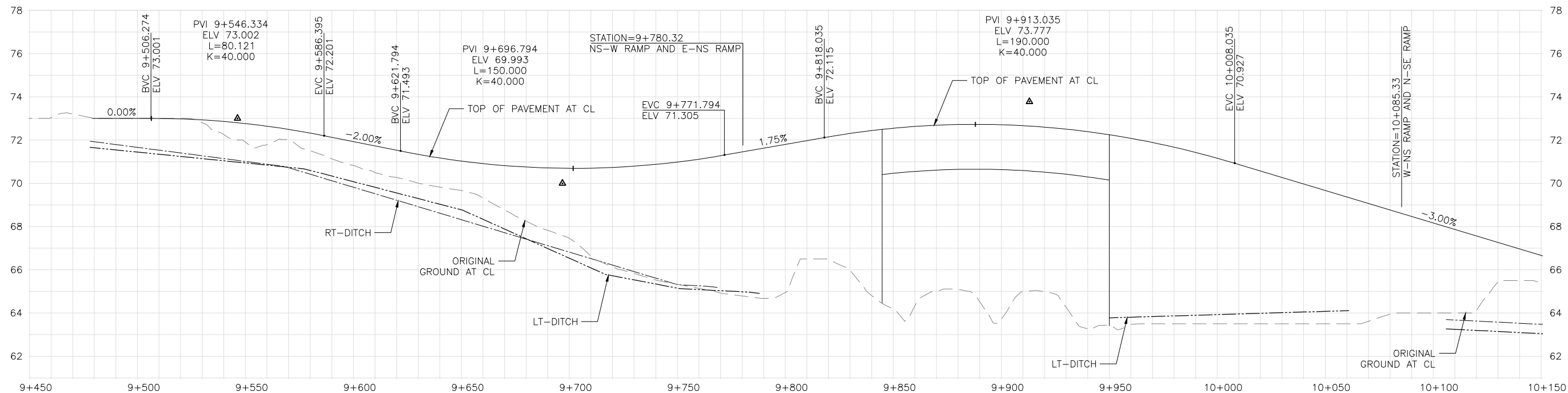
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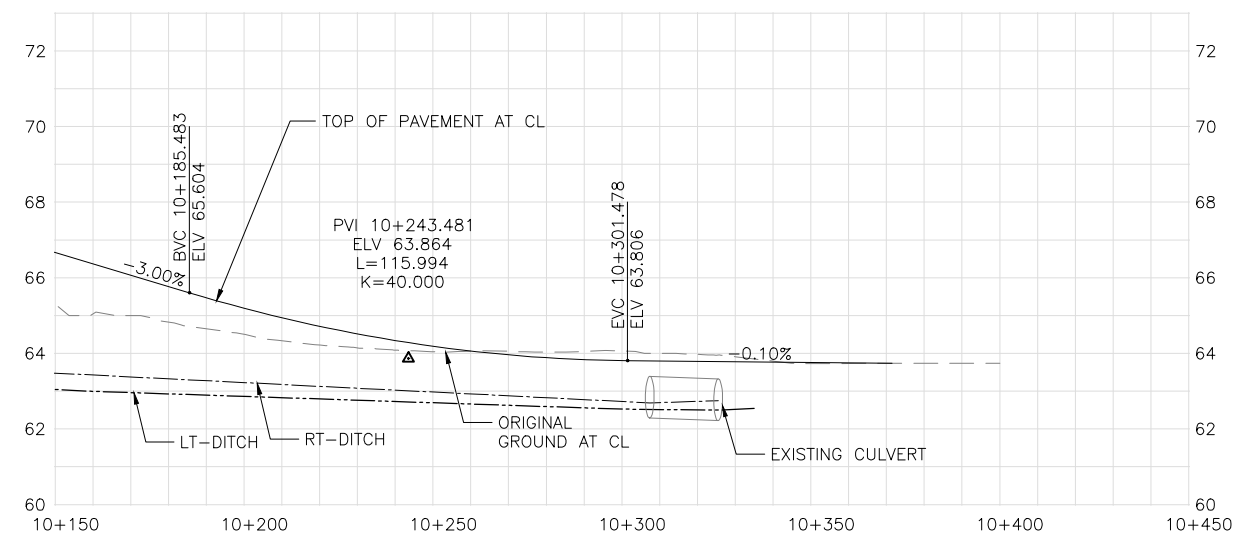
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POWER DAM DRIVE



POWER DAM DRIVE



POWER DAM DRIVE INTERCHANGE
RECOMMENDED DESIGN

POWER DAM DRIVE STA. 9+447 - 10+450

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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

GWP-xxxx-xx-xx

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SHEET
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POWER DAM DRIVE INTERCHANGE
RECOMMENDED DESIGN

HWY 401 WBL STA. 17+813.50 - 18+450
HWY 401 EBL STA. 18+115 - 18+24.50

- TRAVEL LANES

PAVED SHOULDER

GRAVEL SHOULDER

SIDEWALK / MEDIAN
- EDGE OF PAVEMENT

EXISTING PROPERTY LINE

PROPOSED PROPERTY LINE
- PROPOSED DITCH

METRIC
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

GWP-xxxx-xx-xx

DATE: JANUARY 2024

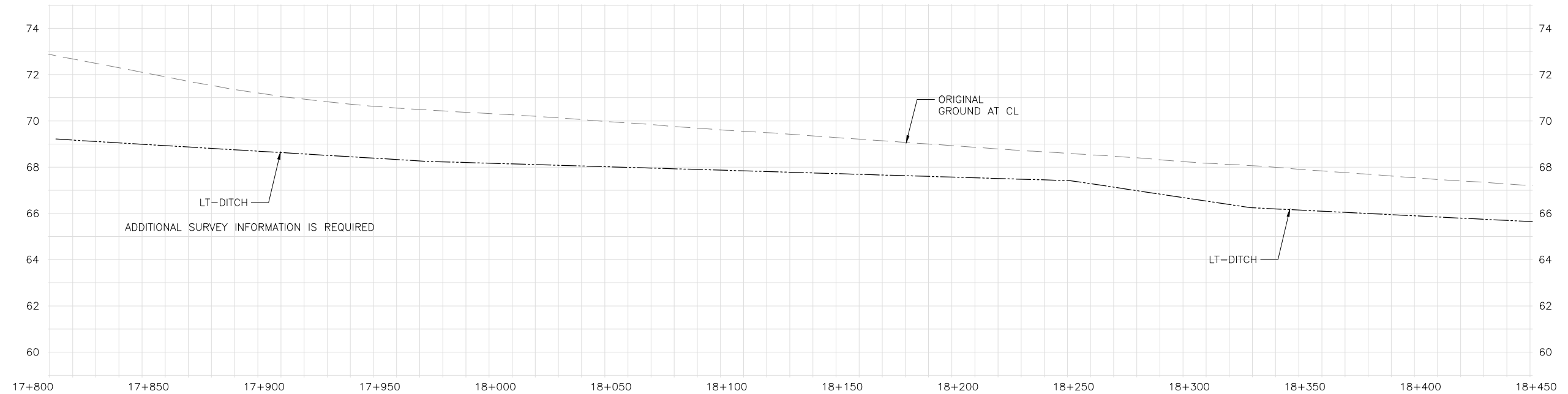
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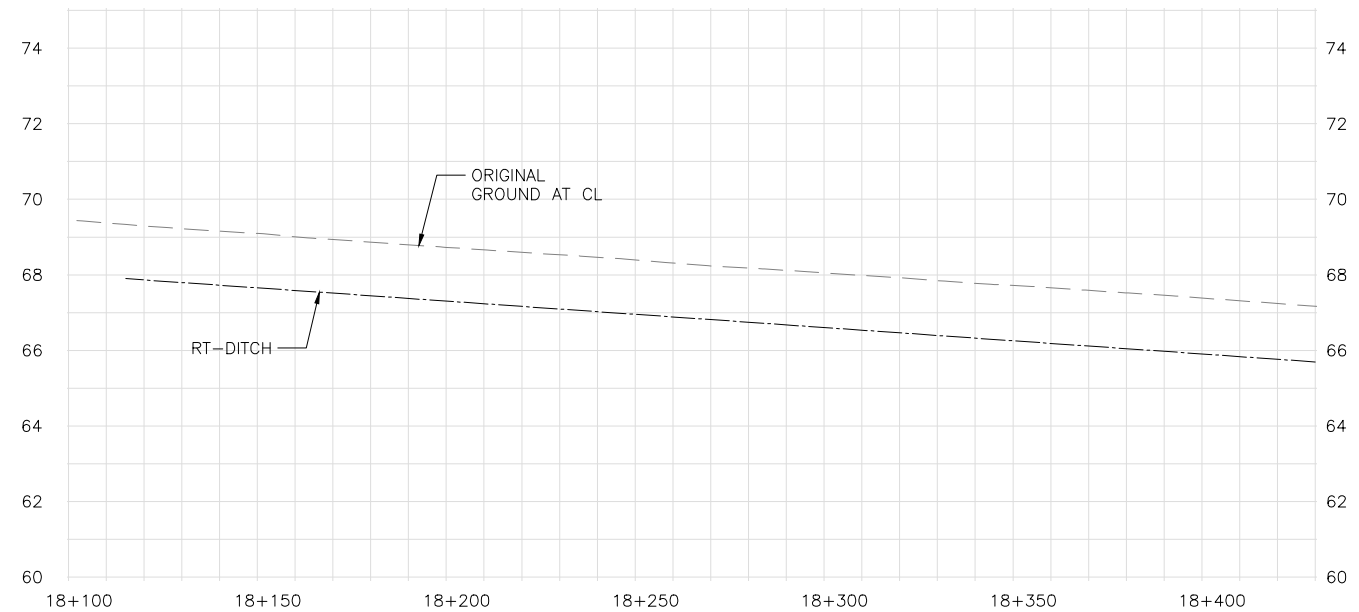


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SHEET NO. 06

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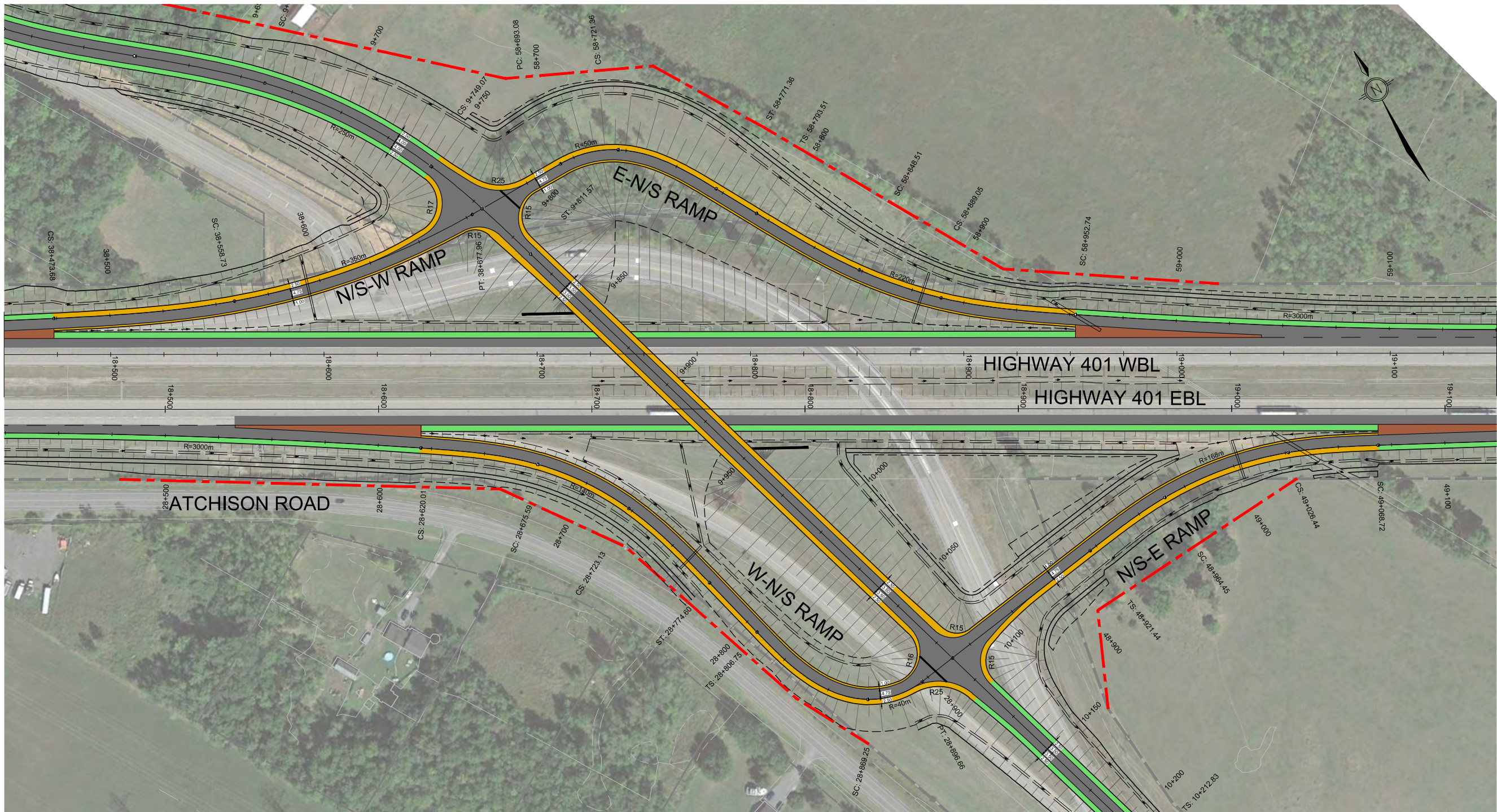


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MATCH STA.18+450
SHEET NO.04



MATCH STA.19+150
SHEET NO.10



POWER DAM DRIVE INTERCHANGE
RECOMMENDED DESIGN
HWY 401 WBL STA. 18+450 - 19+150
N/S-W RAMP, E-N/S RAMP, N/S-E RAMP AND W-N/S RAMP

- TRAVEL LANES
- PAVED SHOULDER
- GRAVEL SHOULDER
- SIDEWALK / MEDIAN
- EDGE OF PAVEMENT
- EXISTING PROPERTY LINE
- PROPOSED PROPERTY LINE
- PROPOSED DITCH

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

GWP-xxxx-xx-xx

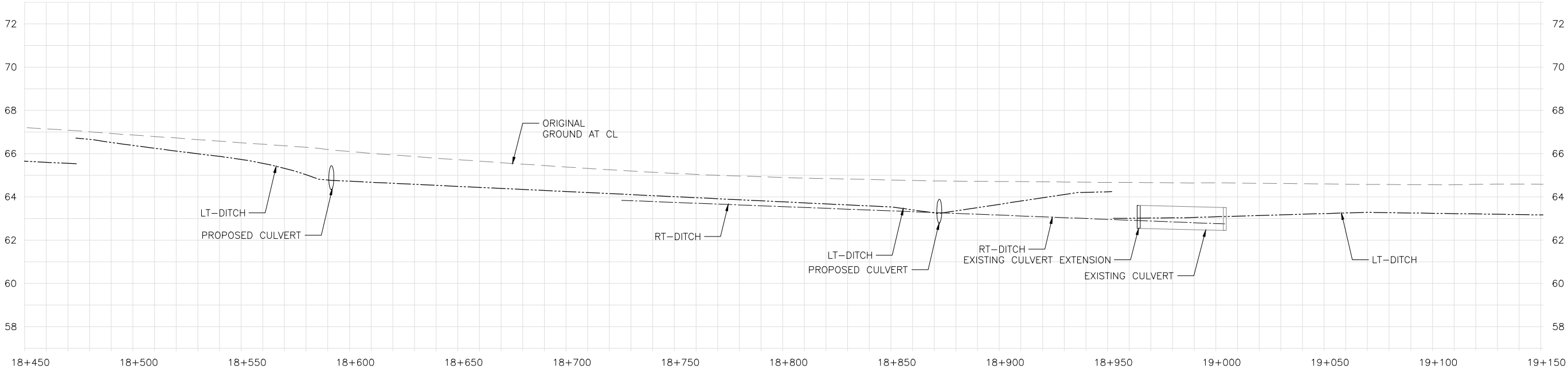
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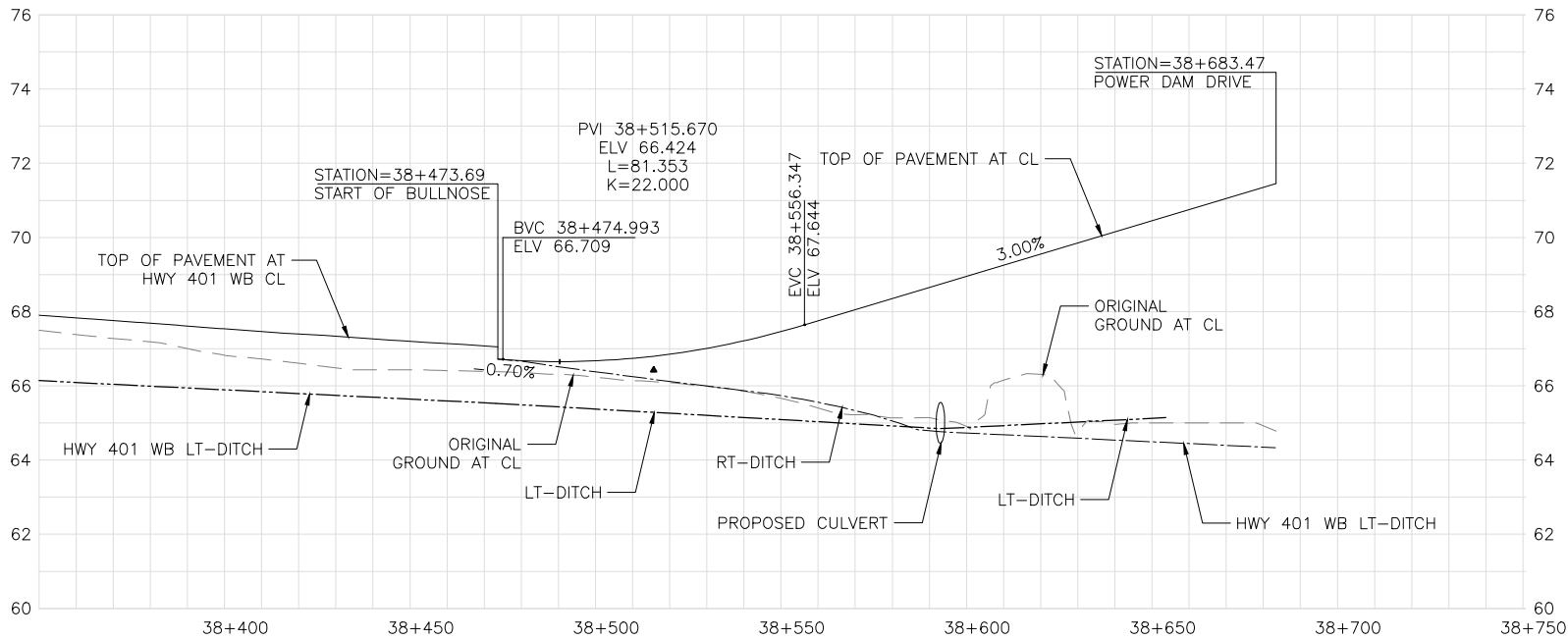
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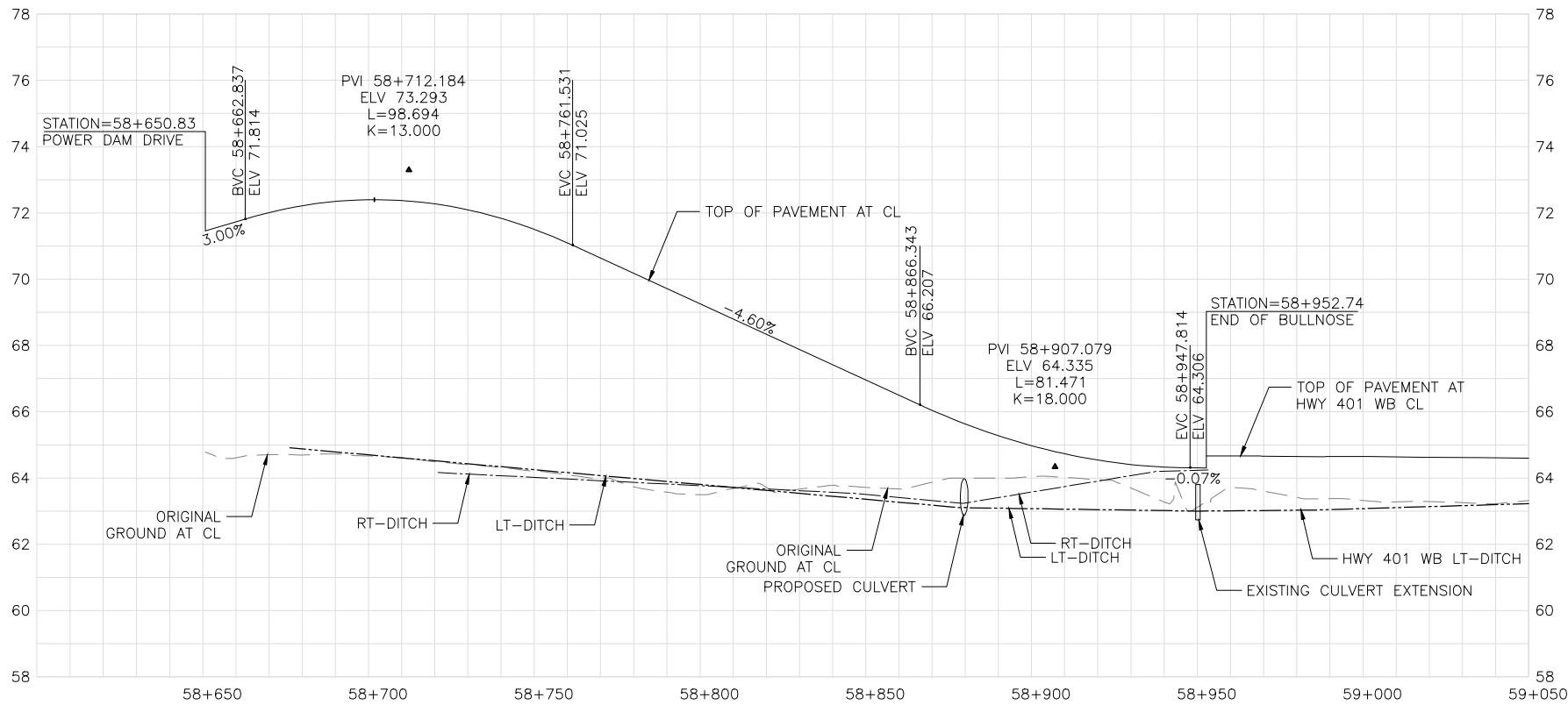
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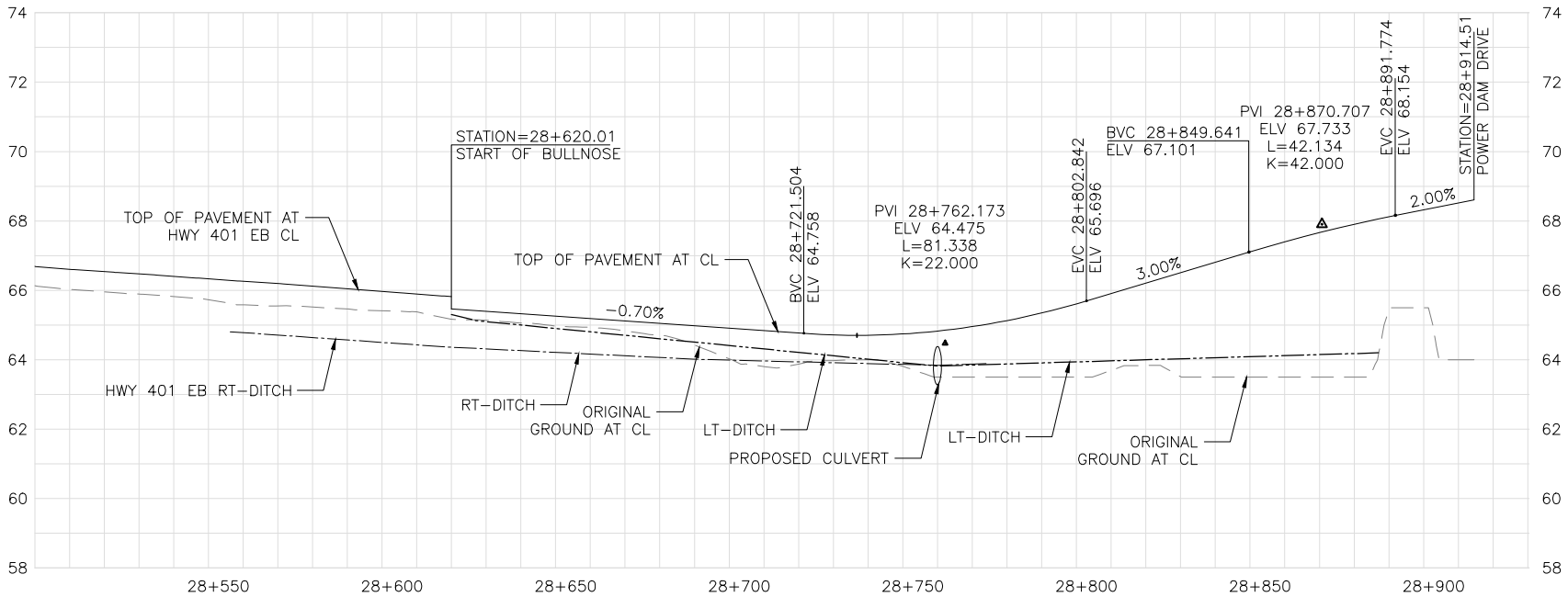
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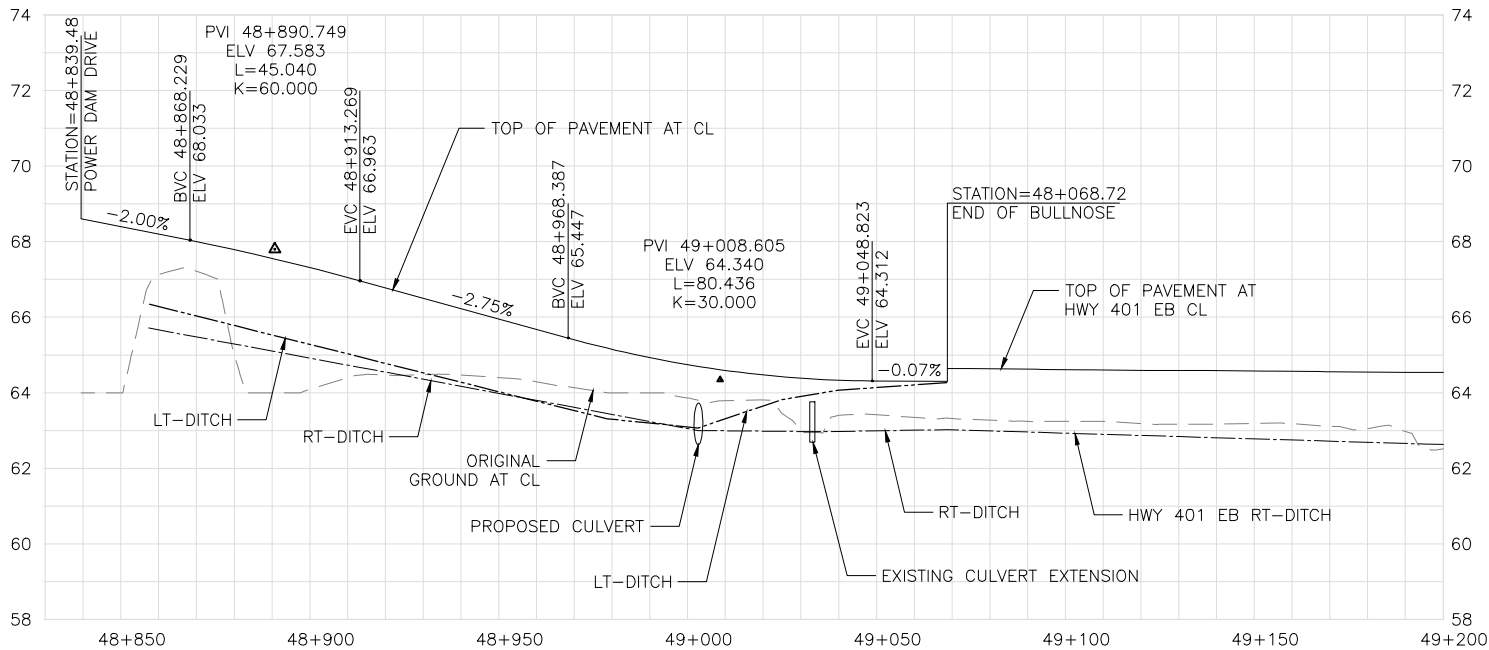
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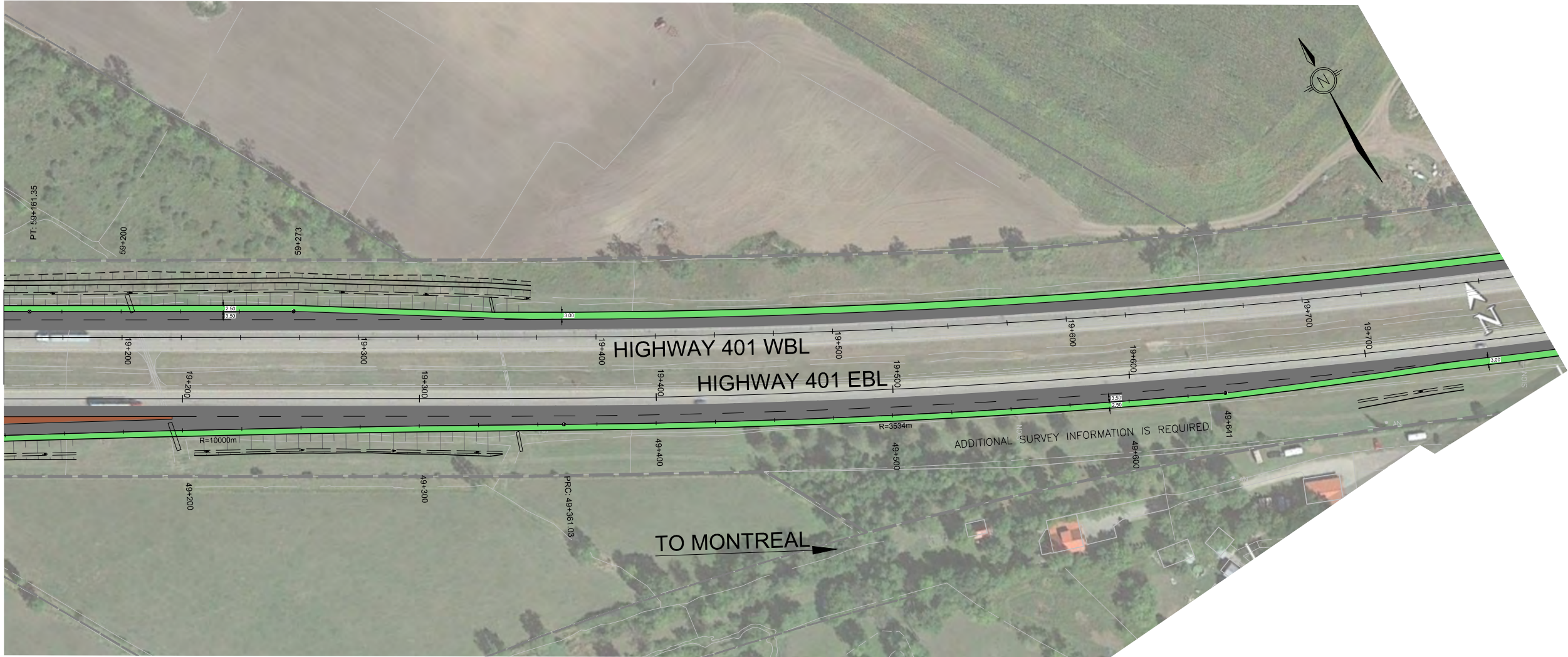


W-N/S RAMP



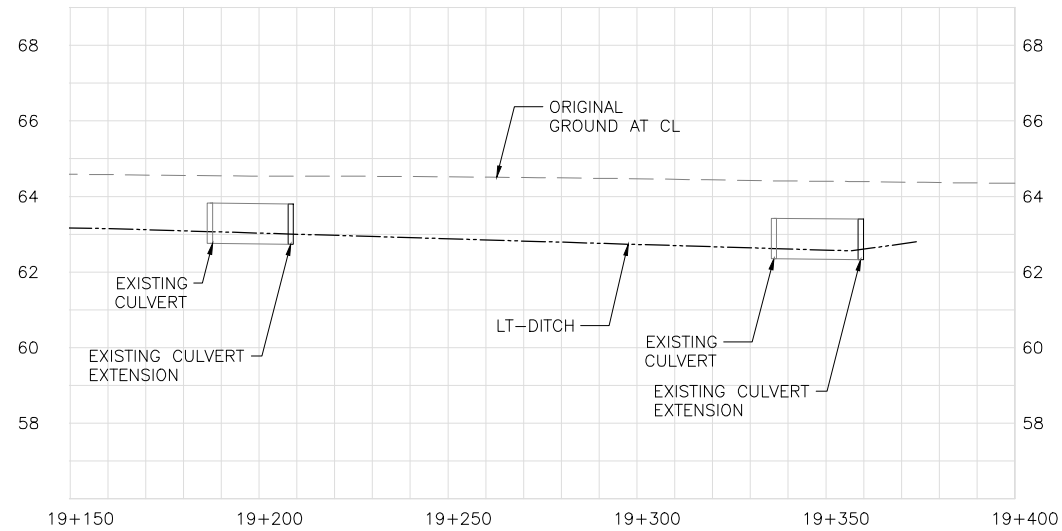
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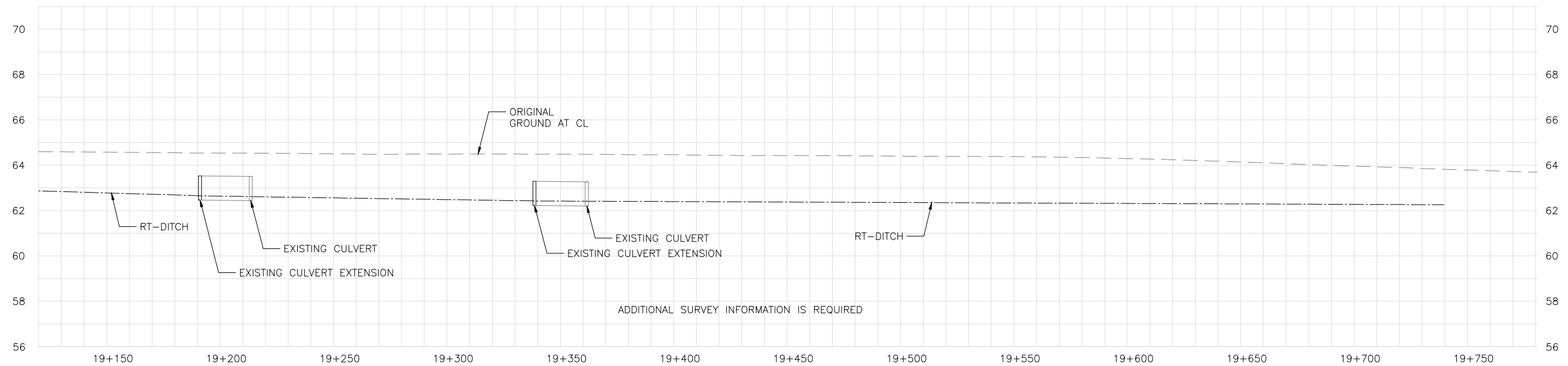


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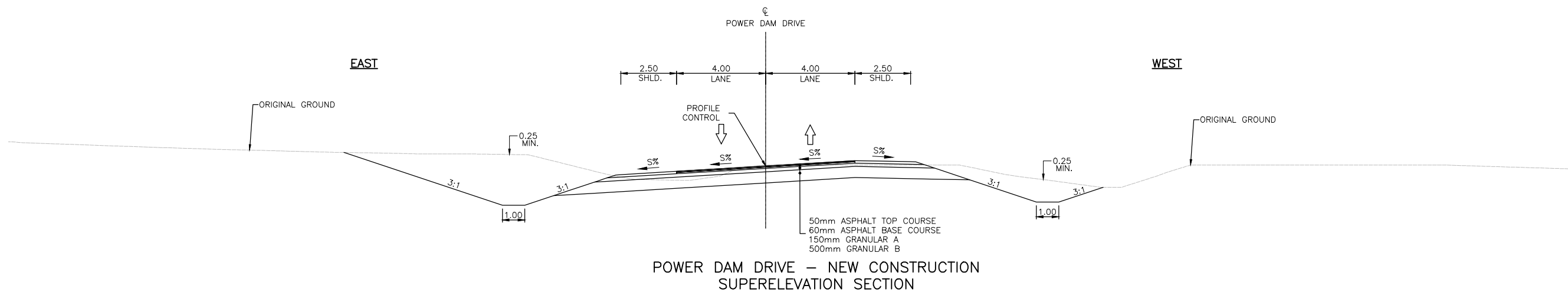
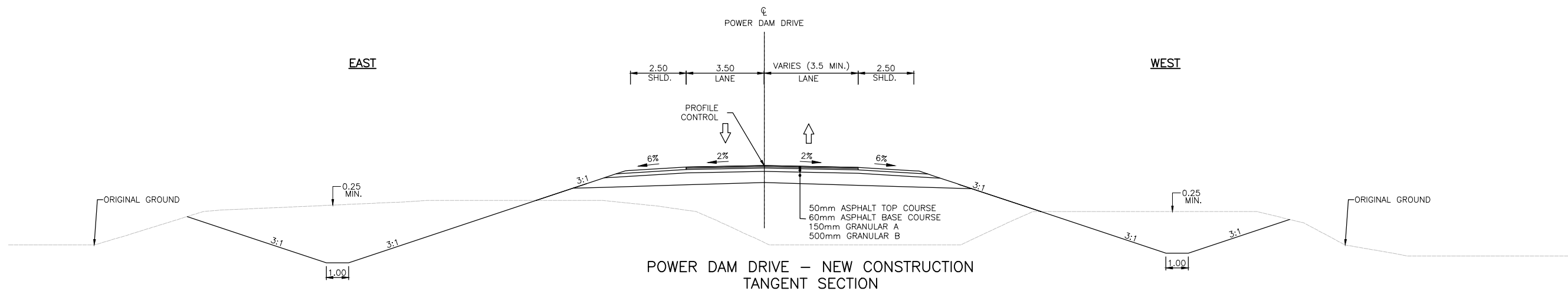
HWY 401 WBL



HWY 401 EBL

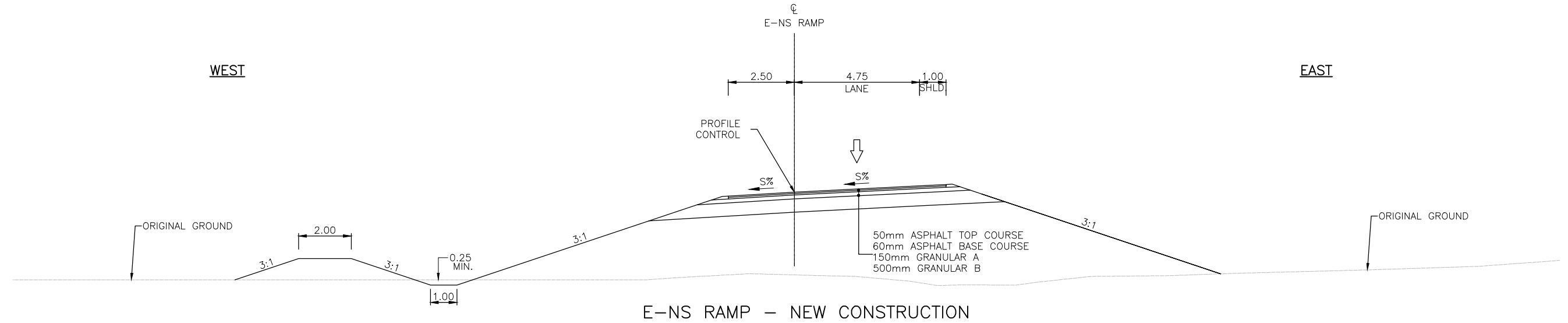
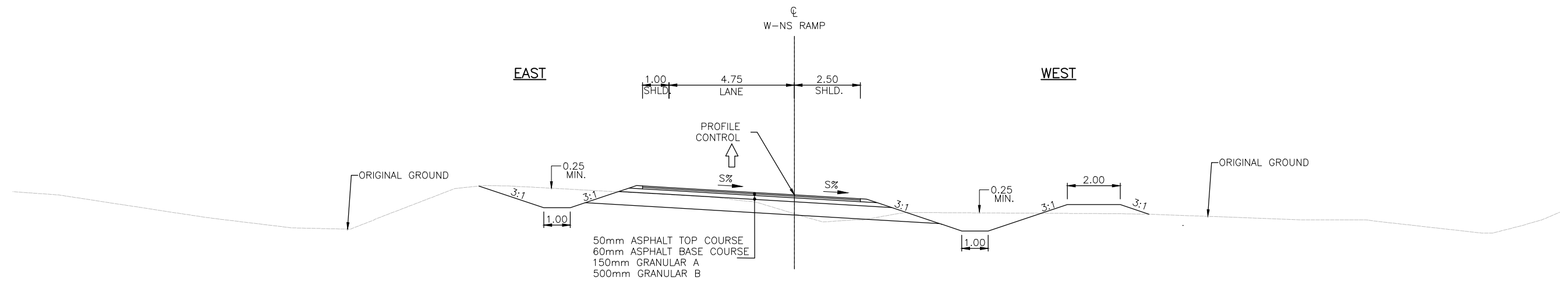
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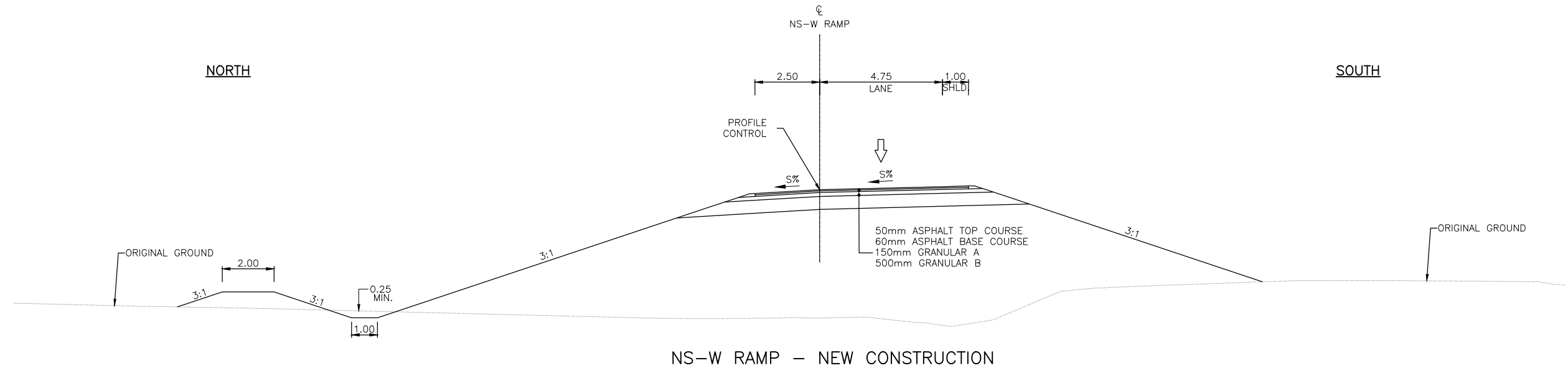
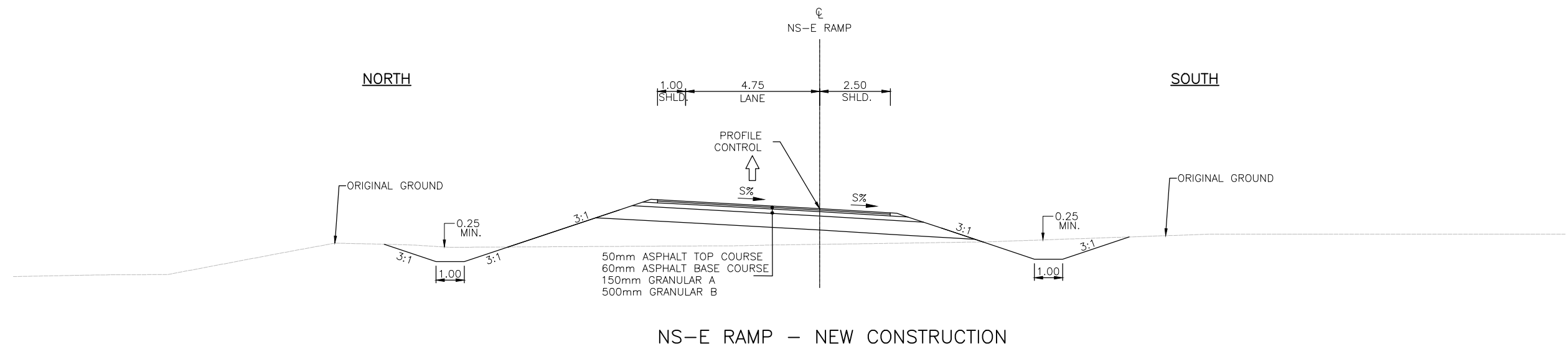
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