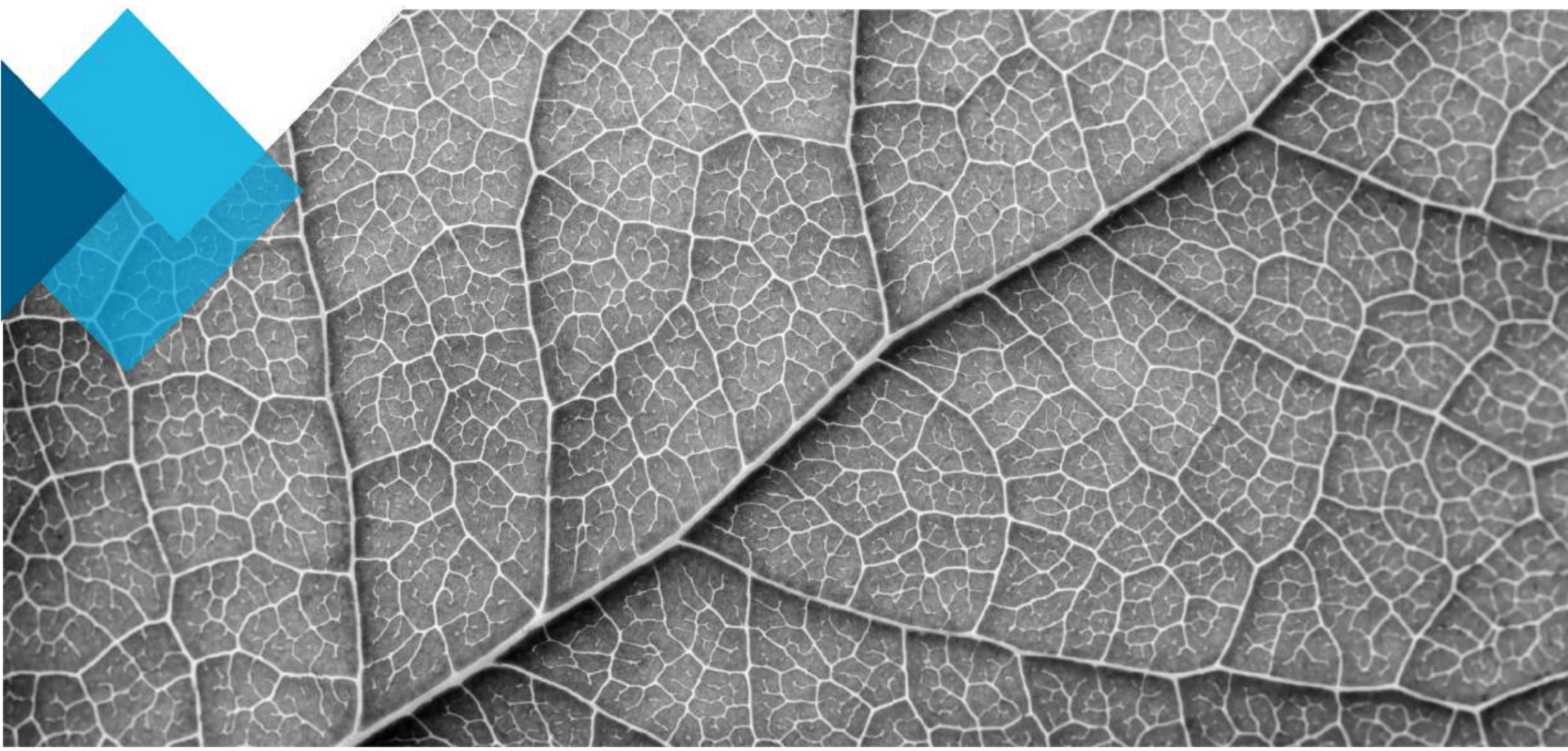
APPENDIX A

Environmental and Regulatory Review and Desktop Baseline Heritage Resource Study Reports

Environmental and Regulatory Review

Saskatoon Freeway Functional Planning Study

Saskatchewan Ministry of Highways and Infrastructure



Environment & Geoscience

August 2020

659183

Notice to Reader

This report has been prepared and the work referred to in this report has been undertaken by SNC-Lavalin Inc. (SNC-Lavalin), for the exclusive use of the Saskatchewan Ministry of Highways and Infrastructure, who has been party to the development of the scope of work and understands its limitations. The methodology, findings, conclusions and recommendations in this report are based solely upon the scope of work and subject to the time and budgetary considerations described in the proposal and/or contract pursuant to which this report was issued. Any use, reliance on, or decision made by a third party based on this report is the sole responsibility of such third party. SNC-Lavalin accepts no liability or responsibility for any damages that may be suffered or incurred by any third party as a result of the use of, reliance on, or any decision made based on this report.

The findings, conclusions and recommendations in this report (i) have been developed in a manner consistent with the level of skill normally exercised by professionals currently practicing under similar conditions in the area, and (ii) reflect SNC-Lavalin's best judgment based on information available at the time of preparation of this report. No other warranties, either expressed or implied, are made with respect to the professional services provided to Saskatchewan Ministry of Highways and Infrastructure or the findings, conclusions and recommendations contained in this report. The findings and conclusions contained in this report are valid only as of the date of this report and may be based, in part, upon information provided by others. If any of the information is inaccurate, new information is discovered or project parameters change, modifications to this report may be necessary.

This report must be read as a whole, as sections taken out of context may be misleading. If discrepancies occur between the preliminary (draft) and final version of this report, it is the final version that takes precedence. Nothing in this report is intended to constitute or provide a legal opinion.

SNC-Lavalin disclaims any liability to third parties in respect of the use of (publication, reference, quoting, or distribution), any decision made based on, or reliance on this report or any of its contents.

Executive Summary

SNC-Lavalin Inc. (SNC-Lavalin) conducted an Environmental and Regulatory Review in support of the Ministry of Highways and Infrastructure (the Ministry) Saskatoon Freeway Functional Planning Study (SFFPS). The Ministry is conducting a functional planning study to determine how the Saskatoon Freeway will look and operate. The study is scheduled to be completed in 2022.

Once constructed, the freeway is expected to be a minimum four-lane, 55-kilometre freeway that will be routed around the City of Saskatoon, with roadway connections at eight provincial highways as well as some municipal roads. The planned route begins at Highway 11 south of Saskatoon and is routed counter-clockwise around the City connecting with Highway 7 west of the city (**Figure 1.1**). It will potentially consist of 16 interchanges, five railway overpasses, at least two flyovers and a bridge crossing the South Saskatchewan River. The functional planning study commenced with a 500 m wide corridor that was identified in preceeding general location studies. Information gained within the functional planning study is used to determine where the centre line of the freeway will be and will define interchange concepts, service roads and access points on and off the freeway. When complete, the functional planning study will more precisely identify the amount of land required for construction and allow for a more precise cost estimate for the construction phase.

The objectives of this environmental and regulatory review are:

- Provide an overview of the federal and provincial assessment processes; potential federal, provincial, and municipal regulatory approvals / permits that may be required; and key environmental legislation relevant to the proposed project;
- Provide an overview of land use, soils, vegetation, fish, wildlife, and heritage resources in the region with a focus on Species of Conservation Concern (SOCC) and other environmental sensitivities based on exising information;
- Complete preliminary surveys in environmentally sensitive areas (e.g. Northeast and small swale, Hudson Bay swale, west swale, South Saskatchewan River valley);
- Identify areas requiring further biological surveys through the desktop review as well as reconnaissance field surveys;
- Identify potential routing sensitivities, which may include protected lands, environmentally sensitive areas and habitat, SOCC, areas of public concern, and heritage resources;
- Recommend potential design, construction and operational mitigations to avoid or reduce impacts, with a focus on environmentally sensitive areas; and
- Solicit input from stakeholder groups to gain information and feedback.

This study includes recommendations for future studies and general constraints/mitigations for the entire corridor, as well as site-specific constraints/mitigations for Phase 1 of the freeway (South Saskatchewan River valley, Hudson Bay swale, and Wanuskewin Heritage Park). Due to the phased nature of the functional planning study, site-specific constraints/mitigations for Phase 2 (Northeast swale and small swale) and Phase 3 (west swale) will be described in an addendum to this report. Subsequent reports will incorporate the results of surveys completed by Meewasin Valley Authority and the results of additional survey work underway in 2020.

Recommended future studies include:

- Environmental and heritage surveys for any ancillary roads, interchanges, and/or laydown areas that fall outside the corridor;
- Wetland classification surveys;
- Various species detection surveys, including: grassland bird, prairie raptor, snow track, rare vascular plant, auditory amphibian, burrowing owl, short-eared owl, sharp-tailed grouse, common nighthawk and yellow rail surveys; and
- A heritage resources impact assessment.

General routing contraints and mitigation measures are described for the following environmental sensitivities:

- Surface water and wetlands (approximately 8% of the project area);
- Native grasslands (approximately 14% of the project area);
- Widllife and Species of Conservation Concern;
- Heritage resources; and
- Contaminated sites.

Routing considerations and mitigation measures specific to Phase 1 are described for the following sensitive areas:

- The South Saskatchewan River valley is an ecologically important feature, serves as a natural corridor for wildlife movement, habitat for fish species, and has a high potential for archaeological finds;
- The Hudson Bay swale is an ecologically sensitive feature and is being considered for future inclusion into the City's natural area protection plan; and
- Wanuskewin Heritage Park is located northeast of the proposed freeway corridor and is classified as a provincial heritage site as well as is currently seeking UNESCO World Heritage status. It is surrounded by a 1.8 km radial buffer and has a high potential to contain heritage resources.

Table of Contents

Tables

Figures

Appendices

1 Introduction

SNC-Lavalin Inc. (SNC-Lavalin) conducted an Environmental and Regulatory Review in support of the Ministry of Highways and Infrastructure (the Ministry) Saskatoon Freeway Functional Planning Study (SFFPS).

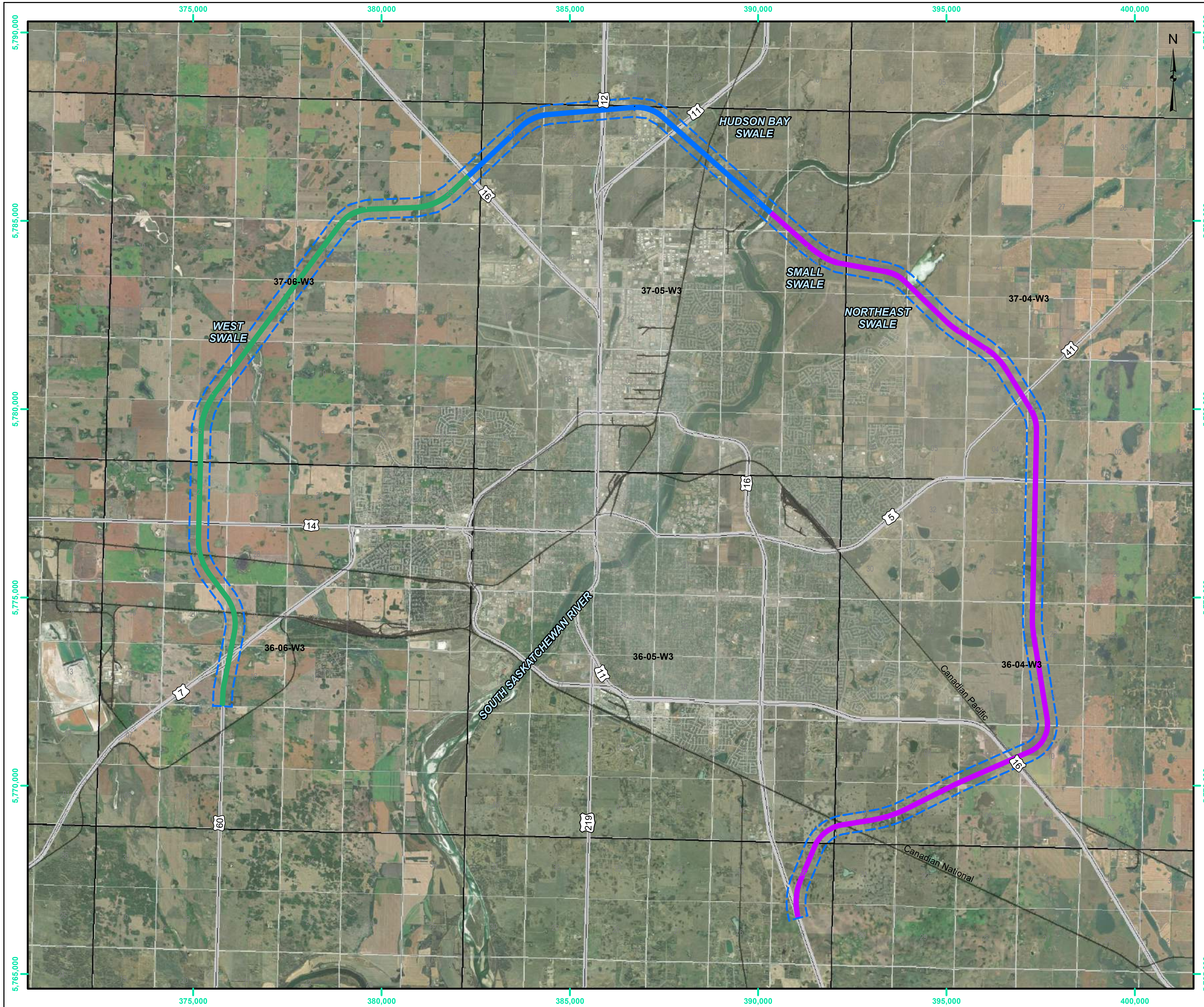
1.1 Project Overview

The Ministry is conducting a functional planning study to determine how the Saskatoon Freeway will look and operate. The study is scheduled to be completed in 2022.

Once constructed, the freeway is expected to be a minimum four-lane, 55-kilometre freeway that will be routed around the City of Saskatoon, with roadway connections at eight provincial highways as well as some municipal roads. The planned route begins at Highway 11 south of Saskatoon and is routed counter-clockwise around the City connecting with Highway 7 west of the city (**Figure 1.1**). It will potentially consist of 16 interchanges, five railway overpasses, two flyovers and a bridge crossing the South Saskatchewan River.

The functional planning study commenced with a 500 m wide corridor that was identified in preceeding general location studies. Information gained within the functional planning study is used to determine where the centre line of the freeway will be and will define interchange concepts, service roads and access points on and off the freeway. When complete, the functional planning study will more precisely identify the amount of land required for construction and allow for a more precise cost estimate for the construction phase. The study is broken into three phases including (**Figure 1.1**):

- Phase 1: North of Saskatoon between the South Saskatchewan River and Highway 16;
- Phase 2: East of Saskatoon between the South Saskatchewan River and Highway 11 (southeast terminus of the Saskatoon Freeway corridor); and
- Phase 3: West side of Saskatoon between Highway 16 and Highway 7 (southwest terminus of the Saskatoon Freeway corridor).



LEGEND

PRELIMINARY FREEWAY ALIGNMENT

- STUDY PHASE 1 (2019-2020)
- STUDY PHASE 2 (2020-2021)
- STUDY PHASE 3 (2021-2022)
- RAILWAY
- HIGHWAY
- PROPOSED FREEWAY CORRIDOR

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SERVICE LAYER CREDITS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 500 1,000 2,000 3,000 4,000 METRES

SCALE: 1:100,000

SNC · LAVALIN

CLIENT: SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION: SASKATOON FREEWAY

TITLE: PROPOSED SASKATOON FREEWAY CORRIDOR

DATE 2019 03 05 | DWG No. 659183-0000-4EDD-0021 | FIG No. 1.1 | REV 00

SIZE 11x17

Path: \\sli1653\Projects QMS\SMH\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0021 Proposed Freeway Corridor.mxd

1.2 Study Objective

The objectives of this environmental and regulatory review are:

› Provide an overview of the federal and provincial assessment processes; potential federal, provincial, and municipal regulatory approvals / permits that may be required; and key environmental legislation relevant to the proposed project.
› Provide an overview of land use, soils, vegetation, fish, wildlife, and heritage resources in the region with a focus on Species of Conservation Concern (SOCC) and other environmental sensitivities based on exising information;
› Complete preliminary surveys in environmentally sensitive areas (e.g. Northeast and small swale, Hudson Bay swale, west swale, South Saskatchewan River valley);
› Identify areas requiring further biological surveys through the desktop review as well as reconnaissance field surveys;
› Identify potential routing constraints, which may include protected lands, environmentally sensitive areas and habitat, SOCC species, areas of public concern, and heritage resources;
› Recommend potential design, construction and operational mitigations to avoid or reduce impacts, with a focus on environmentally sensitive areas; and
› Solicit input from stakeholder groups to gain information and feedback.

2 Regulatory Considerations

The following section describes: the federal and provincial assessment processes; potential federal, provincial, and municipal regulatory approvals / permits that may be required; and key environmental legislation relevant to the proposed project. The information is based on current legislation.

2.1 Environmental Assessment

2.1.1 Federal

The federal environmental assessment process is legislated by the *Impact Assessment Act*. The Physical Activities Regulations (SOR/2019-285) identify the physical activities that constitute the designated projects that may require a federal environmental assessment. Under the regulations, “the construction, operation, decommissioning and abandonment of a new all-season public highway that requires a total of 75 km or more of new right of way” is considered a designated project. The proposed freeway does not meet the 75 km threshold hence is not expected to require a federal environmental assessment.

2.1.2 Provincial

The Environmental Assessment Act provides a coordinated review of developments in Saskatchewan and provides an approval-in-principle that is not intended to duplicate regulatory programs but acts as an umbrella to ensure all relevant impacts for a project are addressed (Government of Saskatchewan 2018). The Saskatchewan environmental assessment process begins with the submission of a Technical Proposal (TP) to the Saskatchewan Ministry of Environment (ENV). The TP is intended to provide ENV with enough information to determine regulatory requirements, including whether the project is considered a development pursuant to *The Environmental Assessment Act*. If the project is not considered a development, the project may proceed as proposed, subject to any conditions and applicable provincial regulatory requirements. If the project is considered a development, it will require ministerial approval and be subject to an Environmental Impact Assessment (EIA). The Act defines a development to mean any project, operation or activity, or any alteration or expansion of any project, operation or activity, which is likely to:

- Influence any unique, rare, or endangered feature of the environment;
- Substantially utilize any provincial resource, and in doing so, pre-empt the use, or potential use of that resource for any other purpose;
- Cause the emission of any pollutants or create by-products, residual or waste products which require handling and disposal in a manner that is not regulated by any other Act or regulation;
- Cause widespread public concern because of potential environmental changes;
- Involve a new technology that is concerned with resource utilization and that may induce significant environmental change; and/or
- Have a significant impact on the environment or necessitate a further development, which is likely to have a significant impact on the environment.

The proposed project has the potential to influence a unique, rare, or endangered feature of the environment (e.g. the Northeast and small swales) and has the potential to cause widespread public concern because of potential environmental changes, hence, will require submission of a TP to determine if the project is subject to an EIA.

Developments subject to an EIA must submit an Environmental Impact Statement (EIS) to the Environmental Assessment and Stewardship Branch (EASB) of ENV for review and approval. The EIS is then reviewed by the Saskatchewan Environmental Assessment Review Panel (SEARP), a multidisciplinary panel consisting of representatives from various provincial ministries and agencies with environmental and socioeconomic interests or responsibilities. If the EIS does not contain all the required information, ENV will issue Technical Review Comments and direct the proponent to provide additional information to address deficiencies. Once the EIS is complete, it will be made available for public review. Following the completion of the public review period, the EASB will make a recommendation to the Minister for a decision on whether the project can proceed with conditional approval. Conditions may include, among other things, a requirement to compensate for lost wetland and grassland habitat. Once approval is granted, the proponent can apply for additional permits and approvals.

2.1.3 Meewasin Valley Authority

The Meewasin Valley Authority (MVA) is a conservation agency dedicated to conserving the cultural and natural resources of the South Saskatchewan River valley. The MVA has the power to coordinate or control the development of public land in accordance with the Development Plan as per section 10 of *The Meewasin Valley Authority Ac*t. The Saskatoon Freeway is located, in part, on lands under the jurisdiction of the MVA (Schedule A of the Act) however the Province is exempt from the MVA Development Review process and not subject to Development Review by the Authority. MVA is a key member of the Technical Working Group (TWG) for Environment and Heritage established as part of the Project Team and has been contracted by the Ministry to collect baseline environmental data within the Northeast swale and surrounding area (including the small swale). As part of the TWG, MVA will participate in mitigation planning for the freeway design through environmentally sensitive areas to ensure that changes made to the river channel within their jurisdiction are compatible with the Authority's Development Plan.

2.2 Regulatory Approvals / Permits and Requirements

Numerous other environmental federal and provincial approvals / permits may be required for development of the proposed project. The project will also be subject to various environmental legislation. **Table 2.1** provides a list of potential approvals / permits and key legislation, however, this list is not inclusive and there may be other applicable approvals / permits and legislation. The Ministry will continue to engage with provincial and municipal agencies as the project progresses and once the layout is determined to discuss applicable approvals and permits.

Table 2.1 Potential environmental permits / approvals and key legislation

Permit and/or Approval	Description	Agency	Applicable Legislation or Regulation
Federal			
Migratory Birds Damage or Danger Permit	The Act prohibits the disruption or loss of active migratory nests, or harm or loss of eggs, young, and breeding adults. Under section 26(1) of the regulations, permits are required: to scare or kill migratory birds; for the collection, destruction, and disposal of eggs of migratory birds; for the removal, relocation, and/or destruction of birds/nests/eggs.	Environment and Climate Change Canada (ECCC)	› *Migratory Birds Convention Act, 1994* › Migratory Birds Regulations
n/a	The *Species at Risk Act* (SARA), provides legal protection of species listed in Schedule 1 to prevent them from becoming extirpated or extinct, and to provide necessary actions for the recovery of a species. Key considerations under SARA include protection of species' critical habitat (Sections 52 and 58); prohibition of killing, harming or taking of species at risk (Section 32); and prohibition of damage or destruction of residences of Species at Risk (Section 33).	ECCC	› *Species at Risk Act*
Fisheries Act Self Assessment / Review / Authorization	The Act requires that projects avoid causing the death of fish [Section 34.4(1)], as well as the avoiding the harmful alteration, disruption or destruction of fish habitat [Section 35(1)] unless authorized by the Minister of Fisheries and Oceans Canada (DFO). This applies to work being conducted in or near almost all waterbodies in Canada. Activities within the South Saskatchewan River and other watercourses will be subject to a request for review to DFO before proceeding and is expected to require an authorization. The Act also prohibits the deposition of deleterious substances in a waterway [section 36(1) to 36(6)].	Fisheries and Oceans Canada (DFO)	› *Fisheries Act*
Approval for a Major Work	An owner who proposes to construct, place, alter, rebuild, remove or decommission a major work in, on, over, under, through or across any navigable water must make an application for an approval to the minister.	Transport Canada	› *Canadian Navigable Waters Act*

SNC·LAVALIN

Permit and/or Approval	Description	Agency	Applicable Legislation or Regulation
Provincial			
n/a	This Act protects the air, land, and water resources of Saskatchewan through the regulation and control of potentially harmful activities and substances. It regulates activities and materials that may affect the environment, including hazardous substances, hazardous waste, industrial waste, sewage and sewage works and waterworks. EMPA sets out permitting/approval processes; environmental protection plans, corrective action plans, reporting responsibilities; and consequences/penalties.	ENV	› *The Environmental Management and Protection Act, 2010* › The Environmental Management and Protection (Saskatchewan Environmental Code Adoption) Regulations › The Hazardous Substances and Waste Dangerous Goods Regulations
Aquatic Habitat Protection Permit (AHPP)	Section 38(4) of the Act prohibits the direct or indirect alteration of any waterbody or wetland without express authorization to do so. Aquatic habitat alteration may be allowed if authorization has been provided via a permit, a previously accepted environmental protection plan, or the Environmental Code (section 38(5)). Authorizations are not required if the watercourse or waterbody is wholly contained within the boundaries of land owned by the person carrying out the alteration and the surface water does not flow directly or indirectly into other surface water that is not wholly contained within the boundaries of that land (section 38(6)).	ENV	› *The Environmental Management and Protection Act, 2010*
n/a	This Act protects wildlife and wild species at risk in Saskatchewan (including most migratory and non-migratory birds that are not protected federally) from being disturbed, collected, harvested, captured, killed, sold or exported without a permit (Sections 31, 32 and 33). In addition, the den, nest, dam, or usual place of habitation of wildlife and wild species at risk is also protected from disturbance and destruction.	ENV	› *The Wildlife Act, 1998* › The Wildlife Regulations
Research Permit	Section 21(2) of the Act requires permits for surveys, research or other activity to detect or observe any species, wild species or wild species at risk, or assess the habitat of any species, wild species at risk, for a commercial, scientific, academic or other purpose prescribed in the regulations without a licence issued by the director.	ENV	› *The Wildlife Act, 1998* › The Wildlife Regulations
Special Collection Permit	This Act protects fish, crustaceans, molluscs, and aquatic invertebrates in Saskatchewan. It also protects the eggs or sperm from these species, as well as the individual parts of these species. This includes species not considered SOCC. Under Section 13 of this Act "*No person shall fish or acquire, raise, possess, use, culture, import, introduce, process, package, market, carry or transport any fish or dispose of any fish or allow any fish to be wasted except in accordance with any licence or any provisions of this Act or the Fisheries Act (Canada) or its regulations.*"	ENV	› *The Fisheries Act, 1994*

Permit and/or Approval	Description	Agency	Applicable Legislation or Regulation
n/a	This Act concerns the spread and propagation of Prohibited, Noxious, and Nuisance Weeds. Section 26(1) outlines requirements for machines to be thoroughly cleaned, inside and out, to ensure the removal or destruction of any prohibited or noxious weeds before the machine is moved. Permits would be required if chemicals were to be used near waterbodies/watercourses.	n/a	› *The Weed Control Act, 2010*
n/a	These Acts concern the spread and propagation of pests that may affect the environment. Sections 5 to 7 require that every person take measures to destroy pests, soils, or any other matter that may contain pests. Requirements for training and certification associated with the application of of pest control products are also stipulated.	n/a	› *The Pest Control Act* › *The Pest Control Products (Saskatchewan) Act*
Water Rights Licence	Under section 50 of the Act a licence is required for the right to use water (surface water or groundwater).	WSA	› *The Water Security Agency Act*
Approvals to Construct / Operate Drainage Works	Under section 59 of the Act and section 11 of the regulations, approval is required for the construction, extension, alteration and operation of drainage works.	WSA	› *The Water Security Agency Act* › The Water Security Agency Regulations
Heritage Property Act Clearance / Heritage Resource Impact Assessment (HRIA) Permit / Mitigation / Research Investigation Permit	If an operation or activity which may be undertaken is likely to result in the alteration, damage or destruction of heritage property, the minister may require under section 63(that person to: (a) carry out an assessment to determine the effect of the proposed operation or activity on that heritage property; (b) prepare and submit to the minister a report containing the assessment mentioned in clause (a); and (c) undertake any salvage, preservation or protective measures, or any other action, that the minister may specify. A Research Permit is required under section 67 to: (a) carry out a survey; (b) make collections; or (c) conduct excavations or other activities; which may disturb or dislocate archaeological or palaeontological objects on a heritage property.	MPCS	› *The Heritage Property Act, 1980*
Utility Crossing Agreements	Agreements with utility companies to regarding movement of existing utilities to accommodate the freeway.	Various utility and oil and gas companies	n/a

n/a - denotes no permit/approval required

3 Stakeholder Engagement

Stakeholder engagement is an ongoing process that will continue throughout the duration of the functional planning study. The goal of the stakeholder engagement program is to build an understanding with stakeholders and the public; create safe environments for information sharing and feedback; and develop appropriate engagement and communication tools and solutions that are sensitive and responsive to the needs of stakeholders. The program includes engagement with all affected and interested community members, including: landowners, associations, community groups, rural and urban levels of government, non-profit corporations, industry representatives, utility corporations, heritage groups, environmental groups, Metis organizations, and First Nations communities and entities.

The final alignment of the Saskatoon Freeway has the potential to impact Treaty and/or Aboriginal rights and/or traditional use and will trigger Duty to Consult obligations with regards to fish and wildlife management, land reservations, land use planning, changes to public access, and environmental approvals.

In addition to general stakeholder engagement activities, the functional planning study also includes a series of Technical Working Group (TWG) meetings. Each key discipline has a TWG that forms part of the overall Project Team. The goal of the TWG meetings is to solicit feedback related to specific studies and to share information related to the progress and findings of the functional planning studies. Specifically, the Environment & Heritage TWG meeting includes; in additional to members from the Ministry and the Project Team, the following invited participants:

› The Meewasin Valley Authority;
› Wanuskewin Heritage Park;
› The City of Saskatoon;
› The Northeast Swale Watchers (resigned from the TWG in Spring 2020);
› The Saskatoon Tribal Council;
› The Water Security Agency (joined TWG in Spring 2020);
› The Saskatchewan Ministry of Environment (joined TWG in Summer 2020); and
› The Saskatchewan Nature Society (joined TWG in Summer 2020).

Main environmental and heritage concerns noted to date include:

› Road infrastructure planned within environmentally sensitive areas, specifically the Northeast swale and small swale and, to lesser extent, the Hudson Bay swale and west swale;
› Stormwater management within environmentally sensitive areas;
› Loss of wetlands throughout the project area;
› Changes to the hydrology of the area;
› Disturbance to archaeological and heritage features that may be located within the corridor; and
› Road infrastructure planned in proximity to Wanuskewin Heritage Park (specifically related to noise and viewscape).

4 Description of the Environment

This section provides a high-level description of the hydrometeorological environment, biophysical environment, protected areas and heritage resources based on existing available data as well as reconnaissance biological field-level surveys.

4.1 Hydrologic Environment

4.1.1 Methods

A desktop review of the hydrometeorological conditions of the region was conducted, based on a hydrological study area including the proposed freeway corridor and key regional water features. Data was collected from the various sources including:

- Topographical datasets from Natural Resources of Canada (2013);
- Climate data from Environment and Climate Change Canada (ECCC 2019), based on the Saskatoon Airport meteorological station (Climate ID: 4057120);
- Evaporation data from Agricultural and Agri-Food Canada (2010); and
- Stream flow data from various Water Survey of Canada (WSC) hydrometric stations (WSC, 2019), shown on **Figure 4.1**.

A flow frequency analysis was completed using the SNC-Lavalin flow assessment and simulation tool (FAST, Henze et. al. 2018). General drainage conditions of the study area were described.

Detailed drainage analysis was completed by the drainage TWG and is further described in the Functional Planning report.

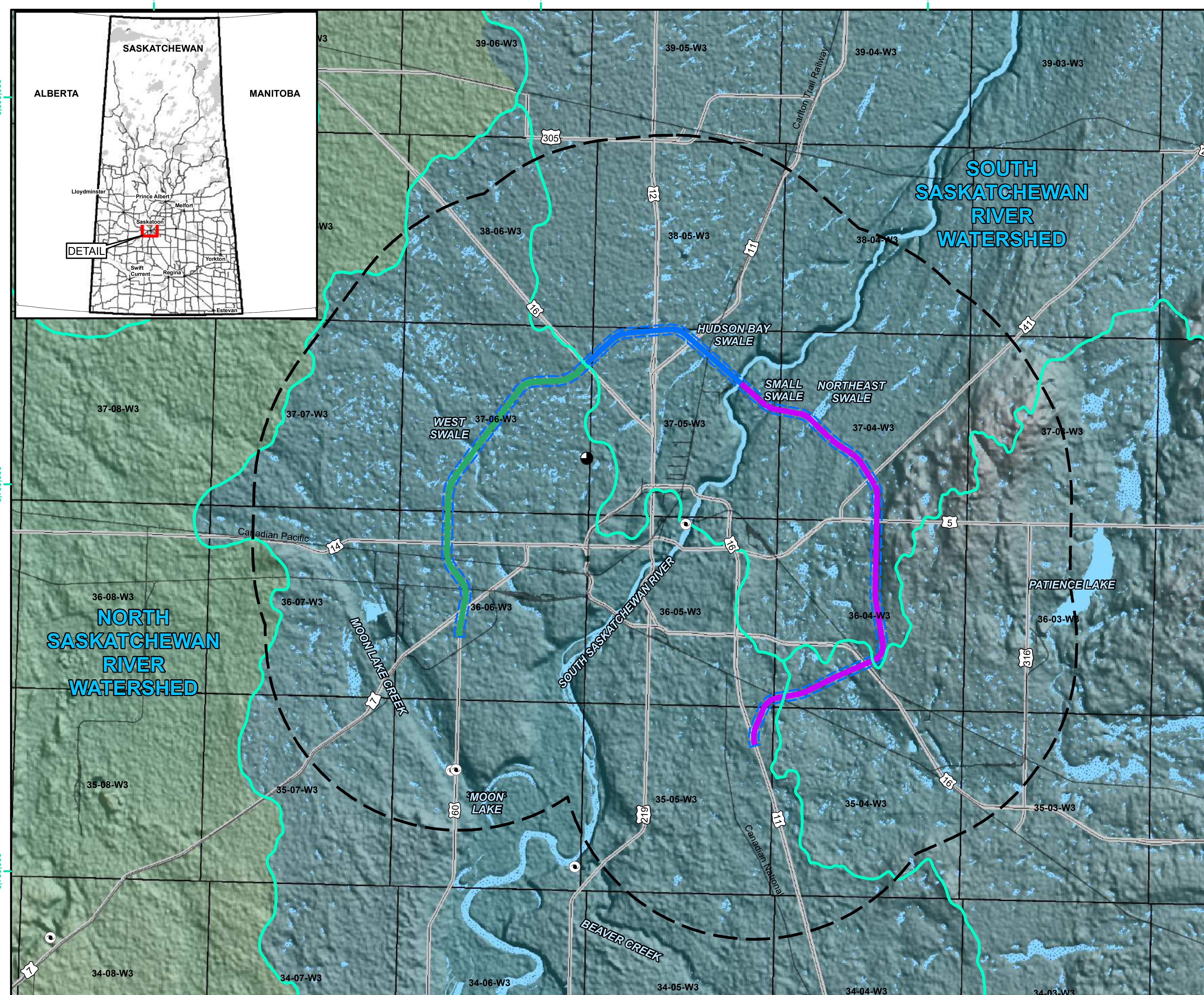
4.1.2 Results

The proposed freeway corridor is located within the South Saskatchewan River Watershed and in the Saskatoon Plain landscape of the Moist Mixed Grasssland Ecoregion in the Prairie Ecozone (Acton et al. 1998). The ground elevation in the study area slopes from approximately 510 masl in the west to 535 masl in the east to 490 masl at the South Saskatchewan River which is entrenched nearly 60 m into the Saskatoon Plain. The local landscape consists of undulating, sandy to silty glacio-lacustrine plains (Action and Ellis, 1978). Regional drainage characteristics of the study area include limited runoff to downstream areas due to large internal wetlands, sloughs and lakes. The hydrometeorological conditions of the proposed freeway location are described in the following sections.

4.1.2.1 Climate

The proposed location of the freeway is in the semi-arid region of Canada where warm-moist summers and cold-dry winters prevail. Historical air temperature profiles (daily minimum, average, and maximum), precipitation (rainfall and snowfall, water equivalent), and evaporation averages of the area are presented in **Figure 4.2**. Historical extreme air temperature and precipitation events are presented in **Table 4.1**.

The daily average temperature over the 30-year period (1981 to 2010) ranges from a high of 18.5ºC in July to a low of -15.5ºC in January (ECCC 2019). The average annual precipitation is approximately 354 mm, with 26% occurring as snowfall. The highest average monthly rainfall typically occurs in June (65.8 mm), and the highest average monthly snowfall occurs in January (17.5 mm, water equivalent). Most of the snowfall occurs from the middle of October to the middle of April.



LEGEND

- SASKATOON AIRPORT CLIMATE STATION
- HYDROMETRIC GAUGING STATION
- STUDY PHASE 1 (2019-2020)
- STUDY PHASE 2 (2020-2021)
- STUDY PHASE 3 (2021-2022)
- RAILWAY
- HIGHWAY
- WATERCOURSE
- WATERBODY
  - Unknown
  - Permanent
  - Intermittent
- HYDROLOGY STUDY AREA
- PROPOSED FREEWAY CORRIDOR

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	LB	KG	HY	JP

0 1 2 4 6 8 KILOMETRES

SCALE: 1:175,000

SNC·LAVALIN

CLIENT	PROJECT LOCATION
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE	SASKATOON FREEWAY

TITLE

HYDROLOGY OVERVIEW

DATE	2019 03 05	DWG No.	659183-0000-4HDD-0001	FIG No.	4.1	REV	00

SIZE 11x17

Path: \\sli1653\Projects QMS\SMH\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4HDD-0001 Hydro Overview.mxd

Table 4.1 Extreme daily climate events at the Saskatoon climate station (ECCC 2019)

Parameter	Quantity	Date
Rainfall (mm)	96.6	24 June 1983
Snowfall (depth in cm)	36.0	10 January 2007
High Air Temperature (ºC)	40.6	05 June 1988
Low Air Temperature (ºC)	-50.0	01 February 1893

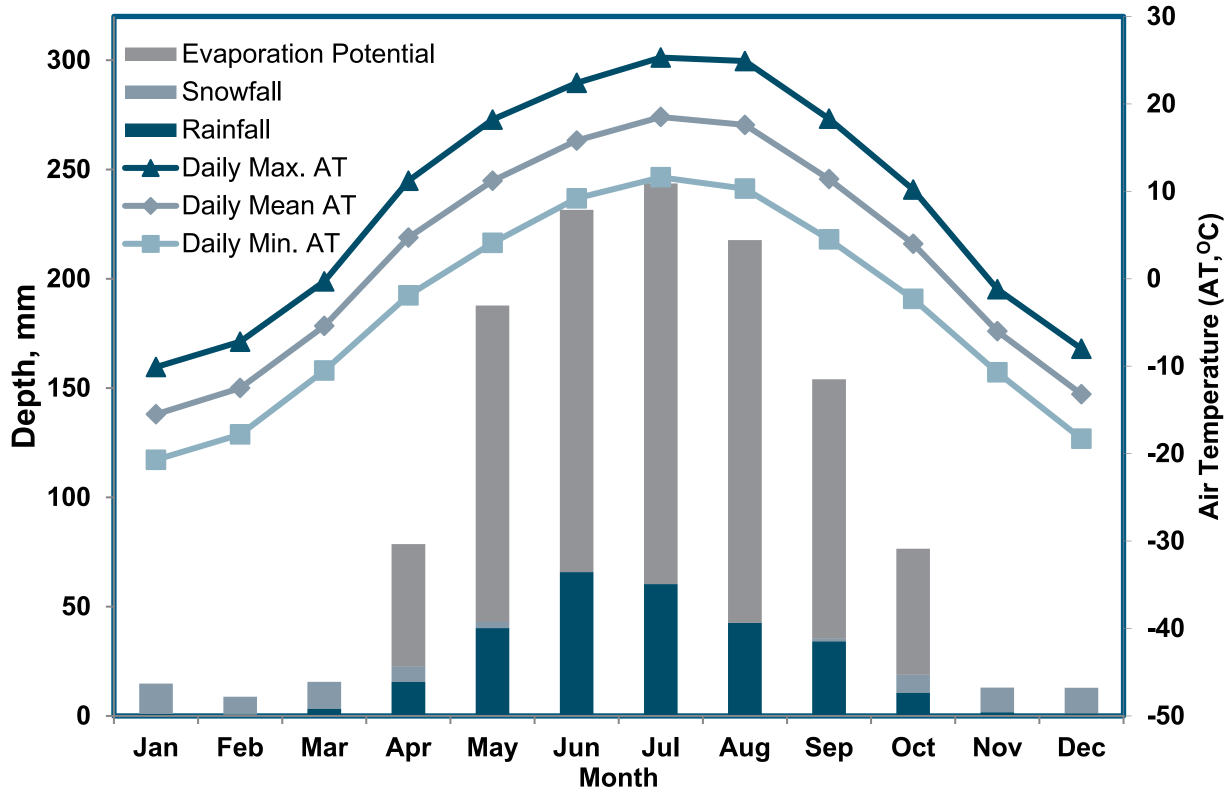


Figure 4.2 Precipitation and air temperature (AT) normals over a 30-year period (1981 to 2010) data obtained from ECCC (2019), and average evaporation potential estimates over a 71-year period (1935 to 2006) data obtained from AAFC (2010)

Monthly averages of evaporation potential estimates for the Saskatoon station over a 71-year period (1935 to 2006, AAFC 2010) are presented in **Figure 4.2**. The annual average of the evaporation potential is 901 mm. Gross evaporation typically peaks in July with an average value of 183.3 mm. During winter (November to March), there is no significant gross evaporation due to low air temperatures and/or ice and snow cover. The air temperature profiles support the gross evaporation trend. The plots indicate a significant moisture deficit in the project area due to a higher evaporation demand than available precipitation during the months with average air temperatures above 0°C.

Intensity-Duration-Frequency (IDF) curves describe probability of extreme rainfall events. The IDF curves are vital information for estimating surface water runoff and to design hydraulic structures such as culvert crossings for the proposed freeway. The IDF curves for the Saskatoon climate station are summarized in **Table 4.2** (ECCC 2018). The extreme rainfall events of 50-year and 100-year return periods each with 24hour duration are approximately 82.8 mm and 92.1 mm, respectively.

Detailed analysis was completed by the drainage TWG and is further described in the Phase 1 Functional Design Report.

Table 4.2 Saskatoon climate station IDF curves summary (based on data from 1960 to 2017) from ECCC (2018)

Return Period	Duration	
(years)	1-Hour	24-Hours
1 in 2	14.7	36.1
1 in 5	26.0	51.1
1 in 10	33.4	61.0
1 in 25	42.8	73.5
1 in 50	49.8	82.8
1 in 100	56.7	92.1

4.1.2.2 Runoff

The dominant surface water features that intersect the proposed freeway corridor are the South Saskatchewan River, Hudson Bay swale, Northeast swale, and the west swale (**Figure 4.1**). Numerous wetlands are also present within the proposed freeway corridor. The South Saskatchewan River flows northeast, merges with North Saskatchewan River 42 km east of Prince Albert, becomes the Saskatchewan River, and flows into Lake Winnipeg. A summary of the gauged streamflow of the South Saskatchewan River is presented in **Figure 4.3**. The gauging station is at approximately 10 km upstream of the freeway crossing along the river. The gauging station has a gross drainage are`a of 141,000 km^2 and an effective drainage area of 88,100 km^2.

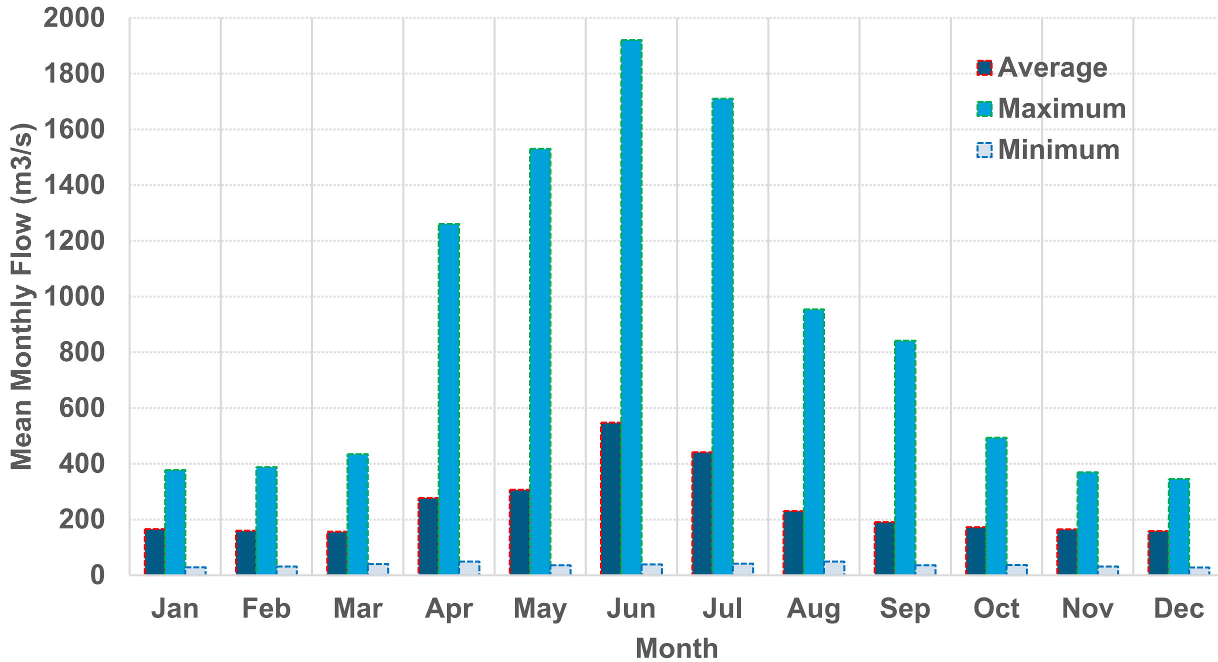


Figure 4.3 Monthly stream flow summary of South Saskatchewan River at Saskatoon (05HG001) over a period of 106 years (1911 to 2017) (data obtained from WSC (2019)

The South Saskatchewan River typically peaks in June following the upstream snowmelt in April and the subsequent delayed flows from the Gardner Dam located approximately 150 km upstream along the river. The flow summary indicates monthly average flow to a maximum of approximately 1,900 m^3/sec in June. The maximum instantaneous flow observed was approximately 4,190 m^3/sec occurred in June 1953. **Figure 4.4** presents a summary of flow frequency analysis completed by using the stream flow data and four probability distributions. The observed extreme flow of 4,190 m^3/sec is close to the 1 in 100-year estimates of Pearson III and Gumbel (EV1) distributions.

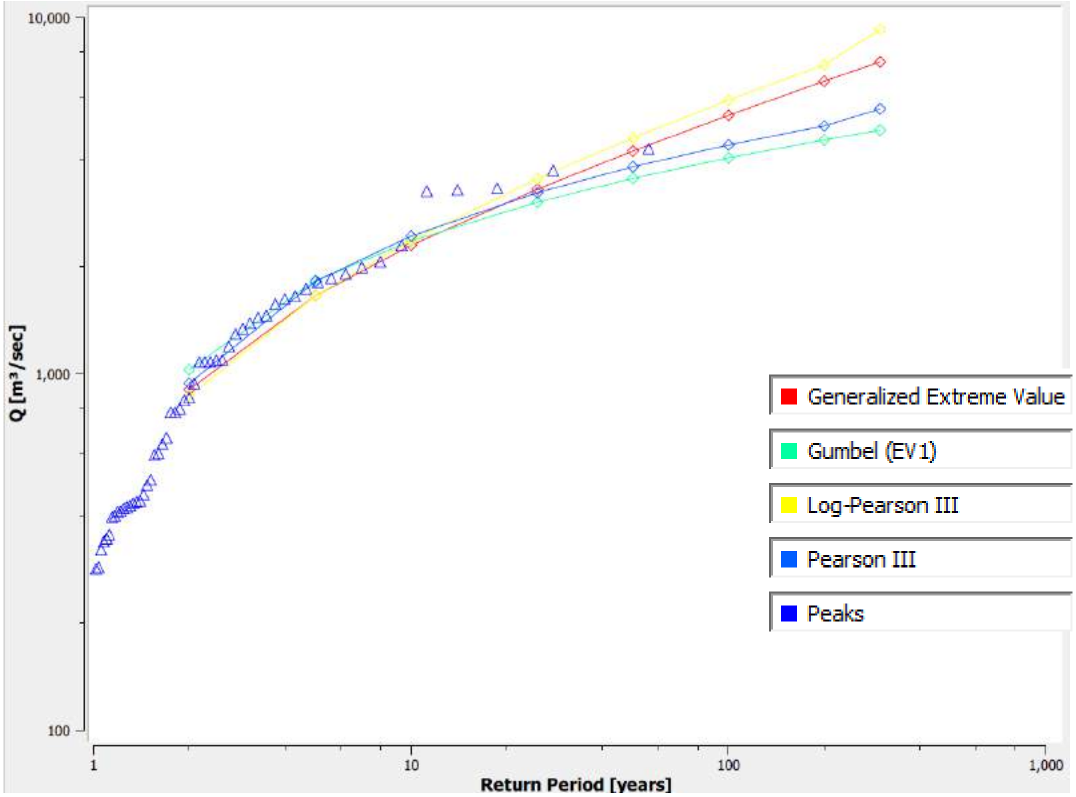


Figure 4.4 A summary of the flow frequency analysis for the South Saskatchewan River

Streamflow and runoff in the study area varies seasonally. Although winter has the lowest levels of precipitation, spring runoff releases the storage of up to five months of precipitation in the snowpack, during a brief melt period. On average, approximately 75% of the natural runoff and streamflow occurs between March and June. Occasional summer and fall rains provide sufficient moisture to produce brief periods of runoff that account for the remaining 25% of the average annual flow. The stormwater from the City of Saskatoon drains into the South Saskatchewan River. Numerous wetlands are present in the the study area which collect significant amounts of the surface runoff, and combined with the high evaporation demands, the normal runoff is significantly less than the normal annual precipitation. In drought years, the runoff can diminish to a small fraction of the normal value, and in wet years it can greatly exceed the norm. The dominant land use in the study area is agriculture. The surface water runoff generation potential in the study area is affected by the seasonal variation of onsite agricultural land use characteristics, precipitation, antecedent soil moisture conditions, and wetland water levels.

Detailed analysis was completed by the drainage TWG and is further described in the Phase 1 Functional Design Report.

4.2 Terrain and Soils

4.2.1 Methods

A desktop analysis of the terrain and soils in the soils study area was conducted using soil reports from Agriculture and Agri-Food Canada (2012), the Saskatchewan Institute of Pedology (Acton and Ellis 1978), and the Saskatchewan Land Resource Unit (2009). These reports are available for the majority of the crop producing regions in the province and were used to provide a description of the soil landscape in the soils study area. Terrain and soil data for the soils study area were summarized, including soil classification and descriptions, soil capability class, and local topography. Soil classification and soil capability maps for the soils study area were developed using digitized databases sourced from the literature.

The vegetation and soils study area includes the proposed freeway corridor surrounded by a 300 m buffer zone (**Figure 4.5**). The vegetation and soils study area occupies approximately 6,034 ha and the proposed freeway right-of-way occupies approximately 2,716 ha.

4.2.2 Results

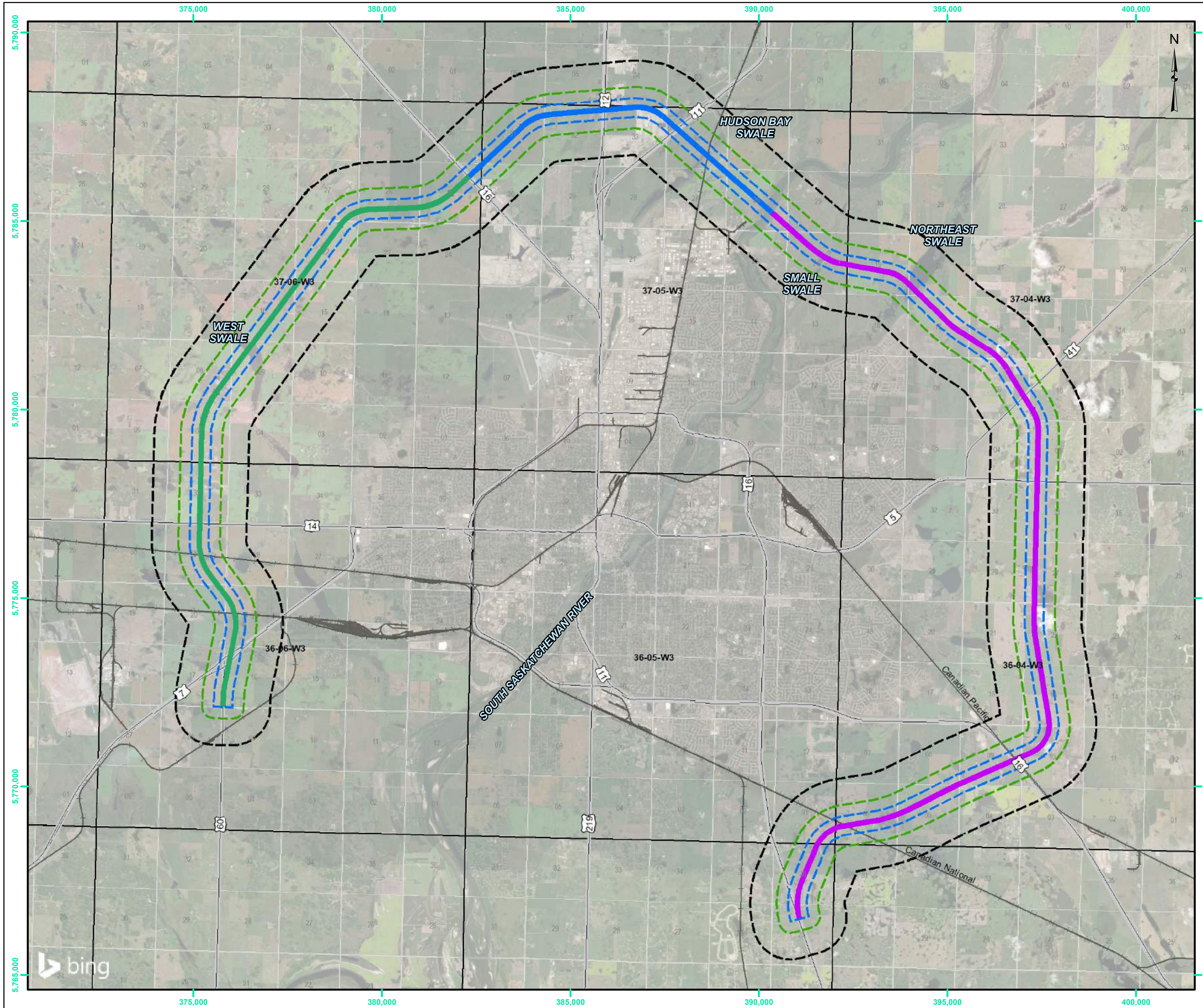
4.2.2.1 Terrain

The soils study area is located in the Moist Mixed Grassland Ecoregion of the Prairie Ecozone (Acton et al. 1998). However, the project is very close to the border of the Aspen Parkland Ecoregion. The landscape in this area is generally undulating, with local relief typically less than three metres, except in the Minichinas Hills where some rolling hills are found (Acton et al. 1978). The South Saskatchewan River valley is a relatively deep valley which contains the lowest elevations in the area. Surficial deposits are primarily glacio-fluvial and glacio-lacustrine in origin, deposited during the most recent glacial period. In most locations in the region, the landforms have remained relatively unchanged since the glaciers retreated, and only local runoff and wind erosion have influenced the area since that time. The South Saskatchewan River valley is an exception, as recent alluvial and colluvial soil deposits are present in the floodplains and valleys of this river.

The soils in the study area fall within the Dark Brown Soil Zone of Saskatchewan (Saskatchewan Land Resource Unit 2009; Acton and Ellis 1978). The soils in the study area are composed of multiple associations and map units (Appendix B).

The deposits generally consist of an undulating sandy to clayey material of glaciolacustrine origin, with a matrix with embedded stones and gravels (Acton et al. 1978). These deposits are distributed unevenly, resulting in a hummocky landscape with irregular patterns of short, steep slopes giving rise to emergent knolls and rounded depressional zones or “kettles” which form small to large wetlands on the landscape.

The majority of the vegetation and soils study area is between 490 masl and 535 masl, with the highest elevations located to the east, and the lowest elevations in the South Saskatchewan River valley. The range of slope classes within the vegetation and soils study area varies between very gently sloping to strongly sloped (0% to 30% incline). The majority of the study area however ranges between very gently sloping to roughly undulating (0.5% to 5%), with steep slopes near the South Saskatchewan River valley.



LEGEND

PRELIMINARY FREEWAY ALIGNMENT

- STUDY PHASE 1 (2019-2020)
- STUDY PHASE 2 (2020-2021)
- STUDY PHASE 3 (2021-2022)
- RAILWAY
- HIGHWAY
- PROPOSED FREEWAY CORRIDOR
- VEGETATION AND SOIL STUDY AREA
- WILDLIFE STUDY AREA

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SERVICE LAYER CREDITS: © 2020 MICROSOFT CORPORATION EARTHSTAR GEOGRAPHICS SIO.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 500 1,000 2,000 3,000 4,000 METRES

SCALE: 1:100,000

SNC·LAVALIN

CLIENT: SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION: SASKATOON FREEWAY

TITLE: BIOPHYSICAL STUDY AREAS

DATE	2019 03 05	DWG No.	659183-0000-4EDD-0001	FIG No.	4.5	REV	00

SIZE 11x17

Path: \\sll1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0001 Biophysical Study Areas.mxd

4.2.2.2 Soil Classification

The vegetation and soils study area is within the Dark Brown Soil Zone of Saskatchewan and the soils are primarily Chernozemic, having formed under grassland vegetation. The distribution of soil associations and a description of soil map units occurring within the vegetation and soils study area is presented in **Figure 4.5**. Approximately 60% of the soils in the study area are Bradwell, Elstow, or Scott Soils, with smaller contributions from a number of other map units.

Asquith soils are dark brown soils that occur throughout the study area. The soils are neutral to moderately alkaline, and soil texture ranges from loamy sand to loam, with sandy loam being predominate. Asquith soils are generally free of stones, although some areas where glacial till is close to the surface may be excessively stony. The landscape of Asquith soils range from gently undulating to moderately rolling, and generally exhibit a knoll and depression pattern. There are three types of Asquith soils that occur within the vegetation and soils study area: Orthic, Carbonated, and Saline dark brown soils. Asquith soils are generally Class 4 or Class 5 soils for agricultural capability

Alluvium soils are a diverse complex of soils of various origins that occur in a single map unit in the northern portion of the study area. These soils extremely variable in texture, ranging from sand to loam. Alluvium soils are associated with flood plains of major rivers and streams. Alluvium soils are generally free of stones but may be underlain by till deposits. Alluvium soils in the region are dominantly carbonated or saline rego humic Gleysols, associated with poorly drained floodplains. Generally speaking, these soils are uncultivated Class 5 and Class 6 soils for agricultural capability.

Biggar soils are dark brown soils that occur in the northern portion of the study area. The soils are neutral to strongly alkaline and are sandy loam to loamy sand in texture. Biggar soils range from stone free to excessively stony. Landforms generally follow a weak knoll and depression pattern. There are three types of Biggar soils that occur within the study area: Orthic, Carbonated, and Saline. Biggar soils are all Class 4 soils for agricultural capability. Biggar soils also are found in complex with eroded till Weyburn soils in the northern part of the study area.

Bradwell soils are dark brown soils that occur in the northern portion of the study area. The soils are generally slightly acidic to neutral and are predominantly loam and fine/very fine sandy loam in texture. Bradwell soils are generally stone-free but may slight to moderate stoniness where glacial till is present in the surface. There are multiple types of Bradwell soils that can be found in the study area: Orthic, Calcareous, Eluviated, Carbonated, and Saline. Bradwell soils are all Class 3 for agricultural capability. Bradwell soils are also found in complex with Biggar, Elstow, and Weyburn soils in the study area.

Elstow soils are dark brown soils that occur predominantly in the western portion of the study area. The soils are generally low in salinity and are predominantly loam in texture, but may have a mixture of silt loam, silty clay loam, and clay loam. Elstow soils are generally stone free but low to moderate amount of stones may be present in areas where glacial till is present in the surface. Landforms are generally undulating with a knoll and depression pattern. There are two types of Elstow soils that occur within the study area: Orthic and Eluviated. Elstow soils are all Class 3 soils for agricultural capability. Elstow soils are also found in complex with Hanley and Sutherland soils in the study area.

Hillwash soils are a complex of Regosolic, Chernozemic and Podzolic soils that occur in a single map unit along the northern portion of the study area, along the South Saskatchewan River. Landforms are gently to steeply sloping, with areas dominated by Regosolic soil being steep and areas dominated by Chernozemic soils being gently sloped. Hillwash soils are classified as Class 5 and Class 6 for agricultural capability.

Hanley soils are dark brown soils that occur on the southeastern portion of the study area. The soils are generally low in salinity and are predominantly loam in texture, but may have a mixture of silt loam, silty clay loam, and clay loam. Hanley soils are generally stone free but low to moderate amount of stones may be present in areas where glacial till is present in the surface. Landforms are generally undulating with a knoll and depression pattern. Only one type of Hanley soils occur within the study area: Solonetzic. Hanley soils are Class 3 and Class 4 soils for agricultural capability. Hanley soils are also found in complex with Elstow soils.

Runway soils are a complex of Chernozemic, Regosolic and Gleysolic soils that occur in a single map unit in the northern portion of the study area. Landforms are gently to moderately sloping with Regosolic soils occurring on the upper portion of steeper areas, and Chernozemic soils occurring on gently sloped areas or mid-portions of steeper areas. Runway soils are excessively to exceedingly stony. Runway soils are Class 5 and Class 6 soils for agricultural capability.

Scott soils are Dark Brown soils that occur in the eastern portion of the study area. Scott soils are moderately acidic and are primarily loamy in texture. Scott soils will occasionally have a thin layer of gravel between the lacustrine material and glacial till, but are generally stone free. Scott soils are found in complex with Weyburn soils in the study area. Scott soils are Class 3 soils for agricultural capability.

Sutherland soils are dark brown soils that occur in the north and northeastern portions of the study area. The soils are low in salinity and are primarily clay and clay loam but can have a heavy clay texture. Sutherland soils are generally free of stones. Landforms are generally gently undulating with a knoll and depression pattern, but may be roughly undulating with a knoll and depression in complexes with Weyburn soils. The soils within the study area are dominantly Orthic or Rego. Sutherland soils are Class 2 and Class 3 for agricultural capability. Sutherland soils are found in complex with Elstow soils in the northern portion of the study area.

Tuxford soils are dark brown soils that occur throughout the study area. The soils are frequently slightly to moderately saline and are clay loam or clay in texture. Tuxford soils are generally free of stones, but slight to moderate amount of stones may occur where shallow glacial till is present on the surface. The soils are Class 3 and Class 4 for agricultural capability. Tuxford soils that occur within the study area are dominantly Solonetz or Solod. Tuxford soils are found in complex with Elstow soils in the eastern portion of the study area.

Valor soils are Regosolic soils that occur in a single map unit in the southern portion of the study area. The soils are mildly to moderately alkaline and are sand or loamy sand in texture. Valor soils are generally free of stones. Landforms are range from undulating, with broad mounds and shallow blow-out pits to hilly dunes. Valor soils in the study area are dominantly Orthic Regosol soils and are Class 6 for agricultural capability.

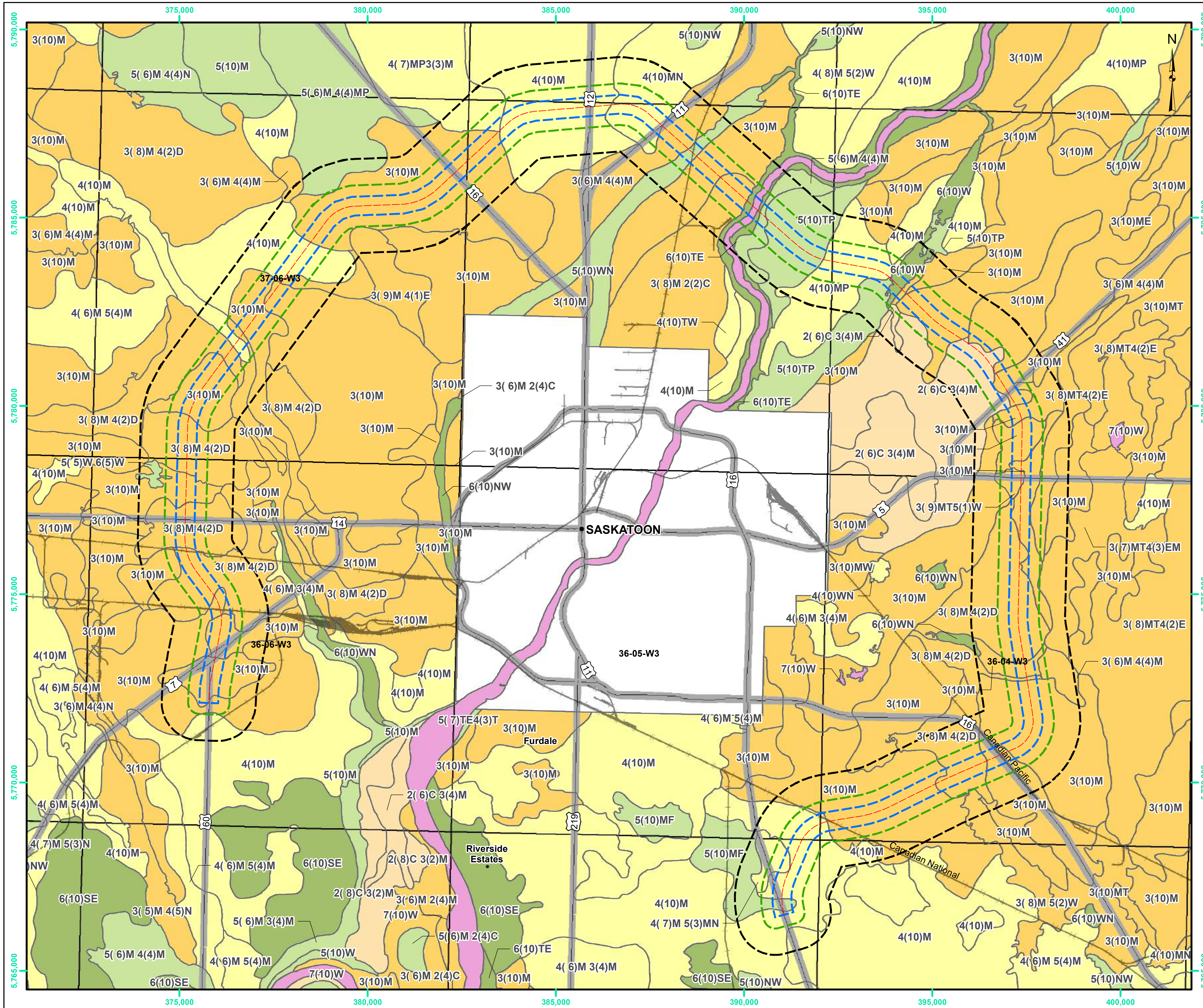
Weyburn soils are dark brown soils that occur throughout the study area. The soils are low in salinity and range from sandy loam to clay loam in texture but are most commonly loam. Weyburn soils are generally moderately stony but may be exceedingly stony in outwash deposits. Landforms range from gently undulating to strongly rolling, but roughly undulating and gently rolling are most common. There are three types of Weyburn soils that occur within the study area: Orthic, Calcareous, and Orthic Regosol. Weyburn soils are can be Class 3, Class 4 or Class 5 for agricultural capability; soils with a loam or clay texture are considered Class 3, sandy loams are Class 4, and moderately and strongly rolling soils are Class 5. Weyburn soils are also found in complex with Bradwell, Asquith, and Biggar soils.

4.2.2.3 Soil Capability for Agriculture

The agricultural capabilities of cropland within the study area are limited by a range of soil and landscape properties that impact the soil's ability to produce annual crops (Saskatchewan Soil Survey 1987 and 1985). Soils are rated based on their ability for sustained production of common crops and the requirement for conservation practices. Generally speaking, lower numbered soil classes are capable of producing crops with the greatest yields. Most land within the area has moderately severe agricultural limitations arising from to soil limitations such as an insufficient moisture holding capacity, as well as landscape limitations such as unfavorable topography or erosion limitations. In some instances, soils are severely limited by excess water due to poor drainage, a high groundwater table, or overland runoff. These locations occur most often as wetlands and small localized depression that retain water for most of the growing season. **Figure 4.7** shows the distribution of soil capability classes within the study area. A description of the soil limitations occurring within the study area is provided in Appendix B.

Gentle undulation within the study area uplands results in the presence of Class 2 through Class 7 soils. The majority of the landscape is composed of Class 3 and Class 4 soils. Landscape limitations such as the presence of excess water and unfavourable topography are the greatest agricultural limitations in the area. Land areas for each capability class within the vegetation and soils study area are presented in Table 4.3.

- **Class 1** soils (soils with no limitations) are not present within the vegetation and soils study area.
- **Class 2** soils are able to support a wide range of cultivated crops, although they exhibit some moderate limitations that may require the application of moderate conservation practices (Saskatchewan Soil Survey 1987 and 1985). In the soils and vegetation study area, Class 2 soils are limited by insufficient precipitation, insufficient soil moisture holding capacity, and/or poor soil structure and/or permeability.
- **Class 3** soils have moderately severe limitations that restrict the range of crops that can be produced or require special conservation practices in order to produce additional crops. Soils in Capability Class 3 are limited by insufficient soil moisture holding capacity, unfavourable topography, and/or soil damage caused by erosion.
- **Class 4** soils have a marginal capacity for sustained crop production due to severe limitations that restrict the range of viable crops and/or require special conservation practices. Class 4 soils in the vegetation and soils study area are limited by insufficient soil moisture holding capacity, poor soil structure and/or permeability, excess water not caused by flooding, excess soil salinity, excessive stoniness, soil damage caused by erosion, and/or insufficient water holding capacity.
- **Class 5** soils have very severe limitations that restrict their use to the production of native or tame forage species, and are often used for pastureland or hay production. Class 5 soils in the vegetation and soils study area are limited by insufficient soil moisture holding capacity, excess soil salinity, low soil fertility, insufficient water holding capacity, unfavourable topography, and/or excess stoniness.
- **Class 6** soils are generally capable of only producing native forage crops, and improvement or conservation practices are not feasible. Class 6 soils in the vegetation and soils study area are limited by unfavourable topography, soil damage caused by erosion, and/or excess water not caused by flooding.
- **Class 7** soils have no capability for agriculture or permanent pasture, and in this area the soils are limited by excess water.



LEGEND

- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- RAILWAY
- PROPOSED FREEWAY CORRIDOR
- VEGETATION AND SOIL STUDY AREA
- WILDLIFE STUDY AREA

SOIL CAPABILITY FOR AGRICULTURE

- CLASS 2
- CLASS 3
- CLASS 4
- CLASS 5
- CLASS 6
- CLASS 7

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2013, SASKGRID2013.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. RAILWAYS OBTAINED FROM THE NATIONAL RAILWAY NETWORK SASKATCHEWAN EDITION 1.0 DATASET, 2012-11-07.
5. SOILS DATA (SKSISV3, 21-JAN-2009) OBTAINED FROM THE SASKATCHEWAN LAND RESOURCE UNIT, UNIVERSITY OF SASKATCHEWAN, SASKATOON, SASK.
6. REFER TO APPLICABLE SOILS SURVEY REPORT (AGRICULTURE AND AGRI-FOOD CANADA) FOR DETAILED SOIL CLASSIFICATION INFORMATION.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 500 1,000 2,000 METRES

SCALE: 1:100,000

SNC · LAVALIN

CLIENT	PROJECT LOCATION
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE	SASKATOON FREEWAY

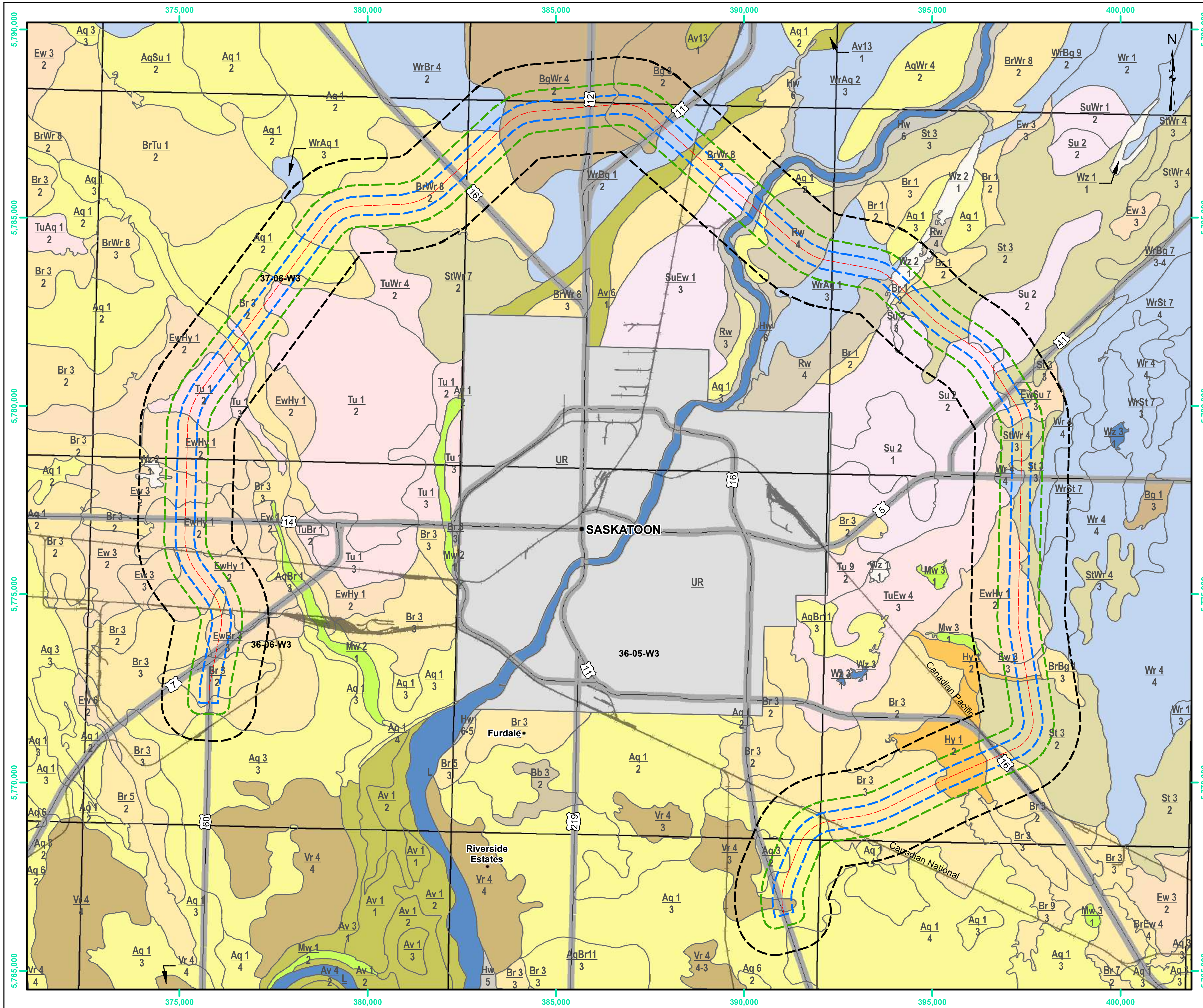
TITLE

SOIL CAPABILITY

DATE	2019 03 05	DWG No.	659183-0000-4EDD-0008	FIG No.	2.4	REV	00

SIZE 11x17

Path: \\sl1653\Projects QMS\SMH\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0008 Soil Capability.mxd



LEGEND

- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- RAILWAY
- PROPOSED FREEWAY CORRIDOR
- VEGETATION AND SOIL STUDY AREA
- WILDLIFE STUDY AREA

SOIL CLASSIFICATION

- Aq - ASQUITH
- AV - ALLUVIUM
- Bb - BOWL BOG
- Bg - BIGGAR
- Br - BRADWELL
- Ew - ELSTOW
- GX - GREY SOLIC
- Hw - HILLWASH
- Hy - HANLEY
- Mw - MEADOW
- Rw - RUNWAY
- St - SCOTT
- Su - SUTHERLAND
- Tu - TUXFORD
- UR - URBAN
- Vr - VALOR
- Wr - WEYBURN
- Wz - WATER

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SOILS DATA (SKSISV3, 21-JAN-2009) OBTAINED FROM THE SASKATCHEWAN LAND RESOURCE UNIT, UNIVERSITY OF SASKATCHEWAN, SASKATOON, SASK.
5. REFER TO APPLICABLE SOILS SURVEY REPORT (AGRICULTURE AND AGRI-FOOD CANADA) FOR DETAILED SOIL CLASSIFICATION INFORMATION.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 500 1,000 2,000 METRES

SCALE: 1:100,000

SNC · LAVALIN

CLIENT: SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION: SASKATOON FREEWAY

TITLE: SOIL CLASSIFICATION

DATE	2019 03 05	DWG No.	659183-0000-4EDD-0009	FIG No.	2.3	REV	00

SIZE 11x17

Path: \\sll1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0009 Soil Classification.mxd

Table 4.3 Land area by soil capability class in the vegetation and soils study area

Capability Class	Land Area (ha)	% of Study Area
Class 1	0	0
Class 2	157.9	2.6
Class 3	4,257.1	70.5
Class 4	1,211.9	20.1
Class 5	316.5	5.2
Class 6	69.3	1.1
Class 7	21.6	0.4
Total	**6,034.4**	**100**

4.3 Biological Environment

4.3.1 Regulatory Context

4.3.1.1 Species of Conservation Concern (SOCC) and Species at Risk (SAR)

The study gives particular attention to plant and wildlife Species of Conservation Concern (SOCC), breeding birds, sensitive wildlife features, wetlands, and other environmental sensitivities that may be present in the study area. For the purpose of this study, an SOCC is defined as any plant or wildlife species that meets one or more of the following criteria:

- Listed under Schedule 1, Schedule 2, or Schedule 3 of the federal *Species at Risk Act* (SARA) as *Endangered*, *Threatened*, or *Special Concern*;
- Currently under consideration for addition to Schedule 1 of SARA;
- Assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as *Endangered*, *Threatened*, or *Special Concern*;
- Listed as a designated species in *The [Saskatchewan] Wildlife Act*, *1998*;
- Ranked as *S1*, *S2*, *S3*, or tracked by the Saskatchewan Data Conservation Centre (SKCDC); and/or
- Assessed as a sensitive species or feature under The Saskatchewan Ministry of Environment (ENV) Saskatchewan Activity Restriction Guidelines (ARGs) for Sensitive Species (ENV 2017).

For the purposes of this study, a Species at Risk (SAR) is defined as species that meets one or more of the following criteria, representing a small subset of the SOCC:

- Listed under Schedule 1 of SARA as *Endangered*, *Threatened*, or *Special Concern*; and/or
- Listed as a designated species in *The [Saskatchewan] Wildlife Act, 1998*.

Explanations of federal and provincial SOCC and SAR rankings are provided in Appendix A.

4.3.1.2 Breeding Birds

Aside from a few non-native and/or common species, all migratory and resident breeding birds and their nests are protected under federal and/or provincial legislation. For the purpose of this study, breeding bird species are defined as those with legislative protection that meet one or more of the following criteria:

- Identified under the federal *Migratory Birds Convention Act, 1994* and Migratory Birds Regulations; and/or,

- Identified under *The [Saskatchewan] Wildlife Act, 1998* and The [Saskatchewan] Wildlife Regulations, 1981.

4.3.1.3 General Wildlife and Sensitive Wildlife Features

The *[Saskatchewan] Wildlife Act, 1998* provides protection for the majority of wildlife in Saskatchewan (1998, c.W-13.12, s.32.). This legislation also provides protection for sensitive wildlife features such as dens, hibernacula, leks, nests, setts (badger residences), etc. Some non-native and nuisance species are exempt from this legislation, such as most rodent species.

4.3.1.4 Wetlands

Wetlands and some species that inhabit them are protected under a combination of federal and provincial legislation, including:

- *The Environmental Management and Protection Act, 2010*
- *The Water Security Agency Act*
- *The Environmental Assessment Act*
- *The Wildlife Act, 1998*
- *The Wildlife Habitat Protection Act*
- *Species at Risk Act*
- *Migratory Birds Convention Act, 1994*

Where impacts to wetlands cannot be avoided, proponents are required to compensate for the loss of wetland habitat as a condition of approval under *The Environmental Assessment Act* or the *Impact Assessment Act* (if applicable).

4.3.2 Land Cover

4.3.2.1 Methods

SNC-Lavalin conducted a land cover mapping exercise to identify current land cover types and land use practices within the wildlife study area, vegetation and soils study area, and proposed freeway corridor. The following geospatial data sources were used to generate a land cover map and estimate the areas occupied by each land cover type:

- The Saskatchewan Digital Land Cover (SDLC) raster dataset (SRC 2003) for land cover data and the locations of active farmsteads, towns, and residences;
- The CanVec series hydrographic features vector dataset (NRC 2013) for additional waterbody land cover data;
- The National Railway Network dataset (NRC 2016) for the locations of active rail lines; and
- The National Road Network dataset (NRC 2017) for the locations of highways, range roads, and township roads.

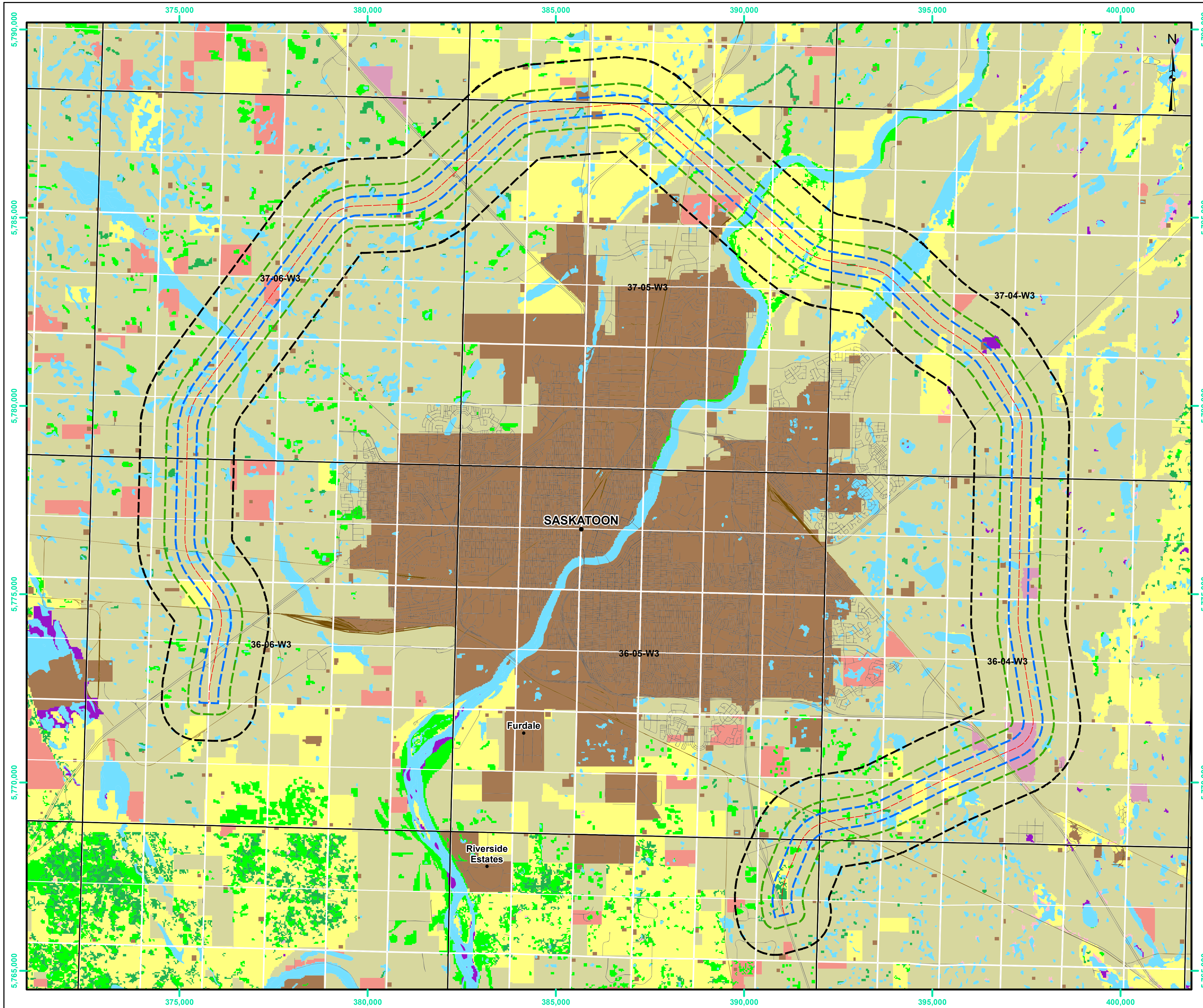
4.3.2.2 Results

The results of the land cover mapping exercise are presented in **Table 4.4** and **Figure 4.8**. Cultivated land accounts for most of the land cover within the proposed freeway corridor, vegetation and soils study area, and wildlife study area. Unseeded grassland and waterbodies such as rivers and wetlands also provide significant land cover in all three of the areas examined. All other land cover types identified during this exercise account for less than 3% of land cover within the proposed freeway corridor and the study areas.

Table 4.4 Land cover mapping results

Land Cover Type	Proposed Freeway Corridor		Vegetation and Soils Study Area		Wildlife Study Area	
	Total Area (ha)	% of Corridor	Total Area (ha)	% of Study Area	Total Area (ha)	% of Study Area
cropland[1]	1,990.1	73.3	4,341.4	71.9	10,043.4	71.8
unseeded grassland[1]	340.9	12.5	851.8	14.1	1,987.0	14.2
waterbody/wetland/marsh[1,2]	193.0	7.1	431.7	7.2	1,061.9	7.6
seeded grassland[1]	66.1	2.4	127.9	2.1	160.1	1.1
hardwood open[1]	31.0	1.1	72.3	1.2	184.6	1.3
hay crop (forage)[1]	31.0	1.1	54.8	0.9	204.9	1.5
road[3]	23.5	0.9	54.9	0.9	131.5	0.9
tall shrub[1]	19.2	0.7	32.5	0.5	57.0	0.4
farmstead/town[1]	15.5	0.6	45.7	0.8	117.9	0.8
railway[4]	2.6	0.1	5.8	0.1	17.3	0.1
herbaceous fen[1]	1.8	0.1	2.6	0	8.9	0.1
mud/sand/saline[1]	1.7	0.1	12.8	0.2	16.8	0.1

Source: (1 – SRC 2003; 2 – NRC 2013; 3 – NRC 2017; 4 – NRC 2016).



LEGEND

- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- RAILWAY
- PROPOSED FREEWAY CORRIDOR
- VEGETATION AND SOIL STUDY AREA
- WILDLIFE STUDY AREA
- CROPLAND
- HAY CROP (FORAGE)
- UNSEEDED GRASSLAND
- TALL SHRUB
- SEEDED GRASSLAND
- HARDWOOD OPEN
- WATERBODY/WETLAND
- HERBACEOUS FEN
- MUD/SAND/SALINE
- FARMSTEAD / TOWN
- RAILWAY
- ROAD

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SASKATCHEWAN DIGITAL LAND COVER OBTAINED THROUGH THE SASKATCHEWAN MINISTRY OF ENVIRONMENT. ORIGINAL DATASET CREATED BY SRC.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 500 1,000 2,000
METRES
SCALE: 1:100,000

SNC·LAVALIN

CLIENT	PROJECT LOCATION
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE	SASKATOON FREEWAY

TITLE

LAND COVER

DATE	2019 03 05	DWG No.	659183-0000-4EDD-0004	FIG No.	2.5	REV	00

SIZE 11x17

Path: \\sli1653\Projects QMS\SMH\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0004 Landcover.mxd

4.3.3 Vegetation

4.3.3.1 Methods

SNC-Lavalin conducted a desktop vegetation review to describe regional terrestrial and wetland vegetation patterns. The vegetation and soils study area includes the proposed freeway corridor surrounded by a 300 m buffer zone (**Figure 4.5**), based on the maximum applicable setback distance for plant SAR identified in the Saskatchewan ARGs for Sensitive Species (ENV 2017). The vegetation and soils study area occupies approximately 6,034 ha. The proposed freeway corridor occupies approximately 2,716 ha.

4.3.3.1.1 Ecoregion and Landscape Area Review

SNC-Lavalin conducted a desktop review of landscape features and vegetation patterns typical of the ecoregion and landscape areas in which the vegetation and soils study area is located. The plant species and communities that occupy any given location are determined by complex interactions between multiple factors. On a regional scale, vegetation patterns are dictated by climate, while landforms, soils, and hydrologic regimes are more influential locally. Agriculture and other human activities are greatly influential at all scales (Acton et al. 1998; Thorpe 2014a). Information for this review was obtained from the following sources:

- The Hunting, Angling, and Biodiversity Information of Saskatchewan (HABISask) tool (Government of Saskatchewan 2019) for ecological land classification maps;
- The Ecoregions of Saskatchewan (Acton et al. 1998) for biophysical characteristics of landscapes at the ecoregion and landscape area levels;
- The Saskatchewan Rangeland Ecosystems publication series (Thorpe 2014a to 2014e) for information on common plant communities and their relationship with soil properties at a local level; and
- Steward and Kantrud's Classification of Natural Ponds and Lakes in the Glaciated Prairie Region (1971) for information on common prairie wetland plant communities and their relationship with surface water permanence and salinity.

4.3.3.1.2 Plant SOCC Screening

A screening exercise was conducted to identify plant SOCC with the potential for occurrence within the vegetation and soils study area. SOCC occurrence and spatial data was obtained from the following sources:

- The SKCDC for a list of recorded plant SOCC occurrences by landscape area (SKCDC 2019a);
- The HABISask tool (Government of Saskatchewan 2019) for (i) a list of plant SOCC occurrences that were previously detected within the region (known as element occurrences), (ii) the locations of federal and/or provincial lands requiring environmental protection, and (iii) predictive distribution models for plant SAR;
- Available studies in the region with data less than 10 years old and with spatial plant SOCC data that could be readily extracted (e.g. presented on maps or with UTM coordinates), including:
  - Final Screening Report, Holmwood East Natural Area Screening Study (Golder 2015);
  - North/Northwest Natural Area Screening Study, City of Saskatoon (Stantec 2012);
  - North Commuter Parkway – Baseline Terrestrial and Aquatic Field Studies, and Heritage Resource Impact Assessment (Stantec 2013a); and
  - North Central/North East Natural Area Screening Study, City of Saskatoon (Stantec 2013b).

Information on plant SOCC habitat requirements was obtained through a review of literature, taxonomic keys, COSEWIC status reports, and herbarium data from the Virtual Herbarium of Plants at Risk in Saskatchewan (W.P. Fraser Herbarium 2006). Current federal and provincial species rankings were provided by the SARA Public Registry (Government of Canada 2019) and the SKCDC (2019b) (Appendix B).

4.3.3.1.3 Wetland Delineation

SNC-Lavalin conducted a desktop wetland delineation exercise to estimate the area occupied by wetland habitat within the proposed freeway corridor (500 m). A multi-year satellite imagery review was performed to identify and digitize the boundaries of wetlands occurring within or partially within the corridor. Recent high-resolution satellite imagery provided by the Ministry (2018) was cross-referenced with seven sets of imagery taken during the growing season by Google, Maxar Technologies (2011a, 2011b, 2011c, 2012a, 2012b, 2013, and 2014) to account for changing climatic conditions and land use regimes.

Wetland boundary digitization was completed by a qualified GIS technician with experience interpreting satellite imagery and digitizing wetlands using ArcMap version 10.6 (Esri Software). Wetland boundaries were delineated based on the greatest boundary extent visible within the representative imagery sets (Government of Alberta 2015). These digitized boundaries represent SNC-Lavalin's best attempt to capture the spatial dimensions of wetlands within the study area and may be subject to interpreter error, naturally occurring variation due to changing climatic conditions (Stuart and Kantrud 1971), and/or permanent alterations that impact drainage or surface water retention.

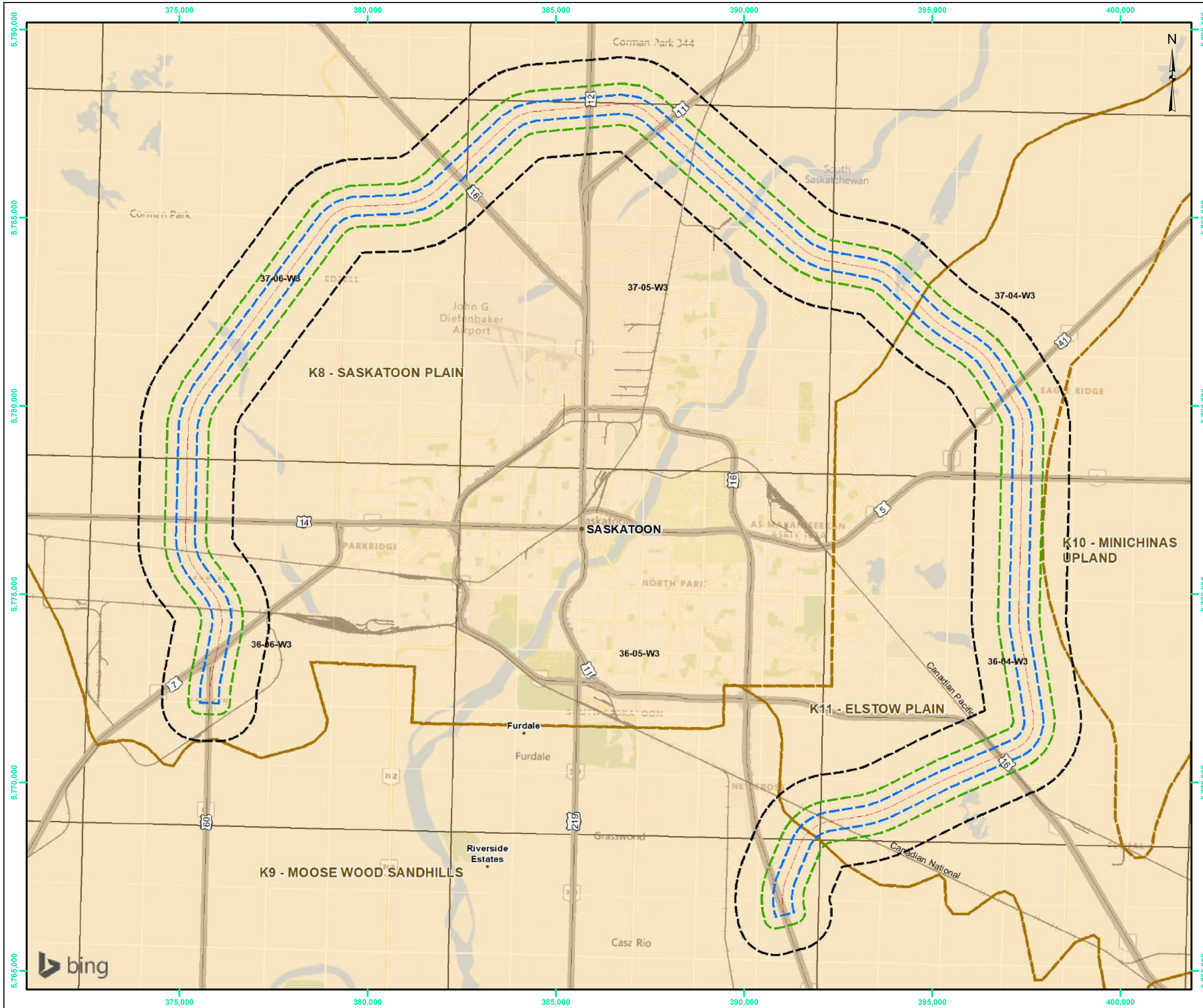
4.3.3.2 Results

4.3.3.2.1 Ecoregion and Landscape Area Review

4.3.3.2.1.1 Moist Mixed Grassland Ecoregion

The vegetation and soils study area is located within the Moist Mixed Grassland Ecoregion of the Prairie Ecozone, and includes portions of the Saskatoon Plain, Moose Wood Sand Hills, Minichinas Upland; and Elstow Plain Landscape Areas (**Figure 4.9**) (Acton et al. 1998). Land use within the Moist Mixed Grassland Ecoregion is largely agricultural, with cultivated cropland comprising approximately 80% of the landscape. However, remnant patches of native vegetation are scattered throughout the region. Untilled landscapes show a regular alternation between grasslands on upper slopes, shrublands in lower areas, and wetlands in poorly drained basins. While present, woodland habitat occurs infrequently due to climatic conditions within the ecoregion. Common plant communities associated with these habitats are described below.

Woodlands within the Moist Mixed Grassland Ecoregion are represented by trembling aspen *(Populus tremuloides*) stands surrounding wetland habitat and occasionally the north-facing slopes of coulees (Acton et al. 1998). Stands occurring on loamy sites typically have a shrub stratum dominated by western snowberry (*Symphoricarpos occidentalis*) and prairie rose (*Rosa arkansana*), while understories are composed of herbs such as western Canada violet (*Viola canadensis var. rugulosa*), showy aster (*Eurybia conspicua*), smooth aster (*Symphyotrichum laeve var. geyeri*), and Kentucky bluegrass (*Poa pratensis*). Shrub stratum composition on sandy sites shifts towards prostrate shrubs like creeping juniper (*Juniperus horizontalis*) and bearberry (*Arctostaphylos uva-ursi*), while hay sedge (*Carex foenea*) becomes a prominent understory herb. Eastern cottonwood (*Populus deltoids*) occasionally occurs in the riparian zones of deep valleys where conditions are moist.



LEGEND

- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- RAILWAY
- PROPOSED FREEWAY CORRIDOR
- VEGETATION AND SOIL STUDY AREA
- WILDLIFE STUDY AREA
- MOIST MIXED GRASSLAND ECOREGION
- LANDSCAPE AREA

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SERVICE LAYER CREDITS: © 2020 MICROSOFT CORPORATION © 2020 HERE.
5. ECOLOGICAL FRAMEWORK OBTAINED FROM CANADIAN SOIL INFORMATION SYSTEM, AGRICULTURE AND AGRI-FOOD CANADA, ENVIRONMENT CANADA.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 500 1,000 2,000 METRES

SCALE: 1:100,000

SNC · LAVALIN

CLIENT	PROJECT LOCATION
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE	SASKATOON FREEWAY

TITLE

LANDSCAPE AREAS

DATE	2019 03 05	DWG No.	659183-0000-4EDD-0005	FIG No.	4.9	REV	00

SIZE 11x17

Path: \\sli1653\Projects QMS\SMH\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0005 Landscape Areas.mxd

Shrublands typically occupy woodland margins, depressions, lower slopes, or occur in association with sandy soils (Acton et al. 1998). Hoary sagebrush (*Artemisia cana*) and prairie rose are common on drier sites, while more moist, sheltered sites are colonized by patches of western snowberry. Shrub cover on the lower slopes of valleys and coulees is usually denser and may include wolf willow (*Elaeagnus commutata*), saskatoon (*Amelanchier alnifolia*), chokecherry (*Prunus virginiana*), and western snowberry. Creeping juniper and hoary sagebrush often assume dominance on sandy soils.

Grasslands on undisturbed upland sites support diverse communities with species compositions that vary based on slope position and soil type. Upper slopes with loamy soils are occupied by low growing, drought resistant shortgrasses like blue grama (*Bouteloua gracilis*), June grass (*Koeleria macrantha*), and needle and thread grass (*Hesperostipa comata*) (Tannas 2003, Thorpe 2014b). Midgrasses like wheatgrasses (*Elymus* spp.), porcupine grass (*Hesperostipa curtiseta*), little bluestem (*Schizachyrium scoparium*), and green needlegrass (*Nassella viridula*) assume dominance on mid-slopes and more mesic sites, eventually transitioning to plains rough fescue (*Festuca hallii*) and Hooker's oat grass (*Avenula hookeri*) on lower and toe slopes if dense shrub stands are not present (Acton et al. 1998). Sites with clayey lacustrine deposits see an increase in the dominance of June grass and northern wheatgrass (*Elymus lanceolatus*) (Thorpe 2014c). Pasture sage (*Artemisia frigida*) is the most frequently occurring grassland herb on all sites, and prairie spike-moss (*Selaginella densa*) often forms low, creeping mats along the grassland understory.

Sandy areas support a distinct assemblage of native grassland species due to the rapid infiltration and limited retention of rainwater characteristic of sandy soils (Acton et al. 1998). Grasses such as Indian rice grass (*Achnatherum hymenoides*), sand grass (*Calamovilfa longifolia*), and sand dropseed (*Sporobolus cryptandrus*), and forbs including prairie sunflower (*Helianthus couplandii*) and lance-leaved psoralea (*Psoralidium lanceolatum*) are restricted to these sites (Tannas 2003; Thorpe 2014d). Shrub cover is often higher than on loamy sites due to increased water availability and favorable conditions for root penetration. Active and stabilized sand dunes provide important habitat for a number of plant SOCC.

Saline soils occur frequently within the Moist Mixed Grassland Ecoregion (Acton et al. 1998). Western wheatgrass (*Pascopyrum smithii*), northern wheatgrass, and June grass are common on somewhat saline uplands, while salt-tolerant graminoids such as saltgrass (*Distichlis spicata*), Nuttall's alkaligrass (*Puccinellia nuttalliana*), Douglas' sedge (*Carex douglasii*), and mat muhly (*Muhlenbergia richardsonis*) occupy low-lying sites where moisture and salinity levels are higher (Tannas 2003, Thorpe 2014e). Frequently associated forbs and low shrubs include gumweed (*Grindelia squarrosa*), tufted white prairie aster (*Symphyotrichum ericoides var. pansum*), Nuttall's saltbush (*Atriplex gardneri var. gardneri*), and winter-fat (*Krascheninnikovia lanata*).

Wetlands occupy glacial kettles and depressions throughout the ecoregion. These undrained depressions support distinctive wetland vegetational zones with plant community composition varying in accordance with soil saturation and permeability (Acton et al. 1998; Stewart and Kantrud 1971):

› Low prairie zones (ephemeral wetlands) retain surface water for a short period in early spring before soil pore ice melts. Surface water is not present during most of the growing season, allowing for the establishment of moist grassland vegetation such as Kentucky bluegrass, slender wheatgrass (*Elymus trachycaulus*), and western snowberry. Low prairie zones occurring on agricultural land are usually fully seeded to field crops or tame forage grasses.
› Wet meadow zones (temporary wetlands), which retain surface water for a few weeks in early spring and during heavy rainfall, are usually dominated by fine-textured graminoid species such as fowl bluegrass (*Poa palustris*), woolly sedge (*Carex pellita*), and Baltic rush (*Juncus balticus*).

- Shallow marsh zones (seasonal wetlands), which retain surface water through spring and into early summer, can be identified by emergent vegetation such as broad-leaved water plantain (*Alisma triviale*), water smartweed (*Persicaria amphibia*) and tall manna grass (*Glyceria grandis*). During periods of surface water drawdown, needle spike-rush (*Eleocharis acicularis*) and golden dock (*Rumex maritimus*) may also be dominant species.
- Deep marsh zones (semi-permanent wetlands) retain surface water for most or all of the year, except in periods of drought. Vegetation in this zone alternates between coarse emergents such as broad-leaved cattail (*Typha latifolia*) and soft-stem bulrush (*Schoenoplectus tabernaemontani*) and submergent plants like Richardson's pondweed (*Potamogeton richardsonii*) and Siberian water-milfoil (*Myriophyllum sibiricum*).
- Permanent open water zones (permanent wetlands) retain surface water year-round, even during periods of drought, and are typically devoid of emergent vegetation. Deep water submergents like western widgeon-grass (*Ruppia cirrhosa*) and sheathed pondweed (*Stuckenia vaginata*) may be present, although deeper wetlands and lakes are often unvegetated.

Wetlands with high surface water salinity favor the establishment of salt-tolerant species, such as Nuttall's alkaligrass, saltgrass, red samphire (*Salicornia rubra*), and sea-blite (*Suaeda calceoliformis*) (Acton et al. 1998; Stewart and Kantrud 1971). Wetlands with saturated alkaline soils and sodium bicarbonate rich surface water usually support fen vegetation such as water sedge (*Carex aquatilis*), spotted water-hemlock (*Cicuta maculata*), tufted hair grass (*Deschampsia cespitosa*), and hoary willow (*Salix candida*) (Stewart and Kantrud 1971).

4.3.3.2.1.2 Saskatoon Plain Landscape Area

The Saskatoon Plain Landscape Area is a level glacial lake and eroded glacial till plain with very gently undulating topography (Acton et al. 1998). It encompasses most of the City of Saskatoon and the surrounding areas located north and west of the city. Cereals are the major crop, and most of the land within the Saskatoon Plain has been converted to cropland. Native moist mixed grassland vegetation is limited to sandy sites in the South Saskatchewan River valley. Grassland and shrubland communities associated with sandy soils are common on upland sites, while saline depressions are vegetated by salt-tolerant species like Nuttall's alkaligrass and red samphire. Trembling aspen stands occur frequently in non-saline areas with high water tables, such as the South Saskatchewan River's riparian corridor.

4.3.3.2.1.3 Moose Wood Sand Hills Landscape Area

The Moose Wood Sand Hills Landscape Area is an expanse of moderately to strongly sloping sand dunes and level alluvial plains that follows the South Saskatchewan River south of the City of Saskatoon (Acton et al. 1998). Land use within the Moose Wood Sand Hills is predominantly agricultural, consisting mainly of rangeland and pastureland. Only about 40% of the landscape area has been converted to cropland, most of which is located on the northern edge of the landscape area where productive sandy loam soils are present. Native moist mixed grassland vegetation is common on sandy sites that are unsuitable for crop production, including three large community pastures that were once managed by the Prairie Farm Rehabilitation Administration Community Pasture Program. Upland sites with partially stabilized sandy soils are dominated by graminoids, while cover from sand-adapted shrub species like creeping juniper increases on more stable sites. Trembling aspen stands are common in locations with high water tables, and the alluvial flats along the South Saskatchewan River support diverse riparian woodlands comprised of Manitoba maple (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), and eastern cottonwood.

4.3.3.2.1.4 Minichinas Upland Landscape Area

The Minichinas Upland Landscape Area is a hilly morainal upland located east of the City of Saskatoon (Acton et al. 1998). The hummocky morainal landscapes are moderately to steeply sloping with numerous glacial kettles. Cereals are the major crop, and most of the land within the Minichinas Upland has been converted to cropland. While fragmented patches of native moist mixed grassland are interspersed with cropland throughout much of the landscape area, continuous expanses of native vegetation are largely restricted to steeply sloping hummocky morainal landscapes in the east. Grassland and shrubland communities occupy upland sites, and non-saline glacial kettles provide habitat for wetland vegetation such as sedges (*Carex* spp.) surrounded by bluffs of willows (*Salix* spp.) and trembling aspen. Salt-tolerant wetland species like saltgrass, Nuttall's alkaligrass, and red samphire often assume dominance in depressions where conditions are saline.

4.3.3.2.1.5 Elstow Plain Landscape Area

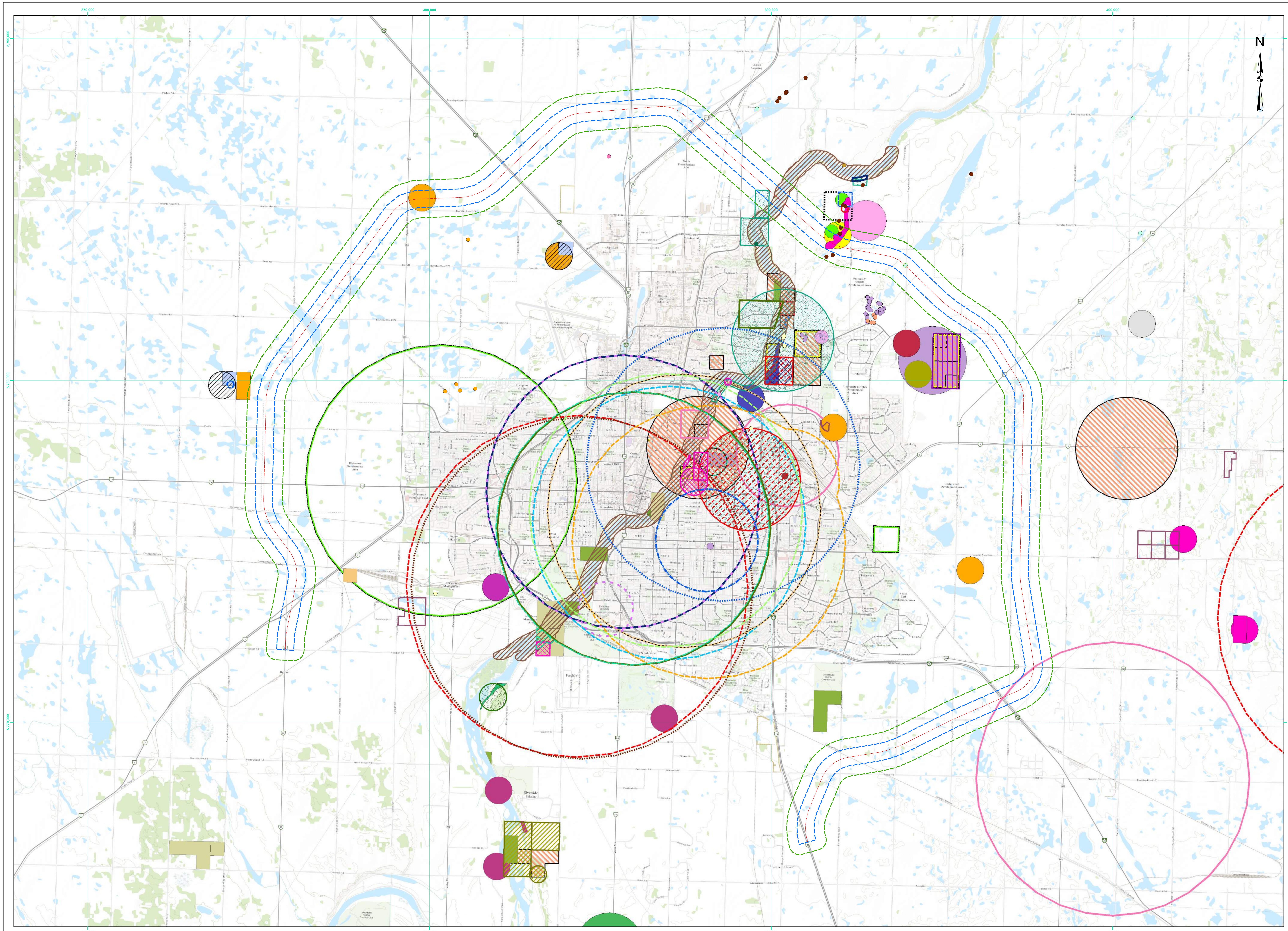
The Elstow Plain Landscape Area is a glacial lake plain that transitions from hummocky and kettled glaciolacustrine landscapes in the east to very gently undulating glaciolacustrine plains in the west (Acton et al. 1998). The northwestern edge of the landscape area falls within the City of Saskatoon. Cereals are the major crop, and most of the land within the Elstow Plain has been converted to cropland. Large expanses of native moist mixed grassland vegetation are associated with steep hummocky morainal landscapes that are unsuitable for crop production. Fragmented patches of native vegetation are also interspersed with cropland throughout the landscape area. Plant community composition and distribution is similar to that of the Minichinas Upland Landscape Area.

4.3.3.2.2 Plant SOCC Screening

There are 89 plant SOCC with recorded occurrences in the Saskatoon Plain, Moose Wood Sand Hills, Minichinas Upland; and Elstow Plain Landscape Areas (SKCDC 2019a), including two SAR. Appendix C presents a list of all 89 species, their current provincial and federal species rankings, and known habitat associations. Explanations of federal and provincial species rankings are provided in Appendix B.

A search of HABISask produced records of 23 plant SOCC and 297 plant SOCC element occurrences within the region, including one SAR element occurrence (**Figure 4.10**; **Table 4.5**) (Government of Saskatchewan 2019). Of these, 13 SOCC and 15 element occurrences are located within the vegetation and soil study area. Appendix D provides a list of all 297 element occurrences. No federal or provincial lands requiring environmental protection were identified within the vegetation and soils study area. HABISask's predictive distribution model identified potentially suitable habitat for two SAR spread throughout entire the vegetation and soils study area:

- 170.5 ha of potential smooth goosefoot (*Chenopodium subglabrum*) habitat. This species is listed as a Schedule 1 *Threatened* species under SARA.
- 146.4 ha of potential slender mouse-ear cress (*Transberingia bursifolia ssp. virgata*) habitat. This species is listed as a Schedule 1 *Threatened* species under SARA and as a *Threatened* species in *The [Saskatchewan] Wildlife Act, 1998.*



LEGEND

PRELIMINARY FREEWAY ALIGNMENT
PROPOSED FREEWAY CORRIDOR
VEGETATION AND SOIL STUDY AREA
PRIVATE CONSERVATION LANDS

VASCULAR PLANT

AMERICAN BUGSEED
AWNED CYPERUS
BLUE WILD RYE
BLUEFLAG
BRISTLE-LEAVED SEDGE
BRISTLY GOOSEBERRY
BUSHY CINQUEFOIL
CALIFORNIA AMARANTH
CHAFFWEED
COLUMBIA NEEDLEGRASS
CRAWE'S SEDGE
CROWFOOT VIOLET
CURVED YELLOW-CRESS
DRY GOOSEFOOT
DWARF CLUBRUSH
EARLY CINQUEFOIL
ENGELMANN'S SPIKE-RUSH
FEW-FLOWERED ASTER
GREEN SPURGE
HAIRY BUGSEED
HOOKER'S BUGSEED
INDIAN MILK-VETCH
LEATHERY GRAPE-FERN
LESSER FRINGED GENTIAN
LONGSTEM WATER-WORT
MARSH FELWORT
MENZIES' CATCHFLY
MUCRONATE BLUE-EYED-GRASS
NARROW-LEAVED WATER PLANTAIN
NORTHERN BLUE-EYED-GRASS
PALE BULRUSH
PALE MOONWORT
PALLAS' BUGSEED
PLAINS ROUGH FESCUE
PRAIRIE DUNEWORT
PURSH'S MILK-VETCH
RED BULRUSH
RED-STEMMED CINQUEFOIL
ROCKY MOUNTAIN SEDGE
SAND-DUNE WHEATGRASS
SANDHILLS CINQUEFOIL
SMALL DROPSEED
SMALL YELLOW LADY'S SLIPPER
SMOOTH GOOSEFOOT *
SMOOTH HAWK'S-BEARD
SMOOTH WILD ROSE
SOFT WILD BERGAMOT
STRIPED CORAL-ROOT
TALL BEGGAR'S-TICKS
TALL BLUE LETTUCE
WHITE-TOP
YELLOW-RATTLE
YUKON SILVERWEED

*** DENOTES A SPECIES AT RISK**

SIZE 22 x 34

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.
5. RARE SPECIES INFORMATION OBTAINED FROM HABISASK COLLECTED BY THE SASKATCHEWAN CONSERVATION DATA CENTRE. INFORMATION IS SENSITIVE AND INTENDED FOR CONSERVATION PURPOSES ONLY. ONLY SPECIES WITHIN STUDY AREA ARE SHOWN.
6. CONSERVATION EASEMENTS OBTAINED FROM THE FISH AND WILDLIFE BRANCH AND THE LANDS BRANCH OF THE MINISTRY OF ENVIRONMENT. ONLY CONSERVATION EASEMENTS WITHIN STUDY AREA ARE SHOWN.

REFERENCE DRAWINGS

DWG No	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 500 1,000 2,000 Metres

SCALE: 1:50,000

SNC·LAVALIN

CLIENT SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION SASKATOON FREEWAY

TITLE HABISASK PLANT SOCC DATA

DATE 2019 03 05 | **DWG No** 659183-0000-4EDD-0003 | **FIG No. 2.6** | **REV** 00

Path: \\sli1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0003 Plant SOCC_REV.mxd

SNC·LAVALIN

Table 4.5 HABISask plant SOCC screening results

Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	SAR	Element Occurrence(s) within Study Area?
Achnatherum nelsonii ssp. dorei	Columbia needlegrass	Poaceae	S3	not ranked	not ranked		no
Alisma gramineum	narrow-leaved water plantain	Alismataceae	S3	not ranked	not ranked		yes
Almutaster pauciflorus	few-flowered aster	Asteraceae	S3	not ranked	not ranked		yes
Amaranthus californicus	California amaranth	Amaranthaceae	S2	not ranked	not ranked		no
Anagallis minima	chaffweed	Primulaceae	S3	not ranked	not ranked		no
Astragalus australis	Indian milk-vetch	Fabaceae	S3	not ranked	not ranked		no
Astragalus purshii var. purshii	Pursh's milk-vetch	Fabaceae	S3	not ranked	not ranked		no
Bidens frondosa	tall beggar's-ticks	Asteraceae	S3	not ranked	not ranked		no
Blysmopsis rufa	red bulrush	Cyperaceae	S3	not ranked	not ranked		no
Botrychium campestre	prairie dunewort	Ophioglossaceae	S2	not ranked	not ranked		yes
Botrychium pallidum	pale moonwort	Ophioglossaceae	S1	not ranked	not ranked		no
Carex crawei	Crawe's sedge	Cyperaceae	S3	not ranked	not ranked		yes
Carex eburnea	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked		no
Carex saximontana	Rocky Mountain sedge	Cyperaceae	S3	not ranked	not ranked		yes
Chenopodium desiccatum	dry goosefoot	Chenopodiaceae	S3	not ranked	not ranked		no
Chenopodium subglabrum	smooth goosefoot	Chenopodiaceae	S3	Threatened	Schedule 1, Threatened	✓	no
Corallorhiza striata var. striata	striped coral-root	Orchidaceae	S3	not ranked	not ranked		no
Corispermum americanum var. americanum	American bugseed	Chenopodiaceae	S3	not ranked	not ranked		no
Corispermum hookeri var. hookeri	Hooker's bugseed	Chenopodiaceae	S2	not ranked	not ranked		no
Corispermum pallasii	Pallas' bugseed	Chenopodiaceae	S2	not ranked	not ranked		no
Corispermum villosum	hairy bugseed	Chenopodiaceae	S2	not ranked	not ranked		no
Crepis runcinata ssp. hispidulosa	smooth hawk's-beard	Asteraceae	S1	not ranked	not ranked		no
Cyperus squarrosus	awned cyperus	Cyperaceae	S3	not ranked	not ranked		no
Cypripedium parviflorum var. makasin	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked		no
Elatine triandra	longstem water-wort	Elatinaceae	S2	not ranked	not ranked		no
Eleocharis engelmannii	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked		yes
Elymus glaucus ssp. glaucus	blue wild rye	Poaceae	S3	not ranked	not ranked		no
Elymus lanceolatus ssp. psammophilus	sand-dune wheatgrass	Poaceae	S2	not ranked	not ranked		no

Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	SAR	Element Occurrence(s) within Study Area?
Erigeron strigosus	white-top	Asteraceae	S3	not ranked	not ranked		no
Festuca hallii	plains rough fescue	Poaceae	S3	not ranked	not ranked		yes
Gentianopsis virgata	lesser fringed gentian	Gentianaceae	S3	not ranked	not ranked		yes
Iris versicolor	blueflag	Iridaceae	S1	not ranked	not ranked		no
Lactuca biennis	tall blue lettuce	Asteraceae	S3	not ranked	not ranked		no
Lomatogonium rotatum	marsh felwort	Gentianaceae	S3	not ranked	not ranked		no
Monarda fistulosa var. mollis	soft wild bergamot	Lamiaceae	S3	not ranked	not ranked		no
Potentilla anserina ssp. yukonensis	Yukon silverweed	Rosaceae	S2	not ranked	not ranked		no
Potentilla concinna var. concinna	early cinquefoil	Rosaceae	S2	not ranked	not ranked		yes
Potentilla lasiodonta	sandhills cinquefoil	Rosaceae	S2	not ranked	not ranked		yes
Potentilla rubricaulis	red-stemmed cinquefoil	Rosaceae	S3	not ranked	not ranked		no
Potentilla supina ssp. paradoxa	bushy cinquefoil	Rosaceae	S3	not ranked	not ranked		no
Rhinanthus minor ssp. minor	yellow-rattle	Scrophulariaceae	S2	not ranked	not ranked		no
Ribes oxyacanthoides ssp. setosum	bristly gooseberry	Grossulariaceae	S2	not ranked	not ranked		no
Rorippa curvipes	curved yellow-cress	Brassicaceae	S3	not ranked	not ranked		no
Rosa blanda	smooth wild rose	Rosaceae	S1	not ranked	not ranked		no
Sceptridium multifidum	leathery grape-fern	Ophioglossaceae	S3	not ranked	not ranked		yes
Scirpus pallidus	pale bulrush	Cyperaceae	S3	not ranked	not ranked		no
Silene menziesii	Menzies' catchfly	Caryophyllaceae	S3	not ranked	not ranked		yes
Sisyrinchium mucronatum	mucronate blue-eyed-grass	Iridaceae	S3	not ranked	not ranked		no
Sisyrinchium septentrionale	northern blue-eyed-grass	Iridaceae	S3	not ranked	not ranked		yes
Sporobolus neglectus	small dropseed	Poaceae	S2	not ranked	not ranked		no
Trichophorum pumilum	dwarf clubrush	Cyperaceae	S1	not ranked	not ranked		no
Viola pedatifida	crowfoot violet	Violaceae	S3	not ranked	not ranked		no

Source: (Government of Saskatchewan 2019; SKCDC 2019b)

Occurrence records of seven plant SOCC were obtained in the review of previous studies conducted within the region (**Table 4.6**) (Golder 2015; Stantec2012, 2013a, and 2013b). These studies did not contain records of plant SAR occurrences. A total of 16 individual SOCC occurrences were identified by the review, including one occurrence of Engelmann's spike-rush (*Eleocharis engelmannii*) within the vegetation and soils study area (**Figure 4.11**).

Table 4.6 Plant SOCC identified in previous studies

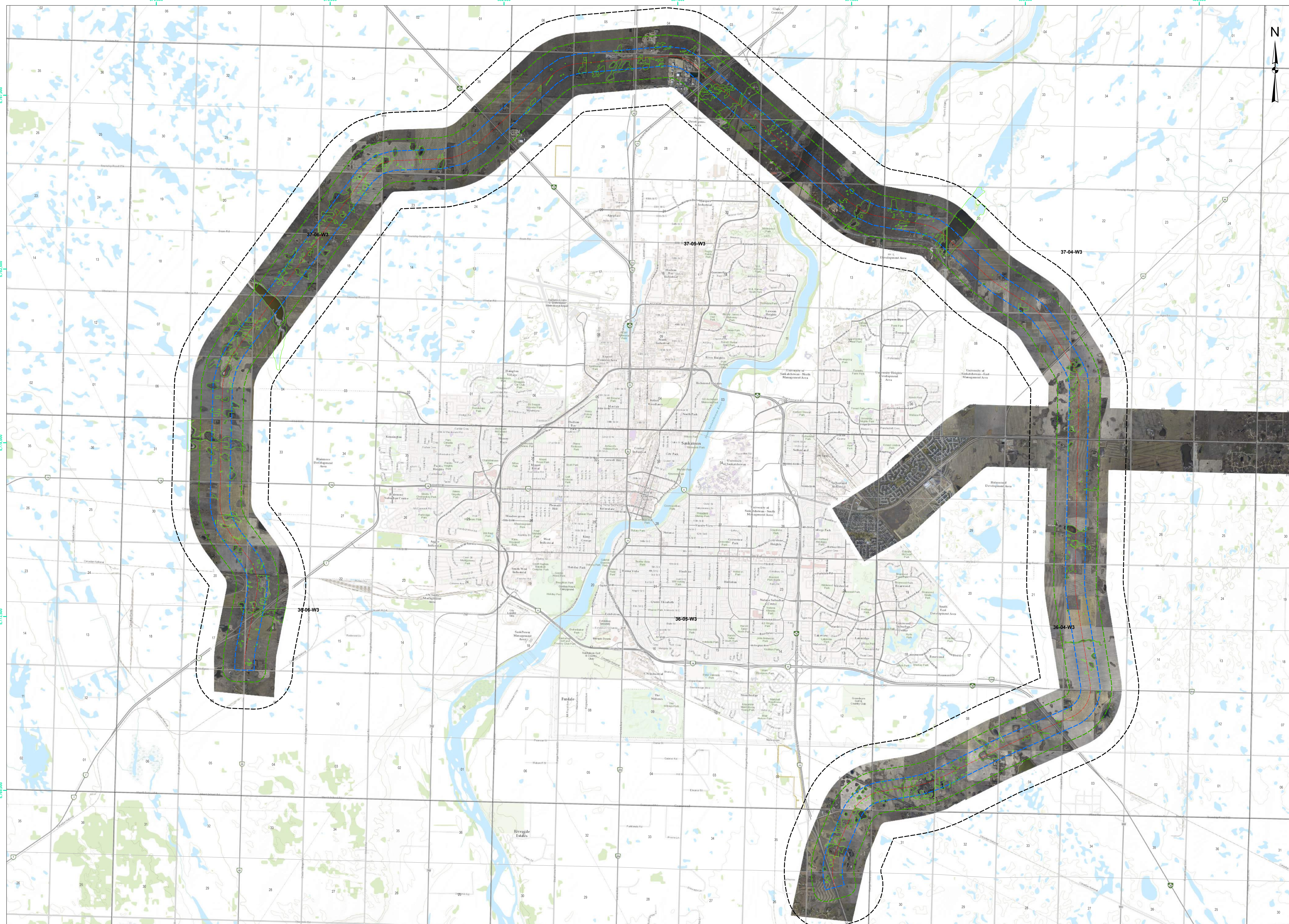
Scientific Name	Common Name	Family	SKCDC Ranking	Number of Occurrences	Occurrences within Study Area
Alisma gramineum	narrow-leaved water plantain	Alismataceae	S3	5	0
Antennaria corymbose	flat-topped pussy-toes	Asteraceae	S1	2	0
Astragalus purshii	Pursh's milk-vetch	Fabaceae	S3	1	0
Bidens frondosa	tall beggar's-ticks	Asteraceae	S3	1	0
Eleocharis engelmannii	Engelmann's spike-rush	Cyperaceae	S3	4	1
Rorippa curvipes	curved yellow-cress	Brassicaceae	S3	2	0
Sisyrinchium septentrionale	northern blue-eyed-grass	Iridaceae	S3	1	0

Source: (Golder 2015; Stantec 2012, 2013a, and 2013b; SKCDC 2019b)

Vegetation surveys in select areas (e.g. the Northeast and small swales) will be completed during Phase 2 studies.

4.3.3.2.3 Wetland Delineation

The desktop wetland delineation exercise identified 452.6 ha of potential wetland habitat within the proposed freeway corridor (**Figure 4.12**).



LEGEND

- WETLAND / WATERCOURSE
- PRELIMINARY FREEWAY ALIGNMENT
- PROPOSED FREEWAY CORRIDOR
- VEGETATION AND SOIL STUDY AREA
- WILDLIFE STUDY AREA

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. IMAGERY (OCT. 16, 17 AND 18, 2018) PROVIDED BY SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE.
5. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
6. WETLANDS DIGITIZED BASED OFF OF IMAGERY PROVIDED BY SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE AND CROSS-REFERENCED WITH AND GOOGLE EARTH IMAGERY.

REFERENCE DRAWINGS

DWG No	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	KH	KG	HY	JP

0 500 1,000 2,000 Metres

SCALE: 1:45,000

SNC · LAVALIN

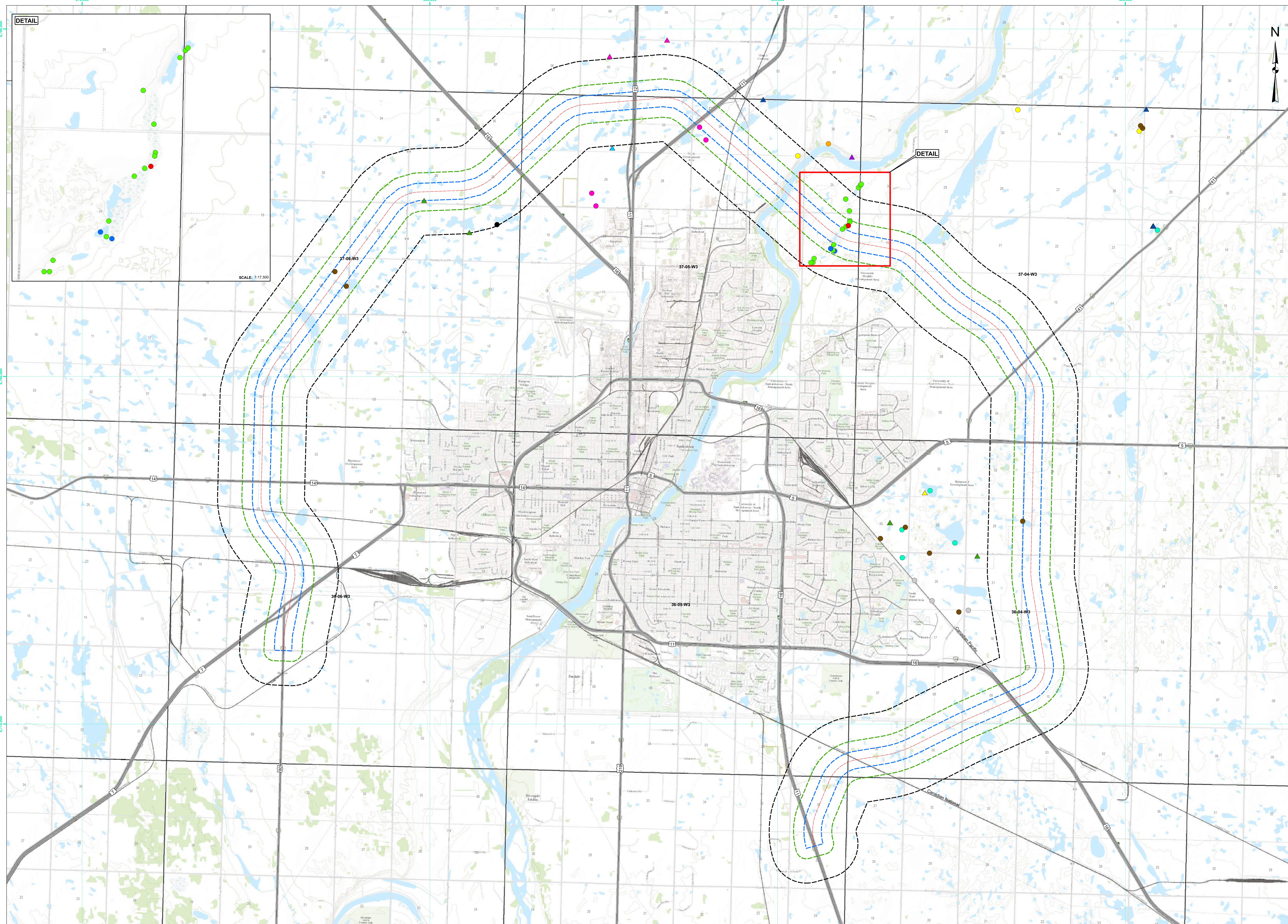
CLIENT
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION
SASKATOON FREEWAY

TITLE
DIGITIZED WETLANDS

DATE	2019 07 23	DWG No	659183-0000-4EDD-0011	FIG No. 2.7	REV	00

Path: \\sli1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0011 Wetland.mxd



LEGEND

PLANT
- CURVED YELLOW-CRESS
- ENGELMANN'S SPIKE-RUSH
- FLAT-TOPPED PUSSY-TOES
- PURSH'S MILK-VETCH
- TALL BEGGAR'S-TICKS
- NARROW-LEAVED WATER PLANTAIN
- NORTHERN BLUE-EYED-GRASS

WILDLIFE
- AMERICAN WHITE PELICAN
- BAIRD'S SPARROW *
- BARN SWALLOW *
- BOBOLINK *
- GREAT BLUE HERON
- HORNED GREBE *
- LOGGERHEAD SHRIKE *
- SPRAGUE'S PIPIT *
- NORTHERN LEOPARD FROG *
- TURKEY VULTURE
- PRELIMINARY FREEWAY ALIGNMENT
- RAILWAY
- HIGHWAY
- PROPOSED FREEWAY CORRIDOR
- VEGETATION AND SOIL STUDY AREA
- WILDLIFE STUDY AREA

* DENOTES A SPECIES AT RISK

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. TOPOGRAPHIC FEATURES OBTAINED FROM CANVEC V12.0 DATASET, NATURAL RESOURCES CANADA EARTH AND SCIENCES SECTOR CENTRE FOR TOPOGRAPHIC INFORMATION, 2013-09-30.
5. HIGHWAYS AND ROADS OBTAINED FROM THE NATIONAL ROAD NETWORK SASKATCHEWAN EDITION 9.0 DATASET, 2017-06-05.
6. RAILWAYS OBTAINED FROM THE NATIONAL RAILWAY NETWORK SASKATCHEWAN EDITION 2.0 DATASET, 2016-10-06.
7. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
8. WILDLIFE AND PLANT SOCC LOCATIONS DIGITIZED FROM REPORTS, STANTEC. (NOVERMBER 19, 2013). NORTH CENTRAL/NORTH EAST NATURAL AREA SCREENING STUDY, CITY OF SASKATOON. PG 64-70., STANTEC. (SEPTEMBER 16, 2012). NORTH/NORTHWEST NATURAL AREA SCREENING STUDY, CITY OF SASKATOON. PG 61., STANTEC. (OCTOBER 30, 2013). NORTH COMMUTER PARKWAY - BASELINE TERRESTRIAL AND AQUATIC FIELD STUDIES, AND HERITAGE RESOURCE IMPACT ASSESSMENT. PG 44., AND GOLDER ASSOCIATES. (NOVEMBER 16, 2015). HOLMWOOD EAST NATURAL AREA SCREEING STUDY. PG 12.

REFERENCE DRAWINGS

DWG No	DESCRIPTION
Golder Associates, 2013 1526165	Holmwood East Natural Area Screening Study
Stantec 2013	North Commuter Parkway - Baseline Terrestrial and Aquatic Field Studies, and Heritage Resource Impact Assessment
Stantec 2013	North Central/ North East Natural Area Sceening Study, City of Saskatoon
Stantec 2012	North/Northwest Natural Area Screening Study, City of Saskatoon

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	LM	KVG	HY	JP

0 500 1,000 2,000 Metres

SCALE: 1:50,000

SNC · LAVALIN

CLIENT SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION SASKATOON FREEWAY

TITLE WILDLIFE AND PLANT SOCC FROM PREVIOUS STUDIES

DATE 2019 07 30 | **DWG No** 659183-0000-4EDD-0013 | **FIG No.** 4.11 | **REV** 00

Path: \\sli1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0013 Previously Recorded Plants and Wildlife.mxd

4.3.4 Wildlife

4.3.4.1 Methods

SNC-Lavalin conducted a desktop review of wildlife and wildlife habitat as well as field-level rapid assessment surveys. For the purpose of this review, wildlife includes fish, bird, mammal, amphibian, reptile and insect species.

The wildlife study area includes the proposed freeway corridor surrounded by a 1,000 m buffer that extends from the edge of each side of the proposed freeway corridor (**Figure 4.5**), based on the maximum applicable setback distance for wildlife SAR identified in the Saskatchewan ARGs for Sensitive Species (ENV 2017). The wildlife study area occupies approximately 13,991 ha. The proposed freeway corridor occupies approximately 2,716 ha.

4.3.4.1.1 Ecoregion Review

SNC-Lavalin conducted a desktop review of commonly occurring wildlife species, including breeding birds and SOCC, and wildlife habitat features typical of the Moist Mixed Grassland Ecoregion. Each individual species has unique requirements for food, shelter, and breeding which inform habitat selection (Acton et al. 1998). Habitat availability at a local scale is greatly influenced by topography, vegetation, hydrologic regimes, and land use practices. Locations that contain a variety of habitat types are more likely to support a diverse assemblage of wildlife species. A list of wildlife species known to occur within the ecoregion and descriptions of their associated habitats was obtained from The Ecoregions of Saskatchewan (Acton et al. 1998).

4.3.4.1.2 Wildlife SOCC Screening

A screening exercise was conducted to identify wildlife SOCC with the potential for occurrence within the wildlife study area. SOCC occurrence and spatial data was obtained from the following sources:

- The HABISask tool (Government of Saskatchewan 2019) for (i) a list of wildlife SOCC occurrences and animal assemblages that were previously detected within the region (known as element occurrences), (ii) the locations of federal and/or provincial lands requiring environmental protection, and (iii) predictive distribution models for wildlife SOCC;
- Available studies in the region with data less than 10 years old and with spatial wildlife SOCC data that could be readily extracted (e.g. presented on maps or with UTM coordinates), including:
  - Final Screening Report, Holmwood East Natural Area Screening Study (Golder 2015),
  - North/Northwest Natural Area Screening Study, City of Saskatoon (Stantec 2012),
  - North Commuter Parkway – Baseline Terrestrial and Aquatic Field Studies, and Heritage Resource Impact Assessment (Stantec 2013a), and
  - North Central/North East Natural Area Screening Study, City of Saskatoon (Stantec 2013b).

Current federal and provincial species rankings were provided by the SARA Public Registry (Government of Canada 2019) and the SKCDC (2019c and 2019d) (Appendix A).

4.3.4.1.3 Field Surveys

4.3.4.1.3.1 Field Survey Design

An examination of satellite imagery was completed and used to infer the land use in each quarter-section within the proposed freeway corridor and identify quarter-sections with high value wildlife habitat.

SNC-Lavalin completed field-level surveys of wildlife and wildlife habitat within the wildlife study area but focussed on areas within the proposed freeway corridor. The majority of quarter sections intersected by the proposed freeway corridor were surveyed, with the exception of quarter sections that appeared to have limited or low-quality habitat. SNC-Lavalin did not complete field surveys within the area located between the Northeast swale and the South Saskatchewan River valley, as this area was surveyed by the Meewasin Valley Authority (MVA). Data associated with MVA's surveys will be presented in an addendum during Phase 2.

Data from the field surveys were used to develop recommendations for future surveys. Detailed species detection surveys were not completed as the project is not expected to be constructed for at least 10 years or more.

4.3.4.1.3.2 Field Surveys

Field surveys consisted of rapid assessment surveys, either conducted as roadside surveys or more in-depth meandering surveys. Some quarter sections where roadside surveys were initially conducted were re-surveyed using meandering surveys if they could not be fully assessed by roadside survey or potential high value wildlife habitat was observed. Meandering surveys were conducted for quarter sections deemed to have potential for high value wildlife habitat or if the quarter met one or more of the following criteria:

- Quarter contained potential native-dominant pasture/prairie or large undisturbed patches of wildlife habitat such as large wetlands or tree stands;
- Quarter contained previously identified SOCC species that may still be present;
- Quarter contained habitat that cannot be assessed from the road due to distance or an obstructed view;
- A roadside survey was determined to be insufficient to characterize the potential habitat; and/or
- The area was of special interest to project stakeholders (described below).

The rapid assessment roadside surveys were completed at 59 points covering 61 quarter sections within the wildlife study area; however, most assessments were located within the proposed freeway corridor. Some quarter sections were evaluated by two roadside surveys if they could be assessed from two different roads and if the first roadside survey was not enough to assess the habitat within the quarter. Some roadside surveys also assessed more than a single quarter section (i.e. both sides of the road had quarter sections crossed by the proposed freeway corridor. Locations for these surveys are provided in Appendix E and **Figure 4.13**. Roadside surveys were completed from June to September 2019. Survey locations were selected prior to beginning field surveys each day and adjusted in the field to allow the surveyor to assess as much habitat within the target quarter section as possible. The surveyor parked in a safe location and walked to the roadside survey location. The surveyor was equipped with binoculars and a spotting scope to assist with data collection. The surveyor attempted to wait for a break in traffic to conduct the auditory portion of the survey so ambient noise was low, and collected the following data:

- An incidental list of all wildlife visually and aurally observed, including SOCC and SAR species;
- A description of the available habitat features (cropland, wetlands, shrublands, tree stands, shelterbelts, grasslands, swales, etc.) and significant developments (industrial, residential, etc.);
- Land use within the quarter section;
- GPS coordinates of assessment location; and
- Photographs of the location and its associated habitat.

Areas of specific interest to stakeholders were identified during Technical Working Group (TWG) meetings. These areas are primarily the swales and other natural areas that surround the City of Saskatoon and include:

- The Hudson Bay swale (Phase 1);
- The Northeast swale and small swale (Phase 2);
- The South Saskatchewan River (Phase 2);
- The west swale (Phase 3);
- Seasonal creeks/drainages (Phase 2 and 3); and
- Native dominant grassland or land with remnant portions of native dominant grassland (All phases).

Meandering surveys were completed in 21 quarter-sections intersected by the proposed freeway corridor. Locations of these assessments are provided in Appendix E and **Figure 4.14**. Some quarters were assessed together if the habitat was similar between them. In this case, individual wildlife species lists were not generated for each quarter, but for the entire group of quarter sections assessed together. Meandering surveys were completed in August and September 2019. Some quarter sections underwent both roadside and meandering surveys. Locations for meandering surveys were determined based on desktop and previous roadside surveys. The surveyor parked on site in a safe location and completed a survey of the area by walking and inspecting all habitat types. The surveyor was equipped with binoculars and a spotting scope to assist with data collection. The data collected during the meandering surveys was the same as the data collected during the roadside surveys, but because of the increased time on-site, more detailed habitat descriptions and incidental wildlife lists were collected during meandering surveys.

SNC-Lavalin also completed snow tracking surveys in the winter of 2020 in the western portions of Phase 1 (between the Hudson Bay swale and the west bank of the South Saskatchewan River). Three transects spaced approximately 250 m apart were completed within the project corridor. Transects were located:

- At the northern limit of the project corridor;
- At the centre of the project corridor; and
- At the southern limit of the project corridor.

Each transect was visited twice during appropriate snow conditions during the winter. All tracks and other sign of wildlife (live animals, bed sites, rub sites, feces, excavations, etc.) were recorded.

Land access permissions were not required for access from public roads. Form A requests were sent out via registered mail to inform landowners and occupants of the intent to access private land for on-foot assessments. SNC-Lavalin also provided notification in the form of a phone call or voice message which was delivered prior to accessing the land (if required).

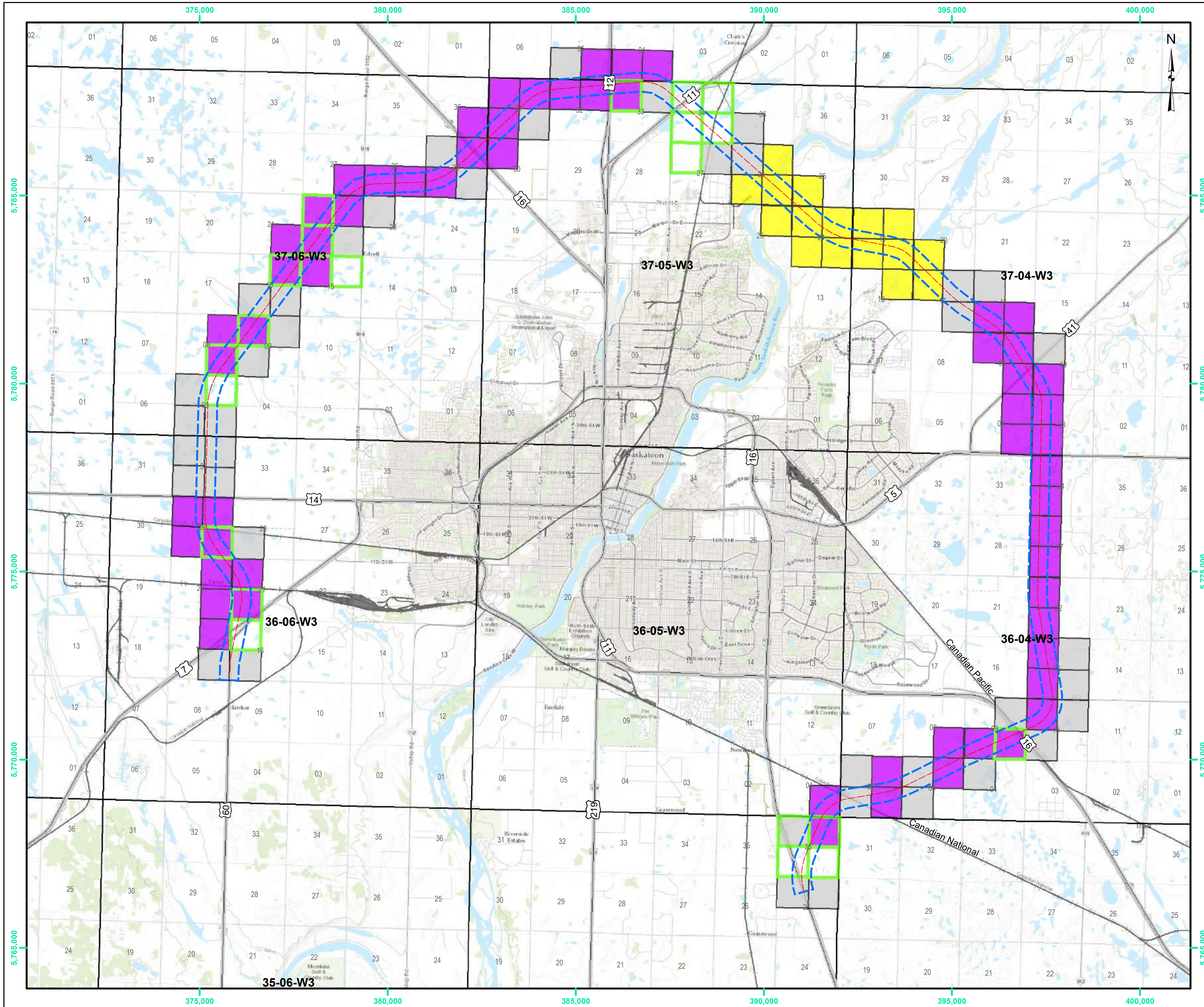
4.3.4.1.3.3 Ongoing Wildlife Field Surveys to Support the SFFPS

Ongoing field surveys to support the SFFPS are scheduled for the winter of 2019/2020 and spring/summer 2020.

SNC-Lavalin completed snow track surveys for the proposed freeway in accordance with ENV (2014) protocols. The primary focus of these snow track surveys was to identify key wildlife travel corridors. The identification of these corridors may help siting of wildlife crossings, if required. Surveys focussed on the Phase 1 portion of the project, as well as within the Northeast swale and small swale.

SNC-Lavalin will also complete additional wildlife surveys during the spring and summer of 2020 in selected areas observed to have potentially high value habitat. These will include the Northeast swale and small swale, west swale, Hudson Bay swale and areas of pasture lands in Phase 2 and 3. The scope of the 2020 surveys is to be determined based on discussions with the Ministry and results of MVA surveys in the

Northeast swale and small swale. Species specific surveys, where completed, will be conducted in accordance with ENV (2014) protocols.



LEGEND

PRELIMINARY FREEWAY ALIGNMENT
RAILWAY
HIGHWAY
PROPOSED FREEWAY CORRIDOR

FIELD ASSESSED QUARTER SECTIONS

DESKTOP QUARTER
MEANDERING SURVEY QUARTER
MVA-SURVEYED QUARTER
ROADSIDE SURVEY QUARTER

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
PA	2020 04 24	ISSUED FOR REVIEW	HY	KVG	HY	JP

0 500 1,000 2,000 3,000 4,000 METRES

SCALE: 1:100,000

SNC·LAVALIN

CLIENT	PROJECT LOCATION
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE	SASKATOON FREEWAY

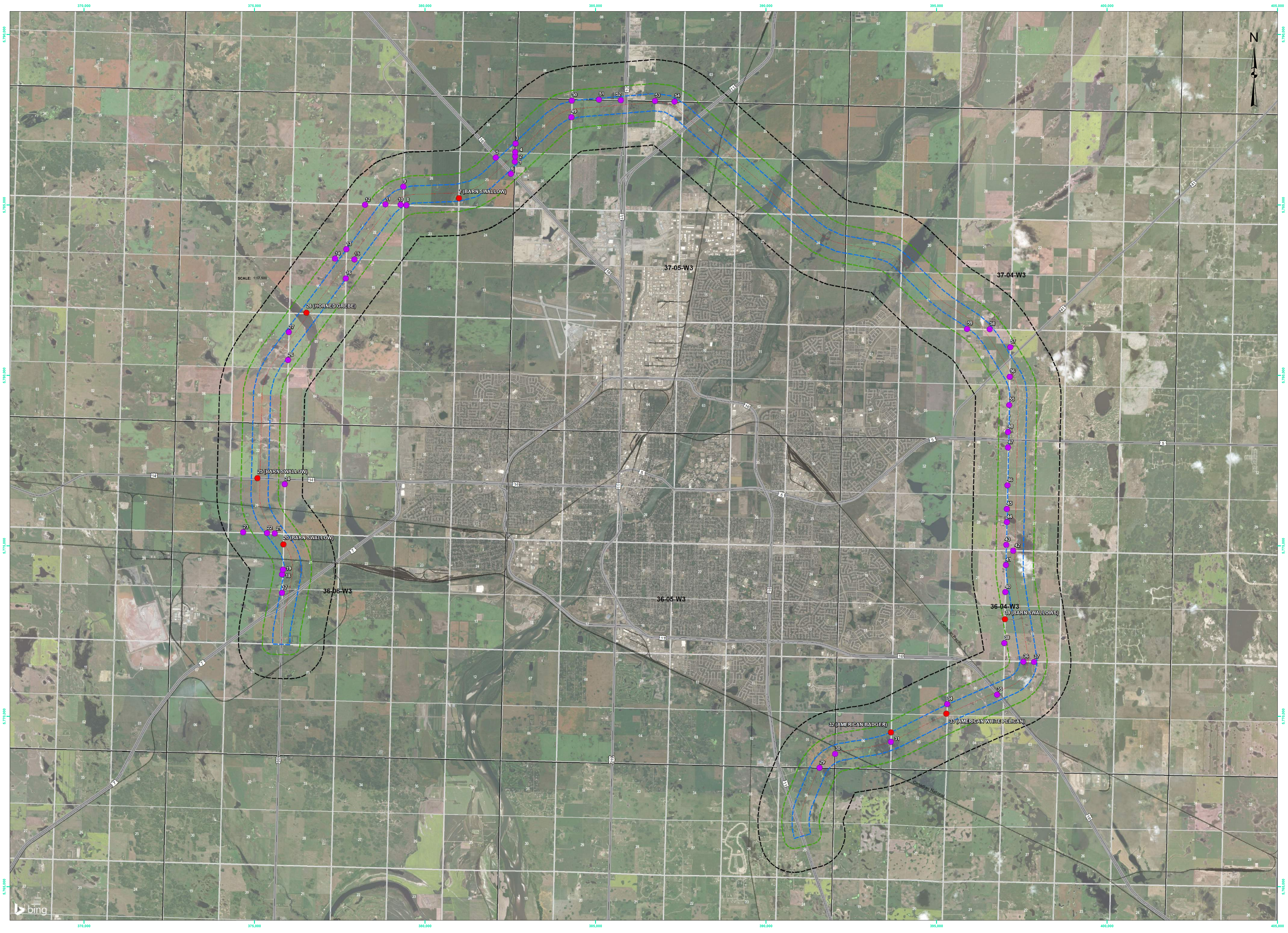
TITLE

RAPID ASSESSMENT SURVEY LOCATIONS – ROADSIDE AND MEANDERING SURVEYS

DATE	2019 10 28	DWG No.	659183-0000-4EDD-0015	FIG No. **4.14**	REV	00

SIZE 11x17

Path: \\sli1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0015 Field Assessed QS.mxd



LEGEND

- ROADSIDE SURVEY LOCATION – SOCC IDENTIFIED
- ROADSIDE SURVEY LOCATION
- PRELIMINARY FREEWAY ALIGNMENT
- RAILWAY
- HIGHWAY
- PROPOSED FREEWAY CORRIDOR
- VEGETATION AND SOIL STUDY AREA
- WILDLIFE STUDY AREA

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. TOPOGRAPHIC FEATURES OBTAINED FROM CANVEC V12.0 DATASET, NATURAL RESOURCES CANADA EARTH AND SCIENCES SECTOR CENTRE FOR TOPOGRAPHIC INFORMATION, 2013-09-30.
5. HIGHWAYS AND ROADS OBTAINED FROM THE NATIONAL ROAD NETWORK SASKATCHEWAN EDITION 9.0 DATASET, 2017-06-05.
6. RAILWAYS OBTAINED FROM THE NATIONAL RAILWAY NETWORK SASKATCHEWAN EDITION 2.0 DATASET, 2016-10-06.
7. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

REFERENCE DRAWINGS

DWG No	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	TL	KG	HY	JP

0 500 1,000 2,000 Metres

SCALE: 1:50,000

SNC · LAVALIN

CLIENT	PROJECT LOCATION
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE	SASKATOON FREEWAY

TITLE
RAPID ASSESSMENT SURVEY LOCATIONS – ROADSIDE SURVEYS

DATE 2019 08 07	DWG No 659183-0000-4EDD-0014	FIG No. 4.13	REV 00

Path: \\sli1653\Projects QMS\SMHI\659183\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0014 Point Counts.mxd

4.3.4.2 Results

4.3.4.2.1 Ecoregion Review

A large diversity of wildlife is supported by the Moist Mixed Grassland Ecoregion, including 51 mammal species (Acton et al. 1998). Common mammals occurring in open grassland habitat include: coyote (*Canis latrans*), porcupine (*Erethizon dorsatum*), white-tailed jackrabbit (*Lepus townsendii*), striped skunk (*Mephitis mephitis*), white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), deer mouse (*Peromyscus maniculatus*), Richardson's ground squirrel (*Spermophilus richardsonii*), red fox (*Vulpes vulpes*), and American badger (*Taxidea taxus taxus*) (SKCDC 2019c). Fragmented deciduous woodland habitat supports less common mammals like moose (*Alces alces*), cougar (*Puma concolor*), and black bear (*Ursus americanus*). Mammals associated with wetland habitat and other water features include North American beaver (*Castor canadensis*), North American river otter (*Lontra canadensis*) and muskrat (*Ondatra zibethicus*) (SKCDC 2019c).

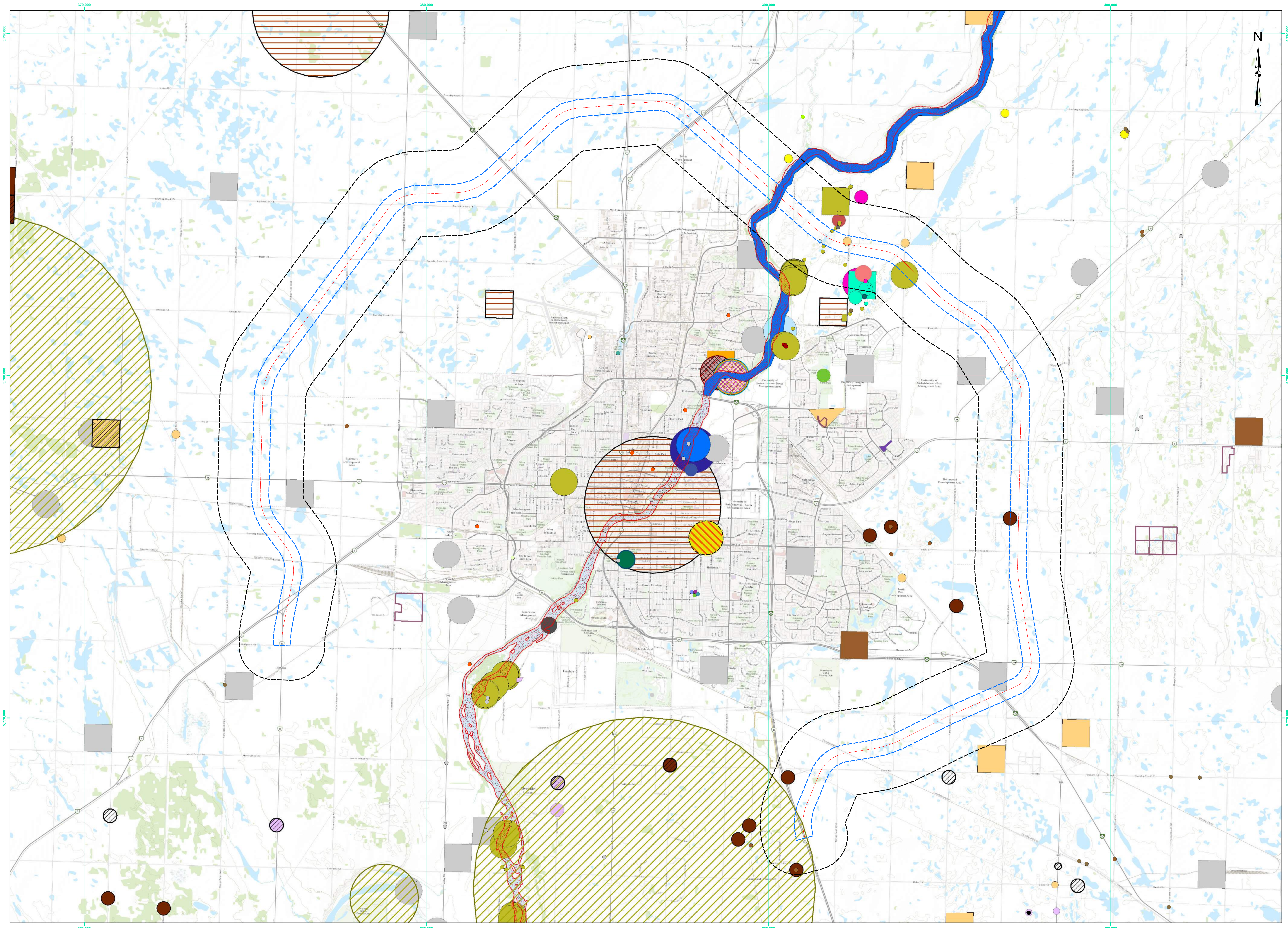
Thirteen species of reptiles and amphibians have been recorded in the Moist Mixed Grassland Ecoregion (Acton et al. 1998). The western painted turtle (*Chrysemys picta belliil)* and the western plains garter snake (*Thamnophis radix haydenii*) are common reptiles observed in a combination of aquatic, riparian, and grassland habitats. Amphibians such as Canadian toad (*Bufo hemiophrys*) and wood frog (*Rana sylvatica*) inhabit select aquatic, riparian, and grassland habitats (SKCDC 2019c).

A total of 198 migratory and resident birds have been recorded in the Moist Mixed Grassland Ecoregion (Acton et al. 1998). Common birds found in open grassland habitat include northern harrier (*Circus cyaneus*), American crow (*Corvus brachyrhynchos*), horned lark (*Eremophila alpestris*), clay-coloured sparrow (*Spizella pallida*), and sharp-tailed grouse (*Tympanuchus phasianellus*). Birds associated with aspen stands and deciduous woodland habitat include ruffed grouse (*Bonasa umbellus*), great horned owl (*Bubo virginianus*), red-tailed hawk (*Buteo jamaicensis*), common raven (*Corvus corax*), least flycatcher (*Empidonax minimus*), hairy woodpecker (*Picoides villosus*), and yellow warbler (*Setophaga petechia*). Wetlands and lentic water features are predominantly populated by waterbirds, such as northern shoveler (*Anas clypeata),* blue-winged teal (*Anas discors*), killdeer (*Charadrius vociferus*), black tern (*Chlidonias niger*), Wilson's snipe (*Gallinago delicata*), eared grebe (*Podiceps nigricollis*), sora (*Porzana carolina*) and American avocet (*Recurvirostra americana*) (Cornell Lab of Ornithology 2019; SKCDC 2019c). Wetlands in the wildlife study area are used by waterfowl as summer breeding areas and spring/fall staging areas.

4.3.4.2.2 Wildlife SOCC Screening

A search of HABISask produced records of 42 wildlife SOCC and 254 wildlife SOCC element occurrences within the region, including 15 SAR and 216 SAR element occurrences (Government of Saskatchewan 2019) (**Figure 4.15**; **Table 4.7**). Appendix D provides a list of all 254 element occurrences. A total of 14 SOCC (including 9 SAR) and 51 SOCC element occurrences (including 44 SAR element occurrences) are located within the wildlife study area. HABISask also identified one migratory bird concentration site within the wildlife study area (**Figure 4.15**). This site follows the South Saskatchewan River into the City of Saskatoon and is locally significant for thousands staging waterfowl (Government of Saskatchewan 2019). No federal or provincial lands requiring environmental protection were identified within the wildlife study area. HABISask's predictive distribution model identified potentially suitable habitat for 16 wildlife SOCC (including 15 SAR) within the wildlife study area (**Table 4.8**).

Occurrence records of 10 wildlife SOCC, including seven SAR, were obtained in the review of previous studies conducted within the region (**Table 4.9**) (Golder 2015; Stantec 2012, 2013a, and 2013b). A total of 44 individual SOCC occurrences were identified, including 21 occurrences within the wildlife study area (**Figure 4.11**).



LEGEND

- PRELIMINARY FREEWAY ALIGNMENT
- PROPOSED FREEWAY CORRIDOR
- WILDLIFE STUDY AREA
- PRIVATE CONSERVATION LANDS

ANIMAL ASSEMBLAGE

- MIGRATORY BIRD CONCENTRATION SITE

VERTEBRATES

- BAIRD'S SPARROW *
- BARN SWALLOW *
- BOBOLINK *
- COMMON NIGHTHAWK *
- COOPER'S HAWK
- HARRIS'S SPARROW
- HORNED GREBE *
- LAKE STURGEON
- LITTLE BROWN MYOTIS *
- LOGGERHEAD SHRIKE *
- NORTHERN LEOPARD FROG *
- NORTHERN SHRIKE
- OLIVE-BACKED POCKET MOUSE
- OSPREY
- PRONGHORN
- RUSTY BLACKBIRD *
- SHARP-TAILED GROUSE
- SHORT-EARED OWL *
- SPRAGUE'S PIPIT *
- TURKEY VULTURE
- WHOOPING CRANE *
- YELLOW RAIL *

INVERTEBRATES

- GROUND BEETLE
- BICOLORED SALLOW MOTH
- BROWN HARPALINE BEETLE
- CLAY-BEACH BEMBIDION BEETLE
- COMMON GREEN DARNER
- ELUSIVE CLUBTAIL
- FIELD BEMBIDION BEETLE
- INDISCRIMINATE BUMBLE BEE
- LANCE-TIPPED DARNER
- MONARCH *
- SALT BEMBIDION BEETLE
- STRIPED MEADOWHAWK
- SUCKLEY'S BUMBLE BEE
- TULE BLUET
- TWENTY-SPOTTED LADY BEETLE
- TWICE-STABBED LADY BEETLE
- WESTERN RED DAMSEL
- WHITE HEELSPLITTER
- YELLOW-BANDED BUMBLE BEE *

*** DENOTES A SPECIES AT RISK**

SIZE 22 x 34

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.
5. RARE SPECIES INFORMATION OBTAINED FROM HABISASK COLLECTED BY THE SASKATCHEWAN CONSERVATION DATA CENTRE. INFORMATION IS SENSITIVE AND INTENDED FOR CONSERVATION PURPOSES ONLY. ONLY SPECIES WITHIN STUDY AREA ARE SHOWN.
6. CONSERVATION EASEMENTS OBTAINED FROM THE FISH AND WILDLIFE BRANCH AND THE LANDS BRANCH OF THE MINISTRY OF ENVIRONMENT. ONLY CONSERVATION EASEMENTS WITHIN STUDY AREA ARE SHOWN.

REFERENCE DRAWINGS

DWG No	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 500 1,000 2,000 Metres

SCALE: 1:50,000

SNC · LAVALIN

CLIENT
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION
SASKATOON FREEWAY

TITLE
HABISASK WILDLIFE SOCC DATA

DATE	DWG No	FIG No.	REV
2019 03 05	659183-0000-4EDD-0002	4.15	00

Path: \\sli1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0002 Wildlife SOCC_Rev.mxd

SNC·LAVALIN

Table 4.7 HABISask wildlife SOCC screening results

Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	SAR	ARG for Species or Feature	Element Occurrence(s) within Study Area?
Baird's sparrow	*Centronyx bairdii*	bird	S4B; tracked	Special Concern	Schedule 1, Special Concern	✓	n/a	yes
barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	✓	n/a	yes
bicolored sallow moth	*Sunira bicolorago*	insect	S3	n/a	n/a		n/a	no
bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	✓	n/a	no
brown harpaline beetle	*Harpalus fuscipalpis*	insect	S3	n/a	n/a		n/a	no
clay-beach bembidion beetle	*Bembidion patruele*	insect	S3	n/a	n/a		n/a	no
common green darner	*Anax junius*	insect	S3	n/a	n/a		n/a	no
common nighthawk	*Chordeiles minor*	bird	S4B, S4M; tracked	Special Concern	Schedule 1, Threatened	✓	breeding bird	no
Cooper's hawk	*Accipiter cooperii*	bird	S4B, S2N, S2M	Not at Risk	n/a		nest site	no
elusive clubtail	*Stylurus notatus*	insect	S2	n/a	n/a		n/a	no
field bembidion beetle	*Bembidion rupicola*	insect	S3	n/a	n/a		n/a	no
ground beetle	*Bembidion intermedium*	insect	S3	n/a	n/a		n/a	no
ground beetle	*Bembidion rapidum*	insect	S3	n/a	n/a		n/a	no
Harris's sparrow	*Zonotrichia querula*	bird	SUB, S5M; tracked	Special Concern	No Status		n/a	no
horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	✓	n/a	yes
indiscriminate bumble bee	*Bombus insularis*	insect	S3	n/a	n/a		n/a	no
lake sturgeon	*Acipenser fulvescens*	fish	S2	Endangered	No Status		selected waters*	yes
lance-tipped darner	*Aeshna constricta*	insect	S2	n/a	n/a		n/a	no
little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	✓	roost/foraging site	no
loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	✓	breeding bird	yes
monarch	*Danaus plexippus plexippus*	insect	S2B	Endangered	Schedule 1, Special Concern	✓	n/a	no
northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	✓	breeding and overwintering habitat	yes
northern shrike	*Lanius borealis*	bird	S1B, S4N, S4M	n/a	n/a		n/a	no
olive-backed pocket mouse	*Perognathus fasciatus*	mammal	S3	n/a	n/a		n/a	yes
osprey	*Pandion haliaetus*	bird	S2B, S2M	n/a	n/a		nest site	yes
pronghorn	*Antilocapra americana*	mammal	S3	n/a	n/a		n/a	no
rusty blackbird	*Euphagus carolinus*	bird	S3B, SUN, S3M	Special Concern	Schedule 1, Special Concern	✓	breeding bird	yes
salt bembidion beetle	*Bembidion insulatum*	insect	S3	n/a	n/a		n/a	no

Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	SAR	ARG for Species or Feature	Element Occurrence(s) within Study Area?
sharp-tailed grouse	*Tympanuchus phasianellus*	bird	S5; tracked	n/a	n/a		lek	yes
short-eared owl	*Asio flammeus*	bird	S3B, S2N, S3M	Special Concern	Schedule 1, Special Concern	✓	breeding bird	yes
Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	✓	breeding bird	no
striped meadowhawk	*Sympetrum pallipes*	insect	S3	n/a	n/a		n/a	no
Suckley's bumble bee	*Bombus suckleyi*	insect	S3	n/a	n/a		n/a	no
tule bluet	*Enallagma carunculatum*	insect	S3	n/a	n/a		n/a	no
turkey vulture	*Cathartes aura*	bird	S3B, S3M	n/a	n/a		n/a	yes
twenty-spotted lady beetle	*Psyllobora vigintimaculata*	insect	S2	n/a	n/a		n/a	no
twice-stabbed lady beetle	*Chilocorus stigma*	insect	S3	n/a	n/a		n/a	no
western red damsel	*Amphiagrion abbreviatum*	insect	S2	n/a	n/a		n/a	no
white heelsplitter	*Lasmigona complanata*	insect	S3	n/a	n/a		n/a	no
whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	✓	staging area	yes
yellow rail	*Coturnicops noveboracensis*	bird	S3B, S3M	Special Concern	Schedule 1, Special Concern	✓	breeding bird	yes
yellow-banded bumble bee	*Bombus terricola*	insect	S5; tracked	Special Concern	Schedule 1, Special Concern	✓	n/a	no

*Proponent is required to contact the Department of Fisheries and Oceans (DFO) if the project is located in or near: the waters of the North Saskatchewan, South Saskatchewan, and Saskatchewan Rivers (including large connected waters such as the Torch River), and the waters of the Churchill River below the confluence of the Reindeer River
Source: (ENV 2017; Government of Saskatchewan 2019; SKCDC 2019c and 2019d)

Table 4.8 HABISask wildlife SAR habitat predictive distribution model results

Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	SAR	ARG for Species or Feature	Amount of Potential Habitat within Study Area (km^2)
American badger	*Taxidea taxus taxus*	mammal	S3	Special Concern	Schedule 1, Special Concern	✓	n/a	97.7
Baird's sparrow	*Centronyx bairdii*	bird	S4B; tracked	Special Concern	Schedule 1, Special Concern	✓	n/a	45.1
bank swallow	*Riparia riparia*	bird	S4B, S5M	Threatened	Schedule 1, Threatened	✓	n/a	47.8
bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	✓	n/a	124.6
burrowing owl	*Athene cunicularia*	bird	S2B, S2M	Endangered	Schedule 1, Endangered	✓	breeding bird	55.7
chestnut-collared longspur	*Calcarius ornatus*	bird	S3B	Threatened	Schedule 1, Threatened	✓	breeding bird	11.0
common nighthawk	*Chordeiles minor*	bird	S4B, S4M; tracked	Special Concern	Schedule 1, Threatened	✓	breeding bird	56.2
ferruginous hawk	*Buteo regalis*	bird	S3	Threatened	Schedule 1, Threatened	✓	nest site	27.5
golden eagle	*Aquila chrysaetos*	bird	S3B, S3N, S4M	Not at Risk	n/a		nest site	3.6

Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	SAR	ARG for Species or Feature	Amount of Potential Habitat within Study Area (km^2)
horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	✓	n/a	135.4
loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	✓	breeding bird	119.9
monarch	*Danaus plexippus plexippus*	insect	S2B	Endangered	Schedule 1, Special Concern	✓	n/a	57.6
northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	✓	breeding and overwintering habitat	76.4
piping plover	*Charadrius melodus circumcinctus*	bird	S3B	Endangered	Schedule 1, Endangered	✓	high-water mark	23.1
short-eared owl	*Asio flammeus*	bird	S3B, S2N, S3M	Special Concern	Schedule 1, Special Concern	✓	breeding bird	45.5
Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	✓	breeding bird	75.7

Source: (ENV 2017; Government of Saskatchewan 2019; SKCDC 2019c)

Table 4.9 Wildlife SOCC identified in previous studies

Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	SAR	ARG for Species or Feature	Number of Occurrences	Occurrences within Study Area
American white pelican	*Pelecanus erythrorhynchos*	bird	S5B, S5M	Not at Risk	n/a		nesting colony	1	0
Baird's sparrow	*Centronyx bairdii*	bird	S4B; tracked	Special Concern	Schedule 1, Special Concern	✓	n/a	3	1
barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	✓	n/a	10	3
bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	✓	n/a	1	1
great blue heron	*Ardea herodias*	bird	S5B; tracked	n/a	n/a		nesting colony	2	2
horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	✓	n/a	5	0
loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	✓	breeding bird	3	0
northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	✓	breeding and overwintering habitat	14	11
Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	✓	breeding bird	4	2
turkey vulture	*Cathartes aura*	bird	S3B, S3M	n/a	n/a		n/a	1	1

Source: (ENV 2017; Golder 2015; Stantec 2012, 2013a, and 2013b; SKCDC 2019c)

4.3.4.2.3 Field Surveys

In total, 73 quarter sections were surveyed by roadside or meandering surveys or both (Appendix Eand **Figure 4.16**). A summary of all field data is presented in this section and is then broken down by project phase (1, 2 and 3) in the subsequent subsections.

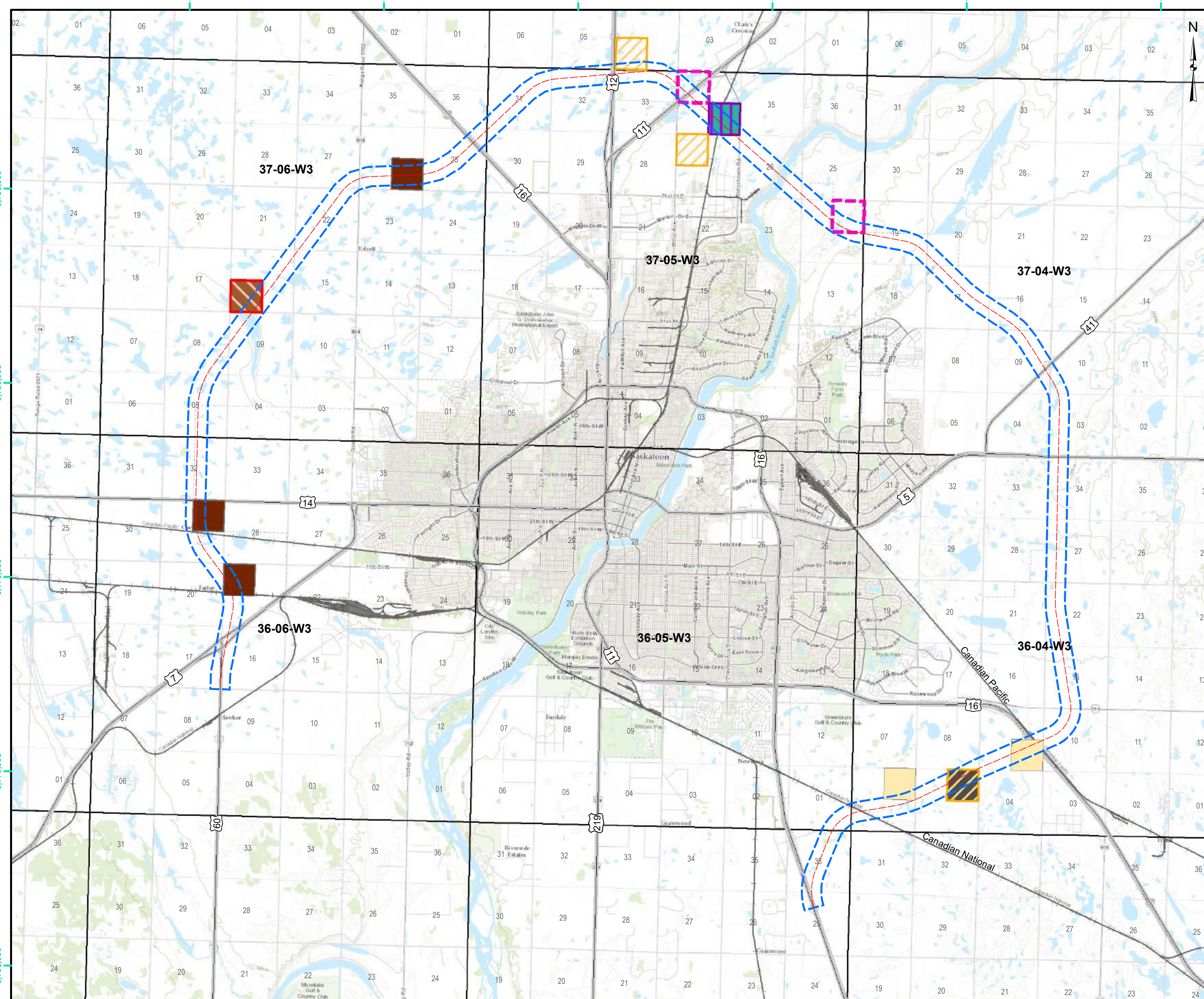
Sixty-one quarters were surveyed by roadside rapid assessment surveys. Species detections ranged from zero to 18 species detected per quarter for roadside survey locations. Data for the surveys are presented in Appendix E and photographs of the representative habitat for each surveyed quarter section are presented in Appendix F.

Twenty-one quarters were surveyed by a meandering rapid assessment survey. Species detections ranged from zero to 30 species detected per quarter. Data for the surveys are presented in Appendix E and photographs of the representative habitat for each assessed quarter section are presented in Appendix F.

A total of 81 wildlife species were incidentally observed during the field studies (Appendix E). This consisted of nine mammal species, two amphibian species, a single reptile species, and 70 bird species. Nine SOCC were also observed, with a number of these SOCC being observed in multiple locations (**Table 4.10**). SOCC were identified in 10 different quarter sections (**Figure 4.16**).

Table 4.10 Field observed SOCC within the proposed freeway corridor

Common Name	Scientific Name	Taxonomic Group	SARA Status	SKCDC Status	ARG Feature	Quarters Observed	SAR
American badger	*Taxidea taxus*	mammal	schedule 1, special concern	S3; tracked	n/a	SE 09-36-04-3, NE 06-36-04-3,	✓
American white pelican	*Pelecanus erythrorhynchos*	bird	n/a	S5B, S5M	nesting colony	NE 05-36-04-3, SW 04-38-05-3, NW 27-37-05-3	
barn swallow	*Hirundo rustica*	bird	schedule 1, threatened	S5B, S5M; tracked	n/a	SE 26-37-06-3, NW 21-36-06-3, NE 29-36-06-3,	✓
double crested cormorant	*Phalacrocorax auritus*	bird	n/a	S5B, S5M	nesting colony	NE 05-36-04-3	
eared grebe	*Podiceps nigricollis*	bird	n/a	S5B, S5M	nesting colony	SE 34-37-05-3	
great blue heron	*Ardea herodias*	bird	n/a	S5B; tracked	nesting colony	SE 34-37-05-3	
horned grebe	*Podiceps auritus*	bird	schedule 1, special concern	S5B, S5M; tracked	n/a	SW 16-37-06-3	✓
red-necked phalarope	*Phalaropus lobatus*	bird	schedule 1, special concern	S4B, S3M; tracked	breeding bird	SW 16-37-06-3	✓
Turkey vulture	*Cathartes aura*	bird	n/a	S3B, S3M; tracked	n/a	NW 34-37-05-3 NE 34-37-05-3	



LEGEND

- PRELIMINARY FREEWAY ALIGNMENT
- RAILWAY
- HIGHWAY
- PROPOSED FREEWAY CORRIDOR
- AMERICAN BADGER
- AMERICAN WHITE PELICAN
- BARN SWALLOW
- DOUBLE CRESTED CORMORANT
- EARED GREBE
- GREAT BLUE HERON
- HORNED GREBE
- RED-NECKED PHALAROPE
- TURKEY VULTURE

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR REVIEW	HY	KVG	HY	JP

0 500 1,000 2,000 3,000 4,000 METRES

SCALE: 1:100,000

SNC·LAVALIN

CLIENT: SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION: SASKATOON FREEWAY

TITLE: FIELD IDENTIFIED SOCC SPECIES

DATE	DWG No.	FIG No.	REV
2019 10 28	659183-0000-4EDD-0016	4.16	00

SIZE 11x17

Path: \\sl1653\Projects QMS\SMH\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0016 Field SOCC.mxd

4.3.4.2.3.1.1 Phase 1

Phase 1 of the proposed freeway corridor intersects approximately 24 quarter sections, 19 of which were surveyed at the field-level. Twelve of these quarter sections were surveyed from roadside surveys and seven by meandering surveys. Both paved and gravel roads are present throughout the Phase 1 corridor. Land use between Highway No. 12 and Highway No. 16 (the western half of the phase) within the corridor was dominated by cropland. Three residential properties were observed in this section of the Phase. Very little natural habitat remains in this area, with the best quality wildlife habitat located within planted tree rows, as well as some small to medium sized wetlands.

Land use within the Phase 1 corridor was most diverse between Highway No. 12 and the South Saskatchewan River Valley, with a mixture of tame and native pasture, industrial property, wetland habitat, road developments, cropland, snow storage facilities, riparian and river valley habitat, and the Hudson Bay swale.

The Hudson Bay swale is in the eastern section of the Phase 1 corridor, approximately one-kilometre west of the South Saskatchewan River. The Hudson Bay swale extends across approximately eight quarter sections, two of which are within the Saskatoon Freeway corridor. The swale is located in a native vegetation dominated pasture. The swale is bordered by a railroad track on its eastern end and has a significant development in NW 27-37-05-W3 that has been built into the wetland and has likely impacted the wetland shape and how the water flows through the area. There is also a snow dump on the west side of Wanuskewin Rd. that potentially has drainages inputs into the Hudson Bay swale.

Considerable wildlife activity was identified in the area, with large numbers of birds, as well as signs of frequent mammal usage. No amphibians were observed during the survey, but potential habitat existed in the area. Three SOCC species were also observed during the on-foot survey; great blue herons, turkey vultures and American white pelicans.

NW 33-27-05-W3 contained suitable habitat for a number of SOCC/SAR. This quarter has been at least partially seeded but includes sections of native vegetation. Cattle were in the pasture at the time of survey, and the area had been heavily grazed in some locations. The pasture also contained completed bird nests and several dugouts that have the potential to support overwintering amphibians.

Outside of the Hudson Bay swale, one additional SOCC was observed, a group of American white pelicans (**Table 4.10** and **Figure 4.16**).

A total of 981 wildlife sign observations were made during the 2020 snow tracking surveys. Hares/rabbits (299), small rodents (239), deer (189), and coyotes (156) were the most frequently observed wildlife signs (**Table 4.11**). Two active American badger excavations (*Taxidea taxus taxus),* an SOCC, were observed during the surveys. Observations were found throughout the transects, but the greatest concentrations of tracks were recorded on the west bank of the South Saskatchewan River, and at several locations within the Hudson Bay swale.

Table 4.11 Wildlife sign observations in Phase 1

Species/Taxa	Scientific Name	Number of wildlife sign observations
American badger	*Taxidea taxus taxus*	2
bird spp.	*n/a*	56
coyote	*Canis latrans*	156
Canada Goose	*Branta canadensis*	1
Deer (white-tailed or mule)[a]	*Odocoileus virginianus/hemionus*	189
hare/rabbit (snowshoe hare or white-tailed jackrabbit)[a]	*Lepus spp.*	299
Hungarian partridge	*Perdix perdix*	13
Red fox	*Vulpes vulpes*	2
Sharp-tailed grouse	*Tympanuchus phasianellus*	15
small rodent[a]	*Mus/Microtus spp.*	239
Weasel[a] (Stoat, least weasel, etc.)	*Mustela spp*	11

[a]No distinction was made in these taxa, due to track similarities.

4.3.4.2.3.1.2 Phase 2

The Northeast swale and small swale are the most significant natural habitat features present within this phase of the project. These swales will be described in an addendum as data collection in these areas is still underway.

Beginning southeast of the Northeast swale, the proposed freeway corridor crosses approximately 62 quarter sections in Phase 2, 30 of which were surveyed by SNC-Lavalin at the field-level and an additional 16 quarter sections that were surveyed by the MVA. Of the 30 quarter sections surveyed by SNC-Lavalin, 27 were surveyed from the roadside and five by meandering surveys. Almost all the quarter sections surveyed by SNC-Lavalin have been developed into agricultural cropland. There are approximately 12 residential developments throughout Phase 2. A small industrial site is also located on SW and SE 16-37-04-W3. Both paved and gravel roads are present throughout the phase. Some natural remnant habitat exists throughout these quarter sections in the forms of small to medium sized wetlands, treed wetlands, small undeveloped patches of grassland, and tree stands. The proposed corridor intersects a large wetland complex which is primarily located in SE 06-36-04-W3 but extends to adjacent quarter sections.

Two small ephemeral creeks/drainages intersected by the proposed freeway crossing are present within this phase (NW 15-36-04-W3 and SE 09-36-04-W3). Both drainages were dry at the time of visit, but likely hold some water during flood events or spring thaw. Fish habitat is unlikely within these drainages (**Section 4.3.5**), but they likely contain temporary habitat for amphibians and breeding birds.

A full section of hayland and pastureland (section 36-35-05-3), which contains suitable habitat for several SOCC/SAR, is present at the southeast end of the corridor in Phase 2. The north and west end of this section has significant road developments. A portion of the section had been recently hayed and bailed prior to the site visit, but some remained unhayed and was likely used as pastureland. Considerable wildlife activity was observed in the section during the field survey. No SOCC species were observed, however there was considerable habitat for nesting and breeding birds, including a diversity of habitat (large wetlands, tree stands, and remnant native prairie). There is also considerable habitat for amphibians and mammals.

Three SOCC were observed in Phase 2; American badger, American white pelican, and double-crested cormorants (**Table 4.10** and **Figure 4.16**).

4.3.4.2.3.1.3 Phase 3

Phase 3 of the proposed freeway corridor intersects approximately 44 quarter sections, 26 of which were surveyed at the field-level. Twenty-three of these quarters were surveyed from the roadside and 10 by meandering surveys. As in Phase 2, most of the area has been developed into agricultural cropland. There appear to be approximately 10 residential properties within the proposed freeway corridor. A large industrial site has also been developed in SE 20-36-06-W3, which is crossed by a small portion of the proposed freeway corridor. Both paved and gravel road developments are present throughout the phase. Some natural remnant habitat exists throughout these quarter sections in the forms of small to medium sized wetlands, treed wetlands, small undeveloped patches of grassland, and tree stands. The proposed freeway corridor intersects another large wetland complex primarily located in SW 21-36-06-W3 and NW 16-36-06-W3.

This phase of the corridor intersects the west swale, a large wetland located west of the City of Saskatoon. The swale complex extends over multiple quarter sections but two quarter sections containing a part of the west swale are within the corridor (SW 16-37-06-W3 and NW 09-37-06-W3). The portions of the swale within the corridor are located within cropland fields which have been tilled very close to the edge of the wetland. In areas where it is not tilled to the edge, tame pasture vegetation such as brome grass dominates the area. Much of the original wetland vegetation has been lost due to the tillage. The boundary of the water body itself did not appear to have been disturbed by development. During the initial roadside survey, water levels were low but water was still present within the wetland. During the meandering survey however, the water in the wetland had completely evaporated within the proposed freeway corridor. Considerable avian activity was observed during this roadside assessment, including two SOCC/SAR species, horned grebe and red-necked phalarope.

Outside of the west swale, barn swallows (an SOCC and SAR) were observed in three locations (**Table 4.10** and **Figure 4.16**). These were the only additional SOCC observed in the phase.

4.3.5 Fish and Fish Habitat

4.3.5.1 Methods

SNC-Lavalin conducted a desktop review of available data to describe fish and fish habitat in the wildlife study area. These data were obtained through a review of satellite imagery, previous desktop and field studies in the area, academic literature, and the following databases and reports:

- The federal *Species at Risk Act* (SARA) Public Registry for information on species-at-risk that may potentially occur within or adjacent to the study areas and to determine their status under the Act (Government of Canada 2014);
- The HABISask tool (Government of Saskatchewan 2019) for fish species that have been recorded in the area;
- The Saskatchewan Conservation Data Center (SKCDC) for fish species of conservation concern (SOCC) or species at risk (SAR) that may occur within the area (SKCDC 2019); and
- Relevant literature and previous studies completed in the area.

4.3.5.2 Results

The wildlife study area is located entirely within the South Saskatchewan River Watershed. The proposed project will cross the South Saskatchewan River at one location, northeast of the City of Saskatoon and approximately one km downstream of the newly developed Chief Mistawasis Bridge. A review of existing land ownership information did not identify any Fish and Wildlife Development Fund lands or First Nations lands within any the wildlife study area (Government of Saskatchewan 2019).

The South Saskatchewan River is impounded upstream by the Gardiner Dam, which is essentially impassable to fish. The dam also has a significant effect on the river's thermal regime and nutrient concentration (Knight Piesold 2010; Partners for the Saskatchewan River Basin 2009), which reduces its overall value for fish habitat. However, fish habitat is still present for multiple species throughout the river. The proposed crossing is located approximately 7.5 km downstream of the City of Saskatoon weir which functions to elevate the water levels within the city. The weir is currently a considerable fish migration barrier, which segments the fish habitat in the river. However, an area downstream of the weir was identified as suitable habitat for fish spawning for a number of species, including lake sturgeon (*Acipenser fulvescens*), walleye (*Sander vitreus*), sauger (*Sander canadensis*), and sucker species (Knight Piesold 2010).

There are approximately 41 total species of fish within the Moist Mixed Grassland Ecoregion and 47 species that have been found in the Aspen Parkland Ecoregion. In addition, at least 34 species of fish have been previously captured within the South Saskatchewan River and its tributaries (Knight Piesold 2010; Atton and Merkowsky 1983; Miles and Sawchyn 1988; Acton et al. 1998, SPRR 1991, Appendix G).

Six fish species that have the potential to be found in this portion of the river are identified as SOCC (SPRR 1991; Table 4.12). One fish SOCC (lake sturgeon, *Acipenser fulvescens*) element occurrence was identified in the HABISask query. A total of 83 individual lake sturgeon were captured andradio tagged by the Water Security Agency from 2009 to 2012 (ENV 2019), and the river contains habitatimportant for this species.

Table 4.12 SOCC fish occurring within the South Saskatchewan River

Common Name	Scientific Name	SKCDC Rank	COSEWIC Status	SARA Status
blacknose dace	*Rhinicthys obtusus*	S3	not ranked	not ranked
common shiner	*Luxilus cornutus*	S3	not ranked	not ranked
flathead chub	*Platygobio gracilis*	S3	not ranked	not ranked
lake sturgeon	*Acipenser fulvescens*	S2	Endangered	not ranked
mooneye	*Hiodon tergisus*	S3	not ranked	not ranked
river shiner	*Notropis blennis*	S3	not ranked	not ranked

Source: SPPR 1991

4.4 Socio-Economic Environment

4.4.1 Parks and Indigenous Lands

4.4.1.1 Methods

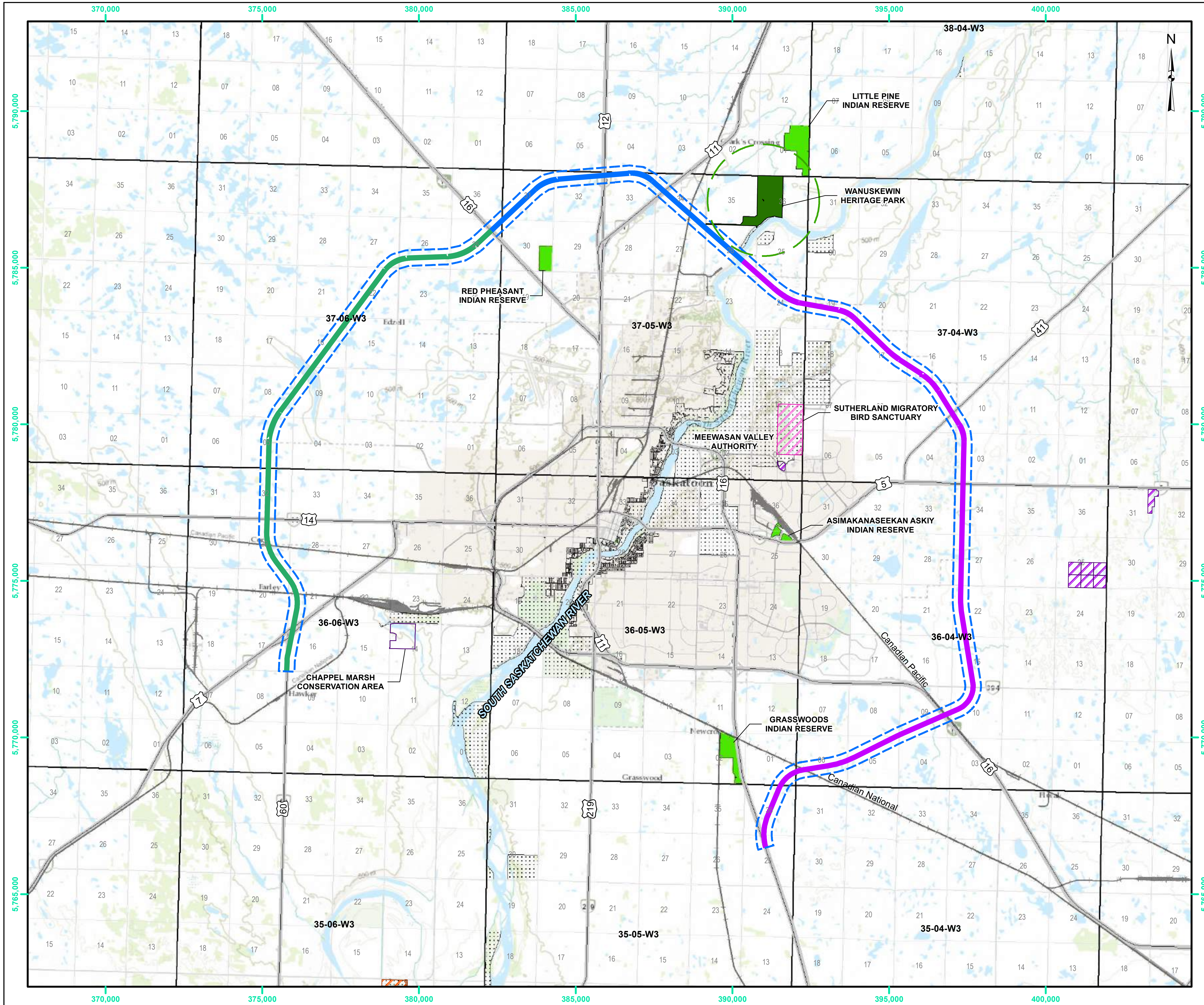
A desktop review of protected and First Nations lands within the proposed freeway corridor and surrounding area was conducted using the following resources:

- The HABISask tool (Government of Saskatchewan 2019) for conservation easements, wildlife habitat protection lands, and migratory bird sanctuaries; and
- Information Services Corporation (2019) for parks and First Nations Lands.

4.4.1.2 Results

The proposed freeway corridor does not intersect any protected lands, however it does intersect the 1.8 km radial buffer surrounding the Wanuskewin Heritage Park (**Figure 4.17**). According to the City of Saskatoon (2015), adjacent landowners and the Wanuskewin Heritage Park Administration must undergo further study and discussion to clarify the types of development that are appropriate within the buffer.

The project is located in Treaty 6 Territory, which extends across central portions of Saskatchewan and Alberta. Treaty 6 was signed in 1876 by Crown represenatatives and Cree, Assiniboine, and Ojibway leaders at Fort Carlton (23 and 28 August 1876) and Fort Pitt (9 September 1876), SK (Taylor 1985). The proposed freeway corridor does not intersect any Indigenous reserves, however, nearby First Nations communities include the Little Pine, Red Pheasant, Asimakaniseekan Askiy, and Grasslands Indian Reserves (**Figure 4.17**).



LEGEND

PRELIMINARY FREEWAY ALIGNMENT

- STUDY PHASE 1 (2019-2020)
- STUDY PHASE 2 (2020-2021)
- STUDY PHASE 3 (2021-2022)
- RAILWAY
- HIGHWAY
- PROPOSED FREEWAY CORRIDOR
- MIGRATORY BIRD SANCTUARY
- PRIVATE CONSERVATION LANDS
- WILDLIFE HABITAT PROTECTION
- WANUSKEWIN HERITAGE PARK
- FIRST NATION LAND

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.
5. CONSERVATION EASEMENTS, WILDLIFE HABITAT PROTECTION AND MIGRATORY BIRD SANTUARY OBTAINED FROM HABISASK, GOVERNMENT OF SASKATCHEWAN.
6. PARK AND FIRST NATION LAND OBTAINED FROM INFORMATION SERVICES CORPORATION (ISC).

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 1,000 2,000 4,000 METRES

SCALE: 1:120,000

SNC • LAVALIN

CLIENT
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION
SASKATOON FREEWAY

TITLE
PROTECTED AREAS

DATE	2019 03 05	DWG No.	659183-0000-4EDD-0021	FIG No	4.17	REV	00

SIZE 11x17

Path: \\sll1653\Projects QMS\SMH\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0021 Protected Areas_remake.mxd

4.4.2 Heritage Resources

SNC-Lavalin Inc. (SNC-Lavalin) completed a desktop baseline heritage resource study to support the SFFPS and identify known heritage resources and areas of archaeological potential. This section provides a summary of the study and the full study is included as Appendix H. The project was also submitted for review by the Heritage Conservation Branch (HCB).

4.4.2.1 Regulatory Context

In Saskatchewan, heritage resources are managed by the HCB of Saskatchewan Parks, Culture and Sport under the authority of *The Heritage Property Act*. The HCB maintains a heritage sensitivity database which identifies lands in Saskatchewan as either heritage sensitive or not heritage sensitive. Projects conducted on heritage sensitive land require clearance from the HCB to determine if a Heritage Resources Impact Assessment (HRIA) is required, whereas projects on not sensitive land are granted clearance under Act. Project conducted on uncharacterized lands are evaluated based on geography and topographical features using the Developers' Online Screening Tool.

4.4.2.2 Methods

The baseline heritage resources study area includes the proposed freeway corridor plus a large area of terrain similar to the project area, covering approximately 850 km^2 (**Figure 4.18**). The desktop review included a review of data from the following databases:

- The HCB's Heritage Sensitivity database to identify heritage sensitive lands;
- The HCB's Archaeological Site Inventory, which contains site inventory forms for all archaeological sites recorded in the province;
- The HCB's Archaeological Permit database, which contains information on most of the heritage work that has been done in Saskatchewan;
- The Saskatchewan Genealogical Society (SGS 2019) cemetery index for records of cemeteries; and
- The Saskatchewan Homestead Index (SHI 2019) for records of homestead documents.

4.4.2.3 Results

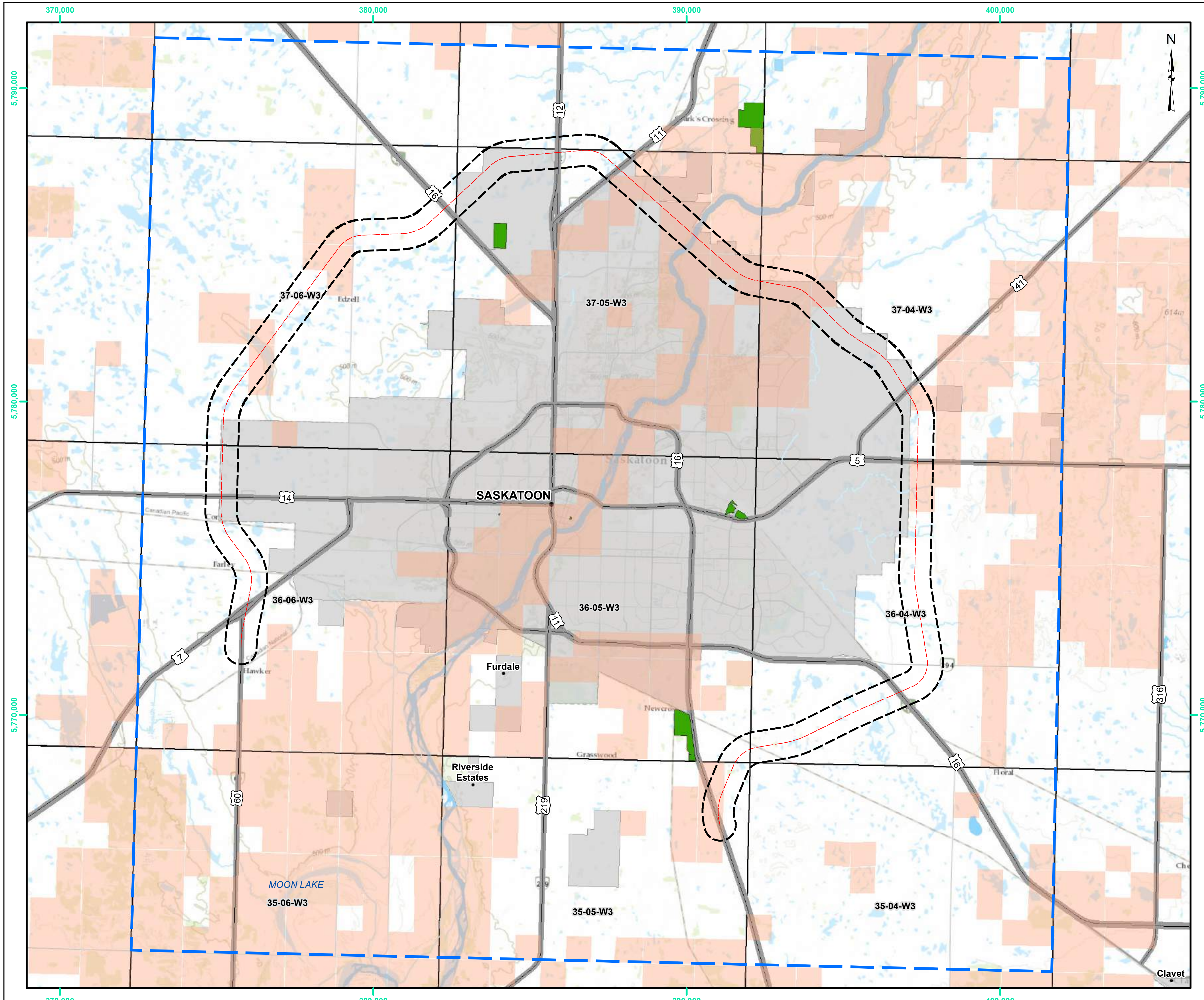
4.4.2.3.1 Heritage Sensitive Lands

There are 425 heritage sensitive quarter sections in the study area, representing approximately 33% of the lands in the study area (**Figure 4.18**). The proposed freeway corridor crosses 37 heritage sensitive quarter sections, representing approximately 26% of the corridor. The sensitive quarter sections are scattered along the corrdior with a definite concentration near the Saskatchewan River crossing and Wanuskewin Heritage Park.

4.4.2.3.2 Previous Heritage Studies

Archaeological work in the study area has been conducted professionally since the early 1980s. Prior to that, amateur and professional archaeologists recorded sites on an informal basis, often without detailed assessment. Approximately 6,386 ha (7.7%) of the study area and 57 ha of the proposed freeway corridor (1%) have been assessed for heritage resources (**Figure 4.19**).

The earliest permitted archaeological work in the study area under *The Heritage Property Act* occurred in 1982. Several of the larger heritage assessments that have been conducted in the study area are listed in **Table 4.13** and described in more detail in Appendix H. Smaller projects have not been included in the table but the footprints of these studies are included in **Figure 4.19**.



LEGEND

- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- HERITAGE SENSITIVE LOCATION
- FIRST NATION LAND
- URBAN MUNICIPALITY
- PRELIMINARY FREEWAY ALIGNMENT 500 METER CORRIDOR
- HERITAGE STUDY AREA
- TOWNSHIP

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. TOPOGRAPHIC FEATURES OBTAINED FROM CANVEC V12.0 DATASET, NATURAL RESOURCES CANADA EARTH AND SCIENCES SECTOR CENTRE FOR TOPOGRAPHIC INFORMATION, 2013-09-30.
5. HIGHWAYS AND ROADS OBTAINED FROM THE NATIONAL ROAD NETWORK SASKATCHEWAN EDITION 9.0 DATASET, 2017-06-05.
6. RAILWAYS OBTAINED FROM THE NATIONAL RAILWAY NETWORK SASKATCHEWAN EDITION 2.0 DATASET, 2016-10-06.
7. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.
8. HERITAGE CONSERVATION BRANCH, SASKATCHEWAN PARKS, CULTURE AND SPORT. THE DATASET INDICATES WHETHER ANY PORTION OF A QUARTER-SECTION IS HERITAGE SENSITIVE. IN THIS CASE, HERITAGE SENSITIVE DESCRIBES THE POTENTIAL OF A QUARTER TO CONTAIN INTACT ARCHAEOLOGICAL OR PALAEONTOLOGY SITES.
9. FIRST NATION LEGISLATED BOUNDARIES OBTAINED FROM ISC.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	JL	KVG	HY	JP

0 1,250 2,500 5,000 METRES

SCALE: 1:120,000

SNC • LAVALIN

CLIENT: SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION: SASKATOON FREEWAY

TITLE: HERITAGE RESOURCE OVERVIEW STUDY AREA

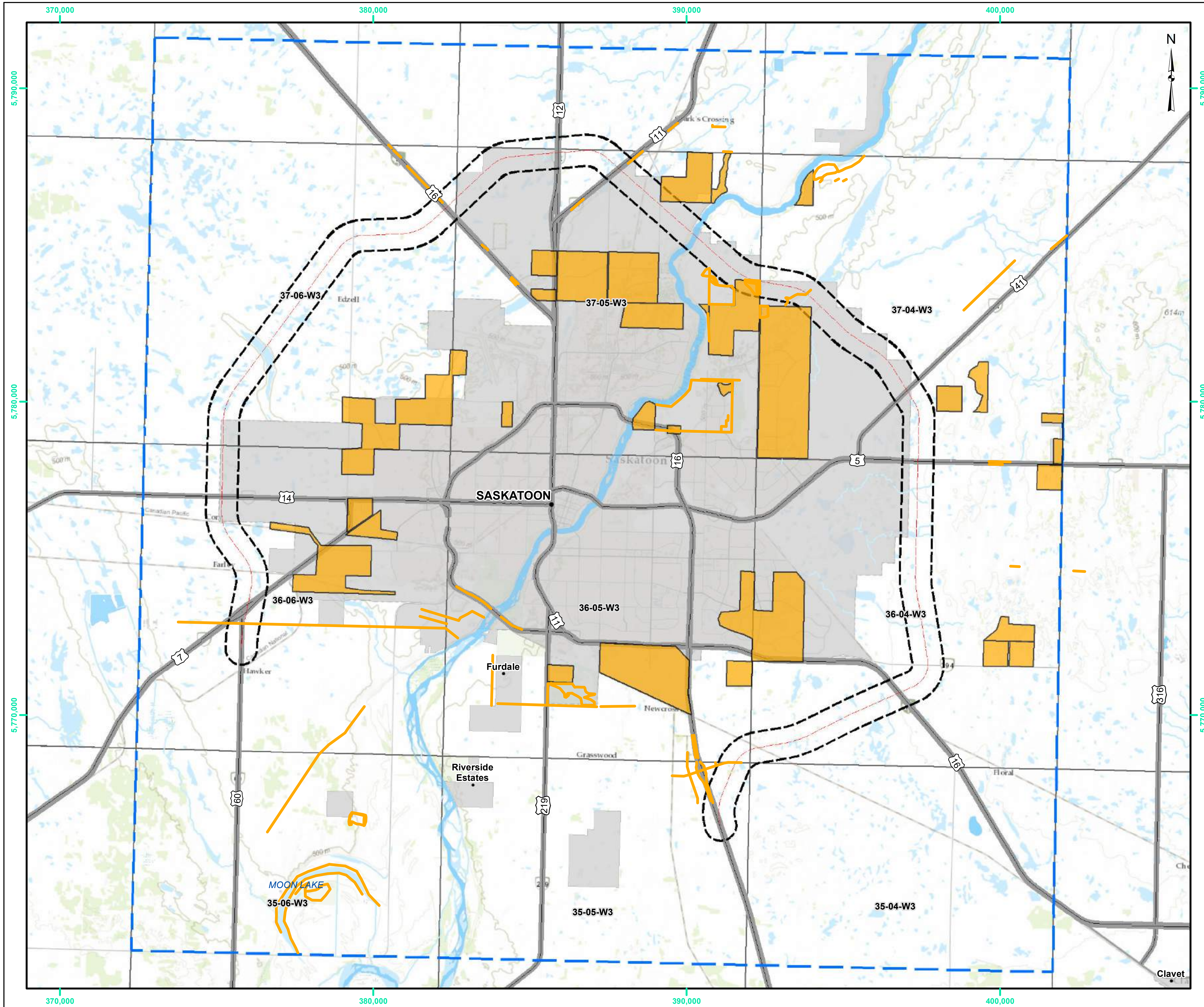
DATE 2019 08 09 | DWG No. 659183-0000-4EDD-0018 | FIG No. 2.8 | REV 00

SIZE 11x17

Path: \\sli1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0018 Heritage Resource Overview.mxd

Table 4.13 Selected archaeological studies in the study area

Permit	Permit Holder	Project	Results	Reference	Comment
82-000-05	Linnamae, U.	*Archaeological survey of proposed 1980 & 1981 suburban development areas of the City of Saskatoon and the Silverwood Site*	FbNp-4	Linnamae 1982	Recommend test excavations
82-026	Walker, E.G.	*Archaeological resource assessment: The Tipperary Creek Project*	17 Sites	Walker 1982	Avoidance and mitigation
83-017	Walker, E.G.	*Saskatoon perimeter archaeological resource assessment*	FaNp-7	Walker 1983	Test excavation
93-000	Jones, Tim E.H.	*Saskatoon Natural Grasslands Archaeological Survey*		Jones 1993	Further assessment
96-025	Ramsay A.M. and C.L. Ramsay	*Heritage assessment of a proposed residential development northeast of Saskatoon, Saskatchewan, (SE¼ and NE¼ of 31-37-4-W3M) HRIA Permit #96-025*	FbPn-62 to 68	Ramsay et. al 1996	No further work recommended
98-030	Ramsay, C.L.	*Heritage resource impact assessment of a proposed subdivision for Eagle Ridge Estates Inc. at SE¼-10-37-4-W3M*	FaNo-10, 16, 17	Ramsay 1998	No further work
01-031	Paquin, Todd A.	*Heritage resources impact assessment program, Tower Hill Developments, Discover Ridge Subdivision, Permit No. 01-031*	FaNo-19	Paquin 2001	No further work
01-038	Friesen, Nathan	*Heritage resource impact assessment of highway re-alignment and interchange at Grasswood Road and Highway 11*	FaNp-29	Friesen 2001	380 m from freeway corridor; no further work
04-090	Novecosky, Brad	*Heritage resources impact assessment program, Tower Hill Ranch Ltd. Hidden Ridge Subdivision Project, Permit No. 04-90*		Novecosky 2004	No further work
08-066	Enns-Kavanagh, K.	*Final report on the Heritage Resources Impact Assessment of NE-14-37-5-W3M*	FbNp-78	Enns-Kavanagh 2008	Site avoidance and mitigation
09-088	Enns-Kavanagh, K.	*Final Report on the monitoring of depression cleanup at FbNp-78, the Hutchins Homestead, in NE-14-37-5-W3M*		Enns-Kavanagh 2009	No recommendations
11-100	Schwab, M.	*Final report, heritage resources impact assessment of proposed Greenbryre Estates, HRIA Permit #2011-11*		Schwab 2011	No further work
13-224	Markowski, M. and K. Wolfe	*Associated Engineering, Eagle Heights Country Estates, W½ 11 37 4 W3M, heritage resources impact assessment, Permit No. 13-224*		Markowski and Wolfe 2013	No further work
13-097	Hein, Lisa	*HRIA of the proposed City of Saskatoon North Commuter Bridge and Central Avenue Extension Project*	FbNp-83, FbNp-84	Hein 2013	Within corridor Test excavations
14-129	Huynh, Tam	*Permit No. 14-129, Ridgewood Estates Subdivision SE 14-36-4 W3M, heritage resources impact assessment*		Huynh 2014	No further work recommended
17-050	Stead, Lauren	*Heritage Resource Detailed Assessment: FbNp-82, FbNp-83, and FbNp-84 – University Heights Neighbourhood 3*	FbNp-82, 83, 84	Stead 2017	Test excavations at FbNp-83



LEGEND

- LINEAR HERITAGE RESOURCE IMPACT ASSESSMENT
- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- AREAL HERITAGE RESOURCE IMPACT ASSESSMENT
- URBAN MUNICIPALITY
- PRELIMINARY FREEWAY ALIGNMENT 500 METER CORRIDOR
- HERITAGE STUDY AREA
- TOWNSHIP

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. TOPOGRAPHIC FEATURES OBTAINED FROM CANVEC V12.0 DATASET, NATURAL RESOURCES CANADA EARTH AND SCIENCES SECTOR CENTRE FOR TOPOGRAPHIC INFORMATION, 2013-09-30.
5. HIGHWAYS AND ROADS OBTAINED FROM THE NATIONAL ROAD NETWORK SASKATCHEWAN EDITION 9.0 DATASET, 2017-06-05.
6. RAILWAYS OBTAINED FROM THE NATIONAL RAILWAY NETWORK SASKATCHEWAN EDITION 2.0 DATASET, 2016-10-06.
7. LINEAR AND AREAL HERITAGE RESOURCE IMPACT ASSESSMENT DATA OBTAINED FROM THE HERITAGE CONSERVATION BRANCH OF SASKATCHEWAN.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	JL	KVG	HY	JP

0 1,250 2,500 5,000 METRES

SCALE: 1:120,000

SNC·LAVALIN

CLIENT	PROJECT LOCATION
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE	SASKATOON FREEWAY

TITLE

ARCHAEOLOGICAL PROJECTS IN THE STUDY AREA

DATE	DWG No.	FIG No.	REV
2019 08 09	659183-0000-4EDD-0019	2.9	00

SIZE 11x17

Path: \\sl1653\Projects QMS\SMH\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0019 Archaeological Projects.mxd

4.4.2.3.3 Heritage Sites

The study area contains 176 recorded archaeological sites including both Historic Period sites and Precontact Period sites, however only three archaeological sites were identified in the proposed freeway corridor (**Table 4.14**; **Figure 4.20**) including (site locations have been redacted as per HCB requirements):

- **FbNq-6:** A surface lithic scatter of material dating to the Middle and Late Plains Indian Periods (approximately between 7,500 BP to 170 BP) located in [redacted] (Epp and Dyck 1983). It was identified in 1965 by an amateur archaeologist. Material collected at that time included two Pelican Lake projectile points, two hafted bifaces, and 18 other lithic artifacts including scrapers and lithic debitage. Pelican Lake artifacts date from the Middle Prehistoric Period, approximately between 3,300 to 1,850 BP. The site has not been professionally assessed;
- **FbNp-83:** Historic Period site relating to homesteading located in [redacted] (Hein 2013). The site was further investigated with test excavations (Stead 2017) which recovered a variety of domestic artifacts including cutlery, glass, metal, and wood fragments. According to the homestead application, the site was occupied at least between 1909 after the application was submitted until 1913 when the land patent was granted. No further details of the occupancy are available. Test excavations were conducted at the site and no further archaeological work is recommended; and
- **FbNp-84:** Historic Period site relating to homesteading located in [redacted] (Hein 2013. FbNp-84 contains several depressions believed to be limestone quarries possibly used by the homesteader. The site was mapped, and several depressions were tested. No further work at FbNp-84 was recommended.

All 176 sites in the study area are summarized in **Table 4.14**, grouped by Township and by Chronological Period. The distribution of the sites are concentrated along the South Saskatchewan River valley (**Figure** 4.20). This may result in part from where archaeological studies have been done, but it also likely indicates a pattern of occupation. Experience throughout Saskatchewan indicates that major river systems were a significant attractor for Precontact people and usually exhibit high site density within the first few hundred metres from the river.

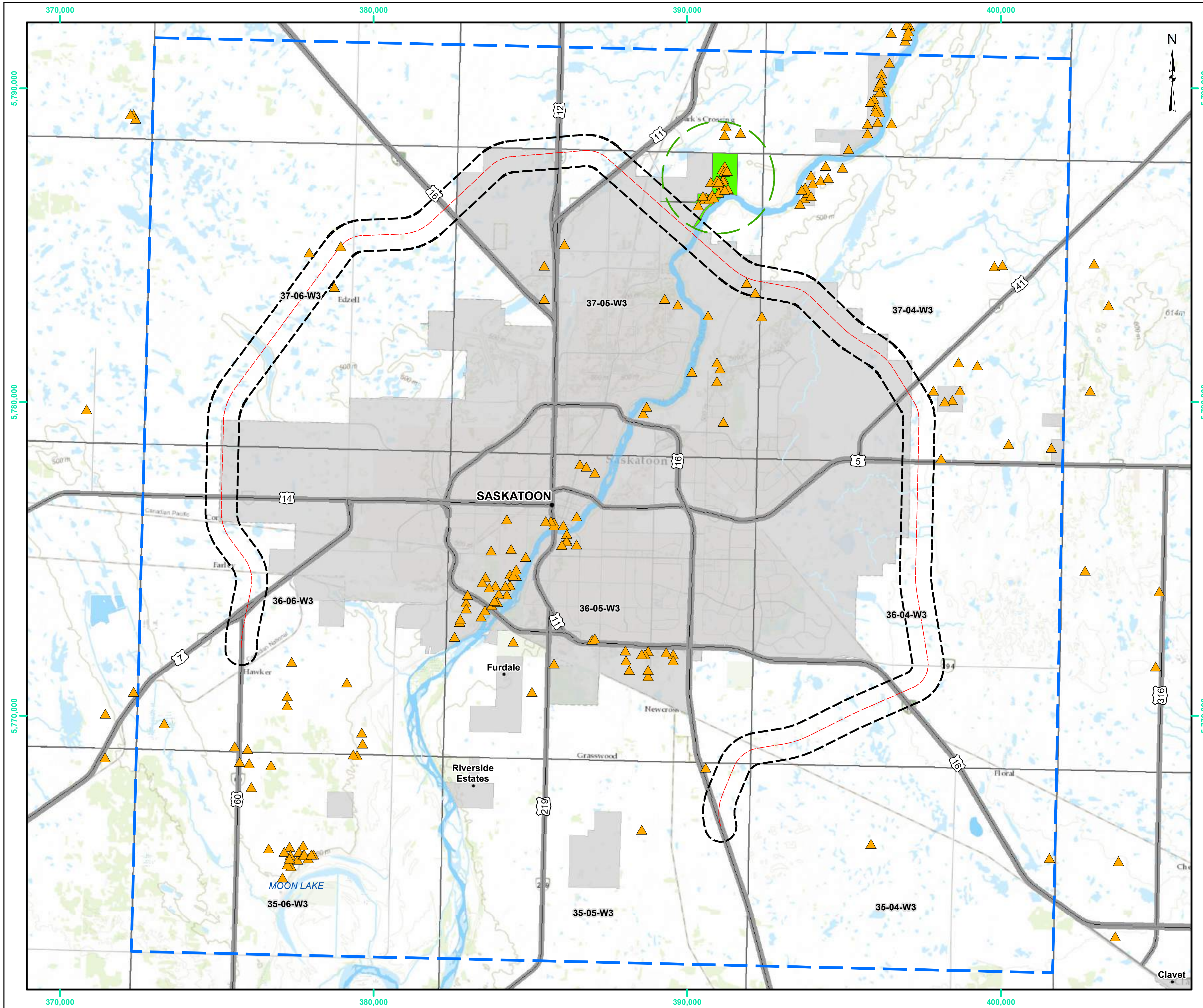
Sites are also concentrated within the Wanuskewin Heritage Park. The park is now listed on the National Register of Historic Sites (Historic Places 2019) and is under consideration as a UNESCO World Heritage site. The park contains sites representing at least 6,000 years of cultural history on the northern Plains including camp sites, tipi rings, stone cairns, bison kill sites, and a medicine wheel.

4.4.2.3.4 Cemeteries

The Saskatchewan Cemetery Index was reviewed to determine if any known cemeteries are within the proposed freeway corridor. No cemeteries were identified.

4.4.2.3.5 Homesteads

SNC-Lavalin identified 109 unique homestead applications within the proposed freeway corridor (SHI 2019; Appendix H, **Attachment I**). Some of these files may have the potential to be Contact period heritage sites which are currently not catalogued by the HCB. The existence of a homestead application file does not necessarily imply that heritage resources are present on a property. However, it indicates that historic period resources may be present and should be investigated. If historical remains are in fact present, the homestead documents are one of the initial sources in determining heritage significance.



LEGEND

- HERITAGE SITE
- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- URBAN MUNICIPALITY
- PRELIMINARY FREEWAY ALIGNMENT 500 METER CORRIDOR
- HERITAGE STUDY AREA
- TOWNSHIP
- WANUSKEWIN HERITAGE PARK
- WANUSKEWIN HERITAGE PARK VISUAL BUFFER

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. TOPOGRAPHIC FEATURES OBTAINED FROM CANVEC V12.0 DATASET, NATURAL RESOURCES CANADA EARTH AND SCIENCES SECTOR CENTRE FOR TOPOGRAPHIC INFORMATION, 2013-09-30.
5. HIGHWAYS AND ROADS OBTAINED FROM THE NATIONAL ROAD NETWORK SASKATCHEWAN EDITION 9.0 DATASET, 2017-06-05.
6. RAILWAYS OBTAINED FROM THE NATIONAL RAILWAY NETWORK SASKATCHEWAN EDITION 2.0 DATASET, 2016-10-06.
7. HERITAGE SITE DATA OBTAINED FROM THE HERITAGE CONSERVATION BRANCH OF SASKATCHEWAN.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	JL	KVG	HY	JP

0 1,250 2,500 5,000 METRES

SCALE: 1:120,000

SNC·LAVALIN

CLIENT SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION SASKATOON FREEWAY

TITLE HERITAGE SITES IN THE STUDY AREA

DATE 2019 08 09 **DWG No.** 659183-0000-4EDD-0020 **FIG No.** 4.20 **REV** 00

SIZE 11x17

Path: \\sli1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0020 Heritage Sites.mxd

Table 4.14 Summary of archaeological sites in the study area

	Township and Range										
Chronological Period	T35 R4	T35 R5	T35 R6	T35 R3	T36 R3	T37 R4	T37 R5	T37 R6	T38 R4	T38 R5	Total
Eurocanadian				**12**		**1**	**7**		**3**	**1**	**24**
Artifact scatter				3					1		4
Artifact/Feature combination				7		1	2		1		11
Midden				1							1
Multiple feature							3		1		4
Recurrent features							1			1	2
Single feature				1			1				2
Precontact	**2**	**2**	**23**	**38**	**8**	**22**	**28**	**2**	**14**	**2**	**141**
Artifact find	1	2	3	10	2	12	4		4		38
Artifact scatter	1		15	18	5	9	14	2	9	1	74
Artifact/Feature combination			4	10			7		1		22
Burial			1		1						2
Medicine wheel							1				1
Midden							1				1
Recurrent features						1					1
Single feature										1	1
Unknown							1				1
Precontact/Eurocanadian				**3**			**1**	**1**			**5**
Artifact scatter				1				1			2
Artifact/Feature combination				2							2
Single feature							1				1
SSN							1				1
Burial							1				1
Unknown				**4**		**1**					**5**
Artifact scatter				2		1					3
Artifact/Feature combination				1							1
Single feature				1							1
Total	**2**	**2**	**23**	**57**	**8**	**24**	**37**	**3**	**17**	**3**	**176**

5 Recommendations

This section includes recommendations for future studies and general constraints/mitigations for the entire corridor, as well as site-specific constraints/migitations for Phase 1 of the freeway (South Saskatchewan River valley, Hudson Bay swale, and Wanuskewin Heritage Park). Due to the phased nature of the functional planning study and the plans for additional survey work in 2020, site-specific constraints/migitations for Phase 2 (Northeast swale and small swale) and Phase 3 (west swale) will be described in an addendum to this report, after the MVA data is incorporated and additional survey work is complete.

5.1 Future Studies

The following studies should be conducted prior to and/or during detailed design to develop a stronger understanding of potential sensitivities and mitigation measures.

5.1.1 Areas Outside Corridor

This environmental and regulatory review was based on the proposed freeway corridor as outlined in **Figure 1.1**. Additional environmental and heritage surveys may be required for any ancillary roads, interchanges, and/or laydown areas that fall outside the corridor.

5.1.2 Surface Water and Wetlands

Surface water and wetlands are located throughout the quarter sections intersected by the freeway (**Figure 4.12**). The following studies should be conducted to better understand wetland haibitat within the corridor and to minimize impacts to surface water:

- Wetland classification surveys will be required in areas where disturbance to wetlands cannot be avoided; and
- Detailed stormwater management studies should be implemented to minimize impacts to surface water and comply with MHI's policy of maintaining existing drainage patterns.

5.1.3 Species of Conservation Concern (SOCC)

5.1.3.1.1 Species Detection Survey Recommendations

Data from the desktop review and rapid assessment surveys were used to develop recommendations for future species detection surveys that may be required in support of future permitting of the project. This report does not contain any field-based recommendations for future surveys within the area surveyed by MVA and will be amended during Phase 2.

The following general species detection surveys can detect multiple species that may use diverse and varied habitats are recommended for essentially all quarter sections within the corridor, as suitable habitat exists for at least some target species in all quarter sections:

- Grassland bird surveys;
- Snow track surveys;
- Prairie raptor surveys; and
- Rare vascular plant surveys.

Rare vascular plant surveys may not be required in a limited number of quarters that have no native habitat left (no edge habitat, wetlands, trees, ditches with native vegetation, grassland, etc). However, most quarters have at least remnant habitat left that could support rare vascular plant species. A reconnaissance wetland survey should be conducted to further identify areas for rare vascular plant surveys.

Additional species detection surveys are recommended if potential habitat for the target species was identified, or if the species itself was identified during the desktop surveys. Species detection surveys and their associated habitat are presented in **Table 5.1**. There are a number of species detection surveys that were not considered (e.g. swift fox, piping plover, western grebe, etc.) as the proposed freeway corridor is located outside the species natural range, or the habitat for these species is unlikely to be present within the proposed freeway corridor.

Table 5.1 Species detection surveys and associated habitat

Species detection survey	Target species	Associated habitat
auditory amphibian	northern leopard frog	wetlands of varying size and permanence for breeding, foraging, and overwintering. overwintering areas may also include large wetlands, rivers, lakes which do not freeze to the bottom
burrowing owl	burrowing owl	native prairie or tame pasture on rolling topography with unoccupied mammal burrows
short-eared owl	short-eared owl	tall native grass prairie or tame pasture, meadows near wetlands, and brushy grasslands with relatively few trees
sharp-tailed grouse	sharp-tailed grouse	open prairie, shrubby sandhills, coulees, and the margins of watercourses and farmland. very dependent on open grassland and shrubland for breeding and return to the same areas year after year for breeding
yellow rail	yellow rail	wetland and marsh complexes dominated by sedges and emergent vegetation. large sedge meadows that provide suitable cover for the species are preferred
common nighthawk	common nighthawk	short, sparse vegetation on flat rolling topography, including sand dunes, beaches, burned areas, forest clearings, logged areas, pastures, open forests, bogs, marshes, gravelled areas, and rocky outcrops.

Fifty-five quarter sections are recommended for one or more future habitat-specific species detection surveys (**Figure 5.1**). All recommendations are based on available habitat, as none of the target species were incidentally identified during field surveys. Habitat for a specific survey may be found throughout the quarter, or in a small portion of the quarter (e.g. a wetland with the potential for northern leopard frogs located in a corner of a quarter section). Previous studies and HABISask data identified northern leopard frogs, sharp-tailed grouse, and short-eared owls, but these locations were all within the Northeast swale and small swale, areas being surveyed by MVA. Whooping cranes were identified during the desktop survey on HABISask at one location within the proposed freeway corridor (NE 09-36-04-W3), however breeding habitat for whooping cranes was not present at this location and it is assumed they were likely observed foraging in the area during migration. Additionally, whooping cranes were not observed during field surveys and there are no species detection surveys for them in Saskatchewan. Barn swallows were also previously observed within the proposed freeway corridor, but these can be detected during future grassland bird surveys. **Table 5.2** provides the number of quarter sections that are recommended for targeted species detection surveys. Appendix E lists each quarter section with at least one recommended survey and the types of surveys associated with that quarter.

Auditory amphibian surveys were the mostly commonly recommended habitat specific species detection survey, as potentially suitable wetlands were found throughout the study area. The target species (northern leopard frogs) will use wide varieties of wetland habitat for the varying stages of their lives, including differing wetland habitat requirements for breeding, foraging, and overwintering. These wetland areas were found distributed throughout the proposed freeway corridor, and as such any quarters with intact wetlands were recommended for future amphibian surveys.

Short-eared owl, sharp-tailed grouse, common nighthawk, and burrowing owl surveys were recommended in fewer locations, and generally these species can be found in pasture/prairie habitat that is not disturbed during the nesting season. Some examples of this may include the pasture and native dominant areas located adjacent to the swales, as well as the remnant pasture found within the proposed freeway corridor. These areas are primarily located near the Hudson Bay swale, as well as the pasture areas near the south end of Phase 2 and Phase 3.

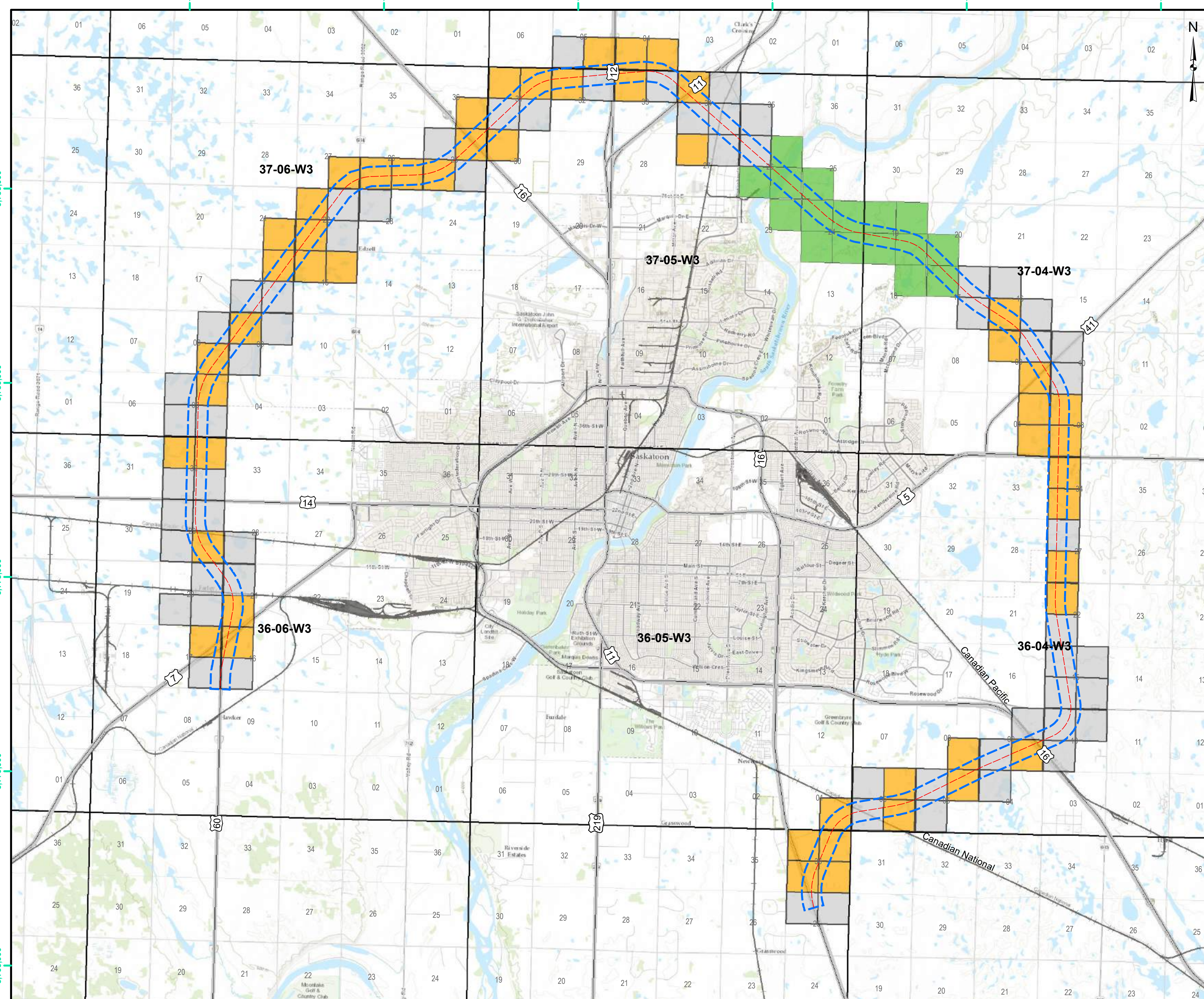
Yellow rail surveys were recommended in relatively few areas. Yellow rails tend to have very specific breeding habitat requirements, which include the requirement of dry mat of dead wetland vegetation surrounding a relatively shallow wetland (or portion thereof) from previous growing seasons (COSEWIC 2001). Many of the wetlands in the study area do not have appropriate habitat, and it is likely they may only be found adjacent to the swales and larger wetlands that have not been tilled up to the water boundary. These areas are primarily located in large wetlands such as the Hudson Bay swale and the wetland complex located in SE 06-36-04-W3.

Table 5.2 Recommendations for targeted species detection surveys

Species detection survey	Target species	Number of quarter sections
auditory amphibian	northern leopard frog	47
burrowing owl	burrowing owl	16
short-eared owl	short-eared owl	18
sharp-tailed grouse	sharp-tailed grouse	18
yellow rail	yellow rail	10
common nighthawk	common nighthawk	18

5.1.4 Heritage Resources

The proposed freeway corridor passes through lands that have been identified as Heritage Sensitive, hence, a project referral to the HCB has been submitted. This referral will initiate a review of the project and will likely identify areas that require a Heritage Resource Impact Assessment.



LEGEND

- PRELIMINARY FREEWAY ALIGNMENT
- RAILWAY
- HIGHWAY
- PROPOSED FREEWAY CORRIDOR
- GENERAL SPECIES DETECTION SURVEYS
- HABITAT SPECIFIC SPECIES DETECTION SURVEYS
- MVA SPECIES DETECTION SURVEYS

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
00	2020 07 23	ISSUED FOR INFORMATION	HY	KVG	HY	JP

0 500 1,000 2,000 3,000 4,000 METRES

SCALE: 1:100,000

SNC · LAVALIN

CLIENT: SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION: SASKATOON FREEWAY

TITLE: QUARTERS RECOMMENDED FOR ADDITIONAL SPECIES DETECTION SURVEYS

DATE	2019 10 28	DWG No.	659183-0000-4EDD-0016	FIG No.	5.1	REV	00

SIZE 11x17

Path: \\sll1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Biophysical\659183-0000-4EDD-0017 Quaters Additional Surveys.mxd

5.2 Routing Considerations and Mitigation Measures

5.2.1 General

Mitigation measures followed the mitigation hierarchy of Avoid, Minimimize, Offset, Reclaim (Figure 5.2).

The project team used a Multiple Account Evaluation (MAE) approach to assess preferred routing within the assigned corridor. The MAE utilizes a diverse group of agencies and groups with strong local knowledge, as well as members of the design team, participating in a design workshop to help the Ministry determine the best alignment and interchange layout for the Saskatoon Freeway. The design workshop was structured to enable an innovative atmosphere in which a diverse group of stakeholders collaborate to generate and select a framework that address the various sections of the Saskatoon Freeway. The goal of the design workshop was to provide the Province with advice on the freeway design that addresses local needs for today and meets the future capacity needs. That advice was provided after participants considered technical input from highway design specialists on road design standards, and environmental, geotechnical and safety concerns.

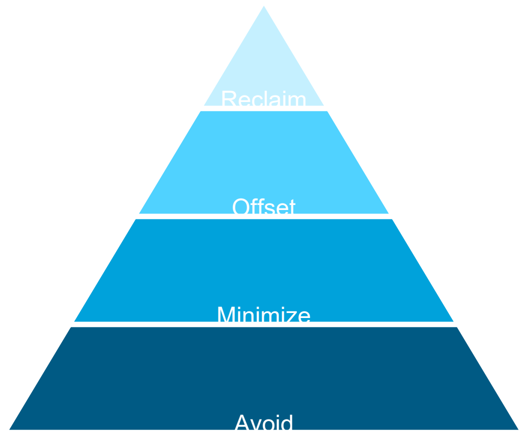


Figure 5.2 Mitigation heirarchy

The objectives of the Design Workshop were for the participants to:

- Review alternatives developed by the design team and determine if other alternatives exist;
- Provide input from the perspective of individuals who work and live in the community;
- Identify best value performance criteria and evaluate which alternative will provide the best value; and,
- Provide considerations for the design team to examine during design of the preferred alternative.

Design workshop participants were asked to provide their issues, concerns, and requirements with respect to the project, which allowed for the group to understand issues from each participant. Participants were asked to provide constructive criticism of scenarios or to identify opportunities to make the design better for road users, local municipalities or environmental effects. Several examples of issues of concern were listed to generate discussion: land issues such as severance, changing land values and encroachments, access to and from the freeway as well as across the freeway, impacts on the environment and driver comprehension (i.e. is the design confusing to motorists).

In addition to the local stakeholders, engineers were present to help explain technical issues like interchange design standards, traffic capacity and safety, constructability and cost. **Section 5.2** of the Saskatoon Freeway Functional Design Report provides additional detail regarding the design workshop for Phase 1. Additional design workshops will be completed in subsequent phases of the project using a similar process.

5.2.1.1 Surface Water and Wetlands

Wetlands are abundant throughout the project corridor and serve as important habitat for wildlife and vegetation. Wetlands are protected in Saskatchewan and proponents are required to compensate for the loss of wetland habitat (**Section 4.3.1.4**), hence, where possible, routing should aim to minimize the total area of wetland habitat affected. For areas where impacts to wetlands are unavoidable, the following mitigations should be considered to reduce impacts:

› A drainage plan should be developed to preserve drainage patterns and minimize potential impacts to the surrounding surface water system. For example, surface water inputs into adjacent wetlands should not cause adverse impacts to the ecological function of undisturbed areas;
› Ancillary roads and laydown areas should avoid wetland habitat where possible;
› An Aquatic Habitat Protection Permit (AHPP) in accordance with *The Environmental Management and Protection Act, 2010* should be obtained for works within the bed, bank, or boundary of a waterbody / wetland, or discharge with adverse effects on water;
› A Drainage Permit may be required for effects to drainage;
› Erosion and sediment control measures should be implemented to protect adjacent wetland areas and the river valley;
› Where impacts to wetlands cannot be avoided, wetland compensation and monitoring should be conducted; and
› Pre-construction species detection surveys for SOCC (e.g. northern leopard frog) should be conducted in wetlands with the potential to support SOCC, followed by suitable mitigation where required.

5.2.1.2 Native Grasslands

Unseeded grassland comprises 14.2% of the project corridor and provides important habitat for a variety of wildlife species. Proponents in Saskatchewan may be required to compensate for the loss of grassland habitat (i.e. compensation has been a condition in some recent ministerial decisions), hence, where possible, routing should aim to minimize the total area of grassland habitat affected. For areas where impacts to grasslands are unavoidable, the following mitigations should be considered to reduce impacts:

› Ancillary and/or temporary construction roads and laydown areas should avoid grassland habitat where possible;
› Disturbed areas should be restored to grassland habitat using native species and compensation for loss of native grasslands should be considered where permanent impacts cannot be avoided; and
› Pre-construction species detections surveys for SOCC should be conducted in native prairie/pasture areas with the potential to support SOCC, followed by suitable mitigation where required.

5.2.1.3 Wildlife and Species of Conservation Concern

A large diversity of wildlife, including Species of Conservation Concern (SOCC) and Species at Risk (SAR), were identified within the proposed freeway corridor. Additional species and occurrences of SOCC and SAR are likely to be identified as more surveys are completed (**Section 5.1.2**). The majority of wildlife and bird species in Saskatchewan are protected by provincial and federal legislation, hence, where possible, routing should aim to minimize effects to areas of important wildlife habitat. There are additional legal protections for SOCC and SAR. Where routing cannot avoid crossing into habitat utilized by wildlife and SOCC/SAR, the following mitigations should be considered to reduce impacts:

› Consider the Environment and Climate Change Canada (ECCC) avoidance guidelines for breeding birds when scheduling construction activities;
› Conduct breeding bird surveys prior to and during construction during the general nesting period;

- Consider design measures that employ strategies to preserve wildlife movement corridors;
- Acquire permits for relocation or removal of wild species, if appropriate;
- Construction activities should consider the restricted activity timing windows for the protection of fish and fish habitat outlined by Fisheries and Oceans Canada (DFO 2013).
- Conduct pre-construction surveys in areas where SOCC/SAR have potential to be found;
- Establish setbacks around wildlife and plant SOCC occurrences prior to construction in accordance with the Saskatchewan Activity Restriction Guidelines (ARGs). Contact ENV or ECCC if project activities fall within listed setback distances;
- Implement construction options that caused the minimal loss of SOCC/SAR habitat, such as bridging over sensitive habitat;
- Implement wildlife crossings to maintain a naturalized connection between habitat on either side of the proposed freeway;
- Consider the implementation of exclusion barriers on the underside of bridge structures to prevent birds roosting on infrastructure; and
- Consider implementing design options that reduce sensory impacts to wildlife (noise, light pollution), such as reduce lighting, dark-sky compliant lighting, sound barriers, etc.

5.2.1.4 Heritage Resources

The proposed freeway corridor passes through areas that have the potential to contain heritage resources, ranging from the earliest occupations to more recent homestead sites. The presence of a concentration of important heritage resources at Wanuskewin Heritage Park highlights the potential of some portions of the proposed freeway route to affect heritage resources. Some of these heritage resources may be sufficiently significant to require extensive mitigation or even require avoidance, and this can affect both the project design and timetable.

5.2.1.5 Contaminated Sites

The potential for contamination exists in areas with current or previous industrial activity. Prior to construction, a Phase 1 Environmental Site Assessment should be completed to identify areas have the potential for contamination. This will allow for the development of a suitable mitigation plan and facilitate estimating costs associated with contaminated material clean-up and/or hauling.

5.2.2 Phase 1

5.2.2.1 South Saskatchewan River Crossing

The South Saskatchewan River valley is an ecologically important feature, serves as a natural corridor for wildlife movement, habitat for fish species, and has a high potential for archaeological finds. As such the location of the crossing should be chosen to minimize disturbance to the channel and banks as much as possible. The following mitigations should be employed for the river crossing:

- Bridge elevation should ensure that wildlife movement through the river valley is preserved;
- Consider the implementation of exclusion barriers on the underside of bridge structures to prevent birds roosting on infrastructure;
- Placement and size of bridge abutments should be considered and minimized as much as practical so that disturbance to the banks is reduced;
- Placement and size of the piers should be minimized as much as practical to limit impacts to fish habitat within the river channel. Compensation for disturbance to fish habitat will likely be required once the final design of the piers and construction plans are known;

- Measures to protect the water quality in the river (i.e. as a result of spills and/or road salt/gravel application) should be considered in bridge designs;
- Species specific surveys for SOCC should be conducted in the river valley prior to disturbance and suitable mitigation measures should be developed based on the results; and
- Construction activities should consider the restricted activity timing windows for the protection of fish and fish habitat outlined by Fisheries and Oceans Canada (DFO 2013).

5.2.2.2 Hudson Bay Swale

The Hudson Bay swale is an ecologically sensitive feature and is being considered for future inclusion into the City's natural area protection plan (pers. comm. Genevieve Russell). Based on this, project designs should consider avoiding or minimizing direct impacts to the Hudson Bay swale where possible. Should impacts to the Hudson Bay swale be unavoidable the following mitigations should be employed:

- Measures to preserve drainage in unimpacted areas of the swale should be taken;
- If the swale forms part of the road drainage network, measures should be taken to ensure that surface water inputs into the swale do not cause adverse impacts to the ecological function. This could include pre-treatment of road runoff using forebay systems and installation of permanent erosion and sediment control measures;
- Implement wildlife crossings to maintain a naturalized connection between habitat on either side of the proposed freeway;
- Consider implementing design options that reduce sensory impacts to wildlife (e.g. noise, light pollution), such as reduce lighting, dark-sky compliant lighting, sound barriers, etc.;
- Depending on the regulatory regime in place at the time of construction, compensation for impacts to this feature may be required;
- Consider restoration of previously impacted areas of the swale as a component of the compensation plan; and
- Species specific surveys for SOCC should be conducted in the swale prior to disturbance and suitable mitigation measures should be developed based on the results.

5.2.2.3 Wanuskewin Heritage Park

Wanuskewin Heritage Park is located northeast of the proposed freeway corridor and is classified as a provincial heritage site. The proposed freeway corridor intersects the 1.8 km radial buffer surrounding the park (**Section 4.4.1**). The area in and adjacent to the park has a high potential to contain heritage resources. Additionally, Wanuskewin is seeking UNESCO World Heritage status which requires natural landscapes adjacent to the park to be preserved. The following mitigations are recommended in areas adjacent to Wanuskewin Heritage Park:

- Heritage assessment of the proposed corridor should be undertaken early in the planning and design process and a suitable mitigation plan should be developed;
- Freeway designs in the vicinity of Wanuskewin should include considerations for viewscape to preserve views from the west edge of the Park; and
- Freeway designs in the vicinity of Wanuskewin should include considerations for noise mitigation to preserve sound levels in the Park. A noise study should be conducted in future planning stages to better understand the potential for noise impacts.

5.2.3 Phase 2

Specific mitigation measures for Phase 2 will be developed once additional survey work is complete.

5.2.4 Phase 3

Specific mitigation measures for Phase 3 will be developed once additional survey work is complete.

6 Closure

This Environmental and Regulatory Review been prepared by SNC-Lavalin Inc. to support the Ministry of Highways and Infrastructure Saskatoon Freeway Functional Planning Study.

Prepared by:

Hayden Yip, M.Sc., P.Biol.
Biologist

Katie Hamilton, B.Sc.
Ecologist

Reviewed by:

Lyndsey MacBride, M.Sc., P.Geo.
Manager, Impact Assessment & Community Engagement, Saskatchewan

Jamie Page, B.Sc.
VP, Impact Assessment & Community Engagement, Prairies

Environment & Geoscience
Engineering, Design and Project Management

7 References

Acton, D.F., and Ellis, J.G. 1978. The Soils of the Saskatoon Map Area (73-B) Saskatchewan. Saskatchewan Institute of Pedology. Publication S4. Saskatoon, SK.

Acton, D. F., G.A. Padbury, and C.T. Stushnoff. 1998. The Ecoregions of Saskatchewan. Canadian Plains Research Centre, Saskatchewan Environment and Resources Management, Regina, SK.

Agriculture and Agri-Food Canada (AAFC). 2010. Gross evaporation estimates in the Canadian Prairies by Prairie Farm Rehabilitation Administration (PFRA).

Agriculture and Agri-Food Canada. 2012. Soil Survey Reports for Saskatchewan. URL: http://sis.agr.gc.ca/cansis/publications/surveys/sk/index.html (accessed March 2019).

City of Saskatoon. 2015. Riel Sector Plan. Planning & Development Branch. File Number PL 4134-3-1. September 2015. URL: https://www.saskatoon.ca/sites/default/files/documents/community-services/planning-development/future-growth/sector-planning/riel_industrial_sector_plan_-_amended_january_25_2016.pdf (accessed December 2019).

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2000. Assessment and Status Report on the Hairy Prairie Clover (*Dalea villosa var. villosa*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. Vii + 62 pp. URL: https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_yellow_rail_1101_e.pdf (accessed November 2019).

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2000. Assessment and Status Report on the Yellow Rail *Coturnicops noveboracensis* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. vi + 22 pp. URL: https://sararegistry.gc.ca/document/default_e.cfm?documentID=51 (accessed September 2019).

COSEWIC. 2006. Assessment and Status Report on the Smooth Goosefoot (*Chenopodium subglabrum*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. vi + 34 pp. URL: https://www.registrelep-sararegistry.gc.ca/document/default_e.cfm?documentID=1042 (accessed September 2019).

Cornell Laboratory of Ornithology. 2019. Various species profiles. URL: http://www.birds.cornell.edu/Page.aspx?pid=1478 (accessed September 2019).

Enns-Kavanagh K. 2008. Final report on the Heritage Resources Impact Assessment of NE-14-37-5-W3M. HCB permit 08-066. A report on file with the Archaeological Resource Management Section, Regina.

Enns-Kavanagh K. 2009. Final Report on the monitoring of depression cleanup at FbNp-78, the Hutchins Homestead, in NE-14-37-5-W3M. HCB permit 09-088. A report on file with the Archaeological Resource Management Section, Regina.

Environment and Climate Change Canada (ECCC). 2018. Short Duration Rainfall Intensity-Duration-Frequency Data. URL:

https://drive.google.com/drive/folders/1VsJnWGfz2NTzT4orgTH1RL3yzZcrdYTC (accessed October 2019).

Environment and Climate Change of Canada (2019). Climate Normals. URL: https://climate.weather.gc.ca/climate_normals/index_e.html (accessed November 2019)

Ertter, B. 2018. Two New North American *Potentilla* sect. *Rubricales* (Rosaceae). Phytoneuron 2018(2): 1–14.

Fisheries and Oceans Canada (DFO). 2013. Saskatchewan Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat. URL: http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/sk-eng.html (accessed December 2019).

Friesen N. 2001. Heritage resource impact assessment of highway re-alignment and interchange at Grasswood Road and Highway 11. A report on file with the Archaeological Resource Management Section, Regina.

Golder Associates (Golder). 2015. Final Screening Report, Holmwood East Natural Area Screening Study. Prepared for: City of Saskatoon. Report Number: 1526165. 16 November 2015.

Google, Maxar Technologies. 2011a. Satellite Image: 5 May 2011.

Google, Maxar Technologies. 2011b. Satellite Image: 18 May 2011.

Google, Maxar Technologies. 2011c. Satellite Image: 9 June 2011.

Google, Maxar Technologies. 2012a. Satellite Image: 21 June 2012.

Google, Maxar Technologies. 2012b. Satellite Image: 24 August 2012.

Google, Maxar Technologies. 2013. Satellite Image: 16 July 2013.

Google, Maxar Technologies. 2014. Satellite Image: 12 May 2012.

Government of Alberta. 2015. Alberta Wetland Identification and Delineation Directive. Water Policy Branch, Alberta Environment and Parks. Edmonton, Alberta. June 2015. URL: https://open.alberta.ca/dataset/b2a69660-7f44-4c8c-9499-0da23946dafa/resource/3917b05d-7cf8-4d08-b3ae-74a15af625ce/download/2015-alberta-wetland-identification-delineation-directive-june-2015.pdf (accessed September 2019).

Government of Canada. 2019. Species at Risk Public Registry. URL: https://wildlife-species.canada.ca/species-risk-registry/sar/index/default_e.cfm (accessed September 2019).

Government of Saskatchewan. 2018. Technical Review Guidelines: A Guide to the Technical Review Process for Environmental Impact Assessments within Saskatchewan under *The Environmental Assessment Act*. June 2014. URL: https://pubsaskdev.blob.core.windows.net/pubsask-prod/107152/107152-Tech_Review_Guidelines_June_2018_Revision.pdf (accessed September 2019).

Government of Saskatchewan. 2019. HABISask web application. URL: https://gisappl.saskatchewan.ca/Html5Ext/?viewer=habisask. (accessed September 2019).

Harms, V.L., and A.L. Leighton. 2011a. Flora of Saskatchewan Fascicle 1: Ferns and Fern Allies of Saskatchewan. Nature Saskatchewan, Regina, SK.

Harms, V.L., and A.L. Leighton. 2011b. Flora of Saskatchewan Fascicle 2: Lilies, Irises and Orchids of Saskatchewan. Nature Saskatchewan, Regina, SK.

Harms, V.L., and A.L. Leighton. 2014. Flora of Saskatchewan Fascicle 4: Grasses of Saskatchewan. Nature Saskatchewan, Regina, SK.

Harms, V.L., A.L. Leighton, and M.A. Vetter. 2018. Flora of Saskatchewan Fascicle 6: Rushes, Bulrushes and Pondweeds plus the remaining Monocots of Saskatchewan. Nature Saskatchewan, Regina, SK.

Hein L. 2013. HRIA of the proposed City of Saskatoon North Commuter Bridge and Central Avenue Extension Project. HCB permit 12-097. A report on file with the Archaeological Resource Management Section, Regina.

Henze C., Wade W., and Wawerla J. 2018. Flow assessment and simulation too (FAST – Version 0.0.2) [computer software]. SNC-Lavalin Inc.

Historic Places. 2019. Government of Canada National Register of Historic Sites. https://www.historicplaces.ca/en/rep-reg/place-lieu.aspx?id=15685&pid=0 (accessed July 2019).

Huynh T. 2014. Permit No. 14-129, Ridgewood Estates Subdivision SE 14-36-4 W3M, heritage resources impact assessment. A report on file with the Archaeological Resource Management Section, Regina.

Information Services Corporation (ISC). 2019. Maps. URL: https://www.isc.ca/Pages/default.aspx (accessed December 2019).

Jones THE. 1993. Saskatoon Natural Grasslands Archaeological Survey. A report on file with the Archaeological Resource Management Section, Regina.

Knight Piesold Consulting. 2010. Saskatoon Light and Power Hydropower and Whitewater Park Development Studies: Environmental Baseline Studies 2009. Prepared For: Saskatoon Light and Power. 15 February 2010.

Leighton, A.L. 2012. Flora of Saskatchewan Fascicle 3: Sedges (Carex) of Saskatchewan. Nature Saskatchewan, Regina, SK.

Linnemae U. 1982. Archaeological survey of proposed 1980 & 1981 suburban development areas of the City of Saskatoon and the Silverwood Site (FbNp-4). HCB permit 82-000-05. A report on file with the Archaeological Resource Management Section, Regina.

Looman, J. and K.F. Best. 1987. Budd's Flora of the Canadian Prairie Provinces. Publ. 1662, Agriculture Canada Research Branch, Ottawa, ON.

Markowski M and Wolfe K. 2013. Associated Engineering, Eagle Heights Country Estates, W½ 11-37-4 W3M, heritage resources impact assessment, Permit No. 13-224.

Meewasin Valley Authority. 2015. Meewasin Northeast Swale Master Plan. 6 November 2015.

Moss, E.H. 1994. Flora of Alberta, 2nd Edition. Revised by J.G. Packer. University of Toronto Press, Toronto, ON. 687 pp.

Natural Resources Canada (NRC). 2013. CanVec hydrographic features dataset version 12.0. URL: https://open.canada.ca/data/en/dataset/9d96e8c9-22fe-4ad2-b5e8-94a6991b744b (accessed January 2019).

Novecosky B. 2004. Heritage resources impact assessment program, Tower Hill Ranch Ltd. Hidden Ridge Subdivision Project, Permit No. 04-90. A report on file with the Archaeological Resource Management Section, Regina.

NRC. 2016. National Railway Network dataset version 2.0. URL: https://open.canada.ca/data/en/dataset/ac26807e-a1e8-49fa-87bf-451175a859b8 (accessed January 2019).

NRC. 2017. National Road Network dataset version 9.0. URL: https://open.canada.ca/data/en/dataset/3d282116-e556-400c-9306-ca1a3cada77f (January 2019).

Paquin TA. 2001. Heritage resources impact assessment program, Tower Hill Developments, Discover Ridge Subdivision, Permit No. 01-031. A report on file with the Archaeological Resource Management Section, Regina.

Ramsay CL. 1998. Heritage resource impact assessment of a proposed subdivision for Eagle Ridge Estates Inc. at SE¼-10-37-4-W3M, HCB Permit 98-030. A report on file with the Archaeological Resource Management Section, Regina.

Ramsay AM and Ramsay CL. 1996. Heritage assessment of a proposed residential development northeast of Saskatoon, Saskatchewan (SE¼ and NE¼ of 31-37-4-W3M) HRIA Permit #96-025. A report on file with the Archaeological Resource Management Section, Regina.

Saskatchewan Conservation Data Centre (SKCDC). 2019a. Saskatchewan Tracked Vascular Plant Taxa by Ecoregion. SKCDC, Regina, SK. URL: http://www.biodiversity.sk.ca/SppList/vasctrack-ecoregion.xls (accessed September 2019).

SKCDC. 2019b. Saskatchewan Tracked Taxa List: Vascular Plants. SKCDC, Regina, SK. URL: http://www.biodiversity.sk.ca/SppList/vasctrack.pdf (accessed September 2019).

SKCDC. 2019c. Saskatchewan Tracked Taxa List: Vertebrates. SKCDC, Regina, SK. URL: http://www.biodiversity.sk.ca/SppList/vertstrack.pdf (accessed September 2019).

SKCDC. 2019d. Saskatchewan Tracked Taxa List: Invertebrates. SKCDC, Regina, SK. URL: http://www.biodiversity.sk.ca/SppList/inverttrack.pdf (accessed September 2019).

SKCDC. 2019e. Species Conservation Rankings. SKCDC, Regina, SK. URL: http://www.biodiversity.sk.ca/ranking.htm (accessed September 2019).

Saskatchewan Genealogical Society (SGS). 2019. Cemeteries in Saskatchewan. URL: http://www.saskgenealogy.com/index.php/cemeteries-in-saskatchewan/ (accessed July 2019).

Saskatchewan Homestead Index (SHI). 2019. URL: http://www.saskhomesteads.com/search.asp. (accessed July 2019).

Saskatchewan Land Resource Unit. 2009. Soils Data. University of Saskatchewan, Saskatoon, SK.

Saskatchewan Ministry of Environment (ENV). 2017. Activity Restriction Guidelines for Sensitive Species. Fish, Wildlife and Lands Branch. 3211 Albert Street, Regina, SK. 4 pp. URL: http://publications.gov.sk.ca/details.cfm?p=79241 (accessed September 2019).

Saskatchewan Ministry of Environment (ENV). 2019. Survey Protocols. URL: http://www.environment.gov.sk.ca/Default.aspx?DN=0797cc9a-b171-4c5b-8e3f-4f56b816a430 (accessed November 2019).

Saskatchewan Ministry of Environment (ENV). 2014. Snow track survey protocol. Fish and Wildlife Branch Technical Report No. 2014-19. 3211 Albert Street, Regina, Saskatchewan. 8pp.

Saskatchewan Ministry of Highways and Infrastructure (the Ministry). 2018. Satellite Image: 16, 17, and 18 October 2018.

Saskatchewan Research Council (SRC). 2003. Saskatchewan Digital Land Cover raster dataset for ArcGIS. URL: https://gis.saskatchewan.ca/arcgis/rest/services/Imagery/SDLC/MapServer (accessed January 2019).

Schwab M. 2011. Final report, heritage resources impact assessment of proposed Greenbryre Estates, HRIA Permit #2011-11. A report on file with the Archaeological Resource Management Section, Regina.

Stantec Consulting Ltd. (Stantec). 2012. North/Northwest Natural Area Screening Study, City of Saskatoon. Prepared for: City of Saskatoon. 16 September 2012.

Stantec Consulting Ltd. (Stantec). 2013a. North Commuter Parkway – Baseline Terrestrial and Aquatic Field Studies, and Heritage Resource Impact Assessment. Prepared for: City of Saskatoon. 30 October 2013.

Stantec Consulting Ltd. (Stantec). 2013b. North Central/North East Natural Area Screening Study, City of Saskatoon. Prepared for: City of Saskatoon. 19 November 2013.

Stead L. 2017. Heritage Resource Detailed Assessment: FbNp-82, FbNp-83, and FbNp-84 – University Heights Neighbourhood 3. Permit No. 17-050. A report on file with the Archaeological Resource Management Section, Regina.

Stewart, R.E. and H.A. Kantrud. 1971. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Resource Publ. 92, U.S. Fish and Wildlife Service, Washington D.C., Jamestown, ND.

Tannas, K. 2003. Common Plants of the Western Rangelands Volume I: Grasses and Grass-like Species. Alberta Agriculture, Food and Rural Development Publications Office, Edmonton, AB.

Taylor JL. 1985: Treaty Research Report – Treaty Six (1876). Historical Research Center, Indian and Northern Affairs Canada. URL: https://www.rcaanc-cirnac.gc.ca/eng/1100100028706/1564413507531 (accessed December 2019).

Thorpe, J. 2014a. Saskatchewan Rangeland Ecosystems Publication 1: Ecoregions and Ecosites. Version 2. Saskatchewan Prairie Conservation Action Plan. Saskatchewan Research Council Pub No. 11881-1E14.

Thorpe, J. 2014b. Saskatchewan Rangeland Ecosystems Publication 4: Communities on the Loam Ecosite. Version 2. Saskatchewan Prairie Conservation Action Plan. Saskatchewan Research Council Pub No. 11881-4E14.

Thorpe, J. 2014c. Saskatchewan Rangeland Ecosystems Publication 6: Communities on the Clay Ecosite. Version 2. Saskatchewan Prairie Conservation Action Plan. Saskatchewan Research Council Pub No. 11881-6E14.

Thorpe, J. 2014d. Saskatchewan Rangeland Ecosystems Publication 5: Communities on the Sand and Sandy Loam Ecosites. Version 2. Saskatchewan Prairie Conservation Action Plan. Saskatchewan Research Council Pub No. 11881-5E14.

Thorpe, J. 2014e. Saskatchewan Rangeland Ecosystems Publication 14: Communities on Saline Ecosites. Version 2. Saskatchewan Prairie Conservation Action Plan. Saskatchewan Research Council Pub No. 11881-14E14.

Walker EG. 1982. Archaeological resource assessment: The Tipperary Creek Project. A report on file with the Archaeological Resource Management Section, Regina.

Walker EG.1983. Saskatoon perimeter archaeological resource assessment. A report on file with the Archaeological Resource Management Section, Regina.

Water Survey of Canada. 2019. URL: https://wateroffice.ec.gc.ca/search/historical_e.html (accessed October 2019).

W.P. Fraser Herbarium. 2006. Virtual Herbarium of Plants at Risk in Saskatchewan. URL: http://www.usask.ca/biology/rareplants_sk/root/htm/en/index.php (accessed September 2019).

Appendix A

Provincial and Federal Status Rankings

Table A.I Provincial species rank definitions

Rank	Status	Definition
S1	critically imperiled	at very high risk of extirpation in Saskatchewan due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors
S2	imperiled	at high risk of extirpation in Saskatchewan due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors
S3	vulnerable	at moderate risk of extirpation in Saskatchewan due to a restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors
S4	apparently secure	at a fairly low risk of extirpation in Saskatchewan due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of recent declines, threats, or other factors
S5	secure	at very low or no risk of extirpation in Saskatchewan due to an extensive range, abundant populations or occurrences, with little to no concern from declines or threats

Ranks provided by the SKCDC are intended to indicate a species' risk of extirpation. They do not necessarily reflect its management priority. In addition, some species may be rare in the province yet not at risk of extirpation" (SKCDC 2019e)

Table A.II Codes and modifiers used to further describe provincial species rankings

Code	Definition
SH	historical occurrence but without recent verification (e.g. within 20 years)
SU	status uncertain in Saskatchewan because of limited or conflicting information (unraked)
SX	believed to be extinct or extirpated from the province
SNR	rank is not yet assigned, or species has not yet been assessed (not ranked)
SNA	conservation status is not applicable to the species (includes introduced species)

Species rank modification codes provided by the SKCDC (2019e)

Table A.III Federal species rank definitions

Rank	Definition
Extinct (X)	a species that no longer exists
Extirpated (XT)	a species no longer existing in the wild in Canada, but occurring elsewhere
Endangered (E)	a species facing imminent extirpation or extinction
Threatened (T)	a species likely to become endangered if limiting factors are not reversed
Special Concern (SC)	a species that is particularly sensitive to human activities or natural events but is not an endangered or threatened species
Data Deficient (DD)	a species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction
Not at Risk (NAR)	a species that has been evaluated and found to be not at risk

Species rank modification codes provided by COSEWIC (SKCDC 2019e)

Appendix B

Soil Classification and Capability Class Information

Table B.I Soil map units occurring within the vegetation and soils study area

Map Unit	Soil Association	Soil Type Distribution	Associated Landforms
Aq 1	Asquith	dominantly Orthic dark brown soils	gently to roughly undulating, with knolls and depressions
Aq 3	Asquith	dominantly Orthic dark brown soils, with Chernozemic soils	gently to roughly undulating, with knolls and depressions
Aq 6	Asquith	combination of Chernozemic and Gleysolic soils, with high salinity areas and poorly-drained soil in depressions	gently to roughly undulating, with knolls and depressions
Bg 3	Biggar	dominantly Orthic dark brown soils, with a combination of Carbonated and/or Saline Chernozemic soils on lower slopes and knolls	gently undulating, with knolls and depressions
BgWr 4	Biggar-Weyburn	dominantly Orthic Biggar soils, with Weyburn soils occurring randomly on eroded tills	gently undulating, with unpatterned and outwash plains
Br 1	Bradwell	dominantly Orthic dark brown soils	gently to roughly undulating, weakly patterned, with knolls and drained depressions
Br 3	Bradwell	dominantly Orthic dark brown soils, with Eluviated dark brown soil in eroded areas	gently to roughly undulating, weakly patterned, with knolls and depressions
BrBg 1	Bradwell-Biggar	dominantly Orthic Bradwell soils, with Biggar soils occurring randomly on slopes	gently to roughly undulating, weakly patterned, with knolls and depressions
BrWr 8	Bradwell-Weyburn	dominantly Orthic Bradwell soils, with Weyburn soils occurring randomly on glacial tills	gently to roughly undulating, weakly patterned, with knolls and depressions
Ew 3	Elstow	dominantly Orthic dark brown soils, with Eluviated dark brown soil	gently to roughly undulating, weakly patterned, with knolls and depressions, or gently to moderately sloping and dissected
EwBr 3	Elstow-Bradwell	dominantly Orthic Elstow soils, with Bradwell soils occurring randomly on slopes Elstow soils may be found on upper or lower slopes	roughly undulating, weakly patterned, with knolls and depressions
EwHy 1	Elstow-Hanley	dominantly Orthic Elstow soils, with Hanley soils occurring randomly on slopes Elstow soils may be found on upper or lower slopes	gently undulating and unpatterned or weakly patterned, with knolls and depressions
EwSu 7	Elstow-Sutherland	dominantly Orthic Elstow soils, with Sutherland soils occurring randomly on slopes Elstow soils may be found on upper or lower slopes	roughly undulating, weakly patterned, with knolls and depressions
Hw	Hillwash	mixture of Regosolic soils on steep, eroding slopes and Chernozemic soils on gentle slopes	glacial drainage channel with steep sloping
Hy 1	Hanley	dominantly dark brown Solonetzic soils, with a combination of Solonetz, Solodized Solonetz, and Solod soils	gently undulating, with knolls and depressions, and dissected
Rw	Runway	mixture of Regosolic soils on upper portions of steep slopes and Chernozemic soils on mid-portions of steep slopes Gleysolic soils may occur in poorly drained systems	moderately sloping, with eskers, and ridge moraines
StWr 4	Scott-Weyburn	dominantly Orthic Elstow soils occurring on lower slopes, with Weyburn soils occurring randomly on glacial tills	roughly undulating with knolls and depressions
Su 2	Sutherland	dominantly Orthic dark brown soils on lower and mid-slopes, with Rego dark brown soil on upper slopes	roughly undulating with knolls and depressions

Map Unit	Soil Association	Soil Type Distribution	Associated Landforms
SuEw 1	Sutherland-Elstow	dominantly Orthic Sutherland soils, with Elstow soils occurring randomly in lake marginal areas	roughly undulating and unpatterned
Tu 1	Tuxford	dominantly dark brown Solonetz soils on upper slopes, with Solod soil on lower flats and depressions	gently to roughly undulating and unpatterned or weakly patterned, with knolls and depressions, or dissected
TuEw 4	Tuxford-Elstow	dominantly Solonetz Tuxford soils, with Elstow soils occurring randomly in lake marginal areas	roughly undulating, with knolls and depressions
Vr 4	Valor	dominantly Orthic Regosol soils	weak dunes, with undulating and gently rolling aeolian plains
Wr 4	Weyburn	dominantly Orthic dark brown soils, combinations of Calcareous and Orthic Regosol soils	gently rolling, with knob and kettle, and dissected moraine
WrAq 1	Weyburn-Asquith	dominantly Orthic Weyburn soils occurring on upper slopes, with Asquith soils occurring randomly on lower slopes	roughly undulating and unpatterned
WrBg 1	Weyburn-Biggar	dominantly Orthic Weyburn soils, with Asquith soils occurring randomly on slopes Weyburn soils are scattered throughout all slope positions	gently undulating with knolls and depressions
WrBr 4	Weyburn-Bradwell	dominantly Orthic Weyburn soils occurring on upper slopes, with Bradwell soils occurring randomly on lower slopes	gently undulating with knolls and depressions

Source: (Acton and Ellis 1978).

Table B.II Soil capability classes occurring within the vegetation and soils study area

Map Unit	Capability Classes Present	Soil Limitations	Landscape Limitations	Climatic Limitations
2(6)C 3(4)M	Class 2 (60%) Class 3 (40%)	insufficient soil moisture holding capacity		moisture deficiency due to insufficient precipitation
3(6)M 4(4)M	Class 3 (60%) Class 4 (40%)	insufficient soil moisture holding capacity		
3(7)MT 4(3)M	Class 3 (70%) Class 4 (30%)	insufficient soil moisture holding capacity	unfavorable topography	
3(8)M 2(2)C	Class 3 (80%) Class 2 (20%)	insufficient soil moisture holding capacity		moisture deficiency due to insufficient precipitation
3(8)MT 4(2)E	Class 3 (80%) Class 4 (20%)	insufficient soil moisture holding capacity	unfavorable topography, erosion limitations	
3(8)M 4(2)D	Class 3 (80%) Class 4 (20%)	insufficient soil moisture holding capacity	poor structure and/or permeability	
3(8)M 5(2)W	Class 3 (80%) Class 5 (20%)	insufficient soil moisture holding capacity	excess water not caused by flooding	
3(9)MT 5(1)W	Class 3 (90%) Class 5 (10%)	insufficient soil moisture holding capacity	unfavorable topography, excess water not caused by flooding	
3(10)M	Class 3 (100%)	insufficient soil moisture holding capacity		
3(10)ME	Class 3 (100%)	insufficient soil moisture holding capacity	erosion limitations	
4(7)MP 3(3)M	Class 4 (70%) Class 3 (30%)	insufficient soil moisture holding capacity	excess stoniness	
4(7)M 5(3)MN	Class 4 (70%)			

Map Unit	Capability Classes Present	Soil Limitations	Landscape Limitations	Climatic Limitations
	Class 5 (30%)	insufficient soil moisture holding capacity, excessive soil salinity		
4(10)M	Class 4 (100%)	insufficient soil moisture holding capacity		
4(10)MN	Class 4 (100%)	insufficient soil moisture holding capacity, excessive soil salinity		
4(10)MP	Class 4 (100%)	insufficient soil moisture holding capacity	excess stoniness	
5(5)M 6(5)MP	Class 5 (50%) Class 6 (50%)	insufficient soil moisture holding capacity	excess stoniness	
5(6)M 4(4)M	Class 5 (60%) Class 4 (40%)	insufficient soil moisture holding capacity		
5(6)M 4(4)MP	Class 5 (60%) Class 4 (40%)	insufficient soil moisture holding capacity	erosion limitations	
5(10)MF	Class 5 (100%)	insufficient soil moisture holding capacity	erosion limitations	
5(10)TP	Class 5 (100%)		unfavorable topography, excessive stoniness	
5(10)WN	Class 5 (100%)	excessive soil salinity	excess water not caused by flooding	
6(10)TE	Class 6 (100%)		unfavorable topography, erosion limitations	
6(10)W	Class 6 (100%)		excess water not caused by flooding	
7(10)W	Class 7 (100%)		excess water not caused by flooding	

Appendix C

Plant Species of Conservation Concern with Occurrences in the Landscape Areas

Table C.I Plant SOCC with occurrences in the Saskatoon Plain, Moose Wood Sand Hills, Minichinas Upland, and Elstow Plain Landscape Areas

Table C.I Plant SOCC with occurrences in the Saskatoon Plain, Moose Wood Sand Hills, Minichinas Upland, and Elstow Plain Landscape Areas

Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Habitat Association
Achnatherum nelsonii ssp. dorei	Columbia needlegrass	Poaceae	S3	no status	no status	prairie hillsides and flats, meadows, open woods, clearings
Alisma gramineum	narrow-leaved water plantain	Alismataceae	S3	no status	no status	wet to drying mudflats, muddy shores, wet to drying wetland edges and seasonal wetlands
Allium cernuum var. cernuum	nodding onion	Liliaceae	S1	no status	no status	woodlands, upland prairies
Almutaster pauciflorus	few-flowered aster	Asteraceae	S3	no status	no status	saline seasonal wetlands and mudflats, damp alkaline soils
Amaranthus californicus	California amaranth	Amaranthaceae	S2	no status	no status	lake shores, roadsides, waste places
Ambrosia acanthicarpa	bur ragweed	Asteraceae	S2	no status	no status	dry, active to semi-stabilized sand dunes
Amphiscirpus nevadensis	Nevada bulrush	Cyperaceae	S3	no status	no status	saline and often alkaline seasonal wetlands, streams
Anagallis minima	chaffweed	Primulaceae	S3	no status	no status	drying slough margins, prairie depressions
Antennaria dimorpha	low pussytoes	Asteraceae	S2	no status	no status	dry sand, silt, gravel, or clay in short-grass prairie
Astragalus australis	Indian milk-vetch	Fabaceae	S3	no status	no status	gravel banks along rivers, gravel slopes
Astragalus purshii var. purshii	Pursh's milk-vetch	Fabaceae	S3	no status	no status	eroded short-grass and mixed-grass prairie
Bidens frondosa	tall beggar's-ticks	Asteraceae	S3	no status	no status	roadsides, railroads, wetland margins, ditches
Blysmopsis rufa	red bulrush	Cyperaceae	S3	no status	no status	seepy, often calcareous sedge meadows, fens, saline wetlands
Botrychium campestre	prairie dunewort	Ophioglossaceae	S2	no status	no status	open grassland, stabilized sand dune meadows, calcareous or alkaline prairie
Botrychium lunaria	common moonwort	Ophioglossaceae	S1	no status	no status	semi-open to open woods, moist meadows
Botrychium minganense	Mingan moonwort	Ophioglossaceae	S1	no status	no status	mesic open aspen woods and ditches; open fields and meadows, gravel slopes, shores
Botrychium pallidum	pale moonwort	Ophioglossaceae	S1	no status	no status	moist shrubby meadows, open regrowth woods
Cardamine nymanii	meadow bitter cress	Brassicaceae	S3	no status	no status	bogs, swampy sites
Carex crawei	Crawe's sedge	Cyperaceae	S3	no status	no status	seepy, often calcareous sedge meadows, fens, bogs, shores
Carex eburnea	bristle-leaved sedge	Cyperaceae	S3	no status	no status	open or semi-open moist woodlands, calcareous springs and seeps
Carex hystericina	porcupine sedge	Cyperaceae	S3	no status	no status	wet woods, moist meadows, muddy spring and brook margins
Carex saximontana	Rocky Mountain sedge	Cyperaceae	S3	no status	no status	moist to dry shaded deciduous woods, valleys, shrub thickets
Castilleja coccinea	scarlet paintbrush	Scrophulariaceae	S1	no status	no status	moist meadows, open woods, roadsides
Chenopodium desiccatum	dry goosefoot	Chenopodiaceae	S3	no status	no status	sand dunes
Chenopodium subglabrum	smooth goosefoot	Chenopodiaceae	S3	Threatened	Schedule 1, Threatened	active to stabilized sand dune blowouts
Cirsium drummondii	short-stemmed thistle	Asteraceae	S3	no status	no status	open prairies and woods
Corallorhiza striata var. striata	striped coral-root	Orchidaceae	S3	no status	no status	moist deciduous woods
Corispermum americanum var. americanum	American bugseed	Chenopodiaceae	S3	no status	no status	sandy shores and prairies, sand dunes, disturbed roadsides, old fields
Corispermum hookeri var. hookeri	Hooker's bugseed	Chenopodiaceae	S2	no status	no status	sandy and gravely shores of rivers and streams, sand dunes
Corispermum pallasii	Pallas' bugseed	Chenopodiaceae	S2	no status	no status	sandy dunes, sandy and gravelly shores, waste places
Corispermum villosum	hairy bugseed	Chenopodiaceae	S2	no status	no status	sandy pine barrens, shores, sand dune blowouts, roadsides, sandy waste places, old fields
Crepis runcinata ssp. hispidulosa	smooth hawk's-beard	Asteraceae	S1	no status	no status	moist saline meadows
Cyperus schweinitzii	Schweinitz's flatsedge	Cyperaceae	S3	no status	no status	active sand dune blowouts
Cyperus squarrosus	awned cyperus	Cyperaceae	S3	no status	no status	moist to drying mudflats, wetland bottoms, tilled depressions
Cyperus strigosus	straw-colored umbrella-sedge	Cyperaceae	SH	no status	no status	shores of Little Manitou Lake
Cypripedium parviflorum var. makasin	small yellow lady's slipper	Orchidaceae	S3	no status	no status	rich, moist, semi-open woodland, moist to wet meadows, stream margins, bogs, fens
Cypripedium parviflorum var. pubescens	large yellow lady's-slipper	Orchidaceae	S2	no status	no status	moist grassland, bogs, wet meadows, moist deciduous woods
Dalea villosa var. villosa	hairy prairie clover	Fabaceae	S2	Special Concern	Schedule 1, Special Concern	stabilized to semi-active sand dune blowouts
Elatine triandra	longstem water-wort	Elatinaceae	S2	no status	no status	moist to drying mudflats, wetland bottoms, tilled depressions
Eleocharis elliptica	slender spike-rush	Cyperaceae	S3	no status	no status	seepy, often calcareous sedge meadows, fens, bogs, shores
Eleocharis engelmannii	Engelmann's spike-rush	Cyperaceae	S3	no status	no status	moist to drying mudflats, wetland bottoms, tilled depressions
Elodea canadensis	Canada waterweed	Hydrocharitaceae	S3	no status	no status	shallow, quiet waters of calcareous lake bays, stream margins, alkaline ponds

Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Habitat Association
Elymus glaucus ssp. glaucus	blue wild rye	Poaceae	S3	no status	no status	dry to moist open woodlands, shrublands, and meadows
Elymus lanceolatus ssp. psammophilus	sand-dune wheatgrass	Poaceae	S2	no status	no status	active sand dune blowouts
Erigeron strigosus var. strigosus	daisy fleabane	Asteraceae	S3	no status	no status	sandy, clay, shale, and alkaline soils in grasslands, shores, forest clearings
Festuca hallii	plains rough fescue	Poaceae	S3	no status	no status	dry to mesic open prairie
Festuca idahoensis	Idaho fescue	Poaceae	S1	no status	no status	open wooded slopes, brushy high meadows
Gentiana fremontii	moss gentian	Gentianaceae	S3	no status	no status	calcareous and saline soil in springy meadow depressions
Gentiana puberulenta	downy gentian	Gentianaceae	SH	no status	no status	mesic prairie
Gentianopsis virgata ssp. virgata	lesser fringed gentian	Gentianaceae	S3	no status	no status	calcareous and saline soil in springy meadow depressions
Hornungia procumbens	oval-purse	Brassicaceae	S3	no status	no status	clayey saline areas
Impatiens noli-tangere	yellow touch-me-not	Balsaminaceae	S2	no status	no status	shaded wet meadows, moist woodlands, streambanks
Iris versicolor	blueflag	Iridaceae	S1	no status	no status	wet ditches, wetland margins, shorelines
Lactuca biennis	tall blue lettuce	Asteraceae	S3	no status	no status	moist woods and shrub thickets
Lomatogonium rotatum	marsh felwort	Gentianaceae	S3	no status	no status	calcareous and saline soil in springy meadow depressions
Lupinus pusillus ssp. pusillus	small lupine	Fabaceae	S3	no status	no status	dry sandy soils, stabilized sand dunes
Marsilea vestita	pepperwort	Marsileaceae	S3	no status	no status	seasonal wetlands, wet depressions, river floodplains
Monarda fistulosa var. mollis	soft wild bergamot	Lamiaceae	S3	no status	no status	mesic to dry shrublands, meadows, open woodlands
Myosurus apetalus var. montanus	bristly mousetail	Ranunculaceae	S2	no status	no status	wetland margins, mudflats, tilled depressions
Myosurus minimus	least mousetail	Ranunculaceae	S3	no status	no status	wetland margins, alkaline mudflats, tilled depressions
Najas flexilis	flexible naiad	Najadaceae	S3	no status	no status	shallow freshwater ponds, lake bays, slow streams
Oenothera caespitosa ssp. caespitosa	gumbo evening primrose	Onagraceae	S3	no status	no status	dry, clayey hillsides, gumbo flats
Platanthera dilatata var. dilatata	scentbottle	Orchidaceae	S3	no status	no status	spruce woods with open muskeg, calcareous wet meadows, fens, bogs
Polygala alba	white milkwort	Polygalaceae	S3	no status	no status	eroded or stony grassland slopes and coulees
Potamogeton strictifolius	upright narrow-leaved pondweed	Potamogetonaceae	S3	no status	no status	submersed in quiet, often saline or alkaline semi-permanent to permanent wetlands and lakes
Potentilla anserina ssp. yukonensis	Yukon silverweed	Rosaceae	S2	no status	no status	dry, sandy and gravelly stream and lakeshores, grasslands, open pine woodlands, waste places
Potentilla concinna var. concinna	early cinquefoil	Rosaceae	S2	no status	no status	dry, open sandy prairie slopes and coulees
Potentilla effusa var. effusa	branched cinquefoil	Rosaceae	S2	no status	no status	dry, rocky slopes, slightly moist meadows, grasslands, limestone grasslands
Potentilla hudsonii	Hudson's cinquefoil	Rosaceae	S2	no status	no status	dry, rocky slopes, sand dune blowouts, open spots in thin-soiled and/or heavily grazed prairie
Potentilla lasiodonta	sandhills cinquefoil	Rosaceae	S2	no status	no status	dry, sandy prairies
Potentilla rubricaulis	red-stemmed cinquefoil	Rosaceae	S3	no status	no status	dry, sandy prairies, open pine woods
Potentilla supina ssp. paradoxa	bushy cinquefoil	Rosaceae	S3	no status	no status	sandy lakeshores, riverbanks, wetland margins, low moist places on sandy soil
Rhinanthus minor ssp. minor	yellow-rattle	Scrophulariaceae	S2	no status	no status	moist open woodlands
Ribes oxyacanthoides ssp. setosum	bristly gooseberry	Grossulariaceae	S2	no status	no status	stream banks, rocky slopes, open woodlands
Rorippa curvipes	curved yellow-cress	Brassicaceae	S3	no status	no status	non-alkaline, drying mudflats and edges of wetlands in sandy or clay soil
Rosa blanda	smooth wild rose	Rosaceae	S1	no status	no status	riparian woods and shrub thickets
Ruppia maritima	beaked ditch-grass	Ruppiaceae	S3	no status	no status	submersed in quiet, often saline or alkaline semi-permanent to permanent wetlands and lakes
Sambucus racemosa ssp. pubens	red elderberry	Caprifoliaceae	S2	no status	no status	semi-open deciduous or mixed woods
Sceptridium multifidum	leathery grape-fern	Ophioglossaceae	S3	no status	no status	mesic to wet, sandy, open shrub thickets and woods
Scirpus pallidus	pale bulrush	Cyperaceae	S3	no status	no status	marshy shores, moist ravine bottoms, seasonal wetland zones, stream banks, ditches
Shinnersoseris rostrata	beaked annual skeleton-weed	Asteraceae	S2	no status	no status	dry, sandy soil in semi-active to stabilized sand dunes
Silene menziesii	Menzies' catchfly	Caryophyllaceae	S3	no status	no status	woodlands, clearings, grasslands, gravelly places, riverbanks
Sisyrinchium mucronatum	mucronate blue-eyed-grass	Iridaceae	S3	no status	no status	moist or seasonally moist grassland
Sisyrinchium septentrionale	northern blue-eyed-grass	Iridaceae	S3	no status	no status	dry to moist meadows, stream banks, often in gravelly soil
Sporobolus neglectus	small dropseed	Poaceae	S2	no status	no status	dry and often disturbed sand or gravel barrens, dry open ground, rocky waste places, urban sites
Teucrium canadense var. occidentale	hairy germander	Lamiaceae	S3	no status	no status	temporary wetland margins, moist meadows, prairie depressions

Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Habitat Association
Trichophorum pumilum	dwarf clubrush	Cyperaceae	S1	no status	no status	moist to wet alkaline marshes, shorelines, floodplains, boggy pond margins
Viola pedatifida	crowfoot violet	Violaceae	S3	no status	no status	dry to mesic grasslands and coulees with well-drained soils

Source: (COSEWIC 2000 and 2006; Ertter 2018; Flora of North America Editorial Committee 1993+; Government of Canada 2019; Harms and Leighton 2011a, 2011b, and 2014; Harms et al. 2018; Leighton 2012; Looman and Best 1987; Moss 1994; SKCDC 2019a and 2019b; W.P. Fraser Herbarium 2006)

Appendix D

HABISask Query Results

Table D.I Plant SOCC element occurrences

Element Occurrence ID	Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Vegetation and Soils Study Area?
16876	*Achnatherum nelsonii ssp. dorei*	Columbia needlegrass	Poaceae	S3	not ranked	not ranked	1938	no
999948723	*Alisma gramineum*	narrow-leaved water plantain	Alismataceae	S3	not ranked	not ranked	2013	no
999948724	*Alisma gramineum*	narrow-leaved water plantain	Alismataceae	S3	not ranked	not ranked	2013	no
999948725	*Alisma gramineum*	narrow-leaved water plantain	Alismataceae	S3	not ranked	not ranked	2013	no
999958797	*Alisma gramineum*	narrow-leaved water plantain	Alismataceae	S3	not ranked	not ranked	2012	no
999958999	*Alisma gramineum*	narrow-leaved water plantain	Alismataceae	S3	not ranked	not ranked	2012	yes
999969205	*Alisma gramineum*	narrow-leaved water plantain	Alismataceae	S3	not ranked	not ranked	1956	no
999974283	*Alisma gramineum*	narrow-leaved water plantain	Alismataceae	S3	not ranked	not ranked	1995	no
9052	*Almutaster pauciflorus*	few-flowered aster	Asteraceae	S3	not ranked	not ranked	1965	yes
999973151	*Amaranthus californicus*	California amaranth	Amaranthaceae	S3	not ranked	not ranked	1979	no
1792	*Anagallis minima*	chaffweed	Primulaceae	S3	not ranked	not ranked	1952	no
9186	*Anagallis minima*	chaffweed	Primulaceae	S3	not ranked	not ranked	1965	no
944	*Astragalus australis*	Indian milk-vetch	Fabaceae	S3	not ranked	not ranked	1972	no
1066	*Astragalus australis*	Indian milk-vetch	Fabaceae	S3	not ranked	not ranked	1972	no
6715	*Astragalus australis*	Indian milk-vetch	Fabaceae	S3	not ranked	not ranked	1970	no
999974649	*Astragalus australis*	Indian milk-vetch	Fabaceae	S3	not ranked	not ranked	2001	no
999948726	*Astragalus purshii var. purshii*	Pursh's milk-vetch	Fabaceae	S3	not ranked	not ranked	2013	no
999974298	*Bidens frondosa*	tall beggar's-ticks	Asteraceae	S3	not ranked	not ranked	1996	no
999976532	*Bidens frondosa*	tall beggar's-ticks	Asteraceae	S3	not ranked	not ranked	1992	no
999976533	*Bidens frondosa*	tall beggar's-ticks	Asteraceae	S3	not ranked	not ranked	1992	no
1253	*Blysmopsis rufa*	red bulrush	Cyperaceae	S3	not ranked	not ranked	1940	no
10941	*Blysmopsis rufa*	red bulrush	Cyperaceae	S3	not ranked	not ranked	1993	no
16582	*Blysmopsis rufa*	red bulrush	Cyperaceae	S3	not ranked	not ranked	1951	no
999954865	*Botrychium campestre*	prairie dunewort	Ophioglossaceae	S2	not ranked	not ranked	1994	yes
999954866	*Botrychium campestre*	prairie dunewort	Ophioglossaceae	S2	not ranked	not ranked	1994	no
999974501	*Botrychium pallidum*	pale moonwort	Ophioglossaceae	S1	not ranked	not ranked	1994	no
4221	*Carex crawei*	Crawe's sedge	Cyperaceae	S3	not ranked	not ranked	1970	no
6393	*Carex crawei*	Crawe's sedge	Cyperaceae	S3	not ranked	not ranked	1972	no
10940	*Carex crawei*	Crawe's sedge	Cyperaceae	S3	not ranked	not ranked	1993	yes
999976298	*Carex crawei*	Crawe's sedge	Cyperaceae	S3	not ranked	not ranked	1970	no
999974512	*Carex eburnea*	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked	1993	no
999974513	*Carex eburnea*	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked	1994	no
999974514	*Carex eburnea*	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked	1994	no
999974515	*Carex eburnea*	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked	1993	no
999976539	*Carex eburnea*	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked	1992	no
999976540	*Carex eburnea*	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked	1992	no
999976541	*Carex eburnea*	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked	1992	no
999976542	*Carex eburnea*	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked	1992	no
999976543	*Carex eburnea*	bristle-leaved sedge	Cyperaceae	S3	not ranked	not ranked	unknown	no
17173	*Carex saximontana*	Rocky Mountain sedge	Cyperaceae	S3	not ranked	not ranked	1937	yes
1913	*Chenopodium desiccatum*	dry goosefoot	Chenopodiaceae	S3	not ranked	not ranked	1979	no
762	*Chenopodium subglabrum*	smooth goosefoot	Chenopodiaceae	S3	Threatened	Schedule 1, Threatened	2017	no

Element Occurrence ID	Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Vegetation and Soils Study Area?
999974526	*Corallorhiza striata var. striata*	striped coral-root	Orchidaceae	S3	not ranked	not ranked	1993	no
14897	*Corispermum americanum var. americanum*	American bugseed	Chenopodiaceae	S3	not ranked	not ranked	1970	no
16082	*Corispermum hookeri var. hookeri*	Hooker's bugseed	Chenopodiaceae	S2	not ranked	not ranked	1964	no
16083	*Corispermum hookeri var. hookeri*	Hooker's bugseed	Chenopodiaceae	S2	not ranked	not ranked	1921	no
16097	*Corispermum pallasii*	Pallas' bugseed	Chenopodiaceae	S2	not ranked	not ranked	1992	no
16106	*Corispermum villosum*	hairy bugseed	Chenopodiaceae	S2	not ranked	not ranked	1992	no
999969060	*Crepis runcinata ssp. hispidulosa*	smooth hawk's-beard	Asteraceae	S1	not ranked	not ranked	1993	no
999969063	*Crepis runcinata ssp. hispidulosa*	smooth hawk's-beard	Asteraceae	S1	not ranked	not ranked	1920	no
16602	*Cyperus squarrosus*	awned cyperus	Cyperaceae	S3	not ranked	not ranked	1970	no
16603	*Cyperus squarrosus*	awned cyperus	Cyperaceae	S3	not ranked	not ranked	1965	no
999971646	*Cypripedium parviflorum*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2017	no
999988482	*Cypripedium parviflorum var. makasin*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2018	no
999988483	*Cypripedium parviflorum var. makasin*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2018	no
999988484	*Cypripedium parviflorum var. makasin*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2018	no
999988485	*Cypripedium parviflorum var. makasin*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2018	no
999988486	*Cypripedium parviflorum var. makasin*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2018	no
999988487	*Cypripedium parviflorum var. makasin*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2018	no
999988488	*Cypripedium parviflorum var. makasin*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2018	no
999988489	*Cypripedium parviflorum var. makasin*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2018	no
999988490	*Cypripedium parviflorum var. makasin*	small yellow lady's slipper	Orchidaceae	S3	not ranked	not ranked	2018	no
8084	*Elatine triandra*	longstem water-wort	Elatinaceae	S2	not ranked	not ranked	1967	no
8394	*Elatine triandra*	longstem water-wort	Elatinaceae	S2	not ranked	not ranked	1939	no
3102	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	1965	no
3843	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	1966	yes
6915	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	1965	no
7227	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	1965	no
999958862	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	2012	no
999958863	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	2012	no
999958864	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	2012	no
999958865	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	2012	no
999958866	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	2012	no
999976344	*Eleocharis engelmannii*	Engelmann's spike-rush	Cyperaceae	S3	not ranked	not ranked	1965	yes
917	*Elymus glaucus ssp. glaucus*	blue wild rye	Poaceae	S3	not ranked	not ranked	1931	no
4464	*Elymus lanceolatus ssp. psammophilus*	sand-dune wheatgrass	Poaceae	S2	not ranked	not ranked	1970	no
999974023	*Elymus lanceolatus ssp. psammophilus*	sand-dune wheatgrass	Poaceae	S2	not ranked	not ranked	1996	no
589	*Erigeron strigosus*	white-top	Asteraceae	S3	not ranked	not ranked	1960	no
999973160	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1974	no
999973170	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1986	no
999973172	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1980	yes
999973183	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1989	no
999973207	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1985	yes
999973228	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1986	no
999973275	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1990	no
999973282	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1992	no

Element Occurrence ID	Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Vegetation and Soils Study Area?
999973283	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1994	no
999973285	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1994	no
999973287	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1993	no
999973288	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1993	no
999973289	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	1951	no
999988474	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	2018	no
999988475	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	2018	no
999988476	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	2018	no
999988477	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	2018	no
999988478	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	2018	no
999988479	*Festuca hallii*	plains rough fescue	Poaceae	S3	not ranked	not ranked	2018	no
999984240	*Gentianopsis virgata*	lesser fringed gentian	Gentianaceae	S3	not ranked	not ranked	2018	yes
16261	*Iris versicolor*	blueflag	Iridaceae	S1	not ranked	not ranked	1994	no
16898	*Lactuca biennis*	tall blue lettuce	Asteraceae	S3	not ranked	not ranked	1954	no
8154	*Lomatogonium rotatum*	marsh felwort	Gentianaceae	S3	not ranked	not ranked	1962	no
999969035	*Monarda fistulosa var. mollis*	soft wild bergamot	Lamiaceae	S3	not ranked	not ranked	1915	no
999969037	*Monarda fistulosa var. mollis*	soft wild bergamot	Lamiaceae	S3	not ranked	not ranked	1930	no
16932	*Potentilla anserina ssp. yukonensis*	Yukon silverweed	Rosaceae	S2	not ranked	not ranked	1901	no
16928	*Potentilla concinna var. concinna*	early cinquefoil	Rosaceae	S2	not ranked	not ranked	1963	yes
16929	*Potentilla concinna var. concinna*	early cinquefoil	Rosaceae	S2	not ranked	not ranked	1992	no
16930	*Potentilla concinna var. concinna*	early cinquefoil	Rosaceae	S2	not ranked	not ranked	1952	no
17033	*Potentilla lasiodonta*	sandhills cinquefoil	Rosaceae	S2	not ranked	not ranked	1990	no
17034	*Potentilla lasiodonta*	sandhills cinquefoil	Rosaceae	S2	not ranked	not ranked	1950	no
999984241	*Potentilla lasiodonta*	sandhills cinquefoil	Rosaceae	S2	not ranked	not ranked	1993	yes
2118	*Potentilla rubricaulis*	red-stemmed cinquefoil	Rosaceae	S3	not ranked	not ranked	1939	no
6665	*Potentilla rubricaulis*	red-stemmed cinquefoil	Rosaceae	S3	not ranked	not ranked	1952	no
770	*Potentilla supina ssp. paradoxa*	bushy cinquefoil	Rosaceae	S3	not ranked	not ranked	1992	no
16950	*Potentilla supina ssp. paradoxa*	bushy cinquefoil	Rosaceae	S3	not ranked	not ranked	1992	no
16964	*Potentilla supina ssp. paradoxa*	bushy cinquefoil	Rosaceae	S3	not ranked	not ranked	1950	no
999976588	*Potentilla supina ssp. paradoxa*	bushy cinquefoil	Rosaceae	S3	not ranked	not ranked	1992	no
999976589	*Potentilla supina ssp. paradoxa*	bushy cinquefoil	Rosaceae	S3	not ranked	not ranked	1992	no
999976590	*Potentilla supina ssp. paradoxa*	bushy cinquefoil	Rosaceae	S3	not ranked	not ranked	1992	no
407	*Rhinanthus minor ssp. minor*	yellow-rattle	Scrophulariaceae	S2	not ranked	not ranked	1992	no
999974011	*Rhinanthus minor ssp. minor*	yellow-rattle	Scrophulariaceae	S2	not ranked	not ranked	1996	no
16698	*Ribes oxyacanthoides var. setosum*	bristly gooseberry	Grossulariaceae	S2	not ranked	not ranked	1938	no
5908	*Rorippa curvipes*	curved yellow-cress	Brassicaceae	S3	not ranked	not ranked	1988	no
6992	*Rosa blanda*	smooth wild rose	Rosaceae	S1	not ranked	not ranked	1974	no
999974301	*Sceptridium multifidum*	leathery grape-fern	Ophioglossaceae	S3	not ranked	not ranked	1995	yes
966	*Scirpus pallidus*	pale bulrush	Cyperaceae	S3	not ranked	not ranked	1992	no
1212	*Silene menziesii*	Menzies' catchfly	Caryophyllaceae	S3	not ranked	not ranked	1992	yes
16724	*Silene menziesii*	Menzies' catchfly	Caryophyllaceae	S3	not ranked	not ranked	1993	no
16750	*Sisyrinchium mucronatum*	mucronate blue-eyed-grass	Iridaceae	S3	not ranked	not ranked	1915	no
16762	*Sisyrinchium septentrionale*	northern blue-eyed-grass	Iridaceae	S3	not ranked	not ranked	1958	yes
16763	*Sisyrinchium septentrionale*	northern blue-eyed-grass	Iridaceae	S3	not ranked	not ranked	1960	no

Element Occurrence ID	Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Vegetation and Soils Study Area?
999958917	*Sisyrinchium septentrionale*	northern blue-eyed-grass	Iridaceae	S3	not ranked	not ranked	2012	no
5188	*Sporobolus neglectus*	small dropseed	Poaceae	S2	not ranked	not ranked	1993	no
8505	*Trichophorum pumilum*	dwarf clubrush	Cyperaceae	S1	not ranked	not ranked	1940	no
1391	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	unknown	no
3933	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	unknown	no
999958934	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	unknown	no
999959000	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2014	no
999959001	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2014	no
999959002	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2014	no
999959003	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2013	no
999959004	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2015	no
999959005	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2014	no
999959006	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2013	no
999959007	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2013	no
999959008	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2016	no
999959010	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2011	no
999959011	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2012	no
999959012	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2012	no
999959013	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2012	no
999959242	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2012	no
999959243	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2012	no
999959244	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2012	no
999959245	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2012	no
999959246	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2012	no
999974959	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	1951	no
999988316	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988317	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988318	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988319	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988320	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988321	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988326	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988327	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988328	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988329	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988330	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988331	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988332	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988333	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988334	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988335	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988336	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988337	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988338	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no

Element Occurrence ID	Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Vegetation and Soils Study Area?
999988339	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988340	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988341	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988342	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988343	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988344	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988345	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988346	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988347	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988348	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988349	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988350	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988351	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988352	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988353	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988354	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988355	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988356	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988357	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988358	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988359	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988360	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988361	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988362	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988363	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988364	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988365	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988366	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988367	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988368	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988369	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988370	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988371	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988372	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988373	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988374	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988375	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988376	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988377	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988378	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988379	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988380	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988381	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988382	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no

Element Occurrence ID	Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Vegetation and Soils Study Area?
999988383	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988384	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988385	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988386	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988387	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988388	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988401	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988402	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988403	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988404	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988405	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988406	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988407	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988408	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988409	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988410	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988411	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988412	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988413	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988414	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988415	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988416	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988417	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988418	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988419	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988420	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988421	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988422	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988423	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988424	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988425	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988426	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988427	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988428	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988429	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988430	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988431	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988432	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988433	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988434	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988435	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988436	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988437	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988438	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no

Element Occurrence ID	Scientific Name	Common Name	Family	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Vegetation and Soils Study Area?
999988439	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988440	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988441	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988442	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988443	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988444	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988445	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988446	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988447	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988448	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988449	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988450	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988451	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988452	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988453	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988454	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988455	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988456	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988457	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988458	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988459	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988460	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988461	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988462	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988463	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988464	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988465	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988466	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988467	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988468	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988469	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988470	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988471	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988472	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no
999988473	*Viola pedatifida*	crowfoot violet	Violaceae	S3	not ranked	not ranked	2018	no

Source: (Government of Saskatchewan 2019; SKCDC 2019b)

Table D.II Wildlife SOCC element occurrences

Element Occurrence ID	Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Wildlife Study Area?
999987264	Baird's sparrow	*Centronyx bairdii*	bird	S4B; tracked	Special Concern	Schedule 1, Special Concern	2013	yes
999987265	Baird's sparrow	*Centronyx bairdii*	bird	S4B; tracked	Special Concern	Schedule 1, Special Concern	2013	no
999987266	Baird's sparrow	*Centronyx bairdii*	bird	S4B; tracked	Special Concern	Schedule 1, Special Concern	2013	no
999941255	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2012	no
999942031	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2013	no

Element Occurrence ID	Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Wildlife Study Area?
999979753	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2018	no
999979794	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2017	no
999984499	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2011	no
999984500	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2011	yes
999984501	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2011	no
999984502	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2011	no
999987267	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2013	no
999987268	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2013	no
999987269	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2013	no
999987357	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2012	no
999987358	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2012	no
999989081	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2017	no
999989082	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2017	no
999989086	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2017	no
999989106	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2017	no
999990349	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2017	no
999990440	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2017	yes
999990450	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2017	no
999990468	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2018	yes
999990542	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2018	no
9999102698	barn swallow	*Hirundo rustica*	bird	S5B, S5M; tracked	Threatened	Schedule 1, Threatened	2019	no
9999106481	bicolored sallow moth	*Sunira bicolorago*	insect	S3	n/a	n/a	2016	no
999989075	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2017	no
999989080	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2017	no
999989089	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2017	no
999991231	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2018	no
999991306	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2018	no
999991358	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2017	no
999991372	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2018	no
999991383	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2018	no
999991401	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2017	no
999999314	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2018	no
999999342	bobolink	*Dolichonyx oryzivorus*	bird	S4B, S4M; tracked	Threatened	Schedule 1, Threatened	2018	no
9999106230	brown harpaline beetle	*Harpalus fuscipalpis*	insect	S3	n/a	n/a	1939	no
9999106109	clay-beach bembidion beetle	*Bembidion patruele*	insect	S3	n/a	n/a	1960	no
9999102480	common green darner	*Anax junius*	insect	S3	n/a	n/a	2012	no
9999105195	common green darner	*Anax junius*	insect	S3	n/a	n/a	2013	no
999938421	common nighthawk	*Chordeiles minor*	bird	S4B, S4M; tracked	Special Concern	Schedule 1, Threatened	unknown	no
999979736	common nighthawk	*Chordeiles minor*	bird	S4B, S4M; tracked	Special Concern	Schedule 1, Threatened	2018	no
999979737	common nighthawk	*Chordeiles minor*	bird	S4B, S4M; tracked	Special Concern	Schedule 1, Threatened	2017	no
9999102593	common nighthawk	*Chordeiles minor*	bird	S4B, S4M; tracked	Special Concern	Schedule 1, Threatened	2019	no
9999102466	Cooper's hawk	*Accipiter cooperii*	bird	S4B, S2N, S2M	Not at Risk	n/a	2018	no
9999105221	elusive clubtail	*Stylurus notatus*	insect	S2	n/a	n/a	2016	no
9999106114	field bembidion beetle	*Bembidion rupicola*	insect	S3	n/a	n/a	1960	no

Element Occurrence ID	Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Wildlife Study Area?
9999106100	ground beetle	*Bembidion intermedium*	insect	S3	n/a	n/a	1960	no
9999106110	ground beetle	*Bembidion rapidum*	insect	S3	n/a	n/a	1960	no
9999102840	Harris's sparrow	*Zonotrichia querula*	bird	SUB, S5M; tracked	Special Concern	No Status	2013	no
999940568	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	2012	no
999940573	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	2012	no
999942040	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	unknown	no
999976648	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	2015	no
999984416	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	2011	no
999984417	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	2011	no
999984418	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	2011	no
999987270	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	2013	no
999987356	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	2012	no
999991430	horned grebe	*Podiceps auritus*	bird	S5B, S5M; tracked	Special Concern	Schedule 1, Special Concern	2017	yes
9999105924	indiscriminate bumble bee	*Bombus insularis*	insect	S3	n/a	n/a	1942	no
999924328	lake sturgeon	*Acipenser fulvescens*	fish	S2	Endangered	No Status	unknown	no
999954716	lake sturgeon	*Acipenser fulvescens*	fish	S2	Endangered	No Status	2009	yes
9999105185	lance-tipped darner	*Aeshna constricta*	insect	S2	n/a	n/a	2011	no
9999101017	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	1980	no
9999101020	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	1978	no
9999101037	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	1989	no
9999101046	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	2001	no
9999101116	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	2014	no
9999101117	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	2014	no
9999101118	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	2015	no
9999101135	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	2017	no
9999101151	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	2018	no
9999101171	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	2011	no
9999101175	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	1994	no
9999102451	little brown myotis	*Myotis lucifugus*	mammal	S4B, S4N; tracked	Endangered	Schedule 1, Endangered	2017	no
13791	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2008	no
13823	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2008	yes
999923985	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2005	no
999923990	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2005	no
999936400	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2009	no
999939443	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	unknown	no
999971535	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2017	yes
999975284	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2018	no
999975361	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2016	no
999984396	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2011	no
999984397	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2011	no
999989105	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2017	no
999990066	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2018	no
999999281	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2018	no
999999341	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2018	no
9999100956	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2017	yes

Element Occurrence ID	Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Wildlife Study Area?
9999100957	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2017	yes
9999102244	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2003	no
9999102245	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2003	no
9999102714	loggerhead shrike	*Lanius ludovicianus*	bird	S2B, S2M	Threatened	Schedule 1, Threatened	2018	no
999975058	monarch	*Danaus plexippus plexippus*	insect	S2B	Endangered	Schedule 1, Special Concern	2016	no
999976632	monarch	*Danaus plexippus plexippus*	insect	S2B	Endangered	Schedule 1, Special Concern	2018	no
999938422	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	unknown	no
999938491	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2012	no
999959226	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2012	no
999959227	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	no
999959228	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	no
999959229	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	no
999959230	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	no
999959231	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	no
999959235	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2015	no
999959236	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2015	no
999959237	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2016	yes
999987160	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	no
999987161	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987162	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987163	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987164	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987165	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987166	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987167	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987168	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987169	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987170	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
999987171	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	no
999987172	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	no
999987288	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2013	yes
9999100959	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100960	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100961	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100962	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100963	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100965	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2017	no
9999100966	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2017	no
9999100967	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2017	no
9999100968	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100969	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100970	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100971	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100972	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100973	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes

Element Occurrence ID	Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Wildlife Study Area?
9999100974	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100975	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100976	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100978	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100980	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100981	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100982	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100983	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100984	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100985	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100986	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100987	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100988	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100989	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100990	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100991	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100992	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100993	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	yes
9999100994	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100995	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999100996	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2017	no
9999100997	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2017	no
9999101001	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2017	no
9999101003	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999101004	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2017	no
9999101006	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2018	no
9999102732	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2014	no
9999102738	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2017	no
9999103366	northern leopard frog	*Lithobates pipiens*	amphibian	S3	Special Concern	Schedule 1, Special Concern	2002	no
9999102711	northern shrike	*Lanius borealis*	bird	S1B, S4N, S4M	n/a	n/a	2018	no
9999102712	northern shrike	*Lanius borealis*	bird	S1B, S4N, S4M	n/a	n/a	2018	no
761	olive-backed pocket mouse	*Perognathus fasciatus*	mammal	S3	n/a	n/a	1965	no
1390	olive-backed pocket mouse	*Perognathus fasciatus*	mammal	S3	n/a	n/a	1958	no
2746	olive-backed pocket mouse	*Perognathus fasciatus*	mammal	S3	n/a	n/a	1955	yes
9999102764	osprey	*Pandion haliaetus*	bird	S2B, S2M	n/a	n/a	2019	yes
9999102765	osprey	*Pandion haliaetus*	bird	S2B, S2M	n/a	n/a	2018	no
9999102511	pronghorn	*Antilocapra americana*	mammal	S3	n/a	n/a	2019	no
9999102674	rusty blackbird	*Euphagus carolinus*	bird	S3B, SUN, S3M	Special Concern	Schedule 1, Special Concern	2018	yes
9999106096	salt bembidion beetle	*Bembidion insulatum*	insect	S3	n/a	n/a	1960	no
999980233	sharp-tailed grouse	*Tympanuchus phasianellus*	bird	S5; tracked	n/a	n/a	2016	yes
9999100952	sharp-tailed grouse	*Tympanuchus phasianellus*	bird	S5; tracked	n/a	n/a	unknown	yes
9999102837	sharp-tailed grouse	*Tympanuchus phasianellus*	bird	S5; tracked	n/a	n/a	2019	yes
999959239	short-eared owl	*Asio flammeus*	bird	S3B, S2N, S3M	Special Concern	Schedule 1, Special Concern	2014	no
999959240	short-eared owl	*Asio flammeus*	bird	S3B, S2N, S3M	Special Concern	Schedule 1, Special Concern	2011	yes
999959241	short-eared owl	*Asio flammeus*	bird	S3B, S2N, S3M	Special Concern	Schedule 1, Special Concern	2010	yes

Element Occurrence ID	Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Wildlife Study Area?
9999100954	short-eared owl	*Asio flammeus*	bird	S3B, S2N, S3M	Special Concern	Schedule 1, Special Concern	2017	yes
9999100955	short-eared owl	*Asio flammeus*	bird	S3B, S2N, S3M	Special Concern	Schedule 1, Special Concern	2018	no
999989076	Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	2017	no
999989077	Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	2017	no
999990650	Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	2018	no
999990659	Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	2018	no
999990750	Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	2017	no
999990766	Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	2017	no
999990777	Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	2018	no
9999101010	Sprague's pipit	*Anthus spragueii*	bird	S3B, S3M	Threatened	Schedule 1, Threatened	2018	no
9999105223	striped meadowhawk	*Sympetrum pallipes*	insect	S3	n/a	n/a	2014	no
9999105942	Suckley's bumble bee	*Bombus suckleyi*	insect	S3	n/a	n/a	1950	no
9999105200	tule bluet	*Enallagma carunculatum*	insect	S3	n/a	n/a	2016	no
999987271	turkey vulture	*Cathartes aura*	bird	S3B, S3M	n/a	n/a	2013	yes
9999102581	turkey vulture	*Cathartes aura*	bird	S3B, S3M	n/a	n/a	2018	no
9999106468	twenty-spotted lady beetle	*Psyllobora vigintimaculata*	insect	S2	n/a	n/a	2016	no
9999106350	twice-stabbed lady beetle	*Chilocorus stigma*	insect	S3	n/a	n/a	2016	no
9999100958	western red damsel	*Amphiagrion abbreviatum*	insect	S2	n/a	n/a	2013	no
9999105193	western red damsel	*Amphiagrion abbreviatum*	insect	S2	n/a	n/a	2013	no
9999105194	western red damsel	*Amphiagrion abbreviatum*	insect	S2	n/a	n/a	2013	no
9999102731	white heelsplitter	*Lasmigona complanata*	insect	S3	n/a	n/a	2018	no
9999101543	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2018	no
9999101544	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2018	no
9999101546	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2018	no
9999101552	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2018	no
9999101603	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2015	no
9999101614	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2015	no
9999101615	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2015	no
9999101621	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2015	no
9999101738	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2016	no
9999101784	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2017	no
9999101798	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2017	no
9999101799	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2017	no
9999101861	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2017	no
9999103488	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1972	no
9999103544	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1976	no
9999103576	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1990	no
9999103586	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1992	no
9999103589	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1992	no
9999103590	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1992	no
9999103599	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1992	no
9999103604	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1992	no
9999103620	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1996	no
9999103626	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1996	no
9999103635	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1996	no

Element Occurrence ID	Common Name	Scientific Name	Taxonomic Group	SKCDC Ranking	COSEWIC Status	SARA Status	Last Observation	Located within Wildlife Study Area?
9999103655	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2005	no
9999103755	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2013	no
9999103760	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2013	no
9999103761	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2013	no
9999103768	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2013	no
9999103769	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2013	no
9999103820	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2014	no
9999103908	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1973/	no
9999103964	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1980	no
9999104077	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1986	no
9999104140	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1988	no
9999104154	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1988	yes
9999104314	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1990	no
9999104403	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1992	yes
9999104474	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1994	no
9999104529	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	1996	no
9999104819	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2005	no
9999104830	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2005	no
9999104836	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2005	yes
9999104839	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2005	no
9999104909	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2008	no
9999104919	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2008	yes
9999104921	whooping crane	*Grus americana*	bird	SXB, S1M	Endangered	Schedule 1, Endangered	2008	no
9999100951	yellow rail	*Coturnicops noveboracensis*	bird	S3B, S3M	Special Concern	Schedule 1, Special Concern	2016	yes
9999105959	yellow-banded bumble bee	*Bombus terricola*	insect	S5; tracked	Special Concern	Schedule 1, Special Concern	1942	no

Source: (Government of Saskatchewan 2019; SKCDC 2019c and 2019d)

Appendix E

Field Wildlife Data

Table E.I Field visited quarter section summaries

Quarter Section	Project Phase	Roadside or Meandering	Roadside Survey No.	UTM Coordinates (Zone Easting Northing)	Date	Available Habitat	Land Use	Avian Species Detected	Mammal Species Detected	Amphibian/Reptile Species Detected
NE 25-37-06-3	1	roadside	1	13N 382634 5786272	26/06/2019	cropland, wetland, modified grassland, tree stand	cropland	BBMA, CORA, AMRO	n/a	n/a
NW 30-37-05-3	1	roadside	2	13N 382643 5786426	26/06/2019	cropland, wetland, tree stand	cropland, residence	RWBL, BBMA	n/a	n/a
SE 36-37-06-3	1	roadside	3	13N 382657 5786801	26/06/2019	cropland, tree rows	cropland, residence	BBMA, CORA	n/a	n/a
SW 31-37-05-3	1	roadside	3	13N 382657 5786801	26/06/2019	cropland	cropland	CORA	n/a	n/a
SE 36-37-06-3	1	roadside	4	13N 382642 5786547	26/06/2019	modified grassland	residence	VESP, BBMA, CCSP, GRAP, BRTH	white-tailed jackrabbit	n/a
NE 25-37-06-3	1	roadside	5	13N 382072 5786387	26/06/2019	cropland, modified grassland	cropland, residence	SOSP, CORA,	n/a	n/a
NE 25-37-06-3	1	roadside	6	13N 382519 5785914	26/06/2019	cropland, modified grassland	cropland, residence	CORA, SOSP	Richardson's ground squirrel	n/a
SE 26-37-06-3	3	roadside	7	13N 380993 5785198	26/06/2019	cropland, modified grassland, wetland	cropland, residence, industrial	RWBL, BARS, EAKI, KILL	n/a	boreal chorus frog
SW 25-37-06-3	3	roadside	7	13N 380993 5785198	26/06/2019	cropland, wetland, tree stand	cropland, residence	AMRO, BAOR	n/a	n/a
SW 26-37-06-3	3	roadside	8	13N 379452 5784997	27/06/2019	cropland, wetland	cropland	RWBL, AMGO, CCSP	n/a	n/a
SW 26-37-06-3	3	roadside	9	13N 379363 5785537	27/06/2019	cropland, wetland	cropland	RWBL, CORA, TRES, AMGO, CCSP	n/a	n/a
SE 27-37-06-3	3	roadside	9	13N 379363 5785537	27/06/2019	cropland, wetland	cropland	AMRO, CORA, RWBL, TRES,	n/a	n/a
NE 22-37-06-3	3	roadside	10	13N 379284 5785004	27/06/2019	cropland	cropland	COGR	n/a	n/a
NE 22-37-06-3	3	roadside	11	13N 378836 5785015	27/06/2019	cropland	cropland	HOLA	n/a	n/a
SE-27-37-06-3	3	roadside	11	13N 378836 5785015	27/06/2019	cropland, wetland	cropland	RWBL, SAVS, SOSP, VESP, EAKI	n/a	n/a
NW 22-37-06-3	III	roadside	12	13N 378238 5785007	27/06/2019	cropland, wetland	cropland, residence	VESP, RWBL, CCSP	Richardson's ground squirrel	n/a
SE 21-37-06-3	III	roadside	13	13N 377691 5783701	27/06/2019	modified grassland, cropland	residence	CCSP, YEWA	n/a	n/a
SE 21-37-06-3	III	roadside	13	13N 377691 5783701	27/06/2019	cropland, wetland	cropland	CCSP, ROPI, YHBL, YEWA	n/a	n/a
NE 16-37-06-3	III	roadside	14	13N 377361 5783426	27/06/2019	pasture/grassland, cropland	cropland, pasture	COGR, MODO, WEME, RTHA, EAKI, AMRO, RWBL	n/a	n/a
SE 21-37-06-3	III	roadside	14	13N 377361 5783426	27/06/2019	cropland	cropland, residence	AMRO, COGR, EAKI, MODO, RTHA, WEME	n/a	n/a
SW 22-37-06-3	III	roadside	15	13N 377927 5783404	27/06/2019	cropland, wetland	cropland	YHBL, CCSP, CORA, RTHA, ROPI	n/a	n/a
NW 15-37-06-3	III	roadside	15	13N 377927 5783404	27/06/2019	pasture/grassland	commercial	ROPI, KILL, WEME, RWBL	Richardson's ground squirrel	n/a
NW 15-37-06-3	III	roadside	16	13N 377675 5782846	27/06/2019	pasture/grassland	commercial	KILL, WEME, COGR, ROPI	n/a	n/a
NE 16-37-06-3	III	roadside	16	13N 377675 5782846	27/06/2019	pasture/grassland, wetland	residence	AMRO, RWBL, TRES	Richardson's ground squirrel	n/a
NE 17-36-06-3	III	roadside	17	13N 375807 5773621	26/07/2019	cropland, wetlands	cropland, residence	AMRO, BAOR, SOSP, CCSP, BCCH, BHCO, TRES, ROPI, MALL, RWBL, BRBL, EAKI	n/a	boreal chorus frog
SE 20-36-06-3	III	roadside	18	13N 375808 5774161	26/07/2019	cropland	cropland, industrial	AMCR, RWBL, WEME	Richardson's ground squirrel	western plains garter snake
SW 21-36-06-3	III	roadside	19	13N 375834 5774304	26/07/2019	cropland, wetlands	cropland	WEME, RBGU, FRGU, CCSP	Richardson's ground squirrel	n/a
NW-21-36-06-3	III	roadside	20	13N 375846 5775043	26/07/2019	cropland	cropland	CCSP, AMCR, BARS, SAVS, VESP, MODO, CORA	n/a	n/a
NE 20-36-06-3	III	roadside	21	13N 375592 5775362	26/07/2019	cropland, aspen stand	cropland	VESP, CCSP, CORA, BLJA, YEWA, SOSP, COYE, AMCR	white-tailed deer, coyote	n/a
SE 29-36-06-3	III	roadside	22	13N 375579 5775369	26/07/2019	cropland, wetlands	cropland	RWBL, CORA	n/a	n/a

Quarter Section	Project Phase	Roadside or Meandering	Roadside Survey No.	UTM Coordinates (Zone Easting Northing)	Date	Available Habitat	Land Use	Avian Species Detected	Mammal Species Detected	Amphibian/Reptile Species Detected
SW 29-36-06-3	III	roadside	23	13N 374665 5775399	26/07/2019	cropland	cropland	CAGO, NOSH, VESP, SOSP, AMCR, TRES, RTHA, RWBL, KILL, COGR	n/a	n/a
NW 29-36-06-3	III	roadside	24	13N 375082 5776986	26/07/2019	cropland	cropland	RWBL, AMCR, MODO, VESP, HOLA, CCSP, ROPI	Richardson's ground squirrel	n/a
NE 29-36-06-3	III	roadside	25	13N 375887 5776812	26/07/2019	cropland, wetland, shelterbelt	cropland	BARS, LCSP, BCCH, CORA	red fox, Richardson's ground squirrel	n/a
SE 08-37-06-3	III	roadside	26	13N 375984 5780449	26/07/2019	cropland, wetland	cropland	RWBL, YHBL, VESP, MALL, BRBL, HOLA	n/a	n/a
NE 08-37-06-3	III	roadside	27	13N 376007 5781266	26/07/2019	cropland	cropland, residence	CCSP, KILL, AMCR, RWBL, VESP	n/a	n/a
NW 09-37-06-3	III	roadside	28	13N 376007 5781266	26/07/2019	cropland, swale/wetland	cropland	WILL, KILL, MALL, GADW, RTHA, AMAV, BWTE, NOSH, RNPH, CCSP, YHBL, RWBL, BHCO, HOGR	n/a	n/a
NE 36-35-05-3	II	roadside	29	13N 391640 5768483	07/08/2019	pasture	pasture, hayland residence	RTHA, SOSP, AMCR, SAVS, MALL, BWTE, CCSP, MAWR, KILL, MODO, HOSP, YEWA, NOSH, GRCA, SOSA, RBGU, GRYE, COYE	n/a	n/a
SE 01-36-05-3	II	roadside	30	13N 391638 5768495	07/08/2019	cropland, wetlands, shrubs	cropland, residence	YEWA, HOLA, BCCH, MALL, ROPI, FRGU, RBGU, RWBL, EAKI, SOSP, CEDW	moose	n/a
SE 06-36-04-3	II	roadside	31	13N 393659 5769249	07/08/2019	cropland, wetland, tree stand	cropland, residence	YEWA, MAWR, RWBL, COYE, MALL, SOSP	n/a	n/a
NE 06-36-04-3	II	roadside	32	13N 393664 5769526	07/08/2019	modified grassland	hayland	SOSP, RWBL, COYE, EAKI, BRBL, BBMA, AMCR	american badger, white-tailed deer, red fox	n/a
NE 05-36-04-3	II	roadside	33	13N 395289 5770075	07/08/2019	cropland, wetland	cropland	COGR, SOSP, VESP, MAWR, AWPE, DCCO	n/a	n/a
SE 08-36-04-3	II	roadside	34	13N 395312 5770357	07/08/2019	cropland, wetland	cropland, residence	AMCR, CORA, RWBL	n/a	n/a
SW 09-36-04-3	II	roadside	34	13N 395312 5770357	07/08/2019	cropland, wetland	cropland, residence	RTHA, RWBL, CCSP, KILL	coyote	n/a
SE 09-36-05-3	II	roadside	35	13N 396771 5770636	07/08/2019	cropland, aspen stand, wetland/stream	cropland	TRES, BRBL, SOSP	n/a	n/a
NW 10-36-04-3	II	roadside	36	13N 397545 5771602	07/08/2019	cropland	cropland, residences	RTHA	n/a	n/a
NE 10-36-04-3	II	roadside	37	13N 397857 5771594	07/08/2019	cropland, aspen stand	cropland	AMCR, SOSP, AMGO, CCSP	n/a	n/a
SW 15-36-04-3	II	roadside	38	13N 396987 5772147	09/08/2019	cropland, wetlands	cropland, residences	CCSP, ROPI	Richardson's ground squirrel	n/a
NW 15-36-04-3	II	roadside	39	13N 397001 5772848	09/08/2019	cropland, wetlands	cropland, residence	GRPA, EAKI, AMRO, CHSP, SOSP, WTSP, CCSP, ROPI, RWBL, BARS	white-tailed deer	n/a
SW 22-36-04-3	II	roadside	40	13N 397016 5773640	09/08/2019	cropland	cropland	AMCR, CCSP	vole spp., white-tailed jackrabbit	n/a
NW 22-36-04-3	II	roadside	41 42	13N 397033 5774441 13N 397247 5774859	09/08/2019	cropland, aspen stand, tame pasture	cropland	HOWR, SOSP, WILL, WEME, CORA, VESP, SORA, RWBL, MAWR	n/a	n/a
SW 27-36-04-3	II	roadside	43 44	13N 397043 5775031 13N 397057 5775698	09/08/2019	cropland, wetlands	cropland	MODO, SOSP, NOSH, WILL, RWBL, KILL, BWTE, GWTE, GADW, WEME, MALL, GRYE, AMGO, WISN	n/a	n/a
NW 27-36-04-3	II	roadside	45	13N 397058 5776080	09/08/2019	cropland, tame pasture, wetland	cropland, residence	AMGO, CCSP	n/a	n/a
SW 34-36-04-3	II	roadside	46	13N 397077 5776776	09/08/2019	cropland, tame pasture, wetland	cropland, residence	BAOR, CCSP, AMCR, EAKI	n/a	n/a

Quarter Section	Project Phase	Roadside or Meandering	Roadside Survey No.	UTM Coordinates (Zone Easting Northing)	Date	Available Habitat	Land Use	Avian Species Detected	Mammal Species Detected	Amphibian/Reptile Species Detected
NW 34-36-04-3	II	roadside	47	13N 397096 5777885	09/08/2019	cropland, wetland	cropland, residence	CORA, HOLA	n/a	n/a
SW 03-37-04-3	II	roadside	48	13N 397095 5778338	15/08/2019	cropland, modified grassland	cropland, farmstead	AMGO, MODO, COYE	n/a	n/a
SE 04-37-04-3	II	roadside	48	13N 397095 5778338	15/08/2019	cropland, wetland, tree stand	cropland, farmstead	MALL	n/a	n/a
NW 31-37-05-3	1	roadside	49	13N 384291 5787574	15/08/2019	cropland, shrubland, wetland	cropland	AMGO, YEWA, SOSP, CCSP, SAVS	n/a	n/a
NW 32-37-05-3	1	roadside	49	13N 384291 5787574	15/08/2019	cropland, wetland, shrubland	cropland, residence	AMGO, WBNU, CCSP	n/a	n/a
NE 31-36-05-3	1	roadside	50	13N 384305 5788061	15/08/2019	cropland, shrubland, wetland	cropland	Sparrow Sp.	n/a	n/a
NW 32-37-05-3	1	roadside	50	13N 384305 5788061	15/08/2019	cropland, shrubland, wetland	cropland, residence	Sparrow Sp.	n/a	n/a
NW 32-37-05-3	1	roadside	51	13N 385098 5788086	15/08/2019	cropland, wetland, shrubland	cropland, residence	CORA, BBMA, WBNU	n/a	n/a
NE 32-37-05-3	1	roadside	51	13N 385098 5788086	15/08/2019	cropland, wetland, shrubland	cropland, industrial	N/A	n/a	n/a
SE 05-38-05-3	1	roadside	52	13N 385740 5788073	15/08/2019	pasture/grassland, wetland	residence	AMGO, RWBL, CHSP, VESP, HOWR	n/a	n/a
NE 32-37-05-3	1	roadside	52	13N 385740 5788073	15/08/2019	cropland, wetland, shrubland	cropland, industrial	HOSP	n/a	n/a
SE 04-38-05-3	1	roadside	53	13N 386742 5788046	15/08/2019	pasture/grassland	pasture	AMGO	n/a	n/a
NW 33-37-05-3	1	roadside	53	13N 386742 5788046	15/08/2019	pasture/grassland	pasture	AMGO	n/a	n/a
SW 04-38-05-3	1	roadside	53	13N 386742 5788046	15/08/2019	pasture/grassland, wetland	pasture	AMGO, AWPE	n/a	n/a
SE 05-38-05-3	1	roadside	54	13N 387317 5788032	15/08/2019	pasture/grassland, shrubland, tree stand	residence	AMGO, GRCA	n/a	n/a
NE 04-37-04-3	II	roadside	55	13N 397126 5779130	15/08/2019	cropland, wetland	cropland	VESP, MODO	n/a	n/a
NW 03-37-04-3	II	roadside	55	13N 397126 5779130	15/08/2019	cropland, wetland	cropland	VESP, MAWR	n/a	n/a
SW 10-37-04-3	II	roadside	56	13N 397142 5779962	15/08/2019	cropland, wetland	cropland, residence	MALL, GRYE, COGR, BBMA	n/a	n/a
SE 09-37-04-3	II	roadside	56	13N 397142 5779962	15/08/2019	cropland, tree stand	cropland	HOSP	n/a	n/a
NE 09-37-04-3	II	roadside	57	13N 397161 5780827	15/08/2019	cropland	cropland	N/A	n/a	n/a
SE 16-37-04-3	II	roadside	58	13N 396558 5781351	15/08/2019	cropland, modified grassland	cropland, industrial	VESP	n/a	n/a
SW 16-37-04-3	II	roadside	59	13N 395894 5781361	15/08/2019	cropland, wetland	cropland, industrial	N/A	n/a	n/a
NW 09-37-04-3	II	roadside	59	13N 395894 5781361	15/08/2019	cropland, wetland	cropland	N/A	n/a	n/a
NW 34-37-05-3 NE-34-37-05-3	1	meandering	N/A	N/A	29/08/2019	modified grassland, native dominant grassland	pasture	TUVU, RTHA, CCSP, AMCR, CAGO, SAVS, ROPI	Richardson's ground squirrel	n/a
SE 34-37-05-3 SW-34-37-05-3	1	meandering	N/A	N/A	29/08/2019	swale, modified grassland, native dominant grassland	pasture, snow dump	NOSH, WILL, SOSP, KILL, RUDU, EAGR, RLHA, CORA, SOSA, BWTE, MAWR, MALL, AMAV, CCSP, GBHE, AMGO, MODO, BLJA, SAVS, CAGO	white-tailed jackrabbit	n/a
NW 27-37-05-3	1	meandering	N/A	N/A	29/08/2019	swale, pasture	gravel operation	AMCO, AMAV, MALL, GADW, BAEA, BWTE, KILL, CAGO, CANV, NOSH, PBGR, SPSA, AWPE	n/a	n/a
SW 22-37-06-3	III	meandering	N/A	N/A	10/09/2019	cropland, wetlands, pastures	cropland	N/A	n/a	n/a
NW 22-37-06-3	III	meandering	N/A	N/A	10/09/2019	cropland, pasture	cropland, residential	CCSP, WEME, MAWR, AMGO, CORA, ROPI, SWHA, MODO	white-tailed deer, white-tailed jackrabbit	n/a
NW 33-37-05-3	1	meandering	N/A	N/A	10/09/2019	pasture, wetlands	pasture, residence	RBGU, WEME, ROPI, CCSP, GRSP, MALL, RUDU	n/a	n/a
NE 16-37-06-3	III	meandering	N/A	N/A	10/09/2019	cropland, tame pasture	cropland	RBGU, WEME, ROPI, CCSP, GRSP, MALL, RUDU	n/a	n/a
SW 21-36-06-3	III	meandering	N/A	N/A	13/09/2019	cropland, hayland, tree stand, wetlands	cropland	RTHA, AMGO, BBMA, MODO, VESP, AMCR, SACR	moose, white-tailed deer	n/a
NW 16-36-06-3	III	meandering	N/A	N/A	13/09/2019	cropland, wetland	cropland, residential	RUDU, GRYE, RTHA, GRPA, AMGO, YRWA, SOSP, YEWA, CHSP, SACR	white-tailed deer	n/a
SE 29-36-06-3	III	meandering	N/A	N/A	13/09/2019	cropland	cropland	RTHA, SAVS, BBMA	n/a	n/a

Quarter Section	Project Phase	Roadside or Meandering	Roadside Survey No.	UTM Coordinates (Zone Easting Northing)	Date	Available Habitat	Land Use	Avian Species Detected	Mammal Species Detected	Amphibian/Reptile Species Detected
NE 05-37-06-3	III	meandering	N/A	N/A	13/09/2019	cropland, wetland	cropland	RTHA, SACR	white-tailed deer	n/a
SE 08-37-06-3	III	meandering	N/A	N/A	13/09/2019	cropland	cropland	SACR, SAVS, MAWR, CHSP	white-tailed deer	n/a
NW 09-37-06-3	III	meandering	N/A	N/A	14/09/2019	swale, modified grassland	pasture, residence	CAGO, GRPA, BBMA, SAVS, MERL, AMGO, SWTH, WEME	white-tailed deer, mouse spp.	n/a
NW 15-37-06-3	III	meandering	N/A	N/A	14/09/2019	modified grassland, wetland	pasture, residence	WEME, SACR, BBMA, BRBL	white-tailed deer	n/a
NE, NW, SE, SW 36-35-05-3	II	meandering	N/A	N/A	14/09/2019	hayland, modified grassland, native grassland	hayland, pasture	CCSP, CAGO, AMGO, ALFL, SOSP, YEWA, BCCH, BBMA, BLJA, AMCR, CEDW, RTHA, NOHA, MALL, AMCO, AMRO, BWTE, KILL, SPSA, LEFL, GHOW, NOSH, NOPI	porcupine, vole spp., coyote, white-tailed deer, moose	boreal chorus frog, wood frog
SE 09-36-04-3	II	meandering	N/A	N/A	14/09/2019	cropland, creek, wetlands	cropland	GRSP, CCSP, AMRO, BAWW, SWHA, BAEA, AMGO	white-tailed deer, coyote, american badger	n/a

Table E.II Field-observed wildlife species

Taxonomic Order	Common Name	Scientific Name	SARA Status	SKCDC Status	Activity Restriction Guidelines	SOCC	SAR
Bird	alder flycatcher	*Empidonax alnorum*	Secure	S5B, S5M	N/A		
Bird	American avocet	*Recurvirostra americana*	N/A	S4B, S4M	N/A		
Mammal	American badger	*Taxidea taxus*	Schedule 1, Special Concern	S3; Tracked	N/A	✓	✓
Bird	American crow	*Corvus brachyrhynchos*	N/A	S5B, S4N, S5M	N/A		
Bird	American goldfinch	*Spinus tristis*	N/A	S5B	N/A		
Bird	American robin	*Turdus migratorius*	N/A	S5B, SUN, S5M	N/A		
Bird	American white pelican	*Pelecanus erythrorhynchos*	Not at Risk	S5B, S5M	Nesting Colony		
Bird	bald eagle	*Haliaeetus leucocephalus*	Not at Risk	S5B, S5N, S4M	N/A		
Bird	Baltimore oriole	*Icterus galbula*	N/A	S5B, S5M	N/A		
Bird	barn swallow	*Hirundo rustica*	Schedule 1, Threatened	S5B, S5M; Tracked	N/A	✓	✓
Bird	black and white warbler	*Mniotilta varia*	N/A	S5B, S5M	N/A		
Bird	black-billed magpie	*Pica hudsonia*	N/A	S5	N/A		
Bird	black-capped chickadee	*Poecile atricapillus*	N/A	S5	N/A		
Bird	blue jay	*Cyanocitta cristata*	N/A	S5	N/A		
Bird	blue-winged teal	*Spatula discors*	N/A	S5B, S5M	N/A		
Amphibian	boreal chorus frog	*Pseudacris maculata*	N/A	S5	N/A		
Bird	Brewer's blackbird	*Euphagus cyanocephalus*	N/A	S4B, SUN, S4M	N/A		
Bird	brown thrasher	*Toxostoma rufum*	N/A	S5B, S5M	N/A		
Bird	brown-headed cowbird	*Molothrus ater*	N/A	S5B, SUN, S5M	N/A		
Bird	Canada goose	*Branta canadensis*	N/A	S5B, S2N, S5M	N/A		
Bird	cedar waxwing	*Bombycilla cedrorum*	N/A	S5B, S5M	N/A		
Bird	chipping sparrow	*Spizella passerina*	N/A	S5B, S5M	N/A		
Bird	clay-coloured sparrow	*Spizella pallida*	N/A	S5B, S5M	N/A		

Taxonomic Order	Common Name	Scientific Name	SARA Status	SKCDC Status	Activity Restriction Guidelines	SOCC	SAR
Bird	common grackle	*Quiscalus quiscula*	N/A	S5B	N/A		
Bird	common raven	*Corvus corax*	N/A	S5	N/A		
Bird	common yellowthroat	*Geothlypis trichas*	N/A	S5B, S5M	N/A		
Mammal	coyote	*Canis latrans*	N/A	S5	N/A		
Bird	double-crested cormorant	*Phalacrocorax auritus*	Not at Risk	S5B, S5M	Nesting Colony	✓	
Bird	eared grebe	*Podiceps nigricollis*	N/A	S5B, S5M	Nesting colony	✓	
Bird	eastern kingbird	*Tyrannus tyrannus*		S5B, S5M			
Bird	Franklin's gull	*Leucophaeus pipixcan*	N/A	S4B, S4M	N/A		
Bird	gadwall	*Mareca strepera*	N/A	S5B, S2N, S5M	N/A		
Bird	grasshopper sparrow	*Ammodramus savannarum*	N/A	S4B	N/A		
Bird	gray catbird	*Dumetella carolinensis*	N/A	S5B, S5M	N/A		
Bird	gray partridge	*Perdix perdix*	N/A	SNA	N/A		
Bird	great blue heron	*Ardea herodias*	N/A	S5B; Tracked	Nesting colony	✓	
Bird	greater yellowlegs	*Tringa melanoleuca*	N/A	S5B, S5M	N/A		
Bird	great-horned owl	*Bubo virginianus*	N/A	S4	N/A		
Bird	green-winged teal	*Anas crecca*	N/A	S5B, S2N, S5M	N/A		
Bird	horned grebe	*Podiceps auritus*	Schedule 1, Special Concern	S5B, S5M; Tracked	N/A	✓	✓
Bird	horned lark	*Eremophila alpestris*	N/A	S4B, S3N, SUM	N/A		
Bird	house wren	*Troglodytes aedon*	N/A	S5B, S5M	N/A		
Bird	killdeer	*Charadrius vociferus*	N/A	S5B, S5M	N/A		
Bird	least flycatcher	*Empidonax minimus*	N/A	S5B, S5M	N/A		
Bird	Leconte's sparrow	*Ammospiza leconteii*	N/A	S5B, S5M	N/A		
Bird	mallard	*Anas platyrhynchos*	N/A	S5B, S5M	N/A		
Bird	marsh wren	*Cistothorus palustris*	N/A	S4B, S4M	N/A		

Taxonomic Order	Common Name	Scientific Name	SARA Status	SKCDC Status	Activity Restriction Guidelines	SOCC	SAR
Bird	merlin	*Falco columbarius*	Not at Risk	S5B, S5N, S5M	N/A		
Mammal	moose	*Alces alces*	N/A	S5	N/A		
Bird	mourning dove	*Zenaida macroura*	N/A	S5B, S5M	N/A		
Bird	northern harrier	*Circus hudsonius*	Not at Risk	S4B, S4M	N/A		
Bird	northern pintail	*Anas acuta*	N/A	S5B, S4N, S5M	N/A		
Bird	northern shoveler	*Spatula clypeata*	N/A	S5B, S5M	N/A		
Mammal	north american porcupine	*Erethizon dorsatum*	N/A	S4	N/A		
Mammal	red fox	*Vulpes vulpes*	N/A	S5	N/A		
Bird	red-necked phalarope	*Phalaropus lobatus*	Schedule 1, Special Concern	S4B, S3M; Tracked	Breeding bird	✓	✓
Bird	red-tailed hawk	*Buteo jamaicensis*	Not at Risk	S5B, S1N, S5M	N/A		
Bird	red-winged blackbird	*Agelaius phoeniceus*	N/A	S5B, SUN, S5M	N/A		
Mammal	Richardson's ground squirrel	*Urocitellus richardsonii*	N/A	S5	N/A		
Bird	ring-billed gull	*Larus delawarensis*	N/A	S5B, S5M	N/A		
Bird	rock pigeon	*Columba livia*	N/A	SNA	N/A		
Bird	ruddy duck	*Oxyura jamaicensis*	N/A	S5B	N/A		
Bird	savannah sparrow	*Passerculus sandwichensis*	N/A	S5B, S5M	N/A		
Bird	solitary sandpiper	*Tringa solitaria*	N/A	S5B, S4M	N/A		
Bird	song sparrow	*Melospiza melodia*	N/A	S5B, S5M	N/A		
Bird	spotted sandpiper	*Actitis macularius*	N/A	S4B, S4M	N/A		
Bird	Swainson's hawk	*Buteo swainsoni*	N/A	S4B, S4M	N/A		
Bird	tree swallow	*Tachycineta bicolor*	N/A	S5B, S5M	N/A		
Bird	turkey vulture	*Cathartes aura*	N/A	S3B, S3M; Tracked	N/A		
Bird	vesper sparrow	*Pooecetes gramineus*	N/A	S5B, S5M	N/A		
Bird	western meadowlark	*Sturnella neglecta*	N/A	S4B, S4M	N/A		
Reptile	western plains garter snake	*Thamnophis radix*	N/A	S5	N/A		

Taxonomic Order	Common Name	Scientific Name	SARA Status	SKCDC Status	Activity Restriction Guidelines	SOCC	SAR
Bird	white-breasted nuthatch	*Sitta carolinensis*	N/A	S5	N/A		
Mammal	white-tailed deer	*Odocoileus virginianus*	N/A	S4	N/A		
Mammal	white-tailed jackrabbit	*Lepus townsendii*	N/A	S4	N/A		
Bird	white-throated sparrow	*Zonotrichia albicollis*	N/A	S5B, S5M	N/A		
Bird	willet	*Tringa semipalmata*	N/A	S4B, S4M	N/A		
Bird	Wilson's snipe	*Gallinago delicata*	N/A	S5B, S5M	N/A		
Amphibian	wood frog	*Lithobates sylvaticus*	N/A	S5	N/A		
Bird	yellow warbler	*Setophaga petechia*	N/A	S5B, S5M	N/A		
Bird	yellow-headed blackbird	*Xanthocephalus xanthocephalus*	N/A	S5B, S5M	N/A		

Table E.III Future survey recommendations by quarter section

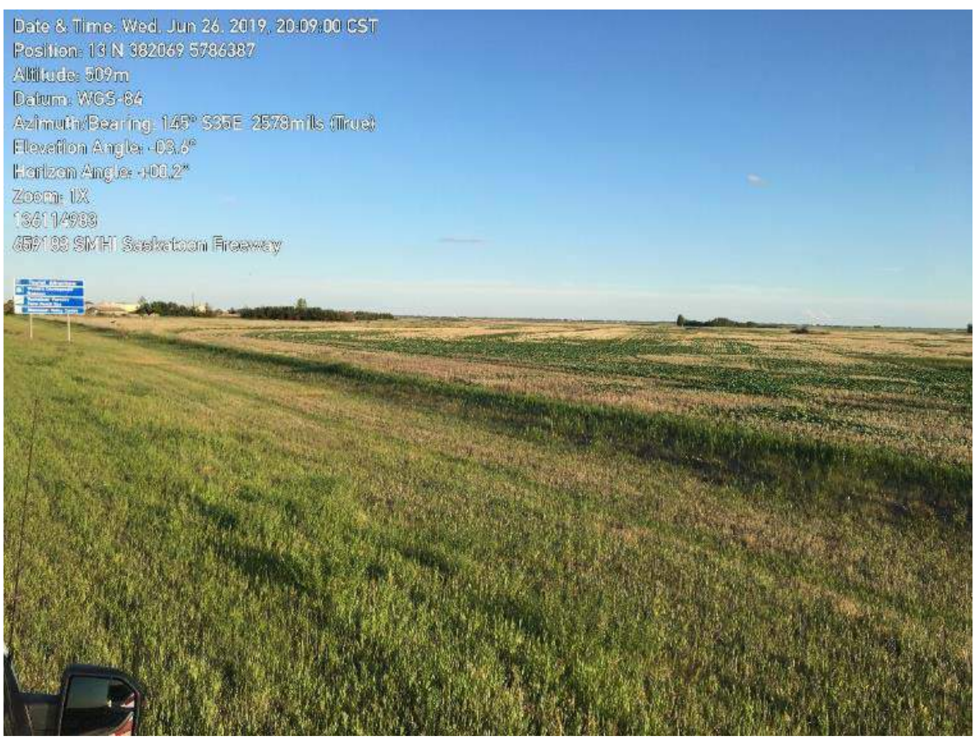
Quarter Section	Amphibian Auditory	Burrowing Owl	Short-eared Owl	Sharp-tailed Grouse	Yellow Rail	Common Nighthawk
NE 04-37-04-3	✓					
NE 05-36-04-3	✓					
NE 05-37-06-3	✓					
NE 06-36-04-3	✓	✓	✓			✓
NE 15-37-06-3	✓	✓	✓	✓		✓
NE 16-37-06-3	✓	✓	✓	✓	✓	✓
NE 17-36-06-3	✓					
NE 25-37-06-3	✓				✓	
NE 31-37-05-3	✓					
NE 32-36-06-3	✓					
NE 36-35-05-3	✓	✓	✓	✓	✓	✓
NW 03-37-04-3	✓					
NW 09-37-04-3	✓					
NW 09-37-06-3	✓					
NW 15-37-06-3		✓	✓	✓		✓
NW 16-36-06-3	✓					
NW 21-36-06-3						
NW 22-36-04-3	✓					

Quarter Section	Amphibian Auditory	Burrowing Owl	Short-eared Owl	Sharp-tailed Grouse	Yellow Rail	Common Nighthawk
NW 22-37-06-3	✓	✓	✓	✓	✓	✓
NW 27-36-04-3						
NW 27-37-05-3	✓				✓	
NW 29-36-06-3						
NW 30-37-05-3	✓					
NW 31-37-05-3	✓					
NW 32-36-06-3	✓					
NW 32-37-05-3	✓					
NW 33-37-05-3		✓	✓	✓		✓
NW 34-36-04-3	✓		✓	✓		✓
NW 34-37-05-3	✓	✓	✓	✓		✓
NW 36-35-05-3	✓	✓	✓	✓	✓	✓
SE 01-36-05-3	✓					
SE 04-37-04-3	✓					
SE 04-38-05-3		✓	✓	✓		✓
SE 05-38-05-3	✓	✓	✓	✓		✓
SE 06-36-04-3	✓				✓	
SE 08-36-04-3	✓					
SE 08-37-06-3	✓					
SE 09-36-04-3	✓					
SE 09-37-04-3	✓					
SE-36-35-05-3	✓	✓	✓	✓	✓	✓
SE 21-36-06-3	✓					
SE 21-37-06-3	✓	✓	✓	✓		✓
SE 26-37-06-3	✓				✓	
SE 27-37-06-3	✓					
SE 29-36-06-3	✓					
SE 36-37-06-3				✓		
SW 03-37-04-3		✓	✓	✓		✓
SW 04-38-05-3	✓	✓	✓	✓		✓
SW 16-37-04-3	✓					
SW-36-35-05-3	✓	✓	✓	✓	✓	✓
SW 22-37-06-3	✓					
SW 25-37-06-3	✓					
SW 26-37-06-3	✓					
SW 27-36-04-3	✓					
SW 34-36-04-3	✓		✓	✓		✓

Appendix F

Field Survey Photographs

Photograph F.1 SE-36-37-06-W3 Cropland habitat; 26-Jun-19



Photograph F.2 SW-36-37-06-W3 Cropland habitat and residence; 26-Jun-19

Photograph F.3 NW-30-37-05-W3 Tree stand and cropland habitat adjacent to commercial development and residence; 26-Jun-19

Photograph F.4 SE-26-37-06-W3 Wetland habitat and residence adjacent to cropland; 26-Jun-19

Photograph F.5 SE-36-37-06-W3 Grassland/pasture, hayland, and cropland habitat and residence. Another photo of this quarter section habitat is presented in Photograph F.1; 26-Jun-19

Photograph F.6 SW-25-37-06-W3 Tree stand habitat and residence adjacent to cropland; 26-Jun-19

Photograph F.7 NE-25-37-06-W3 Cropland habitat north of Highway 16; 26-Jun-19

Photograph F.8 SW-31-37-05-W3 Cropland habitat north of Highway 16; 26-Jun-19

Photograph F.9 SE-21-37-06-W3 Grassland/pasture habitat and residence; 27-Jun-19

Photograph F.10 NE-25-37-06-W3 Grassland/tame pasture and cropland habitat south of Highway 16; 26-Jun-19

Photograph F.11 NE-16-37-06-W3 Grassland/pasture and wetland habitat; 27-Jun-19

Photograph F.12 SE-27-37-06-W3 Cropland, wetland, and tree stand habitat; 27-Jun-19

Photograph F.13 NE-22-37-06-W3 Cropland and tilled wetland habitat; 27-Jun-19

Photograph F.14 SW-26-37-06-W3 Cropland and tilled wetland habitat; 27-Jun-19

Photograph F.15 NW-15-37-06-W3 Grassland/tame pasture habitat and residence; 27-Jun-19

Photograph F.16 SW-22-37-06-W3 Tree stand and cropland habitat; 27-Jun-19

Photograph F.17 NE-08-37-06-W3 Cropland habitat and residence; 26-Jul-19

Photograph F.18 NW-09-37-06-W3 Cropland, tame grassland/pasture, and swale habitat; 26-Jul-19

Photograph F.19 NE-29-36-06-W3 Cropland and tree stand/row habitat; 26-Jul-19

Photograph F.20 SE-08-37-06-W3 Cropland and tilled and seeded wetland habitat; 26-Jul-19

Photograph F.21 SE-29-36-06-W3 Cropland habitat; 26-Jul-19

Photograph F.22 SW-29-36-06-W3 Cropland, wetland, and tree stand habitat; 26-Jul-19

Photograph F.23 NE-20-36-06-W3 Cropland and treed (in ditch) habitat; 26-Jul-19

Photograph F.24 NE-20-36-06-W3 Former yard site habitat. Another photo of this quarter section habitat is presented in Photograph F.23; 26-Jul-19

Photograph F.25 SW-21-36-06-W3 Cropland and wetland habitat; 26-Jul-19

Photograph F.26 NW-21-36-06-W3 Cropland habitat; 26-Jul-19

Photograph F.27 NE-17-36-06-W3 Wetland, tree stand, and cropland habitat; 26-Jul-19

Photograph F.28 SE-20-36-06-W3 Mowed lawn and industrial site; 26-Jul-19

Photograph F.29 NW-10-36-04-W3 Cropland habitat and adjacent residence; 07-Aug-19

Photograph F.30 NE-10-36-04-W3 Tree stand habitat within cropland quarter; 07-Aug-19

Photograph F.31 SW-09-36-04-W3 Cropland and wetland habitat; 07-Aug-19

Photograph F.32 SE-09-36-04-W3 Ephemeral creek/drainage and cropland habitat; 07-Aug-19

Photograph F.33 SE-08-36-04-W3 Cropland and tilled wetland habitat; 07-Aug-19

Photograph F.34 NE-05-36-04-W3 Wetland and cropland habitat and residence; 07-Aug-19

Photograph F.35 SE-06-36-04-W3 Wetland and grassland/pasture habitat; 07-Aug-19

Photograph F.36 NE-06-36-04-W3 Wetland, tree stand, and grassland/hayland habitat; 07-Aug-19

Photograph F.37 SE-01-36-05-W3 Cropland habitat and tilled wetland habitat; 07-Aug-19

Photograph F.38 SW-06-36-04-W3 Cropland, wetland, and tree stand habitat; 07-Aug-19

Photograph F.39 NW-34-36-04-W3 Cropland habitat and tilled wetland habitat; 09-Aug-19

Photograph F.40 NE-36-35-05-W3 Wetland and grassland/pasture habitat and residence; 07-Aug-19

Photograph F.41 NW-27-36-04-W3 Grassland/pasture habitat; 09-Aug-19

Photograph F.42 SW-34-36-04-W3 Cropland habitat and residence; 09-Aug-19

Photograph F.43 SW-27-36-04-W3 Cropland habitat; 09-Aug-19

Photograph F.44 NW-27-36-04-W3 Wetland and cropland habitat. Another photo of this quarter sections habitat is presented in Photograph F.41; 09-Aug-19

Photograph F.45 NW-22-36-04-W3 Cropland and tree stand habitat; 09-Aug-19

Photograph F.46 NW-22-36-04-W3 Grassland and wetland habitat. Another photo of this quarter sections habitat is presented in Photograph F.45; 09-Aug-19

Photograph F.47 NW-15-36-04-W3 Ephemeral creek and cropland habitat; 09-Aug-19

Photograph F.48 SW-22-36-04-W3 Cropland and tilled wetland habitat; 09-Aug-19

Photograph F.49 SW-10-37-04-W3 Wetland, treestand, and cropland habitat; 15-Aug-19

Photograph F.50 SW-15-36-04-W3 Cropland habitat; 09-Aug-19

Photograph F.51 SE-05-38-05-W3 Residence/yard habitat; 15-Aug-19

Photograph F.52 SE-09-37-04-W3 Cropland and wetland habitat; 15-Aug-19

Photograph F.53 SE-04-38-05-W3 Grassland/pasture habitat; 15-Aug-19

Photograph F.54 NE-31-37-05-W3 Cropland habitat; 15-Aug-19

Photograph F.55 NW-32-37-05-W3 Hayland and wetland habitat; 15-Aug-19

Photograph F.56 SW-16-37-04-W3 Cropland habitat; 15-Aug-19

Photograph F.57 NE-04-37-04-W3 Cropland and wetland habitat; 15-Aug-19

Photograph F.58 NW-09-37-04-W3 Cropland and dugout habitat; 15-Aug-19

Photograph F.59 SW-03-37-04-W3 Unused pasture, wetland, and cropland habitat; 15-Aug-19

Photograph F.60 SW-32-37-05-W3 Cropland, tree stand, and wetland habitat; 15-Aug-19

Photograph F.61 NE-32-37-05-3 Cropland habitat and developed industrial site; 15-Aug-19

Photograph F.62 SW-04-38-05-W3 Grassland/pasture habitat and developed industrial site; 15-Aug-19

Photograph F.63 SE-04-37-04-3 Tree stand, wetland, and cropland habitat; 15-Aug-19

Photograph F.64 NW-08-37-04-3 Cropland habitat; 15-Aug-19

Photograph F.65 SE-04-38-05-W3 Grassland habitat. Photo note is mislabeled; 15-Aug-19

Photograph F.66 NE-09-37-04-W3 Cropland habitat; 15-Aug-19

Photograph F.67 NE-31-37-05-W3 Cropland and wetland habitat; 15-Aug-19

Photograph F.68 NE-03-37-04-W3 Grassland, wetland, and cropland habitat; 15-Aug-19

Photograph F.69 NE-28-37-05-W3 Hudson Bay swale; 29-Aug-19

Photograph F.70 SE-16-37-04-W3 Grassland habitat near gravel operation; 15-Aug-19

Photograph F.71 SE-34-37-05-W3 Hudson Bay swale; 29-Aug-19

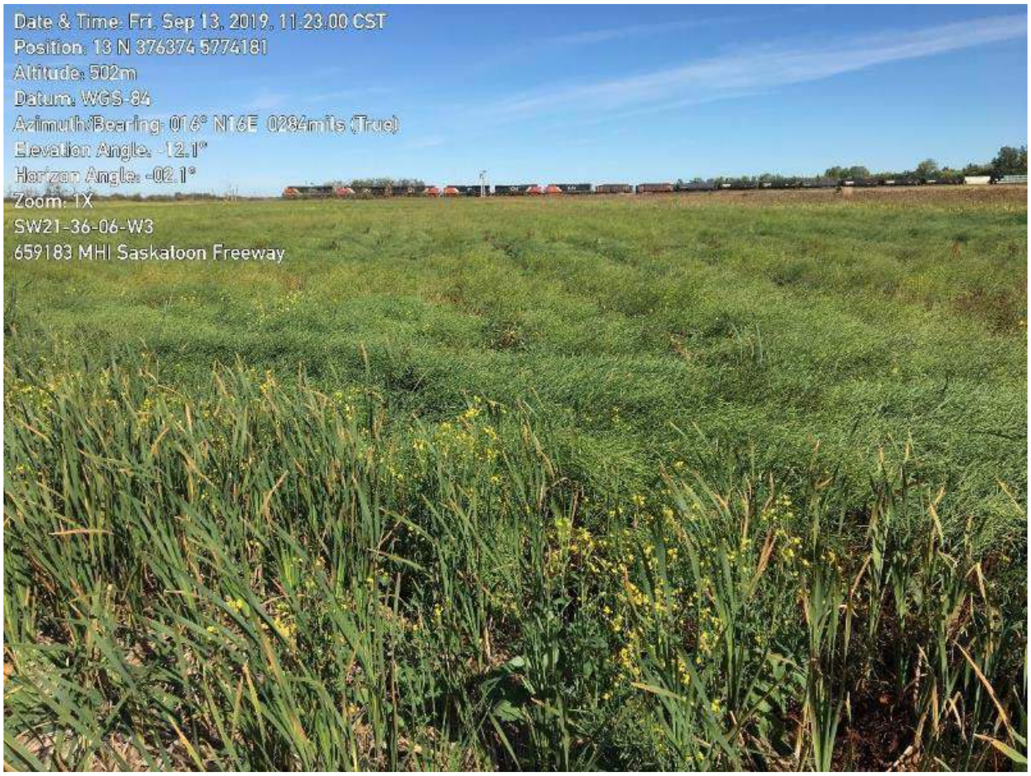
Photograph F.72 SW-34-37-05-W3 Native dominant grassland near Hudson Bay swale; 29-Aug-19

Photograph F.73 NE-05-37-06-W3 Cropland and wetland habitat; 13-Sep-19

Photograph F.74 NW-34-37-05-W3 Native-dominant pasture near Hudson Bay swale; 29-Aug-19

Photograph F.75 SE-08-37-06-W3 Cropland and wetland habitat; 13-Sep-19

Photograph F.76 NW-16-36-06-W3 Cropland and wetland habitat; 13-Sep-19.



Photograph F.77 SW-21-36-06-W3 Cropland and wetland habitat; 13-Sep-19

Photograph F.78 SE-29-36-06-W3 Cropland habitat; 13-Sep-19

Photograph F.79 NW-09-37-06-W3 West swale; Another photo of this quarter section habitat is presented in Photograph F.18; 14-Sep-19

Photograph F.80 NW-15-37-06-W3 Tame Pasture; 14-Sep-19

Photograph F.81 SE-9-36-4-W3 Uncultivated tame pasture; 16-Sep-19

Photograph F.82 Section 36-35-05-W3. Grassland/pasture habitat. Another photo of this quarter section is presented in Photograph F.40; 16-Sep-19

Appendix G

Fish Species within the South Saskatchewan River Watershed

Table G.I. Fish species found in the South Saskatchewan River Watershed

Table G.I. Fish species found in the South Saskatchewan River Watershed

Common Name	Scientific Name	SKCDC Rank	COSEWIC Status	SARA Status
blacknose dace	*Rhinicthys obtusus*	S3	-	-
brook stickleback	*Culaea inconstans*	S5	-	-
brook trout	*Salvelinus fontinalis*	SNA	-	-
burbot	*Lota lota*	S5	-	-
cisco	*Coregonus artedi*	S5	-	-
common shiner	*Luxilus cornutus*	S3	-	-
emerald shiner	*Notropis atherinoides*	S5	-	-
fathead minnow	*Pimephales promelas*	S5	-	-
finescale dace	*Chrosomus neogaeus*	S4	-	-
flathead chub	*Platygobio gracilis*	S3	-	-
goldeye	*Hiodon alosoides*	S4	-	-
Iowa darter	*Etheostoma exile*	S5	-	-
lake chub	*Couesius plumbeus*	S5	-	-
lake sturgeon	*Acipenser fulvescens*	S2	Endangered	-
lake whitefish	*Coregonus clupeaformis*	S5	Not at Risk	-
longnose dace	*Rhinichthys cataractae*	S5	-	-
longnose sucker	*Catostomus catostomus*	S5	-	-
mooneye	*Hiodon tergisus*	S3	-	-
mountain sucker	*Catostomus platyrhynchus*	S1	Threatened	Threatened
northern pike	*Esox lucius*	S5	-	-
shorthead redhorse	*Moxostoma macrolepidotum*	S4	-	-
pearl dace	*Margariscus machtriebi*	S5	-	-
quillback sucker	*Carpiodes cyprinus*	S4	-	-
rainbow trout	*Oncorhynchus mykiss*	SNA	-	-
river shiner	*Notropis blennis*	S3	-	-
sauger	*Sander canadensis*	S5	-	-
silver redhorse	*Moxostoma anisurum*	S4	-	-
slimy sculpin	*Cottus cognatus*	S4	-	-
spoonhead sculpin	*Cottus ricei*	S5	Not at Risk	-
spottail shiner	*Notropis hudsonius*	S5	-	-
trout-perch	*Percopsis omiscomaycus*	S5	-	-
walleye	*Sander vitreus*	S5	-	-
white sucker	*Catostomus commersonii*	S4	-	-
yellow perch	*Perca flavescens*	S5	-	-

Appendix H

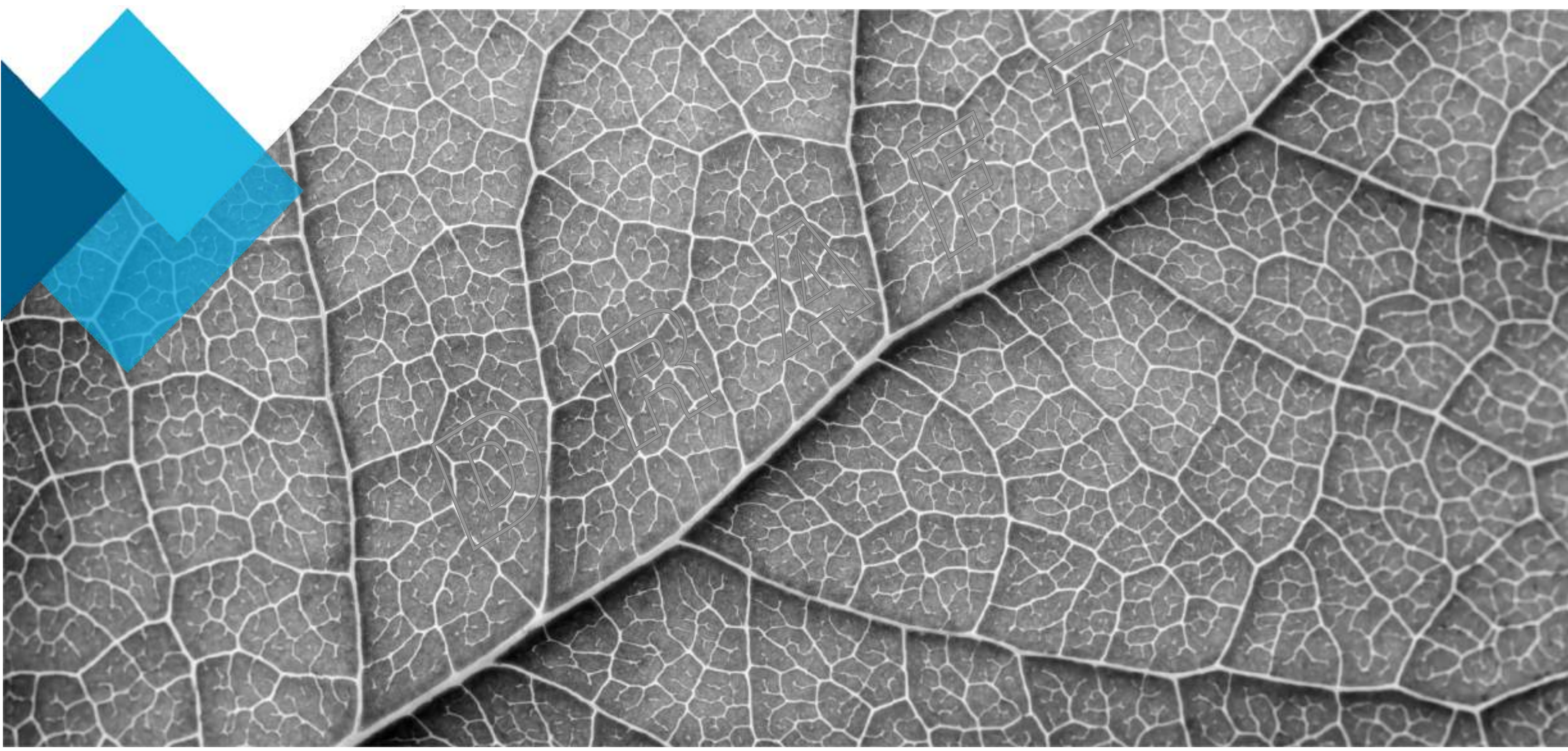
Desktop Baseline Heritage Resources Study

SNC·LAVALIN

Desktop Baseline Heritage Resource Study

Saskatoon Freeway Functional Planning Study

Saskatchewan Ministry of Highways and Infrastructure (MHI)



Environment & Geoscience

6 December 2019

Internal Ref: 659183

Notice to Reader

This report has been prepared and the work referred to in this report has been undertaken by SNC-Lavalin Inc. (SNC-Lavalin), for the exclusive use of Saskatchewan Ministry of Highways and Infrastructure (MHI), who has been party to the development of the scope of work and understands its limitations. The methodology, findings, conclusions, and recommendations in this report are based solely upon the scope of work and subject to the time and budgetary considerations described in the proposal and/or contract pursuant to which this report was issued. Any use, reliance on, or decision made by a third party based on this report is the sole responsibility of such third party. SNC-Lavalin accepts no liability or responsibility for any damages that may be suffered or incurred by any third party as a result of the use of, reliance on, or any decision made based on this report.

The findings, conclusions, and recommendations in this report (i) have been developed in a manner consistent with the level of skill normally exercised by professionals currently practicing under similar conditions in the area, and (ii) reflect SNC-Lavalin's best judgment based on information available at the time of preparation of this report. No other warranties, either expressed or implied, are made with respect to the professional services provided to Saskatchewan Ministry of Highways and Infrastructure (MHI) or the findings, conclusions, and recommendations contained in this report. The findings and conclusions contained in this report are valid only as of the date of this report and may be based, in part, upon information provided by others. If any of the information is inaccurate, new information is discovered, or project parameters change, modifications to this report may be necessary.

This report must be read as a whole, as sections taken out of context may be misleading. If discrepancies occur between the preliminary (draft) and final version of this report, it is the final version that takes precedence. Nothing in this report is intended to constitute or provide a legal opinion.

SNC-Lavalin disclaims any liability to third parties in respect of the use of (publication, reference, quoting, or distribution), any decision made based on, or reliance on this report or any of its contents.

Executive Summary

SNC-Lavalin Inc. (SNC-Lavalin) completed a desktop baseline heritage resource study on behalf of the Saskatchewan Ministry of Highways and Infrastructure (MHI) to support the Saskatoon Freeway Functional Planning Study. This heritage resource study includes a desktop analysis of known heritage resources and areas of archaeological potential that may be affected by the proposed project.

Based on the number of known archaeological sites in the Study Area (176), one might expect as many as 11 or 12 archaeological sites ignoring environmental factors specific to the proposed route. Factors to be considered that could affect this number include the relative proximity of Wanuskewin Heritage Park, an area that includes a very high site density. The extent to which this site density extends beyond the park area is not known, nor whether it extends to the southeast side of the river. Another factor is that the proposed route crosses the South Saskatchewan River only once, while the river extends across the entire Study Area.

The proposed freeway corridor passes through 37 quarter sections that have been identified by the Heritage Conservation Branch (HCB) as Heritage Sensitive, approximately 26% of the quarter sections the corridor crosses. The heritage sensitivity rating, however, only addresses the potential for land to contain Precontact Period heritage sites. The review of the Homestead records for the route identified at least 109 unique homestead applications in lands within the proposed freeway corridor. Some of these may relate to EuroCanadian heritage sites that may require reporting and assessment.

The proposed freeway corridor passes through areas that have the potential to contain heritage resources ranging from the earliest occupations to more recent homestead sites. Because the route passes through lands that have been identified as Heritage Sensitive by the HCB, a project referral to the HCB is required. This referral will initiate a review of the project and potential impacts to heritage resources by the HCB which will issue either project clearance or requirements for further assessment.

The presence of a concentration of important heritage resources at Wanuskewin Heritage Park highlights the potential of some portions of the proposed corridor to affect heritage resources. Some of these heritage resources may be sufficiently significant to require extensive mitigation or even require avoidance, and this can affect both the project design and timetable. Heritage assessment of the proposed freeway corridor should be undertaken early in the planning and design process to avoid potential delays.

Abbreviations, Acronyms, and Glossary

Term	Definition
Artifact	An object modified by humans.
Artifact find	An archaeological site containing five or fewer artifacts.
Artifact scatter	An archaeological site containing six or more artifacts.
BP	Before present. In archaeological terms, dates are calculated using 1950 CE as a base.
Burial	Complete or partial remains of a human skeleton, with or without associated grave goods.
CE	Common Era.
Feature	An arrangement of artifacts or stones representing an activity area such as a cairn, tipi ring, or hearth.
Historic Period	The Historic Period refers to the approximate time of recorded European contact with indigenous Americans.
Homestead	An Historic Period site likely dating between 1872 and 1930 relating to the establishment of homesteads under the *Dominion Lands Act.*
NFW	No further work recommended.
HCB	Heritage Conservation Branch, Saskatchewan Parks, Culture and Sport.
Medicine Wheel	A stone feature consisting of at least two of the following: a large central cairn, a stone ring(s), or radiating lines of stone.
Precontact Period	Includes all archaeological sites dating to before European contact with indigenous Americans; in Saskatchewan, approximately between 11,000 BP and 1,750 CE.
RM	Rural Municipality.
Stratified	Heritage sites that contain more than one cultural deposit separated into distinct depositional layers.
SKCDC	Saskatchewan Conservation Data Centre.
SRC	Saskatchewan Research Council.

Units

Term	Definition
%	percent
cm	centimetre
ha	hectare
km	kilometre
m	metre

SNC·LAVALIN

Table of Contents

Tables

Figures

Attachments

1 Introduction

SNC-Lavalin Inc. (SNC-Lavalin) completed a desktop baseline heritage resource study on behalf of the Saskatchewan Ministry of Highways and Infrastructure (MHI) to support the Saskatoon Freeway Functional Planning Study. This heritage resource study includes a desktop analysis of known heritage resources and areas of archaeological potential and will support the route selection.

The proposed project is an approximately 55 km long freeway that will circle the majority of the City of Saskatoon. Sections of the project are located within City property, while other portions are in the RM of Corman Park No. 344 (**Figure 1.1**). The proposed freeway will connect at Highway 11 to the south and Highway 60 to the southwest. Currently MHI has identified a 500 m wide corridor for the proposed freeway, and the functional planning study will select a preferred right-of-way within the corridor.

1.1 Regulatory Context

In Saskatchewan, heritage resources are managed by the Heritage Conservation Branch (HCB) of Saskatchewan Parks, Culture and Sport under the authority of The Heritage Property Act. The Act defines heritage property as: archaeological objects; paleontological objects; and any property of interest for its architectural, historical, cultural, environmental, archaeological, paleontological, aesthetic, or scientific value. In practice, heritage properties include historic structures, archaeological sites, and paleontological sites.

The Heritage Sensitivity database identifies lands as either Heritage Sensitive or Not Heritage Sensitive. A quarter section of land is deemed to be Heritage Sensitive based on the presence of any one of several criteria such as: native prairie, proximity to a significant topographic feature such as a river valley, or the presence of a known heritage site. For lands that are Heritage Sensitive, the HCB requires the project proponent to refer the proposed development to the HCB for review. The HCB may then require a Heritage Resource Impact Assessment (HRIA). Lands that are deemed to be Not Heritage Sensitive require no further heritage resource assessment and are granted clearance under The Heritage Property Act. A project referral and HRIA are outside the scope of this study.

The Archaeological Site Inventory includes the site inventory forms for all archaeological sites recorded in the province. These forms contain information on a number of factors describing the heritage resource including site location, site type, age, the kind and number of site features, and artifacts observed and collected, among others. This database records the fundamental data used to manage heritage resources in Saskatchewan.

The Archaeological Permit Report Database includes most of the archeological reports that have been prepared since the onset of heritage legislation in Saskatchewan in 1980. The database shows the project footprint for proposed developments and the area assessed for each project. This database records lands where archaeological assessments have been conducted and reviewed by the HCB. The data is used to manage the clearance process for future development.

1.2 Study Area

The baseline heritage resources Study Area was an informal and arbitrary area chosen to include the proposed freeway corridor plus a larger area of terrain similar to the project area. The Study Area boundary is shown in **Figure 1.1**. The Study Area is 28.8 km (18 miles) square and contains 853.4 km^2 (329.5 miles^2) of land.

1.3 Environmental Setting

1.3.1 Terrain and Surficial Geology

The Study Area is in the Moist Mixed Grassland Ecoregion of the Prairie Ecozone (Acton et al. 1998). The landscape in this area is generally undulating, with local relief typically less than three metres, except in the Minichinas Hills where some rolling hills are found (Acton and Ellis 1978). The South Saskatchewan River valley is a relatively deep valley which contains the lowest elevations in the area. Surficial deposits are primarily glacio-fluvial and glacio-lacustrine in origin, deposited during the most recent glacial period. In most locations in the region, the landforms have remained relatively unchanged since the glaciers retreated, and only local runoff and wind erosion have influenced the area since that time. The South Saskatchewan River valley is an exception, as recent alluvial and colluvial soil deposits are present in the floodplains and valleys of this river.

1.3.2 Land Cover

The results of the land cover mapping exercise (SNC-Lavalin 2019) are presented in **Table 1.1**. About 75% of the land is cropland that has been or is being cultivated. Cultivation can have significant impacts on shallowly buried archaeological deposits; however, areas disturbed by cultivation have the potential for more deeply buried and possibly stratified heritage deposits. Habitable lands that are more or less undisturbed (Hardwood Open, Native Dominant Grassland, and Tall Shrub) make up approximately 21% of the Study Area. The extent of potential disturbance on these lands is not clear, but it is these lands that have the best potential for undisturbed shallowly buried heritage deposits.

Table 1.1 Land Cover in the Study Area

	Area in Study Area(ha)	% of Study Area	Area in Freeway Corridor (ha)
Cultivated land	48,991	57.4	
Farmstead	12,332	14.4	
Hardwood open	2,825	**3.3**	
Hay crop (forage)	2,159	2.5	
Herbaceous fen	168	0.2	
Marsh	1,635	1.9	
Mud/sand/saline	238	0.3	
Native dominant grassland	14,087	**16.5**	
Pasture (seeded grassland)	270	0.3	
Tall shrub	1,170	**1.4**	
Waterbody	1,469	1.7	

1.3.3 Wildlife in the Moist Mixed Grassland Ecoregion

A diversity of wildlife is supported by the Landscape Areas within the Moist Mixed Grassland Ecoregion. The border of the Aspen Parkland Ecoregion is located approximately 10 km north of the Study Area, so there is likely considerable habitat for wildlife found in both ecoregions (Acton et al. 1998). Upwards of 55 mammal species have been found in the Ecoregions. Common mammals occurring in open, grassland habitat and the transitional zone between ecoregions include: coyote, porcupine, white-tailed jackrabbit, striped skunk, white-tailed deer, mule deer, deer mouse, Richardson’s ground squirrel, red fox, and American badger. Although not present now, bison would have been common in the area and would have been a significant resource. The fragmented deciduous forest habitat of the Aspen Parkland Ecotone supports less common mammals like moose, cougar, and black bear. Mammals associated with wetland habitat and other water features include North American beaver, North American river otter, and muskrat.

A total of 320 migratory and resident birds have been recorded in the Moist Mixed Grassland and Aspen Parkland Ecoregions, with considerable overlap of the species in the Ecoregions (Acton et al. 1998). Common birds found in open, grassland habitat include northern harrier, American crow, horned lark, clay-coloured sparrow, and sharp-tailed grouse. Birds associated with aspen stands and deciduous forest habitat include ruffed grouse, great horned owl, red-tailed hawk, common raven, least flycatcher, hairy woodpecker, and yellow warbler. Wetlands and lentic water features are predominantly populated by waterbirds, such as northern shoveler*,* blue-winged teal, killdeer, black tern, Wilson’s snipe, eared grebe, sora, and American avocet (SKCDC 2019). Temporary, semi-permanent, and permanent wetlands in the Study Area are used by waterfowl as summer breeding areas and spring/fall staging areas. Some of the migrant waterfowl and upland game such as grouse may have been food resources for pre-contact people. Other smaller birds may have been utilized for their feathers or bones for ceremonial or ornamental purposes.

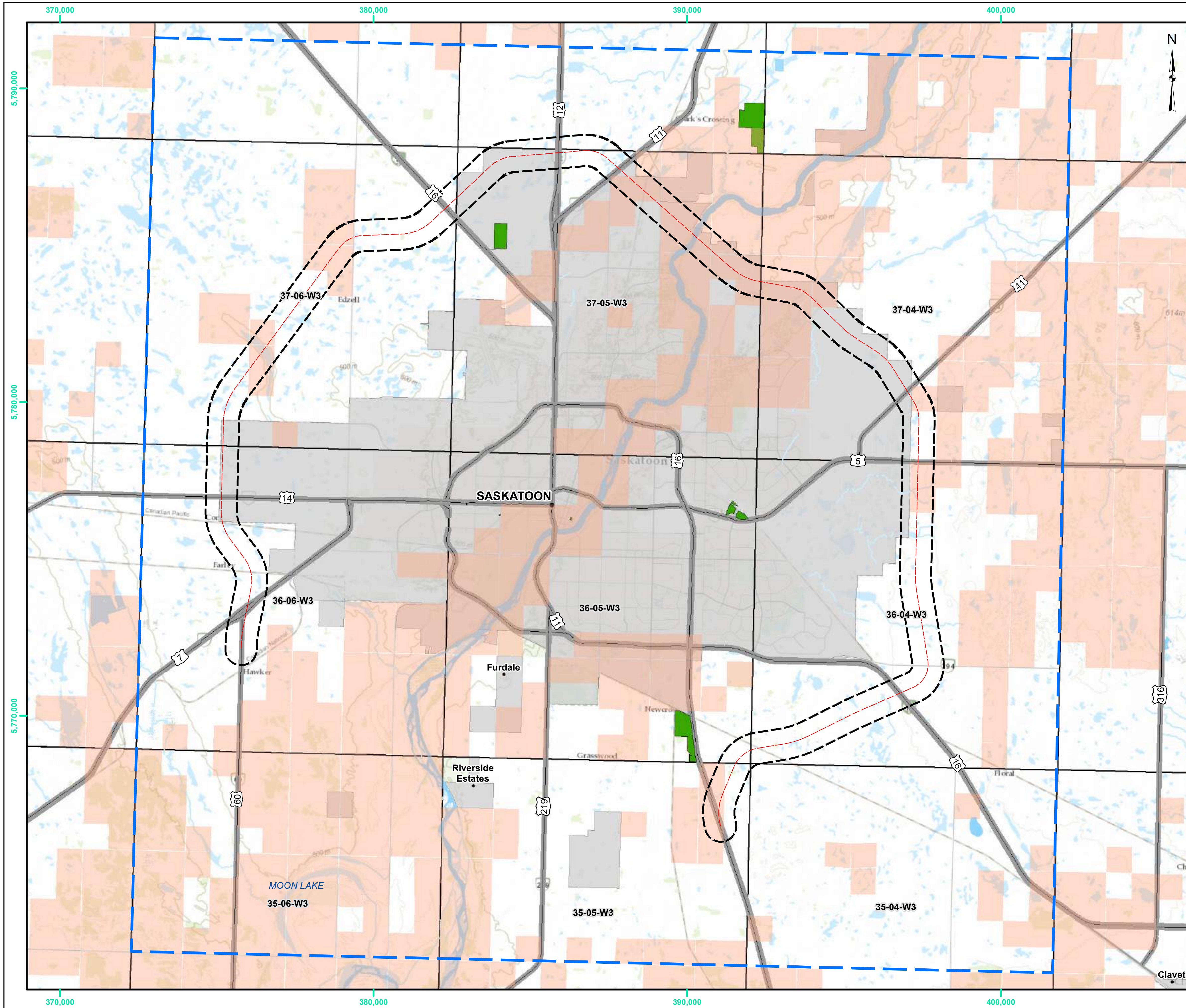
2 Desktop Study Methods

A desktop heritage resources overview study was conducted to collect available information for heritage resources in and around the Study Area.

The HCB maintains three main databases relating to heritage resources in the province: the Heritage Sensitivity database, the Archaeological Site Inventory, and the Archaeological Permit database. These databases contain information on most of the heritage work that has been done in Saskatchewan. These databases were searched for relevant information.

The Saskatchewan Genealogical Society (SGS) cemetery index was searched to obtain records of cemeteries within, or directly adjacent to, proposed freeway corridor. The SGS database contains the name and location of over 3,486 cemetery and burial sites in the province. The collecting of burial records for these cemeteries is an ongoing project of the SGS (SGS 2019).

The Saskatchewan Homestead Index (SHI) was searched to obtain records of homestead files within the Study Area. From this data, homesteads on lands overlapping the freeway corridor were extracted. The Saskatchewan Homestead Index is a file locator database to the homestead files at the Saskatchewan Archives. It contains 360,000 references to those men and women who, from 1872 to 1930, under the terms of the Dominion Lands Act, took part in the homestead process in the area now known as Saskatchewan (SHI 2019). Some of these files may have the potential to be Contact period heritage sites which are currently not catalogued by the HCB.



LEGEND

- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- HERITAGE SENSITIVE LOCATION
- FIRST NATION LAND
- URBAN MUNICIPALITY
- PRELIMINARY FREEWAY ALIGNMENT 500 METER CORRIDOR
- HERITAGE STUDY AREA
- TOWNSHIP

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. TOPOGRAPHIC FEATURES OBTAINED FROM CANVEC V12.0 DATASET, NATURAL RESOURCES CANADA EARTH AND SCIENCES SECTOR CENTRE FOR TOPOGRAPHIC INFORMATION, 2013-09-30.
5. HIGHWAYS AND ROADS OBTAINED FROM THE NATIONAL ROAD NETWORK SASKATCHEWAN EDITION 9.0 DATASET, 2017-06-05.
6. RAILWAYS OBTAINED FROM THE NATIONAL RAILWAY NETWORK SASKATCHEWAN EDITION 2.0 DATASET, 2016-10-06.
7. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
8. HERITAGE CONSERVATION BRANCH, SASKATCHEWAN PARKS, CULTURE AND SPORT. THE DATASET INDICATES WHETHER ANY PORTION OF A QUARTER-SECTION IS HERITAGE SENSITIVE. IN THIS CASE, HERITAGE SENSITIVE DESCRIBES THE POTENTIAL OF A QUARTER TO CONTAIN INTACT ARCHAEOLOGICAL OR PALAEONTOLOGY SITES.
9. FIRST NATION LEGISLATED BOUNDARIES OBTAINED FROM ISC.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
PA	2019 08 09	ISSUED FOR REVIEW	JL	KVG		

0 1,250 2,500 5,000 METRES

SCALE: 1:120,000

SNC · LAVALIN

CLIENT: SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION: SASKATOON FREEWAY

TITLE: HERITAGE RESOURCE OVERVIEW STUDY AREA

DATE	2019 08 09	DWG No.	659183-0000-4EDD-0015	FIG No.	1.1	REV	PA

SIZE 11x17

Path: \\sll1653\projects qms\SMH\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Heritage\659183-0000-4EDD-0015 Heritage Resource Overview.mxd

3 Results

3.1 Heritage Sensitivity

The heritage sensitivity results are presented in **Figure 1.1**. Of the 1,296 quarter sections located in the Study Area, 425 (32.8%) are Heritage Sensitive. The remaining 871 (67.2%) are Not Heritage Sensitive. The proposed freeway corridor will cross approximately 141 quarter sections (excluding very small fragments), including 37 quarters (26%) that are identified as Heritage Sensitive. The Heritage Sensitive quarters are scattered along the route with a definite concentration near the Saskatchewan River crossing and Wanuskewin Heritage Park. The slight difference in relative amounts of Heritage Sensitive lands in the Study Area compared with the freeway corridor and buffer indicates that the data from the Study Area is a good analogue for what might be expected in the proposed route.

3.2 Previous Research

The earliest permitted archaeological work in the Study Area under *The Heritage Property Act (1980)* occurred in 1982. Since that time, archaeological work in the area is largely related to subdivision development. **Table 2.1** presents a list of several of the larger subdivision assessments conducted in the Study Area since permitted archaeological work began. Smaller projects have not been included in **Table 2.1,** but the footprints of these studies are included in **Figure 2.1**.

Walker (1982) conducted an archaeological survey of the Tipperary Creek area after the property had been acquired by the Meewasin Valley Authority. The Tipperary Creek survey area, part of which is now known as Wanuskewin Heritage Park, was composed of 420 acres (170 ha) of cultivated land along and above Tipperary Creek, a tributary on the north/west side of the South Saskatchewan River. At the time of the work, the Tipperary Creek survey area is several kilometres north of the residential area of Saskatoon, but a portion of the survey is now located within the proposed freeway corridor.

The Tipperary Creek survey identified 17 heritage sites (Walker 1982: iii), including 15 prehistoric sites and two historic period sites. Wanuskewin Heritage Park is now listed on the National Register of Historic Sites (Historic Places 2019) and is under consideration as a UNESCO World Heritage site. The park contains sites representing at least 6,000 years of cultural history on the northern Plains including camp sites, tipi rings, stone cairns, bison kill sites, and a medicine wheel.

The Tipperary Creek survey identifies a pattern of land use that is relevant to the present review. As the National Register notes: “The pattern of land use is clear, being richest along the riverbanks and disappearing as the valley becomes shallower” (Historic Places 2019).

In 1983, Ernie Walker conducted the Saskatoon Perimeter Archaeological Survey on many land parcels around the perimeter of Saskatoon totalling 11 square miles (28.5 km^2). At that time, no archaeological work had been conducted on any of the parcels and no archaeological sites were known to exist on the property (Walker 1990). Over 90% of the area surveyed was under cultivation. Cultivated lands were walked in transects with 30 m spacing and available exposures were examined. Shovel testing was not done. In uncultivated lands, shovel tests were excavated at 20 m or 50 m intervals.

The Saskatoon Perimeter survey identified one archaeological site and nine “find spots” due to the provincial practice at the time of separating archaeological sites with larger accumulations of cultural material from those with fewer artifacts. Standard practice now is to record all archaeological finds as sites, with the possible exception of single non-retouched artifacts such as a lithic flake or bone fragment.

Later studies in the area show a clear pattern of following the growth of the city as it expanded outwards. However, few of these studies intersect with the freeway corridor. The lack of intersection between previous archaeological studies and the proposed freeway corridor limits the direct application of this data to the present review, but it can be used as a guide to expected future results.

Walker’s original perimeter study (Walker 1983) provides the best analogue to the present review. Walker’s study selected study sites in a roughly circular perimeter around the city in areas seen as potential locations for future development. These sites are now well inside the proposed corridor, but the circular pattern provides a direct analogy to the present study.

Ramsay (1998) reports on the assessment of the Eagle Ridge Estates subdivision in SE10-37-4-W3. This quarter is within 150 m of the northeast edge of the proposed freeway corridor and is along the edge of the Strawberry Hills uplands. This quarter was largely in cultivation with a small portion of intact native prairie. Three sites were assessed, all in the cultivated areas of the quarter. One site was a previously recorded artifact find, the other two were newly identified artifact finds. All three sites were shovel tested. No intact cultural deposits were identified and no further work was recommended.

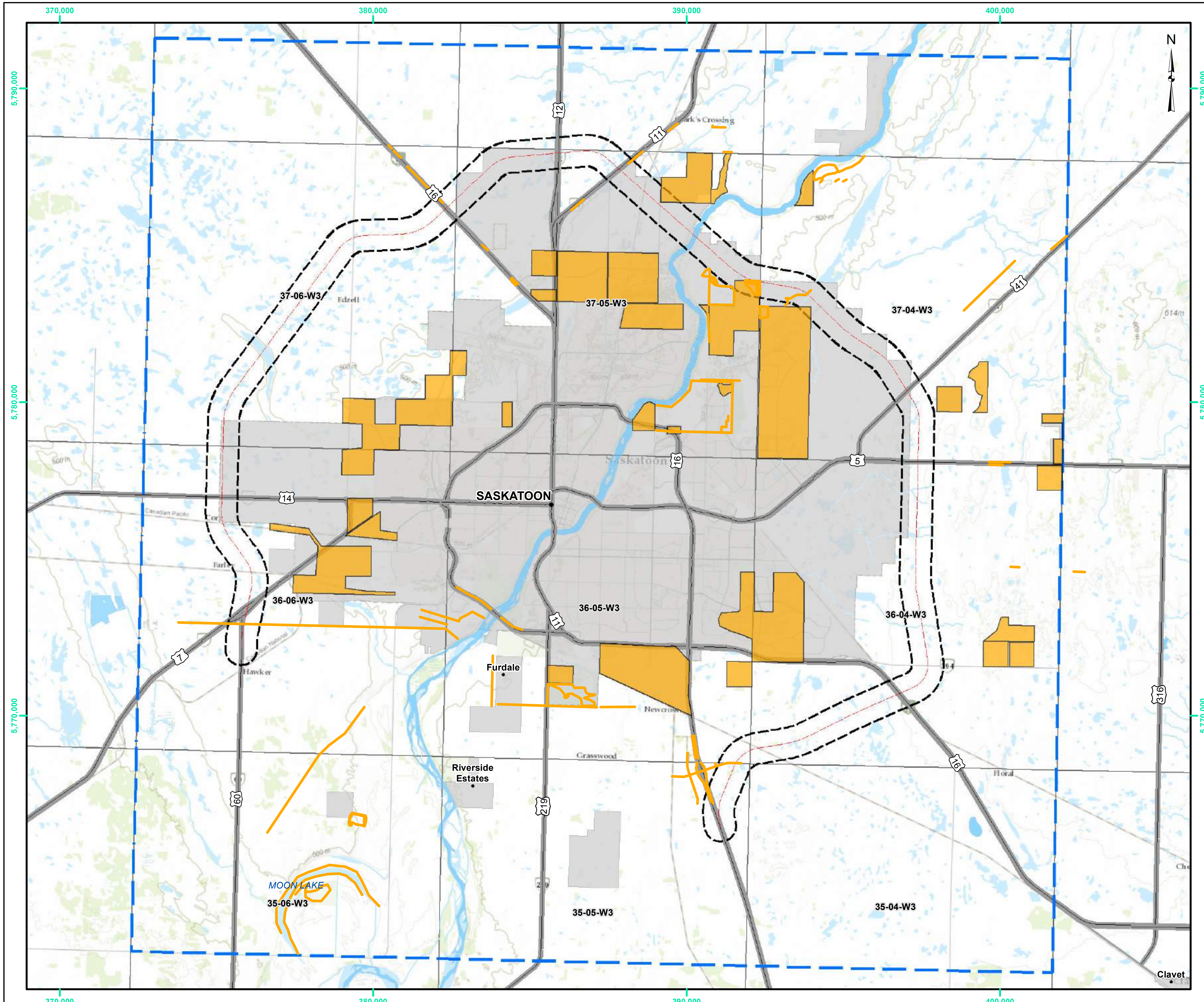
Markowski and Wolfe (2013) assessed a portion of W½ 11-37-4-W3 in advance of a proposed residential subdivision. This project is also in the Minichinas Upland near the northeast part of the freeway route. Slightly more than half of the development area was native prairie and was assessed. The uncultivated portion was not assessed. One archaeological site, FbNo-9, had previously been reported on the property. Native portions of the study area were assessed using pedestrian traverses and shovel testing. The presumed location of FbNo-9 was shovel tested but was not relocated. No further work was recommended, and the project was granted clearance to proceed.

Novecosky (2004) assessed portions of NE13-36-4-W3 and NW14-36-4-W3 just to the east of the southeast corner of the proposed freeway. The area assessed was apparently native prairie in the Minichinas Upland. The terrain is hummocky with many small sloughs interspersed through the Aspen Parkland, a landform that is normally thought to have high archaeological potential. The area was walked and shovel tested with negative results. The project received clearance to proceed without further concerns for heritage resources.

Huynh (2014) assessed a portion of SE14-36-4-W3 in the Minichinas Upland about 1.2 km east of the freeway route. Approximately one third (18 ha) of the quarter section was native prairie and was assessed. The remainder was cultivated and was not surveyed. No heritage resources were identified during the assessment, despite the fact the area was deemed to have a high potential to contain archaeological deposits. Clearance for the project was granted.

Table 2.1 Selected Archaeological Studies in the Study Area

Permit	Permit Holder	Project	Results	Reference	Comment
82-000-05	Linnamae, U.	*Archaeological survey of proposed 1980 & 1981 suburban development areas of the City of Saskatoon and the Silverwood Site*	FbNp-4	Linnamae 1982	Recommend test excavations
82-026	Walker, E.G.	*Archaeological resource assessment: The Tipperary Creek Project*	17 Sites	Walker 1982	Avoidance and mitigation
83-017	Walker, E.G.	*Saskatoon perimeter archaeological resource assessment*	FaNp-7	Walker 1983	Test excavation
93-000	Jones, Tim E.H.	*Saskatoon Natural Grasslands Archaeological Survey*		Jones 1993	Further assessment
96-025	Ramsay A.M. and C.L. Ramsay	*Heritage assessment of a proposed residential development northeast of Saskatoon, Saskatchewan, (SE¼ and NE¼ of 31-37-4-W3M) HRIA Permit #96-025*	FbPn-62 to 68	Ramsay et. al 1996	No further work recommended
98-030	Ramsay, C.L.	*Heritage resource impact assessment of a proposed subdivision for Eagle Ridge Estates Inc. at SE¼-10-37-4-W3M*	FaNo-10, 16, 17	Ramsay 1998	No further work
01-031	Paquin, Todd A.	*Heritage resources impact assessment program, Tower Hill Developments, Discover Ridge Subdivision, Permit No. 01-031*	FaNo-19	Paquin. 2001	No further work
01-038	Friesen, Nathan	*Heritage resource impact assessment of highway re-alignment and interchange at Grasswood Road and Highway 11*	FaNp-29	Friesen 2001	380 m from freeway corridor; no further work
04-090	Novecosky, Brad	*Heritage resources impact assessment program, Tower Hill Ranch Ltd. Hidden Ridge Subdivision Project, Permit No. 04-90*		Novecosky 2004	No further work
08-066	Enns-Kavanagh, K.	*Final report on the Heritage Resources Impact Assessment of NE-14-37-5-W3M*	FbNp-78	Enns-Kavanagh 2008	Site avoidance and mitigation
09-088	Enns-Kavanagh, K.	*Final Report on the monitoring of depression cleanup at FbNp-78, the Hutchins Homestead, in NE-14-37-5-W3M*		Enns-Kavanagh 2009	No recommendations
11-100	Schwab, M.	*Final report, heritage resources impact assessment of proposed Greenbryre Estates, HRIA Permit #2011-11*		Schwab 2011	No further work
13-224	Markowski, M. and K. Wolfe	*Associated Engineering, Eagle Heights Country Estates, W½ 11 37 4 W3M, heritage resources impact assessment, Permit No. 13-224*		Markowski and Wolfe 2013	No further work
13-097	Hein, Lisa	*HRIA of the proposed City of Saskatoon North Commuter Bridge and Central Avenue Extension Project*	FbNp-83, FbNp-84	Hein 2013	Within corridor Test excavations
14-129	Huynh, Tam	*Permit No. 14-129, Ridgewood Estates Subdivision SE 14-36-4 W3M, heritage resources impact assessment*		Huynh 2014	No further work recommended
17-050	Stead, Lauren	*Heritage Resource Detailed Assessment: FbNp-82, FbNp-83, and FbNp-84 – University Heights Neighbourhood 3*	FbNp-82, 83, 84	Stead 2017	Test excavations at FbNp-83



LEGEND

- LINEAR HERITAGE RESOURCE IMPACT ASSESSMENT
- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- AREAL HERITAGE RESOURCE IMPACT ASSESSMENT
- URBAN MUNICIPALITY
- PRELIMINARY FREEWAY ALIGNMENT 500 METER CORRIDOR
- HERITAGE STUDY AREA
- TOWNSHIP

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. TOPOGRAPHIC FEATURES OBTAINED FROM CANVEC V12.0 DATASET, NATURAL RESOURCES CANADA EARTH AND SCIENCES SECTOR CENTRE FOR TOPOGRAPHIC INFORMATION, 2013-09-30.
5. HIGHWAYS AND ROADS OBTAINED FROM THE NATIONAL ROAD NETWORK SASKATCHEWAN EDITION 9.0 DATASET, 2017-06-05.
6. RAILWAYS OBTAINED FROM THE NATIONAL RAILWAY NETWORK SASKATCHEWAN EDITION 2.0 DATASET, 2016-10-06.
7. LINEAR AND AREAL HERITAGE RESOURCE IMPACT ASSESSMENT DATA OBTAINED FROM THE HERITAGE CONSERVATION BRANCH OF SASKATCHEWAN.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
PA	2019 08 09	ISSUED FOR REVIEW	JL	KVG		

0 1,250 2,500 5,000 METRES

SCALE: 1:120,000

SNC · LAVALIN

CLIENT
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE

PROJECT LOCATION
SASKATOON FREEWAY

TITLE
ARCHAEOLOGICAL PROJECTS IN THE STUDY AREA

DATE	2019 08 09	DWG No.	659183-0000-4EDD-0016	FIG No.	2.1	REV	PA

SIZE 11x17

Path: \\SLI1653\Projects QMS\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Heritage\659183-0000-4EDD-0016 Archaeological Projects.mxd

Hein (2013) conducted an assessment on the proposed route of McOrmon Drive as it approaches the South Saskatchewan River northwest of Saskatoon (Hein 2013). This work identified two historic homesteads (FbNp-83 and 84) located in **LOCATION REDACTED AS PER HCB REQUIREMENTS**. These sites are within the 500 m freeway corridor. This assessment consisted of a number of linear transects near and across the proposed Saskatoon Freeway; one follows the northwest edge of the Swales.

This work was followed up by Stead (2017) who returned to these sites as well as another previously recorded homestead, FbNp-82, to further assess these sites. Mapping and testing work were done at the sites and no further work was recommended at FbNp-82 and FbNp-84. Further testing was recommended at FbNp-83. FbNp-83 is about 480 m from the proposed freeway route.

3.3 Heritage Sites

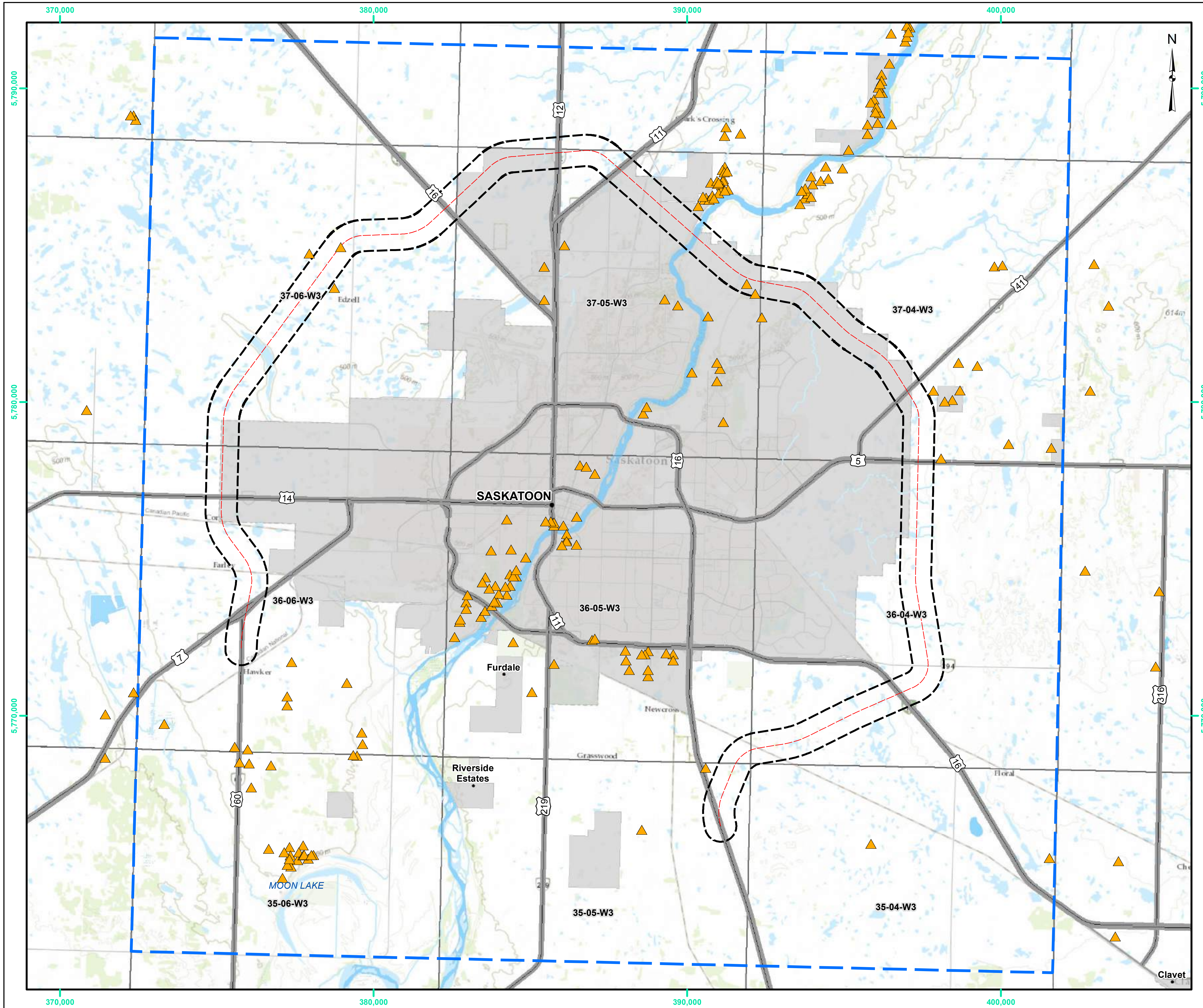
The Study Area contains 176 recorded heritage sites, most of which were identified during impact assessment studies conducted in advance of development, but also includes a smaller number of sites reported prior to regulation or by amateurs and professionals outside of permitted studies. **Table 2.2** presents a summary of these sites grouped by Township and by Chronological Period. Heritage sites have been recorded in all but two of the townships in the Study Area, but this is likely a factor of where archaeological studies have been done rather than indicating an underlying pattern of location. As the table shows, heritage sites recorded in the Study Area span the full range of site type and ages. **Figure 2.2** shows the locations of the known heritage sites in the Study Area. The distribution of these sites exhibits a clear pattern; archaeological site density is much higher along the Saskatchewan River valley. Again, this may result in part from where archaeological studies have been done, but it also likely indicates a pattern of occupation. Experience throughout Saskatchewan indicates that major river systems were a significant attractor for Precontact people and usually exhibit high site density within the first few hundred metres from the river.

Three heritage sites are known to exist within the proposed freeway corridor. FbNq-6 is a lithic scatter site located in **LOCATION REDACTED AS PER HCB REQUIREMENTS**. It was identified in 1965 by an amateur archaeologist. Material collected at that time included two Pelican Lake projectile points, two hafted bifaces, and 18 other lithic artifacts including scrapers and lithic debitage. Pelican Lake artifacts date from the Middle Prehistoric Period, approximately between 3,300 to 1,850 BP. The site has not been professionally assessed.

FbNp-83 and FbNp-84 are Historic Period homestead sites that were identified in **LOCATION REDACTED AS PER HCB REQUIREMENTS** during survey and assessment of the proposed North Commuter Bridge right-of-way (ROW) (Hein, 2013). FbNp-83 was further investigated with test excavations (Stead 2017) which recovered a variety of domestic artifacts including cutlery, glass, metal, and wood fragments. According to the homestead application, the site was occupied at least between 1909 after the application was submitted until 1913 when the land patent was granted. No further details of the occupancy are available. Test excavations were conducted at the site and no further archaeological work is recommended. FbNp-84 contains several depressions believed to be limestone quarries possibly used by the homesteader. The site was mapped, and several depressions were tested. No further work at FbNp-84 was recommended.

Table 2.2 Summary of Archaeological Sites in the Study Area

	Township and Range										
Chronological Period	T35 R4	T35 R5	T35 R6	T35 R3	T36 R3	T37 R4	T37 R5	T37 R6	T38 R4	T38 R5	Grand Total
Eurocanadian				**12**		**1**	**7**		**3**	**1**	**24**
Artifact scatter				3					1		4
Artifact/Feature combination				7		1	2		1		11
Midden				1							1
Multiple feature							3		1		4
Recurrent features							1			1	2
Single feature				1			1				2
Precontact	**2**	**2**	**23**	**38**	**8**	**22**	**28**	**2**	**14**	**2**	**141**
Artifact find	1	2	3	10	2	12	4		4		38
Artifact scatter	1		15	18	5	9	14	2	9	1	74
Artifact/Feature combination			4	10			7		1		22
Burial			1		1						2
Medicine wheel							1				1
Midden							1				1
Recurrent features						1					1
Single feature										1	1
Unknown							1				1
Precontact/Eurocanadian				**3**			**1**	**1**			**5**
Artifact scatter				1				1			2
Artifact/Feature combination				2							2
Single feature							1				1
SSN							1				1
Burial							1				1
Unknown				**4**		**1**					**5**
Artifact scatter				2		1					3
Artifact/Feature combination				1							1
Single feature				1							1
Total	**2**	**2**	**23**	**57**	**8**	**24**	**37**	**3**	**17**	**3**	**176**



LEGEND

- HERITAGE SITE
- PRELIMINARY FREEWAY ALIGNMENT
- HIGHWAY
- URBAN MUNICIPALITY
- PRELIMINARY FREEWAY ALIGNMENT 500 METER CORRIDOR
- HERITAGE STUDY AREA
- TOWNSHIP

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
2. BASE CADASTRAL DATA ADAPTED FROM HER MAJESTY IN RIGHT OF SASKATCHEWAN OR INFORMATION SERVICES CORPORATION OF SASKATCHEWAN, SASKADMIN2016, SASKGRID2016.
3. CADASTRAL BOUNDARIES ARE FOR INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE CONSIDERED SUITABLE FOR LEGAL, ENGINEERING, OR SURVEYING PURPOSES.
4. TOPOGRAPHIC FEATURES OBTAINED FROM CANVEC V12.0 DATASET, NATURAL RESOURCES CANADA EARTH AND SCIENCES SECTOR CENTRE FOR TOPOGRAPHIC INFORMATION, 2013-09-30.
5. HIGHWAYS AND ROADS OBTAINED FROM THE NATIONAL ROAD NETWORK SASKATCHEWAN EDITION 9.0 DATASET, 2017-06-05.
6. RAILWAYS OBTAINED FROM THE NATIONAL RAILWAY NETWORK SASKATCHEWAN EDITION 2.0 DATASET, 2016-10-06.
7. HERITAGE SITE DATA OBTAINED FROM THE HERITAGE CONSERVATION BRANCH OF SASKATCHEWAN.

DISCLAIMER

REFERENCE DRAWINGS

DWG No.	DESCRIPTION

REVISIONS

REV	DATE	DESCRIPTION	DES	DRN	CHK	APP
PA	2019 08 09	ISSUED FOR REVIEW	JL	KVG		

0 1,250 2,500 5,000 METRES

SCALE: 1:120,000

SNC·LAVALIN

CLIENT	PROJECT LOCATION
SASKATCHEWAN MINISTRY OF HIGHWAYS AND INFRASTRUCTURE	SASKATOON FREEWAY

TITLE
HERITAGE SITES IN THE STUDY AREA

DATE	2019 08 09	DWG No.	659183-0000-4EDD-0017	FIG No.	2.2	REV	PA

SIZE 11x17

Path: \\sl1653\projects qms\SMHI\659183_Saskatoon Freeway Functional Planning Study\40_Execution\45_GIS_Dwgs\4.5.1 GIS\Drawings\Heritage\659183-0000-4EDD-0017 Heritage Sites.mxd

3.4 Cemeteries

The Saskatchewan Cemetery Index was reviewed to determine if any known cemeteries are within the proposed freeway corridor. No cemeteries were identified within the proposed freeway corridor.

3.5 Homesteads

The Saskatchewan Homestead Index is a listing of homestead documents in the Saskatchewan Archives. Using the freeway corridor as a filter, the search of the index identified 174 homestead documents on file at the Archives. Of these, a number appear to be duplicated references possibly due to co-applicants or database errors. Excluding duplicate file numbers, there are 109 unique applications for lands along the proposed route. The listing of the Saskatchewan Archives Homestead file numbers including legal locations is included in Attachment I.

The existence of a homestead application file does not necessarily imply that heritage resources are present on a property. However, it indicates that historic period resources may be present and should be investigated. If historical remains are in fact present, the homestead documents are one of the initial sources in determining heritage significance.

4 Summary

Archaeological work in the Study Area has been conducted professionally since the early 1980s. Prior to that, amateur and professional archaeologists recorded sites on an informal basis, often without detailed assessment. Some of these early sites remain in the database with no additional information beyond the original recording and some of these cannot be located more accurately than the quarter section.

In that time, permitted archaeological assessments have examined approximately 6,386 ha, or approximately 7.7% of the total Study Area (82,950 ha). The Study Area contains 176 recorded archaeological sites including both Historic Period sites and Precontact Period sites. These sites date from the Early Precontact Period (possibly as early as 11,000 BP) to more recent Historic Period sites dating to homesteading in the early 1,900s. Many of these sites contain archaeological components dating from multiple periods, so that an Historic Period structure may be standing on much earlier Precontact Period deposits. Many Precontact Period sites were utilized over very long periods of time, as the results of excavations at sites in Wanuskewin Heritage park attest.

The proposed freeway corridor is approximately 55 km long and 500 m wide. Three archaeological sites are known to exist within the corridor. FbNq-6 is a surface lithic scatter of material dating to the Middle and Late Plains Indian Periods (approximately between 7,500 BP to 170 BP) (Epp and Dyck 1983). The other two are Historic Period sites relating to homesteading (FbNp-83 and FbNp-84).

The estimated area within the proposed freeway corridor that has been assessed for heritage resources is approximately 57.2 ha. This number was calculated based on the data provided by HCB for permitted project footprints (**Figure 2.1**). This amounts to approximately 1% of the proposed freeway corridor. Based on the number of known archaeological sites in the Study Area (176), one might expect as many as 11 or 12 archaeological sites ignoring environmental factors specific to the proposed route. Factors to be considered that could affect this number include the relative proximity of Wanuskewin Heritage Park, an area that includes a very high site density. The extent to which this site density extends beyond the park area is not known, nor whether it extends to the southeast side of the river. Another factor is that the proposed route crosses the South Saskatchewan River only once, while the river extends across the entire Study Area.

The proposed freeway corridor passes through 37 quarter sections that have been identified by the HCB as Heritage Sensitive. This is about 26% of the quarters that the route crosses. The heritage sensitivity rating, however, only addresses the potential for land to contain Precontact Period heritage sites. The review of the Homestead records for the route identified at least 109 unique homestead applications in lands within the proposed freeway corridor. Some of these may relate to EuroCanadian heritage sites that may require reporting and assessment.

5 Recommendations

The proposed freeway corridor passes through areas that have the potential to contain heritage resources, ranging from the earliest occupations to more recent homestead sites. Because the route passes through lands that have been identified as Heritage Sensitive by the HCB, a project referral to the HCB is required. This referral will initiate a review of the project and potential impacts to heritage resources by the HCB which will issue either project clearance or requirements for further assessment.

The presence of a concentration of important heritage resources at Wanuskewin Heritage Park highlights the potential of some portions of the proposed freeway route to affect heritage resources. Some of these heritage resources may be sufficiently significant to require extensive mitigation or even require avoidance, and this can affect both the project design and timetable. Heritage assessment of the proposed corridor should be undertaken early in the planning and design process.

6 Closure

SNC-Lavalin Inc. (SNC-Lavalin) prepared this desktop baseline heritage resource study on behalf of the Saskatchewan Ministry of Highways and Infrastructure (MHI) to support the Saskatoon Freeway Functional Planning Study.

Prepared by:

James A. Light, M.A.
Archaeologist

Reviewed by:

Lyndsey MacBride, M.Sc., P.Geo.
Operations Manager, Saskatchewan

Environment & Geoscience
Engineering, Design and Project Management

7 References

Acton, D.F. and Ellis, J.G., 1978. *The Soils of the Saskatoon Map Area (73-B) Saskatchewan*. Saskatchewan Institute of Pedology, Publication S4, Saskatoon, SK.

Acton, D. F., G.A. Padbury, and C.T. Stushnoff, 1998. *The Ecoregions of Saskatchewan*. Canadian Plains Research Centre, Saskatchewan Environment and Resources Management, Regina, SK.

Enns-Kavanagh, K., 2008. *Final report on the Heritage Resources Impact Assessment of NE-14-37-5-W3M.* HCB permit 08-066. A report on file with the Archaeological Resource Management Section, Regina.

Enns-Kavanagh, K., 2009. *Final Report on the monitoring of depression cleanup at FbNp-78, the Hutchins Homestead, in NE-14-37-5-W3M.* HCB permit 09-088. A report on file with the Archaeological Resource Management Section, Regina.

Epp, Henry T. and Ian Dyck, 1983. *Tracking Ancient Hunters: Prehistoric Archaeology in Saskatchewan.* Modern Press, Saskatoon.

Friesen, Nathan, 2001. *Heritage resource impact assessment of highway re-alignment and interchange at Grasswood Road and Highway 11.* A report on file with the Archaeological Resource Management Section, Regina.

Hein, Lisa, 2013. *HRIA of the proposed City of Saskatoon North Commuter Bridge and Central Avenue Extension Project.* HCB permit 12-097. A report on file with the Archaeological Resource Management Section, Regina.

Historic Places, 2019. *Government of Canada National Register of Historic Sites*. https://www.historicplaces.ca/en/rep-reg/place-lieu.aspx?id=15685&pid=0. (accessed July 2019).

Huynh, Tam, 2014. *Permit No. 14-129, Ridgewood Estates Subdivision SE 14-36-4 W3M, heritage resources impact assessment.* A report on file with the Archaeological Resource Management Section, Regina.

Jones, Tim E.H., 1993. *Saskatoon Natural Grasslands Archaeological Survey*. A report on file with the Archaeological Resource Management Section, Regina.

Linnemae, Urve, 1982. *Archaeological survey of proposed 1980 & 1981 suburban development areas of the City of Saskatoon and the Silverwood Site (FbNp-4).* HCB permit 82-000-05. A report on file with the Archaeological Resource Management Section, Regina.

Markowski, Mike and Kara Wolfe, 2013. *Associated Engineering, Eagle Heights Country Estates, W½ 11-37-4 W3M, heritage resources impact assessment, Permit No. 13-224.*

Novecosky, Brad, 2004. *Heritage resources impact assessment program, Tower Hill Ranch Ltd. Hidden Ridge Subdivision Project, Permit No. 04-90.* A report on file with the Archaeological Resource Management Section, Regina.

Paquin, Todd A., 2001. *Heritage resources impact assessment program, Tower Hill Developments, Discover Ridge Subdivision, Permit No. 01-031*. A report on file with the Archaeological Resource Management Section, Regina.

Ramsay, C.L., 1998. *Heritage resource impact assessment of a proposed subdivision for Eagle Ridge Estates Inc. at SE¼-10-37-4-W3M, HCB Permit 98-030*. A report on file with the Archaeological Resource Management Section, Regina.

Ramsay A.M. and C.L. Ramsay, 1996. *Heritage assessment of a proposed residential development northeast of Saskatoon, Saskatchewan (SE¼ and NE¼ of 31-37-4-W3M) HRIA Permit #96-025.* A report on file with the Archaeological Resource Management Section, Regina.

Schwab, Maggie, 2011. *Final report, heritage resources impact assessment of proposed Greenbryre Estates, HRIA Permit #2011-11.* A report on file with the Archaeological Resource Management Section, Regina.

Saskatchewan Conservation Data Centre (SKCDC), 2019. *Saskatchewan Taxa List: Vertebrates*. SKCDC, Regina, SK. URL: http://www.biodiversity.sk.ca/SppList.htm (accessed January 2019).

Saskatchewan Genealogical Society (SGS), 2019. *Cemeteries in Saskatchewan*. http://www.saskgenealogy.com/index.php/cemeteries-in-saskatchewan/. (accessed July 2019).

Saskatchewan Homestead Index (SHI), 2019. http://www.saskhomesteads.com/search.asp. (accessed July 2019).

SNC-Lavalin Inc. (SNC-Lavalin), 2019. *DRAFT Environmental and Regulatory Review, Saskatoon Freeway Functional Planning Study.* Prepared for the Saskatchewan Ministry of Highways and Infrastructure, Regina. December 2019.

Stead, Lauren, 2017. *Heritage Resource Detailed Assessment: FbNp-82, FbNp-83, and FbNp-84 – University Heights Neighbourhood 3. Permit No. 17-050*. A report on file with the Archaeological Resource Management Section, Regina.

Walker, E.G., 1982. *Archaeological resource assessment: The Tipperary Creek Project*. A report on file with the Archaeological Resource Management Section, Regina.

Walker, E.G.,1983. *Saskatoon perimeter archaeological resource assessment*. A report on file with the Archaeological Resource Management Section, Regina.

Walker, Ernest G., 1990. *Saskatoon Perimeter Archaeological Resource Assessment. HCB Investigation Permit No 83-1.* A report on file with the Archaeological Resource Management Section, Regina.

Attachment I

Homestead Data

File Number	Name	Q	Sec.	T	R	M
166726	Lasher, Simeon Martin	NE	4	36	4	W3
370-30	Lasher, Simeon Martin	NE	4	36	4	W3
485491	Lasher, David William	NW	4	36	4	W3
597169	Fiddell, William H.	SE	4	36	4	W3
597169	Lasher, David W.	SE	4	36	4	W3
597169	Lasher, Samuel M.	SE	4	36	4	W3
127712	Temperance Colonization Society	SE	4	36	4	W3
597169	Temperance Colonization Society	SE	4	36	4	W3
1432275	Searles, Frederick James	SE	4	36	4	W3
676421	Floral School District No. 688	SW	4	36	4	W3
676421	Lasher, David William	SW	4	36	4	W3
037408A	Richardson, George	NE	6	36	4	W3
569600	Tulloch, Charles H.	NW	6	36	4	W3
569600	Tupper, Haynes Alvin	NW	6	36	4	W3
841629	Tupper, George Viker	SE	6	36	4	W3
944623	Clark, J. Wesley	SW	6	36	4	W3
944623	Clark, John Thomas	SW	6	36	4	W3
1150776	Patience, Herbert Lorne	NE	10	36	4	W3
679186	Hoge, William	NW	10	36	4	W3
685096	Frazer, George Robert	SE	10	36	4	W3
146323A	Patience, William Uriah	SW	10	36	4	W3
655899	Hunt, Isaac L.	NE	22	36	4	W3
1327635	Lewis, George E.	NE	22	36	4	W3
771692	Hunter, William W.	NW	22	36	4	W3
632503	Winmill, William George	SE	22	36	4	W3
632503	Wilcox, Arthur William	SE	22	36	4	W3
602133	Ross, Vital	SW	22	36	4	W3
602133	Kershaw, William	SW	22	36	4	W3
620060	Evans, Robert Hammersley	NE	28	36	4	W3
620060	Winmill, Myron Thomas	NE	28	36	4	W3
683504	Clement, George Thomas	NW	28	36	4	W3
537194	Evans, John	SE	28	36	4	W3
1249820	Taylor, Alfred	NE	34	36	4	W3
869321	Sutherland, Donald George	NW	34	36	4	W3
829224	Rose, Daniel	SE	34	36	4	W3
829224	Witt, Windsor Charles	SE	34	36	4	W3
829224	Freeborn, Joseph Allen	SE	34	36	4	W3
803376	Welker, Dennis	SW	34	36	4	W3
658331	Kirkpatrick, Ernest A.	NW	16	36	6	W3
658331	Kirkpatrick, Walter Lee	NW	16	36	6	W3
821835	Barber, Wallace Herbert	SE	16	36	6	W3
536231	Kirkpatrick, Wilbur Allan	SW	16	36	6	W3

File Number	Name	Q	Sec.	T	R	M
1845159	Tinant, Henry	NW	17	36	6	W3
426662	Hope, Edward Alexander	NW	20	36	6	W3
426664	King, D.S.	NW	20	36	6	W3
318877	Smith, Henry	NE	28	36	6	W3
164902	Hocking, Martin	NW	28	36	6	W3
332765	Smith, Henry	NW	28	36	6	W3
164902	Smith, Charles Stephen	S	28	36	6	W3
164902	Smith, William Henry	S	28	36	6	W3
164902	Canadian Pacific Railway	SW	28	36	6	W3
403227	Lusk, William Charles	N	32	36	6	W3
403227	Jackson, James	NE	32	36	6	W3
403227	Lusk, David	NE	32	36	6	W3
005532A	Bennett, Robert	NW	32	36	6	W3
516794	Lusk, David	SW	32	36	6	W3
317-49	Hunter, William	SW	4	37	4	W3
181284	Hunter, William	SW	4	37	4	W3
1502700	Mighton, Abigail (Mrs.)	NE	10	37	4	W3
957816	Welker, James Marion	NW	10	37	4	W3
1313278	Mighton, Joseph Alexander	SE	10	37	4	W3
1228041	Schmidt, Ernest Herman	SW	10	37	4	W3
725391	Murphy, William	NE	16	37	4	W3
725391	Sommerfeld, Paul L.	NE	16	37	4	W3
725391	Summerfeld, Paul L.	NE	16	37	4	W3
725391	Murphy, William	NE	16	37	4	W3
725391	Sommerfeld, Paul L.	NE	16	37	4	W3
725391	Summerfeld, Paul L.	NE	16	37	4	W3
127712	Branley, John L.	NW	16	37	4	W3
663509	Brawley, J.L.	NW	16	37	4	W3
663509	Royal Bank of Canada	NW	16	37	4	W3
127712	Little, George Thomas	NW	16	37	4	W3
362840	Temperance Colonization Society	NW	16	37	4	W3
894053	Temperance Colonization Society	NW	16	37	4	W3
127712	Branley, John L.	NW	16	37	4	W3
663509	Brawley, J.L.	NW	16	37	4	W3
663509	Royal Bank of Canada	NW	16	37	4	W3
127712	Little, George Thomas	NW	16	37	4	W3
362840	Temperance Colonization Society	NW	16	37	4	W3
894053	Temperance Colonization Society	NW	16	37	4	W3
692874	McDonald, David Marshall	SW	16	37	4	W3
692874	McDonald, David Marshall	SW	16	37	4	W3
362840	Little, George Thomas	NW	17	37	4	W3
362840	Little, George Thomas	NW	17	37	4	W3

File Number	Name	Q	Sec.	T	R	M
1656109	Mosley, Daniel Albert	NW	19	37	4	W3
2861360	Rabenberg, Martha (Mrs.)	SE	19	37	4	W3
1685339	Ketchum, Jesse	SW	19	37	4	W3
127712	Richardson, Thomas William	E	20	37	4	W3
1612403	Blackley, David	NE	20	37	4	W3
1612403	Stephenson, George W.	NE	20	37	4	W3
127712	Stephenson, George William	NE	20	37	4	W3
1161348	Anderson, Thomas Edward	NW	20	37	4	W3
127712	Blackley, David	SE	20	37	4	W3
127712	Blackley, Helen	SE	20	37	4	W3
127712	Standard Trusts Company	SE	20	37	4	W3
362854	Anderson, Newton Joseph	SW	20	37	4	W3
023035A	Mosley, Daniel Albert	NE	24	37	5	W3
1474634	Donaldson, Alfred Sidney	NW	24	37	5	W3
1474634	Pettit, John Willis	NW	24	37	5	W3
923497	Reaney, George	SE	24	37	5	W3
1162929	Hutchins, William Reuben	SW	24	37	5	W3
1162929	Stahl, Joseph A.	SW	24	37	5	W3
1162929	Woods, W.F.	SW	24	37	5	W3
1804590	Baker, Frank Harry	SE	25	37	5	W3
1804590	Horne, Richard H.	SE	25	37	5	W3
1685347	Manuel, Frederick	SW	25	37	5	W3
1685347	Parkhurst, Reginald P.	SW	25	37	5	W3
1685347	Pettit, John Willis	SW	25	37	5	W3
822340	Lindsay, Alexander John	NE	26	37	5	W3
822340	Morris, Walter	NE	26	37	5	W3
1777410	Hickey, Catherine (Mrs)	SE	26	37	5	W3
722529	Adamson, A.J.	NW	30	37	5	W3
722528	Adamson, A.J.	NW	30	37	5	W3
762296	Adamson, A.J.	NW	30	37	5	W3
762296	Canada Territories Corporation Limited	NW	30	37	5	W3
762296	Pambrun, Frederick	NW	30	37	5	W3
683308	Hovey, Willis J.	SE	30	37	5	W3
066572A	Gendron, Louis	SW	30	37	5	W3
783726	Dickson, Alexander Forest	NE	32	37	5	W3
783726	Kennedy, Duncan	NE	32	37	5	W3
783726	Scharf, Silias	NE	32	37	5	W3
1198259	Dewar, John Duncan	NW	32	37	5	W3
783727	Willison, James Thomas	SE	32	37	5	W3
783727	Rice, George	SE	32	37	5	W3

File Number	Name	Q	Sec.	T	R	M
783727	Scharf, Abram	SE	32	37	5	W3
070721A	McKee, William Herbert	SW	32	37	5	W3
736421	Heinrichs, Peter	NE	34	37	5	W3
736421	Loewen, Bernhard B.	NE	34	37	5	W3
767378	Dyck, Peter John	NW	34	37	5	W3
1198261	Sunderland, Frank	SE	34	37	5	W3
686207	Ward, William	SW	34	37	5	W3
686207	Neufeldt, Johann S.	SW	34	37	5	W3
686207	Neufeldt, Peter J.	SW	34	37	5	W3
786507	Haynes, Alfred	NE	36	37	5	W3
096701A	Penner, Jacob	NW	36	37	5	W3
1153644	Dyck, Henry K.	SE	36	37	5	W3
1165358	Peters, Jacob K.	SW	36	37	5	W3
688047	Richards, Thomas	NE	6	37	6	W3
692671	Richards, William Henery	NW	6	37	6	W3
516586	Partridge, Frederick W.	SE	6	37	6	W3
757992	McCormack, William James	SW	6	37	6	W3
4031513	Cherry, J. C.	NW	9	37	6	W3
638121	Crawford, James	NE	16	37	6	W3
638121	Crawford, James R.	NE	16	37	6	W3
598810	Lang, Alexander	NW	16	37	6	W3
598810	Whittle, Frederick	NW	16	37	6	W3
764748	Lindsay, George	SE	16	37	6	W3
764494	Lindsay, Alexander	SW	16	37	6	W3
880842	Fuhr, William	NE	22	37	6	W3
144078A	Pultz, Frank	NW	22	37	6	W3
775047	Wilker, Charles H.	NW	22	37	6	W3
725000	Kyle, Thomas	SE	22	37	6	W3
711883	Graham, George	NE	26	37	6	W3
711883	Sandberg, John A.	NE	26	37	6	W3
583418	Lindsay, David Franklin	NE	28	37	6	W3
990532	Stahl, Andreas	NW	28	37	6	W3
841439	Becker, Titus	SW	28	37	6	W3
768569	Marr, Gordon A.	NE	36	37	6	W3
745466	Kizer, James Austin	NW	36	37	6	W3
759923	Doney, Henry Bliss	SE	36	37	6	W3
759923	Jefferies, Francis Barnes	SE	36	37	6	W3
759923	Jefferies, Francis Barnes	SE	36	37	6	W3
708574	Gendron, Francis Arthur	SW	36	37	6	W3
708574	Gendron, John Joseph	SW	36	37	6	W3
1249993	Barton, Hubert Ernest	NE	36	35	5	W3
1249999	Maule, Richard Lawrence	SE	36	35	5	W3

File Number	Name	Q	Sec.	T	R	M
631212	Vandal, Frederic	SE	36	35	5	W3
815537	Dyck, Jacob	NE	4	38	5	W3
712549	Braun, Dietrich	NW	4	38	5	W3
712549	Toews, Cornelius	NW	4	38	5	W3
712549	Friesen, Jacob J.	NW	4	38	5	W3
815537	Friesen, Peter N.	NE	4	38	5	W3
120802A	Penner, Abraham P.	SE	4	38	5	W3
010901A	Gougeon, William	SW	4	38	5	W3

SNC·LAVALIN

216 - 1st Avenue South
Saskatoon, Saskatchewan, Canada S7K 1K3
306.668.6800
www.snclavalin.com

APPENDIX B

Utility Conflicts and Quantity Estimates

Table B1: Utility Conflicts

SaskTel Utility Conflicts

Affected Quarter Section	Description
SE 17-36-06 W3M	Copper cable and pedestals
NW 16-36-06 W3M	Major fiber, home service connections
SE 21-36-06 W3M	Home service connections
NE 29-36-06 W3M	Major fiber, copper cable
NE 08-37-06 W3M	Home service connections
NW 09-37-06 W3M	Home service connections, copper cable and pedestal
NE 16-37-06 W3M	Home service connections
SE 21-37-06 W3M	Home service connections
NW 15-37-06 W3M	Major fiber, copper cable and pedestals
SE 27-37-06 W3M	Copper cables
NE 25-37-06 W3M	Copper cables, home service connections
NW 30-37-05 W3M	Home service connections
NE 32-37-05 W3M	Major fiber and copper cables in middle and east ditches
NW 33-37-05 W3M	Copper cable and pedestal
NE 33-37-05 W3M	Arial copper cable and poles
SE 34-37-05 W3M	Major fiber east of tracks
NW 26-37-05 W3M	Copper cable and pedestals
SE 26-37-05 W3M	Copper cable and pedestals
SW 19-37-04 W3M	Copper cable and pedestals
SE 19-37-04 W3M	Copper cable and pedestals
SW 20-37-4 W3M	Copper cable and pedestals
SE 16-37-05 W3M	Copper cable and pedestals, home service connections
SW 16-37-05 W3M	Copper cable and pedestals
SE 09-37-04 W3M	Major fiber and copper cables, home service connections
NW 34-36-04 W3M	Home service connections, major fiber
SW 27-36-04 W3M	Copper cables and pedestals, home service connections
NW 22-36-04 W3M	Home service connections
SW 15-36-04 W3M	Home service connections
NW 10-36-04 W3M	Home service connections
SW 10-36-04 W3M	Home service connections, major copper cable and fiber east of rail tracks
SE 09-36-04 W3M	Major copper cable and fiber east of rail tracks
NE 05-36-04 W3M	Home service connections
NW 05-36-04 W3M	Home service connections
SE 01-36-05 W3M	Copper cable and pedestal
SW 35-35-05 W3M	Major copper cable and fiber in middle and west ditch, pedestals
NE 25-35-05 W3M	Major copper cable and fiber in middle and west ditch, pedestals

SaskEnergy Utility Conflicts

Affected Quarter Section	Description
NW 09-36-06 W3M	E1 – 33.4 Polyethylene (PE) IP
NE 08-36-06 W3M	E1 – 33.4 PE IP
SW 21-36-06 W3M	C1 – 26.7 PE IP, 60.3 PE IP
SE 05-37-06 W3M	C2 – 26.7 PE IP
SW 05-37-06 W3M	C2 – 26.7 PE IP
NW 09-37-06 W3M	E2 – 33.4 PE IP
NE 16-37-06 W3M	E3 – 26.7 PE IP
SW 22-37-06 W3M	C3 – 33.4 PE IP, 60.3 PE IP
SW 26-37-06 W3M	C4 – 60.3 PE IP, 26.7 PE IP
SE 26-37-06 W3M	E4 – 26.7 PE IP, 33.4 PE IP
NE 25-37-06 W3M	C5 – 26.7 PE IP33.4 PE IP, 60.3 PE IP, 114.3 PE IP
NW 33-37-05 W3M	C6 – 33.4 PE IP
NE 33-37-05 W3M	C7 – 33.4 PE IP, 60.3 PE IP, 168.3 PE IP
NE 27-37-05 W3M	E5 – 33.4 PE IP
SE 26-37-05 W3M	C8 & C9 – 33.4 PE IP
SW 25-37-05 W3M	C8 & C9 – 33.4 PE IP
NE 24-37-05 W3M	C10 – 48.3 PE IP
SE 24-37-05 W3M	C10 – 48.3 PE IP
SW 16-37-04 W3M	C11 – 114.3 PE IP
SW 10-37-04 W3M	C12 – 26.7 PE IP, 33.4 PE IP
SW 09-37-04 W3M	C13 – 26.7 PE IP, 33.4 PE IP
NW 34-36-04 W3M	C13 – 48.3 PE IP, 33.4 PE IP
SW 34-36-04 W3M	E6 – 33.4 PE IP
NW 37-36-04 W3M	C14 – 33.4 PE IP
SW 27-36-04 W3M	C15 – 48.3 PE IP, 33.4 PE IP
NW 22-36-04 W3M	C15 – 33.4 PE IP
NW 10-36-04 W3M	C16 – 33.4 PE IP
NW 04-36-04 W3M	E7 – 60.3 PE IP
NE 05-36-04 W3M	E7 – 33.4 PE IP
NW 05-36-04 W3M	E8 – 33.4 PE IP
SE 01-36-05 W3M	C17 – 33.4 PE IP, 48.3 PE IP
NW 36-35-05 W3M	C18 – 60.3 PE IP, 114.3 PE IP

SaskPower Utility Conflicts

Affected Quarter Section	Description
SW 16-36-06 W3M	Overhead (OH) 25kV
NE 17-36-06 W3M	Underground (UG) 25 kV
NW 16-36-06 W3M	UG 25 kV
SW 21-36-06 W3M	Three 138 kV circuits, one 72 kV circuit, one UG communication circuit
SE 20-36-06 W3M	UG 25 kV
NW 21-36-06 W3M	OH 14.4 kV
SW 21-36-06 W3M	OH 25 kV
NW 21-36-06 W3M	OH 25 kV
SE 29-36-06 W3M	OH 25 kV
SW 28-36-06 W3M	OH 25 kV
SE 32-36-06 W3M	OH 72 kV transmission line
NW 32-36-06 W3M	OH 72 kV transmission line
SE 05-37-06 W3M	OH 14.4 kV
SW 05-37-06 W3M	OH 14.4 kV
NE 08-37-06 W3M	UG 25 kV
NW 09-37-06 W3M	UG 14.4 kV
SW 16-37-06 W3M	OH 14.4 kV
SE 16-37-06 W3M	OH 14.4 kV
NE 16-37-06 W3M	OH 14.4 kV
NW 15-37-06 W3M	OH 14.4 kV
SE 21-37-06 W3M	UG 25 kV, OH 14.4 kV
SW 22-37-06 W3M	OH 14.4 kV
NE 25-37-06 W3M	OH 14.4 kV, UG 14.4 kV
NE 31-37-05 W3M	OH 14.4 kV
NE 32-37-05 W3M	OH 25 kV
NW 32-37-05 W3M	OH 25 kV
NW 33-37-05 W3M	UG 14.4kV
NE 33-37-05 W3M	OH 25 kV
SE 34-37-05 W3M	138 kV transmission line
SW 35-37-05 W3M	OH 25 kV
NE 27-37-05 W3M	UG 14.4 kV
NW 26-37-05 W3M	OH 25 kV
SE 26-37-05 W3M	OH 138 kV, OH 14.4 kV
SW 25-37-05 W3M	OH 138 kV, OH 14.4 kV
NE 24-37-05 W3M	OH 138 kV
SE 24-37-05 W3M	OH 138kV
SE 09-37-04 W3M	OH 25 kV
SW 10-37-04 W3M	OH 25 kV, UG 14.4 kV
NW 03-37-04 W3M	OH 25 kV
NE 03-37-04 W3N	OH 25 kV
NW 34-36-04 W3M	UG 14.4 kV
SW 34-26-04 W3M	UG 14.4 kV
NW 27-36-04 W3M	UG 14.4 kV
SW 27-36-04 W3M	OH 14.4 kV, UG 25 kV

NW 22-36-04 W3M	UG 25 kV
NW 10-36-04 W3M	OH 14.4 kV
SE 09-36-04 W3M	OH 25 kV, UG 14.4 kV
SW 09-36-04 W3M	Two 230 kV circuits, one 72 kV circuit, one UG communication circuit, UG 14.4 kV
NW 04-36-04 W3M	UG 14.4 kV
NW 05-36-04 W3M	OH 14.4 kV
SW 05-36-04 W3M	OH 14.4 kV
SE 01-36-04 W3M	UG 14.4 kV
NE 36-35-04 W3M	OH 138 kV, OH 25 kV
SE 35-35-05 W3M	OH 14.4 kV
SW 35-35-05 W3M	OH 14.4 kV, UG 14.4 kV

TransGas Utility Conflicts

Affected Quarter Section	TransGas Pipeline Name	Pipeline #
SW 21-36-06 W3M SE 20-36-06 W3M	Biggar-Saskatoon NPS 14	09.0700.100
SE 20-36-06 W3M	Biggar-Saskatoon NPS 16	09.0800.400
NW 26-37-05 W3M	Grenora-Saskatoon NPS 12	09.0800.200
SW 16-37-04 W3M NW 09-37-04 W3M	Saskatoon-South Saskatchewan River NPS 6	04.0400.100
SW 15-36-04 W3M SE 15-36-04 W3M	Saskatoon-Prud Homme NPS 12	05.0200.100
NE 05-35-04 W3M SE 08-36-04 W3M NE 05-36-04 W3M	Saskatoon-Dundurn NPS 6	11.0100.100

City of Saskatoon Utility Conflicts

Affected Quarter Section	Description
NW 26-37-05 W3M	Sanitary Sewer Force Main (200 mm and 250 mm)
SW 35-37-05 W3M	Sanitary Sewer Force Main (200 mm and 250 mm)

Highway 41 Water Utility Conflicts

Affected Quarter Section	Description
SW 3-37-04 W3M	Water pipe
NE 4-37-04 W3M	Water pipe
SE 9-37-04 W3M	Water pipe
SW 10-37-04 W3M	Water pipe
SE 16-37-04 W3M	Water pipe
NW 19-37-04 W3M	Water pipe
SW 20-37-04 W3M	Water pipe

Rogers Communication Utility Conflicts

Affected Quarter Section	Description
LSD-05-06-36-04-W3, SW-06-36-04-W3	Fiber cable
NW-21-36-06-W3	Fiber cable

Shaw Communication Utility Conflicts

Affected Quarter Section	Description
NW-34-37-05-W3	Fiber cable

Telus Communication Utility Conflicts

Affected Quarter Section	Description
SE-29-36-06-W3	Fiber cable
SE-09-36-04-W3	Fiber cable

Bell Communication Utility Conflicts

Affected Quarter Section	Description
SE-29-36-06-W3	Fiber cable
SE-09-36-04-W3	Fiber cable

SaskWater Utility Conflicts

Affected Quarter Section	Description
SE-4-37-4-W3	200 mm HDPE potable
NE-27-37-5-W3	500 mm Steel potable and 200 mm Steel potable
NE-17-36-6-W3	200 mm CI potable and 250 mm PVC potable
SE-17-36-6-W3	200 mm CI potable, 250 mm PVC potable, 300 mm DI non-potable and 400 mm Steel non-potable
NW-26-37-5-W3	500 mm Steel potable and 200 mm Steel potable
NW-10-37-4-W3	200 mm HDPE potable
SW-10-37-4-W3	Two 200 mm HDPE potable lines
SW-35-37-5-W3	500 mm Steel potable and 200 mm Steel potable
NW-3-37-4-W3	200 mm HDPE potable
SW-3-37-4-W3	200 mm HDPE potable
SW-21-36-6-W3	200 mm CI potable and 250 mm PVC potable
NE-9-37-4-W3	200 mm HDPE potable
SE-9-37-4-W3	200 mm HDPE potable
SE-1-36-5-W3	350 mm PVC potable, 300 mm Steel (abandoned), 231 mm HDPE non-potable and 250 mm HDPE non-potable
SW-16-36-6-W3	300 mm DI non-potable and 400 mm Steel non-potable
SW-6-36-4-W3	350 mm PVC potable, 300 mm Steel (abandoned) and 230 mm HDPE non-potable
SE-6-36-4-W3	350 mm PVC/450 mm HDPE potable, 300 mm Steel (abandoned) and 231 mm HDPE non-potable
SE-34-37-5-W3	500 mm Steel potable and 200 mm Steel potable
NW-16-36-6-W3	200 mm CI potable and 250 mm PVC potable
NE-4-37-4-W3	250 mm HDPE potable and 200 mm HDPE potable

Highway 11 Quantity Estimates

Utility	Detail	Removal Quantity (m)	Relocation Quantity (m)
SaskPower Distribution	OH 138 kV	793	647
SaskPower Distribution	UG 14.4 kV	533	0
SaskPower Distribution	OH 25 kV	1034	1662
SaskPower Distribution	OH 25 kV	90	90
SaskPower Distribution	UG 14.4 kV	50	0
SaskPower Distribution	UG 14.4 kV	374	0
SaskPower Distribution	OH 25 kV	152	0
SaskPower Distribution	UG 14.4 kV	32	32
SaskEnergy		97	107
TransGas	323.9 mm pipe	101	111
SaskEnergy	33.4 PE IP	967	0
SWC Line		80	80
SaskTel	Svc to Customer	206	0
SaskTel	Svc to Customer	1763	1553
SaskTel	Svc to Customer	371	0
SaskEnergy		59	0
SaskEnergy		845	0
SaskEnergy		100	110
SaskPower Distribution	OH 25 kV	21	21
SaskPower Distribution	OH 25 kV	21	21
SaskTel	Svc to Customer	24	48
SaskPower Distribution	OH 25 kV	90	100
SaskPower Distribution	OH 25 kV	21	21
SaskEnergy		100	100
SaskEnergy		100	100
SaskEnergy		120	120
SaskTel	Major Fiber	793	647

Table B3: Quantities Summary

Highway 11 Quantity Estimates

Utility	Detail	Removal Quantity (m)	Relocation Quantity (m)
SaskPower Distribution	OH 138 kV	793	647
SaskPower Distribution	UG 14.4 kV	533	0
SaskPower Distribution	OH 25 kV	1034	1662
SaskPower Distribution	OH 25 kV	90	90
SaskPower Distribution	UG 14.4 kV	50	0
SaskPower Distribution	UG 14.4 kV	374	0
SaskPower Distribution	OH 25 kV	152	0
SaskPower Distribution	UG 14.4 kV	32	32
SaskEnergy		97	107
TransGas	323.9 mm pipe	101	111
SaskEnergy	33.4 PE IP	967	0
SWC Line		80	80
SaskTel	Svc to Customer	206	0
SaskTel	Svc to Customer	1763	1553
SaskTel	Svc to Customer	371	0
SaskEnergy		59	0
SaskEnergy		845	0
SaskEnergy		100	110
SaskPower Distribution	OH 25 kV	21	21
SaskPower Distribution	OH 25 kV	21	21
SaskTel	Svc to Customer	24	48
SaskPower Distribution	OH 25 kV	90	100
SaskPower Distribution	OH 25 kV	21	21
SaskEnergy		100	100
SaskEnergy		100	100
SaskEnergy		120	120
SaskTel	Major Fiber	793	647

Highway 12 Quantity Estimates

Utility	Detail	Removal Quantity (m)	Relocation Quantity (m)
SaskTel	Svc to Customer	858	1563
SaskTel	Svc to Customer	307	0
SaskTel	Svc to Customer	450	0
SaskEnergy	60.3 PE IP	608	0
SaskPower Distribution	OH 25 kV	1430	2301
SaskPower Distribution	UG 14.4 kV	152	0
SaskPower Distribution	UG 25 kV	395	0
SaskPower Distribution	UG 14.4 kV	302	0
SaskTel	Svc to Customer	1222	1780
SaskTel	Svc to Customer	1873	0
SaskTel	Svc to Customer	186	0
SaskTel	Svc to Customer	250	0
SaskTel	Svc to Customer	410	0
SaskEnergy	26.7 PE IP	1702	1329
SaskPower Distribution	UG 14.4 kV	833	0
SaskPower Distribution	UG 14.4 kV	559	0
SaskTel	Svc to Customer	329	0
SaskEnergy	33.4 PE IP	324	790
SaskEnergy	33.4 PE IP	210	0
SaskPower Distribution	UG 14.4 kV	137	0
SaskEnergy	168.3 PE IP	77	77
SaskPower Distribution	OH 25 kV	77	77
SaskTel	Aerial Copper	77	77
SaskPower Distribution	UG 14.4 kV	184	0
SaskEnergy		102	102
SaskEnergy		74	74
SaskEnergy		74	74
SaskTel	Major Fiber	2050	3000
SaskTel	Major Fiber	2050	3000
SaskPower	OH 14.4 kV	63	63
SaskTel	Svc to Customer	63	63
Shaw	Major Fiber	74	74
SaskPower Distribution	OH 25 kV	90	90
SaskTel	Svc to Customer	858	1563
SaskTel	Svc to Customer	307	0

SaskTel	Svc to Customer	450	0
SaskEnergy	60.3 PE IP	608	0
SaskPower Distribution	OH 25 kV	1430	2301
SaskPower Distribution	UG 14.4 kV	152	0
SaskPower Distribution	UG 25 kV	395	0
SaskPower Distribution	UG 14.4 kV	302	0
SaskTel	Svc to Customer	1222	1780
SaskTel	Svc to Customer	1873	0
SaskTel	Svc to Customer	186	0
SaskTel	Svc to Customer	250	0
SaskTel	Svc to Customer	410	0
SaskEnergy	26.7 PE IP	1702	1329
SaskPower Distribution	UG 14.4 kV	833	0
SaskPower Distribution	UG 14.4 kV	559	0
SaskTel	Svc to Customer	329	0
SaskEnergy	33.4 PE IP	324	790
SaskEnergy	33.4 PE IP	210	0
SaskPower Distribution	UG 14.4 kV	137	0

Highway 16 Quantity Estimates

Utility	Detail	Removal Quantity (m)	Relocation Quantity (m)
SaskPower Distribution	UG 14.4 kV	415	0
SaskPower Distribution	OH 14.4 kV	405	0
SaskPower Distribution	UG 14.4 kV	197	0
SaskPower Distribution	OH 25 kV	2125	3207
SaskPower Distribution	UG 14.4 kV	109	0
SaskPower Distribution	UG 14.4 kV	167	0
SaskTel	Svc to Customer	409	0
SaskTel	Copper	2125	3207
SaskTel	Svc to Customer	155	0
SaskTel	Svc to Customer	657	0
SaskTel	Svc to Customer	265	
SaskEnergy	33.4 PE IP	81	81
SaskTel	Svc to Customer	163	0
SaskEnergy	114.3 PE IP	1089	1782
SaskEnergy		1247	1935
SaskEnergy	60.3 PE IP	920	1694
SaskEnergy	26.7 PE IP	25	0
SaskTel	Copper	1195	0
SaskTel	Svc to Customer	652	0
SaskTel	Copper	1272	1207
SaskTel	Svc to Customer	50	0
SaskTel	Svc to Customer	130	0

APPENDIX C

Microsimulation Results

Memorandum

To:	David Stearns	**Date:**	April 21, 2020
From:	Don Cleghorn, Danny Kang	**Ref:**	659183
CC:			

Subject: TRAFFIC MICROSIMULATION - SFFPS Phase 1

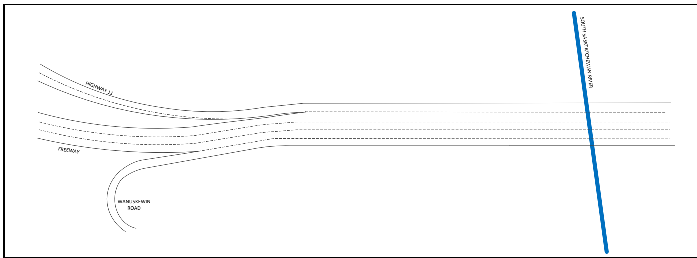
Introduction

This memo documents the use of a microsimulation model to test a range of interchange configurations for the horizon year forecast traffic conditions in the Saskatoon Freeway. PTV VISSIM software was selected for the simulation. The study area was in the NE quadrant of the City of Saskatoon, specifically where SB Highway 11 will be merging onto the EB freeway along with the Wanuskewin on-ramp. The simulation results from five different road network scenarios are compared to note advantages and disadvantages of each scenario.

Study Approach and Assumptions

A microsimulation model differs from a traditional (or macroscopic) transportation model by the level of detail of the simulation. In a macroscopic model, traffic is represented as aggregated vehicle flows, e.g. vehicles per hour in a particular direction across a road link. Capabilities vary between macroscopic models depending on software features and the level of detail and effort in the collection of data and construction of the model, but such models do not generally account for things like queues, lane changing/weaving, or even the physical capacity of a road link. In contrast, a microsimulation represents every individual vehicle in that demand flow as a separate entity, with statistical distributions used to randomly generate vehicle behaviours such as desired speeds, driver aggressiveness, car-following behaviour, propensity to change lanes and to allow another vehicle to merge, and so on. As such, a microsimulation takes much more time to run, and takes much more input data to properly calibrate and validate for a given road network, but it has better ability to estimate traffic operations at a detailed level invisible to macroscopic models.

For this case, as the surrounding highway and arterial network connections haves been determined, the essential difference among the five scenarios is the number of lanes and how they combine at the merge location. The three entering flows come in from the west and exit the model to the east across the planned bridge over the South Saskatchewan River. **Figure 1** below shows schematics of each scenario layout that was used in the model analysis.



Scenario 1: Base case is five lanes across the river bridge comprising three lanes extending EB from Highway 12, one lane from Highway 11 and one lane from Wanuskewin ramp.

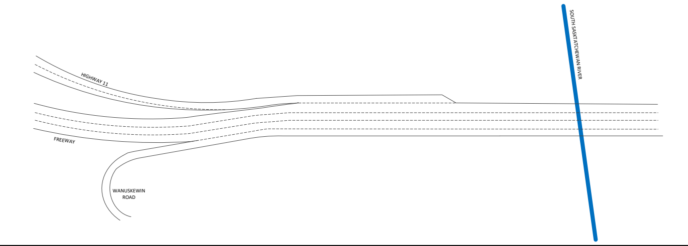
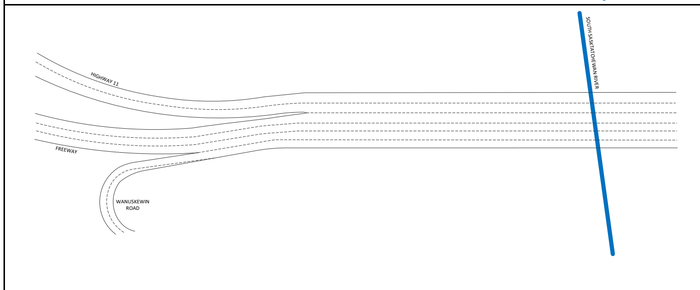
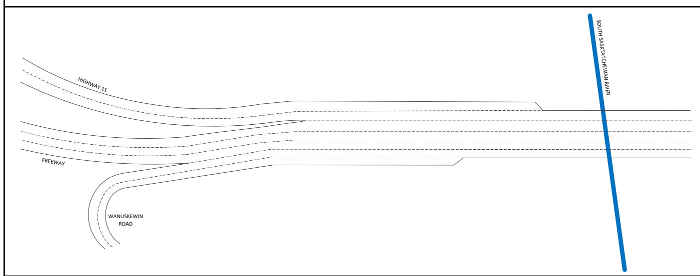
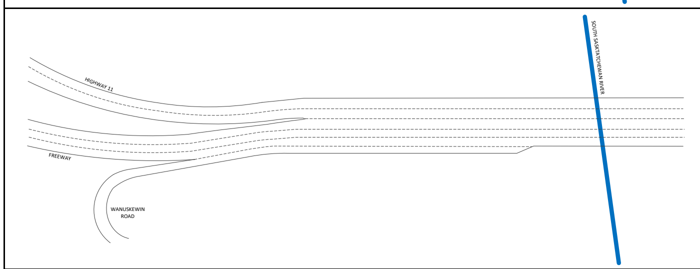
	**Scenario 2:** Same as Scenario 1, but the Highway 11 lane is dropped before the bridge, leaving just four lanes across the river bridge, effectively giving priority to Wanuskewin traffic over Highway 11.
	**Scenario 3:** Same as Scenario 1 but instead of dropping a lane on Highway 11, two lanes are carried from Highway 11 across the bridge, making it a 6-lane bridge. This scenario also includes a two to one lane drop on the Wanuskewin ramp before it reaches the mainline.
	**Scenario 4:** Similar to Scenario 3, but one lane from Highway 11 drops before the bridge, resulting in just five lanes across the river. This also has the Wanuskewin two to one lane drop occur after the ramp merges with the freeway.
	**Scenario 5:** Same as Scenario 3, but the Wanuskewin ramp lane is dropped before the bridge, leaving only five lanes across the river.

Figure 1: Schematics of Road Network Scenarios

Model Construction

Due to the computation requirements of microsimulation, models are always trimmed to the minimum extent necessary to capture the desired effects, so this case includes no upstream or downstream effects, just focusing on the merging among the three entering flows. Normally a microsimulation model is based on an existing condition which is measured (e.g. detailed traffic counts, travel times), and used to calibrate and validate a base model. That base is then modified to incorporate contemplated changes (e.g. adding a lane) and the model is run to estimate the impacts of the change. In this case we have no existing condition freeway to model, so we rely on VISSIM default parameters for the most part. Model assumptions included:

- Use of VISSIM's Wiedemann 74 car-following model to best simulate the merging conditions.
- Look ahead distance and look back distance parameters both increased to from default value of 250 m to 1000 m.
- Speed limit 110 km/h except for 70 km/h on Wanuskewin Road on-ramp.

Demand volumes for all scenarios were taken from the VISUM Horizon Year (2063) model outputs. These are shown in Figure 2, overlaid on a sample of the VISSIM model network.

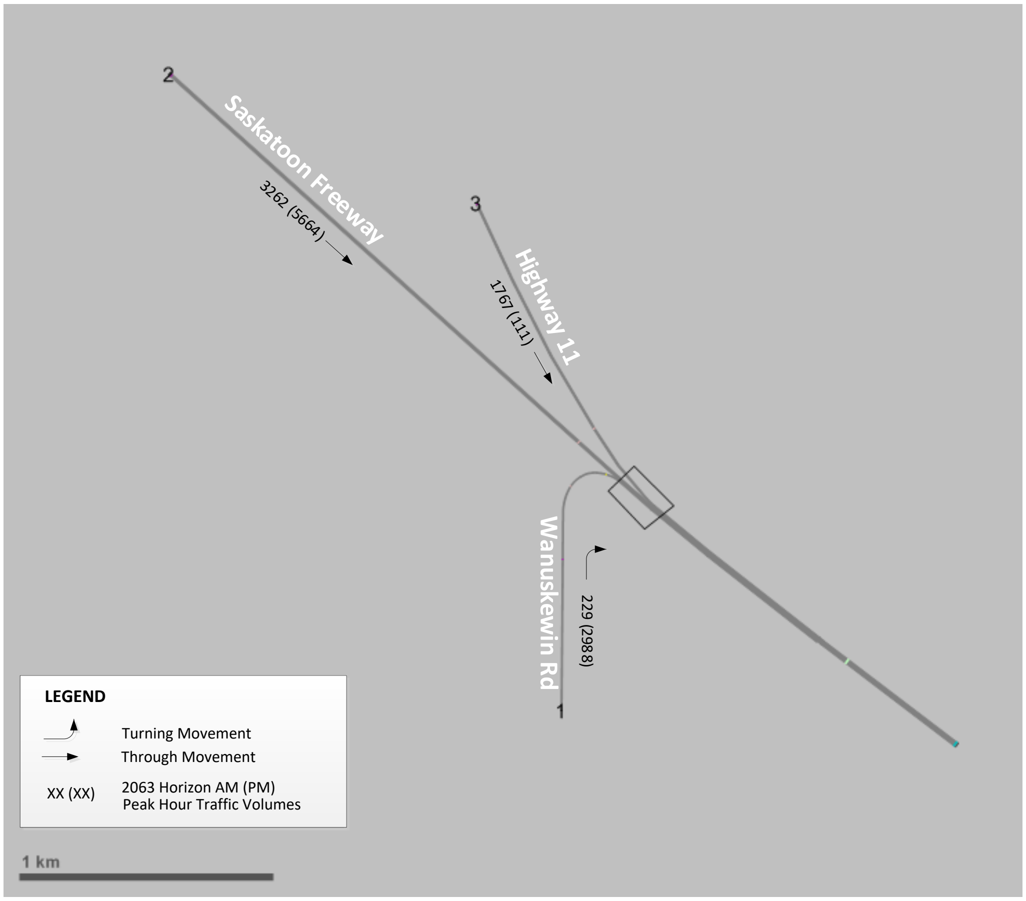


Figure 2: VISSIM Model Network and demand volumes used

After inputting traffic volumes in VISSIM model, it was also necessary to make route decisions, in this case simply that all the vehicles were destined to cross the bridge over the river. The following **Table 1** defines the number of lanes and locations of lane drops modelled on each link in each Scenario.

Table 1: Number of Lanes in Scenarios

Scenario	Entry Lanes from			Exit Lanes
	Wanuskewin Rd	Freeway (mainline)	Hwy 11	Bridge
1	1	3	2 → 1	5
2	1	3	2 → 1* → 0**	4
3	2 → 1*	3	2	6
4	2 → 1**	3	2 → 1**	5
5	1 → 1**	3	2	5

Notes: * Lane drop before Freeway (mainline) merge
** Lane drop after Freeway (mainline) merge

Travel Time Analysis

Travel time data is one of the most important measures of system performance. In VISSIM, this is collected from the model runs by creating vehicle travel time sections. In our model, three equal-length sections were created, with A, B and C as start points, all heading to D as the end point, with the points positioned as shown in **Figure 3.**

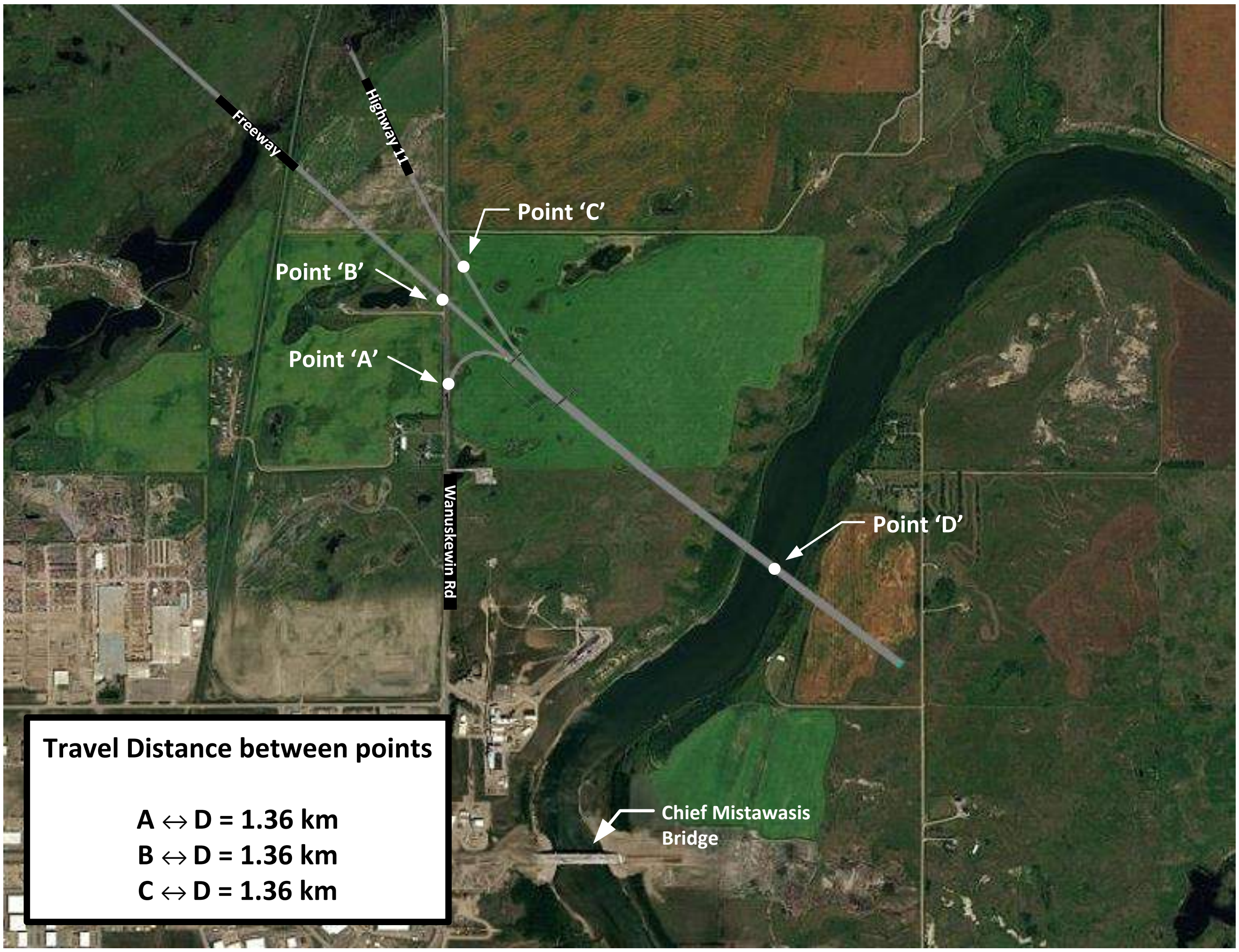


Figure 3: Travel Time Segment Placement for O-D Data

Travel time segments in VISSIM also count the vehicles that pass through them and so can be used as a validation of Origin-Destination volumes through the section. Each VISSIM model run uses random numbers to load vehicles into the network and simulate elements of driver behaviour and vehicle performance as the vehicles move through the network. As such, multiple simulation runs were performed for each Scenario in both AM and PM peaks to collect the average traffic data. The number of vehicles travelling from one entry point to one exit point are given in **Table 2**.

Table 2: Output Number of Vehicles Travel Summary

Scenario	Number of Vehicles Travelling on each Travel Time Section					
	AM peak hour			PM peak hour		
	A - D	B - D	C -D	A - D	B - D	C -D
1	229	3268	1755	2613	5663	109
2	229	3268	1728	2612	5664	108
3	229	3268	1760	1982	5663	109
4	229	3268	1760	2941	5661	109
5	229	3268	1760	2566	5668	109
Input Demand	**229**	**3262**	**1767**	**2988**	**5664**	**111**

The randomized elements of microsimulation runs means that the volumes observed in the model won't necessarily match the input demands exactly, but allowing for this minor variation from demand in **Table 2**, the results of analysis indicate that number of vehicles travelling match the expected demand well, with a few notable exceptions highlighted in the table:

- Scenario 2
  - C-D during AM peak hour
- Scenario 1, 2, 3, 5
  - A-D during PM peak hour

Scenario 2 on the C-D section (flow from Highway 11) showed the lowest flow of all the scenarios for the Highway 11 during AM peak hour and may be indicative of the fact that Scenario 2 offers the least capacity to the C-D flow, as there is no lane crossing the bridge from Highway 11. The other 4 scenarios have at least one lane carry through the river crossing. This indicates that one lane from Highway 11 is likely sufficient to accommodate the predicted demand as long as the lane proceeds to cross the bridge.

For the A-D section (flow from the Wansekewin on-ramp) during PM peak hour, the demand volume from the VISUM model is greater than would be expected reasonable for an on-ramp capacity (due to the imprecision of a macroscopic model), so lower flow results should be considered carefully. In reality, local traffic trying to access the freeway would likely have other alternatives within the City network (e.g. further river-crossing capacity additions between 2020 and 2063), and also the peak hour will likely have spread in time to better use the available infrastructure. Scenario 3 showed the least flow, and while it does carry an on-ramp lane all the way to the bridge, the lane drop on the on-ramp creates a lot of friction to entering vehicles, with the model exhibiting a stop-and-go condition at the on-ramp merge before the ramp enters the mainline, resulting in a large proportion of the predicted demand not being loaded onto the network. Scenarios 1 and 2 avoid this on-ramp merge issue, but still suffer lower flow again due to the predicted demand exceeding the capacity of a single-lane ramp. Scenario 5 loses a bit more than 1 and 2 due to the Wanuskewin on-ramp lane dropping before the bridge.

In addition to the number of vehicles travel summary, the travel time from one entry point to one exit point was also obtained from the VISSIM model for each movement, as shown in **Table 3** below.

Table 3: Travel Time Validation Summary

Scenario	Travel Time (s)					
	AM peak hour			PM peak hour		
	A – D	B – D	C -D	A - D	B - D	C -D
1	50	47	49	54	48	47
2	50	48	61	52	48	49
3	50	47	47	68	48	46
4	50	47	48	67	48	47
5	51	47	47	81	52	47
Average	**50**	**47**	**50**	**64**	**49**	**47**

In the AM travel time from C to D showed variation where the Scenario 2 has the greatest delay during AM peak hour. As mentioned above, one lane from Highway 11 should be provided across the river to accommodate the demand.

In the PM peak hour, A-D showed considerable travel time variation. Scenario 5 was the worst, likely because it is the only case where the Wanuskewin on-ramp has no lane crossing the river, and the delay resulting from the need to merge with the mainline is also suggested in the slightly higher travel time for B-D in scenario 5. Scenarios 1 and 2 showed the shortest travel time for traffic travelling from Wanuskewin to the river because both have one dedicated lane from Wanuskewin Road across the bridge. Scenarios 3 and 4 are in the middle of the results due to the delay caused by the merge on the ramp, whether before it reaches the mainline or at the mainline appears to make little difference.

Conclusion

This memo explores the potential ultimate operational conditions of five scenarios for the eastbound freeway where Highway 11 and Waneskewin Road join it. Based on analysis using VISSIM traffic microsimulation software, the following comments can be made:

- Highway 11 requires at least one continuous lane across the river to serve the predicted ultimate demand
- Wanuskewin Road predicted demand will not be fully served unless it is provided a two-lane on-ramp and at least one lane across the river. However as this is demand from a local road network it would be reasonable to investigate other options including the likelihood of additional river-crossing capacity within the City network between now and 2063, as well as spreading out the demand peak.
- The freeway mainline flow from the west can be served by 3 lanes on the bridge

It should be noted that the volume and travel time results above should not be taken as precise estimates, partly because the demands are long-range forecasts, but particularly because the vehicle behaviours in the microsimulation have not been calibrated to existing driver population in the study area. They should be used only as *relative* indications of the effectiveness of each configuration.

APPENDIX D

Design Criteria Memorandum

AECOM

SNC·LAVALIN

AECOM Canada Ltd.
30 Leek Crescent
4th Floor
Richmond Hill ON L4B 4N4
Canada

T: 905.882.4401
F: 905.882.4399
aecom.com

To:
Geoffrey Meinert, MHI
Craig Habermehl, RM Corman Park
David LeBoutillier, City of Saskatoon

CC:
Rob Bushman, MHI
Douglas Ross, MHI
Alan Duff, AECOM
Nathan Ruecker, SNC

Project name:
Saskatoon Freeway Function Planning Study

Project ref:
60594864

From:
Tim Sorochinsky

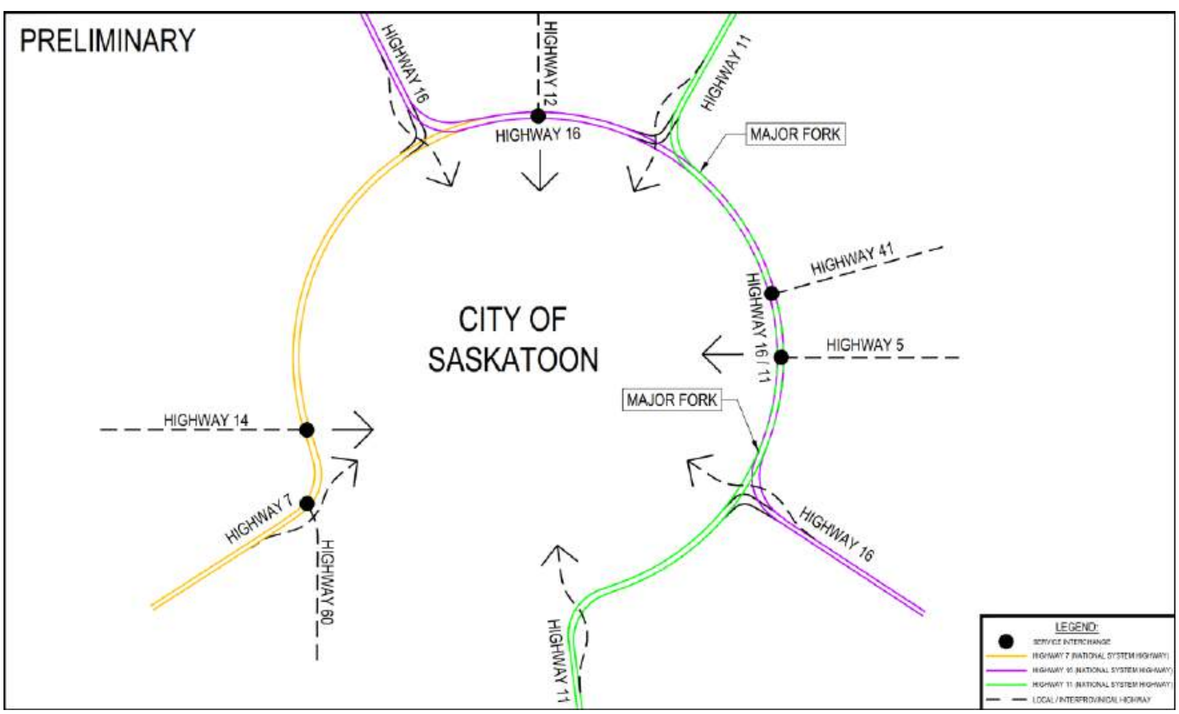
Date:
September 19, 2019

Memo

RE: Saskatoon Freeway Function Planning Study Design Criteria Memorandum

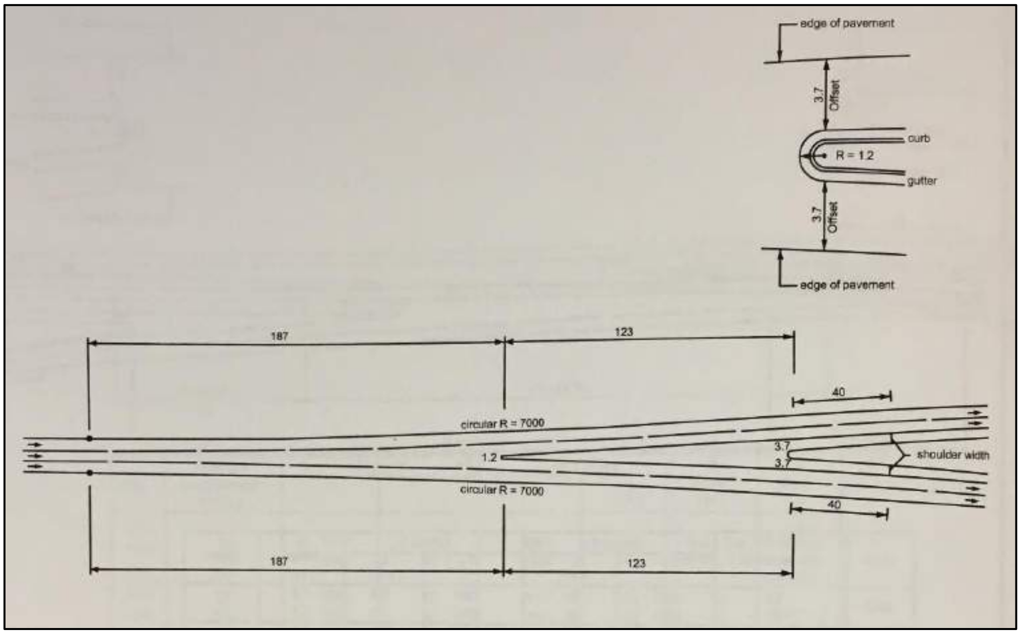
This memo documents the proposed design criteria for the future Saskatoon Freeway and surrounding road network. The Saskatoon Freeway will provide route continuity for Highways 11 and 16 which are part of the National Highway System. The Saskatoon Freeway will also function as a free-flow bypass of the City of Saskatoon. The Saskatoon Freeway will connect the south legs of Highway 11 and 16 with the corresponding north legs, allowing National Highway traffic to bypass the City of Saskatoon. This includes system level interchanges between Highways 11, 16 and 7 and the proposed Saskatoon Freeway. Furthermore, the Saskatoon Freeway will provide greater connectivity between the City of Saskatoon and the surrounding area. A schematic illustrating this concept is provided below in **Figure 1**.

Figure 1: Route Continuity Schematic



To maintain route continuity with a design speed of 130 km/h, key convergence and divergence points between National Highways 11 and 16 will be designed as a Major Fork (divergence) and a “Major” Connector (convergence). According to TAC Section 10.6.3.1, ‘*A major fork occurs when a terminating freeway/expressway divides into two directional ramps that connect to another crossing freeway or when a freeway branches into two connecting ramps to separate high-speed road routes of equal importance. In a major fork, there is effectively a left exit ramp and a right exit ramp with no through movement. A high ramp design speed should be provided.’* Figure 10.8.4 of the TAC Geometric Design Guide (illustrated below in **Figure 2**) details the typical design of a major fork.

Figure 2: TAC Figure 10.8.4 – Typical Design Major Fork



<u>Ministry of Highways and Infrastructure Standards</u>

The Saskatoon Freeway will be designed as a divided minimum four-lane freeway with a 130 km/h design speed. The Saskatoon Freeway will be classified as a D-130-7430 roadway, in accordance with SP20020. Provincial roadways crossing the Saskatoon Freeway include both divided and undivided highways, and are classified as D-130-7430 and U-110-7010. A summary of the geometric design standards are summarized below in **Tables 1 and 2**.

Table 1: Highway Standards – Saskatchewan Ministry of Highways and Infrastructure (Class 10)

		Geometric Design Standard	Reference
Functional Highway Classification		D-130-7430 (Divided) Provincial Highways Saskatoon Freeway	SP20020
Minimum ROW Width (m)		101.4m	SP21010
Equivalent Minimum "K" Factor	**Crest**	195	SP20250
	Sag	75	SP20255
Minimum Stopping Sight Distance (m)		290m	SP20250 / SP20255
Maximum Grade (%)	**Upgrade**	3%	SP20270
	Downgrade	5%	SP20270
Minimum Grade (%)		0%	DM302-5

Maximum Superelevation (m/m)		0.06	TAC Table 3.2.3
Minimum Radius (m)		950m	TAC Table 3.2.3
Minimum Spiral "A" Parameter (m)		300m	TAC Table 3.2.6
Number of Lanes		4	SP20020 / SP21010
Through Lane Width (m)		3.7m	SP21010
Shoulder Width (m)	**Inner**	1.0m	SP21010 / SP20020
	Outer	3.0m	SP21010 / SP20020
Standard Cross-Fall (m/m)	**Lanes**	0.02	SP20020
	Inner Shoulder	0.02	SP20020
	Outer Shoulder	0.05	SP20020
Median Width (m)		32m	SP21010
Surfacing Structure		Standard Pavement - Asphalt Concrete	SP20020

Table 2: Highway Standards – Saskatchewan Ministry of Highways and Infrastructure

		Geometric Design Standard	Reference
Functional Highway Classification		U-110-7010 (Undivided) Provincial Highways	SP21055
Minimum ROW Width (m)		46m	SP21050 / RM Primary Grid
Equivalent Minimum "K" Factor	**Crest**	125	SP20250
	Sag	55	SP20255
Minimum Stopping Sight Distance (m)		230m	SP20250 / SP20255
Maximum Grade (%)	**Upgrade**	3%	SP20270
	Downgrade	5%	SP20270
Minimum Grade (%)		0%	DM302-5
Maximum Superelevation (m/m)		0.06	TAC Table 3.2.3
Minimum Radius (m)		250m	TAC Table 3.2.3 (DS 80 km/h based on RM)
Minimum Spiral "A" Parameter (m)		125m	TAC Table 3.2.6
Number of Lanes		2	SP21055 / SP21050
Through Lane Width (m)		3.5m	SP21050
Shoulder Width (m)		1.0m	SP21055 / SP21050
Standard Cross-Fall (m/m)	**Lanes**	0.03	SP21055 / RM Primary Grid
	Shoulder	0.03	SP21055 / RM Primary Grid

Surfacing Structure	150mm minimum earth embankment thickness	SP21055

The geometric design standards for interchange ramps are summarized in **Table 3** below:

Table 3: Ramp Standards – Saskatchewan Ministry of Highways and Infrastructure

		Geometric Design Standard	Reference
Single Lane Ramp Width (m)	**Condition A**	4.0m	SKS20720
	Condition B	4.8m	SKS20720
	Condition C	5.0m	SKS20720
Shoulder Width (m)	**Left**	0.6m	SKS20720
	Right	2.5m	SKS20720
Minimum Design Speed of Loop Ramp (km/h)		50km/h	DM620
Minimum Radius of Curve (m)	**DS=50***	90m	TAC Table 3.2.3
	DS=60*	130m	TAC Table 3.2.3
	DS=70*	190m	TAC Table 3.2.3
	DS=80*	250m	TAC Table 3.2.3
	DS=90*	340m	TAC Table 3.2.3
	DS=100*	440m	TAC Table 3.2.3
	DS=110*	600m	TAC Table 3.2.3
	DS=120*	750m	TAC Table 3.2.3
	DS=130*	950m	TAC Table 3.2.3
Equivalent Minimum "K" Factor Crest (Sag)	**DS=50***	10 (10)	SP20250 / SP20255
	DS=60*	15 (15)	SP20250 / SP20255
	DS=70*	25 (25)	SP20250 / SP20255
	DS=80*	40 (30)	SP20250 / SP20255
	DS=90*	50 (35)	SP20250 / SP20255
	DS=100*	85 (45)	SP20250 / SP20255
	DS=110*	125 (55)	SP20250 / SP20255
	DS=120*	165 (65)	SP20250 / SP20255
	DS=130*	195 (75)	SP20250 / SP20255
Exit Terminal Speed Change Length (m)			SP26442
Entrance Terminal Speed Change Length (m)			SP26443

***Note:** A minimum 50 km/h design speed to be used for loop ramps only. 60 km/h – 90 km/h design speed to be used for Highway – Arterial connections. 100 km/h – 120 km/h to be used for Highway – Highway connections. 130 km/h Design speed to be used along Saskatoon Freeway and maintaining route continuity between National Highways (Highway 16, Highway 11, and Highway 7).

Miscellaneous

Design Vehicles: Critical interchange movements along the National Highway System will be designed to accommodate a WB-51 design vehicle while at-grade intersections will be designed to accommodate a WB-20 design vehicle.

Roundabouts: Roundabouts will be considered at ramp terminal intersections as an alternative to signalized intersections. If warranted, roundabouts will be designed in accordance with the Alberta Transportation Design Bulletin 68, Roundabout Design Guidelines on Provincial Highways.

Pavement Widening at Structures: Mainline pavement widening (including speed change lanes for ramps, forks, and connectors) adjacent to the South Saskatchewan River to begin a minimum of 100m from the structure abutments.

Interchange Spacing: Based on the Saskatchewan Roadside Management Manual (RSMM 430-30), the Saskatoon Freeway is considered 'U-1' access management level which represents the highest level of urban control and is considered a freeway standard. At-grade intersections are not permitted at this access management level and interchanges are to be spaced at a minimum of 3.2 km.

In addition to the interchange spacing standard provided in the Roadside Management Manual, Section 3.7.3.3 of TAC Geometric Design Guide for Canadian Roads recommends a minimum weaving length to ensure efficient operation on freeways. In particular, '*weaving length between a freeway interchange and an arterial interchange normally should be in the range of 800 m to 1000 m and between arterial interchanges in the range of 550 m and 700 m.*'

Rural Municipality of Corman Park Standards

The Rural Municipality of Corman Park surrounds the City of Saskatoon and includes over 1200 km of municipal roads spanning over 2000 km^2. The roadway standards for the Rural Municipality of Corman Park are summarized below in **Tables 4** through **6**.

Primary Grid Road: Standards for Graveled Primary Grid and Heavy Haul Roads.

Table 4: Corman Park Standards – Primary Grid Road

	Geometric Design Standard	Reference
Minimum Right-of-Way (m)	46.0m	RM Primary Grid: 3
Design Speed (km/h)	80km/h	RM Primary Grid: 4.1
Finished Top Width (m)	4.3m / lane	RM Primary Grid: 4.1
Standard Cross-Fall (m/m)	0.03 – 0.04	RM Primary Grid: 4.1
Minimum Radius (m)	250m	TAC Table 3.2.3
Side Slope	3:1 to 4:1	RM Primary Grid: 4.3
Ditch Bottom Width (m)	5.0m to 6.0m	RM Primary Grid: 4.4
Maximum Road Gradient (%)	6%	RM Primary Grid: 4.6
Stopping Sight Distance (m)	140m	RM Primary Grid: 4.6

Main Farm Access Road: Standards for Graveled Main Farm Access Roads.

Table 5: Corman Park Standards – Main Farm Access Road

	Geometric Design Standard	Reference
Minimum Right-of-Way (m)	30.0m	RM Farm Access: 3
Design Speed (km/h)	80km/h	RM Farm Access: 4.1
Finished Top Width (m)	3.5m / lane	RM Farm Access: 4.1
Standard Cross-Fall (m/m)	0.03 – 0.04	RM Farm Access: 4.1
Minimum Radius (m)	250m	TAC Table 3.2.3
Side Slope	3:1	RM Farm Access: 4.3
Ditch Bottom Width (m)	4.0m to 6.0m	RM Farm Access: 4.4
Maximum Road Gradient (%)	9%	RM Farm Access: 4.6
Stopping Sight Distance (m)	140m	RM Farm Access: 4.6

Industrial Paved Road: Standards for Industrial Paved (Asphalt Concrete) Roads.

Table 6: Corman Park Standards – Industrial Paved Road

	Geometric Design Standard	Reference
Minimum Right-of-Way (m)	46.0m	RM Industrial: 3
Design Speed (km/h)	100km/h	RM Industrial: 4.7
Finished Top Width (m)	4.5m / lane	RM Industrial: 4.1
Standard Cross-Fall (m/m)	0.02	RM Industrial: 4.1
Minimum Radius (m)	440m	TAC Table 3.2.3
Side Slope	3:1 to 4:1	RM Industrial: 4.3
Ditch Bottom Width (m)	4.0m to 7.0m	RM Industrial: 4.4
Maximum Road Gradient (%)	5%	RM Industrial: 4.6
Stopping Sight Distance (m)	200m	RM Industrial: 4.6

City of Saskatoon Standards

The City of Saskatoon uses a road classification system that considers land service and traffic characteristics including vehicular mix and destination. The classification system is summarized below in **Table 7** and key City of Saskatoon Design Standards are summarized below in **Tables 8** through **12**.

Table 7: City of Saskatoon Standards – Roadway Classification

Roadway Type	Daily Service Volume (veh/day)	Design Speed	Posted Speed (Maximum)
Freeways and Expressways	>20,000	20km/h above posted	100km/h
Arterials	5,000 to 30,000	10km/h above posted	70km/h
Collectors	1,000 to 15,000	10km/h above posted	50km/h

Local Streets	<1,000	50km/h	50km/h
Lanes	None specified	30-40km/h	20km/h

Freeways and Expressways: Intended to accommodate heavy volumes of traffic moving at high speeds under free-flow conditions. Urban sections should be considered where the ROW is less than 100m

Table 8: City of Saskatoon Standards – Freeways and Expressways

		Geometric Design Standard	Reference
Minimum Right-of-Way (m)		100m	Saskatoon 3.4.3
Minimum Number of Lanes		4	Saskatoon 3.4.4
Minimum Lane Width (m)		3.60m	Plan 102-0029-002r003
Minimum Radius (m)		670m	Saskatoon 3.4.6
Minimum length of Spiral (m)		50m	Saskatoon 3.4.6
Minimum Cross-Slope (%)		2.5%	Saskatoon 3.4.2
Interchange Ramp Width (m)	**Ramp**	4.0m	Saskatoon 3.4.2
	Loop	5.0m	Saskatoon 3.4.2
Interchange Inside (Outside) Shoulder Width (m)	**Ramp**	1.0m (2.5m)	Saskatoon 3.4.2
	Loop	1.0m (2.5m)	Saskatoon 3.4.2
Maximum Longitudinal Gradient (%)		5%	Saskatoon 4.1
Minimum Longitudinal Gradient (%)		0.5%	Saskatoon 4.1
K-Value of Vertical Curve		None Specified	Saskatoon 4.2
Superelevation (m/m)		0.06	Saskatoon 4.3

Arterials: Intended to carry large volumes of all types of traffic moving at medium speeds. They expedite movement of through traffic to major traffic generators and from subdivision to subdivision.
Class A: 6 lanes, divided
Class B: 4 lanes, divided
Class C: 4 lanes, undivided

Table 9: City of Saskatoon Standards – Arterial Roads

		Geometric Design Standard	Reference
Minimum Right-of-Way (m)	**Class A**	38m	Saskatoon 3.5.3
	Class B	32m	Saskatoon 3.5.3
	Class C	30m	Saskatoon 3.5.3
Minimum Number of Lanes		4	Saskatoon 3.5.4
Minimum Lane Width (m)		3.60m	Plan 102-0029-004r003
Minimum Radius (m)		250m (400 to 5,000m preferred)	Saskatoon 3.5.6
Minimum length of Spiral (m)		50m	Saskatoon 3.5.6
Minimum Cross-Slope (%)		2.5%	Saskatoon 3.5.2
Preferred Intersection Spacing (m)		450m (250m minimum)	Saskatoon 3.5.7
Maximum Longitudinal Gradient (%)		5%	Saskatoon 4.1

Minimum Longitudinal Gradient (%)	0.5%	Saskatoon 4.1
K-Value of Vertical Curve	As per Engineer's design	Saskatoon 4.2

Collectors: Intended to provide both traffic movement and land access. They carry traffic between local and arterial streets.
Class A: 2 lanes, undivided, parking lane on both sides
Class B: 2 lanes, undivided, parking lane on one side
Class C: 2 lanes, undivided, no parking lanes

Table 10: City of Saskatoon Standards – Collector Roads

		Geometric Design Standard	Reference
Minimum Right-of-Way (m)	**Class A**	22m	Saskatoon 3.6.3
	Class B	22m	Saskatoon 3.6.3
	Class C	20m	Saskatoon 3.6.3
Number of Lanes (see parking requirements above)		2	Saskatoon 3.6.4
Minimum Lane Width (m)		3.60m	Plan 102-0029-008r003
Minimum Radius (m)			TAC Table 3.2.3
Minimum Cross-Slope (%)		2.5%	Saskatoon 3.6.2
Minimum Intersection Spacing (m)		60m	Saskatoon 3.6.6
Maximum Longitudinal Gradient (%)		5%	Saskatoon 4.1
Minimum Longitudinal Gradient (%)		0.5%	Saskatoon 4.1
K-Value of Vertical Curve		20	Saskatoon 4.2

Locals: Intended to provide land access. Not intended to carry large volumes of traffic.
Class A & B: Preferred. Class B is less than 500m in length
Class C: Serving Cul-de-sacs

Table 11: City of Saskatoon Standards – Local Roads

		Geometric Design Standard	Reference
Minimum Right-of-Way (m)	**Class A**	18m	Saskatoon 3.7.3
	Class B	16m	Saskatoon 3.7.3
	Class C	15m	Saskatoon 3.7.3
Number of Lanes		2 traveled + minimum 1 parking	Saskatoon 3.7.4
Minimum Lane Width (m)		4.5m	Plan 102-0029-011r003
Minimum Cross-Slope (%)		2.5%	Saskatoon 3.7.2
Maximum Longitudinal Gradient (%)		5%	Saskatoon 4.1
Minimum Longitudinal Gradient (%)		0.5%	Saskatoon 4.1
K-Value of Vertical Curve		10	Saskatoon 4.2

Industrial Roads: Intended to provide both traffic movement and land access within industrial zoned areas. These roadways may be classified as arterials, collectors, or locals.

Table 12: City of Saskatoon Standards – Industrial Roads

	Geometric Design Standard	Reference
Minimum Right-of-Way (m)	20m	Saskatoon 3.8.3
Number of Lanes	2 traveled + 2 parking	Saskatoon 3.8.4
Minimum Through Lane Width (m)	4m	Plan 102-0029-007r003
Minimum Parking Lane Width (m)	3.5m	Plan 102-0029-007r003
Minimum Cross-Slope (%)	2.5%	Saskatoon 3.8.2
Maximum Longitudinal Gradient (%)	5%	Saskatoon 4.1
Minimum Longitudinal Gradient (%)	0.5%	Saskatoon 4.1
K-Value of Vertical Curve	20	Saskatoon 4.2

APPENDIX E

Structure Design Criteria Summary

Saskatoon Freeway Functional Planning Study

Structure Design Criteria Summary

Saskatchewan Ministry of Highways

September 29, 20210

20200505_659183_Structure_Design_Criteria_Summary_FINAL_V00.Docx

Notice to Reader

This report has been prepared and the work referred to in this report has been undertaken by SNC-Lavalin Inc. (SNC-Lavalin), for the exclusive use of Saskatchewan Ministry of Highways (the Client), who has been party to the development of the scope of work and understands its limitations. The methodology, findings, conclusions and recommendations in this report are based solely upon the scope of work and subject to the time and budgetary considerations described in the proposal and/or contract pursuant to which this report was issued. Any use, reliance on, or decision made by a third party based on this report is the sole responsibility of such third party. SNC-Lavalin accepts no liability or responsibility for any damages that may be suffered or incurred by any third party as a result of the use of, reliance on, or any decision made based on this report.

The findings, conclusions and recommendations in this report (i) have been developed in a manner consistent with the level of skill normally exercised by professionals currently practicing under similar conditions in the area, and (ii) reflect SNC-Lavalin's best judgment based on information available at the time of preparation of this report. No other warranties, either expressed or implied, are made with respect to the professional services provided to the Client or the findings, conclusions and recommendations contained in this report. The findings and conclusions contained in this report are valid only as of the date of this report and may be based, in part, upon information provided by others. If any of the information is inaccurate, new information is discovered or project parameters change, modifications to this report may be necessary.

This report must be read as a whole, as sections taken out of context may be misleading. If discrepancies occur between the preliminary (draft) and final version of this report, it is the final version that takes precedence. Nothing in this report is intended to constitute or provide a legal opinion.

The contents of this report are confidential and proprietary. Other than by the Client, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of the Client and SNC-Lavalin.

Rev.	Item	Description
	Geometry	
	Spans:	Site specific. Continuous superstructure for multi-span bridges.
0	**Vertical Alignment:**	For deck drainage purposes, a minimum longitudinal grade of 0.5% shall be provided on bridge decks that are not on vertical curves. Bridges may be located on vertical curves, for this situation, it is desirable that the crest of the vertical curve shall be located beyond the length of the superstructure and approach slabs, and in no case shall more than a 20 m length of the bridge have a gradient less than 0.5% (see Bridge Design Criteria BD100-Ver 2018-1 (Section 4.2)). Vertical Clearance requirements: Minimum 5.3 m clear from top of underlying roadway to underside of superstructure. Minimum 7.31 m clear from top of rail to underside of superstructure at railway overpasses. Navigation requirements (stream crossings): Navigation vessel clearance TBD. 0.3 freeboard from 1:100 flood levels. Navigation requirements (river crossings): Navigation vessel clearance TBD. 2.5 m freeboard from 1:100 flood levels. Refer to site specific roadway alignment drawings.
0	**Horizontal Alignment:**	Refer to site specific roadway alignment drawings.
0	**Skew:**	Refer to Design Manual Part 1 Standard Plans 20150 and 20152, and TAC Geometric Design Guide Supplement SKS2.2.10-A.
0	**Lanes, Widths and Clearance:**	Site specific.
0	**Overall Width of Structure:**	N/A
0	**Future requirements:**	

Rev.	Item	Description
	Design Parameters	
0	**Live Load:**	Cl-750 truck loading plus dynamic load allowance as defined in CHBDC. No adjustments are required for the 9 kN/m uniformly distributed load for lane load. (see BD100 CL 1.2).
0	**Fatigue Design:**	Class A Highway requirements as defined in CSA-S6 Clause 1.4.2.2.
0	**Temperature Range:**	Site specific according to CSA-S6:19.
	Structural Materials	
0	**Concrete:**	Deck Concrete: Type DC, 45 MPa at 28 days, 5-7% air, w/c=0.38. Superstructure and Substructure: Type C, 35 MPa at 28 days, 5-7% air, w/c=0.40.
0	**Reinforcing Steel:**	CAN/CSA- G30.18, Grade 400. Stainless Steel ASTM A276 and ASTM A955/A955M – UNS S24100, S31653, S31603, S31803, S30400, or S32304. Low carbon/chromium reinforcing steel ASTM. A1035/A1035M, with min. CR content of 9.2% and min. yield strength of 690 MPa.
0	**Structural Steel:**	Girders, and all welded attachments: CAN/CSA G40.2 M, Grade 350 AT, Category 3. Bracing material bolted to girders: CAN/CSA G40.2 M, Grade 350 A.
0	**Concrete Cover:**	Concrete Cover: Refer to MHI document “BD100- Bridge Design Criteria” section 6.3.

Rev.	Item	Description
	Abutments	
0	**Type:**	Integral, Semi-integral, or conventional reinforced concrete abutment with wing wall perpendicular to the abutment.
0	**Foundation:**	TBD
0	**Approach Slabs:**	0.300 m thick, extend to the end of parallel wingwalls or minimum 4800 mm long measured parallel to centreline of roadway.
0	**Finishes and Sealing:**	An approved Type 1 c sealer shall be applied to all concrete surfaces that are susceptible to deterioration by water and de-icing salts.
0	**Slope Protection:**	All concrete slope protection shall be done in accordance with Alberta Transportation Standard Drawing S-1409-99 (Concrete Slope Protection).
0	**Abutment Seat:**	Tops of abutment seat shall have a wash slope of 3%.
	Piers	
0	**Type:**	Solid concrete multiple circular column piers with rectangular pile cap and rectangular pier cap. Piers with three columns or less shall have a minimum cross-section area of 2.8 m^2 for each column. Piers with 4 or more columns shall have a minimum cross-section area of 1.8 m^2 for each column.
0	**Foundation:**	TBD
0	**Finishes and Sealing:**	An approved Type 1c sealer shall be applied to all concrete surfaces that are susceptible to deterioration by water and de-icing salts.
0	**Abutment Seat:**	Tops of pier cap shall have a wash slope of 3%.

Rev.	Item	Description
	Bearings	
0	**General:**	Bearings to be replaceable by jacking the superstructure. Abutment and Pier bearing seats shall be designed to allow for an appropriate area for jacking.
0	**Abutments:**	Proposed fixed, unidirectional (longitudinal) and multidirectional reinforced elastomeric bearings with Teflon / stainless steel sliding plate. Pot bearings to be considered if warranted due to load demands.
0	**Orientation W.R.T Skew:**	Primary movement parallel with girder centerline.
	Steel Girders	
0	**Analysis Type:**	Simplified Method of Analysis in accordance with CHBDC CAN/CSA-S6:19.
0	**Type:**	Welded plate girder, straight, nominal web depth based on span. Nelson shear studs to be provided for composite action with concrete deck.
0	**Number and Spacing:**	spans < 50 m - minimum of 4 girder lines. spans > 50 m - minimum of 3 girder lines.
0	**Continuity:**	Non-composite girders under self- weight and deck self-weight, composite girders under superimposed dead load and live loads.
0	**Yield Strength, F_y:**	350 MPa.
0	**Section Properties:**	Before composite action: Bare steel girder only (S). After composite action 1 x n: Live Loads (S_n). After composite action, 3 x n: dead loads applied after composite action, to account for creep and shrinkage (S_{3n}).

Rev.	Item	Description
0	**Diaphragms:**	Girders cross- frame maximum spacing 8.0 m. Integral and Semi-Integral Abutment diaphragms: 0.80 m wide full depth concrete sections. Minimum gap between the diaphragm and abutment is 0.020 m to allow jacking of the superstructure where applicable.
	Prestressed Concrete Girders	
0	**Analysis Type:**	Simplified Method of Analysis in accordance with CHBDC CAN/CSA-S6:19.
0	**Type:**	NU precast prestressed concrete girders, depth based on spans.
0	**Number and Spacing:**	Spans < 50 m - minimum of 4 girder lines. Spans > 50 m - minimum of 3 girder lines.
0	**Continuity:**	Simple span non-composite girders under self-weight and deck self-weight, continuous composite girders under superimposed dead load and live loads.
0	**Design:**	Zero tension in girders under service load after all losses.
0	**Precast Concrete:**	Type G, Air content = 5-7%, w/c = 0.38, minimum 35 MPA.
0	**Reinforcement:**	CAN/CSA-G30.18, Grade 400.
0	**Prestressing Steel:**	CAN/CSA-G279, Grade 1860 low relaxation.
0	**Lateral Stressing:**	N/A
0	**Stressing Ducts:**	N/A
0	**Grouting:**	N/A

Rev.	Item	Description
0	**Diaphragms:**	Integral and Semi-Integral Abutment diaphragms: 0.80 m wide full depth concrete sections. Intermediate diaphragms: 0.30 m wide full depth concrete sections or steel bracing with maximum spacing 13.0 m. Minimum gap between the diaphragm and abutment is 0.020 m to allow hacking of the superstructure where applicable.
	Deck	
0	**Construction:**	Cast-in-place conventional reinforced concrete deck.
0	**Nominal Thickness:**	Minimum slab thickness to be the greater of the girder c/c spacing divided by 15.0 or 225 mm. Slab thickness shall be increased 70 mm over the girders to allow for formwork adjustment.
0	**Crossfall:**	Nominal 2% cross fall each way from center crown.
0	**Wearing Surface:**	Standard deck protection and wearing surface system has a total thickness of 90 mm consisting of a nominal 5 mm thick rubberized asphalt waterproofing membrane, plus 3 mm protective board, plus two 40 mm lifts of asphaltic concrete pavement.
0	**Sidewalks:**	None.
0	**Median:**	TBD
0	**Curbs:**	Curb control joints spaced maximum 2.5 m. Tops of curbs and barriers shall have a wash slope of 3%.
0	**Deck Drains:**	Both sides.
0	**Utilities/Lighting:**	Two 100 mm diameter PVC ducts complete with pull wires in each curb on each side of bridge.
0	**Deck Joints**	Site specific.
0	**Bridge Railing**	See BD100 Clause 16.

SNC·LAVALIN
202 - 1911E Truesdale Drive
Regina, Saskatchewan, Canada S4V 2N1
306.546.4220
www.snclavalin.com

APPENDIX F
Design Workshop Memorandum

SNC·LAVALIN

AECOM Imagine it. Delivered.

To:
Geoffrey Meinert, P.Eng
Senior Project Manager
Saskatchewan Ministry of Highways and Infrastructure

CC:
Jorge Antunes, SNC-Lavalin

Project Name:
Saskatoon Freeway Functional Planning Study

Project Ref: 60594864

Prepared By:
Tammy Dow

Date:
August 30th, 2019

Memo

Subject: Saskatoon Freeway Functional Planning Study Design Workshop for Phase 1 (North Section)

1. Introduction

SNC Lavalin and AECOM were retained by the Saskatchewan Ministry of Highways and Infrastructure (the Ministry) to undertake the Saskatchewan Freeway Functional Planning Study, which includes 55 km of freeway, 16 interchanges, 5 railway crossings, at least 2 flyovers and 1 major bridge crossing. The study area is included in **Figure 1**. Each phase will take approximately one year to complete with the project estimated to be completed in late 2021.

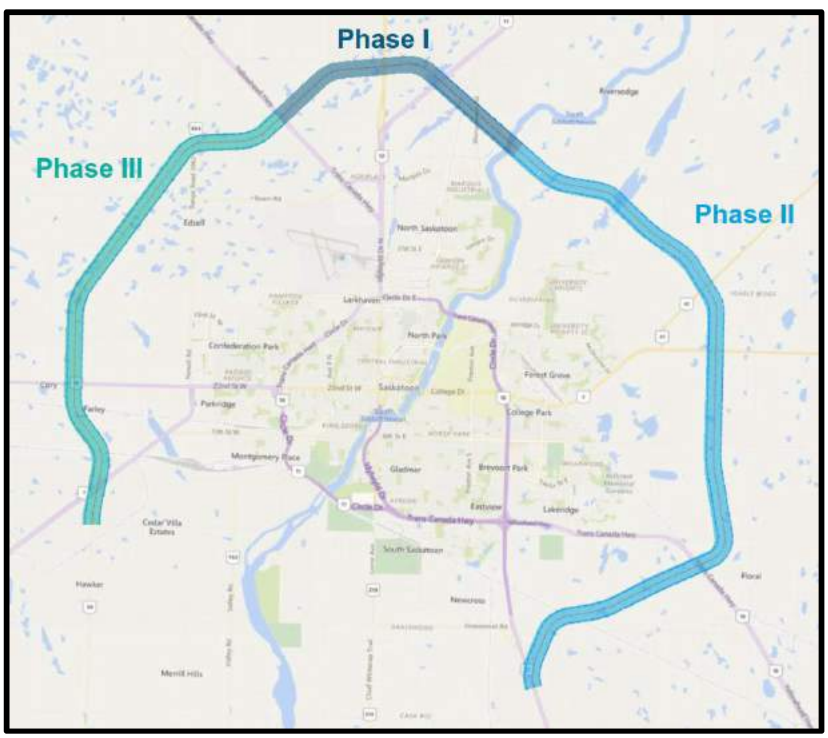


Figure 1: Saskatoon Freeway Functional Planning Study Area

The study limits for Phase 1 (i.e. north section), which is the focus of the design workshop, are illustrated in **Figure 2.**

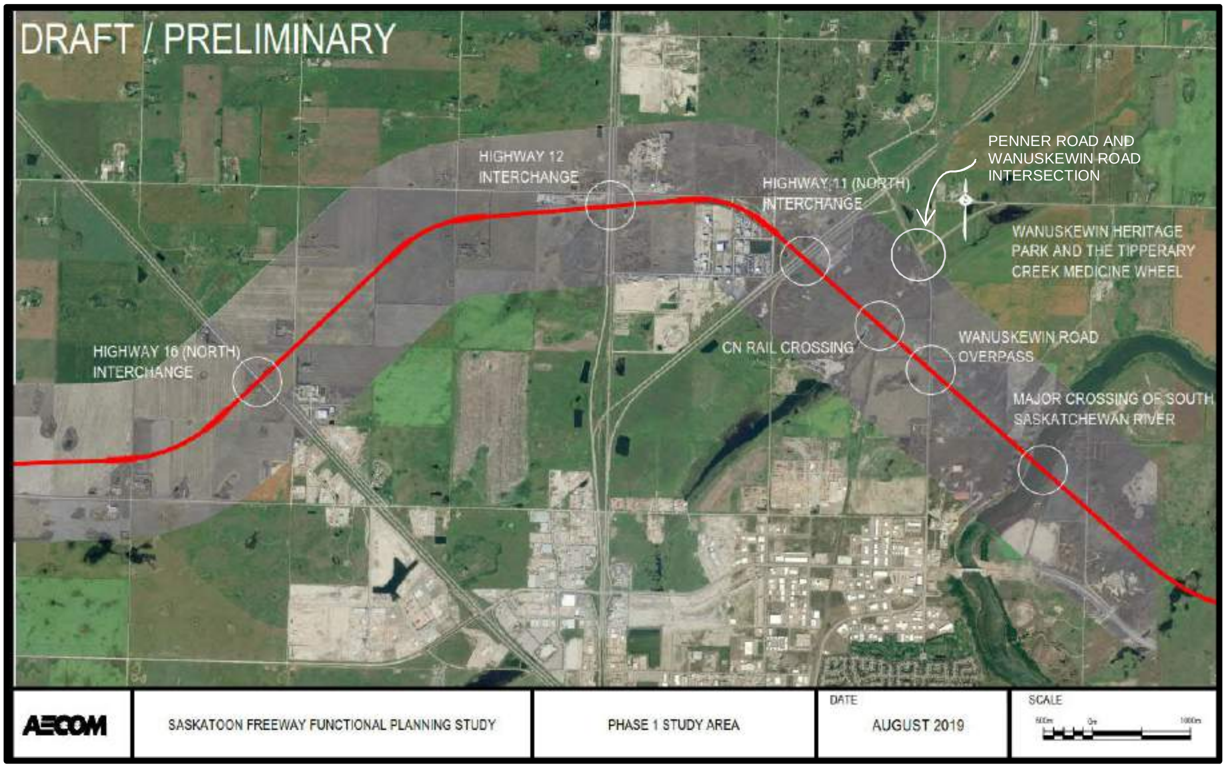


Figure 2: Phase 1 Study Limits from West of Highway 12 to East of Wanuskewin Road

Phase 1 of the Saskatoon freeway is perhaps the most complex of the three phases. It's a busy corridor with Highways 11 and 12, as well as Wanuskewin Road and Millar Avenue in this area, in addition to proposed crossings of the South Saskatchewan River and a CN Rail line.

The purpose of the design workshop was to enable an innovative atmosphere in which a diverse group of stakeholders can collaborate to generate and select a framework to address this complex section of the Saskatoon Freeway in the north. A diverse group of agencies and groups with strong local knowledge as well as members of the design team were invited to participate in a design workshop for Phase 1 from June 27th to June 28th, 2019 to help the Ministry of Highways and Infrastructure determine the best alignment and interchange layout for the north section of the Saskatoon Freeway. The goal of the design workshop is to provide the Province with a suggested layout that addresses local needs, meets all road design standards for safety, and meets the future capacity needs for the community of 750,000 people.

The objectives of the Design Workshop were for the participants to:

- Review the four (4) alternatives developed by the design team and determine if other alternatives exist;
- Provide input from the perspective of individuals who work and live in the community;
- Identify best value performance criteria and evaluate which alternative will provide the best value; and,
- Provide considerations for the design team to consider during design of the preferred alternative.

Design workshop participants were asked to provide their issues, concerns, and requirements with respect to the Phase 1 section of the project, which allowed for the group understanding of issues from each participant.

2. Design Workshop Discussions

Design workshop participants were asked to provide their issues, concerns, and requirements with respect to the Phase 1 section of the project. The discussion was recorded and includes:

- Ministry
  - Concern is access for locals with regard to local traffic trying to get to work, land, schools, etc. therefore, looking for general concerns from partners with regard to public access
  - Maintaining connectivity with road system to other areas without Freeway impacting in place routes
  - The Freeway should not be a barrier to development
  - Allows other modes of transportation access to development areas (e.g. cyclists crossing without going on the Freeway)
  - Connectivity between development areas
  - Ability to add a transportation utility corridor for utilities around the City in conjunction with the Saskatoon Freeway
- North Saskatoon Business Association (NSBA)
  - Learn about the Freeway project with respect to alignment, access, traffic operation, property acquisition and interchange layout
- Wanuskewin Heritage Park
  - Interested in balancing adequate buffer zone between the Freeway and the Heritage Park as well as ease of access into the park
  - Noise impacts
- Corman Park
  - Ease of access from east Cory Industrial Park
  - Compensation for land purchases
  - Releasing land for development as soon as possible
  - Timeliness for acquisition of land
  - Understanding the long-range property requirements and how access will occur to and from the Freeway as well across the Freeway
- City of Saskatoon
  - Connectivity, environmental impact clarity, utility accommodations, transition from the Freeway to City streets (e.g. safety and speed), servicing split City areas on opposite sides of the Freeway
  - City ITS strategy alignment with Freeway ITS strategy
  - Compatibility with the City's *North Saskatoon Network Planning Study*, particularly related to Highway 11 and Wanuskewin Road
  - Understanding of downstream impacts
  - Phasing of construction to minimize impacts to the roadway system and co-ordination with municipalities
- Meewasin Valley Authority
  - Do not compromise function and value of land

- Planning For Growth (P4G)
  - Ensure other plans and work being done are taken into consideration
  - Ensure growth plan and buffers for noise are considered
  - Ensure road allows for multiple mobility options in terms of new traffic technology ITS/vehicles
- All participants
  - Considerations for emergency vehicles, safety, maintenance (e.g. snow clearance)
  - Understanding the Government's long-range plans for the Freeway so development can occur in harmony with those plans

3. Alternatives for Phase 1

To enable the design team to focus on the most complex area of Phase 1, the following project elements were outside the scope of the Design Workshop:

- Alignment is fixed at Highway 12 and at the Saskatchewan River crossing. Only minor alignment changes will be considered between the fixed points
- South Saskatchewan River Crossing
- Interchange ramp configurations
- Developing Service Road and Local Road network
- Interchange at Highway 16
- Phase 2 (east) and Phase 3 (west)

The design team developed four (4) alternatives for Phase 1. The design team presented the following key design challenges in the development of the four (4) alternatives, which were presented to the Design Workshop participants:

- Closely Spaced Interchanges
  - 2.2 km between Highway 12 and Highway 11
  - 2.1 km between Highway 11 and Wanuskewin Road
  - Ministry of Highways and Infrastructure desirable interchange spacing is 8 km; minimum spacing is 3.2 km
  - Interchanges between two Freeways require larger footprint (i.e. at Highway 12 and 11)
  - Close spacing will result in weaving concerns and poor operations in the future
- Communities of Warman and Martinsville
  - Two rapidly growing communities close to Saskatoon will create high peak hour commuter traffic that must be accommodated with expected provincial highway traffic
- CN Rail Crossing
  - Potential sight line concerns crossing over the railway
- Compatibility with City of Saskatoon and RM of Corman Park existing and future infrastructure including the *North Saskatoon Network Planning Study*
- Proximity and access to Wanuskewin Heritage Park.

Figure 3 provides the legend for the alternative design drawings presented to the Design Workshop participants.

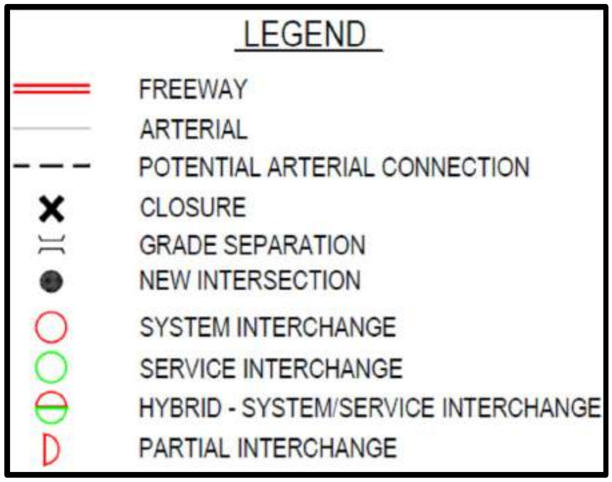


Figure 3: Alternatives Design Legend

3.1 Alternative 1: Three Interchanges

Figures 4 and 5 illustrate Alternative 1: Three Interchanges based on previous transportation planning studies. The key features of this alternative include:

- Closure of Highway 11 from Highway 12 Saskatoon Freeway
- System Interchange at Highway 12
- Partial System Interchange at Highway 11
- System Interchange at Wanuskewin Road
- Wanuskewin Road connection to Penner Road
- Potential connection from Wanuskewin Road / Penner Road to Warman Road TWP Road 3052

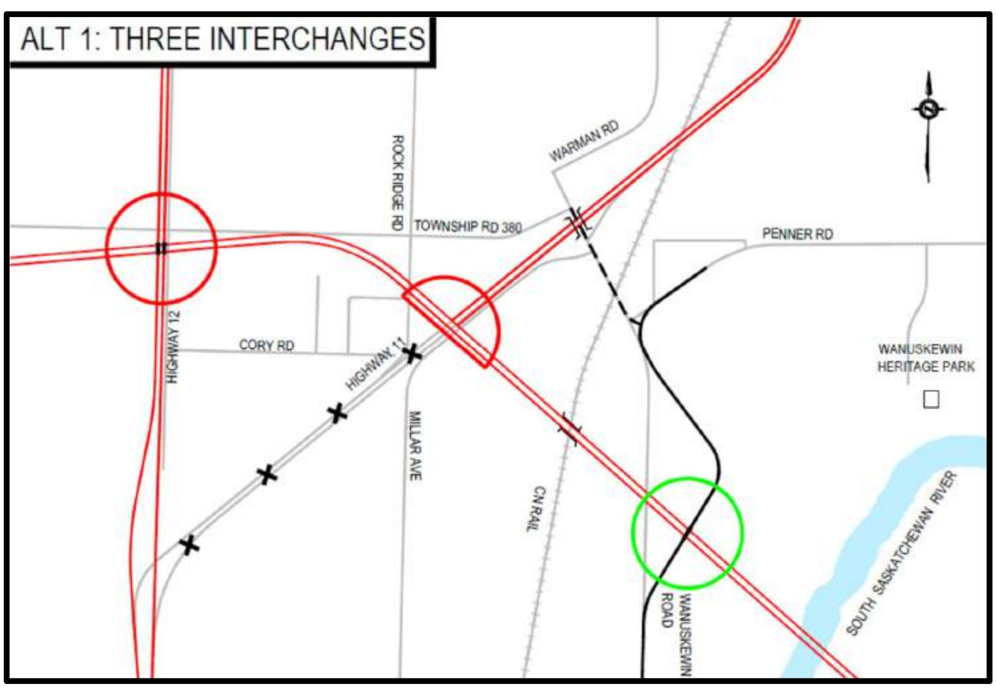


Figure 5 provides potential interchange configurations for this alternative.

Figure 4: Alternative 1: Three Interchanges

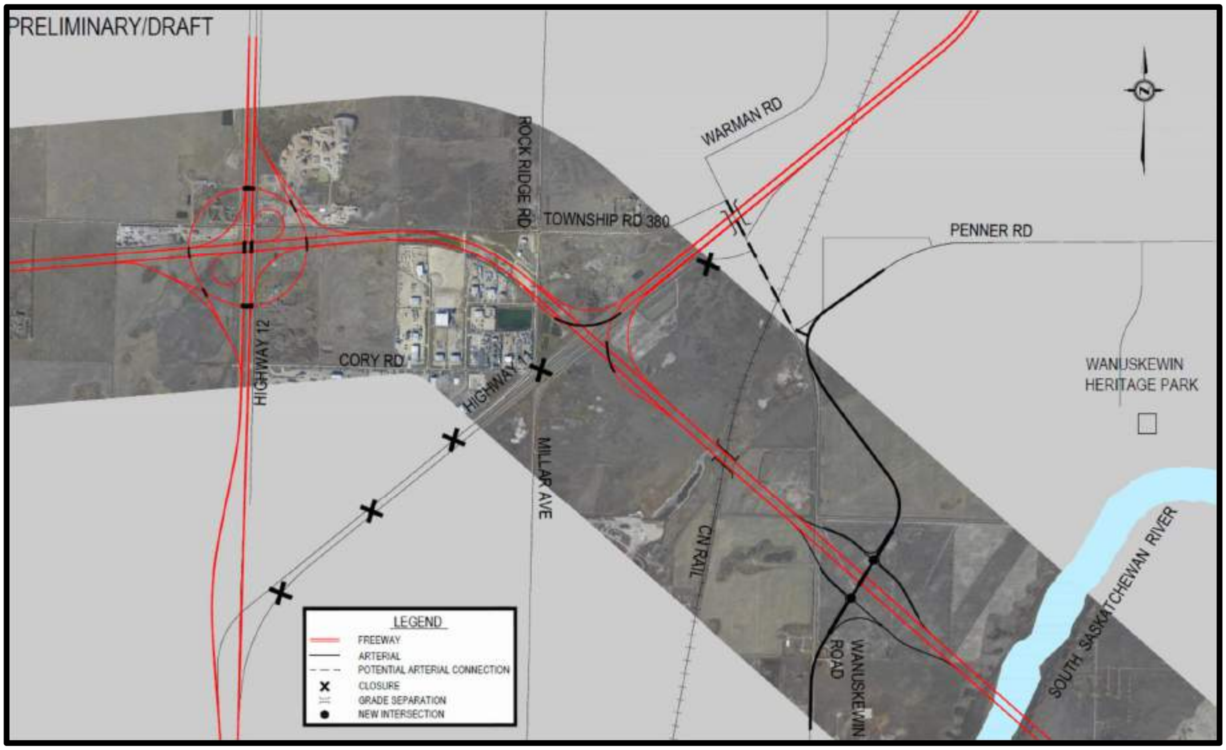


Figure 5: Alternative 1: Three Interchanges

A critical concern with this alternative is the close spacing of interchanges and the risk of weaving movements between interchanges that may seriously impact traffic flow. One way to address this issue is the use of a core collector system. **Figure 6** illustrates a typical freeway cross-section compared to a typical core collector system.

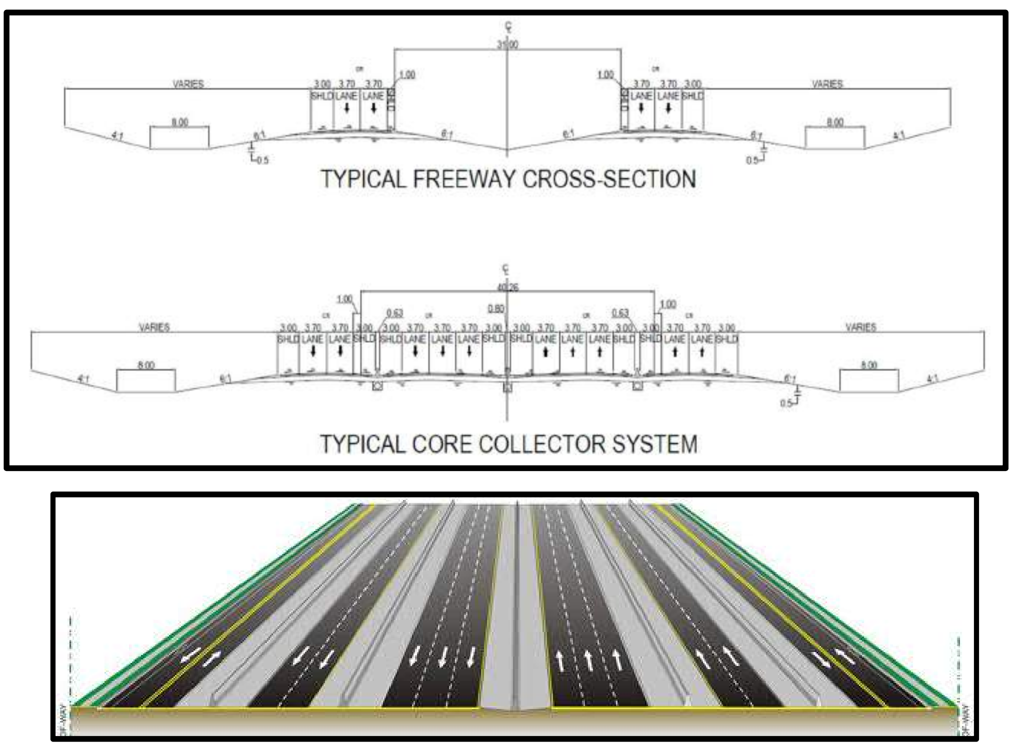


Figure 6: Typical Core Collector System Cross-Section

The technical

advantages and disadvantages of Alternative 1: Three Interchanges are provided in **Table 1**.

Table 1: Technical Advantages and Disadvantages of Alternative 1: Three Interchanges

Advantages	Disadvantages
• More points of access to Saskatoon Freeway • Opportunity to provide arterial connection between Wanuskewin and Warman Road via Highway 11 overpass • Basic Service interchange at Wanuskewin	• Interchange spacing doesn't meet Ministry's minimum standards of 3.2 km's between interchanges (3 interchanges in 4.3 km's) • Concerns with complex and confusing overhead directional signing • Ultimately may require core-collector lanes • Core collector would require additional property requirements and higher cost • Direct connection from Highway 11 into Saskatoon removed, results in out-of-way travel i.e. traffic must backtrack to Highway 12 or 'zig-zag' to Wanuskewin via Saskatoon Freeway. • Requires 2.5 km closure of Highway 11.

3.2 Alternative 2: Two Interchanges

Figures 7 and 8 illustrate Alternative 2: Two Interchanges. This alternative meets the Ministry's minimum spacing requirement between interchanges. Spacing between interchanges is 4.3 km's and the minimum spacing is 3.2 km's. The key features of this alternative include:

- Realignment of Highway 11 to Wanuskewin Road
- Closure of Highway 11 from Highway 12 to east of the CN railway
- System Interchange at Highway 12
- Hybrid Interchange at realigned Highway 11 and Wanuskewin Road
- Partial Service Interchange at Penner Road
- Millar Avenue to Wanuskewin Road Connector
- Potential connection from Penner Road to Warman Road TWP Road 3052

Figure 8 provides potential interchange configurations for this alternative.

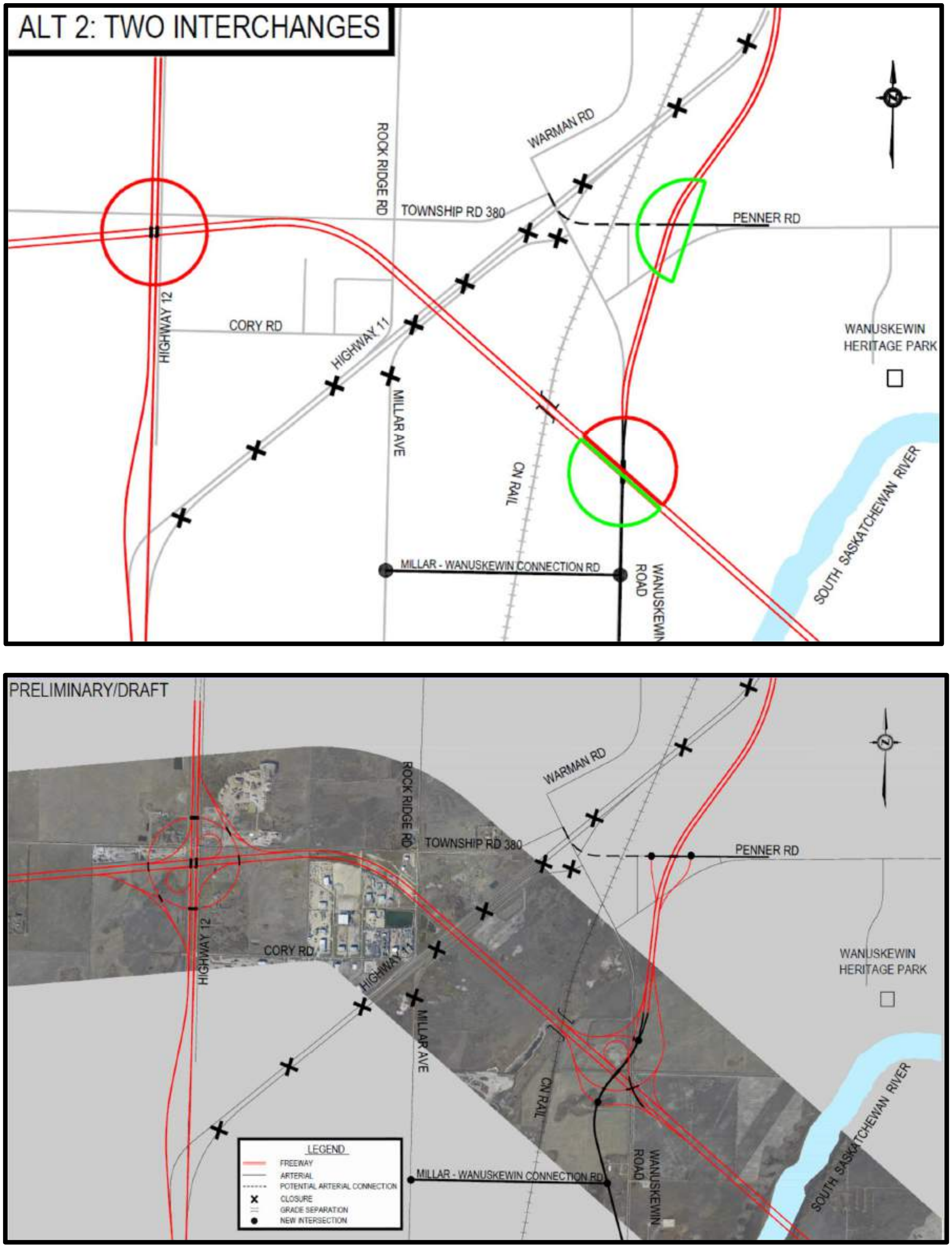


Figure 7: Alternative 2: Two Interchanges

The technical advantages and disadvantages of Alternative 2: Two Interchanges are provided in **Table 2**.

Table 2: Technical Advantages and Disadvantages for Alternative 2: Two Interchanges

Advantages	Disadvantages
• 2 Interchanges spaced 4.3 km apart • Opportunity to provide arterial connection between Penner Road and Warman Road • Millar-Wanuskewin Connection Road provides opportunity to better distribute northbound and southbound traffic • Establishes north-south orientation of roads to and from Saskatoon • Reduced staging impacts at existing roads (i.e. Wanuskewin interchange) • Speed transition from Highway 11 (Freeway) to Wanuskewin (arterial) provided through curvilinear alignment with traffic signals at ramp terminals	• Poor connectivity of local roads north and south of Saskatoon Freeway • Poor access to Penner Road and Wanuskewin Heritage Park from the north • Tight spacing between partial interchange at Highway 11/Penner Road and Highway 11/Saskatoon Freeway • Realignment of Highway 11 has the potential to draw more traffic to Wanuskewin • Abandoning infrastructure due to the 6 km closure of Highway 11

3.3 Alternative 3: Millar Flyover

Figures 9 and 10 illustrate Alternative 3: Millar Flyover. The key features of this alternative include:

- Realignment of Highway 11 to Wanuskewin Road
- Closure of Highway 11 from Highway 12 to east of the CN railway. New Highway 11 relocated eastward.
- Millar Avenue connection to Penner Road to provide access to and from the south, linking industrial area's north and south of the Saskatoon Freeway
- System Interchange at Highway 12 (based on Highway 12 south of Freeway classified as freeway)
- Hybrid Interchange at realigned Highway 11
- Partial Service Interchange at Penner Road to provide access to and from the north
- Millar Avenue to Wanuskewin Road Connector
- Potential connection from Millar Avenue / Penner Road to Warman Road

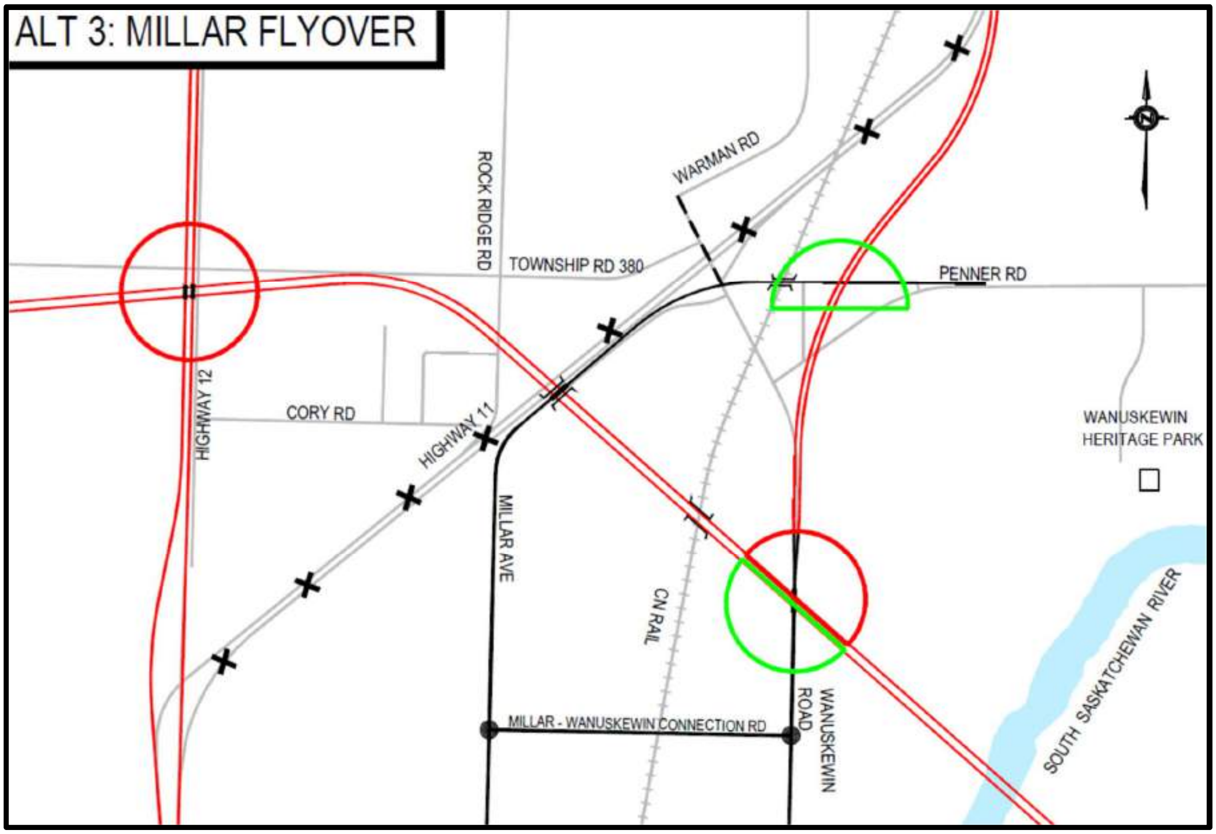


Figure 8: Alternative 3: Millar Flyover

Figure 10 provides potential interchange configurations for this alternative.

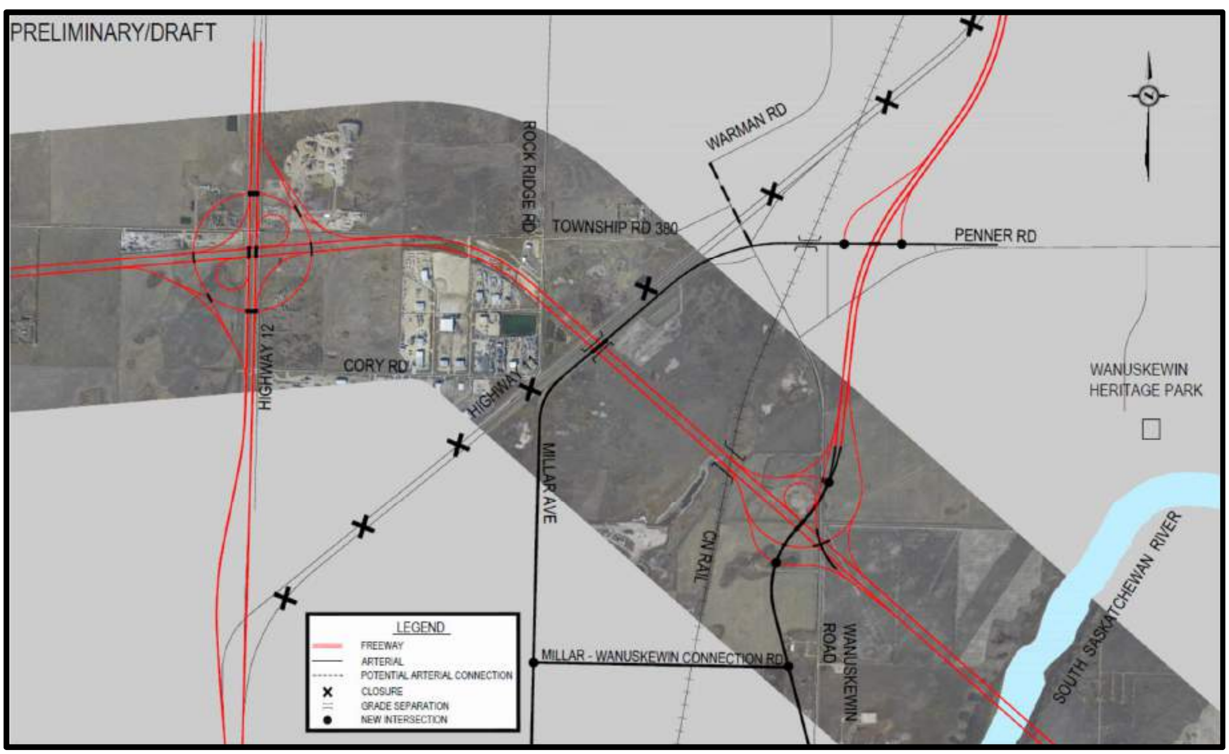


Figure 9: Alternative 3: Millar Flyover

The technical advantages and disadvantages of Alternative 3: Millar Flyover are provided in **Table 3.**

Table 3: Technical Advantages and Disadvantages for Alternative 3: Millar Flyover

Advantages	Disadvantages
• 2 Interchanges spaced 4.3 km apart • Millar Avenue connection to Penner Road provides continuity with local road system • Opportunity to provide arterial connection between Penner Road and Warman Road • Millar-Wanuskewin Connection Road provides opportunity to better distribute northbound and southbound traffic • Establishes north-south orientation of roads to and from Saskatoon • Reduced staging impacts at existing roads (i.e. Wanuskewin interchange) • Speed transition from Highway 11 (Freeway) to Wanuskewin (arterial) provided through curvilinear alignment with traffic signals at ramp terminals	• Wanuskewin Road access to Penner Road from the south is closed; access from south via Millar Avenue • Realignment of Highway 11 has the potential to draw more traffic to Wanuskewin Road • Requires 5 km closure of Highway 11

3.4 Alternative 4: Highway 11 Flyover

Figures 11 and 12 illustrate Alternative 4: Highway 11 Flyover. This alternative was developed to match the preliminary findings from the City of Saskatoon's *North Saskatoon Network Planning Study.* The key features of this alternative include:

- Realignment of Highway 11 to Wanuskewin Road
- Old Highway 11 arterial connection to Penner Road
- Hybrid Interchange at Highway 12 (based on Highway 12 south of Freeway classified as major arterial)
- Hybrid Interchange at realigned Highway 11
- Partial Service Interchange at Penner Road
- Millar Avenue to Wanuskewin Road Connector
- Potential connection from Highway 11 Arterial / Penner Road to Warman Road TWP Road 3052

The following key elements from the *North Saskatoon Network Planning Study* (Draft) are incorporated in this alternative:

- Conversion of Highway 12 and Highway 11 to arterial roads with intersections
- Grade separation of Old Highway 11 at Saskatoon Freeway (flyover)

Figure 12 provides potential interchange configurations for this alternative.

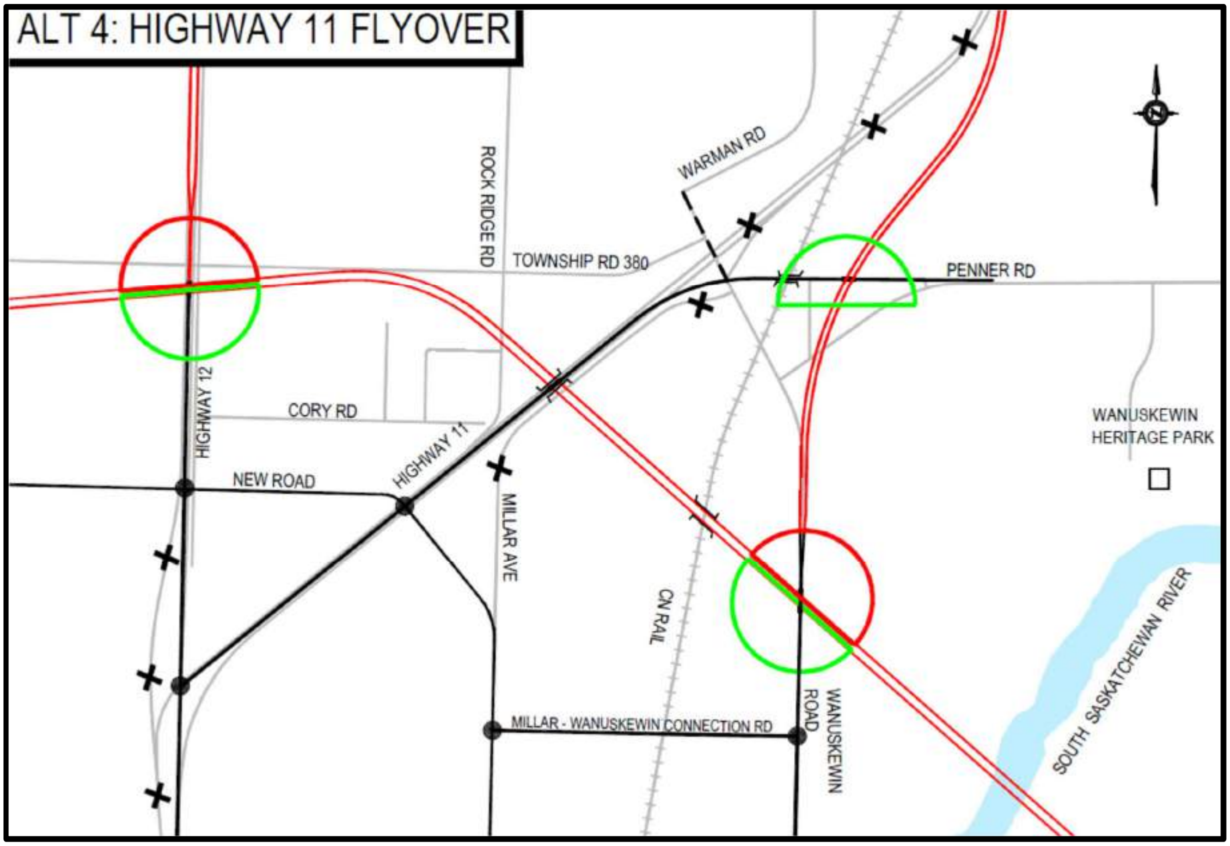
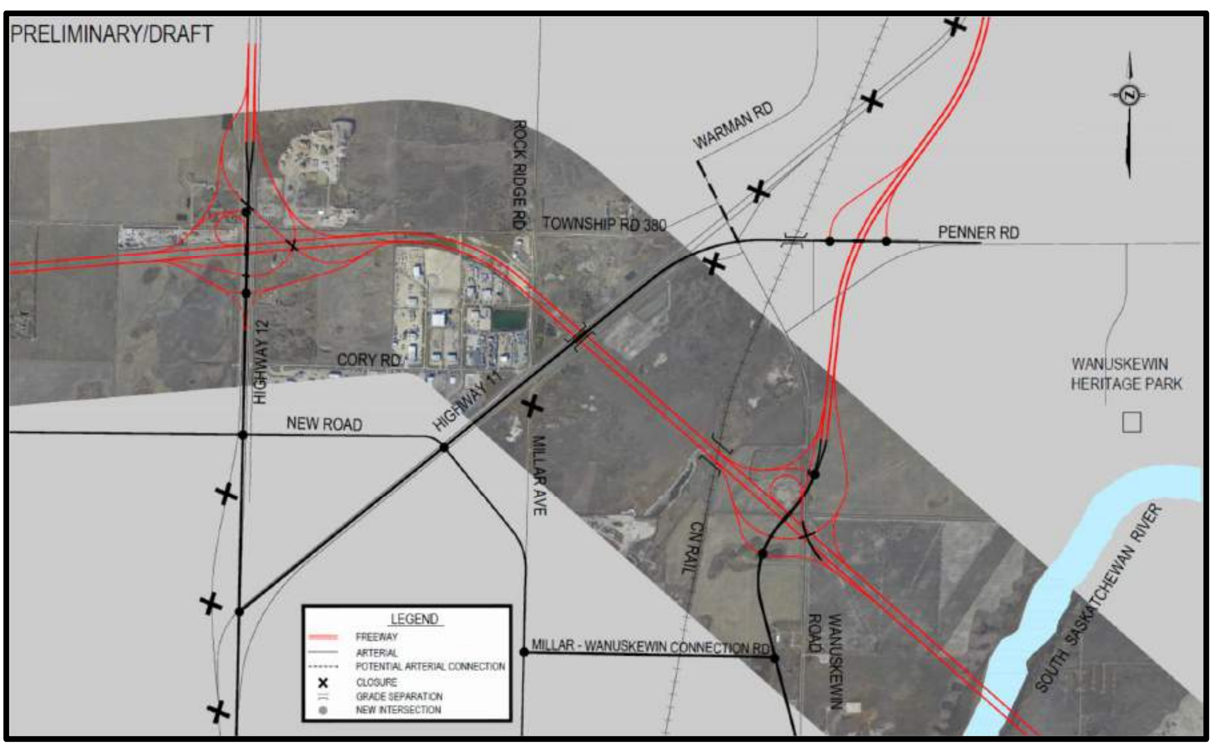


Figure 10: Alternative 4: Highway 11 Flyover



The technical advantages and disadvantages of Alternative 4: Highway 11 Flyover are provided in **Table 4.**

Figure 11: Alternative 4: Highway 11 Flyover

Table 4: Technical Advantages and Disadvantages for Alternative 4: Highway 11 Flyover

Advantages	Disadvantages
• 2 Interchanges spaced 4.3 km apart • Compatible with preliminary recommendations from *North Saskatoon Network Planning Study* (Highways 12 and 11 converted to arterial roads with intersections south of Saskatoon Freeway) • Generally, maintains original road network • High level connectivity on local roads • Opportunity to provide arterial connection between Penner Road and Warman Road • Millar-Wanuskewin Connection Road provides opportunity to better distribute northbound and southbound traffic • Hybrid interchange at Highway 12 requires fewer complex moves, lower costs to construct • Reduced staging impacts at existing roads (i.e. Wanuskewin interchange) • Speed transition from Highway 11 (Freeway) to Wanuskewin (arterial) provided through curvilinear alignment with traffic signals at ramp terminals	• No direct access from Freeway to Wanuskewin Heritage Park • Realignment of Highway 11 has the potential to draw more traffic to Wanuskewin • Requires 2.5 km closure of Highway 11

3.5 Comments on the Alternatives

After the design team presented the four (4) alternatives, the following comments, questions and responses were recorded as provided by the design workshop participants for consideration by the design team as the project proceeds:

- City of Saskatoon
  - Inquired as to whether Highway 11 could be turned over to the City if it is abandoned by the Ministry
    - Yes, it could be a local road. All highways within the Saskatoon Freeway would be transferred to the City
  - What would be the posted speed limit for the Freeway?
    - Freeway would be posted at 110 km/hr
    - Ramps would be posted at 80 km/hr unless ramp connected national system highways
  - All growth is to be in the northeast and northwest. Biggest concern is a high level of connectivity will be required; therefore, need a number of ways to get into the City from the north
  - Based on long-term growth, a full interchange is required on Highway 11 at Penner Road
    - Ministry stated that there is another interchange to the north that needs to be taken into consideration
- North Saskatoon Business Association (NSBA)
  - Who determines the type of connection from Wanuskewin Road/Penner Road to Warman Road?

- Further consultations are required

- Overall comment on Alternative 1: Three Interchanges
  - This would be the first core collector in the province
  - There were concerns with respect to snow removal and maintenance during the winter months
  - Insufficient property between built up developments on either side of the Freeway right of way immediately east of Highway 12
- Saskatchewan Ministry of Highways and Infrastructure
  - For Alternative 2: Two Interchanges, could Highway 11 remain?
    - Yes, but a flyover would be required, and it would have to be turned over to the City
- Wanuskewin Heritage Park
  - Require direct and easy access from Saskatoon off the highway
  - Interested in visual and sound barriers between the Freeway and the park
  - Would like a large buffer between the Freeway and park
  - Would like the design team to consider options for access from Warman Road
- Overall general comments
  - Need to ensure that drivers understand that a flyover is a flyover and that ramps can’t be on them
  - Should provide options for motorists making short trips so they don’t have to use the Freeway
    - This allows for local and international/interprovincial trips not to mix on the Freeway
  - Traffic model should include the future widening of Wanuskewin Road and future works by the City of Saskatoon
  - City of Warman will expand in the future and lot of people will be coming to Saskatoon via Wanuskewin Road for work
  - Consideration of future development along Penner Road and the increase in traffic
  - Wanuskewin Heritage Park is expecting over 120,000 tourists over a 4-month period. This 25% expected increase is due to their United Nations Educational, Scientific and Cultural Organization (UNESCO) application
    - Need to confirm that this is included in the traffic model
  - There are additional residential developments being planned to the north
  - North industrial areas are the biggest trip generators for both commuter and interprovincial traffic in the area, GDP capital of the province and critical for access
  - It is anticipated that there will be a lot of travel between planned growth north of the river (north of Wanuskewin Heritage Park) and the large development node in the City across the river

4.0 Evaluation of Alternatives

4.1 Advantages and Disadvantages of the Alternatives

After the technical advantages and disadvantages of the four (4) alternatives were presented by the design team, the Design Workshop participants brainstormed advantages, disadvantages, opportunities, potential risks and items for the design team to consider as the design proceeds for each of the alternatives. **Table 5** includes the design team’s technical advantages and disadvantages for each alternative as well as the results of the Design Workshops participants advantages and disadvantages discussions.

Table 5: Advantages, Disadvantages, Potential Risks and Items to Consider for Each Alternative

Alternatives	Advantages	Disadvantages	Opportunities	Potential Risks	Items to Consider

Alternative 1: Three Interchanges	• Least amount of change to the existing network; therefore, public opinion may approve of maintaining continuity
	• Easy to add on more pieces without complete redesign
	• More points of access to Saskatoon Freeway
	• Opportunity to provide arterial connection between Wanuskewin and Warman Road via Highway 11 overpass
	• Basic Service interchange at Wanuskewin
		• Larger property impacts near Wanuskewin Heritage Park
		  o cuts into their buffer the most
		  o possible to re-alignment to have less impact
		• Interchange spacing doesn't meet Ministry's minimum standards of 3.2 km's between interchanges (3 interchanges in 4.3 km's)
		• Highway 11 traffic enters a high-speed road on a curve, which is a potential safety risk
		• Increased capital and maintenance costs
		• Costs due to purchasing property within the industrial park
		  o encroachment onto existing developed property
		• Additional structure required to separate railway
		• Traffic accommodation during construction will be difficult
		• Connectivity north-south (N-S) is not as easily accomplished compared to other alternatives
		• Less potential for active or alternative modes of transportation, particularly at structures
		• TWS Road 380 unable to maintain current connection
		• Concerns with complex and confusing overhead directional signing
		• Ultimately may require core-collector lanes
		• Driver education and confusion due to core collector
		• Core collector would require additional property requirements and higher cost
		• Direct connection from Highway 11 into Saskatoon removed, results in out-of-way travel i.e. traffic must backtrack to Highway 12 or 'zig-zag' to Wanuskewin via Saskatoon Freeway
		• Requires 2.5 km closure of Highway 11
			• None identified	• Early congestion, early failure in traffic movement system (due to weaving between interchanges)
				• Penner Road gets more traffic than model suggests
				• Land purchases required in East Cory Industrial Park
					• Potentially leave Wanuskewin Road where it is located now
					• Potentially, 10 lane wide crossing-core collector
					• Consider impacts to TLE Lands
					• High speed ramp bulging out
					• Potential right-of-way provisions may be required for Wanuskewin and trail along the river
					• Green network provisions (i.e. maintain corridors and consider future phases)
					• Residential future development northeast (NE) along the river; therefore, consider future connections for alternative modes of transportation
					• Drainage network from Warman and Martinsville needs to be considered
					• City transit implications and accommodations potential for high occupancy vehicles such as LRT/BRT
					• Saskwater line / Saskpower lines to be considered
					• Consider Hudson Bay Swale impact
					• Provision of N-S cycling routes for commuter cyclists

Alternatives	Advantages	Disadvantages	Opportunities	Potential Risks	Items to Consider
Alternative 2: Two Interchanges	• Eliminates an at grade rail crossing at Highway 11 and CN • 2 interchanges spaced 4.3 km's apart • Allows for possibility of N-S flyover for Millar Avenue • Travel time reduced for Highway 11 • Opportunity to provide arterial connection between Penner Road and Warman Road • Millar-Wanuskewin Connection Road provides opportunity to better distribute northbound and southbound traffic • Establishes north-south orientation of roads to and from Saskatoon • Reduced staging impacts at existing roads (i.e. Wanuskewin Interchange) • Speed transition from Highway 11 (Freeway) to Wanuskewin (arterial) provided through curvilinear alignment with traffic signals at ramp terminals	• Provides less access to City compared to Alternatives 3 and 4 • Less traffic on Millar Avenue • Abandoning infrastructure due to the 6 km closure of Highway 11 • No provision for flyovers o less access to City o less connectivity • Poor connectivity of local roads north and south of Saskatoon Freeway • Less potential for active modes • Lack of access from East Cory Industrial Park • No direct access to Wanuskewin Heritage Park from the north • Tight spacing between partial interchange at Highway 11/Penner Road and Highway 11/Saskatoon Freeway • Realignment of Highway 11 has the potential to draw more traffic to Wanuskewin • Poor connectivity of local roads north and south of Saskatoon Freeway • Poor access to Penner Road and Wanuskewin Heritage Park from the north	• Potential north / south flyover at Millar Avenue	• Crossing discussions with CN • Potential risk with Penner Road vertical alignment • Land purchase for relocated Highway 11	• Full access on Penner Road • More traffic distributed to Wanuskewin Road inside City limits from Highway 11 • Consider impacts to TLE Lands at Warman Road north and west of existing Highway 11 • Potential right-of-way provisions may be required for Wanuskewin Heritage Park and trail along the river • Green network provisions (i.e. maintain corridors and consider future phases) • Residential future development NE along river; therefore, consider future connections for alternative modes of transportation • Drainage network from Warman and Martinsville needs to be considered • City transit implications and accommodations potential for high occupancy vehicles such as LRT/BRT • Saskwater line / Saskpower lines to be considered • Consider Hudson Bay Swale impact • Provision of N-S cycling routes for commuter cyclists
Alternative 3: Millar Flyover	• Eliminates an at grade rail crossing at Highway 11 and CN • More suitable for pedestrian crossovers and alternatives modes of transportation • Better accommodates future City transit • Safety due to interchange spacing • Flyovers in-between interchanges to allow for traffic in north industrial to exit/enter City easily • Flow is simpler and less stoppages to keep flow higher for drivers; therefore, less chance for driver error o safer option as it allows drivers to	• Loss of infrastructure on Highway 11 due to using Millar Avenue • Poor access to Penner Road • No direct access from Freeway to Wanuskewin Heritage Park • Poor access to East Cory Industrial Park (Highway 12 is freeway) • Wanuskewin Road access to Penner Road from the south is closed; access from south via Millar Avenue • Realignment of Highway 11 has the potential to draw more traffic to Wanuskewin Road • Requires 5 km closure of Highway 11	• City to take over Highway 11 and use as arterial • Allow for municipalities to determine the road network south and north of Freeway	• Crossing discussions with CN • Land purchase for relocated Highway 11	• Full access on Penner Road from all directions • Consider impacts to TLE Lands • Potential right-of-way provisions may be required for Wanuskewin and trail along the river • Green network provisions (i.e. maintain corridors and consider future phases) • Residential future development NE along river; therefore, consider future connections for alternative modes of transportation • Drainage network from Warman and Martinsville needs to be considered • City transit implications and accommodations potential for high

Alternatives	Advantages	Disadvantages	Opportunities	Potential Risks	Items to Consider
	correct in a more spacious area • 2 interchanges spaced 4.3 km's apart • Millar Avenue connection to Penner Road provides continuity with local road system • Opportunity to provide arterial connection between Penner Road and Warman Road • Millar-Wanuskewin Connection Road provides opportunity to better distribute northbound and southbound traffic • Reduced staging impacts at existing roads (i.e. Wanuskewin Interchange) • Speed transition from Highway 11 (Freeway) to Wanuskewin (arterial) provided through curvilinear alignment with traffic signals at ramp terminals				occupancy vehicles such as LRT/BRT • Saskwater line / Saskpower lines to be considered • Consider Hudson Bay Swale impact • Provision of N-S cycling routes for commuter cyclists
Alternative 4: Highway 11 Flyover	• Eliminates an at grade rail crossing at Highway 11 and CN • Aligns with current City of Saskatoon sector planning for everything inside Freeway, including not yet approved plans • Existing Highway 11 staying near the railway • Safety due to interchange spacing • Flyovers in-between interchanges to allow for traffic in north industrial to exit/enter City easily • Flow is simpler and less stoppages to keep flow higher for drivers; therefore, less chance for driver error o safer option as it allows drivers to correct in a more spacious area • Better utilizes existing Highway 11 infrastructure • More suitable for pedestrian crossovers and alternative modes of transportation • Better accommodates future City	• More out of way travel due to access to Wanuskewin • No direct access from Freeway to Wanuskewin Heritage Park • Realignment of Highway 11 has the potential to draw more traffic to Wanuskewin • Requires 2.5 km closure of Highway 11	• Allow for municipalities to determine the road network south and north of Freeway	• Land purchase for relocated Highway 11 • Crossing discussions with CN Rail	• Move Penner Road intersection north to accommodate for interchange to provide direct access to Wanuskewin • Consider impacts to TLE Lands • Millar Avenue could be a signalized intersection to continue to connect to Highway 11 • Leave Highway 11 parallel to railroad to not affect connectivity • Transition from high speed Freeway to interior City arterial roads • Spacing of Highway 11 to rail line may need realignment • Full access on Penner Road • Potential right-of-way provisions may be required for Wanuskewin and trail along the river • Green network provisions (i.e. maintain corridors and consider future phases) • Residential future development NE along river; therefore, consider future connections for alternative modes of transportation • Drainage network from Warman and

Alternatives	Advantages	Disadvantages	Opportunities	Potential Risks	Items to Consider
	transit • Good access to East Cory Industrial Park (Highway 12 is arterial) • 2 Interchanges spaced 4.3 km's apart • Compatible with preliminary recommendations from *North Saskatoon Network Planning Study* (Highways 12 and 11 converted to arterial roads with intersections south of Saskatoon Freeway) • Generally, maintains original road network • High level connectivity on local roads • Opportunity to provide arterial connection between Penner Road and Warman Road • Millar-Wanuskewin Connection Road provides opportunity to better distribute northbound and southbound traffic • Hybrid interchange at Highway 12 requires fewer complex moves, lower costs to construct • Reduced staging impacts at existing roads (i.e. Wanuskewin Interchange) • Speed transition from Highway 11 (Freeway) to Wanuskewin (arterial) provided through curvilinear alignment with traffic signals at ramp terminals				Martinsville needs to be considered • City transit implications and accommodations potential for high occupancy vehicles such as LRT/BRT • Saskwater line / Saskpower lines to be considered • Consider Hudson Bay Swale impact • Provision of N-S cycling routes for commuter cyclists

4.2 Performance Criteria and Measures

By consensus, the design workshop participants identified the performance criteria and measures by which the four (4) alternatives would be compared to each other in order for the participants to identify which alternative will provide the best value. **Table 6** provides the performance criteria and their measures used by the design workshop participants to identify a preferred alternative. Some of the benefits of performance Criteria and measures include:

- Builds consensus among project stakeholders (especially those holding conflicting views)
- Develops a better understanding of a project's goals and objectives
- Develops a baseline understanding of how a project is meeting performance goals and objectives

Table 6: Performance Criteria and Measures

Performance Criteria	Measures
Access Inside Freeway	Access to industrial lands
Access Outside Freeway	Access to industrials, residential and First Nation lands
Access to Wanuskewin Heritage Park	Potential to provide full access from provincial Highway system
Alternative Modes of Transportation	Flexibility to integrate all modes of transportation, including transit and active transportation
Connectivity to Municipal Infrastructure	Aligns with future, planned, and existing infrastructure
Interchange Spacing	Meets interchange spacing requirements
Environmental/Heritage Impact (Wanuskewin Heritage Park and Meewasin Valley Authority)	Noise, view shed and sound scape impacts
Highway to Highway Connectivity	Travel time passing through the City of Saskatoon
Access Across Freeway for InterCity Travel	Travel time and distribution of traffic across multiple points in and out of the City of Saskatoon

4.3 Performance Criteria Weighting

The purpose of the weighted evaluation technique is to provide a more objective method to evaluate subjective criteria (or attributes). Two evaluation techniques were used to determine the relative importance of the performance criteria relative to the requirements of the Design Workshop participants.

The Paired Comparison Method provides a simple, balanced approach for comparing multiple criteria. Discussion generated during this method can be very helpful in gaining consensus to make tough decisions. This method uses a table where each criterion is compared to another in turn.

Using a weighted Paired Comparison Method, the Design Workshop participants evaluated the relative importance of the performance criteria that would be used to evaluate the four (4) alternatives to determine a preferred alternative. The weighted Paired Comparison Method table and its weights are shown in **Table 7**.

Table 7: Paired Comparison Table

Performance Criteria Matrix		
Project Name: Saskatoon Freeway Functional Planning Study		Date: June 28th, 2019
Evaluative Criteria		
ID	**Criteria**	**Measures**
A	Access Inside Freeway	Access to industrial lands
B	Access Outside Freeway	Access to industrials, residential and First Nation lands
C	Access to Wanuskewin Heritage Park	Potential to provide full access from provincial Highway system
D	Alternative Modes of Transportation	Flexibility to integrate all modes of transportation, including transit and active transportation
E	Connectivity to Municipal Infrastructure	Aligns with future, planned, and existing infrastructure
F	Interchange Spacing	Meets interchange spacing requirements
G	Environmental/Heritage Impact	Noise, view shed and sound scape impacts
H	Highway to Highway Connectivity	Travel time passing through the city of Saskatoon
I	Access Across Freeway for Intercity Travel	Travel time and distribution of traffic across multiple points in and out of the city of Saskatoon

Criteria Matrix

	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)		Total Points	% of Total	Adjusted Values
(A)	A/B	A3	A3	A/E	F3	A3	H3	I3		11.0	10.8%	10.8%
	(B)	B3	B3	B/E	F3	B3	H3	I3		11.0	10.8%	10.8%
		(C)	C3	E2	F3	C3	H3	I3		6.0	5.9%	6.0%
			(D)	E3	F3	D/G	H3	I3		1.0	1.0%	1.0%
				(E)	F3	E3	H3	E/I		11.0	10.8%	10.8%
					(F)	F3	F3	F3		24.0	23.5%	23.5%
						(G)	H3	I3		1.0	1.0%	1.0%
							(H)	H3		21.0	20.6%	21.0%
								(I)		16.0	15.7%	15.5%
											0.0%	
									Total	102.0		100.4%

With emphasis on preference

A# = *A is of greater importance with # preference emphasis*

A/B = *A and B are of equal importance*

How Important

WITH *3 - Major Preference*

2 - Medium Preference

1 - Minor Preference

It is important to note that a low assigned criteria weight does not indicate that the criteria is not important, but rather that the criteria is not a significant discriminator between the alternatives.

In addition to the weighted Paired Comparison Method, the design workshop participants also used the 100 Point Allocation Method to weigh the performance criteria. For the 100 Point Allocation Method, all of the design workshop participants were given 100 points to distribute over the performance criteria based on their own option of the importance of each criterion to the project. Once all of the design workshop participants provided their weights for each criterion, the average of the weights for each criterion was calculated. The results of the 100 Point Allocation Method are provided in **Table 8**.

Table 8 also provides the weights for each criterion based on the Paired Comparison Method. The average of the Paired Comparison Method and the 100 Point Allocation Method was calculated and recorded in the "Average of the Two Methods" column. After much discussion, the design participants agreed by consensus that the "Average of the Two Methods" weights highlighted in yellow in **Table 8** were the most representative of the relative importance of the criteria and would be used to compare the alternatives.

Table 8: 100 Point Allocation Method and Selected Performance Criteria Weights

Criteria	Number of Participants													100 Point Results	Pairwise Comparison Results	Average of the Two Methods
	1	2	3	4	5	6	7	8	9	10	11	12	13			
Access Inside Freeway	10	5	12	11	15	10	10	12	10	15	7	7	15	11	10.8	11
Access Outside Freeway	10	5	12	11	15	5	5	12	10	15	7	7	15	10	10.8	10
Access to Wanuskewin Heritage Park	10	5	6	7	5	10	10	8	5	3	10	3	10	7	6	7
Alternative Modes of Transportation	5	5	3	4	3	5	5	5	2	10	5	1	5	4	1	3
Connectivity to Municipal Infrastructure	10	10	10	10	10	5	10	10	10	14	10	5	10	10	10.8	10
Interchange Spacing	25	35	22	21	20	25	25	22	20	10	25	36	15	23	23.5	23
Environmental/Heritage Impact	5	5	3	4	2	5	5	7	3	7	10	2	5	5	1	3
Highway to Highway Connectivity	10	25	20	18	20	15	15	14	25	10	20	32	10	18	21	20
Access Across Freeway for Intercity Travel	15	5	12	14	10	20	15	10	15	16	6	7	15	12	15.5	14
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

4.4 Alternative Evaluation Matrix

Members of the Design Workshop team determined the weights for the performance criteria, the next step was to evaluate each of the alternatives against the performance criteria by using a rating scale of 1 to 10, where 1 is the worst and 10 is the best. The performance criteria rating was then multiplied by the weighting of the particular performance criteria and summed with all other criteria ratings to provide an overall total performance score for each alternative. The results of the evaluation of the alternatives is provided in **Table 9**.

Based on the results of the evaluation, Alternative 4: Highway 11 Flyover has the highest performance score of 804. All members of the Design Workshop team agreed by consensus that Alternative 4 was the best value alternative and is the preferred alternative for the design team to develop further as the design proceeds.

Table 9: Alternatives Evaluation Matrix

EVALUATION MATRIX											
1. HOW WELL DOES THE SCENARIO SATISFY THE PERFORMANCE CRITERIA (ENTER RATING FROM 1-10, 10=BEST) 2. ENTER ASSIGNED WEIGHT TIMES RATING IN SUB TOTAL 3. SUM ACROSS AND RANK	Performance Criteria - Performance Measure	Access Inside Freeway	Access Outside Freeway	Access to Wanuskewin Heritage Park	Alternative Modes of Transportation	Connectivity to Municipal Infrastructure	Interchange Spacing	Environmental / Heritage Impact	Highway to Highway Connectivity	Access Across Freeway for Intercity Travel	Total Performance (P)
Alternatives	Weight →	11	10	7	3	10	23	3	20	14	
Alternative 1: Three Interchanges	Rating 1-10	1.00	3.00	5.00	3.00	3.00	1.00	7.00	5.00	1.00	
	Sub Total	11.00	30.00	35.00	9.00	30.00	23.00	21.00	100.00	14.00	273
Alternative 2: Two Interchanges	Rating 1-10	2.00	4.00	9.00	2.00	4.00	7.00	4.00	8.00	5.00	
	Sub Total	22.00	40.00	63.00	6.00	40.00	161.00	12.00	160.00	70.00	574
Alternative 3: Millar Flyover	Rating 1-10	5.00	6.00	9.00	5.00	6.00	8.00	4.00	8.00	6.00	
	Sub Total	55.00	60.00	63.00	15.00	60.00	184.00	12.00	160.00	84.00	693
Alternative 4: Highway 11 Flyover	Rating 1-10	8.00	7.00	9.00	5.00	8.00	8.00	4.00	9.00	8.00	
	Sub Total	88.00	70.00	63.00	15.00	80.00	184.00	12.00	180.00	112.00	804

The following provides the discussion recorded during the rating of the alternatives for each of the performance criteria.

- Alternative 1: Three Interchanges
  - Access Inside Freeway
    - Rating of 1 was given due to poor access inside compared to other alternatives
  - Access Outside Freeway
    - Rating of 3 was given due to poor outside access compared to other alternatives
  - Access to Wanuskewin Heritage Park
    - Rating of 5 was given as the access not as good as existing access and not intuitive for motorist destined to the park.
  - Alternative Modes of Transportation
    - Rating of 3 was given due to poor flexibility to provide all modes of transportation. There is the potential to provide a stand-alone crossing structure
  - Connectivity to Municipal Infrastructure
    - Rating of 3 was given due poor connectivity compared to other alternatives
  - Interchange Spacing
    - Rating of 1 was given due to the very poor interchange spacing
  - Environmental / Heritage Impact
    - Rating of 7 was given as this is a good alternative with respect to the environmental impact criteria especially close to the Heritage Park

  - Highway to Highway Connectivity
    - Rating of 5 was given as there is good connectivity through the City but connection to Highway 11 southbound is poor
  - Access Across Freeway for InterCity Travel
    - Rating of 1 was given as access across the Saskatoon Freeway is very poor

- Alternative 2: Two Interchanges
  - Access Inside Freeway
    - Rating of 2 was given as access inside the Freeway is poor but slightly better than Alternative 1: Three Interchanges
  - Access Outside Freeway
    - Rating of 4 was given as access outside the Freeway is marginally better than Alterative 1: Three Interchanges
  - Access to Wanuskewin Heritage Park
    - Rating of 9 was given as there is the potential to create a diamond interchange at Penner Road for access to the park
  - Alternative Modes of Transportation
    - Rating of 2 was given as this is the worst alternative in terms of alternative modes of transportation
  - Connectivity to Municipal Infrastructure
    - Rating of 4 was given as this marginally better than Alternative 1: Three Interchanges due to new road between Millar Ave. and Wanuskewin Rd.
  - Interchange Spacing
    - Rating of 7 was given due to the potential to move the Penner Road Interchange to the north
  - Environmental / Heritage Impact
    - Rating of 4 was given as due to larger structure; therefore, more environmental impacts
  - Highway to Highway Connectivity
    - Rating of 8 was given as the highway to highway connectivity is well planned
  - Access Across Freeway for InterCity Travel
    - Rating of 5 was given as it allows connection across Millar Avenue; therefore, distributing traffic well

- Alternative 3: Millar Flyover
  - Access Inside Freeway
    - Rating of 5 was given as the access inside the Freeway is better with the Millar Flyover
  - Access Outside Freeway
    - Rating of 6 was given as access outside the Freeway is better with the Millar Flyover
  - Access to Wanuskewin Heritage Park
    - Rating of 9 was given as the same park access is provided as in Alternative 2: Two Interchanges

- Alternative Modes of Transportation
  - Rating of 5 was given as this alternative is good in terms of alternative modes of transportation due to the potential for two crossings
- Connectivity to Municipal Infrastructure
  - Rating of 6 was given as this alternative is better is terms of connectivity to municipal infrastructure than Alternative 1: Three Interchanges and Alternative 2: Two Interchanges
- Interchange Spacing
  - Rating of 8 was given due to the potential to move the Penner Road Interchange to the north and better spacing than Alternative 2: Two Interchanges
- Environmental / Heritage Impact
  - Rating of 4 was given as it is the same as Alternative 2: Two Interchanges in terms of this criteria
- Highway to Highway Connectivity
  - Rating of 8 was given as the highway to highway connectivity is well planned
- Access Across Freeway for InterCity Travel
  - Rating of 6 was given as it is slightly better than Alternative 2: Two Interchanges

- Alternative 4: Highway 11 Flyover
  - Access Inside Freeway
    - Rating of 8 was given as it is the better than Alternative 3: Millar Flyover
  - Access Outside Freeway
    - Rating of 7 was given as it is similar to Alternative 3: Millar Flyover but higher since Highway 12 is 4-lanes compared to Millar Avenue being 2-lanes in Alternative 3: Millar Flyover
  - Access to Wanuskewin Heritage Park
    - Rating of 9 was given as it is the same as Alternative 2: Two Interchanges and Alternative 3: Millar Flyover
  - Alternative Modes of Transportation
    - Rating of 5 was given as it is the same as Alternative 3: Millar Flyover
  - Connectivity to Municipal Infrastructure
    - Rating of 8 was given as it provides additional interior roads
  - Interchange Spacing
    - Rating of 8 was given as it is the same as Alternative 3: Millar Flyover
  - Environmental / Heritage Impact
    - Rating of 4 was given as it is the same as Alternative 2: Two Interchanges and Alternative 3: Millar Flyover
  - Highway to Highway Connectivity
    - Rating of 9 was given as the highway to highway connectivity is well planned and the interchange at Highway 12 is better
  - Access Across Freeway for InterCity Travel

- Rating of 8 was given as better interchange is provided at Highway 12; therefore, providing a better distribution of traffic

4.5 Design Considerations for the Preferred Alternative

After the selection of the preferred alternative, the design workshop participants marked up the alternative display boards to provide design considerations for the design team to consider during the development of alternatives for the Saskatoon Freeway. These design considerations are illustrated in **Figures 13 to 16**. As there is was only one display board for Alternative 4 and Alternatives 2 and 3 are similar to Alternative 4, design workshop participants provided design considerations for Alternative 4 on the Alternative 2 and 3 display boards.

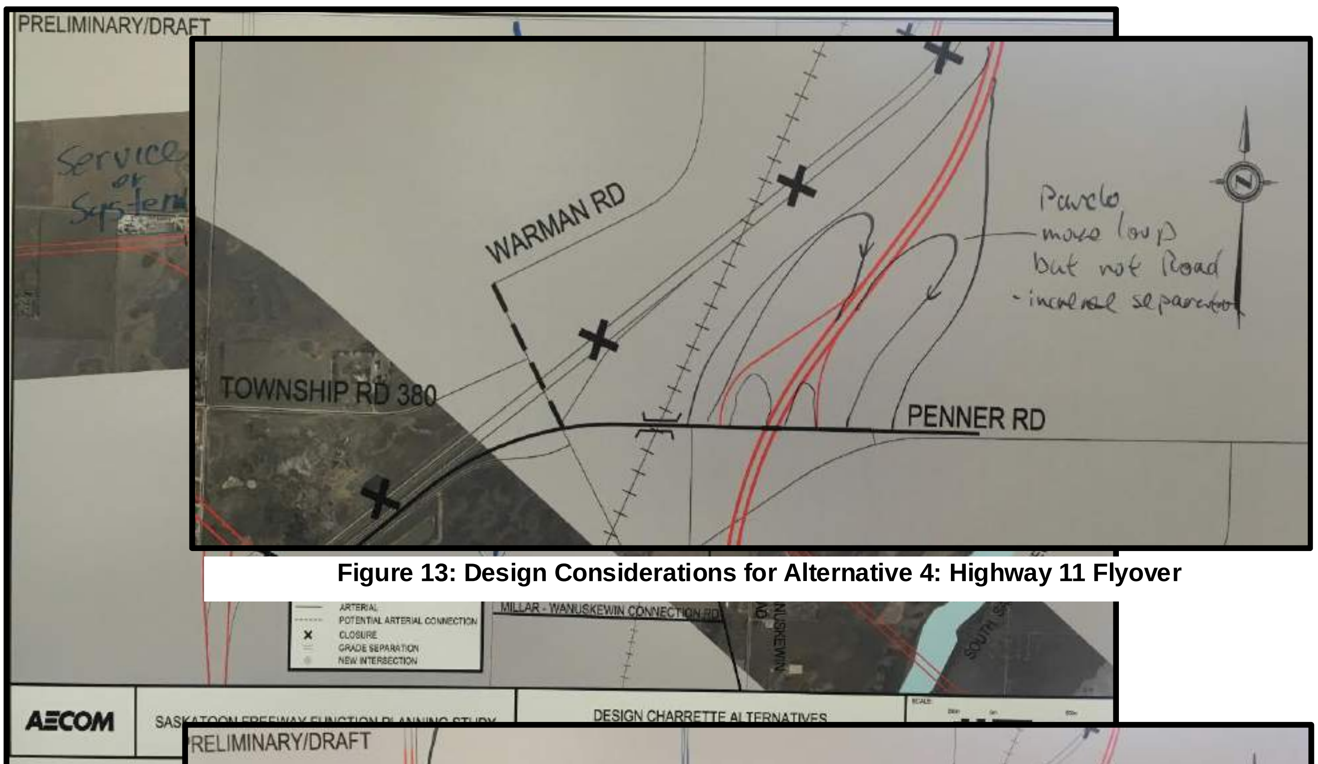


Figure 13: Design Considerations for Alternative 4: Highway 11 Flyover

Figure 12: Design Considerations for Alternative 4: Highway 11 Flyover

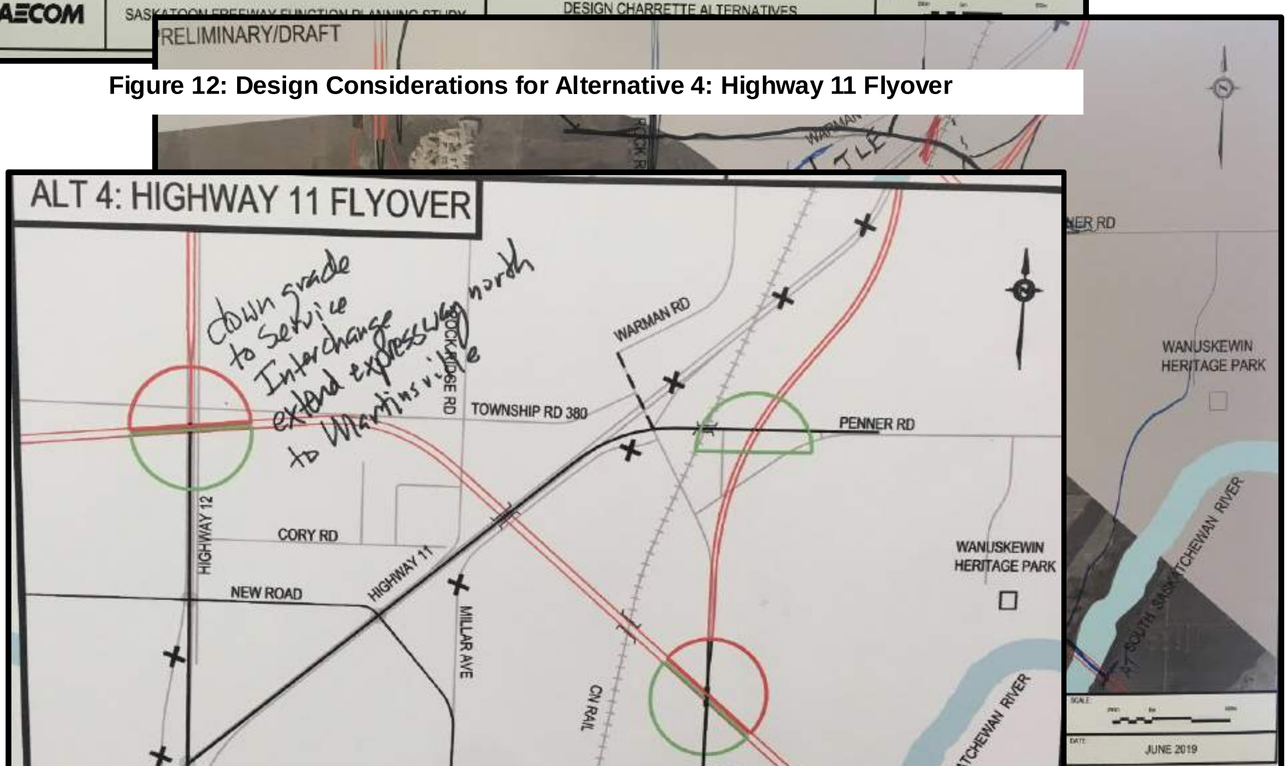


Figure 15: Design Considerations for Alternative 4: Highway 11 Flyover **Flyover**

5.0 Conclusions

With Phase 1 being the most complex of the three phases of the Saskatoon Freeway study, given the proximity of Highway 12, Highway 11, Wanuskewin Road and existing developments. The Design Workshop was required to quickly evaluated and select an alternative for further development. The preferred alternative was selected because it best addressed the numerous technical challenges, including interchange spacing and access requirements, while ensuring the future Saskatoon Freeway meets all road design standards for safety, and meets the future capacity needs for the community of 750,000 people.

The design workshop participants provided the design team with their issues, concerns and requirements with respect to Phase 1 as well as their comments and items to consider for each of the alternatives. This information provides the design team with input from the perceptive of individuals who work and live in the community.

The design workshop participants identified the performance criteria and measures by which the four alternatives would be compared to each other in order for the participants to identify which alternative will provide the best value. The development of the performance criteria and measures built consensus among project stakeholders; provided all of the stakeholders with a understanding of the project's goals and objectives; and, how the alternatives meet their performance goals and requirements.

Using the Paired Comparison and 100 Point Allocation Methods, the design workshop participants agreed by consensus on the weighting for each of the performance criteria and measures. The design workshop participants, through the analysis and evaluation of the potential alternatives, the group reached consensus that Alternative 4: Highway 11 Flyover was the best value alternative with a total performance score of 804 compared to 693 for Alternative 3: Millar Interchange, which was the second highest alternative. Therefore, Alternative 4: Highway 4 Flyover

is the preferred alternative for the design team to develop further as the design proceeds. The design workshop participants also provided the design team with a number of items to consider and design considerations for Alternative 4: Highway 11 Flyover.

The key features from the highest rated framework include:

- Realignment of Highway 11 to Wanuskewin Road;
- Providing an overpass connection to Highway 11 at Penner Road;
- Interchanges at Highway 12 and at the realigned Highway 11 with the Saskatoon Freeway;
- Connector from Millar Road to Wanuskewin Road;
- A flyover across the Saskatoon Freeway at the old Highway 11 location.

The realignment of Highway 11 into Wanuskewin Road is a major component of the preferred framework, this change eliminates an existing high collision intersection (Highway 11/Wanuskewin Rd) and follows the flow of the majority of existing Highway 11 users turning onto Wanuskewin Rd.

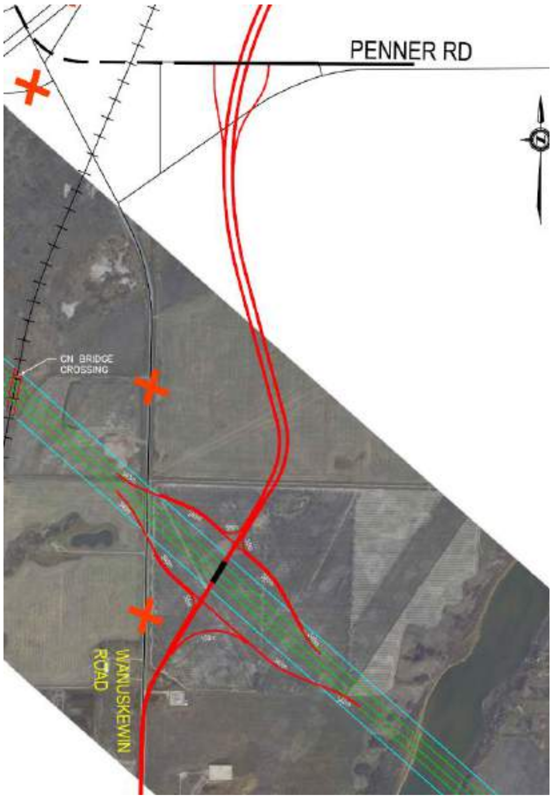
The preferred alternative will provide the framework for all future options that will be developed and reviewed. The Ministry will continue working with its consultants and stakeholders to develop numerous options that will be shown to stakeholders and the public to receive additional input. These options are expected to be finalized by late Fall 2019 and presented to the public prior to the end of the year

Sincerely,

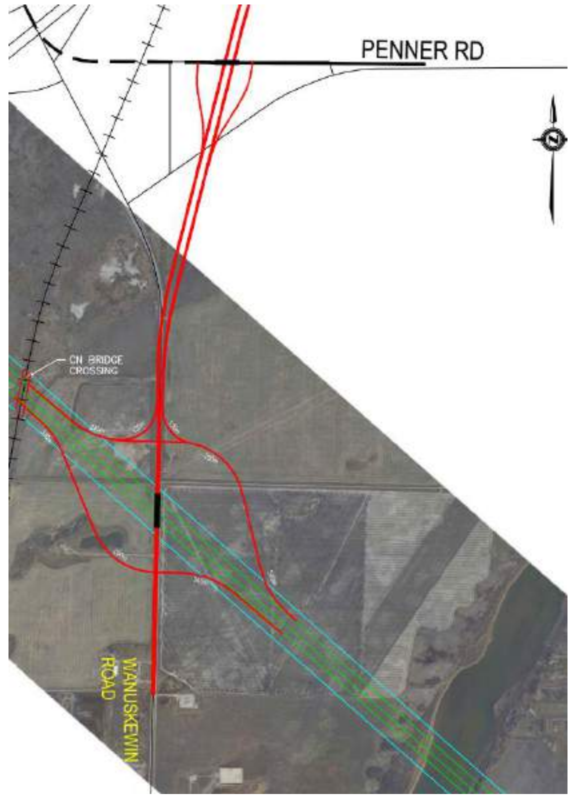
Allan Duff, P.Eng.
Senior Project Manager
allan.duff@aecom.com

APPENDIX G
Interchange Concepts

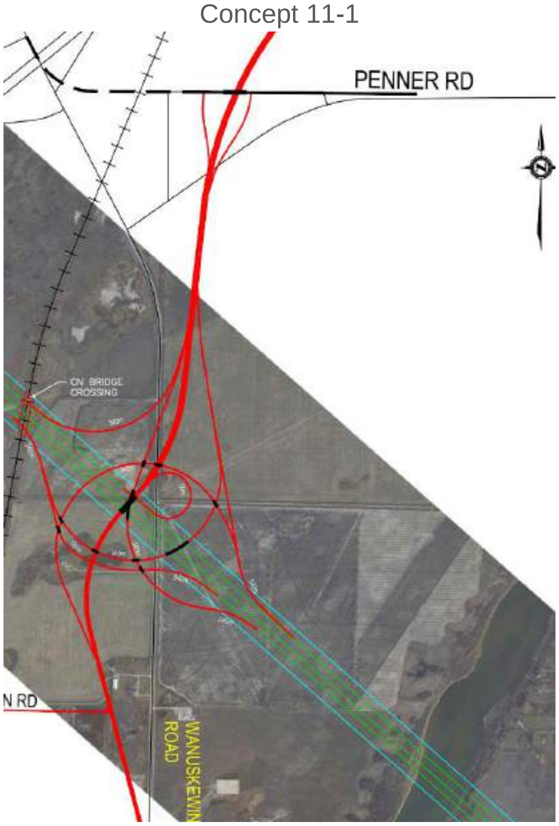
Highway 11 Initial Interchange Concepts



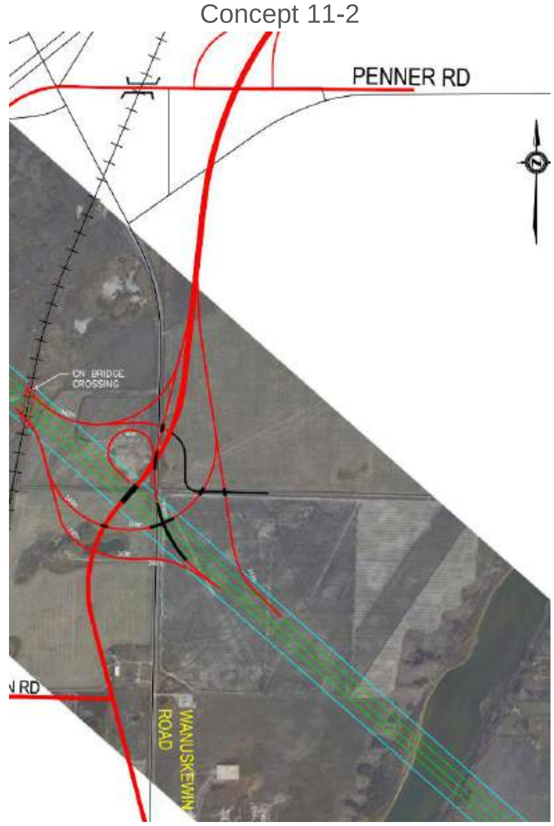
Concept 11-1



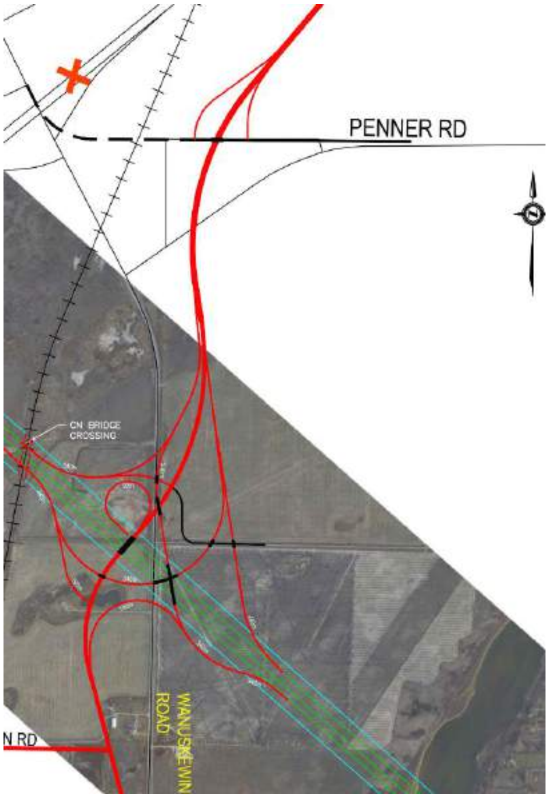
Concept 11-2



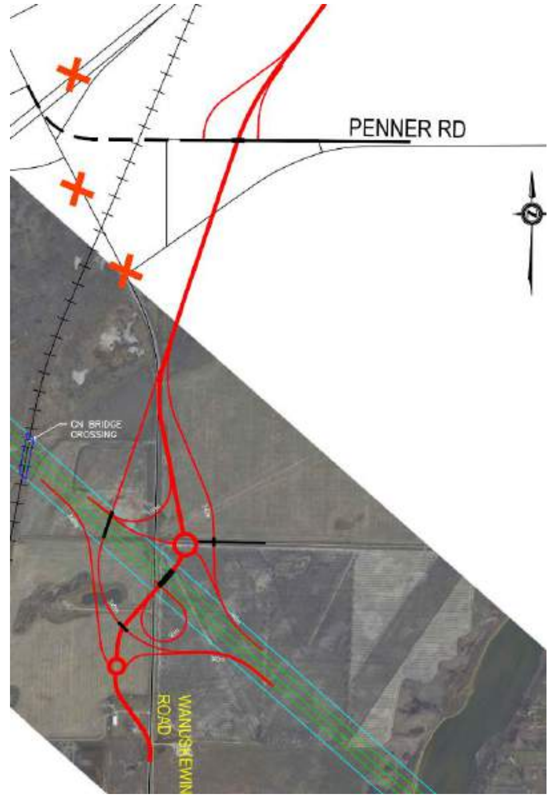
Concept 11-3



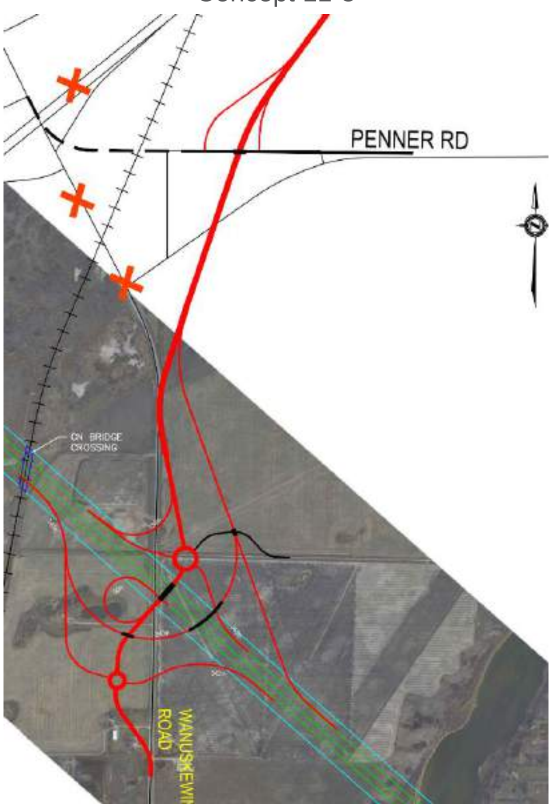
Concept 11-4



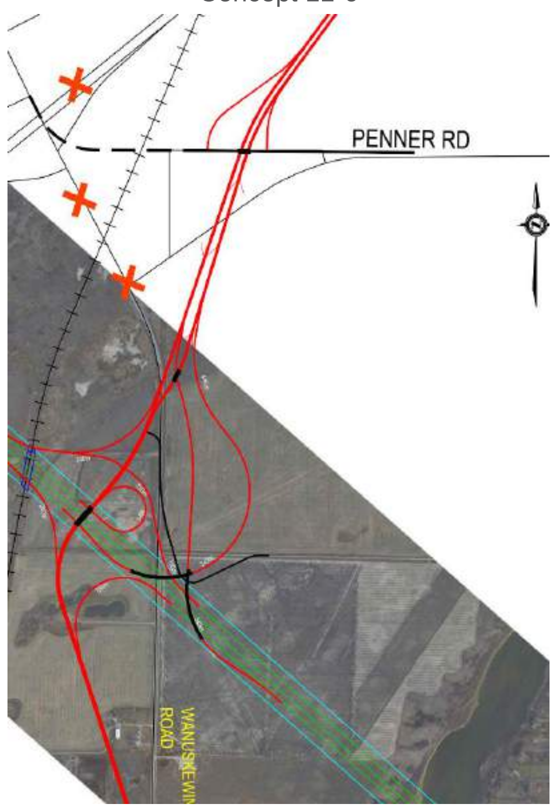
Concept 11-5



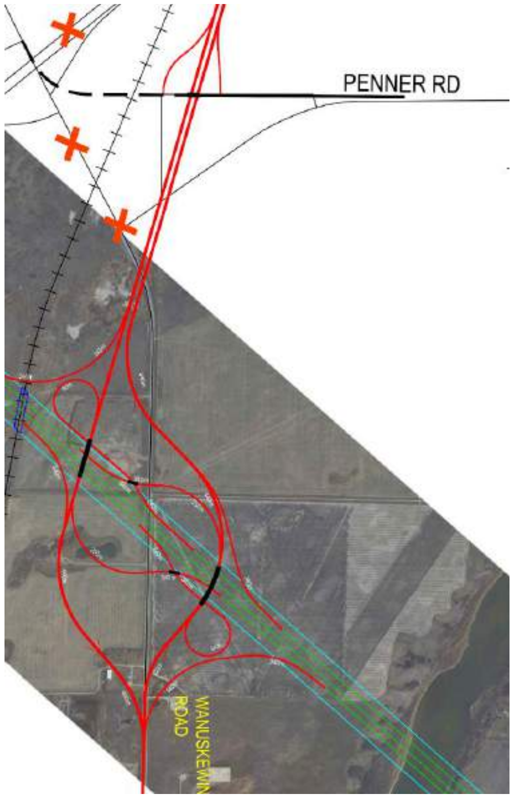
Concept 11-6



Concept 11-7

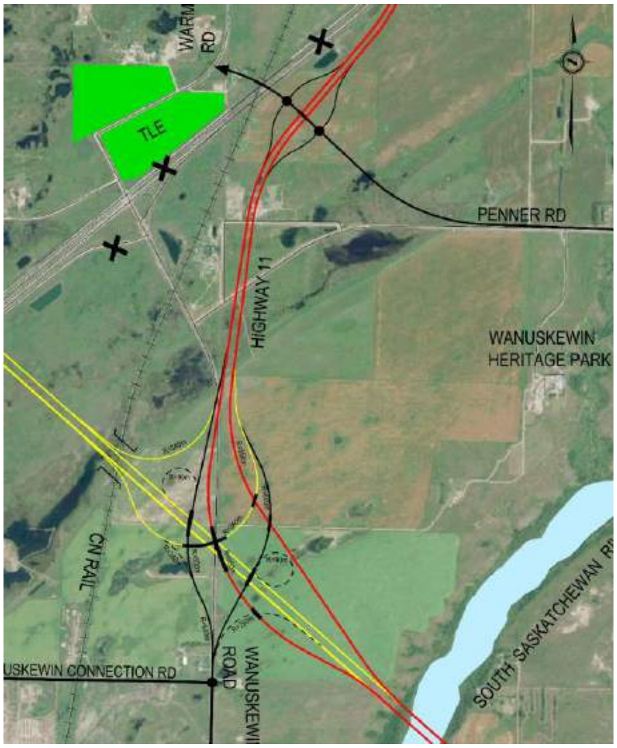


Concept 11-8

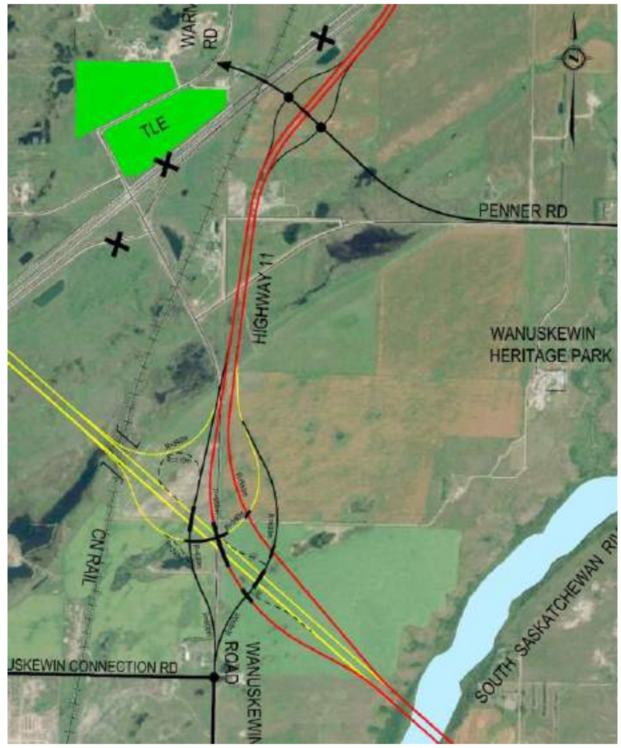


Concept 11-9

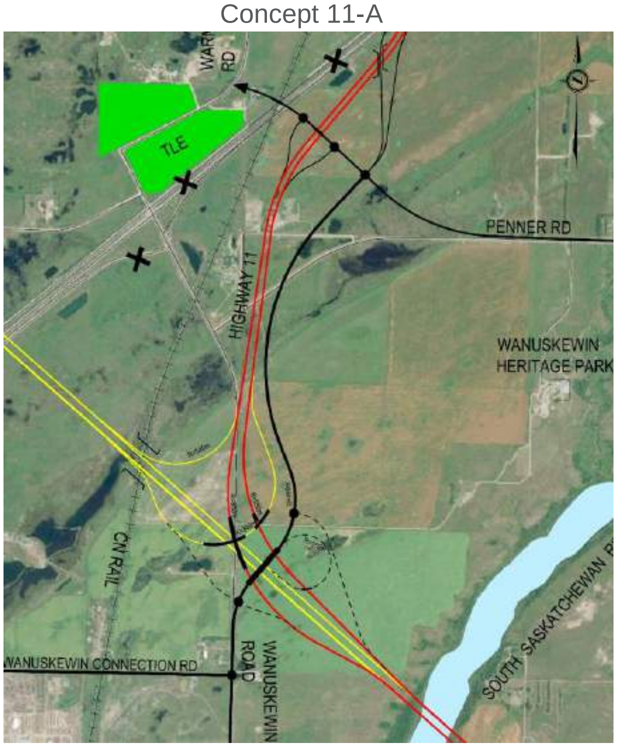
Highway 11 Revised Interchange Concepts

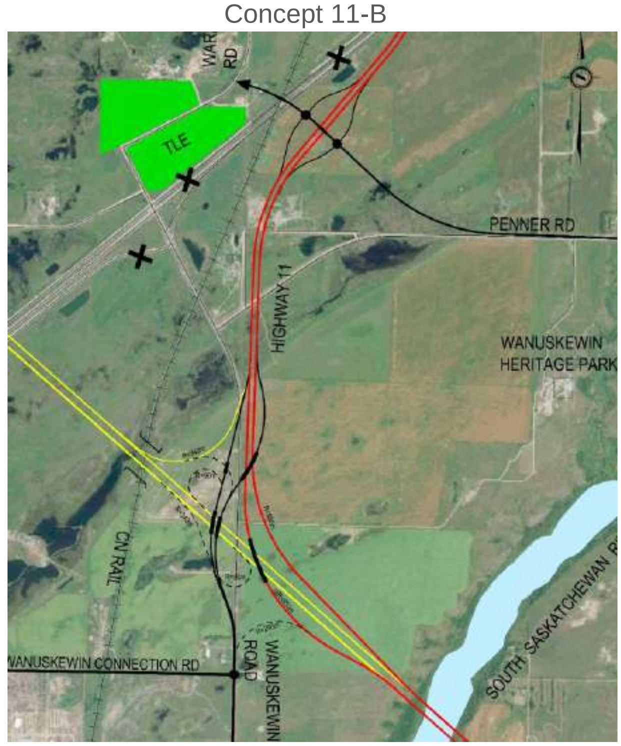


Concept 11-A



Concept 11-B

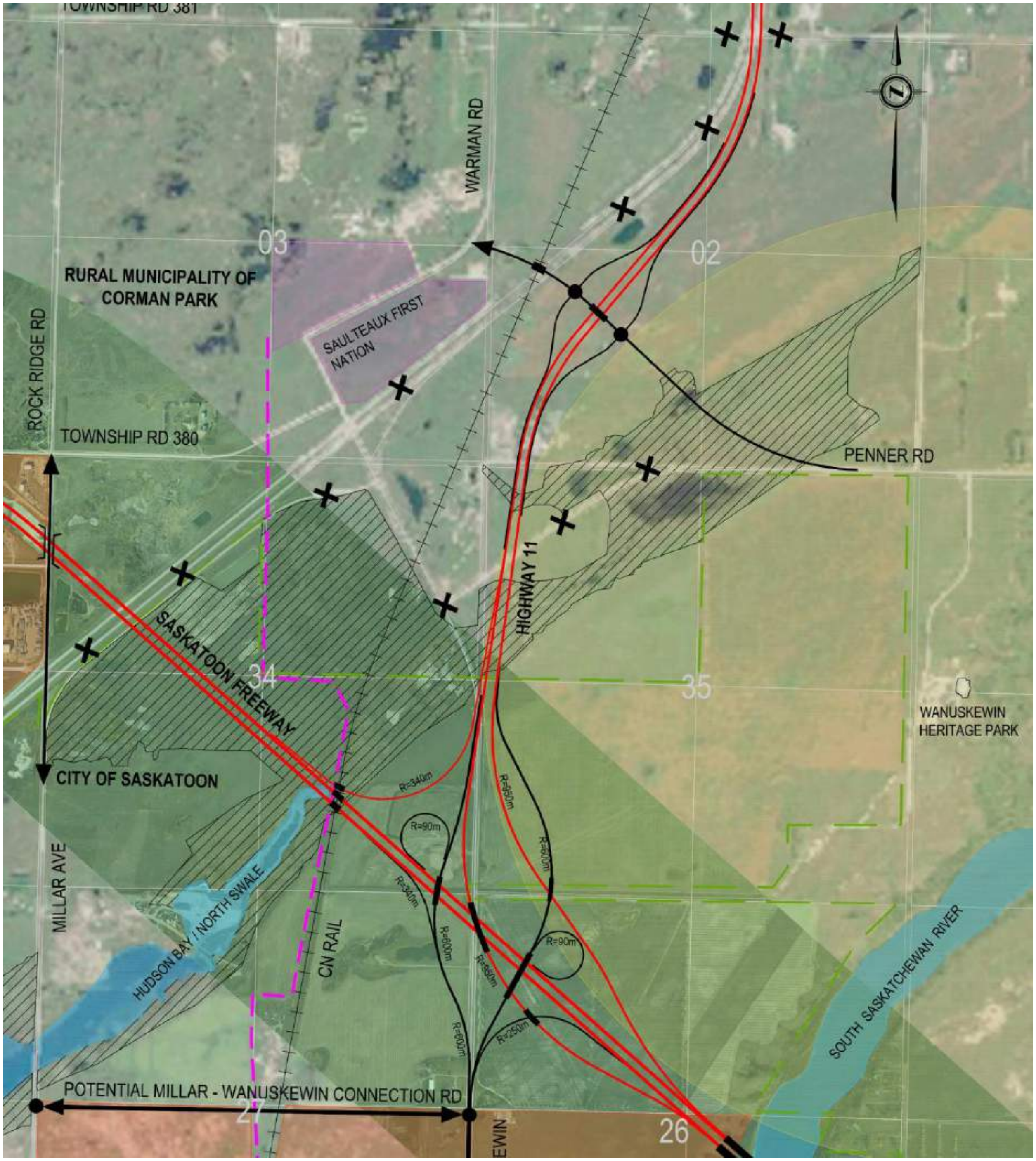




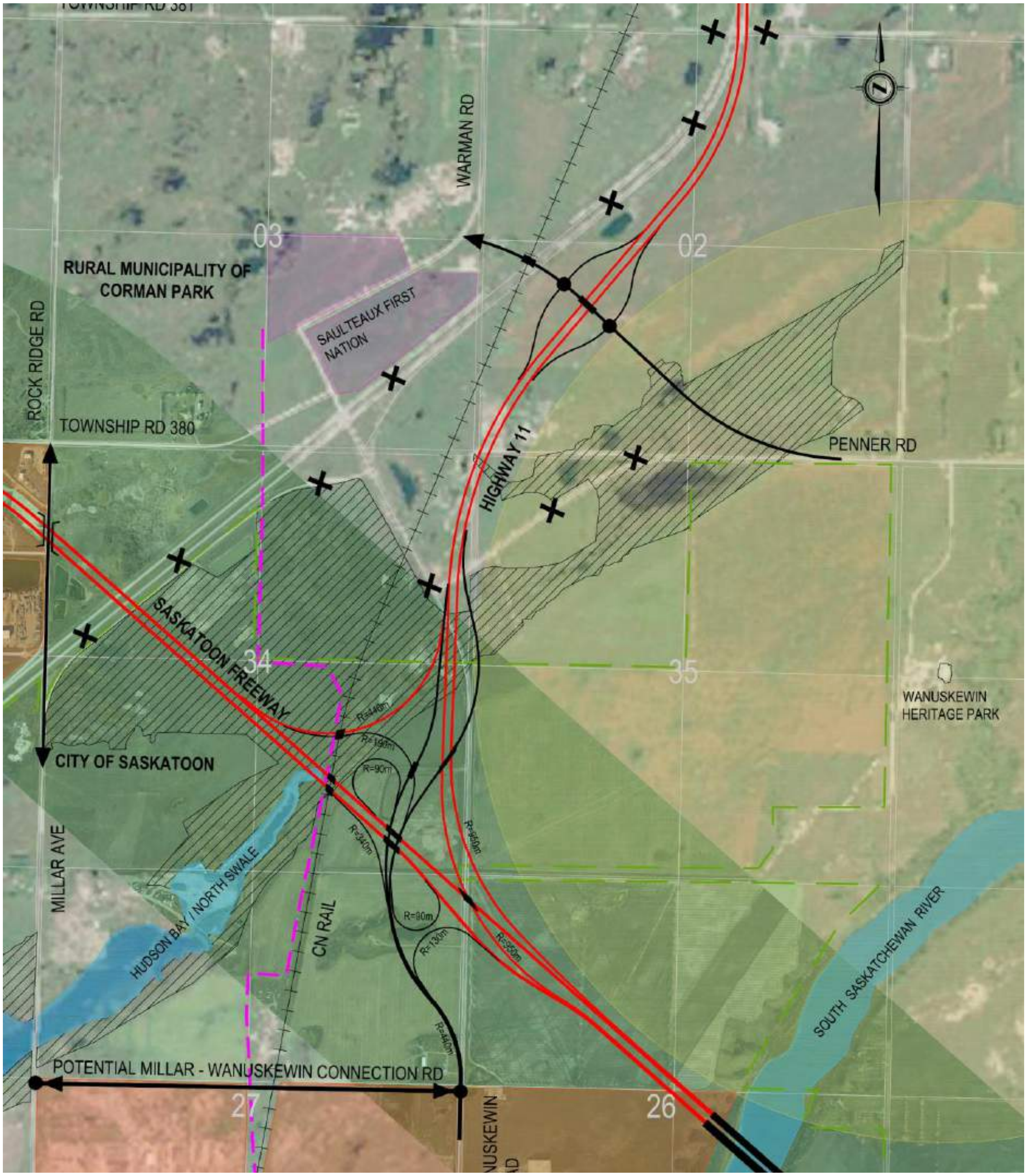
Concept 11-C

Concept 11-D

Highway 11 Interchange Concepts Carried Forward

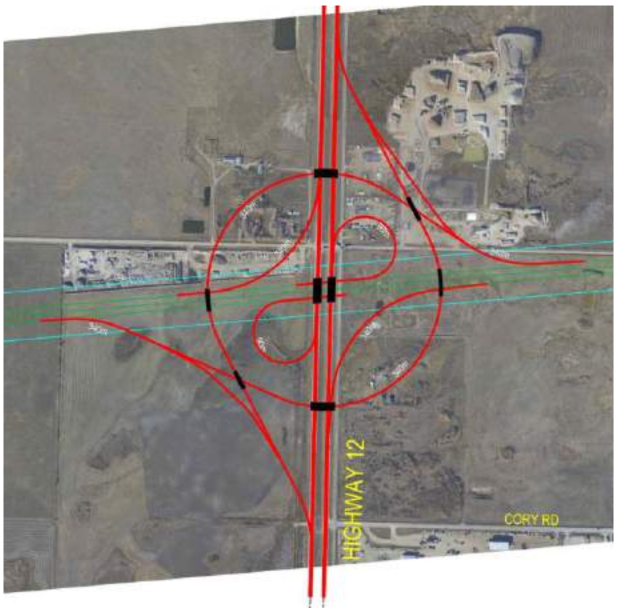


Concept 11-1


TOWNSHIP RD 381
WARMAN RD
RURAL MUNICIPALITY OF
CORMAN PARK
SAULTEAUX FIRST
NATION
ROCK RIDGE RD
TOWNSHIP RD 380
PENNER RD
HIGHWAY 11
SASKATOON FREEWAY
03
02
34
35
WANUSKEWIN
HERITAGE PARK
CITY OF SASKATOON
MILLAR AVE
HUDSON BAY / NORTH SWALE
CN RAIL
SOUTH SASKATCHEWAN RIVER
POTENTIAL MILLAR - WANUSKEWIN CONNECTION RD
27
26

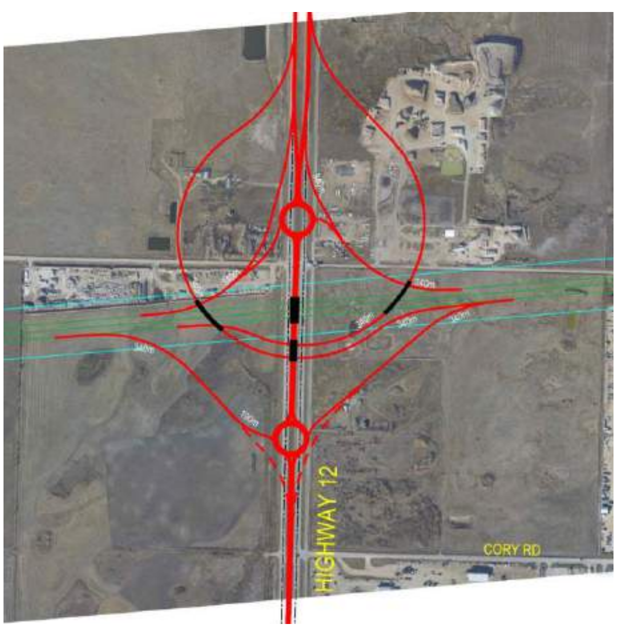
Concept 11-2

Highway 12 Initial Interchange Concepts



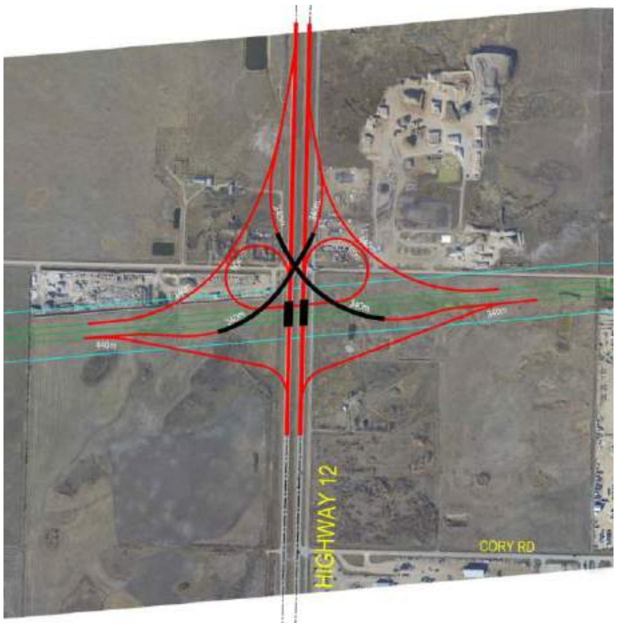
Concept 12-1

Concept 12-2



Concept 12-3

Concept 12-4

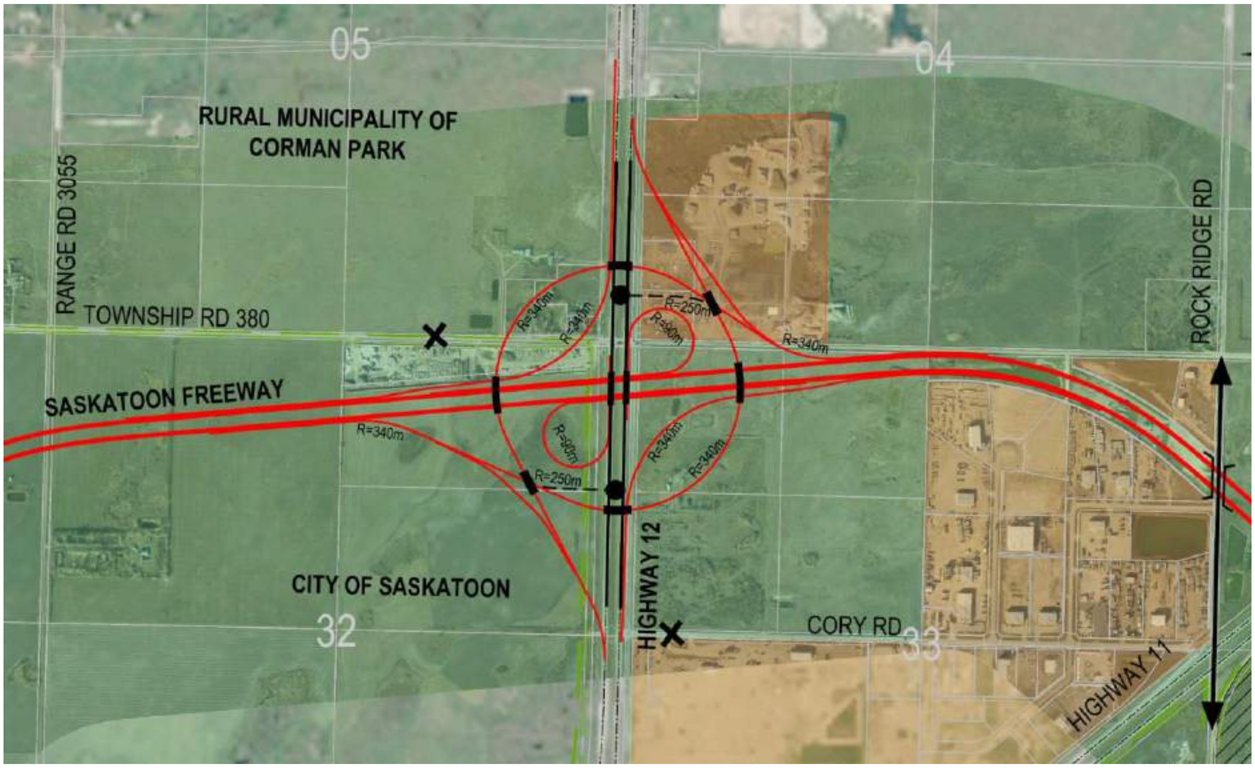


Concept 12-5

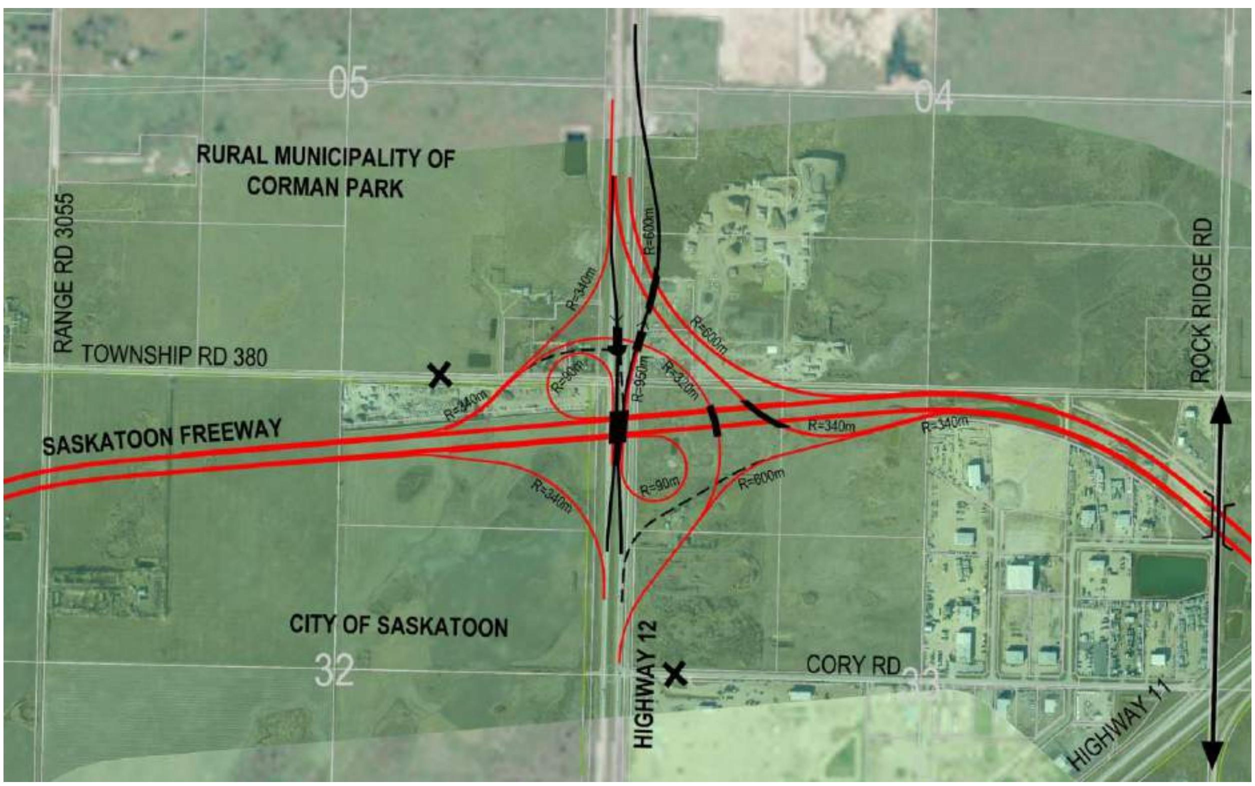
Concept 12-6

Concept 12-7

Highway 12 Interchange Concepts Carried Forward

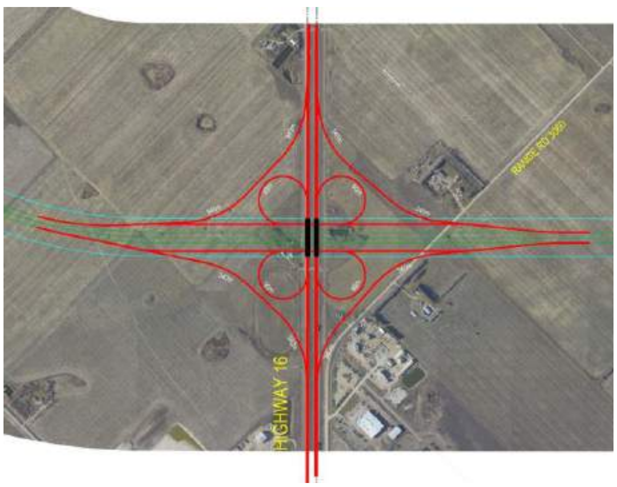


Concept 12-1



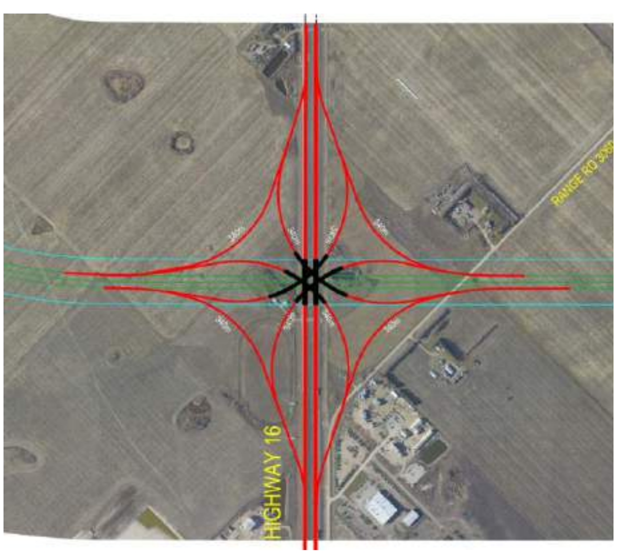
Concept 12-2

Highway 16 Initial Interchange Concepts

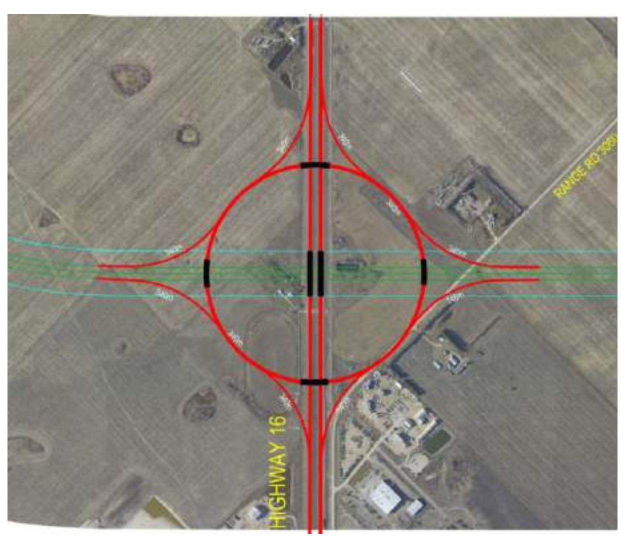


Concept 16-1

Concept 16-2



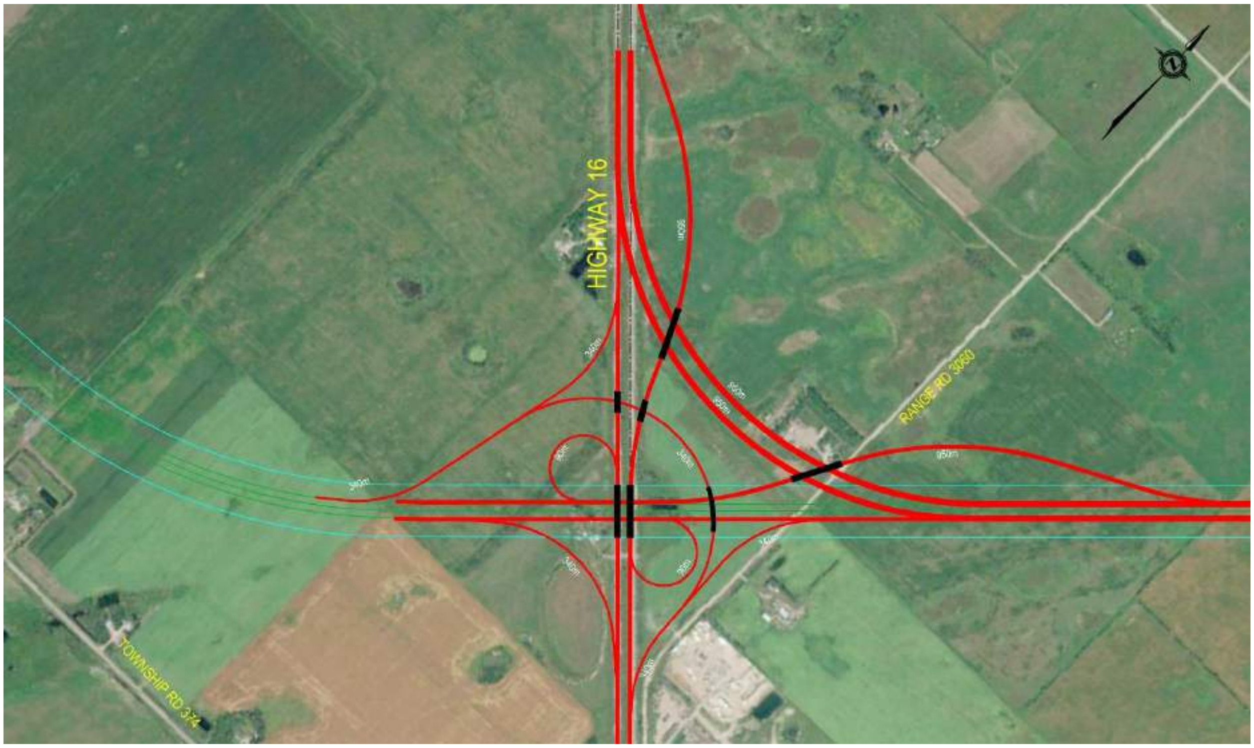
Concept 16-3



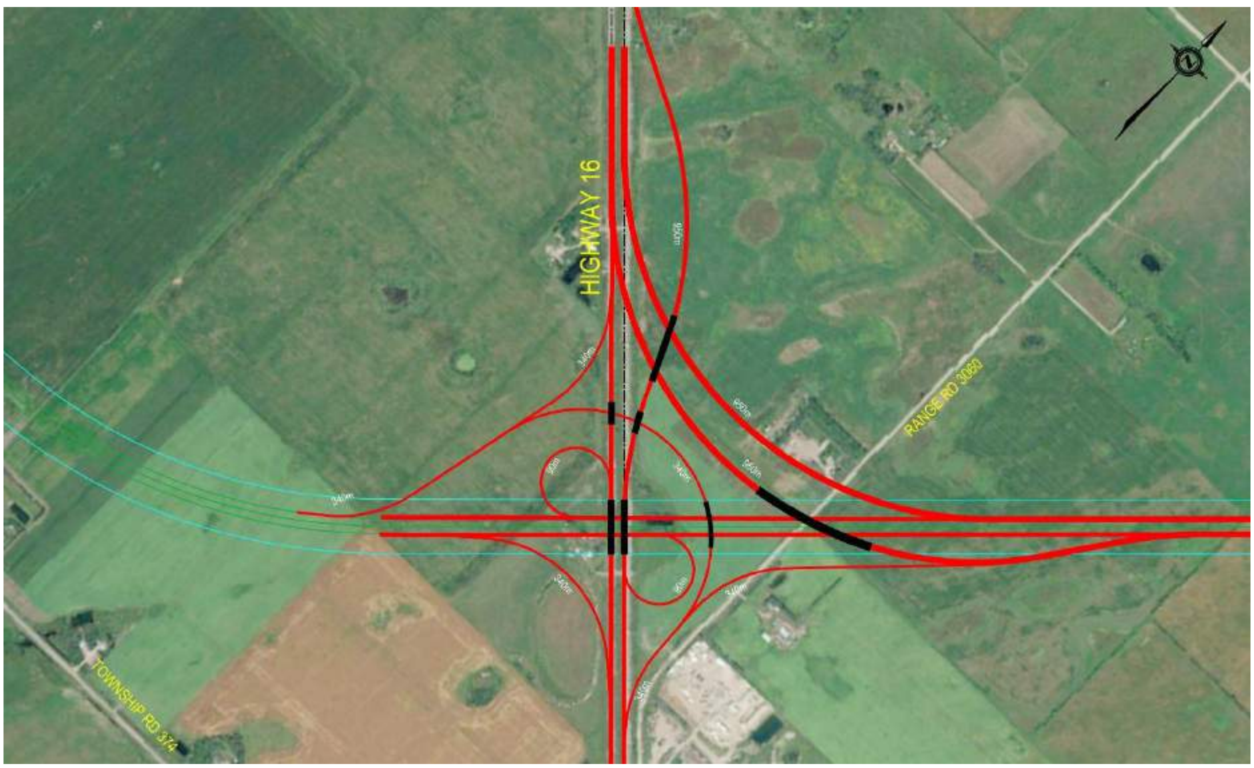
Concept 16-4

Concept 16-5

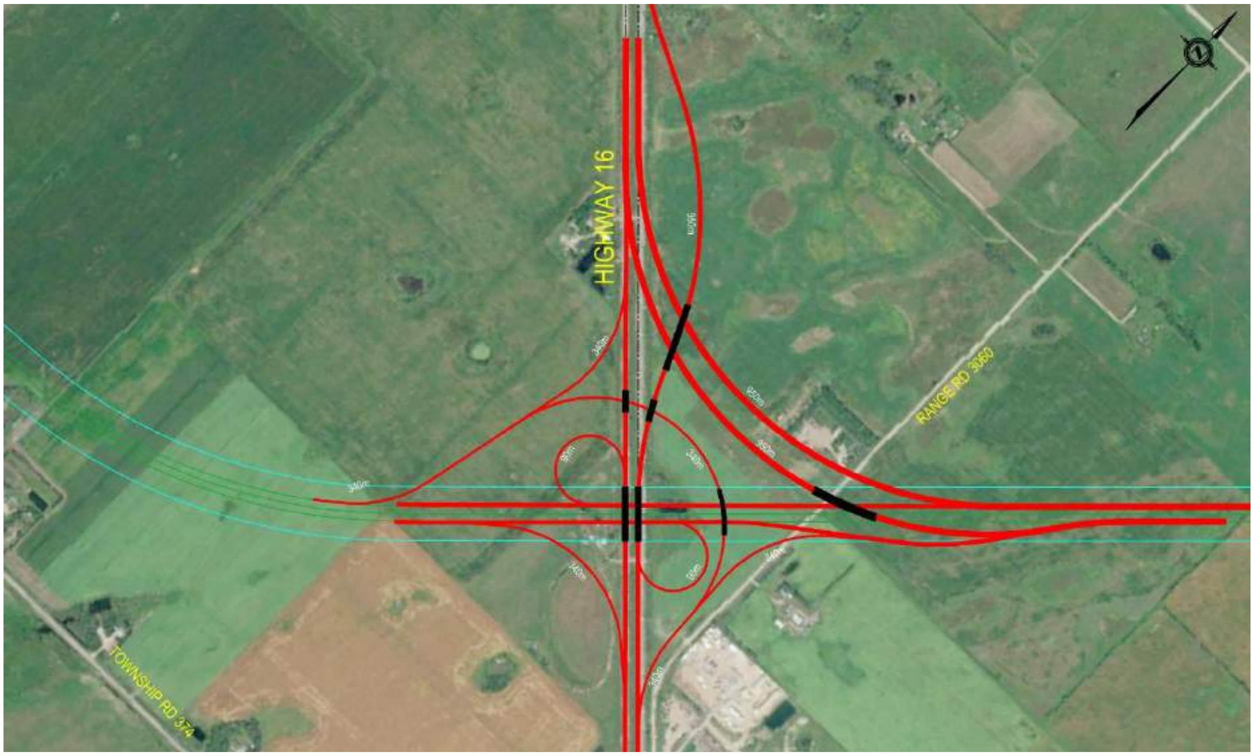
Highway 16 Revised Interchange Concepts



Concept 16-A



Concept 16-B



Concept 16-C

Highway 16 Interchange Concepts Carried Forward

Concept 16-1

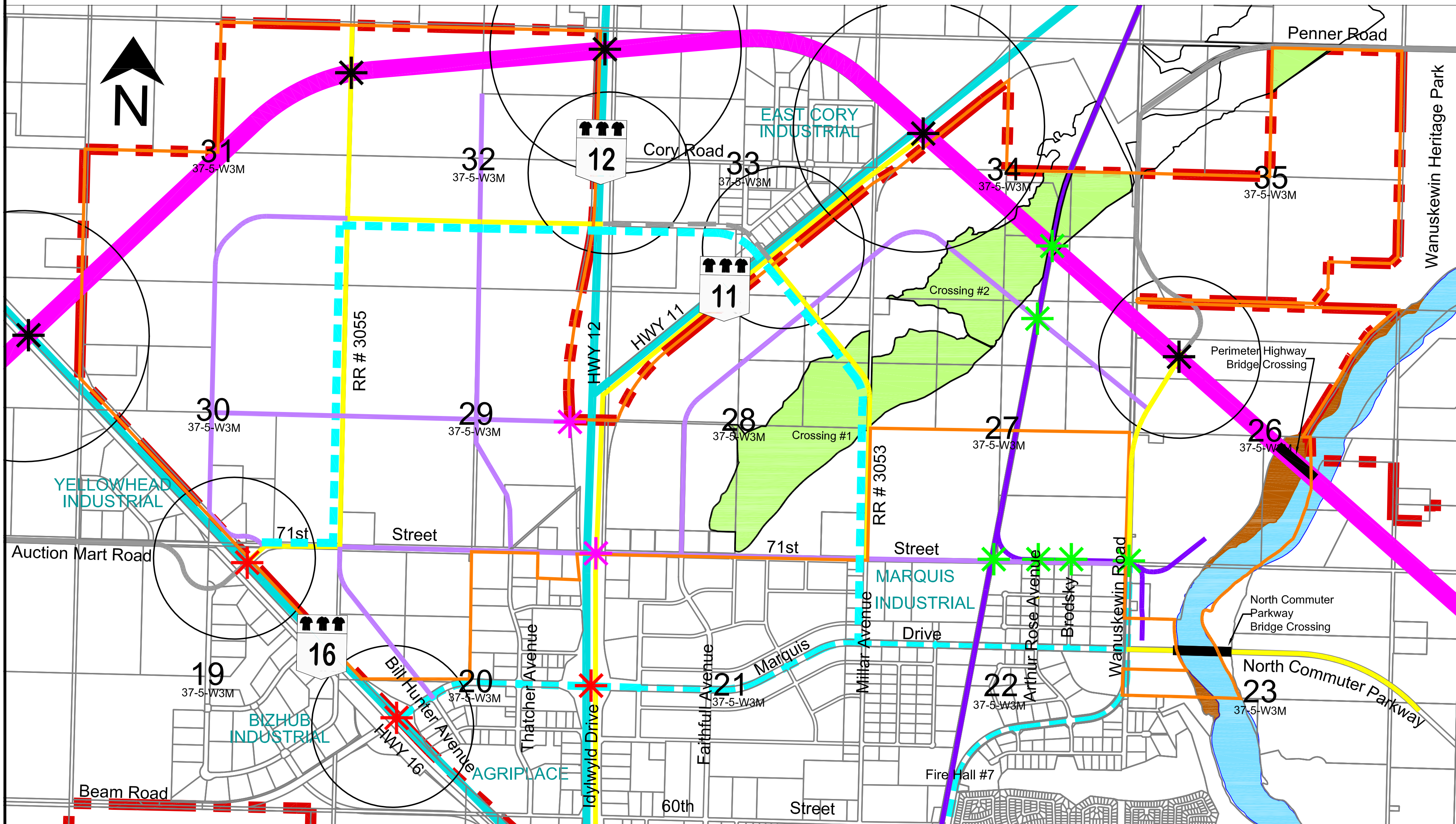
Concept 16-2

APPENDIX H

City of Saskatoon Riel Industrial Sector Plan

Figure 6 - Roadways Plan

Riel Industrial Sector Plan



Scale: N.T.S.

Legend

- City Limits
- North Sector
- CN Rail Line
- Perimeter Highway
- Proposed Arterial Roads
- Proposed Collector Roads
- Proposed Rural Road Connections
- Dangerous Goods and Long Haul Truck Routes
- Pick Up and Delivery Truck Routes
- Grade Separated
- At Grade Rail Crossing
- At Grade Right-in/Right-out
- Grade Separated Highway
- NW Access Management Highway Control Circles
- Wetland Complex

City of Saskatoon
Community Services
Planning & Development Division

NOTE: The information contained on this map is for reference only and not to be used for legal purposes.

February, 2018

File No: 4134 - 3 - 1

APPENDIX I

Drainage Catchment Areas and Culvert Details

Table I1: Catchment Areas

Catchment	Area (ha)	Drainage Path	Characteristics & Assumptions
A	-	1	The eastern catchment boundary is Highway 16 and the western boundary extends into Phase 3. Drainage follows a southerly direction. This catchment will be assessed as part of Phase 3 design.
B	1025 *1529	2	Includes existing Highway 16 and the proposed Highway 16 interchange and intercepts a combination of overland flow and ditch flow from the north. This catchment area differs from the area shown in P4G's Green Network report because their model did not include culverts along Highway 16. Flow west of Range Road 3060 is intercepted and drains south by one or more existing culverts along Highway 16. A series of 5 culverts is required to pass flow under the freeway and interchange ramps. *A potential dynamic drainage pattern exists at the intersection of Township Road 380 and Range Road 3060 where runoff from an area of 504 ha can pass through one of two culverts. Survey data shows the south culvert is lower but later discussion with City of Saskatoon indicated that their LiDAR data shows a ditch block that would back up the water causing it to spill east.
C	74	2	The freeway will intercept overland flow from 13+300 to 14+240. Some of the overland flow will also be intercepted and directed south by a field ridge at 14+240. In SW 31-37-05-3 an area of agricultural land, roughly 24 ha, will be cut off from natural overland flow from the northwest.
D	40 *1042	2	The freeway will intercept overland flow from 14+250 to 15+210 as well as ditch flow at 15+210. Ditch flow includes a portion of Township Road 380 and Range Road 3055. *A potential dynamic drainage pattern exists at the intersection of Township Road 380 and Range Road 3055 where an area of 1002 ha could drain through one of two culverts. The LiDAR data shows a higher ditch to the south that spills at roughly the same elevation as the culvert draining east. Depending on headwater conditions, flows may be conveyed in either direction or split. The catchment size also depends on what happens at the intersection of Township Road 380 and Range 3060 in catchment B where flow could travel south or be directed east and added to this catchment. There is a field ridge in NE 31-37-05-3 that appears to be directing overland flow to a dugout south of the freeway. Most of this flow will be cut off by the Saskatoon Freeway. It is recommended to hold landowner discussions to determine if the dugout is desired and the freeway ditch grades can be adjusted accordingly.
E	8	2	The freeway will intercept overland flow from 15+210 to 15+560. In NW 32-37-05-3, an access road and treeline at 15+560 seems to be directing runoff into a slough and dugout to the

Catchment	Area (ha)	Drainage Path	Characteristics & Assumptions
			south and the flow will be redirected by the freeway. It appears that this may be an intentional and desirable water source. It is recommended to hold landowner discussions to determine if the dugout is desired and the freeway ditch grades can be adjusted accordingly.
F	17	3	Flow from the south ditch of Range Road 380 will be intercepted along the southbound to westbound ramp of the Highway 12 interchange. Overland flow will also be intercepted along the freeway from 15+560 to 16+050. A treeline at 16+050 directs the overland flow south where it would join the wetlands in Catchment G. The freeway ditch will be a more direct route to the same drainage path. Approximately 9 ha of agricultural land to the south will be cut off from overland flow.
G	91	3	An existing culvert under Highway 12 conveys flow across the highway to its east ditch. This culvert is within the Highway 12 interchange footprint and may be replaced. At least two addition culverts will be required to pass flow under the interchange ramps. The culvert's existing catchment size will be reduced. Approximately half of this catchment is characterized by existing wetland. The area south of this catchment will also flow east to Highway 12 and appears to follow the highway ditch south into the Saskatoon Storm Sewer system.
H	97	3	The catchment area contains a large proportion of industrial development. It appears that the developments have a detention pond that manages on-site drainage and outlets easterly across Rock Ridge Road. Freeway construction will abandon the neighboring section of Highway 11. This will leave an option of sending flow across the freeway at this point or sending flow down the freeway ditch, effectively adding it to the flows of catchment I. A small amount of overland flow may also be intercepted by the freeway from the Highway 12 interchange to 18+575.
I	754	3	The majority of flow from this catchment enters the Hudson Bay swale which crosses the freeway at 20+000 (CN Rail Overpass). Development of Saskatoon's North Industrial Sector is expected to reduce the size of this catchment over time as new development diverts flow into the City's storm sewer system. Flow from catchment F and G are added to this area. Flow from catchment H could also be added depending on how Highway 11 decommissioning is done.
J	93 *224	3	Some runoff may be intercepted by the freeway east ditch between 18+575 and the Highway 11 interchange. However, most flow enters the Hudson Bay swale directly or along the CN Rail. Flow along the west side of the CN Rail will travel south and cross through an existing culvert at the CN overpass (part of the Hudson Bay swale system). The new Highway 11 alignment intercepts the Hudson Bay swale at 9+600. This alignment is presently part of Wanuskewin Road and includes an existing culvert that will be replaced. Catchments F, G, I, are combined with J at this crossing. *It appears that Highway 11 is presently impounding a 34 ha wetland and a number of dugouts that are filled by catchment H

Catchment	Area (ha)	Drainage Path	Characteristics & Assumptions
			and preventing it from draining directly to the Hudson Bay Swale. The drainage instead flows northeast to culverts near intersection of existing Highway 11 and existing Wanuskewin Road. Phase 1 design proposes decommissioning a section of Highway 11. Ditch blocks may be required to maintain the current drainage path or this area and Catchment H may be permitted to drain south along the freeway.
K	305 *1307	3	Drainage from this catchment is intercepted by the north ditch of Township Road 380 and flows east towards Highway 12. The existing Highway 12 culverts route flow east across the highway where it joins Catchment L. At least one additional culvert will be required to pass flow under the interchange ramps. A large existing dugout may be retaining some flow. *As discussed in Catchments A and D, there is the possibility of a dynamic situation at two grid road intersections. The north ditch of Township Road 380 appears to be deeper than the ditches that would direct flow to the south. However, the culvert inverts favour a southerly flow. It is expected that the flow is predominantly east at this location but could split and travel south under dynamic conditions.
L	*3098	3	A large area west of Highway 12 is intercepted by the north ditch of Township Road 382 and flows east towards Highway 12. After crossing Highway 12, it combines with flow from Catchments H and M before crossing the re-routed Highway 11 near 8+900. Note. The Green Network drainage map shows an area north of this catchment flowing east towards Highway 11 and then flowing southwesterly along the Highway 11 ditch. However, a CN Rail culvert (not in their original model) was found to pass flow to a set of Highway 11 culverts. *Refer to comments in Catchment J regarding the possible re-direction of a 34 ha wetland and Catchment H due to decommissioning of Highway 11.
M	66	3	Most of this watershed is intercepted by the CN Rail where it flows south in the west ditch. A culvert may not be required as the flow will follow the ditch under the proposed CN overpass. A minimal flow will travel along the east Warman Road ditch and cross at the intersection of the re-routed Penner Road.
N	27	3	Overland flow is intercepted by the west ditch of Highway 11 between Township Roads 381 and 382. It crosses Highway 11 on the north side of Township Road 381 through existing culverts. This is near the location that the re-routed Highway 11 ties into the present alignment so the existing culverts may be retained. After crossing Highway 11, the flow will drain south to the Opimihaw creek tributary via grid road ditches.
O	31	3	Overland flow will be intercepted by the west ditch of the re-routed Highway 11 from Township Road 381 south to the re-routed Penner Road overpass (6+950 to 7+850). After crossing the new Highway 11 alignment, the flow will make its way to the Opimihaw creek tributary.

Catchment	Area (ha)	Drainage Path	Characteristics & Assumptions
P	218	3	The majority of the catchment drains directly to the Hudson Bay Swale and the remainder is intercepted by the east side of the Highway 11 interchange. Flow from catchments F, G, H, I, J, L, and M are all added to the Hudson Bay Swale before it crosses the re-routed Penner road.
Q	6	4	Most of the overland flow east of Wanuskewin Road follows natural terrain to the South Saskatchewan River. The freeway embankment leading up to the Highway 11 interchange severs a portion of the catchment.
-	<10	4	Two additional catchment areas were mapped. They are 4 and 5 ha and follow relatively short overland drainage paths directly to the South Saskatchewan River. Since the freeway will be in cut as it passes through these catchments, it is recommended that they are managed by the freeway ditch.

Table I2: Culverts Along Saskatoon Freeway

STATION	DRAINAGE PATH	AREAS DRAINED	CULVERT SIZE
13+046	2	Catchment B including flow from: › Northeast ditch of Highway 16; › East and west ditches along Range Road 3060; › Overland sheet flow from field and wetlands in SE36-37-06-3; › Portions of the Highway 16 interchange; and, › Freeway right-of-way from Highway 16 interchange east to 13+300. A series of 5 culverts will be required to pass flow under the freeway and interchange ramps.	Major
13+800	2	Southwest portion of catchment C including flow from: › Overland sheet flow from portions of the west half of 31-37-05-3; and, › Freeway right-of-way from 13+300 to 13+800. There is no ditch at this location. To maintain natural drainage, this culvert should outlet at existing ground elevation which requires the freeway cross-section to be full embankment at this location with no ditch cut. The ditch high point will be at 13+300 to maintain existing drainage. However, the road high point can be as far east as 13+465. This will reduce the amount of fill required. *Refer to **Section** Error! Reference source not found. regarding redirected flow.	Minor
14+200	2	Remaining portion of Catchment C including flow from: › Overland sheet flow from portions of the west half of 31-37-05-3; › Flow intercepted by a ridge splitting the section and directing flow south; and, › Freeway right-of-way from 13+800 to 14+200. To maintain natural drainage, this culvert should outlet at existing ground elevation, which requires the freeway cross-section to be full embankment at this location with no ditch cut. *Refer to **Section** Error! Reference source not found. regarding redirected flow	Minor
14+800	2	Southwest portion of Catchment D including flow from: › Overland sheet flow from portions of field in NE31-37-05-3; and, › Freeway right-of-way from 14+200 to 14+800. There is no ditch at this location. To maintain natural drainage, this culvert should outlet at existing ground elevation. A field ridge appears to be directing a large portion of the overland flow east to a dugout. This proposed culvert can either continue to drain to the dugout along the field ridge or direct flow to the southeast, which is its natural drainage pattern. A third option would be to eliminate this culvert and feed the dugout from the ditch and proposed culvert at 15+215. *Refer to **Section** Error! Reference source not found. regarding redirected flow.	Minor
15+215	2	Catchment D including flow from: › North and south ditches along Township Road 380 (refer to potential dynamic situation in Catchment D description); › East and west ditches along Range Road 3055; › Overland sheet flow from portions of field in NE31-37-05-3; and, › Freeway right-of-way from 14+800 to 15+250.	Minor

STATION	DRAINAGE PATH	AREAS DRAINED	CULVERT SIZE
15+550	2	Catchment E including flow from: › Overland sheet flow from NW 32-37-05-3; › Flow intercepted by treeline at 15+550 and directing water south to culvert; and, › Freeway right-of-way from 15+250 to 15+575. There is no ditch at this location. To maintain natural drainage, this culvert should outlet west of the treeline at existing ground elevation, which requires the freeway cross-section to be full embankment at this location with no ditch cut. *Refer to comments in Catchment E and **Section** Error! Reference source not found. regarding redirected flow. It is recommended to investigate if the overland flow is desirable to the landowner for filling dugouts.	Minor
16+200	3	Catchment F including flow from: › Primarily overland sheet flow in the NW 32-37-05-3; › Flow in the south ditch of Township Rd. 380; › Freeway right-of-way from 15+575 to Highway 12 interchange (north side); and, › Portions of the Highway 12 interchange. The overland flow would naturally be intercepted by a treeline at 16+040 where it would flow south and join a series of wetlands that drain east through an existing Highway 12 culvert. The freeway ditch and this culvert will provide a more direct route, but the drainage path remains unchanged.	Minor
Highway 12 Km2.7	3	Use or replace existing Highway 12 culvert (km 2.7) south of interchange. At least one new culvert will be required to pass flow under the interchange ramps. Catchments F and G including flow from: › Overland sheet flow from an area of approximately 9.7 ha; › Freeway right-of-way from 15+575 to Highway 12 interchange (south side); and, › Portions of the Highway 12 Interchange.	Minor
Highway 12 Km 3.4	3	Retain or replace the existing Highway 12 culvert (km 3.4) north of interchange. Add at least two additional culverts under the interchange ramps to maintain the drainage path. Catchment K including flow from: › North ditch of Township Road 380; › West ditch of Highway 12 from the intersection of Township Road 381 south to the Highway 12 interchange; and, › Portions of the Highway 12 Interchange.	Minor
18+750	3	Catchment H including flow from: › North ditch of Cory Road; › Outfall from existing detention pond servicing the East Cory Light Industrial Park north of Cory Road and west of Rock Ridge Road. This pond drains east across Rock Ridge Road into two dugouts which will then spill to neighboring wetlands to the northeast; and, › South side of freeway right-of-way from the Highway 12 interchange to 18+950.	Minor
20+000	3	The CN overpass is located near an existing CN culvert which passes flow from the Hudson Bay swale. A series of at least 5 culverts are	Major

STATION	DRAINAGE PATH	AREAS DRAINED	CULVERT SIZE
		recommended. This would include culverts under the freeway lanes, ramps, CN railroad, access road, and multiuse pathways. Catchments F, G, and I including flow from: › Hudson Bay Swale; › CN railroad ditches both north and south of the Freeway overpass; › West side of freeway right-of-way from ~18+950 to Wanuskewin Road interchange; › Portions of the Wanuskewin Road interchange; and, › Also refer to Catchment H regarding possible flow re-direction due to Highway 11 decommissioning.	
Highway 11 Ramps **Southbound to Westbound** **Northbound to Westbound**	3	Flow passing the culvert at 20+000 will also need to pass these ramps at the Highway 11 interchange. Flow would follow the CN Rail ditches under the overpasses. A culvert will be required under the proposed multi use path and service road.	Major
21+000	4	Small volume of overland flow from Catchment Q and the freeway right-of-way from 20+800 to 21+200.	Minor
21+900	4	Given the deep cuts through the riverbank and the relatively small catchment sizes, it is recommended that the area southeast of 21+200 follows the freeway ditches to the river. However, it is recommended that culverts direct flow from the median ditch to the outside ditches to reduce risk of bank erosion near the bridge structure.	Minor

Table I3: Culverts Along Wanuskewin Road and Re-Routed Highway 11

STATION	DRAINAGE PATH	AREAS DRAINED	CULVERT SIZE
6+940	3	Catchment N including flow from: › West side of existing Highway 11 right-of-way between Township Roads 381 and 382; and, › East side of the CN Rail between Township Roads 381 and 382. This is near the tie in to existing Highway 11 alignment. The existing culverts are still slightly off the re-alignment and should be replaced.	Minor
7+400	3	Catchment O including flow from: › West side of the new Highway 11 right-of-way from 6+950 (Township Road 381) to 7+875. Culverts are located across from existing culverts on the decommissioned section of Highway 11.	Minor
7+850	3	South portion of Catchment O including flow from: › Inside and around the Penner Road overpass; and, › North of Penner Road the overpass ramp ditches would also drain through these culverts. This would be a series of four culverts under the overpass ramps and the freeway. It is recommended to install culverts on the north side of Penner Road to avoid flow having to cross penner road again. Flow on the south side of Penner road will flow southwest to the Hudson Bay swale then back to the north along the swale.	Minor
8+900	3	Catchments K, L, and H including flow from: › Portions of the CN Rail ditches; and, › Highway 11 right-of-way from Penner Road to 9+500. *Highway 11 decommissioning could divert flow from Catchment H and a 34 ha section of Catchment L away from this culvert to the culvert at 9+550.	Major
9+550	3	Catchments F, G, I, and J including flow from: › Hudson Bay Swale; › Overland sheet flow from CN Rail east to Wanuskewin/Highway 11; › Freeway right-of-way from 18+950 to Wanuskewin Road interchange; and, › Most of the Highway 11 interchange. *Highway 11 decommissioning could divert flow from Catchment H and a 34 ha section of Catchment L to this culvert. The highway appears to be blocking the natural drainage path, resulting in a 34 ha wetland between Highway 11 and Township Road 380. This wetland is also an outlet for the East Cory Light Industrial Park’s detention pond. The new freeway ditch could open up the natural drainage route for this area without addition of ditch blocks.	Major

Table I4: Culverts Along Penner Road

STATION	DRAINAGE PATH	AREAS DRAINED	CULVERT SIZE
9+350	3	Catchments F, G, H, I, J, K, L, M, and P including flow from: › Hudson Bay Swale; › South side of Penner Road from 8+700 to the Penner Road overpass; and, › Portions of the Penner Road overpass.	Major
10+660	3	Portions of Catchment M. Most of this watershed will be intercepted by the CN Rail ditch which will direct the flow south to its intersection with existing Highway 11. The CN overpass will accommodate the majority of the flow without a culvert. A small flow will follow the east ditch of Warman Road. Therefore, a culvert is recommended at the intersection of Warman Road and Penner Road.	Minor

Table I5: Culverts Along Access Proposed Access Roads

STATION	DRAINAGE PATH	ACCESS ROAD LOCATION AND AREAS DRAINED	CULVERT TYPE
N/A	3	Catchments F, G, H, I, J, K, L, M, and P including flow from: › Hudson Bay Swale; › South side of Penner Road from 8+700 to the Penner Road overpass; and, › Portions of the Penner Road overpass. The proposed access road intersecting re-aligned Penner Road at 9+600 and connecting to the original Penner Road crosses the tributary between the Hudson Bay Swale and Opimihaw creek. Moving this access road east out of the drainage path would eliminate the need for a major culvert.	Major
N/A	3	The west access road at the future interchange of Highway 12 and Township Road 382 (Lutheran Road) will cut off an existing drainage path. Currently the south bound lanes have a 500 mm culvert at km 5.35, the north bound lanes have a 600 mm culvert at km 5.84 and another at km 5.60, and the East Service Road has a 600 mm culvert at km 5.60 and another at km 5.68.	Minor

Table I6: Interchange Culverts

INTERCHANGE	CULVERTS
Highway 11 and Wanuskewin	10
Highway 12	11
Highway 16	10
Penner Road Overpass	4

APPENDIX J

Bridge Option Study Reports

Leonhardt, Andrä und Partner

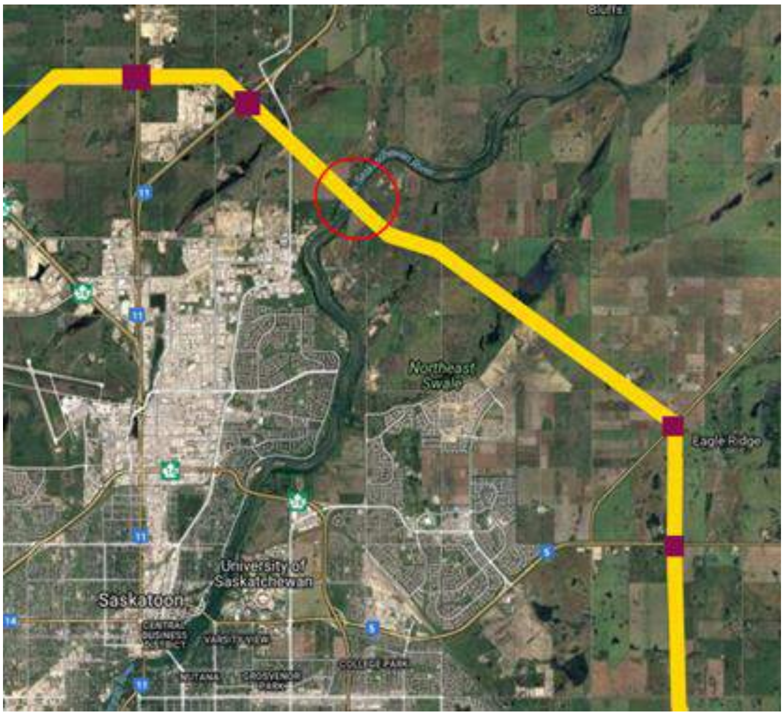
Functional Planning Study for the Saskatoon Freeway Project

Phase 1

Inhaltsverzeichnis

1 Introduction

LAP has been contracted by SNC Lavalin to perform an option study for the Saskatoon Freeway Project As part of the functional planning study we were asked to assess the possible bridge types for a crossing of the South Saskatchewan River North of the city of Saskatoon shown in the circle below. This river crossing is part of a new Freeway to be planned around the City of Saskatoon. It is a signature element of the project.



The crossing has a span length of 460 m from top of bank to top of bank. The river span at the water's edge is about 230 m. The elevation difference from top of bank to water's edge is about 35m on the West approach and 20 m on the East approach. The river is likely 10m deep, on average.

The valley walls are prone to landslide activity and often the Ministry will cut the slope on the approach and place the abutments part way up the valley walls. These abutments tend to have stability problems and become a possible future maintenance issue due to creep movements from the landslides. Also, the Valleys are known cultural and heritage sensitive areas, so the Environmental aspects may dictate a top of bank to top of bank solution.

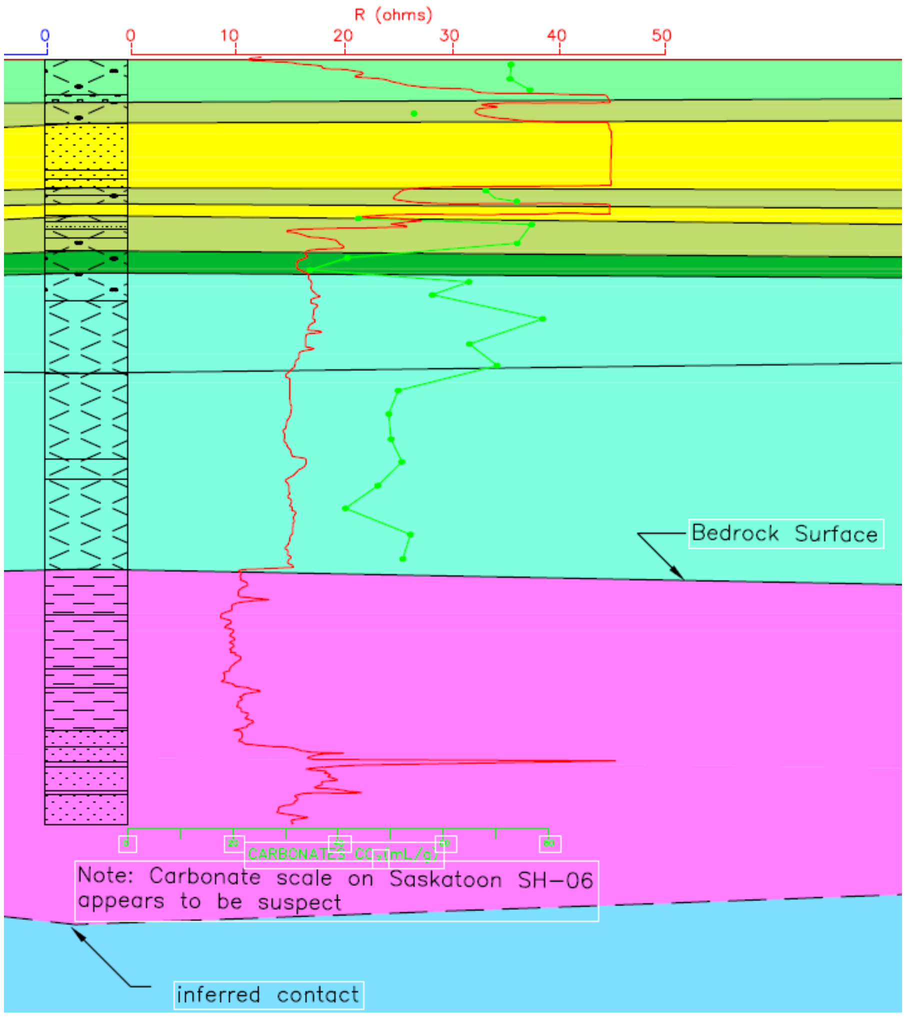
Also, it is becoming more difficult to place multiple piers in the river due to Environmental and fisheries issues.

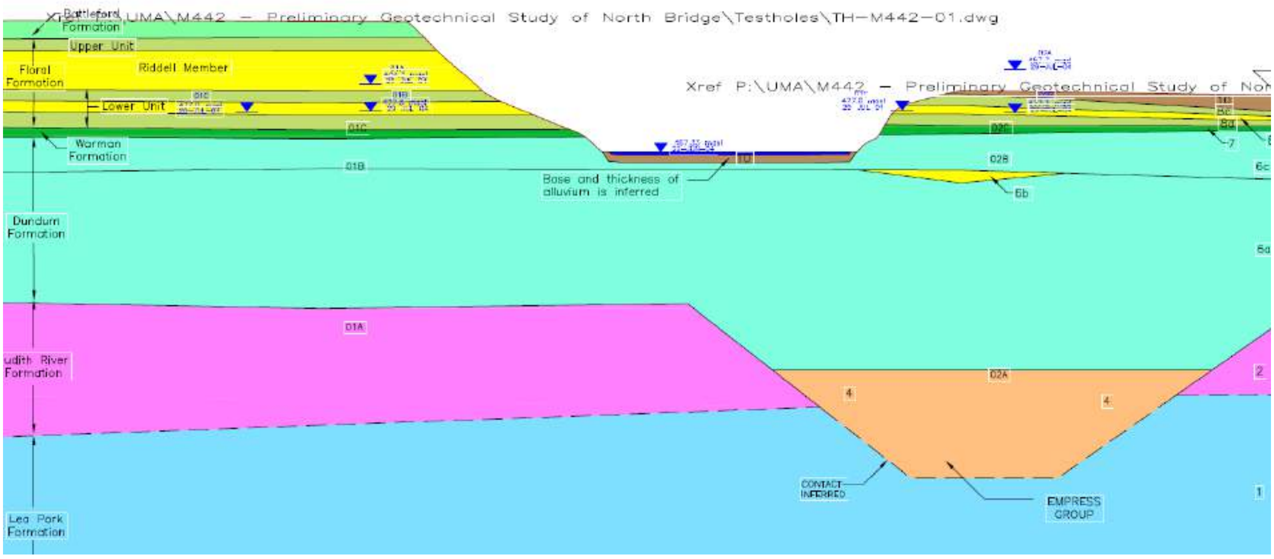
The typical bridge type usually selected in Saskatchewan is plate girder with multiple spans in the river like the one shown below:

Given the Environmental and landslide type risks, the Ministry may want to look at options for a signature bridge unlike what is currently constructed in Saskatchewan.

2 Geotechnic

Saskatoon Area							
Time			Stratigraphy (1)			Lithology	
Quaternary	Holocene		Saskatoon Group	Surficial Stratified Deposits		Sands and Silts	10
						Silts and Clays	
	Late Pleistocene	Late Wisconsin		Battleford Formation		Till	9
		Early Wisconsin		Floral Formation	Upper Unit	Till	8e
	Early and middle Pleistocene	Sangamon			Riddel Member	Silt, Sand, Gravel	8d
		Illinoian			Lower Unit	Till	8c
						Clay, silt, sand	8b
						Till	8a
		Pre-Illinoian	Sutherland Group	Warman Formation		Till	7
						Sand, Gravel	
				Dundurn Formation		Till	6c
						Sand, Gravel	6b
						Till	6a
				Mennon Formation		Till	5
Tertiary		Pliocene	Empress Group			Sand, gravel, silt, clay	4
Late Cretaceous			Montana Group	Bearpaw Formation		Silt and Clay	3
				Judith River Formation		Sand, Silt, Clay	2
				Lea Park Formation		Silt and Clay	1


R (ohms)
0
0
10
20
30
40
50
Bedrock Surface
Note: Carbonate scale on Saskatoon SH–06
appears to be suspect
inferred contact

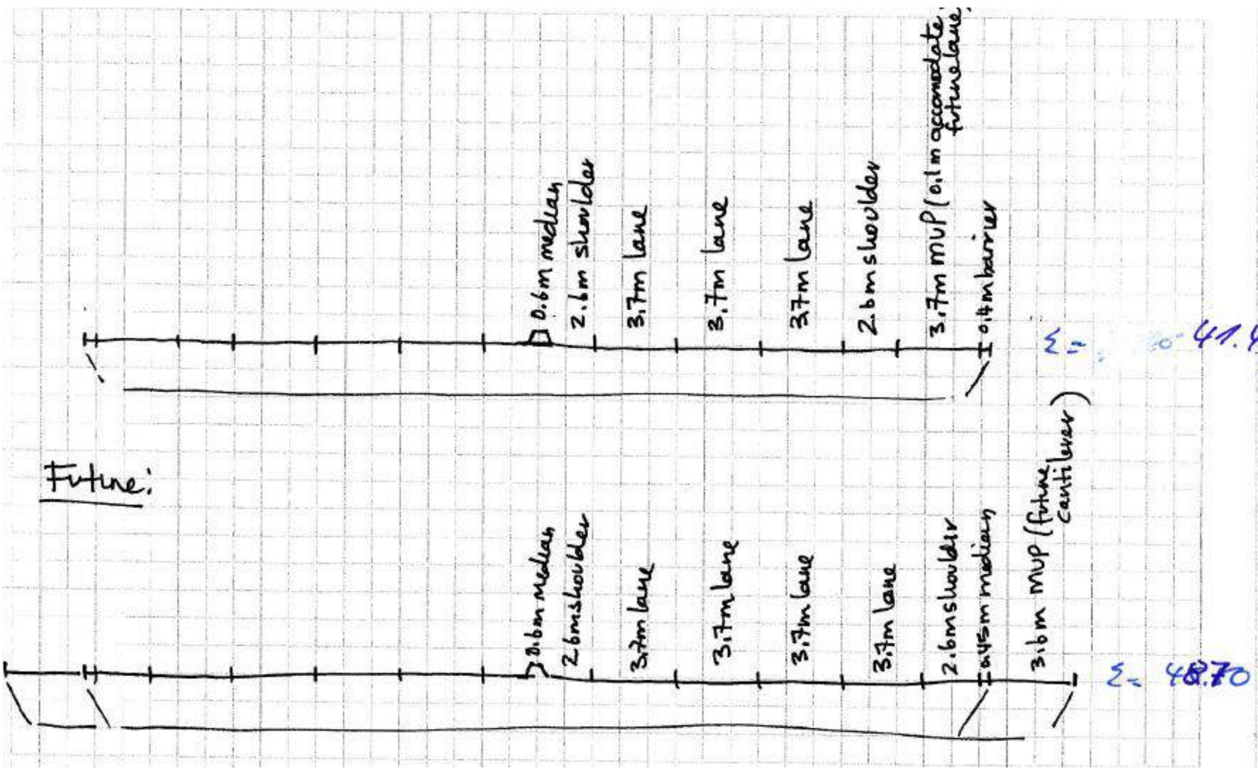

UMA\M442 – Preliminary Geotechnical Study of North Bridge\Testholes\TH–M442–01.dwg
Battleford Formation
Upper Unit
Floral Formation
Riddell Member
Lower Unit
Warman Formation
Dundurn Formation
Judith River Formation
Lea Park Formation
Xref P:\UMA\M442 – Preliminary Geotechnical Study of Nor
Base and thickness of alluvium is inferred
01C
01B
01A
02C
02B
02A
6b
6c
6a
4
4
2
1
CONTACT INFERRED
EMPRESS GROUP

3 Options

3.1 General

All the options below are described in more detail in the matrix, additional information such as examples and better quality sketches are listed below

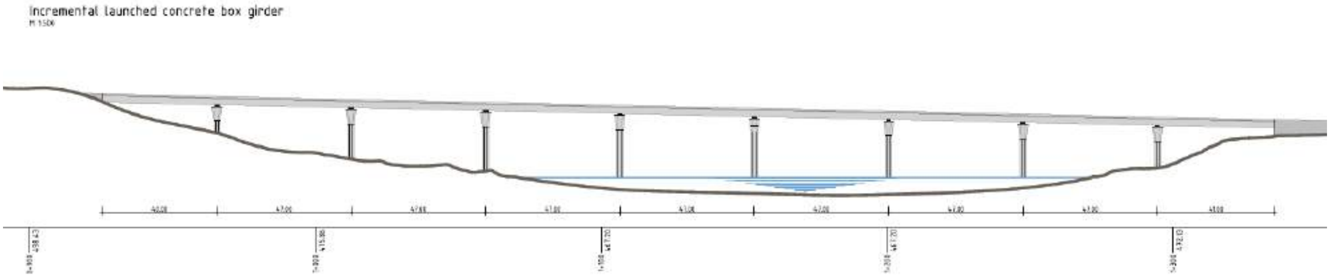
Tentative roadway arrangement:



All options shown below allow to add a future MUP on a light steelwork, attached to the side

3.2 Option 1- Prestressed Concrete Girder

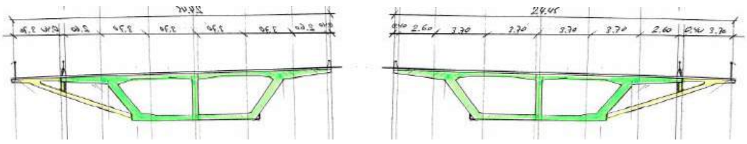
3.2.1 Layout



Girder Bridge with 10 spans, 41-7x47-40 = 410, four piers in the water, 2 at shore and 2 at westbank

3.2.2 Cross Sections

A) Twin Box Girder, prestressed.



B) Feasible alternative would be AASHTO Girder Bridge (Precast T- beams with 45m spans)

3.2.3 Construction

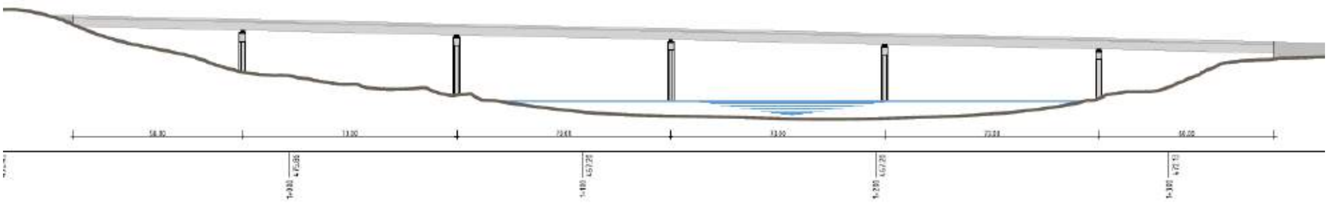
A) Twin Box Girder would allow incremental launching from one side,
B) PC girders would need to be placed by cranes, which is possibly not in accordance with environmental restriction (access all along needed)

Concrete boxes, incrementally launched, would be the first choice in Europe, since it is the most economical and robust type for shorter spans. But many piers in the water increases constructability problems

MUP added later on light steel structure –this is valid for all options below

3.3 Option 2 – Steel Composite Girder

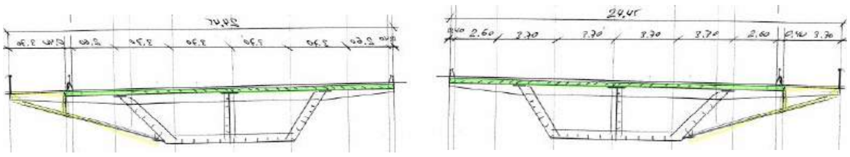
3.3.1 Layout



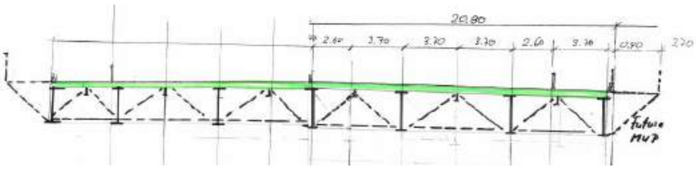
Girder Bridge with 6 spans of 60-4x73-58 = 410m with 2 Piers in the water, two on shore, one on the westbank

3.3.2 Cross Section

A) Composite Box Girder (Twin Boxes) --> European preference



B) Multiple Steel Plate Girder --> likely local preference



for Alt A)

3.3.3 Example

for Alt 1

for Alt 2

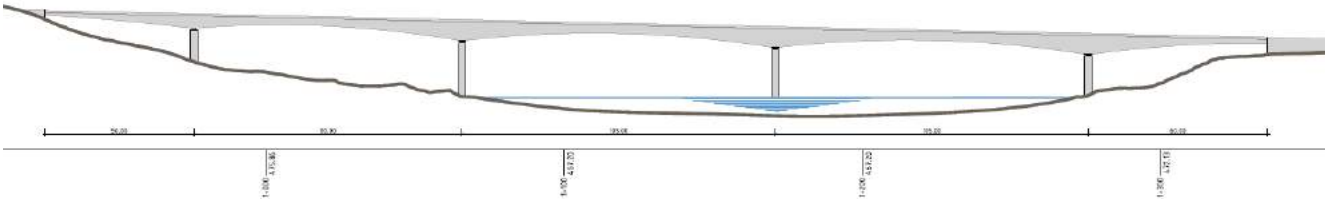
3.3.4 Construction

A) Box girders and steel plate girders with constant depth could be launched from one side.
Note, that bottom flanges needs to be welded for launching

B) Steel plate girder could be placed by cranes in a spanwise erection on auxiliary piers, but that's possibly not in accordance with environmental restrictions, since access is needed all along.

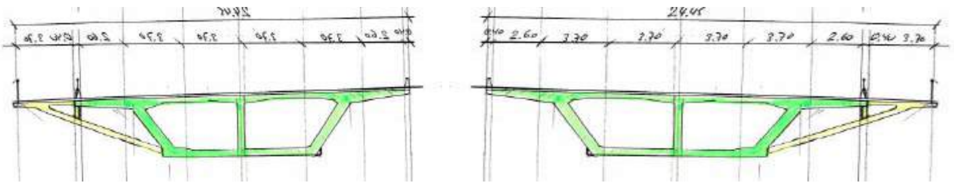
3.4 Option 3 – Haunched Prestressed Concrete Girder Bridge

3.4.1 Layout



Concrete box girder with 5 spans, 60- 2x105-90-50 = 410, 1 pier in the water, 2 on shore, 1 in the westbank

3.4.2 Cross Section



Inclined webs provide some geometrical problems with the haunch, probably vertical webs are more appropriate

MUP added later on light steel structure

3.4.3 Example

Rheinfelden, River Rhine, Germany, Mainspan 101m

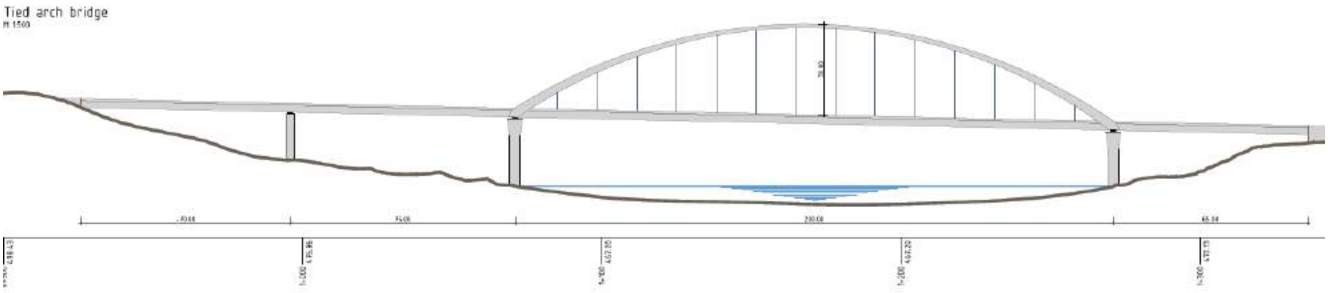
3.4.4 Construction

CIP Segmental Free Cantilever Construction by a Formtraveler.

Delivery of material at the piers (access needed)

3.5 Option 4 – Tied Arch Bridge

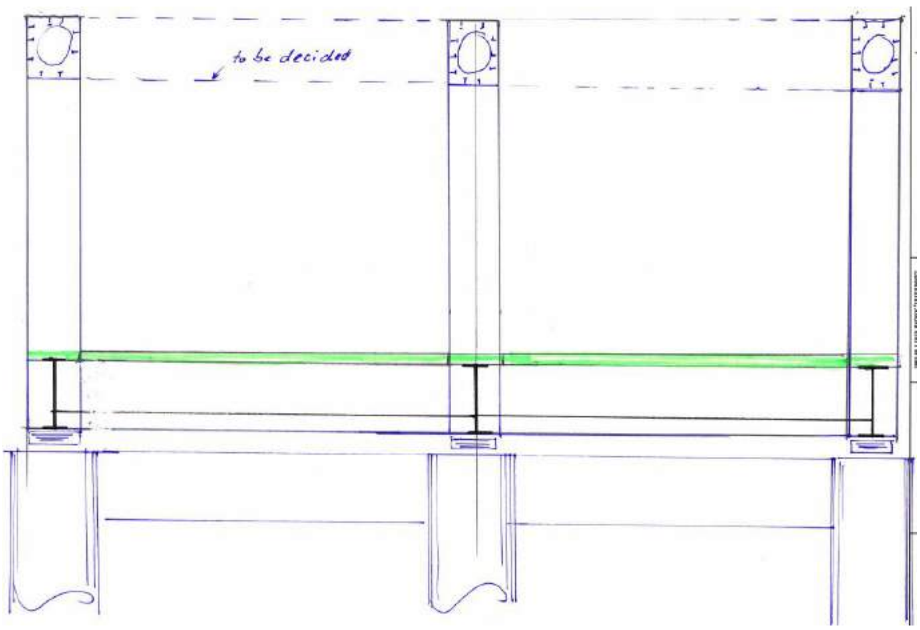
3.5.1 Layout



Tied arch bridge with spans of 65-200-75-70 = 410, 2 piers at shore, 1 pier in the west bank, none pier in the water

Note: Piers at shore might be a bit too close to the water, with a 215m span this situation would improve and the cost would increase only marginal

3.5.2 Cross Section

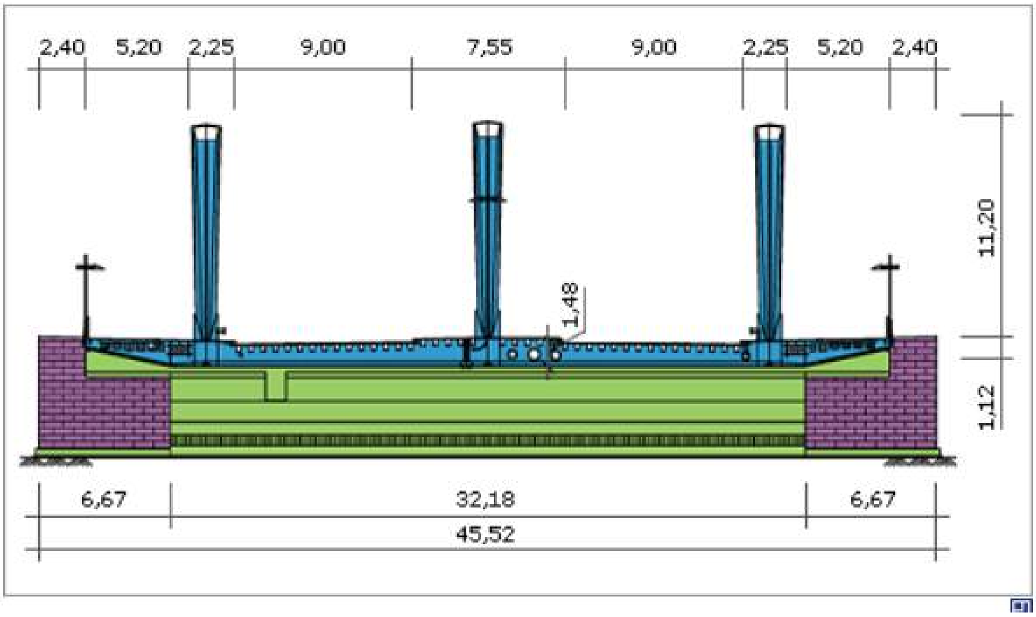


The example below does not have any crossbeam on top. However, with a span over 200m those may very well be needed.

Other alternatives are twin arches (e.g a doubling of the below shown Nijmegen Bridge) or inclined arches as shown for option 6 below

3.5.3 Example

A) Tripple Arch



B) Twin Arch

Two of those would be needed for Option 4

C) Inclined Arches

Waterdale Bridge, Edmonton

Here the legs are carried down to the ground, for a true tied arch bridge
they rest on the pier, however, the appearance is similar

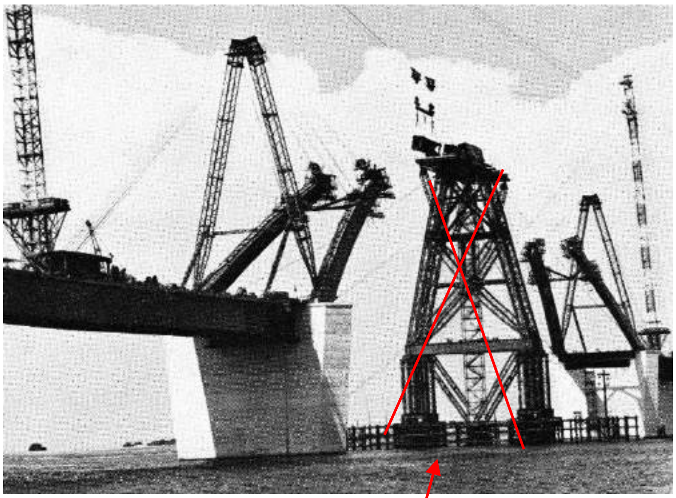
3.5.4 Construction

Alt A:

- Incremental launching of plate girder with two auxiliary pier in the water (additional steel in the longitudinal girder needed),
- placement of roadway slabs (precast panels),
- casting of stiches
- erection of arches on the finished deck

Alt B:
Free cantilever erection, supported by temporary stay, deck and arch being erected parallel

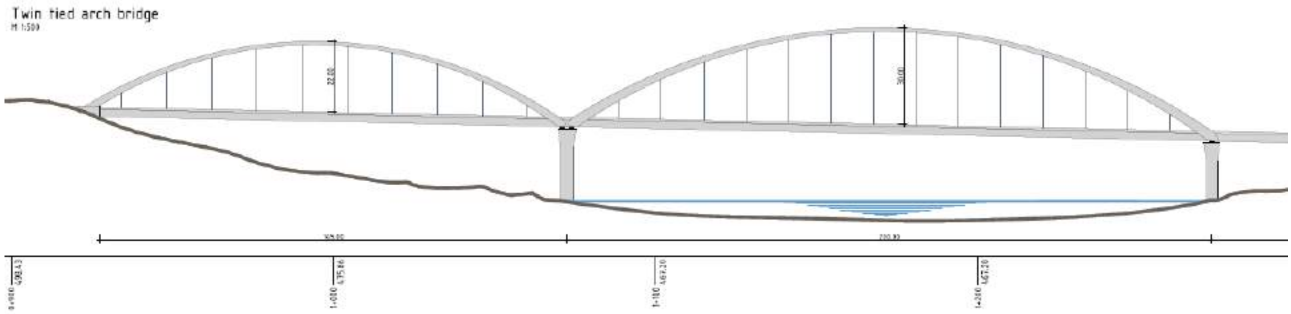
Example form Fehmarnbelt crossing – centre pier not needed for Saskatoon



This auxiliary pier is not required

3.6 Option 5 – Tied Dual Arch Bridge

3.6.1 Layout



Same as Option 4, but with another arch to bridge the westbank pier-free, resulting in spans spans of 65-200 *) -145= 410

*) better go to 215 m

3.6.2 Cross Section

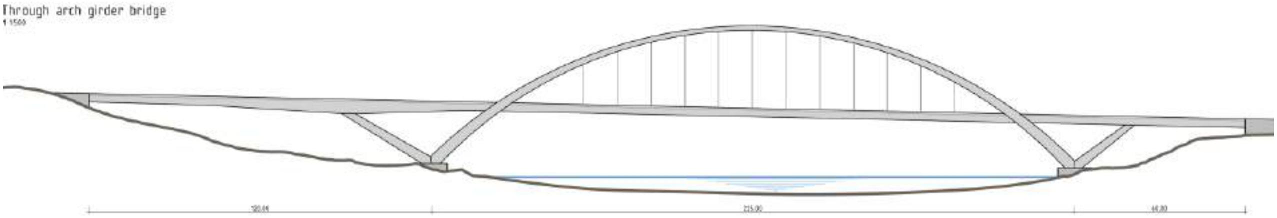
see option 4 above

3.6.3 Construction

- Incremental launching of plate girder with two auxiliary pier in the water (additional steel in the longitudinal girder needed),
- one in the westbank, placement of roadway slabs (precast panels),
- casting of stiches
- erection of arches on the finished deck

3.7 Option 6 – Through Arch Bridge

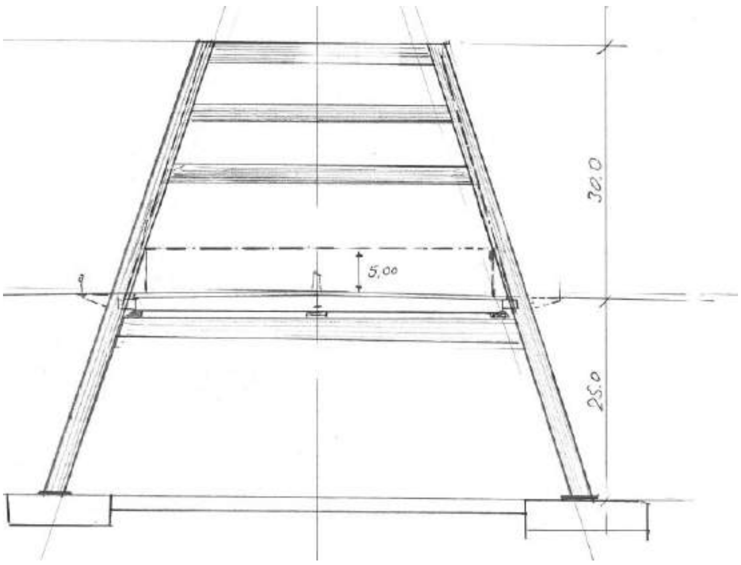
3.7.1 Layout



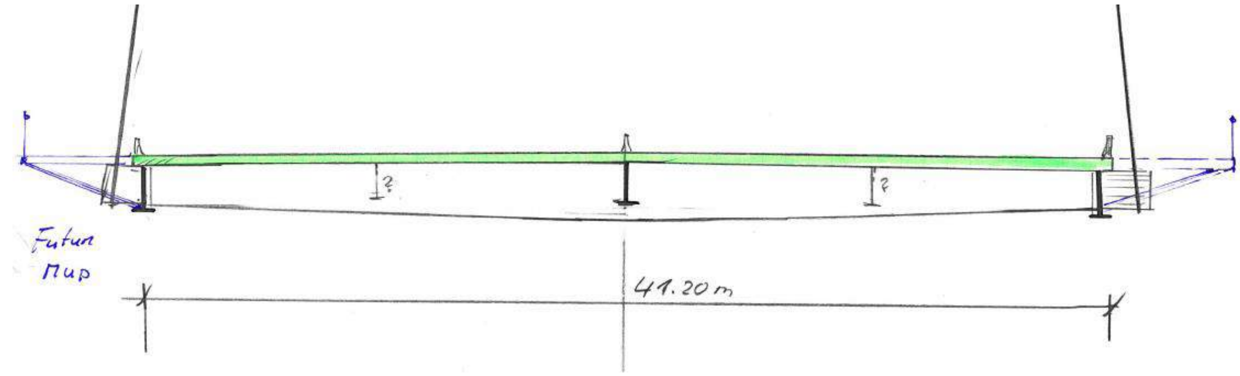
Through Arch Bridge with spans of 60-225-120= 410. Only two piers/foundations needed

The large span on the west bank requires haunched plate girders

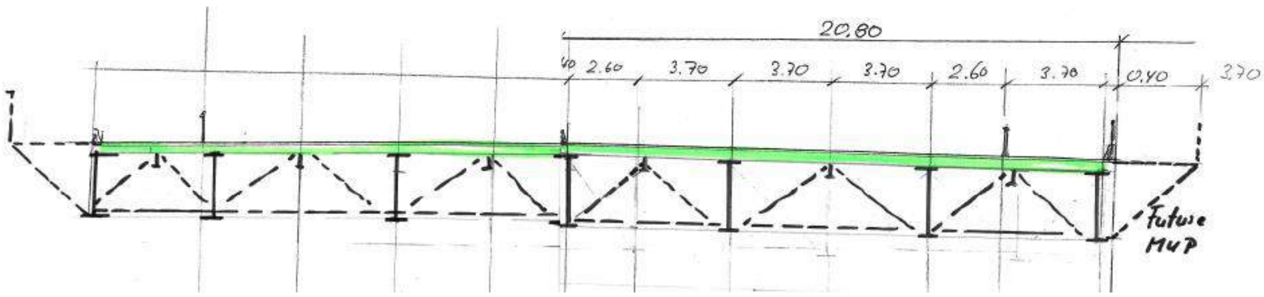
3.7.2 Cross Section



Cross section at the arch: Two inclined arches

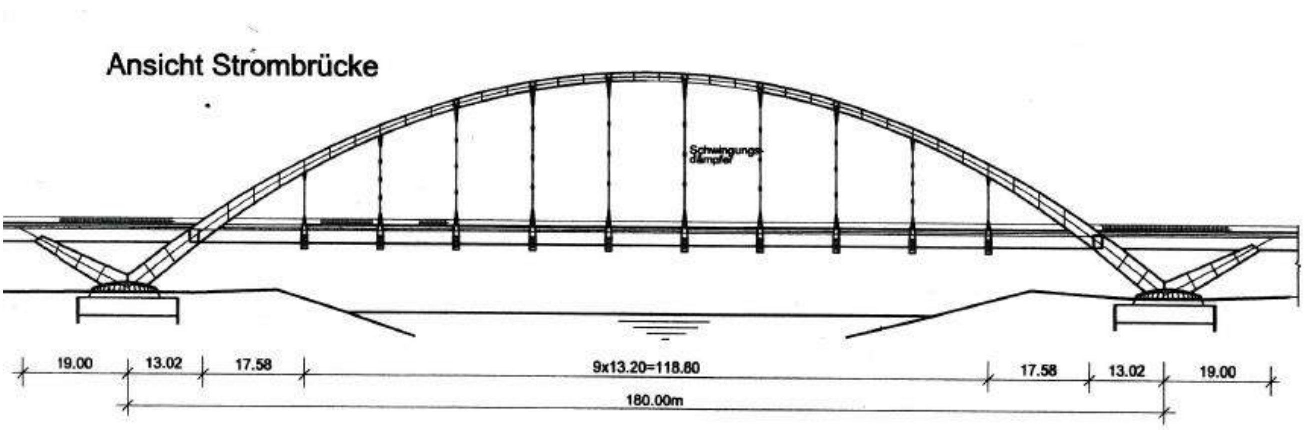


Alternative cross section at the sidespans



3.7.3 Examples

A) Saalebrücke Beesedau



Competition Design Svinesund Bridge

Layout under the deck is diferent, but above the deck very similar to option 6

3.7.4 Construction

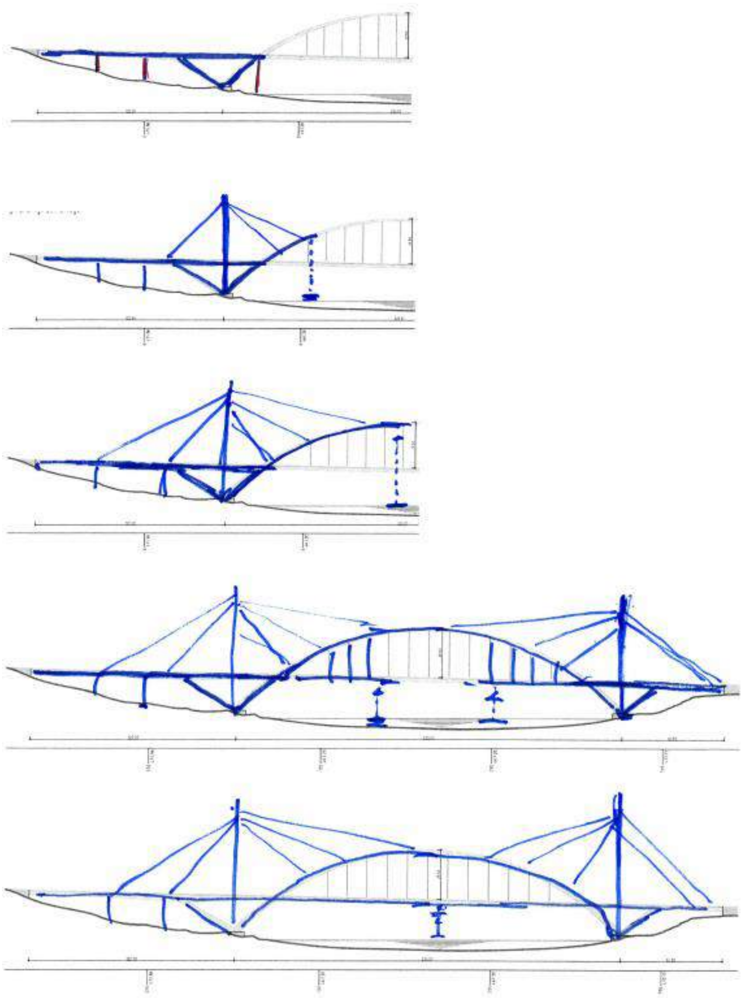
Alt A)

Because of the required haunch, incremental launching of the sidespan West is on a first view not possible and the plate girder needs to be erected on auxiliary piers by cranes.

The mainspan could be launched from the east, but two auxiliary piers are needed in the water (also additional steel in the longitudinal girder needed). Therefore a span-wise erection on aux piers is most likely the best choice, followed by placement of roadway slabs (PC Panels), casting of stiches and erection of arches on the finished deck

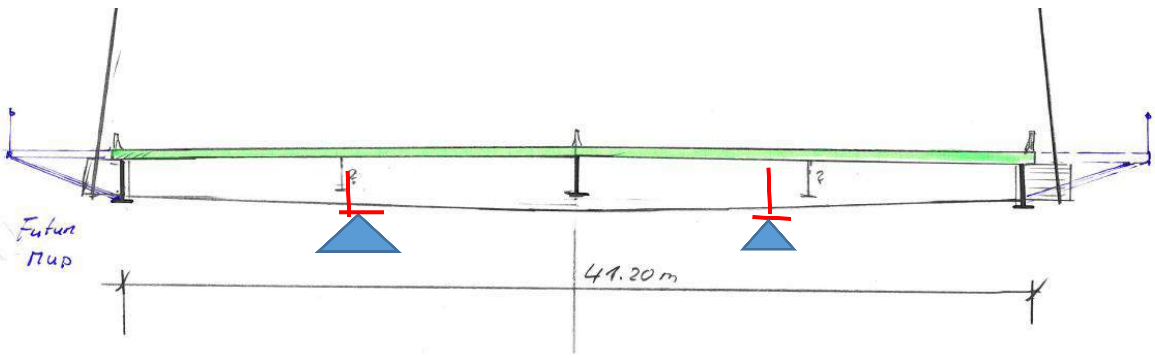
Alt B)

Free Cantilever erection supported by temporary stay and Tower, small Segments delivered to lifting point and assembled a site

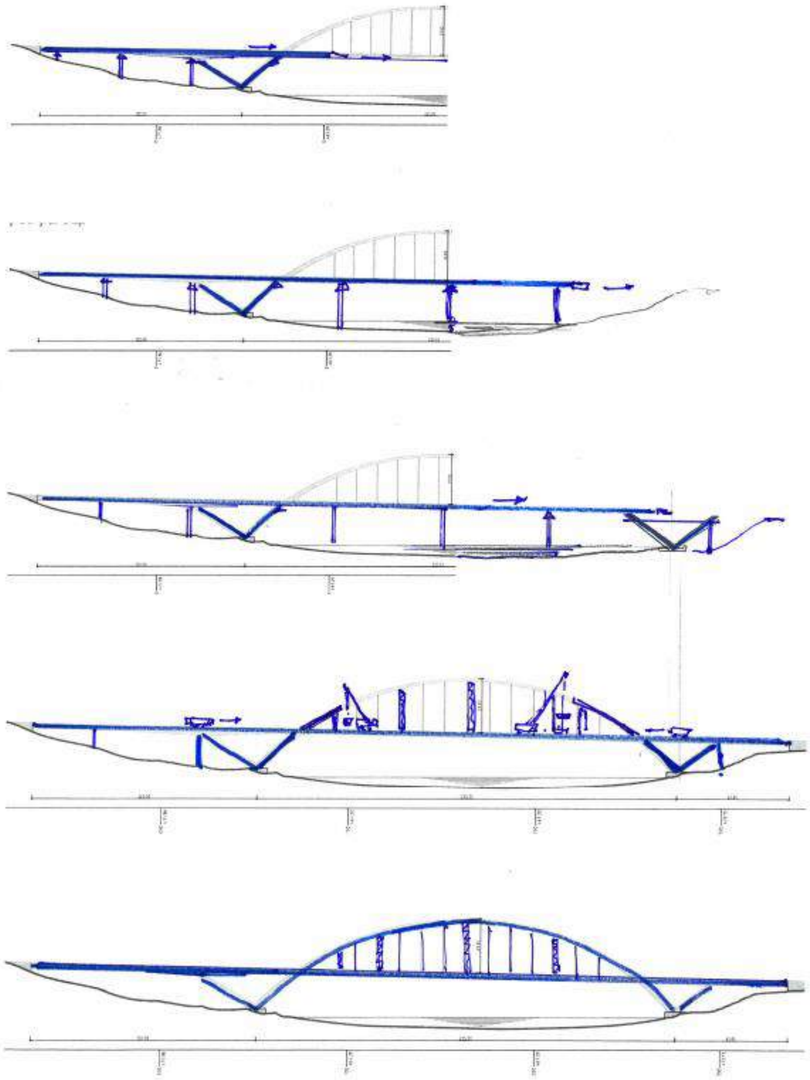


Alt C)

However, if the launching bearings are not placed under the edge girder, but under the secondary beams, launching all over the crossing from west to east would be possible.

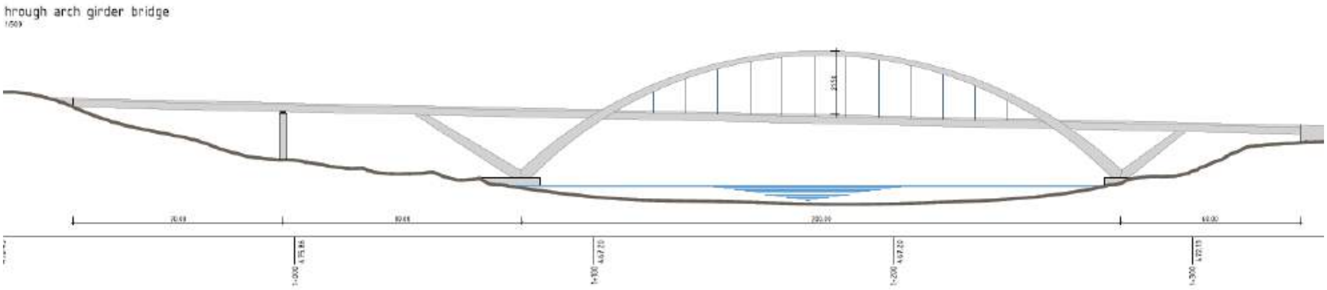


Of course, some temporary piers are needed in a distance of about 50m



3.8 Option 7 - Through Arch Bridge

3.8.1 Layout



Through Arch Bridge with spans of 60-200-80-70= 410.

In order to reduce the length of the sidespan on the westbank, another pier is placed in the banks

Cross Sections, Examples and construction as for Option 5.   One temporary pier less is needed

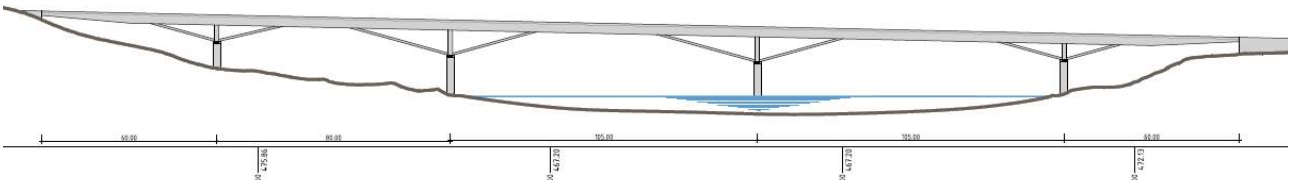
3.8.2 Construction

As option 6 above, but because the edge girder has a constant depth, launch bearing can be placed there.

On the other hand, for connection of the underdeck struts to the edge girder it may very well be of advantage, to have the launching bearings under secondary girders further inside.

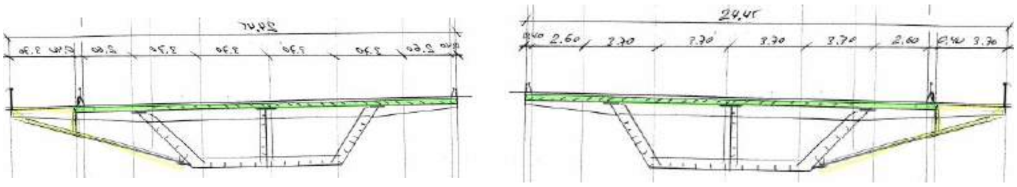
3.9 Option 8- Braced Box Girder Bridge

3.9.1 Layout



Braced girder with span of 60-105-105-80-60= 410m

3.9.2 Cross Section



3.9.3 Example

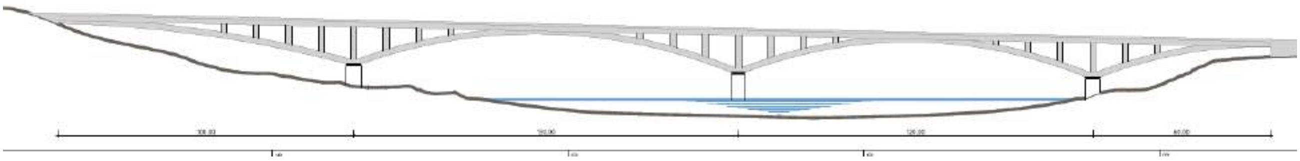
The example Sundsvall has only one composite box girder, but due to the extreme width, we would need two individual box girders

3.9.4 Construction

Erection of box girders on auxiliary piers, span by span or incrementally launched, erection of bracing under the finished deck

3.10 Option 9 – Spandial Arch Bridge

Layout

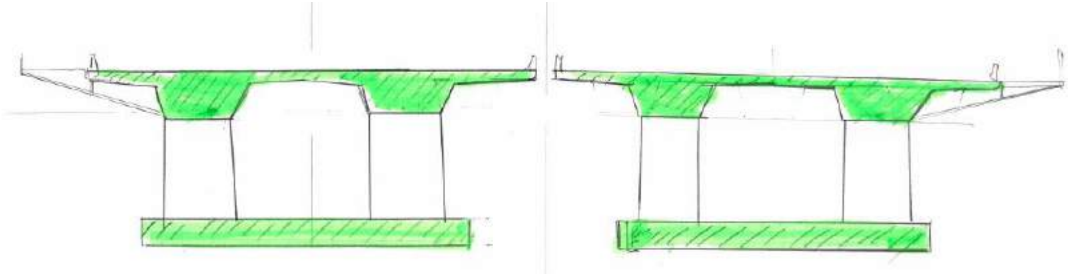


Underdeck Arch Bridge with spans of 60-105-105-80-60= 410m

These type of arch bridges are usually made of concrete, but also steel boxes and steel columns, in combination with a composite deck, are feasible and has been constructed

3.10.1 Cross Section

A) Concrete



B) Steel Composite would be also a feasible option with piers in concrete or steel

3.10.2 Examples

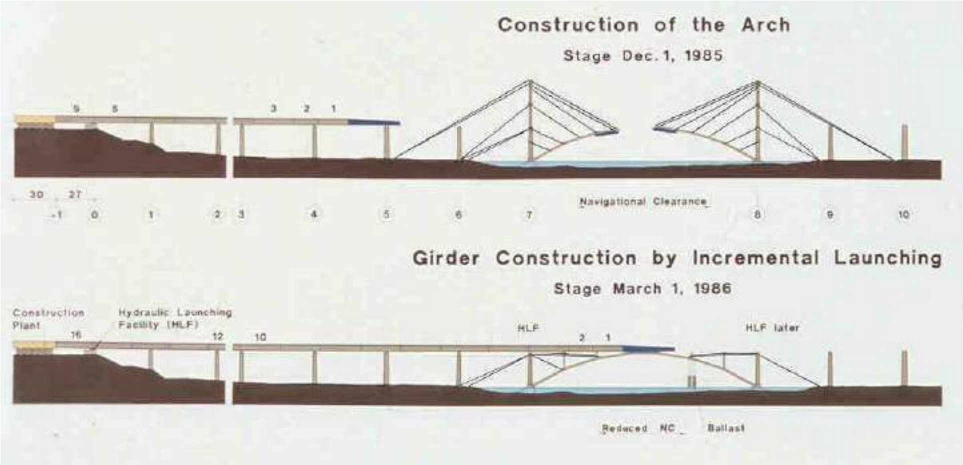
Neckarbrücke Hochberg near Stuttgart (last century)

Filstal Option Study (modern type)

3.10.3 Construction

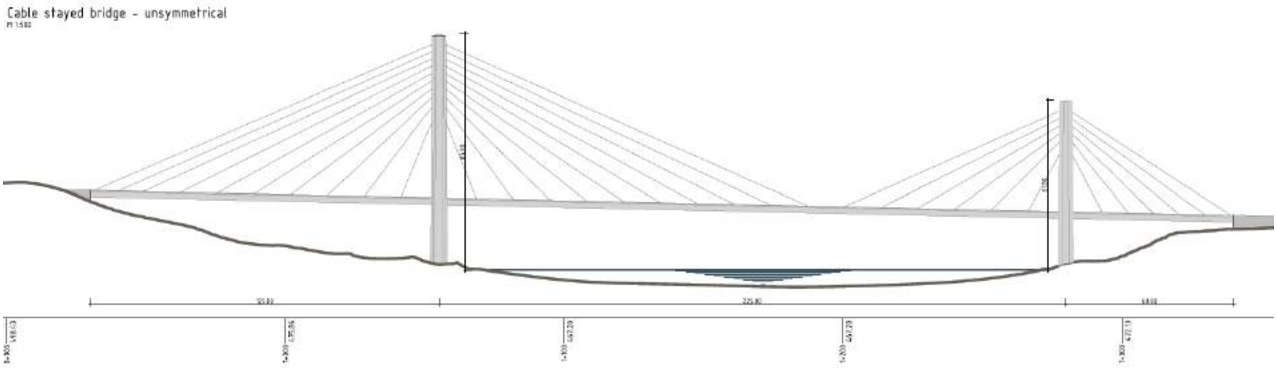
- arch in segments on auxiliary piers or stay cable supported
- Erection of Piers
- Steel Grid Placement span by span or incrementally launched
- Roadway slabs (PC Panels)

Construction Example _ Mainbridge Veitshöchheim

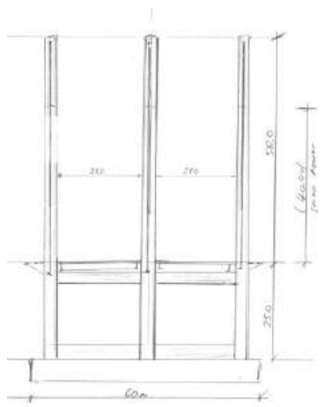


3.11 Option 10 – Unsymmetrical Stay Cable Bridge

3.11.1 Layout



Unsymmetrical stay cable bridge with spans of 60-225-125 = 410m



It is desirable to place the two pylons on shore and avoid piers in the critical hill on the left. The logical consequence is an asymmetrical two-tower cable stayed bridge.

Whether the towers will have two legs or three needs to be developed further. Also the cable arrangement can be modified from the fan type shown above, it could be a harp type or bundled cables. Those (the bundled) need, however, a rather deep superstructure to cope with bending between the cables.

3.11.2 Tower Material and Stay Anchorages

Material for the tower could be concrete or steel (boxes). In order to keep the dimensions small, stay anchorages saddles would have to be arranged as saddle

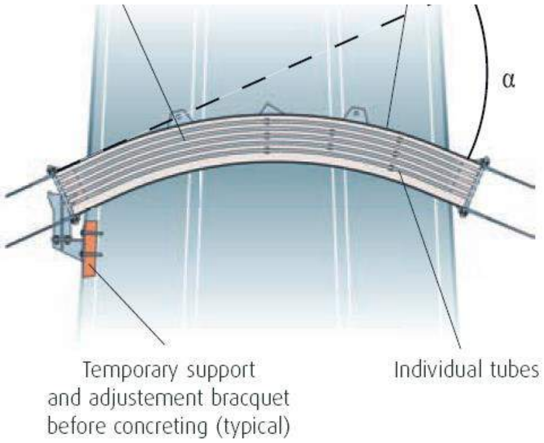


Fig: Freyssinet Saddle

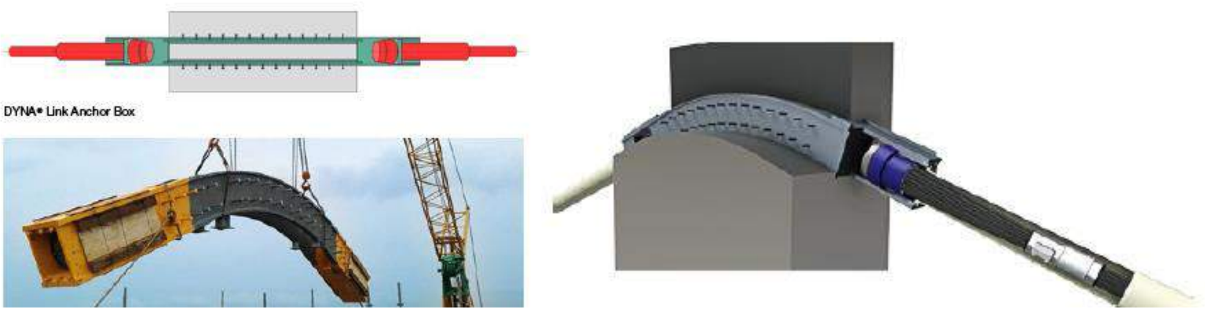


Fig: Dynalink Box Type saddle from DSI – as used at Champlain Bridge

or fork type anchor connected to plate extensions

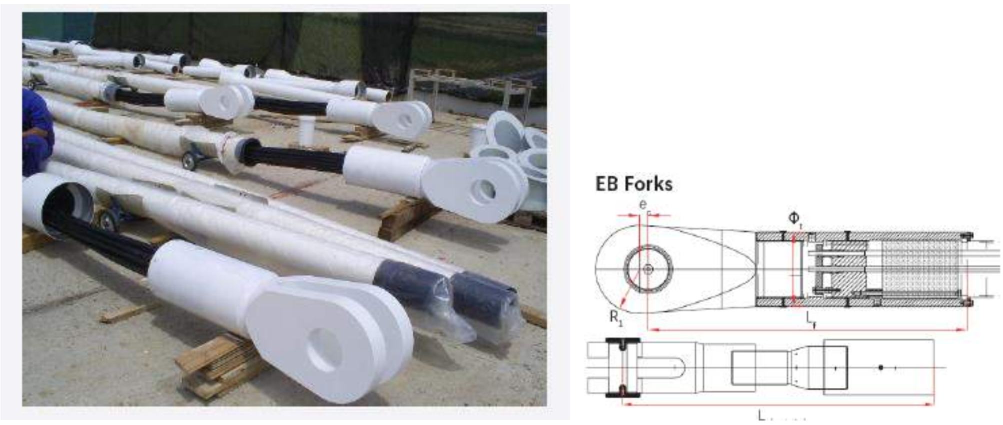
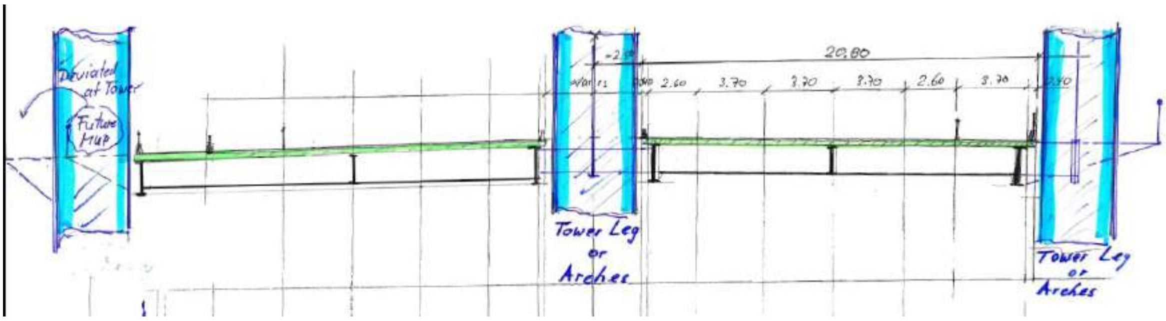


Fig: Fressinet H 2000 Fork

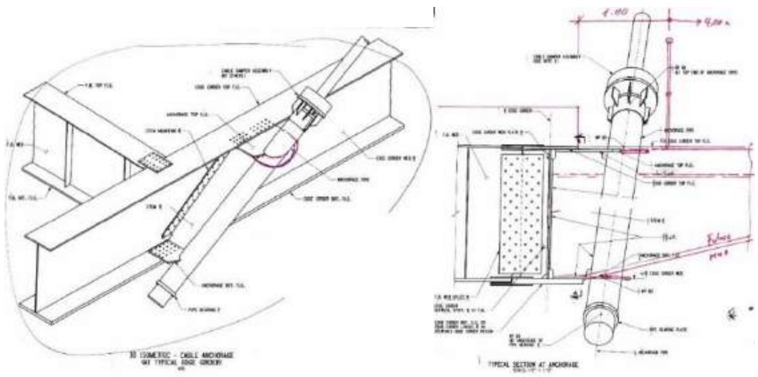
Fig: Clevis Cable Anchorage from DSI

3.11.3 Cross Section

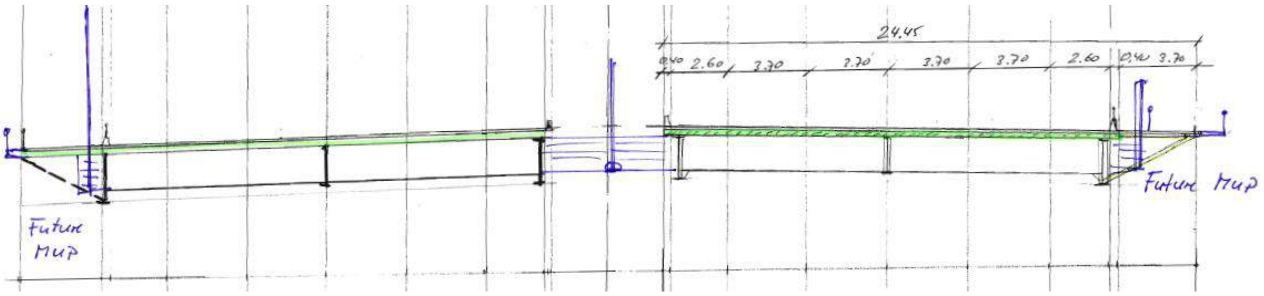
Feasible cross section would be a plate girder type, similar to the one for the Tappan Zee Bridge, split in the center to allow the mid tower passing through the deck



Cables are attached to brackets, connected to the main girders by bolting or welding



In the future configuration an MUP is attached as a light steel structure at each side and the roadway expanded to the barriers. A gap needs to be provided between roadway and MUP structure to pass the stay cables through



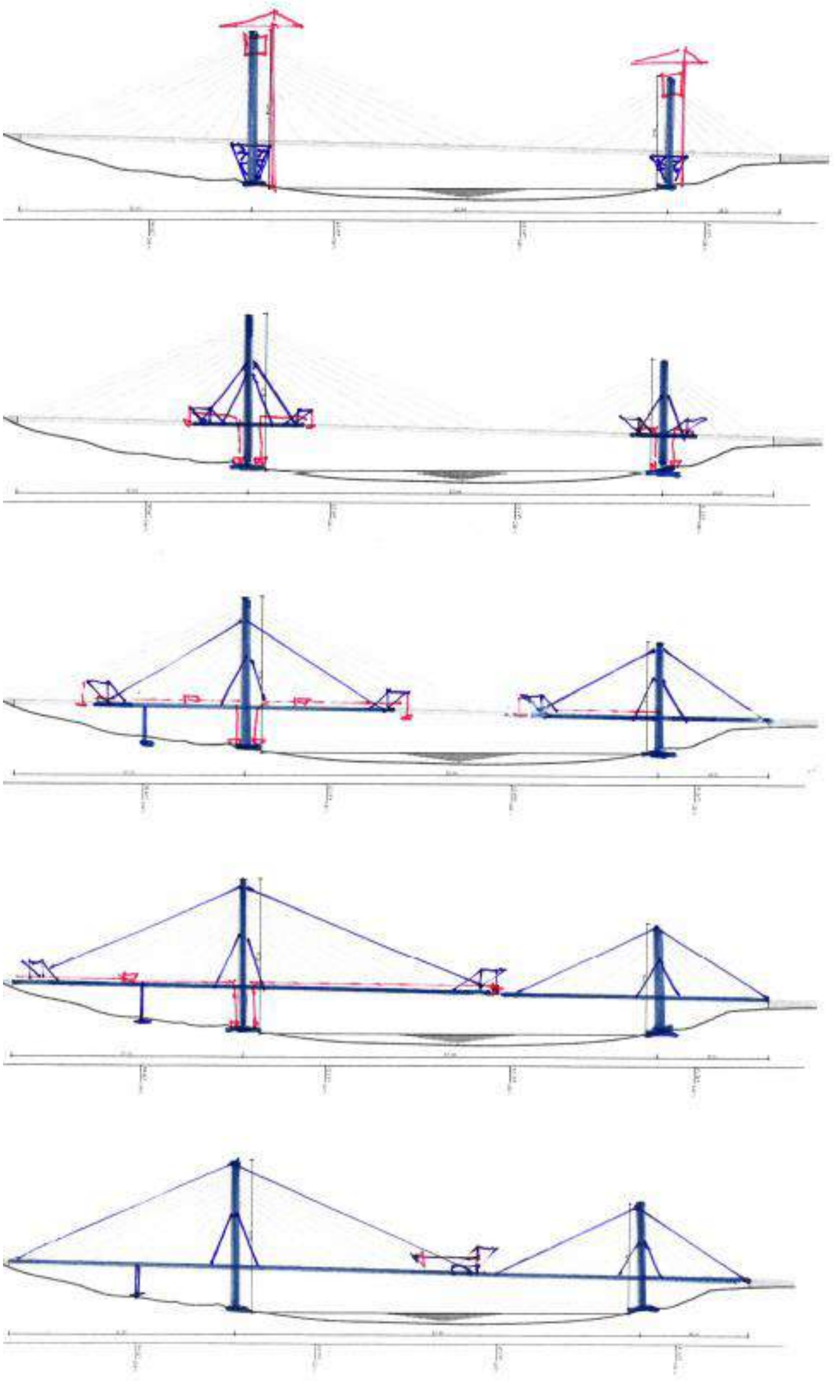
3.11.4 Example

A nice example is shown below with a mainspan of 205m (Norderelbebrücke, winning option in a bridge design competition in Hamburg)

3.11.5 Construction

Alt A)

- erect tower starter segments on falsework
- deliver steelwork segments in pieces to the tower,
- lift by heavy tower crane or mobile crane placed on the starter segments
- carry elements or fully assembled segment to the erection front,
- position it by a mobile crane (or derrick) followed by bolting of the splices.



Note: the Tower Crane needs to remain in place also for stay erection (not shown above).

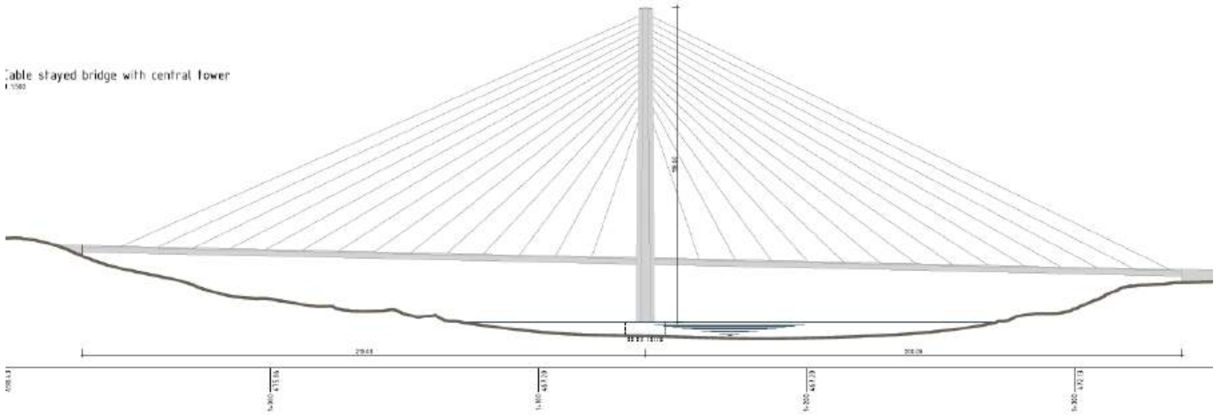
Alt B)

Alternatively the sidespan could be constructed first on auxiliary piers and the mainspan segments carried over the sidepan for erection by derrick or mobile cranes.

Example: Lifting Derrick of the Udevalla Bridge, Sweden

3.12 Option 11- Central Tower Cable Stayed Bridge

3.12.1 Layout

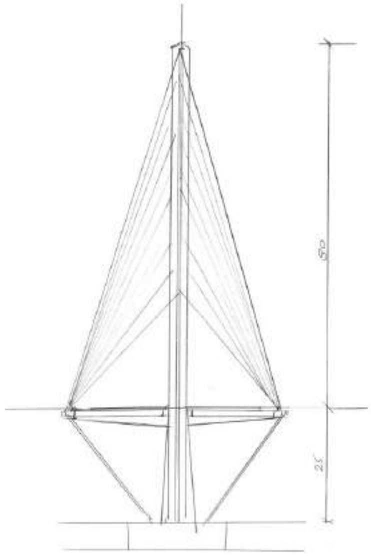


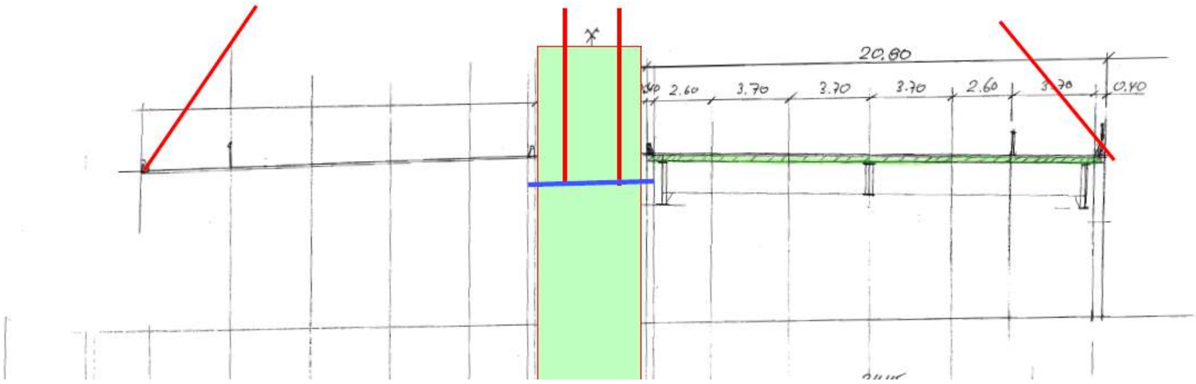
Single Tower stay cable bridge with spans of 200-210 = 410m

This option has just one pier in the river, no other piers are needed. The fixed /restraining point would be on the right with a heavy ballast abutment to cope with uplift. Bearing loads on the left are small, depending on the distance of the last cable to the abutment. It is a question of fine-tuning how much bearings loads will occur on the left. Slight uplift under ULS may be acceptable, so that the compression loads are minimized, which should be beneficial for the abutment

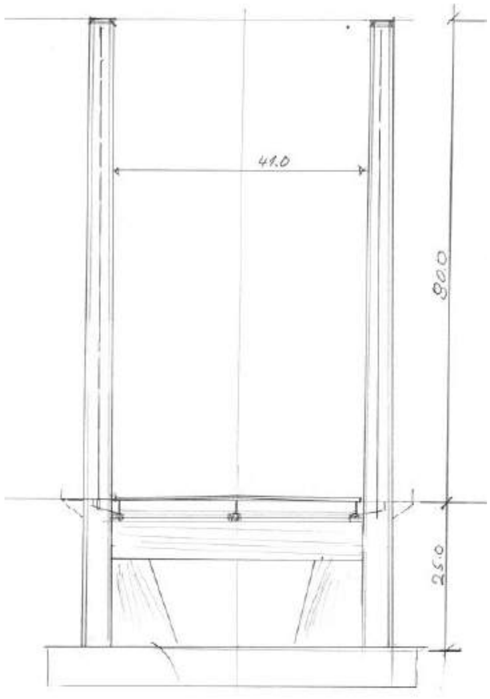
3.12.2 Cross Section

The stay cable configuration would be a tent like type as for the Port Mann Bridge in Vancouver.





An H-Type Tower might be also feasible. Quite likely a cross beam above the deck is not required since seismic loads are small. That means the tow tower option would be a goal post type. However, the proportions are not quite nice, it would look better with a three-leg tower, too, as option 10 above



3.12.3 Example

Port Mnn Bridge, Vancouver

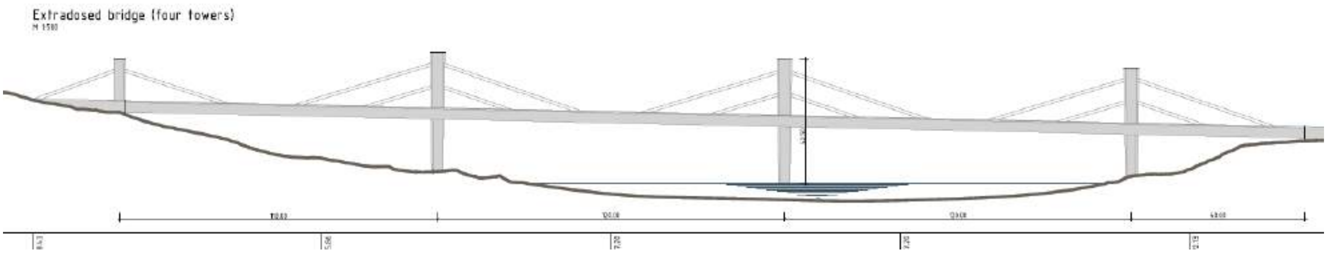
3.12.4 Construction

Alt A)
Stay cable supported free cantilever erection of about 13.50m long segments. Segments could be assembles on shore, floated in below the cantilever and lifted by a derrick, followed by Stay Cable installation and

Alt B)
If floating-in of segments is not possible, small steelwork segments have to be delivered to the tower, lifted by heavy tower crane or a mobile crane, placed on the starter segments, and launched to the erection front, positioned by a mobile crane (or derrick), followed by bolting of the splices – same as Alt A) for Option 10

3.13 Option 12 - Extradosed Bridge (4 Towers)

3.13.1 Layout



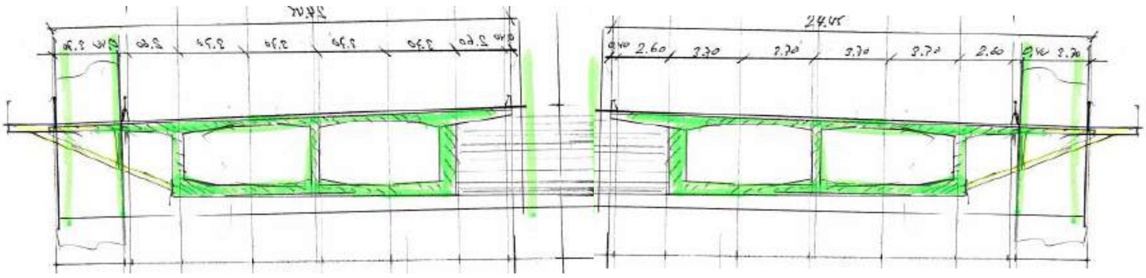
Stay supported concrete girder bridge with spans of 60-120-120-110 = 410m

The usual girders for Extradosed Bridges are concrete box girders, however, steel boxes are also possible as selected for the Golden Ears Bridge, which is actually a Stay Cable Bridge, but considered also as Extradosed Bridge in many publications due to the very low inclination of the stay cables, which is around 17degree, while standard stay cable bridges are above 20deg

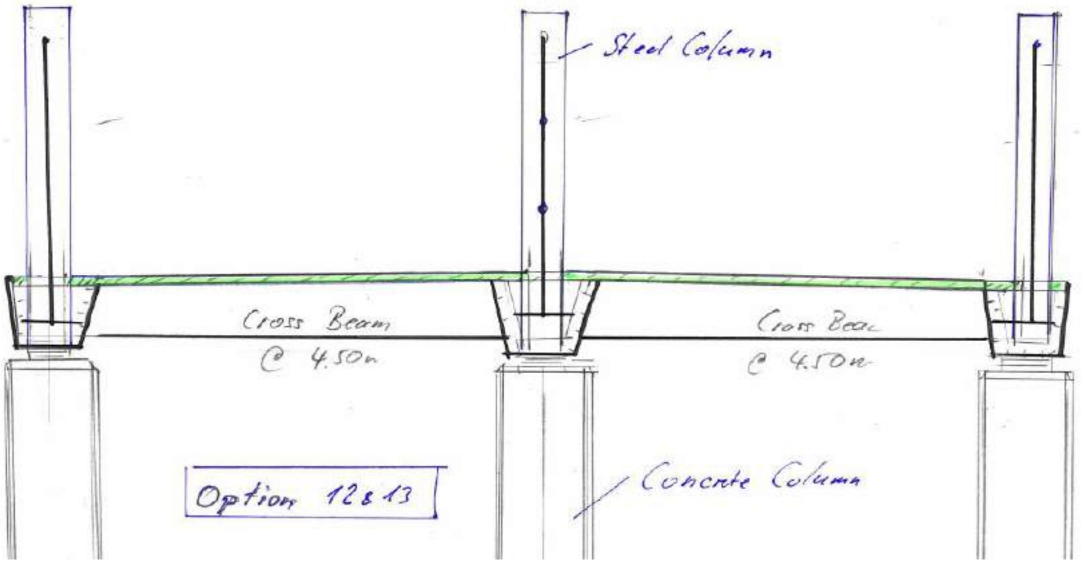
3.13.2 Cross Section

Standard sections for Extradosed bridges are concrete box girder; however, some are made of steel also

A) Concrete Box Girder



B) Small Steel Composite Box Girders

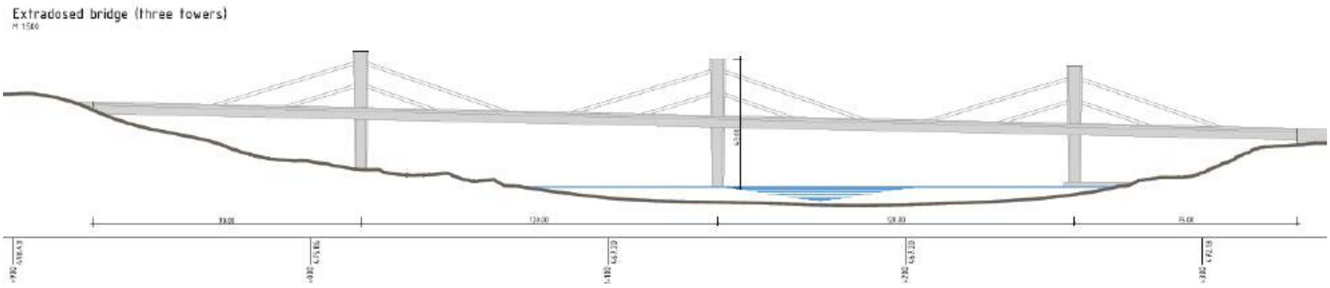


3.13.3 Construction

Free cantilever CIP segmental construction with Formtraveller, cantilever supported by final stays

3.14 Option 13- Extradosed Bridge (3 Towers)

3.14.1 Layout



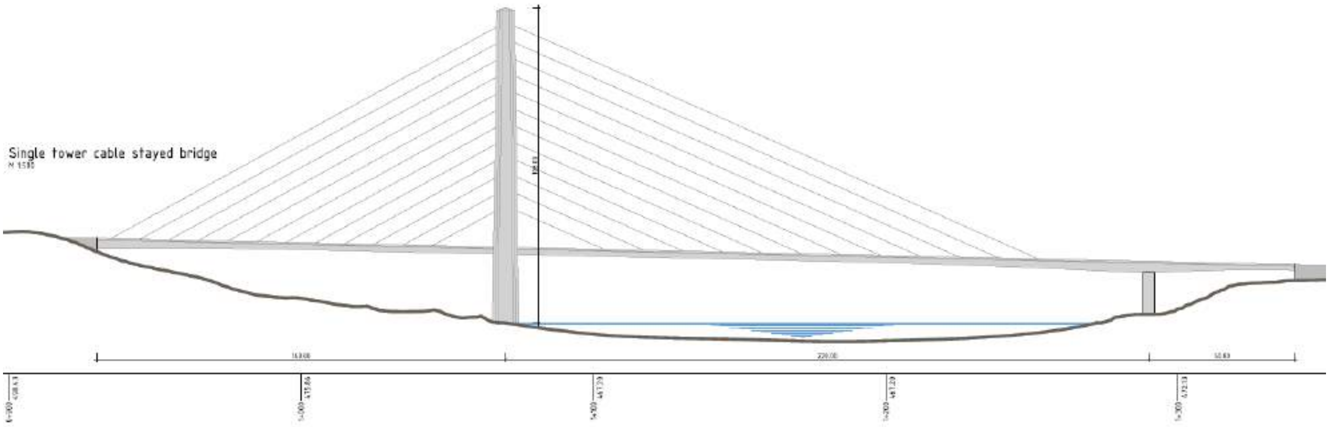
Stay supported concrete girder bridge with spans of 75-120-120-90 = 405m

Similar as option 12 but without tie-up of the endspan, but piers shifted further to the left, so that the left Pier is placed more into the hillside, the right one a bit into the water

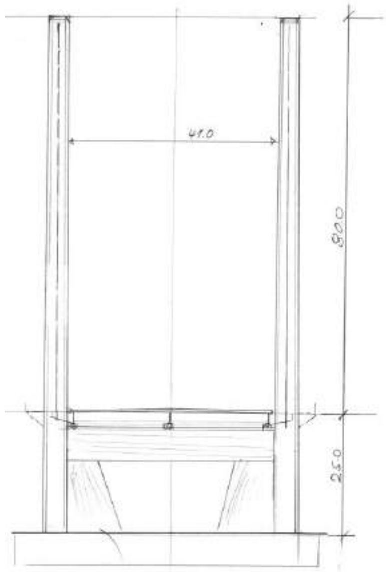
Same applies on Cross Section and Construction as for Option 12 above.

3.15 Option 14 – Unsymmetrical Single Tower Stay Cable Bridge

3.15.1 Layout



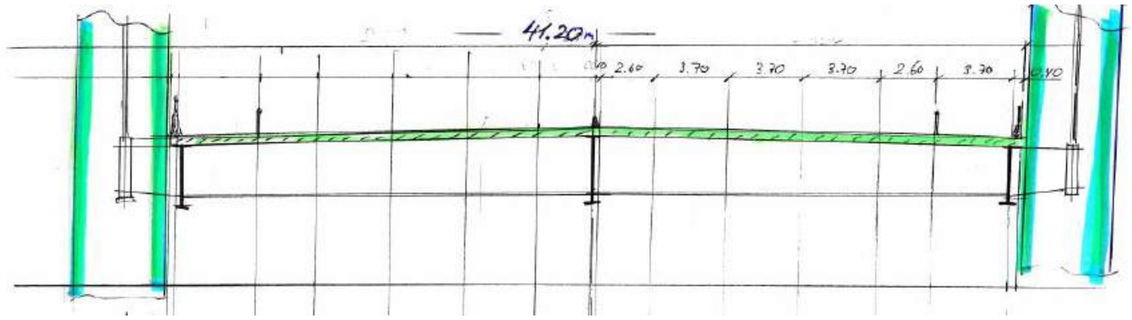
Single Tower stay cable bridge with spans of 60-225-125= 410



Single Tower Stay Cable Bridge with one Pylon on shore. The Pylon could be a pin tower, an H-Tower or a goalpost type, as shown in the sketch above

The abutment on the left will be provided with ballast concrete to cope with the uplift. Most likely, the fixed point needs to be on the left, not at the tower, this facilitates to cope with uplift.

3.15.2 Cross section



3.15.3 Example for Goalpost Type Stay Cable Bridge

Öresund Bridge, Denmark, Example for Goalpost Tower

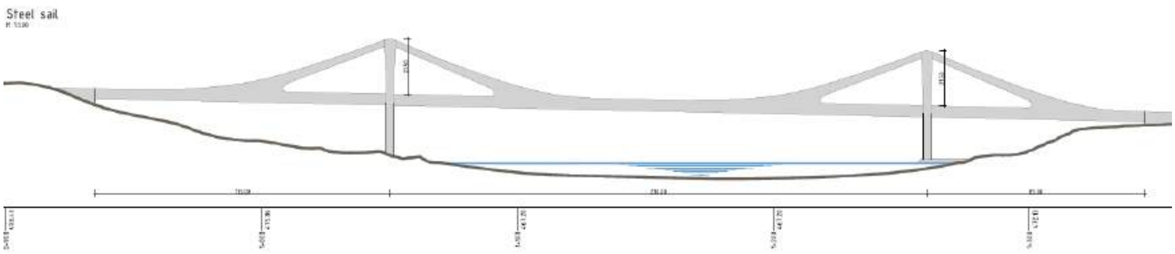
3.15.4 Construction

Balanced Cantilever Construction is the traditional construction procedure for stay cable bridges. If access is possible over the water, the segments may be installed by floating cranes or lifted directly from barges. In case access from the water is not given, the mainspan needs to be erected in the same manner as the sidespan:

- erect tower starter segments on falsework
- deliver steelwork segments in pieces to the tower,
- lift by heavy tower crane or mobile crane placed on the starter segments
- carry elements or fully assembled segment to the erection front,
- position it by a mobile crane (or derrick) followed by bolting of the splices.

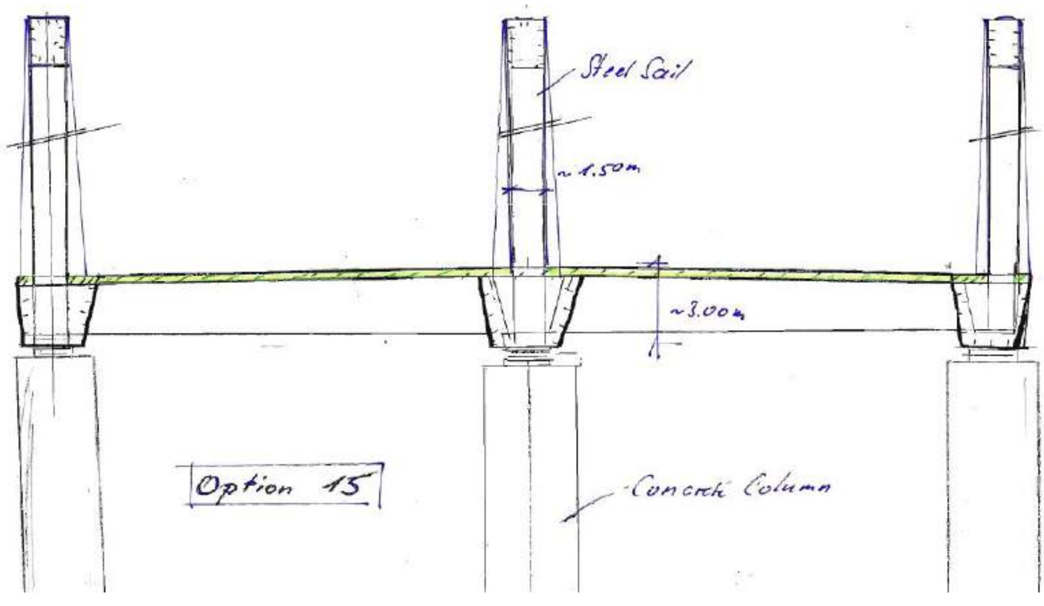
3.16 Option 15- Steel Girder Bridge with External Sail

3.16.1 Layout



Iconic bridge with spans of 85 – 210 -115 = 410m

This is a type of Extradosed bridge, where the Cables are replaced by a steel fin – or plate



3.16.2 Example

Neckarbrücke Stuttgart

3.16.3 Construction

Incremental Launching as illustrated below

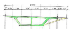
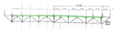
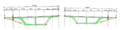
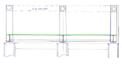
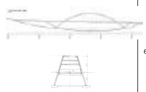
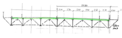
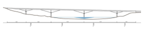
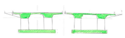
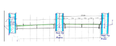
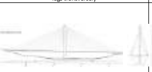
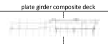
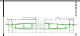
Alternative: erection of box girders on auxiliary pier or incrementally launched, erection of "sails" on the finished deck

4 Summary_Matrix

Sakatoon Freeway Bridge Option Study

04.09.2019

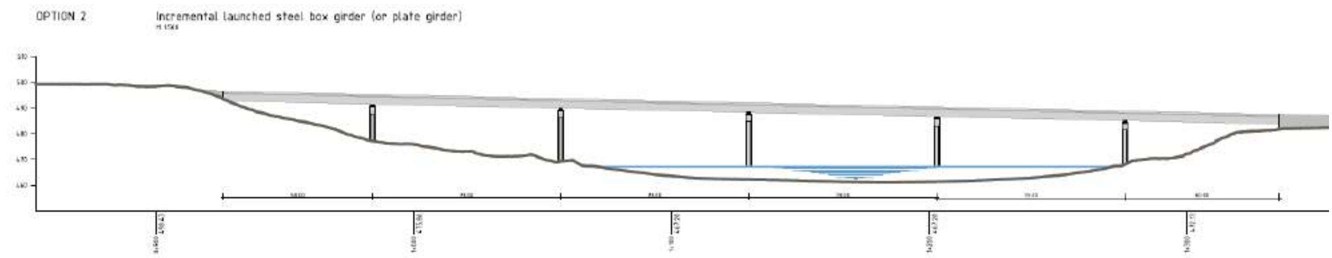
1 = Low	2 = medium	3 = high
Good	Fair	Poor

Option No	Type	Layout	Spans between EJs [m]	feasible Superstructure Types: Var A	Var B	Total No. of Piers (Foundations)	No. of Piers in the Water (Foundations)	No. of Piers in West Bank (Foundations)	Slope Stability Risk	Environmental Considerations	Compatible with Local Bridges	Feasible Construction Procedures	Constructibility	Expandability for Future added Lanes/MUP	Capital Cost	Life Cycle/O&M Cost	Replaceable Elements (expansion joints (2 on each - same	Aesthetics	Overall	Remarks
1	Prestressed Concrete Girder	Box Girder (or AASHTO Girder) Bridge with 9 spans	41-7x47-40 = 410	 concrete Boxes	Precast Beams (AASHTO girders	8	4	2	3	3	3	Twin Box Girder would allow incremental launching from one side, PC girders would need to be placed by cranes, possibly not in accordance with environmental restriction (access all along needed)	2	3	2	3	bearing (30-50 years), erosion potential on piers (riprap), barriers	3	22	Concrete boxes, incrementally launched, would be the first choice in Europe, since it is the most economical and robust type for shorter spans. But many piers in the water increases constructablity problems
2	Steel Composite Box or Steel Plate girder	 Composite Girder with 6 Spans	60-4x73-58 = 410	 multiple Plate Girder (local standard)		5	2	1	2	3	1	Box girders and steel plate girders with constant depth could be launched form one side, if bottom flanges are welded.' Steel plate girder could also be placed by cranes in a patchwork erection on auxiliary piers, but that's possibly not in accordance with environmental restriction since access is needed all along.	2	2	1	2		3	16	European Style would be a box girder, US or Canada praxis suelry surely a multiple plate girders
3	Haunched prestressed Concrete Box Girder	concrete box girder with 5 spans	60- 2x105-90-50 = 410	 Two Concrete Box girder		4	1	1	2	3	3	CIP Segmenetal Free Cantilever Construction by a formtraveller, delivery of material at the piers (access needed)	2	3	2	2		3	20	steel composite box girder may also be feasible
4	Tied arch bridge	 one arch in plane, three arches transversely	65-200-75-70 = 410			3	0	1	2	2	2	incremental launching of plate girder with 2 auxiliary pier in the water (additional steel in the longitudinal girder needed), erection of arches on the finished deck	3	2	2	3	heavier bearings	2	18	Piers might be a bit to close too the shore, with a 215m span this situation would improve and the cost would increase only marginal
5	Tied dual arch bridge	 two arches in plane, two or three arches transversely	65-200-145= 410	Steel Plate Girder with concrete slab		2	0	0	1	2	2	incremental launching of plate girder with 2 auxiliary pier in the water (additional steel in the longitudinal girder needed), erection of arches on the finished deck	3	2	3	3	heavier bearings	2	18	
6	Through arch bridge	 one arch in plane, two arches transversely	60-225-120= 410	Cross section at the arch: Two inclined arches  Alternative cross section at the sidespans 		2	0	0	1	2	2	Alt A) Because of the required haunch, incremental launching of the sidespan West is on a first view not possible and the plate girder needs to be erected on auxiliary piers by cranes. The mainspan could be launched from the east, but two auxiliary piers are needed in the water (also additional steel in the longitudinal girder needed). Therefore a span-wise erection on aux piers is most likely the best choice, followed by placement of roadway slabs (PC Panels), casting of stiches and erection of arches on the finished deck Alt B) Free Cantilever erection supported by temporary stay and Tower, small Segments delivered to lifting point and assembled a site	3	2	3	2		1	16	capital cost considered to be similar as Option 7, the omitted pier on the westbank is offset by the larger spans
7	Through arch bridge	 one arch in plane, two arches transversely	60-200-80-70= 410	Steel Plate Girder with concrete slab		3	0	1	2	2	2	Incremental launching of plate girder with two auxiliary pier in the water (additional steel in the longitudinal girder needed), placement of roadway slabs (PC Panels), casting of stiches and erection of arches on the finished deck	3	2	3	2		1	17	
8	Braced Composite Girder	 5 span bridge , supported by tubular steel bracings	60-105-105-80-60= 410	 in steel composite box girders		4	1	1	2	3	2	erection of box girders on auxilary pier or incrementally launched, erection of bracing under the finished deck	3	2	3	2		3	20	Sundsvall Type
9	Spandrel Arch Bridge	3 spandrel arches , two transversely	60-105-105-80-60= 410	 prestress solid concrete or composite girders		3	1	-1	2	3	2	• arch in segments on auxiliary piers or stay cable supported • Erection of Piers • Steel Grid Placement • Roadway slabs (PC Panels)	3	2	3	2		2	19	main pier on the left shifted into the west banks
10	Unsymetrical Stay Cable Bridge	 unsymmetrical stay cable bridge , tower with 2 or 3 legs transversely	60-225-125 = 410	 plate girder composite deck		2	0	0	1	1	3	Alt A) • erect tower starter segments on falsework • deliver steelwork segments in pieces to the tower, • lift by heavy tower crane or mobile crane placed on the starter segments • carry elements or fully assembled segment to the erection front, • position it by a mobile crane (or derrick) followed by bolting of the splices. Alt B) Alternatively the sidespan could be constructed first on auxiliary piers and the mainspan segments carried over the sidepan for erection by derrick or mobile cranes	1	2	2	1	cables?	1	12	minimum number of piers with simple construction procedure
11	Central Tower Stay Cable Bridge	 central Tower , 3 cable Planes (as Port Mann)	200-210 = 410	 plate girder composite deck		1	1	0	1	3	3	A) Stay cable supported free cantilever erection of about 13.50m long segments. Segments could be assembles on shore, floated in below the cantilever and lifted by a derrick, followed by Stay Cable installation and B) If floating in of segments is not possible, small steelwork segments have to be delivered to the tower, lifted by heavy tower crane or mobile crane placed on the starter segments, and launched to the erection front, positioned by cranes followed by bolting of the splices.	1	2	3	2		2	17	
12	Extradosed bridge	 Extradosed bridge with small column on the abutment,3 pylon legs transversely	60-120-120-110 = 410	 twin concrete box girder	 tripple steel box girder	3	1	0	1	3	3	free cantilever CIP segemntal construction with Formtraveller, cantilever supported by final stays	2	3	2	2		2	18	- small column placed on the abutment to support deck and avoid critical pier locations -main pier on the left placed not directly at shore
13	Extradosed bridge	Extradosed bridge , 3 pylon legs transversely	75-120-120-90 = 405			3	2 (one place near the shore)	1 near the critical slope	2	3	3	free cantilever CIP segemntal construction with Formtraveller, cantilever supported by final stays	2	3	2	2		2	19	
14	Unsymetrical single Tower Stay Cable Bridge	unsymmetrical stay cable bridge , tower with one, 2 or 3 legs	60-225-125= 410	 plate girder composite deck		2	0	0	1	1	3	Alt A) • erect tower starter segments on falsework • deliver steelwork segments in pieces to the tower, • lift by heavy tower crane or mobile crane placed on the starter segments • carry elements or fully assembled segment to the erection front, • position it by a mobile crane (or derrick) followed by bolting of the splices. Alt B) Alternatively the sidespan could be constructed first on auxiliary piers and the mainspan segments carried over the sidepan for erection by derrick or mobile cranes.	1	2	3	2		1	14	
15	Steel Girder Bridge with external "sail"	3 span bridge , supported by external steel boxes	85-210-115=410	 steel composite box girders		2	0	0	1	2	3	Incremental launching or erection of box girders on auxiliary pier or incrementally launched, erection of "sails" on the finished deck	3	2	3	2		2	18	transverse shape needs further studier- European examples is made of box girders

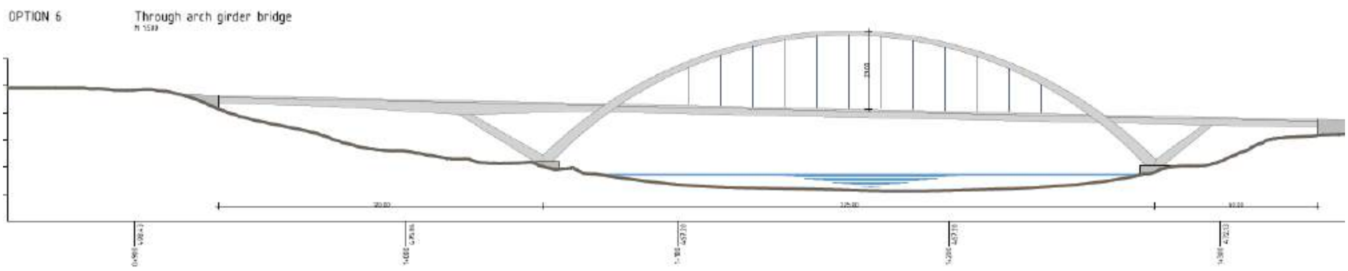
5 Conclusion

Four of the options are carried to Phase 2, which are

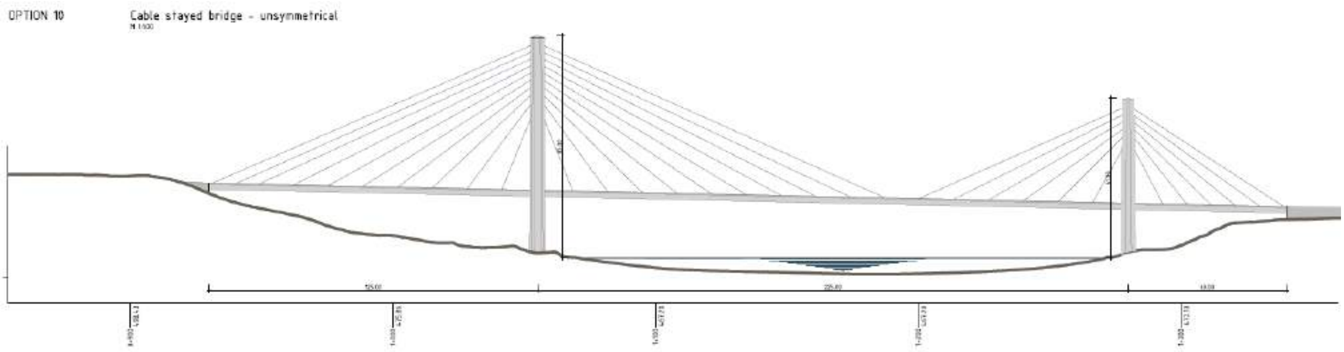
Option 2:



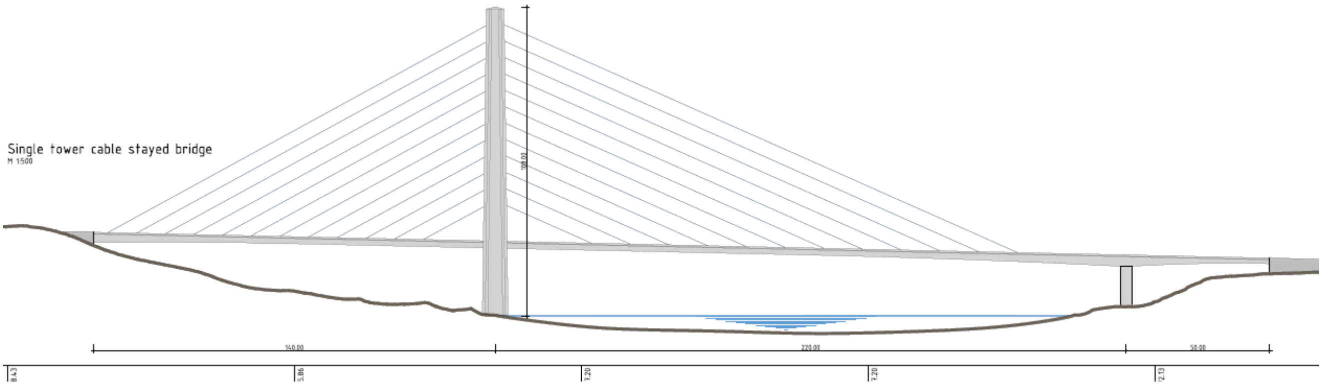
Option 6:



Option 10:



Option 14:



In Phase 2 those 4 options will be evaluated further, mainly with respect to cost.

To identify a fair cost relation, the main quantities will be evaluated based on experience and some simple calculations.

The cost for the foundations will be determined by SNC Lavalin based on foundation loads provided by LAP.

Leonhardt, Andrä und Partner

Functional Planning Study for the Saskatoon Freeway Project

Phase 2

Revision	Title	By	Reviewed	Date
Rev 0	First Issue. Loads and Reactions (Quantities Pending)	RRM	MM	20.09.2019
Rev 1	Quantities and several amendments	Hf	RRM	18.10.2019
Rev 2	General Revision, Issues discussed in the 25th Oct workshop added	Hf	RRM	06.11.2019
Rev 3	Update to take into account Nov 2019 discussions	Hf	Hf	12.12.2019
Rev 4	Update for Comments of Dec 13, 2019	Hf/RRM	Hf	08.01.2020

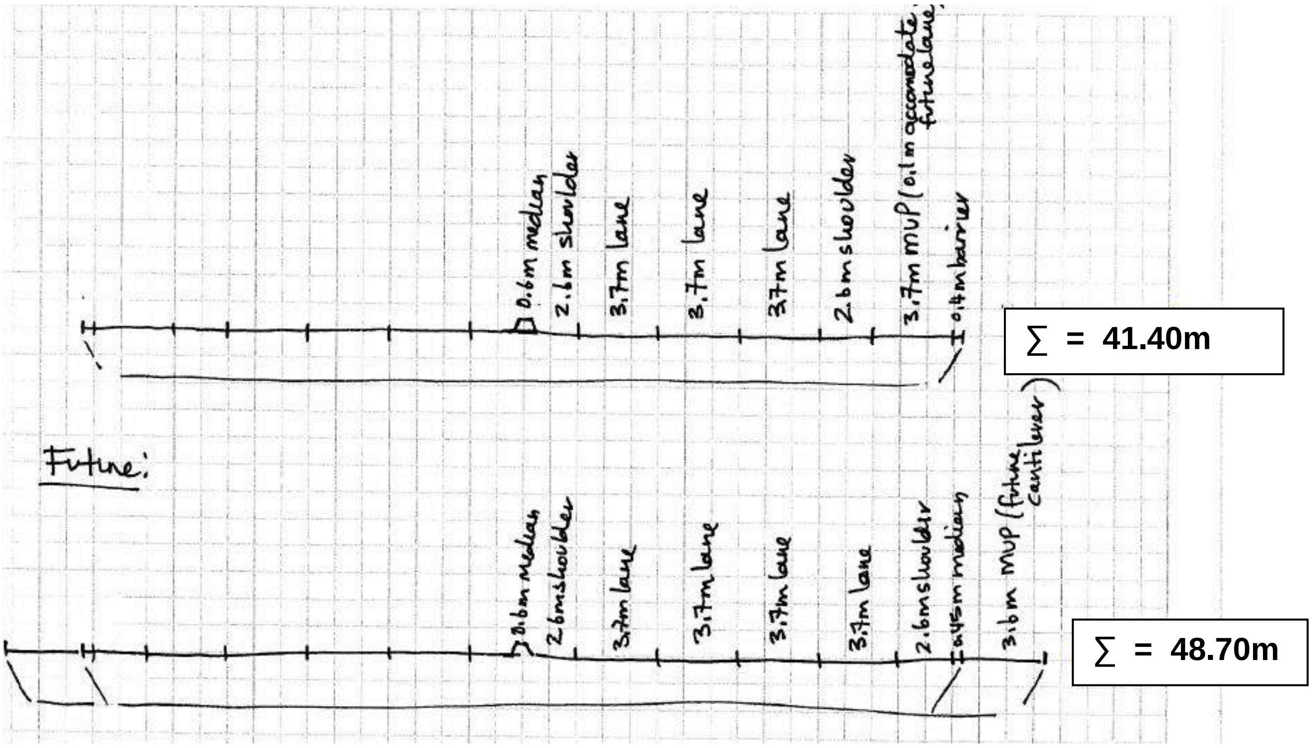
Table of contents

1 Introduction

1.1 Roadway Layout

As explained in Phase 1 Report, the roadway consist initially in each bound of 3 Traffic Lanes (3.70m ea.), 2 shoulders (2,60m ea) and one MUP (3.70m wide).

The future configuration may be changed to 4 Lanes and the MUP attached to the deck on each side.

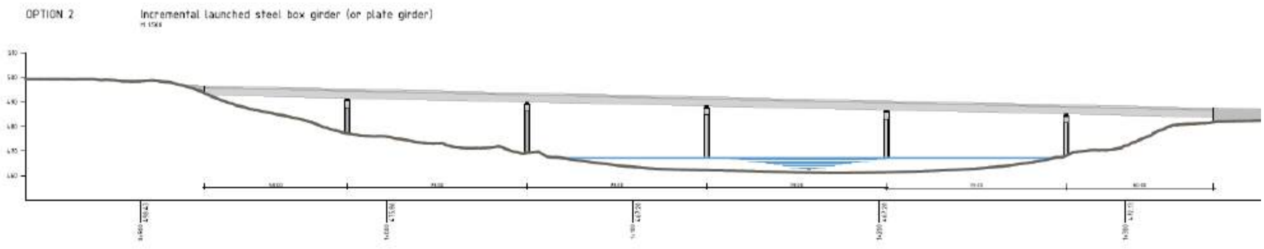


1.2 Structures

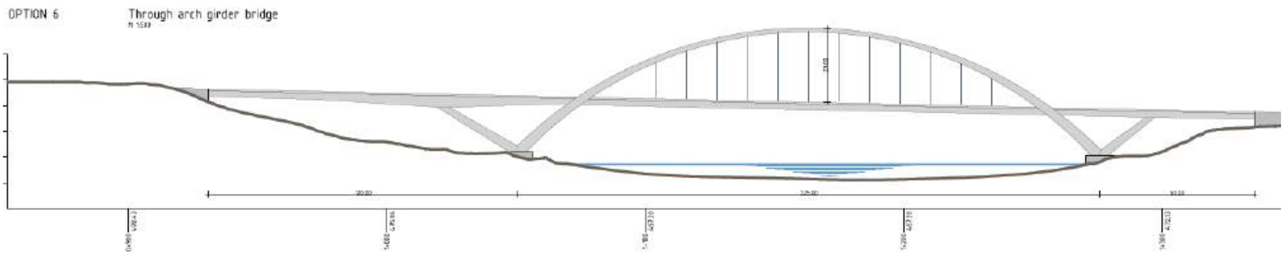
LAP has been contracted by SNC Lavalin to perform an option study for the Saskatoon Freeway Project As part of the functional planning study we were asked to assess the possible bridge types for a crossing of the South Saskatchewan River North of the city of Saskatoon. This river crossing is part of a new Freeway to be planned around the City of Saskatoon. It is a signature element of the project.

In Phase1 a qualitative evaluation of 15 different options was performed (see report *Functional Planning Study Phase 1*). Four of those 15 options have been carried into Phase 2, those are

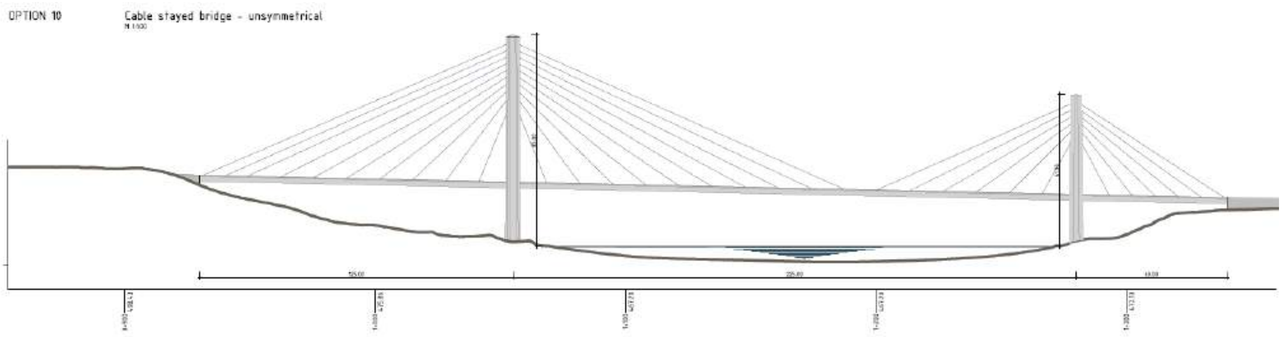
Option 2:



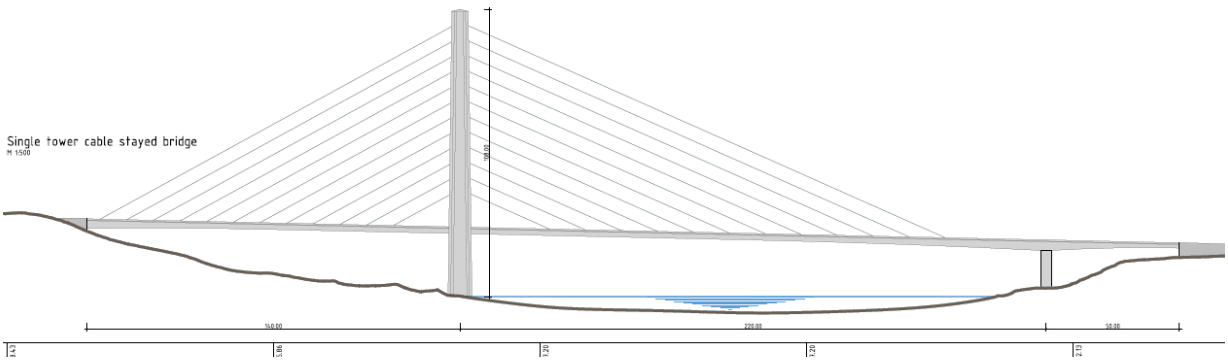
Option 6:



Option 10:



Option 14:



In the current report, these four options are evaluated further, mainly with respect to cost, bearing configuration and some construction details. For this purpose, the main quantities are evaluated based on experience and some simplified 3D calculations.

1.3 Loads

Foundation loads are provided in order to serve as a basis for the foundation cost analysis, which will be carried out by SNC-Lavalin.

For all four solutions, the following load combination factors have been considered:

Permanent Loads							
Self weight	SW Lower Pylon legs		SLS	ULS1	ULS2	ULS3	ULS4
	SW Piers		1.00	1.20	1.20	1.20	1.20
	SW Concrete slab main span		1.00	1.11	1.11	1.11	1.11
	SW Concrete slab side spans		1.00	1.17	1.17	1.17	1.17
	SW Steel main span		1.00	1.10	1.10	1.10	1.10
	SW Steel side spans		1.00	1.10	1.10	1.10	1.10
	SW Arches/Upper Pylon		1.00	1.10	1.10	1.10	1.10
	SW Cables/hangers		1.00	1.10	1.10	1.10	1.10
	SW future MUP +3cm wearing srf		1.00	*1.23*	*1.23*	*1.23*	*1.23*
	SDL TOT		1.00	*1.40*	*1.40*	*1.40*	*1.40*
		10 cm asphalt c. overlay	1.00	1.50	1.50	1.50	1.50
		parapets (x4)	1.00	1.10	1.10	1.10	1.10
		Others (Utilities, railing…)	1.00	1.10	1.10	1.10	1.10

Note: Factors for SW of Pylon are shown for a steel pylon (ULS factor for cast in place concrete Pylon would be 1,20). Factors for concrete deck are interpolated values provided that different factor is to be considered for the precast panel and for the cast in place part.

Variable Loads						
Live Load	2x5 lanes 3.00 m wide/DLL - Design LL	0.90	1.70	1.60	1.40	0.00
	MUP pedestrian load	0.00	1.70	1.60	1.40	0.00
	Design Truck	0.90	1.70	1.60	1.40	0.00
Wind	Design horizontal Wind (Wh)	0.00	0.00	0.00	0.45	1.40
	Design vertical Wind (Wv)	0.00	0.00	0.00	0.45	1.40
	Wind on Pylons/arch	0.00	0.00	0.00	0.45	1.40
	Wind on Vehicles (WL)	0.00	0.00	0.00	0.45	1.40
	Wind on Piers	0.00	0.00	0.00	0.45	1.40
Temperature	TU Composite					
	TU+	0.80	0.00	1.15	1.00	1.25
	TU-	0.80	0.00	1.15	1.00	1.25
	TG Composite					
	TG+	0.80	0.00	1.15	1.00	1.25
	TG-	0.80	0.00	1.15	1.00	1.25
Bearing Friction		1.00	1.00	1.00	1.00	1.00

Note: the Design truck CL-W is defined in CAN-CSA S6 14 to be a 500 kN truck when considered simultaneously with uniform traffic load, and to be used with a ULS factor of 1,7. According to the project requirements, the truck CL-750 is also to be considered. This truck was defined in CAN-CSA S6 88 to be a 740 kN to be used with a ULS factor of 1.6 (740 x 1,6=1184 kN). For the analysis of the four options, a 750 kN truck with factor 1.7 has been considered (750 x 1,7=1275 kN), which would mean an implicit dynamic load allowance of 1275/1184=1.076 > 1.00 with respect to the truck of norm CAN-CSA S6 88, which is a conservative assumption. The truck load is affected by a 0.8 factor if considered together with uniform load (0.8 x 750 = 600kN).

1.4 Durability and Maintenance

The following general measures for an improved durabilty are recommended and considered in the BoQ evaluation for all options:

- Most important for a durable structure is a proper inspection and maintenance in short intervals. The tables below are based on German practice and European recommendations, but contains also elements from the Pattullo bridge in BC

- Durability of the deck is improved by implementing measures which are required in the BC supplement and/or requested for the Pattullo Bridge design
  - waterproof membrane
  - 100mm wearing surface
  - stainless steel rebars in the upper zone of the roadway slab as a general requirement
  - stainless steel rebars in full depth of the roadway slab in cables stayed spans

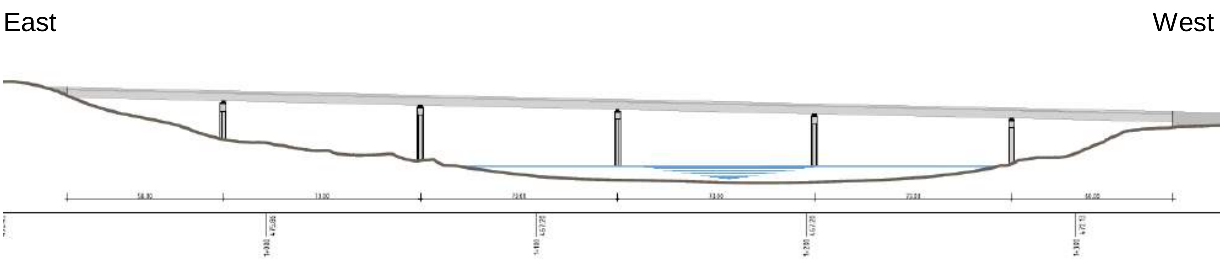
- A weathering steel is used for the superstructure, acc. to the BC supplement for bridge design no loss due to corrosion has to be taken into account

- provide access to bearings, design for force introduction of hydraulic jacks and mark the position of those on the sub/superstructures

2 Selected Options

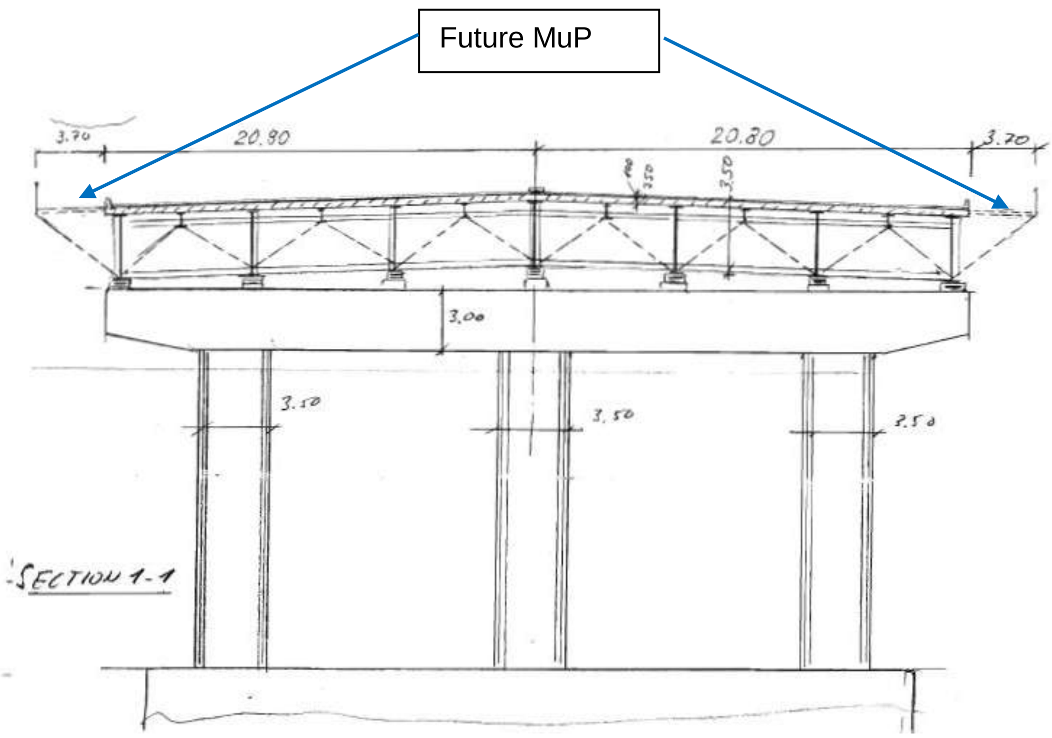
2.1 Option 2 – Steel Composite Girder

2.1.1 Layout



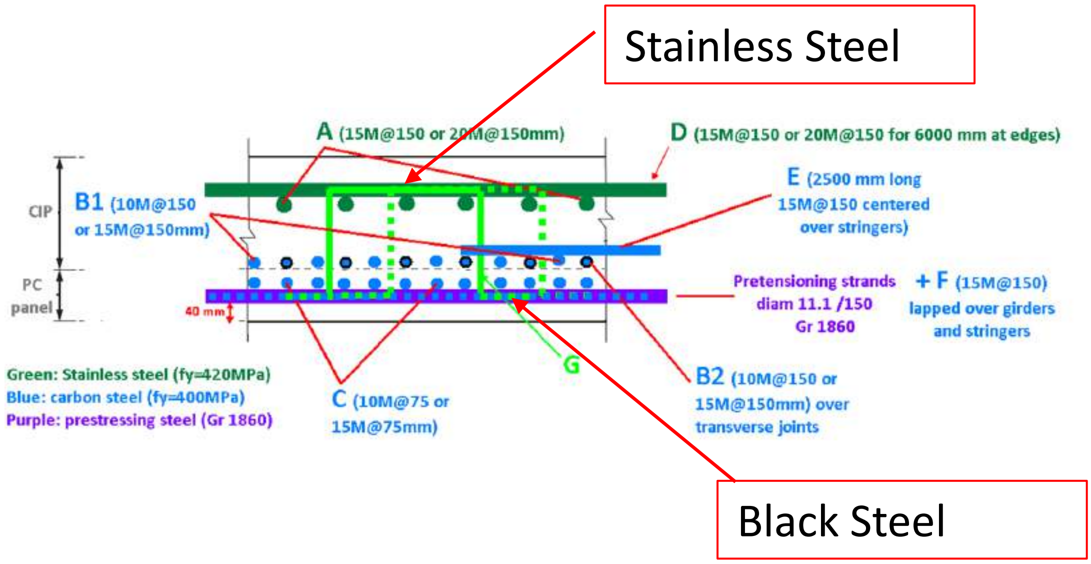
Girder Bridge with six spans of 58 - 4 x 73 - 60 = 410m with two Piers in the water, two on shore, and one on the West bank.

For the cross section, a Multiple Steel Plate Girder has been considered. The total depth is about 3.50m, the depth of the steel plate girder about 3.20m



The deck consists of concrete slab with 350 mm total thickness, were the formwork is made with 120 mm pre-stressed precast panels spanning around from 3.4 to 3.7 meters in transverse direction between main girders and a longitudinal stringer placed between the main girders. That allows a distance of around 7 meters for the heavy plate girders. A transverse bracing spaced from five to 7 meters needs to be provided. An average steel weight of 3.0 kN/m2 (including provision for transverse diaphragms at supports) is assumed based on experience with similar solutions.

In order to enhance durability the upper layer of reinforcement will be made of stainless steel (that's how it is considered in the BoQ and cost evaluation



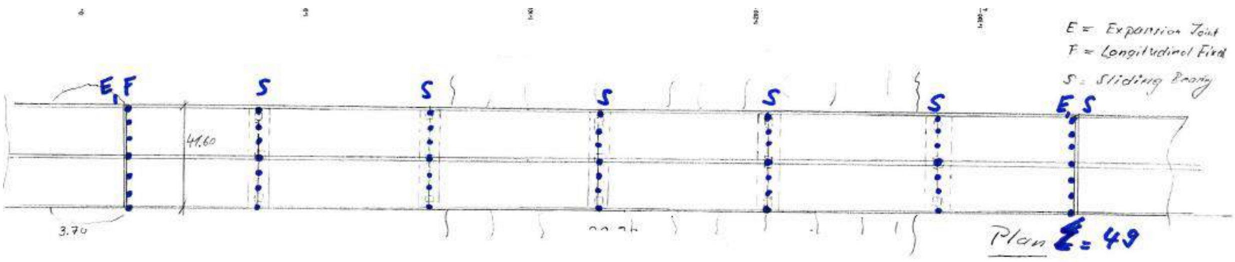
Variations in the deck configuration:

a) The more traditional Canadian way is a layout without stringers, so that 13 plate girders instead of only seven girders would be needed. It is a simpler layout, but needs likely more structural steel and much more bearings. The influence on the total cost is minor, but a value Engineering for verification of the best alternative would be appropriate in the next stage.

b) For the time being, a single deck superstructure has been considered, since it simplifies attachment of the future MuP: the loads would be more evenly distributed to the plate girders. Two independent superstructures for North- and Southbound could also be envisaged. It would have an advantage in case elements such as deck slabs have to be exchanged (traffic to be relocated to the superstructure **not** under construction). This option (twin deck) may have some problems with attachment of the future MuP: The fixing to one edge only would create torsion and may cause uplift in the inner bearings. Also the deformation caused by the eccentric weight of the future MuP needs to be addressed. It will change the crossfall, so either it's made a bit larger initially and is correct in future, or have it at 2% initially and a bit smaller in future – or average it out.

Cost wise, both options are quite similar, therefore they have not been distinguished in the BoQ

<u>Bearing Scheme</u>



The deck is supported by elastomeric bearings at every pier and at the abutments: one vertical bearing under each plate girder. Longitudinal fixation is provided at Abutment 1 (this arrangement is currently considered in the foundation loads). Alternatively, the fixed point could also be shifted to the two central piers.

A fixation for movements in transverse direction is assumed for every pier, provided by one or more laterally fixed bearings.

Exchange of the bearings is possible pier by pier. All bearings on one pier have to be jacked up by about 10mm, this is sufficient to pull them out and new ones in. This jack up (negative bearing settlement) is usually considered in the detailed design (not here in the concept study) as temporary situation and combined with full traffic loads (standard loads, not extreme ones)

2.1.2 Example

2.1.3 Summary of assumed Loads

LOADS

			OPTION 2	
Perm Loads				
	Self weight	SW Piers	327	kN/m
		SW Concrete slab main span	9.1	kN/m2
		SW Concrete slab side spans	9.1	kN/m2
		SW Steel main span	3.0	kN/m2
		SW Steel side spans	2.5	kN/m2
		SW Arches/Pylon	-	-
		SW Cables/hangers	-	-
		SW future MUP +3cm wearing srf	2.2	kN/m2
		SDL TOT	3.1	kN/m2
Var Loads	Live Load			
		2x5 lanes 3.00 m wide/DLL - Design Lane Load	3.0	kN/m2
		2x3.6m MUP pedestrian load	1.3	kN/m2
		Design Truck (*)	600	kN
	Wind			

	Design horizontal Wind (Wh)	8.0	kN/m
	Design vertical Wind (Wv)	20.0	kN/m
	Wind on Pylons/arch	-	-
	Wind on Vehicles (WL)	4.0	kN/m
	Wind on Piers	10.0	kN/m
Temperature			
	TU+	50	K
	TU-	-50	K
	TG+(**)	10	K
	TG-(**)	-10	K
Friction **)		4	%

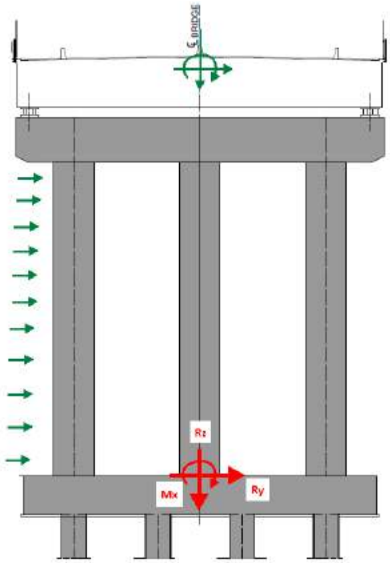
(*) Value of design truck to be considered together with lane load

(**) 10°C Gradient over the complete deck height assumed (similar effect as a 30°C gradient over the concrete slab depth)

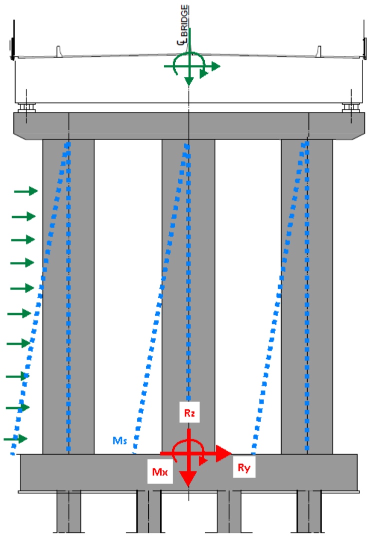
(***) 4 % friction in combination with max vertical load, no influence study for lower loads has been performed yet, needs to be done in coming design stages.

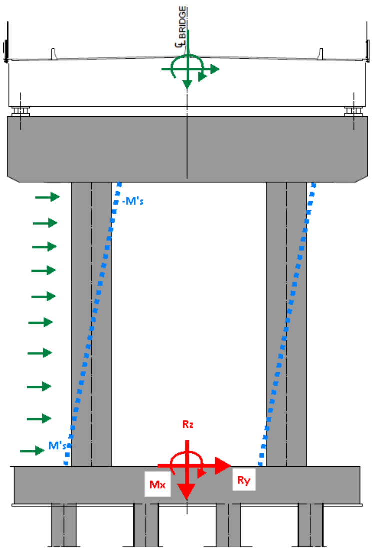
2.1.4 Foundation Reactions

Following tables show an estimate of the reaction on top of foundation (weight of foundation not included). The reactions are given for the full width (both bounds, so both traffic directions), at the midpoint between both bounds. An estimation of the weight of the pier shafts, wind on piers and bearing friction has been added to the loads coming from the deck, so that the reactions shown in the table below (in red in the following sketch) includes o provision for those effects.

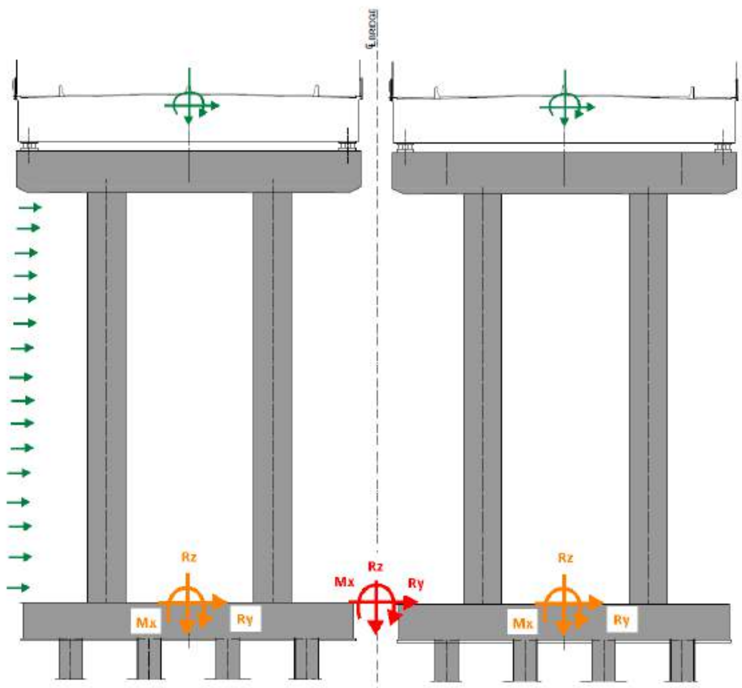


The above sketch shows the proportions of a possible solution for the substructure. It is to be noted that the section forces at the substructure (for example bending moments at the pile shafts) may vary significantly depending on the later design of the piers (see sketch below for two –exaggerated- different solutions). Nevertheless, assuming that the foundation is stiff enough, the reactions given in the tables below (in red in the sketch) should fairly represent the resulting reactions at the midpoint, on top of foundation.





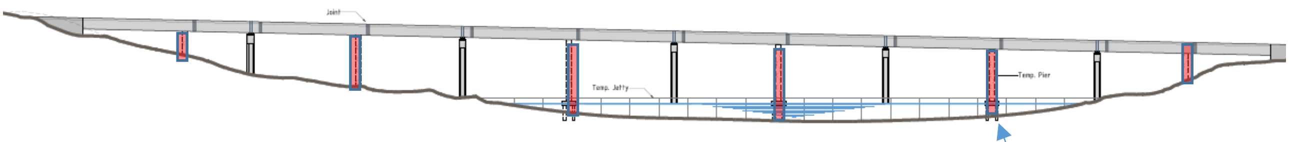
For two independent superstructures two independent foundations could be envisaged. The reactions given below are still those corresponding to the midpoint of a fictive common foundation (in red). The independent reactions can be estimated from the ones given for the midpoint (but such an estimation is out of the scope of this report, provided the still large number of design options for each substructure).



	Abutment 1 (fix point)				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**22.91**	0.00	0.00	0.00	0.00
TOT Traffic	**4.93**	0.00	**0.70**	**41.89**	**3.50**
TOT Wind	**0.45**	**0.41**	**0.87**	**6.86**	**4.29**
TOT Temp	**0.14**	0.00	0.00	0.00	0.00
SLS	**27.30**	**0.80**	**0.70**	**38.70**	**3.20**
ULS	**36.00**	**1.40**	**1.40**	**76.10**	**6.90**
	P1/P5 (external piers)				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**59.28**	0.00	0.00	0.00	0.00
TOT Traffic	**8.04**	0.00	0.00	**62.64**	0.00
TOT Wind	**1.48**	**0.96**	**0.16**	**30.38**	**1.71**
TOT Temp	**0.17**	0.00	0.00	0.00	0.00
SLS	**66.00**	**2.20**	**2.20**	**83.20**	**34.90**
ULS	**85.00**	**3.90**	**3.10**	**151.90**	**47.80**
	P2/P4 (internal piers)				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**60.60**	0.00	0.00	0.00	0.00
TOT Traffic	**8.25**	0.00	0.00	**64.05**	0.00
TOT Wind	**1.46**	**1.10**	**0.22**	**38.25**	**3.23**
TOT Temp	**0.04**	0.00	0.00	0.00	0.00
SLS	**67.40**	**2.20**	**2.20**	**96.70**	**47.50**
ULS	**86.90**	**4.00**	**3.20**	**170.60**	**66.30**
	P3 (central pier)				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**62.56**	0.00	0.00	0.00	0.00
TOT Traffic	**8.31**	0.00	0.00	**64.44**	0.00
TOT Wind	**1.46**	**1.16**	**0.28**	**45.45**	**5.23**
TOT Temp	**0.02**	0.00	0.00	0.00	0.00
SLS	**69.40**	**2.20**	**2.20**	**109.90**	**60.50**
ULS	**89.40**	**4.10**	**3.20**	**189.30**	**85.90**
	Abutment 2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**22.91**	0.00	0.00	0.00	0.00
TOT Traffic	**4.93**	0.00	0.00	**41.89**	0.00
TOT Wind	**0.45**	**0.41**	**0.05**	**6.86**	**0.17**
TOT Temp	**0.14**	0.00	0.00	0.00	0.00
SLS	**27.30**	**0.80**	**0.80**	**38.70**	**3.70**
ULS	**36.00**	**1.40**	**1.10**	**76.10**	**5.10**

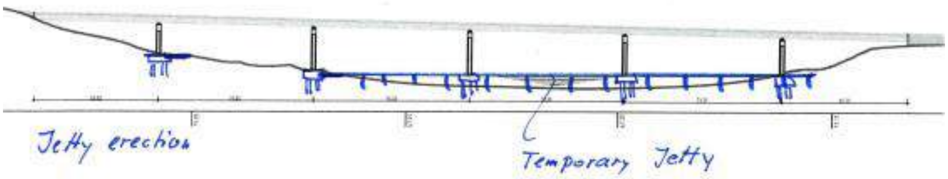
2.1.5 Construction

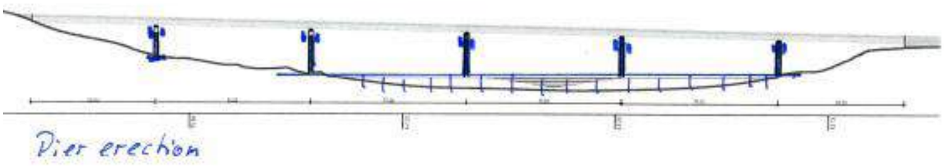
One feasible erection procedure is elaborated below

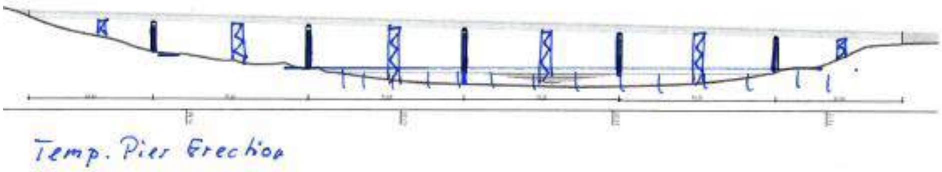


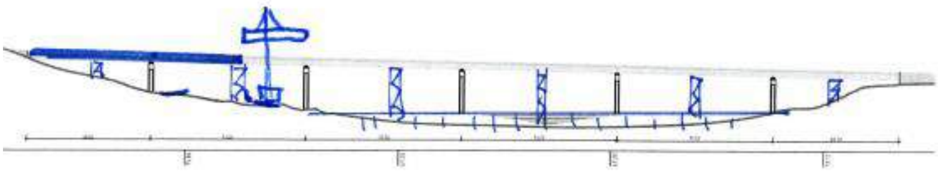
Erection Sequence

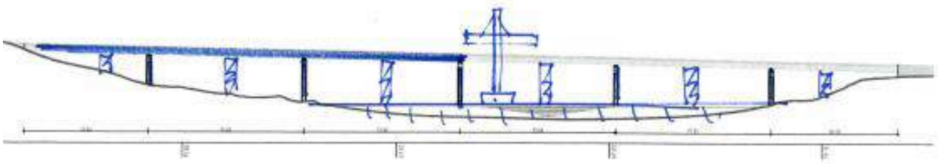
- for access in the river a **temporary jetty** or a **cofferdam** needs to be constructed
- access to the slopes is required either from the shore or from the banks
- foundation and piers erection in a conventional method
- since the span of 70 m is too large for erection of the girders, quite likely 6 temporary piers are needed
- erection of the steel plate girder by mobile cranes running on the jetty/coffer dam or placed next to the pier in the slope – care for access of the cranes
- place roadway slabs in a sequence which reduces tensile stresses above the piers as much as possible
- dismantle temporary piers
- dismantle jetty/coffer dam


Jetty erection
Temporary Jetty


Pier erection


Temp. Pier Erection





Construction Alternative:

Theoretically, construction by Incremental Launching would also be an option. This would omit the need of a jetty/cofferdam. However

- the same amount of temporary and final piers is needed, with access requirements to all of the piers in the river
- top flanges needs to be strengthened considerably
- temporary lateral bracing in the top and bottom flanges is needed
- launching bearings should be placed at two girders only, the others would need to be connected by strong vertical bracing
- bottom flanges should better be welded, since launching over splice plates is quite complicated, but can be done. Filler plates between the splice plates would be needed, with holes at location of the bolts. Those filler plates need to be fixed by bolting or clamps.

Therefore launching has not yet been considered further, but could be done in the next phase

2.1.6 Slope Stability

One permanent pier and two temporary piers are placed in the critical slope and need to be protected against hill sliding. For the temporary piers this is not such a critical issue, any vertical movement can be compensated by jacks placed on the piers, horizontal movement needs to be corrected or sufficient tolerances provided in the load introduction zone.

For the permanent pier this is a bit more critical and mitigation measures need to be developed to cope with any movement. Soil pressure could by high acting on pile foundations and have to be taken into account in the design of the pile footing

2.1.7 Durability and Maintenance

The concrete deck runs over five permanent piers and at each point tensile stresses in the concrete are high, leading surely to cracks. With a perfect waterproof membrane and stainless steel rebars on the upper half of the slab (also shear hoops or any rebar entering the upper half of the slab), the durability will be rather high, so the replacement period for the deck could be extended to say 70 or so. However, in order to guarantee such a good function, inspection has to be done very careful, any sign of leaking water has to be reported, and repair works performed immediately. In the table below it’s assumed that the deck have to be replaced once in 100 year, taking into account that inspection and maintenance is never done perfect.

A weathering steel is used for the superstructure, acc. to the BC supplement for bridge design no loss due to corrosion has to be taken into account. However, since the superstructure consists of many small parts in the cross frames, it is assumed that some of those have to be exchanged once in 100 years = 3 % of the structural steel

The superstructure rests on about 49 elastomeric bearings. Some are just plain pads, but 35 of them (as a minimum) are provided with a sliding surface, which is more sensitive and may need to be replaced more often, say in an interval of about 30. As an average 35years are assumed.

Access need to be provided to the bearings for exchange from the bottom up – i.e. from the river. This may become a quite costly exercise.

Item	frequency of Inspection			design service/lifetime [years]	replacement [times]
	visual, from a distance (authority/client)	visual (specialist)	"hands on" inspection / non. destructive testing		
structural weathering steel, superstructure	1 time / year	1 time / 3 years	1 time / 6 years	100	-
steel coating systems (not considered so far)	1 time / year	1 time / 3 years	1 time / 3 years	35	2
concrete deck slab girder bridge	1 time / year	1 time / 3 years	-	50	1
concrete deck slab stay cable bridge	1 time / year	1 time / 3 years		100	-
concrete pier	-	1 time / 3 years	-	100	-
concrete pile cap	-	-	-	100	-
concrete piles	-	-	-	100	-
elastomeric bearings	1 time / year	1 time / 3 years	1 time / 6 years	35	2
expansion joint	1 time / year	1 time / 3 years	1 time / 6 years	35	2
wearing surface	1 time / year	1 time / 3 years	1 time / 3 years	25	3
drainage	1 time / year	1 time / 3 years	-	35	2
Joint seals, sliders and springs	1 time / year	1 time / 3 years	-	15	6
Structural Health Monitoring Systems	1 time / year	1 time / 3 years	1 time / 6 years	25	3
galvanized steel barriers	1 time / year	1 time / 3 years	-	40	2
galvanized steel railing	1 time / year	1 time / 3 years	-	40	2
concrete barriers	1 time / year	1 time / 3 years	-	40	2
Sign support structures	1 time / year	1 time / 3 years	-	50	1
lamp post	1 time / year	1 time / 3 years	1 time / year (luminance test)	50 / upon need	1

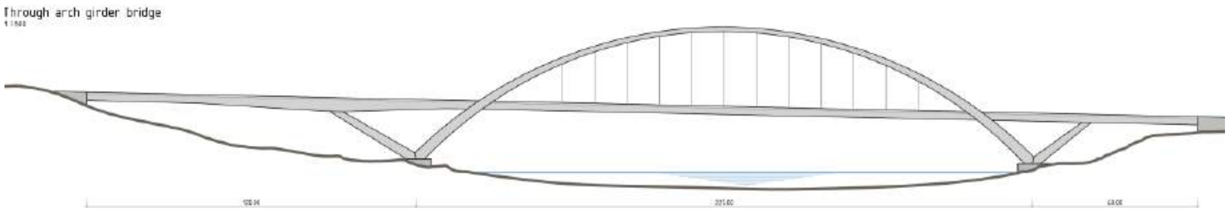
Items, which are different to the other options

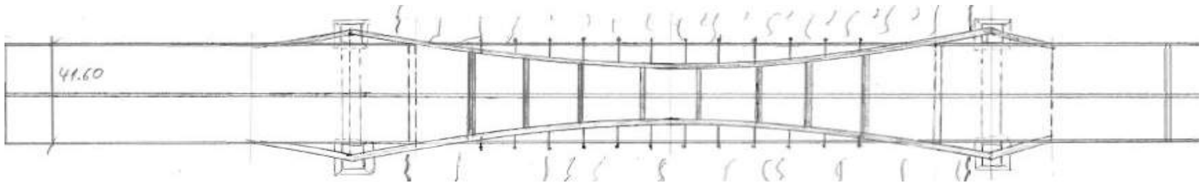
- Full deck slab on 410m length needs likely to be exchanged once in 100y
- About 49 Elastomeric Bearings need to be exchanged twice (with difficult access in the river)

2.2 Option 6 – Through Arch Bridge

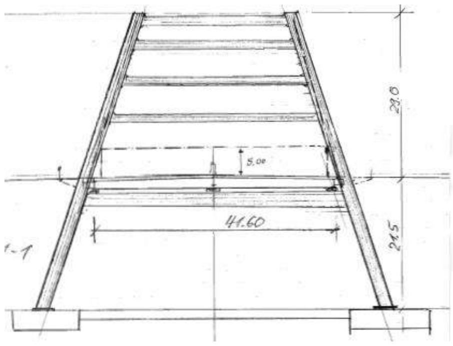
2.2.1 Layout

East West

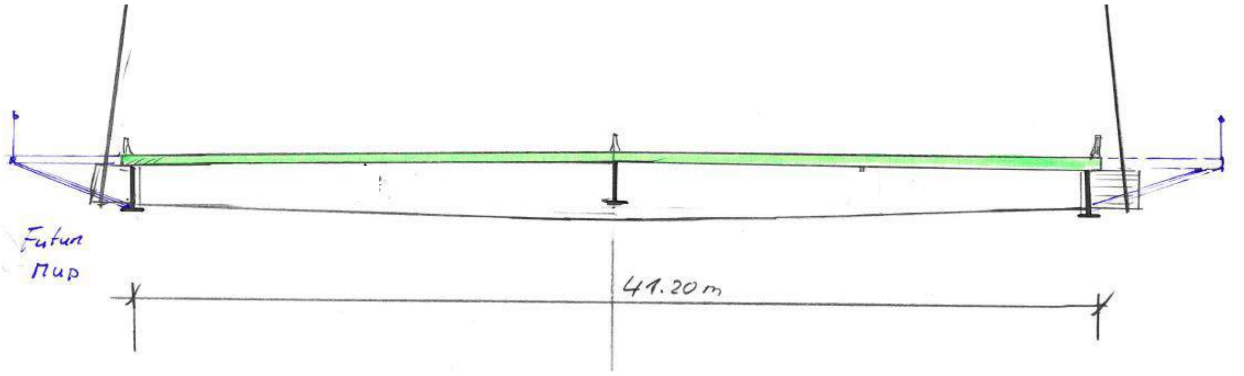




Option 2 consists of a Through-Arch Bridge with spans of 120 – 225 – 65 = 410 m. Only two piers/foundations would be needed. The large span on the w bank requires haunched plate girders (variable depth).



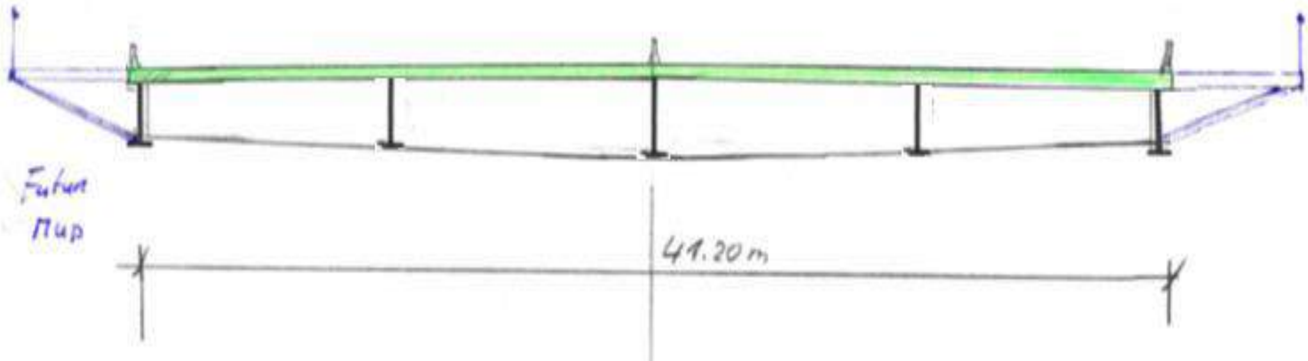
The cross section at the main span consists of three longitudinal steel main girders, connected by transverse cross girders spaced around four meters. The concrete slab is assumed to have a thickness of 270 mm, spanning longitudinally between cross girders. An average steel weight of 2.75 kN/m2 is assumed for the deck (arch not included), based on experience with similar solutions.



Cross section of the mainspan

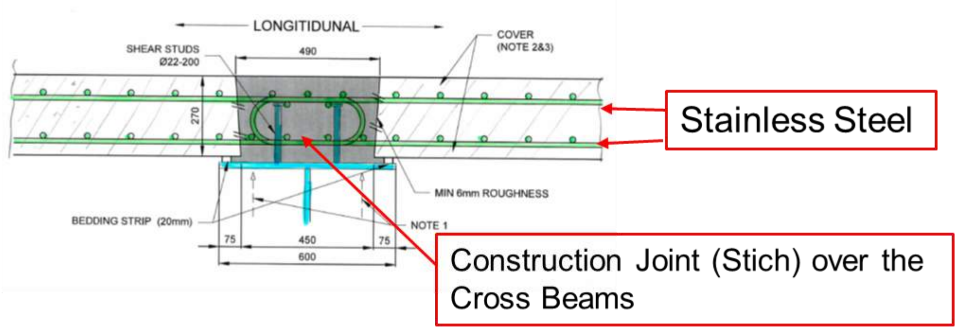
At sidespans a similar cross section is considered (with a 270mm slab), but with two additional longitudinal girders placed between the edge girders and the central one. The depth of the longitudinal girders need to be increased over the pier on the east side.

An average steel weight of 3.5 kN/m2 is considered for the longest sidespan, and 2.90 kN/m2 for the shorter one.

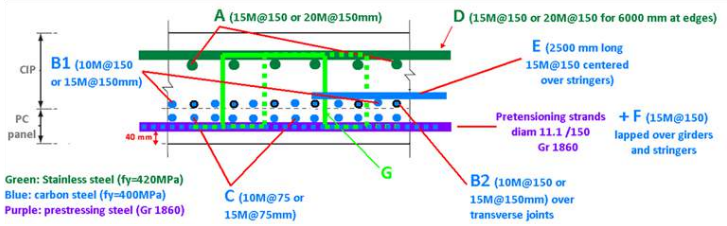


Cross Section of the Sidespan

Suspended Deck at the Arch, about 290m long

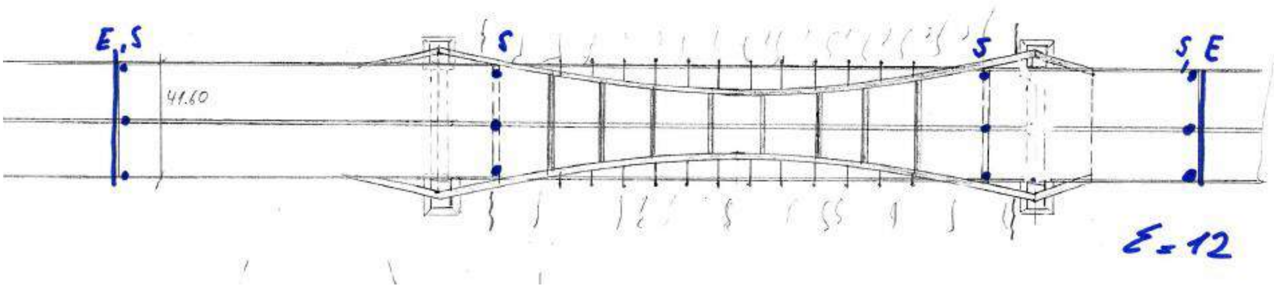


Girder Deck, about 120 m long



At Phase 1 it was noted, that an alternative cross section at the sides pans is possible (similar to that of Option 1). By removing the transverse girders and providing some lighter bracing instead some steel would be saved. A thicker slab would be needed, though, spanning in transverse direction and supported on extra longitudinal stringers, similar to Option 1. However, the side span is likely not long enough to justify a different design (that would mean also different construction means for execution of concrete slab, for example).

<u>Bearing Scheme:</u>



The deck is assumed to be fully fixed (integral) at both sides to the laterally inclined struts. At the abutments and cross beams (at arch to deck crossing) elastomeric bearings and expansion joints are considered.

2.2.2 Example

Saalebridge Beesedau

2.2.3 Summary of assumed Loads

LOADS

			OPTION 6	
Perm Loads				
	Self weight	SW Piers	0	kN/m
		SW Concrete slab main span	7.0	kN/m2
		SW Concrete slab side spans	7.0	kN/m2
		SW Steel main span	2.75	kN/m2

		SW Steel side spans	3.5	kN/m2
		SW Arches	85	kN/m
		SW Cables/hangers	0.03	kN/m2
		SW future MUP +3cm wearing srf	2.2	kN/m2
		SDL TOT	3.1	kN/m2
Var Loads	Live Load			
		2x5 lanes 3.00 m wide/DLL - Design Lane Load	3.0	kN/m2
		2x3.6m MUP pedestrian load	1.3	kN/m2
		Design Truck (*)	600	kN
	Wind			
		Design horizontal Wind (Wh)	8.0	kN/m
		Design vertical Wind (Wv)	10.0	kN/m
		Wind on Pylons/arch	18.0	kN/m
		Wind on Vehicles (WL)	4.0	kN/m
		Wind on Piers	10.0	kN/m
	Temperature			
		TU+(**)	40.0	K
		TU-(**)	-40.0	K
		TG+(***)	10.0	K
		TG-(***)	-10.0	K
	Friction		4	%

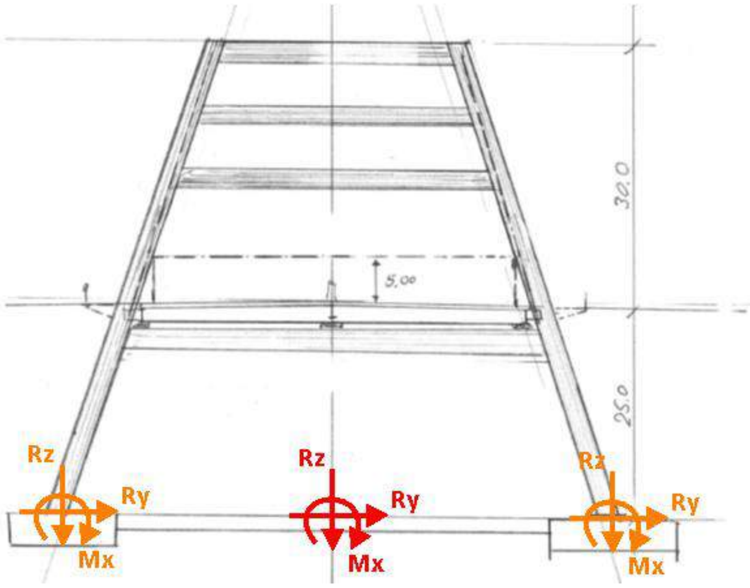
(*) Value of design truck to be considered together with lane load

(**) 40°C assumed (instead of 50°C) applied to a system with infinite rigid supports, in provision for foundation flexibility

(***) 10°C Gradient over the complete deck height assumed (similar effect as a 30°C gradient over the concrete slab depth)

2.2.4 Foundation Reactions

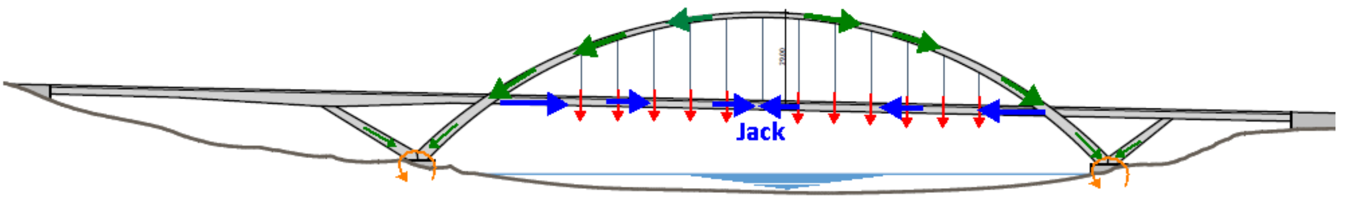
Following tables show an estimate of the reaction on top of foundation (weight of foundation not included). The reactions are given for the full width (both bounds, so both traffic directions), at the midpoint between both bounds (in red in sketch below).



For the two supports next to the shore (the supports of the arch) two separated foundations (probably linked with a transverse tie, with reactions as shown in orange) are likely the most suitable solution. Nevertheless, for sake of consistency with the other solutions (and ease of comparisons between them) the reactions are in this case also given as resultant forces at the mid-point, top of foundation (in red). The independent reactions can be estimated from the ones given for the midpoint.

With this format, the reactions at the midpoint shown in the following tables do not give any information about the tensile force in the transverse tie connecting both foundations. Therefore, a column for the tie force T_{tie} has been added to the tables for this option.

It is to be noted that the horizontal longitudinal Reactions Rx at the arch supports, as well as the bending moment My, highly depend on the construction sequence. Without any manipulation, the weight of the side spans (introduced by inclined legs into the foundation, and therefore introducing an horizontal component in opposite direction to the reaction from the arch) already compensates partially the horizontal reaction of the arch. Additionally, the remaining horizontal reaction at the support may be removed by different manipulations, such as a horizontal stressing at deck closure at the midpoint of the main span.



With such manipulation, the axial force at the two lower legs can be calibrated so that they compensate each other. Therefore, a horizontal force Rx close to zero and a bending moment My also close to zero could be obtained for permanent loads.

Nevertheless, at such an early stage it may be too audacious to assume such a reduction. Therefore, the reactions Rx and My of a situation without a construction manipulation (thus, the reactions obtained under the assumption of the whole bridge “magically” erected simultaneously) have been included in the tables below.

Should these two components of the permanent load reactions (marked in yellow in the tables below) penalize much the design of the foundations, a certain reduction/redistribution could be taken into account.

	Abutment 1				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**37.57**	0.00	0.00	0.00	0.00
TOT Traffic	**5.55**	0.00	0.00	**33.66**	0.00
TOT Wind	**0.38**	**0.89**	**0.05**	**4.93**	**0.17**
TOT Temp	**0.85**	0.00	0.00	0.00	0.00
SLS	**38.60**	**1.20**	**1.20**	**32.40**	**6.00**
ULS	**49.10**	**2.50**	**1.70**	**65.00**	**8.00**

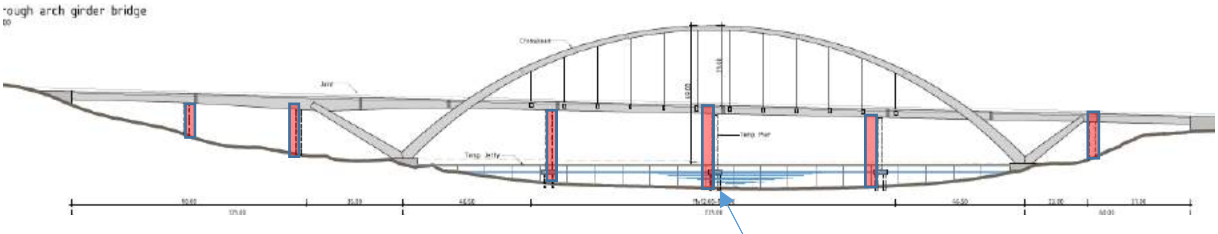
	Support 1					
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]	Ttie [MNm]
TOT Perm Loads	**123.40**	0.00	**16.87**	0.00	**97.65**	**41.41**
TOT Traffic	**15.22**	0.00	**11.74**	**98.12**	**25.20**	**3.45**
TOT Wind	**1.91**	**5.32**	**1.17**	**177.99**	**34.97**	**0.57**
TOT Temp	**0.77**	0.00	**11.51**	0.00	**49.75**	0.00
SLS	**136.10**	**0.00**	**35.50**	**67.90**	**158.20**	**44.10**
ULS	**170.00**	**6.50**	**51.90**	**254.00**	**225.80**	**54.50**

	Support 2					
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]	Ttie [MNm]
TOT Perm Loads	**99.98**	0.00	**16.87**	0.00	**145.20**	**26.59**
TOT Traffic	**12.92**	0.00	**11.74**	**82.73**	**31.08**	**2.60**
TOT Wind	**1.54**	**5.05**	**1.17**	**166.65**	**34.97**	**0.37**
TOT Temp	**2.15**	0.00	**11.51**	0.00	**37.17**	0.00
SLS	**112.00**	**0.00**	**35.50**	**58.00**	**200.10**	**28.60**
ULS	**139.90**	**6.20**	**51.90**	**232.80**	**266.90**	**35.70**

	Abutment 2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**23.34**	0.00	0.00	0.00	0.00
TOT Traffic	**4.61**	0.00	0.00	**27.35**	0.00
TOT Wind	**0.22**	**0.65**	**0.05**	**3.57**	**0.17**
TOT Temp	**2.06**	0.00	0.00	0.00	0.00
SLS	**24.70**	**0.70**	**0.70**	**25.60**	**3.20**
ULS	**32.40**	**1.50**	**0.90**	**50.70**	**4.40**

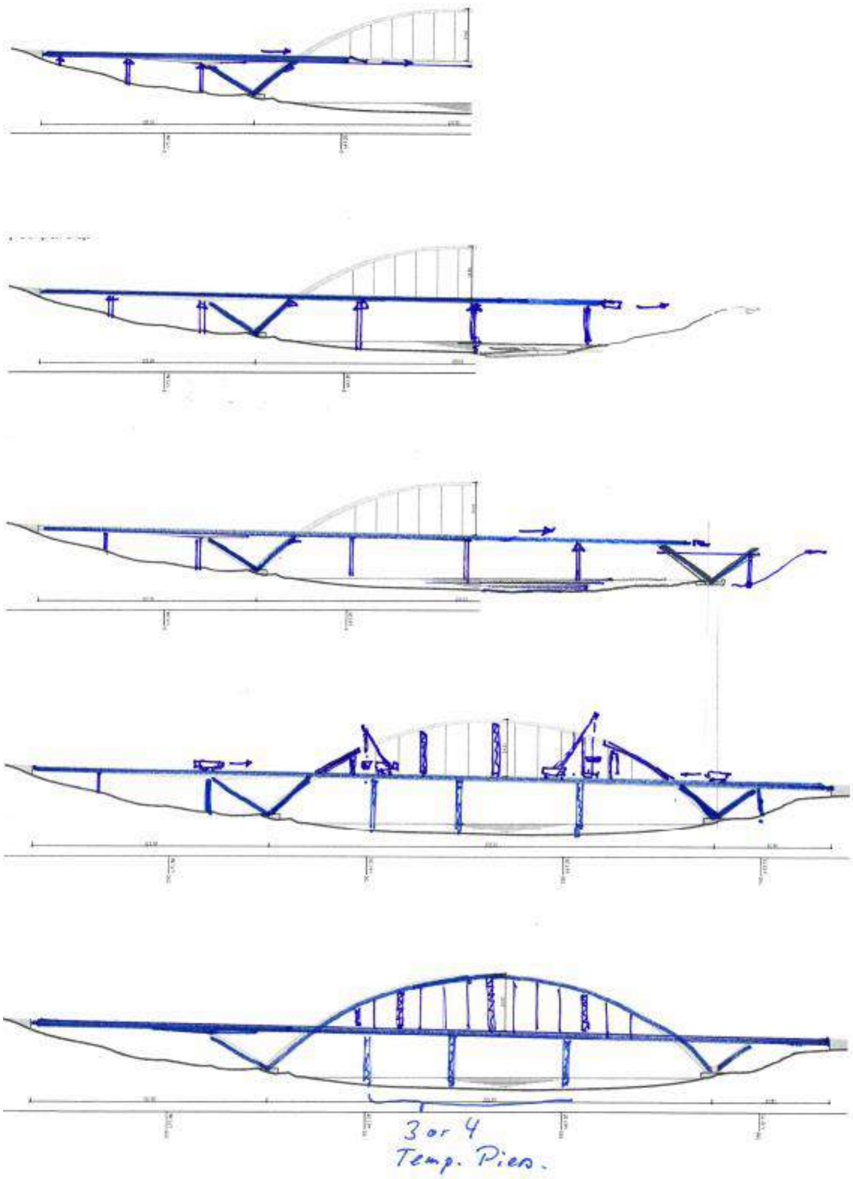
2.2.5 Construction

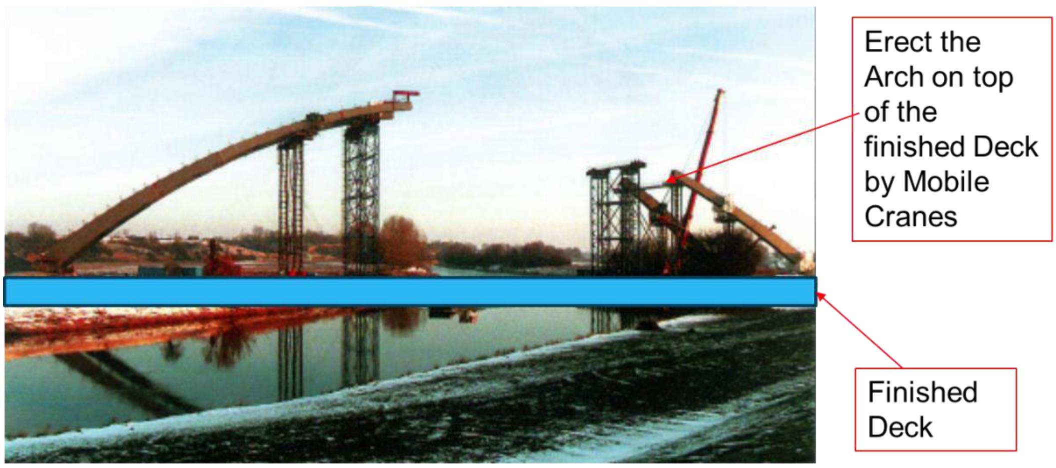
The most feasible option seems to be to erect the deck first including the roadway and construct the arch on top of the finished superstructure. Temporary piers are needed for that construction procedure.



Sequence:

• erect plate girder of the superstructure span by span on temporary piers from jetty/cofferdam
• place deck panels and cast stiches
(same procedures as for Option 2)
• erect the arches on top of the finished deck


3 or 4
Temp. Piers.

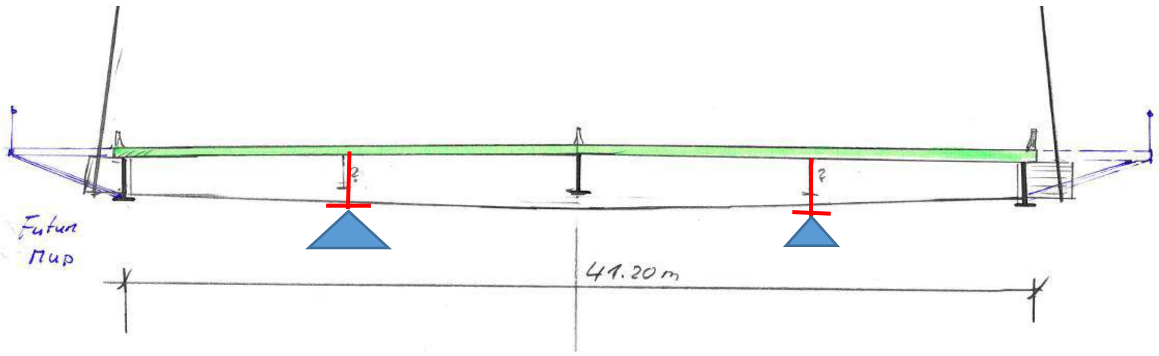

Erect the Arch on top of the finished Deck by Mobile Cranes
Finished Deck

<u>Alternative Procedure</u>

Theoretically, construction by Incremental Launching would also be an option. This would omit the need of a jetty/dam.

However

- At least 2 temporary piers would be needed in the river
- launching bearings should be placed at two girders only, since the main girders are haunched, secondary girders would be needed
- the bottom flanges of the secondary girder should better be welded, since launching over splice plates would be quite difficult, alternatively filler plates needs to be attached to the BF



2.2.6 Slope Stability

Slope stability is not a big issue here, since no permanent pier is placed in this zone. Depending on the erection procedure, temporary piers may be needed there, but for those it is not really a problem since any vertical movement can be compensated by jacks placed on the piers, horizontal movement needs to be corrected or sufficient tolerances provided in the load introduction zone.

2.2.7 Durability and Maintenance

The concrete deck would be under tension over a rather long area. However, the construction sequence mentioned above assures that stresses under permanent loads are rather low. Anyway, cracking has to be assumed. With a perfect waterproof membrane and stainless steel rebar's for the full depth of the slab in the main span, the durability will be rather good and 100y are assumed for the central part of 285 m length.

The remaining girder part (about 30% of the total), were tensile stresses are even higher and stainless steel is placed in the upper zone only, the slab may need to be replaced once.

The superstructure rests on only 12 elastomeric bearings with relative large loads. Those have to be replaced at an interval of about 30 to 40 years. Access should not be such a problem, since the bearings are close to the shore or at the abutment only.

Item	frequency of Inspection			design service/lifetime [years]	replacement [times]
	visual, from a distance (authority/client)	visual (specialist)	"hands on" inspection / non. destructive testing		
structural weathering steel, superstructure	1 time / year	1 time / 3 years	1 time / 6 years	100	-
structural weathering steel in the arch	1 time / year	1 time / 3 years	1 time / 6 years	100	-
steel coating systems (not considered so far)	1 time / year	1 time / 3 years	1 time / 3 years	35	2
concrete deck slab arch zone (285m long)	1 time / year	1 time / 3 years	-	100	-
concrete deck slab remaining are a (30% of the total)	1 time / year	1 time / 3 years		50	1
concrete pile cap	-	-	-	100	-
concrete piles	-	-	-	100	-
elastomeric bearings	1 time / year	1 time / 3 years	1 time / 6 years	35	2
expansion joint	1 time / year	1 time / 3 years	1 time / 6 years	35	2
wearing surface	1 time / year	1 time / 3 years	1 time / 3 years	25	3
drainage	1 time / year	1 time / 3 years	-	35	2
Joint seals, sliders and springs	1 time / year	1 time / 3 years	-	15	6
Hangers	1 time / year	1 time / 3 years	1 time / 6 years	50	1
Structural Health Monitoring Systems	1 time / year	1 time / 3 years	1 time / 6 years	25	3
galvanized steel barriers	1 time / year	1 time / 3 years	-	40	2
galvanized steel railing	1 time / year	1 time / 3 years	-	40	2
concrete barriers	1 time / year	1 time / 3 years	-	40	2
Sign support structures	1 time / year	1 time / 3 years	-	50	1
lamp post	1 time / year	1 time / 3 years	time / year (luminance tes	50 / upon need	1

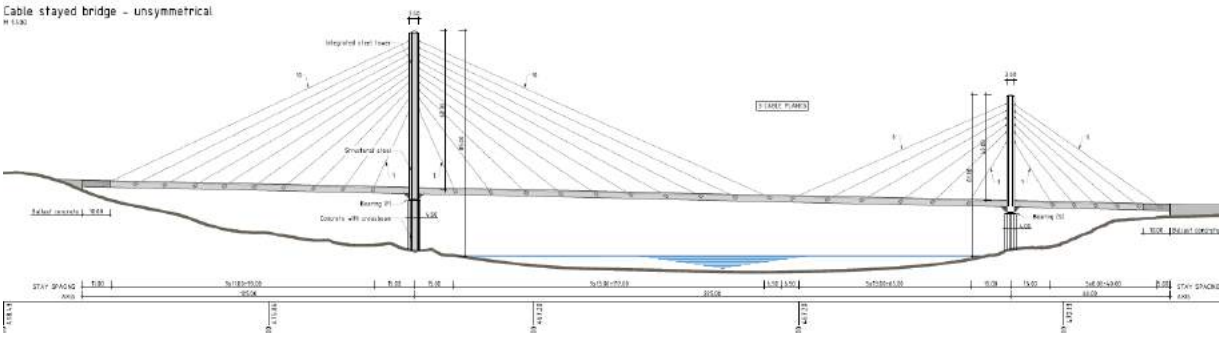
Items which are different to the other options

- 30% of deck slab (120m) needs to be exchanged once in 100y
- 12 Elastomeric Bearings with relative large loads need to be exchanged twice
- 24 Hangers need to be exchanged once

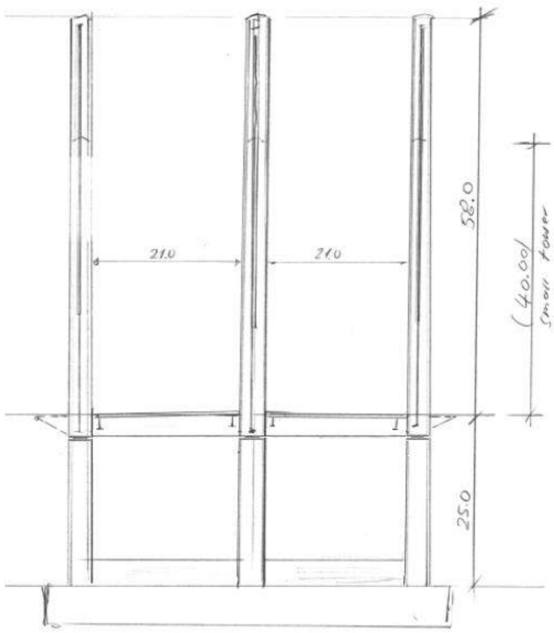
2.3 Option 10 – Unsymmetrical Stay Cable Bridge

2.3.1 Layout

East West

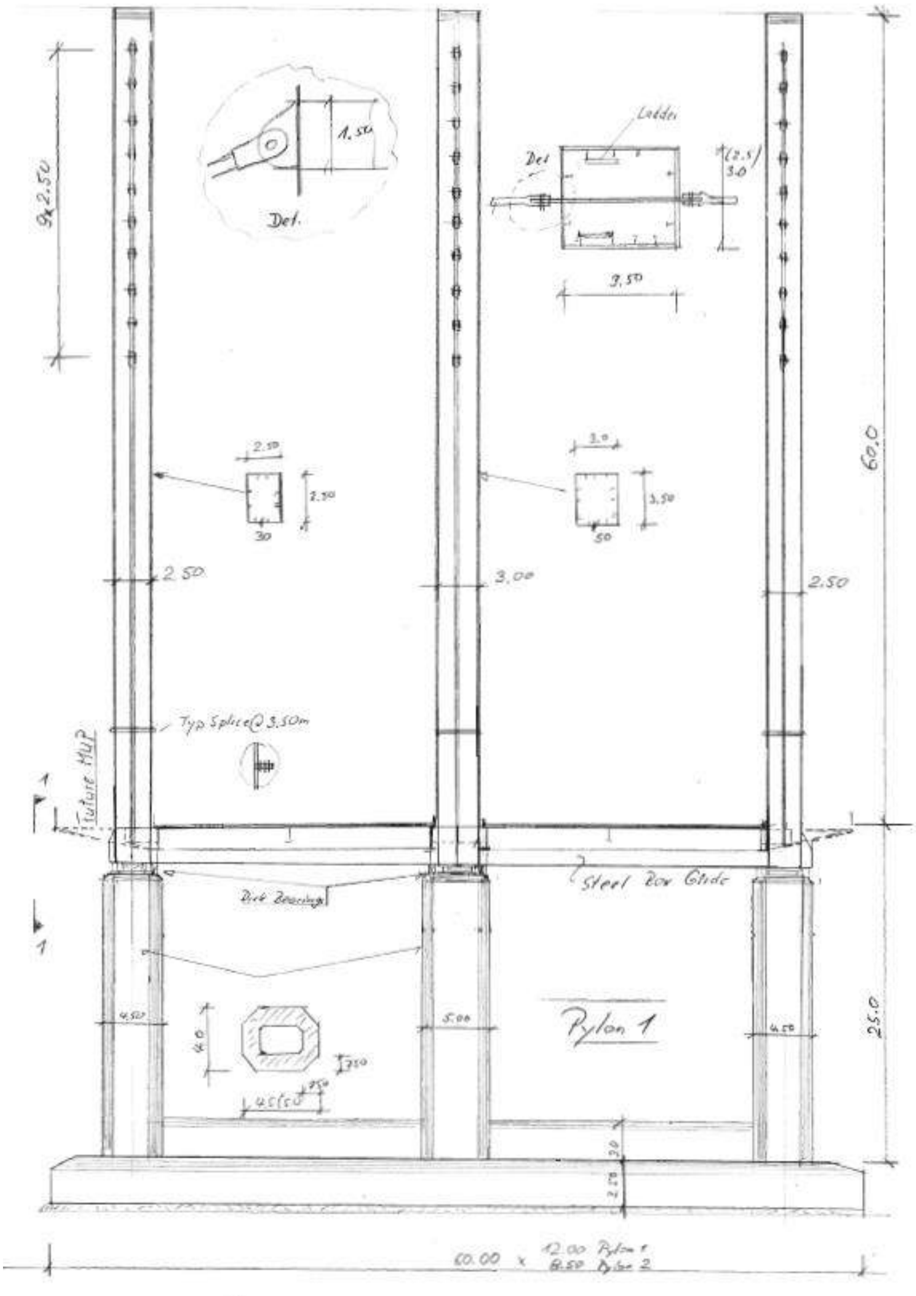


Option 10 is an unsymmetrical stay cable bridge with spans of 125 – 225 - 60 = 410 m.
Two Pylons with three legs has been assumed, a taller one on the East and a smaller one on the West.

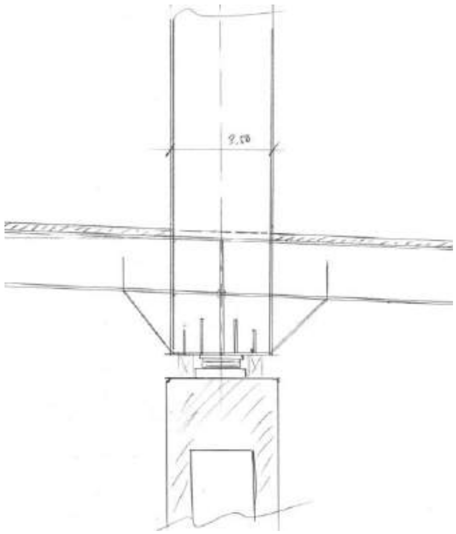


Several solutions for the pylon-to-deck fixation are possible. For the basic configuration, called option 10a, upper tower legs made of steel have been assumed, which are fully fixed to the deck (displacements and rotations). The integrated structure deck/pylon rests on bearings on top of a concrete frame **pier** (following the example of recent experiences such as New Duisburg Bridge or Nord Elbe Bridge). The fix point for longitudinal movements is assumed to be at the (taller)

East Pylon (fixed bearing in longitudinal direction; sliding bearing for East Pylon), with expansion joint at both abutments.



Pylon Layout with Details



Elevation at Deck Level – Section 1-1

Cost estimate for disc bearings under the tower columns is based on a current German Project:

Option 10 a		Loads [MN]		Maurer		
		SLS	ULS	Cost	Installation (33%)	Total
Large Tower	Outer	50	75	27'500 €	9'075 €	36'575 €
	Inner	100	150	82'500 €	27'225 €	109'725 €
	Outer	50	75	27'500 €	9'075 €	36'575 €
Large Tower	Outer	33	50	20'000 €	6'600 €	26'600 €
	Inner	66	99	36'500 €	12'045 €	48'545 €
	Outer	33	50	20'000 €	6'600 €	26'600 €
		332	498	214'000 €	70'620 €	284'620 €
average						47'437 €

Note, that this option requires quite heavy bearings (2x50MN plus 100MN at the large tower and 2x30+60MN at the small tower), therefore another solution with legs fixed to the substructure and not to the superstructure, have been looked into – see option 10b and c below.

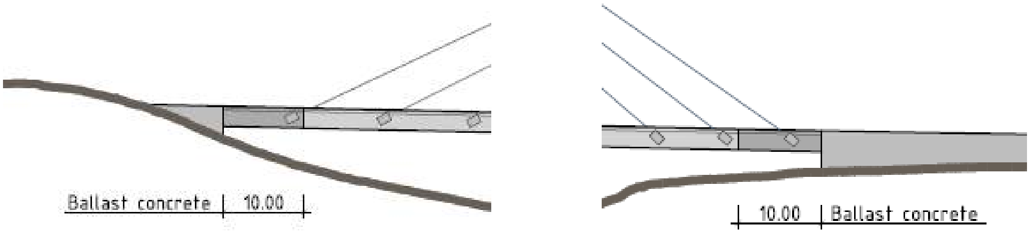
<u>Potential Uplift at the Bridge Ends (Abutments</u>

In order to cope with the unbalance of permanent and variable loads, in many stay cable bridges holddown cables/tendons are provided, mostly built up like the stay cables and prestressed so that no uplift occurs in the bearings under SLS or ULS loads (depending on the conditions of the clients).

Two measures have been adopted to avoid uplift:

1. For balance of dead weight the concrete slab is made thicker in the backspan

2. For balance of live load ballast concrete is placed at the end and considered in the BoQ, This concrete is place over 10 m length of the deck and the full width between the edge girders.



Both measures together are designed so that no uplift occurs under full ULS loads in the elastomeric bearings provided at the abutments.

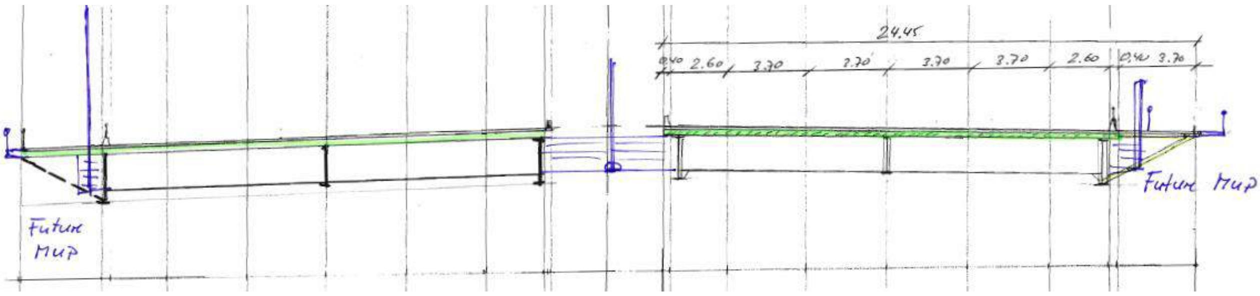
Deck Layout

The deck itself is assumed to be a plate girder type, similar to the one for the Tappan Zee Bridge, with cross girders spaced around 4,5 m, split in the center to allow the mid tower passing through the deck. The slab thickness is taken 270 mm, and the resulting average weight of steel 2.5 kN/m2:

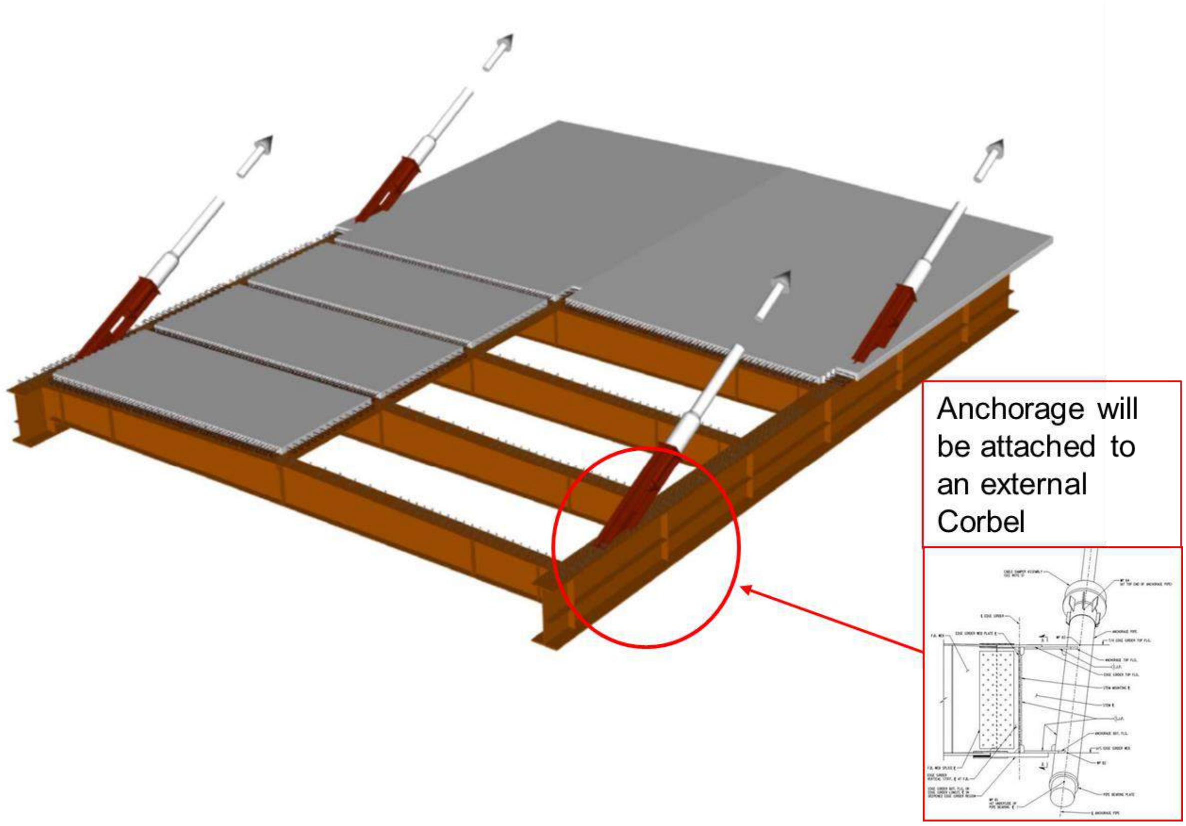
In the future configuration an MUP is attached as a light steel structure at each side and the roadway expanded to the barriers. A gap needs to be provided between roadway and MUP structure to pass the stay cables through. The concrete slab for the main span is assumed to be a full depth precast panel spanning longitudinally between cross girders, with 270 mm depth. For the side spans, a total depth of 400 mm for the larger back span and 600 mm for the shorter backspan is assumed, with 1/3 of the depth being precast panel and 2/3 of the depth cast in place concrete. With this arrangement, the higher permanent loads of the main span are partially balanced with the weight of backspans. In order to compensate the remaining part and to cope with the uplift forces that would appear at the abutments with traffic loads only at the main span, end transverse concrete beams of around 1230 tons and 1870 tons for West and East abutments respectively are assumed (with a depth of around 3.5 m and full 40 m width, the needed length for this concrete end beam is around 3.5 m and 5.3 m respectively).

In many other stay cable bridges, the ballast is replaced by hold-down cables. Those cable need a certain length to cope with the deformations, so this is not a feasible solution here. Also provision of pendulum link bars may be an option, but that is quite tricky in the detailing. Whatever solution is adopted, the Influence on total cost is minor.

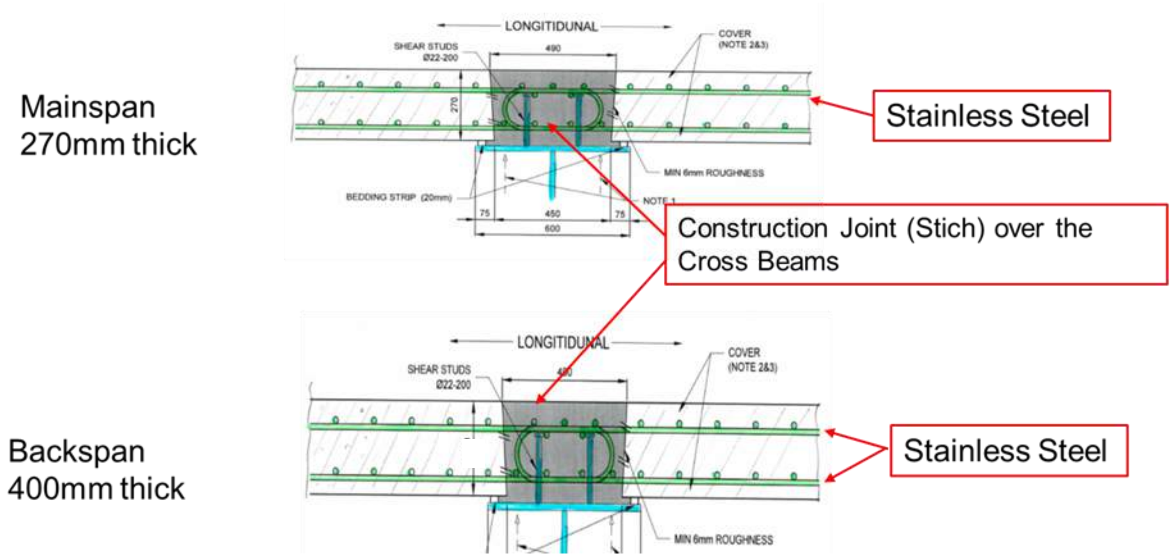
The central cable can be anchored to transverse brackets linking the superstructures of both bounds, or this cable could instead be split in two, one for each bound, without needing these brackets and having then two independent decks. For this variant, the two bounds need to be separated enough to leave room for the anchorages of both bounds.



These two central planes of cables can be anchored to one only central tower, or this central tower can also be split in two thinner ones (as done for both New Duisburg Bridge and Nord Elbe Bridge), allowing then a fully independent construction of both bounds.

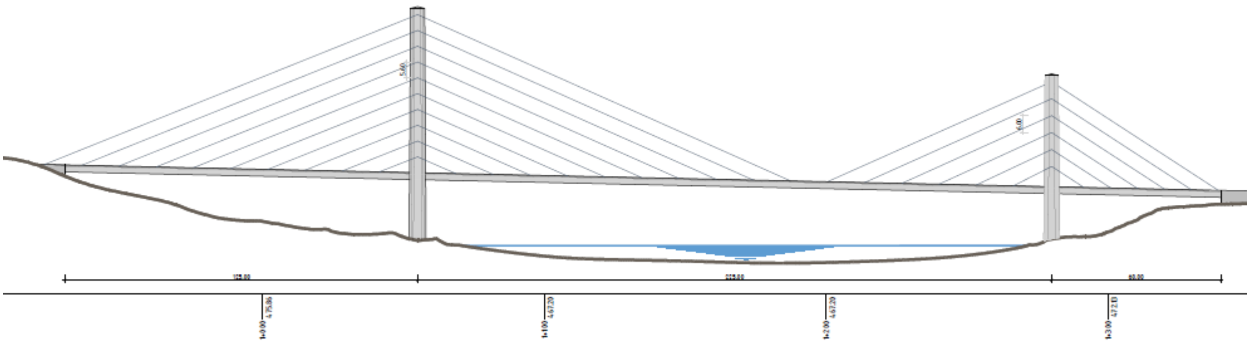


Upper and lower rebars are made of stainless steel, in the mainspan as well as in the sidespan



<u>Modification of Stay Cable Configuration</u>

The cable arrangement can be modified from the fan type shown above, to a harp type:

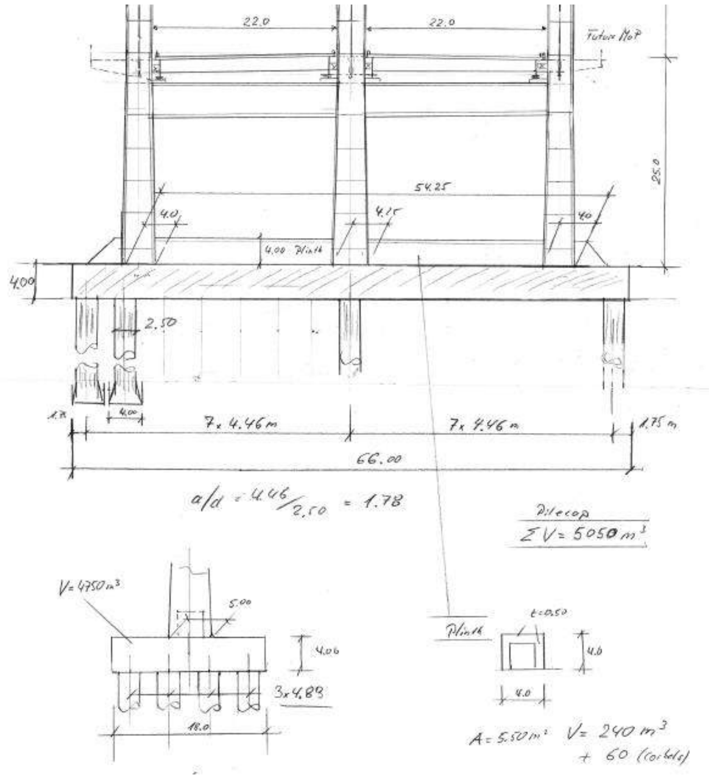


In this case, the 370 tons of steel on cables estimated for the fan solution would increase to around 400 tons (or around 390 tons if the shorter cables of each tower were removed). Other than this, the cable arrangement has no relevant influence in the reactions given below.

<u>Foundation Layout</u>

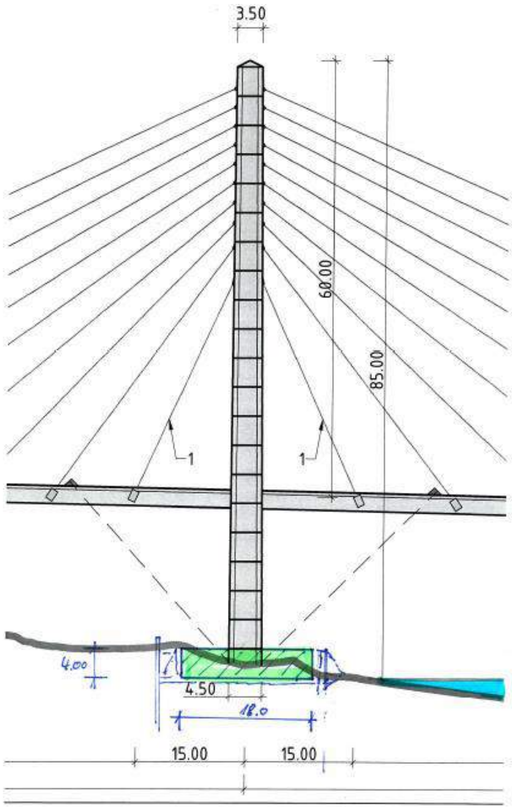
Initial concept: Pile Foundation with a pilecap of

- 18.0 x 66.0 x4.00m at Pylon 1 (shown below)
- 12.0 x 66.0 x3.50m at Pylon 2



Optimization: Spread Footing

OPTION 10a - UNSYMMETRICAL STAY CABLE BRIDGE (SPREAD FOOTING FOR PYLON FOUNDATIONS)				
Substructure Element	**Length (m)**	**Width (m)**	**Thickness (m)**	**Concrete Volume (m3)**
Pylon 1	60.00	12.00	3.50	2520
Pylon 2	60.00	8.50	3.50	1785
			Totals	**4305**



The distance of the pylon to the shoreline is sufficient to allow pilecap construction incl. temporary works without entering the river, even for the extreme width of a pilecap. The spread footing is less critical, since it has a max. width of 12.00m only. The final distance can be optimized in the next phase.

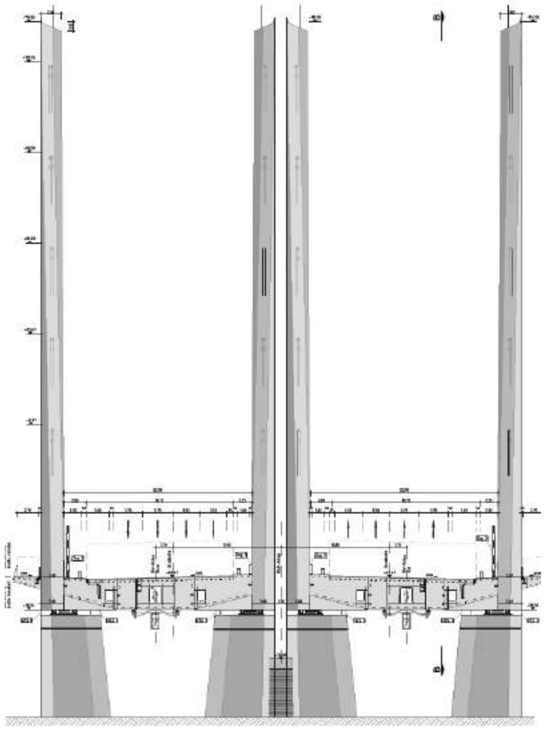
2.3.2 Example

Norderelbebrücke, Hamburg

2.3.3 Feasible Variants

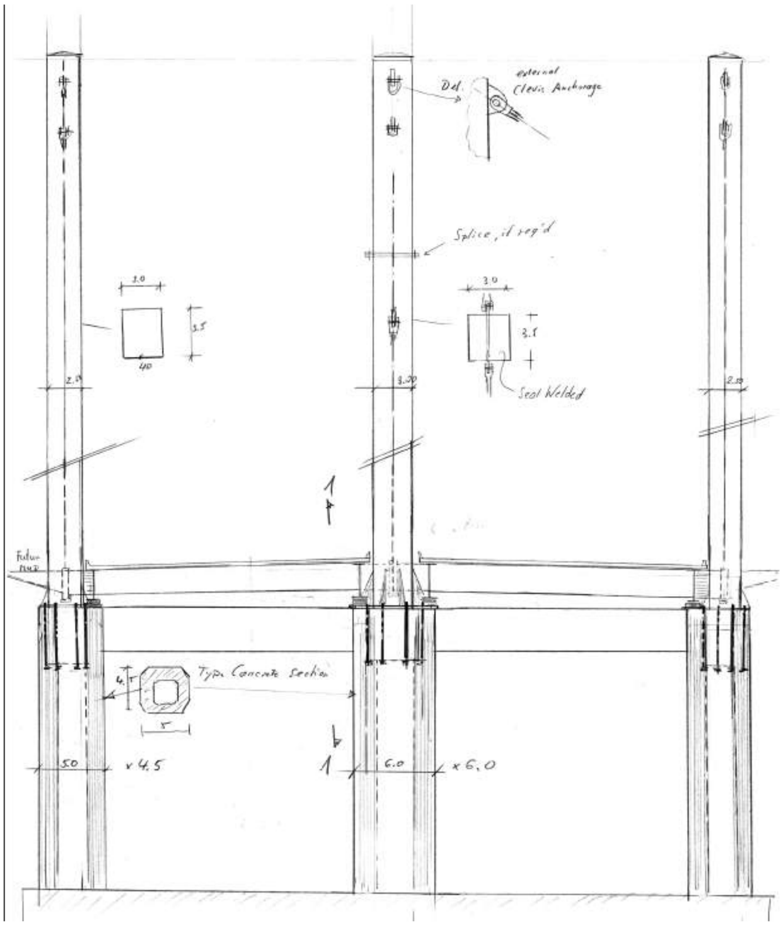
a) Independent Superstructures with 4 Tower legs
This is the concept of the example from Norderelbe. The central legs are close together, so that it looks like one leg from a distance. Two independent structures have the advantage that one bound could be closed and traffic diverted to the other bound in case a real heavy repair works (e.g. fully replacement after 100y) would be needed.

However, this bears one problem: in case of adding the future MUP on one side of the superstructure, the loads will go to one cable plane only (even a bit more and the other gets de-loaded). This could be considered in the design, but additional deformation downward may create a problem for the crossfall- may get too big. It may not be possible to increase the slope initially, so that it is correct after adding the future MuP, a compromise may have to be found: a bit more initially and a bit lower in the future. This can only be addressed in detail with further calculations. For the time being we will proceed with a combined superstructure and three tower legs, integrated into that one.



Typical Layout of German Stay Cable Bridges with Twin Deck

b) Steel Tower Legs **not** integrated into the superstructure but stressed by PT bars to the top of the concrete legs and the superstructure is continuous between the legs, provided with small elastomeric bearings. This option is named Option 10b in the following.



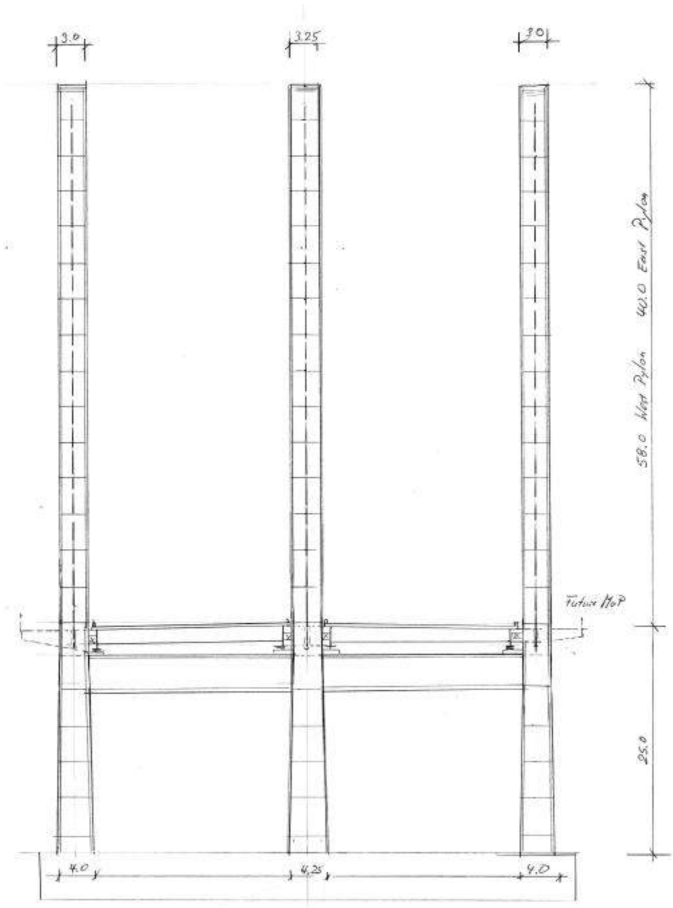
Option 10 b

Placement and replacement of bearings is much simpler for such a solution, construction slightly more difficult (accurate placement of the first steel element is essential for the tower geometry.). Tower bending and Mx Moments (longitudinal bending) at Top of Foundations are higher than for option 10a.

This option is called Option **10b** in the BoQ and Matrix below

c) Concrete Tower Legs

This option, named 10 c, would look quite similar as the option 10b above, but steel would be replaced by concrete columns. These concrete columns could be made of precast elements, placed by the tower crane or mobile cranes, tied together by vertical PT bars.

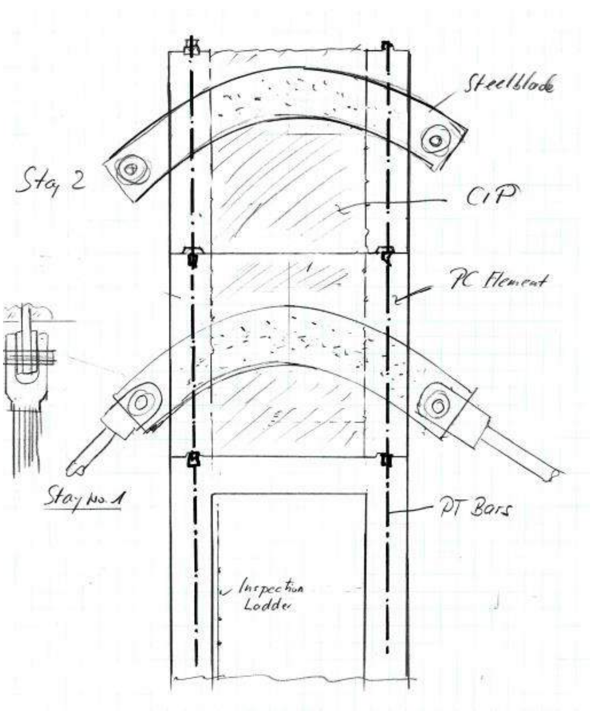


Option 10 c

Stay Anchor Zone

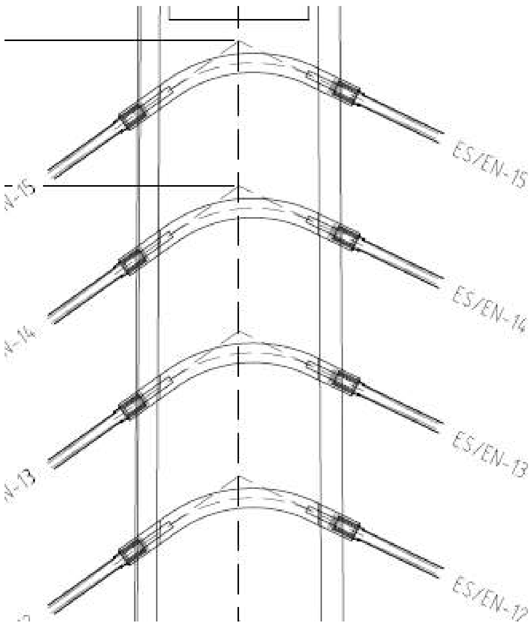
The stay cable anchorages in the upper zone are fixed to steel blades extending beyond the wall – see example from Champlain.

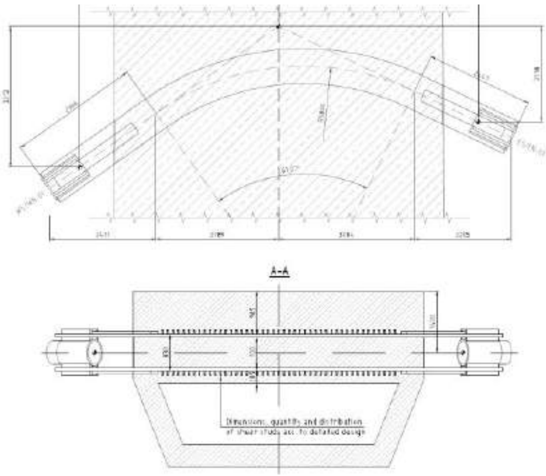
If done as precast segments, those would be light with say 400mm thick walls, filled with CIP Concrete after placement.

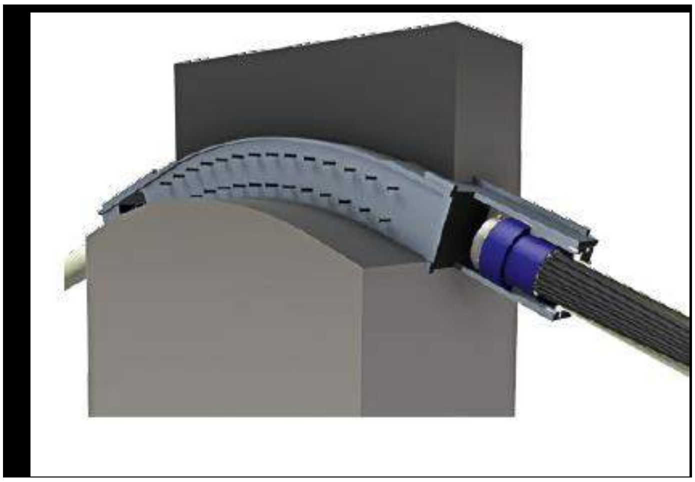


Concrete Tower Leg- Stay Anchor Zone

Example from Champlain







Stay Anchorages Champlain – System Dyna Link form DSI

Foundation loads will increase as shown in section 2.3.4 below

<u>Bearing Scheme - Option 10 b and c</u>

(Option 10 a has only three bearings in one axis)

Longitudinal Fixing is at East Pylon (1), all the others are sliding bearings, in total 14 vertical elastomeric bearings are needed plus 8 horizontal (wind) bearings (two on each side of one of the twin decks)

2.3.4 Summary of assumed Loads

Option 10a and 10b

LOADS			OPTION 10	
Perm Loads				
	Self weight	SW Pylon lower legs	508	kN/m
		SW Concrete slab main span	7.0	kN/m2
		SW Concrete slab side spans (*)	10.4	kN/m2
		SW Steel main span	2.5	kN/m2
		SW Steel side spans	2.5	kN/m2
		SW upper Pylon (**)	128	kN/m
		SW Cables	0.25	kN/m2
		SW future MUP +3cm wearing srf	2.2	kN/m2
		SDL TOT	3.1	kN/m2
Var Loads	Live Load			
		2x5 lanes 3.00 m wide/DLL - Design LL	3.0	kN/m2
		2x3.6m MUP pedestrian load	1.3	kN/m2
		Design Truck (***)	600	kN
	Wind			
		Design horizontal Wind (Wh)	8.0	kN/m
		Design vertical Wind (Wv)	10.0	kN/m
		Wind on Pylons/arch	18.0	kN/m
		Wind on Vehicles (WL)	4.0	kN/m
		Wind on Piers	10.0	kN/m
	Temperature			
		TU+/	50.0	K
		TU-	-50.0	K
		TG+(****)	10.0	K
		TG-(****)	-10.0	K
	Friction		4	%

(*) Value for west side, East side: 15.6 kN/m2

(**) Value for west side, East side: 88 kN/m

(***) Value of design truck to be considered together with lane load

(****) 10°C Gradient over the complete deck height assumed (similar effect as a 30°C gradient over the concrete slab depth)

Option 10c

LOADS

			OPTION 10	
Perm Loads				
	Self weight	SW Pylon lower legs	508	kN/m
		SW Concrete slab main span	7.0	kN/m2
		SW Concrete slab side spans (*)	10.4	kN/m2
		SW Steel main span	2.5	kN/m2
		SW Steel side spans	2.5	kN/m2
		SW upper Pylon (**)	700	kN/m
		SW Cables	0.25	kN/m2
		SW future MUP +3cm wearing srf	2.2	kN/m2
		SDL TOT	3.1	kN/m2
Var Loads	Live Load			
		2x5 lanes 3.00 m wide/DLL - Design Lane Load	3.0	kN/m2
		2x3.6m MUP pedestrian load	1.3	kN/m2
		Design Truck (***)	600	kN
	Wind			
		Design horizontal Wind (Wh)	8.0	kN/m
		Design vertical Wind (Wv)	6.0	kN/m
		Wind on Pylons/arch	18.0	kN/m
		Wind on Vehicles (WL)	4.0	kN/m
		Wind on Piers	10.0	kN/m
	Temperature			
		TU+	50.0	K
		TU-	-50.0	K
		TG+(****)	10.0	K
		TG-(****)	-10.0	K
	Friction		4	%

(*) Value for west side, East side: 15.6 kN/m2

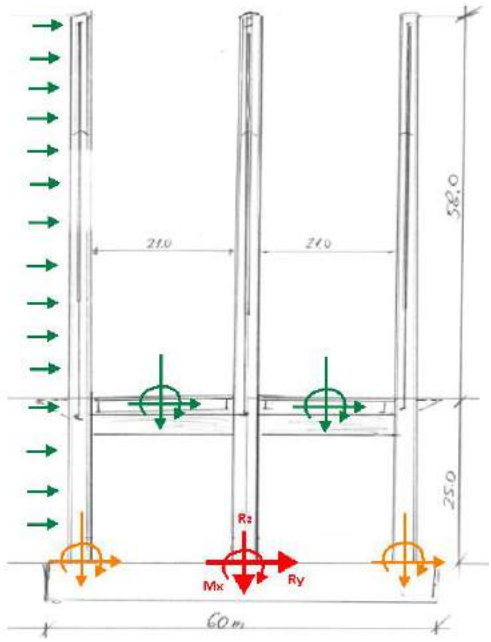
(**) Average value between lower part (precast hollow box) and upper part (including cast in place filling)

(***) Value of design truck to be considered together with lane load

(****) 10°C Gradient over the complete deck height assumed (similar effect as a 30°C gradient over the concrete slab depth)

2.3.5 Foundation Reactions

Following tables show an estimate of the reaction on top of the foundation (weight of foundation not included). The reactions are given for the full width (both bounds, so both traffic directions), at the midpoint between both bounds. An estimation of the weight of the pylon shafts, wind on pylon and bearing friction has been added to the loads coming from the deck, so that the reactions shown in the table below (in red in the following sketch) includes o provision for those effects.



There would be several options to design the foundations. Even independent foundations for each leg (maybe liked together by a bottom beam) could be envisaged. For the reactions given below a common foundation for the three legs was assumed, those being referred to the midpoint of both bounds (in red). In case of independent foundations, the independent reactions (in orange) can be estimated from the ones given for the midpoint.

Regarding the design options explained in the previous chapter (regarding the central tower and central plane of cables - one common tower and cable plane for both bounds or independent ones), the differences of the reactions at the midpoint of the foundation between each option are negligible at the current stage of the analysis.

Option 10a

	Abutment 1				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**18.08**	0.00	0.00	0.00	0.00
TOT Traffic	**5.65**	0.00	0.00	**40.58**	0.00
TOT Wind	**0.40**	**1.85**	**0.05**	**10.37**	**0.17**
TOT Temp	**0.1**	0.00	0.00	0.00	0.00
SLS	**23.00**	**0.60**	**0.60**	**35.00**	**2.90**
ULS	**31.30**	**2.50**	**0.90**	**72.70**	**4.00**

	Pylon 1 (Fix Point)				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**190.57**	0.00	0.00	0.00	0.00
TOT Traffic	**19.65**	0.00	**0.70**	**149.45**	**16.10**
TOT Wind	**2.29**	**3.45**	**1.05**	**125.02**	**22.48**
TOT Temp	**0.15**	0.00	0.00	0.00	0.00
SLS	**206.10**	**7.50**	**0.70**	**276.50**	**14.50**
ULS	**259.70**	**13.60**	**1.50**	**500.50**	**32.70**

	Pylon2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**132.77**	0.00	0.00	0.00	0.00
TOT Traffic	**13.38**	0.00	0.00	**100.65**	0.00
TOT Wind	**1.16**	**2.66**	**0.18**	**70.20**	**2.16**
TOT Temp	**0.2**	0.00	0.00	0.00	0.00
SLS	**143.60**	**5.10**	**5.10**	**163.60**	**91.80**
ULS	**180.00**	**9.60**	**6.90**	**297.30**	**122.40**

	Abutment 2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**16.90**	0.00	0.00	0.00	0.00
TOT Traffic	**4.77**	0.00	0.00	**33.73**	0.00
TOT Wind	**0.25**	**1.85**	**0.05**	**10.37**	**0.17**
TOT Temp	**0.15**	0.00	0.00	0.00	0.00
SLS	**21.20**	**0.50**	**0.50**	**30.10**	**2.50**
ULS	**28.40**	**2.40**	**0.80**	**60.60**	**3.50**

Option 10b

	Abutment 1				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**18.08**	0.00	0.00	0.00	0.00
TOT Traffic	**5.65**	0.00	0.00	**40.58**	0.00
TOT Wind	**0.40**	**1.85**	**0.05**	**10.37**	**0.17**
TOT Temp	**0.1**	0.00	0.00	0.00	0.00
SLS	**23.00**	**0.60**	**0.60**	**35.00**	**2.90**
ULS	**31.30**	**2.50**	**0.90**	**72.70**	**4.00**
	Pylon 1 (Fix Point)				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**192.12**	0.00	0.00	0.00	0.00
TOT Traffic	**19.65**	0.00	**9.65**	**149.45**	**294.58**
TOT Wind	**2.29**	**3.45**	**2.17**	**125.02**	**86.20**
TOT Temp	**0.15**	0.00	0.00	0.00	0.00
SLS	**207.70**	**1.20**	**7.50**	**129.40**	**230.50**
ULS	**261.70**	**5.30**	**16.50**	**309.20**	**500.80**
	Pylon2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**134.32**	0.00	0.00	0.00	0.00
TOT Traffic	**13.38**	0.00	**8.01**	**100.65**	**251.09**
TOT Wind	**1.16**	**2.66**	**0.95**	**70.20**	**34.40**
TOT Temp	**0.2**	0.00	0.00	0.00	0.00
SLS	**145.10**	**1.10**	**7.20**	**90.00**	**213.40**
ULS	**182.00**	**4.30**	**15.00**	**201.60**	**450.50**
	Abutment 2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**16.90**	0.00	0.00	0.00	0.00
TOT Traffic	**4.77**	0.00	0.00	**33.73**	0.00
TOT Wind	**0.25**	**1.85**	**0.05**	**10.37**	**0.17**
TOT Temp	**0.15**	0.00	0.00	0.00	0.00
SLS	**21.20**	**0.50**	**0.50**	**30.10**	**2.50**
ULS	**28.40**	**2.40**	**0.80**	**60.60**	**3.50**

Option 10c

	Abutment 1				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**18.08**	0.00	0.00	0.00	0.00
TOT Traffic	**5.65**	0.00	0.00	**40.58**	0.00
TOT Wind	**0.40**	**1.85**	**0.05**	**10.37**	**0.17**
TOT Temp	**0.1**	0.00	0.00	0.00	0.00
SLS	**23.00**	**0.60**	**0.60**	**35.00**	**2.90**
ULS	**31.30**	**2.50**	**0.90**	**72.70**	**4.00**

	Pylon 1 (Fix Point)				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**227.36**	0.00	0.00	0.00	0.00
TOT Traffic	**19.65**	0.00	**10.34**	**149.45**	**352.89**
TOT Wind	**2.29**	**3.45**	**2.17**	**125.02**	**86.20**
TOT Temp	**0.15**	0.00	0.00	0.00	0.00
SLS	**242.90**	**1.20**	**8.20**	**129.40**	**283.00**
ULS	**300.40**	**5.30**	**17.60**	**309.20**	**600.00**

	Pylon2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**151.12**	0.00	0.00	0.00	0.00
TOT Traffic	**13.38**	0.00	**8.69**	**100.65**	**309.39**
TOT Wind	**1.16**	**2.66**	**0.95**	**70.20**	**34.40**
TOT Temp	**0.2**	0.00	0.00	0.00	0.00
SLS	**161.90**	**1.10**	**7.80**	**90.00**	**265.90**
ULS	**200.40**	**4.30**	**16.10**	**201.60**	**549.70**

	Abutment 2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**16.90**	0.00	0.00	0.00	0.00
TOT Traffic	**4.77**	0.00	0.00	**33.73**	0.00
TOT Wind	**0.25**	**1.85**	**0.05**	**10.37**	**0.17**
TOT Temp	**0.15**	0.00	0.00	0.00	0.00
SLS	**21.20**	**0.50**	**0.50**	**30.10**	**2.50**
ULS	**28.40**	**2.40**	**0.80**	**60.60**	**3.50**

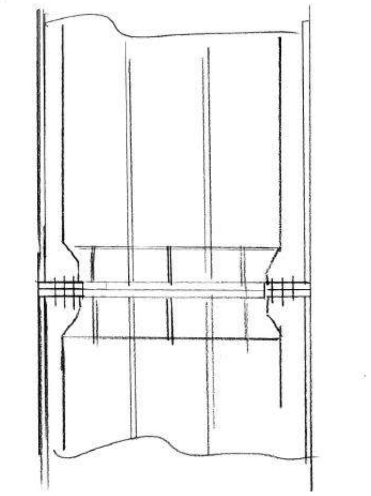
2.3.6 Construction

2.3.6.1 Tower erection

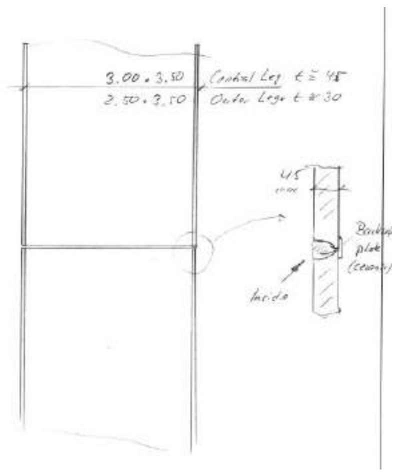
<u>Option 10a</u>

The legs below the deck are conventional piers and constructed as those. Only the legs above the deck are made of structural steel.

This option has no concrete crossbeam, the steel crossbeam (a box girder) is integrated into the deck and will be lifted after placement of bearings by a mobile crane on top of those, temporarily stressed down to the falsework. Immediately after the crossbeam is fixed and secured, the erection of the upper legs can proceed. The 3.50m high box segments will come to site in two halves (U-shaped, max dimension 3.50 x 3.50 x 1.50m. The two halves will be welded together to a box (3.50 x 3.50 x 3) with a max weight of 21mt at the base (50mm average wall thickness, incl. splice plates for the head to head splice. Segment 2 (45mm thick) will weigh 19mt incl. splices. The segments are lifted by a crawler crane and fixed together by a bolted head to head splice



Bolted Splice



Welded Splice

In case site welding would be possible in a protected environment, the welded splices could be arranged in a way that allows welding from the inside. The only work form outside would be the removal of the backing plate. Since the structure is built up by weathering steel it could even be considered to leave the backing plates in. Aesthetics would not be harmed much.

Option 10b:

Erection of the legs in a similar ways as option 10, lower leg in concrete, upper leg in structural steel. Concrete crossbeam on falsework, supported down to the foundation.

Erection of the starter elements:

- Tower legs starter segment is placed on the concrete legs, the gaps grouted and later, after curing of the grout, PT bars are stressed, further segments as for option 10a
- Deck starter segment placed on the concrete crossbeam – as for option 10 c

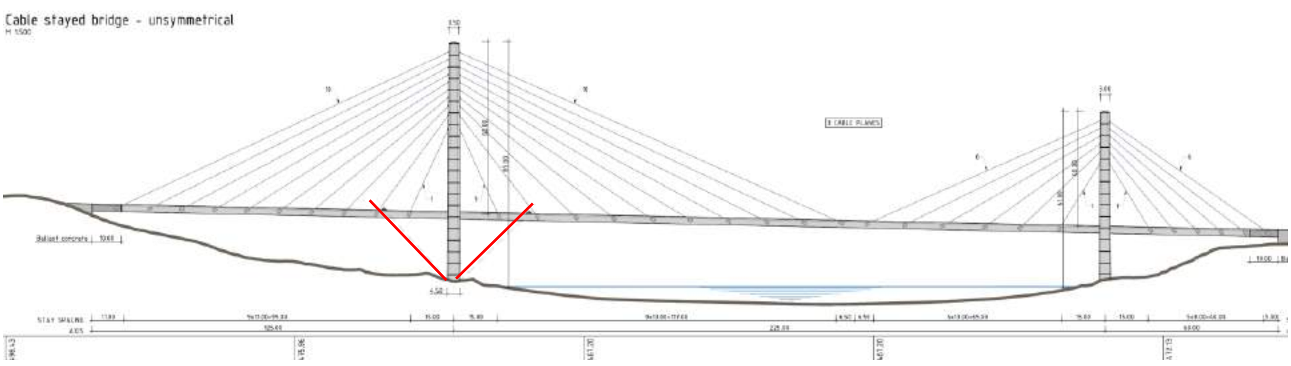
Option 10c:

Lower leg as for Option 10b.

Upper legs proposed with precast segmental construction, segments stressed together by PT bars in such a way that no tension occurs during erection and in the final stage (SLS). Legs below the stay anchorage zone may remain hollow, legs at anchorage zone should be filled by CIP concrete.

CIP Construction by a jumpform is also possible, slipforming is not recommended – and not feasible in the anchorage zone.

2.3.6.2 Superstructure erection



No temporary piers are needed for erection of the deck. For aerodynamic stability likely some diagonal ties are required in pylon 1 (East Pylon) , as shown in red above. Pylon 2 has a rather short cantilever, so it likely will be stable w/o any temporary tie downs.

<u>General Sequence</u>

1 erect tower starter segments on falsework (Option 10b and 10c may need only a fixation by PT bars to the crossbeam below), Option 10a has no concrete crossbeam and a falsework is needed.

2 deliver steelwork segments in pieces to the tower

3 lift by heavy tower crane or mobile crane placed on the starter segments

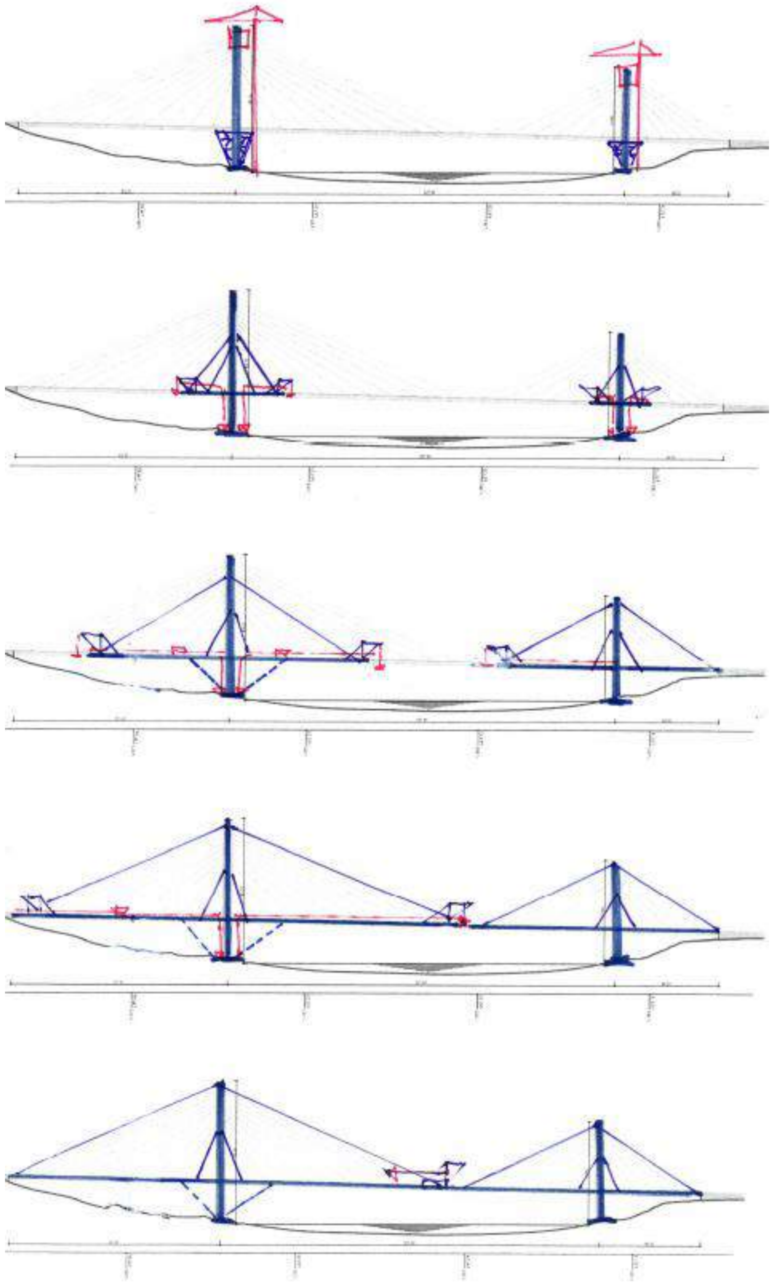
4 carry elements or fully assembled segment to the erection front

5 position it by a mobile crane (or derrick) followed by bolting of the splices

6 install stay cable

7 place deck panels and cast stiches

9 restress stay cables

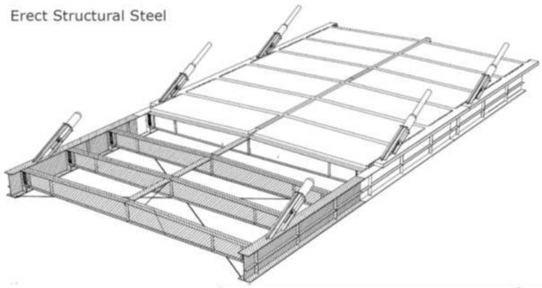


Note: the Tower Crane needs to remain in place also for stay erection (not shown above).

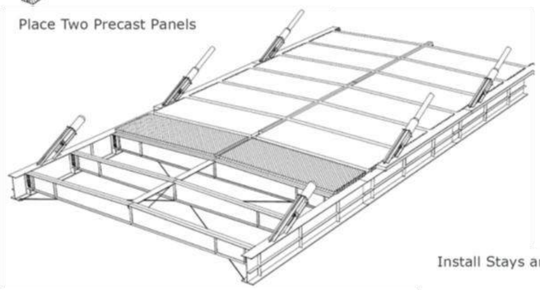
- Erect Pier Table
- Lift elements at the Tower by Tower Crane or Mobile Crane

Carry elements to the front e.g. with heavy duty modules

<u>Deck Erection Sequence</u>

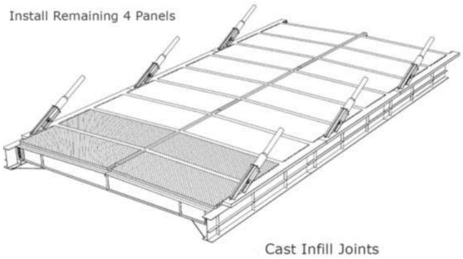


Erect structural steel



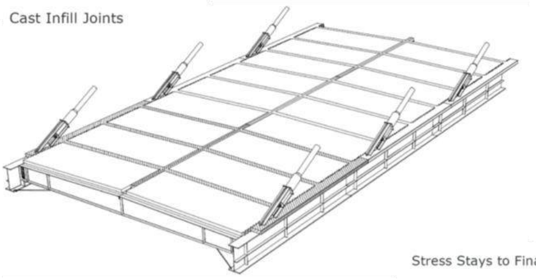
Place Two Precast Panels

Install and Stress Stay to level 1



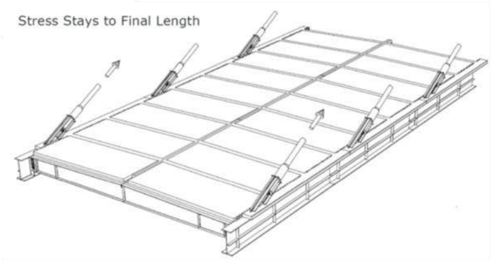
Install Remaining 4 Panel

(another stay stressing may be needed after panel placement)



Cast Infill Joints

Stress Stay to Final Length



<u>Deck Plate Erection</u>

Stay Cable Installation

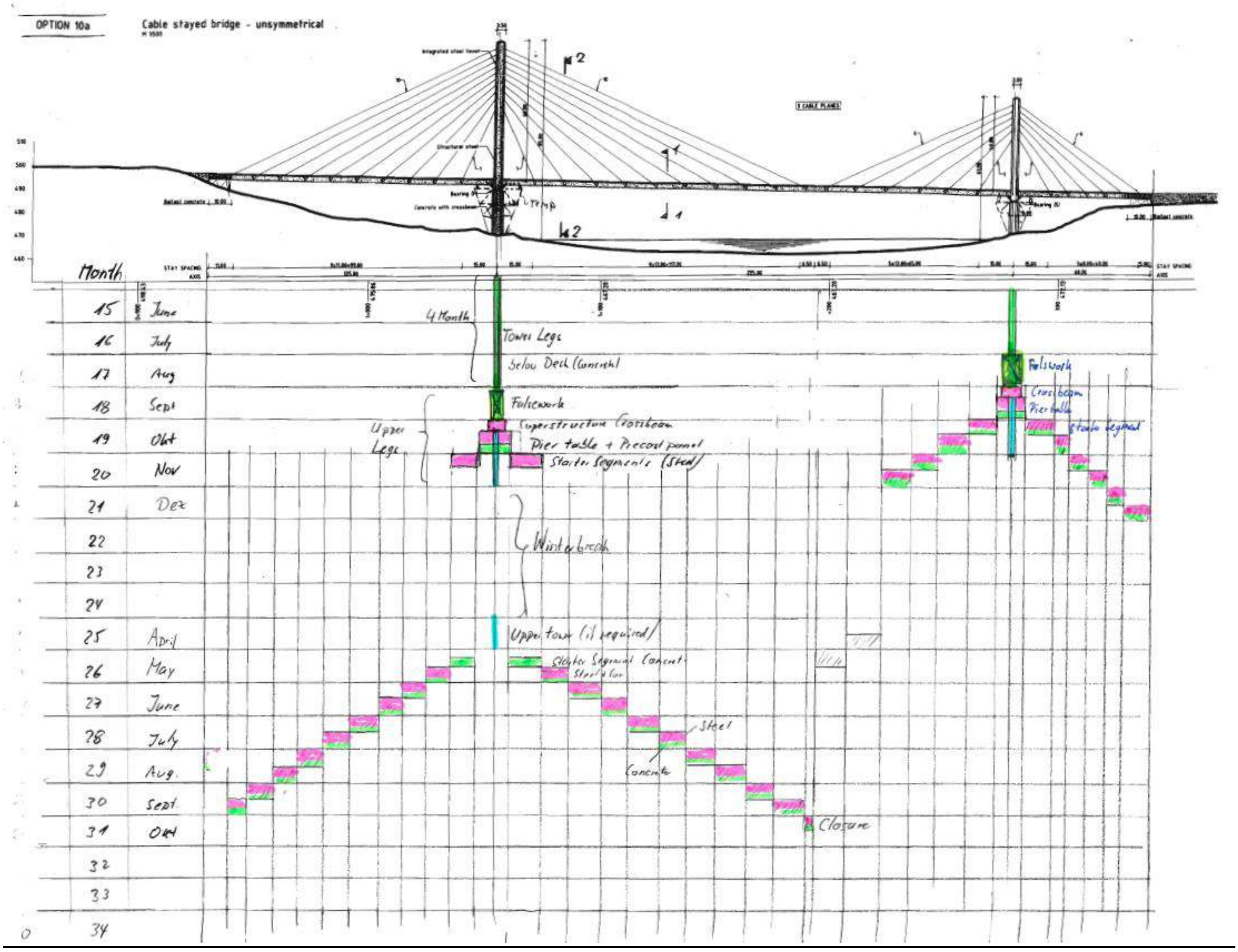
HDPE Duct gets
inserted

Pull –In and Stress Strands,
one after the other

Feasible Schedule

The below schedule for the free cantilever construction of Option 10a is based on

- Tower below deck are simple box structures, like the piers of Option 02 without cross beams. They should be done in max 3 month (in my opinion even faster)
- Towers above deck is a bolted steelwork, quickly to erect and not very critical w.r.t. temperature.
- Superstructure is made of a steel grid with full depth concrete panels in the mainspan and in the Backspan. Casting of stiches has to be done immediately after the steelwork and stay cables are erected. Curing of stiches may be done in winter with warmed up concrete aggregates and heating blanket cover (as been done for the Forth Bridge). This is likely not required, since the cantilever of Pylon 1 can be finished within 5 months, assuming a cycle of one twin segment (North and Southbound) in two weeks. Quite often such 13m segments have be done within 10 days, but a 4 day margin to cope with bad weather conditions and achieve a little stagger to the neighbor deck would be beneficial.


OPTION 10a
Cable stayed bridge - unsymmetrical
Month
15 June
16 July
17 Aug
18 Sept
19 Okt
20 Nov
21 Dez
22
23
24
25 April
26 May
27 June
28 July
29 Aug.
30 Sept.
31 Okt
32
33
34
4 Month
Tower Legs
below Deck (Concrete)
Falsework
Upper Legs
Superstructure Crossbeam
Pier table + Precast panel
Starter Segments (Steel)
Winter break
Upper tower (if required)
Starter Segment Concrete
Steel
Concrete
Closure
Crossbeam
Pier table
Starter Segment

2.3.7 Slope Stability

Not an issue since no pier is placed in this zone, also no temporary pier

2.3.8 Durability and Maintenance

2.3.8.1 Pylons

The lower legs can be accessed through doors, openings at top of foundations. They also could be filled with lean concrete, so that no access is needed.

No stay anchorages are provided inside of the leg, so access is only needed for a 5-10 year interval inspection. Ladders with platforms are placed in the boxes.

On top of the pylon a hoist system (like window cleaners have it at highrise buildings) is placed for access to the stay anchorages.

2.3.8.2 Superstructure

The action forces in that option would be adjusted in such a way, that almost no tension will occur in the concrete deck, only a small area near the abutment may be under tension, but that could be compensated by a light longitudinal prestressing. Not much cracking has to be assumed and inspection could be concentrated to the area near the abutments. With stainless steel rebars for the full slab depth over the whole length of the bridge, the durability will be very high and no deck replacement is envisaged over the design period of 100 years.

2.3.8.3 Stay Cables

Stay cables are provided with 3 barriers against corrosion: galvanizing, wax and HDPE sheet. Most of the suppliers are confident that they last the 100y without replacement. Nevertheless, replacement of individual cables must be possible in case something goes wrong. This is done the inverted way from the erection: taking out strand-by-strand, only small jack are needed for that work (monostrand jacks). Acc. to most suppliers it should even be possible to take one strand out and pull a new one in at the same place. Since the probability of a replacement is low, but not zero, it is difficult to address any cost for that issue. In the table below it is assumed that 10% of the strands are to be replaced once in 100y. No full bridge closure is needed for such a replacement, just one lane close next to the stay cables need to be closed, all other lanes can be used without any load restrictions (except for super heavy trucks)

Other elements of a stay cable bridge are essential for a good function

- HDPE Duct – outer sheathing: These ducts are exposed to sun radiation full time. The durability has been tested and is not any more a problem, but fading of the color, therefore bright colors (close to white/light grey) are a good choice.
- Dampers: depending on the type they may last 30 to 50 years. Exchange is rather simple. Since the cables in option 10 are rather short we do not expect to have dampers in more the 50% of the stays.
- Ice removal system: If stay cables with small ducts are used (e.g. parallel wire systems or ropes) the risk of ice accumulation decreases considerably. Many suppliers perform currently many researches and are close to a solution to mitigate that problem completely, so at the time the bridge is built, this is surely no issue any more.

The issue of bearing exchange depends on the sub- option. Option 10a is more complex, since it rest on heavy disc bearings, which are quite expensive and difficult to exchange.
Option 10 b and 10 c are much better in that respect, therefore they are recommended for further developments. The superstructure of those options rests on only 14 rather small elastomeric bearings

- abutments 2x3 = 6 Pcs
- at towers 2x4 vertical = 8 Pcs
- plus 2 x 4 wind bearing = 8 Pc

The 14 vertical bearings have to be replaced at an interval of about 30 to 40 years. However, access should not be a problem, since the bearings are on shore or at the abutment only.

The 8 wind bearings are not heavily loaded and may last much longer

structural weathering steel, pylon (0a and b)	1 time / year	1 time / 3 years	1 time / 6 years	100	-
steel coating systems (not considered so far)	1 time / year	1 time / 3 years	1 time / 3 years	35	2
concrete pylon (10c)	-	1 time / 3 years	-	100	-
concrete deck slab stay cable bridge	1 time / year	1 time / 3 years		100	-
concrete pier	-	1 time / 3 years	-	100	-
concrete pile cap	-	-	-	100	-
concrete piles	-	-	-	100	-
elastomeric bearings	1 time / year	1 time / 3 years	1 time / 6 years	35	2
disc bearing bearings (10a only)	1 time / year	1 time / 3 years	1 time / 6 years	50	1
expansion joint	1 time / year	1 time / 3 years	1 time / 6 years	35	2
wearing surface	1 time / year	1 time / 3 years	1 time / 3 years	25	3
drainage	1 time / year	1 time / 3 years	-	35	2
Joint seals, sliders and springs	1 time / year	1 time / 3 years	-	15	6
stay cables [1)]	-	1 time / 3 years	1 time / 6 years	100	0.1
Sheaths for Stay cables [2)]	1 time / year	1 time / 3 years	1 time / 6 years	100	0.1
Dampers for Stay Cables	1 time / year	1 time / 3 years	1 time / 6 years	50	1
Structural Health Monitoring Systems	1 time / year	1 time / 3 years	1 time / 6 years	25	3
galvanized steel barriers	1 time / year	1 time / 3 years	-	40	2
galvanized steel railing	1 time / year	1 time / 3 years	-	40	2
concrete barriers	1 time / year	1 time / 3 years	-	40	2
Sign support structures	1 time / year	1 time / 3 years	-	50	1
lamp post	1 time / year	1 time / 3 years	time / year (luminance te	50 / upon need	1

Items that are different to the other options

- Deck slab needs **not** to be exchanged
- 14 Elastomeric Bearings (with moderate to small loads) need to be exchanged twice
- 8 Elastomeric Windbearings need to be exchanged once
- Around 10% of the strands may need to be replaced along the structure lifetime
- Using bright colors (white or nearly white) will increase the lifetime of the sheets considerably (getting close to 100y). We assume that not more than 10 % of the sheets need to be replaced within the 100y

Inspection Services of Stay Cables are provided by some specialized firms, for example by Alpintechnik :

https://www.alpintechnik.com

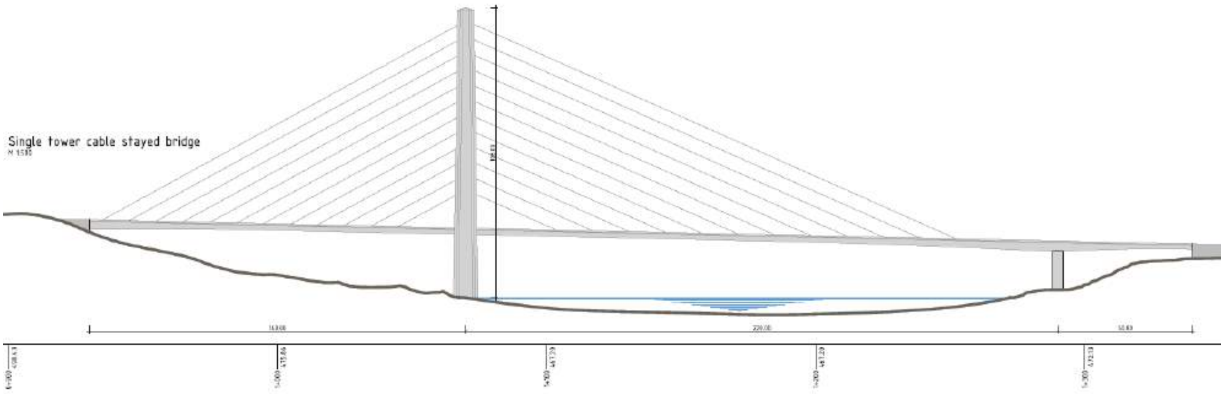
2.4 Option 14 – Single Tower Stay Cable Bridge

2.4.1 Layout

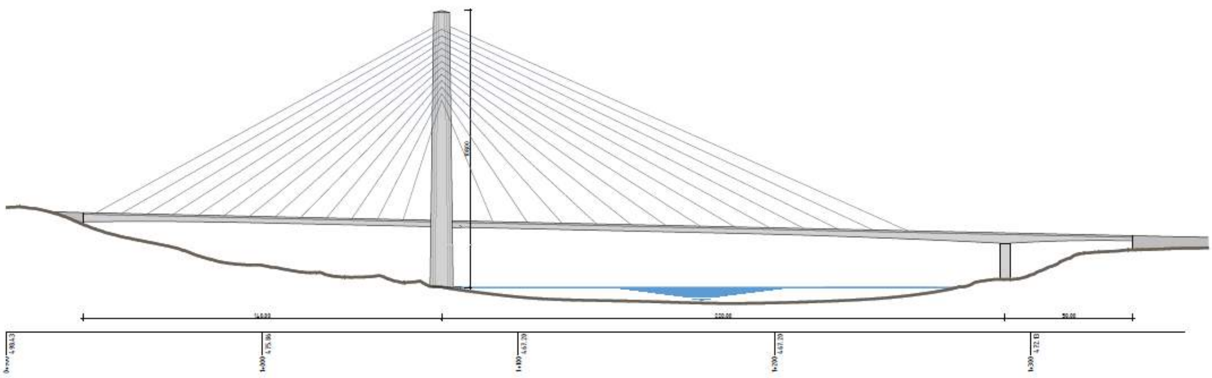
The following layout was shown as Option 14 in Phase 1, consisting of a Single Tower Stay Cable Bridge with spans 140– 220 – 50 = 410 m and only one Main Pylon on shore, with 2 x 12 cables at each side:

A small pier with a haunched plate girder superstructure is placed on the East bank.

East West



As for option 10, also, the alternative design with fan arrangement was analyzed; with 2 x 13 cables at each side (This option would be preferred).



The cable arrangement has no relevant effect on the reactions given below. The quantities given for steel on cables (455 tons in 2x2x13 cables) is the one estimated for the fan arrangement (the second from the two above). For the harp arrangement, a slightly higher tonnage has been estimated (490 tons in 2x2x12 cables).

Two different variants have been estimated, which differ in the tower design:

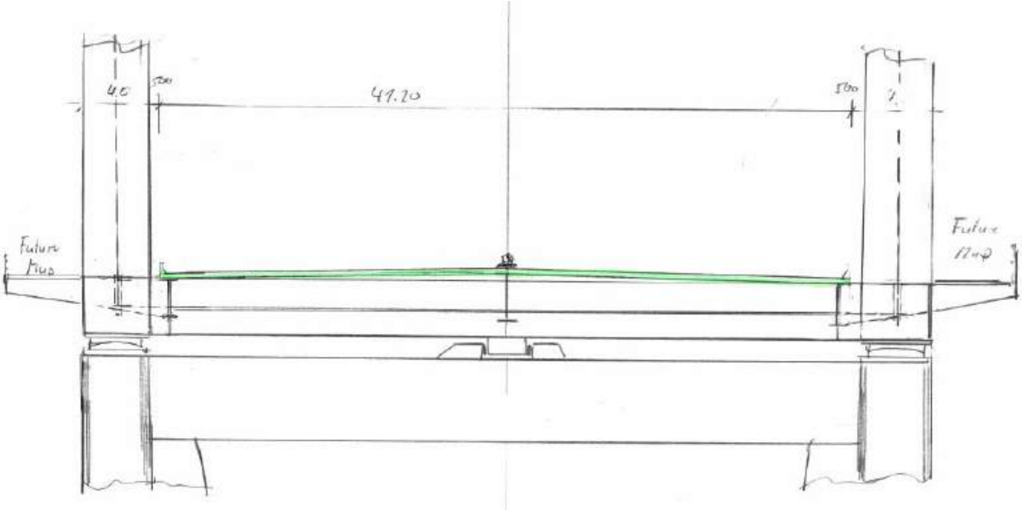
Option 14a has similar towers as option 10a, thus two upper steel arms rigidly connected to the deck, and supported over heavy sliding disc bearings on a lower concrete frame (sliding bearings for East Tower, fixed in longitudinal direction for West Tower).

Option 14b is provided with a full concrete H Pylon. For this option, the deck lays on the cross beam over elastomeric bearings.

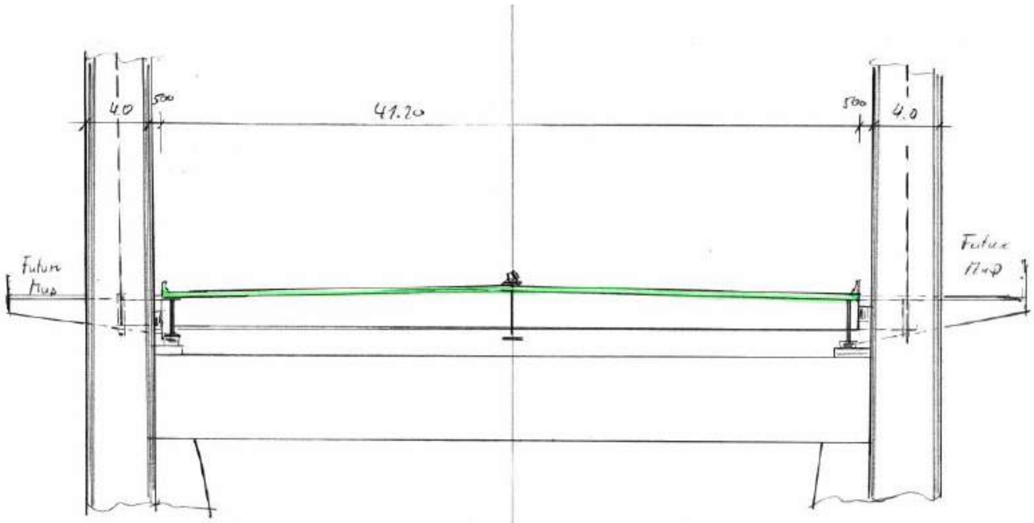
For both cases, a fixed point for longitudinal movements is provided at the Pylon (where the large vertical loads come down), with expansion joint and sliding bearings at both abutments. On the west pier the deck is supported by elastomeric bearings (sliding), one under each plate girder.

The cross section at the main span consists of three longitudinal steel main girders, connected by transverse cross girders spaced at around 4.5 meters. The concrete slab is assumed to have a thickness of 270 mm at main span, spanning longitudinally between cross girders. An average steel weight of 2.75 kN/m2 is assumed, slightly more than for Option 10, taking into account that for the adopted layout the cross beams have to span more than 40 m between the two external cables - while Option 10 is supported additionally by a central cable.

Option 14a



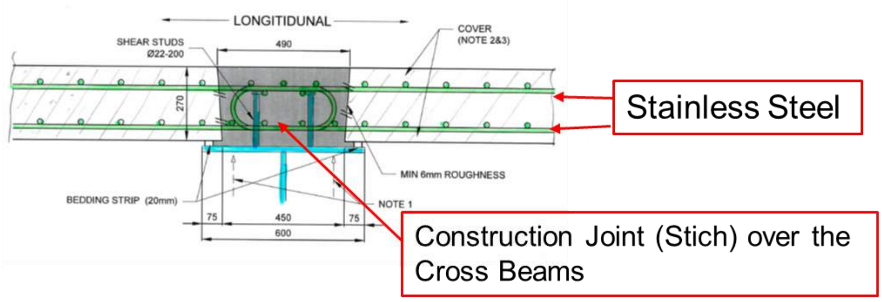
Option 14b



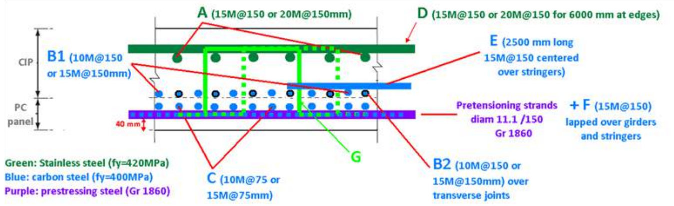
The depth of the slab is increased for the back span at the East to 500 mm. With this arrangement, the permanent loads are almost balanced between main and backspan. In order to cope with the uplift forces that would appear at the abutments in case traffic loads are only placed over the full length of the main span, transverse concrete beams of around 3000 tons (East) and 1900 tons (West) are provided , with a depth of around 3.5 m and full 40 m width. The required length for this concrete end beam is around 8.6 m and 5.4 m respectively.

<u>Deck Rebar Layout</u>

Cable Suspended Deck



Girder Deck, about 80m long



2.4.2 Example

As an example for a goalpost tower, the Öresund Bridge in Denmark is shown above.

2.4.3 Summary of assumed Loads

Option 14 a

LOADS	-	-	-	-	-	-
-	-	-	-	-	OPTION 14a	
Perm Loads						
	Self weight	SW Lower Pylon legs			570	kN/m
		SW Piers			327	kN/m
		SW Concrete slab main span			7.0	kN/m2
		SW Concrete slab side spans			13.0	kN/m2
		SW Steel main span			2.75	kN/m2
		SW Steel side spans			2.75	kN/m2
		SW Upper Pylon			165	kN/m
		SW Cables			0.30	kN/m2
		SW future MUP +3cm wearing srf			2.2	kN/m2
		SDL TOT			3.1	kN/m2
Var Loads	Live Load					
		2x5 lanes 3.00 m wide/DLL - Design				
		Lane Load			3.0	kN/m2
		2x3.6m MUP pedestrian load			1.3	kN/m2
		Design Truck (*)			600	kN
	Wind					
		Design horizontal Wind (Wh)			8.0	kN/m
		Design vertical Wind (Wv)			10.0	kN/m
		Wind on Pylons/arch			18.0	kN/m
		Wind on Vehicles (WL)			4.0	kN/m
		Wind on Piers			10.0	kN/m
	Temperature					
		TU+			50.0	K
		TU-			-50.0	K
		TG+(**)			10.0	K
		TG-(**)			-10.0	K
	Friction				4	%

(*) Value of design truck to be considered together with lane load

(**) 10°C Gradient over the complete deck height assumed (similar effect as a 30°C gradient over the concrete slab depth)Option 14 b

LOADS

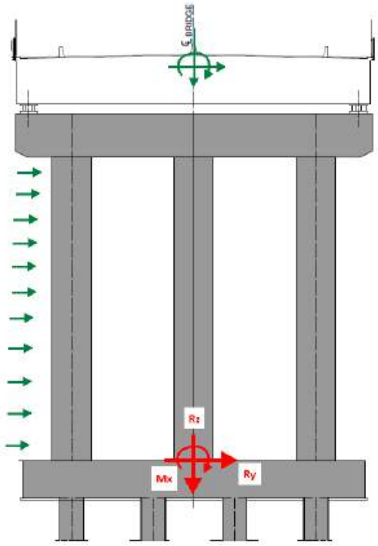
			OPTION 14b	
Perm Loads				
	Self weight	SW Lower Pylon legs	600	kN/m
		SW Piers/lowe Pylon legs	327	kN/m
		SW Concrete slab main span	7.0	kN/m2
		SW Concrete slab side spans	13.0	kN/m2
		SW Steel main span	2.75	kN/m2
		SW Steel side spans	2.75	kN/m2
		SW Upper Pylon	420	kN/m
		SW Cables	0.30	kN/m2
		SW future MUP +3cm wearing srf	2.2	kN/m2
		SDL TOT	3.1	kN/m2
Var Loads	Live Load			
		2x5 lanes 3.00 m wide/DLL - Design Lane Load	3.0	kN/m2
		2x3.6m MUP pedestrian load	1.3	kN/m2
		Design Truck (*)	600	kN
	Wind			
		Design horizontal Wind (Wh)	8.0	kN/m
		Design vertical Wind (Wv)	10.0	kN/m
		Wind on Pylons/arch	18.0	kN/m
		Wind on Vehicles (WL)	4.0	kN/m
		Wind on Piers	10.0	kN/m
	Temperature			
		TU+	50.0	K
		TU-	-50.0	K
		TG+(**)	10.0	K
		TG-(**)	-10.0	K
	Friction		4	%

(*) Value of design truck to be considered together with lane load

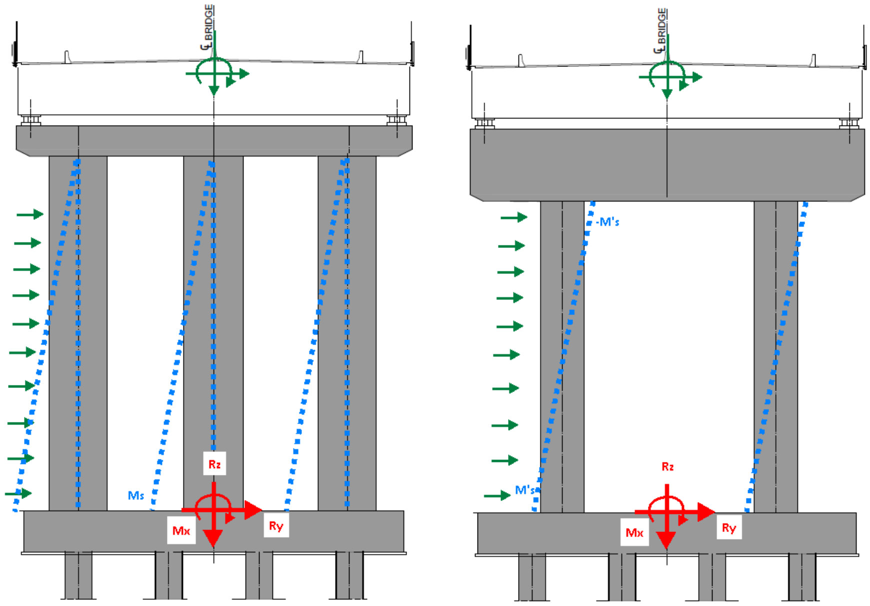
(**) 10°C Gradient over the complete deck height assumed (similar effect as a 30°C gradient over the concrete slab depth)

2.4.4 Foundation Reactions

Following tables show an estimate of the reaction on top of foundation (weight of foundation not included). The reactions are given for the full width (both bounds, so both traffic directions), at the midpoint between both bounds. An estimation of the weight of the pylon/pier shafts, wind on pylon/pier and bearing friction has been added to the loads coming from the deck, so that the reactions shown in the table below (in red in the following sketch) includes o provision for those effects.



Previous sketch show the proportions of a possible solution for the substructure of East pier. It is to be noted that the section forces at the substructure (for example bending moments at the pile shafts) may vary significantly depending on the later design of the piers (see sketch below for two –exaggerated- different solutions). Nevertheless, assuming that the foundation is stiff enough, the reactions given in the tables below (in red in the sketch) should fairly represent the resulting reactions at the midpoint, on top of foundation.



<u>Option 14 a</u>

	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
	Abutment 1				
TOT Perm Loads	**23.37**	0.00	0.00	0.00	0.00
TOT Traffic	**6.24**	0.00	0.00	**38.38**	0.00
TOT Wind	**0.50**	**1.13**	**0.05**	**6.29**	**0.17**
TOT Temp	**0.5**	0.00	0.00	0.00	0.00
SLS	**29.00**	**0.90**	**0.90**	**33.60**	**4.10**
ULS	**38.70**	**2.20**	**1.20**	**70.50**	**5.50**
	Pylon (Fix Point)				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**274.28**	0.00	0.00	0.00	0.00
TOT Traffic	**25.47**	0.00	**0.70**	**167.17**	**17.50**
TOT Wind	**2.89**	**4.29**	**1.07**	**198.03**	**24.77**
TOT Temp	**0.1**	0.00	0.00	0.00	0.00
SLS	**294.20**	**2.70**	**0.70**	**178.70**	**15.80**
ULS	**367.40**	**8.50**	**1.60**	**423.10**	**35.70**
	Pier				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**47.51**	0.00	0.00	0.00	0.00
TOT Traffic	**8.88**	0.00	0.00	**56.08**	0.00
TOT Wind	**0.46**	**1.89**	**0.18**	**34.08**	**2.16**
TOT Temp	**0.25**	0.00	0.00	0.00	0.00
SLS	**55.00**	**1.70**	**1.70**	**70.60**	**29.70**
ULS	**71.50**	**4.00**	**2.40**	**134.60**	**41.70**
	Abutment 2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**27.74**	0.00	0.00	0.00	0.00
TOT Traffic	**5.06**	0.00	0.00	**30.52**	0.00
TOT Wind	**0.30**	**0.41**	**0.05**	**3.29**	**0.17**
TOT Temp	**0.2**	0.00	0.00	0.00	0.00
SLS	**29.30**	**0.90**	**0.90**	**28.60**	**4.10**
ULS	**38.40**	**1.50**	**1.20**	**57.30**	**5.60**

Option 14 b

	Abutment 1				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**23.37**	0.00	0.00	0.00	0.00
TOT Traffic	**6.24**	0.00	0.00	**38.38**	0.00
TOT Wind	**0.50**	**1.13**	**0.05**	**6.29**	**0.17**
TOT Temp	**0.5**	0.00	0.00	0.00	0.00
SLS	**29.00**	**0.90**	**0.90**	**33.60**	**4.10**
ULS	**38.70**	**2.20**	**1.20**	**70.50**	**5.50**
	Pylon (Fix Point)				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**296.76**	0.00	0.00	0.00	0.00
TOT Traffic	**25.47**	0.00	**10.50**	**167.17**	**310.95**
TOT Wind	**2.89**	**4.29**	**2.57**	**198.03**	**130.32**
TOT Temp	**0.1**	0.00	0.00	0.00	0.00
SLS	**316.70**	**2.60**	**8.20**	**174.90**	**241.70**
ULS	**396.00**	**8.30**	**17.90**	**418.10**	**528.70**
	Pier				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**42.05**	0.00	0.00	0.00	0.00
TOT Traffic	**8.88**	0.00	0.00	**56.08**	0.00
TOT Wind	**0.46**	**1.89**	**0.18**	**34.08**	**2.16**
TOT Temp	**0.25**	0.00	0.00	0.00	0.00
SLS	**49.50**	**1.70**	**1.70**	**70.60**	**29.70**
ULS	**64.90**	**4.00**	**2.40**	**134.60**	**41.70**
	Abutment 2				
	Rz [MN]	Ry [MN]	Rx [MN]	Mx [MNm]	My [MNm]
TOT Perm Loads	**27.74**	0.00	0.00	0.00	0.00
TOT Traffic	**5.06**	0.00	0.00	**30.52**	0.00
TOT Wind	**0.30**	**0.41**	**0.05**	**3.29**	**0.17**
TOT Temp	**0.2**	0.00	0.00	0.00	0.00
SLS	**29.30**	**0.90**	**0.90**	**28.60**	**4.10**
ULS	**38.40**	**1.50**	**1.20**	**57.30**	**5.60**

2.4.5 Construction

Balanced Cantilever Construction is the traditional construction procedure for stay cable bridges.

- erect tower starter segments on falsework
- deliver steelwork segments in pieces to the tower,
- lift by heavy tower crane or a mobile crane placed on the starter segments
- carry elements or fully assembled segment to the erection front,
- position it by a mobile crane (or derrick) followed by bolting of the splices
- install stay cable
- place deck panels
- cast stiches
- restress stay cables

Actually, the same is valid as for Option 10, except that the east span is erected by mobile cranes.

2.4.6 Slope Stability

Not an issue since no pier is placed in this zone, also no temporary pier

2.4.7 Durability and Maintenance

The action forces in that option would be adjusted in such a way, that almost no tension will occur in the concrete deck, only a small area near the abutment may be under tension, but that could be compensated by a light longitudinal prestressing. Not much cracking has to be assumed and inspection could be concentrated onto the area near the abutments. With stainless steel rebars for the full slab depth for the whole length of the bridge, the durability will be very high and no deck replacement is envisaged over the design period of 100 years in this area. The part over the east pier acts like a girder bridge and has stainless steel in the upper zone only. Therefore, an exchange after 50 year is taken into account.

Stay cables are provided with 3 barriers against corrosion: galvanizing, wax and HDPE sheet. Most of the suppliers are confident that they last the 100y without replacement. Nevertheless, replacement of individual cables must be possible in case something goes wrong. This is done the inverted way from the erection: taking out strand-by-strand, only small jack are needed for that work (monostrand jacks). Acc. to most suppliers it should even be possible to take one strand out and pull a new one in at the same place. Since the probability of a replacement is low, but not zero, it is difficult to address any cost for that issue. In the table below it is assumed that 10% of the strands are to be replaced once in 100y. No full bridge closure is needed for such a replacement, just one lane close next to the stay cables need to be closed, all other lanes can be used without any load restrictions (except for super heavy trucks)

Other elements of a stay cable bridge are essential for a good function

- HDPE Duct – outer sheathing: These ducts are exposed to sun radiation full time. The durability has been tested and is not any more a problem, but fading of the color, therefore bright colors (close to white/light grey) are a good choice.
- Dampers: depending on the type they may last 30 to 50 years. Exchange is rather simple. Since the cables in option 10 are rather short we do not expect to have dampers in more the 50% of the stays.
- Ice removal system: If stay cables with small ducts are used (e.g. parallel wire systems or ropes) the risk of ice accumulation decreases considerably. Many suppliers perform currently a lot of researches and are close to a solution to mitigate that problem completely, so at the time the bridge gets built, this is surely no issue any more.

The issue of bearing exchange depends on the option. 14a is much more complex, since it rest on very heavy bearings, which are quite expensive on difficult to exchange. Option 14b is much better in that respect. Therefore, that are recommended for further developments. The superstructure of those option rests on only 12 elastomeric bearings and has 2 windbearings

- 2 bearing at west abutment,
- 2 vertical bearing the tower plus 2 windbearings
- 4 at east pier
- 4 at east abutment.

The vertical bearings have to be replaced at an interval of about 30 to 40 years. However, access should not be a problem, since the bearings are on shore or at the abutment only.

The windbearings (4 Pcs) are not heavily loaded and may last much longer

Item	frequency of Inspection			design service/lifetime [years]	replacement [times]
	visual, from a distance (authority/client)	visual (specialist)	"hands on" inspection / non. destructive testing		
structural weathering steel, superstructure	1 time / year	1 time / 3 years	1 time / 6 years	100	-
structural weathering steel, pylon (0a and b)	1 time / year	1 time / 3 years	1 time / 6 years	100	-
steel coating systems (not considered so far)	1 time / year	1 time / 3 years	1 time / 3 years	35	2
concrete pylon (14b)	-	1 time / 3 years	-	100	-
concrete deck slab girder bridge (80m)	1 time / year	1 time / 3 years	-	50	1
concrete deck slab stay cable bridge (330m)	1 time / year	1 time / 3 years		100	-
concrete pier	-	1 time / 3 years	-	100	-
concrete pile cap	-	-	-	100	-
concrete piles	-	-	-	100	-
elastomeric bearings	1 time / year	1 time / 3 years	1 time / 6 years	35	2
disc bearing bearings (14a only)	1 time / year	1 time / 3 years	1 time / 6 years	50	1
expansion joint	1 time / year	1 time / 3 years	1 time / 6 years	35	2
wearing surface	1 time / year	1 time / 3 years	1 time / 3 years	25	3
drainage	1 time / year	1 time / 3 years	-	35	2
Joint seals, sliders and springs	1 time / year	1 time / 3 years	-	15	6
stay cables [1)]	-	1 time / 3 years	1 time / 6 years	100	0.1
Sheaths for Stay cables [2)]	1 time / year	1 time / 3 years	1 time / 6 years	100	0.1
Dampers for Stay Cables	1 time / year	1 time / 3 years	1 time / 6 years	50	1
Structural Health Monitoring Systems	1 time / year	1 time / 3 years	1 time / 6 years	25	3
galvanized steel barriers	1 time / year	1 time / 3 years	-	40	2
galvanized steel railing	1 time / year	1 time / 3 years	-	40	2
concrete barriers	1 time / year	1 time / 3 years	-	40	2
Sign support structures	1 time / year	1 time / 3 years	-	50	1
lamp post	1 time / year	1 time / 3 years	1 time / year (luminance test)	50 / upon need	1

Items that are different to the other options

- Deck slab needs to be exchanged **on about 80m** length once
- 14 Elastomeric Bearings (with moderate to small loads) need to be exchanged twice
- Elastomeric Windbearings need to be exchanged once
- Around 10% of the strands may need to be replaced along the structure lifetime
- Using bright colors (white or nearly white) will increase the lifetime of the sheets considerably (getting close to 100y). We assume that not more than 10 % of the sheets need to be replaced within the 100y

3 Foundations

3.1 Initial Design

An initial Design was prepared by Aecom based on the loads listed above

Saskatoon Freeway - River Bridge Preliminary Foundation Design Summary **15-Oct-19**

Option 14 - Unsymmetrical Single Tower Stay Cable Bridge		**Concrete Volumes (m^3)**	
Pylon	5 rows of 18 piles (90 piles)		
	2500 mm dia. shaft c/w 3500mm dia. bell founded at 23 mbgs	10373	
	Pile cap = 30m x 90m x 2.4m thick	6480	
Pier	3 rows of 15 piles (45 piles)		
	2500 mm dia. shaft c/w 3600mm dia. bell founded at 22 mbgs	4990	
	Pile cap = 20m x 65m x 2.4m thick	3120	
Abutment 1	2 rows of 12 piles (24 piles)		
	1500 mm dia. shaft, no bell x 29m long	1230	
	Abutment Pile cap = 42m x 4m wide x 3.8m high c/w wingwalls and abutment walls	779	
Abutment 2	2 rows of 12 piles (24 piles)		
	1800 mm dia. shaft, no bell x 30m long	1832	
	Abutment Pile cap = 42m x 4m wide x 3.8m high c/w wingwalls and abutment walls	779	
	Total	**29583**	m^3
Option 10 - Unsymmetrical Stay Cable Bridge			
Pylon 1	4 rows of 15 piles (60 piles)		
	2500 mm dia. shaft c/w 4000mm dia. bell founded at 23 mbgs	7119	
	Pile cap = 18m x 66m x 2.4m thick	2851	
Pylon 2	3 rows of 15 piles (45 piles)		
	2000 mm dia. shaft c/w 4000mm dia. bell founded at 22 mbgs	3534	
	Pile cap = 12m x 66m x 2.4m thick	2851	
Abutment 1	2 rows of 12 piles (24 piles)		
	1500 mm dia. shaft, no bell x 30m long	1272	
	Abutment Pile cap = 48m x 4m wide x 3.8m high c/w wingwalls and abutment walls	894	
Abutment 2	2 rows of 12 piles (24 piles)		
	1500 mm dia. shaft, no bell x 29m long	1230	
	Abutment Pile cap = 48m x 4m wide x 3.8m high c/w wingwalls and abutment walls	894	

		Total	**20646**	m^3
Option 6 - Through Arch Bridge				
Support 1	3 rows of 15 piles (60 piles)			
	2500 mm dia. shaft c/w 4000mm dia. bell founded at 23 mbgs		7119	
	Pile cap = 21m x 66m x 2.4m thick		3326	
Support 2	3 rows of 15 piles (45 piles)			
	3000 mm dia. shaft c/w 4200mm dia. bell founded at 22 mbgs		7499	
	Pile cap = 12m x 66m x 2.4m thick		3326	
Abutment 1	2 rows of 21 piles (42 piles)			
	1500 mm dia. shaft, no bell x 31m long		2301	
	Abutment Pile cap = 54m x 4m wide x 3.8m high c/w wingwalls and abutment walls		993	
Abutment 2	2 rows of 18 piles (36 piles)			
	1500 mm dia. shaft, no bell x 29m long		1845	
	Abutment Pile cap = 54m x 4m wide x 3.8m high c/w wingwalls and abutment walls		993	
		Total	**27402**	m^3
Option 2 - Steel Composite Girder				
Pier 1	3 rows of 7 piles (21 piles)			
	2000 mm dia. shaft c/w 4000mm dia. bell founded at 23 mbgs		1715	
	Pile cap = 16m x 41m x 2.4m thick		1574	
Pier 2	3 rows of 7 piles (21 piles)			
	2000 mm dia. shaft c/w 4000mm dia. bell founded at 23 mbgs		1715	
	Pile cap = 16m x 41m x 2.4m thick		1574	
Pier 3	3 rows of 7 piles (21 piles)			
	3000 mm dia. shaft c/w 4250mm dia. bell founded at 26 mbgs		3953	
	Pile cap = 16m x 41m x 2.4m thick		1574	
Pier 4	3 rows of 7 piles (21 piles)			
	3000 mm dia. shaft c/w 4250mm dia. bell founded at 26 mbgs		3953	
	Pile cap = 16m x 41m x 2.4m thick		1574	
Pier 5	3 rows of 7 piles (21 piles)			
	2000 mm dia. shaft c/w 4000mm dia. bell founded at 22 mbgs		1649	
	Pile cap = 16m x 41m x 2.4m thick		1574	
Abutment 1	2 rows of 18 piles (36 piles)			
	1200 mm dia. shaft, no bell x 30m long		1221	
	Abutment Pile cap = 42m x 4m wide x 3.8m high c/w wingwalls and abutment walls		779	

3.2 Iteration

An iteration was performed with more accurate foundation loads (the initial one was done with Option 10a loads, not 10c) and spread footings were included

OPTION 2 - STEEL PLATE GIRDER (PILE FOUNDATIONS)

Substructure Element	Shaft Diameter (m)	Bell Diameter (m)	Shaft Length (m)	# of Piles per row	# of rows	Pile spacing (m) (each direction)	Pile Concrete Volume (m^3)	Estimated Abutment/Pier Concrete Volume (m^3)	Max. Factored Pile Reaction (kN)	Factored Pile Resistance (kN)
Abutment 1 (East)	1.70	3.00	35.0	16	2	3.600	2736	1324	2550	2591
Abutment 2 (West)	1.60	3.00	35.0	16	2	3.600	2455	1301	2529	2576
Pier 1 (27.4 x 46.8 x 2.4m thick)	2.50	3.90	23.0	10	5	4.850	6235	3069	4006	4082
Pier 2 (27.4 x 46.8 x 2.4m thick)	2.50	4.00	23.0	10	5	4.850	6300	3069	4163	4194
Pier 3 (22.5 x 46.8 x 2.4m thick)	2.50	3.90	26.0	10	5	4.850	6971	2525	4020	4085
Pier 4 (27.4 x 46.8 x 2.4 m thick)	2.50	4.00	26.0	10	5	4.850	7037	3069	4163	4197
Pier 5 (27.9 x 47.1 x 2.4 m thick)	3.25	4.20	29.0	10	5	4.800	10066	3145	4056	4147
						Totals	41801	17501		

OPTION 2 - STEEL PLATE GIRDER (SPREAD FOOTING FOUNDATIONS FOR PIERS)

Substructure Element	Length (m)	Width (m)	Thickness (m)	Concrete Volume (m3)
Pier 1	42.00	6.00	2.40	605
Pier 2	42.00	6.50	2.40	655
Pier 3	42.00	7.00	2.40	706
Pier 4	42.00	6.50	2.40	655
Pier 5	42.00	6.00	2.40	605
			Totals	3226

OPTION 10c - UNSYMMETRICAL STAY CABLE BRIDGE (PILE FOUNDATIONS)

Substructure Element	Shaft Diameter (m)	Bell Diameter (m)	Shaft Length (m)	# of Piles per row	# of rows	Pile spacing (m) (each direction)	Pile Concrete Volume (m^3)	Estimated Abutment/Pier Concrete Volume (m^3)	Max. Factored Pile Reaction (kN)	Factored Pile Resistance (kN)
Abutment 1 (East)	1.70	3.00	32.0	16	2	3.600	2519	1324	2393	2431
Abutment 2 (West)	1.60	3.00	30.0	16	2	3.600	2134	1301	2244	2275
Pylon 1 (44.4 x 75.0 x 3.5m thick)	3.00	4.50	34.0	15	8	5.100	30907	11655	6143	6218
Pylon 2 (31.8 x 60.5 x 3.5m thick)	2.50	3.50	37.0	15	7	4.100	19833	6734	4884	4952
						Totals	55393	21014		

OPTION 10c - UNSYMMETRICAL STAY CABLE BRIDGE (SPREAD FOOTING FOR PYLON FOUNDATIONS)

Substructure Element	Length (m)	Width (m)	Thickness (m)	Concrete Volume (m3)
Pylon 1	60.00	16.00	3.50	3360
Pylon 2	60.00	14.00	3.50	2940
			Totals	6300

OPTION 14b - UNSYMMETRICAL SINGLE TOWER STAY CABLE BRIDGE (PILE FOUNDATIONS)

Substructure Element	Shaft Diameter (m)	Bell Diameter (m)	Shaft Length (m)	# of Piles per row	# of rows	Pile spacing (m) (each direction)	Pile Concrete Volume (m^3)	Estimated Abutment/Pier Concrete Volume (m^3)	Max. Factored Pile Reaction (kN)	Factored Pile Resistance (kN)
Abutment 1 (East)	1.80	2.50	24.0	16	2	3.100	2038	1080	1872	1889
Abutment 2 (West)	1.80	2.50	32.0	16	2	3.100	2526	1080	2376	2421
Pylon 1 (80.6 x 101 x 7.0m thick)	3.50	4.50	37.0	20	15	5.100	110623	56984	7038	7107
Pier 1 (23.1 x 39.5 x 3.5m thick)	2.00	3.50	29.0	10	5	4.100	5034	3194	3697	3705
						Totals	120221	62338		

OPTION 14b - UNSYMMETRICAL SINGLE TOWER STAY CABLE BRIDGE (SPREAD FOOTING FOR PYLON & PIER FOUNDATIONS)

Substructure Element	Length (m)	Width (m)	Thickness (m)	Concrete Volume (m3)
Pylon 1	65.00	20.00	7.00	9100
Pier 1	42.00	5.00	3.50	735
			Totals	9835

From the numbers above and the Canadian Unit priced received in the meantime it became apparent, that

- spread footings are much more economical than pile footings
- Option 10a will be more economical than 10 c, since the bending moments in the lower tower legs are considerably smaller (for 10b they are about the same as for 10c)

OPTION 10a - UNSYMMETRICAL STAY CABLE BRIDGE (SPREAD FOOTING FOR PYLON FOUNDATIONS)

Substructure Element	Length (m)	Width (m)	Thickness (m)	Concrete Volume (m3)
Pylon 1	60.00	12.00	3.50	2520
Pylon 2	60.00	8.50	3.50	1785
			Totals	4305

4 Cost Evaluation

4.1 Initial Estimate

We have performed an initial cost evaluation based on our quantity estimate and current European unit costs.

The BOQ estimate has been supported by some preliminary calculations, which we have needed for calculation of the support reactions anyway.

The unit prices need to be considered with care, they vary also in Europe quite a bit.

The construction cost for Foundation and Abutments are not yet included.

The table below shows pure construction cost with rather rough estimates in item 6.

Usually we do not consider temporary works in those structural costs, but here the differences may become rather high, so we have added estimated costs for

- the jetty or a dam in the river with 1 mill Euro – the price should be critically assessed with local experience
- temporary pier incl. foundation with 80 000€ ea. - ditto
- erection derrick at front of CSB with 200 000€ ea. whether one or two derricks are needed, depends on the construction time schedule and time constraints. It may also be possible to rent such a derrick. e.g. an so called “American Shear Leg Derrick S40”

Note that fixed cost for

- mobilization
- construction equipment (other than mentioned above),
- planning/engineering
- environmental assessment reports and other documentations

are not yet included below.

To confirm the tonnage of the stay cables at Option 10 a more refined analysis has been performed with teh following results (valid for all three Options 10 a to 10 c)

Option 10 Pylon 1				**g composite deck , future MuP included**				**650**	**KN/m**	total Bridge	
				P UDL plus TL				**176**	**KN/m**	total Bridge	
				Cable Distance			**Mainspan**	**13.0**	**m**	Sidespan A	**11.0**
				all'bl Load/Strand (ULS)				**180**	**KN**		
							ULS	ULS	n	G	
	Tower		Beam				three Cable Plane		per Stay	per CPL	
Stay No	X	Y	X	Y	Alpha	L	PL	Traffic	**(3 Planes)**		
Mainspan	m	m	m	m	grd	m	KN	KN		ton	
1	1.75	59.00	15.00	24.00	69.265	38.08	9035	2446	22	0.97	
2	1.75	61.50	28.00	24.00	55.008	46.80	10315	2793	25	1.36	
3	1.75	64.00	41.00	24.00	45.542	57.28	11839	3206	28	1.91	
4	1.75	66.50	54.00	24.00	39.125	68.72	13391	3626	32	2.58	
5	1.75	69.00	67.00	24.00	34.592	80.71	14884	4030	35	3.37	
6	1.75	71.50	80.00	24.00	31.259	93.04	16284	4409	39	4.25	
7	1.75	74.00	93.00	24.00	28.720	105.59	17585	4761	42	5.20	
8	1.75	76.50	106.00	24.00	26.730	118.29	18787	5087	45	6.22	
9	1.75	79.00	119.00	24.00	25.130	131.10	19897	5388	47	7.30	
10	1.75	81.50	132.00	24.00	23.819	143.98	20923	5665	50	8.42	
										41.56	
							ULS	ULS	n	G	
South	Tower		Beam				per Cable Plane	per Cable Plane	per Stay	per CPL	
Stay No	X	Y	X	Y	Alpha	L	PL	Traffic			
Backspan	m	m	m	m	grd	m	KN	KN		ton	
1	1.75	59.00	15.00	23.00	69.794	41.00	9261	2063	21	1.03	
2	1.75	61.50	26.00	23.00	57.794	48.46	11098	2288	25	1.44	
3	1.75	64.00	37.00	23.00	49.313	57.23	12718	2553	29	1.93	
4	1.75	66.50	48.00	23.00	43.245	66.78	14262	2826	32	2.52	
5	1.75	69.00	59.00	23.00	38.782	76.81	15718	3091	35	3.19	
6	1.75	71.50	70.00	23.00	35.398	87.16	17077	3342	38	3.92	
7	1.75	74.00	81.00	23.00	32.763	97.72	18339	3578	41	4.72	
8	1.75	76.50	92.00	23.00	30.659	108.42	19506	9864	55	7.00	
9	1.75	79.00	103.00	23.00	28.946	119.24	20586	10393	58	8.12	
10	1.75	81.50	114.00	23.00	27.527	130.13	21585	10884	60	9.29	
										43.15	
		ass'd to act as Backstays							MS	41.6	
									BS	43.2	
								Pylon 1 (one plane)		84.7	
								Pylon 2 (one plane		32.7	
								Three Planes	Total Bridge	**352**	
									take	**370**	

			Option 02			Option 06			Option 10a			Option 10b		
			Multiple Plate Girder Bridge			Arch Bridge			unsymetrical CSB with two 3-Leg Steel Towers, integrated into superstructure			unsymetrical CSB with two 3-Leg Steel Towers, integrated into lower piers		
	Descripicion	Unit	Unit Cost Estimate Individual [€]	Quantity	Cost [€]	Unit Cost Estimate Individual [€]	Quantity	Cost [€]	Unit Cost Estimate Individual [€]	Quantity	Cost [€]	Unit Cost Estimate Individual [€]	Quantity	Cost [€]
A.	**Main Bridge L =**	m		**410**			**410**			**410**			**410**	
1.	**Main Foundations**	Numbers		7			4			4			4	
1.1	**Piles**													
1.11	Pile Diameter	m			-			-			-			-
1.12	Number of Piles	Pc			-			-			-			-
1.13	Structural Steel Grade 350	ton	3000		-	3000		-	3000		-	3000		-
1.14	Concrete Grade 35 - Piles	m3	400		-	400		-	400		-	400		-
1.15	Reinforcement Grade 420	ton	1300		-	1300		-	1300		-	1300		-
											-			
1.2	**Pilecap**				-			-			-			-
1.21	Concrete Grade 35 - Pilecap	m3	500		-	500		-	500		-	500		-
1.22	Reinforcement Grade 420	ton	1300		-	1300		-	1300		-	1300		-
	SUBTOTAL				-			-			-			-
2.	**Piers (excluding abutments)**													
2.01	Number of Piers	Pc		5	-		-	-		-	-		-	-
2.02	Concrete Grade 40	m3	600	2'718	1'630'619	600	-	-	600	-	-	600	-	-
2.03	Reinforcement Grade 420	ton	1300	544	706'602	1300	-	-	1300	-	-	1300	-	-
	SUBTOTAL				2'337'221			-			-			-
3.	**Towers / Arch (option 6)**						(Arch only)							
3.01	Number of Towers/arches	Pc		-	-		1	-		2	-		2	-
3.02	Concrete Grade 45	m3	600	-	-	600	-	-	600	1'350	810'000	600	1'540	924'000
3.03	Reinforcement Grade 420	ton	1300	-	-	1300	-	-	1300	338	438'750	1300	385	500'500
3.04	PT Bars	ton	6000	-		8000	-	-	6000	-	-	6000	10	
3.05	Structural Steel, Grade 350 AT, Cat 2	ton	4000	-	-	4000	3'000	12'000'000	4000	1'180	4'720'000	4000	1'250	5'000'000
	SUBTOTAL				-			12'000'000			5'968'750			6'424'500
4.	**Superstructure**													
4.1	**Mainspan L =**	m					180.00			225.00			225.00	
4.10	Area (deck without MUP)						7'560			9'450	-		9'450	
4.11	Precast Concrete f'c=55 Mpa	m3	800		-	800	1'837	1'469'664	800	2'296	1'837'080	800	2'296	1'837'080
4.12	Cast in Place Concrete Grade 55	m3	600		-	600	204	122'472	600	255	153'090	600	255	153'090
4.13	Reinforcement Black steel Grade 400	ton	1300		-	1300	-	-	1300	-	-	1300	-	-
4.14	Reinforcement Stainless steel Grade 520	ton	3000			3000	510	1'530'900	3000	638	1'913'625	3000	638	1'913'625
4.15	Longitudinal Posttensioning Grade 1860 Mpa	ton	6000		-	6000	-	-	6000	-	-	6000	-	-
4.16	Transverse Posttensioning Grade 1860 Mpa	ton	6000		-	6000	-	-	6000	-	-	6000	-	-
4.17	Transverse Prestressing in PCP Grade 1860 Mp	ton	6000			6000	-	-	6000	-	-	6000	-	-
4.18	Structural Steel, Grade 350 AT, Cat 2	ton	4500		-	4500	2'306	10'376'100	4500	2'800	12'600'000	4500	2'700	12'150'000
	SUBTOTAL				-			13'499'136			16'503'795			16'053'795
4.2	**Backspans L =**	m		410.00			230.00			185.00			185.00	
4.20	Area (deck without MUP)			17'220	-		9'660	-		7'770	-		7'770	
4.21	Precast Concrete f'c=55 Mpa	m3	800	2'070	1'656'000	800	2'610	2'088'000	800	1'200	960'000	800	1'200	960'000
4.22	Cast in Place Concrete Grade 55	m3	600	4'000	2'400'000	600	-	-	600	2'430	1'458'000	600	2'430	1'458'000
4.23	Reinforcement Black steel Grade 400	ton	1300	850	1'104'740	1300	365	475'020	1300	-	-	1300	-	-
4.24	Reinforcement Stainless steel Grade 520	ton	3000	607	1'821'000	3000	261	783'000	3000	726	2'178'000	3000	726	2'178'000
4.25	Ballast Concrete	m3	300	-	-	300	-		300	3'100	930'000	300	3'100	930'000
4.26	Longitudinal Posttensioning Grade 1860 Mpa	ton	6000	-	-	6000	-	-	6000	-	-	6000	-	-
4.27	Transverse Posttensioning Grade 1860 Mpa	ton	6000	-	-	6000	-	-	6000	-	-	6000	-	-
4.28	Transverse Prestressing in PCP Grade 1860 Mp	ton	6000	79	473'460	6000	-	-	6000	-	-	6000	-	-
4.29	Structural Steel, Grade 350 AT, Cat 2	ton	4500	5'650	25'425'000	5000	3'462	17'310'720	5000	2'280	11'400'000	5000	2'180	10'900'000
	SUBTOTAL				32'880'200			20'656'740			16'926'000			16'426'000
5.	**Stay cables/Hangers**													
5.01	Number of Stay Cables/ Hangers	Pc					24			96			96	
5.02	Strands , Grade 1860 Mpa, 150mm2 (0.60")	ton	7500		-	10000	20	240'000	7500	370	2'775'000	7500	370	2'775'000
5.03	Dampers	Pc							5000	48	240'000	5000	48	240'000
5.04	Ice removal system (not considered so far)													
	SUBTOTAL				-			240'000			2'775'000			2'775'000
6.	**Ancillaries**													
6.01	Barriers	ml	200	1'230	246'000	200	1'230	246'000	200	1'230	246'000	200	1'230	246'000
6.02	Wearing Surface t = 100mm	m2	100	17'056	1'705'600	100	17'056	1'705'600	100	17'056	1'705'600	100	17'056	1'705'600
6.03	Waterproof	m2	50	17'056	852'800	50	17'056	852'800	50	17'056	852'800	50	17'056	852'800
6.04	Expansion Joints	ml	2000	84	168'000	2000	84	168'000	2000	84	168'000	2000	84	168'000
6.05	Elastomeric Bearings (Fixed and Sliding)	Pc	8000	49	392'000	8000	12	96'000	6000	6	36'000	6000	22	132'000
6.05	Disk Bearings	Pc	0	-	-	0		-	47500	6	285'000	50000	-	-
	SUBTOTAL				3'364'400			3'068'400			3'293'400			3'104'400
7.	**Major Temporary Works - estimate**													
7.01	Jetty	Pc	1000000	1	1'000'000	1000000	1	1'000'000	1000000	-	-	1000000	-	-
7.02	Temporary Piers incl Foundation	Pc	80000	6	480'000	80000	6	480'000	80000	1	80'000	80000	-	-
7.03	Lifting Derricks	Pc	200000	-	-	200000	1	200'000	200000	2	400'000	200000	2	400'000
	SUBTOTAL				1'480'000			1'680'000			480'000			400'000
TOTAL	**excluding Foundation and Abutment Cost**				**40'100'000**			**51'100'000**			**45'900'000**			**45'200'000**
Cost in % related to least expensive Option				100%			127%			114%			113%	
		ml = long. meter												

			Option 10c			Option 14 a			Option 14 b		
			unsymetrical CSB with two 3-Leg PC Concrete Towers			One Tower Stay Cable Bridge Steel Tower above deck			One Tower Stay Cable Bridge Concrete Tower		
	Descripicion	Unit	Unit Cost Estimate Individual [€]	Quantity	Cost [€]	Unit Cost Estimate Individual [€]	Quantity	Cost [€]	Unit Cost Estimate Individual [€]	Quantity	Cost [€]
A.	**Main Bridge L =**	m		**410**			**410**			**410**	
1.	**Main Foundations**	Numbers		4			4			4	
1.1	**Piles**										
1.11	Pile Diameter	m			-			-			-
1.12	Number of Piles	Pc			-			-			-
1.13	Structural Steel Grade 350	ton	3000		-	3000		-	3000		-
1.14	Concrete Grade 35 - Piles	m3	400		-	400		-	400		-
1.15	Reinforcement Grade 420	ton	1300		-	1300		-	1300		-
1.2	**Pilecap**				-			-			-
1.21	Concrete Grade 35 - Pilecap	m3	500		-	500		-	500		-
1.22	Reinforcement Grade 420	ton	1300		-	1300		-	1300		-
	SUBTOTAL				-			-			-
2.	**Piers (excluding abutments)**										
2.01	Number of Piers	Pc		-	-		1	-		1	-
2.02	Concrete Grade 40	m3	600	-	-	600	220	132'000	600	220	132'000
2.03	Reinforcement Grade 420	ton	1300	-	-	1300	55	71'500	1300	55	71'500
	SUBTOTAL				-			203'500			203'500
3.	**Towers / Arch (option 6)**										
3.01	Number of Towers/arches	Pc		2	-		1	-		1	-
3.02	Concrete Grade 45	m3	1000	3'800	3'800'000	800	830	664'000	1000	2'300	2'300'000
3.03	Reinforcement Grade 420	ton	1300	1'140	1'482'000	1300	208	269'750	1300	575	747'500
3.04	PT Bars	ton	6000	30	180'000						
3.05	Structural Steel, Grade 350 AT, Cat 2	ton	240	230	55'200	4000	1'700	6'800'000	4000	200	800'000
	SUBTOTAL				5'517'200			7'733'750			3'847'500
4.	**Superstructure**										
4.1	**Mainspan L =**	m		225.00			220.00			220.00	
4.10	Area (deck without MUP)			9'450			9'240			9'240	
4.11	Precast Concrete f'c=55 Mpa	m3	800	2'296	1'837'080	800	2'245	1'796'256	800	2'245	1'796'256
4.12	Cast in Place Concrete Grade 55	m3	600	255	153'090	600	249	149'688	600	249	149'688
4.13	Reinforcement Black steel Grade 400	ton	1300	-	-	1300	-	-	1300	-	-
4.14	Reinforcement Stainless steel Grade 520	ton	3000	638	1'913'625	3000	624	1'871'100	3000	624	1'871'100
4.15	Longitudinal Posttensioning Grade 1860 Mpa	ton	6000	-	-	6000	500	3'000'000	6000	500	3'000'000
4.16	Transverse Posttensioning Grade 1860 Mpa	ton	6000	-	-	6000	-	-	6000	-	-
4.17	Transverse Prestressing in PCP Grade 1860 Mp	ton	6000	-	-	6000	-	-	6000	-	-
4.18	Structural Steel, Grade 350 AT, Cat 2	ton	4500	2'700	12'150'000	4500	2'918	13'131'900	4500	2'818	12'681'900
	SUBTOTAL				16'053'795			19'948'944			19'498'944
4.2	**Backspans L =**	m		185.00			190.00			190.00	
4.20	Area (deck without MUP)			7'770			7'980			7'980	
4.21	Precast Concrete f'c=55 Mpa	m3	800	1'200	960'000	800	1'160	928'000	800	1'160	928'000
4.22	Cast in Place Concrete Grade 55	m3	600	2'430	1'458'000	600	2'350	1'410'000	600	2'350	1'410'000
4.23	Reinforcement Black steel Grade 400	ton	1300	-	-	1300	92	120'079	1300	129	168'111
4.24	Reinforcement Stainless steel Grade 520	ton	3000	726	2'178'000	3000	610	1'828'895	3000	610	1'828'895
4.25	Ballast Concrete	m3	300	3'100	930'000	300	2'000	600'000	300	2'000	600'000
4.26	Longitudinal Posttensioning Grade 1860 Mpa	ton	6000	-	-	6000	-	-	6000	-	-
4.27	Transverse Posttensioning Grade 1860 Mpa	ton	6000	-	-	6000	-	-	6000	-	-
4.28	Transverse Prestressing in PCP Grade 1860 Mp	ton	6000	-	-	6000	-	-	6000	-	-
4.29	Structural Steel, Grade 350 AT, Cat 2	ton	5000	2'180	10'900'000	5000	2'534	12'669'500	5000	2'434	12'169'500
	SUBTOTAL				16'426'000			17'556'474			17'104'505
5.	**Stay cables/Hangers**										
5.01	Number of Stay Cables/ Hangers	Pc		96			52			52	
5.02	Strands , Grade 1860 Mpa, 150mm2 (0.60")	ton	7500	370	2'775'000	7500	455	3'412'500	7500	455	3'412'500
5.03	Dampers	Pc	5000	48	240'000	6000	52	312'000	6000	52	312'000
5.04	Ice removal system (not considered so far)										
	SUBTOTAL				2'775'000			3'412'500			3'412'500
6.	**Ancillaries**										
6.01	Barriers	ml	200	1'230	246'000	200	1'230	246'000	200	1'230	246'000
6.02	Wearing Surface t = 100mm	m2	100	17'056	1'705'600	100	17'056	1'705'600	100	17'056	1'705'600
6.03	Waterproof	m2	50	17'056	852'800	50	17'056	852'800	50	17'056	852'800
6.04	Expansion Joints	ml	2000	84	168'000	2000	84	168'000	2000	84	168'000
6.05	Elastomeric Bearings (Fixed and Sliding)	Pc	6000	22	132'000	8000	12	96'000	8000	14	112'000
6.05	Disk Bearings	Pc	50000	-	-	95000	2	190'000	0	-	-
	SUBTOTAL				3'104'400			3'258'400			3'084'400
7.	**Major Temporary Works - estimate**										
7.01	Jetty	Pc	1000000	-	-	1000000	-	-	1000000	-	-
7.02	Temporary Piers incl Foundation	Pc	80000	-	-	80000	-	-	80000	-	-
7.03	Lifting Derricks	Pc	200000	2	400'000	200000	1	200'000	200000	1	200'000
	SUBTOTAL				400'000			200'000			3'284'400
TOTAL	**excluding Foundation and Abutment Cost**				**44'300'000**			**52'300'000**			**50'400'000**
Cost in % related to least expensive Option				110%			130%			126%	

Notes: 1) The total cost above does not include mobilisation, environmental penalties and construction cost for foundation, abutments, slope stabilisation

2) Items in Pos 6 and 7 have been added with best guess prices

Comparison

			Option 02	Option 06	Option 10a	Option 10b	Option 10c	Option 14 a	Option 14 b
			Multiple Plate Girder Bridge	**Arch Bridge**	**unsymetrical CSB with two 3-Leg Steel Towers, integrated into superstructure**	**unsymetrical CSB with two 3-Leg Steel Towers, integrated into lower piers**	**unsymetrical CSB with two 3-Leg PC Concrete Towers**	**One Tower Stay Cable Bridge Steel Tower above deck**	**One Tower Stay Cable Bridge Concrete Tower**
	Descripicion	Unit	Cost [€]	Cost [€]	Cost [€]	Cost [€]	Cost [€]	Cost [€]	Cost [€]
TOTAL excluding Foundation and Abutment Cost			**40'100'000**	**51'100'000**	**45'900'000**	**45'200'000**	**44'300'000**	**52'300'000**	**50'400'000**
Cost in % related to least expensive Option			**100%**	**127%**	**114%**	**113%**	**110%**	**130%**	**126%**

Notes: 1) The total cost above does not include mobilisation, environmental penalties and construction cost for foundation, abutments, slope stabilisation

4.2 Refined Estimate

In the Bridge Option Evaluation Workshop at 25th October it has been decided to evaluate only Option 02 and Option 10c further. With the first greensheet estimates and the results of the foundation study summarized above it became also clear that Option 10a, which was ruled out earlier, is likely more economical than 10 c. This was confirmed with the final results summarized below.

	28. Nov 19 rev04		Option 02			Option 10a			Option 10c		
			Multiple Plate Girder Bridge w/ spread footings			Unsymetrical CSB with two 3-Leg Steel Towers, integrated into superstructure w/ spread footings			Unsymetrical CSB with two 3-Leg CIP Concrete Towers w/ spread footings		
	Descripicion	Unit	QTY check (RT)	Unit Cost [CAD]	Total Cost [CAD]	QTY check (RT)	Unit Cost [CAD]	Total Cost [CAD]	QTY check (RT)	Unit Cost [CAD]	Total Cost [CAD]
A.	**Main Bridge L =**	m									
1.	**Main Foundations**	Numbers									
1.1	**Piles**										
1.11	Pile Diameter	m									
1.12	Number of Piles	Pc									
1.13	Structural Steel Grade 350	ton									
1.14	Concrete Grade 35 - Piles	m3									
1.15	Reinforcement Grade 420	ton									
1.2	**Spread Foundation**										
1.21	Concrete Grade 35 - Spread footing	m3	3'826	$ 634.73	$ 2'428'231.29	4'665	$ 634.73	$ 2'961'025.45	6'660	$ 634.73	$ 4'227'316.07
1.22	Reinforcement Grade 420	ton	727	$ 2'691.00	$ 1'955'991.02	886	$ 2'691.00	$ 2'385'167.85	1'265	$ 2'691.00	$ 3'405'191.40
	SUBTOTAL				4'384'222			5'346'193			7'632'507
2.	**Piers (excluding abutments)**										
2.01	Number of Piers	Pc	5	$ -							
2.02	Concrete Grade 40	m3	2'718	$ 1'386.07	$ 3'766'920.75						
2.03	Reinforcement Grade 400	ton	544	$ 2'980.00	$ 1'619'748.60						
	SUBTOTAL				5'386'669			-			-
3.	**Towers / Arch (option 6)**										
3.01	Number of Towers/arches	Pc				2			2	$ -	
3.02	Concrete Grade 45	m3				1'350	$ 3'526.44	$ 4'760'700.69	3'815	$ 3'510.60	$ 13'394'506.26
3.03	Reinforcement Grade 400	ton				338	$ 2'940.00	$ 992'250.00	1'145	$ 3'031.22	$ 3'469'635.99
3.04	PT Bars	ton				-		$ -	-		$ -
3.05	Structural Steel Grade 350	ton				1'260	$ 9'224.12	$ 11'622'388.34	200	$ 11'313.00	$ 2'262'600.00
3.06	PT Tendons in Crossbeams	ton									
	SUBTOTAL				-			17'375'339			19'126'742
4.	**Superstructure**										
4.1	**Mainspan L =**	m									
4.10	Area (deck without MUP)					9'338	$ -		9'338	$ -	
4.11	Precast Concrete f'c=55 Mpa	m3				2'552	$ 6'881.48	$ 17'558'100.00	2'552	$ 6'881.48	$ 17'558'100.00
4.12	Cast in Place Concrete Grade 55	m3					incl.	incl.		incl.	incl.
4.13	Reinforcement Black steel Grade 400	ton					incl.	incl.		incl.	incl.
4.14	Reinforcement Stainless steel Grade 520	ton					incl.	incl.		incl.	incl.
4.15	Longitudinal Posttensioning Grade 1860 Mpa	ton									
4.16	Transverse Posttensioning Grade 1860 Mpa	ton									
4.17	Transverse Prestressing in PCP Grade 1860 Mpa	ton									
4.18	Structural Steel, Grade 350	ton				2'800	$ 6'277.68	$ 17'577'512.20	2'700	$ 6'277.68	$ 16'949'743.90
	SUBTOTAL				-			35'135'612			34'507'844
4.2	**Backspans L =**	m	410.00								
4.20	Area (deck without MUP)		17'220	$ -		7'678	$ -		7'678	$ -	
4.21	Precast Concrete f'c=55 Mpa	m3	2'070	$ 9'417.19	$ 19'493'578.13	3'630	$ 9'300.00	$ 33'759'000.00	3'630	$ 9'300.00	$ 33'759'000.00
4.22	Cast in Place Concrete Grade 55	m3	4'000	$ 1'038.88	$ 4'155'531.32		incl.	incl.		incl.	incl.
4.23	Reinforcement Black steel Grade 400	ton	850	$ 3'216.00	$ 2'732'956.80		incl.	incl.		incl.	incl.
4.24	Reinforcement Stainless steel Grade 520	ton	607	$ 8'250.00	$ 5'007'750.00		incl.	incl.		incl.	incl.
4.25	Ballast Concrete	m3	-	$ -	$ -	3'100	$ 785.07	$ 2'433'725.00	3'100	$ 785.07	$ 2'433'725.00
4.26	Longitudinal Posttensioning Grade 1860 Mpa	ton	-	$ -	$ -						
4.27	Transverse Posttensioning Grade 1860 Mpa	ton	-	$ -	$ -						
4.28	Transverse Prestressing in PCP Grade 1860 Mpa	ton	79	$ 12'412.53	$ 979'472.74						
4.29	Structural Steel, Grade 350	ton	5'650	$ 6'630.98	$ 37'465'012.20	2'280	$ 6'277.68	$ 14'313'117.07	2'180	$ 6'277.68	$ 13'685'348.78
	Schedule Delay (2 seasons/years)				see below			N/A			N/A
	SUBTOTAL				69'834'301			50'505'842			49'878'074
5.	**Stay cables/Hangers**										
5.01	Number of Stay Cables/ Hangers	Pc									
5.02	Strands , Grade 1860 Mpa, 150mm2 (0.62")	ton				370	$ 15'351.94	$ 5'680'217.86	370	$ 15'351.94	$ 5'680'217.86
	SUBTOTAL				-			5'680'218			5'680'218
6.	**Ancillaries**										
6.01	Barriers	ml	1'640	$ 1'350.00	$ 2'214'000.00	1'640	$ 1'350.00	$ 2'214'000.00	1'640	$ 1'350.00	$ 2'214'000.00
6.02	Wearing Surface t = 100mm	m2	17'056	$ 55.00	$ 938'080.00	17'056	$ 55.00	$ 938'080.00	17'056	$ 55.00	$ 938'080.00
6.03	Waterproof	m2	17'056	$ 75.00	$ 1'279'200.00	17'056	$ 75.00	$ 1'279'200.00	17'056	$ 75.00	$ 1'279'200.00
6.04	Expansion Joints	ml	84	$ 12'000.00	$ 1'008'000.00	84	$ 12'000.00	$ 1'008'000.00	84	$ 12'000.00	$ 1'008'000.00
6.05	Elastomeric Bearings	Pc	49	$ 15'000.00	$ 735'000.00	6	$ 15'000.00	$ 90'000.00	22	$ 15'000.00	$ 330'000.00
6.05	Disk Bearings	Pc				6	$ 71'155.50	$ 426'933.00			
	SUBTOTAL				6'174'280			5'956'213			5'769'280
7.	**Major Temporary Works - estimate**										
7.01	Jetty, accesses, soil stabilization (pile option) & cofferdams	Pc	1	$ 18'600'225.71	$ 18'600'225.71	1	$ 6'172'177.32	$ 6'172'177.32	1	$ 6'590'577.32	$ 6'590'577.32
7.02	Temporary Piers incl Foundation	Pc	6	$ 365'875.00	$ 2'195'250.00						
7.03	Lifting Derricks	Pc				4	$ 200'000.00	$ 800'000.00	4	$ 200'000.00	$ 800'000.00
7.04	Deck Erection Gantry					4	$ 150'000.00	$ 600'000.00	4	$ 150'000.00	$ 600'000.00
	SUBTOTAL				20'795'476			7'572'177			7'990'577
TOTAL	**excluding Foundation and Abutment Cost**				**$ 106'570'000**			**$ 127'570'000**			**$ 130'590'000**
	Cost in % related to least expensive Option							3%			5%
			ml = long. meter	**Total Cost**	**$ 144'440'000**		**Total Cost**	**$ 148'070'000**		**Total Cost**	**$ 151'090'000**
Notes:	1) The total cost above does not include mobilisation, environmental penalties and construction cost for foundation, ab				WAHR			WAHR			WAHR
	2) Items in Pos 6 and 7 have been added with best guess prices			Area [m2]	cost per m2		Area [m2]	cost per m2		Area [m2]	cost per m2
	3) Barriers in Option 2 might be 3 only, but in that case the central one will be stronger			17'220	$ 8'388		17'220	$ 8'599		17'220	$ 8'774
	4) All unit rates are at cost i.e. not included: indirect, soft costs, engineering, escalation, contingency, risk, profit.							$ 3'630'000.00			$ 6'650'000.00

Additional costs:	Qty	Un	UP	Total	Qty	UP	Total	Un	UP	Total
Abutments				**$ 12'715'384.66**			**$ 11'898'457.06**			**$ 11'898'457.06**
Concrete for piles	5191	m3	$ 1'518.45	$ 7'882'288.48	4653	$ 1'518.45	$ 7'065'360.87	4653	$ 1'518.45	$ 7'065'360.87
Concrete for abutment pier	2625	m3	$ 1'841.18	$ 4'833'096.19	2625	$ 1'841.18	$ 4'833'096.19	2625	1'841.18	$ 4'833'096.19
Electrical & ITS	17220	m2	$ 280.00	**$ 4'821'600.00**	1	$ 280.00	**$ 4'821'600.00**	1	$ 280.00	**$ 4'821'600.00**
Health Monitoring System	17220	m2	$ 150.00	**$ 2'583'000.00**	1	$ 150.00	**$ 2'583'000.00**	1	$ 150.00	**$ 2'583'000.00**
Inspection trucks	20		$ 10'000.00	**$ 200'000.00**	1	$ 300'000.00	**$ 300'000.00**	1	$ 300'000.00	**$ 300'000.00**
Cradles & Hoists				n/a	6	$ 150'000.00	**$ 900'000.00**	6	$ 150'000.00	**$ 900'000.00**
			Sub-Total	**$ 20'319'984.66**		**Sub-Total**	**$ 20'503'057.06**		**Sub-Total**	**$ 20'503'057.06**
Environmental delays and work in the river							**N/A**			**N/A**
Construction schedule delay:	Salaries on average including fringes (no expats, bonus, etc)									
			$/month	$ 13'000						
say	30 staff office									
	60 site (control/planning/managers/engineering/etc)									
			staff	90						
			$/ month	$ 19'500						
			total / mo	$ 1'755'000						
			months	10						
			total schedule extension cost	**$ 17'550'000**			**N/A**			**N/A**

Total Direct		% on selling	**$**	**144'440'000**		% on selling	**$**	**148'070'000**		% on selling	**$**	**151'090'000**
1.0 Indirects		**25%**	**$**	**77'101'500**		**25%**	**$**	**77'371'000**		**25%**	**$**	**78'939'000**
Staff Salaries		7.0%	$	22'029'000		7.0%	$	22'106'000		7.0%	$	22'554'000
Indirect Expenses		7.0%	$	22'029'000		7.0%	$	22'106'000		7.0%	$	22'554'000
Engineering & Consulting Expeneses		8.0%	$	25'176'000		8.0%	$	25'264'000		8.0%	$	25'776'000
Indirect Labor and Equipment		1.0%	$	3'147'000		1.0%	$	3'158'000		1.0%	$	3'222'000
Non-productive days & Winter Conditions		1.5%	$	4'720'500		1.5%	$	4'737'000		1.5%	$	4'833'000
2.0 Soft Costs		**4.6%**	**$**	**14'476'200**		**3.6%**	**$**	**11'368'800**		**3.6%**	**$**	**11'599'200**
Bonds & Insurances		0.5%	$	1'573'500		0.5%	$	1'579'000		0.5%	$	1'611'000
Warranties & Follow-ups		0.1%	$	314'700		0.1%	$	315'800		0.1%	$	322'200
Escalation (2020 + construction years)	52 months	4.0%	$	12'588'000	42 months	3.0%	$	9'474'000	42 months	3.0%	$	9'666'000
Currency Risk			$	-			$	-			$	-
Financing			$	-			$	-			$	-
3.0 Risks, Contingencies and OH&Profits		**25.0%**	**$**	**78'675'000**		**25.0%**	**$**	**78'950'000**		**25.0%**	**$**	**80'550'000**
Risks		5.0%	$	15'735'000		5.0%	$	15'790'000		5.0%	$	16'110'000
Contingencies		5.0%	$	15'735'000		5.0%	$	15'790'000		5.0%	$	16'110'000
OH & Profit		15.0%	$	47'205'000		15.0%	$	47'370'000		15.0%	$	48'330'000
Total Indirect			**$**	**170'252'700**			**$**	**167'689'800**			**$**	**171'088'200**
Total Selling (+/- 15%)		Option 02	**$**	**314'700'000**		Option 10a	**$**	**315'800'000**		Option 10c	**$**	**322'200'000**
								0.3%				2.4%

5 Recommended Inspection Cycles

Item	frequency of Inspection		
	visual, from a distance (authority/client)	visual (specialist)	"hands on" inspection / non. destructive testing
structural weathering steel, superstructure	1 time / year	1 time / 3 years	1 time / 6 years
structural weathering steel, pylon / arch	1 time / year	1 time / 3 years	1 time / 6 years
steel coating systems (not considered so far)	1 time / year	1 time / 3 years	1 time / 3 years
concrete pylon	-	1 time / 3 years	-
concrete deck slab girder bridge	1 time / year	1 time / 3 years	-
concrete deck slab stay cable bridge	1 time / year	1 time / 3 years	
concrete pier	-	1 time / 3 years	-
concrete pile cap	-	-	-
concrete piles	-	-	-
elastomeric bearings	1 time / year	1 time / 3 years	1 time / 6 years
disc bearing bearings	1 time / year	1 time / 3 years	1 time / 6 years
expansion joint	1 time / year	1 time / 3 years	1 time / 6 years
wearing surface	1 time / year	1 time / 3 years	1 time / 3 years
drainage	1 time / year	1 time / 3 years	-
Joint seals, sliders and springs	1 time / year	1 time / 3 years	-
stay cables [1)]	-	1 time / 3 years	1 time / 6 years
Sheaths for Stay cables [2)]	1 time / year	1 time / 3 years	1 time / 6 years
Dampers for stay cables	1 time / year	1 time / 3 years	1 time / 6 years
Stay Cable Snow and Ice Removal System [3)]	1 time / year	1 time / 3 years	1 time / 6 years
Hangers	1 time / year	1 time / 3 years	1 time / 6 years
Structural Health Monitoring Systems	1 time / year	1 time / 3 years	1 time / 6 years
galvanized steel barriers	1 time / year	1 time / 3 years	-
galvanized steel railing	1 time / year	1 time / 3 years	-
concrete barriers	1 time / year	1 time / 3 years	-
Sign support structures	1 time / year	1 time / 3 years	-
lamp post	1 time / year	1 time / 3 years	1 time / year (luminance test)

Durability/Replacement Periods assumed

Item	design service/lifetime [years]	replacement [times]	design service/lifetime [years]	replacement [times]	design service/lifetime [years]	replacement [times]	design service/lifetime [years]	replacement [times]
structural weathering steel, superstructure	100	-	100	-	100	-	100	-
structural weathering steel, pylon / arch	-	-	100	-	100	-	100	-
steel coating systems (not considered so far)	35	2	35	2	35	2	35	2
concrete pylon	-	-	-	-	100 (10c)	-	100 (14b)	-
concrete deck slab girder bridge	50	1 x 410m	50 (30% of total)	1 x 120m	-	-	50 (20% of Total)	1 x 80m
concrete deck slab cable suspended girder	100	-	100	-	100	-	100	-
concrete pier	100	-	100	-	100	-	100	-
concrete pile cap	100	-	100	-	100	-	100	-
concrete piles	100	-	100	-	100	-	100	-
elastomeric bearings	35	2 x 49	35	2 x 26	35	2 x 22	35	2 x 14
disc bearing bearings	-	-	-	-	50 (10a)	1 x 6	50 (14a)	1 x 2
expansion joint	35	2	35	2	35	2	35	2
wearing surface	25	3	25	3	25	3	25	3
drainage	35	2	35	2	35	2	35	2
Joint seals, sliders and springs	15	6	15	6	15	6	15	6
stay cables [1)]	-	-	-	-	100	1 x 10%	100	1 x 10%
Sheaths for Stay cables [2)]	-	-	-	-	100	1 x 10%	100	1 x 10%
Dampers for stay cables	-	-	-	-	50	1	50	1
Stay Cable Snow and Ice Removal System [3)]	-	-	-	-	25	3	25	3
Hangers	-	-	50	1	-	-	-	-
Structural Health Monitoring Systems	25	3	25	3	25	3	25	3
galvanized steel barriers	40	2	40	2	40	2	40	2
galvanized steel railing	40	2	40	2	40	2	40	2
concrete barriers	40	2	40	2	40	2	40	2
Sign support structures	50	1	50	1	50	1	50	1
lamp post	50 /upon need	1	50 /upon need	1	50 /upon need	1	50 / upon need	1

Notes

1) Around 10% of the strands may need to be replaced along the structure lifetime

2) Using bright colours (white or nearly white) will increase the lifetime of the sheets considerably (getting close to 100y). We assume that 10 % of the sheets may need to be replaced within the 100y

3) If stay cables with small ducts are used (e.g. parallel wire systems or ropes) the risk of ice accumulation decrease considerably. Many suppliers are close to a solution to mitigate that problem completely

6 Further Comments

6.1 Inspection Gantry

The need of an inspection gantry is usually defined by the clients. Should he request one for the Saskatoon Freeway Project, some slight changes in the design could be done, so that **one** gantry is sufficient

1. Lower the Pylon crossbeam by about 1.20m. That creates a clear distance of 1.3 (to date) + 1.2 = of 2.5 m between crossbeam top and deck bottom so that the gantry can path the Pylon legs: turn it or shift it together (slide rule principle). Note that option 10a has no crossbeam below the deck at all and the gantry can pass easily.

2. At one of the abutments path over tracks would allow to shift it from upstream to downstream deck or vs)

6.2 Widening the Roadway

The design was so far developed according to the sketch on page 5 of this report

- Initial Layout: 4 Lanes with 3.70m each, 3 of them for Traffic, one for MuP, 2 Shoulders with 2.60m
- Future Layout: 4 Lanes with 3.70m each, 2 Shoulders with 2.60m. MuP on a light Cantilever with 3.60m width

Should it be required to add another lane to the Southbound, it has no structural consequence except that in a first approach the cost will rise proportionally to the deck area for Option 2 and 10.

By adding a forth traffic lane to the Southbound, two alternatives may be further developed

Alt 1 does not change the Southbound, it has 4 traffic lanes from the beginning and 4 in future
Initial Layout:

- Northbound: 4 Lanes with 3.70m each, 3 Lanes for Traffic, one for MuP, 2 Shoulders with 2.60m (as above)
- Southbound: 4 Lanes with 3.70m each plus 1 Lane 3.60m for MuP, 2 Shoulders with 2.60m

Future Layout:

- Northbound: 4 Lanes with 3.70m each, 2 Shoulders with 2.60m. MuP on a light Cantilever with 3.60m width
- Southbound: 4 Lanes with 3.70m each plus 1 Lane 3.60m for MuP, 2 Shoulders with 2.60m – same as initial

Alt 2 has 4 lanes at the beginning and 5 traffic lanes on Southbound in the future
Initial Layout:

- Northbound: 4 Lanes with 3.70m each, 3 Lanes for Traffic, one for MuP, 2 Shoulders with 2.60m (same as Alt1)
- Southbound: 4 Lanes with 3.70m each plus 1 Lane 3.60m for MuP, 2 Shoulders with 2.60m

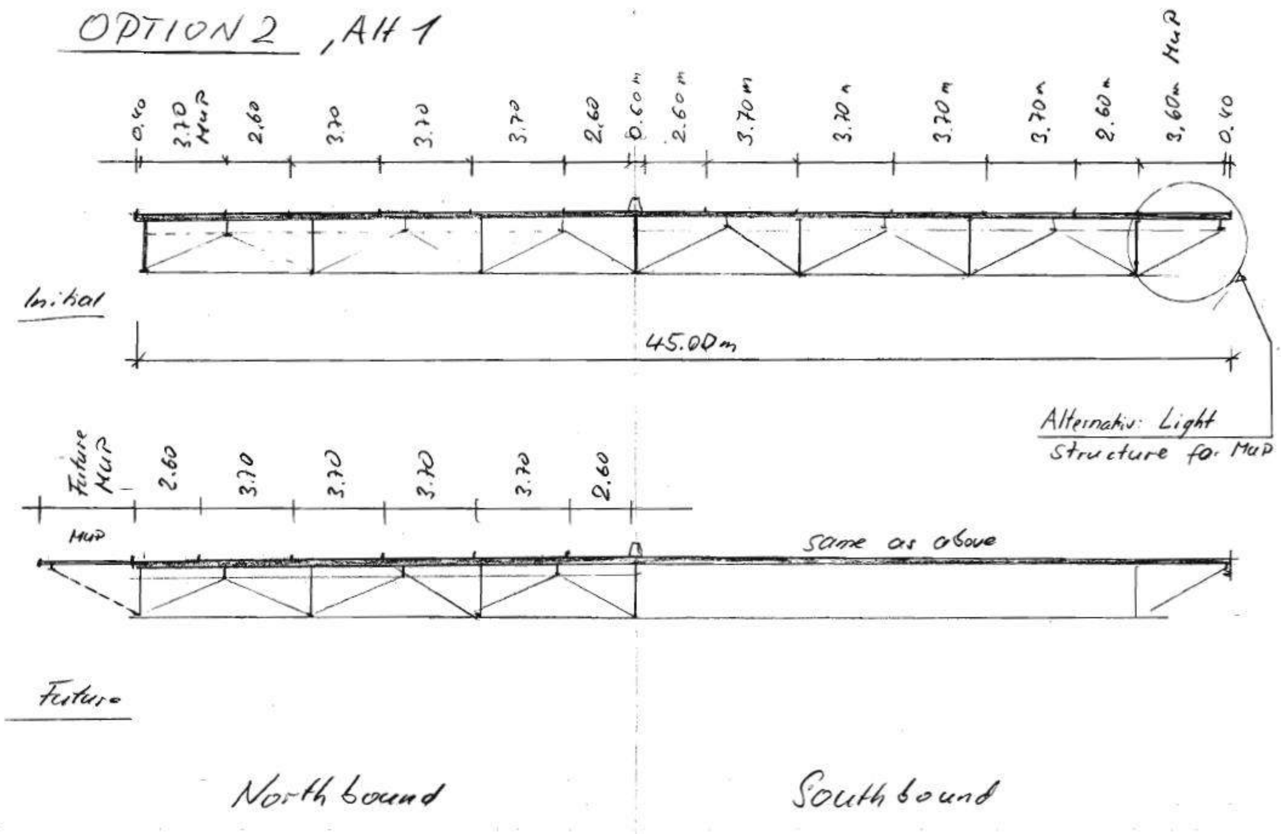
Future Layout:

- Northbound 4 Lanes with 3.70m each, 2 Shoulders with 2.60m. MuP on a light Cantilever with 3.60m width (same as Alt 1)
- Southbound: 5 Lanes with 3.70m each, 2 Shoulders with 2.60m. MuP on a light Cantilever with 3.60m width

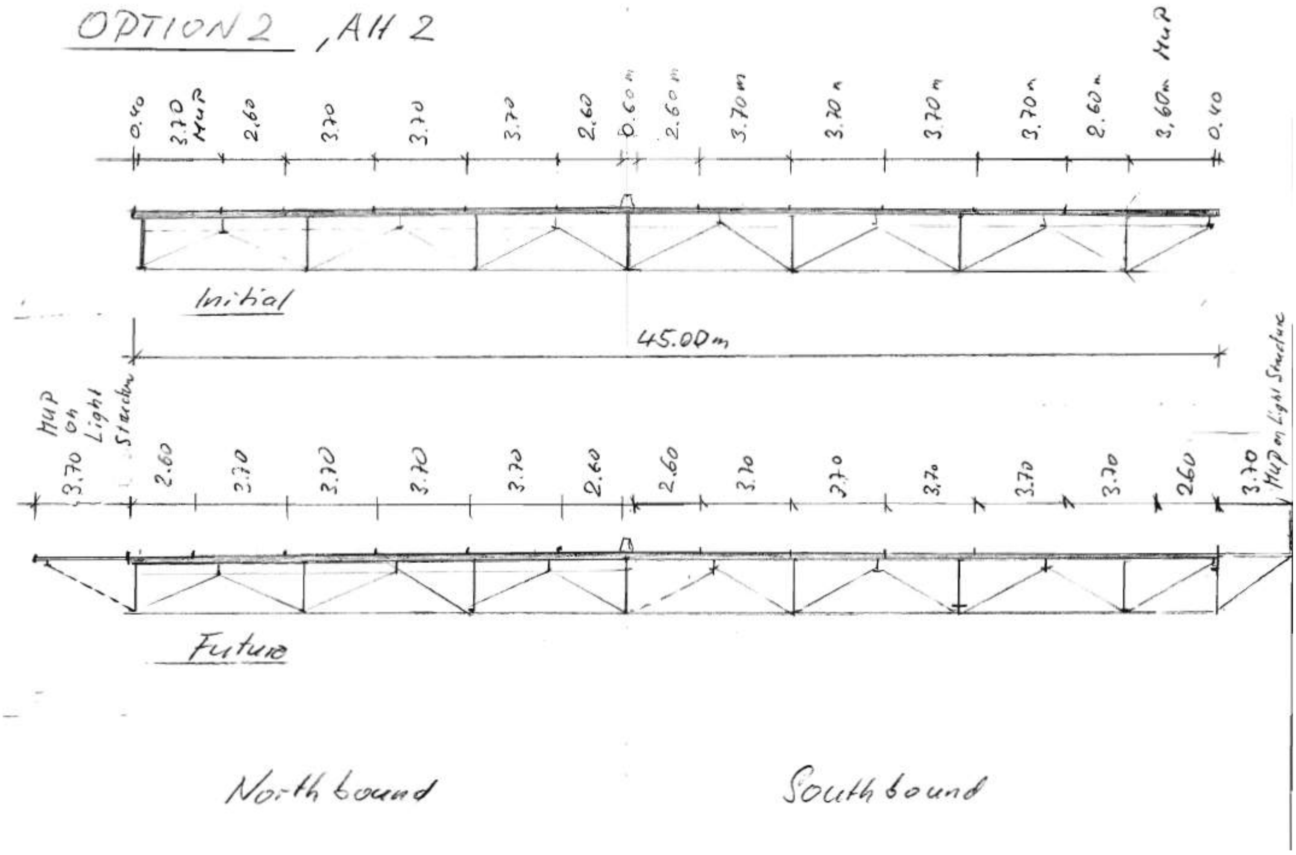
Consequences for the Options:

Option 2
For Option 2 this can be directly adopted

Alt 1



Additional remark: It may be possible to place the Southbound MuP from the very beginning on a light cantilever. This would avoid the very wide concrete slab

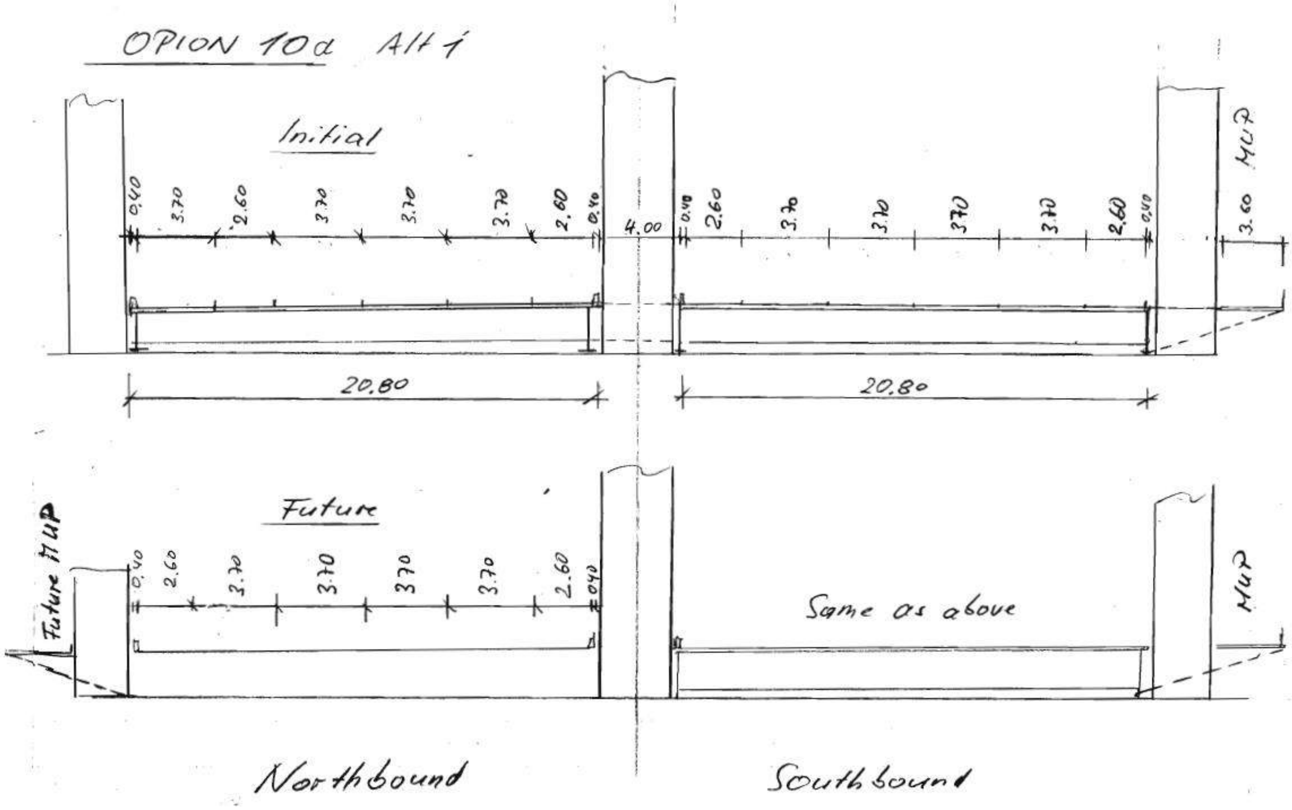


This alternative requires a really wide concrete deck. So, a twin deck with separated superstructures should really be taken into account, but the problems with adding an eccentric MuP Lane (torsion & deformations) needs to be addressed.

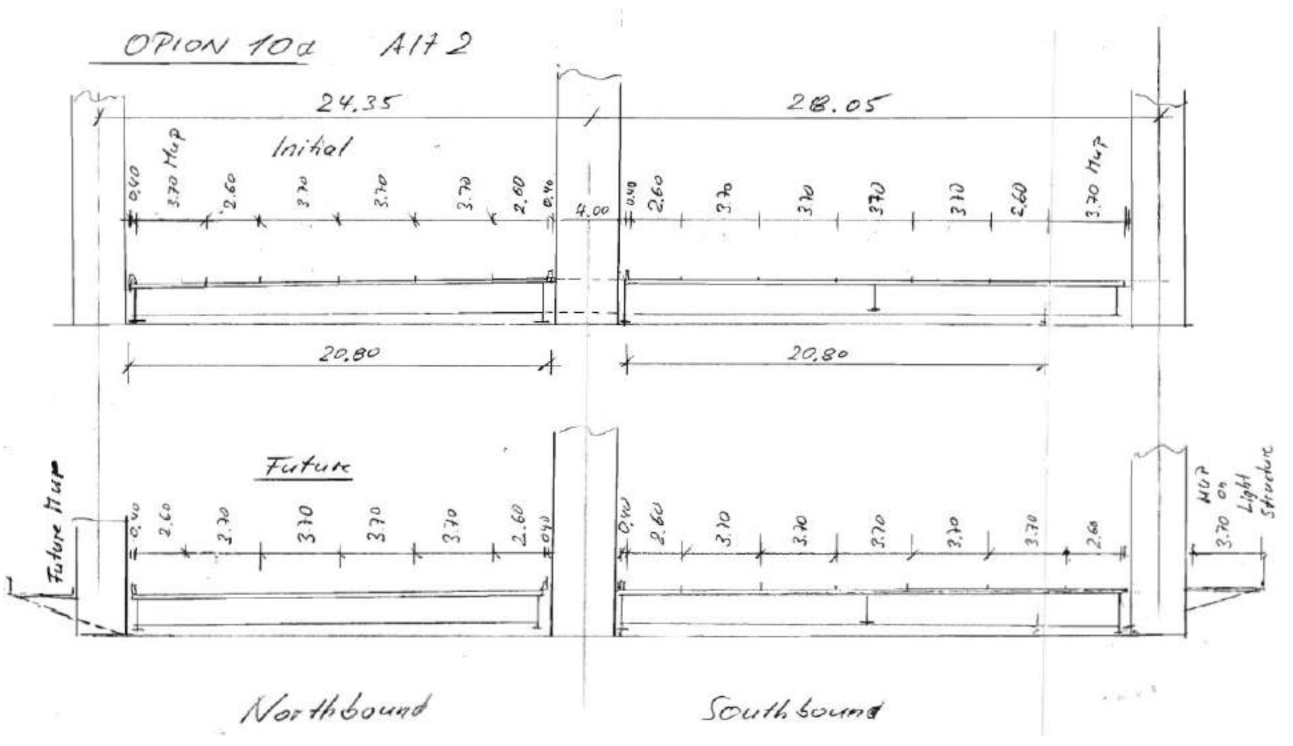
Option 10

For Option 10 the MuP should be placed from the beginning on a light structure in order to clear the outer pylon leg.

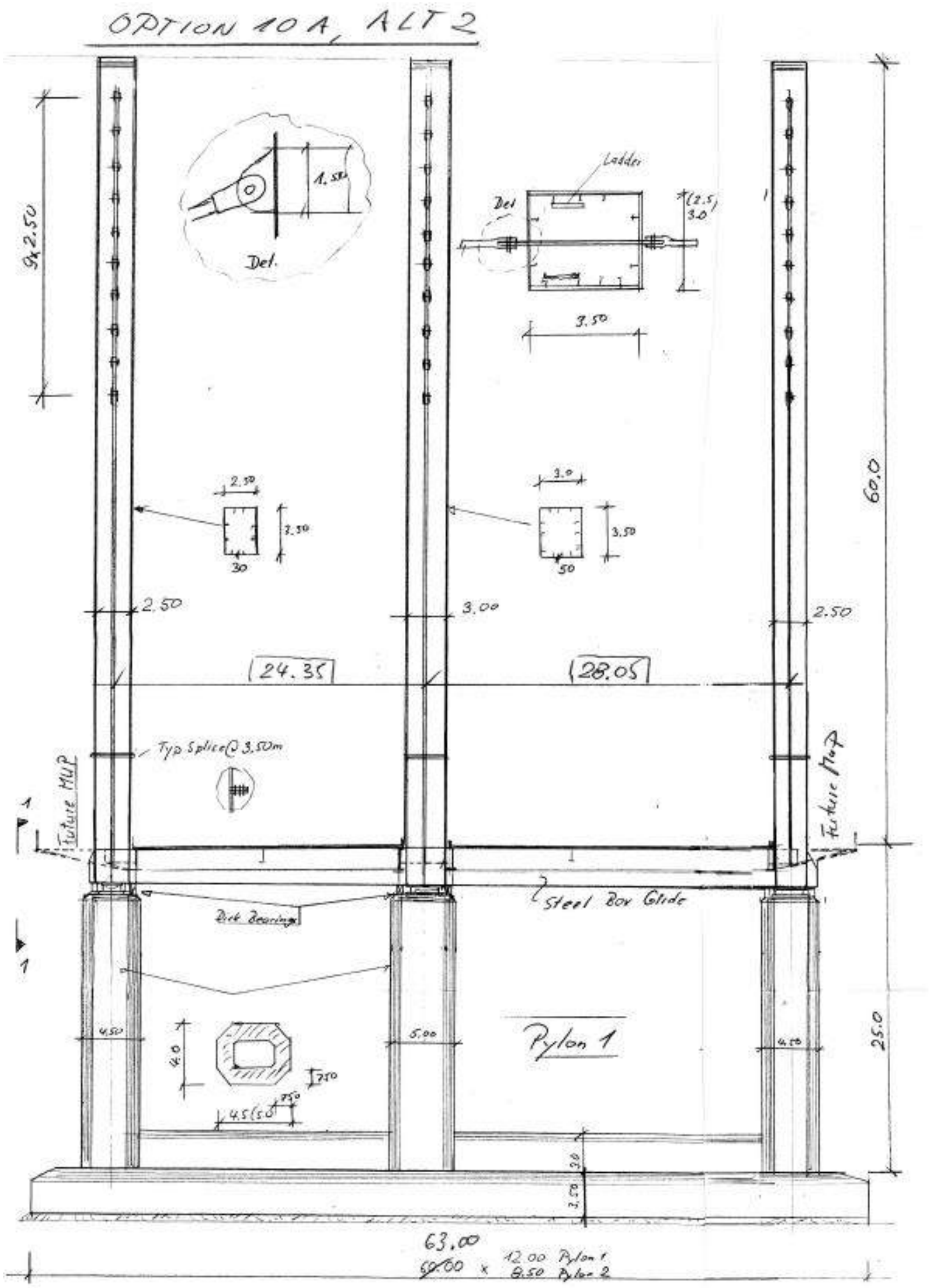
Alt 1


OPION 10a Alt 1
Initial
0.40
3.70
2.60
3.70
3.70
3.70
2.60
0.40
4.00
0.40
2.60
3.70
3.70
3.70
3.70
2.60
0.40
3.60
MUP
20.80
20.80
Future
Future MUP
0.40
2.60
3.70
3.70
3.70
3.70
2.60
0.40
Same as above
MUP
Northbound
Southbound

Alt 2


OPION 10a Alt 2
24.35
28.05
Initial
0.40
3.70 MUP
2.60
3.70
3.70
3.70
2.60
0.40
4.00
0.40
2.60
3.70
3.70
3.70
3.70
2.60
3.70 MUP
20.80
20.80
Future
Future MUP
0.40
2.60
3.70
3.70
3.70
3.70
2.60
0.40
0.40
2.60
3.70
3.70
3.70
3.70
3.70
2.60
3.70
MUP on Light Structure
Northbound
Southbound

In case a 5th Traffic Lanes is needed (Alt 2), the tower legs would have a different spacing: Northbound 24.35m, Southbound 28.05m. This is illustrated below and one can see that it does not harm the aesthetics much. Most of the public would not realize this at all or would believe it is done by purpose to bring more visual tension into the design.



Option 6 and 14 would get more problems due to the extremely long span of the crossbeams, but those options will not be considered further anyway.

APPENDIX K

Multiple Account Evaluation Summaries

SASKATOON FREEWAY FUNCTION PLANNING STUDY: INTERCHANGE "Highway 11" EVALUATION

Multiple Account Evaluation: SUMMARY

Rating: 0 = Unacceptable 1 = Marginally Acceptable 2 = Acceptable 3 = Excellent 4 = Exemplary

CONCEPT 11 - 1

CONCEPT 11- 2

	Weighting /Importance	CONCEPT 11 - 1 Average Rating	CONCEPT 11 - 1 Total Evaluation Points	CONCEPT 11- 2 Average Rating	CONCEPT 11- 2 Total Evaluation Points
ROAD USER ACCOUNT	**31.2%**				
Travel Time Cost (Delay Time)	13	2	26	2	26
Vehicle Operating Cost (Congestion, Start/Stop)	10	3	30	3	30
Safety Cost (At-grade intersections, LOS/Congestion)	12	2	24	3	36
Construction Impacts to Road Users (Detours, Delays)	8	2	16	3	24
Maximized Benefits Related to Construction Schedule	Equal	Equal		Equal	
Granular Materials Haul Impact on Public Roads	Equal	Equal		Equal	
ENVIRONMENTAL ACCOUNT	**18.1%**				
Green House Gas Costs (Construction/Operation)	5	3	15	3	15
Non-renewable Resources Utilization	2	2	4	2	4
Heritage Impact (Sensitive Areas, Heritage Park Buffer)	10	2	20	3	30
Impact to Hudson Bay Swale and Wetlands	8	3	24	2	16
Impact to Wildlife	Equal	Equal		Equal	
Geotechnical Risk (Erosion, Embankment Stability)	Equal	Equal		Equal	
Integration with Multi-Use Active Trail Network	Equal	Equal		Equal	
Habitat Connectivity	Equal	Equal		Equal	
SOCIAL ACCOUNT	**29.0%**				
City of Saskatoon Road Network Plans (Alignment)	11	3	33	3	33
RM Corman Park Road Network Plans (Alignment)	9	2	18	3	27
First Nations Road Network Plans (Alignment)	4	2	8	3	12
Public Information Session Feedback/Acceptance	6	3	18	3	18
Land Owner Impacts/Access	Equal	Equal		Equal	
Business Impacts/Access	Equal	Equal		Equal	
Heritage Park Development Plans	10	2	20	2	20
ECONOMIC ACCOUNT					
Employment During Construction	Equal	Equal		Equal	
Development Opportunities (Land Access Availability)	Equal	Equal		Equal	
Local Resource Availability	Equal	Equal		Equal	
FINANCIAL ACCOUNT	**21.7%**				
Capital Cost (Excludes Utility Costs)	14	2	28	3	42
Operating Cost	Equal	Equal		Equal	
Mainteance Cost	9	2	18	2	18
Utility Cost/Impacts	7	2	14	2	14
			316		**365**

SASKATOON FREEWAY FUNCTION PLANNING STUDY: INTERCHANGE "Highway 12" EVALUATION

Multiple Account Evaluation: SUMMARY

Rating: 0 = Unacceptable   1 = Marginally Acceptable   2 = Acceptable
3 = Excellent   4 = Exemplary

CONCEPT 12 - 1

CONCEPT 12 - 2

Accounts and Elements	Weighting /Importance	CONCEPT 12 - 1 Average Rating	CONCEPT 12 - 1 Total Evaluation Points	CONCEPT 12 - 2 Average Rating	CONCEPT 12 - 2 Total Evaluation Points
ROAD USER ACCOUNT	**47.4%**				
Travel Time Cost (Delay Time)	8	3	24	2	16
Vehicle Operating Cost (Congestion, Start/Stop)	7	3	21	2	14
Safety Cost (At-grade intersections, LOS/Congestion)	8	3	24	2	16
Construction Impacts to Road Users (Detours, Delays)	4	2	8	2	8
Maximized Benefits Related to Construction Schedule	Equal	Equal		Equal	
Granular Materials Haul Impact on Public Roads	Equal	Equal		Equal	
ENVIRONMENTAL ACCOUNT	**3.5%**				
Green House Gas Costs (Construction/Operation)	2	3	6	2	4
Non-renewable Resources Utilization	Equal	Equal		Equal	
Heritage Impact (Sensitive Areas, Heritage Park Buffer)	Equal	Equal		Equal	
Impact to Hudson Bay Swale and Wetlands	Equal	Equal		Equal	
Impact to Wildlife	Equal	Equal		Equal	
Geotechnical Risk (Erosion, Embankment Stability)	Equal	Equal		Equal	
Integration with Multi-Use Active Trail Network	Equal	Equal		Equal	
Habitat Connectivity	Equal	Equal		Equal	
SOCIAL ACCOUNT	**10.5%**				
City of Saskatoon Road Network Plans (Alignment)	Equal	Equal		Equal	
RM Corman Park Road Network Plans (Alignment)	Equal	Equal		Equal	
First Nations Road Network Plans (Alignment)	Equal	Equal		Equal	
Public Information Session Feedback/Acceptance	Equal	Equal		Equal	
Land Owner Impacts/Access	Equal	Equal		Equal	
Business Impacts/Access	6	2	12	3	18
Heritage Park Development Plans	Equal	Equal		Equal	
ECONOMIC ACCOUNT	**7.0%**				
Employment During Construction	Equal	Equal		Equal	
Development Opportunities (Land Access Availability)	4	2	8	3	12
Local Resource Availability	Equal	Equal		Equal	
FINANCIAL ACCOUNT	**31.6%**				
Capital Cost (Excludes Utility Costs)	9	2	18	3	27
Operating Cost	5	2	10	3	15
Mainteance Cost	4	2	8	3	12
Utility Cost/Impacts	Equal	Equal		Equal	
Total Rating Points			**139**		**142**

SASKATOON FREEWAY FUNCTION PLANNING STUDY: INTERCHANGE "Highway 16" EVALUATION

Multiple Account Evaluation: SUMMARY

Rating: 0 = Unacceptable 1 = Marginally Acceptable 2 = Acceptable 3 = Excellent 4 = Exemplary

CONCEPT 16 - 1

CONCEPT 16 - 2

	Weighting /Importance	CONCEPT 16 - 1 Average Rating	CONCEPT 16 - 1 Total Evaluation Points	CONCEPT 16 - 2 Average Rating	CONCEPT 16 - 2 Total Evaluation Points
ROAD USER ACCOUNT	**50.0%**				
Travel Time Cost (Delay Time)	3	3	9	3	9
Vehicle Operating Cost (Congestion, Start/Stop)	Equal	Equal		Equal	
Safety Cost (At-grade intersections, LOS/Congestion)	4	2	8	3	12
Construction Impacts to Road Users (Detours, Delays)	Equal	Equal		Equal	
Maximized Benefits Related to Construction Schedule	Equal	Equal		Equal	
Granular Materials Haul Impact on Public Roads	Equal	Equal		Equal	
ENVIRONMENTAL ACCOUNT	**7.1%**				
Green House Gas Costs (Construction/Operation)	1	2	2	2	2
Non-renewable Resources Utilization	Equal	Equal		Equal	
Heritage Impact (Sensitive Areas, Heritage Park Buffer)	Equal	Equal		Equal	
Impact to Hudson Bay Swale and Wetlands	Equal	Equal		Equal	
Impact to Wildlife	Equal	Equal		Equal	
Geotechnical Risk (Erosion, Embankment Stability)	Equal	Equal		Equal	
Integration with Multi-Use Active Trail Network	Equal	Equal		Equal	
Habitat Connectivity	Equal	Equal		Equal	
SOCIAL ACCOUNT	**14.3%**				
City of Saskatoon Road Network Plans (Alignment)	Equal	Equal		Equal	
RM Corman Park Road Network Plans (Alignment)	Equal	Equal		Equal	
First Nations Road Network Plans (Alignment)	Equal	Equal		Equal	
Public Information Session Feedback/Acceptance	Equal	Equal		Equal	
Land Owner Impacts/Access	2	2	4	3	6
Business Impacts/Access	Equal	Equal		Equal	
Heritage Park Development Plans	Equal	Equal		Equal	
ECONOMIC ACCOUNT					
Employment During Construction	Equal	Equal		Equal	
Development Opportunities (Land Access Availability)	Equal	Equal		Equal	
Local Resource Availability	Equal	Equal		Equal	
FINANCIAL ACCOUNT	**28.6%**				
Capital Cost (Excludes Utility Costs)	4	2	8	3	12
Operating Cost	Equal	Equal		Equal	
Mainteance Cost	Equal	Equal		Equal	
Utility Cost/Impacts	Equal	Equal		Equal	
	Total Rating Points		**31**		**41**

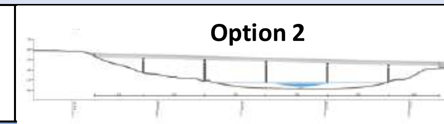
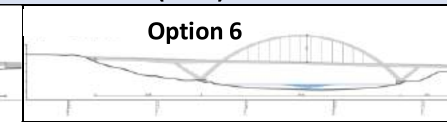
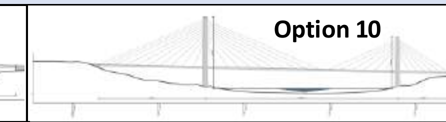
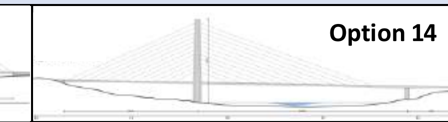
Bridge Option Study Phase 1 Matrix Ranking

Sakatoon Freeway Bridge Option Study

04.09.2019

1 = Low	2 = medium	3 = high
Good	Fair	Poor

Option No	Type	Layout	Spans between EJs [m]	feasible Superstructure Types: Var A	feasible Superstructure Types: Var B	Total No. of Piers	No. of Piers in the Water	No. of Piers in West Bank	Slope Stability Risk	Environmental Considerations	Compatible with Local Bridges	Feasible Construction Procedures	Constructibility	Expandability for Future added Lanes/MUP	Capital Cost	Life Cycle/O&M Cost	Replaceable Elements (expansion joints (2 on each - same	Aesthetics	Overall	Remarks
						Foundations														
1	Prestressed Concrete Girder	Box Girder (or AASHTO Girder) Bridge with 9 spans	41-7x47-40 = 410	concrete Boxes	Precast Beams (AASHTO girders	8	4	2	3	3	3	Twin Box Girder would allow incremental launching from one side, PC girders would need to be placed by cranes, possibly not in accordance with environmental restriction (access all along needed)	2	3	2	3	bearing (30-50 years), erosion potential on piers (riprap), barriers	3	22	Concrete boxes, incrementally launched, would be the first choice in Europe, since it is the most economical and robust type for shorter spans. But many piers in the water increases constructablity problems
2	Steel Composite Box or Steel Plate girder	Composite Girder with 6 Spans	60-4x73-58 = 410	multiple Plate Girder (local standard)		5	2	1	2	3	1	Box girders and steel plate girders with constant depth could be launched form one side, if bottom flanges are welded.' Steel plate girder could also be placed by cranes in a patchwork erection on auxiliary piers, but that's possibly not in accordance with environmental restriction since access is needed all along.	2	2	1	2		3	16	European Style would be a box girder, US or Canada praxis suelry surely a multiple plate girders
3	Haunched prestressed Concrete Box Girder	concrete box girder with 5 spans	60- 2x105-90-50 = 410	Two Concrete Box girder		4	1	1	2	3	3	CIP Segmenetal Free Cantilever Construction by a formtraveller, delivery of material at the piers (access needed)	2	3	2	2		3	20	steel composite box girder may also be feasible
4	Tied arch bridge	one arch in plane, three arches transversely	65-200-75-70 = 410	Steel Plate Girder with concrete slab		3	0	1	2	2	2	incremental launching of plate girder with 2 auxiliary pier in the water (additional steel in the longitudinal girder needed), erection of arches on the finished deck	3	2	2	3	heavier bearings	2	18	Piers might be a bit to close too the shore, with a 215m span this situation would improve and the cost would increase only marginal
5	Tied dual arch bridge	two arches in plane, two or three arches transversely	65-200-145= 410			2	0	0	1	2	2	incremental launching of plate girder with 2 auxiliary pier in the water (additional steel in the longitudinal girder needed), erection of arches on the finished deck	3	2	3	3	heavier bearings	2	18	
6	Through arch bridge	one arch in plane, two arches transversely	60-225-120= 410	Cross section at the arch: Two inclined arches Alternative cross section at the sidespans Steel Plate Girder with concrete slab		2	0	0	1	2	2	Alt A) Because of the required haunch, incremental launching of the sidespan West is on a first view not possible and the plate girder needs to be erected on auxiliary piers by cranes. The mainspan could be launched from the east, but two auxiliary piers are needed in the water (also additional steel in the longitudinal girder needed). Therefore a span-wise erection on aux piers is most likely the best choice, followed by placement of roadway slabs (PC Panels), casting of stiches and erection of arches on the finished deck Alt B) Free Cantilever erection supported by temporary stay and Tower, small Segments delivered to lifting point and assembled a site	3	2	3	2		1	16	capital cost considered to be similar as Option 7, the omitted pier on the westbank is offset by the larger spans
7	Through arch bridge	one arch in plane, two arches transversely	60-200-80-70= 410			3	0	1	2	2	2	Incremental launching of plate girder with two auxiliary pier in the water (additional steel in the longitudinal girder needed), placement of roadway slabs (PC Panels), casting of stiches and erection of arches on the finished deck	3	2	3	2		1	17	
8	Braced Composite Girder	5 span bridge , supported by tubular steel bracings	60-105-105-80-60= 410	in steel composite box girders		4	1	1	2	3	2	erection of box girders on auxilary pier or incrementally launched, erection of bracing under the finished deck	3	2	3	2		3	20	Sundsvall Type
9	Spandrel Arch Bridge	3 spandrel arches , two transversely	60-105-105-80-60= 410	prestress solid concrete or composite girders		3	1	-1	2	3	2	• arch in segments on auxiliary piers or stay cable supported • Erection of Piers • Steel Grid Placement • Roadway slabs (PC Panels)	3	2	3	2		2	19	main pier on the left shifted into the west banks
10	Unsymetrical Stay Cable Bridge	unsymmetrical stay cable bridge , tower with 2 or 3 legs transversely	60-225-125 = 410	plate girder composite deck		2	0	0	1	1	3	Alt A) • erect tower starter segments on falsework • deliver steelwork segments in pieces to the tower, • lift by heavy tower crane or mobile crane placed on the starter segments • carry elements or fully assembled segment to the erection front, • position it by a mobile crane (or derrick) followed by bolting of the splices. Alt B) Alternatively the sidespan could be constructed first on auxiliary piers and the mainspan segments carried over the sidepan for erection by derrick or mobile cranes	1	2	2	1	cables?	1	12	minimum number of piers with simple construction procedure
11	Central Tower Stay Cable Bridge	central Tower , 3 cable Planes (as Port Mann)	200-210 = 410	plate girder composite deck		1	1	0	1	3	3	A) Stay cable supported free cantilever erection of about 13.50m long segments. Segments could be assembles on shore, floated in below the cantilever and lifted by a derrick, followed by Stay Cable installation and B) If floating in of segments is not possible, small steelwork segments have to be delivered to the tower, lifted by heavy tower crane or mobile crane placed on the starter segments, and launched to the erection front, positioned by cranes followed by bolting of the splices.	1	2	3	2		2	17	
12	Extradosed bridge	Extradosed bridge with small column on the abutment,3 pylon legs transversely	60-120-120-110 = 410	twin concrete box girder	tripple steel box girder	3	1	0	1	3	3	free cantilever CIP segemntal construction with Formtraveller, cantilever supported by final stays	2	3	2	2		2	18	- small column placed on the abutment to support deck and avoid critical pier locations -main pier on the left placed not directly at shore
13	Extradosed bridge	Extradosed bridge , 3 pylon legs transversely	75-120-120-90 = 405			3	2 (one place near the shore)	1 near the critical slope	2	3	3	free cantilever CIP segemntal construction with Formtraveller, cantilever supported by final stays	2	3	2	2		2	19	
14	Unsymetrical single Tower Stay Cable Bridge	unsymmetrical stay cable bridge , tower with one, 2 or 3 legs	60-225-125= 410	plate girder composite deck		2	0	0	1	1	3	Alt A) • erect tower starter segments on falsework • deliver steelwork segments in pieces to the tower, • lift by heavy tower crane or mobile crane placed on the starter segments • carry elements or fully assembled segment to the erection front, • position it by a mobile crane (or derrick) followed by bolting of the splices. Alt B) Alternatively the sidespan could be constructed first on auxiliary piers and the mainspan segments carried over the sidepan for erection by derrick or mobile cranes.	1	2	3	2		1	14	
15	Steel Girder Bridge with external "sail"	3 span bridge , supported by external steel boxes	85-210-115=410	steel composite box girders		2	0	0	1	2	3	Incremental launching or erection of box girders on auxiliary pier or incrementally launched, erection of "sails" on the finished deck	3	2	3	2		2	18	transverse shape needs further studier- European examples is made of box girders

SASKATOON FREEWAY FUNCTION PLANNING STUDY: RIVER CROSSING - BRIDGE OPTION STUDY					
MULTIPLE ACCOUNT EVALUTION (MAE)					
	Weighting/ Importance	Option 2 	Option 6 	Option 10 	Option 14 
CUSTOMER ACCOUNT					
Travel Time Cost	EQUAL				
Vehicle Operating Cost	EQUAL				
Safety Cost	EQUAL				
Customer Account Total (Points) =		-	-	-	-
ENVIRONMENTAL ACCOUNT					
Green House Gas Costs (Construction/Operation)	EQUAL				
Non-renewable Resources	EQUAL				
Heritage Considerations	4	1	2	3	3
Piers in the River	6	1	3	3	3
Construction in the River	7	1	2	4	4
Geotechnical Risk - Slope Stability	7	1	2	3	3
Geotechnical Risk - Foundations	7	2	2	4	2
Environmental Account Total (Points) =		**38**	**68**	**107**	**93**
SOCIAL ACCOUNT					
Impact to Local Landowners/Businesses	EQUAL				
Alignment to Development Plans	2	0	0	0	0
Iconic Value/Aesthetics	5	1	3	3	2
Impact to Heritage Park/First Nations & Municipalities	5	2	3	4	2
Social Account Total (Points) =		**15**	**30**	**35**	**20**
ECONOMIC ACCOUNT					
Employment	5	3	1	3	2
Economic Account Total (Points) =		**15**	**5**	**15**	**10**
FINANCIAL ACCOUNT					
Operation & Maintenance	7	2	1	4	3
Financial Account Total (Points) =		**14**	**7**	**28**	**21**
MAE TOTAL POINTS =		**82**	**110**	**185**	**144**

German Pricing based on BoQ*:	**100%**	**127%**	**110%**	**126%**
Factored from North American Bridge Construction*:	**100%**	**182%**	**162%**	**162%**

* Percentage based on base case (Option 2)

APPENDIX L

Functional Design Plan and Profiles

Saskatoon Freeway

Saskatchewan

SCALE
1: 5 000 HORIZONTAL
1: 400 000 VERTICAL

REVISIONS		
NO	DATE	SIGNATURE

CS	N/A	TAB NO	A1_16
PHOTO DATE	N/A	SHEET	1 OF 4
DRAWN BY	J. GREENE	DATE	20/05/20
DESIGNED BY	AECOM	DATE	20/05/20

HIGHWAY 16 INTERCHANGE
STA. 10+800 TO STA. 14+700
SASKATOON FREEWAY PROJECT

ACAD DWG: PHASE 1 DESIGN PLATES.DWG
LAST REV DATE: May 26, 2021

Saskatoon Freeway

Saskatchewan

SCALE
1: 5 000 HORIZONTAL
1: 400 000 VERTICAL

REVISIONS		
NO	DATE	SIGNATURE

CS	N/A	TAB NO	A1_12
PHOTO DATE	N/A	SHEET	2 OF 4
DRAWN BY	J. GREENE	DATE	20/05/20
DESIGNED BY	AECOM	DATE	20/05/20

HIGHWAY 12 INTERCHANGE
STA. 14+700 TO STA. 18+700
SASKATOON FREEWAY PROJECT

ACAD DWG:PHASE 1 DESIGN PLATES.DWG
LAST REV DATE: May 26, 2021

Saskatoon Freeway	Saskatchewan	REVISIONS			CS	N/A	TAB NO	A1_11
		NO	DATE	SIGNATURE	PHOTO DATE	N/A	SHEET	3 OF 4
					DRAWN BY	J. GREENE	DATE	20/05/20
					DESIGNED BY	AECOM	DATE	20/05/20
	SCALE 1: 5 000 HORIZONTAL 1: 400 000 VERTICAL				HIGHWAY 11 INTERCHANGE STA. 18+700 TO STA. 22+500 SASKATOON FREEWAY PROJECT			

ACAD DWG:PHASE 1 DESIGN PLATES.DWG
LAST REV DATE: June 4, 2020

Saskatoon Freeway

Saskatchewan

SCALE
1: 5 000 HORIZONTAL
1: 400 000 VERTICAL

REVISIONS		
NO	DATE	SIGNATURE

CS	N/A	TAB NO	A1_Penner
PHOTO DATE	N/A	SHEET	4 OF 4
DRAWN BY	J. GREENE	DATE	20/05/20
DESIGNED BY	AECOM	DATE	20/05/20

PENNER ROAD INTERCHANGE
HIGHWAY 11 STA. 6+700 TO STA. 9+000
SASKATOON FREEWAY PROJECT

ACAD DWG: PHASE 1 DESIGN PLATES.DWG
LAST REV DATE: May 26, 2020

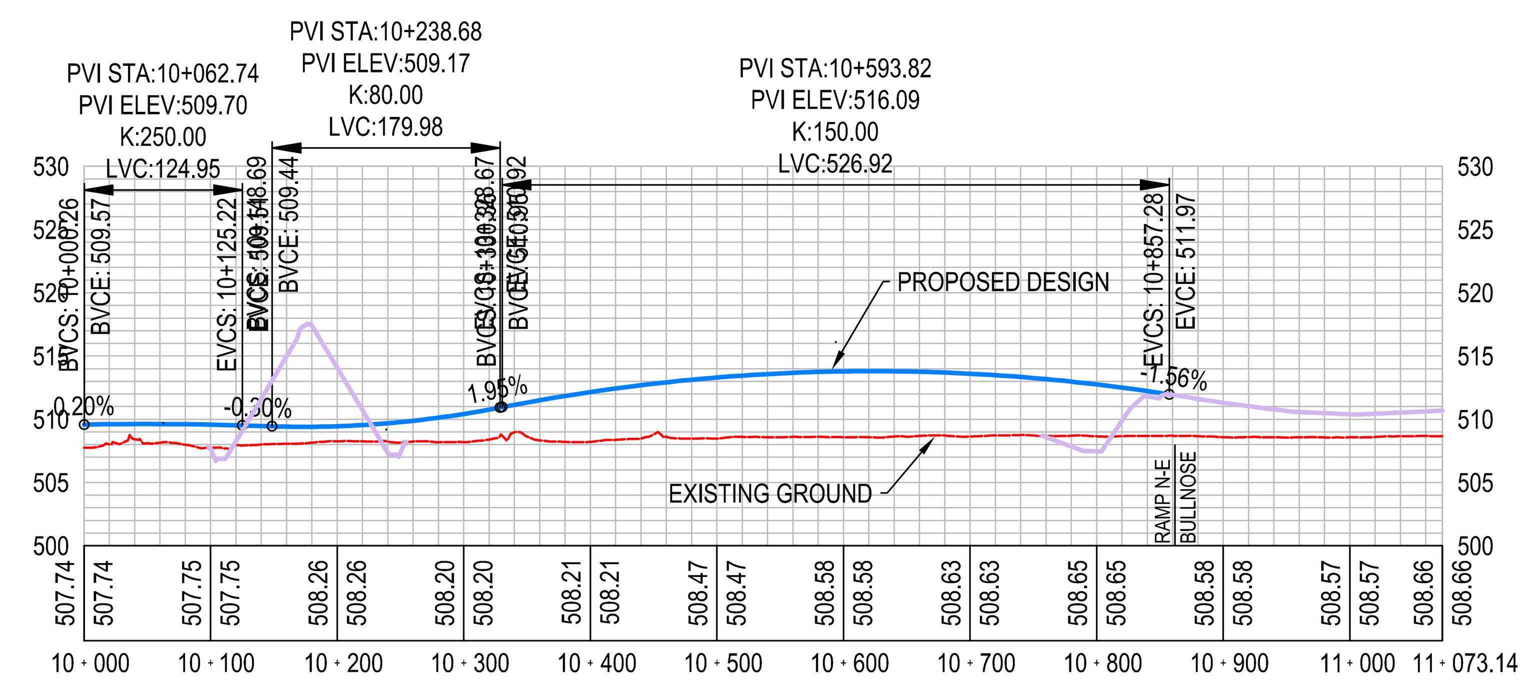
REVISIONS			CS	N/A	TAB NO	A1_16_Profile_1
NO	DATE	SIGNATURE	PHOTO DATE	N/A	SHEET	1 OF 2
			DRAWN BY	J. GREENE	DATE	28/05/20
			DESIGNED BY	AECOM	DATE	28/05/20

SCALE
1: 5 000 HORIZONTAL
1: 50 000 VERTICAL

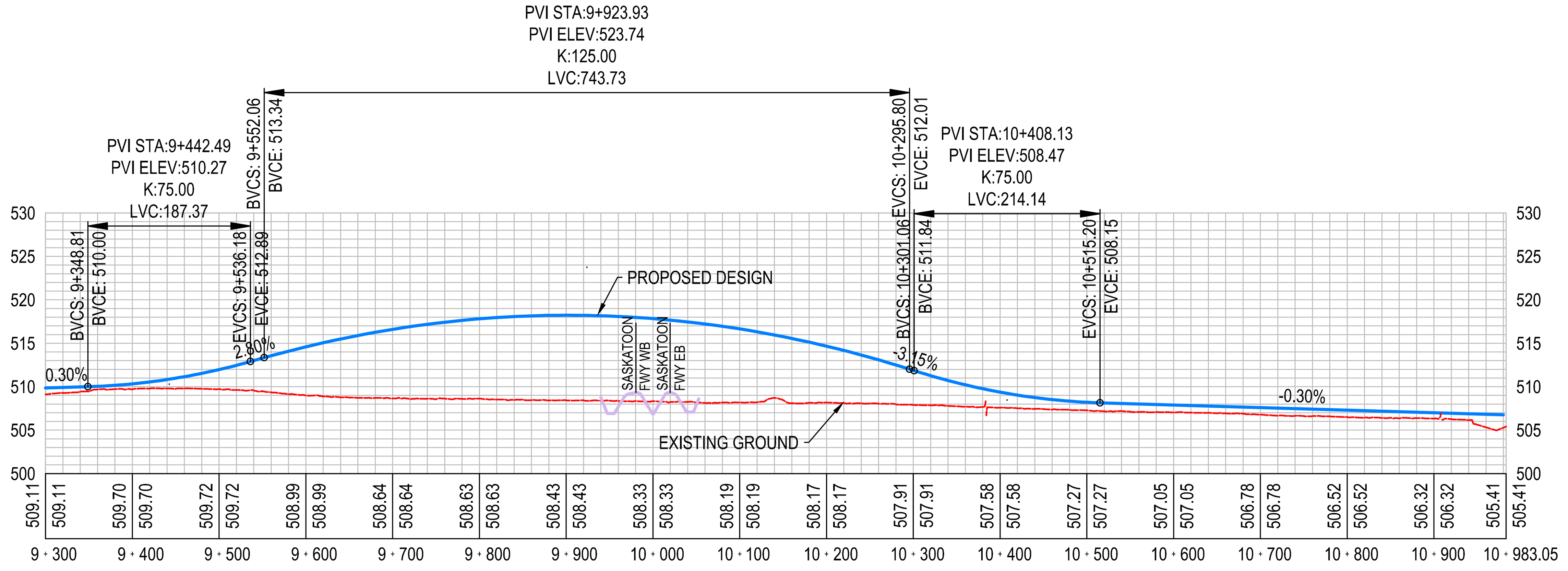
HIGHWAY 16 INTERCHANGE
PROFILES
SASKATOON FREEWAY PROJECT

SASKATOON FREEWAY MAINLINE PROFILE

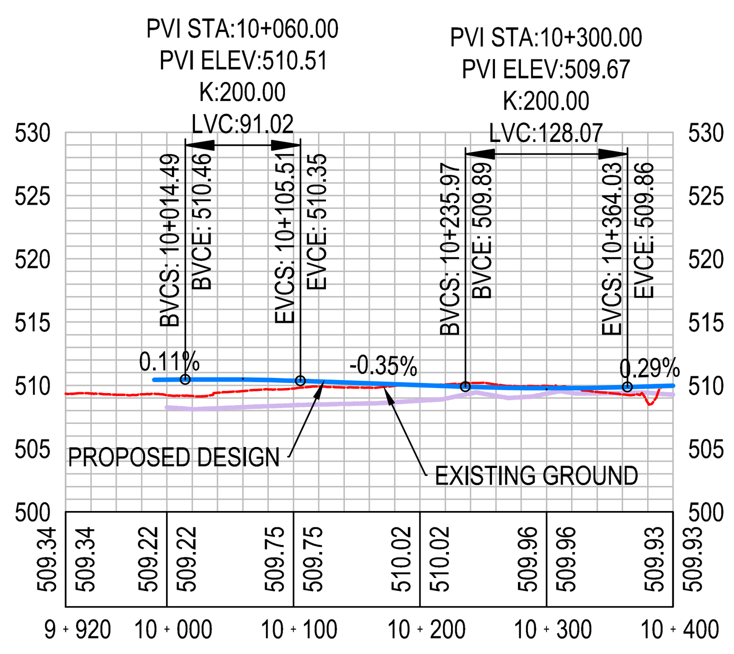
SASKATOON FREEWAY EASTBOUND SHIFT THROUGH INTERCHANGE PROFILE



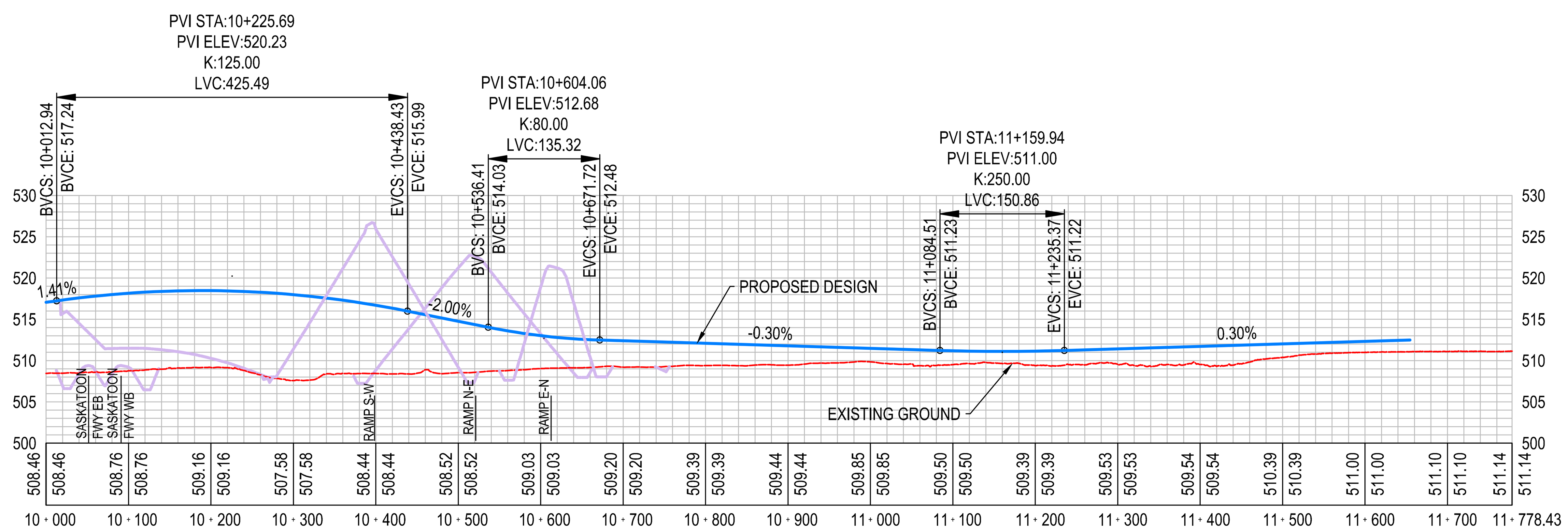
HIGHWAY 16 SOUTHBOUND PROFILE



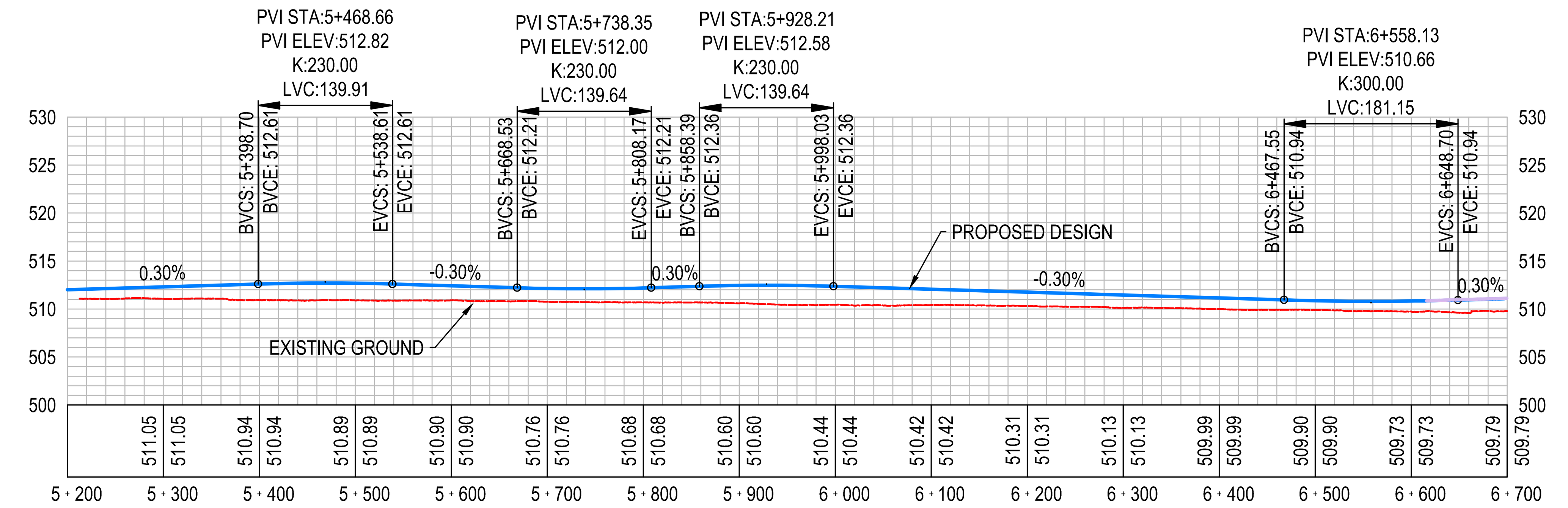
HIGHWAY 16 SOUTHBOUND NORTH OF INTERCHANGE PROFILE



HIGHWAY 16 NORTHBOUND PROFILE



HIGHWAY 16 NORTH OF INTERCHANGE PROFILE



ACAD DWG: X_HWY 16 IC_ALIGNMENT AND PROFILE.DWG
LAST REV DATE: May 28, 2020

Saskatoon Freeway

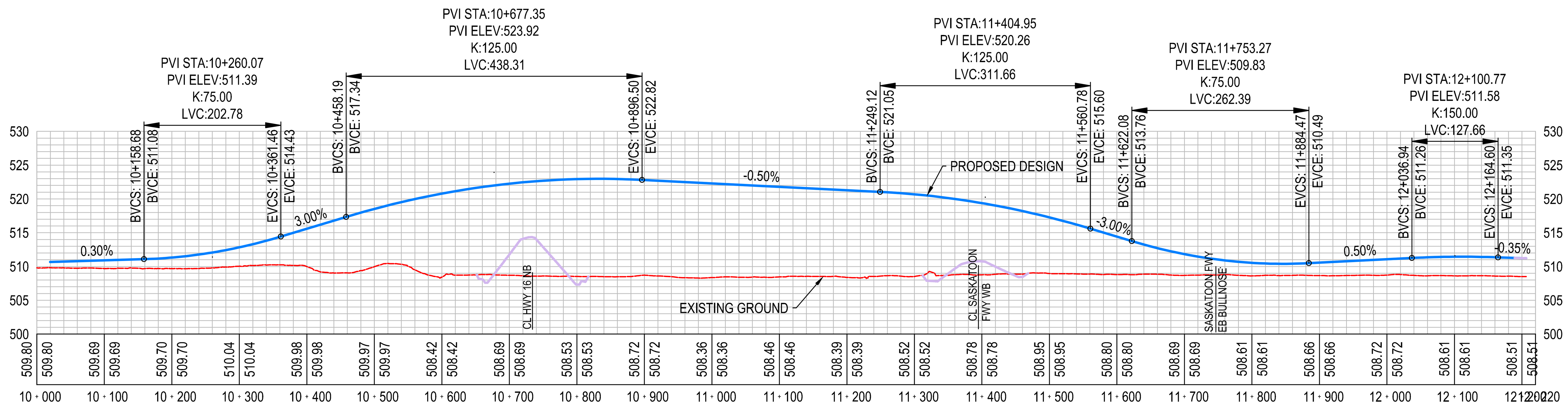
Saskatchewan

SCALE
1: 5 000 HORIZONTAL
1: 50 000 VERTICAL

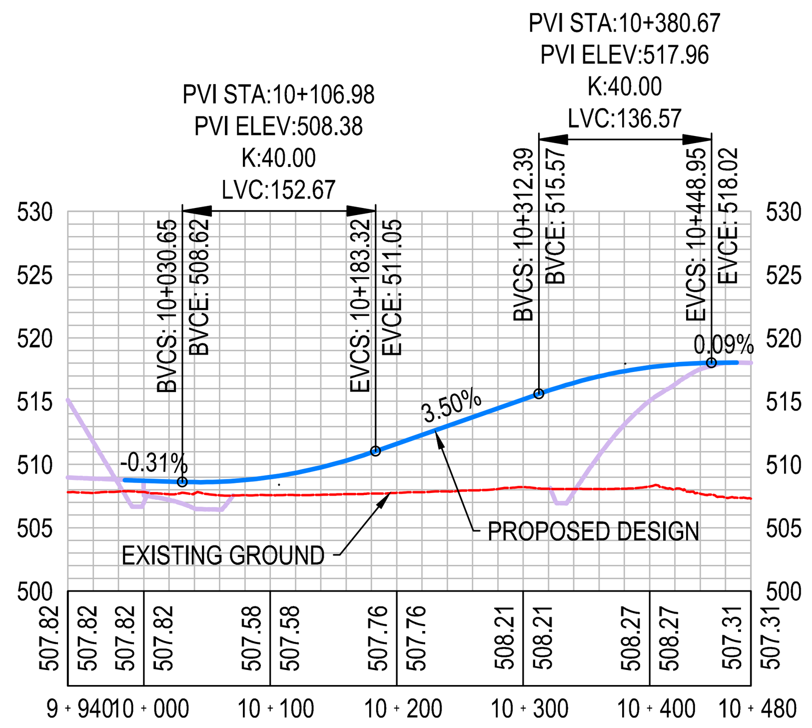
REVISIONS						
NO	DATE	SIGNATURE	CS	N/A	TAB NO	A1_16_Profile_2
			PHOTO DATE	N/A	SHEET	2 OF 2
			DRAWN BY	J. GREENE	DATE	28/05/20
			DESIGNED BY	AECOM	DATE	28/05/20

HIGHWAY 16 INTERCHANGE
PROFILES
SASKATOON FREEWAY PROJECT

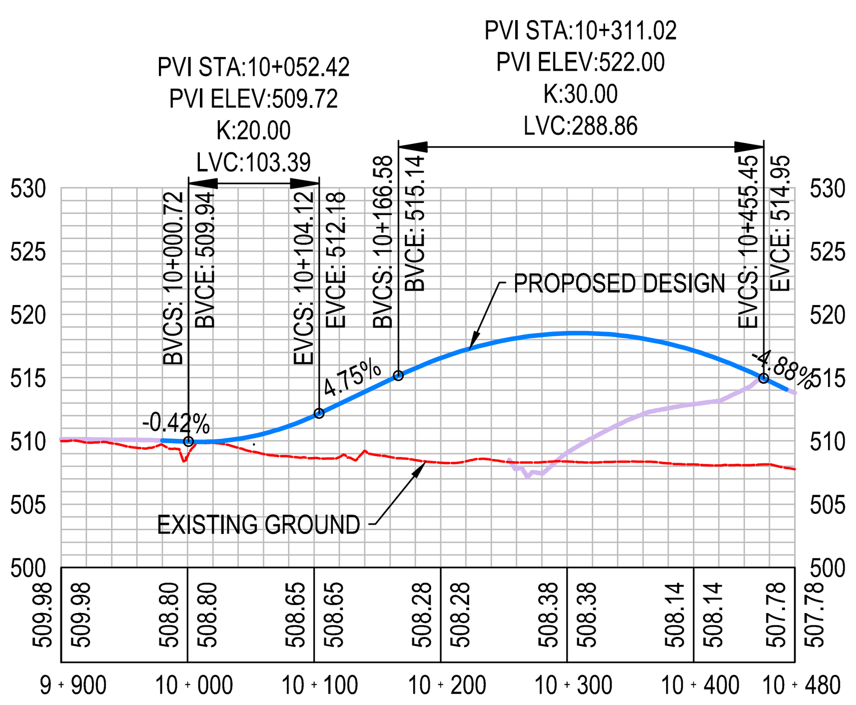
HIGHWAY 16 N-E RAMP PROFILE



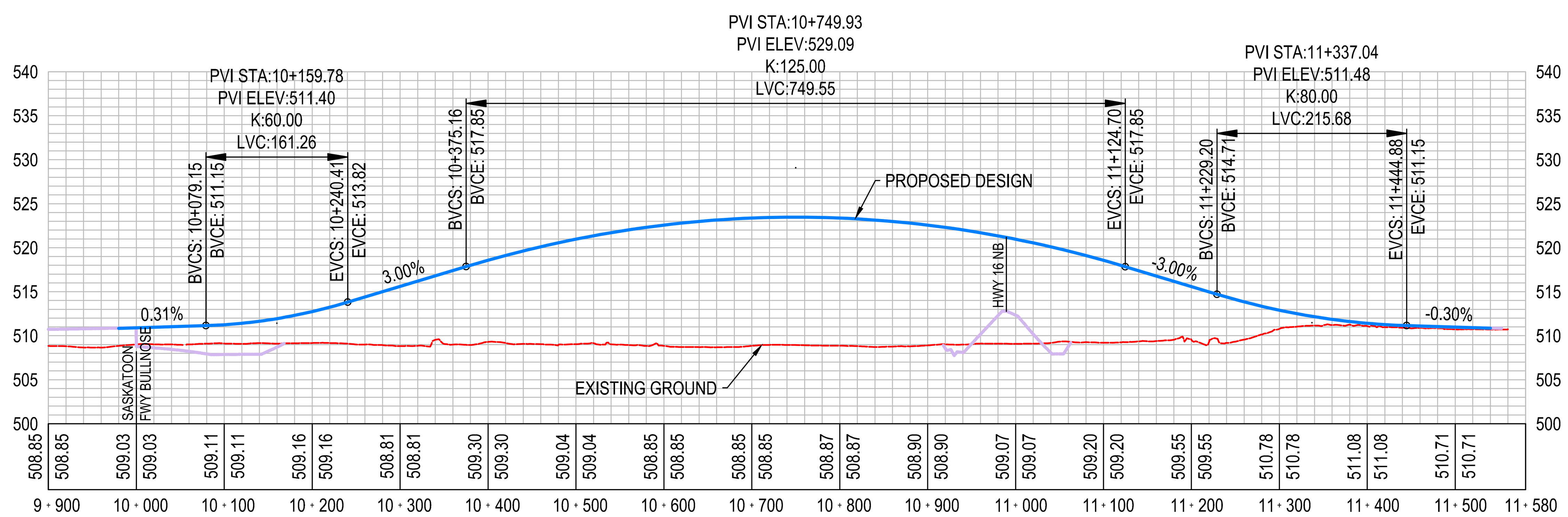
HIGHWAY 16 E-S RAMP PROFILE



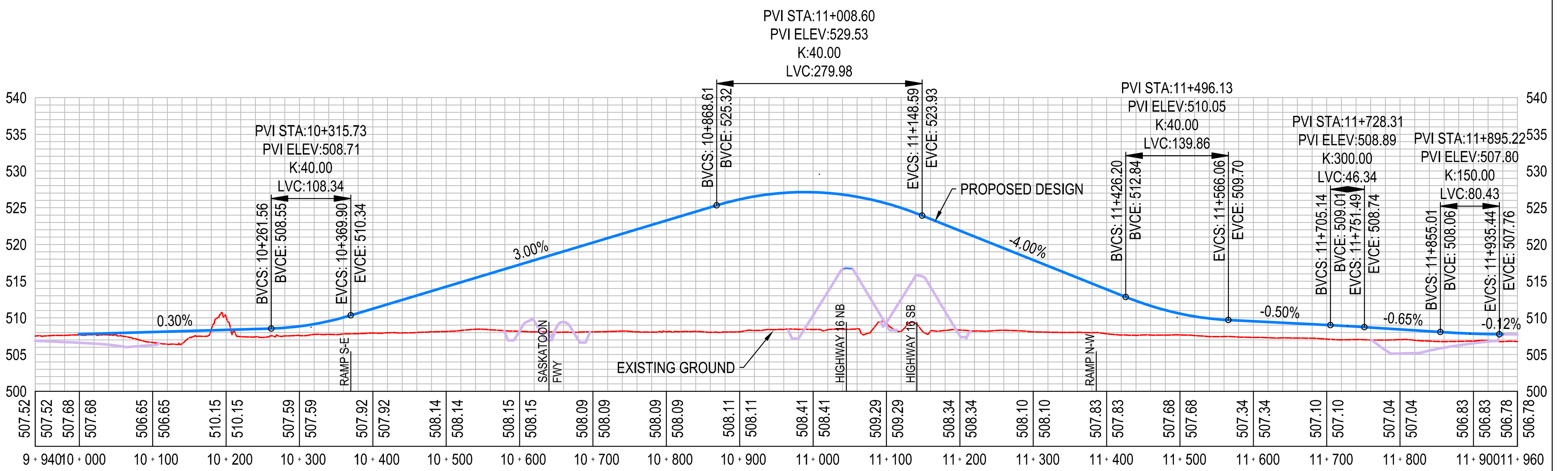
HIGHWAY 16 N-W RAMP PROFILE



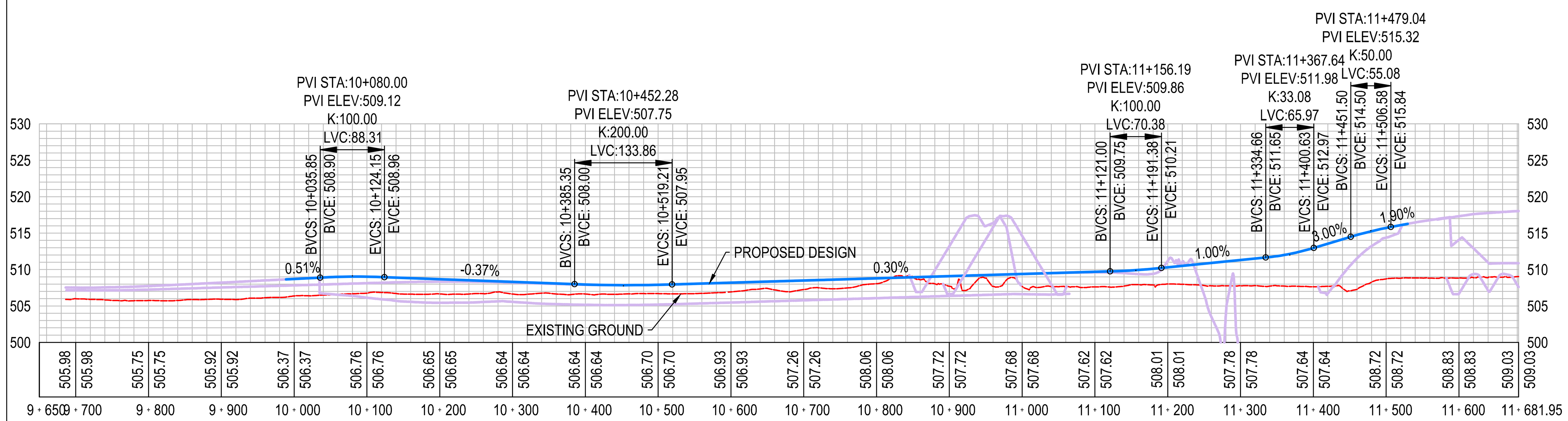
HIGHWAY 16 E-N RAMP PROFILE



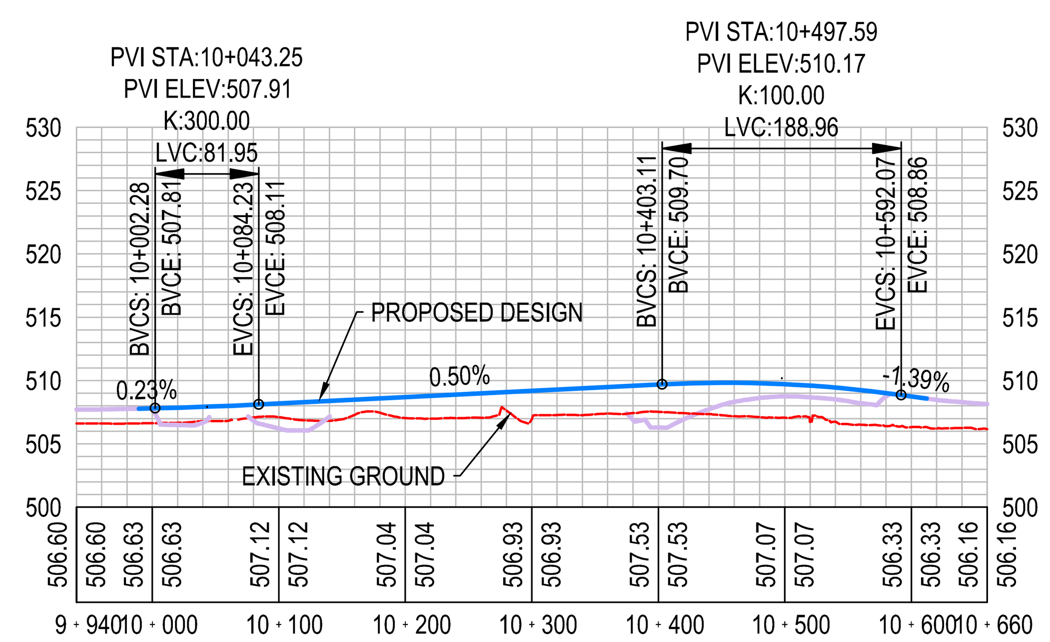
HIGHWAY 16 S-W RAMP PROFILE



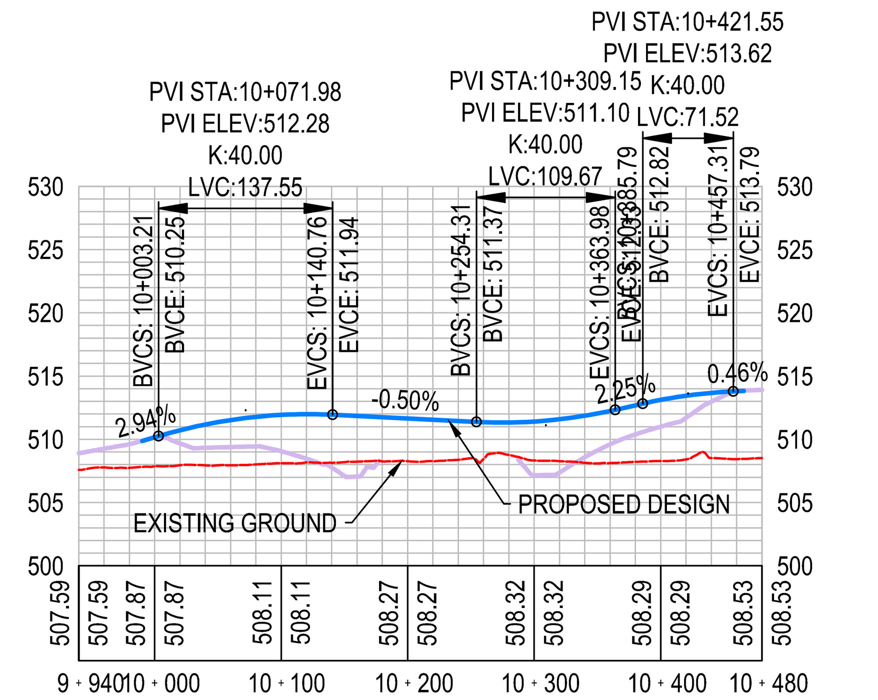
HIGHWAY 16 W-N RAMP PROFILE



HIGHWAY 16 W-S RAMP PROFILE



HIGHWAY 16 S-E RAMP PROFILE



ACAD DWG:X_HWY 16_IC_ALIGNMENT AND PROFILE.DWG
LAST REV DATE: May 29, 2020

Saskatoon Freeway

Saskatchewan

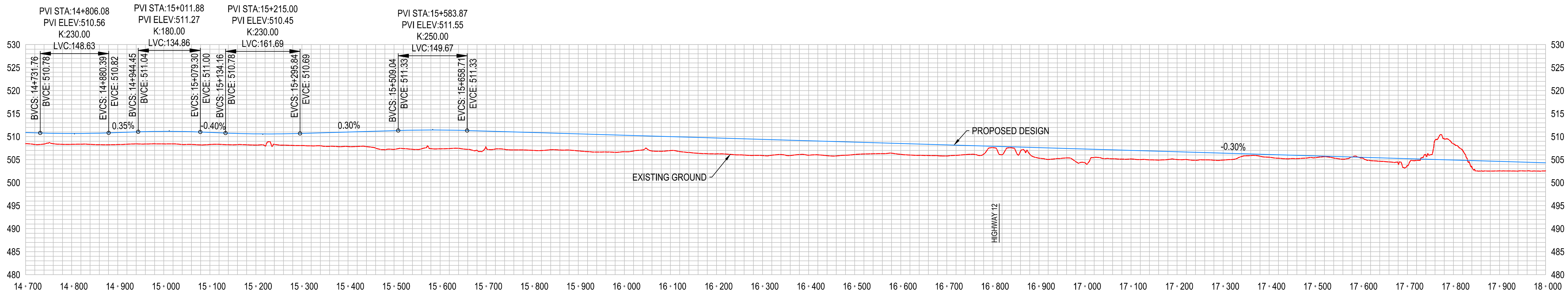
REVISIONS				
NO	DATE	SIGNATURE		

CS	N/A	TAB NO	A1_12_Profile_1
PHOTO DATE	N/A	SHEET	1 OF 2
DRAWN BY	J. GREENE	DATE	28/05/20
DESIGNED BY	AECOM	DATE	28/05/20

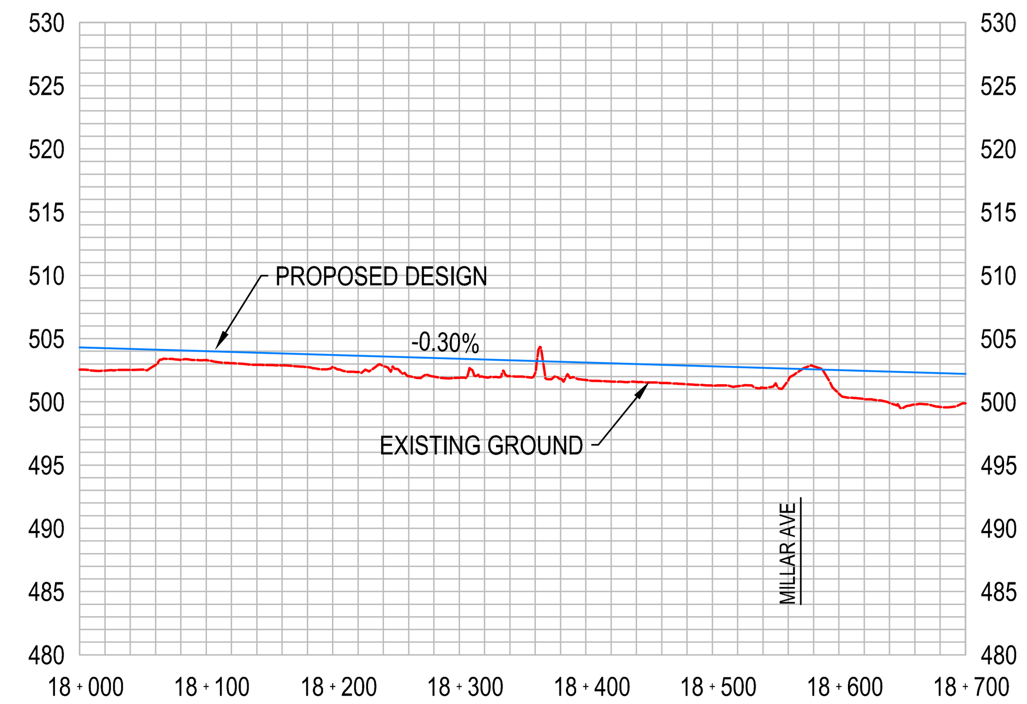
SCALE
1: 5 000 HORIZONTAL
1: 50 000 VERTICAL

HIGHWAY 12 INTERCHANGE
PROFILES
SASKATOON FREEWAY PROJECT

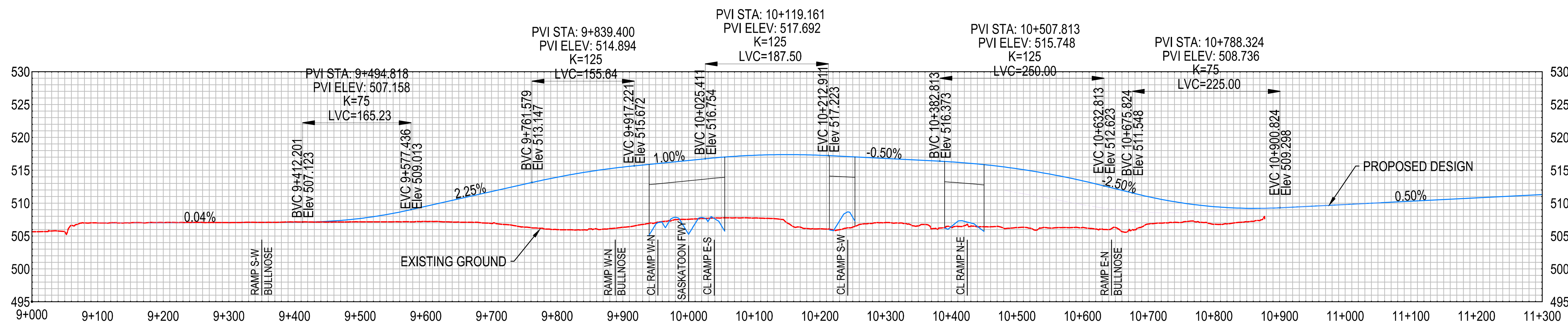
SASKATOON FREEWAY MAINLINE PROFILE



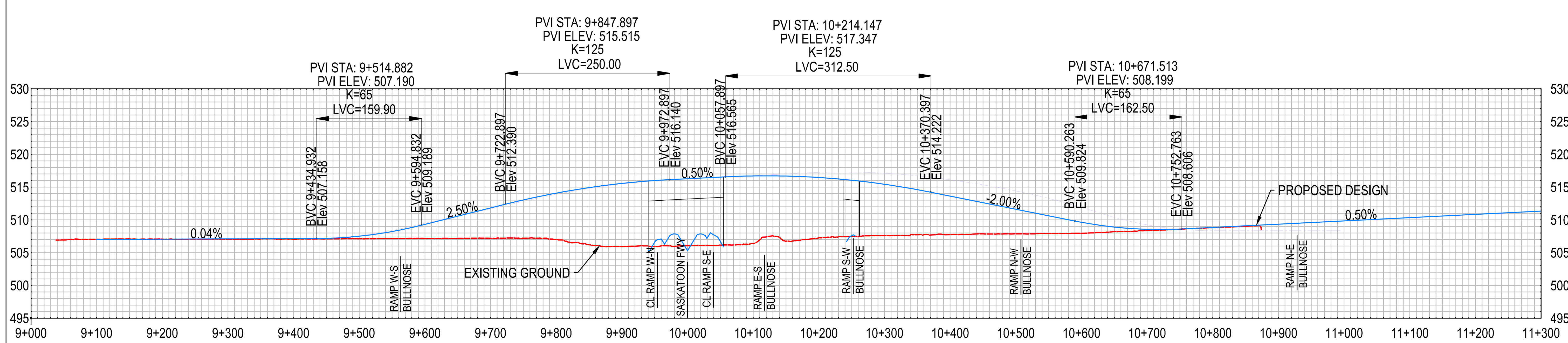
SASKATOON FREEWAY MAINLINE PROFILE



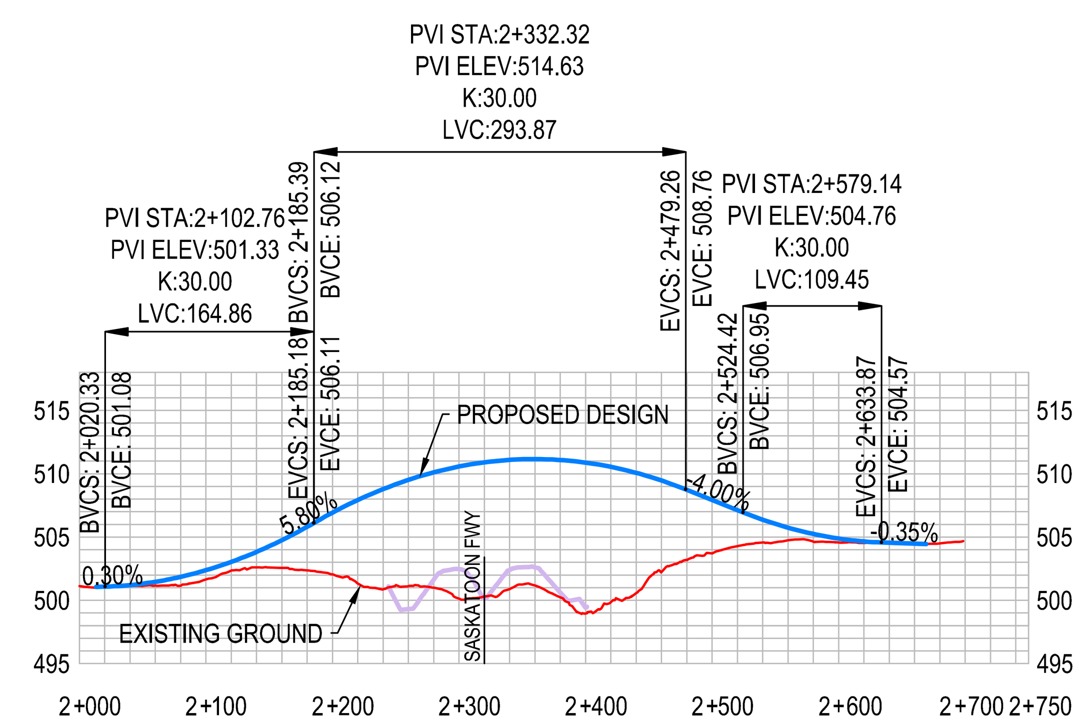
HIGHWAY 12 NORTHBOUND PROFILE



HIGHWAY 12 SOUTHBOUND PROFILE



MILLAR AVE PROFILE



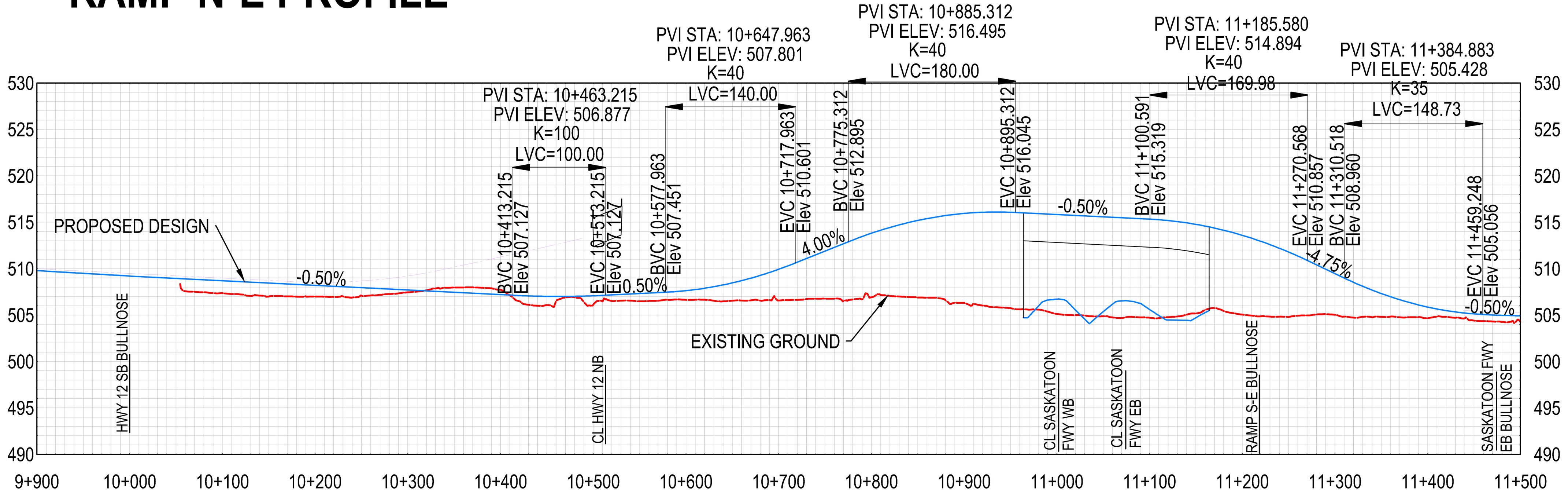
ACAD DWG:X_HWY 12 IC_ALIGNMENT AND PROFILE.DWG
LAST REV DATE: June 1, 2020

Saskatoon Freeway	Saskatchewan	REVISIONS			CS	N/A	TAB NO	A1_12_Profile_2
		NO	DATE	SIGNATURE	PHOTO DATE	N/A	SHEET	2 OF 2
					DRAWN BY	J. GREENE	DATE	28/05/20
					DESIGNED BY	AECOM	DATE	28/05/20

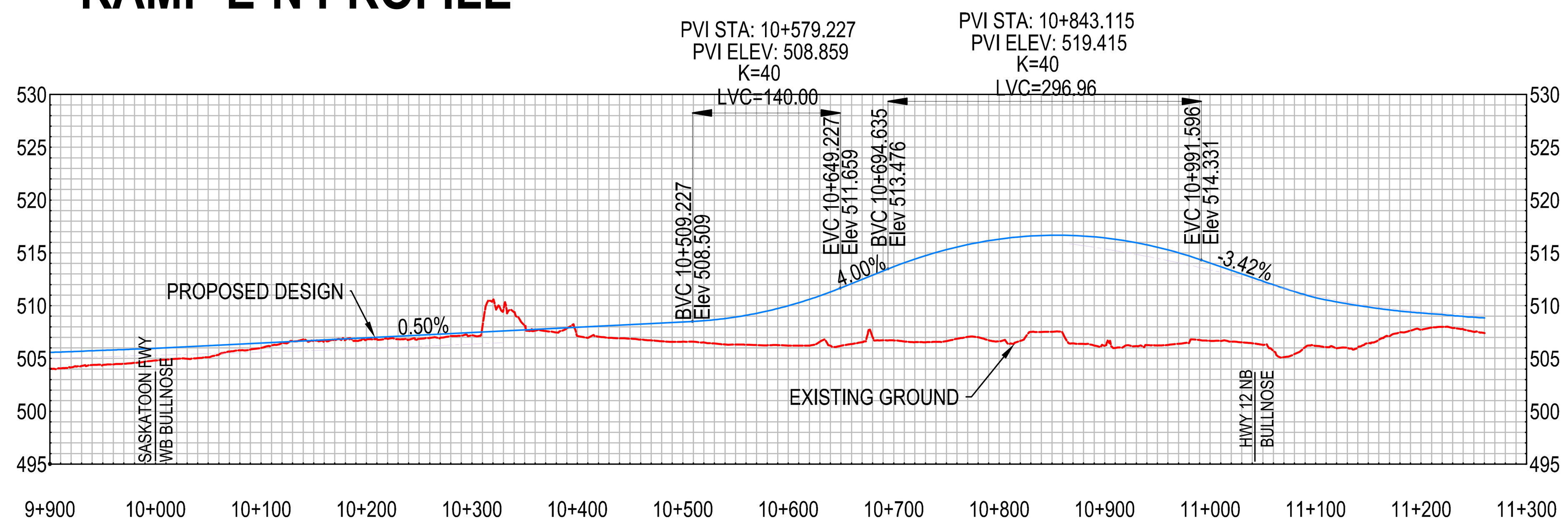
SCALE
1: 5 000 HORIZONTAL
1: 50 000 VERTICAL

HIGHWAY 12 INTERCHANGE
PROFILES
SASKATOON FREEWAY PROJECT

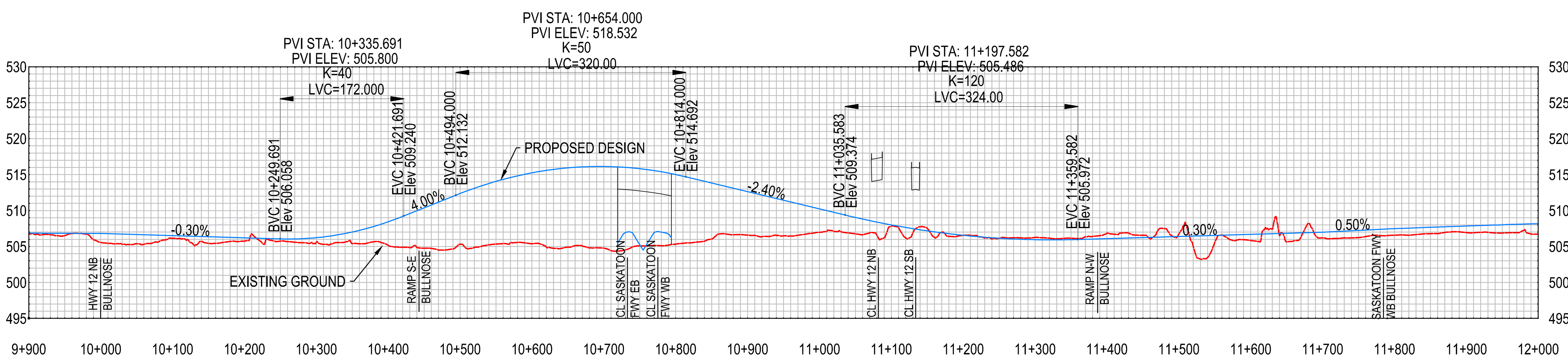
RAMP N-E PROFILE



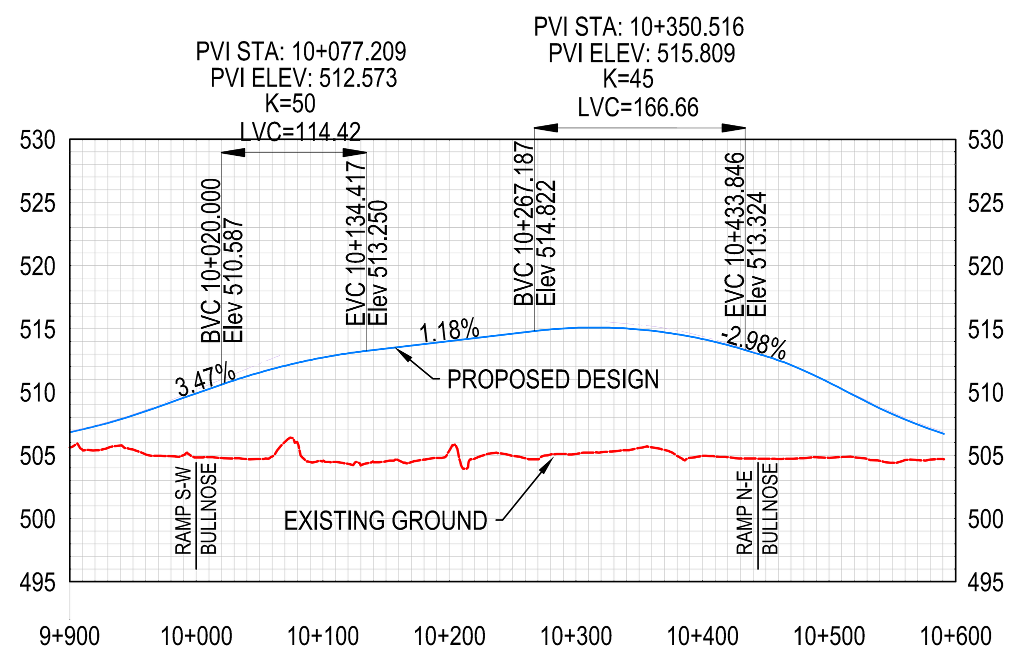
RAMP E-N PROFILE



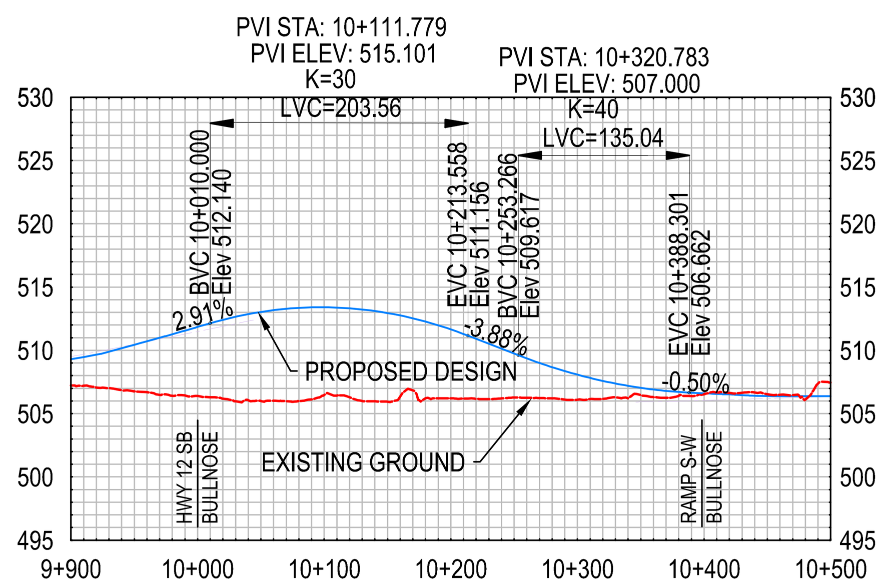
RAMP S-W PROFILE



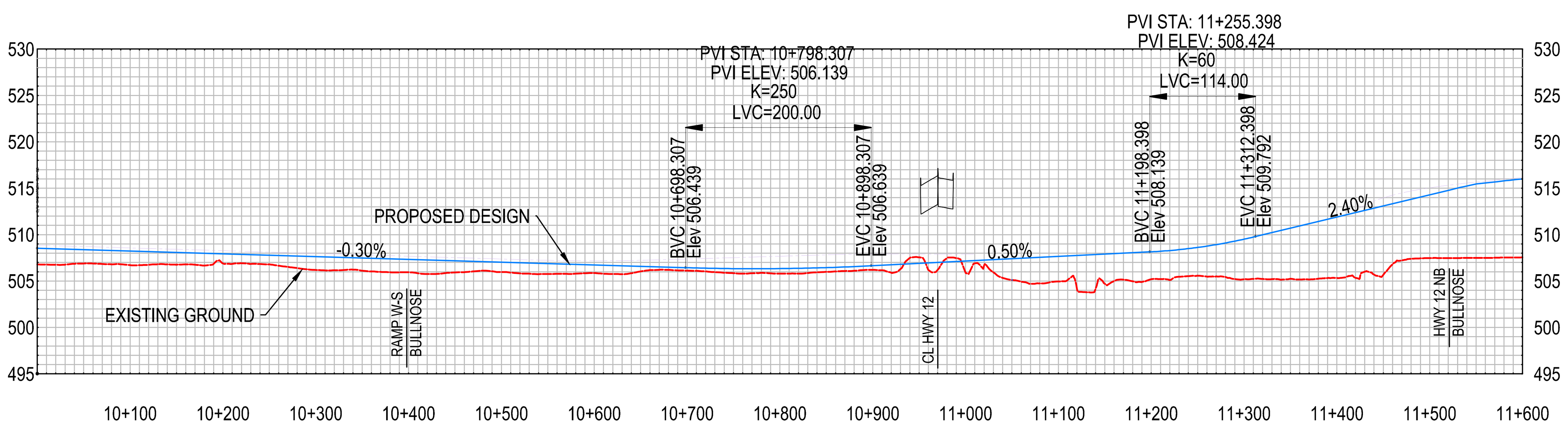
RAMP S-E PROFILE



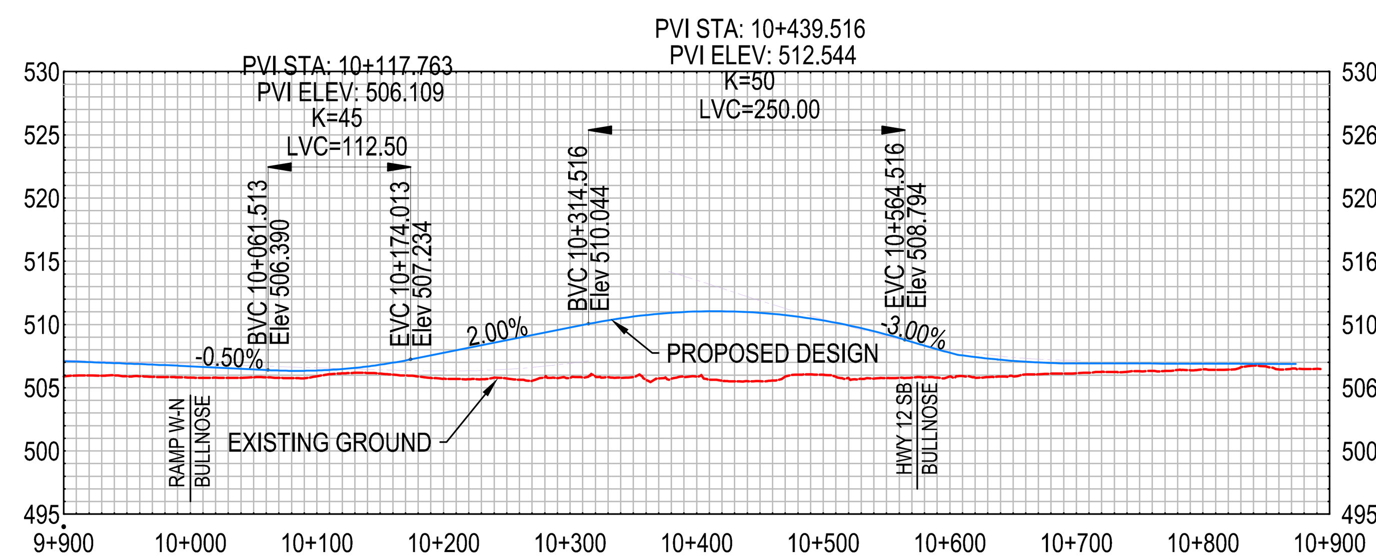
RAMP N-W PROFILE



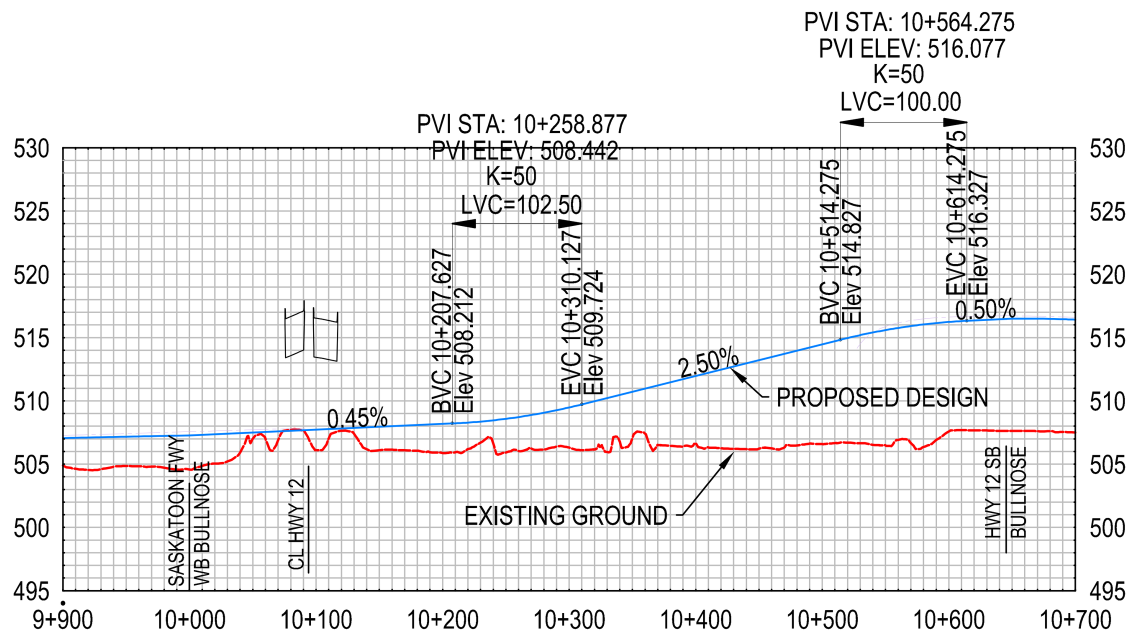
RAMP W-N PROFILE



RAMP W-S PROFILE



RAMP E-S PROFILE



ACAD DWG: X_HWY 12 IC_ALIGNMENT AND PROFILE.DWG
LAST REV DATE: June 1, 2020

Saskatoon Freeway

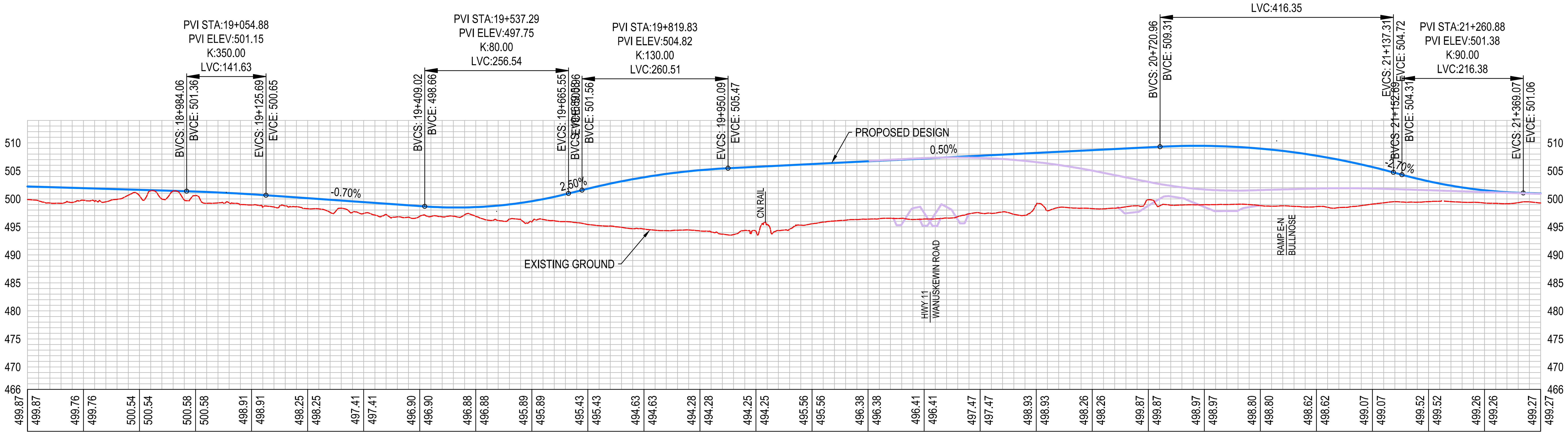
Saskatchewan

REVISIONS			CS	N/A	TAB NO	A1_11_Profile_1
NO	DATE	SIGNATURE	PHOTO DATE	N/A	SHEET	1 OF 3
			DRAWN BY	J. GREENE	DATE	28/05/20
			DESIGNED BY	AECOM	DATE	28/05/20

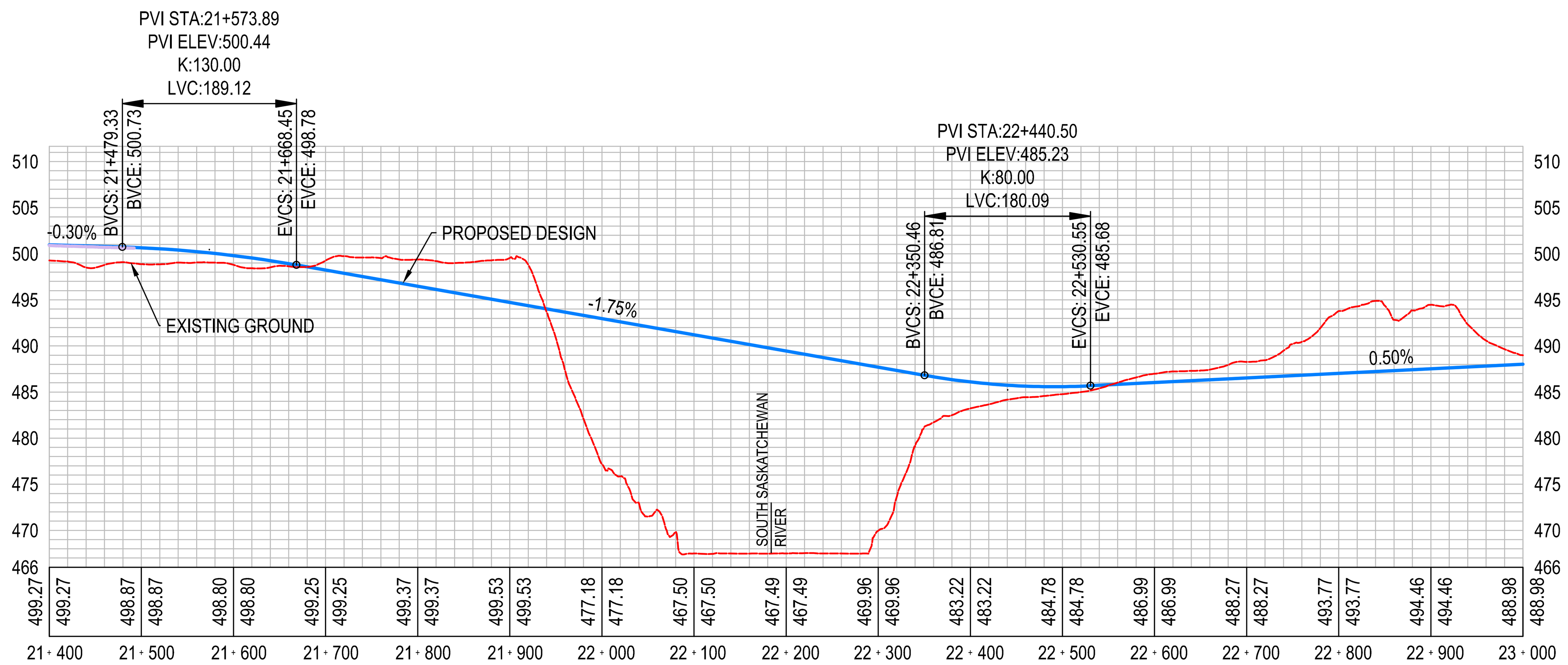
SCALE
1: 5 000 HORIZONTAL
1: 50 000 VERTICAL

HIGHWAY 11 INTERCHANGE
PROFILES
SASKATOON FREEWAY PROJECT

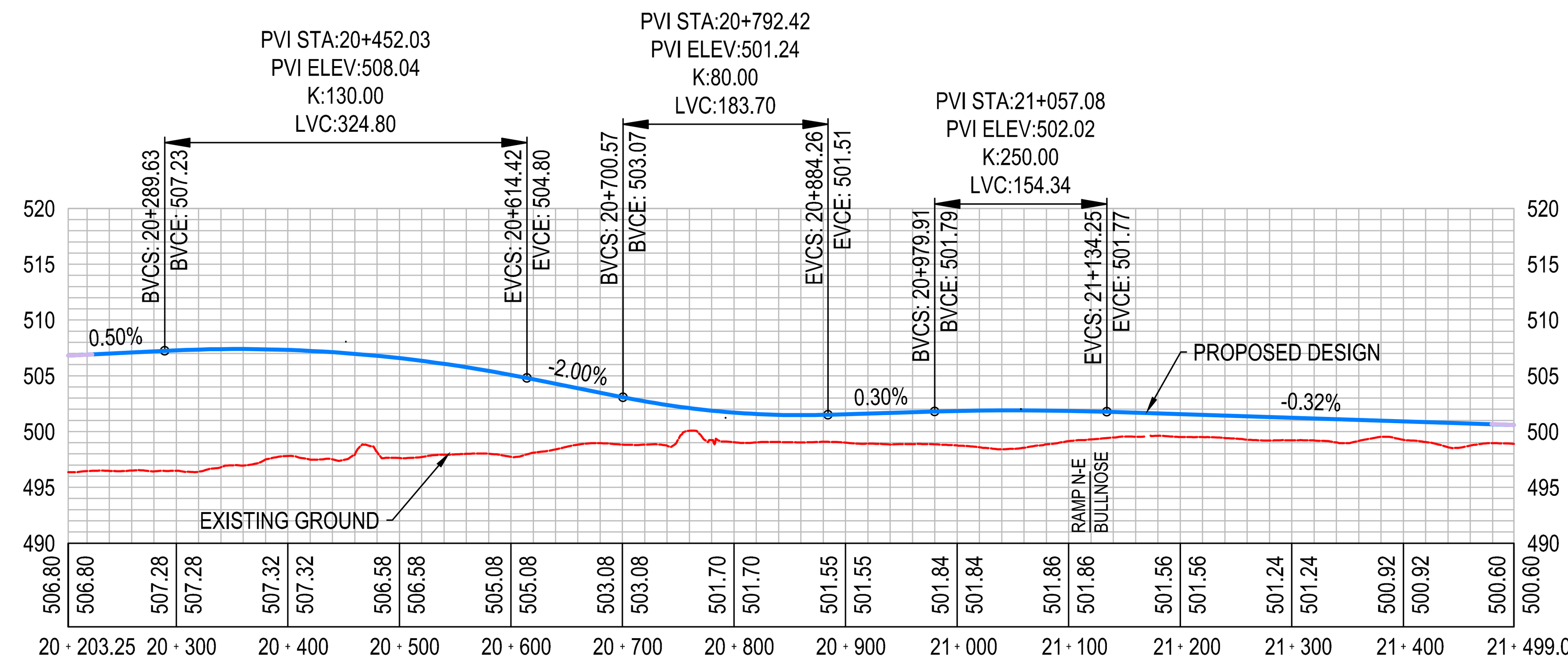
SASKATOON FREEWAY MAINLINE PROFILE



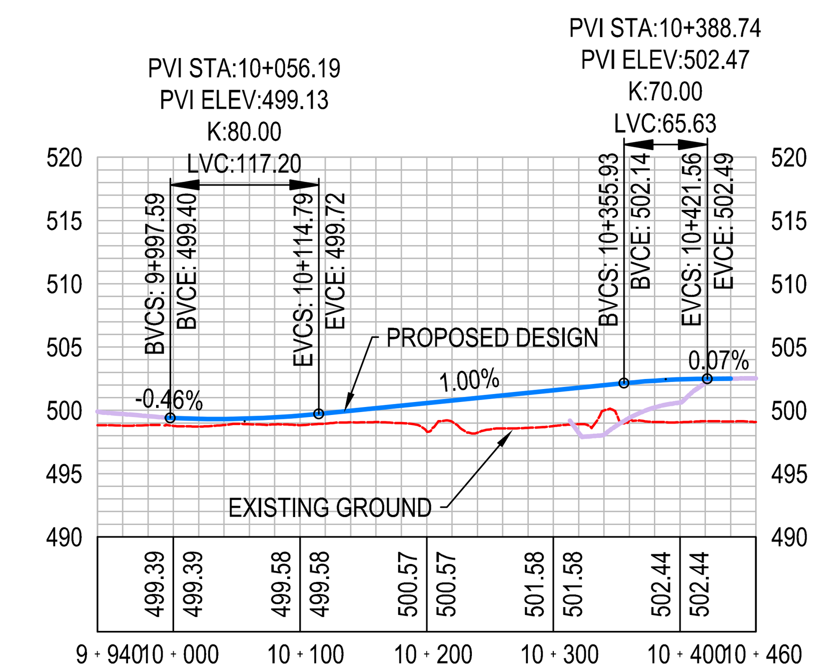
SASKATOON FREEWAY MAINLINE PROFILE



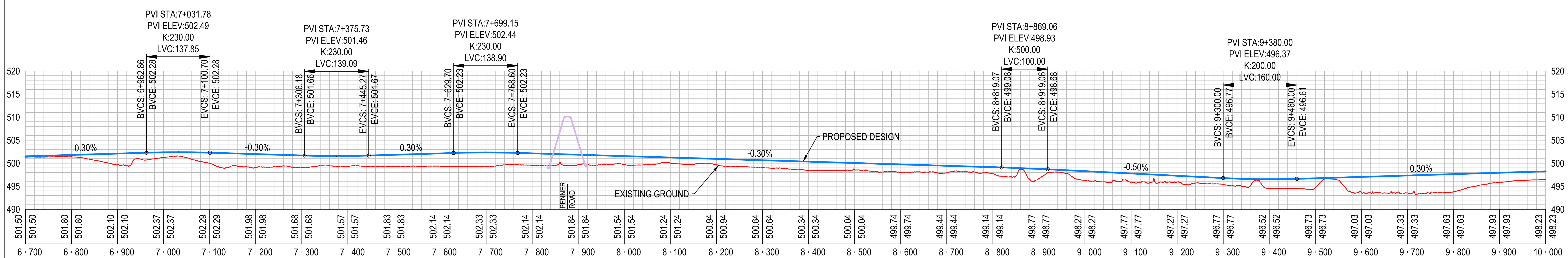
SASKATOON FREEWAY EASTBOUND SHIFT THROUGH INTERCHANGE PROFILE



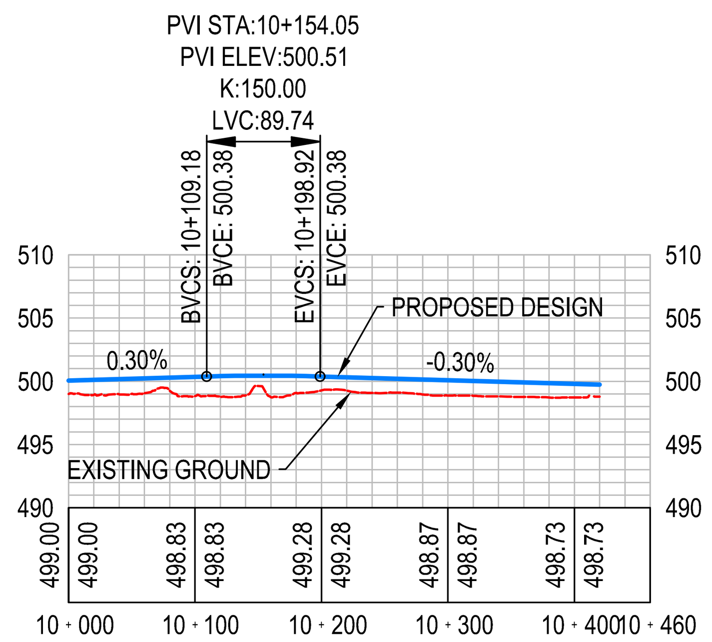
RAMP S-E PROFILE



HIGHWAY 11 PROFILE



HIGHWAY 11 SOUTH CONNECTION PROFILE



ACAD DWG:X_HWY 11 IC_ALIGNMENT AND PROFILE.DWG
LAST REV DATE: May 29, 2020

Saskatoon Freeway

Saskatchewan

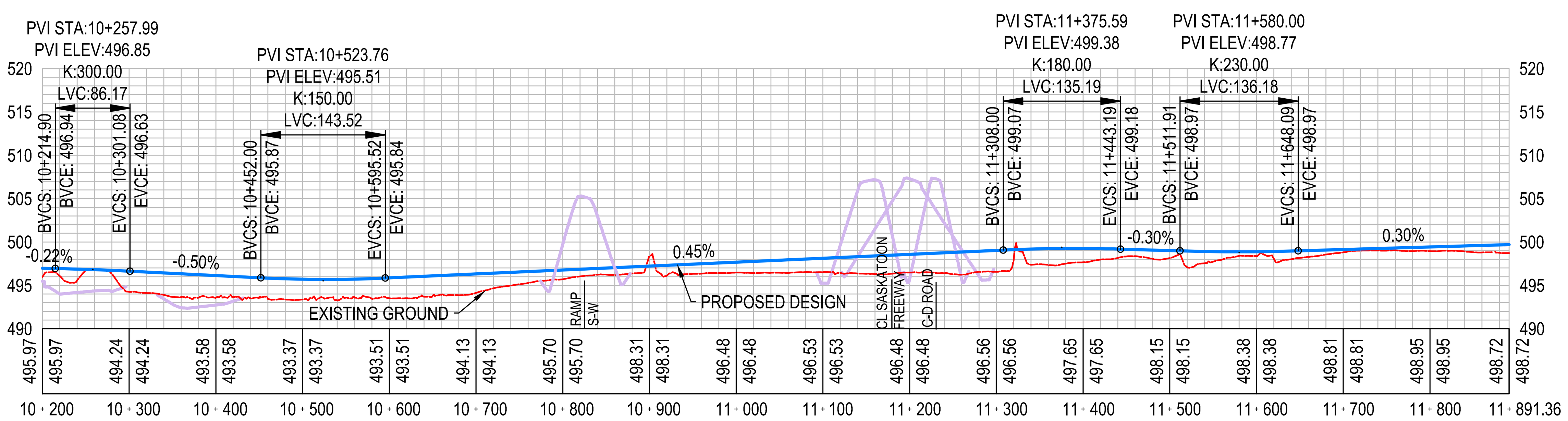
REVISIONS		
NO	DATE	SIGNATURE

SCALE
1: 5 000 HORIZONTAL
1: 50 000 VERTICAL

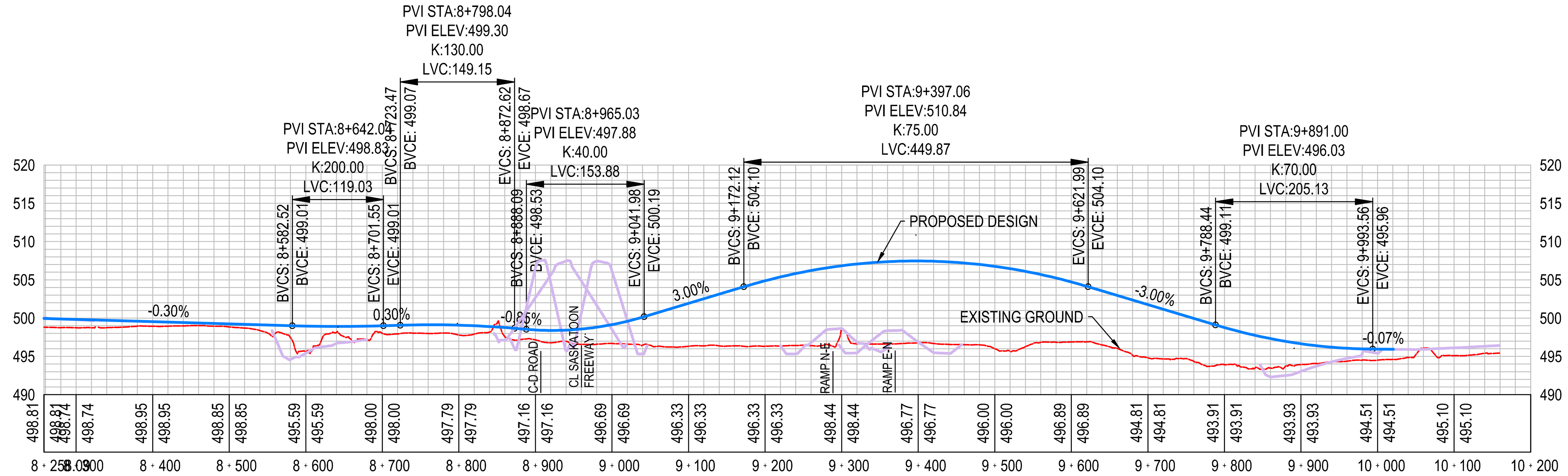
CS	N/A	TAB NO	A1_11_Profile_2
PHOTO DATE	N/A	SHEET	2 OF 3
DRAWN BY	J. GREENE	DATE	28/05/20
DESIGNED BY	AECOM	DATE	28/05/20

HIGHWAY 11 INTERCHANGE
PROFILES
SASKATOON FREEWAY PROJECT

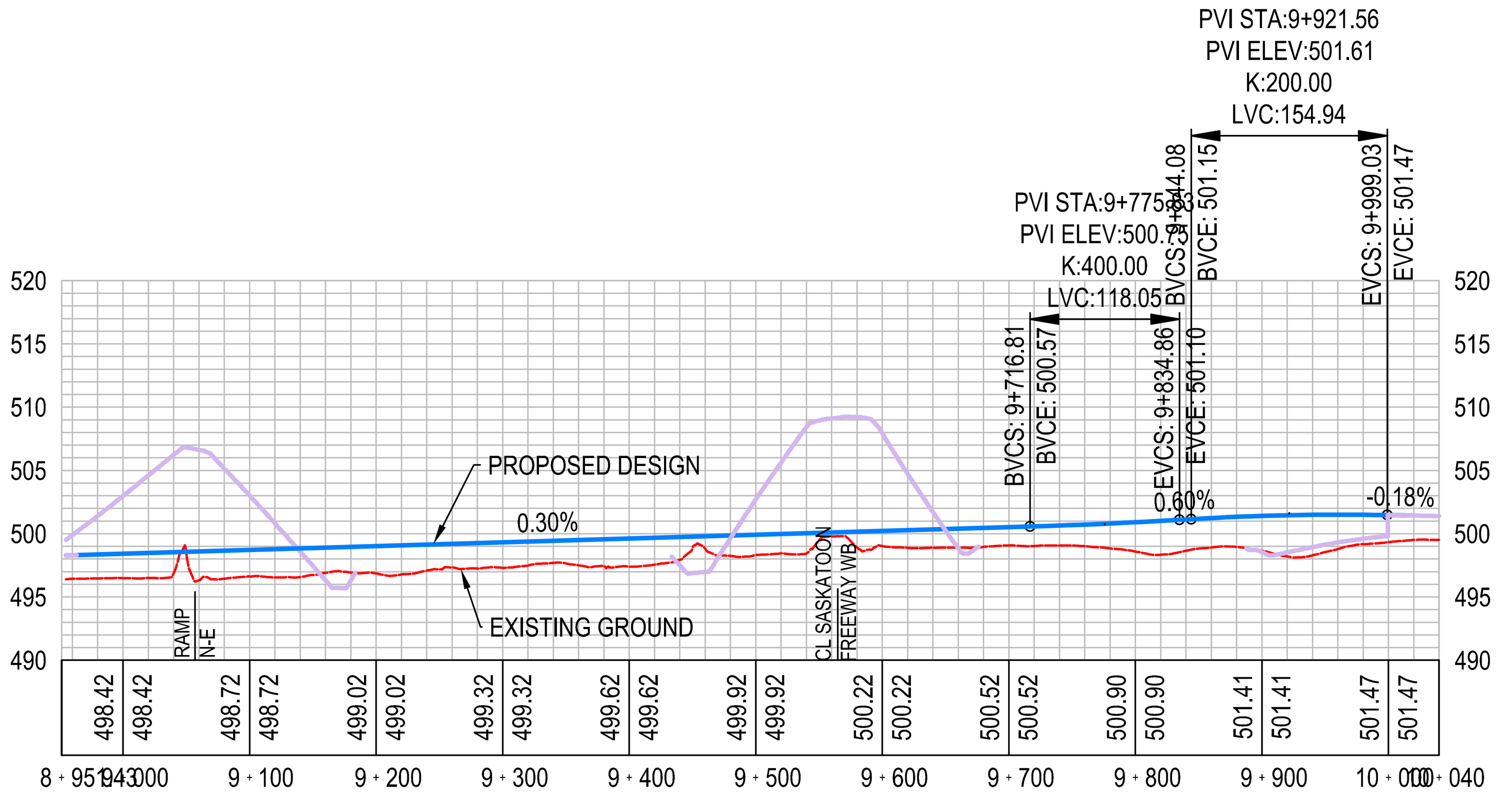
RAMP N-S PROFILE



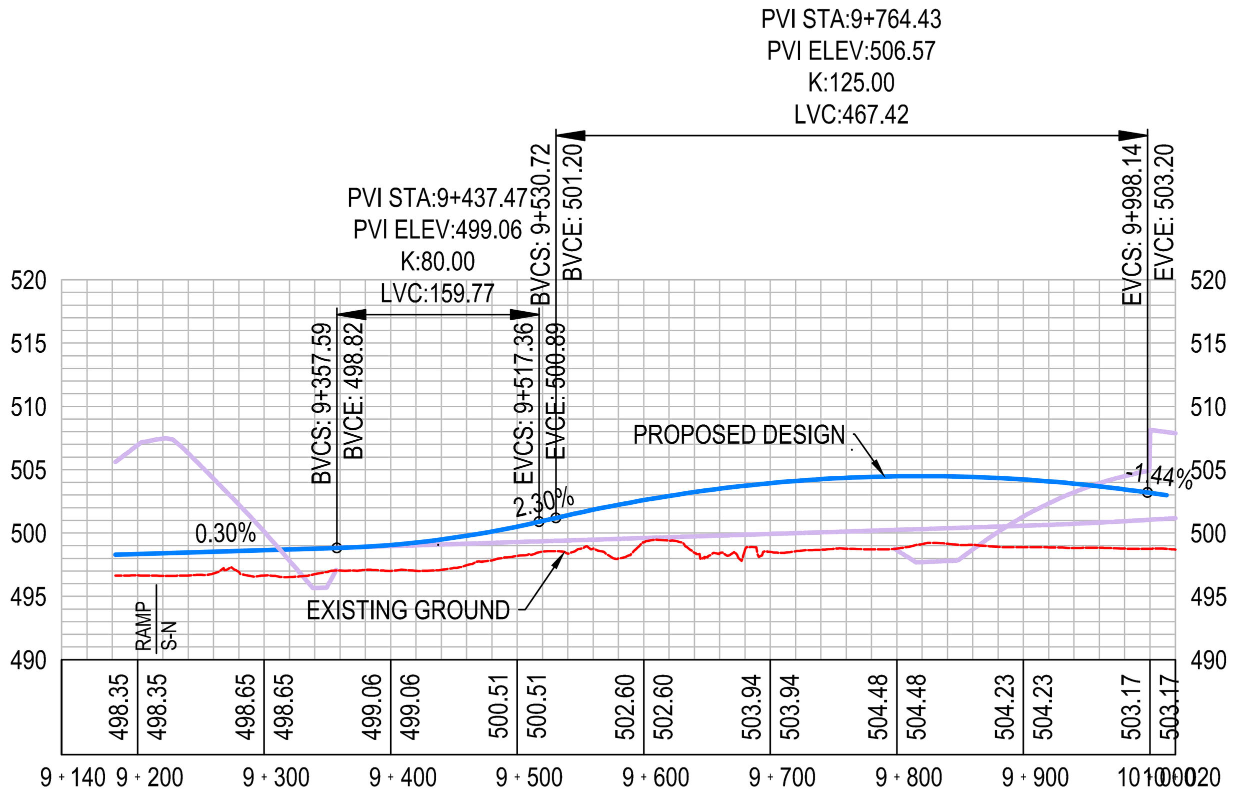
RAMP S-N PROFILE



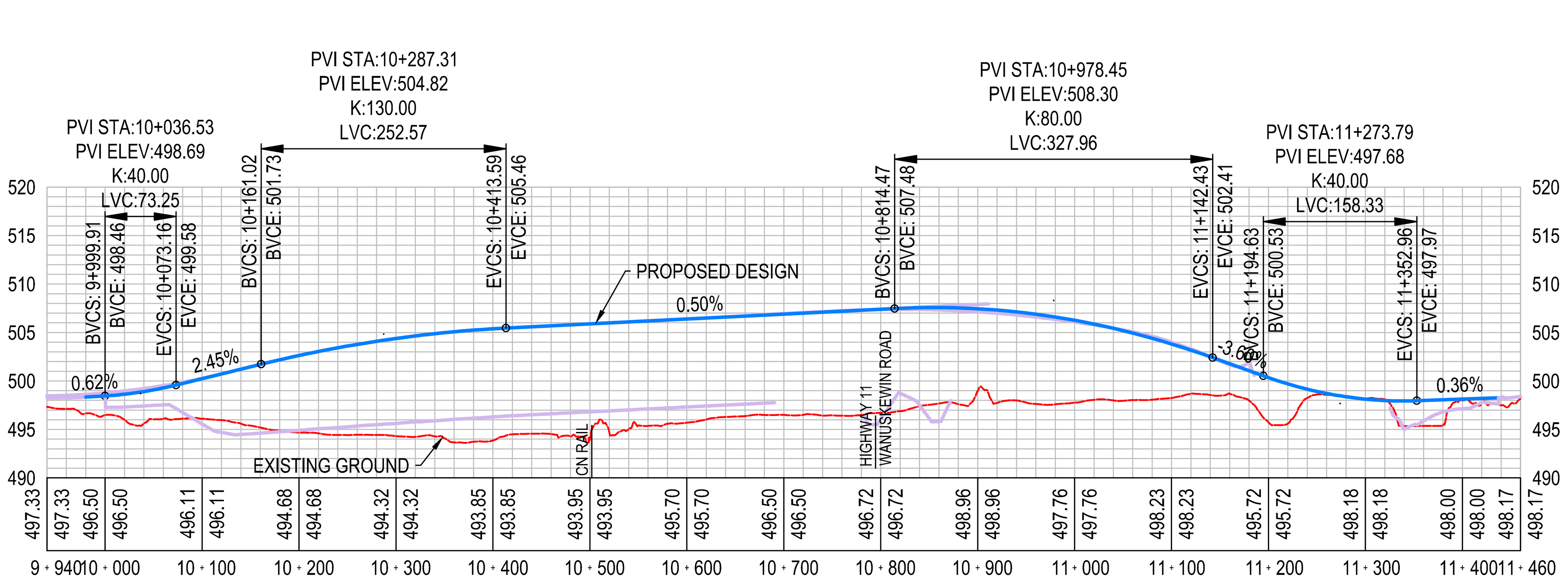
RAMP N-E PROFILE



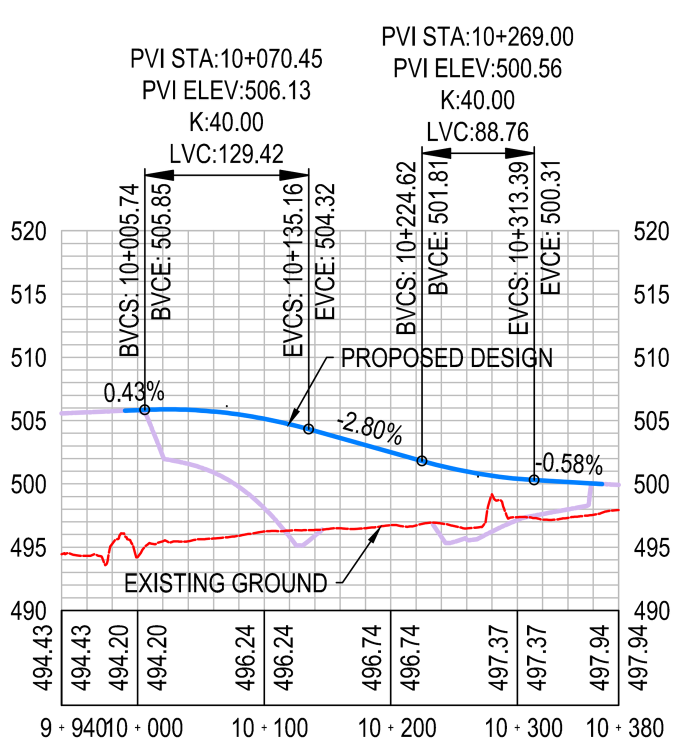
RAMP E-N PROFILE



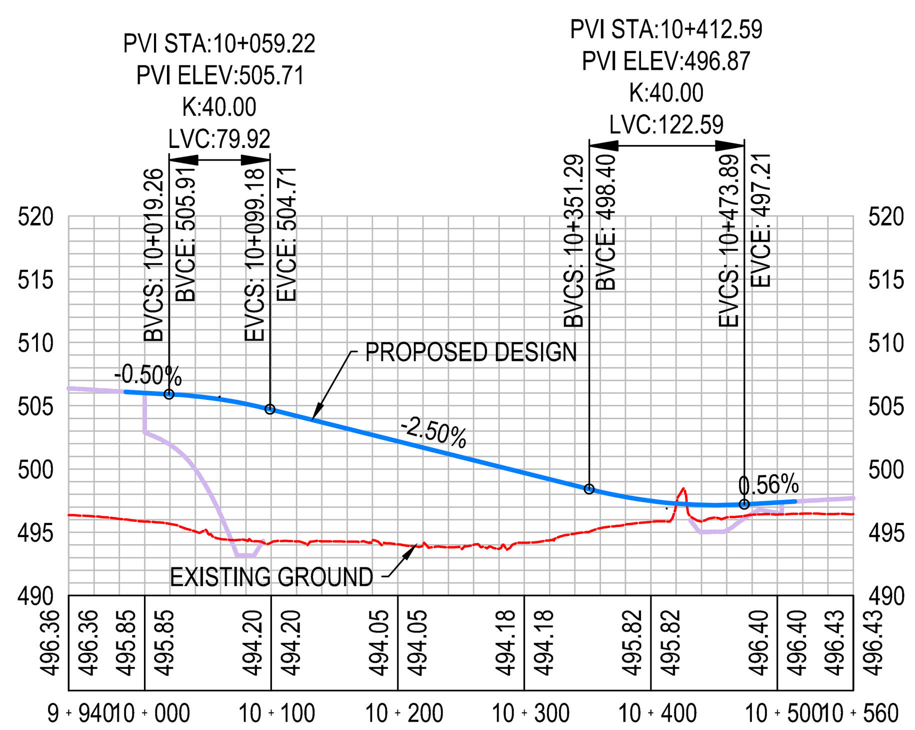
RAMP W-N PROFILE



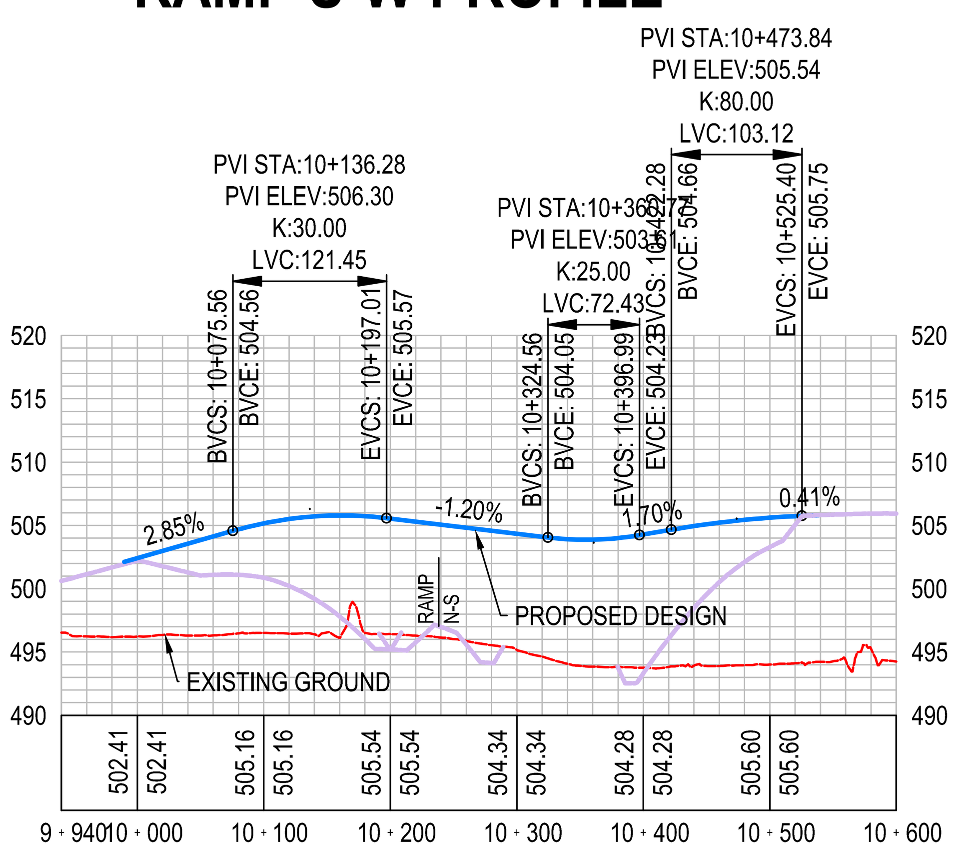
RAMP W-S PROFILE



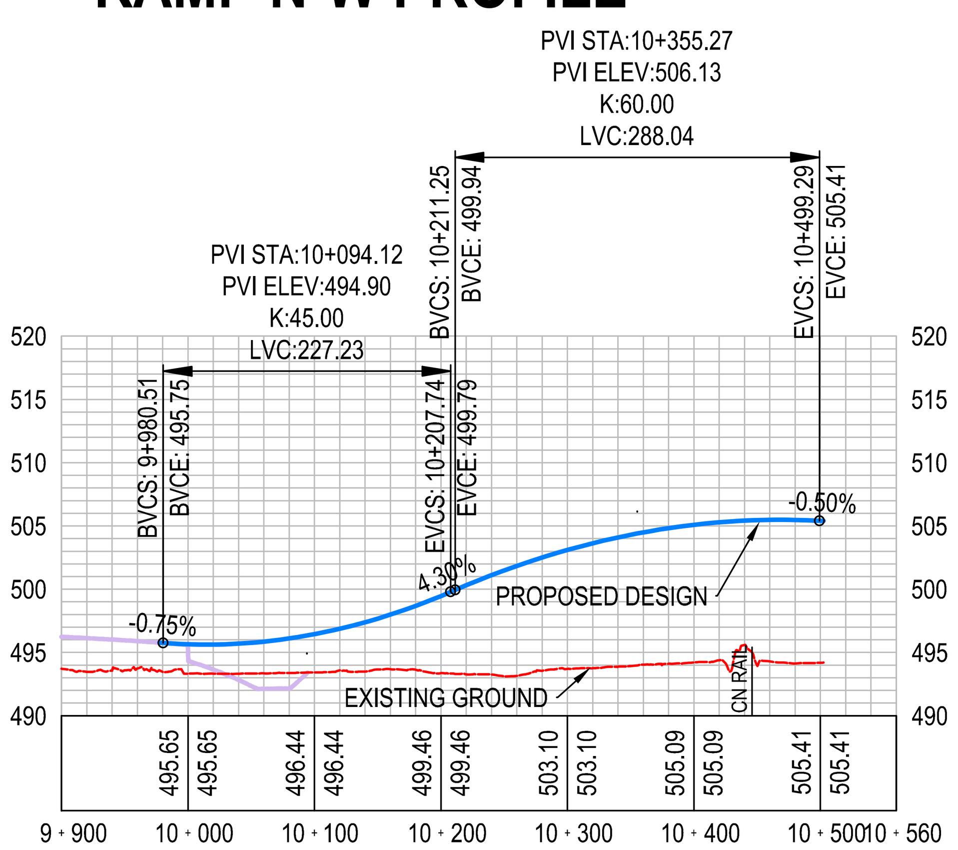
RAMP E-S PROFILE



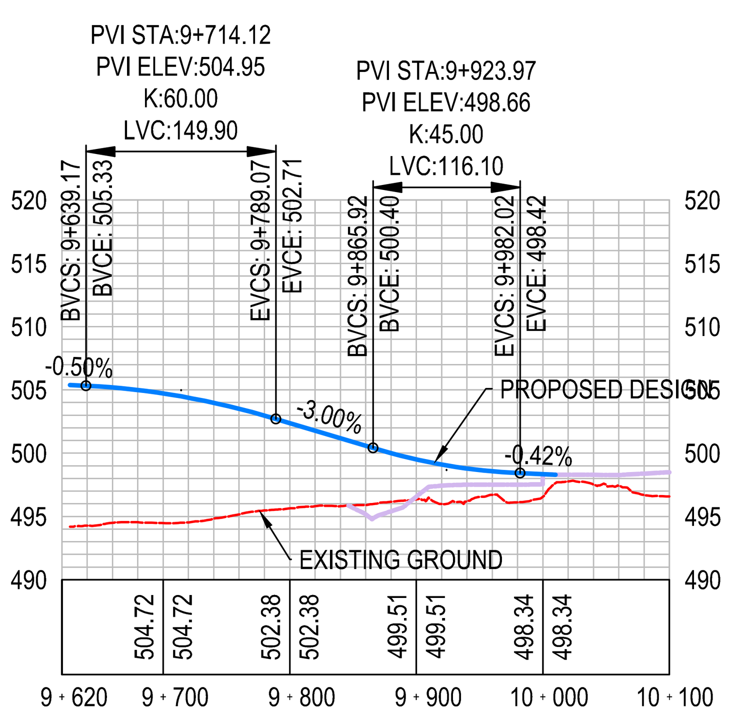
RAMP S-W PROFILE



RAMP N-W PROFILE



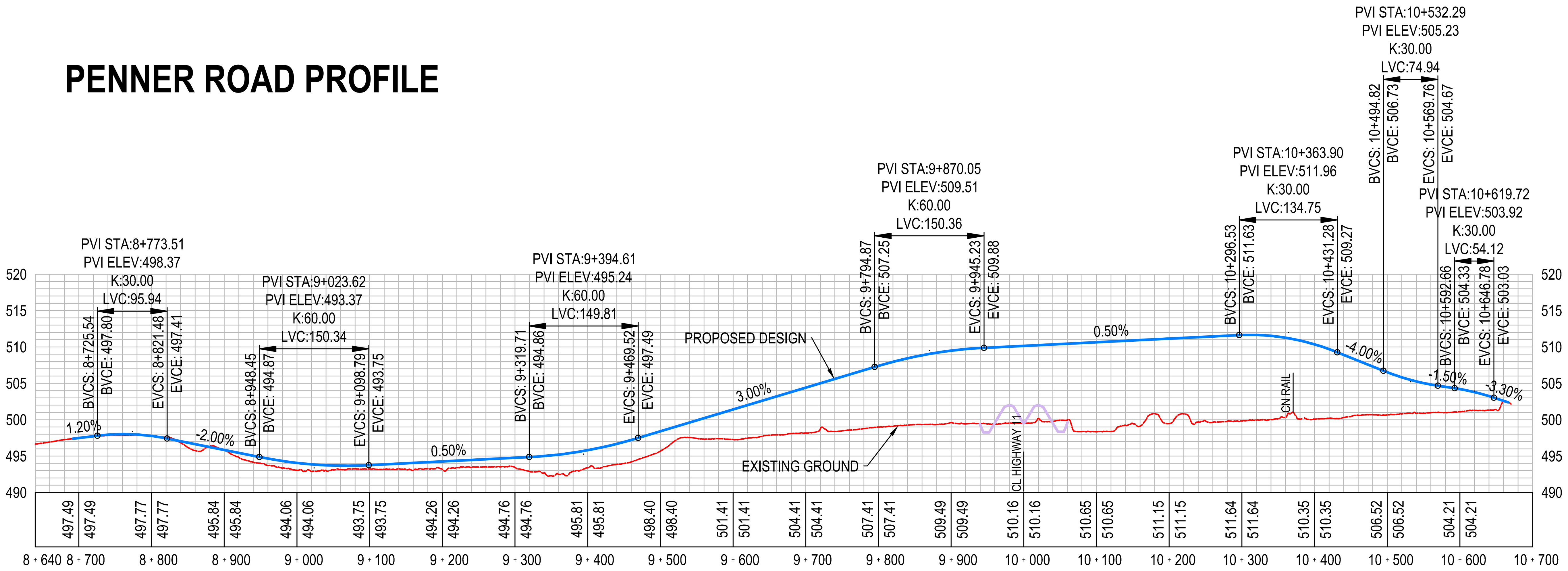
RAMP N/S-W PROFILE



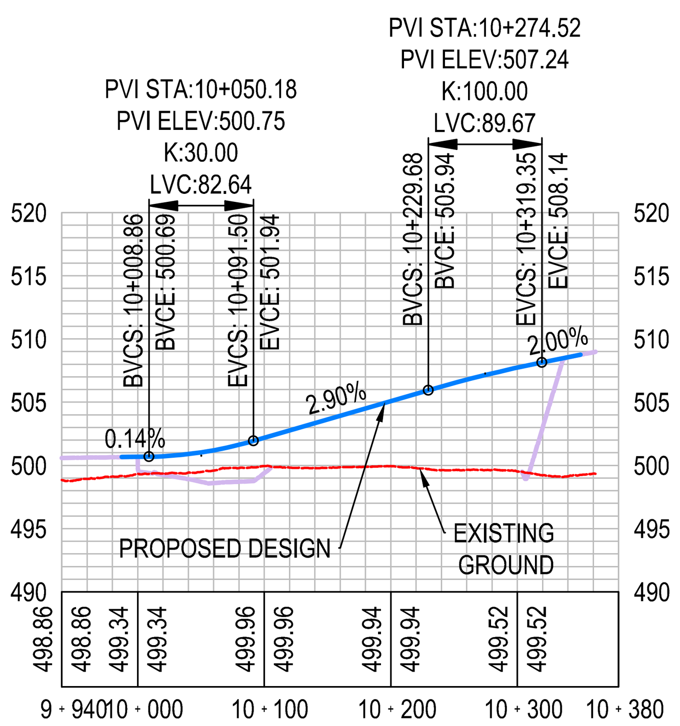
ACAD DWG:X_HWY 11 IC_ALIGNMENT AND PROFILE.DWG
LAST REV DATE: May 29, 2020

Saskatoon Freeway	Saskatchewan	REVISIONS			CS	N/A	TAB NO	A1_11_Profile_3
		NO	DATE	SIGNATURE	PHOTO DATE	N/A	SHEET	3 OF 3
					DRAWN BY	J. GREENE	DATE	28/05/20
					DESIGNED BY	AECOM	DATE	28/05/20
	SCALE 1: 5 000 HORIZONTAL 1: 50 000 VERTICAL				HIGHWAY 11 INTERCHANGE PROFILES SASKATOON FREEWAY PROJECT			

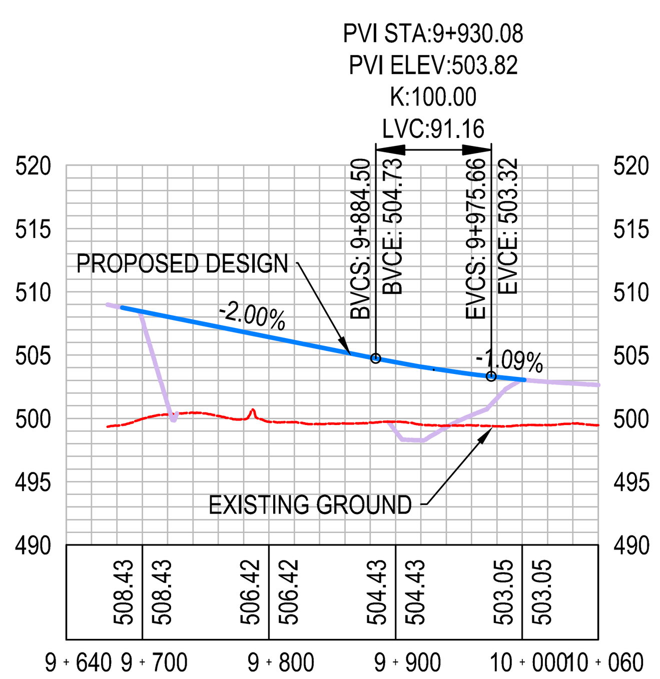
PENNER ROAD PROFILE



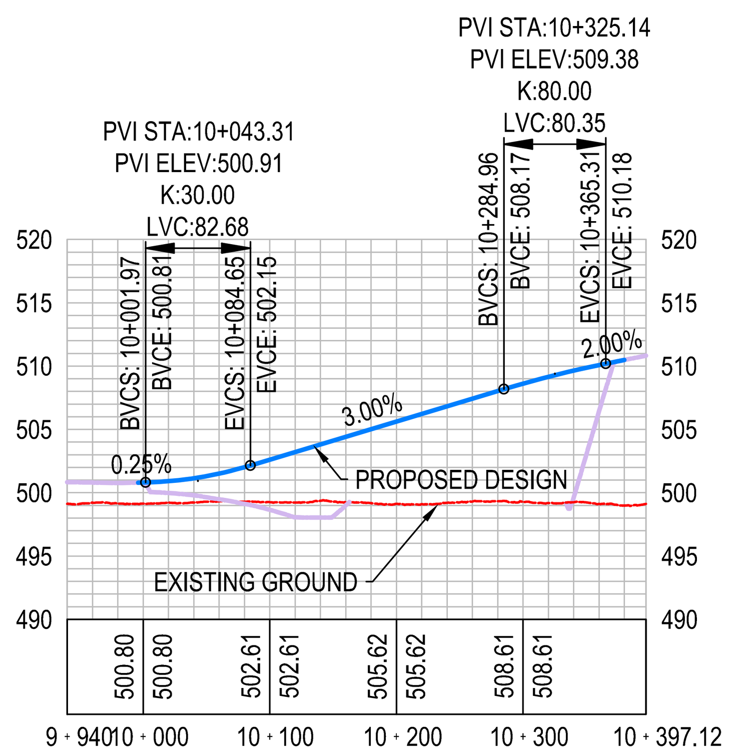
RAMP S-E/W PROFILE



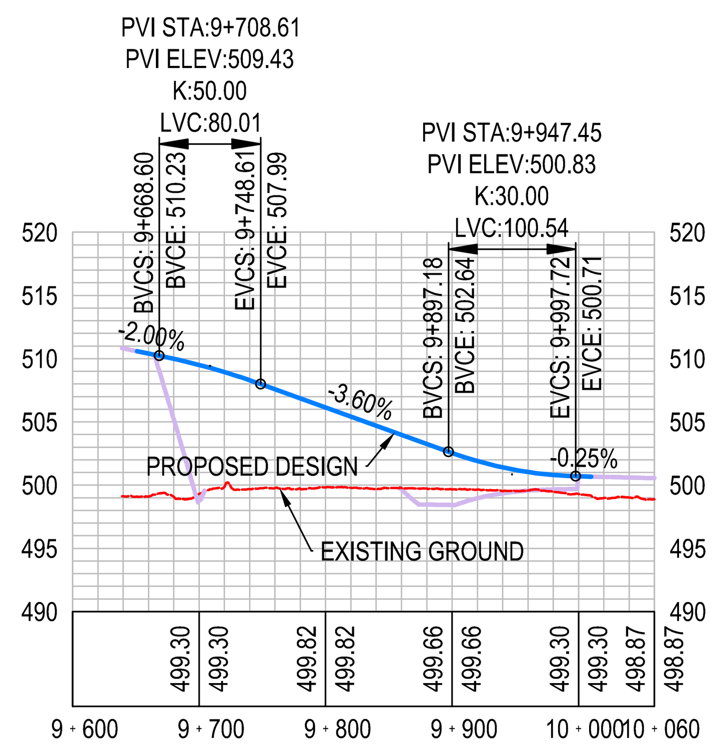
RAMP E/W-N PROFILE



RAMP N-E/W PROFILE



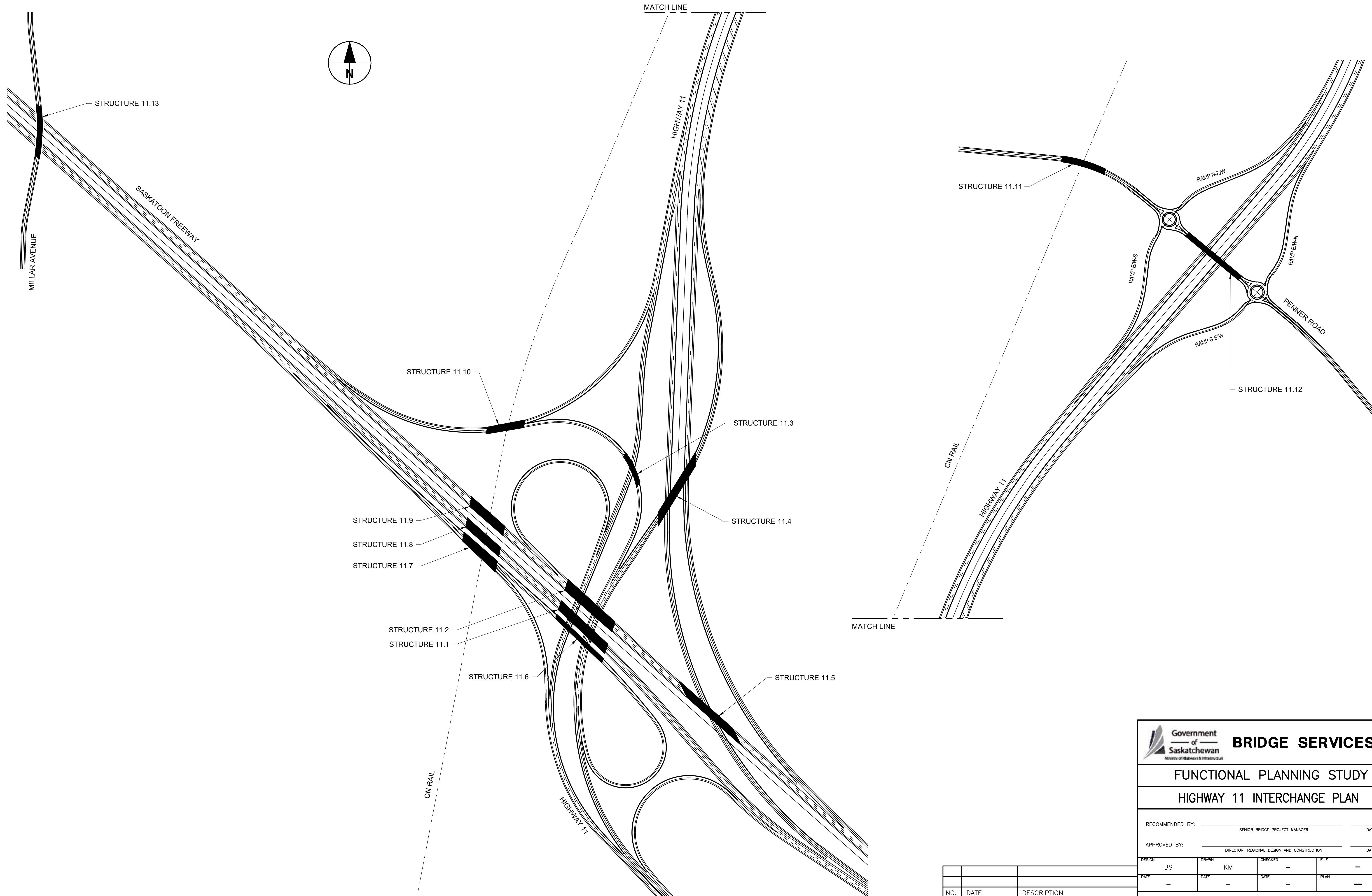
RAMP E/W-S PROFILE



ACAD DWG:X_HWY 11 IC_ALIGNMENT AND PROFILE.DWG
LAST REV DATE: May 29, 2020

APPENDIX M

Interchange Bridge Plan and Profiles



Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11\XPE-11-0.DWG

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

HIGHWAY 11 INTERCHANGE PLAN

RECOMMENDED BY: ____ SENIOR BRIDGE PROJECT MANAGER ____ DATE

APPROVED BY: ____ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ____ DATE

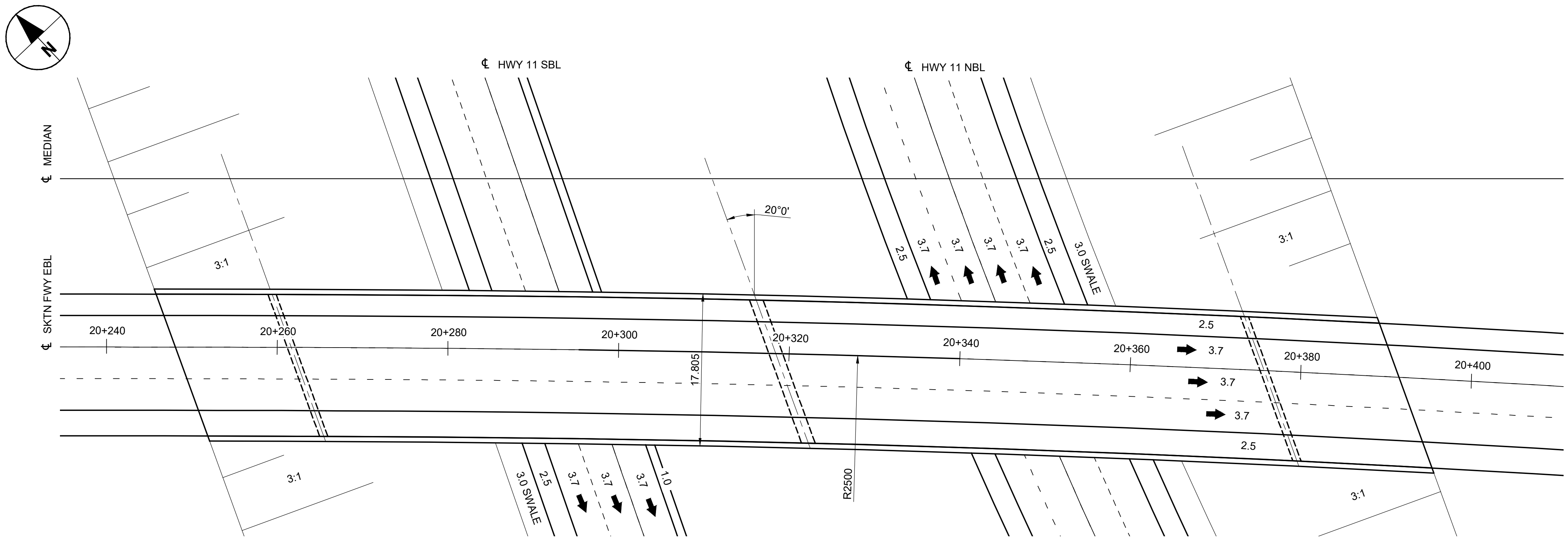
DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE –	DATE –	DATE –	PLAN –

NO.	DATE	DESCRIPTION

REVISIONS

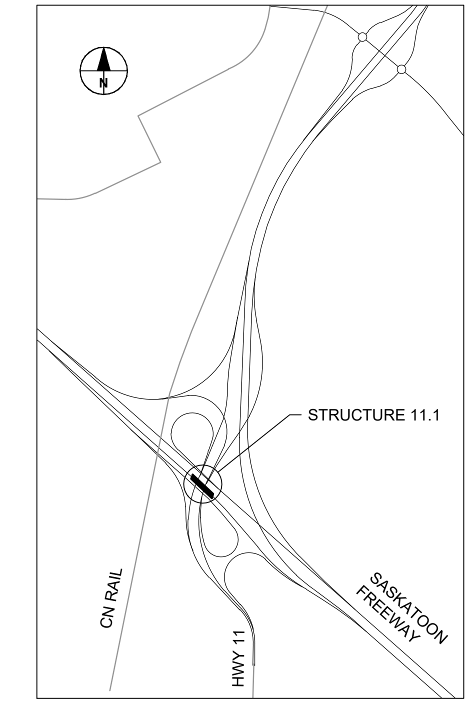
Sheet – of –

LAST REVISED DATE: 22–JAN–2009 1:40 PM

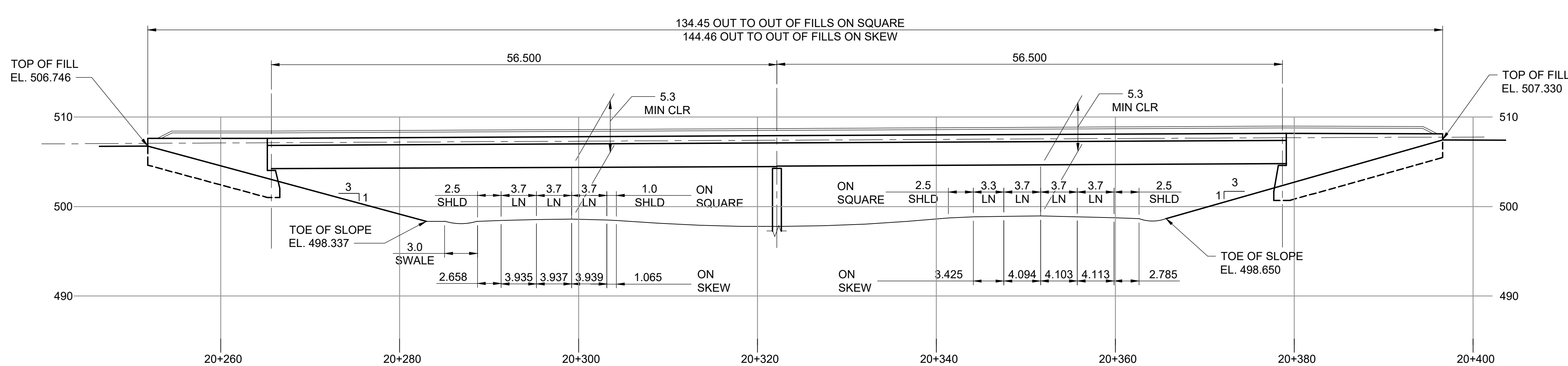


PLAN

Scale 1:600



KEY PLAN



ELEVATION

Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.1

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

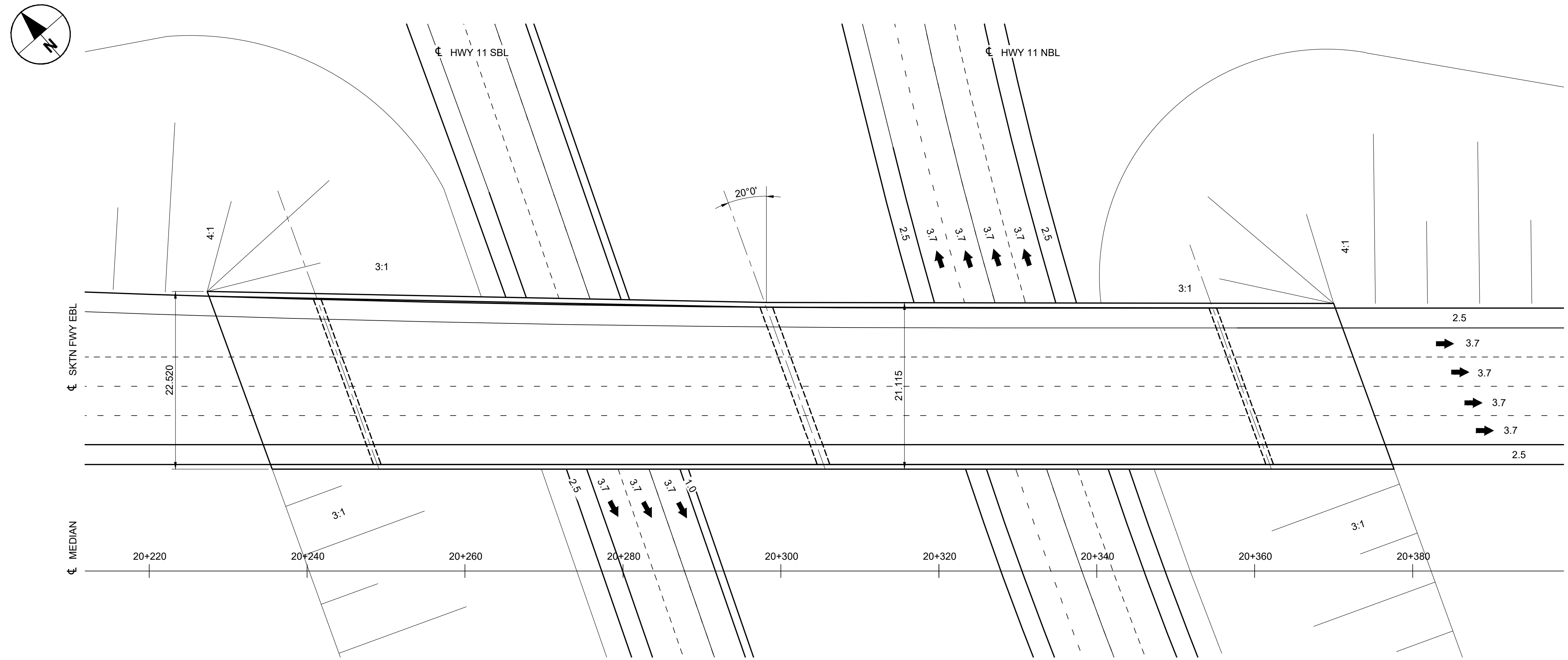
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
–	KM	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

Sheet 1 of –

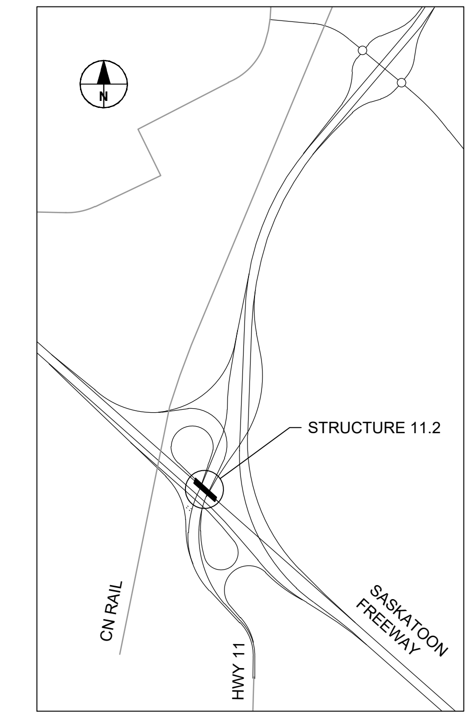
LAST REVISED DATE: 22–JAN–2009 1:40 PM

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11XPE-11-1.DWG

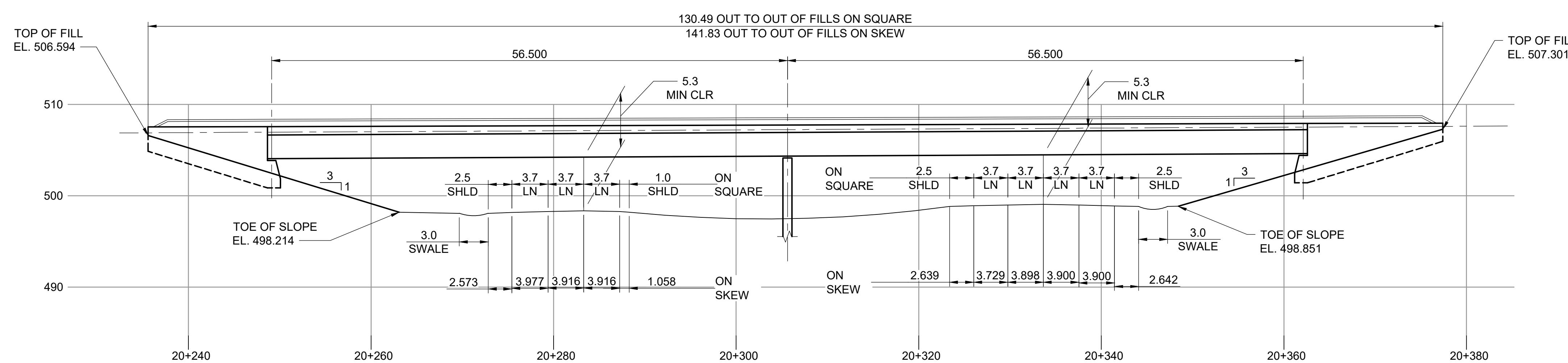


PLAN

Scale 1:600



KEY PLAN



ELEVATION

Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.2

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

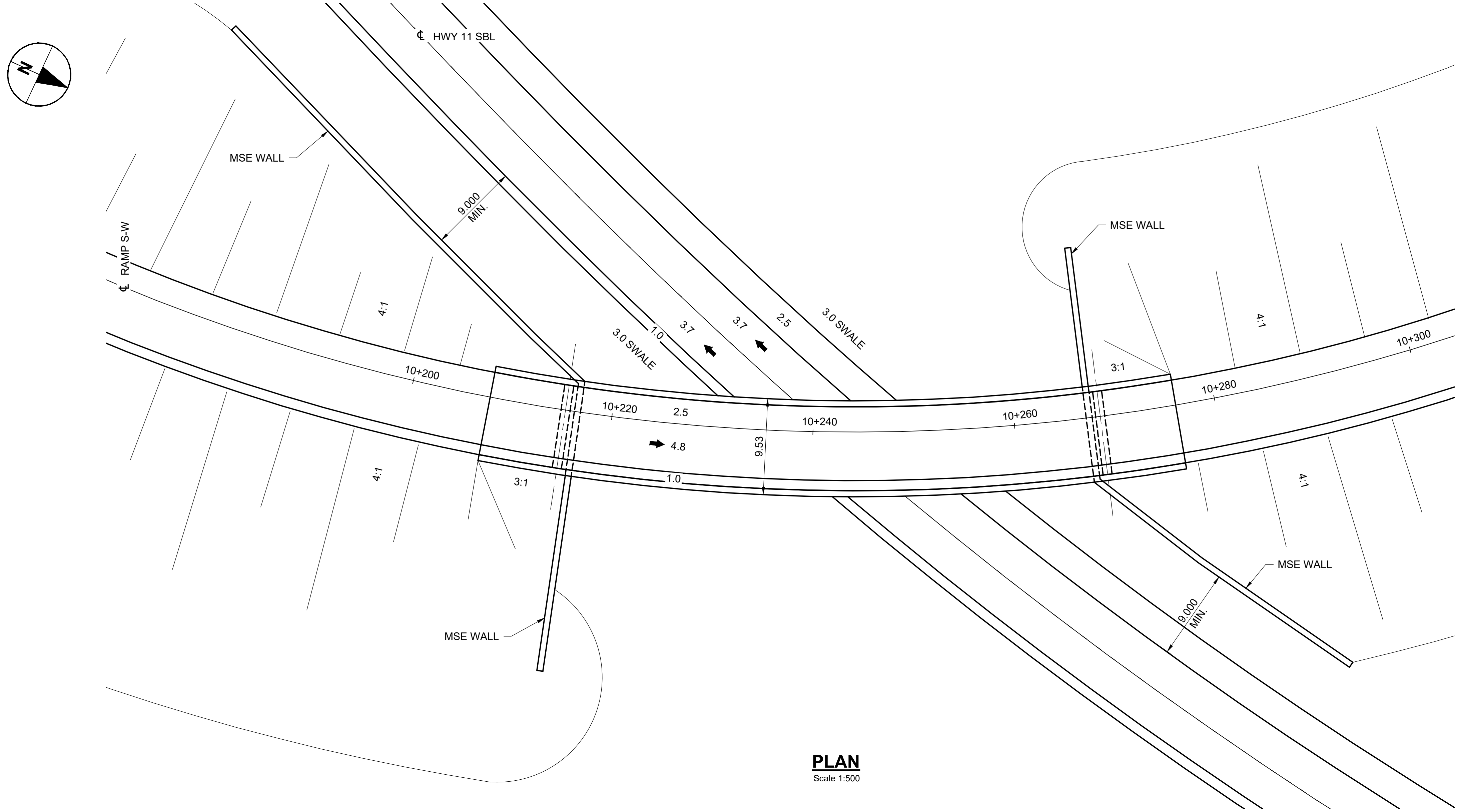
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE –	DATE –	DATE –	PLAN –

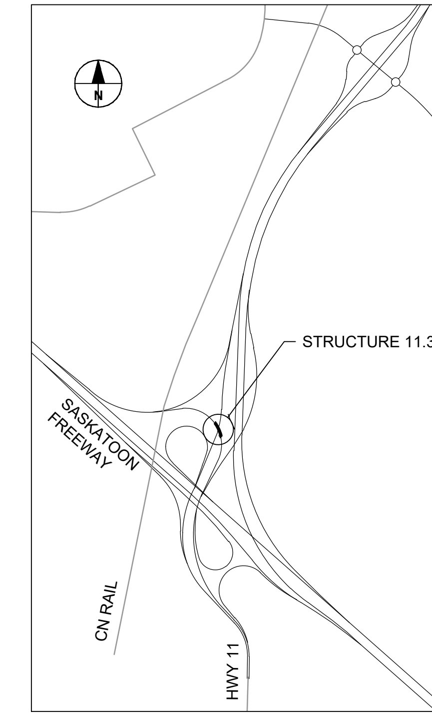
Sheet 1 of –

LAST REVISED DATE: 22–JAN–2009 1:40 PM

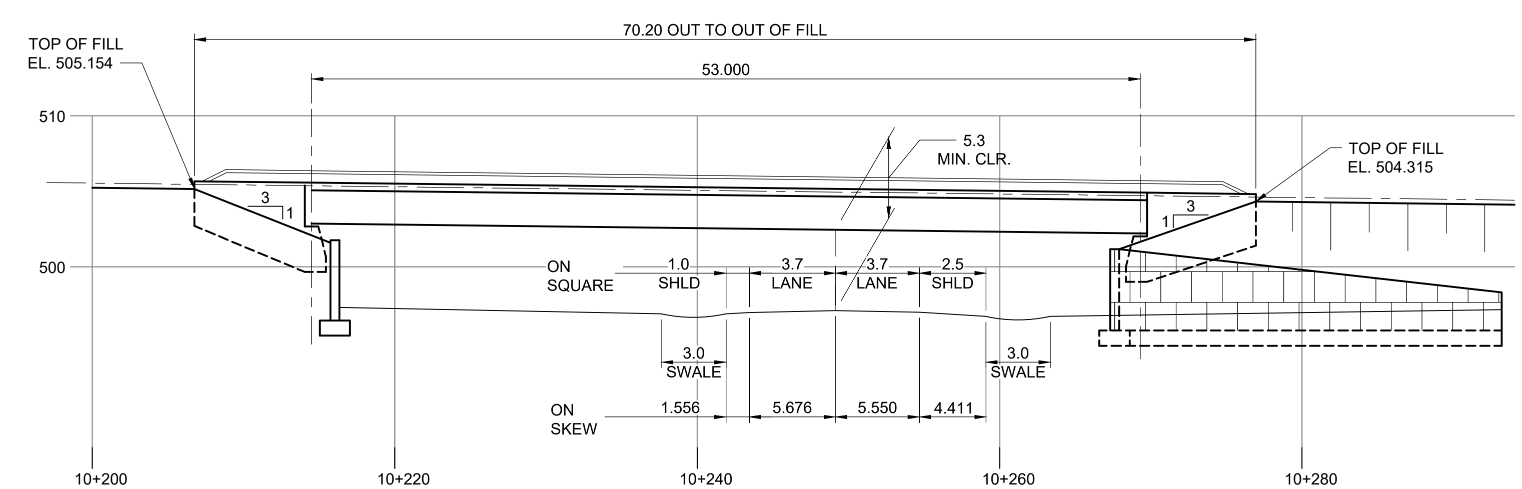
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11\XPE-11-2.DWG



PLAN
Scale 1:500



KEY PLAN



ELEVATION
Scale 1:400

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.3

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

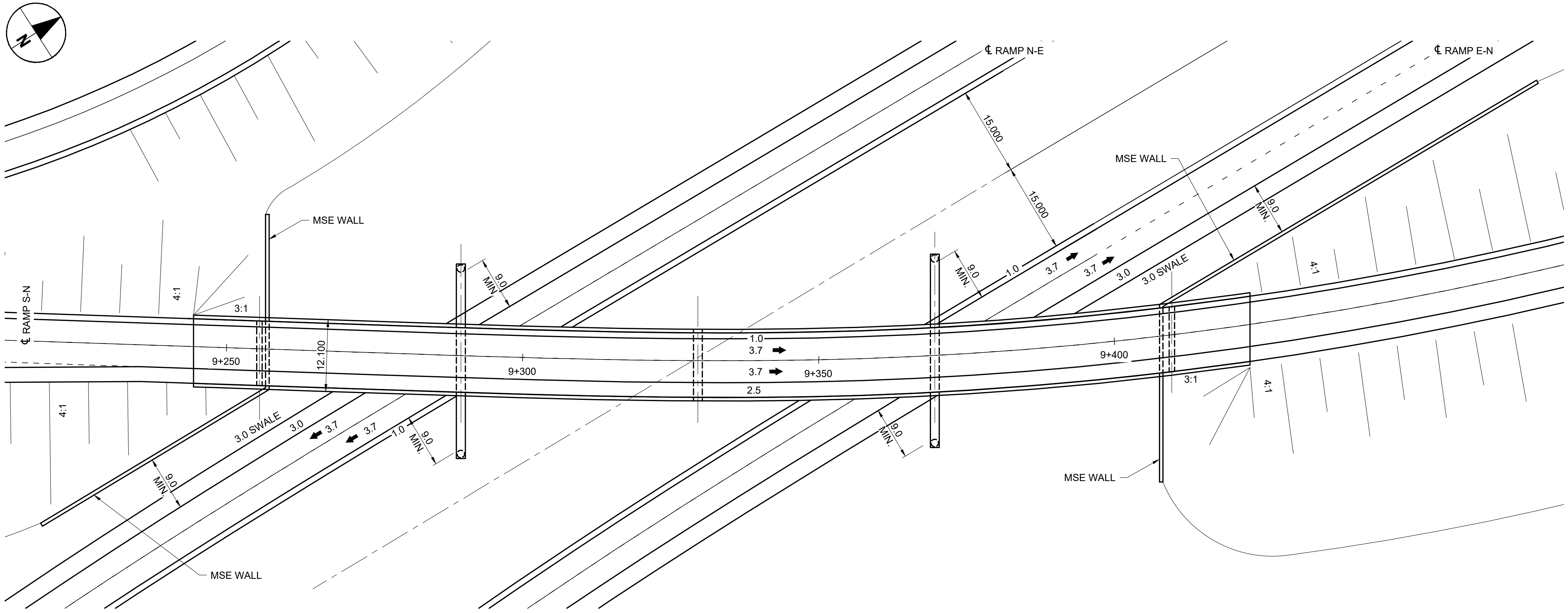
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE –	DATE –	DATE –	PLAN –

Sheet 5 of –

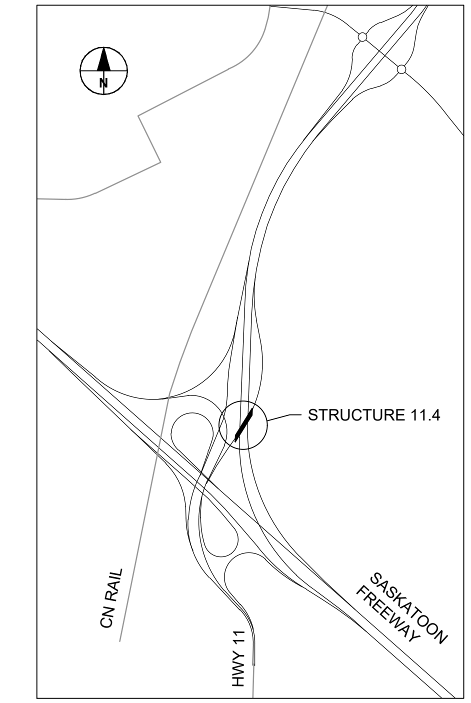
LAST REVISED DATE: 22–JAN–2009 1:40 PM

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11\XPE-11-3.DWG

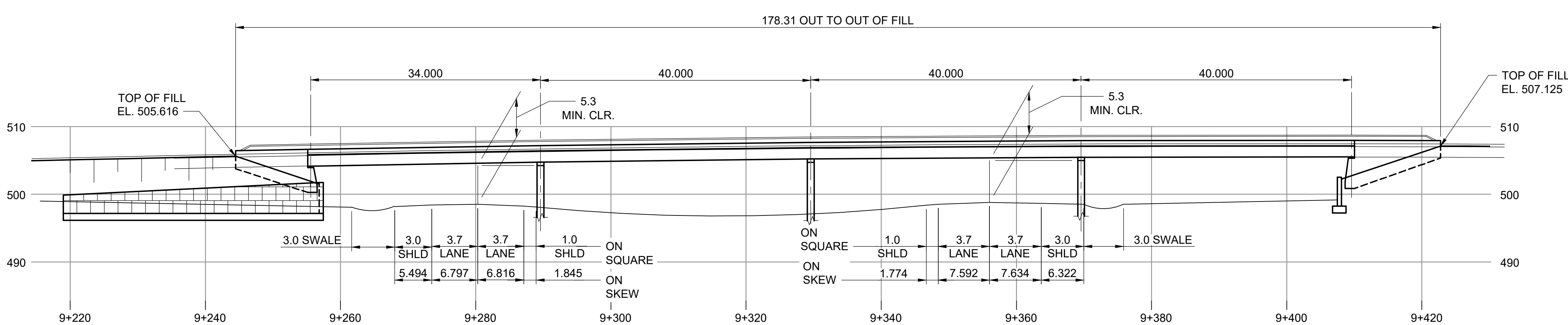


PLAN

Scale 1:800



KEY PLAN



ELEVATION

Scale 1:800

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.4

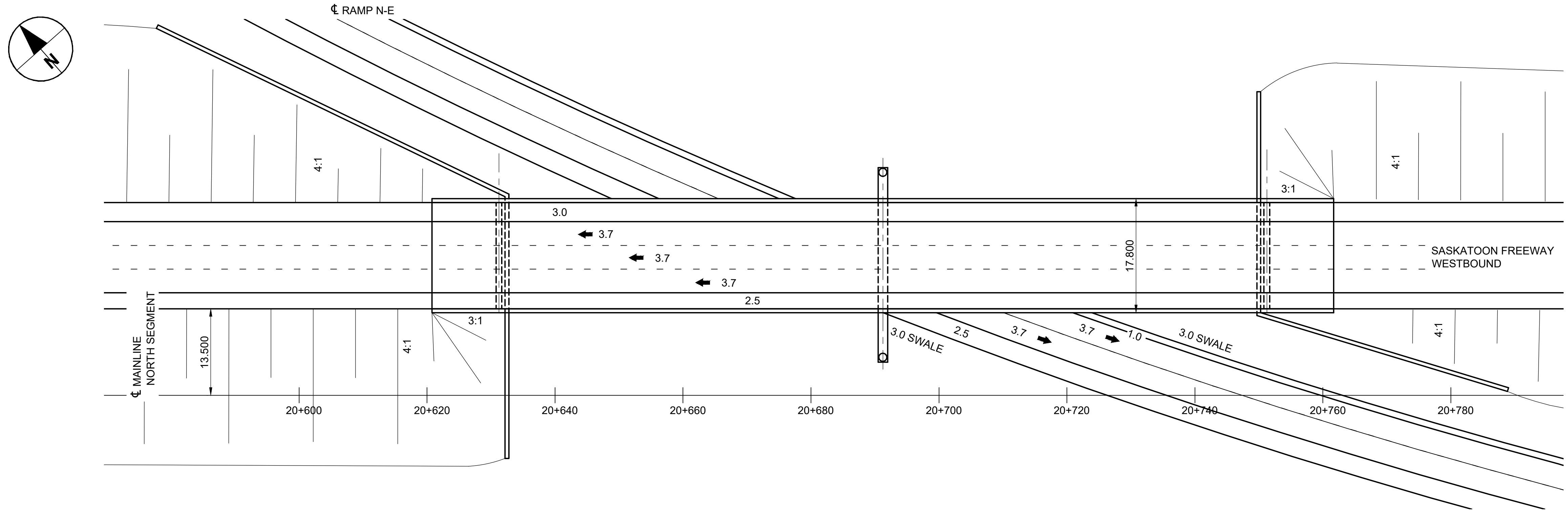
RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

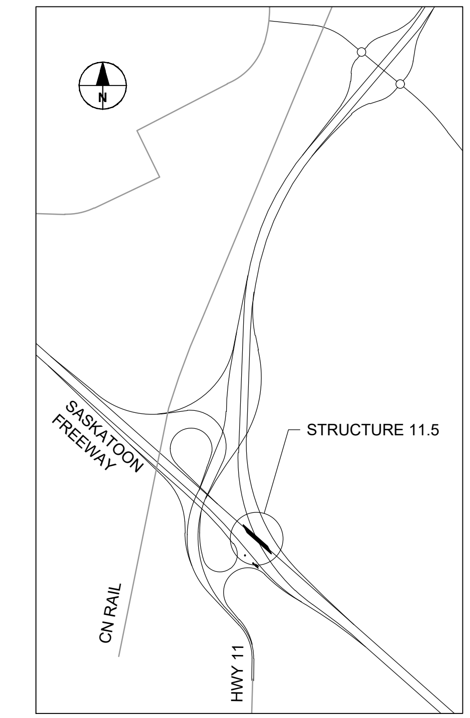
DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

Sheet 4 of –

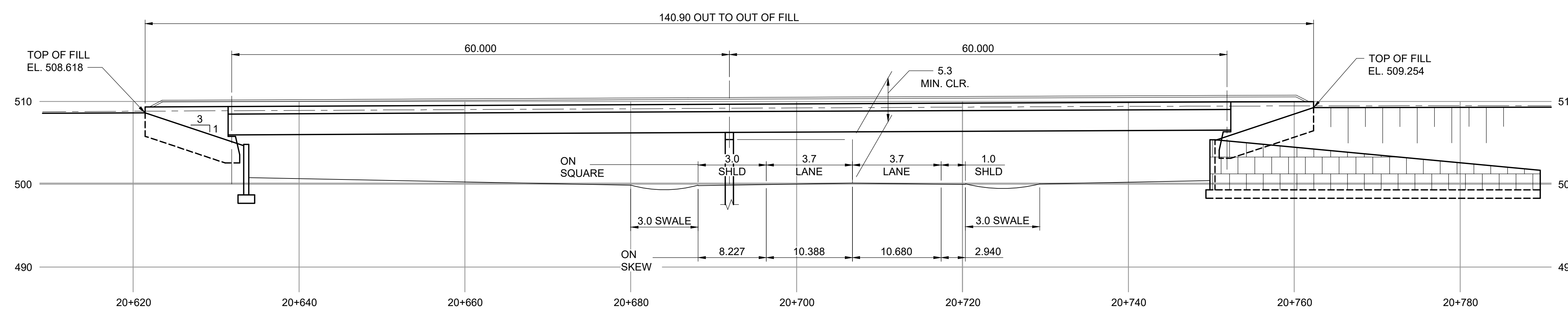
LAST REVISED DATE: 22–JAN–2009 1:40 PM



PLAN
Scale 1:800



KEY PLAN



ELEVATION
Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.5

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

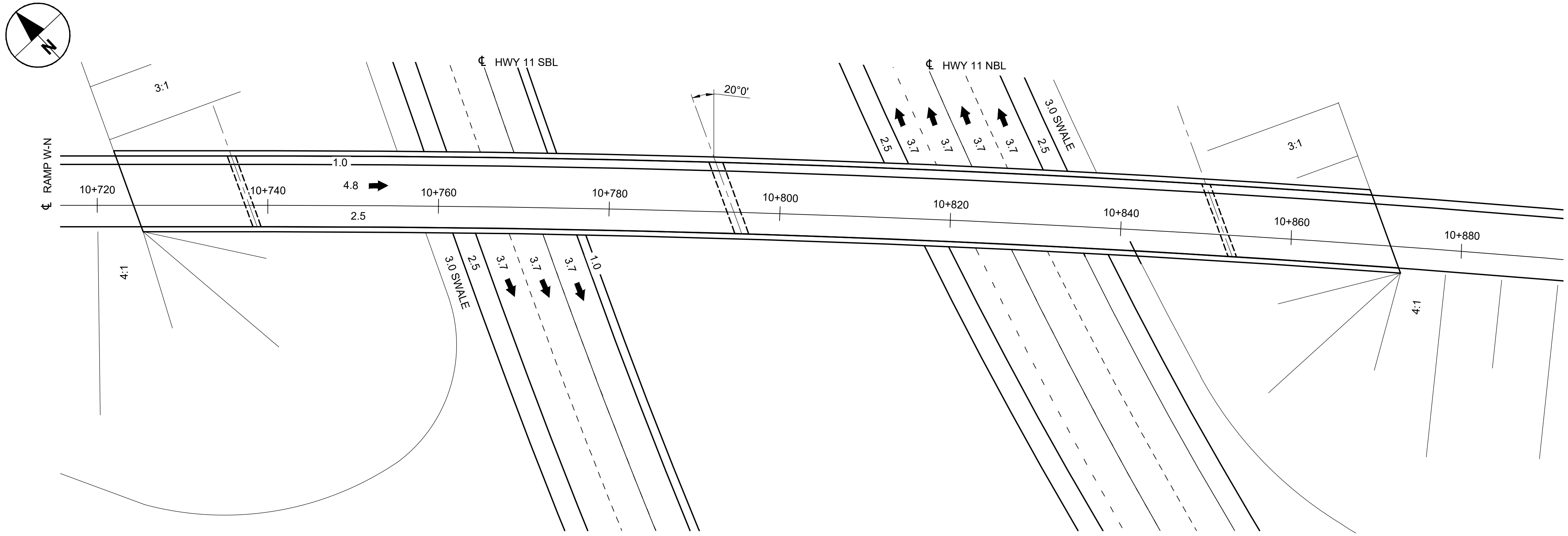
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
–	–	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

Sheet 5 of –

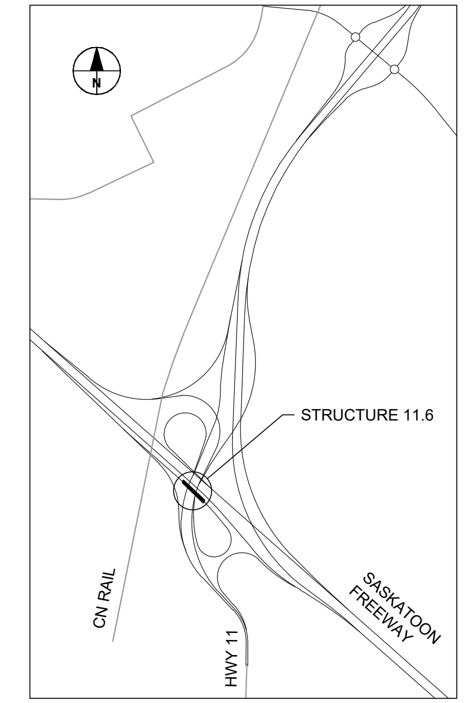
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11\XPE-11-5.DWG

LAST REVISED DATE: 22-JAN-2009 1:40 PM

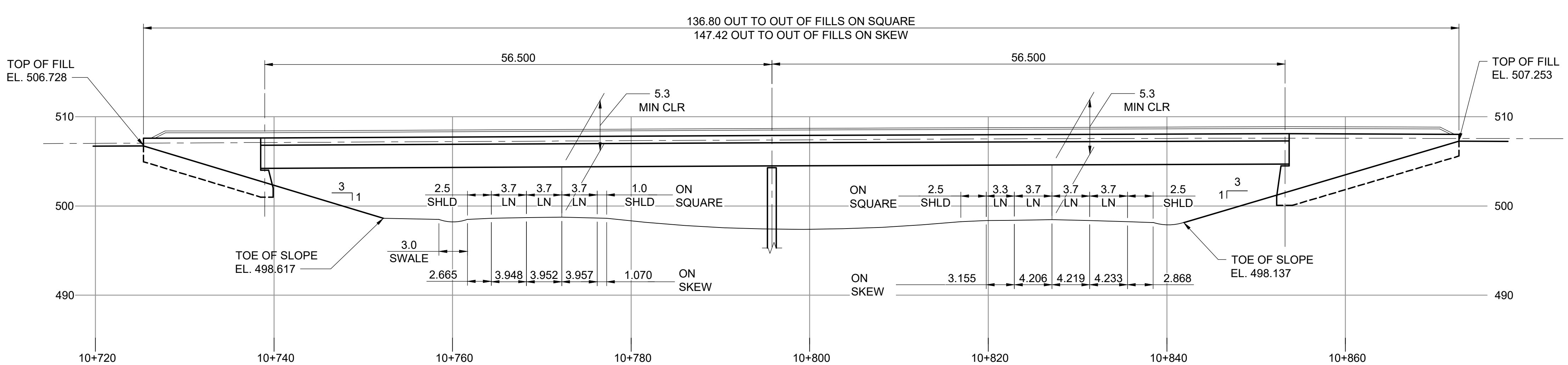


PLAN

Scale 1:600



KEY PLAN



ELEVATION

Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.6

RECOMMENDED BY: ________ SENIOR BRIDGE PROJECT MANAGER ________ DATE

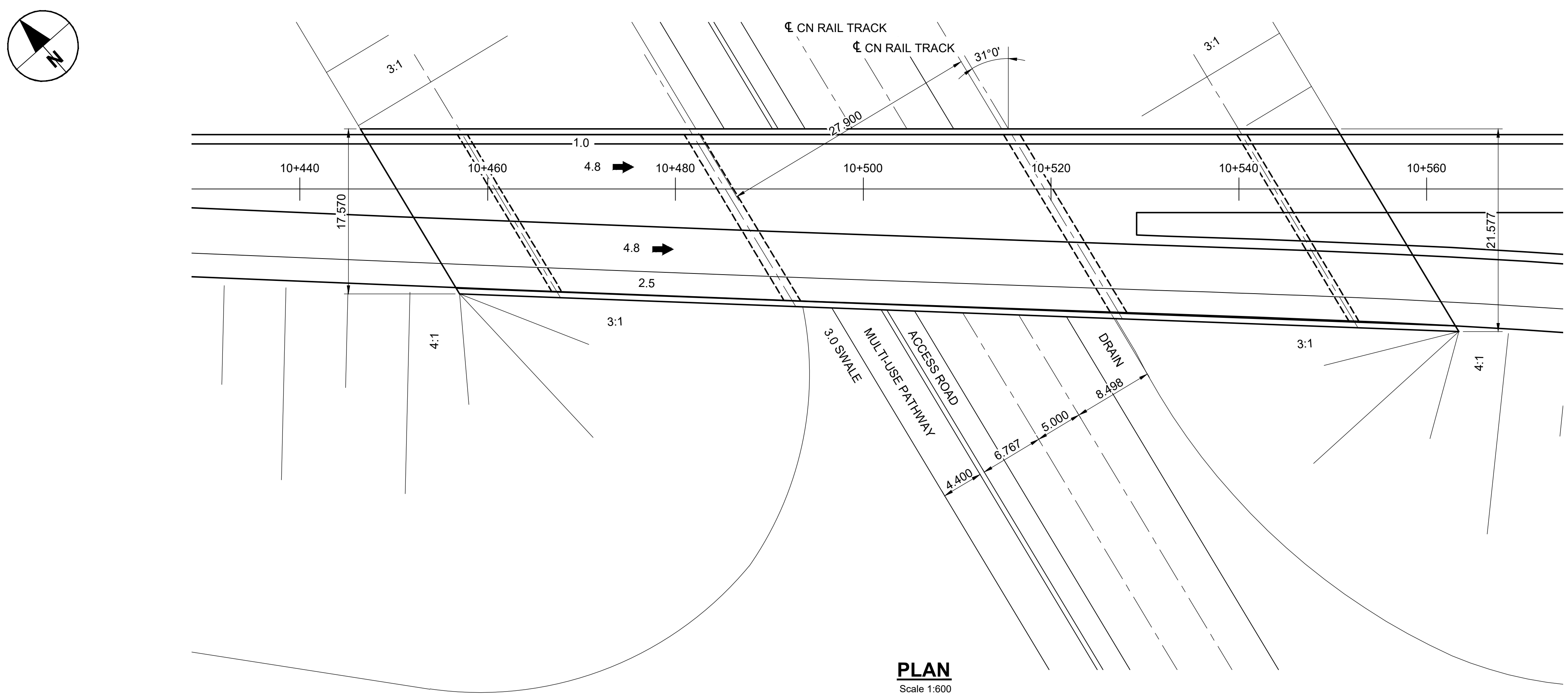
APPROVED BY: ________ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ________ DATE

DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

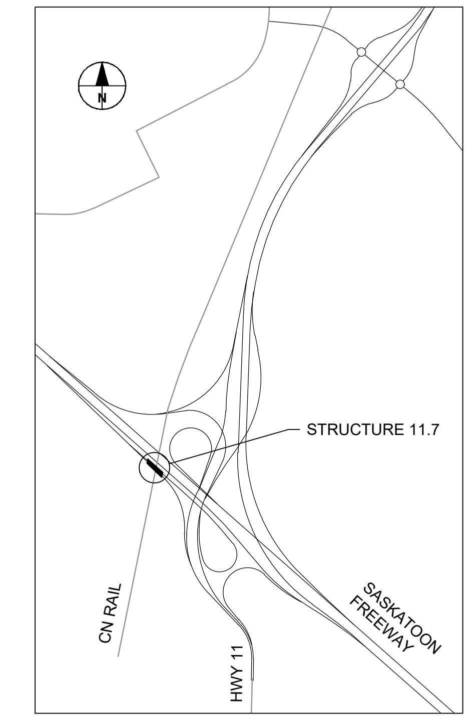
Sheet 1 of –

LAST REVISED DATE: 22–JAN–2009 1:40 PM

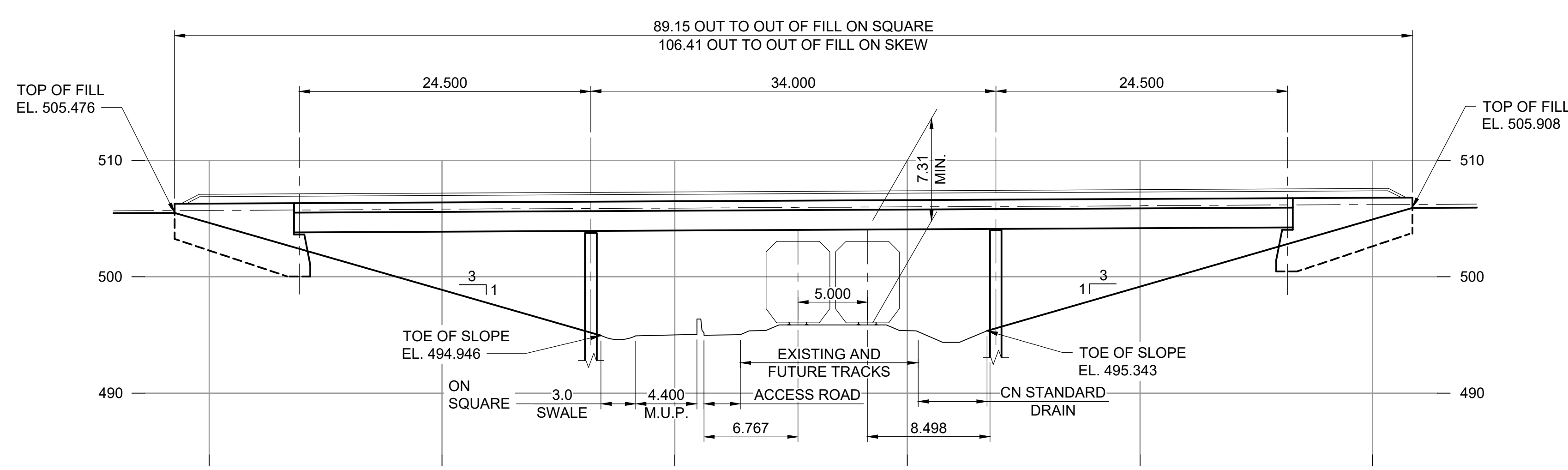
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11XPE-11-6.DWG



PLAN
Scale 1:600



KEY PLAN



ELEVATION
Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.7

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

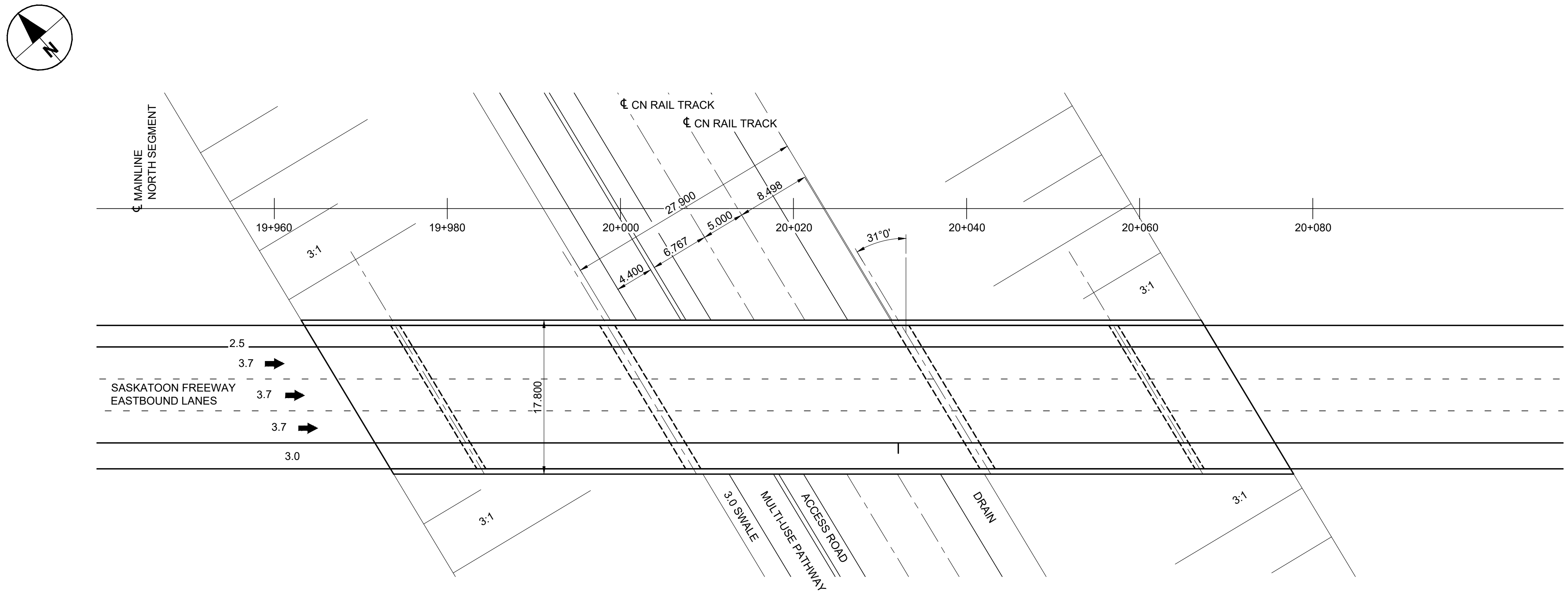
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

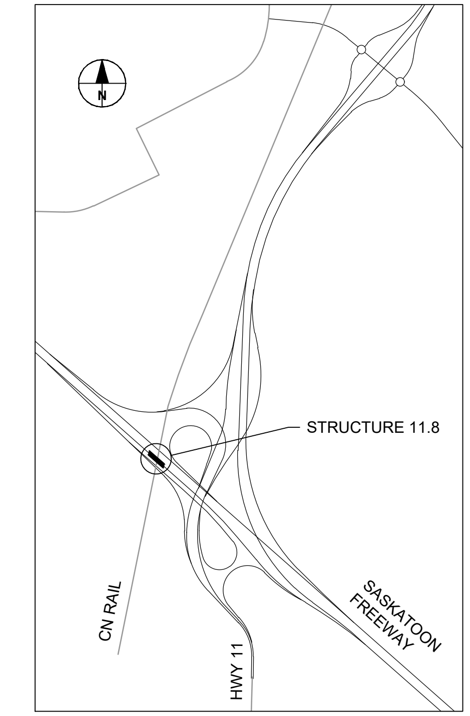
DESIGN	DRAWN	CHECKED	FILE
–	–	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

Sheet – of –

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11XPE-11-7.DWG

LAST REVISED DATE: 22–JAN–2009 1:40 PM

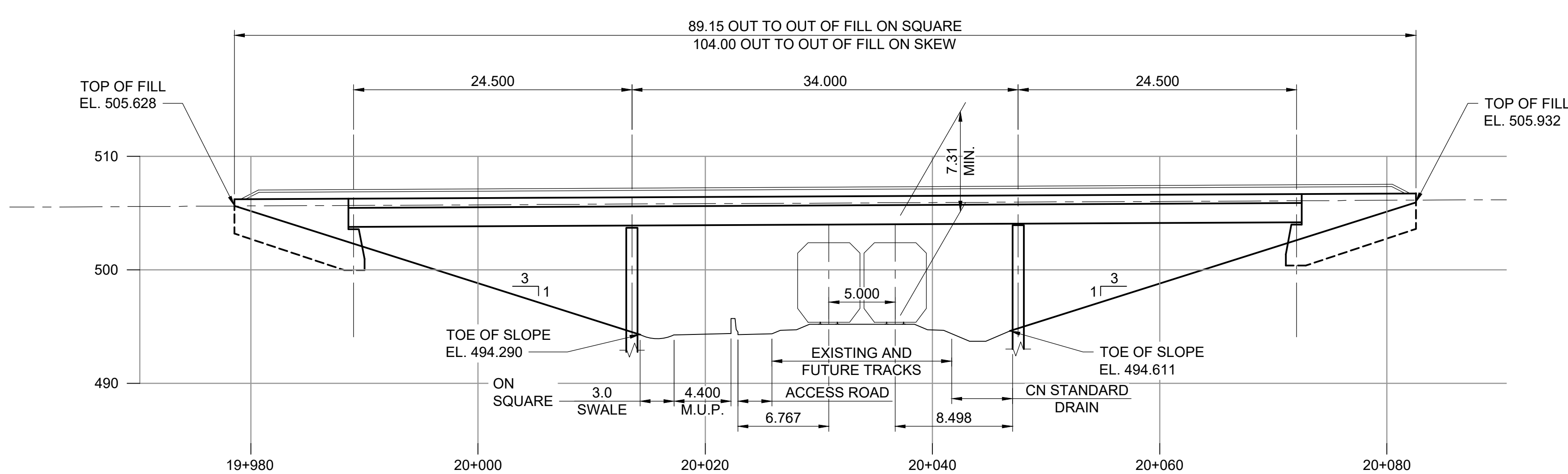




KEY PLAN

PLAN

Scale 1:600



ELEVATION

Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.8

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

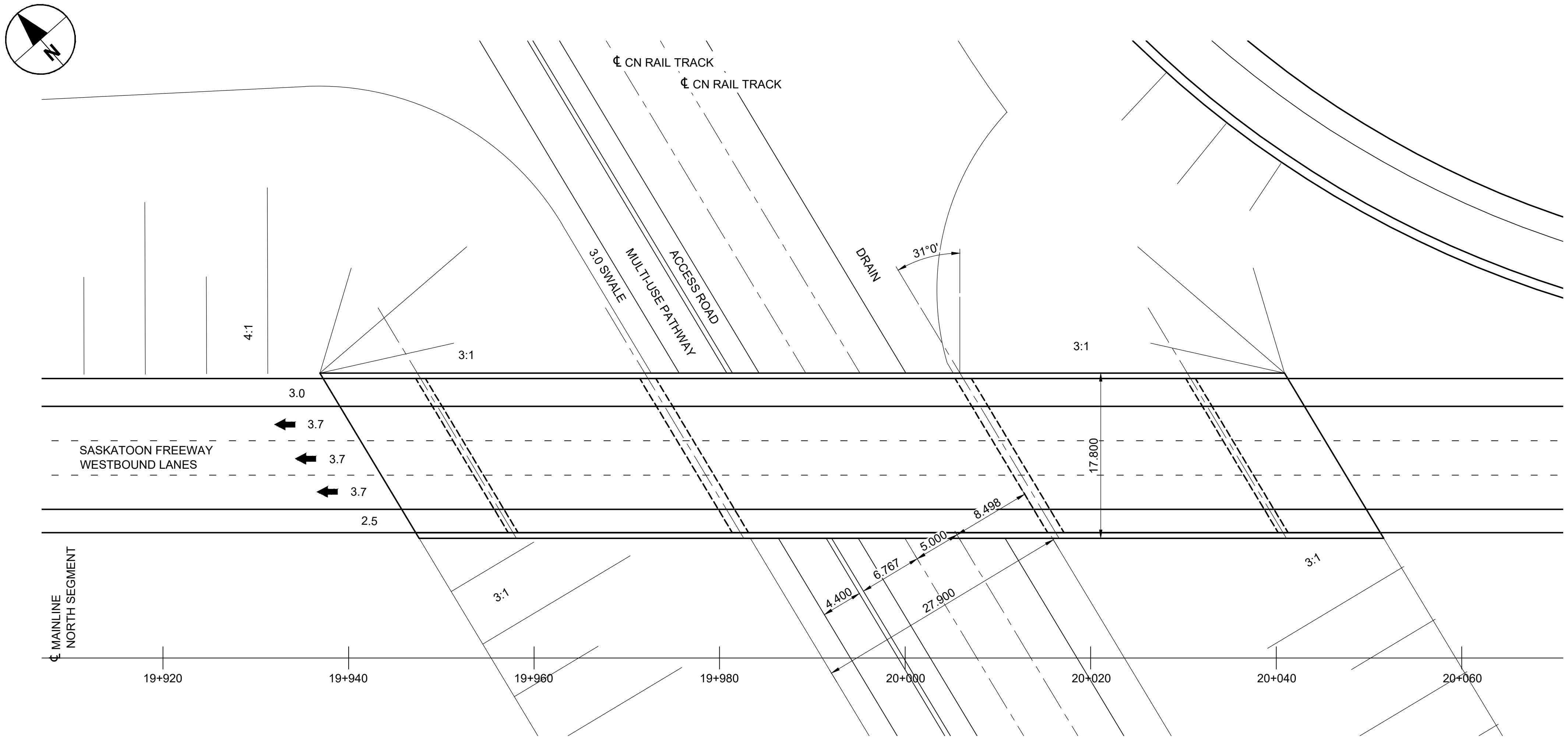
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

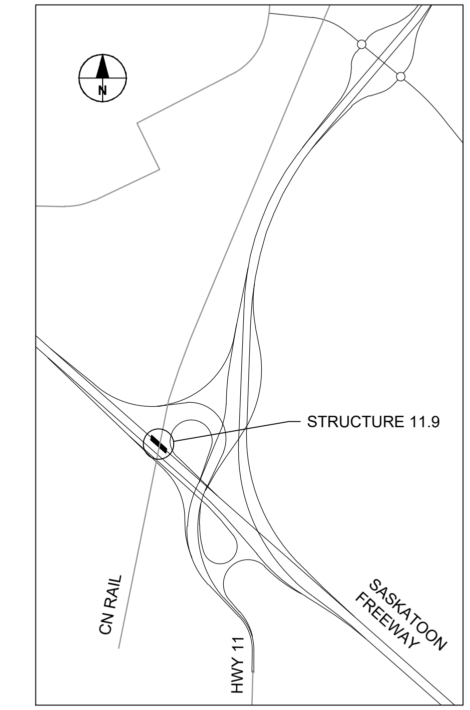
Sheet – of –

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11\XPE-11-8.DWG

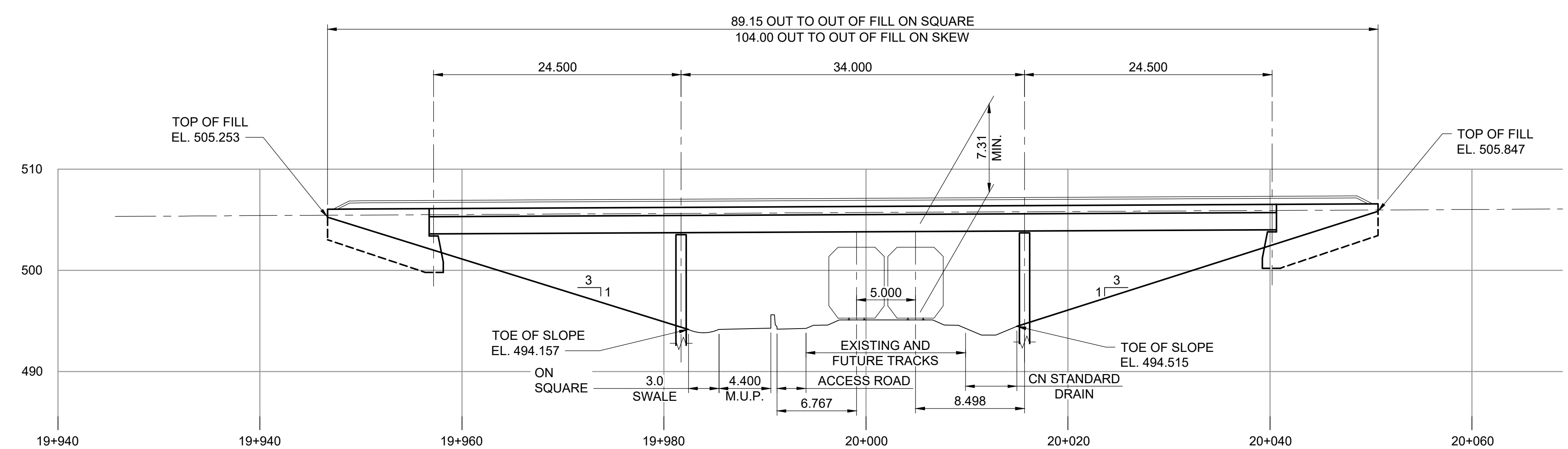
LAST REVISED DATE: 22-JAN-2009 1:40 PM



PLAN
Scale 1:600



KEY PLAN



ELEVATION
Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION
		REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.9

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

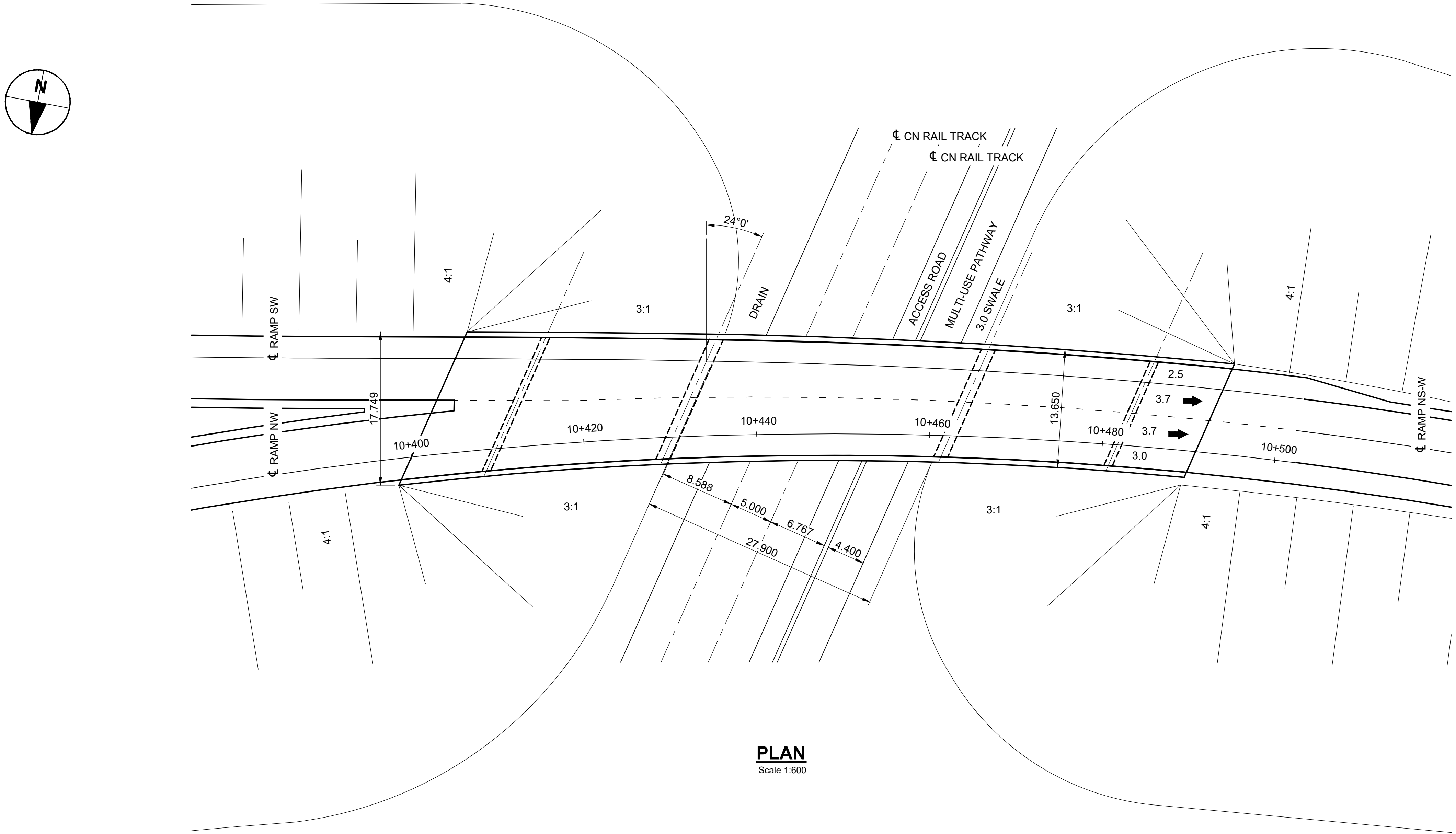
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
–	–	–	–
DATE –	DATE –	DATE –	PLAN –

Sheet – of –

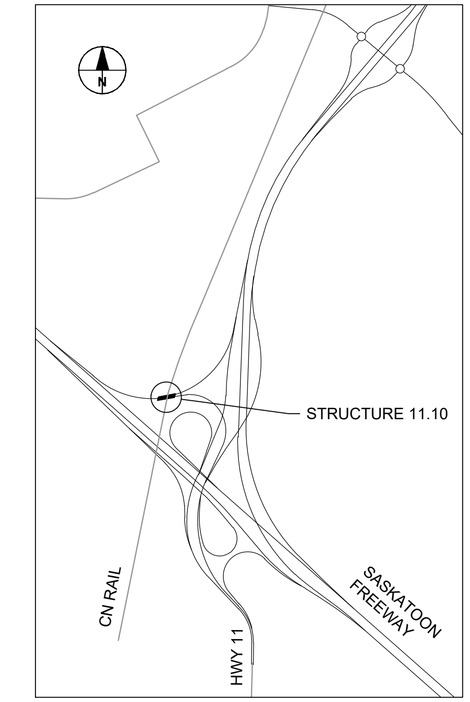
LAST REVISED DATE: 22–JAN–2009 1:40 PM

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11\XPE-11-9.DWG

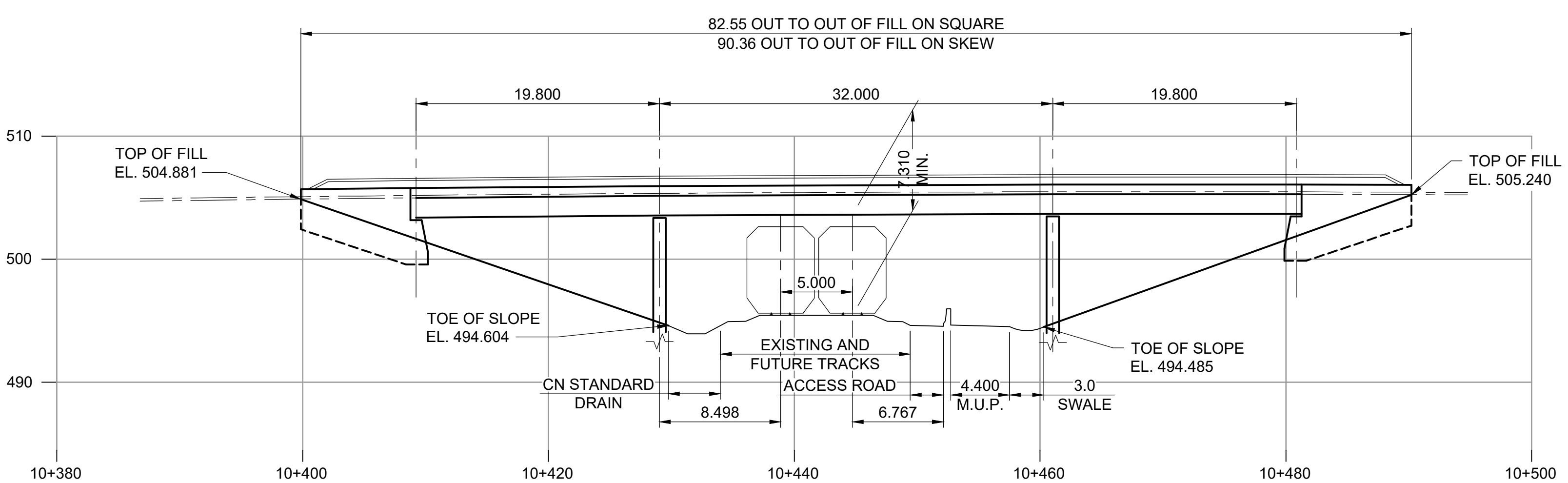


PLAN

Scale 1:600



KEY PLAN



ELEVATION

Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.10

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

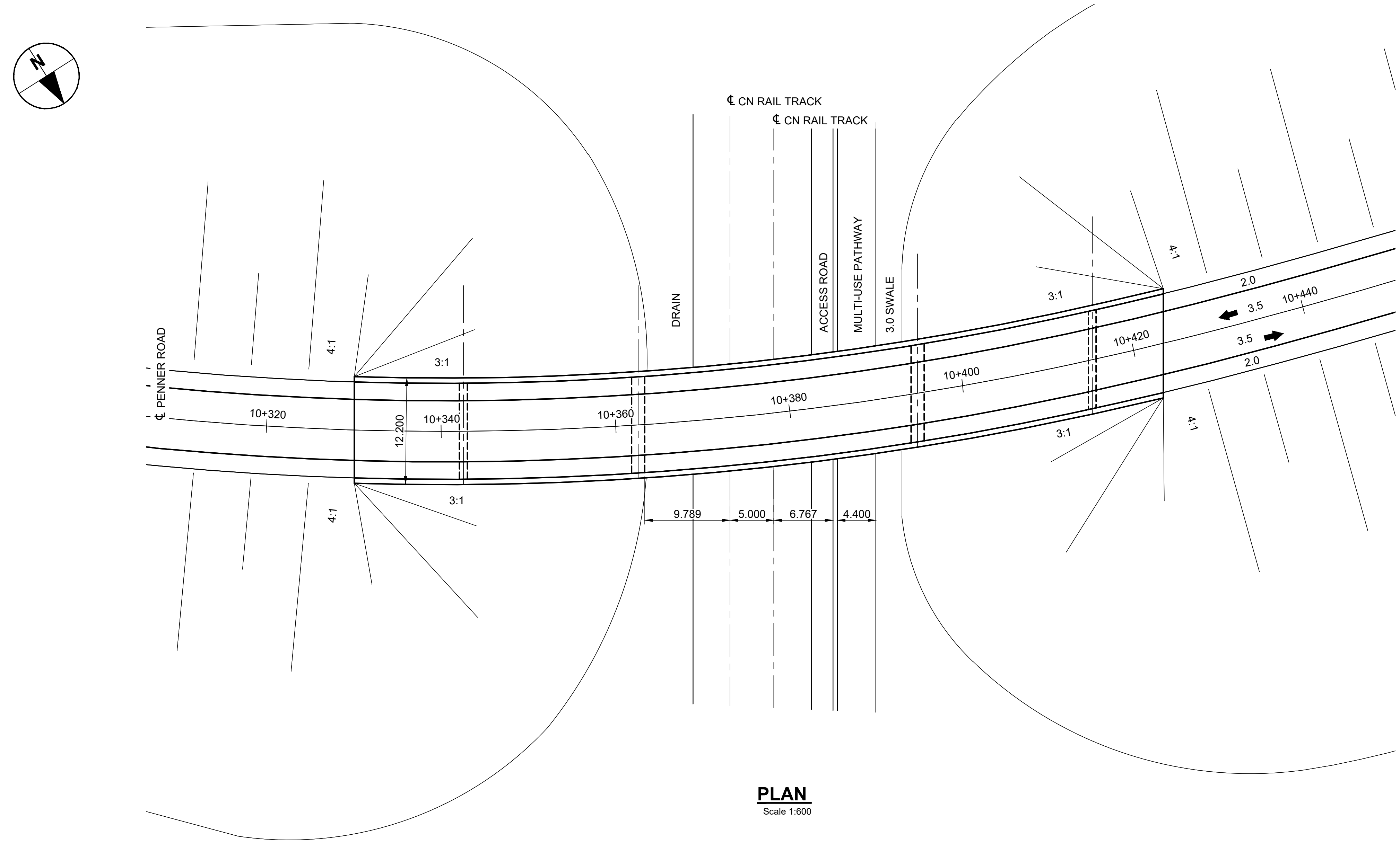
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

Sheet – of –

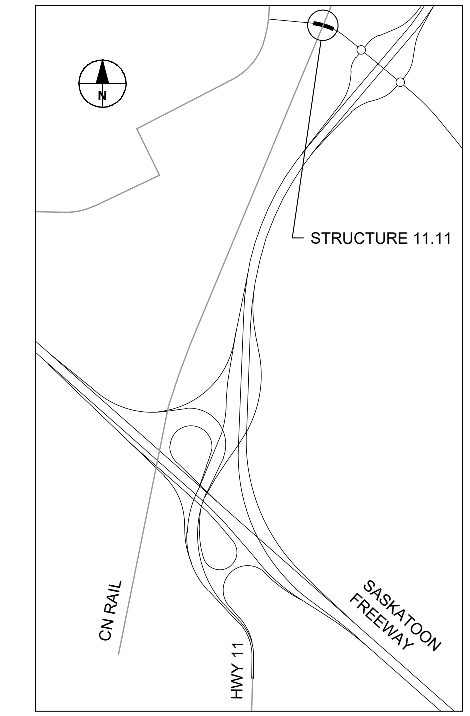
LAST REVISED DATE: 22–JAN–2009 1:40 PM

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11\XPE-11-10.DWG

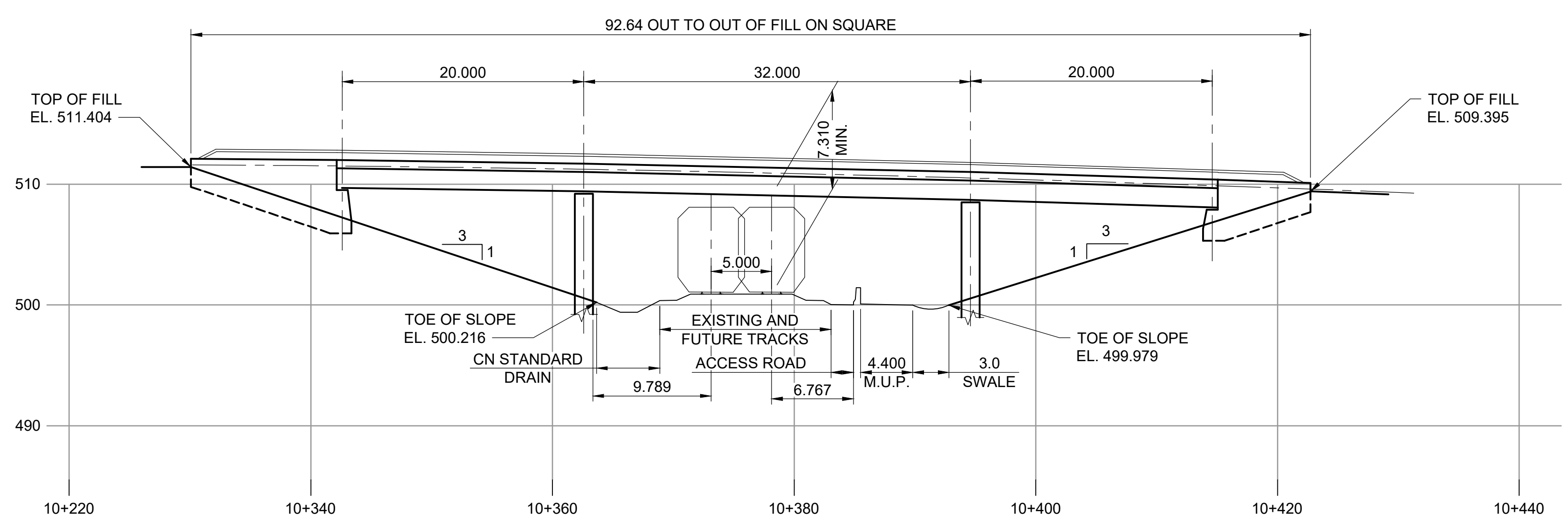


PLAN

Scale 1:600



KEY PLAN



ELEVATION

Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.11

RECOMMENDED BY: ____________ DATE
SENIOR BRIDGE PROJECT MANAGER

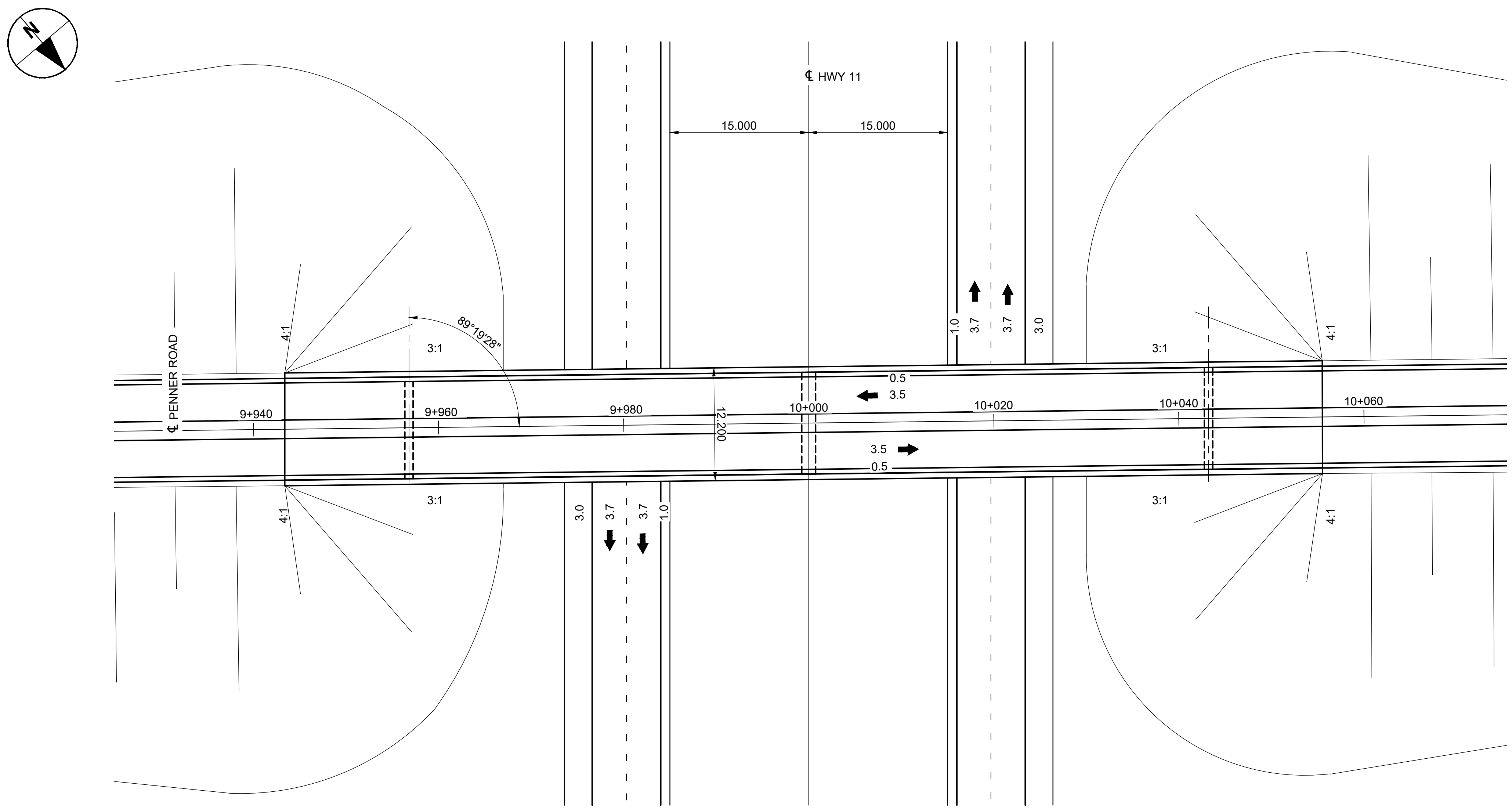
APPROVED BY: ____________ DATE
DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION

DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

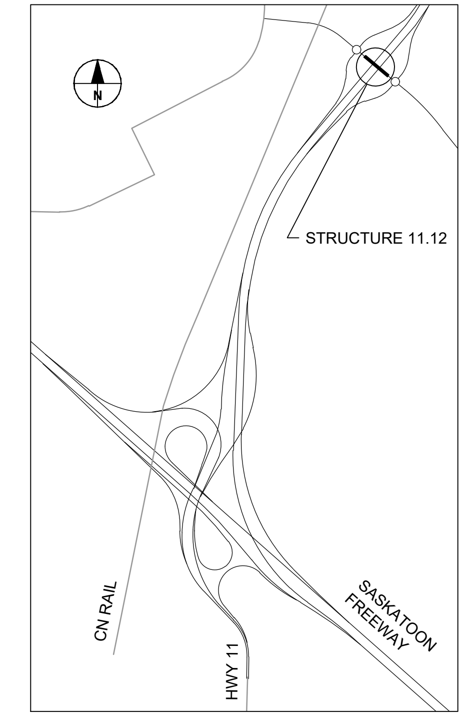
Sheet – of –

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11\XPE-11-11.DWG

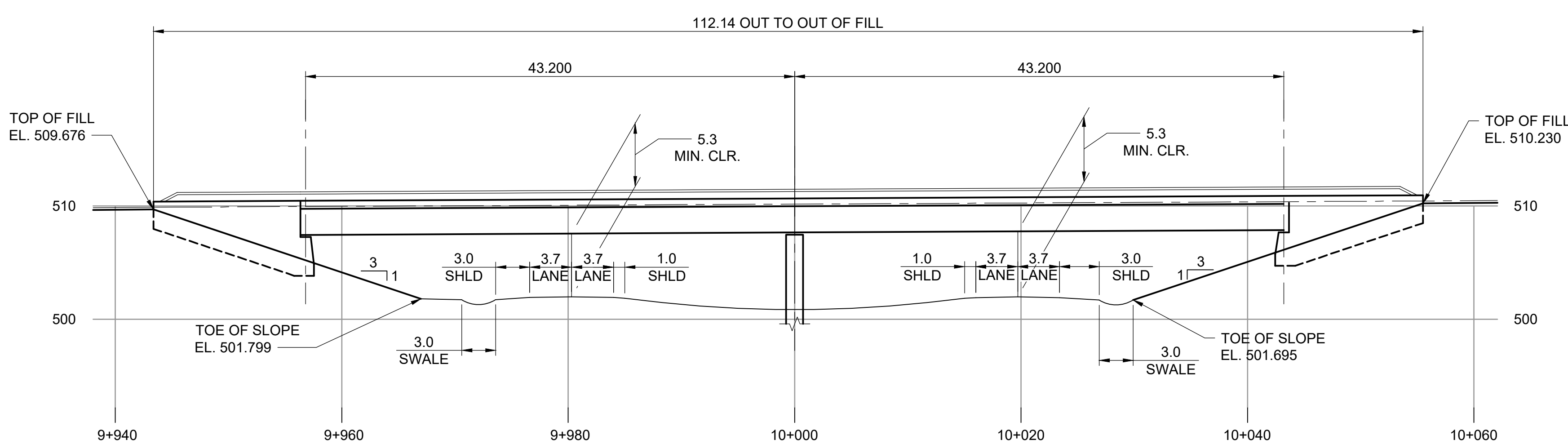
LAST REVISED DATE: 22–JAN–2009 1:40 PM



PLAN
Scale 1:600



KEY PLAN



ELEVATION
Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.12

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

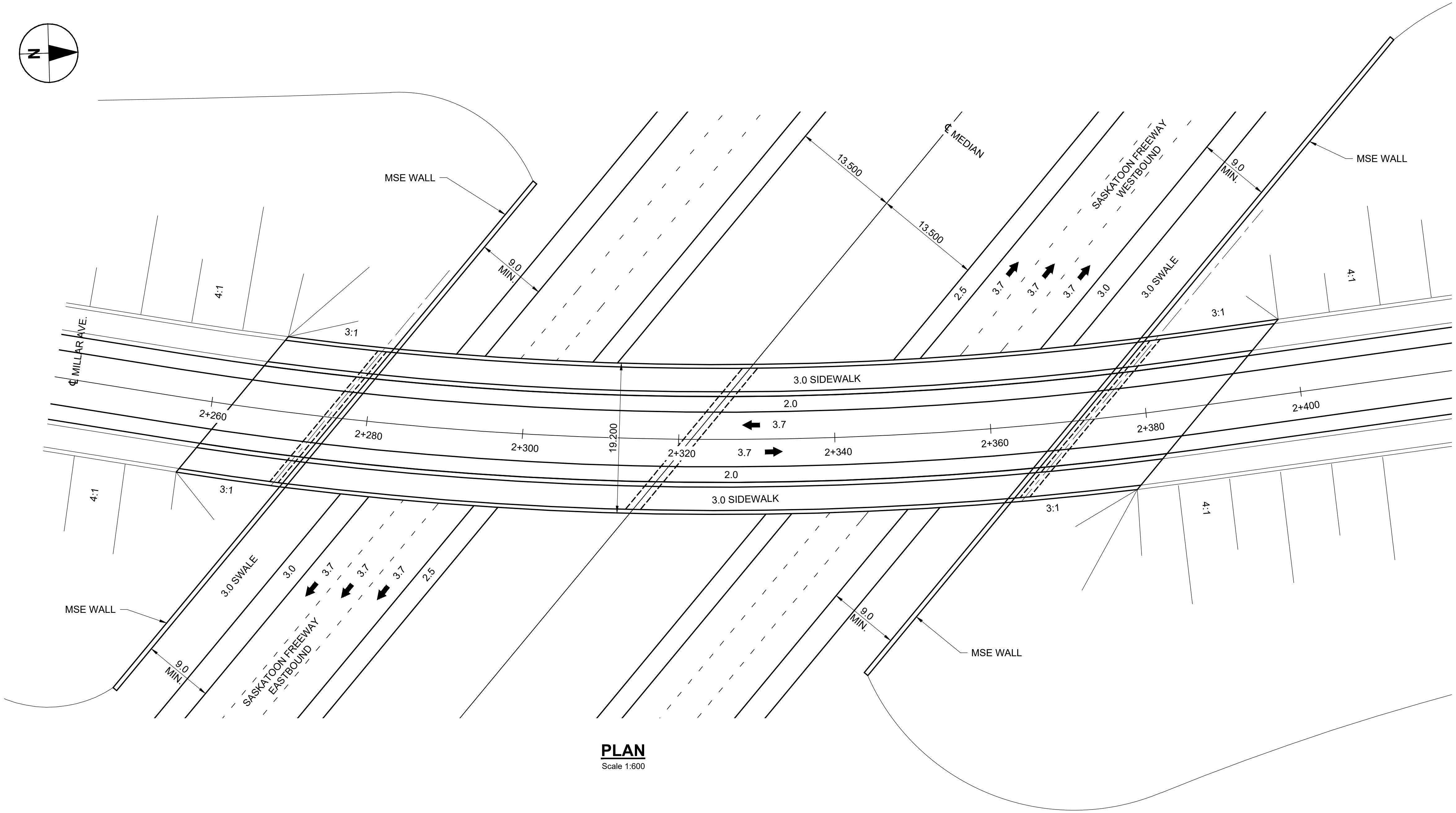
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
–	–	–	–
DATE –	DATE –	DATE –	PLAN –

Sheet – of –

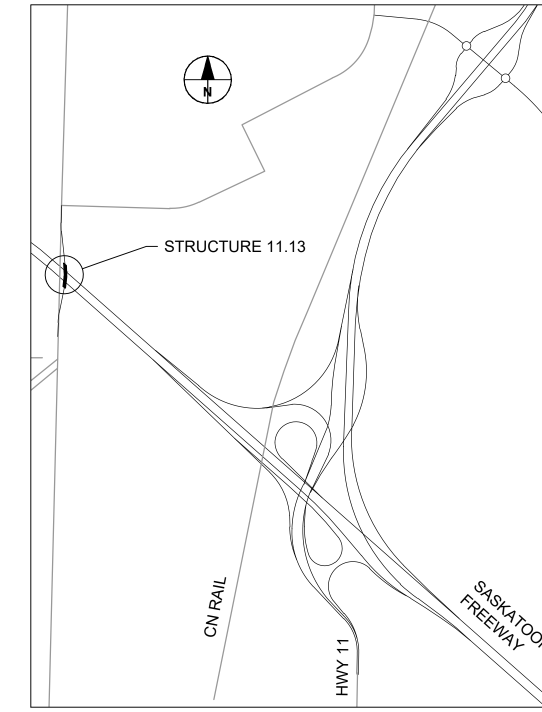
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11\XPE-11-12.DWG

LAST REVISED DATE: 22–JAN–2009 1:40 PM

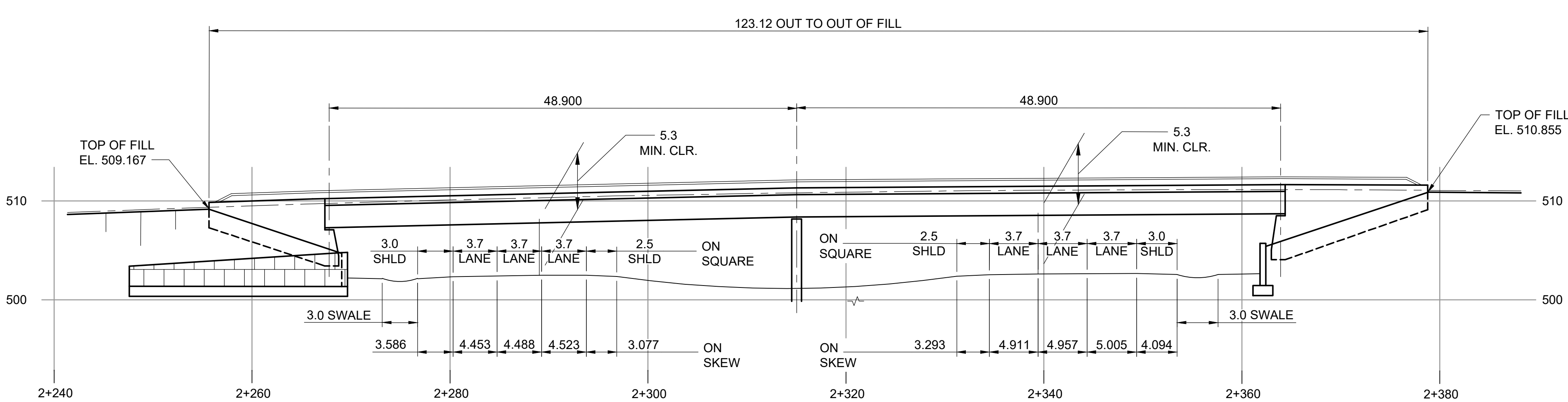


PLAN

Scale 1:600



KEY PLAN



ELEVATION

Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan — Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 11.13

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

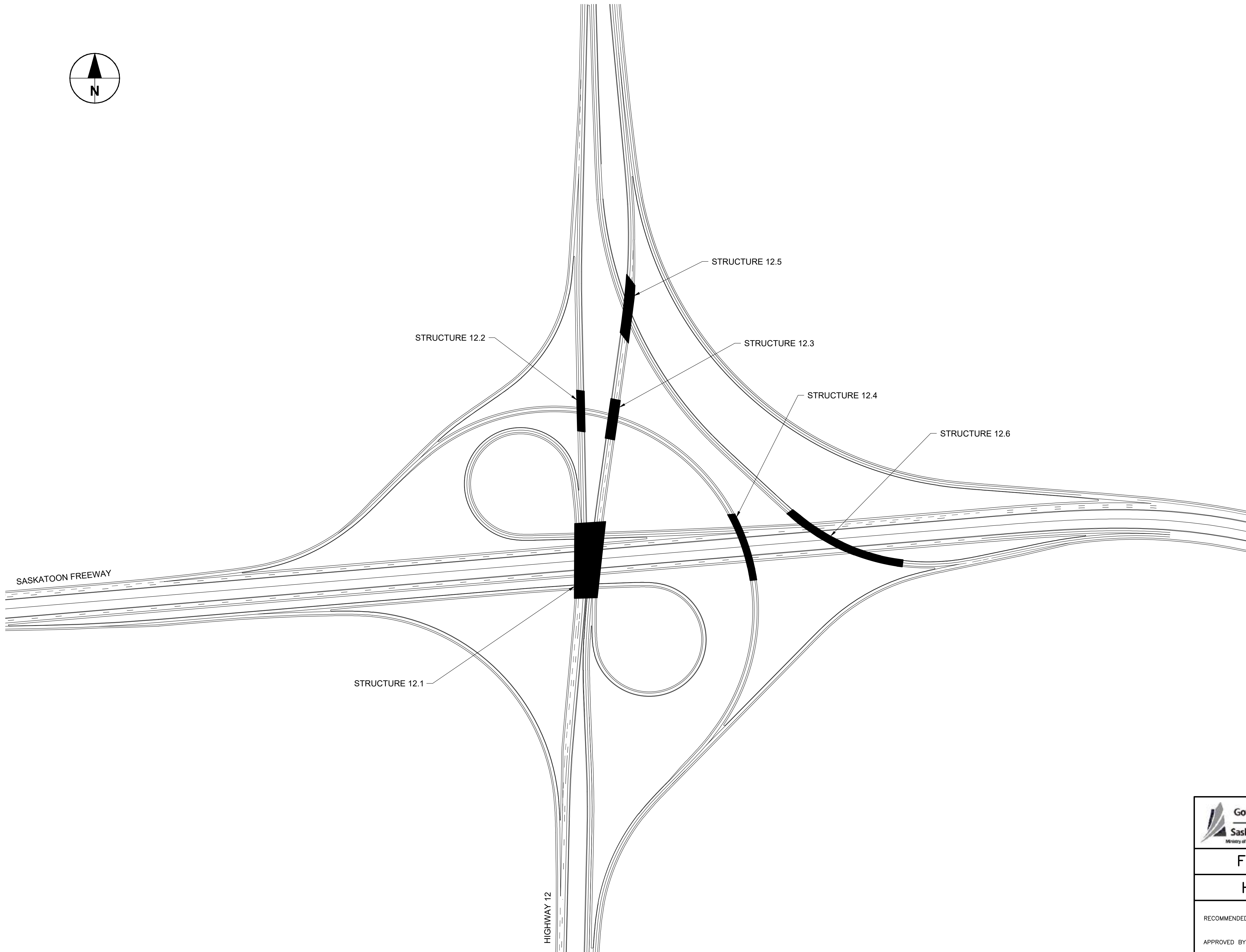
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

Sheet – of –

LAST REVISED DATE: 22–JAN–2009 1:40 PM

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S11XPE-11-M.DWG



Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

HIGHWAY 12 INTERCHANGE PLAN

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

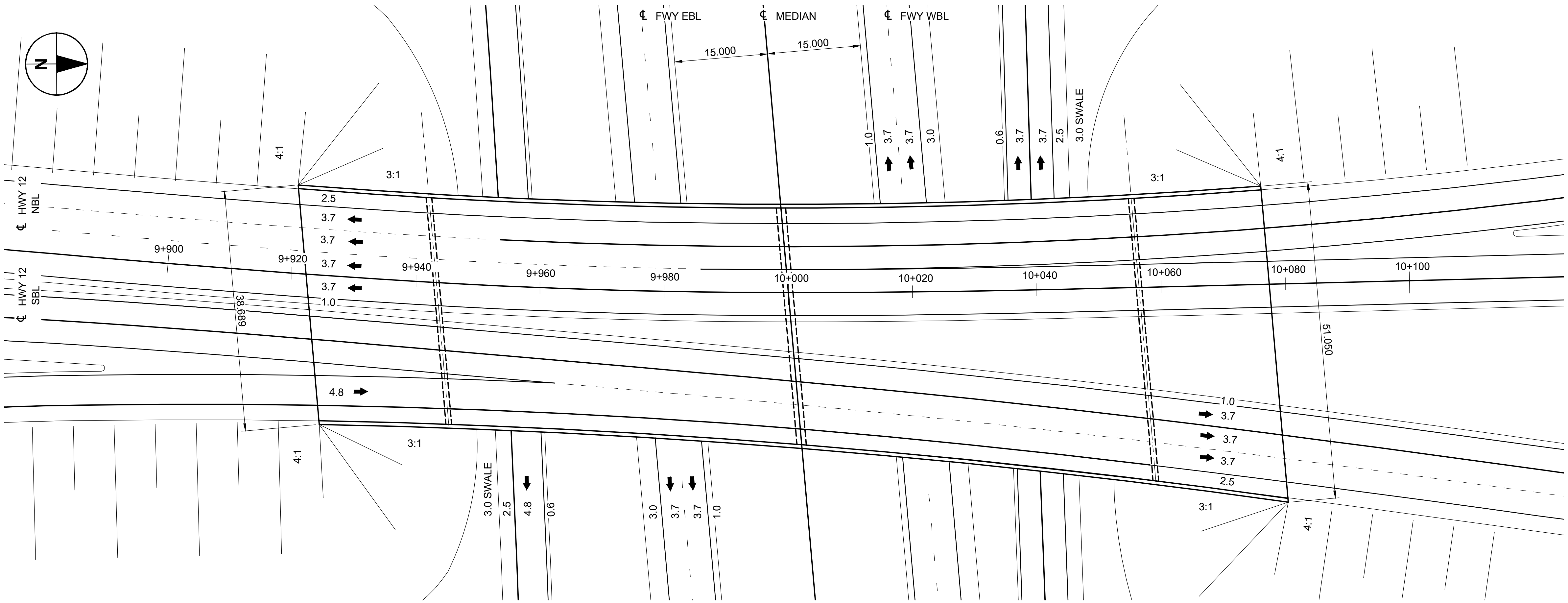
DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE –	DATE –	DATE –	PLAN –

Sheet – of –

NO.	DATE	DESCRIPTION
	REVISIONS	

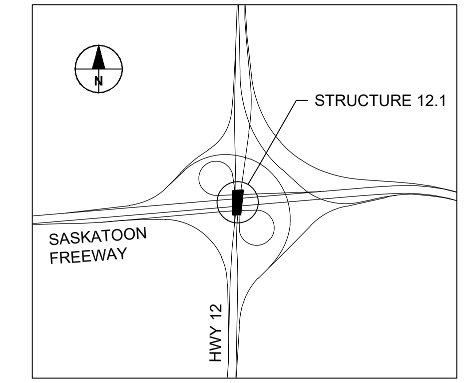
LAST REVISED DATE: 22–JAN–2009 1:40 PM

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\12\XPE-12-0.DWG

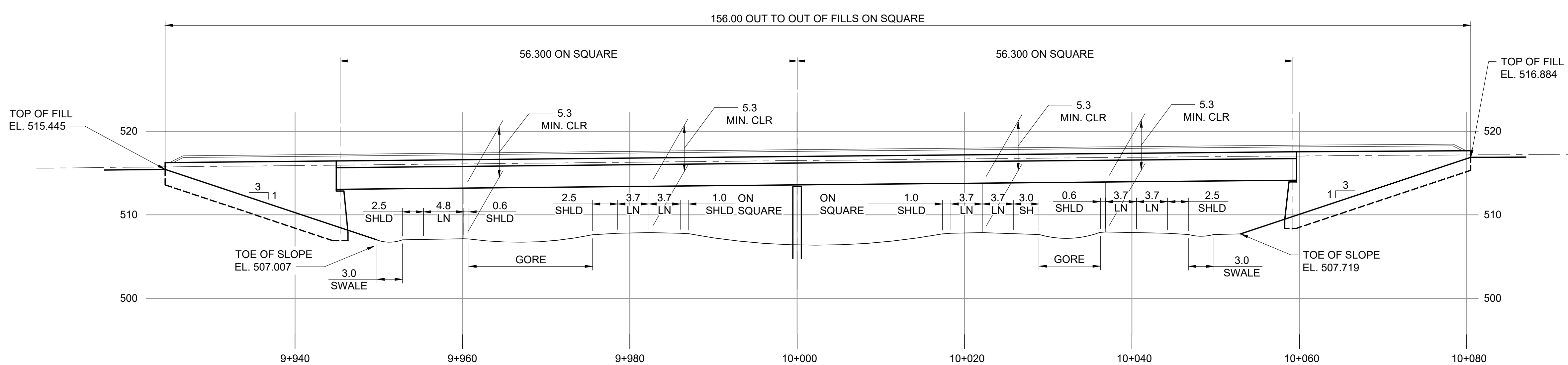


PLAN

Scale 1:800



KEY PLAN



ELEVATION

Scale 1:600

PRELIMINARY

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 12.1

RECOMMENDED BY: SENIOR BRIDGE PROJECT MANAGER DATE

APPROVED BY: DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION DATE

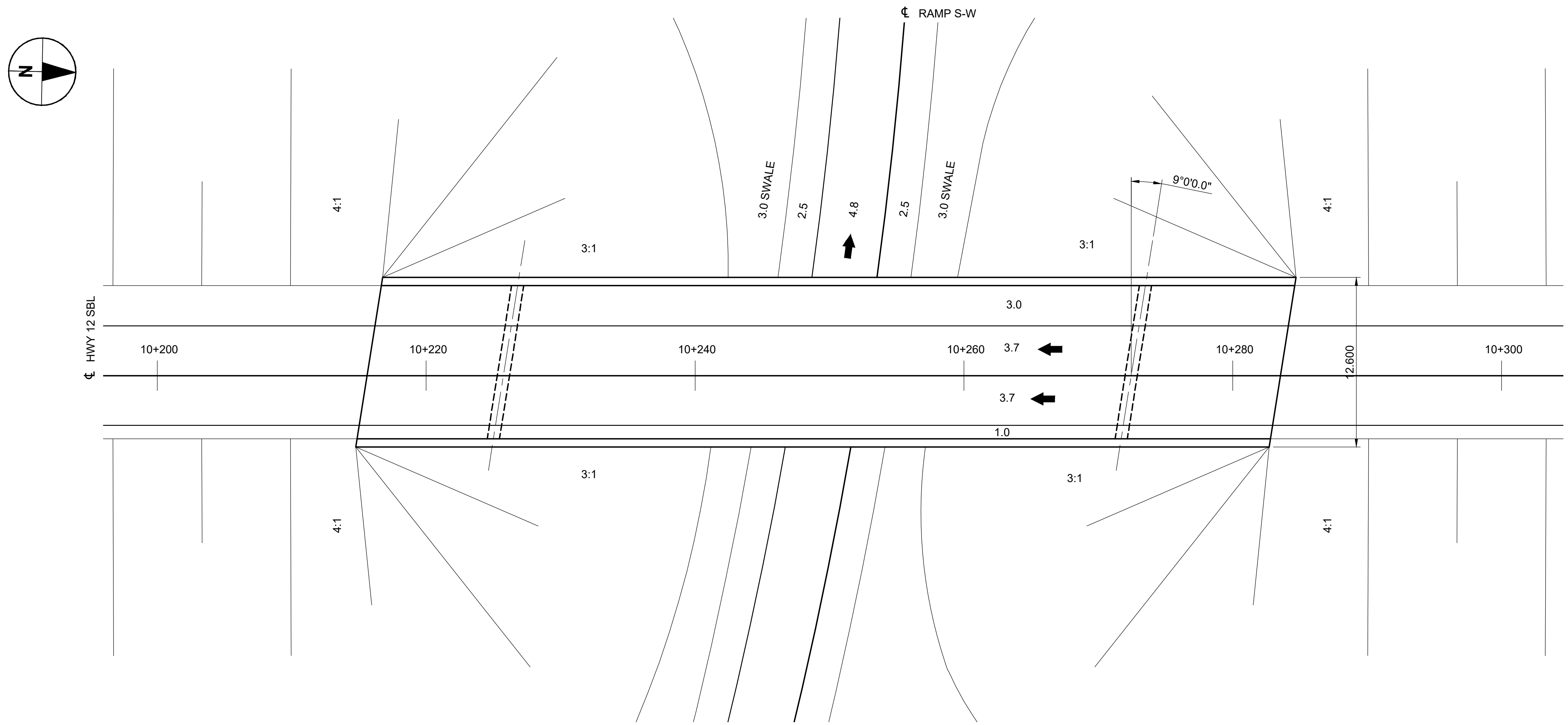
DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

NO.	DATE	DESCRIPTION
		REVISIONS

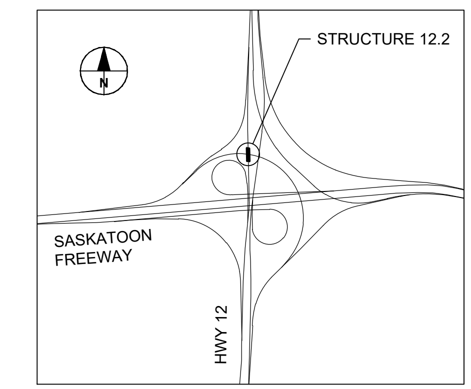
Sheet – of –

LAST REVISED DATE: 22–JAN–2009 1:40 PM

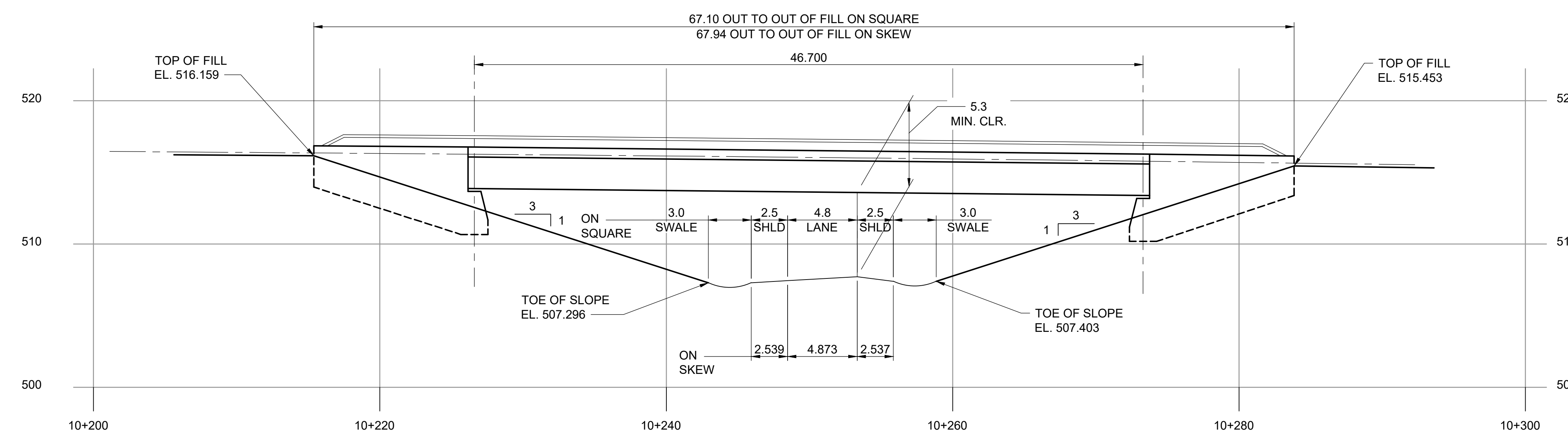
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S12\XPE-12-1.DWG



PLAN
Scale 1:400



KEY PLAN



ELEVATION
Scale 1:400

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 12.2

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

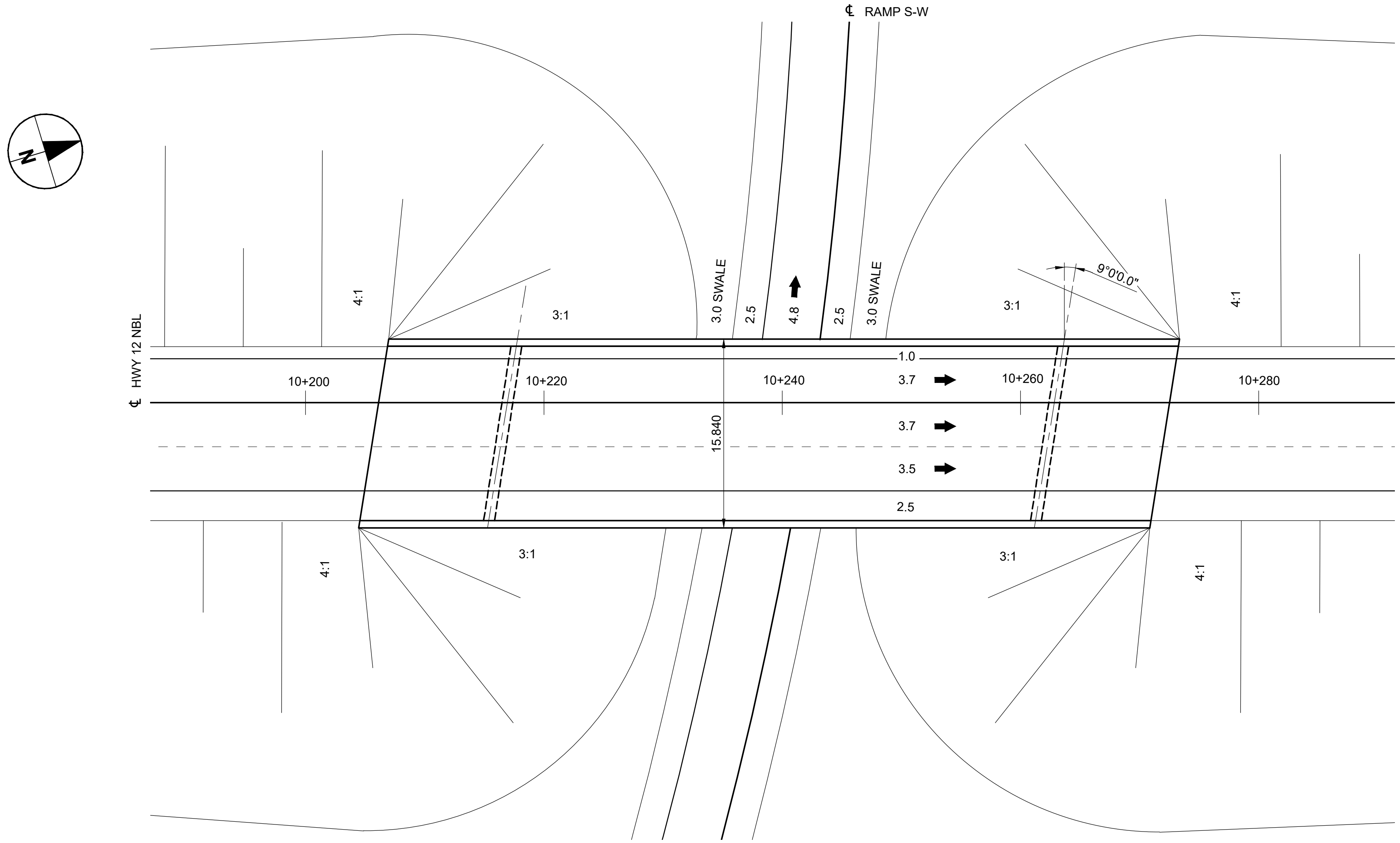
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
–	–	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

Sheet – of –

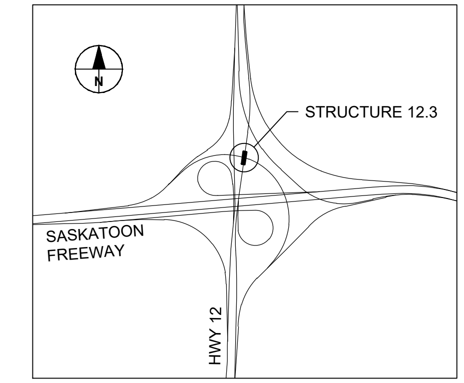
LAST REVISED DATE: 22–JAN–2009 1:40 PM

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\12\XPE-12-2.DWG

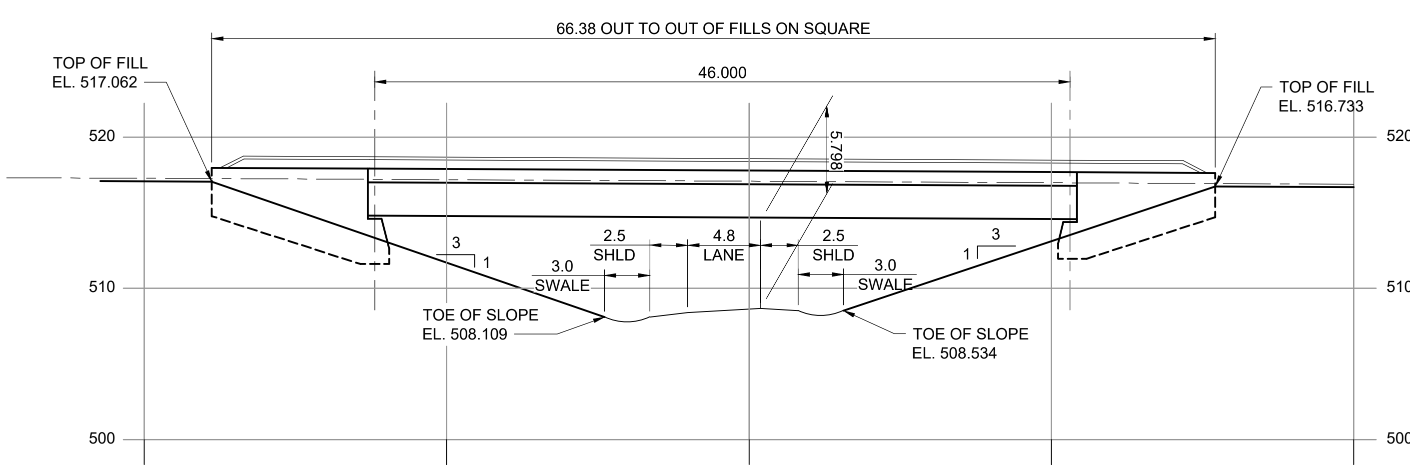


PLAN

Scale 1:500



KEY PLAN



ELEVATION

Scale 1:500

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 12.3

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

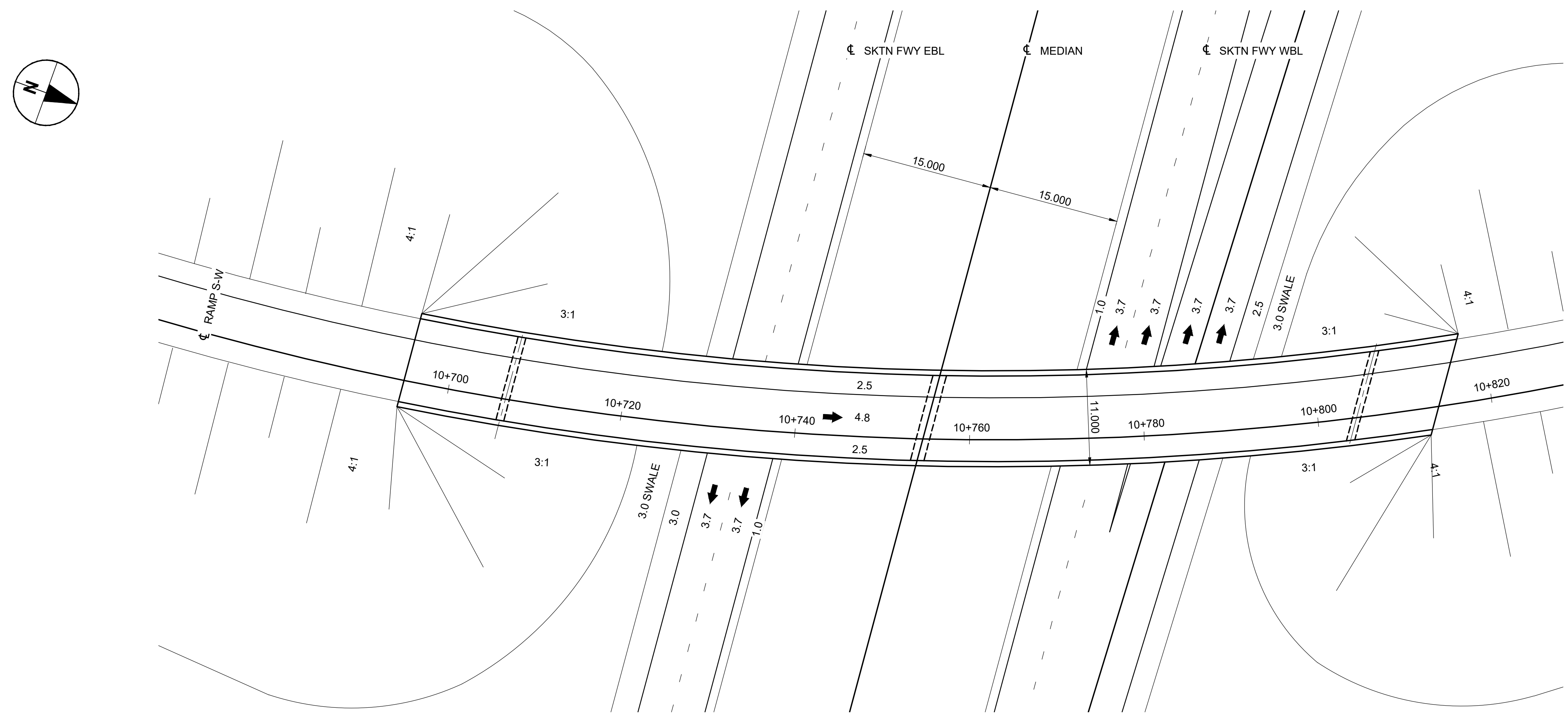
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
–	–	–	–
DATE –	DATE –	DATE –	PLAN –

Sheet – of –

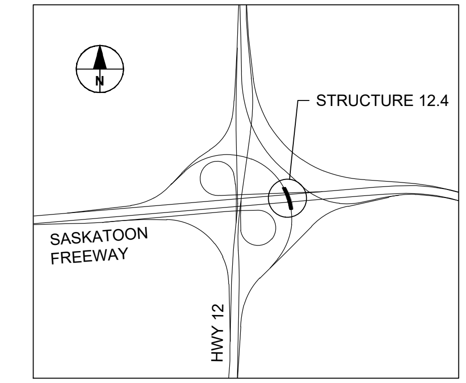
LAST REVISED DATE: 22-JAN-2009 1:40 PM

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\12\XPE-12-3.DWG

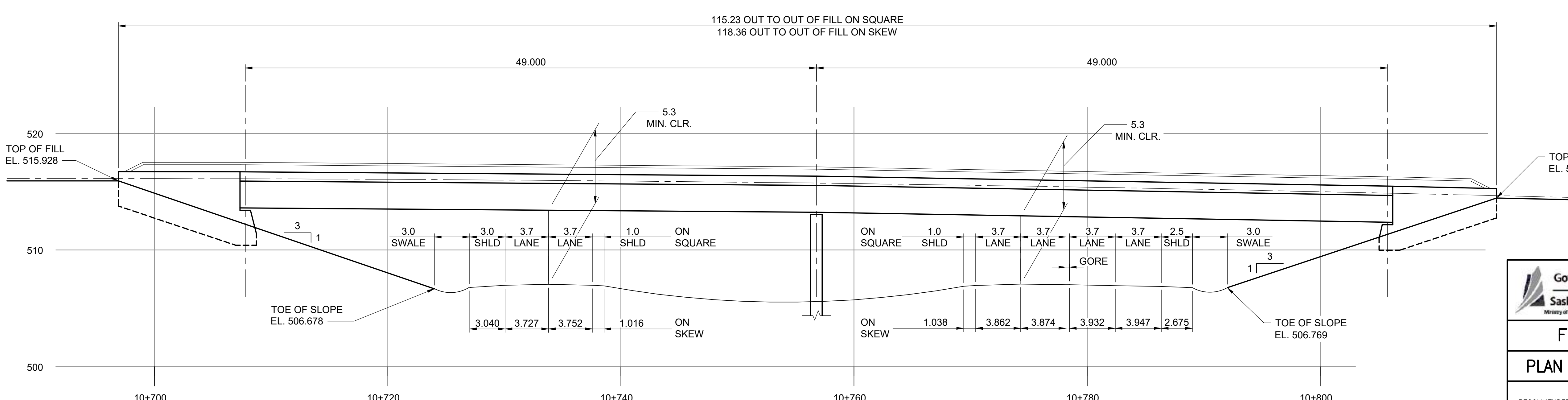


PLAN

Scale 1:600



KEY PLAN



ELEVATION

Scale 1:400

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 12.4

RECOMMENDED BY: SENIOR BRIDGE PROJECT MANAGER DATE

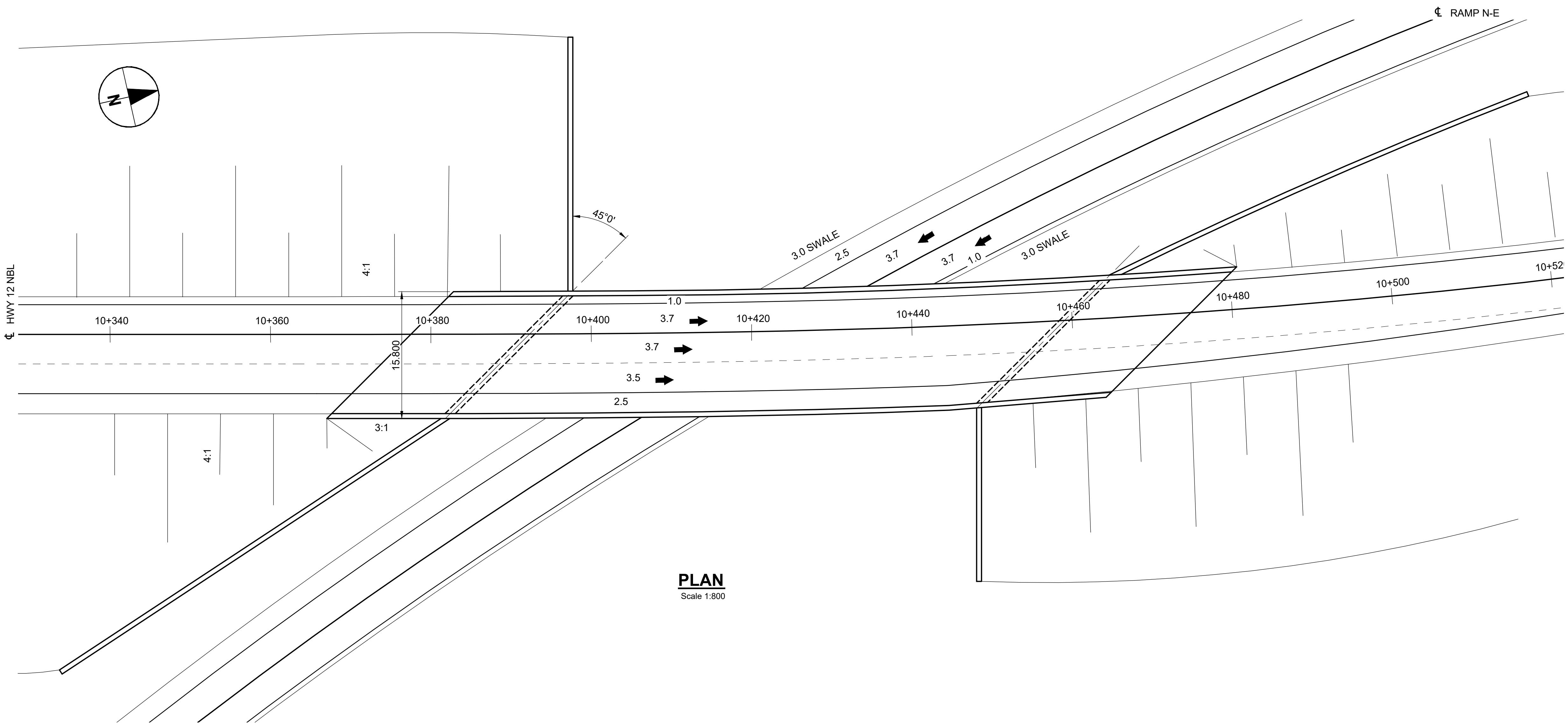
APPROVED BY: DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION DATE

DESIGN	DRAWN	CHECKED	FILE
–	–	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

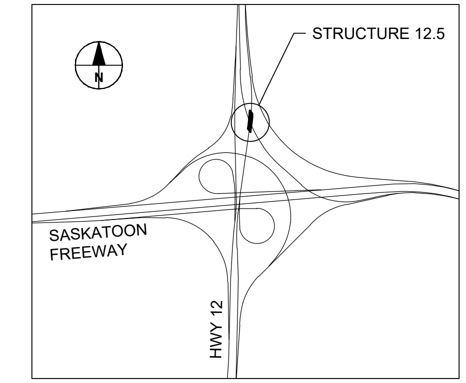
Sheet – of –

LAST REVISED DATE: 22–JAN–2009 1:40 PM

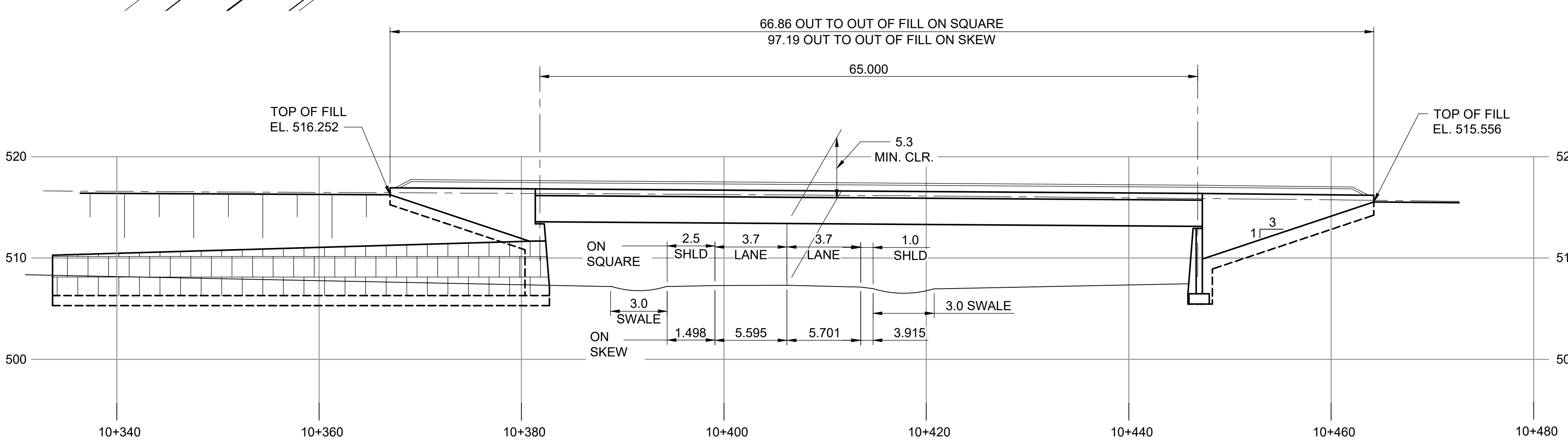
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\12\XPE-12-4.DWG



PLAN
Scale 1:800



KEY PLAN



ELEVATION
Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 12.5

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

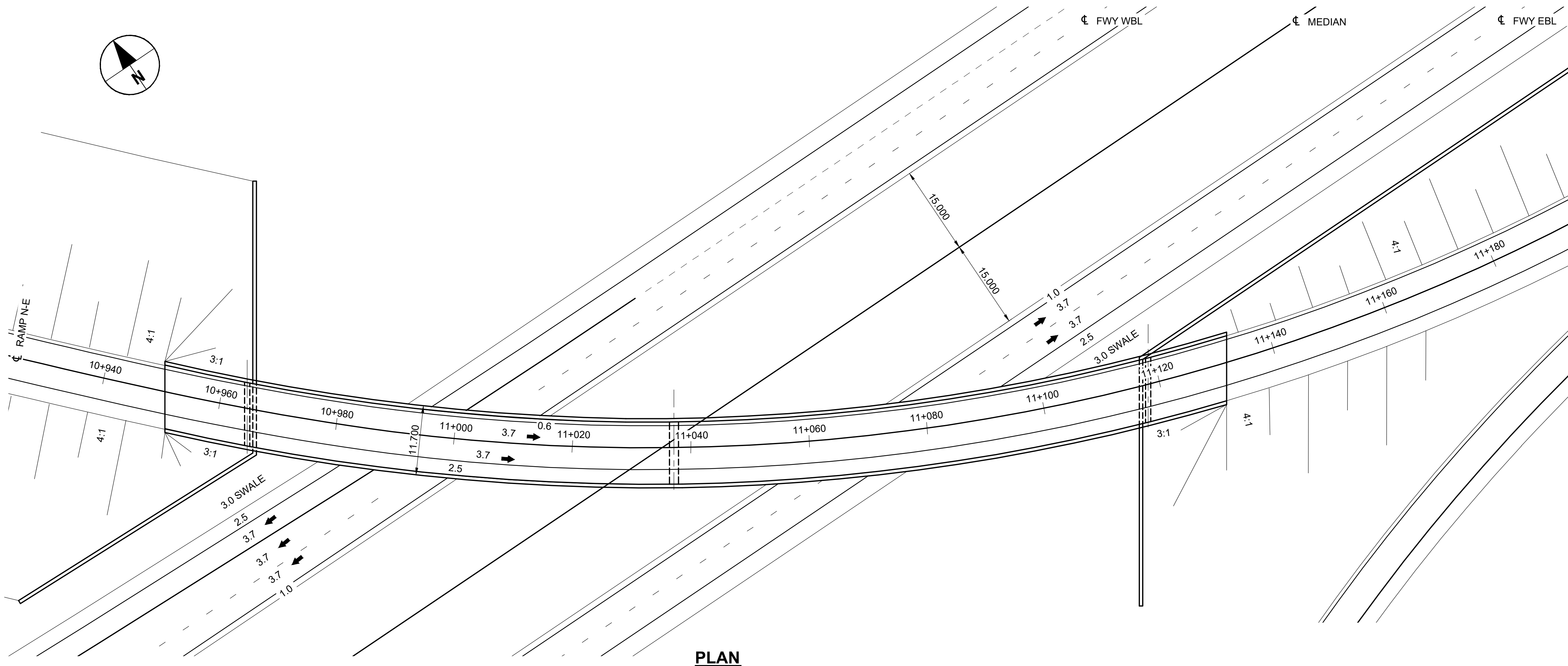
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE	DATE	DATE	PLAN
–	–	–	–

Sheet – of –

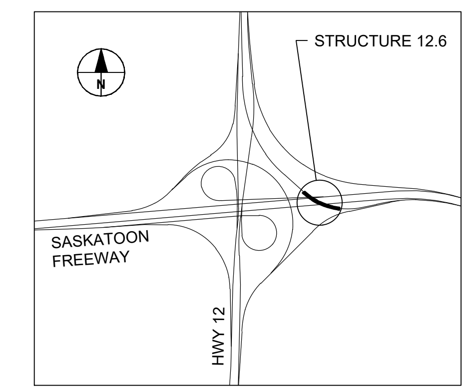
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\12\XPE-12-5.DWG

LAST REVISED DATE: 22–JAN–2009 1:40 PM

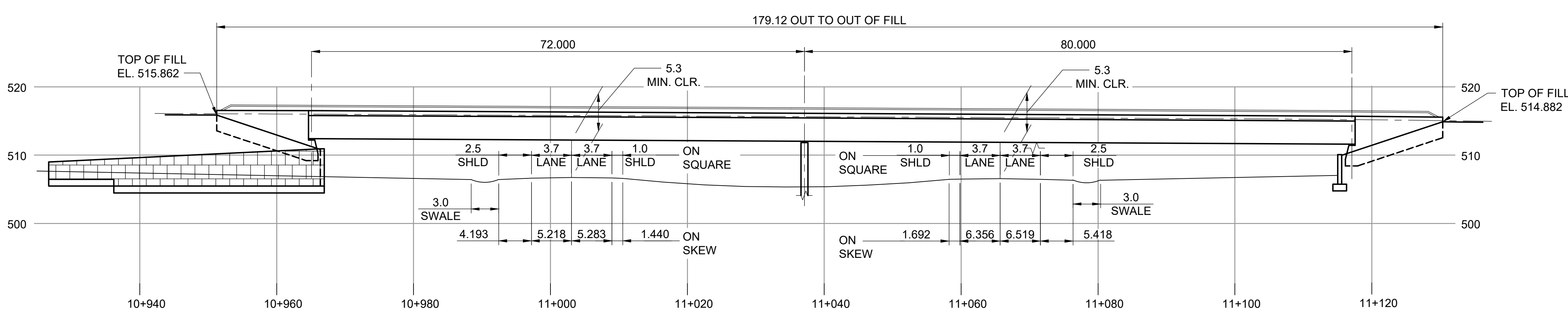


PLAN

Scale 1:800



KEY PLAN



ELEVATION

Scale 1:800

PRELIMINARY

NO.	DATE	DESCRIPTION
		REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 12.6

RECOMMENDED BY: SENIOR BRIDGE PROJECT MANAGER DATE

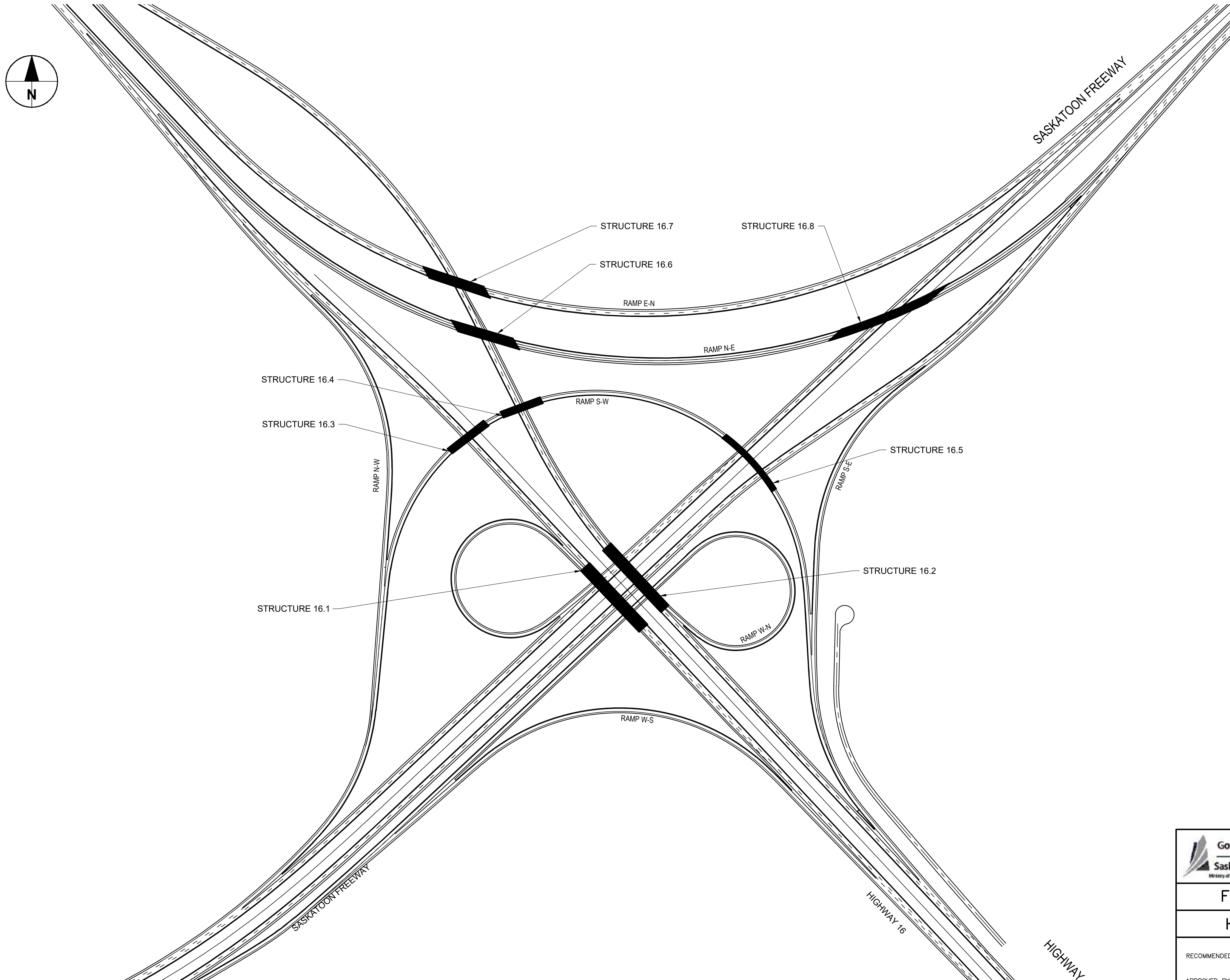
APPROVED BY: DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION DATE

DESIGN	DRAWN	CHECKED	FILE
BS	KM	–	–
DATE –	DATE –	DATE –	PLAN –

Sheet – of –

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MH\\S\12\XPE-12-6.DWG

LAST REVISED DATE: 22-JAN-2009 1:40 PM



Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

HIGHWAY 16 INTERCHANGE PLAN

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
NGD	KM	–	–
DATE –	DATE –	DATE –	PLAN –

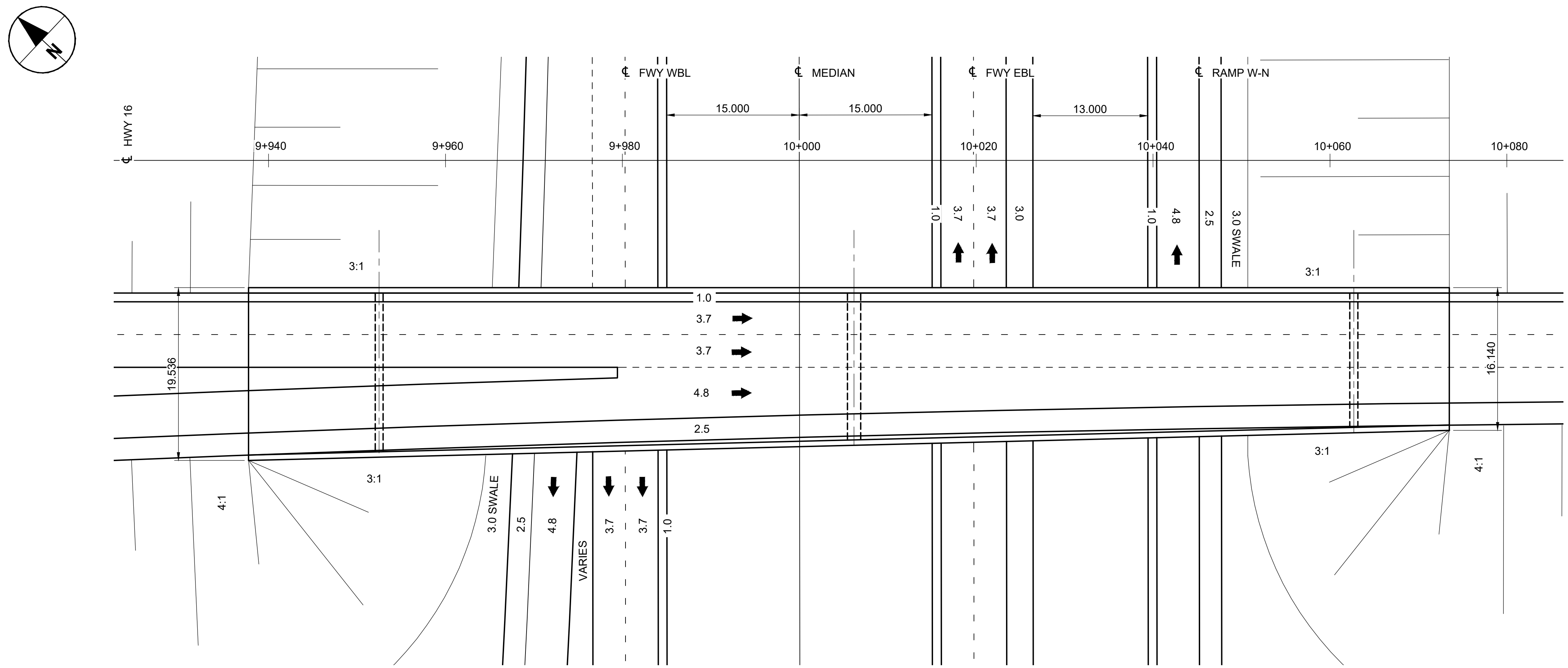
NO.	DATE	DESCRIPTION

REVISIONS

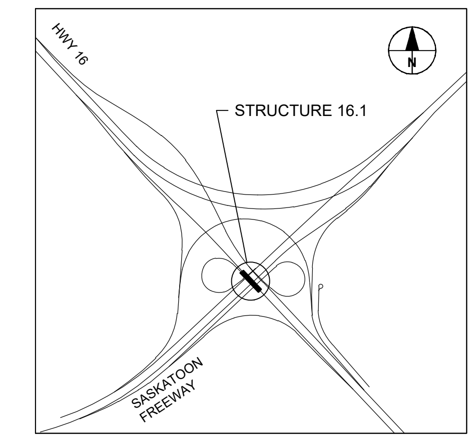
Sheet – of –

LAST REVISED DATE: 22–JAN–2009 1:40 PM

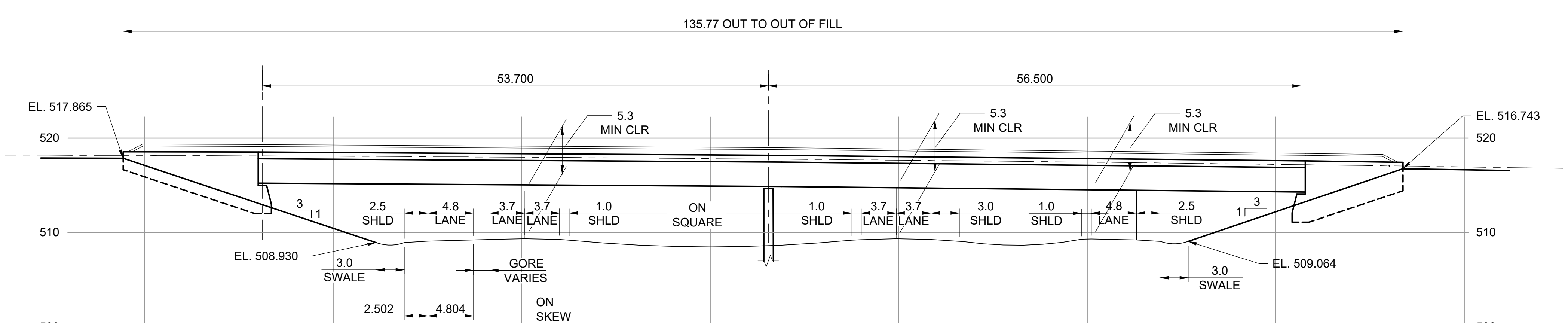
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\16\XPP-16-0.DWG



PLAN
Scale 1:600



KEY PLAN



ELEVATION
Scale 1:600

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 16.1

RECOMMENDED BY: ____________ SENIOR BRIDGE PROJECT MANAGER ____ DATE

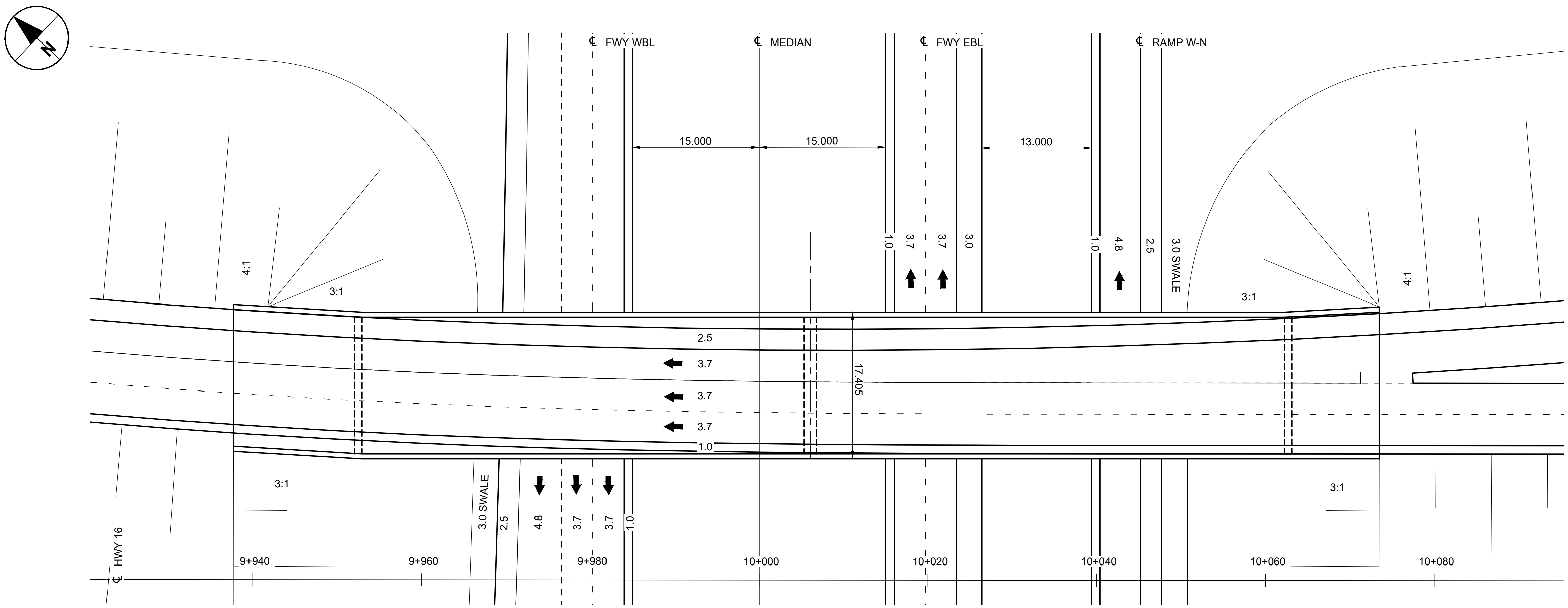
APPROVED BY: ____________ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ____ DATE

DESIGN	DRAWN	CHECKED	FILE
	KM		
DATE	DATE	DATE	PLAN

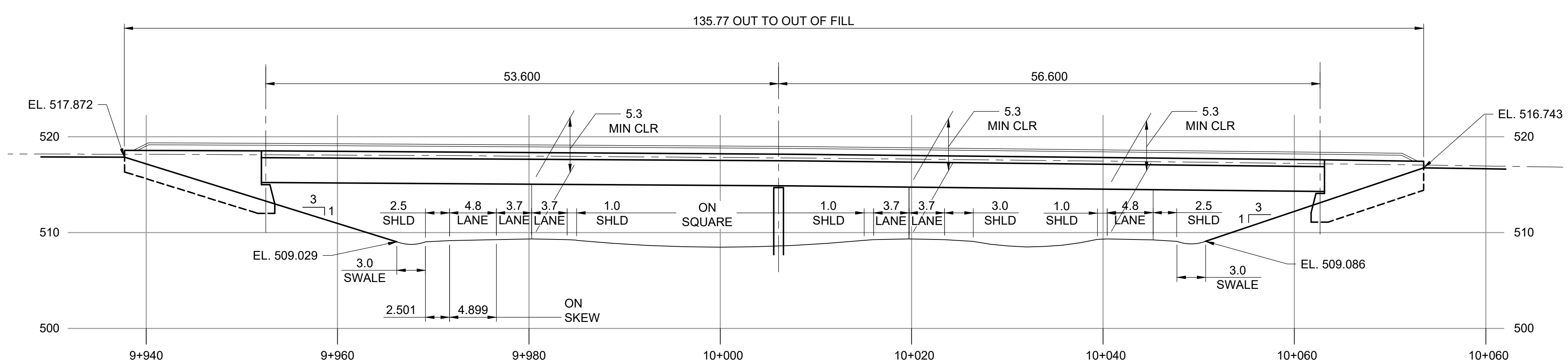
Sheet 1 of 1

LAST REVISED DATE: 22-JAN-2009 1:40 PM

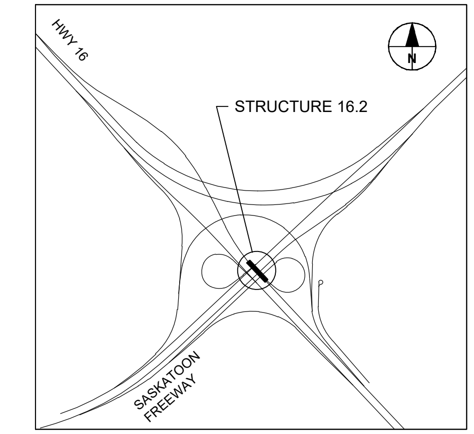
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\16\XPE-16-1.DWG



PLAN
Scale 1:600



ELEVATION
Scale 1:600



KEY PLAN

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 16.2

RECOMMENDED BY: SENIOR BRIDGE PROJECT MANAGER DATE

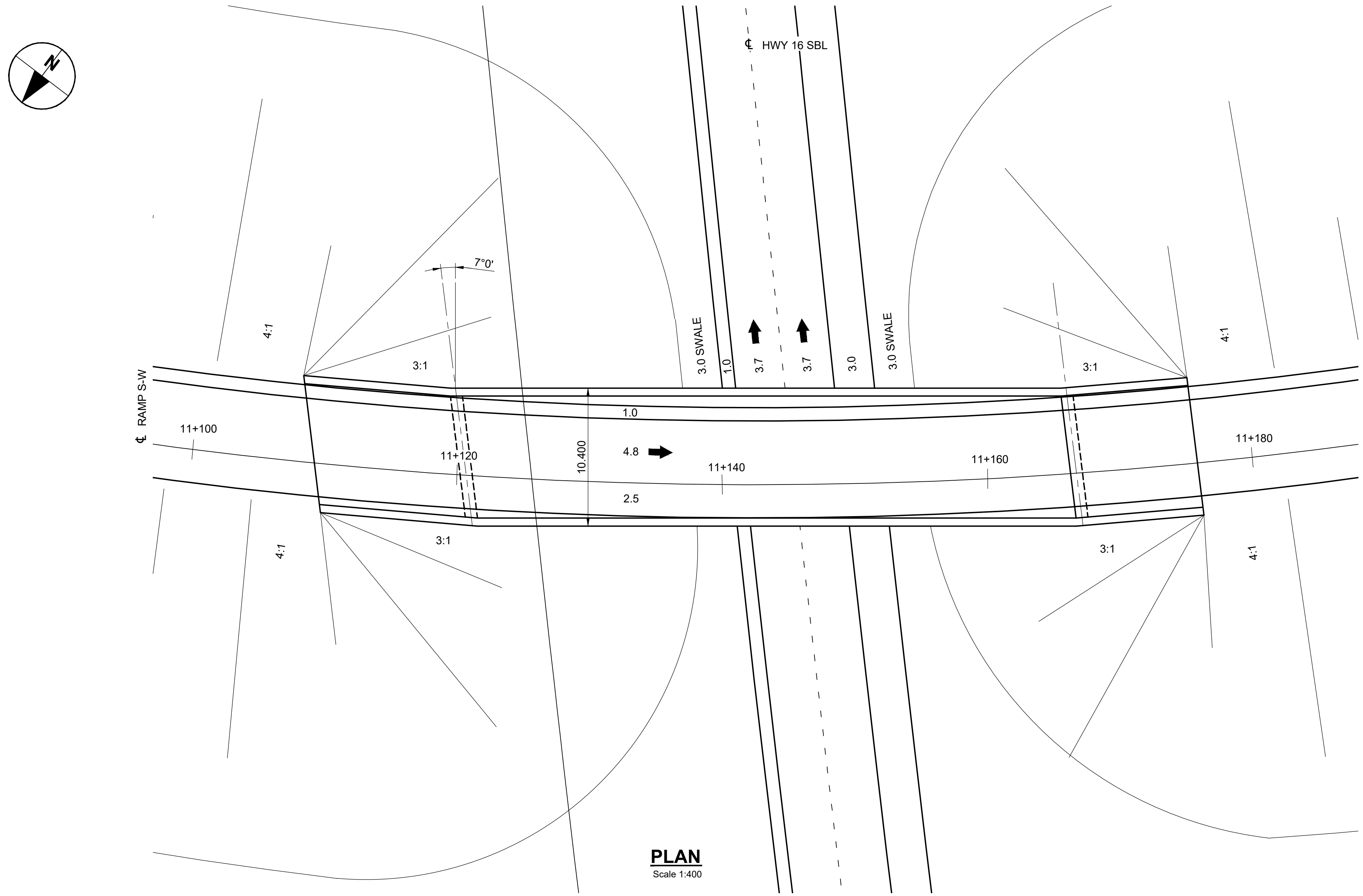
APPROVED BY: DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION DATE

DESIGN	DRAWN	CHECKED	FILE
	KM		
DATE	DATE	DATE	PLAN

Sheet 1 of 1

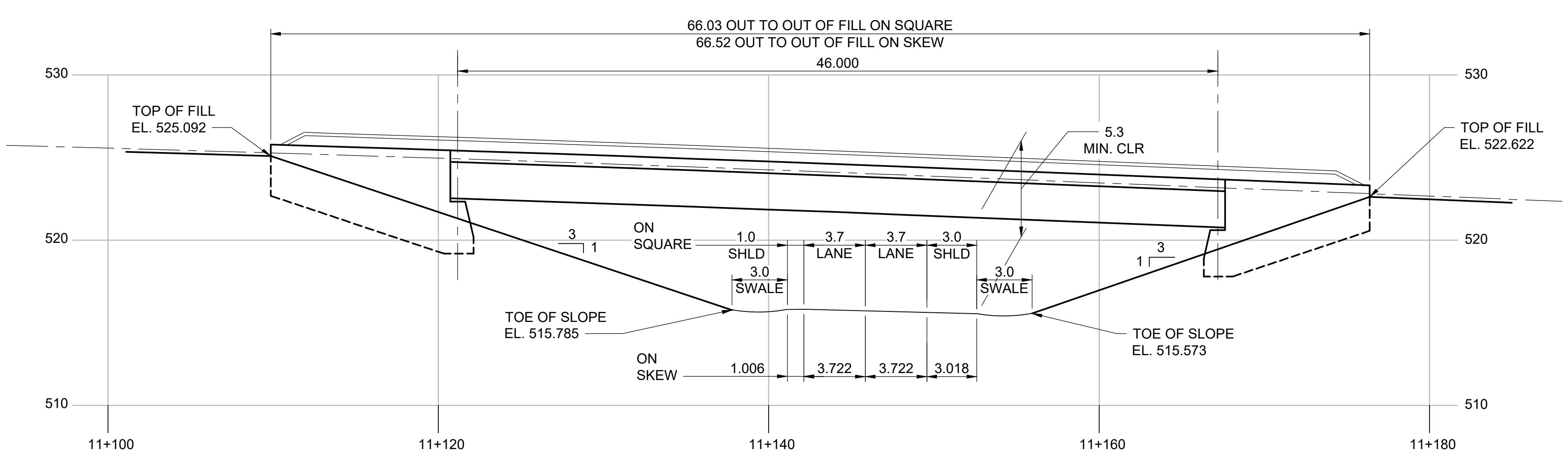
LAST REVISED DATE: 22–JAN–2009 1:40 PM

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\16\XPE-16-2.DWG



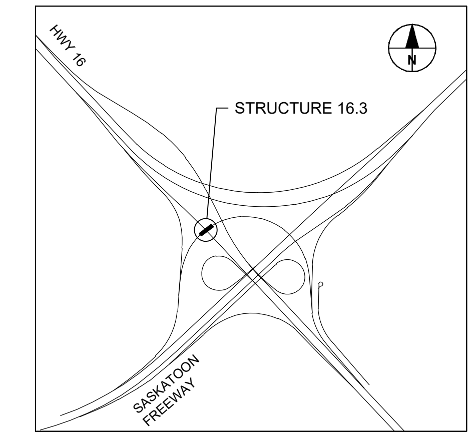
PLAN

Scale 1:400



ELEVATION

Scale 1:400



KEY PLAN

PRELIMINARY

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 16.3

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

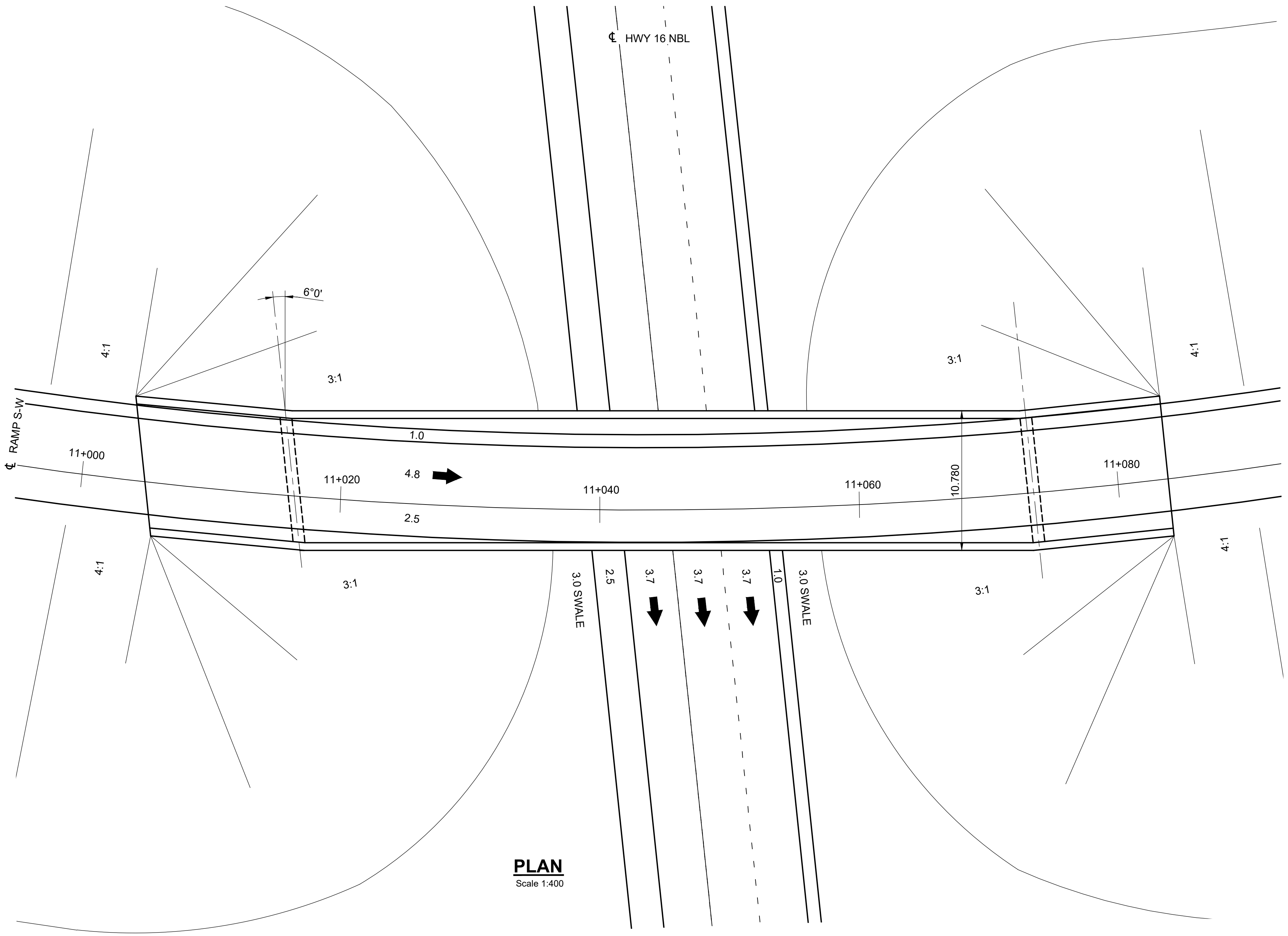
DESIGN	DRAWN	CHECKED	FILE
	KM		
DATE	DATE	DATE	PLAN

Sheet 1 of 1

NO.	DATE	DESCRIPTION
		REVISIONS

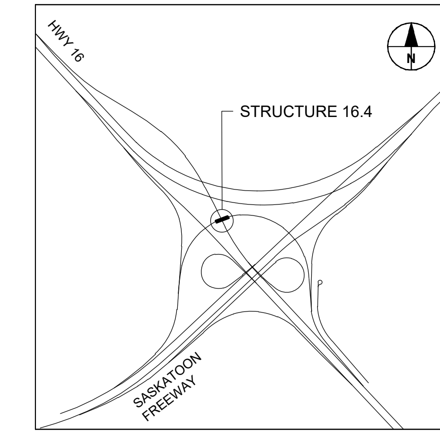
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\16\XPE-16-3.DWG

LAST REVISED DATE: 22-JAN-2009 1:40 PM

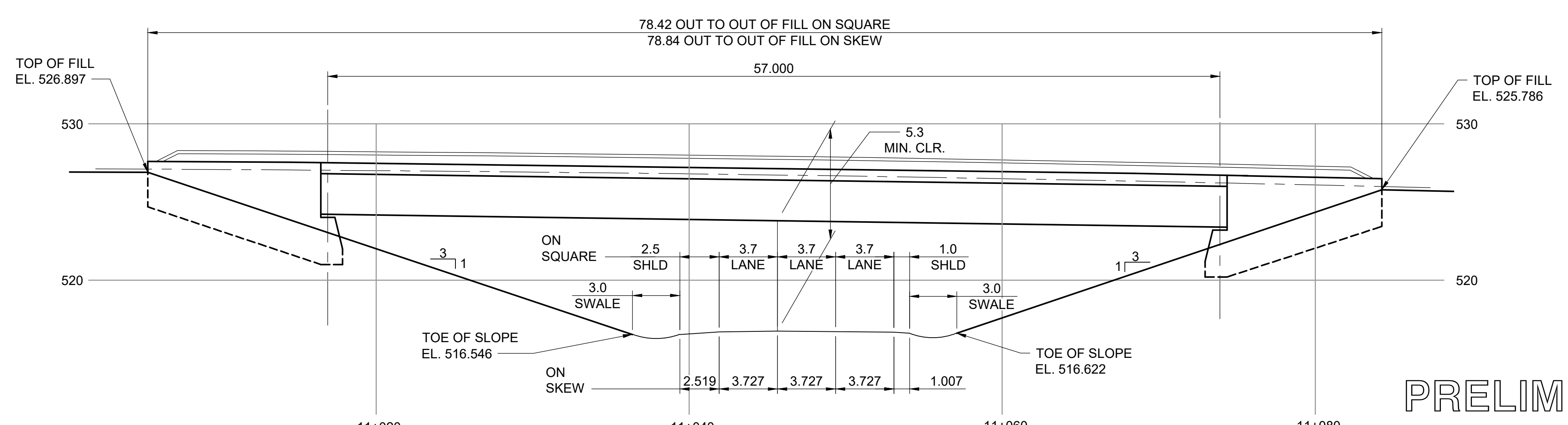


PLAN

Scale 1:400



KEY PLAN



ELEVATION

Scale 1:400

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 16.4

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

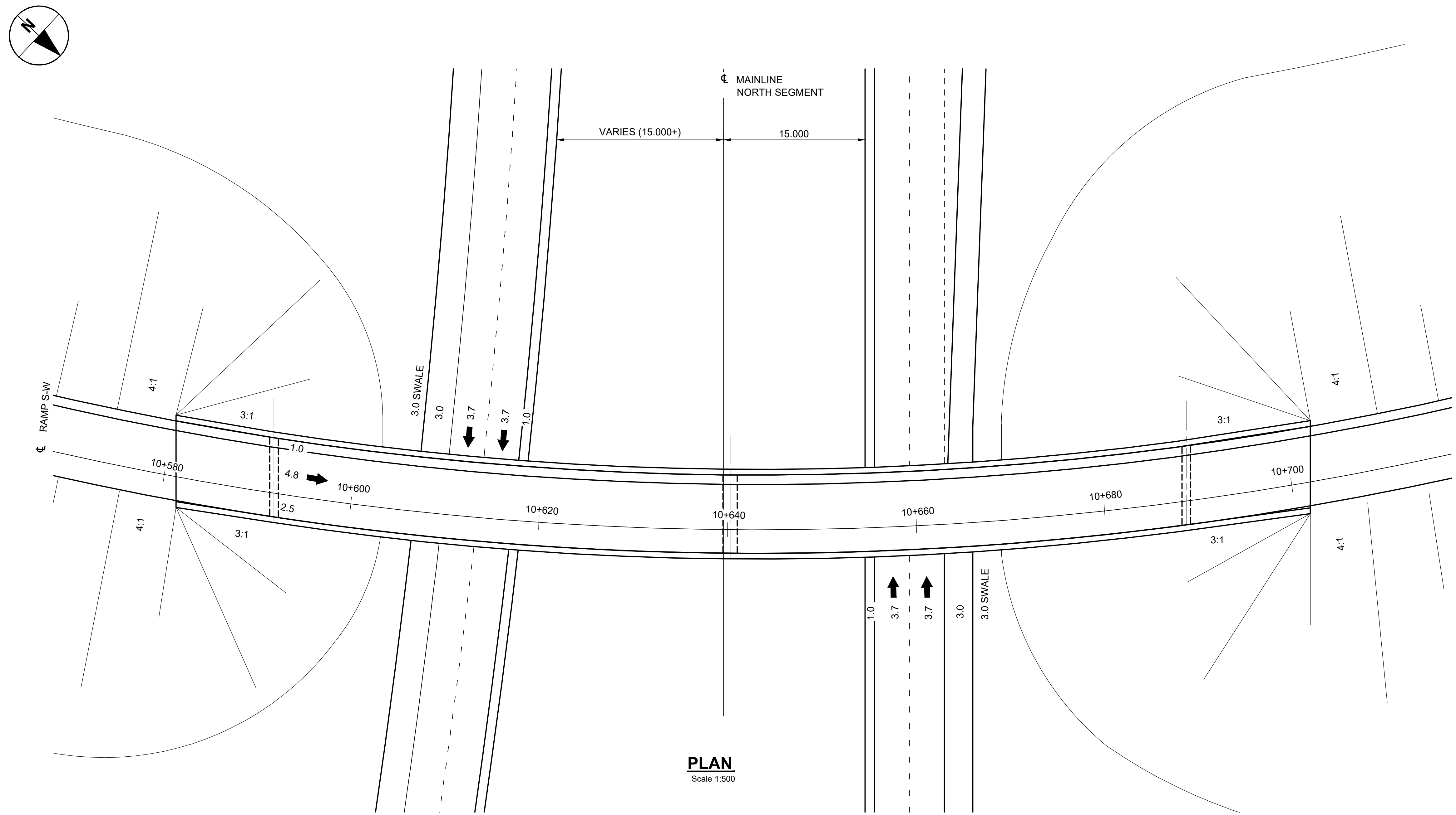
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
	KM		
DATE	DATE	DATE	PLAN

Sheet 1 of 1

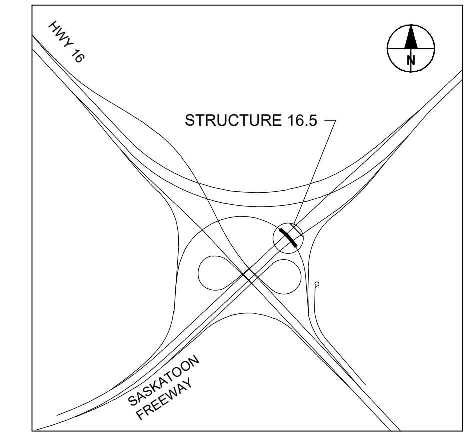
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\16\XPE-16-4.DWG

LAST REVISED DATE: 22-JAN-2009 1:40 PM

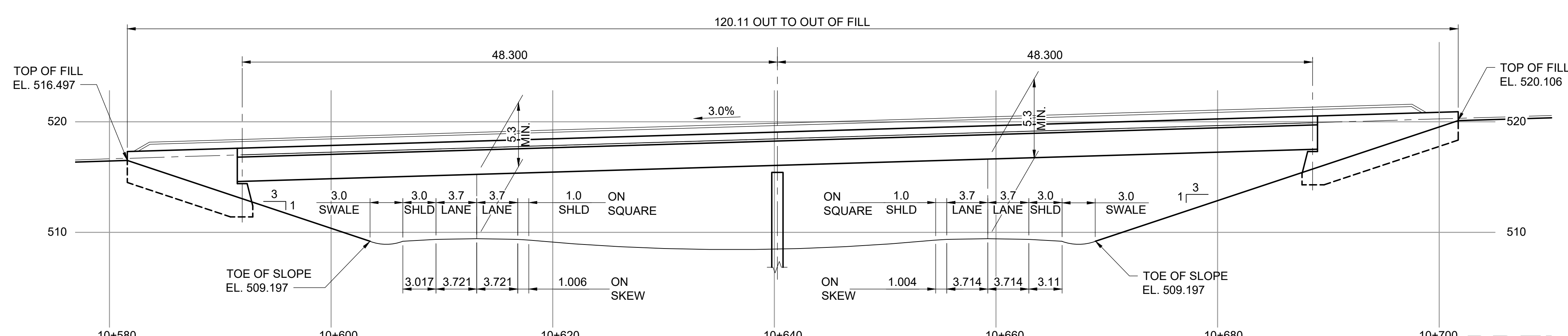


PLAN

Scale 1:500



KEY PLAN



ELEVATION

Scale 1:500

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 16.5

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

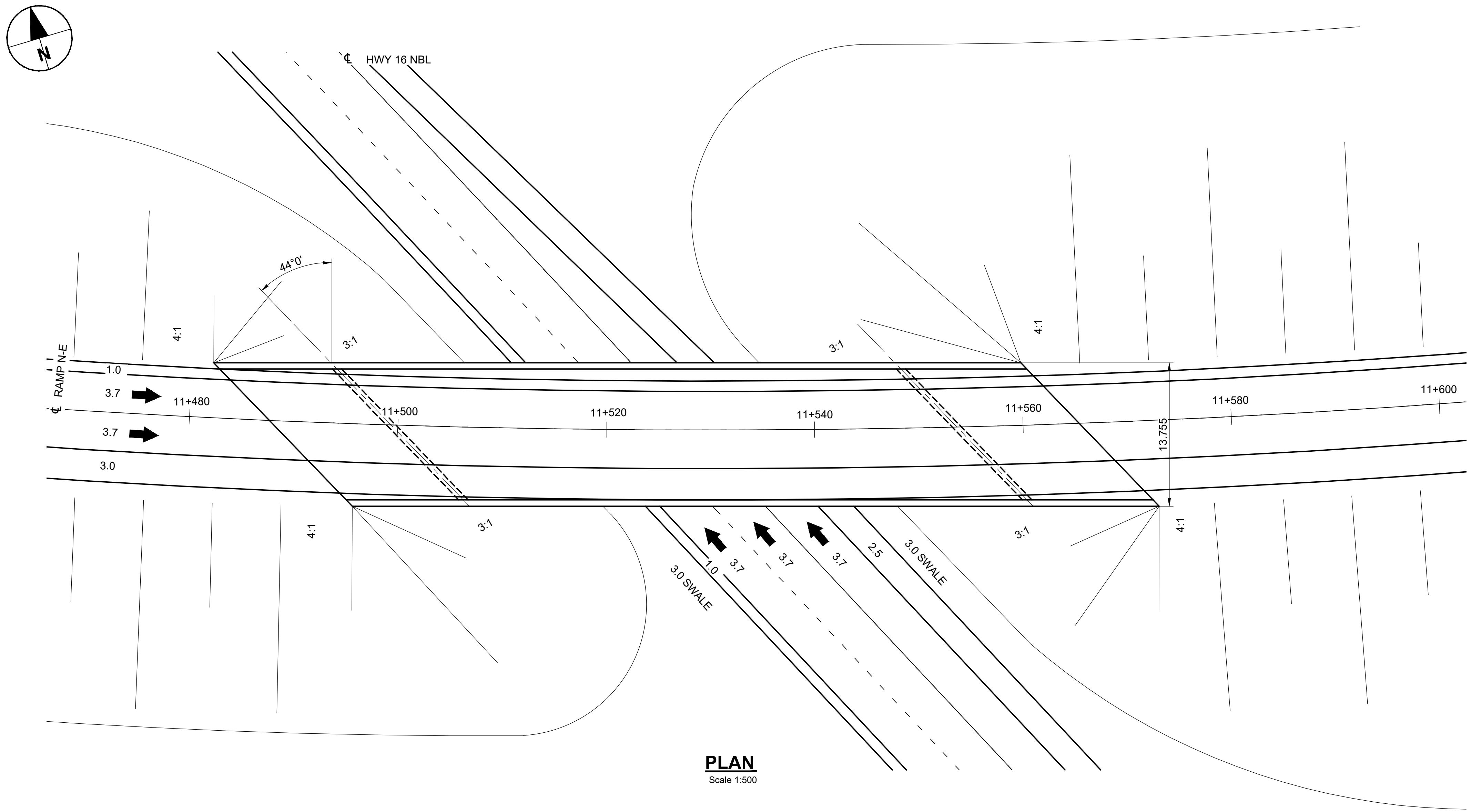
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
	KM		
DATE	DATE	DATE	PLAN

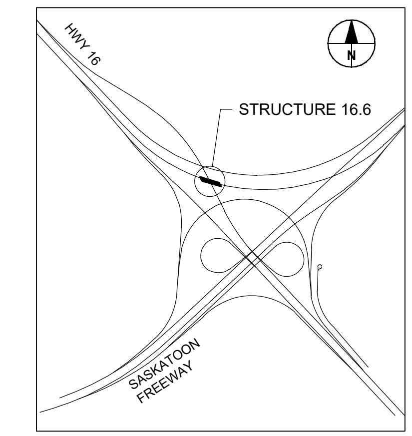
Sheet 1 of 1

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S16\XPE-16-5.DWG

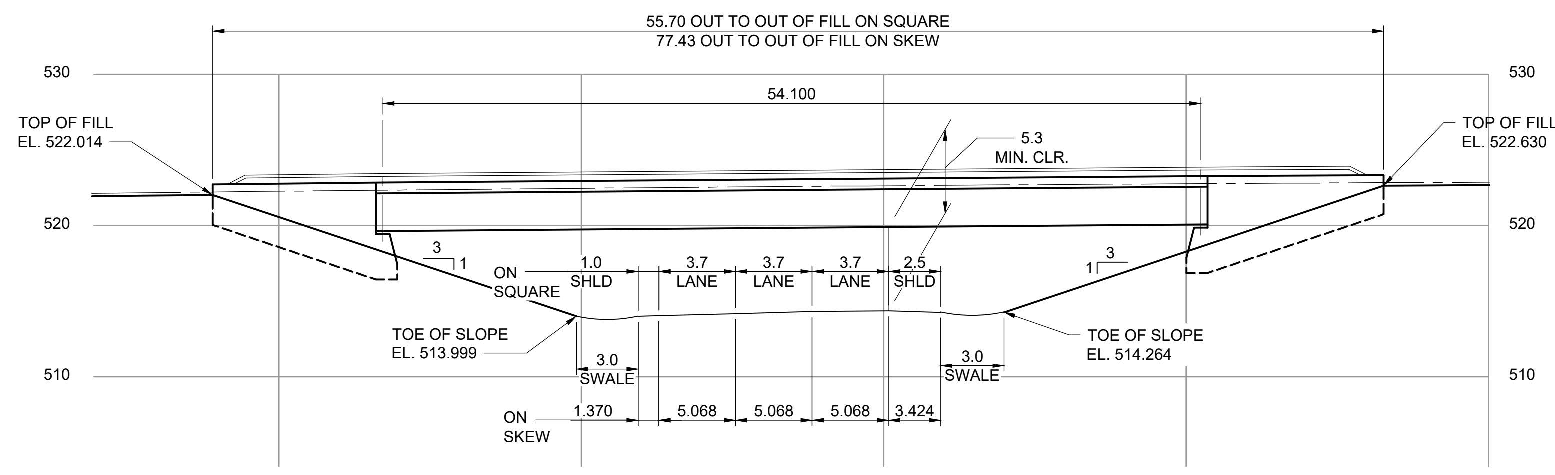
LAST REVISED DATE: 22–JAN–2009 1:40 PM



PLAN
Scale 1:500



KEY PLAN



ELEVATION
Scale 1:500

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 16.6

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

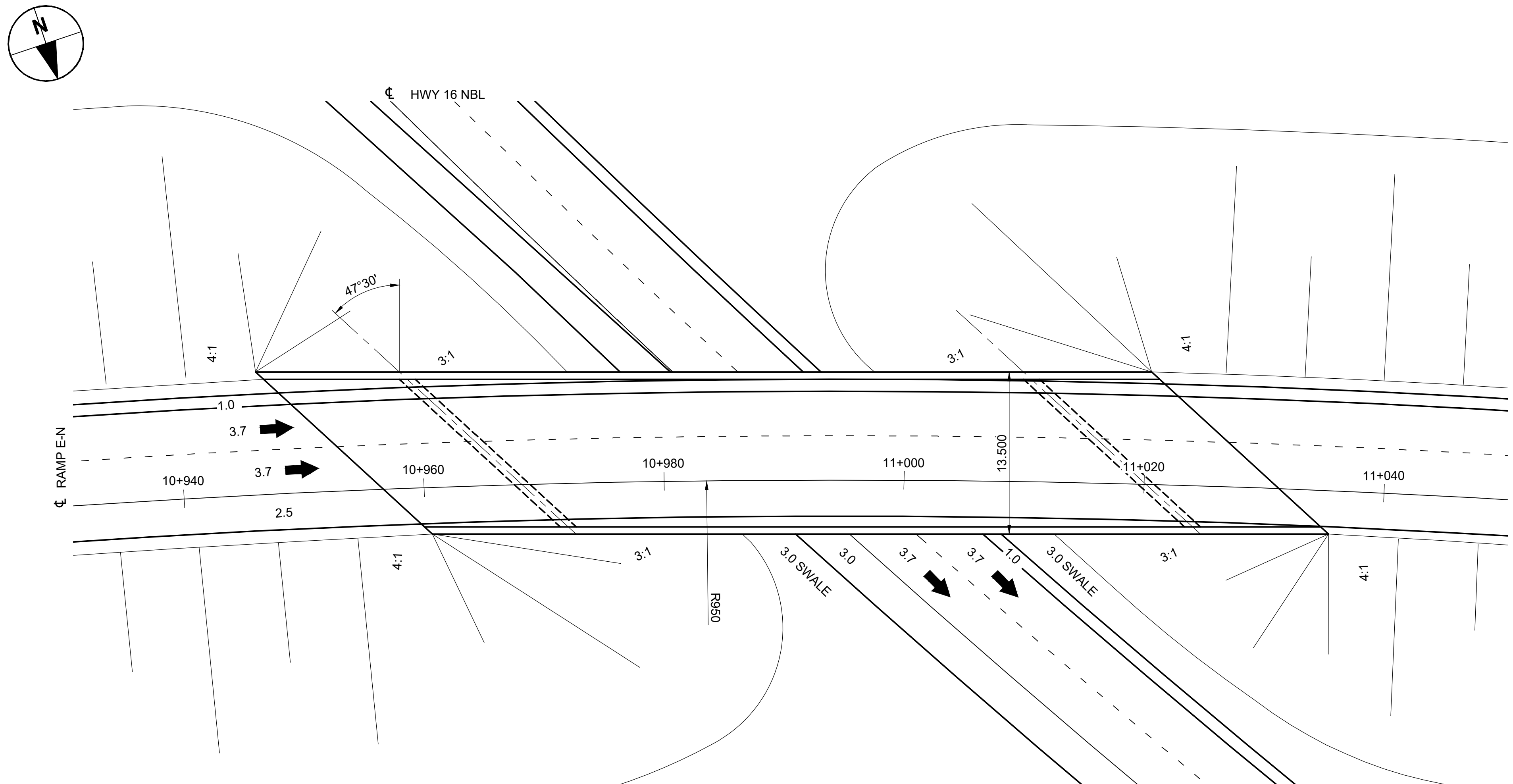
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
	KM		
DATE	DATE	DATE	PLAN

Sheet 1 of 1

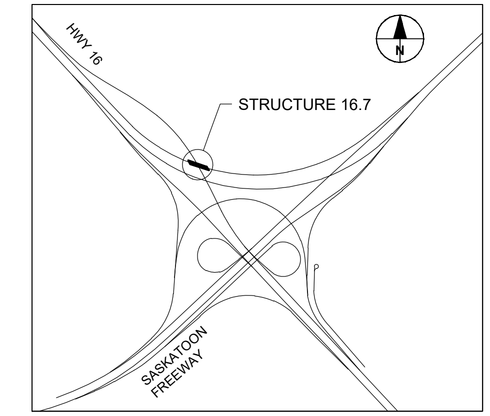
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\16\XPE-16-6.DWG

LAST REVISED DATE: 22-JAN-2009 1:40 PM

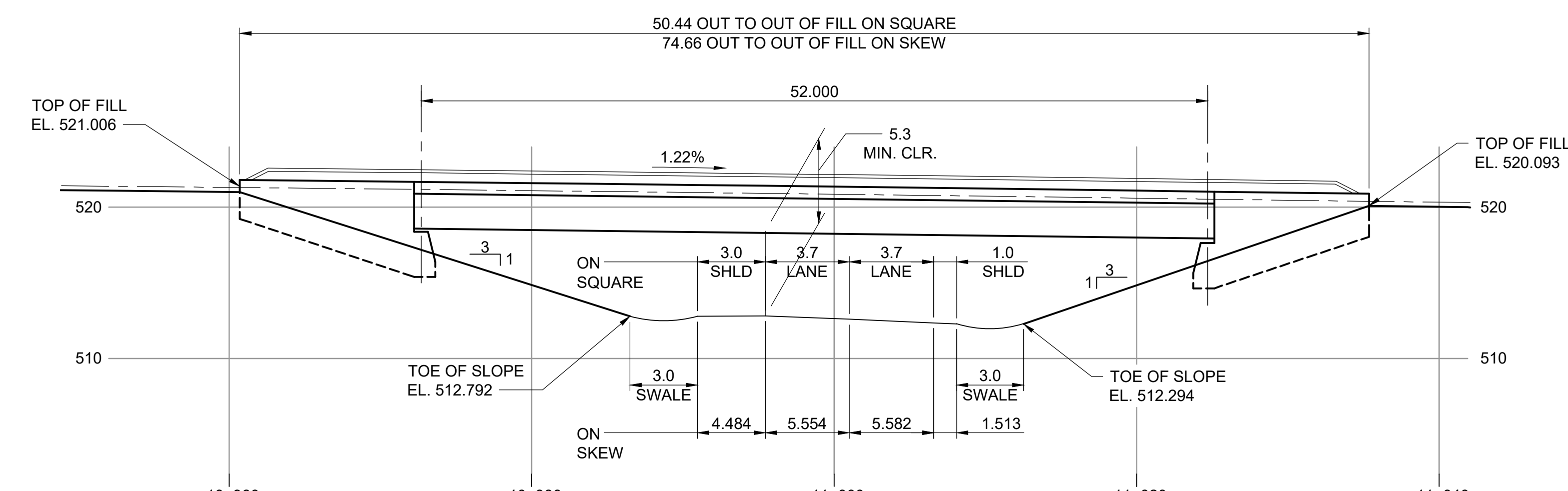


PLAN

Scale 1:500



KEY PLAN



ELEVATION

Scale 1:500

PRELIMINARY

NO.	DATE	DESCRIPTION

REVISIONS

Government of Saskatchewan
Ministry of Highways & Infrastructure

BRIDGE SERVICES

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 16.7

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

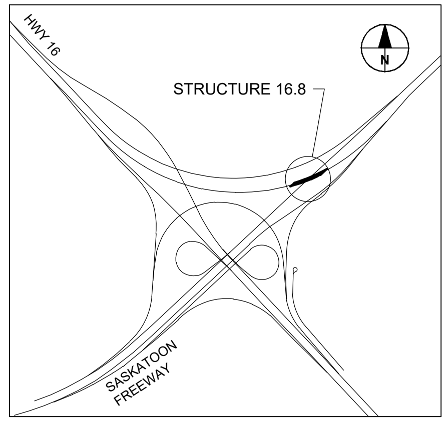
APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
	KM		
DATE	DATE	DATE	PLAN

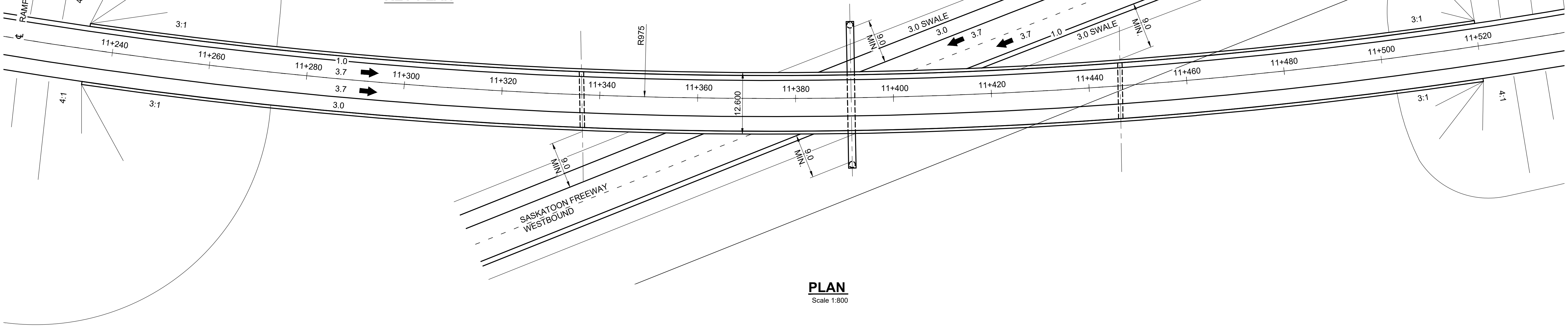
Sheet 1 of 1

LAST REVISED DATE: 22-JAN-2009 1:40 PM

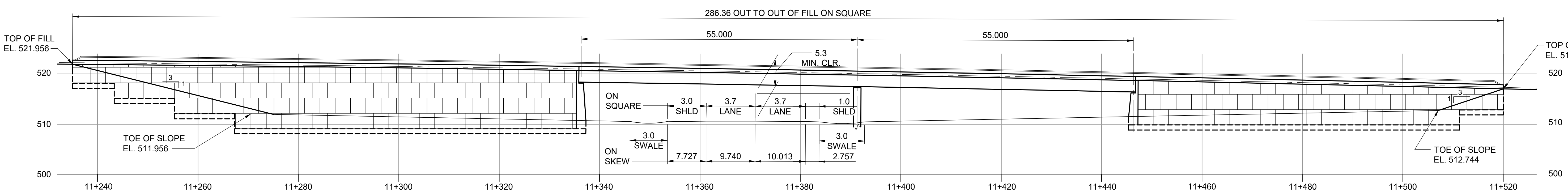
Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\16\XPE-16-7.DWG



KEY PLAN



PLAN
Scale 1:800



ELEVATION
Scale 1:800

PRELIMINARY

Government of Saskatchewan
Ministry of Highways & Infrastructure

FUNCTIONAL PLANNING STUDY

PLAN AND ELEVATION – STRUCTURE 16.8

RECOMMENDED BY: ______ SENIOR BRIDGE PROJECT MANAGER ______ DATE

APPROVED BY: ______ DIRECTOR, REGIONAL DESIGN AND CONSTRUCTION ______ DATE

DESIGN	DRAWN	CHECKED	FILE
	KM		
DATE	DATE	DATE	PLAN

NO.	DATE	DESCRIPTION

Sheet 1 of 1

Filename: C:\USERS\MALKIEWICZK\ONEDRIVE - AECOM DIRECTORY\WORK\60594864 - MHI\S\16\XPE-16-8.DWG

LAST REVISED DATE: 22–JAN–2009 1:40 PM