Northeast Leg – Anthony Henday Drive

Environmental Assessment

Final Report

Prepared for:

Alberta Transportation
Edmonton, Alberta

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Under contract to:

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Project Number EP- 387

June 2010

EXECUTIVE SUMMARY

Alberta Transportation (AT) proposes to construct 8.6 kilometers of a new freeway and make improvements to 9.8 kilometers of existing freeway (Highway 216) within the Edmonton Transportation and Utility Corridor (TUC) across the City of Edmonton's northeastern edge [Northeast Anthony Henday Drive (NEAHD)]. They also propose to make improvements to approximately 8 kilometers within the Highway 16 corridor to Highway 21. All components will be designated as Dangerous Goods Routes. The project is currently at the advanced functional planning stage, which forms the basis for this environmental assessment.

Most of the proposed NEAHD project study area is through relatively flat to gently undulating terrain comprised of cultivated farm or pasture lands and scattered woodland and wetland areas. The exception is the deeply incised North Saskatchewan River Valley where a major new river crossing will be constructed as a component of the NEAHD project. There is a significant elevation difference between the north and south banks, with the north bank rising approximately 30 m higher than the south bank.

The north bank of the North Saskatchewan River has a history of slope instability, however, extensive geotechnical investigations and analysis has been conducted in support of the NEAHD advanced functional planning study. Further, hydrotechical design parameters have been developed. It is assumed that any remaining residual minor impacts with regards to north bank slope stability will be resolved during the detailed design phase of the project. River hydraulics are not expected to be negatively effected by the proposed instream bridge piers and increased bank erosion is not expected.

Due to relatively level terrain, and the absence of significant drainage, surface erosion is not a major concern in the tablelands to the north and south of the North Saskatchewan River. Surface erosion and sedimentation are significant concerns on the north bank of the river due to the steepness and instability of that slope and the resultant potential to reduce water quality in the North Saskatchewan River.

A Limited Phase I Environmental Screening Assessment (ESA) conducted in the project area identified several areas of potential environmental concern including soil and groundwater contamination. A Phase II ESA is required to confirm areas of soil contamination.

With regard to groundwater contamination, the former Celanese plant site (now Worthington B.P.) contains a confirmed groundwater contamination plume from the area of a former herbicide plant located west of Meridian Street between Hayter Road and Highway 16. There is also a deep groundwater plume on the north end of the facility that extends toward the EPCOR Clover Bar Generating Station. Alberta Transportation is currently conducting a Phase II ESA to confirm the extent of groundwater contamination.

Stormwater management design for NEAHD addresses stormwater quantity and quality management as well as spill containment throughout the roadway right-of-way areas.

The proposed stormwater management system will include a combination of conveyance systems including: ditches, culverts, storm sewers, outlet control structures, drop and river outfall structures, and creek and river crossings. Storage/treatment systems will include: dry ponds, natural and constructed wetlands and vegetated swales with erosion control devices.

Of the 61.42 ha of native upland and riparian vegetation available in the NEAHD project area, approximately 29.45 ha (23.8%) will be directly impacted by the proposed NEAHD project footprint. The largest areas of treed stands to be impacted are poplar mix woodlots located south of the proposed North Saskatchewan River crossing and north of 130 Avenue in the NEAHD project study area. The largest area of riparian habitat to be directly impacted by the NEAHD project footprint is located along Oldman Creek and the unnamed tributary to Oldman Creek. Both cross Highway 16 just west of Highway 21. The area of upland and riparian habitat impacted is locally significant, providing habitat for a wide variety of wildlife and vegetation species.

Seventeen (17) “special status” plant species were identified within the project limits. Of those, 15 are considered uncommon (S3). Mitigation measures are not typically implemented for the loss of S3 plant species. The remaining two rare plant species, marsh muhly (*Muhlenbergia racemosa)* and smooth sweet cicely (*Osmorhiza longistylis),* were observed within the NEAHD project study area between Manning Drive and Highway 16 East and may be directly impacted by the project. Marsh muhly is classified as an S1 species in Alberta, meaning there are five or fewer occurrences in the province and smooth sweet cicely is classified as an S2 species in Alberta, meaning there area 6-20 occurrences in the province. Smooth sweet cicely will be directly impacted by NEAHD construction and marsh muhly, although it is currently located outside the proposed construction limits, may be impacted if the construction limits change or an outfall structure is constructed at that site. Appropriate mitigation will be developed to avoid or minimize the impact to the sites containing the S1 and S2 species. One viable option is to transplant the plants from their respective areas to a suitable area, away from future disturbance. In addition, seeds will be collected from the plants and donated to the seed bank at the Devonian Botanical Garden near Devon, Alberta.

There are approximately 62.5 ha of wetland habitat within the NEAHD project study area. Approximately 33.16 ha of that wetland habitat will be directly impacted by roadway construction, representing 53% of the wetland habitat available within the study area (Note: stormwater management ponds and any other impact areas proposed for outside the study area surveyed were not included in the impact analysis). The potential loss or alteration of wetlands is considered a significant impact. Adverse impacts will include direct effects resulting from drainage and road development. All wetlands and associated functional upland zone (FUZ) directly impacted by the proposed project will be appropriately compensated using an approach negotiated with Alberta Environment during detailed design to achieve no net loss of wetland area and function.

Two Canadian toad (provincially ranked as May Be at Risk) individuals were heard in May 2006 calling from a naturalized man-made pond in a gravel extraction area west of

Meridian Street. Attempts to determine if Canadian toads successfully bred (through tadpole surveys in 2006) were unsuccessful, however, the sandy soils and the presence of pocket gopher burrows around the wetland, located in the North Saskatchewan River floodplain, suggest that the area is potentially good Canadian toad breeding and hibernating habitat. Because evidence of breeding was not confirmed for the Canadian toad, it is unknown at this time whether compensation for the naturalized man-made wetland will be required under Alberta's *Water Act* and the Interim Wetland Policy (1993). The contractor will need to coordinate with Alberta Environment and Alberta Sustainable Resource Development during detailed design to confirm their requirements in this case.

Some impacts to wildlife will remain despite mitigation measures. As discussed above, significant amounts of native upland and wetland habitat will be removed, thereby having a negative impact on local, and possibly regional, wildlife populations. Wildlife movement through the North Saskatchewan River valley will be impacted by bridge construction activities in the short-term, however, over the long-term wildlife passage will be maintained with the inclusion of a wildlife corridor under the bridge along the banks of the river.

Impacts to fish and fish habitat in the North Saskatchewan River should be minimized with appropriate bridge construction mitigation measures, however, there will likely be a relatively small HADD from bridge abutment and pier footprints. There may be additional HADD from construction of new outfalls on the north and south river banks adjacent to the east side of the proposed bridge.

The predicted NEAHD sound levels for 2041 traffic are expected to meet the AT guideline noise limit of 65 dBA Leq (24-hour) at all nearby residence locations, with one exception. The closest residence to the NEAHD project area is in the Maple Ridge community. It is about 50 m from Highway 216 and will be about the same distance from Anthony Henday Drive. Current traffic sound levels at that location are about 5 dBA Leq above the AT noise limit, and future NEAHD traffic noise is expected to exceed the AIT noise limit by a similar amount. Traffic noise mitigation measures (e.g., noise berms/walls) would be required to reduce current and future traffic noise at this dwelling, however, this and other nearby dwellings in the Maple Ridge area may be removed at a future date pending a potential change of the land use to industrial. Since the AT noise attenuation guideline does not require traffic noise mitigation for land uses other than residential, future removal of the dwellings would relieve the need for future noise mitigation in the Maple Ridge area.

The project traverses an area with only a few environmental sensitivities, although the matters of of slope stability in the North Saskatchewan River Valley, soil and groundwater contamination, native plant communities and wetlands and wetland wildlife habitats do have some outstanding concerns. Those concerns can be addressed by development of detailed mitigation measures during the detailed design phase of the project. A wetland compensation plan detailing how wetland losses will be compensated for will ensure no net loss of wetland habitat and function in the long-term.

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1.0 INTRODUCTION

1.1 Project Overview

1.1.1 Project Brief

Alberta Transportation (AT) proposes to construct 8.6 kilometers of a new freeway and make improvements to 9.8 kilometers of existing freeway (Highway 216) within the Edmonton Transportation and Utility Corridor (TUC) across the City of Edmonton's northeastern edge [Northeast Anthony Henday Drive (NEAHD)]. They also propose to make improvements to approximately 8 kilometers within the Highway 16 corridor to Highway 21 (Figure 1.1). All components will be designated as Dangerous Goods Routes. The project is currently at the advanced functional planning stage, which forms the basis for this environmental assessment.

Anthony Henday Drive (AHD), also known as Edmonton's Ring Road, will be completed with improvements to the east segment, Highway 216, and construction of the remaining segment of the northeast leg from Highway 16 north across the North Saskatchewan River to Manning Drive. This ring road has been a part of the Province's and City's transportation plans for over 30 years.

Highway 16, commonly known as Yellowhead Trail (YHT), is part of the Trans Canada Highway, and the National Highway System (NHS), providing an important link for interprovincial and international trade. AT has identified Highway 16 as a future freeway facility, requiring upgrades to the existing interchanges within the corridor, particularly at AHD, which will connect this important regional connector to the future Outer Ring Road.

The project study area traverses southeast from Manning Drive (Highway 15), across the North Saskatchewan River, to Yellowhead Trail then travels along the existing sections of Highway 216 from Yellowhead Trail to Whitemud Drive, and along Highway 16 from 17 Street to Highway 21. Manning Drive has been used as a major and easily identifiable landmark for clarity of discussion, however, the short section between Manning Drive and the Canadian National Railway to the east is currently under construction as part of Northwest Anthony Henday Drive and has been previously cleared of vegetation and wetlands. The project limits are shown in Figure 1.2. The project will include systems interchanges at Manning Drive (Highway 15), Yellowhead Trail (Highway 16), Sherwood Park Freeway (Wye Road), and Whitemud Drive (Twp Rd 522). Service interchanges and flyovers are planned at the cross arterials. Railway grade separations and local access are included and a new crossing of the North Saskatchewan River is required. AT plans to advance this project to the detailed design and construction stages and consequently, the project is being considered for a Design, Build, Finance, Operate (DBFO) delivery model.

The proposed project is currently at the advanced functional planning stage, which assesses roadway capacity and detailed bridge structure requirements relative to future traffic volume projections and includes results from detailed soils, noise, and environmental impact assessment investigations as well as consultation with numerous

NORTH EAST EDMONTON RING ROAD

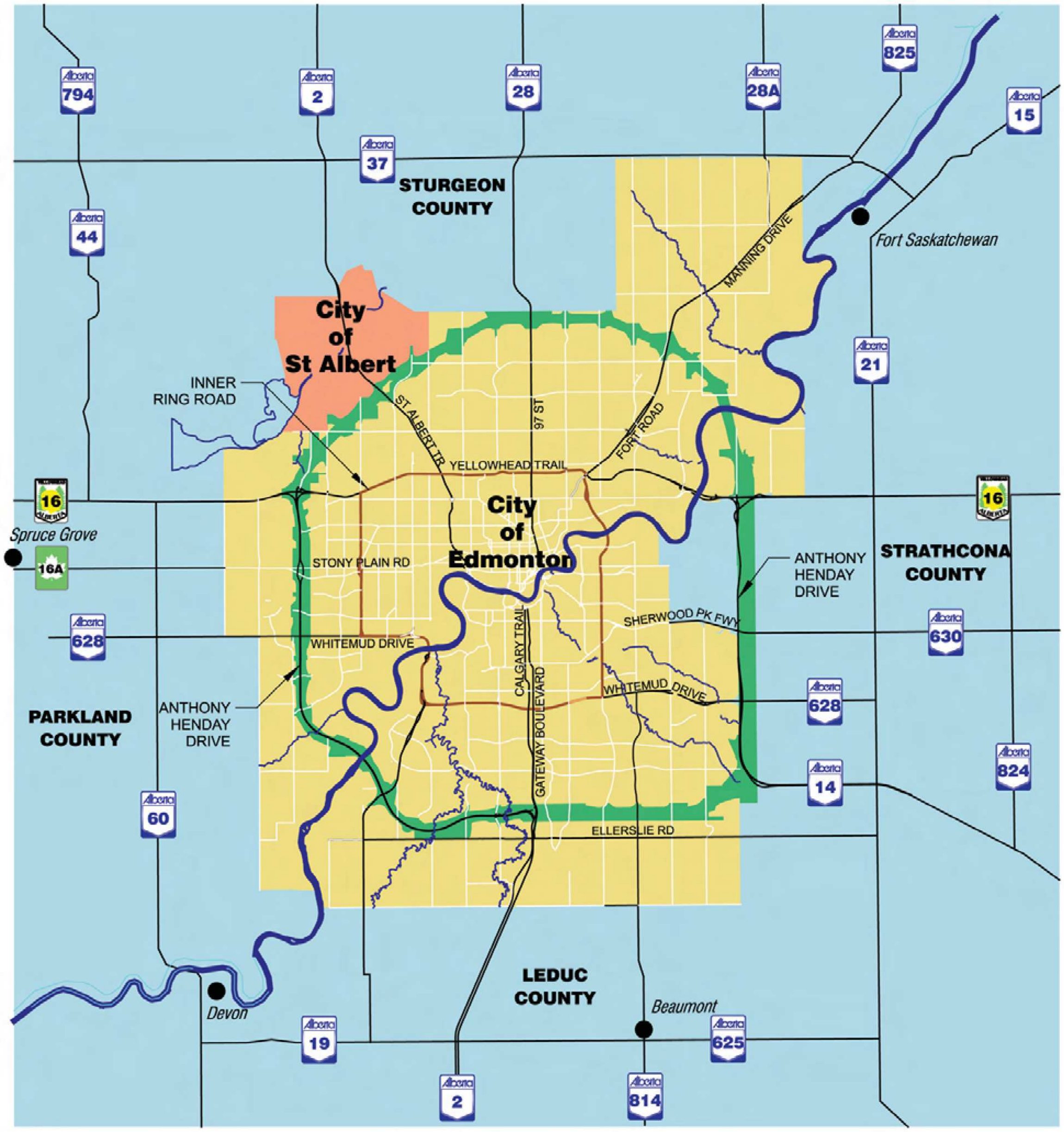

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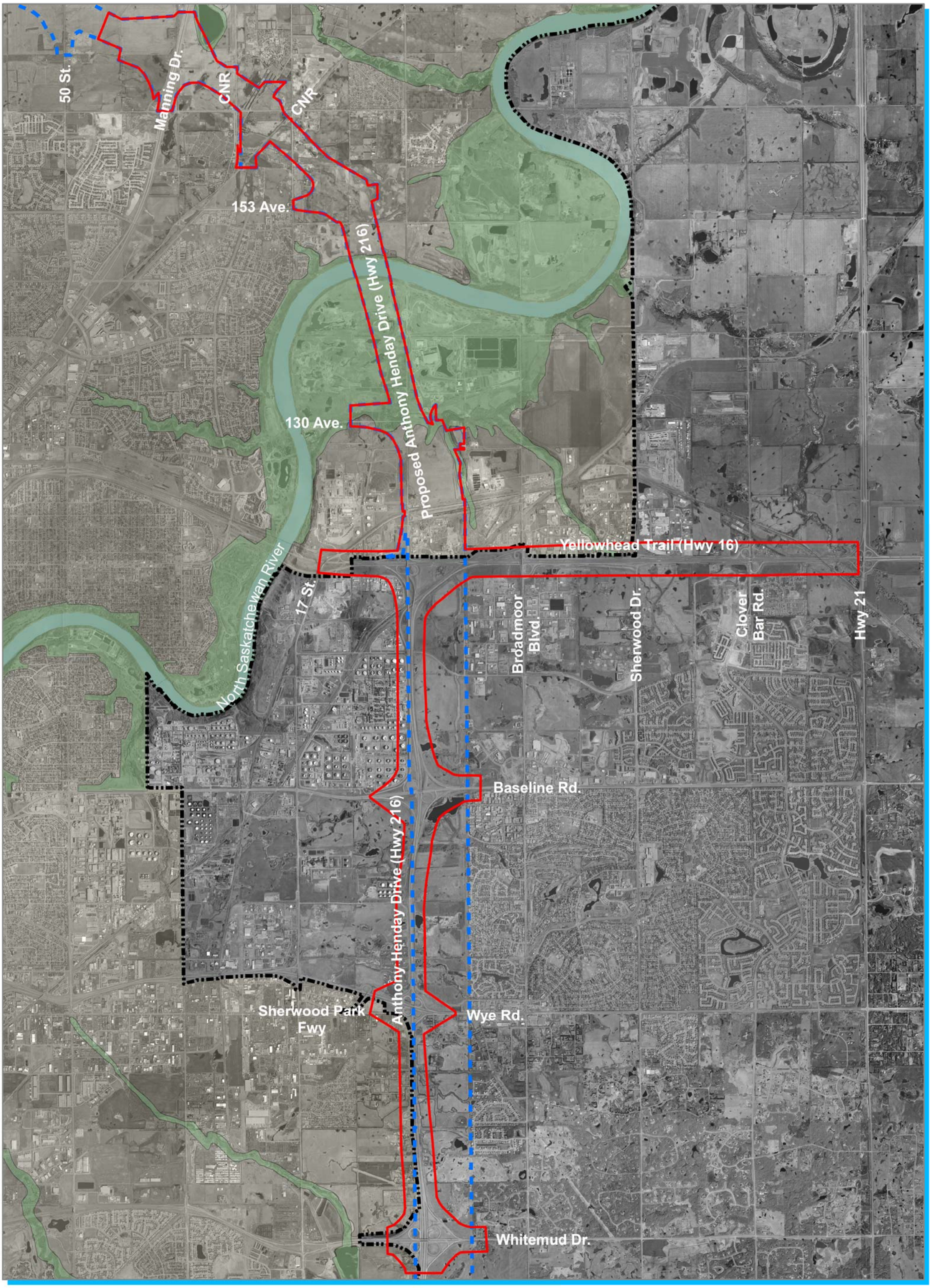
Figure 1.1. Project Setting

Alberta Transportation



Legend

- NE AHD Study Area
- TUC
- Edmonton City Limit
- NSR ARP Boundary

N

0 0.5 1 2 Kilometers

1:50,000

Figure 1.2 Northeast Anthony Henday Drive Project Study Area

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

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stakeholders. Project stakeholders included: various environmental agencies, pipeline companies, utility operators, the City of Edmonton, Strathcona County, regulatory agencies, adjacent existing and planned residential subdivisions, major industrial complexes and the public. Roadway requirements for regional populations of 1.6 million [Stage 1: Year 2041 (30 Year)] and 2.5 million (Ultimate Stage: Long Term) are identified in this study. Both stages will be free flow (no traffic signals). Forecast noise levels are based on the 1.6 million target population [(Stage 1) (2041)] road network. The resulting Stage 1 advanced functional plan will guide staged detailed design, which will become subsequent phases of the project.

Previous functional plans have been completed in the study area including:

- Highway 16 Functional Planning Study (West of 17 Street to East of SH 824) (ISL 2000);
- Southeast Anthony Henday Drive (Study 2) (ISL 2005); and
- North Edmonton Ring Road (ISL 2007).

This current study brings the road planning to a consistent traffic horizon and roadway design standard.

1.1.2 Urban Context

The proposed roadway project is located in an urban area dominated by the City of Edmonton and the urban node of Sherwood Park. Much of the natural vegetation that previously existed was removed years ago to make way for agricultural land use. The Province of Alberta in general, including the City of Edmonton and the surrounding region, is currently undergoing enormous economic growth. Specifically, the north side of the City of Edmonton up to the City limits and to the northeast towards Fort Saskatchewan are quickly being developed to residential, commercial and industrial land uses, thus increasing the urban population and urban footprint in those areas. Much of the agricultural land is being replaced with urban infrastructure. Construction of the proposed roadway will be located within the existing and growing urban footprint and has been planned since the 1970's.

1.1.3 Project Purpose

The northeast leg of Anthony Henday Drive (NEAHD) and the improvements to Highway 216 and Yellowhead Trail will serve three purposes:

- It will serve current and future transportation needs within the Edmonton region, particularly with respect to traffic congestion related to current urban and industrial developments, and future developments, in the northern part of the city.

- It will facilitate travel both within Alberta and inter-provincially.

- It will form an important feeder to the Province of Alberta's North/South Trade Highway Initiative and forms part of the National Highway system.

As such, the motoring public will see enhanced access and mobility across the north end of Edmonton and the Capital Region will see the completion of the Edmonton Ring Road to complement the existing highway network in the regional movement of goods and services.

1.1.4 Project Proponent

Prior to 1999, the City of Edmonton's Transportation and Streets Department was responsible for planning and constructing sections of AHD. In that year, the Government of Alberta assumed all responsibility for planning, developing and funding AHD. In addition, the Province also controls Highway 16 (Yellowhead Trail). The project proponent is, therefore, Alberta Transportation (AT).

1.1.5 Project Location

Edmonton, Alberta is located in the northeast portion of the Parkland Natural Region. Agriculture is the principal land use in this region, and natural areas remain primarily on undevelopable lands. The proposed NEAHD project is located primarily within and near the north-eastern edge of the City of Edmonton, Alberta and along the north-western edge of Sherwood Park, Alberta (Figure 1.3). Land use in the immediate vicinity of the proposed project is a mixture of agricultural, urban residential and industrial land uses.

The City of Edmonton is served by several major highways, which include:

- Highway 2 North and South;
- Highway 16 (Yellowhead Trail) East and West;
- Highway 216; and,
- Highways 15 and 28.

The project will enhance access and mobility across the north end of Edmonton by providing freeway standard roadways connecting Yellowhead Trail and Anthony Henday Drive to all of Edmonton's regional connections. Completion of this project will facilitate interprovincial and international trade and travel opportunities.

1.2 Project Funding

Alberta Transportation will fund this project.

1.3 Environmental Permitting Requirements

1.3.1 Federal Government

1.3.1.1 Canadian Environmental Assessment Act (CEAA)

Under the *Canadian Environmental Assessment Act (CEAA)*, projects that receive federal funding, occur on federal lands, or require federal permits for development to proceed, require an environmental assessment (EA). Currently, this project will not receive federal funding, nor does it occur on federal lands, however, federal permits are required.

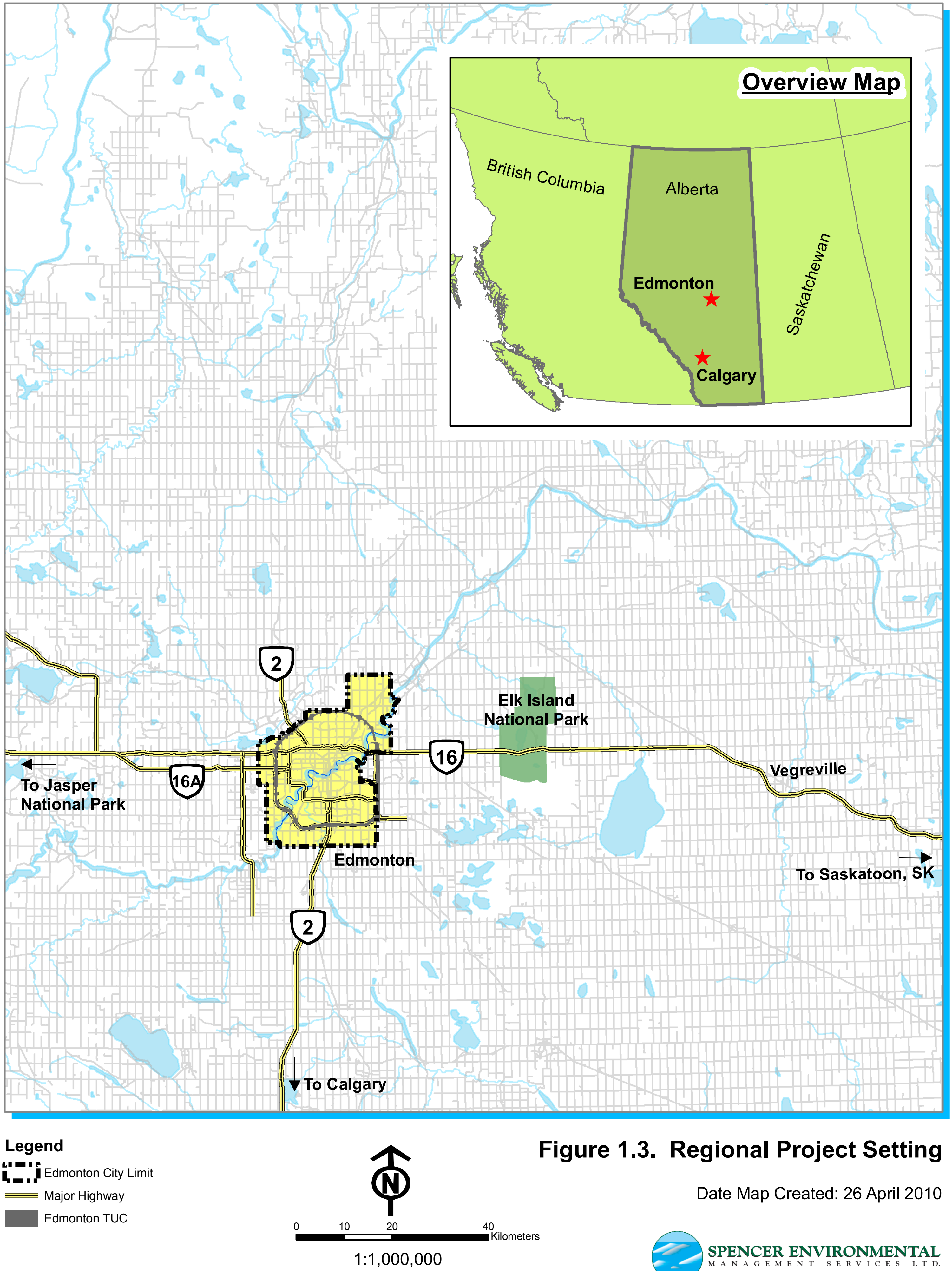

Figure 1.3. Regional Project Setting

Date Map Created: 26 April 2010

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An EA has been prepared for the whole road project, including the crossing of the North Saskatchewan River, to reflect the recent (January 2010) project scoping decision by the Supreme Court of Canada. It is not known what future utilities may be placed in the TUC. Those utilities will undergo a separate EA as required at that time by the proponent of those utilities.

1.3.1.2 Canadian Fisheries Act

The proposed project requires a new bridge crossing over the North Saskatchewan River, an important fish-bearing watercourse, and two outfalls on fish-bearing Oldman Creek, an outfall on the fish-bearing tributary to Oldman Creek and two outfalls on the fish-bearing Gold Bar Creek (unnamed tributary to the NSR). The presence of fish habitat and the potential for harmful alteration, disruption or destruction (HADD) of habitat in the North Saskatchewan River and fish-bearing watercourses within the project study area will trigger the need for an authorization pursuant to the Canadian *Fisheries Act* by Fisheries and Oceans Canada (DFO). This environmental assessment considered the potential for a HADD from construction on the river and watercourses, and identified mitigation measures to minimize potential impacts that may be of concern to DFO. The project is expected to be delivered through the Design, Build, Finance and Operate (DFBO) model. To facilitate this, Alberta Transportation and DFO have worked closely together to streamline the existing approval acquisition process.

1.3.1.3 Navigable Waters Protection Act

The federal *Navigable Waters Protection Act* (NWPA) is administered in Alberta by Transport Canada (TC). The North Saskatchewan River channel, within the project study limits, is considered a navigable waterway, therefore, construction of the bridge crossing will require approval under the *NWPA*. It is expected that the proposed project will be delivered under a Public-Private Partnership (P3) Design-Build-Finance-Operate (DBFO) model. It will be critical for the successful Contractor to be able to secure the NWPA approval in a timely manner to minimize risk to the project schedule and costs. Recognizing this fact, AT and Transport Canada, Prairie and Northern Region, have worked closely together to streamline the existing approval acquisition process for AT’s DBFO for the proposed North Saskatchewan River crossing in northeast Edmonton.

In October of 2009 Alberta Transportation and Transport Canada met and agreed that a list of Navigable Waters Protection Program (NWPP) criteria would be developed for placement into the DBFO bid documents. The expectation being that if the Contractors bidding on the project were given a list of NWPP criteria at the outset of the process, they would be able to incorporate those measures into their DBFO submissions. Additionally, the Transport Canada agreed to participate in AT’s DBFO submission review process as a means of providing timely feedback to the Contractor’s prior to tender award. Under this process the successful Contractor should have sufficient information to aid in acquiring the NWPA approval in a timely manner.

In December 2009/January 2010 AT and Transport Canada developed a list that comprised three components: 1) a Design and Construction Plan, 2) a Navigational

Safety Plan, and 3) a Transport Canada – NWPP Communications Plan for inclusion into the DBFO documentation.

1.3.1.4 Canada Transportation Act

The federal *Canada Transportation Act* (CTA) is administered by the Canadian Transportation Agency. Four CN (Canadian National) and two CP (Canadian Pacific) railway crossings are associated with the project, which may trigger Section 101 of the *CTA* if agreement is not reached with respect to crossing design. The Canadian Transportation Agency is responsible under the provisions of the *Canada Transportation Act* for attaining the objectives of the national transportation policy (described in Section 5, *Canada Transportation Act*) as they relate to safe railway operation. Among other duties, the CTA is responsible for resolving issues arising between railway companies under its jurisdiction and other interested parties such as utility companies, road authorities or landowners.

The plans and site profile for any federal railway crossing work requires an agreement between the Railway and AT. The agreement is filed with the Canadian Transportation Agency which issues an Order authorizing works, as indicated in the agreement, to be undertaken pursuant to Section 101 of the *Canada Transportation Act*. If an agreement cannot be reached with the Railway, AT may apply to CTA for authorization to construct a suitable road crossing. Under Section 5 of the *Canadian Environmental Assessment Act*, when an agreement cannot be reached with the Railway, an assessment of the environmental impacts of any rail infrastructure project must be completed before the Canadian Transportation Agency can issue a ruling. Crossing transfers and cost sharing disputes required a CTA ruling do not require an environmental assessment.

1.3.1.5 Aeronautics Act

The Department of National Defence (DND) has designated a Bird Hazard Zone area centered on the Edmonton Garrison Heliport at Namao, just north of Edmonton. The “Edmonton Garrison Heliport Zoning Regulations” of the *Aeronatics Act* restrict building heights, electronic communications and land features like stormwater management facilities, in order to reduce bird hazards to aviation. The DND Bird Hazard Zone extends into a section of the NEAHD study area along Highway 16 and the North Saskatchewan River crossing (Figure 1.4). Based on the DND Bird Hazard Zone boundaries, restrictions are placed on the types and sizes of ponds that can be placed along Highway 16 between just west of 17 Street to the west and just west of Highway 21 to the east. All new stormwater management facilities proposed within the designated bird hazard area must be approved by DND.

1.3.1.6 Migratory Birds Convention Act

Environment Canada administers the *Migratory Birds Convention Act* (MBCA), which prohibits the disturbance of nests of bird species covered under the *Act* (primarily migratory birds). With respect to construction, the *Act* provides guidelines for enforcement only; it is not linked to formal approvals. Violation of the *Act* may, however, result in penalties. A recent amendment to the *MBCA* further protects

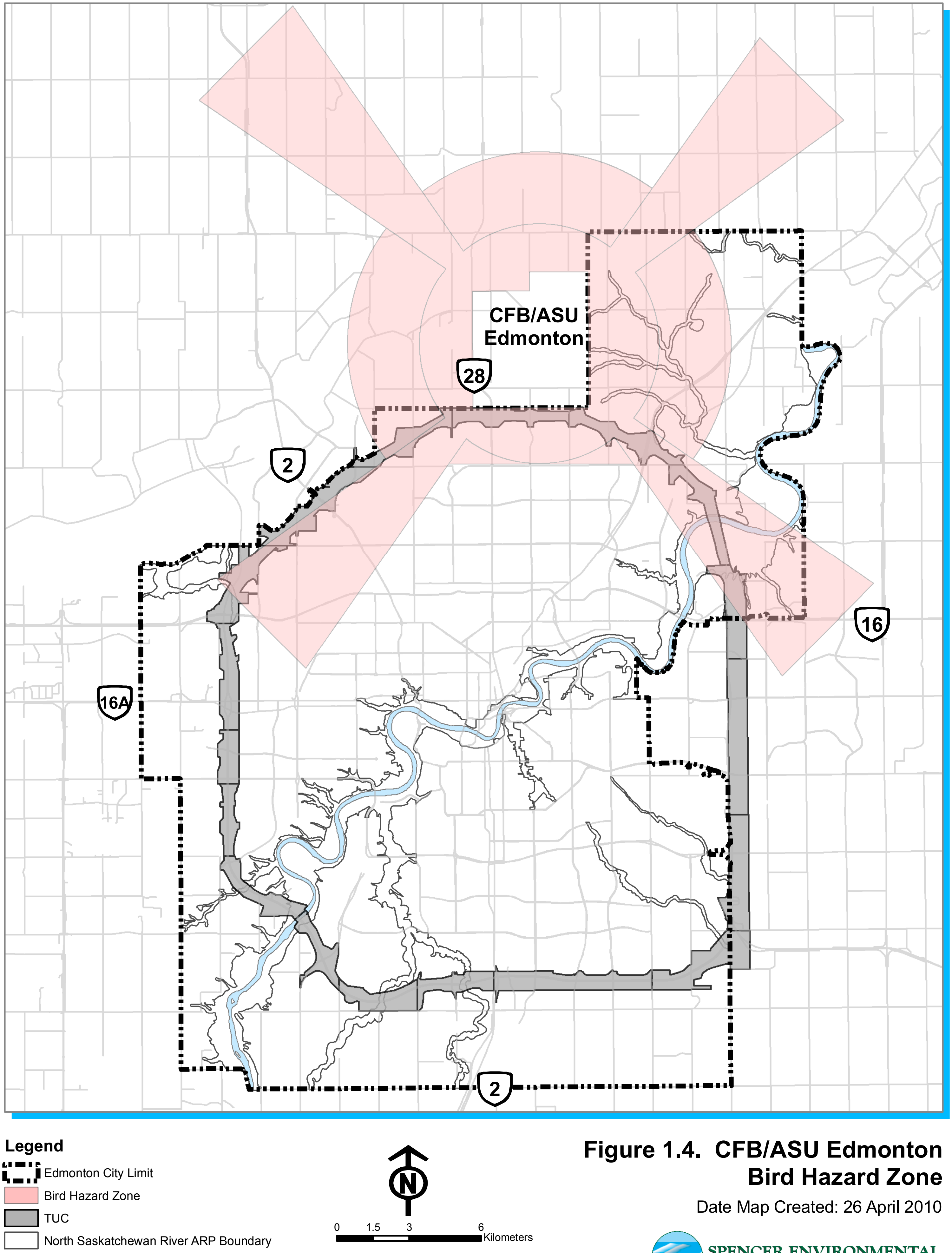

Figure 1.4. CFB/ASU Edmonton Bird Hazard Zone

Date Map Created: 26 April 2010

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disturbance to individual migratory birds and prohibits release of deleterious substances into waters or areas frequented by migratory birds.

1.3.1.7 Species at Risk Act

Environment Canada administers the *Species at Risk Act* (SARA), which is part of a Government of Canada strategy for the protection of species at risk. SARA contains prohibitions against the killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling or trading of individuals of endangered, threatened and extirpated species listed in Schedule 1 of the Act. The Act also contains a prohibition against the damage or destruction of their residences (e.g., nest or den).

Authorizations are required by anyone conducting activities that may affect species listed in Schedule 1 of SARA, as extirpated, endangered, or threatened and which contravene the Act's general or critical habitat prohibitions. This requirement comes into effect as soon as a species is listed under SARA, and is independent of where the species is in the recovery planning process.

To be eligible for an authorization, the proposed activity must (Government of Canada 2010):

- be scientific research relating to the conservation of the species and conducted by qualified people; or
- be an activity that benefits the species or is required to enhance its chance of survival in the wild; or
- have an effect(s) on the species that is incidental to the carrying out of the activity.

In addition, all of the following pre-conditions must be met:

- all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;
- all feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and
- the activity will not jeopardize the survival or recovery of the species.

Authorizations will, however, be considered on a case-by-case basis. A competent minister is not required to authorize a proposed activity even if it qualifies and meets all of the three pre-conditions. In addition, existing recovery strategies and action plans will be taken into consideration when applications are reviewed.

1.3.2 Provincial Government

1.3.2.1 Alberta Water Act

Activities that impact water resources, including water held in permanent or temporary wetlands, irrespective of Provincial ownership, require an approval under Alberta's *Water Act.* Application for approval under the act will be required for all draining and filling of wetlands directly impacted by roadway construction. A wetland compensation plan will also be required as part of the *Water Act* application and approval process.

Following, are the components of the proposed project that have implications for Alberta's *Water Act*:

- Wetlands as defined in the Province of Alberta's 1993 Interim Wetland Policy may need to be removed or disturbed in order to construct project infrastructure.
- Drainage facilities to include stormwater management facilities (SWMFs) and stormwater outfalls will be required to manage stormwater.

Under the provincial 1993 Interim Wetland Policy, in cases where wetlands as defined by the policy are to be removed or disturbed, approval pursuant to Alberta's *Water Act* is required and compensation for wetland loss may be required. A wetland compensation report will need to accompany the application for *Water Act* approval.

The *Code of Practice for Watercourse Crossings* and the *Code of Practice for Outfall Structures on Water Bodies* under Alberta's *Water Act* apply to this project. The Codes of Practice outline conditions and recommendations for environmentally-sound construction, placement, installation, maintenance, replacement or removal of all or part of a watercourse crossing structure or outfall, or any activity associated with those works. Specific conditions of *Codes of Practice* are dependent upon the classification of the water body. The North Saskatchewan River is considered a Class C water body in the proposed river crossing area (Spencer Environmental 2007). Under the *Codes of Practice*, watercourse crossing and outfall activities are permitted on such rivers with a restricted activity period of 16 September to 31 July. Gold Bar Creek, Clover Bar Creek, and tributaries of Gold Bar Creek, Clover Bar Creek and Oldman Creek will also be subject to the *Code of Practice for Outfall Structures on Water Bodies* for construction of outfalls on the above-mentioned watercourses to accommodate NEAHD stormwater discharge. Oldman Creek and the tributary to Oldman Creek are Class C waterbodies and the unnamed tributary to the North Saskatchewan River is a Class D waterbody. Provided mitigative conditions applicable to the type of watercourse crossing or outfall activity are met, only notification to Alberta Environment (AE) is required. The appropriate mitigation and design measures must be incorporated in the project design.

1.3.2.2 Alberta Environmental Protection and Enhancement Act

Stormwater drainage and management facilities are regulated by Alberta's *Environmental Protection and Enhancement Act* (*EPEA*). Construction of those facilities in support of NEAHD construction will require approvals under *EPEA*.

1.3.2.3 Alberta Wildlife Act

The Alberta *Wildlife Act* prohibits disturbance to a nest or den of prescribed wildlife species. Although permitting is not required under that Act, violations may result in fines. The potential to impact nests or dens is addressed in this EA so that potential impacts can be addressed through project design and construction.

1.3.2.4 Historical Resources Act

Any development with potential to disturb historical resources requires clearance by Heritage Resources Branch (HRMB) of Alberta Culture and Community Spirit (formerly Alberta Tourism, Parks, Recreation and Culture), pursuant to the *Historical Resources Act*. The potential for historical resources to be disturbed by this project was addressed by the Archaeology Group under contract to ISL.

1.3.3 Municipal Regulatory and Permitting Processes

The City of Edmonton's North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188) requires environmental reviews for projects undertaken in the North Saskatchewan River Valley and tributary ravines. Although the proposed river crossing will pass through Bylaw boundaries, the Bylaw does not apply to provincial lands (in this case the TUC). Similarly, the City of Edmonton's Corporate Tree Policy is not applicable to the project as it also only applies to City of Edmonton-owned properties. City of Edmonton PolicyC-147 concerning City-designated Natural Areas does not apply as none, by definition, can be included within the TUC, which is provincially owned land.

1.4 Report Organization

This EA comprises 9 chapters. Chapter 1 provides background information related to the project and describes the report structure. Chapter 2 is the detailed project description, including project justification, the scope of work, procedures to be used and construction scheduling. Chapter 3 outlines the impact assessment methodology.

Chapters 4 and 5 are organized to describe each potentially affected resource in terms of Valued Ecosystem Components (VECs). Existing conditions for all VECs are described in Chapter 4. Impacts related to project implementation, any recommended mitigation measures and the residual impacts after mitigation are described in Chapter 5. Chapters 6 and 7 provide discussion on two topics required by the *CEAA*: climate change and cumulative effects, respectively. Chapter 8 summarizes the EA assessment, identifies monitoring requirements and follow-up work and summarizes steps taken to resolve issues identified during the assessment. Chapter 9 provides all references and personal communications cited in the report.

Appendices to the report include:

Appendix A: Functional Planning Study Stormwater Management Plan
Appendix B: Terms of Reference
Appendix C: Public Consultation
Appendix D: Geotechnical Assessment
Appendix E: Soils Assessment
Appendix F: Fish and Aquatic Resources Assessment
Appendix G: Air Quality Assessment
Appendix H: Vegetation Survey
Appendix I: Wildlife Species Potentially Found in Study Area

2.0 PROJECT DESCRIPTION

2.1 Project Justification

The proposed project, including completion of Anthony Henday Drive (AHD) from Manning Drive to Yellowhead Trail (East) and the upgrades to Highways 16 and 216, will complete Edmonton's Ring Road and improve access to this new facility from one of the City's major connectors (Figure 2.1). This project will facilitate travel within Alberta and also provide an alternative travel route within the City of Edmonton, thus alleviating city congestion as a result of increasing traffic volumes. Current planning is based on two stages with capacity for the projected population growth within the city: Stage 1 will accommodate a population of 1.6 million (estimated 30-year horizon population in 2041), whereas the Ultimate Stage is based on a population of 2.5 million (estimated 80-year horizon population) for the Edmonton metropolitan region.

2.1.1 Transportation Utility Corridor

Anthony Henday Drive forms part of Edmonton's Ring Road. Planning for the City of Edmonton's Ring Road began in the 1950's when the Edmonton Regional Planning Commission identified a need to develop such a road to accommodate the increased traffic volumes that would result from the future growth of Edmonton. The intention of the ring road was to serve the traffic needs of the City of Edmonton as well as those of the province. Lands surrounding the city that would interfere with future growth were designated for ring road development, and set aside as a Restricted Development Area.

In the 1970s, the Government of Alberta adopted Edmonton's concept of a ring road and refined it to include a corridor of land around the city that would accommodate a ring road and major utilities. Both the Alberta Department of Highways and Transport, and Alberta Environment supported that concept. Alberta Environment's support was based largely on the premise that sound environmental planning should be an objective of the planning process. They believed that concentrating facilities in a single corridor would result in more successful management than that which could be achieved by dispersing them over a wider area. The name Anthony Henday Drive was selected for the proposed ring road.

An engineering study commissioned by Alberta Environment in 1984-85 proposed an alignment for a centre line for AHD as well as the locations of other facilities within the Restricted Development Area. Between 1985 and 1989, AT refined the land requirements to accommodate roads and utilities and undertook land surveys. The corridor required for these facilities became known as the Transportation Utility Corridor (TUC). The province released lands not required for the TUC; however, additional lands that were deemed necessary for the TUC continue to be acquired.

In 1992, construction of the first segment of AHD between Whitemud Drive in west Edmonton and Highway 16A West was completed in the TUC. Then, in 1998, the section between Highway 16A West and Yellowhead Trail in west Edmonton was completed. Those two segments are an important link between Yellowhead Trail in the

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Northeast Edmonton Ring Road

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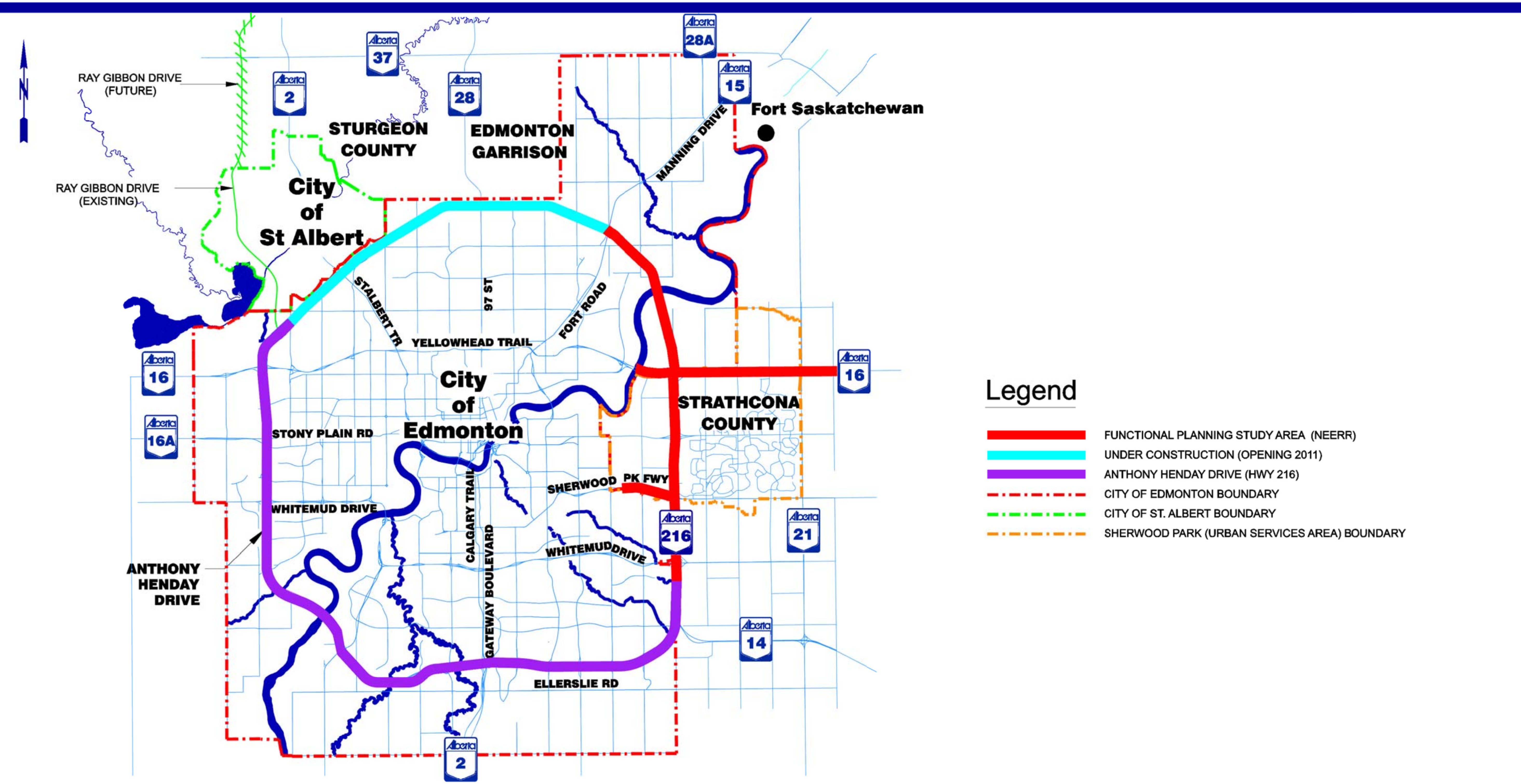

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Figure 2.1 Northeast Edmonton Ring Road
Functional Plan Study Area

northwest and Whitemud Drive in the southwest. Construction of South AHD was completed across the Blackmud Creek Valley in 2006, linking Yellowhead Trail (West) to the Calgary Trail interchange, and then to Yellowhead Trail (East) in 2007. In 2008, construction began on the 21 kilometer section that will connect Yellowhead Trail (West) to Manning Drive in the northeast. Completion of that project is scheduled for 2011. The missing link between Manning Drive and Yellowhead (East) will complete the Ring Road.

Currently, approximately 98% of the land required for the TUC has been purchased. Alberta Transportation is responsible for obtaining the remaining parcels required, and for administering lands within the TUC. Lands not immediately required for development are all leased, often to former owners, until they are needed. Once TUC component requirements are finalized, any surplus lands will be sold.

2.1.2 National Highway System

The concept of a National Highway System (NHS) was initially considered in 1987 by the Council of Ministers Responsible for Transportation and Highway Safety in response to a growing concern about the potentially detrimental implications for Canadian trade and travel resulting from the poor conditions of highway infrastructure in Canada. A set of free flow standards were established to ensure that all regions of Canada are provided with adequate and equal levels of service, safety, and efficiency in highway transportation, to serve interprovincial and international trade and travel, and enhance Canadian economic competitiveness. The main purpose of the NHS is to develop primary routes that connect capital cities or major provincial population centers, commercial centers, major ports of entry to the US highway network, and connections to other transportation modes. From those criteria, Highway 16 was identified as a National Highway between the Saskatchewan and BC borders. In 1994, the federal Minister of Transport announced that due to a lack of consensus regarding funding, there would be no national highway program at that time. Since that time, the prospect of a NHS has been raised periodically, but difficulties related to funding continue.

2.1.3 Trans-Canada Highway

The Trans-Canada Highway was constructed in 1950 following the approval of the Trans-Canada Highway Act of 1948. Officially completed in 1971, the highway links Victoria, British Columbia to St. John’s, Newfoundland. The highway system is recognizable by its distinctive white-on-green maple leaf route markers. Within Alberta, Highway 16 is considered part of the Trans-Canada Highway.

2.1.4 Edmonton Transportation Master Plan

At present, Yellowhead Trail is the principal road for moving traffic between west and east Edmonton, north of the North Saskatchewan River. In 2007, Yellowhead Trail ranked as the second highest traffic volume roadway in Edmonton. Peak volumes were over 81,000 vehicles per day of which 18%, or about 14,000 vehicles per day, was truck traffic. Congestion along Yellowhead Trail is compounded by the presence of numerous at-grade signal controlled intersections.

The 1999 City of Edmonton Master Transportation Plan indicated that the percentage of trips within the city that are termed “outer destination to outer destination” will increase faster than those termed “outer inner” or “inner inner”. The City of Edmonton, therefore, required that solutions be developed to reduce anticipated traffic congestion. Construction of this project would help to alleviate traffic congestion along Yellowhead Trail and other east-west arterials in north Edmonton by providing a route around the city for long distance and regional traffic as well as cross city trips.

Edmonton’s Transportation Master Plan includes the development of an Inner Ring Road, an Outer Ring Road and a system of connectors between these two components. This project proposes to complete the construction of the Outer Ring Road, and make improvements to one of the City’s main connectors, Highway 16.

Edmonton’s Transportation Master Plan describes the importance of the Edmonton Ring Road as follows:

> “The Edmonton Ring Road is expected to play a key role in the conveyance of people and goods within and through the greater Edmonton region. Its role in the region is to facilitate efficient access to, and movement between, Edmonton and the region’s municipalities, thereby relieving the respective internal roadway systems of the burden of through-movement.
>
> The Edmonton Ring Road’s specific benefit to Edmonton will be its ability to provide effective and efficient access to Edmonton-based industrial and commercial areas and reinforce Edmonton’s position and strength as a distribution and manufacturing centre for northern Alberta. In particular, the Edmonton Ring Road will permit excellent access between Edmonton area industries and the provincial and national highway systems. This should enhance the ability of Edmonton area industries and businesses to access external markets with minimum locally-induced transportation costs”.

The 2008 Transportation Master Plan Draft has recently been released for comment. The document identifies AHD and Highway 16 as playing “a key role in the efficient movement of people, goods, and services throughout the greater Edmonton region”.

2.1.5 North/South Trade Corridor

In the mid 1990s, the Government of Alberta announced a North/South Trade Corridor initiative with the objective of facilitating the efficient movement of goods between Alberta, the United States and Mexico. The project included upgrading several existing Alberta Highways to four-lane divided highway standards. An important component of the North/South Trade Corridor is completion of AHD, which will allow traffic to avoid the city's internal traffic and connect directly with highways to the west and north of the city.

2.1.6 Summary of Project Justification

The following points summarize the justification for the proposed roadway project:

- The project would provide an important feeder to the National Highway System and Province of Alberta's North/South Trade Corridor initiative.
- A significant length of this project is already constructed and simply requires modifications to meet current standards and future demands.
- Construction of this new portion of AHD is part of the Outer Ring Road Project for which planning began in the 1950s.
- Land has been acquired for this project since the 1970s.
- The project has the potential to relieve traffic congestion within the City of Edmonton, serve the future expansion of Edmonton and accommodate greater volumes of commercial traffic.
- The project is an important component of Edmonton's Transportation Master Plan, which was approved by City Council.

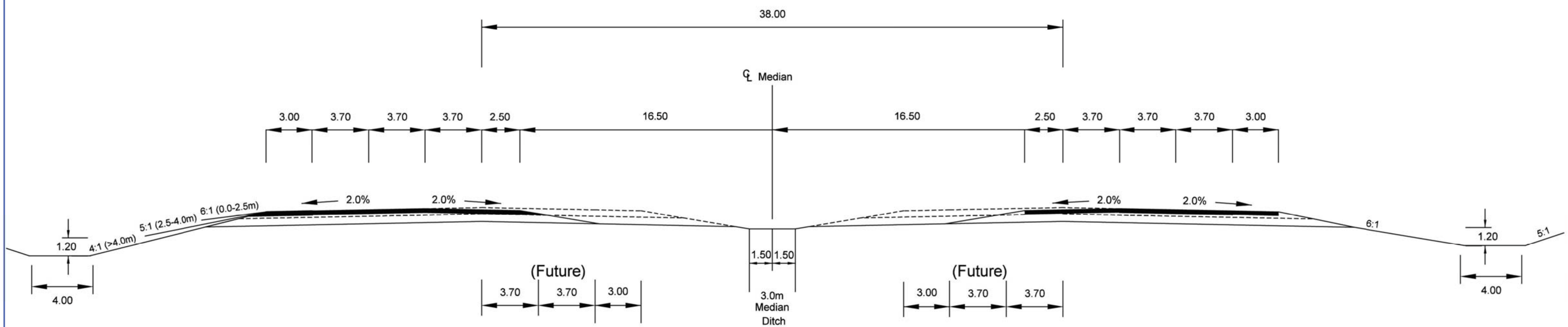
2.2 Nature of the Project

2.2.1 Design

Although detailed design for the road has not yet been completed, the northeastern portion of AHD would require one new watercourse crossing, which would require the installation of two bridge structures across the North Saskatchewan River at Section 29-53-23-W4M. As part of the current advanced functional planning study, ISL Engineering and Land Services (ISL) identified lane configurations that are consistent with design guidelines, standards and best practices to ensure minimum weaving requirements and lane balance. The Stage 1 plan recommends a 6 to 8 lane divided road with pre-grading for an ultimate 10-lane divided highway (Figure 2.2). It is anticipated that additional traffic lanes will be added to the Stage 1 road to accommodate future city growth. This will involve adding lanes to the inner edge of the roadway. At the Ultimate Stage, the road will be developed to 10-lanes plus auxiliary lanes, where required (Figures 2.3 and 2.4).

2.2.2 Project Route

The following is a brief description of the features that occur along the route of the proposed AHD extension between Manning Drive and Whitemud Drive and along Yellowhead Trail from the North Saskatchewan River to Highway 21.



ISL Engineering and Land Services

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Figure 2.2 Northeast Anthony Henday Drive
Cross Section Stage 1 (Year 2041)
6- Lane with Pre-Grading for 10-Lane

SCALE 1:250
1.0m 0 2.5m 5m

Government of Alberta

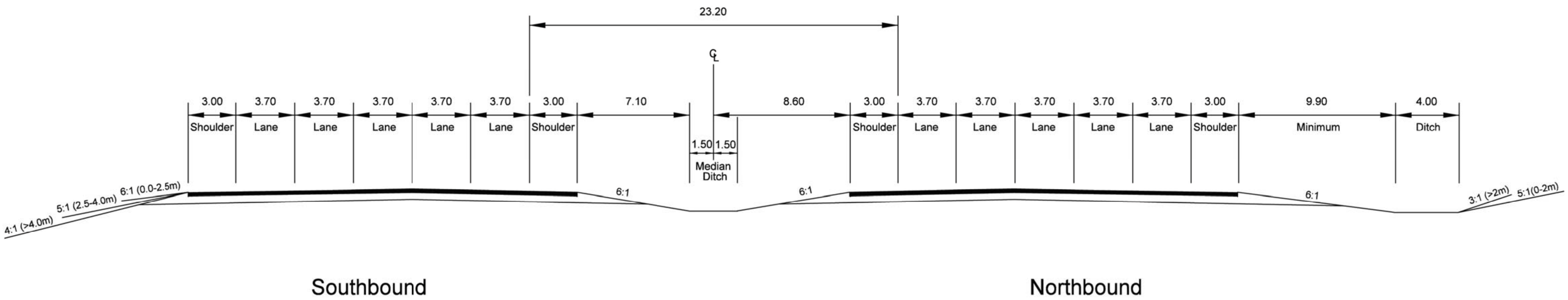

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Figure 2.3 Northeast Anthony Henday Drive
Cross Section- Long Term Stage
Typical Section 10-Lane Section

SCALE 1:250
1.0m 0 2.5m 5m

Government of Alberta

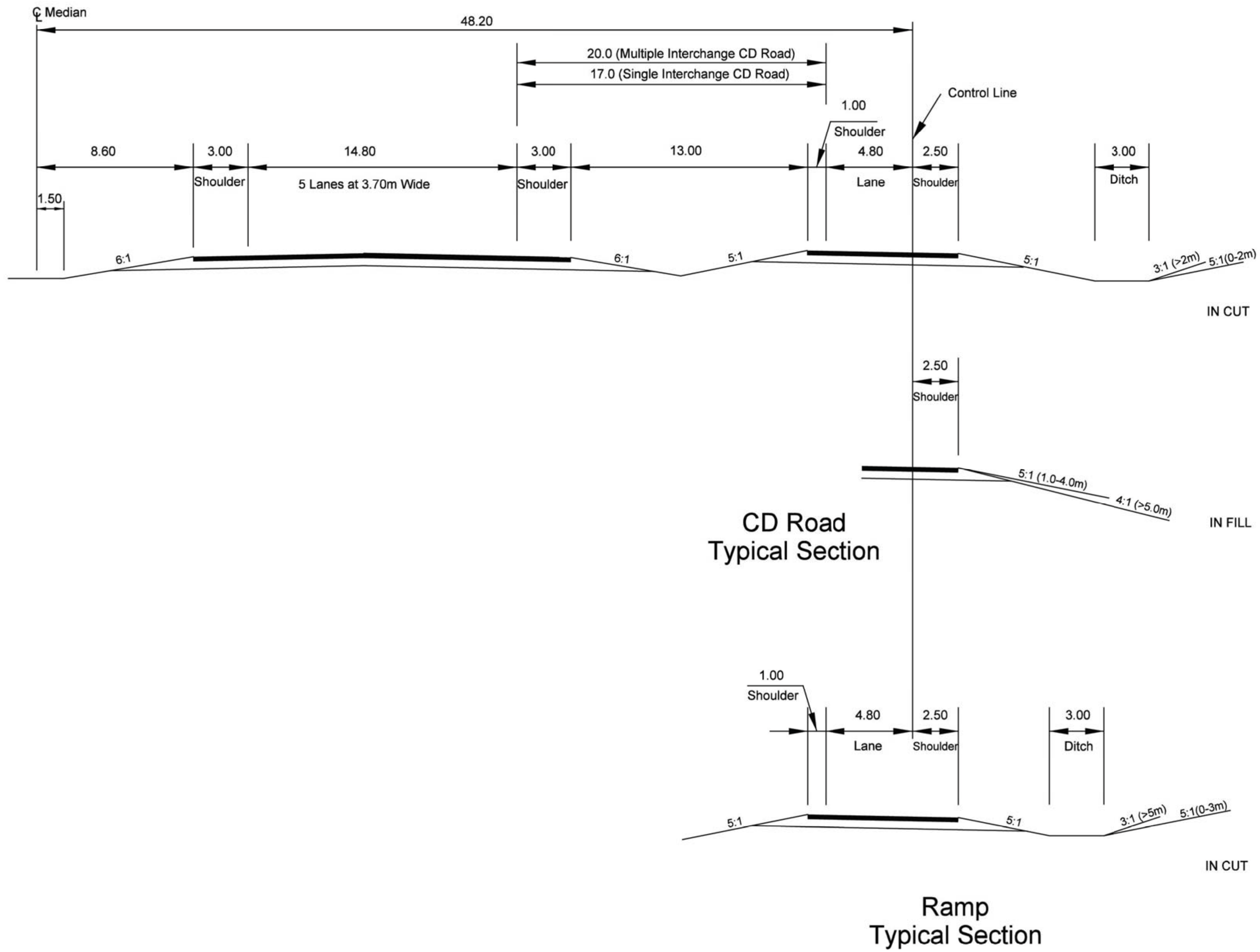

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Figure 2.4 Northeast Anthony Henday Drive
Cross Section- Long Term Stage
with CD Roads- 10-Lane Section

SCALE 1:250
1.0m 0 2.5m 5m

Government of Alberta

2.2.2.1 NEAHD - Manning Drive to the North Saskatchewan River (4.2km)

The proposed NEAHD alignment will continue in a southeast direction between Manning Drive and the North Saskatchewan River. The primary land use in this area is agricultural. Adjacent land uses include light industrial/commercial, institutional, agricultural and residential.

Because this segment of the route crosses two CN Rail lines, modifications to the local road network are required (consistent with available City of Edmonton plans). The proposed alignment will cross under two sets of CN Rail tracks as well as a proposed extension of Victoria Trail. An interchange at 153 Avenue is planned with NEAHD travelling under 153 Avenue.

2.2.2.2 NEAHD - North Saskatchewan River Crossing

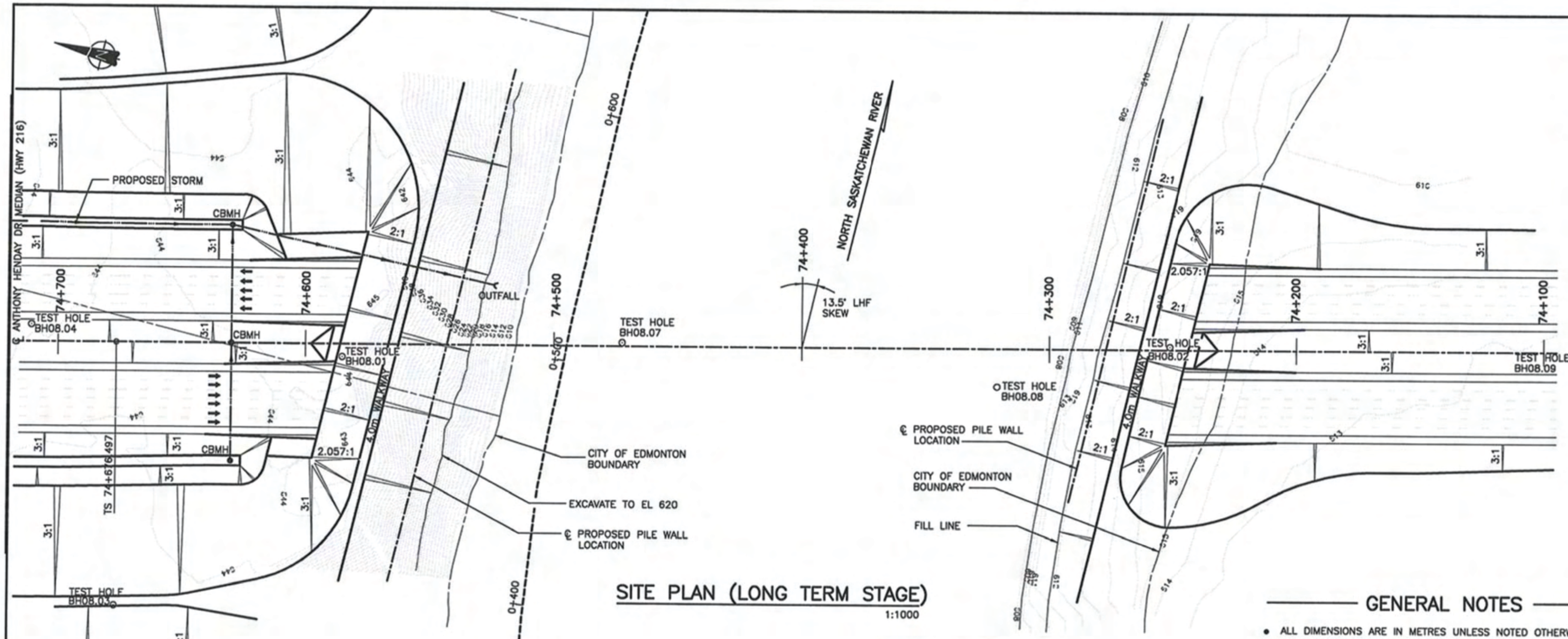
Two multi-span bridges are proposed for the crossing over the North Saskatchewan River (NSR) in east Edmonton (Figures 2.5 to 2.8). An under-slung pedestrian walkway may be suspended under the bridge. A wildlife corridor and pedestrian trail are proposed under the bridge on the north and south banks of the NSR. Stormwater management plans for the bridge and roadway include stormwater management ponds and outfalls on the north and south banks of the NSR on the east side of the bridge. The stormwater management plan and design criteria are contained in Appendix A.

2.2.2.3 NEAHD - North Saskatchewan River to Yellowhead Trail (east) (4.3km)

NEAHD will travel south between the North Saskatchewan River and Yellowhead Trail. The proposed alignment will cross existing and former gravel extraction operations and existing industrial areas, including the CN Rail mainline and Clover Bar Yard (Spencer Environmental 2007). The proposed alignment will be located on the west side of the TUC to avoid existing and planned major utility corridors on the east side. The road elevation will rise so that it may be elevated over the railroad and Yellowhead Trail. An interchange at 130 Avenue is planned where 130 Avenue will cross over AHD. 130 Avenue is the primary access to the adjacent industrial land and the Edmonton Waste Management Centre (Spencer Environmental 2007).

2.2.2.4 NEAHD - Yellowhead Trail to Whitemud Drive (11.3 km)

From Yellowhead Trail NEAHD will travel along the general alignment and profile of Highway 216. Beyond the project study area the area is built-up with industrial to the west and residential to the east of the TUC. The alignment crosses over the CPR



SITE PLAN (LONG TERM STAGE)

1:1000

SURVEY INFORMATION

- BY HYROAD SURVEYS, UNDER THE DIRECTION OF GEORGE WHITE SURVEYED BETWEEN JULY 2008 AND DECEMBER 2008
- THE HYDROLOGICAL SURVEY AND REPORT BY GOLDER ASSOCIATES LTD OF EDMONTON, UNDER THE SUPERVISION OF MARCEL CHICHAK, COMPLETED APRIL, 2009.
- THE TOPOGRAPHIC SURVEY IS REFERENCED TO GRID. THE COMBINED SCALE FACTOR (CSF) IS 0.999812 DIMENSIONS SHOWN ON THESE DRAWINGS ARE TO GROUND.
- ASCM 253716, N 5935294.759, E 45710.040, EL 703.170
- ASCM 454256, N 5930846.401, E 43426.280, EL 711.126

MAPPING PLANE	3TM
REFERENCE MERIDIAN	114°
DATUM CODE	NAD 83

HYDROTECHNICAL DATA

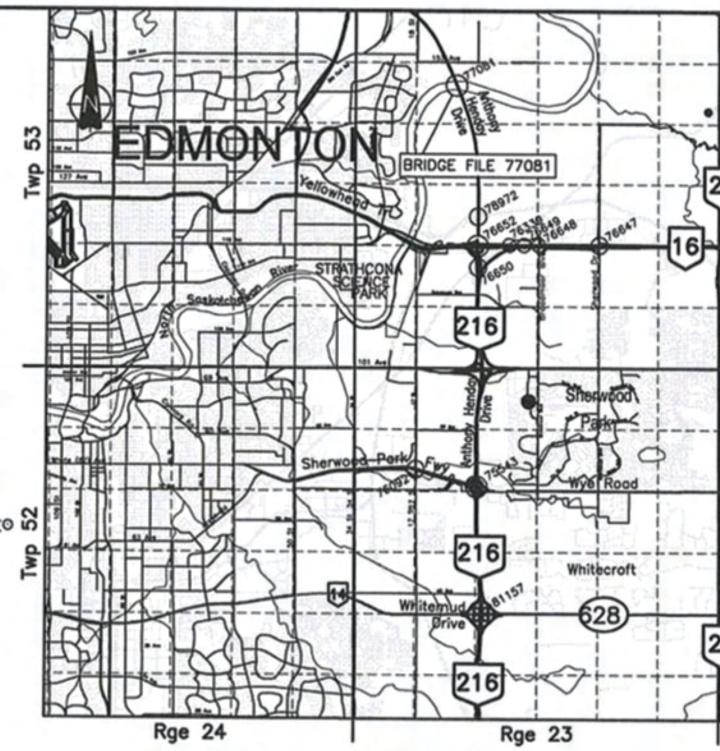
- REFER TO GOLDER ASSOCIATES REPORT DATED APRIL, 2009 "HYDROTECHNICAL DESIGN PARAMETERS" FOR DETAILS
- DRAINAGE AREA = 27 625 km^2
- DESIGN DISCHARGE = 5800 m^3/S
- MEAN VELOCITY FOR DESIGN DISCHARGE THROUGH THE PROPOSED OPENING IS 3.2 m/s
- AVERAGE SURVEYED SLOPE = 0.0004 m/m
- DESIGN HIGH WATER ELEVATION 618.0 m GEODETIC
- MINIMUM BOTTOM FLANGE ELEVATION a) LEFT BANK 620.0 m
  b) RIGHT BANK 619.0 m
- DESIGN HIGH ICE IS SITUATION b) AT ELEVATION 615.0 m
- PIERS SHOULD NOT BE PLACED WITHIN 15 m OF THE LEFT (NORTH) BANK TO AVOID DRIFT COLLECTION BETWEEN THE PIER AND BANK

GENERAL NOTES

- ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE
- ROAD DESIGN STANDARD – ANTHONY HENDAY DR (HWY 216)

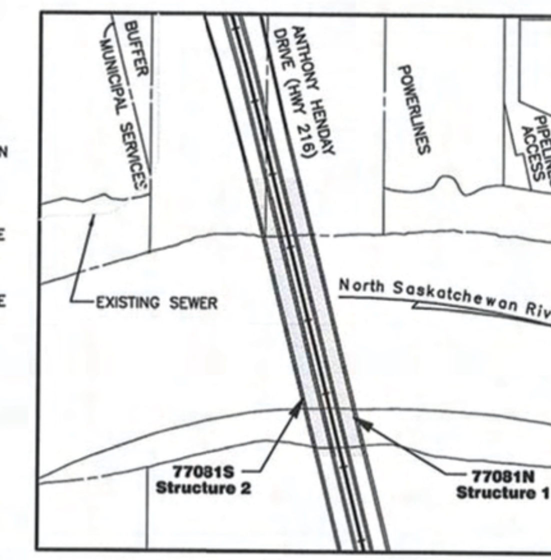
STAGE 1	RDF 820.3–110
LONG TERM STAGE	RDF 1024.5–110 (MODIFIED)

- THE GRADELINE SHOWN FOR THIS RIVER BRIDGE STRUCTURE IS BASED ON THE MINIMUM DESIGN VERTICAL CLEARANCE REQUIREMENTS ABOVE THE DESIGN HIGH WATER WHICH INCLUDES AN ALLOWANCE OF 1.0 m FOR FREEBOARD AND AN ESTIMATED STRUCTURE DEPTH OF 8.1 m (BRIDGE SUPERSTRUCTURE 4.9 m AND PROPOSED WALKWAY OF 3.2 m), AS SHOWN ON DRAWING DD1793A. FURTHER OPTIMIZATION OF THE GRADELINE TO MAINTAIN THE MINIMUM BOTTOM FLANGE ELEVATION FOR THE STRUCTURE AND WALKWAY OF 619.0 m MAY BE REQUIRED ONCE THE FINAL STRUCTURE DEPTHS HAVE BEEN DETERMINED. ALL GEOMETRIC AND BRIDGE LOCATION DETAILS MUST BE CHECKED AND VERIFIED TO MEET THE P3 TECHNICAL REQUIREMENTS AND SITE CONSTRAINTS ONCE THE GRADELINE IS OPTIMIZED
- CRITICAL VERTICAL CLEARANCE TO BE BASED ON THE FUTURE WIDENING OF ANTHONY HENDAY DRIVE TO ULTIMATE LANE FACILITY
- CONSTRUCT STANDARD APPROACH FILLS AS PER THE CURRENT BRIDGE STRUCTURES DESIGN CRITERIA (VERSION 6.1) SECTION 4, POINT "E"
- SIDE SLOPE DESIGN BEYOND THE BRIDGE HEADSLOPES ARE TO BE COORDINATED WITH THE ROADWAY DESIGN GROUP DURING THE DETAILED DESIGN PHASE OF THIS PROJECT
- REMOVAL OF VEGETATION IS TO BE CONFINED TO THE EMBANKMENT AND EXCAVATION LIMITS AND IS TO BE KEPT TO A MINIMUM
- THE INFORMATION SHOWN ON THESE DRAWINGS IS FOR THE DESIGN PURPOSES OF THIS SPECIFIC PROJECT AND IS FOR THE BENEFIT OF THE CLIENT ONLY
- THE TEST HOLE LOGS SHOWN ON DD 1793B ARE FOR DESIGN PURPOSES ONLY. THE INFORMATION IS COMPILED FOR CONVENIENCE FROM THE GEOTECHNICAL REPORT BY EBA ENGINEERING CONSULTANTS LTD. ALL DISCLAIMERS IN THIS REPORT ARE APPLICABLE. ADDITIONAL INFORMATION IS AVALABLE AND IN CASE OF DISCREPANCY THE GEOTECHNICAL REPORT GOVERNS
- ALL BRIDGE BARRIERS SHALL BE PL–3 SINGLE SLOPE BARRIER AS PER ALBERTA TRANSPORTATION STANDARD DRAWING S–1702–06



SITE MAP 1:100 000

- PRIMARY HIGHWAY – 1–216
- PRIMARY HIGHWAY – 500–986
- LOCAL ROAD
- RAILWAY



KEY PLAN

NTS

SHEET	DESCRIPTION	DRAWING
5	SOIL LOGS	DD1793D
4	MOSAIC PROFILE	DD1793C
3	BRIDGE SECTIONS & THALWEG PROFILES	DD1793B
2	ELEVATION	DD1793A
1	DESIGN DATA SHEET	DD1793

DRAWING INDEX

NOTE:
THE UTILITIES SHOWN ON THESE DD DRAWINGS ARE BASED ON AVAILABLE INFORMATION FROM THE CITY OF EDMONTON AND STRATHCONA COUNTY, 2006 DATABASES, AND ON THE FIELD SURVEY UNDERTAKEN IN 2008, FOR THE ROADWAY/BRIDGE DESIGN, HOWEVER, IT MAY NOT INCLUDE ALL THE UTILITIES AT THIS SITE. THE EXACT LOCATION AND DEPTH OF ALL THE UTILITIES, AT THIS SITE, MUST BE CONFIRMED PRIOR TO THE DETAIL DESIGN AND CONSTRUCTION OF THIS FACILITY COMMENCING.

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REV	DATE	REVISIONS	BY

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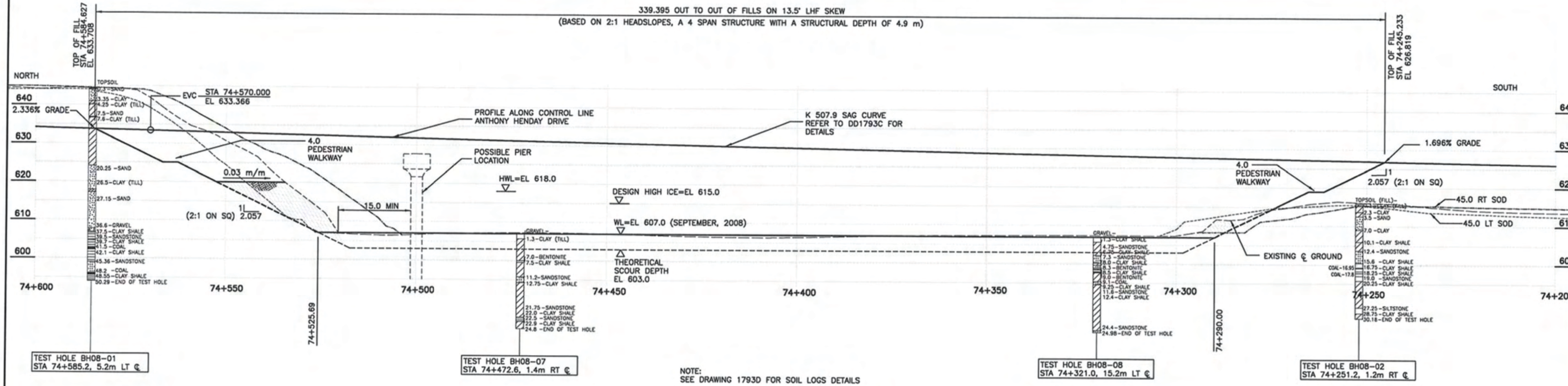
SUBJECT TO REVISION
ISL Engineering and Land Services

DESIGNER | CHECKER | DATE | DATE

Government of Alberta ■ Transportation

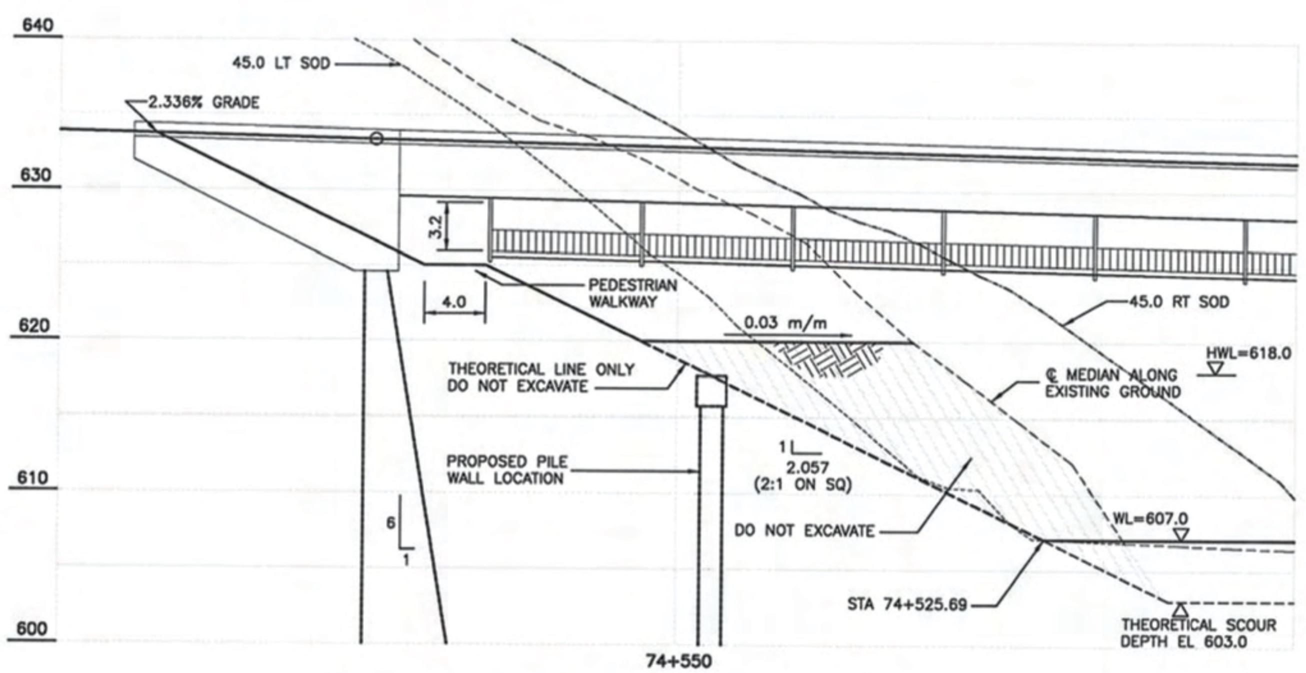
Figure 2.5 - North Saskatchewan River Bridge on Anthony Henday Drive in Edmonton Structures 1 & 2 Design Data Sheet

DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	Date Printed:	DRAWING
–	2009–11–10	NORTH SASKATCHEWAN RIVER	NE 29–53–23–4	216:02	77081N 77081S	05-Nov-2009	DD 1793



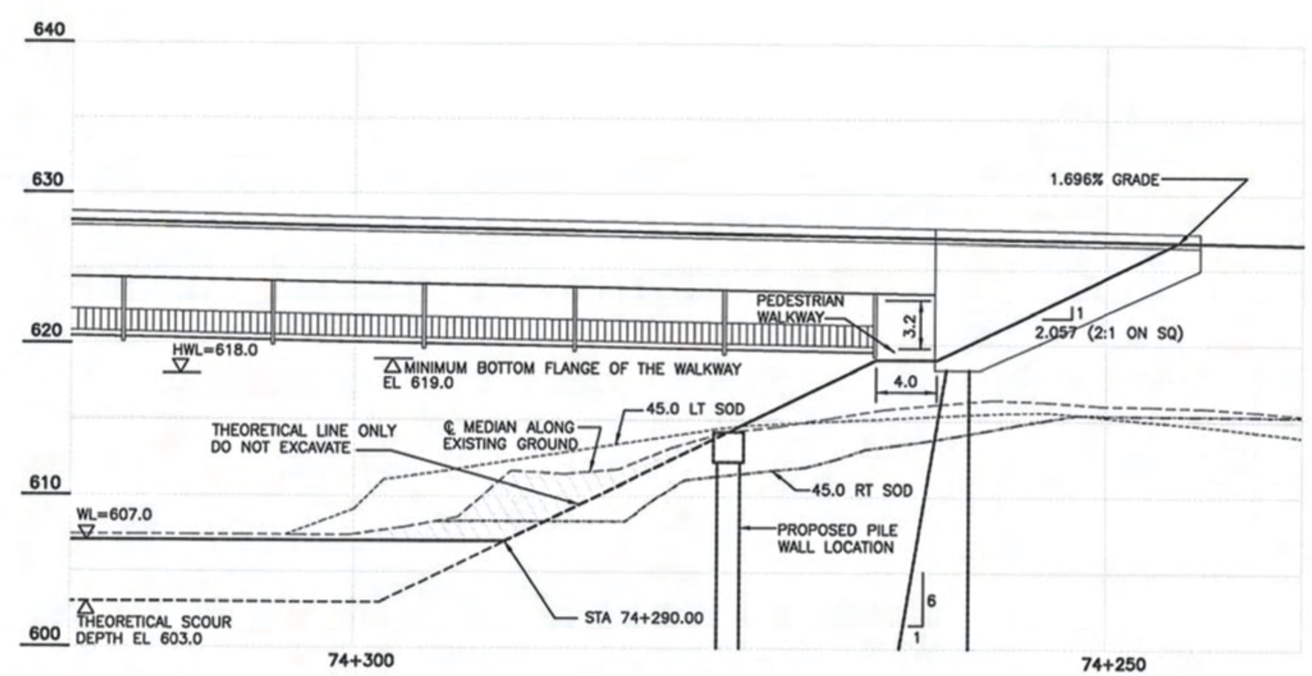
ANTHONY HENDAY DR ELEVATION

1:500



ANTHONY HENDAY DR NORTH ELEVATION

1:250



ANTHONY HENDAY DR SOUTH ELEVATION

1:250

NOTES

- REFER TO EBA ENGINEERING CONSULTANTS LTD GEOTECHNICAL REPORT DATED SEPTEMBER 28, 2009 FOR METHODS OF SLOPE STABILIZATION TECHNIQUES DURING CONSTRUCTION OF HEADSLOPES. LONG TERM SOLUTIONS TO INCREASE THE FACTOR OF SAFETY OF HEADSLOPES IS ALSO COVERED IN EBA'S GEOTECHNICAL REPORTS
- BOTH NORTH AND SOUTH HEADSLOPES ARE TO BE MONITORED ON A REGULAR BASIS TO DETERMINE IF SCOUR IS OCCURRING. BANK PROTECTION WITH HEAVY ROCK RIP RAP WILL BE NECESSARY ON THE THEORETICAL 2:1 SLOPE LINES TO CONTROL ANY SCOUR THAT'S OCCURRING
- ABUTMENT PILING, WALKWAY STRUCTURE AND THE PILE WALL LOCATION ARE CONCEPTUAL ONLY ON THESE ELEVATION VIEWS

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CHECKER — DATE

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Figure 2.6 - North Saskatchewan River Bridge on Anthony Henday Drive in Edmonton Structures 1 & 2 Elevation

DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	Date Printed:	DRAWING
–	2009-11-10	NORTH SASKATCHEWAN RIVER	NE 29-53-23-4	216:02	77081N 77081S	05-Nov-2009	DD 1793A

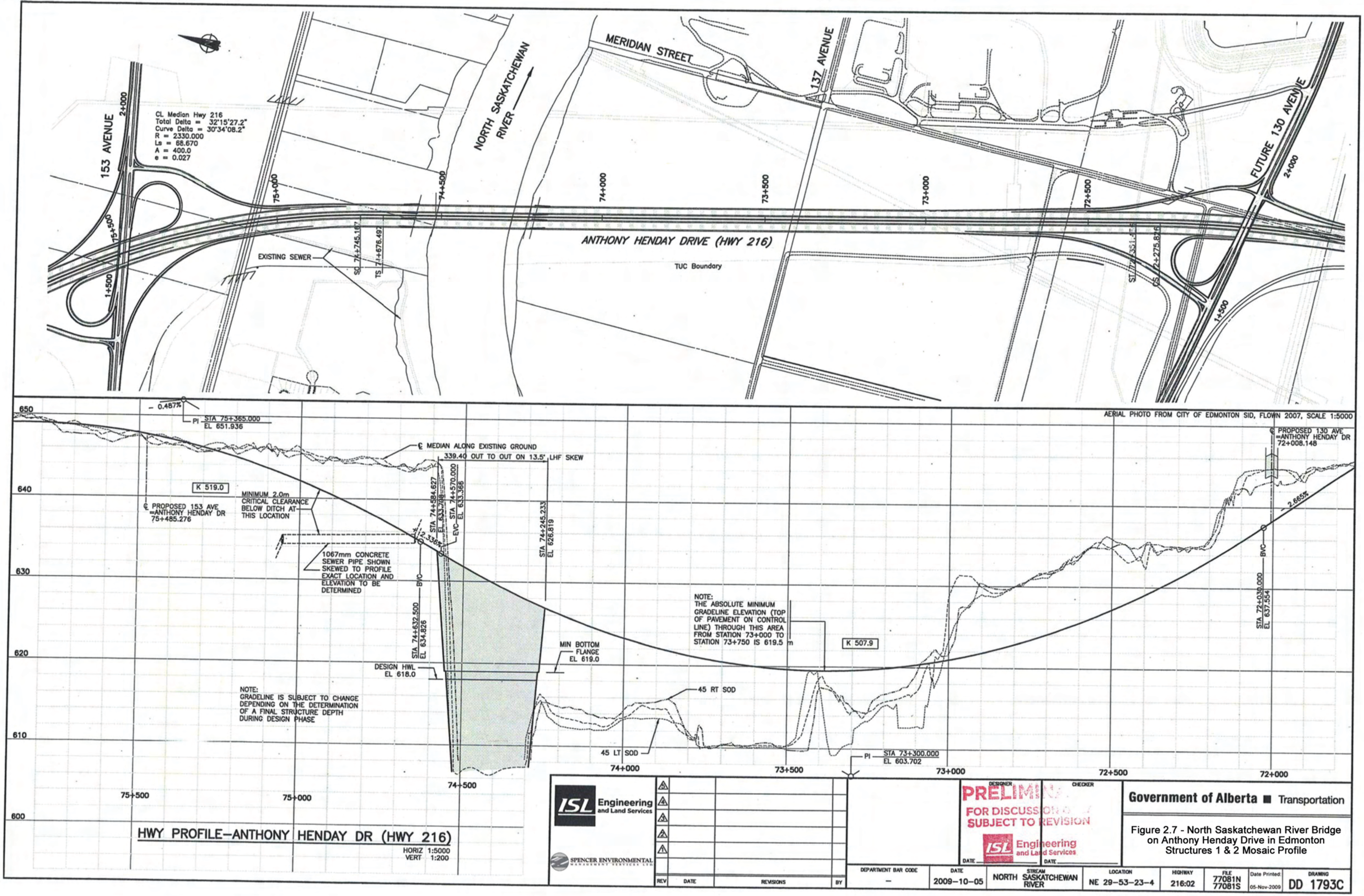
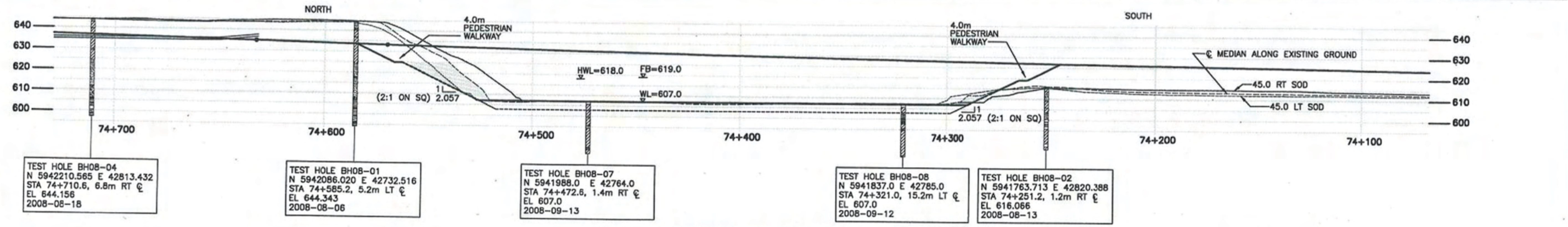
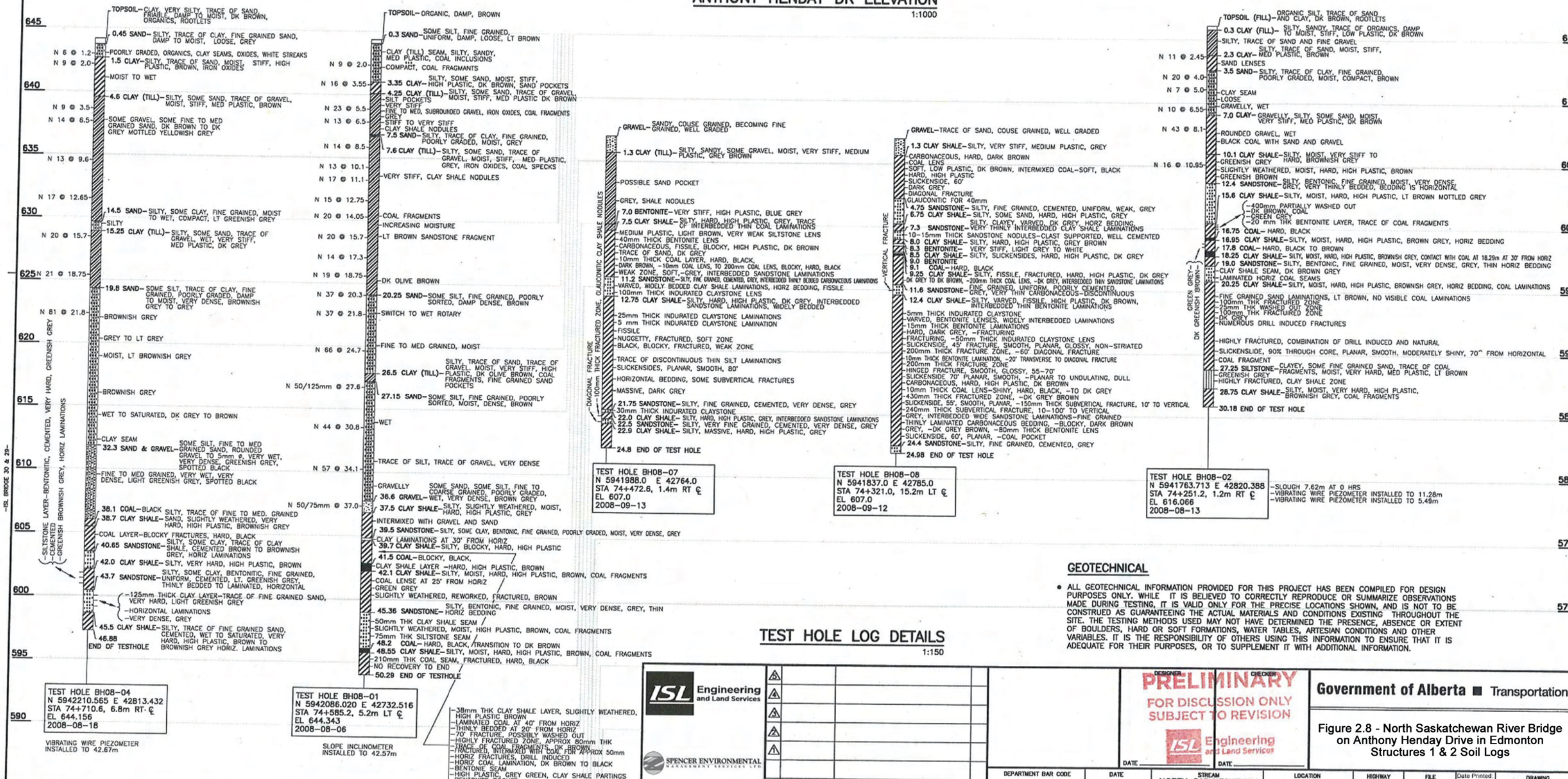


Figure 2.7 - North Saskatchewan River Bridge on Anthony Henday Drive in Edmonton Structures 1 & 2 Mosaic Profile



ANTHONY HENDAY DR ELEVATION

1:1000



TEST HOLE LOG DETAILS

1:150

GEOTECHNICAL

- ALL GEOTECHNICAL INFORMATION PROVIDED FOR THIS PROJECT HAS BEEN COMPILED FOR DESIGN PURPOSES ONLY. WHILE IT IS BELIEVED TO CORRECTLY REPRODUCE OR SUMMARIZE OBSERVATIONS MADE DURING TESTING, IT IS VALID ONLY FOR THE PRECISE LOCATIONS SHOWN, AND IS NOT TO BE CONSTRUED AS GUARANTEEING THE ACTUAL MATERIALS AND CONDITIONS EXISTING THROUGHOUT THE SITE. THE TESTING METHODS USED MAY NOT HAVE DETERMINED THE PRESENCE, ABSENCE OR EXTENT OF BOULDERS, HARD OR SOFT FORMATIONS, WATER TABLES, ARTESIAN CONDITIONS AND OTHER VARIABLES. IT IS THE RESPONSIBILITY OF OTHERS USING THIS INFORMATION TO ENSURE THAT IT IS ADEQUATE FOR THEIR PURPOSES, OR TO SUPPLEMENT IT WITH ADDITIONAL INFORMATION.

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Figure 2.8 - North Saskatchewan River Bridge on Anthony Henday Drive in Edmonton Structures 1 & 2 Soil Logs

REV	DATE	REVISIONS	BY	DEPARTMENT BAR CODE	DATE	STREAM	LOCATION	HIGHWAY	FILE	Date Printed	DRAWING
				—	2009-10-05	NORTH SASKATCHEWAN RIVER	NE 29-53-23-4	216:02	77081N 77081S	05-Nov-2009	DD 1793D

mainline directly south of Yellowhead Trail. Interchange improvements are required at Yellowhead Trail, Baseline Road, Wye Road, and Whitemud Drive.

2.2.2.5 Yellowhead Trail – Highway 216 to Highway 21 (8 km)

The mainline of Yellowhead Trail will generally travel along the existing alignment and profile of Highway 16; however new and improvements to existing interchanges will need to be constructed as part of the upgrades. Interchanges are planned or will need to be improved at Broadmoor Boulevard, Sherwood Drive, Clover Bar Road, and Highway 21. The corridor land use transitions from industrial near Highway 216 to residential and agricultural further east. There is presently one CP and one CN railway crossing within this area (Highway 216/16 alignment).

2.2.3 Railway Crossings

The proposed NEAHD project will cross four (4) CN Rail tracks and two (2) CP Rail tracks. The City of Edmonton also plans to extend the LRT line north to 153 Avenue and beyond. Each of the crossings will be grade separated and are summarized below.

2.2.3.1 CN mile 0.85 Coronado Subdivision

- Crossing located approximately 1000m east of Manning Drive
- NEAHD will cross under existing CN track
- Single track, however provisions for a second track may be required due to expected increase on line
- Train count consists of 2 trains / day operating at 25 mph

2.2.3.2 City of Edmonton Northeast LRT Extension

- LRT extension to the north, paralleling the existing CN (Coronado) Rail tracks to 153 Avenue
- LRT line will diverge to the east on an S-curve and continue traveling north across NEAHD, parallel to 18 Street
- An LRT station is planned for the tangent of the S-curve north of 153 Avenue

2.2.3.3 CN mile 123.50 Vegreville Subdivision

- Crossing located approximately 800m east of CN Colorado crossing
- NEAHD will cross under existing CN track
- Single track – average train count consists of 10 trains / day operating at 40mph
- No additional requirements identified at this time

2.2.3.4 CN mile 259.1 Wainwright Subdivision (CN Clover Bar yard)

- Crossing is located approximately 700 m north of Yellowhead Trail

- NEAHD will cross over the CN tracks
- 6 track crossing, located at the west end of the CN's Clover Bar Yard
- Average daily train traffic consists of 22 trains / day operating at a maximum speed of 45 mph
- There are switch and shunting movements over the crossing which could be 40 or more movements / day
- It is likely that another track will be required sometime in the future
- An 8 foot maintenance road would likely be required along one side of the outer tracks
- Clover Bar Yard is also the location of the public team track (ramp track). Access to the team track facility is from the south of the crossing and will require continued access for public use
- A CP rail siding also runs along the north side of the Clover Bar yard

2.2.3.5 CP Mile 165.14, Willingdon Subdivision

- The crossing is located approximately 0.4 km south of Highway 16
- NEAHD will cross over three existing CP tracks
- AT is senior at the crossing
- CP's yard is immediately west of the crossing
- CP has not requested at this stage that provision for additional tracks is required at this site.

2.2.3.6 CN Mile 255.30, Wainwright Subdivision (East of Clover Bar Road)

- Highway 16 underpasses one existing CNR mainline tracks that carries in excess of 46 MGTM per year
- The existing subway is on a 47.5 LHF skew, on a tangent alignment, and consists of five spans
- The superstructure consists of an open concrete ballast deck having a Cooper E-85 loading
- The existing track is presently on a 0.4% grade as it proceeds in an easterly direction crossing over Highway 16
- AT is senior at the crossing

2.2.4 Stormwater Management

2.2.4.1 Existing Drainage

Surface drainage of Highway 216, Sherwood Park Freeway and Yellowhead Trail road right-of-way generally discharges either directly to, or through creek systems into the North Saskatchewan River (ISL 2009). Areas north of the river generally drain south to the river and areas south of the river drain northwest to the river. In general, drainage of lands along the section of the proposed Anthony Henday Drive (AHD) from Manning Drive southeast to the river follows the road alignment sloping towards the river, with adjacent lands generally draining away from this section of the roadway. As a result, there are no contributing areas identified for this section of the proposed AHD, as it is planned that drainage from the future development of adjacent lands will be contained within those developments and directed elsewhere (ISL 2009). County lands draining west to AHD continue to drain west into Fulton Creek (not included in the environmental assessment study area), Gold Bar Creek and Unnamed Creek basins. County lands draining north to Yellowhead Trail will continue to drain north into Clover Bar Creek and Oldman Creek basins. Stormwater management for the proposed roadway improvements must accommodate runoff from these external areas for both current and ultimate development conditions. The full stormwater management plan can be found in Appendix A (ISL 2009).

2.2.4.2 Design

Stormwater management design for NEAHD addresses stormwater quantity and quality management as well as spill containment throughout the roadway right-of-way areas, including Highway 216 and Yellowhead Trail road right-of-way (ISL 2009). The proposed stormwater management system will include a combination of conveyance systems including: ditches, culverts, storm sewers, outlet control structures, drop and river outfall structures, and creek and river crossings. Storage/treatment systems will include: dry ponds, natural and constructed wetlands and vegetated swales with erosion control devices. All storage elements discharging to downstream receiving watercourses other than the North Saskatchewan River will be designed with outlet control structures that limit pond discharges for all events up to and including the 1:100 year design event, to a rate based on the allowable limit of 4.0 L/s/ha of contributing drainage area (ISL 2009). Wetlands will be designed with controlled discharge rates to ensure runoff volumes collected form the 1:2 year, 24 hour, Huff design storm will take at least 24 hours to draw down, in order to provide enough time to ensure maximum treatment of common runoff events (ISL 2009).

Design Storm Events

All storage elements will be designed to store runoff less than the designated controlled discharge rate from the greater of the following design storms:

- 1:100 year, 24 hour, Huff distribution design storm
- 1:100 year, 4 hour, Chicago distribution design storm

For all storage elements discharging to creek systems at a small controlled rate of 3.0 or 4.0 L/s/ha, the 1:100 year, 24 hour Huff event governed. Major conveyance system elements (ditches, storm sewers) will be designed to convey runoff from the 1:100 year, 4 hour Chicago design storm. Roadway culverts and storm sewers conveying pond discharges will be sized to convey from a 1:5 year design storm, and will be a minimum of 600 mm diameter. Treatment elements will be designed to provide water quality treatment for runoff from the 1:2 year, 24 hour, Huff design storm (ISL 2009).

Creek crossing will be designed to pass an estimate of the largest historic response at the site, as outlined in Alberta Transportation’s Hydrotechnical Design Guidelines for Stream

Crossings (September 2006) (ISL 2009). Estimates of the largest historic responses are to be made by developing estimates from the following three techniques, and using the largest value derived:

- Channel Capacity – an assessment of site-specific channel geometric conditions, especially useful when significant overbank storage exists
- Historic Highwater Observations – provides valuable insight to the hydrologic and hydraulic responses of the basin and stream to large runoff events
- Basin Runoff Potential – used in conjunction with channel capacity method to account for limitations in runoff supply in a hydrologic region

Controlled Discharge Rates

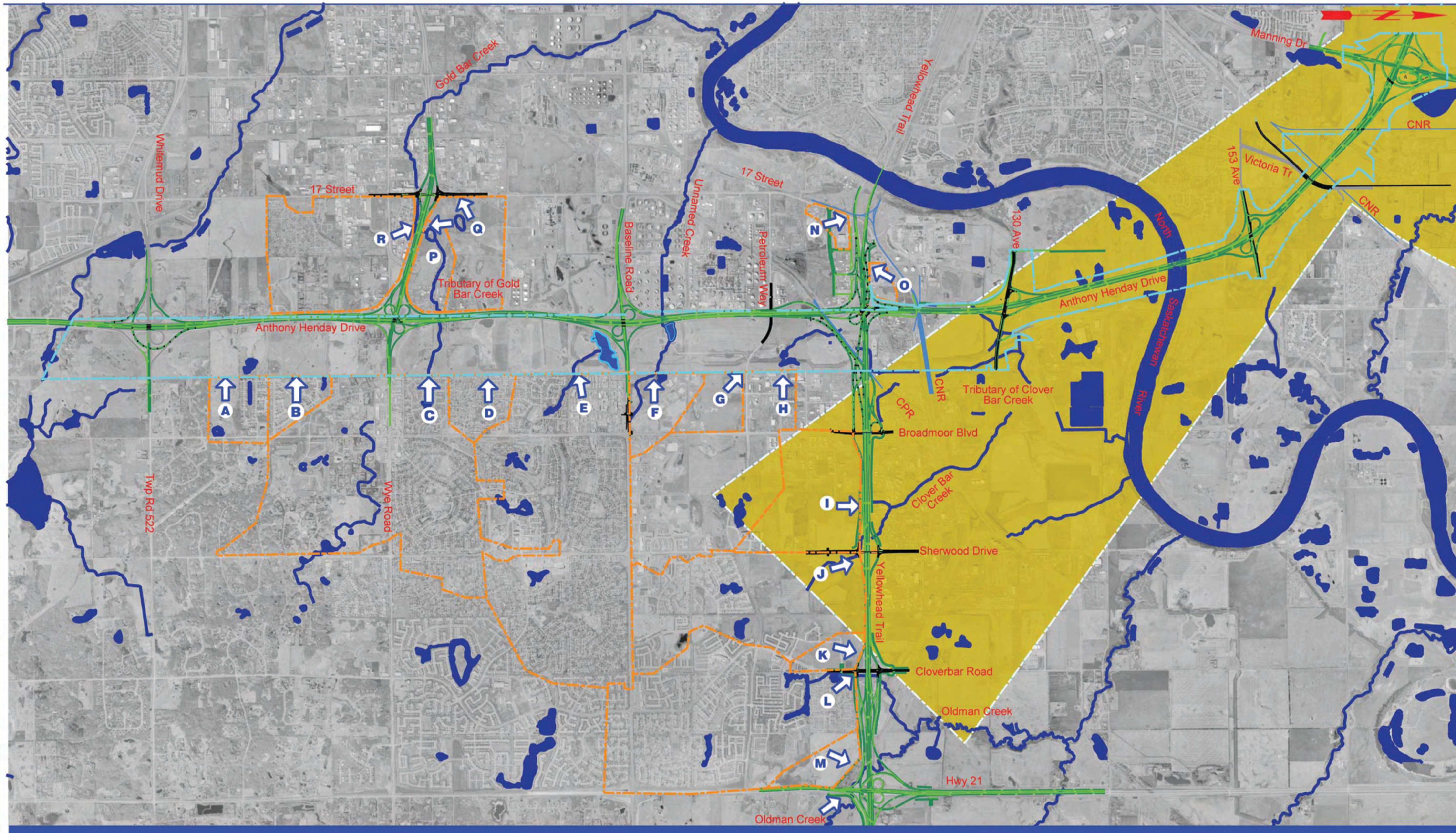
All storage elements discharging to downstream receiving watercourses other than the North Saskatchewan River will be designed with outlet control structures that limit pond discharges for all events up to and including the 1:100 year design event (ISL 2009). The discharge rates will be controlled to a maximum allowable limit of 4.0 L/s/ha of contributing drainage area, with the exception of facilities discharging to the Fulton Creek basin where a 3.0 L/s/ha maximum rate is in effect. This rate has been arrived at by Strathcona County as described in the various local drainage studies identified above, and is assumed to provide adequate erosion protection to downstream receiving watercourses (ISL 2009).

There is no maximum discharge limit for any storage element discharging directly to the North Saskatchewan River. However, for purposes of providing a practical outlet sewer design, a maximum discharge rate based on the 1:5 year design storm was assumed (ISL 2009).

Wetlands are also to be designed with controlled discharge rates to ensure runoff volumes collected from the 1:2 year, 24 hour, Huff design storm take at least 24 hours to draw down, in order to provide enough time to ensure maximum treatment of common runoff events. This will require a two-tiered outlet structure with a low discharge rate for low water levels and a higher discharge rate for higher water levels (ISL 2009).

External Drainage

Significant areas of Strathcona County located south of Yellowhead Trail and east of Anthony Henday Drive drain generally in a north-westerly direction and contribute to stormwater runoff to these sections of roadway (Figure 2.9) (ISL 2009). In addition, runoff from the Owens Corning and Lafarge sites contribute to the Yellowhead Trail



ISL Engineering and Land Services

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Legend

- DND Bird Hazard Zone
- External Area Inflow Location (A)
- External Area Boundaries
- Study Area (TUC / Yellowhead ROW)

SCALE 1:50 000

375 250 0 500m 1000m

Alberta TRANSPORTATION

Project Anthony Henday Drive

Title Figure 2.9 - Northeast Anthony Henday Drive Stormwater Management Plan

Figure No. 1 Drainage Area Key Plan

drainage system west of Anthony Henday drive, and lands adjacent to Sherwood Park Freeway drain towards the Freeway. Much of the external drainage areas are currently developed (ISL 2009). Development Plans are in place for the remaining areas. Stormwater management for the proposed roadway improvements must accommodate runoff from these external areas for both current and ultimate development conditions (ISL 2009).

Drainage from the external areas will contribute to the project study area as either direct drainage or lake controlled drainage. All lake controlled drainage (existing and future development conditions) will contribute flows to Highway 216 at a rate of 4.0 L/s/ha (3.0 L/s/ha to Fulton Creek basin). External drainage contributions were determined through a review of the local drainage studies identified in Figure 2.9 (ISL 2009).

Department of National Defence (DND) Bird Hazard Zone

The Department of National Defence (DND) has designated a Bird Hazard Zone area centered on the Edmonton Garrison Heliport at Namao, just north of Edmonton. The "Edmonton Garrison Heliport Zoning Regulations" restrict building heights, electronic communications and land features like stormwater management facilities, in order to reduce bird hazards to aviation (ISL 2009).

The DND Bird Hazard Zone extends into a section of the NEAHD study area along Highway 16 and the North Saskatchewan River crossing (Figure 2.9). Based on the DND Bird Hazard Zone boundaries, restrictions are placed on the types and sizes of ponds that can be placed along Highway 16 between just west of 17 Street to the west and just west of Highway 21 to the east. Those restrictions are placed to discourage birds from using stormwater management ponds, therefore reducing the potential of bird/helicopter collisions. The total bird hazard area in which the regulations apply are defined by the following two areas centered on the intersection of runways 11-29 and 02-20 (in SW 12-54-24 W4M):

- inclusive of an 8 km radius around the heliport at the Edmonton Garrison, and
- approach surfaces extending 15 km from the ends of each runway (in four directions) and gradually widening from width of the runways at one end, out to a width of 4.8 km.

The DND has set out specific regulations for stormwater management facilities within the affected area as a means of reducing the risk of aircraft failures due to bird strikes. The DND may permit land to be used as an open water reservoir if:

- water resides for a period no longer than 48 hours;
- if water resides for a period longer than 48 hours, reasonable measures are taken during the design, construction and operation of the facility to minimize bird hazards and habitat; or
- if the reservoir consists of a dry pond that is wet for a period longer than 48 hours more than once per year, measures are taken during the design, construction and

operation of the facility to minimize bird hazards and habitat, and these measures must be approved by the Minister of National Defence or the acting authority.

All new stormwater management facilities proposed within the designated bird hazard area must be approved by DND. DND will consider each proposed facility on a case-by-case basis. DND will approve facilities deemed to provide unattractive bird habitats. Dry ponds are preferred. Wet ponds or wetlands may be deemed acceptable if they are designed with reduced bird habitat features. Some of the most important features that are considered to provide reduced bird habitat include:

- minimized open water area – elongated open water areas are considered less appealing to ducks and other bids than circular areas as the birds are closer to potential shore based predators;
- the presence of tall emergent vegetation like cattails discourages birds – provides habitat for predators to hide;
- minimizing the presence of gentle, grassed slopes down to the water that birds like to walk on.

In addition to these features there is a preference for smaller facilities over larger facilities. Facilities less than 2.5 ha are preferred and can be approved locally, with facilities larger than 2.5 has requiring the approval of higher levels of authority. Stormwater ponds 8, 9, 10, 16, 17 and 18 (Appendix A) that are proposed for this project will fall within the DND Bird Hazard Zone and will require DND approval (ISL 2009).

Proposed Stormwater Management Systems

The proposed stormwater management concept will comprise twenty seven (27) stormwater management facilities (SWMFs) to service the proposed NEAHD (Highway 216 and 16) highway system upgrade (Appendix A). All of the facilities will discharge at a rate of 4.0 L/s/ha. Fulton Creek is 3.0 L/s/ha. The number and location of those ponds could change and will be finalized during the detailed design phase of this project. As such, stormwater flows will be accommodated within the project study area, and will be managed using culverts and controlled flows through pond outlet control structures.

2.3 Project Staging

Detailed staging and construction schedules will be determined by Alberta Transportation and the successful Contractor during the detailed design phase of the project.

2.4 Alternatives Considered

During the development of the advanced functional plan, numerous alternatives for any given interchange segment or element were considered. The following represents alternatives considered at key locations.

2.4.1 Sherwood Park Freeway Interchange Configuration Options

As part of the review and optimization of the functional plan for NEAHD, the previous recommendation for a third-level directional ramp at the Sherwood Park Freeway / Anthony Henday Drive interchange was evaluated. Based on traffic analysis carried out during the current study, the cloverleaf with a directional ramp for the eastbound to northbound movement proposed in the previous study is still the most efficient in accommodating the proposed traffic volumes. Two options were considered for the geometry of the directional ramp, the previously proposed three-level directional structure, and a two-level directional structure outside of the loop ramps.

A cursory assessment of the two options was also carried out based on the following criteria:

- construction costs,
- life cycle costs,
- constructability,
- geometrics,
- road user costs,
- safety,
- stakeholders concerns,
- access management,
- right-of-way,
- environmental impacts,
- traffic accommodation,
- utilities, and
- surface drainage.

The following table summarizes key elements of the directional ramp alignment options:

Table 2.1. Key Elements of the Direction Ramp Alignment Options

	Three-level directional (Alternative 1)	**Two-level directional** (Alternative 2)
Bridge Costs	~$32.5M for EB to NB directional	~$24M for EB to NB directional
Right-of-way impacts	0.32ha required which has limited impact on existing properties and businesses	1.31ha required; however, this will severely impact a business that would likely need to be purchased entirely
Operations	Climbing grade of 2.6% (down grade of 4.3%)	Lower gradeline, easier to accommodate large trucks on vertical grades

The two-level directional ramp is preferred because it will cost approximately $8.5M less and will operate better than the three-level ramp; however, it has larger property and business impacts.

2.4.2 Highway 16 Service Road (Broadmoor Boulevard to Sherwood Drive)

The widening of Yellowhead Trail will impact the existing service road between Broadmoor Boulevard and Sherwood Drive. Two options were considered to provide local access to the fifteen properties that are served by this road. The first option was to reconstruct the service road further north, and the second option was to provide alternate access to these properties or purchase them and seek consolidation opportunities.

The construction of a new service road to the north would require nine of the fifteen properties to be purchased outright due to the loss of their buildings and/or the remnants would become too small to redevelop. There is also uncertainty related to the construction of the service road through the Clover Bar Cemetery. If the plots at the south end of the cemetery are already occupied, then exhumation procedures would need to be followed. Visual inspection implies there are no occupied graves but City staff have not yet confirmed the availability of right-of-way.

The preferred option is to use alternate existing street access to provide local access to as many businesses as possible and seek consolidation where possible. This option would require the total purchase of six properties that would become isolated parcels, but has the option of redevelopment/reconsolidation.

3.0 METHODS

3.1 General Methods

Our general approach to the environmental assessment was as follows:

- We followed the guidelines for information, format and impact severity provided in the TOR by AT (provided in Appendix B) and by Transport Canada (N. Galvin, pers. comm.). The project area along Highway 16 from Highway 216 to Highway 21 was a change in scope and added after the project had begun. We assessed those phases of the project from construction through to operation.
- We reviewed existing environmental information from several sources including City of Edmonton Natural Sites Reports, Alberta Sustainable Resources databases [Fisheries and Wildlife Management Information System (FWMIS) and Alberta Conservation Information Management System (ACIMS) (formerly ANHIC)] and other published and unpublished sources of information. We also reviewed previously conducted environmental assessments for Southwest Anthony Henday Drive, Southeast Anthony Henday Drive and North Anthony Henday Drive as those projects represent other sections of the overall Anthony Henday Ring Road (Spencer 2001, 2004 and 2007). Those assessments were reviewed in order to describe existing environmental conditions, potential impacts and mitigation for the proposed project.
- We identified site-specific concerns by reviewing recent aerial photography, alignment sheets provided by the lead engineering consultant (ISL) and by conducting site investigations. Because the right-of-ways are located in a semi-urban setting and have been largely modified by agricultural, light industrial and transportation infrastructure activities, we focused on areas of remaining natural watercourse crossings, wetlands and native vegetation.
- We participated in open house sessions with the general public. Those meetings were held to inform stakeholders and other publics about the project and the functional planning study that was being conducted. Attendees were also invited to identify any environmental issues and to provide any environmental knowledge about the project area that they possessed. Attendees were informed that an environmental assessment pursuant to CEAA is being prepared.
- We reviewed all public consultation materials and meeting results for the Northeast Anthony Henday Drive project area.
- During the period of April 2006 to June 2006 and April 2008 – October 2008, field surveys were conducted in the project area to obtain information about surface drainage, soils, vegetation, rare plants, wetlands, wildlife and fish and fish habitat. An additional vegetation survey was conducted in June 2009.
- In spring of 2008, when traffic modeling information was available for the project, the information was supplied to specialists on air quality and noise in order that they could calculate potential project impacts to air quality and noise conditions.
- Based on the descriptions of existing conditions, the potential impacts of the proposed project were assessed and their significance described. The impact severity was classified according to a system requested by Transport Canada.

Where feasible, mitigation measures were developed to minimize the severity of impact, and the significance of the residual impact was re-evaluated.

- During the period September 2009 – January 2010, AT met with Fisheries and Oceans Canada (DFO) and Transport Canada to develop a streamlined approvals process for the proposed North Saskatchewan River Crossing in support of the DFBO process. Specific navigability criteria and fisheries mitigation measures were developed, which are included in this environmental assessment (Chapter 6).

3.2 Detailed Methods

The following sections describe in more detail the steps followed in preparing this EA.

3.2.1 Scoping the Assessment

The assessment scope confirms the assessment process and key regulatory stakeholders to be involved in a given project. Scoping determines the level of assessment, identifies the specific issues to be addressed (including permitting requirements), and establishes the spatial and temporal boundaries of the study area. The steps involved in scoping the assessment for this project are outlined in the sections below.

3.2.1.1 Spatial and Temporal Boundaries

Spatial and temporal boundaries appropriate to each Valued Ecosystem Component (VEC) are selected to help focus the assessment on an area / time frame most likely to be affected by the proposed project. In this way, the assessment is specific to the project and the VEC. For most VECs, the assessment focused on the area identified in red, including the proposed bridge crossing, in Figure 1.2, although in some instances this area was expanded or contracted for specific VECs. Areas outlined in blue were previously assessed in Spencer Environmental (2007). Where deviations were used, they are mentioned in the description of existing conditions.

3.2.1.2 Issue Identification

EA issues were identified through the following means and sources:

- Meetings were held with the engineering (ISL) staff to obtain a fundamental understanding of the current status of the project's design.
- Aerial photograph mosaic alignment sheets showing the right-of-way were examined for environmental features.
- Environmental assessment documents for other roadway transportation projects in Edmonton, particularly the southeast, southwest and north sections of Anthony Henday Drive were examined to determine what key issues were raised for those projects.
- Issues were identified on the basis of information and concerns identified by stakeholders and interested individuals at public sessions intended to obtain that type of information. Main issues identified by the public included future traffic

noise levels, visual impacts of roadway construction and operation and loss of treed and wetland areas.

- Specialist consultants for the subjects of fisheries, wildlife, vegetation, soils, hydrology and historical resources identified issues as part of their assessments for the proposed project.
- We relied on our professional judgment based on our broad experience with similar projects undertaken in the Edmonton region.

VECs were provided by AT's Terms of Reference. The extent to which the proposed project may affect the VEC is confirmed through the impact assessment process. In some instances, a perceived concern may not be affected by project activities, but once identified it must still be analyzed and characterized to satisfy the requirements of the impact assessment process.

3.2.1.3 Selection of Valued Environmental Components

No environmental assessment can be so broad in scope that it investigates potential impacts on all components of the natural, social and heritage environments (historic resources are being investigated and discussed in another report that forms part of the supporting studies for the functional planning exercise). To be effective, investigations must focus on selected environmental features that are considered most important within the context of the proposed development. Although EIA practitioners use a variety of terms to describe these features, in this assessment they are termed Valued Environmental Components (VECs). Three types of VECs were identified for this assessment:

- **Valued Ecosystem Components**: species or features of the natural environment.
- **Valued Socio-economic Components**: features of human settlement/development or cultural values
- **Valued Heritage Components:** sites, artifacts or structures of our natural and human history.

VECs were selected based on five criteria:

- relative abundance or status,
- public concern,
- professional concern,
- economic importance, or
- regulatory concern.

Relative abundance or species status refers to resources within the study area that are considered rare, threatened or endangered at a provincial or national level. It can also include those resources that have a limited distribution or abundance within the local or regional study area.

Resources of public concern include attributes or features that were raised as issues by the public during public consultation. Professional concerns are related to those features of the environment known to be critical for sustaining the ecosystem, or maintaining social values within the affected site. Resources of economic importance are various and range from aesthetic values important for tourism to sport fisheries.

Lastly, features of regulatory concern apply to resources that have been identified as special concerns by provincial or federal regulatory agencies. These include resources such as water quality, fish habitat, and rare or migratory species, depending on the project type and location. Selected VECs and the justification used for their selection for this project are listed in Table 3.1.

In the case of the NEAHD, VECs have already been identified by AT, on a broad basis, in the Terms of Reference provided for the project environmental assessment (Appendix B) to the engineering consultant. That list simplified the exercise of developing a list of VECs for this assessment. VECs identified for the consultant were:

- landforms and soils,
- vegetation,
- fisheries,
- wildlife,
- hydrology and surface water quality,
- stormwater*
- wetlands,
- air quality,
- cultural resources,
- navigation*, and
- noise.

* Stormwater and navigation are an AT requirement, but are not normally considered a Valued Environmental Component.

Table 3.1. AT Selected VECs

Valued Environmental Components	Relative Abundance or Status	Public Concern	Professional Concern	Economic Importance	Regulatory Concern	Comments
Valued Ecosystem Components						
Soils/Geology/ Geomorphology		√	√		√	• *CEAA*
Hydrology and Surface Water Quality (and stormwater*)		√	√		√	• *CEAA* • *Navigable Waters Act* • Alberta *Water Act* • *EPEA*
Vegetation and Wetlands - Native vegetation - Special Status species	√	√	√		√	• *CEAA* • Federal *Species at Risk Act* • Alberta Water Act
Wildlife - Habitat - Special Status species	√	√	√		√	• Federal *Species at Risk Act* • Federal *Migratory Birds Convention Act* • Alberta *Wildlife Act*
Fish and Aquatic Resources - Habitat - Special Status species	√	√	√		√	• *CEAA* • Federal *Fisheries Act* • Federal *Species at Risk Act*
Air Quality - Vehicle emissions		√	√		√	• *CEAA* • *Canadian Environmental Protection Act* • *Alberta Environmental Protection Act*
Valued Socio-economic Components						
Land Disposition and Zoning		√	√	√	√	• *CEAA* • Alberta *Public Lands Act*
Other Land Uses -Aboriginal Lands - Residential - Industrial - Navigation *		√	√	√	√	• *CEAA* • *Navigable Waters Act*
Noise		√	√	√	√	• Alberta Transportation's Noise Policy
Valued Heritage Components						
Historical Resources		√	√		√	• *CEAA* • Alberta *Historic Resources Act*

* Stormwater and navigation are an AT requirement, but are not normally considered a Valued Environmental Component

3.2.2 Description of Existing Conditions

The description of existing conditions provides a snapshot of the current state of the project area, over which the proposed project can be overlaid to identify areas of potential concern (impacts). Existing conditions relative to wildlife, significant wildlife corridors, vegetation, wetlands, potential special status species and significant biophysical features were identified during the assessment process. Wildlife (avifauna and amphibians), vegetation, and fisheries investigations were conducted in the project area in the spring/summer of 2008. Historical resources investigations [Historical Resources Overviews (HRO) and Historical Resources Impact Assessments (HRIA)] were conducted at different times (i.e., 2003 and 2006) for the three distinct segments of roadway included in this environmental assessment. Specific methods used to describe the existing conditions for each VEC are described in the representative sections of Chapter 5.

3.2.2.1 Impact Analysis

Impact analysis is the final step in confirming the likelihood and severity of a potential effect of the project on the environment. In this step, concerns raised by the public, regulators and environmental scientists are evaluated with respect to the existing environmental conditions and characterized so that their significance can be assessed by the regulatory authorities responsible for the environmental assessment process. While some potential impacts might eventually be determined to be negligible, the potential interaction of a VEC with a given project activity must be described and documented in order to resolve the original concern. Impact analysis, therefore, involves a statement of the potential effect, followed by a description of the means by which the VEC may be affected, or remain unaffected, by the project. Lastly, the impact is characterized in terms of standardized descriptors to allow a reviewer to evaluate the significance of project effects. The various stages of impact analysis are outlined in more detail below.

3.2.2.2 Impact Identification

To identify ways in which the proposed project could affect VECs, a matrix with project activities along one axis and VECs along the other was developed (Table 5.1). Potential interactions between the elements of each axis were then identified and assessed with regard to the type of change that would occur in the existing environment as a result of the proposed development. Each of these interactions was then described in terms of the project's effect on each VEC.

3.2.2.3 Impact Description Characteristics

The characteristics used to describe impacts were based on terminology usually used in *CEAA* assessments. Impacts were described and classified as to their direction (positive or adverse), magnitude/severity (negligible, minor, or major), duration (temporary or permanent) and confidence (predictable effect or uncertain effect) as requested in AT's Terms-of-Reference and enhanced by Transport Canada's guidelines (N. Galvin, Transport Canada). These criteria were defined follows:

Project Period:

Construction: An interaction related to the construction period only.

Operation: An interaction related to the operation and maintenance period only.

Decommissioning: Where this activity comprises part of the project, any interaction related to decommissioning activities.

Direction:

Positive Impact: An interaction that enhances the quality or abundance of physical features, natural or historical resources, or recreational pursuits or opportunities.

Adverse Impact: An interaction that diminishes the abundance or quality of physical features, natural or historical resources, or recreational pursuits or opportunities.

Magnitude:

Negligible Impact: An interaction that results in no noticeable effect on the resource. Such impacts are not characterized with respect to direction, duration or confidence.

Minor Impact: An interaction that has a noticeable effect but does not affect local or regional populations, natural or historical resources or physical features beyond a defined critical threshold (where that exists) or beyond normal limits of natural perturbation. Also, does not alter existing or future recreational pursuits at established facilities or well-used areas.

Major Impact: An interaction that affects local or regional populations, natural or historical resources, or physical features beyond a defined critical threshold (where that exists) or beyond the normal limits of natural perturbation; or alters existing or future recreational pursuits at established facilities or well-used areas.

Geographic Extent:

Local: An interaction limited spatially to the project footprint and immediately adjacent lands.
Regional: An interaction that extends beyond the project footprint into the broader surrounding region (e.g., air emissions that could disperse into the surrounding lands).

Provincial/National: An interaction with effects that could extend well beyond the region in which a project is located (e.g., water quality or quantity impacts).

Duration:

Short-term Impact: An interaction resulting in a measurable change that does not persist for longer than one year post-construction.

Long-term Impact: An interaction resulting in a measurable change that persists longer than one year post-construction but is predicted to dissipate completely at some point.

Permanent Impact: An interaction resulting in measurable change that is predicted to persist indefinitely.

Frequency:

Occasional: An interaction that occurs only periodically during a project period, or during a short phase of that period (e.g., initial clearing, reclamation, materials hauling)

Constant: An interaction that will occur throughout a majority of a project period.

Reversibility:

Reversible: An interaction that will result in an effect that can be reversed within a reasonable period (e.g., several years), and/or without prohibitive expense.

Irreversible: An interaction that will result in an effect that can only be reversed over a long period of time (e.g., generations), and/or with considerable expense.

Probability of Occurrence:

Low: The possibility for an interaction to occur is considered to be unlikely due to the distribution of resources in the project area, or limited overlap in space or time of the resource and the project activity.

High: The possibility for an interaction to occur is considered to be very likely due to the distribution of resources in the project area, or overlap in space or time of the resource and the project activity.

Scientific Confidence:

Predictable Impact: Effects are well understood through application in projects of a similar nature.

Uncertain Impact: Effect on VEC is not well understood due to lack of knowledge of the VEC and/or its response to disturbance.

3.2.2.4 Initial Impact Assessment and Mitigation Development

All interactions identified by means of the matrix were analyzed and described according to the characteristics defined above. Features of the project activities and planning that would reduce the degree of impact were reviewed at this stage and used to assign the degree of impact; however, no additional mitigation measures were considered at this point.

In the next step of the assessment, mitigation measures were developed that would reduce the severity and/or duration of the potential adverse impacts on a VEC. All attempts were made to reduce impact severity in these cases, however; this was not always feasible or practical. For some, but not all of the minor impacts, mitigation measures were proposed if they were considered to be cost-effective and/or worked in concert with other proposed measures.

3.2.2.5 Residual Impact Assessment

Any effect remaining after mitigation is termed a residual impact. For the final stage of the assessment, residual impacts were classified according to the impact characteristics described above and summarized.

3.3 Public and Aboriginal Consultation

3.3.1 Public Consultation

A public consultation program was undertaken for the proposed Northeast Anthony Henday Drive and ran in conjunction with the environmental assessment process. Open houses were held in two consecutive locations, Sherwood Park and north Edmonton, on 24 and 27 November 2008 and 08 and 10 June 2009. Those open houses provided information and solicited comments and additional information from stakeholders including businesses, residents, recreationists, community associations and special interest groups. Any questions or concerns they had were addressed in this environmental assessment. Details of the public consultation program and summary reports documenting the results of the public consultation process were produced as separate reports and may be found in Appendix C.

3.3.2 Aboriginal Consultation

The Province of Alberta has a duty to consult with First Nation’s communities where there is the potential to adversely impact treaty rights. It is Alberta Transportation’s (AT) view that there will be no infringement of First Nations treaty rights or traditional uses as a result of this project for the following reasons (D. Carter, pers. comm.):

- There are no First Nations treaty rights or traditional uses being exercised within the project area.

- The Province's Transportation and Utility Corridor (TUC), in its entirety, is located within the municipal boundaries of the City of Edmonton and the County of Strathcona. There are no hunting or trapping activities permitted within the City or the TUC, therefore, this project does not have the potential to cause an adverse impact to First Nations with respect to these treaty rights. First Nations have not been undertaking traditional uses in the area for a considerable length of time, therefore, the project does not have the potential to adversely affect traditional uses.

- The project is located on designated/occupied lands that have been surrendered under treaty and are vested in the Crown. The TUC has been planned since the late 1960's, with most of the lands being acquired from private land owners by the late 1980's. No unoccupied lands are to be up-taken as a result of the project.

- The project will not significantly disrupt animal habitat or migration patterns that could negatively impact hunting or trapping in the area as surrounding areas have already been impacted by existing agricultural activities and development. Fishing opportunities in the North Saskatchewan River will remain unchanged as standard mitigation measures with respect to fish passage and turbidity monitoring will be implemented during the construction period and fisheries compensation will be incorporated to offset impacts.

A good portion of the work for this project involves the upgrading of an existing highway facility (Highway 216/16) to that of a freeway standard with interchanges in order to alleviate increased traffic demand. The reconfiguration of the existing Highway 216 is consistent with the current land use in this area that has been in place since the early 1990's. The presence of the existing facility means that the land is already in a visible use that is incompatible with the exercise of treaty rights such as hunting or trapping.

A Notification letter was sent to the Enoch Cree First Nation in February 2009 (D. Carter, pers. comm.). That letter was copied to DFO and Transport Canada. The purpose of the Notification was to inform the Enoch Cree of the scale and scope of the project including instream works and activities in the North Saskatchewan River and anticipated construction timelines.

4.0 EXISTING CONDITIONS

Existing conditions of the proposed Northeast Anthony Henday project described in this chapter focus on the existing areas of Highway 216 between Whitemud Drive and Highway 16 (Yellowhead Trail), Highway 16 between 17 Street and Highway 21 (Highway 216/16 alignment) and the proposed new alignment between Manning Drive and Highway 16 East, including the new North Saskatchewan River crossing. Existing conditions of the area between Manning Drive and Highway 16 East were previously described in the North Leg- Anthony Henday Drive Environmental Assessment prepared by Spencer Environmental Management Services Ltd. (2007); however, relevant parts of that environmental assessment are incorporated into this environmental assessment. Manning Drive has been used as a major and easily identifiable landmark for clarity of discussion, however, the short section between Manning Drive and the Canadian National Railway to the east is currently under construction as part of Northwest Anthony Henday Drive and has been previously cleared of vegetation and wetlands.

4.1 Biophysical Resources

4.1.1 Geology/Geomorphology

4.1.1.1 Methods

Literature Review

Highway 216/16 Alignment and Manning Drive to Highway 16 East

Geology and surficial geology and landforms of the NEAHD study area (Highway 216/16 alignment) was described in the Bedrock Geology Map of Alberta (Green 1972 in Paragon 2009). Major landforms were identified through interpretation of aerial photographs of the study area (Paragon 2009). Thurber (2009a) conducted a review of available geological and geotechnical information to provide preliminary information on the soil and groundwater conditions from Hayter Road to Whitemud Drive along Highway 216 and from the Highway 216/16 interchange to Sherwood Drive in the NEAHD project area. Information was obtained from published geotechnical and geological reports, Alberta Transportation library, and in-house files. Thurber's (2006) previous preliminary geotechnical investigation study for the area between Manning Drive and Highway 16 in support of a previous interchange rationalization functional planning study was also reviewed.

North Saskatchewan River Crossing

Geology and geomorphology of the North Saskatchewan River Valley were described in the EPEC Consulting Western Ltd. (1981) report on biophysical resources of the river valley and, more recently, in a guide produced by the Edmonton Geological Society (Godfrey 1993). With respect to the proposed North Saskatchewan River crossing, previous geotechnical investigations were conducted by McElhanney (2001), EBA (2001) and Thurber Engineering (2006). Those documents provided baseline information in support of this environmental assessment for the NEAHD project area.

- More recently, topographic contours of the bridge site were provided to EBA by ISL (EBA 2008). Surficial and bedrock geology was described in Urban Geology of Edmonton (Kathol and McPherson 1975 in EBA 2008). Two geotechnical investigations were previously performed for the North Edmonton Ring Road (NERR) and each of those geotechnical investigations included information for the proposed North Saskatchewan River bridge crossing.

Coal Mines

The Atlas of Coal Mine Workings (Spence Taylor 1971 in Thurber 2009a), the catalogue of Coal Mines of the Alberta Plains (Campbell 1964 in Thurber 2009a) and the Coal Mine Atlas, (EUB 2004 in Thurber 2009a) were reviewed to check for the presence of any former underground coal mines in the proposed project area. That review indicated that there are possibly some underground coal mines along the investigated portions of Highway 216 and Highway 16 (Thurber 2009a).

Field Investigations

Highway 216/16 Alignment and Manning Drive to Highway 16 East

Previously, Thurber Engineering (2006) undertook a preliminary geotechnical investigation in support of the interchange rationalization functional planning study for NAHD. Thurber's investigation included a review of available geological and geotechnical information on soil and groundwater conditions in addition to a drilling program. Eighteen (18) deep test holes and eight (8) shallow test holes were drilled between 12 June and 26 July, 2006 to investigate subsurface conditions at the proposed interchange locations and along the Manning Drive to Highway 16 section of the proposed NAHD alignment (Thurber 2006). Water levels were noted during and after completion of the drilling and standpipe piezometers were installed in several deep and shallow test holes. Groundwater levels were measured at the piezometers between 31 July and 1 August, 2006, approximately four weeks after drilling completion (Thurber 2006). All soil samples were visually classified in the laboratory and tested for their natural moisture content. The findings from that report are summarized below and the full report is available under separate cover.

More recently, a preliminary geotechnical investigation was carried out by Thurber Engineering Ltd. (2009a) as part of the current advanced functional planning study for NEAHD. The project limits consisted of two separate highway alignments as follows:

- Along Highway 216 from the intersection with Manning Drive in the northeast end of the City of Edmonton to the intersection with Whitemud Drive in the southeast part of the city in a north-south direction.
- Along Yellowhead Trail (Highway 16) from the intersection with Highway 216 to Sherwood Drive, in the city's east end in an east-west direction.

The portion of Highway 216 from Manning Drive to Hayter Road, including the North Saskatchewan River bridge crossing, was not part of Thurber's scope of work.

The scope of the geotechnical investigation was to obtain soils and groundwater information along the NEAHD alignment and specifically at the proposed grade separations in order to identify geotechnical issues that may impact the design and construction (Thurber 2009a). A site reconnaissance was carried out by Thurber on 04 June 2008 to visually inspect the existing conditions at the proposed bridge abutment sites, including a visual assessment of the approach fill slopes at the existing grade separation structures (Thurber 2009a).

Forty-three (43) deep test holes were drilled between 24 July and 21 November 2008 to investigate the subsurface conditions at the proposed bridge abutment locations. This included six (6) deep test holes that were drilled at the revised bridge abutment locations for bridges located at the Sherwood Park Freeway and Broadmoor Boulevard (Thurber 2009a). The test holes located at the bridge structure abutments were advanced to depths ranging from 10.5 m to 31.7 m below existing ground surface (Thurber 2009a). In addition, twenty—one (21) shallow probe holes were drilled to depths ranging between 4.6 m to 5.3 m along the Highway 216 and Highway 16 corridors between 26 November and 2 December 2008 to investigate the subsurface conditions along the proposed roadway alignments (Thurber 2009a).

The locations of the deep test holes were chosen in conjunction with ISL prior to commencing the field program and were staked in the field by ISL prior to drilling (Thurber 2009a). The roadway shallow probe holes were drilled at approximately 500 m intervals at locations between the bridge abutment test holes. The locations of the roadway probe holes were selected by Thurber and were later surveyed by ISL for as-built elevation and location (Thurber 2009a).

North Saskatchewan River Crossing

EBA Engineering Consultants Ltd. (2008) undertook a geotechnical assessment for the proposed North Saskatchewan River (NSR) bridge crossing between 05 August and 13 September 2008. They conducted additional stability analysis for the proposed headslope design for that crossing in 2009 (EBA 2009). The 2009 study further analyzed new geometry for the north and south headslopes, compared headslope options with and without an under-slung pedestrian crossing and analyzed the feasibility of toe berms. No geotechnical field investigations were undertaken at the NSR crossing in 2009. Both of EBA's reports (2008 and 2009) can be found in Appendix D of this document.

The 2008 field investigation comprised drilling six boreholes on the north and south sides of the proposed crossing and two boreholes in the river (EBA 2008). All samples were visually classified using the Modified Unified Soil Classification System and the individual soil strata and interfaces between them were noted. Borehole logs are presented in Appendix D. Bedrock samples were visually classified and measured total core recovery and the rock quality designation (RQD). The RQD is defined as the length of the core recovered with an unfractured length greater than 10 cm divided by the total core run length (EBA 2008).

4.1.1.2 Description

Regional Geomorphological Features

Most of the proposed NEAHD alignment in the TUC on the table lands adjacent to the north and south sides of the North Saskatchewan River valley is through cultivated farm land or pasture land with scattered treed areas. The topography is relatively flat to gently undulating. The north bank of the North Saskatchewan River has a top-of-bank elevation of approximately 644 m, is relatively steep and rises about 37 m from the river's edge (Thurber 2006).

The project area south of the river is a low-level, wide terrace that is relatively flat with some cultivated and treed areas, wetlands, numerous gravel pits and commercial and industrial land uses. It is approximately 30 m lower in elevation than the north river bank.

Bedrock and Surficial Geology

Bedrock

Highway 216 / 16 Alignment and Manning Drive to Highway 16 East

Bedrock geology in the study area consists of Upper Cretaceous fine grained calcareous and bentonitic sandstone, bentonitic and carbonaceous clay shale and siltstone with coal layers and bentonite seams of the Edmonton Group (Thurber 2009a).

Based on the published geological information (Kathol and McPherson, Figure 20 and L.D. Andriashek, NTS 83H map in Thurber 2009a), the bedrock surface along the alignment varies from a high elevation of about 700 m at the southern extent of the NEAHD near Whitemud Drive to an elevation of 663 m in the vicinity of Manning Drive with a low elevation of 610 m at the proposed river crossing (Thurber 2006 and 2009a).. The elevation of bedrock along the Highway 16 corridor between Sherwood Drive and 17 Street is expected to range from about 640 m to 645 m (Thurber 2009a).

The depth to bedrock is expected to range from about 5 m to 75 m below existing ground surface (Thurber 2009a). The preglacial Beverly Channel traverses the Edmonton area to the north of the NEAHD alignment. In addition, several tributary thalwegs to the Beverly Channel intersect the NEERR in an east to west direction, notably in the vicinity of Sherwood Drive and to the south of Whitemud Drive in the vicinity of Fulton Creek (also known as the Bretona Valley Channel) (Thurber 2009a).

The bedrock valleys, or thalwegs, were formed during preglacial times, and preglacial sand and gravel of the Empress Formation is found in the base and terraces of these preglacial valleys (Thurber 2009a). The preglacial valleys were subsequently infilled with glacial till and lake deposits in glacial and post glacial times.

North Saskatchewan River Crossing

General bedrock and surficial conditions varied greatly on either side of the NSR (EBA 2008). Glacial and alluvial deposits, in particular, were spatially irregular and changed significantly over short distances (EBA 2008).

Bedrock encountered during drilling on the north (BH-01, BH-04 and BH-05 and south (BH-02 and BH-06) (Appendix D of this document) abutments comprised interbedded clay shale and sandstone deposits. The bedrock contained variable seams of coal and minor bentonite seams (EBA 2008). The top of the bedrock was at approximate elevations of 605.3 m and 606.8 m, respectively. The upper 2 to 3 m of bedrock was generally slightly weathered. Visible bedding planed within the bedrock was horizontal to sub-horizontal and varied from laminated to widely spaced (EBA 2008).

The clay shale bedrock at both abutments was silty, very stiff to hard, brown to grey to greenish grey and moist. The clay shale contained lenses of coal (EBA 2008). The sandstone was generally silty, bentonitic, fine grained and very dense. The sandstone was horizontally bedded and contained indurated claystone seams (EBA 2008). Bedrock was encountered in the riverbed at sites BH-07 and 08 (Appendix D). The top of the bedrock was at an elevation of about 600 m in BH-07 and approximately 605.5 m in BH-08 (EBA 2008). The bedrock encountered during drilling comprised interbedded clay shale and sandstone deposits and contained variable seams of coal and minor bentonite seams. A bentonite layer was encountered at the top of the bedrock in BH-07 and directly beneath the clay till (EBA 2008).

Coal Mines

As identified by Thurber (2009a), several coal mine workings are located in the project area. Table 4.1 below indicates where the proposed bridge structures may be located over the coal mine workings. It should be noted, however, that the coal mine workings are relatively deep, between 25 m and 43 m below original ground surface.

Table 4.1. List of Documented Coal Mine Workings (Spence Taylor 1971, Campbell 1964 and EUB 2004 in Thurber 2009a)

Mine No.	Type of Mine	Anticipated Depth of Cover (m)	Legal Land Description (LSD or SEC-TWP-RGE-MER)	Possibly Affected Bridges
699	Underground	33 to 43	8 & 9 of 8-53-23-4	11 & 32
			15 & 16 of 8-53-23-4	25
			5, 12 & 13 of 9-53-23-4	12,13,16 & 32
91	Underground	25	15 of 8-53-23-4	25
			2, 3 & 4 of 17-53-23-4	26

According to the literature, a coal mine, identified as No. 0699, was operated by Marcus Collieries Ltd. from 1917 to 1940, to the south of the current Highway 216/16 interchange and had a cover of approximately 33 m to 43 m (Thurber 2009a). No definite information is available regarding the actual north extent of Mine No. 0699, but it is likely to be near the location of the proposed Bridge 16 (Thurber 2009a). Some cave-in activity, categorized as minor to major, was observed during the operation of Mine No. 0699. No evidence of coal mine workings was noted during drilling of the test holes that were advanced through about 10 m to 11 m of fill to depths of 22.6 m to 30.1 m for proposed Bridge 16 (Thurber 2009a).

Surficial Geology

Highway 216/16 Alignment and Manning Drive to Highway 16 East

The expected surficial deposits in the study area are shown on Figure 4.3 as obtained. The surficial deposits expected along Highway 216 are expected to consist of the following units, from north to south (from Kathol and McPherson 1975 Geology of the Edmonton Area, Map 23 in Thurber 2009a):

- From the North Saskatchewan River Valley south to Highway 16, the surficial deposits generally consist of glaciolacustrine deposits, consisting of bedded silts and clays overlying clay till and sand deposits.
- From Highway 16 to 82 Avenue (Sherwood Park Freeway/Wye Road), the surficial deposits generally consist of glacial till underlain by bedrock. The till consists of a clay matrix containing sand, silt, pebbles, coal fragments and occasional cobbles and boulders.
- From 82 Avenue to south of Sherwood Park Freeway, the surficial deposits generally consist of glaciofluvial outwash sand and gravel overlying glacial clay till.
- From south of Sherwood Park Freeway to north of Whitemud Drive, the surficial deposits generally consist of glacial till underlain by bedrock. The till consists of a clay matrix containing sand, silt, pebbles, coal fragments and occasional cobbles and boulders.
- From north of Whitemud Drive southwards, the surficial deposits generally consists of undulating to gently rolling glacial till composed of mixed clay, silt and sand with pebbles, boulders, lenses of sand, gravel and local bedrock.
- In the vicinity of the Baseline Road Interchange, and at other select locations, lake slough deposits, consisting of silt, clay, organic muck and marl overlying clay and clay till are likely to be present.

North Saskatchewan River Crossing

Soil conditions on the north side of the river were associated primarily with glacial deposits. Up to 0.5 m of organic topsoil was encountered on the north side of the river. The topsoil was underlain by glaciolacustrine deposits of sand, silt and clay within the upper 1 to 4.5 m. The glaciolacustrine deposits were thickest in BH-01 and BH-04 (Appendix D of this document). Sixteen (16) to approximately 19 m of glacial clay till was encountered below the glaciolacustrine deposits. Preglacial alluvial sand and gravel deposits were encountered below the glacial till. Thin clay seams were encountered in the sand. The gravel was between 1 and 6 m thick (EBA 2008).

Soil conditions on the south side of the river were associated with fills over primarily alluvial deposits. Approximately 0.3 m of organic topsoil underlain by 2 m of variable silt and clay fill was encountered. The alluvial deposits closest to the river (i.e. BH-02; Appendix D of this document) comprised fine grained sand, silt and clay overlying gravely clay. Alluvial deposits were approximately 4.7 m thick with those set back from the river (i.e. BH-06; Appendix D) comprising fine grained sand underlain by sand and gravel. The gravelly clay was about 3 m thick in BH-02 (Appendix D) and was considered to be a very localized deposit (EBA 2008).

Sand and gravel deposits encountered in the riverbed were approximately 1.3 m thick. A 5.7 m thick deposit of glacial clay till was encountered in BH-07 (Appendix D). Bedrock directly underlies the clay till at BH-07 and the riverbed gravels at BH-08 (Appendix D). The exact depositional environment of the riverbed clay till is unknown; however it could be colluvium rather than till resulting from an ancient slump failure causing rotation of the north valley wall and transport of glacial till to the base of the slump block (EBA 2008).

Subsurface Conditions

Highway 216/16 Alignment and Manning Drive to Highway 16 East

The entire NEAHD study area (Highway 216/16 alignment) overlies the Horseshoe Canyon Formation (Green 1971 in Paragon 2009). The formation composition is described as gray, feldspathic, clayey sandstone; gray bentonitic sandstone and carbonaceous shale; concretionary ironstone beds, scattered coal and bentonitic beds of variable thickness. The formation is non-marine in origin and includes scattered thin limestone beds (Green 1971 in Paragon 2009).

Soil stratigraphy encountered during the previous drilling programs in 2001 and 2006 along the proposed NAHD alignment, including the section between Manning Drive and Highway 16, generally comprised the following major soil units, in descending order (EBA 2001; Thurber 2006):

- Topsoil and fill
- Lacustrine clay
- Silt and sand
- Clay Till
- Bedrock

The 2009 geotechnical investigation results were subdivided into six (6) sections of similar stratigraphy conditions (Thurber 2009a):

- Section 1 (Highway 216, Hayter Road/CNR to Yellowhead Trail).
- Section 2 (Highway 216, Yellowhead Trail to Petroleum Way);
- Section 3 (Highway 216, Petroleum Way to Sherwood Park Freeway).
- Section 4 (Highway 216, Sherwood Park Freeway to Whitemud Drive).
- Section 5 (Highway 216, Sherwood Park Freeway to 17 Street NW).
- Section 6 (Highway 16, Sherwood Drive to Highway 216).

Section 1 (Highway 216, Hayter Road/CNR to Yellowhead Trail)

The soil stratigraphy is quite variable within the depth of investigation and consists of the following generalized sequence in descending order:

- Topsoil
- Fill
- Lacustrine Clay

- Clay Till
- Empress Formation (Sand and Gravel)
- Bedrock

The depth of bedrock along this section increases in a southerly direction from about 10 m at the Hayter Road/CNR crossing to about 20 m at the Highway 216/16 interchange. Empress Formation sand is present above the bedrock throughout this section and rafted bedrock is also present within the clay till layer (Thurber 2009a).

<u>Section 2 (Highway 216, Yellowhead Trail to Petroleum Way)</u>
The soil stratigraphy consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil
- Fill
- Lacustrine Clay
- Clay Till
- Empress Formation (Sand & Gravel)
- Bedrock

Fill consisting predominately of clay was encountered in most of the test holes along the alignment as it passes through the existing Highway 216 corridor and bridge abutment fills (Thurber 2009a).

Clay shale and sandstone bedrock was encountered in the Yellowhead Trail interchange test holes at depths ranging from approximately 16 m to 24 m. Based on the geological maps, the clay till is anticipated to be underlain by bedrock throughout this section at depths ranging from 25 m to 17 m below existing ground, surface typically decreasing in depth in a southerly direction. (Thurber 2009a).

Rafted clay shale and sandstone bedrock were encountered within the clay till layer at depths ranging from 1.3 m to 11.5 m. A layer of Empress Foundation sand and gravel (up to 2 m thick) was encountered between the clay till and bedrock layers (Thurber 2009a).

<u>Section 3 (Highway 216, Petroleum Way to Sherwood Park Freeway)</u>
The soil stratigraphy consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil
- Fill
- Clay Till
- Bedrock

Fill material consisting of predominately clay was encountered in most of the test holes along the alignment as it passes through the existing Highway 216 corridor and bridge abutment fills (Thurber 2009a).

Peat layers were encountered underlying the fill in two test holes. Sandstone clay shale bedrock was encountered underlying the clay till at depths ranging from approximately 12 m to 20 m at the Sherwood Park Freeway interchange test holes. Rafted bedrock layers were encountered within the clay till at depths ranging from 6 m to 12 m at the Petroleum Way interchange test holes (Thurber 2009a).

Based on the geological maps, an unnamed preglacial thalweg, which is a tributary to the Beverly preglacial channel, dissects this section in an east-west direction immediately north of Sherwood Park Freeway. The clay till is anticipated to be underlain by undulating bedrock throughout this section at depths ranging from 20 m to 30 m at Petroleum Way and from 15 m to 20 m at Sherwood Park Freeway. Thin layers of Empress Formation sand and gravel are anticipated to be encountered between the till and bedrock layers throughout this section (Thurber 2009a).

Section 4 (Highway 216, Sherwood Park Freeway to Whitemud Drive)
The soil stratigraphy consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil
- Fill
- Lacustrine clay
- Clay Till
- Bedrock

Fill material consisting of predominately clay was encountered in most of the test holes along most of the alignment as it passes through the existing Highway 216 corridor and bridge abutment fills (Thurber 2009a).

Bedrock was encountered at depths of approximately 12 m to 20 m in the test holes drilled at the Sherwood Park Freeway interchange and at depths of approximately 21 m to 30 m at the Whitemud Drive interchange. Sand layers and thin rafted bedrock lenses were encountered within the clay layers throughout Section 4. Based on geological maps, the depth to bedrock is anticipated to vary between 6 m and 18 m through this section (Thurber 2009a).

Section 5 (Highway 216, Sherwood Park Freeway to 17 Street NW)
The soil stratigraphy along Section 5 consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil
- Fill
- Lacustrine clay

- Clay till
- Bedrock

Fill predominately consisting of clay was encountered in most of the test holes along most of the alignment. Topsoil layers ranging from approximately 600 mm to 1200 m thick were encountered underlying the fill material in three test holes (Thurber 2009a).

Bedrock was encountered at depths of approximately 12 m to 20 m in the test holes drilled at the Sherwood Park Freeway interchange (Thurber 2009a). Based on the geological maps, the bedrock topography is dominated by an un-named preglacial thalweg tributary to the Beverly preglacial channel that crosses through this section in an east-west direction immediately north of Sherwood Park Freeway. The depth to bedrock is expected to vary between 15 m and 20 m, typically increasing from east to west. Thin layers of Empress Formation sand and gravel are expected to be present between the till and bedrock layers throughout this section (Thurber 2009a).

Section 6 (Highway 16, Sherwood Drive to Highway 216)
The soil stratigraphy consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil
- Fill
- Lacustrine clay
- Sand
- Clay till
- Empress Formation (sand and gravel)
- Bedrock

Fill consisting of predominately clay was encountered in most of the test holes along the alignment as it passes through the existing Highway 16 corridor and bridge abutment fills (Thurber 2009a).

Bedrock was encountered at depths ranging from approximately 15 m to 25 m in the test holes drilled at the Highway 216/16 interchange and CPR railway overpass structures. Sand and rafted bedrock layers were encountered within the clay till layers throughout this section. Based on the geological maps, the depth to bedrock is expected to vary between approximately 8 m and 30 m through this section (Thurber 2009a).

Empress Formation sand and gravel layers were encountered at depths ranging from approximately 10 m to 15 m. Thin layers of Empress sand and gravel are expected to be encountered between the till and bedrock layers throughout this section (Thurber 2009a).

Material Properties

Following is a brief summary of the material properties of the various strata based on the available geotechnical data.

Topsoil

Topsoil was encountered at ground surface along the NEAHD alignment (Highway 216/16 alignment), either overlying fill material or native soil, except for test holes that were drilled through roadway structures and gravel surfaced embankments (Thurber 2009a).

The topsoil was typically brown to black, silty, and contained a trace of clay, organics, roots and rootlets. The natural moisture content of the topsoil samples ranged from 9% to 66% (Thurber 2009a). It should be noted that the depth of topsoil may vary between the locations of the test holes. Additional shallow test pits may be required if a more accurate topsoil quantity estimate is required (Thurber 2009a).

Fill

Fill layers throughout the test holes included organic fill at ground surface elevation, asphalt, sand and gravel, clay fill and sand fill. Sand and gravel fill was light brown to brown, fine to coarse grained with varying quantities of silt, clay, gravel, oxides and organics (Thurber 2009a). Clay fill is generally brown to grey, silty with variable quantities of gravel with silt layers, and some organic intrusions throughout. The sand fill was typically brown, fine to coarse grained with varying quantities of gravel, silt and clay (Thurber 2009a).

Clay

Lacustrine clay was encountered in the majority of test holes below the topsoil, and/or fill and ranged from 0.7 m to 6.4 m in thickness (Thurber 2009a). The clay was typically dark brown to grey, silty, sandy and contained, trace of oxides, gravel, coal, white salts and occasional ironstone inclusions. Sand, silt and coal lenses were encountered within the clay layer in several test holes. Some organics and rootlets were also encountered near the surface (Thurber 2009a).

Natural moisture content in the clay generally ranged from 9% to 47%. Atterberg limits tests carried out on selected samples indicated that the clay was medium to high plastic, with plastic limits ranging between about 18% and 26% and liquid limits ranging between about 48% and 75%. SPT 'N' values typically ranged from 5 to 37 blows per 300 mm penetration indicating a firm to hard consistency (Thurber 2009a).

Clay Till

Clay till was encountered below the topsoil or lacustrine clay and fill layers in the majority of deep test holes (Thurber 2009a). The clay till was typically brown to grey, silty, sandy, medium to low plastic, and contained trace to some amount of gravel, clay shale and sandstone inclusions, trace coal, oxides, and gravel with occasional sand and silt lenses (Thurber 2009a).

Natural moisture contents in the clay till ranged from 8% to 35%. Atterberg limit tests conducted on samples of the clay till indicated plastic limits varying between 12% and 20% and the liquid limits varying between 26% and 52%, indicating that the clay till is low to high plastic (Thurber 2009a). SPT 'N' values ranged from 6 blows per 300mm penetration to 75 blows per 75 mm penetration, indicating firm to very hard consistency (Thurber 2009a).

Sand and gravel layers were frequently found within the clay till. These inter-till sand and gravel layers were light grey to brown, poorly graded; fine to medium grained and contained trace amounts of silt, clay, oxides, and coal (Thurber 2009a).

Ice rafted (reworked) bedrock layers consisting mainly of weathered clay shale and sandstone with siltstone and coal layers were encountered within the clay till in several test holes. With respect to foundation conditions, the ice rafted bedrock can be considered similar to the clay till (Thurber 2009a).

The rafted clay shale was typically grey to brown, silty, bentonitic, and contained pebbles, varying quantities of sand and occasional coal lenses. Natural moisture contents in the rafted clay shale ranged from 15% to 43%. SPT 'N' values ranged from 13 to 90 blows per 300 mm penetration, indicating a variable stiff to very hard consistency (Thurber 2009a).

The rafted sandstone bedrock was typically brown to black, fine grained, bentonitic and contained trace quantities of silt and oxides. Natural moisture contents ranged from 8% to 35% and SPT 'N' values ranged from 13 to 87 blows per 300 mm penetration, indicating a compact to very dense state (Thurber 2009a).

Rafted coal layers were encountered in six (6) test holes. The rafted coal layers were black and varied in thickness from approximately 0.2 m to 0.8 m. Moisture content typically ranged from 44% to 85%. One SPT 'N' value of 32 blows per 300 mm penetration indicates a hard consistency (Thurber 2009a).

<u>Empress Formation (Sand and Gravel)</u>

Empress Formation sand and gravel deposits were found underlying the clay till in approximately half of the bridge abutment test holes drilled along the Highway 16 corridor (Thurber 2009a).

The sand was typically grey to yellowish brown with varying quantities of gravel and contained trace oxides, occasional coal and silt lenses. The natural moisture contents of the sand varied from 2% to 27%, with values greater than 10% typically encountered below zones of seepage. SPT 'N' values ranged from approximately 8 blows per 300 mm penetration to 110 blows per 300 mm penetration indicating a compact to very dense state (Thurber 2009a).

<u>Bedrock</u>

Bedrock consisting predominantly of clay shale and sandstone with occasional siltstone layers and coal seams was encountered either underlying the clay till, or Empress sand in most of the bridge abutment test holes (Thurber 2009a).

North Saskatchewan River Crossing

The north bank of the North Saskatchewan River crossing is at an elevation of approximately 643 m with a slope of 34 m vertical height and steep with slope gradients varying between 1.3H:1V and 2H:1V (EBA 2008). The topography of the south bank of the NSR has been altered through the extraction of aggregates and import of materials. The terrace topography area is flat with a minor depression along the river terrace where gravel mining has occurred (EBA 2008). The crest of the south slope of the NSR is at an elevation of approximately 615 m with a slope of 6 m vertical height and overall slope gradient of 4.5H:1V (EBA 2008).

Review of the boreholes and sections obtained from the surveyed topography indicate the following stratigraphy for the north and south slopes and bridge approaches (EBA 2008):

North Slope

- Lacustrine deposits (~ 4.3 m thick)
- Clay till (~ 16 m thick)
- Sand (~16.3 m thick)
- Gravel (~1 m thick)
- Bedrock consisted of alternating sequences of clay shale, bentonitic sandstone and coal with semi-continuous seam of bentonite at an elevation between 603 and 600 m.

South Slope

- Existing fill (~2.3 m thick)
- Alluvial deposits (~4.7 m thick)
- Gravelly clay with discontinuous sand and gravel (~3 m thick)
- Bedrock consisting of alternating sequences of clay shale, bentonitic sandstone and coal.

Coal and bentonite seams were observed at similar elevations in different boreholes, with the most critical bentonite seams located near the top of the bedrock (EBA 2008).

Frost Effects

The expected depths of frost penetration for the various soil types along the NEAHD alignment are presented in Table 4.2. The depths of frost penetration have been estimated for the in-situ for both the mean annual Air Freezing Index (AFI) and the 50-year return period AFI of 1400˚C and 2200˚C days, respectively (Thurber 2009a).

Table 4.2. Estimated Depth of Frost Penetration (Source: Thurber 2009a)

Soil Type	Mean Annual AFI (1650˚C Days)	50 Year Return AFI (2350˚C Days)
Clay	1.5 m	2.2 m
Clay (Till)	2.0 m	2.8 m
Silt	2.2 m	3.2 m
Sand/Gravel	2.4 m	3.5 m

The mean annual depth of frost penetration could be used for short-term construction cases with some risk; the 50-year return depth is usually chosen for long-term design. These depths of frost penetration are estimated assuming no insulation cover. If the area is covered with topsoil or significant snow cover, the depth of frost penetration will be less (Thurber 2009a).

Slope Stability

North Saskatchewan River Crossing

Stability analysis for both the north and south sides of the North Saskatchewan River examined existing and designed geometry of slopes, analyzed information collected during field investigations, assessed soil strength properties, reviewed instrumentation data, used equilibrium slope stability analysis software (Slope/W) and engineering judgment and experience. Shallow, near surface and deep seated failures were analyzed in 2008 (EBA 2008) and additional stability analysis was conducted for the proposed headslope design for the proposed North Saskatchewan River crossing in 2009 (EBA 2009).

The factor of safety against slope failure is defined as the ratio of the stabilizing forces (shear strength of soil) to the destabilizing forces (gravity forces on the slope). A factor of safety of 1.0 represents a condition where the stabilizing forces equal the destabilizing forces. A factor of safety of 1.3 has been selected by AT for the approach fills on the south valley terrace, and the valley wall on the north side of the North Saskatchewan River in the study area (EBA 2008, 2009). The stability analysis conducted by EBA assessed the following conditions:

- Short and long term stability of the headslopes;
- Long term stability of the headslopes considering 4 m of vertical scour to the river bottom. The 4 m scour was provided by Golder and indicated on the proposed headslope designs provided by ISL (EBA 2009); and
- Conceptual design of stabilizing the headslopes, where the Factor of Safety was less than 1.3.

The existing conditions at the proposed bridge site comprises a relatively steep slope with no floodplain at the toe of the north side of the river, while the south side of the river comprises a broad alluvial terrace that has been extensively mined for gravel. The north slope was analyzed to have a factor of safety of 1.1, while the south slope was assessed to have a high factor of safety due to the low and relatively flat slope associated with the river terrace deposits (EBA 2009).

Apart from shallow slumping failures along the north valley wall, the existing slopes appear to be stable, suggesting a factor of safety greater than 1.0 for a deep seated failure that would impact the full height of the slope (EBA 2008). For the 6 m high and much flatter riverbank slope along the south valley terrace, the factor of safety of the existing area is estimated to be much greater than 1.0. The factor of safety is expected to decrease with the construction of the south bridge approach and addition of about 11 m of fill near the river (EBA 2008, 2009).

Back analysis for shallow, sloughing failures on the steep north slope of the proposed headslope location, indicated that the glacial till and sand are metastable (EBA 2008). Slope analysis for shallow slope failures calculated a factor of safety close to 1.0 for slip surfaces near the surface of the slope. This agreed with visual observations of the slope and engineering judgment. The stability analysis for shallow failures along the north slope indicates that the lower reaches of the slope have a factor safety of 1.4 (EBA 2008). The stability analysis for deep seated failures for both the existing slope and design slope is considerably more complex due to the unknown existing friction angle of the bedrock, potential historic landslide activity and rebound effect of unloading the slope during construction (EBA 2008). The factor of safety for the critical slip surface analyzed for the slope was calculated to be 1.1. As this analysis agreed with the engineering judgment for the slope, these parameters were selected as a reasonable initial analysis of the designed head slopes (EBA 2008).

4.1.2 Soils

4.1.2.1 Methods

Manning Drive to Highway 16 East

Two geotechnical reports were reviewed for soils information along the TUC between Manning Drive and Highway 16 East: a geotechnical investigation conducted by EBA (2001) in support of McElhanney's (2001) Functional Planning Study Technical Report for the North Edmonton Ring Road and a preliminary geotechnical investigation conducted by Thurber (2006) in support of the previous functional planning study for NAHD. EBA (2001) based their field report on soil conditions on a review of borehole information from previous investigations in the area, a review of a 1999 air photo series and a review of Kathol and McPherson's Bulletin 32, Urban Geology of Edmonton (1975). Thurber (2006) drilled 18 deep and 8 shallow test holes along the proposed alignment and reviewed available soil information for the project area. All soil samples were visually classified in the laboratory and tested for their natural moisture content (Thurber 2006).

Highway 216/16 Alignment

Soils Investigations

Paragon Soil and Environmental Consulting Inc. (Paragon) conducted a review of existing soil information for the proposed Northeast Anthony Henday Drive (NEAHD) alignment upgrade project area from Whitemud Drive to Highway 16 and Highway 16 from 17 Street to Highway 21 (Paragon 2009). In addition, soil scientists conducted a targeted soil survey within the Highway 216/16 study area on 30 October 2008 to supplement the mapping review and provide site-specific data. Sites were sampled within 150 m of the existing roadway on either side. Paragon's complete report can be found in Appendix E of this document. Thurber's (2006 and 2009a) geotechnical reports and EBA's (2001) report were reviewed for additional soils information.

Objectives of the soil survey included mapping soil resources, describing present land use and conducting soil sampling (Paragon 2009). In addition to identifying soil classes present along the existing roadway, the information facilitated identification of potential sites requiring alternate materials handling techniques during proposed roadway construction activities.

Field personnel recorded topsoil depths, topsoil texture, colour change, moisture regime, basic vegetation composition, slope class, landform type, parent material and land use (Paragon 2009). Since the primary focus of the survey was topsoil characteristics, each soil inspection point was investigated to a maximum depth of 0.30 m. The majority of the study area has been disturbed and falls within existing road right-of-ways or on otherwise developed land. Wetland soils were assessed for any special features requiring attention during roadway construction activities.

Soils encountered in the Highway 216/16 alignment project area were initially described according to the *Agricultural Region of Alberta Soil Inventory Database* (*AGRASID)* Version 3.0 (Alberta Soil Information Centre 2005 in Paragon 2009), *Canadian System of Soil Classification* (Agriculture Canada Expert Committee on Soil Survey 1998 in Paragon 2009), *Alberta Soil Names File Generation 3 Users' Handbook* (Agriculture and Agri-Food Canada 2006 in Paragon 2009), and the *Soil Series Information for Reclamation Planning in Alberta, Volume 1 and 2* (SCA 10, 11; Alberta Conservation and Reclamation Council 1993 in Paragon 2009). Typical soil series found in the area were identified prior to field activities through a detailed review of the AGRASID database (Alberta Soil Information Centre 2005 in Paragon 2009). Site inspection locations were then selected throughout the study area to capture major landforms and soil polygons. Special care was taken to identify water-course crossings or wetlands within the study area.

Limited Phase I Environmental Site Assessment

Thurber Engineering Ltd. (Thurber) conducted a Limited Phase I Environmental Site Assessment (ESA) for the proposed NEAHD project study area on 16 October 2008 and 24 March 2009 to identify potential and actual contamination of land by record reviews, visual site inspection and evaluation and reporting (Thurber 2009b). The study area consisted of existing highway road alignment and segments of two highways, an existing segment of Meridian Street and portions of the TUC to be utilized under the proposed NEAHD alignment. The first highway segment included Highway 216 from 34 Avenue to Highway 16, the second highway segment included Highway 16 from 17 Street to Cloverbar Road, and the remaining area included approximately 2.4 km of Meridian Street north of Highway 16 and the TUC to Manning Drive (Thurber 2009b). Historical air photos were reviewed from 1949 (earliest available), 1962, 1972, 1982, 1994, 2001 and 2007.

Ecomark Ltd. previously carried out a Phase I ESA at the former Celanese plant site (now Worthington B.P.) and a Phase II ESA for that site is being conducted by Alberta Transportation (Thurber 2009b). Further assessment of that site was not part of Thurber's (2009b) Limited Phase I ESA.

4.1.2.2 Description

Manning Drive to Highway 16 East

General Soil Conditions

Malmo Series

The project area in the TUC is dominated by soils of the Malmo Series (EBA 2001). Malmo soils are Eluviated Black Chernozemic soils developed on moderately fine to fine-textured glaciolacustrine parent material. These soils have black to very dark grey coloured, medium to moderately fine textured surface or topsoil (Ap or Ah horizons), ranging in thickness from 12 to 34 cm and averaging 22 cm (EBA 2001). Wind erosion risk is low and water erosion risk is low except on slopes steeper than approximately 9%. Susceptibility to excessive compaction and loss of soil structure is high (EBA 2001).

Navarre Series

Gleyed Black Chernozemic soils of the Navarre Series occur in isolated, poorly drained depressions along the proposed project area in the TUC (EBA 2001). Those soils have developed on moderately fine to fine-textured glaciolacustrine parent material. Topsoil thickness ranges from 10 to 40 cm and averages 22 cm (EBA 2001). Wind erosion risk is low and water erosion risk is low except on slopes steeper than approximately 9%. There is a very high susceptibility to excessive compaction and loss of soil structure in this type of soil (EBA 2001).

Peace Hills Series

A small area south of Moran Lake near the Manning Freeway is comprised of Orthic Black Chernozemic soils of the Peace Hills Series (EBA 2001). Those soils are sandy loam in texture and have developed on moderately coarse textured fluvioeolian parent materials (EBA 2001). Topsoil ranges in thickness from 20 to 40 cm with an average of 34 cm. Wind erosion risk is high while water erosion risk is low except on slopes steeper than approximately 9%. These soils have a low susceptibility to excessive compaction and loss of soil structure (EBA 2001).

Highway 216/16 Alignment

Surficial Geology and Landforms

The NEAHD project area (Highway 216/16 alignment) landform was predominantly gently undulating with slopes ranging from 2 to 5 percent (Paragon 2009). The majority of the study area consisted of upland soil series, with the most common series being Disturbed Land (DL), developed on various parent materials. That series includes disturbances from road ditches and residential and industrial areas developed on moderately fine till.

General Soil Patterns and Land Use

The study area lies in the Black Chernozem Zone of Alberta (Paragon 2009). Frequently encountered natural soils included the Beaverhills (BHV) soil series and the Angus Ridge (AGS) series and its variants, including gleyed Angus Ridge (glAGS) and gleyed, eroded Angus Ride (glerAGS) (Appendix E) (Paragon 2009).

Minor extents of the existing Highway 216/16 alignment were characterized by small inclusions of various upland series and lowland series (Paragon 2009). Those series included Cooking Lake (COA), Golden Spike (GSP), Uncas (UCS), Jarvie (JVE), Edburg (scEDG), and Brosseau (crzrBSU) series. The COA soils are Orthic Gray Luvisols developed on moderately fine till parent material and the GSP soils are Terric Mesisols created from sedge fen peat accumulation. UCS soils are Dark Gray Luvisols developed on moderately fine till parent material, while the JVE series are Humic Luvic Gleysols developed on medium glaciolacustrine parent material (Paragon 2009). The EDG series is a variant with saline subsoil and eroded topsoil developed on moderately fine till. The crzrBSU soil series is a variant developed on soft rock with a regosolic profile and carbonates throughout the profile.

Inspection site locations included two soil pits: one in the disturbed road right-of-way and one in the adjacent, undisturbed land (Paragon 2009). Disturbed and natural soil descriptions can be compared to determine where disturbed soil ends and natural soil begins. Natural soil must be stockpiled separately from disturbed soil. Inspection site locations and soil series distribution and character in the study area is outlined in Appendix E (Paragon 2009).

Limited Phase I Environmental Site Assessment

The Phase I ESA did not encounter any historical evidence indicating that the study area had been impacted by contaminants; however, portions of the study area from Highway 16 to Manning Drive were covered with up to 300 mm of snow at the time of the 24 March 2009 site reconnaissance (Thurber 2009b). Areas of potential environmental concern for the study area include (Thurber 2009b):

- the presence of three cemeteries including two funeral homes; two cemeteries and a funeral home along the west side of Highway 16 between Sherwood Park Freeway and Whitemud Drive and a third cemetery with a funeral home south of 167 Avenue and east of 34 Street;
- a petroleum refinery (Petro-Canada) to the west of Highway 216 between Baseline Road and Highway 16;
- the presence of a past landfill (Lafarge location) just south of Highway 16 on the east side of 17 Street;
- an active landfill facility (Edmonton Waste Management Centre) immediately east of Meridian Street north of Highway 16;
- three petroleum terminals (Enbridge, Kinder Morgan and Shell) along the west side of Highway 216 from just south of Baseline Road to Highway 16;
- known groundwater contamination between Hayter Road and Highway 16, west of Meridian Street (former Celanese plant, see Section 4.1.3 below);
- past and present borrow pit activities, including fill, between Highway 16 and the North Saskatchewan River near Meridian Street;
- various petroleum storage tanks located at rural residences, borrow pits and commercial facilities;
- numerous railway lines, including a railway yard, oriented parallel to or crossing the study area;

- one current (Salisbury Store) and three past petroleum service stations along Highways 216 and 16;
- extensive oil and gas facilities including: past wells, active disposal wells, approximately 111 known pipeline crossings, several adjacent pipeline corridors and forty-three reported spills/incidents near the study area; and
- hydrocarbon odours encountered during geotechnical testing in the vicinity of an abandoned pipeline east of the Highway 16/216 interchange.

4.1.3 Hydrology/Surface Water Quality

4.1.3.1 Methods

Groundwater and Surface water

Groundwater conditions throughout the Edmonton Region have been described by the Edmonton Geological Society (Godfrey 1993). That work describes regional bedrock aquifer locations and buried valleys and provides an overview of the nearest deep groundwater sources. In addition, McElhanney (2001) and Thurber (2006) were reviewed for information regarding hydrology and surface water drainage between Manning Drive and Highway 16. EBA (2008) was reviewed for information regarding hydrology, surface water and site drainage of the North Saskatchewan River Crossing in the project area. Groundwater level measurements were taken within vibrating wire piezometers on 04 September 2008.

Groundwater conditions of the NEAHD study area were assessed by Thurber Engineering Ltd (Thurber 2006 and 2009a). Standpipe piezometers were installed along the alignment between Manning Drive and Highway 16 (Thurber 2006) and in the majority of the bridge abutment test holes throughout the alignment to allow for future monitoring of groundwater levels (Thurber 2009a). Groundwater levels were measured at the completion of drilling and after approximately two to six weeks following the completion of drilling (Thurber 2006 and 2009a).

Thurber (2009b) also conducted a Limited Phase I ESA in the project area to identify areas of potential environmental concern, including groundwater.

Water Quality

Surface water quality field investigations in the NEAHD project study area (Highway 216/16 alignment) were conducted by Pisces Environmental Consulting Services Ltd (Pisces) on 05 June and 10 to 12, 16 September 2008 at seven watercourse crossing sites and two waterbodies (Figure 4.1; Table 4.3) (Pisces 2009). Basic water quality parameters including dissolved oxygen, conductivity, pH, turbidity and temperature were

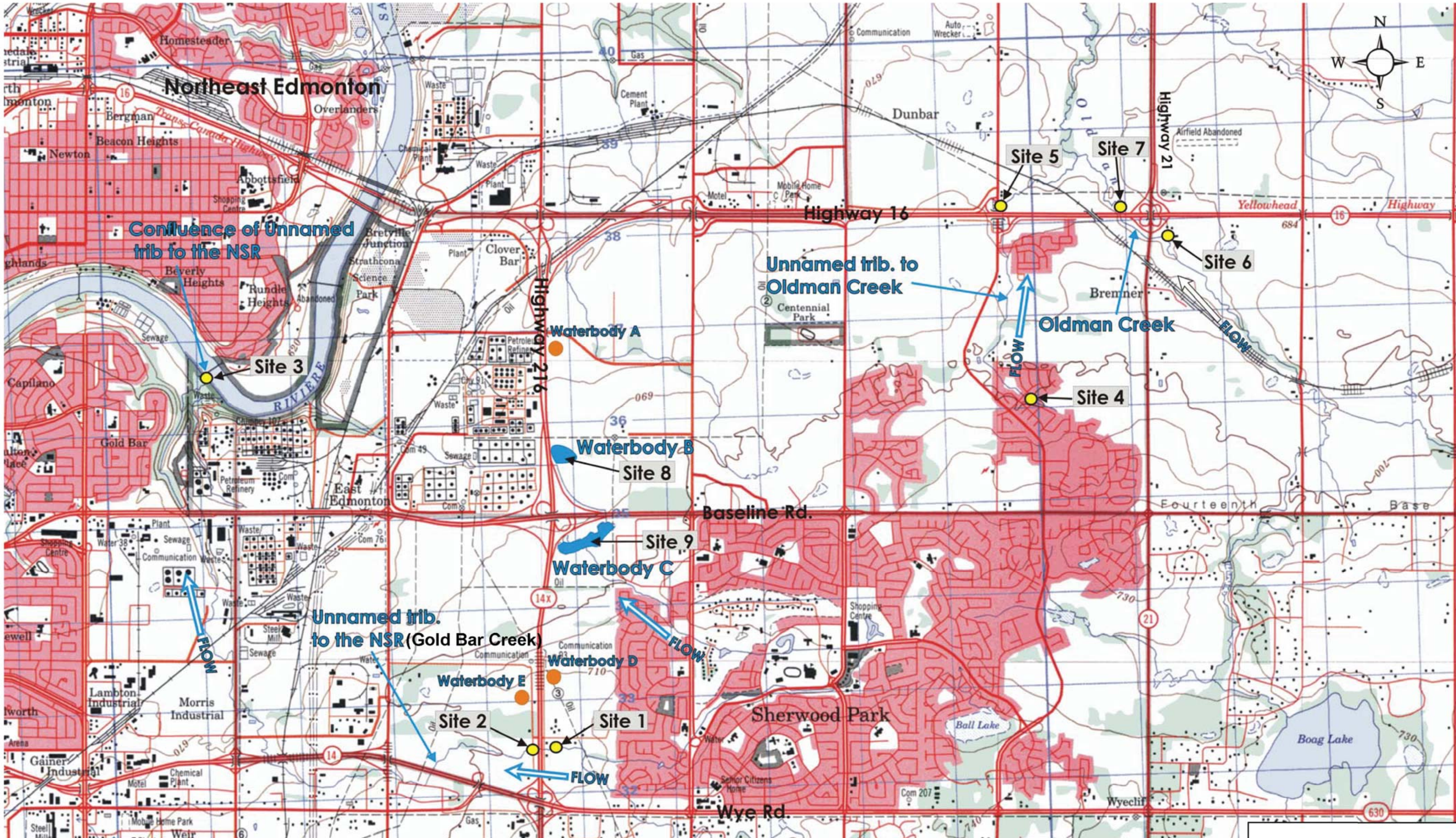


Figure 4.1 Study Area for the Fisheries and Water Quality Valued Ecosystem Components

measured in the field. More detailed analysis examined total suspended solids (TSS), salinity, hydrocarbons and other typical storm water constituents. Typical common highway runoff pollutants include nitrogen, phosphorus, lead, zinc, iron, copper, cadmium, chromium, nickel, manganese, cyanide, sodium, calcium and chloride (Dupuis 2002 in Pisces 2009). Water samples were collected from all sites, preserved in the field and sent to an independent laboratory for analysis. Pisces' complete report can be found in Appendix F.

Table 4.3. Locations of Water Quality Sample Sites (Source: Pisces 2009; Appendix F)

Site 1	Located 35 m upstream of the highway 216 culvert on the unnamed tributary to the NSR at ISW 28-52-23 W4.
Site 2	Located 5 m downstream of the highway 216 culvert on the unnamed tributary to the NSR at ISE 29-52-23 W4.
Site 3	Located 25 m upstream of the mouth of the unnamed tributary to the NSR at INE 01-53-24 W4.
Site 4	Located south of Dawson Dr. approximately 2.17 km upstream of the highway 16 crossing on the unnamed tributary to Oldman Creek at INW 01-53-23 W4.
Site 5	Located 45 m downstream of the highway 16 crossing centreline on the unnamed tributary to Oldman Creek at ISW 13-53-23 W4.
Site 6	Located approximately 820 m upstream of the highway 16 crossing centreline on Oldman Creek at ISE 13-53-23 W4.
Site 7	Located approximately 50 m downstream of the highway 16 crossing centreline on Oldman Creek at SSE 13-53-23 W4.
Site 8	Located on Waterbody B at SW 04-53-23 W4.
Site 9	Located on Waterbody C at NW 35-52-23 W4.

4.1.3.2 Description

Groundwater

Manning Drive to Highway 16 East

Groundwater levels measured approximately four weeks after drilling varied between 1.5 m and 17.9 m below the existing ground surface (Thurber 2006). Table 4.4 summarizes the depth to groundwater along the TUC. The test holes drilled at 127 Street, Manning Drive, near 137 Avenue and Meridian Street, and near 130 Avenue and Meridian Street had groundwater levels between 1.5 m and 2.5 m below the existing ground, indicating that the stabilized groundwater levels at these locations are relatively high (Thurber 2006).

Table 4.4. Depth to Groundwater along TUC (Thurber 2006)

TUC Section		
From	**To**	**Depth to Groundwater* (m)**
Manning Freeway	Fort Road	6.3-9.7
Fort Road	153 Avenue	7.1-13
153 Avenue	NSR	-
NSR	130 Avenue	-
130 Avenue	Yellowhead Trail	6.5-9.7

*Based on groundwater levels measured on 31 July 2006 and may vary during construction (Thurber 2006).

Thurber (2009b) determined the Celanese property and area contained a groundwater contamination plume. The plume, from the area of a former herbicide plant located west of Meridian Street between Hayter Road and Highway 16, is known to be moving northwest under Hayter Road. The contaminated groundwater is recovered and sent to a disposal well on the former herbicide plant property. Thurber (2009b) also determined there is a deep groundwater plume present on the north end of the former Celanese facility that extends towards the EPCOR Clover Bar Generating Station.

North Saskatchewan River Crossing

Initial readings obtained from the vibrating wire piezometers suggested that there are at least three separate groundwater tables present on the north side of the North Saskatchewan River (NSR) valley and at least two separate groundwater tables present on the south side of the NSR valley (EBA 2008). The locations of the groundwater tables are presented below:

North Slope

- Within glacial clay till (~636 m elevation)
- Within sand and gravel (~614 m elevation)
- Within bedrock (~610 m elevation)

South Slope

- Within sand and gravel (~ 610 m elevation)
- Within bedrock (~608 m elevation)

Pore water pressures within the bedrock were confined on shore and were judged to be artesian within the river. Artesian conditions were indicated by a small surge of water during drilling in the river (EBA 2008).

Highway 216/16 Alignment

Groundwater levels measured in the test holes throughout the NEAHD project study area (Highway 216/16 alignment) varied from 0.7 to 22.6 m below current ground elevations (Thurber 2009a).

Surface Water

Surface water bodies in the NEAHD project area include the Moran Lake, North Saskatchewan River (NSR), Gold Bar Creek (also referred to as an unnamed tributary to the NSR), Clover Bar Creek and unnamed tributary, Oldman Creek, tributary to Oldman Creek, and several wetlands. In general, surface water drainage first enters existing sloughs, creeks and roadway ditches before entering those surface water bodies. All drainage basins within the project study area (Highway 216/16 alignment) ultimately discharge into the NSR.

Moran Lake

Moran Lake, located outside and adjacent to the northwestern edge of the TUC immediately east of Manning Drive, is a large permanent water body in northeast

Edmonton. It is considered regionally significant and is included in the City of Edmonton's North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188). Moran Lake encompasses approximately 21 ha, is relatively shallow and drains to Horsehills Creek to the north. Horsehills Creek ultimately flows into the North Saskatchewan River.

North Saskatchewan River

At a regional scale, the most dominant water feature is the North Saskatchewan River (NSR). That river originates at the Saskatchewan Glacier 500 km upstream of Edmonton and flows through Edmonton for 48 km in a southwest to northeast direction (EBA 2008). It also provides Edmonton with a drinking water supply. Golder Associates (2009) conducted a bathymetric survey and determined the hydrotechnical design parameters of the river crossing in support of the preliminary bridge design drawings. They determined that following design parameters (also see Figure 2.5):

- Drainage area = 27,625 km^2
- Channel slope = 0.0004m/m
- Bed width 220 m at elevation 607 m (mean bed elevation)

Gold Bar Creek (unnamed tributary to the NSR)

Gold Bar Creek crosses Highway 216 north of Wye Road near the south end of the NEAHD study area. It flows in a northwesterly direction and discharges into the North Saskatchewan River.

Clover Bar Creek and Unnamed Tributary

Clover Bar Creek crosses Highway 16 west of Sherwood Drive west of Clover Bar Road. It flows in a northwesterly direction and discharges into the North Saskatchewan River. The unnamed tributary flows in a northeasterly direction into Clover Bar Creek and then into the North Saskatchewan River.

Oldman Creek

Oldman Creek crosses Highway 16 at the east end of the NEAHD study area just west of Highway 21. It flows in a northwesterly direction and discharges into the North Saskatchewan River. An unnamed tributary to Oldman Creek is located southwest of Oldman Creek and crosses Highway 16 just west of Clover Bar Road.

Wetlands

There are a total of 79 wetlands within the NEAHD project study area comprising 62.5 ha. Table 4.5 below lists the wetland class (Stewart and Kantrud classification system), number and area of each wetland.

Table 4.5. Wetland Class, Number and Area of Wetlands in the NEAHD Project Study Area

Wetland Class [a]	Deepest Vegetation Zone	Number of Wetlands	Wetland Area (ha)
II (Temporary pond)	Wet Meadow	16	4.78
III (Seasonal pond)	Shallow Marsh	19	9.94
IV (Semi-permanent pond)	Deep Marsh	24	11.55
V (Permanent pond)	Permanent Open Water	12	24.88
VII (Fen)	Fen Ponds	7	4.30
VIII [b] (Shrub wetland)	Shrub Wetland	4	0.82
Total		**82**	**56.27**

[a] After Stewart and Kantrud (1971): I-ephemeral; II-temporary; III-seasonal; IV-semi-permanent; V-permanent; VII-fen
[b] VIII-new classification added by Spencer Environmental

Site Drainage

Runoff from Highway 216, Sherwood Park Freeway and Yellowhead Trail rights-of-way generally drains either directly to, or through creek systems into the North Saskatchewan River. Areas north of the river generally drain south to the river. Areas south of the river generally drain northwest to the river (ISL 2009).

Significant areas of the County of Strathcona located south of Yellowhead Trail and east of Highway 216 (Anthony Henday Drive) drain generally in a north-westerly direction and contribute stormwater runoff to these sections of roadway (ISL 2009). Much of these lands are currently developed and comprise the community of Sherwood Park. Development plans are in place for the remaining areas. County lands draining west to Highway 216 drain west into Fulton Creek (outside environmental assessment study area), Gold Bar Creek and Unnamed Creek basins (ISL 2009; Appendix A). County lands draining north to Yellowhead Trail drain north into Clover Bar Creek and Oldman Creek basins. Stormwater management for the proposed roadway improvements must accommodate runoff from these external areas for current and ultimate development conditions.

Sherwood Park Freeway drainage in Edmonton between Highway 216 and 17 Street drains east to west. Adjacent lands to the north and south drain through this section of Sherwood Park Freeway and discharge into Gold Bar Creek (Appendix A).

Water Quality

Basic water quality parameters impacting aquatic habitat suitability (e.g. dissolved oxygen) were measured in the field (Pisces 2009; Appendix F) and summarized in Table 4.6. Detailed laboratory water quality test results may be found in Appendix F.

Table 4.6. Results of the field water quality analysis (Source: Pisces 2009; Appendix F)

Parameter	Site 1	Site 2		Site 3	Site 5	Site 7	Site 8	Site 9
Date	June 5/08.	June 5/08	Sep. 11/08	June 5/08.	Sep. 11/08	Sep. 10/08	Sep.12/08	Sep.12/08
Temp (°C) /Time	18.1@15:00	16.8@15:30	12 @ 10:50	20.1@16:20	17.3 @ 17:41	16.6 @ 16:00	15.2 @ 16:30	16.1 @14:39
Turbidity (NTU)	6.51	29.2	12.6	3.52	38.9	6.11	3.45	21.8
Conductivity (*u*S/cm)	1180	1273	515	1493	670	879	707	787
pH	7.17	7.17	7.7	7.88	8.02	8.3	8.26	8.22
Dissolved Oxygen (mg/L)	10.3	7.9	6.4	7.6	8.9	8.2	12.6	9.6

All water quality parameters that were measurable in the field were within parameters for fish survival as given by CCME (CCME 2006 in Pisces 2009). Detailed analysis indicated several regulatory guidelines exceedances present. Of the inorganic non-metallic elements, phosphorus was found to exceed the guideline value at 5 sites (Appendix F). Numerous exceedances were found among the metals tested, specifically iron, aluminum, chromium, copper, lead, nickel and zinc. In addition, chloride and sulphate results exceeded regulatory guidelines at sites 2 and 4 (Figure 4.1), respectively. No guideline exceedances were found for any of the hydrocarbon compounds tested.

4.1.4 Air Quality

4.1.4.1 Methods

RWDI Air Inc (RWDI) conducted screening level air quality assessments for the Manning Drive to Highway 16 East (RWDI 2007) and Highway 216/16 (RWDI 2009) sections of the NEAHD project area to address concerns regarding future air quality associated with the operation of upgraded roadway. Vehicle emission and atmospheric dispersion computer modeling (MOBILE 6.2 and CAL3QHCR, respectively) was conducted to determine the potential combined impacts of future traffic emissions on air quality in the project area at varying distances from selected receptors. Those receptors represented areas within the study area that contain the 'worst-case' section of roadway (i.e. the section that had the highest traffic movements coupled with the closest distance to sensitive receptors) (RWDI 2007 and 2009). For the section of the project area between Manning Drive and Highway 16 East, no potential sensitive receptors were identified for modeling (RWDI 2007). For the Highway 216/16 Alignment section of the project area, two 'worst case' sections of roadway and five discrete sensitive receptors were selected for modeling by studying the peak morning and afternoon hourly traffic volumes in relation to existing nearby land use (RWDI 2009). Existing ambient air pollution levels caused by vehicle emissions were determined from five years (2001-2005) of ambient air quality measurements for carbon dioxide (CO), nitrogen dioxide (NO_2) and particulate matter ($PM_{2.5}$) obtained from the Edmonton Northwest Station from the Clean Air Strategic Alliance (CASA) website (CASA 2006 in RWDI 2007 and 2009). That station was chosen due to its proximity to the proposed roadway. Future pollutant levels were modeled for the year 2041 [Stage 1 (1.6 million population)] using input variables including traffic volumes and speed, ambient temperature, humidity and geometric configuration of the roadway and receptors (RWDI 2007 and 2009). Modeling scenarios included emission and dispersion modeling where dispersion modeling included additional inputs such as receptor locations, meterology, traffic volumes and hourly distributions (RWDI 2007 and 2009). The modeled results were then compared to required provincial ambient air quality objectives. RWDI's full reports are available in Appendix G.

4.1.4.2 Description

Contaminants typically associated with vehicular activity on urban roadways include carbon monoxide (CO), nitrogen oxides (NO_x) and particulate matter ($PM_{2.5}$) (RWDI 2009). CO is a product of incomplete combustion. NO_x are produced in many combustion processes and are primarily comprised of nitric oxide (NO) and nitrogen dioxide (NO_2). Much of the NO emitted from a vehicle is converted to NO_2 and released into the atmosphere after the combustion process has taken place (RWDI 2009). While emission factors and air quality models typically evaluate NO_x, regulatory bodies often specify NO_2 ambient air quality objectives due to human health concerns. For analysis, therefore, RWDI converted NO_x to NO_2 using the ozone limiting method (2009; Appendix G). Nitrogen oxides rarely affect health directly but are one of the main ingredients of photochemical smog (Spiro and Stigliani 1996 in RWDI 2009).

Alberta Environment has developed Alberta Ambient Air Quality Objectives (AAAQO) for numerous contaminants which have, at elevated levels, the potential to cause harmful effects to human health or to cause degradation to the environment (Alberta Environment 2005 in RWDI 2009). Table 4.7 presents the ambient air quality objectives and criteria for CO, NO_2 and $PM_{2.5}$.

Table 4.7. Summary of Relevant Ambient Air Quality Objectives (µg/m^3) (Source: RWDI 2009; Appendix G)

Contaminant	Averaging Period	AAAQO[1]
CO	1-hr	15,000
NO_2	1-hr	400
$PM_{2.5}$	24-hr	30

[1] AAAQO- Alberta Ambient Air Quality Objective

Air quality monitoring is often used to determine ambient pollutant levels and establish trends. Background concentration (i.e. concentrations due to natural, nearby, and unidentified sources) are an important component of air contaminant concentration. Five years (2001 to 2005) of ambient air quality measurements for CO, NO_2 and $PM_{2.5}$ were downloaded from the Edmonton Northwest Station from the CASA website (CASA 2006 in RWDI 2009). The five year time period is an industry standard and provides confidence that the data are temporally representative. A summary of the statistics for the three pollutants of concern are provided in Table 4.8.

Table 4.8. Summary of Historical Ambient Air Quality Measurements (2001 to 2005) for the Edmonton Northwest Station at 13335-127 Street (Source: RWDI 2009; Appendix G)

Pollutant	CASA Station Location	Statistic	Measured Value
1-Hour CO ($\mu g/m^3$)	Edmonton Northwest	1-hr Max	12,822
		Mean	644
		90^{th} Percentile	1,259
1-Hour NO_2 ($\mu g/m^3$)	Edmonton Northwest	1-hr Max	260
		Mean	40
		90^{th} Percentile	81
PM2.5 (continuous) ($\mu g/m^3$)	Edmonton Northwest	24-hr Max	56
		Mean	8.5
		90^{th} Percentile	15.6

4.1.5 Vegetation

4.1.5.1 Methods

The main objectives of the vegetation survey were to determine the type and range of plant communities, map areas covered by native vegetation, assess the level of disturbance of native plant communities and locate rare plants or unusual plant communities within the NEAHD project study area. All areas with naturally occurring vegetation were included in the survey, with the exception of narrow (<10 m wide) hedgerows. The site survey involved walking throughout the study area in meandering transects. All vascular plant species were recorded, and each species was ranked as dominant, frequent, occasional or rare (uncommon) within the site (Appendix H). All wildlife sightings and sign and surface disturbances were recorded. Representative sites were photographed.

The vegetation study area (Figures 5.2a-f) was selected to include the footprint of the proposed NEAHD project area, including Manning Drive to Highway 16 East and the existing Highway 216/16 section of the project area. Upland and riparian plant communities were classified according to the dominant vascular plants present and wetlands were classified according to the Stewart and Kantrud (1971) system of wetland classification. That classification system is accepted by Alberta Environment who administers the Alberta *Water Act* and the 1993 Interim Wetland Policy.

Whenever a plant species could not be identified in the field, a specimen was collected. Those specimens were later examined using a dissecting scope and various flora references to determine their identity. When all specimens had been identified, the site data were compiled in an Excel spreadsheet for further analysis.

In addition to the vegetation survey, the Alberta Conservation Information Management System (formerly ANHIC) (2008) was searched for existing records of rare or unusual plants in or near the NE AHD study area.

Manning Drive to Highway 16 East

EBA (2001) previously identified vegetation communities within the TUC and proposed right-of-way as part of a previous environmental screening report in support of the Edmonton North Ring Road Functional Planning Study Final Report. To supplement that report and the next NERR functional planning study and environmental assessment (Spencer 2007) additional field work was conducted by a professional plant ecologist between 01 and 18 June 2006. The purpose of that field work was to further quantify native vegetation communities and wetlands within the TUC in the North Anthony Henday Drive project area and to determine if any special status plant species occur in the area. The data from the section of that study between Manning Drive and Highway 16 East is included in this environmental assessment.

Highway 216/16 Alignment

A vegetation survey of the Highway 216/16 section of the project area was conducted by a professional plant ecologist on 08 to 12 June 2008. The project area included Highway 216 from Whitemud Drive to Highway 16 and Highway 16 from Highway 216 to Highway 21. The section of Highway 16 between 17 Street and Highway 216 was not surveyed because, based on a site reconnaissance, there was no native vegetation in that area due to the presence of existing roadway infrastructure and development. In the

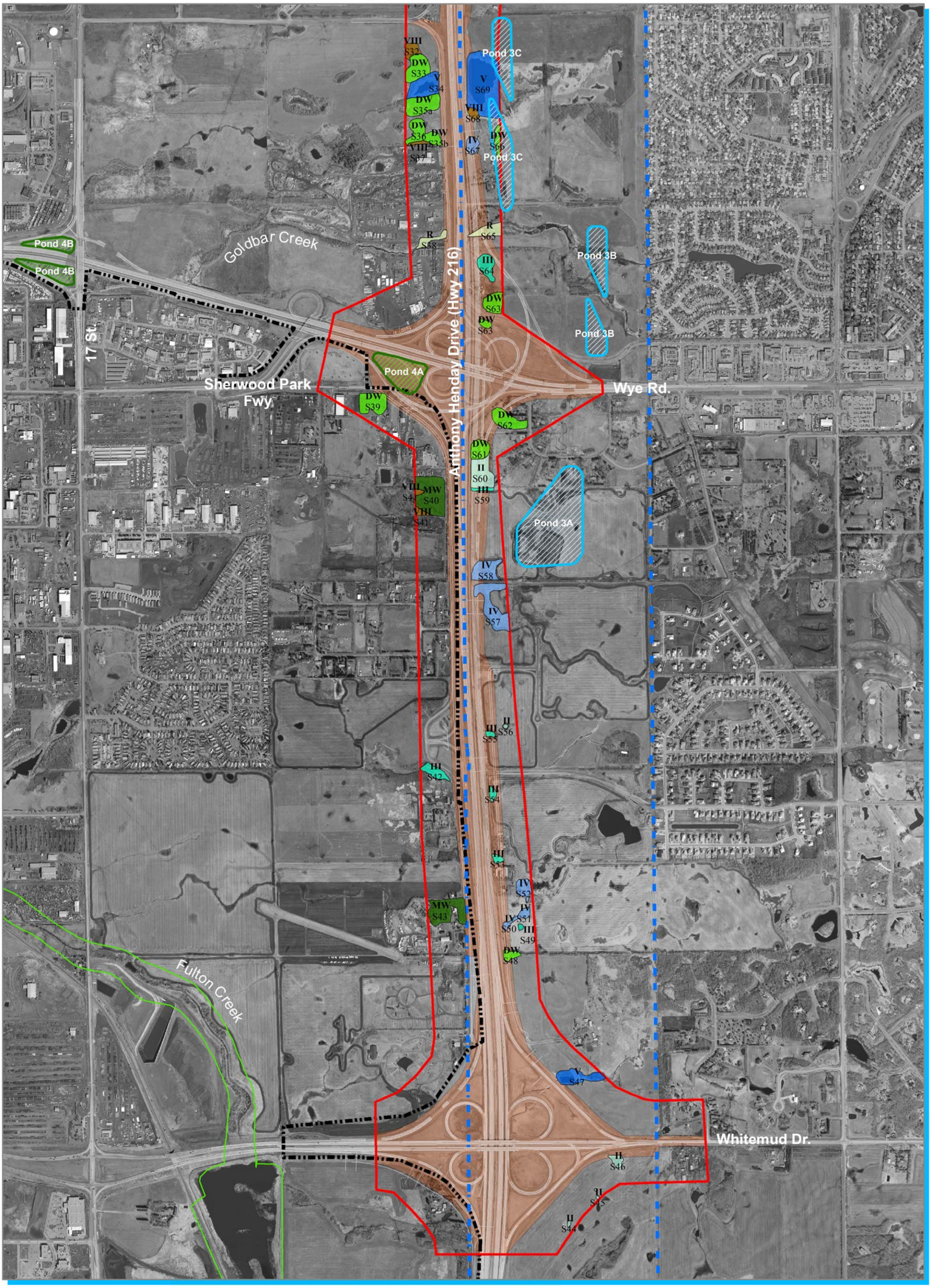
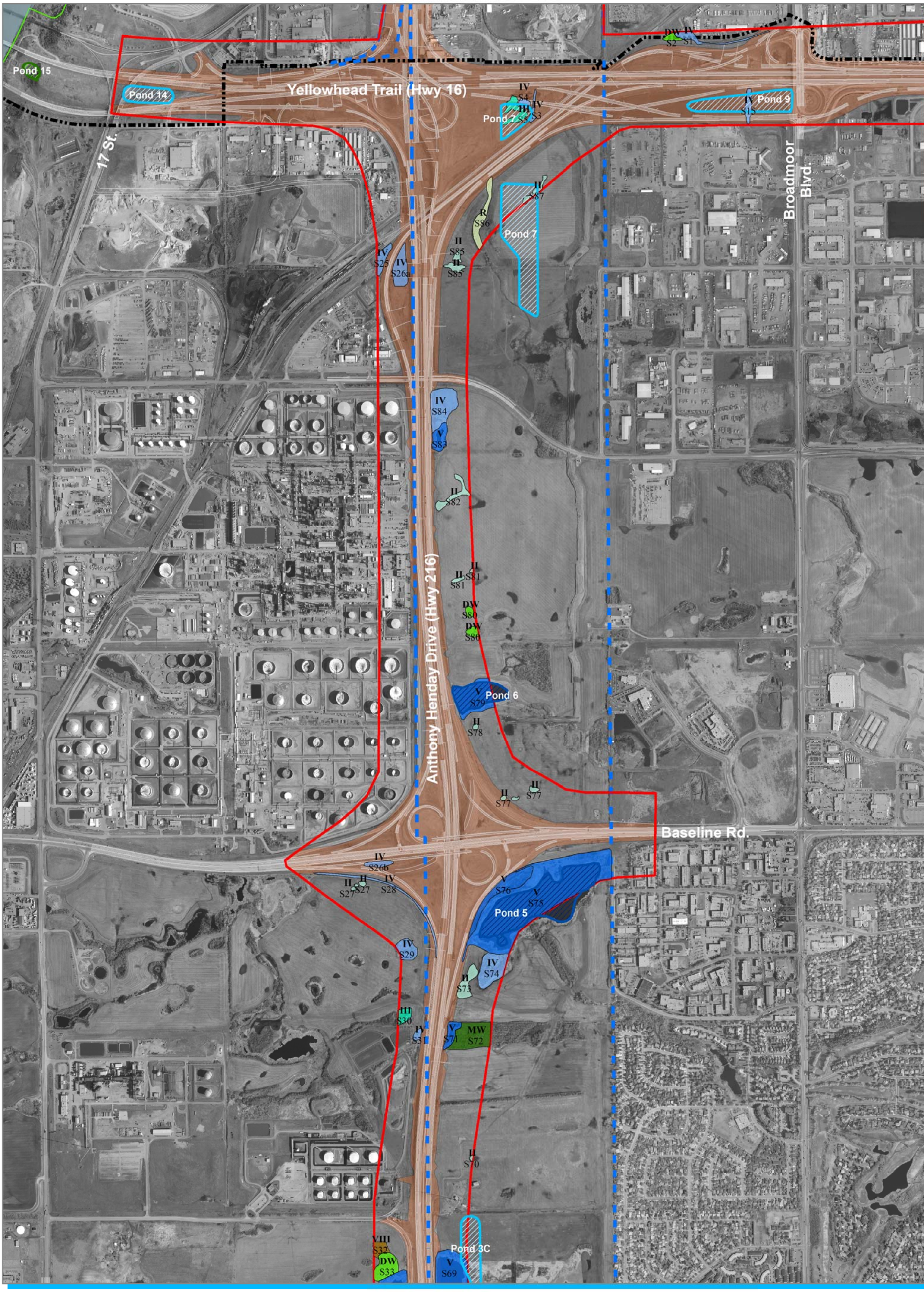


Figure 4.2a Wetland and Plant Communities in NEAHD Study Area

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.



Legend

Proposed Alignment (Yr. 2041)
NE AHD Study Area
TUC
NSR ARP Boundary
Edmonton City Limit
Proposed Construction Limit

Stormwater Management

Existing Wetland
Proposed Wetland
Proposed Dry Pond

Wetland Communities

Class II (Temporary)
Class III (Seasonal)
Class IV (Semi-Permanent)
Class V (Permanent Ponds)
Class VII (Fen/Alkaline Bog)
Class VIII (Shrub Swamp)
Manmade Pond (MP)
Wet Crop (WC)

Upland Communities North*

Aspen (AS)
Balsam (BA)
Poplar mix (PM)
Grassland (G)
Low shrub (LS)
Tall shrub (TS)
Weedy upland (WU)

Upland Communities South*

Riparian (R)
Deciduous Woodlands (DW)
Mixed Woodlands (MW)

Rare Plants

Muhlenbergia racemosa
Osmorhiza longistylis

*North: Manning Dr. to Hwy. 16E; South: Hwy 216/16 Alignment

N

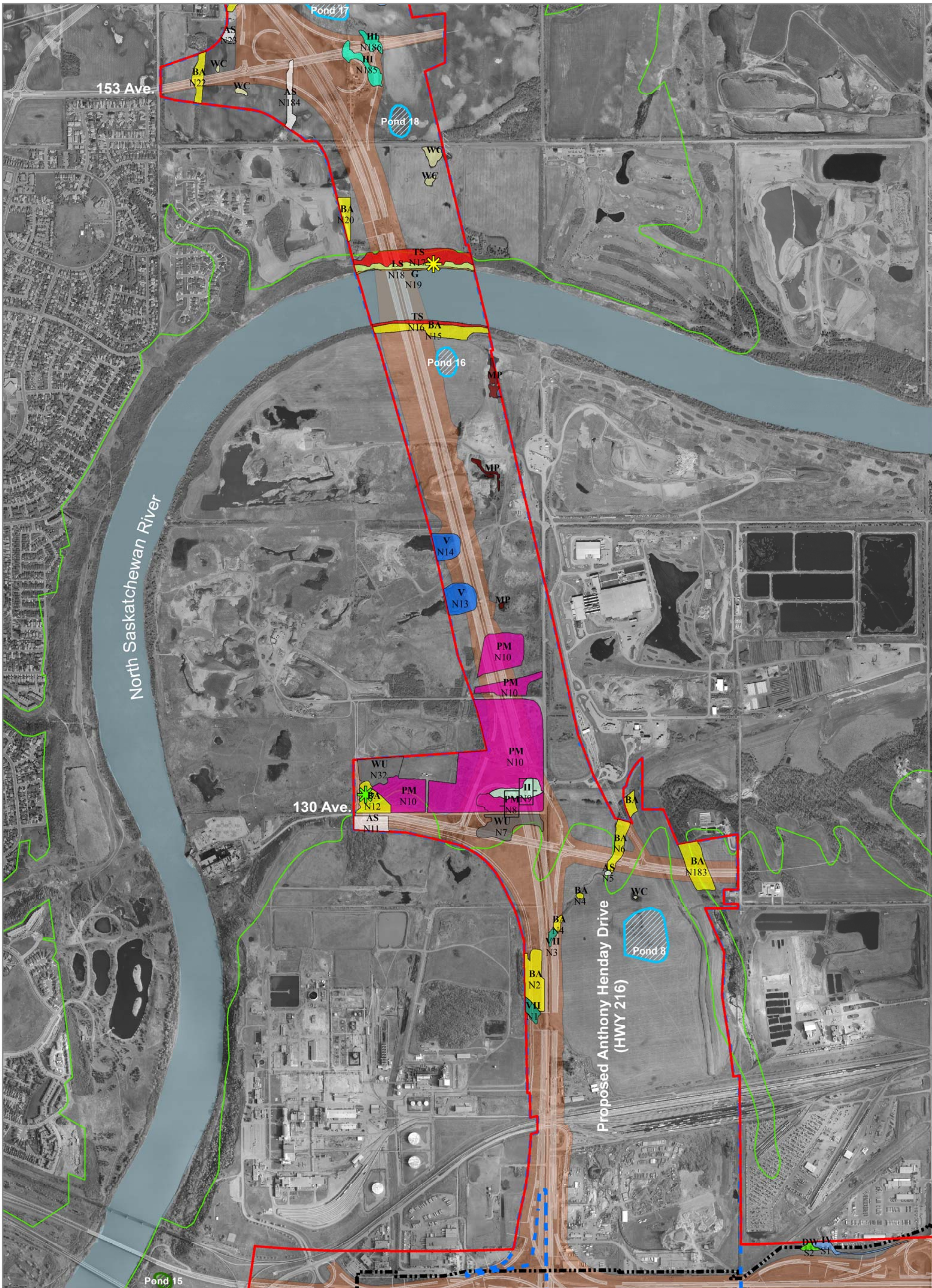
0 0.25 0.5 Km

1:15,000

Figure 4.2b Wetland and Plant Communities in NEAHD Study Area

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.



Legend

Proposed Alignment (Yr. 2041)
NE AHD Study Area
TUC
NSR ARP Boundary
Edmonton City Limit
Proposed Construction Limit

Stormwater Management

Existing Wetland
Proposed Wetland
Proposed Dry Pond

Wetland Communities

Class II (Temporary)
Class III (Seasonal)
Class IV (Semi-Permanent)
Class V (Permanent Ponds)
Class VII (Fen/Alkaline Bog)
Class VIII (Shrub Swamp)
Manmade Pond (MP)
Wet Crop (WC)

Upland Communities North*

Aspen (AS)
Balsam (BA)
Poplar mix (PM)
Grassland (G)
Low shrub (LS)
Tall shrub (TS)
Weedy upland (WU)

Upland Communities South*

Riparian (R)
Deciduous Woodlands (DW)
Mixed Woodlands (MW)

Rare Plants

Muhlenbergia racemosa
Osmorhiza longistylis

*North: Manning Dr. to Hwy. 16E; South: Hwy 216/16 Alignment

N

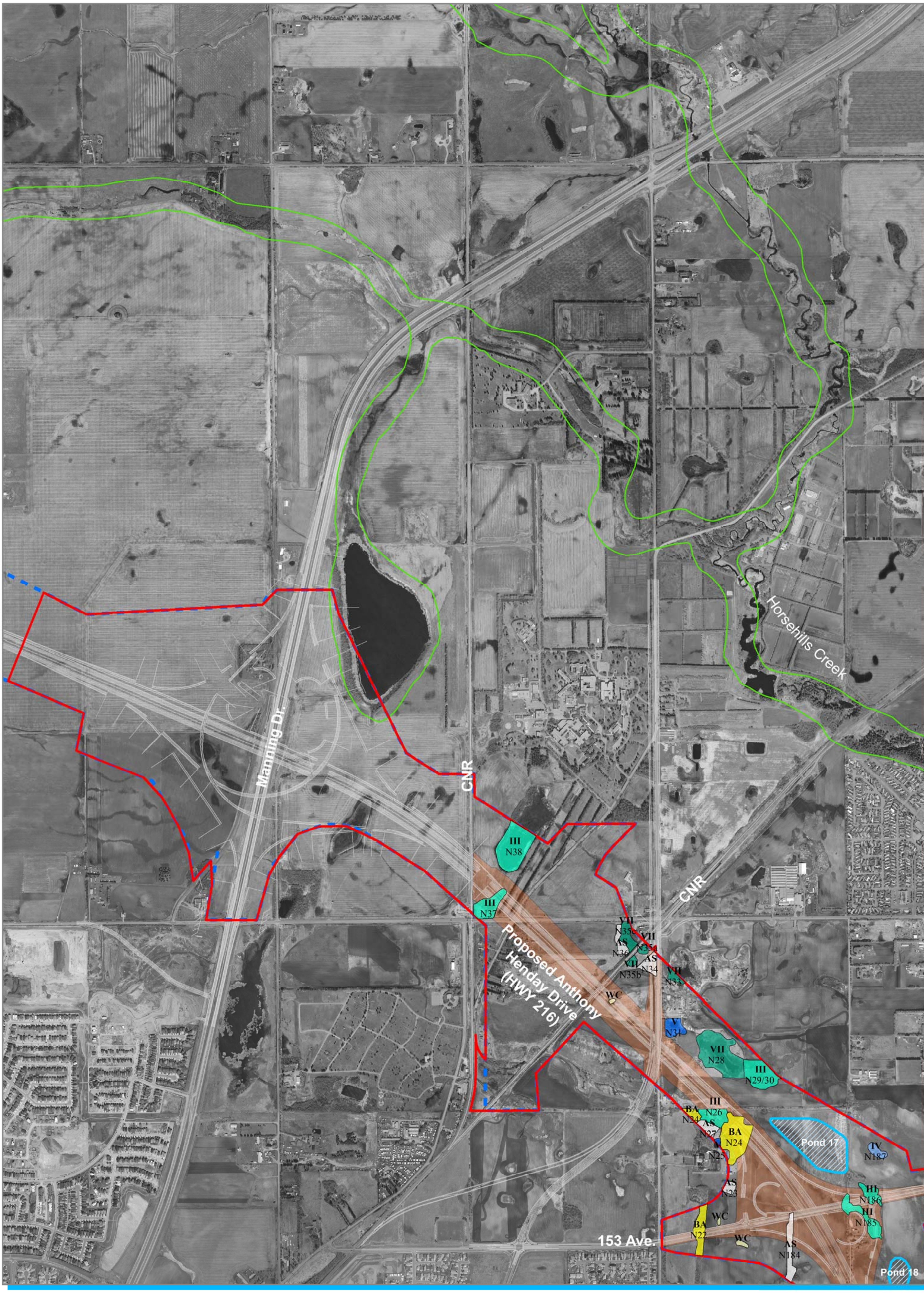
0 0.25 0.5 Km

1:15,000

Figure 4.2c Wetland and Plant Communities in NEAHD Study Area

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.



Legend

- Proposed Alignment (Yr. 2041)
- NE AHD Study Area
- TUC
- NSR ARP Boundary
- Edmonton City Limit
- Proposed Construction Limit

Stormwater Management

- Existing Wetland
- Proposed Wetland
- Proposed Dry Pond

Wetland Communities

- Class II (Temporary)
- Class III (Seasonal)
- Class IV (Semi-Permanent)
- Class V (Permanent Ponds)
- Class VII (Fen/Alkaline Bog)
- Class VIII (Shrub Swamp)
- Manmade Pond (MP)
- Wet Crop (WC)

Upland Communities North*

- Aspen (AS)
- Balsam (BA)
- Poplar mix (PM)
- Grassland (G)
- Low shrub (LS)
- Tall shrub (TS)
- Weedy upland (WU)

Upland Communities South*

- Riparian (R)
- Deciduous Woodlands (DW)
- Mixed Woodlands (MW)

Rare Plants

- Muhlenbergia racemosa
- Osmorhiza longistylis

*North: Manning Dr. to Hwy. 16E; South: Hwy 216/16 Alignment

Figure 4.2d Wetland and Plant Communities in NEAHD Study Area

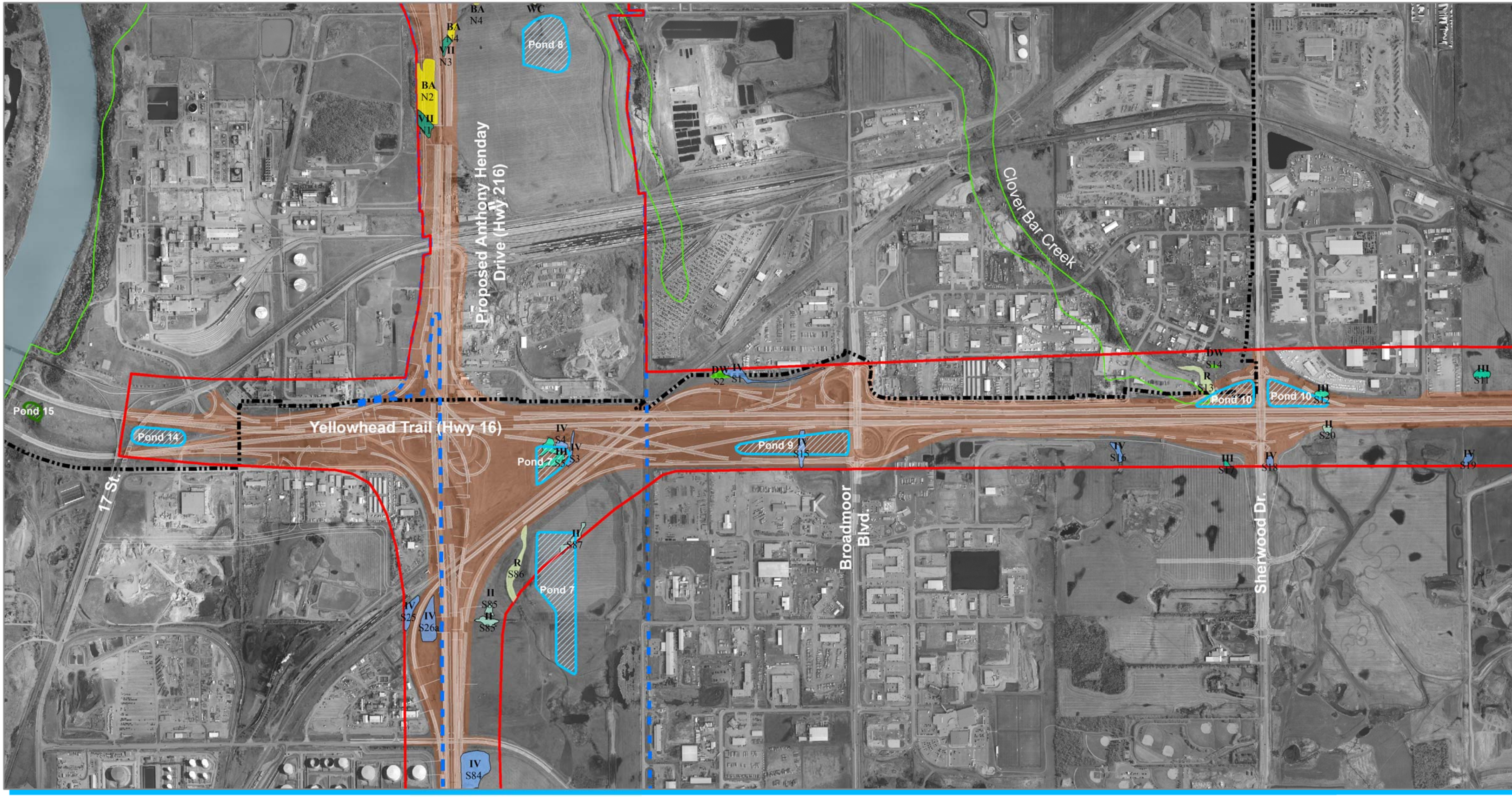
N

0 0.25 0.5 Km

1:15,000

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.



Legend

- Proposed Alignment (Yr. 2041)
- NE AHD Study Area
- TUC
- NSR ARP Boundary
- Edmonton City Limit
- Proposed Construction Limit

Stormwater Management

- Existing Wetland
- Proposed Wetland
- Proposed Dry Pond

Wetland Communities

- Class II (Temporary)
- Class III (Seasonal)
- Class IV (Semi-Permanent)
- Class V (Permanent Ponds)
- Class VII (Fen/Alkaline Bog)
- Class VIII (Shrub Swamp)
- Manmade Pond (MP)
- Wet Crop (WC)

Upland Communities North*

- Aspen (AS)
- Balsam (BA)
- Poplar mix (PM)
- Grassland (G)
- Low shrub (LS)
- Tall shrub (TS)
- Weedy upland (WU)

Upland Communities South*

- Riparian (R)
- Deciduous Woodlands (DW)
- Mixed Woodlands (MW)

Rare Plants

- *Muhlenbergia racemosa*
- *Osmorhiza longistylis*

*North: Manning Dr. to Hwy. 16E; South: Hwy 216/16 Alignment

0 0.25 0.5 1 Kilometers

1:15,000

Figure 4.2e Wetland and Plant Communities in NEAHD Study Area

Aerial Photograph Date: 2007

Date Map Created: 12 May 2010

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Legend

Proposed Alignment (Yr. 2041)
NE AHD Study Area
TUC
NSR ARP Boundary
Edmonton City Limit
Proposed Construction Limit

Stormwater Management

Existing Wetland
Proposed Wetland
Proposed Dry Pond

Wetland Communities

Class II (Temporary)
Class III (Seasonal)
Class IV (Semi-Permanent)
Class V (Permanent Ponds)
Class VII (Fen/Alkaline Bog)
Class VIII (Shrub Swamp)
Manmade Pond (MP)
Wet Crop (WC)

Upland Communities North*

Aspen (AS)
Balsam (BA)
Poplar mix (PM)
Grassland (G)
Low shrub (LS)
Tall shrub (TS)
Weedy upland (WU)

Upland Communities South*

Riparian (R)
Deciduous Woodlands (DW)
Mixed Woodlands (MW)

Rare Plants

Muhlenbergia racemosa
Osmorhiza longistylis

*North: Manning Dr. to Hwy. 16E; South: Hwy 216/16 Alignment

N

0 0.25 0.5 1 Kilometers

1:15,000

Figure 4.2f Wetland and Plant Communities in NEAHD Study Area

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

surveyed area, vegetation was surveyed within 150 m on either side of the existing roadway.

Rare plant surveys were completed along the Highway 216/16 alignment on 8 to 12 July 2008, and 25 and 26 June 2009. The data from those surveys was augmented by data from 2003 and 2006 that was previously collected at some of the same sites for other projects (L. Kershaw, pers. comm.).

4.1.5.2 Description

Regional Vegetation

The project study area lies within the Central Parkland Sub-region of the Parkland Natural Region (NRC 2006). Trembling aspen forests dominate the area with balsam poplar stands occurring on poorly drained sites. Both forest types generally have a well-developed and diverse shrub layer, dominated by species such as snowberry, Saskatoon serviceberry, chokecherry, prickly rose, red-osier dogwood, and willow (NRC 2006). Much of the native vegetation within this sub-region has been cleared for urban and agricultural development, with remnant communities found in ravines and valleys.

Local Vegetation

The vegetation in the NEAHD study area is a mix of native plant communities, agricultural land, residential, commercial and industrial sites. Fifteen (15) native upland plant and wetland communities were identified within 129 survey sites throughout the project study area. Upland vegetation was classified on the basis of dominant vascular plants, and wetlands were classified using Stewart and Kantrud (Stewart and Kantrud 1971). Those communities are summarized in Table 4.9 and are mapped on Figure 4.2a-f.

A total of 250 plant species were observed within the survey area (Appendix H). The following sections describe the vegetation present in the study area, using standardized common names of each species (Kershaw 2007). Appendix H contains a list of all common names with corresponding scientific names and the abundance of each species by site. Taxonomy follows the Flora of Alberta (Moss 1983).

Table 4.9. Summary of Existing Vegetation Types, Dominant Species, Total Area of Each Vegetation Type and Percentage of Each Vegetation Type out of the Overall Total Area of Vegetation Types for the Proposed NEAHD Project Area

Vegetation Type	Dominant Species	Site #*	Total Area (ha) of Each Vegetation Type	Percentage (%) of Each Vegetation Type out of Overall Total Area of Vegetation Types
Upland				
Deciduous Woodland	balsam poplar, aspen poplar, red-osier dogwood, choke cherry, prickly rose, smooth brome, bluejoint reedgrass, dandelion, creeping thistle	S2, S9, S14, S22, S33, S35, S36, S39, S48, S61, S62, S63, S66, S80	7.14	6.12
Mixed Woodland	balsam poplar, aspen poplar, white spruce, red-osier dogwood, choke cherry, prickly rose, smooth brome, bluejoint reedgrass, Kentucky bluegrass, horsetail	S40, S43, S72	4.95	4.24
Aspen	trembling aspen, red – osier dogwood, saskatoon serviceberry, choke cherry, prickly rose, red raspberry and common snowberry	N5, N11, N23, N27, N34, N36, N184	3.17	2.71
Balsam Poplar	balsam poplar, trembling aspen, red-osier dogwood, choke cherry, saskatoon serviceberry	N2, N4, N6, N12, N15, N20, N22, N24, N183	11.91	10.20
Poplar Mix	trembling aspen, balsam poplar, red-osier dogwood, saskatoon serviceberry, beaked hazelnut and choke cherry	N8, N10	22.33	19.12
Tall shrub	speckled alder, red-osier dogwood, bluejoint reedgrass, common spikerush, saskatoon serviceberry, high bush-cranberry	N16, N17	3.33	2.85
Low shrub	meadow willow, American silverberry, prickly rose, woods rose, common snowberry, western snowberry,	N18	0.25	0.21
Grassland	plains muhly, slender wildrye, prairie sagebrush, woods rose, yellow sweetclover	N19	1.08	0.92
		Upland Total	**54.18**	**46.39**

Vegetation Type	Dominant Species	Site #*	Total Area (ha) of Each Vegetation Type	Percentage (%) of Each Vegetation Type out of Overall Total Area of Vegetation Types
Stream				
Riparian	balsam poplar, willows, red-osier dogwood, reed canarygrass, smooth brome, Kentucky bluegrass, cattail, sedges, common horsetail, Canada anemone	S7, S8, S13, S24, S38, S65, S86	6.34	5.43
		Stream Total	**6.34**	**5.43**
Wetland Class (Deepest Vegetation Zone)				
Class II – temporary pond (Wet Meadow)	foxtail barley, field pennycress, smooth perennial sowthistle, creeping thistle, smooth brome	S20, S27, S44, S45, S46, S56, S60, S70, S73, S77, S78, S81, S82, S85, S87, N9	4.78	4.09
Class III – seasonal ponds and lakes (Shallow Marsh)	reed canarygrass, common spikerush, sloughgrass, foxtail barley, common plantain, creeping thistle, smooth perennial sowthistle	S5, S10, S11, S12, S17, S30, S42, S49, S53, S54, S55, S59, S64, N26, N29, N30, N37, N38, N185, N186	9.94	8.51
Class IV – semi-permanent ponds and lakes (Deep Marsh)	common cattail, bottle sedge, awned sedge, reed canarygrass, common spikerush, common horsetail, field mint, Baltic rush	S1, S3, S4, S6, S15, S16, S18, S19, S21, S25, S26, S28, S29, S31, S50, S51, S52, S57, S58, S67, S74, S84	11.55	9.89
Class V – permanent ponds and lakes (Permanent Open Water)	common cattail, willows, reed canary	S34, S47, S69, S71, S75, S76, S79, S83, N13, N14, N25,N31	24.88	21.30
Class VII – Fen (Fen ponds)	water sedge, common waterhemlock, sandbar willow	N1, N3, N28, N33, N35	4.30	3.68
Class VIII – shrub wetland (Shrub Wetland)	willows, red-osier dogwood, tall mannagrass, field mint, stinging nettle, bluejoint reedgrass	S32, S37, S41, S68	0.82	0.70
		Wetland Total	**56.27**	**48.19**

Vegetation Type	Dominant Species	Site #*	Total Area (ha) of Each Vegetation Type	Percentage (%) of Each Vegetation Type out of Overall Total Area of Vegetation Types
Miscellaneous (from North side) - not included in Overall Vegetation Type Total				
Weedy Upland	Exotic species dominate the sites	N (no site number)	3.65	-
Wet crop	Non-wetland	N (no site number)	0.80	-
Manmade Ponds	Non-wetland	N (no site number)	0.77	-
		Miscellaneous Total	**5.22**	-
Overall Total Area of Vegetation Types within the Study Area (not including Miscellaneous)(ha)			**116.77**	**100**
Total Area in Study Area (ha)			**1539.79**	
Percentage of Vegetation Types within Total Study Area (%)			**7.58**	

*Site #'s: N = sites between Manning Drive and Highway 16 East; S= sites along the existing Highway 216/16 alignment

Upland Vegetation

Manning Drive to Highway 16 East

Aspen

Seven sites within the project study area (Sites N5, N11, N23, N27, N34, N36 and N184; Figures 4.2a-f) supported an aspen vegetation community. Those sites represented 2.56% (3.17 ha) of the total survey area (Table 4.9). All seven sites were located on the north side of the North Saskatchewan River (Figures 4.2a-f). Trembling aspen trees formed the canopy of all sites, but balsam poplar trees were also present, sometimes frequently, in almost half of the stands. In relatively undisturbed sites, the understory vegetation usually contained a variety of tall and short shrubs. Some of the most common tall shrubs were red-osier dogwood, saskatoon serviceberry and choke cherry. Below this, short shrubs such as prickly rose, red raspberry and common snowberry were common, along with the woody vine and blue-green twining-honeysuckle (Appendix H). Ground cover in the aspen stands ranged from dense to extremely sparse. One of the most abundant plants was smooth brome, which often formed monocultures in disturbed sites. A mixture of forbs was usually present including ground cover species such as northern bedstraw, veiny meadowrue and common dewberry (Appendix H).

In total, 79 vascular plant species were observed in trembling aspen stands in the survey area (Appendix H). The number of species in a single stand ranged from 15 (Site N36; Figures 4.2a-f) to 32 (Site N10; Figures 4.2a-f), with an average of 25 species per site.

Disturbance / Weeds

Many of the trembling aspen stands were affected by natural and anthropogenic disturbances. Grazing by cattle and horses was the most widespread human activity affecting those sites. Under wet conditions, trampling has also had a major impact in some areas. Natural disturbance effects were also evident in many stands where large numbers of standing, recently-dead trees were present. The drought has killed many trees in and around Edmonton, and may have been the reason for this dieback. The canopies of some aspen stands had been defoliated by caterpillars. A leaf-rolling caterpillar was the most common cause of leaf loss during the vegetation survey in 2006.

Balsam

Nine sites within the project study area (N2, N4, N6, N12, N15, N20, N22, N24 and N183; Figures 4.2a-f) supported a balsam vegetation community. Those sites represented 2.56% (3.17 ha) of the total project study area (Table 4.9). In this community, balsam poplar was the dominant tree species, but trembling aspen was also present in more than half of these stands.

The understory typically consisted of both tall and short shrubs and a rich variety of forbs and grasses. The most common tall shrubs were red-osier dogwood, choke cherry and saskatoon serviceberry (Appendix H). Below these, the woody vine, blue-green twining-honeysuckle, and shorter shrubs such as prickly rose, common snowberry and red raspberry were also common. Ground cover was dominated by broad-leaved forbs such as wild sarsaparilla and tall bluebells mixed with grasses, including smooth brome and Kentucky bluegrass. Star-flower false-lily-of-the-valley, northern bedstraw, common cowparsnip and American vetch were also very common, but tended to be less abundant when present (Appendix H).

In total, 103 vascular plant species were observed in balsam poplar stands in the survey area (Appendix H). The number of species in a single site ranged from 16 (Site N4; Figures 4.2a-f) to 58 (Site N2; Figures 4.2a-f), with an average of 35 species per site.

Disturbance/Weeds

Smooth brome often dominated the ground cover of disturbed balsam poplar stands, but weeds were not otherwise abundant. Two other exotic weeds were among the most common plants observed: creeping thistle was occasional in 5 of the 9 sites and Kentucky bluegrass was common in 6 of the 9 sites (Appendix H).

Poplar mix

Two sites within the project study area (N8 and N10; Figures 4.2a-f) supported a poplar mix vegetation community. Those sites represented 18.02% (22.33 ha) of the total project study area (Table 4.9). Both sites were located south of the North Saskatchewan River and north of 130 Avenue within the project study area (Figures 4.2a-f). Both trembling aspen and balsam poplar formed the canopy of several sites. Since neither species was clearly dominant, these have been classified as 'mixed poplar stands'. Generally mixed poplar sites are intermediate between trembling aspen and balsam poplar stands, and share characteristics with both. Often the combination was the result of rolling topography, which created a mix of raised, well-drained sites for trembling aspen and moister depressions for balsam poplar.

The understory of less-disturbed sites supported a multi-layered variety of tall and short shrubs over a rich mix of forbs. The most common tall shrubs were red-osier dogwood, saskatoon serviceberry, beaked hazelnut and choke cherry. Saplings of balsam poplar and trembling aspen were common (Appendix H).

Ground cover in less-disturbed sites included a diverse mix of forbs, grasses and sedges. The most common forbs were star-flower false-lily-of-the-valley, wild sarsaparilla, Canada violet and veiny meadowrue. Most forbs grew as scattered individuals, but wild sarsaparilla and common dewberry often created abundant-dominant ground cover (Appendix H). Grasses, on the other hand, often grew profusely, and when present, tended to dominate ground cover.

In total, 60 vascular plant species were observed in mixed poplar stands in the survey area (Appendix H). The total number of species in Site N8 was 36 and there was a total of 32 species in Site N10.

Disturbance/Weeds

The most common disturbances in the mixed poplar stands in the survey corridor were grazing, browsing and trampling by cattle and horses. Disturbances in mixed poplar

stands often provided habitat for weedy species. The most common weeds were common dandelion, smooth brome and Kentucky bluegrass (Appendix X)
.

Tall Shrub

Two sites within the project study area (N16 and N17; Figures 4.2a-f) supported a tall shrub vegetation community. Those sites represented 2.69% (3.33 ha) of the total project study area (Table 4.9). Tall shrub vegetation was found on both sides of the river valley; on the relatively wet, lower slopes along the south shore (Site 16; Figures 4.2a-f), and on higher, drier slopes above the north bank (Site 17; Figures 4.2a-f). Although these sites shared species, dominant plants were very different. Moisture-loving species such as speckled alder, red-osier dogwood, bluejoint reedgrass and common spikerush dominated the cooler, moister sites on the north-facing bank (Appendix H).

On the north side of the river, exposed, south-facing slopes provided a much drier environment. Here, the dominant plants were more drought resistant, and included upland shrubs such as Saskatoon serviceberry, choke cherry and common snowberry (Appendix H). However, wetter microsites in gullies and near seeps provided moister sites where plants such as red-osier dogwood, high bush-cranberry and sloughgrass were abundant.

Disturbance / Weeds

Some of the tall shrub vegetation was quite weedy. Of the 50 species observed in these 2 sites, 12 were exotic weeds, and half of these were common in the areas where they occurred (Appendix H). Weeds were especially prevalent on the upper part of the north bank, where exotic shrubs such as Peking cotoneaster, tatarian honeysuckle, European buckthorn and lilac were often abundant.

Low Shrub

One site within the project study area (N18; Figures 4.2a-f) supported a low shrub vegetation community. That site represented 0.20% (0.25 ha) of the total project study area (Table 4.9). Low shrub vegetation was found on the steep lower north bank of the North Saskatchewan River (Site 18; Figures 4.2a-f). Much of this slope appeared to be unstable and eroding. The soil was often very wet, due the combined effect of springs and proximity to the river.

No single shrub species was dominant in this area, but the vegetation included a rich mix of woody species, including meadow willow, America silverberry, prickly rose, Woods rose, common snowberry and western snowberry (Appendix H). Several large, impenetrable patches of western poison-ivy were also discovered here. In more open areas, on moist slopes and along the river, grasses (e.g. smooth brome, reed canarygrass, Kentucky bluegrass), sedges (e.g. woolly sedge) and bulrushes (e.g. red-sheath bulrush) were abundant (Appendix H). Forbs generally grew as scattered individuals.

Disturbance / Weeds

Of the 33 species observed at the Low Shrub site, 12 were exotic weeds (Appendix H). Most of these were forbs such as leafy spurge, common toadflax, common plantain and field pennycress. Only the two grass species, smooth brome and Kentucky bluegrass were common in this area (Appendix H).

Grassland

One site within the project study area (N19; Figures 4.2a-f) supported a grassland vegetation community. That site represented 0.87% (1.08 ha) of the total project study area (Table 4.9). The steep dry slopes and bluffs on the upper, south-facing slopes of the river valley supported vegetation dominated by grasses and drought-tolerant species (Site 19; Figures 4.2a-f). This was not a grassland in the sense of the Westworth (1980) classification, because it was vegetated by native, rather than agronomic, species. The dominant species on these unstable, exposed slopes were plains muhly, slender wildrye, prairie sagebrush, Woods rose and yellow sweetclover (Appendix H). There were also many patches of western poison-ivy and scattered, weedy forbs.

Disturbance / Weeds

In comparison with the other river valley vegetation types, the grassland site was quite weedy. Of the 24 species recorded from this site, 9 were exotic weeds (Appendix H). One of these (yellow sweetclover) was a dominant component of the community, and four others (rape mustard, lambs-quarters goosefoot, leafy spurge and common hedgemustard) were very common (Appendix H).

Highway 216/16 Alignment

Deciduous Woodlands

Fourteen sites in the survey area (Sites S2, S9, S14, S22, S33, S35, S36, S39, S48, S61, S62, S63, S66, and S80; Figure 5.2a-f) supported a deciduous woodland vegetation type. Those sites represented 5.90% (7.31 ha) of the total survey area (Table 4.9). Sites S2, S9 and S14 were located along Highway 16 and Sites S22, S33, S35, S36, S39, S48, S61, S62, S63, S66 and S80 were all located along Highway 216 (Figure 5.2a-f).

The tree canopy was dominated by balsam poplar (10 stands) and/or aspen poplar (8 stands) and Manitoba maple trees were also common in stands around residential areas. The understory of most sites included a mix of saplings (e.g. balsam poplar, aspen poplar, Manitoba maple), tall shrubs (e.g. red-osier dogwood, saskatoon serviceberry, choke cherry, beaked hazelnut) and low shrubs and vines (e.g. prickly rose, currants, red raspberry, snowberry, blue-green twining honeysuckle) (Plate 4.1).

Plate 4.1. Deciduous Woodland, Site S33

Groundcover was dominated by grasses (e.g. smooth brome, bluejoint reedgrass, Kentucky bluegrass) and a mix of native forbs (e.g. northern bedstraw, common horsetail, Canada goldenrod, American vetch and common dewberry) and weeds (e.g. creeping thistle, dandelion, common toadflax) (Plate 4.2).

Plate 4.2. Deciduous Woodland, Site S35

Disturbance / Weeds

A total of 98 plant species were identified. Of those, 72 (73%) were native and 26 (27%) were exotic species. Four weeds (creeping thistle, common toadflax, common tansy, smooth perennial sowthistle) were noxious weeds and four (common dandelion, brittle-stem hempnettle, creeping wildrye, field pennycress) were nuisance weeds under the Alberta *Weed Control Act* (Alberta Agriculture 2006).

Mixed Woodlands

Three sites in the survey area (Sites S40, S43 and S72; Figures 4.2a-f) supported a mixed woodland vegetation type. Those sites represented 7.94% (5.25 ha) of the total survey area (Table 4.9). All three sites were located along Highway 216 in the study area. The tree canopy was dominated by white spruce, balsam poplar and/or aspen poplar. Alaska paper birch was dominant at Site S40 and occasional at Site S43 Figures 4.2a-f; Plate 4.3).

Plate 4.3. Mixed Woodland, Site S43

The shrub layer comprised of a mix of saplings including aspen poplar, balsam poplar, green ash, Alaska paper birch and white spruce. Tall shrubs, mainly beaked hazelnut and red-osier dogwood, and low shrubs and vines including snowberry, prickly rose, red raspberry, blue-green twining-honeysuckle, swamp red currant and black-berry honeysuckle also dominated the shrub layer (Appendix H; Plate 4.4). Groundcover was dominated by grasses (e.g. bluejoint reedgrass, Kentucky bluegrass) and a mix of forbs including common horsetail, northern bedstraw, wild sarsaparilla, star-flower false-lily-of-the-valley and common fireweed (Appendix H)

Plate 4.4. Mixed Woodland, Site S40

Disturbance / Weeds

A total of 57 plant species were identified in the mixed woodland vegetation type (Appendix H). Of those, 46 (81%) were native and 11 (19%) were exotic. Of the weedy species observed, one (creeping thistle) was noxious and two (common dandelions and brittle-stem hempnettle) were nuisance weeds under the Alberta *Weed Control Act* (Alberta Agriculture 2006).

Stream

Riparian

Seven sites in the survey area encompassed streams/riparian vegetation. Two of those sites (Sites S7 and S24; Figures 4.2a-f) were located along the Oldman Creek, and five sites (Sites S8, S13, S38, S65 and S86; Figures 4.2a-f) were located along smaller, unnamed channels. This vegetation type represented 10.27% (6.79 ha) of the total survey area (Table 4.9). Balsam poplar dominated several sections of the stream banks, shading a dense, multi-layered shrub understory. Willows dominated large areas in all the sites (Plate 4.5). Red-osier dogwood was present in most stream sites, and dominated much of the vegetation in Site S24 (Figures 4.2a-f). On higher, well-drained slopes above the channels, woods rose, prickly rose and snowberry were abundant.

Plate 4.5. Stream, Site S7

Kentucky bluegrass and smooth brome dominated elevated areas above the annual floodplain, while wetter areas adjacent to the streams supported dense colonies of rhizomatous, moisture-loving species such as reed canarygrass, awned sedge and common cattail. Common horsetail was abundant in most sites, and dominated much of the groundcover at Site S24 (Plate 4.6; Figures 4.2a-f).

Plate 4.6. Stream, Site S24

Disturbance / Weeds

A total of 109 plant species were identified in streamside communities (Appendix H). Of those, 86 (79%) were native and 23 (21%) were exotic. Of the weedy species, 5 (smooth perennial sowthistle, creeping thistle, common toadflax, common tansy and bluebuttons) were noxious weeds and 6 (common dandelion, creeping wildrye, wormseed wallflower, field pennycress, creeping bellflower and Norway cinquefoil) were nuisance weeds under the Alberta *Weed Control Act* (Alberta Agriculture 2006) observed in the stream sites (Appendix H).

Wetlands

Following Stewart and Kantrud's (1971) wetland classification system, wetland class is determined by the vegetation zone that appears the deepest, typically the central part of the wetland, and occupies at least 5% of the total wetland area. The potential list of central vegetation zones include, in order from driest to wettest:

- low-prairie
- wet meadow
- shallow marsh
- deep marsh
- fen
- shrub swamp, and
- permanent open water

Each of the vegetation zones contains plant species adapted to the particular environmental conditions in that zone (e.g. submergent plants in permanent open water areas), which, in conjunction with hydrological conditions, are used to determine the wetland class. The wet meadow and low prairie zones typically support vegetation species tolerant of progressively drier conditions (e.g. grasses). The remaining three zones support vegetation better adapted to soils that are inundated or saturated for greater periods of time, and typically include emergent species and submerged aquatic plants.
According to Stewart and Kantrud (1971), a Class I (ephemeral) wetland is characterized by a central area of low-prairie vegetation. At the other end of the spectrum, a Class V (permanent) wetland is one in which the central area is represented by the permanent-open-water zone. In between, Classes II, III and IV are considered temporary, seasonal and semi-permanent wetlands, respectively, with the main difference being the depth and permanence of water which, in turn, affects the central vegetation zone. A Class VII wetland is a fen/alkaline bog, best described as "shrubby willow wetlands". These wetlands typically have shallow water pockets and hummocky mounds of grassy vegetation indicative of moist by not permanently saturated soils and a tall willow shrub layer. In some instances, very small patches of cattails occupied deeper pocket depressions within the wetland that perhaps held water longer than the rest of the wetland. These sites did not support permanent water levels and by late summer, might appear dry. Class VIII is a shrub swamp characterized by wetland-adapted shrubs (e.g. willows, alders) and generally saturated soils with a surface that can dry out during the season.

Seventy nine (79) sites containing wetlands were identified in the survey area and were classified according to Stewart and Kantrud (1971) (Figures 4.2a-f). The wetland class, deepest vegetation zone, site number and area are listed in Table 4.10. Wetland data from the entire NEAHD project area (Manning Drive to Highway 16 East and Highway 216/16 alignment) is presented below.

Table 4.10. Wetland Class, Deepest Vegetation Zone, Site Number and Area Found in the NEAHD Project Area

Wetland Class [a]	Deepest Vegetation Zone	Site #[c]	Area (ha)
II (Temporary Pond)	**Wet meadow**	S20	0.10
		S27	0.11
		S44	0.04
		S45	0.03
		S46	0.24
		S56	0.03
		S60	1.14
		S70	0.08
		S73	0.63
		S77	0.17
		S78	0.05
		S81	0.31
		S82	0.69
		S85	0.33
		S87	0.31
		N9	1.05
Subtotal Class II			**5.32**
III (Seasonal pond)	**Shallow marsh**	S5	0.57
		S10	0.28
		S11	0.20
		S12	0.14
		S17	0.24
		S23	0.33
		S30	0.33
		S42	0.46
		S49	0.05
		S53	0.14
		S54	0.15
		S55	0.09
		S59	0.13
		S64	0.59
		N26	0.75
		N29	1.39
		N30	1.39
		N37	0.96
		N38	2.26
		N185	0.93
		N186	0.47
Subtotal Class III			**10.14**
IV (Semi-permanent pond)	**Deep Marsh**	S1	0.54
		S3	0.19

Wetland Class [a]	Deepest Vegetation Zone	Site #[c]	Area (ha)
		S4	0.17
		S6	0.18
		S5	0.34
		S16	0.19
		S18	0.23
		S19	0.14
		S21	0.28
		S25	0.55
		S26	1.11
		S28	0.59
		S29	0.70
		S31	0.13
		S50	0.14
		S51	0.18
		S52	0.45
		S57	1.88
		S58	0.86
		S67	0.33
		S74	1.59
		S84	1.55
Subtotal Class IV			**12.63**
V (permanent pond)	**Permanent Open Water**	S34	1.11
		S47	0.94
		S69	3.56
		S71	0.44
		S75	14.41
		S76	1.40
		S79	2.92
		S83	0.60
		N13	1.54
		N14	1.15
		N25	0.06
		N31	0.57
Subtotal Class V			**28.70**
VII (Fen)	**Fen (alkaline bog)**	N1	0.38
		N3	0.16
		N28	2.71
		N33	0.24
		N35	0.80
Subtotal Class VII			**4.30**
VIII [b] (Shrub wetland)	**Shrub wetland**	S32	0.36
		S37	0.11
		S41	0.77
		S68	0.17
Subtotal Class VIII			**1.41**
Total Wetland Area in Project Area (ha)			**62.5**

[a] After Stewart and Kantrud (1971): I-ephemeral; II-temporary; III-seasonal; IV-semi-permanent; V-permanent; VII-fen
[b] VIII-new classification added by Spencer Environmental
[c] Site #'s: N = sites between Manning Drive and Highway 16 East; S= sites along the existing Highway 216/16 alignment

Class II (Wet Meadow)

Wet meadow vegetation is found near the middle of relatively shallow pond basins and around edges of most ponds and lakes (Stewart and Kantrud 1971). Usually, surface water is present for a few weeks in the spring after snowmelt, and for several days after heavy rainstorms. Plants grow as emergents during these periods, but are rarely submerged (Stewart and Kantrud 1971). Tilled wet-meadow sites usually have ponded water in early spring, but this soon draws down to expose bare soil or the remains of plants from the previous year. The water in wet-meadows ranges from fresh or slightly brackish, but wet meadow vegetation is often found around the edges of fresh to subsaline permanent water bodies (Stewart and Kantrud 1971). Low, fine-textured graminoids are usually dominant.

Sixteen sites (16) in the survey area (Sites S20, S27, S44, S45, S46, S56, S60, S70, S73, S77, S78, S81, S82, S85, S87 and N9) were Class II (wet meadow) wetlands (Table 4.10; Figures 4.2a-f). Even though those sites lack surface water for most of the year, they support plant communities that need moist conditions to thrive. With the exception of Site S20 (located on the south side of Highway 16, west of Cloverbar Road) and N9 (located north of 130 Ave south of the NSR), all sites were located along Highway 216 in the study area (Figures 4.2a-f). Class II wetlands comprised 4.29% (5.32 ha) of the total area surveyed (Table 4.10).

A total of 11 vascular species were observed within the Class II wetlands surveyed (Appendix H). Of those, only two species were native and 9 species were exotic. The dominant species included field pennycress, creeping thistle, foxtail barley and smooth perennial sowthistle (Appendix H).

Disturbance / Weeds

Most of the Class II wetland sites were heavily disturbed, usually by cultivation, and weeds were abundant (Plate 5.7). Of the weedy species observed, two (smooth perennial sowthistle and creeping thistle) are noxious weeds and two (field pennycress and dandelion) are nuisance weeds under the Alberta *Weed Control Act* (Alberta Agriculture 2006).

Plate 4.7. Class II wetland (Wet meadow), Site S27, tilled

Class III (Shallow Marsh)

Class III wetlands are normally flooded for extended periods in spring-early summer and dry in late summer-fall (Stewart and Kantrud 1971). They usually include an open water zone (often with submerged aquatic plants), an emergent zone, and a drawdown emergent zone (with bare-soil in periods of low precipitation).

Twenty sites (20) in the survey area (Sites S5, S10, S11, S12, S17, S30, S42, S49, S53, S54, S55, S59, S64, N26, N29, N30, N37, N38, N185 and N186) were Class III wetlands (Plates 4.8 and 4.9). Sites S5, S10, S11, S12 and S17 were located along Highway 16, Sites S30, S42, S49, S53, S54, S55, S59 and S64 were located along Highway 216 and Sites N26, N29, N30, N37, N38, N185 and N186 were located south of Manning Drive in the study area (Figures 4.2a-f). The Class III wetland sites were dominated by a mixture of grasses and sedges. Some of the most common plant species included reed canarygrass, sloughgrass, common spikerush, little meadow-foxtail and tall mannagrass (Plates 4.8 and 4.9; Appendix H). In more elevated areas, plant species such as creeping thistle, smooth perennial sowthistle, marsh yellowcress and foxtail barley surrounded the edges of the Class III wetlands. Weedy species such as field pennycress and common dandelion were also present in those sites (Appendix H). Class III wetlands comprised 8.18% (10.14 ha) of the total area surveyed (Table 4.10).

Plate 4.8. Class III (Shallow Marsh), Site S5

Plate 4.9. Class III (Shallow Marsh), Site S49

Disturbance / Weeds

A total of 85 plant species were observed in Class III (Shallow marsh) wetland sites (Appendix H). Of the 85 species observed, 68 (80%) of those were native and 17 (20%) were exotic. Five weedy species (creeping thistle, smooth perennial sowthistle, scentless false-mayweed, white bladder-campion and common toadflax) are noxious and six (field pennycress, common shepherd-purse, common dandelion, annual hawksbeard, creeping wildrye and Norway cinquefoil) are exotic weeds under the Alberta *Weed Control Act* (Alberta Agriculture 2006).

Class IV (Deep Marsh)

Deep-marsh vegetation dominates the centre of wetlands that retain surface water usually through spring-summer and often into fall-winter (Stewart and Kantrud 1971). Deep marshes also occur as bands around the edges of deeper permanent-open-water. Zones in deep-marshes usually include emergent and open-water phases, but during drought there may also be drawdown areas with bare-soil or emergent vegetation (Stewart and Kantrud 1971). Salinity in the deep-marshes ranges from fresh to slightly brackish. Coarse, tall graminoids typically dominate emergent vegetation at these sites (Stewart and Kantrud 1971). Submerged or floating plants are also common in deeper areas.

Twenty-two (22) sites (Sites S1, S3, S4, S6, S15, S16, S18, S19, S21, S25, S26, S28, S29, S31, S50, S51, S52, S57, S58, S67, S74 and S84) supported Class IV (deep marsh) wetland habitat. Sites S1, S3, S6, S15, S16, S18 and S19 were located along Highway 16 and Sites S4, S21, S25, S26, S28, S29, S31, S50, S51, S52, S58, S67, S74 and S84 were located along Highway 216 in the study area (Figures 4.2a-f). At the time of the survey, most of those sites had deep standing water in their lowest sections. Common cattail dominated the vegetation of most of the Class IV wetlands, but in some cases cattail was restricted to only part of the site. Other dominant species included soft stem clubrush and common reed (Appendix H). Most of the deep marshes showed zonation of vegetation with changes in water depth from higher ground at the outer edges to deep water at the centre. In most cases, there was an outer ring of wet meadow vegetation dominated by plant species such as field mint, Baltic rush, creeping thistle, common silverweed and fowl bluegrass. With increasing moisture, shallow marsh plant species including awned sedge, bottle sedge, water sedge and reed canarygrass were present (Appendix H). The deepest parts of the sites, deep marsh species, most notably common cattail, dominated the vegetation (Plate 4.10). Class IV wetlands comprised 10.19% (12.63 ha) of the total area surveyed (Table 4.10).

Plate 4.10. Class IV (Deep Marsh), Site S67

Disturbance / Weeds

A total of 113 plant species were observed in Class IV (deep marsh) sites (Appendix H). Of those, 88 (78%) were native and 25 (22%) were exotic. Six weedy species including smooth perennial sowthistle, creeping thistle, common toadflax, common tansy, bluebuttons and scentless false-mayweed are noxious weeds and 8 species including common dandelion, creeping wildrye, field pennycress, wormseed wallflower, lady's thumb smartweed, flixweed tansymustard, black twining-knotweed and Norway cinquefoil are exotic weeds under the Alberta *Weed Control Act* (Alberta Agriculture 2006).

Class V (Permanent Open Water)

Permanent-open-water sites are ponds and lakes with fairly stable water levels. Salinity ranges from slightly brackish to subsaline (Stewart and Kantrud 1971).

Twelve (12) sites in the survey area (Sites S34, S47, S69, S71, S75, S76, S79, S83, N13, N14, N25 and N31) were classified as Class V (permanent open water) wetlands surrounded by deep marsh vegetation. Sites S34, S47, S69, S71, S75, S76, S79 and S83 were all located along Highway 216 and Sites N13, N14, N25 and N31 were located south of Manning Drive (Figures 4.2a-f). On slightly elevated sites, shallow marsh species such as awned sedge and reed canarygrass. Tall willows and moisture-loving plants such as fowl bluegrass, field mint and creeping thistly were observed along the outer edges of the sites.

Plate 4.11. Class V (permanent open water), Site S34

Disturbance / Weeds

A total of 42 plant species were observed in Class V (permanent open water) wetland sites within the project survey area (Appendix H). Of those, 37 (88%) were native and 5 (12%) were exotic. Two weedy species (smooth perennial sowthistle and creeping thistle) are noxious weeds and one species (common dandelion) is a nuisance weed under the Alberta *Weed Control Act* (Alberta Agriculture 2006). Class V wetlands comprised 38.38% (25.37 ha) of the total area surveyed (Table 4.9).

Class VII (Fen)

Fen vegetation sometimes dominates the centres of ponds, but usually these fresh-water sites are found in isolated pockets at the edges of brackish to saline ponds and lakes (Stewart and Kantrud 1971). Surface water may be lacking, but mucky bottom soils are usually saturated by alkaline groundwater seepage. When present, springs are usually on raised mounds of wet organics covered with mats of vegetation (Stewart and Kantrud 1971). Gently sloping sites around ponds/lakes usually have near-surface groundwater flow from nearby streams or seeps. Salinity generally increases as water moves down slope and fen species area often gradually replaced by plants that can tolerate more saline conditions (Stewart and Kantrud 1971).

The classification of wetlands as fens was based solely on the presence of indicator species. The most common indicators encountered during this survey were water sedge, little-bottle sedge and marsh skullcap. Apart from the presence of these fresh-water species, the sites shared most species and drainage characteristics with other wetlands types. Of the 5 fens surveyed, 1 (Site 3) was very similar to shallow marshes, 2 (Sites 1 and 35; Figures 4.2a-f) resembled deep marshes, and 2 (Sites 28 and 33) contained permanent open water (Figures 4.2a-f).

The central parts of most sites were dominated by sedges and rushes (e.g. awned sedge, little-bottle sedge, water sedge and common spikerush), while grasses (e.g. reed canarygrass, bluejoint reedgrass, slim-stem reedgrass and rivergrass) covered slightly higher ground. Tall shrubs, such as meadow willow, Bebb willow and pussy willow, ringed the outer edges of many fen sites

In total, 111 vascular plant species were observed in fen sites in the survey area. The number of species in a single site ranged from 15 (Site 69; Figure 5-2e) to 36 (Site 35; Figure 5-2f), with an average of 27 species per site.

Disturbance / Weeds

Weeds were common in fen sites, but rarely dominated the vegetation. The most common exotic weeds were creeping thistle, dandelion and perennial sowthistle.

Class VIII (Shrub Wetland)

Shrub wetlands area seasonally flooded mineral-soil wetlands with the water table at or near the surface for most of the growing season. They often form riparian areas adjacent to creeks, rivers, lakes and other wetland types and can occur in transition between uplands and meadow marshes. They are generally ‘permanent’ wetlands in the sense that irrespective of climatic conditions, they are always clearly defined by their tall shrub layer. Class VIII wetlands comprised 3.54% (2.27 ha) of the total area surveyed (Table 4.9).

Four sites in the survey area supported shrub wetland habitat (Sites S32, S37, S41 and S68). All sites were located along Highway 216 (Figures 4.2a-f). Tall willows dominated all of the sites. Willow species varied from one site to the next, but the most common were balsam willow, Bebb willow, meadow willow and pussy willow (Plate 4.12; Appendix H). Red-osier dogwood and wild black currant were also abundant in most sites. Trees were uncommon and were generally restricted to slightly elevated ground along the outer edges of these sites. Manitoba maple was dominant in parts of Site S32 (Figures 4.2a-f; Appendix H).

Plate 4.12. Shrub wetland, Site S37

Groundcover at the shrub wetland sites was dominated by a mix of moisture-loving grasses, sedges and forbs (Plate 4.13). Bluejoint reedgrass, stinging nettle, field mint and creeping thistle were the most abundant non-woody plants in the shrub wetland sites, but shallow marsh species were also common. These included awned sedge, bottle sedge, water sedge, tall mannagrass, reed canarygrass and tufted yellow-loosestrife (Appendix

H). On slightly elevated ground, moisture-loving shrubs such as red raspberry, hairy-stem gooseberry, swamp red currant and high bush-cranberry were often abundant.

Plate 4.13. Shrub wetland, Site S41

Disturbance / Weeds

A total of 74 plant species were observed in shrub wetland habitat in the survey area (Appendix H). Of those, 64 (86%) were native and 10 (14%) were exotic. Two plant species (creeping thistle and perennial sow thistle) are noxious weeds and three plant species (brittle-stem hempnettle, field pennycress and Norway cinquefoil) are nuisance weeds under the Alberta *Weed Control Act* (Alberta Agriculture 2006). Class VIII wetlands comprised 2.13% (1.41 ha) of the total area surveyed (Table 4.9).

4.1.5.3 Rare Plants

Manning Drive to Highway 16 East

Two species of rare plants were identified in the project area in 2006 (Spencer 2007). Each species and its location(s) are discussed below.

Smooth sweet-cicely

Smooth sweet-cicely (*Osmorhiza longistylis)* is a perennial herb that grows up to 1 m tall. It has coarsely-toothed leaves 2-3 times divided in 3s. Like other members of this genus, it has small (1.8-2.2 cm), narrowly club-shaped fruits in sparse, umbrella-shaped clusters with wide-spreading branches (Kershaw *et al* 2001) (Plate 4.14). Smooth sweet-cicely is distinguished by the persistent, leaf-like bracts at the base of its flower clusters and by the relatively long (2-3 mm) styles at the tips of its bristly fruits. The thick aromatic roots of sweet cicely plants smell like licorice (Kershaw *et al* 2001). Smooth sweet-cicely has been found less than 10 times in Alberta, and is classified as an S2 species. Edmonton lies at the northern edge of its range in the province (Kershaw *et al* 2001).

Plate 4.14. Smooth sweet – cicely flowers and fruits

One group of smooth sweet-cicely was discovered in the project area. The plants were growing in a moist, sheltered site under a canopy of balsam poplar. A single plant with 3 flowering stalks was found at Site N12 (UTM co-ordinates: 344046E 5940414N 12V NAD 83) (Figures 4.2a-f). This was a moist, shrubby community with tall pin cherry, red-osier dogwood and high bush-cranberry in the overstory; common snowberry, fringed yellow-loosestrife, cow-parsnip, wild sarsaparilla, wild black currant & red baneberry in the understory. The site was a moist (mesic) area at base of a steep (60°) slope approx. 1.5 m below and 4 m southwest of a muddy track.

Marsh muhly

Marsh muhly (*Muhlenbergia racemosa)* is a perennial grass, 30-60 cm tall that forms clumps from spreading underground stems or rhizomes (Plate 4.15). It has smooth, shiny stems with hairy joints and the leaf sheaths have a lengthwise ridge down the back (Kershaw *et al* 2001). The leaves are 2-7 mm wide with a minute (0.6-1.5 mm) membranous ligule. The florets are borne in 1-flowered, short-stalked spikelets that form dense, spike-like panicles, 3-7 cm long and 5-15 mm wide. The outer bracts of each floret (the glumes) are tipped with long bristles; the inner bracts (the lemmas) are hairy on the lower half and are tipped with shorter, slender bristles (Kershaw *et al* 2001). The anthers are 0.4-0.8 mm long. It is classified as an S1 species in Alberta, meaning there are five or fewer occurrences in the province.

Plate 4.15. Marsh Muhly

Despite its name, marsh muhly usually grows on dry, sandy hills and eroded banks. Two clumps of this grass were discovered on dry, steep, south-facing banks, high above the North Saskatchewan River (UTM coordinates: 344437E 5942639N 12V NAD83)(Site N19; Figures 4.2a-f). The sparse vegetation in this area was dominated by prairie sagebrush and plains muhly, with scattered Woods rose shrubs.

Highway 216/16 Alignment

No rare plant species (ranked S1 or S2) were identified during the 2008 and 2009 surveys but 15 uncommon (S3) species were observed (Table 4.11). S3 species are known to have 20-100 occurrences in the province, and are often uncommon in the areas where they are found. S1 and S2 species both occur in small populations with S1 species found in 5 or fewer locations in the province and S2 species are known to have 6-20 occurrences in the province. These are discussed briefly in the following section, using information from the Flora of Alberta (Moss 1983), Rare Vascular Plants of Alberta (Kershaw et al 2001) and Alberta Conservation Information Management System (ACIMS) (formerly ANHIC) (Alberta Natural Heritage Information Centre 2008). UTM locations of S3 species were not recorded.

Table 4.11. Rare and Uncommon Species of the NEAHD Survey Area

Common Name	Scientific Name	Status	Site(s) and Abundance
high bush-cranberry	*Viburnum opulus*	S3	S37(O/A) [a], S39 (O), S41(O), S61 (O), S72 (A), S86 (F)
Pennsylvania buttercup	*Ranunculus pensylvanicus*	S3	S29(O)
common reed	*Phragmites australis*	S3	S31(D)
slender-beak sedge	*Carex anthrostachya*	S3	S30(O), S80 (O)
rough water-horehound	*Lycopus asper*	S3	S3(O), S24(R), S25(A), S31(O), S34(R)
peachleaf willow	*Salix amygdaloides*	S3	S8(R)
America wintercress	*Barbarea orthoceras*	S3	S29(O), S30(O)

white wintergreen	*Pyrola elliptica*	S3	S40(O)
spreading woodfern	*Dryopteris assimilis*	S3	S37(R)
tufted yellow-loosestrife	*Lysimachia thrsiflora*	S3	S7(O), S24(O), S37(F), S41(O), S65 (O)
Labrador bedstraw	*Galium labradoricum*	S3	S65 (O)
water mudwort	*Limosella aquatica*	S3	S86 (R)
purple peavine	*Lathyrus venosus*	S3	S47 (O)
awlfruit sedge	*Carex stipata*	S3	S65 (O), S71 (O)
marsh willowherb	*Epilobium palustre*	S3	S58 (R)

[a] O= occasional, A= abundant, F= frequent, R= rare

High bush-cranberry (*Viburnum opulus*) (Plate 4.16) is a tall, spreading shrub that grows in rich moist sites, often near water or in sheltered ravines. The attractive red berries persist through the winter, and attract many songbirds. High bush-cranberry is found at scattered locations in central Alberta, but its range extends across Canada and the northern U.S. In the survey area, its abundance was occasional to abundant at Site S37, occasional at Sites S39, S41 and S61, abundant at Site S72, and frequent at Site S86 (Table 4.11; Figures 4.2a-f).

Plate 4.16. High bush-cranberry

Pennsylvania buttercup (*Ranunculus pensylvanica*) (Plate 4.17) is an erect, hairy buttercup with stalked terminal leaflets, tiny petals (shorter than the sepals) and oblong-cylindrical heads of achenes. It grows on marshy ground from B.C. to Newfoundland and south through the northern U.S. In Alberta, it is found in central to northeastern parts of the province. It was occasional at Site S29 (Table 4.11; Figures 4.2a-f).

Plate 4.17. Pennsylvania buttercup

Common reed (*Phragmites australis*) (Plate 4.18) is Alberta's largest grass, with stout, leafy stems 1.5 – 3 m tall. The distinctive, broad, 1-3 cm wide leaf blades and large (10-40 cm long) fluffy panicles make this grass unique. Common reed grows in marshes and around lakes in boreal regions around the world. In Canada it is found from B.C. to N.S., and in Alberta it grows at scattered locations in central and northern parts of the province. It was dominant at Site S31 in the survey area (Table 4.11; Figures 4.2a-f).

Plate 4.18. Common reed

Slender-beak sedge (*Carex athrostachya*) (Plate 4.19) is a 10-50 cm tall, loosely tufted sedge with 4-20 densely clumped spikes in a 1-2 cm long, ovoid head. It grows on marshy ground from Alaska to Saskatchewan and south to California, Colorado and North Dakota. In Alberta it has been found at scattered locations in the southern half of the province. It was occasional at Sites S30 and S80 in the survey area (Table 4.11; Figures 4.2a-f).

Plate 4.19. Slender-beak sedge

Rough water-horehound (*Lycopus asper*) (Plate 4.20) is a white-flowered member of the mint family that might be mistaken for field mint. It is identified by the clusters of tiny white flowers in its leaf axils, each with 2 stamens. It grows in marshes and on shores at scattered sites from central to eastern Alberta. Rough water-horehound was occasional in Sites S3 and S31, abundant in Site S25 and rare in Sites S24 and S34 in the survey area (Table 4.11; Figures 4.2a-f).

Plate 4.20. Rough water-horehound

White wintergreen (*Pyrola elliptica*) (Plate 4.21) is a white-flowered wintergreen with 3-7 cm long leaves that are slightly more elongated than those of Common pink wintergreen. It grows in rich woods in central Alberta with a few scattered sites to the north and south. White wintergreen was occasional at Site S40 in the study area (Table 4.11; Figures 4.2a-f).

Plate 4.21. White wintergreen

Spreading woodfern (*Dryopteris assimilis*) (Plate 4.22), is a large, feathery fern with twice to thrice divided leaves (fronds) up to 1 m long. It has stout, scaly leaf stalks (stipes) with persistent bases that cover its thick rhizomes. Spreading woodfern grows in moist woods from Alaska to Newfoundland and south to California and Colorado. In Alberta, it has been found at scattered sites throughout the province. Spreading woodfern was rare at Site S37 in the study area (Table 4.11; Figures 4.2a-f).

Plate 4.22. Spreading woodfern

Tufted yellow-loosestrife (*Lysimachia thyrsiflora*) (Plate 4.23) is a distinctive wetland plant with pairs of fluffy yellow flower clusters growing on slender stalks from the leaf axils. It grows in marshes, ditches and on shores from Alaska to Hudson Bay and Labrador, and south to California, Missouri and West Virginia. In Alberta, it has been found across much of the central and eastern parts of the province. Tufted yellow-loosestrife was occasional at Sites S7, S24, S41 and S65 and frequent in Site S37 in the study area (Table 4.11; Figures 4.2a-f).

Plate 4.23. Tufted yellow-loosestrife

Peachleaf willow (*Salix amygdaloides*) is a tall shrub or small tree that can reach 10 m in height. The large (5-12 cm long) leaves have finely toothed margins, hairless lower surfaces, and long, slender tapered tips. Peachleaf willow grows on floodplains from B.C. to Quebec and south to the northern U.S.

America wintercress (*Barbarea orthoceras*) is a 20-50 cm tall member of the mustard family with 4-petalled, yellow flowers and erect, linear, 2-4 cm long pods (siliques). It is identified by its deeply lobed to pinnate stem leaves, which have clasping lobes at their bases. American wintercress grows on stream banks and in moist woods from Alaska to Newfoundland and south to California, Minnesota and New Hampshire.

Labrador bedstraw (*Galium labradoricum*) (Plate 4.24) is a tiny, sprawling plant that usually forms delicate tangled mats in wetland vegetation. Its slender stems reach 10-30 cm in length and bear whorls of four small (8-14 mm long) leaves. It is very similar in appearance and habitat to its much more common cousin, small bedstraw (*Galium trifidum* L.), but is easily distinguished by its smooth (rather than scabrous) stems and by its tiny (2 mm wide), 4-lobed (rather than 3-lobed) flowers. Labrador bedstraw grows on marshy ground and in moist woods and bogs scattered across the northern half of the province. Its range extends from the southwestern N.W.T to B.C. and east to Newfoundland and New Jersey. In the survey area, it was occasionally abundant at Site S65 (Table 4.11; Figures 4.2a-f).

Plate 4.24. Labrador bedstraw

Water mudwort (*Limosella aquatica* L.) (Plate 4.25) is a tiny, annual wetland plant that grows on mud flats and in shallow water. Although this tiny forb may grow to 6-12 cm in length underwater, it is easily overlooked on land, where it seldom reaches more than 1-2 cm in height. Water mudwort is identified by its slender (2-6 mm wide), fleshy, spatula-shaped leaves and tiny (2 mm), white to pink, 5-lobed flowers. In Alberta, it is found mainly central and southern parts of the province, with disjunct populations in the northeast corner. Its range in North America extends from Alaska to Newfoundland, and south from California to Minnesota. In the survey area, it was rare at Site S86 (Table 4.11; Figures 4.2a-f).

Plate 4.25: Water mudwort

Purple peavine (*Lathyrus venosus* Muhl. ex Willd.) (Plate 4.26) is a tall (often 1 m), twining, herbaceous vine with a slender tendril at the tip of each compound leaf. Peavine is larger than the more common America vetch (*Vicia americana*), which also has purplish, pea-like flowers and tendril-tipped leaves. Purple peavine grows in moist woods in east-central Alberta. In the survey area, it was occasionally abundant at Site S47 (Table 4.11; Figures 4.2a-f).

Plate 4.26: Purple peavine

Awl-fruit sedge (*Carex stipata* Muhl. ex Willd.) (Plate 4.27) is easily identified by its long (40-100 cm), thick, soft, 3-sided stems and its dense, spiky flower clusters composed of stalkless, bisexual spikelets. It grows in wet meadows and thickets in central Alberta (from Lesser Slave Lake to south of Edmonton) and across North America. In the survey area, this species was occasionally abundant at Sites S65 and S71 (Table 4.11; Figures 4.2a-f).

Plate 4.27. Awl-fruit sedge

Marsh willowherb (*Epilobium palustre* L.) (Plate 4.28) has slender (5-80 cm tall), erect stems which have several pairs of narrow, smooth-edged leaves and produce thread-like stolons and compact, fleshy offsets (turions) at their bases. The inconspicuous white to pale pink flowers often nod when young (in bud), and have no glandular hairs. Marsh willowherb grows in marshes and bogs at scattered across Alberta and throughout much of northern North America. In the survey area, it was found rare at Site 58 (Table 4.11; Figures 4.2a-f).

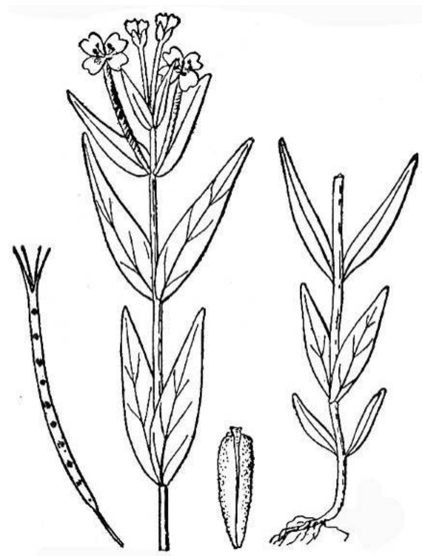


Plate 4.28. Marsh willowherb (Britton and Brown, 1913)

ACIMS

The Alberta Conservation Information Management System (ACIMS) (formerly ANHIC) operated by Alberta Tourism, Parks, Recreation and Culture was contacted regarding existing records of rare plants in the study are and a database search was performed on 18 March 2008 (ANHIC 2008).

The ACIMS database contained five records of tracked elements near the NEAHD project study area. Those records include a rare moss, *Rhodobryum ontariense*, false dragonhead (*Physostegia ledinghamii*), smooth sweet cicely (*Osmorhiza longistylis*), Herriot's sagewort (*Artemisia tilesii*) and crowfoot violet (*Viola pedatifida*). A rare moss, *Rhodobryum ontariense*, was collected in 1973 in a poplar grove about 1.5 km east of Clover Bar Road. False dragonhead was collected in 1918 from a wooded ravine in the North Clover Bar area of Edmonton. False dragonhead is currently listed as SU (provincial status unknown), most likely because its rank is being reassessed as a result of numerous recent collections. Smooth sweet cicely is an S2 species that was collected in 1994 in a nearby ravine in the North Saskatchewan River valley. Herriot's sagewort is an S2 species that was collected in 1917 on the bank of the North Saskatchewan River at the mouth of Oldman Creek and also in 1999 on a disturbed site between bridges at Bretville Junction in Edmonton. Crowfoot violet is an S2 species that was found in 2001 in a small patch of remnant prairie near Highway 21, south of Fort Saskatchewan. None of the species mentioned above were observed during the 2008 and 2009 vegetation and rare plant surveys.

4.1.6 Wildlife

4.1.6.1 Methods

Habitat Characterization

Habitat present within the study area was described from vegetation mapping developed for this environmental assessment (Figures 4.2a-f). A regional study area was established primarily based on ecological boundaries relevant for those animals with large home range requirements that are likely to occur in the NEAHD project study area (Figure 4.3). The extent of potential impacts related to the proposed project was also considered in selecting the study area. The regional wildlife study area was bounded north of Manning Drive to the north, Highway 21 to the east, Whitemud Drive to the south and 17 Street to the west. The local study area, the same as that used for vegetation, addressed species with smaller area requirements.

Literature Review

Alberta Tourism, Parks and Recreation conducted database searches of the Alberta Conservation Information Management System (ACIMS) (formerly ANHIC) and the Fisheries and Wildlife Management Information System (FWMIS), respectively, for Manning Drive to Highway 16 East on 03 April 2006 and Highway 216/16 alignment on 24 July 2008. Those searches provided information regarding special status species recorded in the NEAHD regional study area. Environmental assessments to support other proposed roadway infrastructure along Yellowhead Trail (Spencer Environmental 1997) and North Anthony Henday Drive (Spencer Environmental 2007) has resulted in a well-developed understanding of the locations and movement patterns of medium to large-sized animals in the general area.

Wildlife-vehicle collision data

Highway 216/16 Alignment

Alberta Transportation provided two data sets on all recorded wildlife-vehicle collisions along Highways 16 and 216 in 2003 to 2007, respectively (Alberta Transportation 2009). The quality of the records provided for Highway 216 was poor based on the lack of detail in specific collision locations and wildlife species and, because of this, it was not possible to determine the specific location of any of the records. That data is not included in the wildlife-vehicle collision data analysis in this environmental assessment. The quality of the Highway 16 data was better and was reviewed to extract relevant records occurring in the NEAHD project area. When it was not possible to determine the specific location of a collision to within approximately 200 m based on the information contained in the database, those records were deleted.

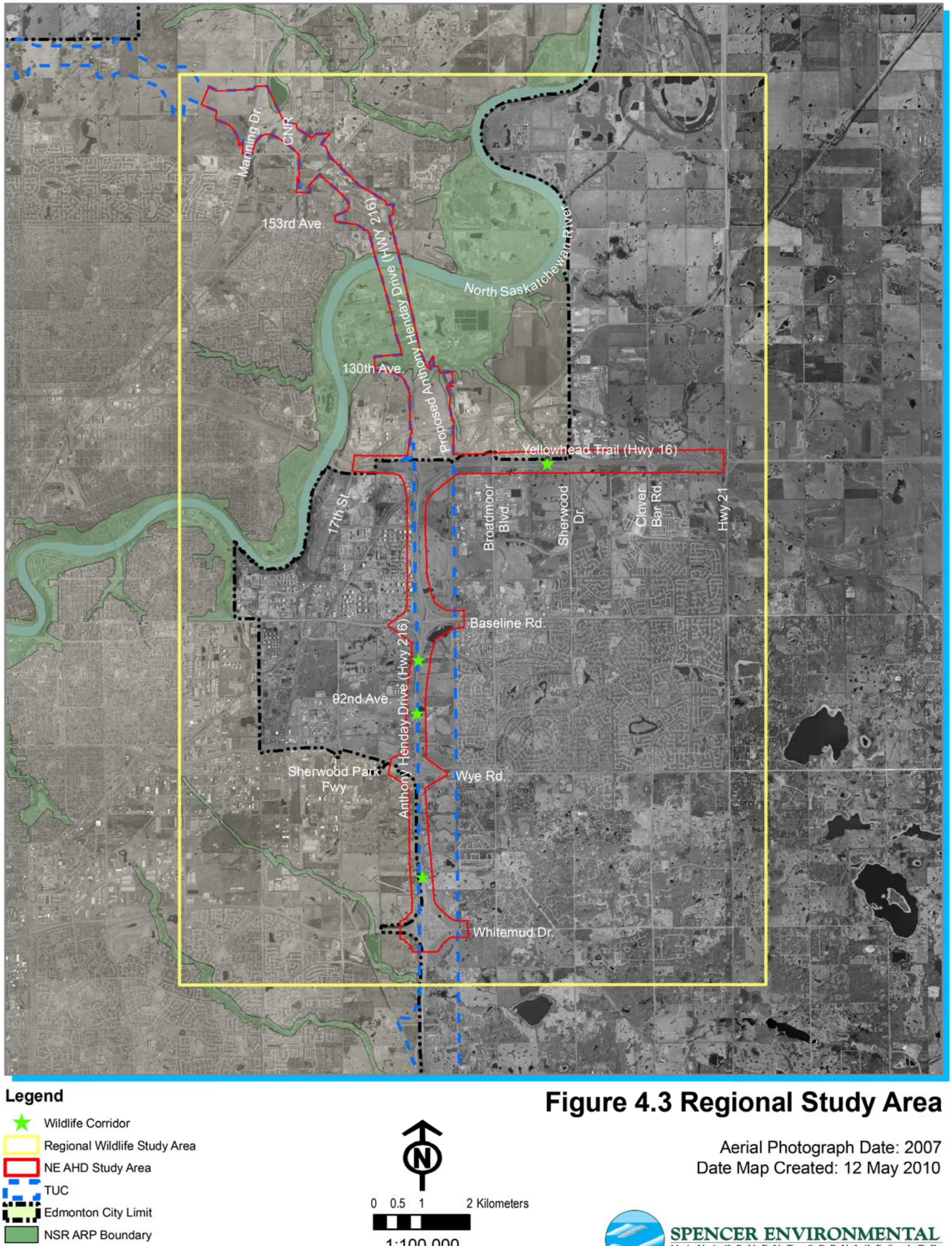


Figure 4.3 Regional Study Area

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

Field Investigations

Amphibian Survey

Amphibian call surveys were conducted at selected wetlands with potential to harbour amphibians in the NEAHD project area. Surveys for the section of Manning Drive to Highway 16 East were conducted on 16, 18 and 19 May 2006, and surveys for the Highway 216/16 alignment were conducted on 13, 14 and 26 May 2008. Twenty eight (28) wetland sites were selected for surveying based on air photo analysis (1: 10,000 2007) and local knowledge of the project area (Figures 4.4a-b). Twenty three (23) of those sites were located in the Highway 216/16 alignment and 5 sites were located in the section between Manning Drive to Highway 16 East (Figures 4.4a-b). A site reconnaissance was conducted prior to the amphibian surveys to confirm that the selected wetland sites contained water and were characteristic of what is generally considered suitable amphibian habitat.

Amphibian call surveys were conducted following standard Alberta Volunteer Amphibian Monitoring Program protocol (Alberta Conservation Association 2006). Specifically, the call survey was conducted at dusk, approximately 30 minutes after sunset, under conditions of low wind speeds and little or no rain. At each site, surveyors waited 2 minutes to allow the animals to settle and then listened for and recorded the number and species of amphibians heard for the next 5 minutes.

Breeding Bird Survey

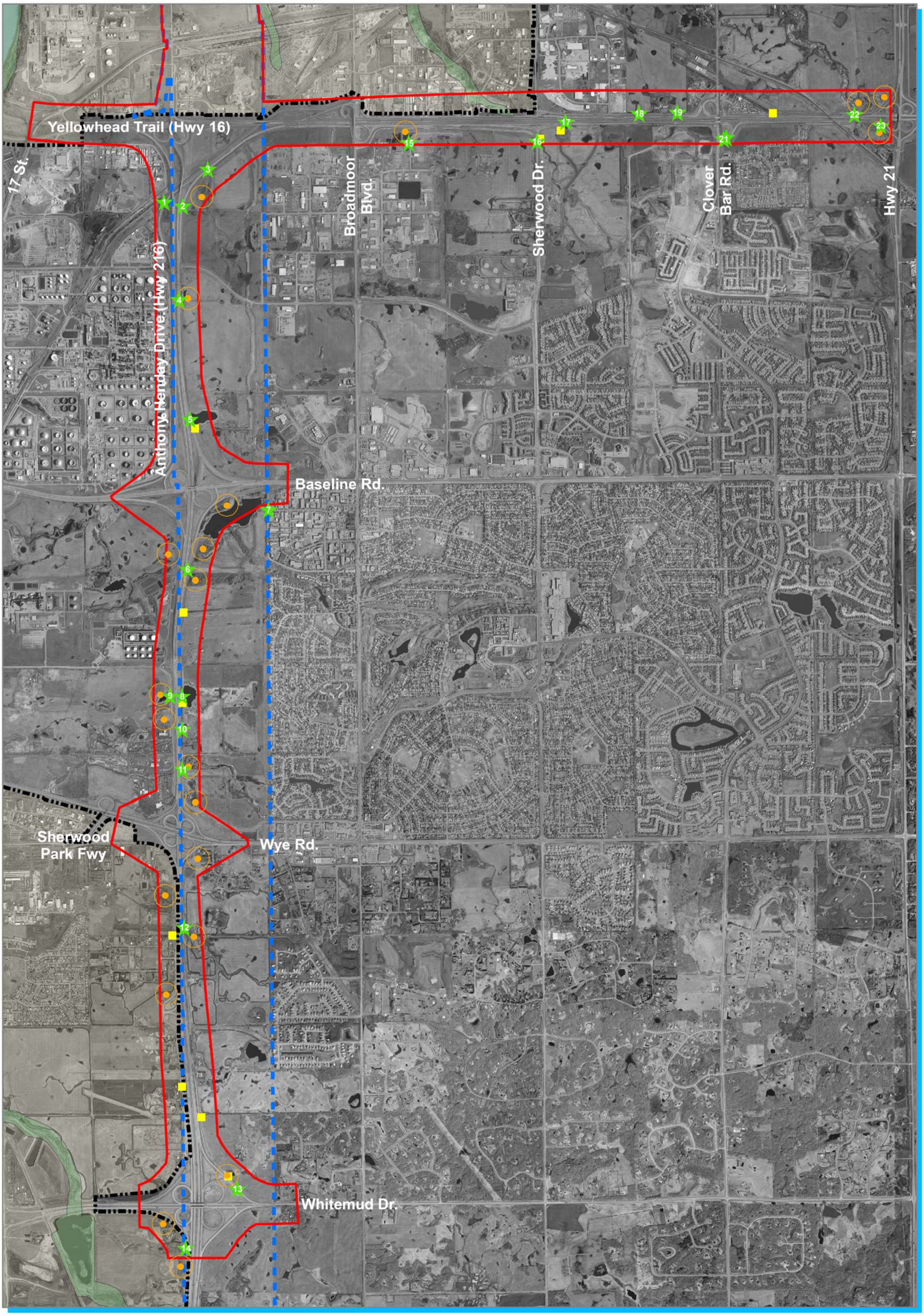
Manning Drive to Highway 16 East

Breeding bird surveys to characterize breeding bird richness and abundance in the section of Manning Drive to Highway 16 East in the NEAHD study area were conducted on 6, 7, 19 and 20 June 2006. The resulting data supplemented information obtained from the literature review. A total of 17 point count stations were surveyed in six major habitat types available in the local study area: deciduous wetland, agricultural field, hedgerow, poplar stand, riparian and wetland (Table 4.12). An 8-minute survey was conducted at each point count station and each station was visited twice. All birds detected within a 50 m and 100 m radius were recorded. All animal observations or signs were documented and described in terms of presence and habitat use.

Highway 216/16 Alignment

Breeding bird surveys to characterize breeding bird species richness and abundance were conducted during two separate surveys, allowing 10 days between the first and second survey. The first survey was conducted on 9 and 10 June 2008 and the second survey was conducted on 19 and 20 June 2008. The resulting data supplemented information obtained from the literature review.

Breeding bird surveys were conducted using point-count stations and fixed-width transects. A total of 19 point count stations (Figures 4.4a-b) were surveyed in eight (8) major habitat types available in the local study area: aspen/riparian, aspen woodland, aspen/wetland, crop/wetland, pasture/mixedwood, pasture/wetland, wetland-aspen/willow



Legend

- NE AHD Study Area
- TUC
- NSR ARP Boundary
- Edmonton City Limit

Amphibian Survey Location
- Manning Drive to Highway 16 East
- Highway 216/16 Alignment

Breeding Bird Survey

Point Count Location (with 100m buffer)
- Manning Drive to Highway 16 East
- Highway 216/16 Alignment

Transect Location
- Manning Drive to Highway 16 East
- Highway 216/16 Alignment

Note: Site numbers refer to amphibian survery sites.

N

0 0.5 1 2 Kilometers

1:32,000

Figure 4.4a Breeding Bird and Amphibian Survey Locations

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

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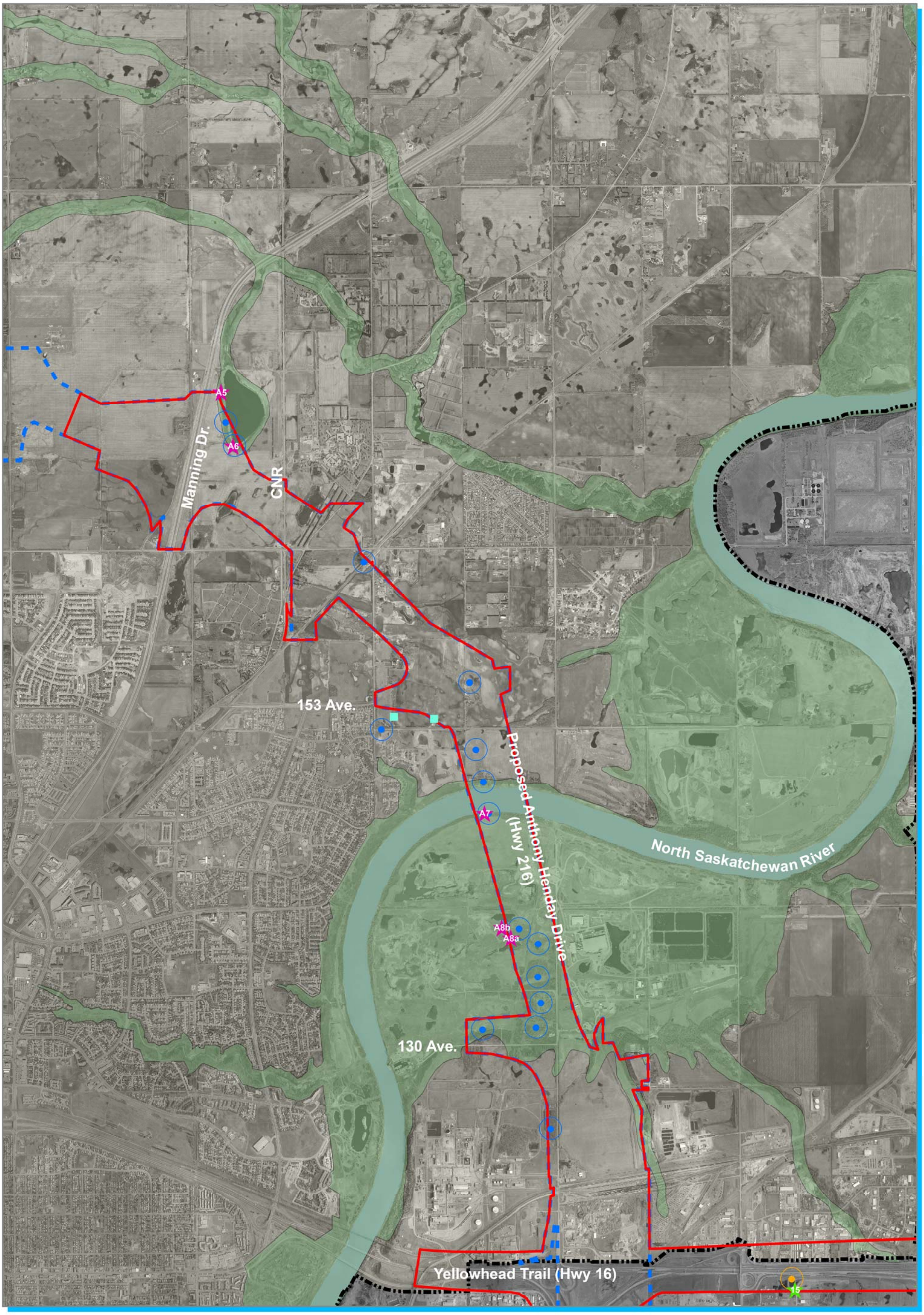

Legend

- NE AHD Study Area
- TUC
- NSR ARP Boundary
- Edmonton City Limit

Amphibian Survey Location
- Manning Drive to Highway 16 East
- Highway 216/16 Alignment

Breeding Bird Survey

Point Count Location (with 100m buffer)
- Manning Drive to Highway 16 East
- Highway 216/16 Alignment

Transect Location
- Manning Drive to Highway 16 East
- Highway 216/16 Alignment

Note: Site numbers refer to amphibian survery sites.

N

0 0.5 1 2 Kilometers

1:32,000

Figure 4.4b Breeding Bird and Amphibian Survey Locations

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

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fringe and wetland–willow fringe (Table 4.12). An 8-minute survey was conducted at each point count station and each station was visited twice. All birds detected within a 100 m radius were recorded. Wetlands containing water were scanned for presence of wetland- and water-associated birds and recorded.

A total of eight (8) transects were surveyed in seven major habitat types available in the local study area: aspen hedgerow, aspen hedgerow/caragana, aspen hedgerow/crop, aspen hedgerow/wetland/crop, caragana hedgerow/tilled, mixedwood hedgerow/crop and riparian/crop (Table 4.12). Transects were walked and all birds were detected within a distance of 40 m on either side of the transect (total transect width of 80 m). All animal observations or signs were documented and described in terms of presence and habitat use. Three (3) waterbody habitat types were surveyed within the study area. Waterbodies were surveyed for presence of bird species by scanning the area with binoculars and recording the number of males of each species observed (Table 4.12). Only breeding males of each species were considered in the total number counted at each waterbody. However, due to the difficulty of visual determination of sex of some waterbird/waterfowl species such as American coots, the observation number of those species may have resulted in an overestimate.

Table 4.12. Habitat Types Surveyed for NEAHD Breeding Bird Surveys – May 2006 and 2008

Habitat Type	**Description**
Point Count Stations	
Manning Drive to Highway 16 East	
Agricultural field	Cultivated field
Deciduous wetland	Wetland surrounded by deciduous trees
Hedgerow	Narrow strip of vegetation (e.g.,shrubs, trees)
Poplar	Poplar dominated tree stand
Riparian	North Saskatchewan River valley
Wetland	Wetland vegetation only
Highway 216/16 Alignment	
Aspen riparian	A drainage or creek within an aspen stand
Aspen woodland	Aspen stand
Aspen/wetland	Wetland surrounded by aspen
Crop/wetland	Crop field with a small wetland within the 100m radius
Tame pasture/mixedwood	Tame pasture, aspen and spruce trees
Tame pasture/wetland	Tame pasture, wetland with treed fringe, cattails and sedge
Wetland, aspen-willow fringe	Wetland surrounded by a mix of aspen and willow
Wetland, willow fringe	Wetland surrounded by willow
Transects	
Highway 216/16 Alignment	
Aspen hedgerow	Aspen hedgerow
Aspen hedgerow/caragana	Hedgerow mix of caragana and aspen
Aspen hedgerow/crop	Aspen hedgerow in crop field
Aspen hedgerow/wetland/crop	Aspen hedgerow in crop field containing wetland(s) within 80 m width of transect
Caragana hedgerow/tilled field	Caragana hedgerow in tilled field
Mixed hedgerow/crop	Hedgerow mix of caragana, aspen and spruce within crop field

Riparian/crop	Drainage/riparian in crop field
Waterbodies	
Highway 216/16 Alignment	
Open water pond/wetland-willow fringe	Open water pond/wetland with willow fringe
Open water pond/wetland-aspen/willow fringe	Open water pond/wetland with mix of aspen and willow fringe

Wildlife Tracking

Manning Drive to Highway 16 East

Winter wildlife tracking was conducted on 14 and 21 March 2006 along the north and south banks of the North Saskatchewan River. The primary objective of the winter tracking was to assess wildlife movement in potential wildlife corridor movement areas. Snow tracking transects were established systematically in the two target areas. Each wildlife track that crossed each transect was counted (for medium and large-sized species) during the survey, including those that were known or suspected to have been created by the same individual (Alberta Biodiversity Monitoring Institute 2009). Surveys were conducted between two and seven days after a track-obliterating snowfall (i.e., >1 cm; Moses *et al* 2001). Each track was identified to species and direction of travel was determined. Any additional behavior of interest (e.g., turning back from a roadway) was documented. Where it appeared that more than one individual had created the track, the number of individuals involved up to a maximum of three was estimated. The tracks were recorded as "trails" in cases where it appeared that four or more individuals had traveled along the same route.

Highway 216/16 Alignment

A winter wildlife tracking survey of the Highway 216/16 alignment was completed on 31 January 2009. At the time of the survey, the last track-obliterating snowfall (i.e., >1cm; and the time from which wildlife tracks would have had the chance to accumulate) occurred on 12 January 2009, 19 days prior to the survey. Between that snowfall and the tracking survey, the Edmonton area experienced unseasonably mild weather, strong winds and a few light (<1cm) snowfalls. The tracking conditions at the time of the survey, therefore, were generally quite poor (i.e., melted, glazed and often dirty snow). Despite this, snow conditions were relatively consistent along the alignment, making it possible to collect data that would be representative of the wildlife crossing situation along Highways 216 and 16 in the project study area.

The tracking survey consisted of a 'roadside' survey of the highway's edge and ditch. Tracking was completed from a vehicle traveling along the shoulder of the highway at approximately 15 km/h. Each time the surveyor observed a track, they performed a closer visual inspection in an effort to identify the track to species. The surveyor also stopped and conducted a more thorough search of areas previously identified as potential wildlife crossing areas (based on interpretation of aerial photography).

Highway 16 was surveyed along the north edge of the westbound lanes beginning at Highway 21. A total of 5.0 km was surveyed along Highway 16; the eastern 1.5 km was not surveyed because of untrackable snow conditions and unsafe traffic conditions. Highway 216 was surveyed beginning 1.5 km south of Highway 16, at a point where the east bound lanes of Highway 16 merge with the southbound lanes of Highway 216. Highway 216 was tracked along the west edge of the southbound lanes. The first 1.5 km of Highway 216 was not tracked because of untrackable snow conditions and unsafe traffic conditions. A total of 8.2 km was surveyed along Highway 216, extending south to Whitemud Drive.

Tracking results were grouped into kilometer segments along each highway. When interesting associations between track locations and landscape features were observed, these were recorded.

4.1.6.2 Description

Background

Based on information obtained from current provincial distribution, local records and field investigations, a total of 234 species (amphibian, reptiles, birds and mammals) *may occur* in the regional study area (Appendix I). Occurrence refers to species residing year round, during the breeding season only, during the winter, and, more briefly, migrating annually or dispersing through the area. Many of the more common species are those tolerant of human activity.

The extent of urban, agricultural and industrial development throughout the NEAHD project study area likely influences the habitat selection of species potentially occurring in the regional study area. There are, however, relatively large patches of upland and wetland vegetation that have the potential to support species less tolerant of disturbance. For example, the wetlands in the project study area, including the wetlands in the TUC, including Moran Lake east of Manning Drive and the large wetland on the east corner of Highway 216 and Baseline Road, provide staging and breeding habitat for waterfowl, geese and shorebirds. The fragmented and disturbed habitat within the project study area is most suitable for urban-adapted species, such as deer, coyote, weasel, small mammals and a variety of bird species.

Wildlife habitat within the local study area is variable. Areas of undisturbed vegetation and wetlands exist but are fragmented throughout the project study area thus creating significant edge habitat for generalist and urban-tolerant species. In contrast, the topography of the North Saskatchewan River valley and the associated vegetation along the river banks provides a more contiguous area of habitat for breeding songbirds and small mammals that require more cover. The river valley also acts as a corridor for wildlife movement throughout the Edmonton area.

Wildlife-Vehicle Collision Data Results

Highway 216/16 Alignment

Among the wildlife-vehicle collision records provided for Highway 16, 44 records were located between the Highway 16/216 interchange in the west and the Highway16/21 interchange in the east. Of the 44 records, 43 of those were collisions involving deer and 1 collision involving a coyote (Alberta Transportation 2009).

The locations of all 44 collisions along the length of Highway 16 within the project area were mapped (Figure 4.5) and compared to the results of the wildlife tracking results conducted on 31 January 2009. The most notable concentration of reported collisions was located at Highway 16 and Sherwood Drive (RR 231 to the north). That area coincides with the southern terminus of a narrow ravine that extends through the light industrial development just north of Highway 16. That area is also the only area where wildlife tracks were observed crossing the highway during the field tracking survey. These data, therefore, support the notion that the ravine facilitates the movement of wildlife, particularly deer, and that the area at its southern end represents an area of frequent roadway crossings.

Though no other location has as many collisions, a few other groupings of wildlife-vehicle collisions were of interest. A group of 5 collisions was reported from the area of the Highway 16/21 interchange. That interchange bisects Oldman Creek and the associated ravine. Similar to the previous example, the ravine likely facilitates the movement of wildlife, funneling animals towards that crossing location. A short distance west, a small concentration of collisions occurred in association with the rail crossing of Highway 16. It is possible that wildlife travel along the rail right-of-way, particularly as it is directly linked to the ravine just north of the highway. A few other small concentrations of collisions were noted; however, those do not appear related to any specific landscape feature.

Amphibian Survey Results

Manning Drive to Highway 16 East

Of the five (5) wetland sites surveyed in the section from Manning Drive to Highway 16 east, amphibian species were heard at 4 sites (Table 4.13). The survey station on the south bank of the North Saskatchewan River (Site A7; Figures 4.4a-b) yielded no amphibians. Boreal chorus frogs were heard at all four sites containing amphibians and wood frogs were heard at 2 of the 5 sites. The presence of wood frogs at the remaining 3 sites could be under represented because wood frogs spawned relatively early in the Edmonton area (mid- to late- April) in 2006 (W. Roberts, pers comm.).

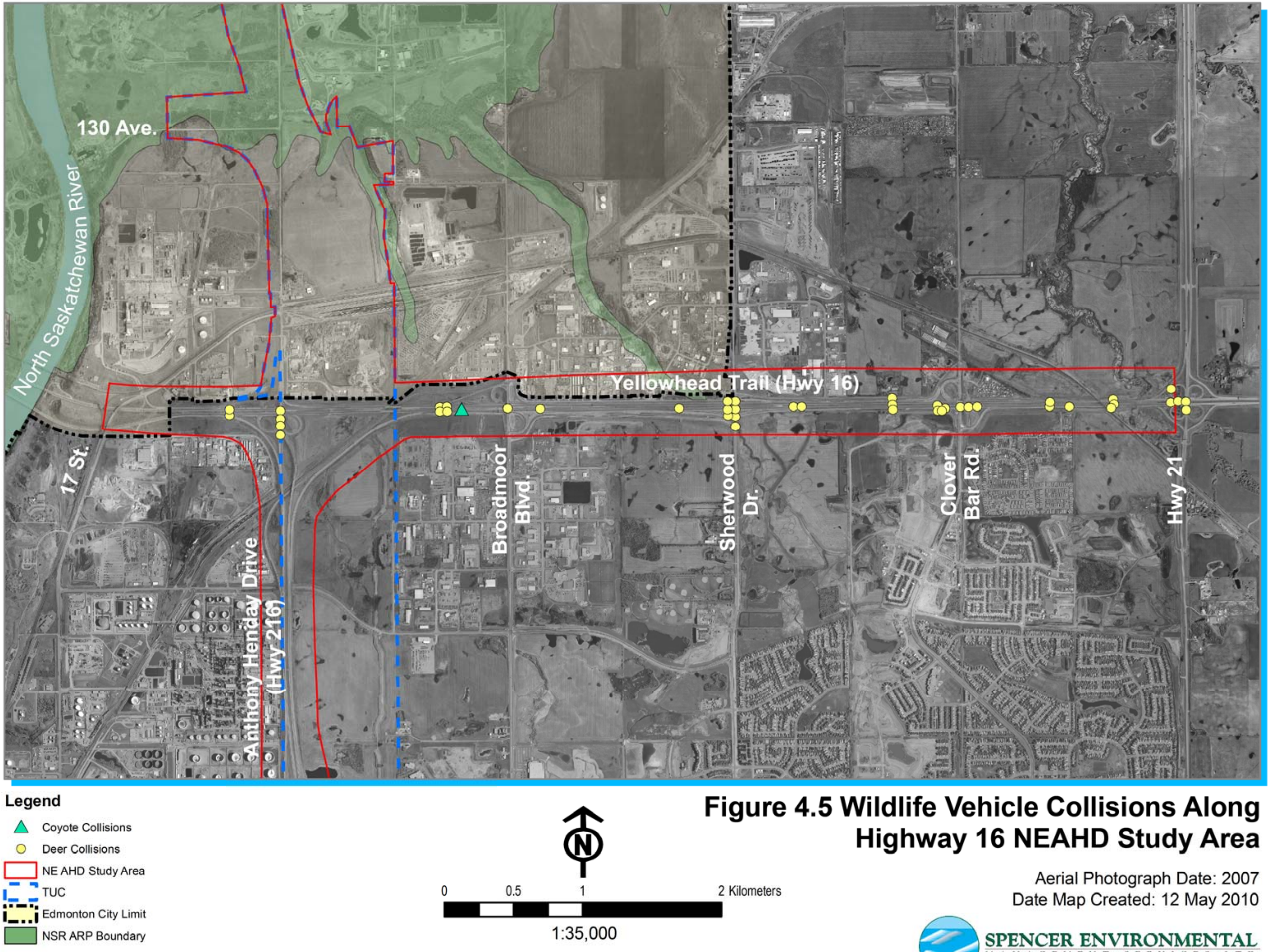

Figure 4.5 Wildlife Vehicle Collisions Along Highway 16 NEAHD Study Area

Aerial Photograph Date: 2007
Date Map Created: 12 May 2010

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Source: Alberta Collision Information System, Alberta Transportation 2009

Table 4.13. Amphibian Survey Results for 5 Wetland Sites along Manning Drive to Highway 16 East in the NEAHD Project Area (Surveyed 16, 18 and 19 May 2006)

	Wetland Site				
Species	**A5**	**A6**	**A7**	**A8a**	**A8b**
Wood Frog	1	1	0	0	0
Boreal Chorus Frog	3	3	0	2	3
Canadian Toad	0	0	0	0	1[b]

[a]Calling Index Codes (after ACA and ASRD 2006): 1 = frog(s) or toad(s) can be counted; no overlapping calls (e.g., 1-3 animals); 2 = individual frogs and toads can be counted; some calls overlapping (e.g., 4-7 animals); 3 = individuals cannot be counted, full chorus; calls overlapping (e.g., 8 or more animals)
[b] Two individuals

Two Canadian toad individuals were heard vocalizing in May 2006 at Site A8b, a man-made pond along the eastern section of the TUC in a former gravel extraction area. No Canadian toads were heard at Site A8a. Two rounds of minnow trapping produced wood frog tadpoles and no Canadian toad tadpoles at Site 8b. Several adult wood frogs were observed on the banks of the north side of the Site 8b wetland during the trapping sessions. The north side of that wetland was also where the most tadpoles were captured. No tadpoles were captured at Site 8a.

Highway 216/16 Alignment

Of the 23 wetland sites surveyed in the Highway 216/16 alignment of the NEAHD study area, amphibian species were heard at 21 sites (Table 4.14). No amphibians were observed at Sites 22 (newly restored creek, very little vegetation) and 20 (drainage ditch lined with rip rap, no vegetation). Boreal chorus frogs were heard at all 21 sites and wood frogs were heard at 9 of the 21 sites (Table 4.14). No toad species were observed.

Table 4.14. Amphibian Survey Results for 23 Wetland Sites in the Highway 216/16 Alignment in the NEAHD Project Area (Surveyed 13, 14 and 26 May 2008)

	Wetland Site																				
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**21**	**23**
Boreal Chorus Frog	1[a]	3	2	3	3	3	2	3	3	3	2	3	3	3	2	2	3	3	3	2	2
Wood Frog	0	0	0	3	2	1	1	1	1	1	0	1	2	0	0	0	0	0	0	0	0

[a]Calling Index Codes (after ACA and ASRD 2006): 1 = frog(s) or toad(s) can be counted; no overlapping calls (e.g., 1-3 animals); 2 = individual frogs and toads can be counted; some calls overlapping (e.g., 4-7 animals); 3 = individuals cannot be counted, full chorus; calls overlapping (e.g., 8 or more animals)

Breeding Bird Survey Results

Manning Drive to Highway 16 East

The results presented in Table 4.15 are a summary of the average bird species density and total number of species (species richness) observed in each of the six (6) habitat types surveyed. The average density was calculated by adding the density of all the species in a habitat type and dividing that by the number of habitat types within the study area.

Only those species observed within the 100 m radius of the point count stations were included in the analysis.

A total of 17 breeding bird survey point count stations were located in the project area of Manning Drive east to Highway 16 and a total of 52 bird species were observed across those stations (Table 4.15). The most common species included yellow warbler, clay-colored sparrow, European starling, song sparrow, red-winged blackbird, house wren, Franklin's gull, and savannah sparrow. Clay colored and Song sparrows were the only species to be observed in all six habitat types. All of those species are common in rural/urban areas and utilize a broad range of habitats.

Table 4.15. Summary Table of Bird Species Density and Diversity in Habitat Types Found in the NEAHD Project Study area – Manning Drive to Highway 16 East (Surveyed 6, 7, 19 and 20 June 2006)

	Habitat						Total (Average) Density in Study Area
Species	**Deciduous Wetland (n=7)**	**Agricultural Field (n=1)**	**Hedgerow (n=2)**	**Poplar (n=4)**	**Riparian (n=2)**	**Wetland (n=1)**	
Alder Flycatcher	0.14			0.24			0.06
American Coot	1.00						0.17
American Crow	0.23		0.16	0.16	0.16	0.32	0.17
American Goldfinch	0.09			0.32			0.07
American Robin	0.09		0.32	0.24		0.64	0.21
American White Pelican[a]					**3.03**		**0.50**
Barn Swallow					0.96		0.16
Black-billed Magpie	0.05			0.32	0.48	0.96	0.30
Black-capped Chickadee	0.05		0.32	0.08			0.07
Brown-headed Cowbird	0.18	0.32	0.16		0.16		0.14
Black Tern	0.55						0.09
Brewer's Blackbird							0.00
Blue-winged Teal	0.55						0.09
Canvasback	0.27						0.05
Clay-colored Sparrow	0.82	0.64	0.32	1.19	0.16	0.32	0.57
Cedar Waxwing	0.09			0.24	0.16		0.08
Chipping Sparrow			0.16				0.03
Cinnamon Teal	0.09						0.02
Eared Grebe	0.23						0.04
European Starling						3.50	0.58
Franklin's Gull	2.27						0.38
Gadwall	0.14						0.02
Gray Catbird				0.00	0.16		0.03
Gray Partridge				0.08			0.01
Green-winged Teal	0.05						0.01
House Wren	0.32	0.32	0.32	0.40	0.16		0.25
Killdeer	0.05						0.01
Le Conte's Sparrow		0.64				0.32	0.16
Least Flycatcher	**0.23**			**0.08**			**0.05**
Lesser Scaup	0.18			0.00			0.03
Lincoln's Sparrow	0.18			0.16			0.06
Mallard Duck	0.64			0.00	0.16		0.13
Marsh Wren	0.05						0.01
Northern Flicker	0.05		0.16	0.08			0.05
Northern Harrier	**0.05**						**0.01**
Northern Shoveler	0.32						0.05
Red-breasted Nuthatch	0.05						0.01
Redhead	0.91						0.15

	Habitat						Total (Average) Density in Study Area
Species	**Deciduous Wetland (n=7)**	**Agricultural Field (n=1)**	**Hedgerow (n=2)**	**Poplar (n=4)**	**Riparian (n=2)**	**Wetland (n=1)**	
Red-eyed Vireo	0.05		0.16	0.24	0.48		0.15
Rock Pigeon	0.14						0.02
Red-tailed Hawk	0.14		0.16		0.16		0.08
Ruddy Duck	0.64						0.11
Red-winged Blackbird	1.14					0.64	0.30
Savannah Sparrow	0.18	1.91	0.16	0.40		0.64	0.55
Sora	**0.14**						**0.02**
Song Sparrow	0.55	0.32	0.48	0.40	0.32	0.64	0.45
Tree Swallow	0.05						0.01
Warbling Vireo	0.14		0.16				0.05
White-throated Sparrow	0.09		0.16	0.24			0.08
Western Wood Peewee						0.32	0.05
Yellow-headed Blackbird	0.14						0.02
Yellow-rumped Warbler	0.05						0.01
Yellow Warbler	0.82		0.16	0.72	0.96	0.64	0.55
Density (#males/ha)	**14.10**	**4.14**	**3.34**	**5.57**	**7.48**	**8.92**	**7.26**
Total # Species (Species Richness)	**44**	**6**	**15**	**18**	**14**	**11**	**52**

[a] Species names that appear in bold denote species listed as Sensitive in the General Status of Wild Species (Government of Alberta 2005).

Deciduous Wetland

This habitat type, a wetland area surrounded by deciduous trees, had the largest number of point count stations (7). A total of 44 species, the highest diversity of all habitat types, were observed at those point count stations, with an average breeding bird density of 14.10 males per ha (Table 4.15). Redhead, Yellow warbler and clay-colored sparrow had the highest densities in this habitat type with 0.91, 0.82 and 0.82 males per ha, respectively (Table 4.15).

Species observed in this habitat included those with a wide variety of habitat preferences, including habitat generalists, forest species, edge-adapted species, forest interior species, wetland-adapted species and those adapted to shrub thickets. Species that prefer willow thickets and shrubby areas adjacent to wet areas, including, yellow warbler, white-throated sparrow, savannah sparrow, red-winged blackbird and Brewer's blackbird. Forest species observed in the poplar stands include least flycatcher, brown-headed cowbird, downy woodpecker, warbling vireo, American robin, cedar waxwing, chipping sparrow and American goldfinch. Ovenbird, a forest interior species, was also observed in this habitat type.

Two of the point count stations, Stations 49 and 50, were located along the edge of Moran Lake, near Manning Drive. Station 50, had the largest breeding bird abundance and diversity of all 17 point count stations, with 25 species observed. The species with the largest density at that station was Franklin's gull. A large number of wetland species, including grebes, terns, teals and gulls, were observed on Moran Lake. The large surface water area at that site, along with the adjacent upland forested habitat, is ideal breeding habitat for many wetland associated species.

Agricultural Field

One point count station was located in an agricultural field, yielding 6 species and an average density of 4.14 males per ha (Table 4.15). This habitat type, while likely not suitable for breeding for most species because of its disturbed nature, provides foraging opportunities for many of the passerines observed at the survey locations including clay-colored sparrow, Le Conte's sparrow, song sparrow and savannah sparrow. The disturbed nature of the cultivated fields surveyed reduced the likelihood that ground nesting species would occur in those areas.

Hedgerow

Two hedgerows were sampled, with 15 species of birds observed at an average density of 3.34 males per ha (Table 4.15). This habitat, much like the previous one, provided habitat for generalist species, but is not suitable for interior specialist species because of the lack of core habitat. The species observed, including American robin, brown-headed cowbird, northern flicker, warbling vireo and white-throated sparrow, follow this trend.

Poplar Stand

A total of 18 species were observed in four stands, with an average density of 5.57 males per ha (Table 4.15). The species with the highest densities were yellow warbler (0.72 males/ha), house wren (0.40 males/ha), savannah sparrow (0.40 males/ha) and song sparrow (0.40 males/ha). Some of the species observed, including northern flickers, are commonly found at forest edges. Others, such as American crow, black-billed magpie and black-capped chickadees are habitat generalists that occur in a variety of habitats. Based on the bird species observed in the poplar stands, there is suitable habitat for a variety of species including forest interior, edge- adapted and generalist species.

Riparian

Two point count stations were located along the North Saskatchewan River at the proposed river crossing. Fourteen bird species were observed with an average density of 7.48 males per ha (Table 4.15). Pelicans and mallard ducks were observed on the river. Species observed in the riparian woody vegetation include forest species such as cedar waxwing, clay-coloured sparrow, gray catbird, red-tailed hawk, song sparrow and yellow warbler.

Wetland

One point count station was located within entire wetland areas. Eleven (11) species were observed with an average density of 8.92 males per ha (Table 4.15). Although this habitat type did not have the greatest diversity of species, it had the second highest density compared to all other habitat types. Red-winged blackbird and Franklin's gull are two species commonly found near marshes and were observed at the wetland site. Emergent and shrubby vegetation provided habitat for the passerine bird species observed including clay-coloured sparrow, Le Conte's sparrow, savannah sparrow and song sparrow.

Highway 216/16 Alignment

Point Count Surveys

A total of 21 breeding bird survey point count stations were located throughout Highway 216/16 alignment within the NEAHD study area and a total of 49 bird species were observed across those stations (Table 4.16). The most common species included red - winged blackbird, song sparrow, yellow warbler, savannah sparrow, black-billed magpie, black-capped chickadee and least flycatcher. Those species are known to be habitat generalists, utilizing a wide range of habitats available in the area. Song sparrow, house wren and savannah sparrow were observed in seven of the eight habitat types. Three species, least flycatcher, sora, and common yellowthroat are listed as Sensitive by the Government of Alberta (2005). For a discussion of those species, see Special Status Species below. Overall, the species composition of the study area was relatively typical of an urban-dominated aspen parkland area.

Table 4.16. Avian Species and Numbers Observed at the NEAHD – Highway 216/16 Alignment Point Count Survey Sites During the Breeding Bird Survey (09, 10, 19 and 20 June 2008)

	Density (# males/ha)								
Species	**Aspen riparian (n=3)**	**Aspen woodland (n=5)**	**Aspen/ wetland (n=1)**	**Crop/ wetland (n=1)**	**Tame pasture/ mixedwood (n=1)**	**Tame pasture/ wetland (n=1)**	**Wetland, aspen-willow fringe (n=5)**	**Wetland, willow fringe (n=2)**	**Total (average) Density in Study Area**
American coot							0.13	0.32	0.06
American crow	0.32	0.25				0.32			0.11
American goldfinch	0.11	0.19					0.19		0.06
American robin	0.21				0.32		0.25	0.16	0.12
American tree sparrow	0.11	0.06							0.02
Barn swallow	0.11								0.01
Black-billed magpie	0.74	0.45	0.32	0.32			0.19	0.16	0.27
Black-capped chickadee	0.11	0.25	1.27				0.06		0.21
Blue-winged teal			0.32				0.19	0.32	0.10
Brown-headed cowbird	0.53	0.06	0.64				0.06	0.16	0.18
Brewer's Blackbird	0.32								0.04
Cedar waxwing	0.21		0.64				0.13		0.12
Chipping sparrow		0.06							0.01
Clay-colored sparrow	0.64	0.70		0.96	0.96		0.45	0.48	0.52
Common goldeneye							0.06		0.01
Common yellowthroat[a]						**0.32**			**0.04**
Dark-eyed junco		0.19							0.02
Downy woodpecker					0.32		0.06		0.05
European starling	0.11				0.32		0.06		0.06
Gadwall							0.13	0.32	0.06
Gray catbird	0.11								0.01
House sparrow		0.13			0.32				0.06
House wren	0.32	0.51	0.96	0.32	0.64		0.64	0.32	0.46
Killdeer							0.06		0.01

Species	Density (# males/ha)								
	Aspen riparian (n=3)	Aspen woodland (n=5)	Aspen/ wetland (n=1)	Crop/ wetland (n=1)	Tame pasture/ mixedwood (n=1)	Tame pasture/ wetland (n=1)	Wetland, aspen-willow fringe (n=5)	Wetland, willow fringe (n=2)	Total (average) Density in Study Area
Le Conte's sparrow		0.13						0.32	0.06
Least flycatcher	**0.32**	**0.06**	**0.96**						**0.17**
Mallard			0.32					0.32	0.08
Mourning warbler		0.06					0.06		0.02
Northern shoveler							0.13	0.16	0.04
Pine siskin			0.32						0.04
Red-breasted nuthatch		0.06							0.01
Redhead							0.13	0.32	0.06
Red-eyed vireo	0.11	0.13							0.03
Red-tailed hawk							0.06		0.01
Red-winged blackbird	0.42		0.64	0.32		5.73	1.78	0.80	1.21
Ring-necked duck							0.19		0.02
Rock dove	0.85								0.11
Ruddy duck							0.06		0.01
Savannah sparrow	0.32	0.25		0.64	0.96	0.64	0.25	0.16	0.40
Sora			**0.32**				**0.19**		**0.06**
Song sparrow	0.85	0.38	0.64	0.96	0.64		0.51	0.16	0.52
Tennessee warbler		0.19							0.02
Tree swallow	0.11								0.01
Warbling vireo	0.11								0.01
Western wood-peewee		0.06							0.01
White-throated sparrow		0.13							0.02
Yellow-headed blackbird						0.32			0.04
Yellow-rumped warbler		0.06					0.06		0.02
Yellow warbler	0.53	0.32	1.91			0.32	0.70	0.16	0.49
Density (#males/ha)	7.54	4.71	9.55	3.50	4.46	7.64	6.88	4.62	6.11
Total # Species (Species Richness)	23	23	13	6	8	6	27	16	49

[a] Species names that appear in bold denote species listed as Sensitive in the General Status of Wild Species (Government of Alberta 2005).

The wetland-aspen/willow fringe habitat type contained the highest bird species richness; 27 of the 49 listed species (Table 4.16). The aspen/wetland habitat type supported the highest density of breeding birds (9.55), whereas crop/wetland habitat type supported the lowest species richness and diversity (6 and 3.50, respectively) (Table 4.16). Species richness was the same in the aspen-riparian and aspen stand habitat types (23 species) as well as between the crop/wetland and tame pasture/wetland habitat types (6 species) (Table 4.16).

Most of the species observed during the breeding bird survey included habitat generalists, species that occur in a wide range of habitats, including American robin, least flycatcher, black-billed magpie and yellow warbler. Secondary cavity-nesters included black-capped chickadee, red-breasted nuthatch, tree swallow, and house wren. Those species prefer using an existing woodpecker hole or cavity for nesting (Fisher and Acorn 1998). Clay-colored, Le Conte's, savannah, song and white-throated sparrows, common yellowthroat and Tennessee warbler nest on the ground or close to the ground, in the grass or under small shrubs (Fisher and Acorn 1998).

Wetland-associated habitat conditions were variable in that some wetlands contained water and others were dry because of drought conditions. Waterfowl species including blue-winged teal, common goldeneye, American coot, gadwall, mallard, northern shoveler, redhead, ring-necked duck and ruddy duck were specific to wetlands containing water because they are water-dependent species. Other wetland-associated bird species include red-winged blackbird, yellow-headed blackbird and sora. Red-winged and yellow-headed blackbirds prefer cattail marshes, wet meadows, croplands and shoreline shrubs (Fisher and Acorn 1998). Soras prefer wetlands with abundant emergent cattails, bulrushes, sedges and grasses (Fisher and Acorn 1998).

Transect Surveys

A total of eight transects were located throughout the Highway 216/16 alignment in the NEAHD project area and a total of 22 bird species were observed within those transects (Table 4.17). Transects were surveyed for species presence/absence only, therefore, densities were not calculated (Table 4.17). The most common species included American robin, clay-colored sparrow, savannah sparrow, song sparrow and yellow warbler. Those species are known to be habitat generalists, utilizing a wide range of habitats available in the area, as was presented in the results of the point count surveys. Clay-colored sparrow was found in all seven of the transect habitat types. One species, sora, is listed as Sensitive by the Government of Alberta (2005). For a discussion of that species, see Special Status Species below.

The aspen hedgerow/crop habitat type supported the highest bird species richness with 14 of the 22 observed species, whereas the caragana hedgerow/tilled habitat type supported the lowest species richness (3) (Table 4.17). The addition of aspen to a caragana stand introduces a less horizontal and more vertical habitat structure, resulting in a greater tree canopy and thus, more bird species present in the area. Species richness was the same in the aspen hedgerow and aspen hedgerow/wetland/crop habitat types (9) (Table 4.17). Three species including cedar waxwing, gull species, and red-tailed hawk were observed in only one of the seven transect habitat types. Cedar waxwings prefer forest edges, deciduous forests, shrublands and riparian woodlands and red-tailed hawks prefer open country with trees, roadsides, fields and mixed forests (Fisher and Acorn 1998). The gulls observed were difficult to identify to a species level because of their distance from the observer. Gulls can be found in a variety of habitat types and it is typical to observe gulls in agricultural fields feeding on terrestrial invertebrates (Fisher and Acorn 1998).

Table 4.17. Avian Species Observed at the NEAHD Transect Survey Sites During the Breeding Bird Survey (09, 10, 19 and 20 June 2008)

Species	Habitat						
	Aspen hedgerow (n=1)	**Aspen hedgerow/caragana (n=1)**	**Aspen hedgerow/crop (n=2)**	**Aspen hedgerow/wetland/crop (n=1)**	**Caragana hedgerow, tilled (n=1)**	**Mixedwood hedgerow/crop (n=1)**	**Riparian, crop (n=1)**
American crow	√					√	
American robin	√	√	√	√		√	
Black-billed magpie	√		√	√			
Black-capped chickadee		√	√	√			
Brown-headed cowbird	√		√	√			
Brewer's blackbird					√	√	
Cedar waxwing						√	
Chipping sparrow	√					√	
Clay-colored sparrow	√	√	√	√	√	√	√
Downy woodpecker		√	√				
European starling			√				
Gull sp			√				
House sparrow			√			√	
House wren			√	√			
Le Conte's sparrow			√			√	
Mallard							√
Red-tailed hawk	√						
Red-winged blackbird	√		√				√
Savannah sparrow			√	√	√	√	√
Sora[a]							√
Song sparrow	√	√	√	√			√
Yellow warbler		√		√		√	
Total # species (n=22) (Species richness)	**9**	**6**	**14**	**9**	**3**	**10**	**6**

[a] Species names that appear in bold denote species listed as Sensitive in the General Status of Wild Species (Government of Alberta 2005).

Waterbodies

A total of 26 bird species were observed in three waterbody habitat types within the study area (Table 4.18). There was an abundance of American coots in both open water pond/wetland habitats (Table 4.18). American coots prefer shallow marshes, ponds and wetlands with open water and emergent vegetation (Fisher and Acorn 1998). Redhead and red-winged blackbird were also observed in large numbers throughout the study area. Redheads prefer large wetlands with emergent vegetation (Fisher and Acorn 1998) while red-winged blackbirds are a more generalist species that tolerate a wider variety of wetland habitat conditions including cattail marshes, wet meadows, croplands and shoreline shrubs (Fisher and Acorn 1998). Five (5) species, common yellowthroat, horned grebe, pied-billed grebe and sora are listed as Sensitive by the Government of Alberta (2005). For a discussion of those species, see Special Status Species below.

Table 4.18. Avian Species and Numbers Observed at the NEAHD Waterbody Survey Sites During the Breeding Bird Survey (09, 10, 19 and 20 June 2008)

Species	Open water pond/wetland, aspen/willow fringe	Open water pond/wetland, willow fringe	Total
American coot	30	19	49
American robin	1		1
American wigeon	1	1	2
Blue-winged teal	2	4	6
Brewer's blackbird	1		1
Canadian goose	1	2	3
Clay-colored sparrow			1
Common goldeneye		1	1
Common yellowthroat[a]		**1**	**1**
Eared grebe		1	1
Gadwall	2	3	5
Horned grebe		**1**	**1**
Killdeer	1		1
Lesser scaup		**1**	**1**
Lesser yellowlegs			1
Mallard	2	4	7
Northern shoveler		2	2
Pied-billed grebe	**1**		**1**
Redhead	8	4	12
Red-winged blackbird	7	8	15
Ring-necked duck	1	2	3
Ruddy duck	4	2	6
Savannah sparrow			2
Sora	**1**	**1**	**2**
Spotted sandpiper			1
Tree sparrow	3	1	4
Total # species (species richness)	**16**	**18**	**29**
Total breeding males	**66**	**58**	**130**

[a] Species names that appear in bold denote species listed as Sensitive in the General Status of Wild Species (Government of Alberta 2005).

Observations during site reconnaissance

Sixteen bird species were observed during the site reconnaissance conducted on 26 May 2008. All of the species were wetland-associated birds observed on or near the large open water wetlands within the NEAHD project study area. Those species included red-winged blackbird, green-winged teal, mallard, American coot, ring-necked duck, bufflehead, redhead, northern shoveler, tree swallow, lesser scaup, blue-winged teal, gadwall, Canada goose, canvasback, sora and song sparrow.

Of those species, three of them are provincially listed as Sensitive (Government of Alberta 2005) including green-winged teal, sora and lesser scaup. For a discussion of those species, see Special Status Species below.

Wildlife Tracking

Manning Drive to Highway 16 East

North Saskatchewan River – North Bank

Coyote, deer and hare tracks were observed on the top-of-bank of the north side of the river. Coyote tracks oriented in a north/south direction were concentrated in the tire tracks leading south of 153 Avenue onto the TUC and adjacent new residential development areas and along the north side of the shrubs along the top-of-bank. Tracks also crossed the TUC in an east-west direction in several locations.

Deer, coyote and hare tracks also crossed the open area north of the farm adjacent to the western edge of the TUC. The top strand of a 4-strand barbed wire fence running in a north/south direction west of the driveway was bent in one location where deer crossed over the fence in an east/west direction. Coyote and hare tracks crossed under the fence in several locations along that same fence line.

Deer tracks, located south of 153 Avenue adjacent to the western edge of the TUC, headed from the road ditch and hedgerow and across the cleared area south of 153 Avenue. There were also tracks along the south side of the hedgerow on the south side of 153 Avenue heading to the west toward two large overgrown mounds of soil in the northwestern corner of the residential development parcel. Gray partridge tracks and burrows were also observed between the hedgerow and the cultivated area at the western edge of the TUC. In addition, abundant hare tracks were observed along the hedgerow and south of the hedgerow in the cultivated field.

Deer used the top-of-bank area of the north side of the river extensively. There were approximately 7 sets of deer tracks along the north side of the vegetation at the top-of-bank in the TUC area. Tracks headed to the northeast and northwest across the cultivated field and along the top-of-bank to the east toward a house and a small clearing in the vegetation at the eastern edge of the TUC. There was a concentrated area of deer activity in that clearing with tracks, pellets, browse and beds in the snow. Immediately west of that clearing was a steep ravine and it appeared that that ravine may act as a barrier to deer. There was a relatively well-defined trail leading down the steep bank from the small clearing with fresh deer tracks on it. It seems that deer may use that trail to travel to the top-of-bank to the clearing from below and along the edge of vegetation across the top of the ravine. There were also trees with stripped bark in the clearing and ravine, indicating porcupine use. In addition, there were deer, hare, grouse and squirrel tracks in the ravine.

Three sets of coyote tracks were located along the edge of the river on the ice on the north river bank and two more sets of tracks were visible on the river ice at the edge where there was open water. No deer tracks were observed along the edge of the river or on the ice. Hare tracks were observed throughout the shrub understory on the steep riverbank. Swallow nest holes were observed in the riverbank in a large slump area below the farm on the western edge of the TUC.

North Saskatchewan River – South Bank

The south river bank and two adjacent shallow terraces contained many animal tracks. Deer and coyote tracks were located along the river bank at the water's edge. High numbers of mule deer have been previously observed on the south side of the river and to the west of the proposed alignment (J. Folinsbee, pers. comm.). Deer, squirrel and hare tracks were observed along the two river bank terraces and up to the edge of the riparian vegetation at the top-of-bank. One set of grouse tracks was also observed parallel to one of the tracking transects. Hare tracks were abundant along the southern edge of the riparian vegetation and into the adjacent grassland. A possible weasel track was noted on the raised embankment on the east side of the TUC alignment.

Highway 216/16 Alignment

A total of 13.2 km (81%) of the entire 16.3 km alignment was surveyed. A total of 30 tracks were observed, with only 6 of those being identifiable to species (4 deer, 2 coyote). The remaining 24 tracks were unidentifiable to species, although it is highly likely that all of those tracks were of either deer or coyote (Appendix I).

Tracks were observed crossing Highway 16 in only one location: where a narrow ravine meets the highway (Figure 4.5). Both deer (2) and coyote (2) were confirmed as crossing at this location. This ravine extends northward through an area of industrial development, then agricultural land before merging with the North Saskatchewan River (NSR) valley near the Clover Bar Landfill (Edmonton Waste Management Centre). Despite being fragmented by road and rail crossings, and being degraded by adjacent industrial land uses this ravine appears to continue to function, to some degree, as a movement corridor for deer and coyote traveling between the NSR valley and surrounding 'tableland' areas. Much of the industrial development along the north side of Highway 16 includes extensive chain-link fencing, making much of the area impermeable to all but the smaller terrestrial species. This likely enhances the functionality of the ravine as the only 'fence-free' corridor through the area. Because of the extensive use of fencing, upon exiting the ravine, any wildlife having traveled from the NSR valley have little choice but to cross Highway 16 at this location. Interestingly, one of the coyotes appears to have traveled through a culvert beneath the access road just north of Highway 16 before crossing the Highway (Plate 4.29).

Plate 4.29. Coyote tracks passing through a culvert beneath the access road north of Highway 16

Highway 216 was crossed much more frequently compared to Highway 16, with 25 of the 30 (83%) observed tracks occurring along this highway. No tracks were, however, observed crossing Highway 216 between Highway 16 and 101 Ave./Baseline Rd. Along this stretch, petro-chemical industrial development dominates the west side of the highway and, combined with the extensive use of chain-link fencing, presents an impenetrable barrier to terrestrial wildlife movement.

The stretch of Highway 216 between 101 Ave./Baseline Rd. and Sherwood Park Freeway/Wye Rd. comprised two areas of concentrated wildlife crossing activity (Figure 4.5). The first was associated with an east-west linear woodland on the east side of the highway (tracking KM 2.56; road KM 4.06). At this location, lands immediately to the east of the highway consist of a woodland, cultivated agricultural fields and a large wetland located a short distance to the north. To the west of the highway, there is some industrial development, but much land remains agricultural, with many small wetlands present. The combination of agricultural fields, which provide foraging habitat, and the woodland, which provides some protective cover, makes this area among the most suitable wildlife habitat along the alignment. This same combination of factors is also present a short distance to the south (tracking KM 3.70; road KM 5.20) where wetlands are present on both the east and west sides of Highway 216.

In particular, the wetland to the west is associated with a wooded riparian area that extends to the west along the edge of an agricultural field. It is likely that these features would 'funnel' wildlife into a relatively narrow movement corridor where they intersect with Highway 216. The only other notable concentration of tracks was observed towards the south end of the alignment at KM 7.2 (road KM 8.7) in association with a small woodland and farmstead to the west of Highway 216, and agricultural lands to the east. This southern portion of the alignment supports the least amount of development of the entire project area and, accordingly, remains as some of the most suitable habitat for deer and coyote, both of which are well adapted to the mosaic of remnant wooded areas, hedgerows and cultivated fields typical of the agricultural landscape.

Wildlife Movement Corridors

Open spaces, such as highly developed agricultural or urban regions, are barriers to wildlife movement and dispersal. In such cases, wildlife corridors play a key role in wildlife dispersal because they serve as links between larger habitat areas, accommodating daily, seasonal or dispersal movements that enable genetic exchange and access to other resources (Paquet *et al.* 2004). The viability of an area as a wildlife corridor is a function of the continuity in its vegetation structure, its width, the amount and type of surrounding disturbance and the quality of the habitat it connects. Major wildlife corridors provide cover and resources, connecting large areas of habitat at a regional scale. Those corridors are wide, and can support a high diversity of species. Minor wildlife corridors provide only limited cover and resources, lack continuity in vegetation structure, and cannot support as wide a variety of species. Wide-ranging species such as deer need functional linkages between essential habitats to satisfy all life-stage requirements including food, cover, shelter and reproduction (access to potential mates). Even smaller, but still highly-mobile animals, like songbirds, utilize such corridors to move between areas of suitable habitat. Fragmented landscapes with large open areas and extensively developed lands are barriers or deterrents to many of these species, limiting their ability to move from one habitat patch to the next.

The NEAHD project area is highly fragmented from surrounding industrial and residential development. Pockets of natural woodlots and wetlands exist throughout the project area as well as agricultural lands. Lands to the immediate west of Highway 216 between Baseline and Wye Roads provide an area of greenspace that can potentially act as a corridor from the North Saskatchewan River Valley to the project study area in which larger mammals such as deer and coyote may use. Outside the study area to the east of Highway 21, the lands are much less developed and provide a greater amount of natural habitat for wildlife. In terms of habitat connectivity and movement corridors, this area would provide the greatest functional linkages between essential habitats to satisfy all life stage requirements for wildlife.

Early winter tracking survey data indicated three wildlife movement corridors along Highway 216. One identified wildlife corridor is located just south of Baseline Rd on the east side of Highway 216 in a wooded plot (Maps 1-11; Appendix L). That wooded area is linked with a naturally vegetated area and drainage system (associated with the wetland located on the east corner of Baseline Road and Highway 216) (Maps 1-11;Appendix L). A second wildlife corridor is located just south of 92 Avenue and is comprised of a naturally vegetated area (patches of natural tree stands) with wetlands (Appendix L). A third wildlife corridor is located south of Sherwood Park Freeway/Wye Road and contains a drainage course associated with a wetland on the east side of Highway 216 and naturally occurring vegetation surrounded by agricultural land (Maps 1-11; Appendix L). One area along Highway 16, located between 17 Street and Sherwood Drive (Maps 1-11; Appendix L), was deemed a wildlife crossing area based on the presence of several deer tracks adjacent to the highway and presence of coyote tracks in a culvert as mentioned above. That particular crossing is associated with an existing drainage to the North Saskatchewan River (Maps 1-11, Appendix L).

Special Status Wildlife Species

One special status amphibian species, Canadian toad, was identified during the 2006 amphibian survey (Table 4.13). Canadian toads are provincially ranked as May Be at Risk and federally as Not at Risk. It was observed in 1997 in west Edmonton west of the TUC, and in 2004 north of St. Albert. During the amphibian survey in 2006, Canadian toads were heard vocalizing in a wetland in the TUC south of the North Saskatchewan River, however, breeding was not confirmed (see Amphibian Survey Results section above). Canadian toads breed in ponds and marshes and generally remain close to waterbodies (Russell and Bauer 2000). Canadian toads could occur in additional suitable wetland areas in the NAHD project area in the TUC.

Four (4) special status bird species, all provincially ranked as Sensitive, were identified during the 2006 breeding bird survey: American white pelican, least flycatcher, northern harrier and sora (Table 4.19). . Seven (7) special status bird species, all provincially ranked as Sensitive, were identified during the 2008 breeding bird survey and site reconnaissance: common yellowthroat, least flycatcher, sora, horned grebe, pied-billed grebe, lesser scaup and green winged teal. Common yellowthroat prefers cattail marshes, riparian willow and alder clumps near water while least flycatchers prefer aspen forests and alder and willow thickets (Fisher and Acorn 1998). Soras are a wetland-associated species that prefer wetlands with abundant emergent cattails, bulrushes, sedges and grasses (Fisher and Acorn 1998). Horned grebes are usually found in large lakes and wetlands, however, they prefer shallow weedy wetlands for breeding whereas pied-billed grebes prefer small ponds, marshes and backwaters with thick emergent vegetation (Fisher and Acorn 1998). The green-winged teal is a dabbling duck that prefers shallow lakes, wetlands, small ponds and rivers and feeds on aquatic invertebrates, sedge seeds and pondweeds, whereas the lesser scaup is a diving duck which prefers woodland ponds and lake edges with grassy margins where they feed on aquatic invertebrates (Fisher and Acorn 1998). American white pelicans prefer large lakes and rivers for breeding and foraging and are colonial nesters (Fisher and Acorn 1998). Northern harriers like pen country, including fields, wet meadows, cattail marshes and croplands. They tend to nest on the ground, usually in grass, cattails or tall vegetation (Fisher and Acorn 1998).

Based on habitat requirements, habitat availability in the local project area, and provincial distributions, we identified 48 special status species with the potential to occur within the project area (Appendix I). Of those, two are provincially ranked as At Risk and four are ranked as May Be at Risk (Table 4.19) and 42 species are provincially ranked as Sensitive (Appendix I). Some of those species have also been granted special status by the federal government (see Appendix I and Table 4.19). The following sections briefly discuss the potential of the majority of the listed species to occur on the subject parcel. Undetermined and provincially ranked Sensitive species are not discussed here, but are shown in Appendix I.

Table 4.19. Select Special Status Species with Potential to Occur in the Local Study Area

	Provincial Status (General Status of AB Wild Species)	Wildlife Act Designation and New Species Assessed by ESCC[a]	COSEWIC Designation[a]	SARA Designation[b]	Potential Habitat Use	Likelihood of Occurring
Peregrine Falcon	At Risk	Threatened	Special Concern	At Risk	Foraging	Moderate
Short-eared Owl	May be At Risk		Special Concern	Schedule 3 (Special Concern)	Breeding/Foraging	Moderate
Northern Bat	May be At Risk				Breeding/Foraging	High
Long-tailed weasel	May be At Risk		Not at Risk	May be At Risk	Breeding/Foraging	Moderate

[a]Federal ranking by Committee on the Status of Endangered Wildlife in Canada (COSEWIC)
[b]Federal ranking by the *Species of Risk Act* (SARA)

When discussing listed species, the likelihood of such species occurring in the area in question and the likely duration of their stay are critical considerations for assessments related to development, as this will influence the possibility that a particular species could be affected by a project. For many of these species, the presence of available habitat does not necessarily indicate that a species will be present. For example, many special status species are listed as such because of limited distribution, therefore, for those, not all suitable habitats will be occupied. To account for this, Appendix I also includes a qualitative assessment of the likelihood of a species occurring on the subject parcel (noted as low, moderate or high), based on our professional opinion arrived at by considering habitat availability at the site and on adjacent lands, and, specific potential habitat use by each species, e.g., potentially breeding at the site, or passing through the area on migration and stopping to forage.

Fish and Wildlife Management Information System (FWMIS)

A search of the FWMIS database in 2006 and 09 July 2008 resulted in historical records of seven (7) special status species occurring in the local study area. Those included Swainson's hawk (provincially ranked Sensitive), peregrine falcon (provincially ranked At Risk), barred owl (provincially ranked Sensitive), bay-breasted warbler (provincially ranked Sensitive), northern pygmy owl (provincially ranked Sensitive), short-eared owl (provincially ranked May Be at Risk), and long-tailed weasel (provincially ranked May Be at Risk). Of those, Swainson's hawk was recorded in the study area at one location in 2005 and at three locations in 2006. The 2005 record was from north of Yellowhead Trail and east of Highway 216. In 2006, Swainson's hawk was observed east of Highway 216 and south of Wye road, east of Highway 216 and north of Baseline Road and east of Highway 216 and south of Yellowhead Trail (FWMIS 2008). The additional six special status species were historically recorded on lands surrounding the project study area. Peregrine falcons were observed in 1960, 1995, 1996 and 1997. The northern-pygmy owl was observed on surrounding lands in 2001, short-eared owls were observed in 1989 and 1977, barred owls were observed in 1983, bay breasted-warblers were observed in 1975, 1979 and 1980 and the long-tailed weasel was observed in 2000 (FWMIS 2008).

Avifauna

Forty of the 48 potential special status species are birds. One bird species, peregrine falcon, is provincially ranked as At Risk. Although peregrine falcons prefer rocky cliffs, or tall buildings in cities, for nesting (Fisher and Acorn 1998; Semenchuk 1992), their likelihood of occurring in the project area is considered moderate, as they could forage in the project area.

Short-eared owl is provincially listed as May be at Risk. Short-eared owls prefer open grassland areas, including wet meadows, for nesting and hunting (Fisher and Acorn 1998). Their likelihood of occurring in the NEAHD project area is considered moderate as they could potentially be found foraging in open grasslands, wet meadows and agricultural fields.

The remaining 37 special status bird species are provincially-ranked as Sensitive, primarily due to declining population numbers, including elsewhere in their distribution range other than Alberta, and habitat loss. Of those Sensitive species, six were observed in the project area during breeding bird surveys in 2008 including pied-billed grebe, lesser scaup, least flycatcher, horned grebe, sora, and common yellowthroat (Appendix I). Accordingly, the likelihood of those species re-occurring in the project area is rated as high. Although they are ranked as Sensitive, all six species are relatively abundant at suitable habitat in and around the City of Edmonton (and are relatively abundant in Alberta).

Although they were not observed in the project area during field surveys, two Sensitive bird species have a high likelihood of occurring in the local project area because of habitat availability and their common presence where suitable habitat occurs in the region: eastern phoebe and pileated woodpecker. Eastern phoebe is a migratory songbird that breeds on forest edges of open mixed, deciduous and coniferous forests or near open areas (Semenchuk 1992). Pileated woodpeckers prefer mature mixedwood forests containing dead and dying trees (snags) (Fisher and Acorn 1998). The mature aspen stands in the local project area are suitable habitat for eastern phoebes and pileated woodpeckers, therefore, their likelihood of occurrence is rated as high.

The remaining Sensitive bird species noted in Appendix I have a moderate to low likelihood of occurrence in the local study area. As stated earlier, they are considered Sensitive largely due to general declining populations over their entire range, not just in Alberta. Their likelihood of occurrence on the site varies with their potential habitat use and habitat availability.

Mammals

Four special status mammal species could potentially occur in the project area: northern bat (provincially ranked as May Be At Risk), long-tailed weasel (May Be At Risk), silver-haired bat (Sensitive) and hoary bat (Sensitive). Northern, silver-haired and hoary bats prefer forested areas, usually those close to waterbodies (Pattie and Fisher 1999). Considering the forested areas, wetlands and proximity to the North Saskatchewan River, these species have the potential to occur within the project area and have been identified as having a high likelihood of occurring in the study area. The long-tailed weasel prefers agricultural areas and preys on small mammals such as voles and ground squirrels (Pattie and Fisher 1999). Suitable long-tailed weasel habitat is available in the project area, however, this is a wide-ranging species and, if present, the proposed project area may comprise only part of its territory. Considering the above, we have rated their likelihood of occurrence on the subject parcel as moderate.

Herptiles (Reptiles and Amphibians)

Four herptile special status species could potentially occur in the project area: Canadian toad, western toad, red-sided garter snake and plains garter snake (Appendix I). Canadian toad is provincially ranked as May Be at Risk and federally as Not at Risk. Canadian toads breed in ponds and marshes and generally remain close to waterbodies (Russell and Bauer 2000). The Canadian toad was observed in 1997 in west Edmonton west of the project study area, and in 2004 north of St. Albert. During the amphibian survey in 2006 conducted for the study section of Manning Drive east to Highway 16, Canadian toads were heard vocalizing in a wetland south of the North Saskatchewan River, however, breeding was not confirmed. Canadian toads could occur in additional suitable wetland areas in the NEAHD project area. Overwintering habitat, typically sandy soils, may be present in the riparian/creek habitat located adjacent to Highway16 (north side) just west of the Highway 21/Highway 16 interchange. Overall, the likelihood of occurrence within the project area is moderate

Western toad is listed provincially as Sensitive and federally as Special Concern (Schedule 1 in SARA). While these toads breed in small pools or ponds, they prefer shallow water with sandy bottoms and are largely a terrestrial species that burrows into the soil (Russell and Bauer 2000). Although no western toads were heard during the amphibian surveys, they could be present in suitable wetland areas in the project area and utilize the forested upland areas within and adjacent to the study area for foraging and hibernating, but the likelihood is low.

The red-sided garter snake and plains garter snake are listed provincially as Sensitive primarily because they use hibernacula to overwinter. All reptiles in Alberta congregate in winter dens or hibernacula. Snake hibernacula may be naturally occurring pits or crevices in rocky outcrops, burrows either co-opted from small to medium sized mammals or excavated by the snakes themselves (Russell and Bauer 2000), or disturbed granular soils. Garter snakes are most vulnerable to disturbance as they move in and out of these hibernacula. Hibernacula are protected by Alberta's *Wildlife Act*. There is suitable summer habitat and potential hibernacula sites for both species within the NEAHD project area, including in the North Saskatchewan River valley. Consequently, their likelihood of occurring at the site is moderate.

Fish

There is one special status fish species, lake sturgeon that does occur within the study area in the North Saskatchewan River. Lake sturgeon is provincially ranked as At Risk and is currently federally ranked as *Endangered*. It is expected that this species will be included on the *Species at Risk Act* Schedule 1 in the near future (See Section 4.1.7.2 below).

4.1.7 Fish and Aquatic Resources

4.1.7.1 Methods

Manning Drive to Highway 16 East

Pisces Environmental Consulting Services Ltd (Pisces 2006; Appendix F this document) conducted an assessment of the fisheries resources and habitat of the North Saskatchewan River (NSR) at the proposed river crossing. For their assessment, Pisces reviewed existing information on fish and fisheries resources in the Edmonton area and undertook field investigations to determine the habitat and river characteristics at the proposed crossing. Supplemental fisheries investigations were conducted on Moran Lake and Horsehills Creek in 2007 in support of proposed outfall construction in association with drainage for Northwest Anthony Henday Drive (Pisces 2007). Their complete reports are available in Appendix I.

Literature Review

The following reports were reviewed during the fisheries assessment:

- Munson (1978 in Pisces 2006)) Mercury and Goldeye in the North Saskatchewan River, Alberta
- Allan (1984 in Pisces 2006)) The fish and Fisheries of the North Saskatchewan River Basin

- RL&L Environment Services Ltd. (1989 in Pisces 2006) North Saskatchewan River – Aquatic Biological Resources
- Watters (1993 in Pisces 2006)) Lake Sturgeon, *Acipenser fulvescens* Rafinesque, in the North Saskatchewan River, Alberta
- Mayhood (1995 in Pisces 2006) The Fishes of the Central Canadian Rockies Ecosystem
- Alberta Environment (2000) Code of Practice for Watercourse Crossings
- Pisces (2005) Assessment of the habitat and fisheries resources of the North Saskatchewan River adjacent to the proposed Phase II development at Louise McKinney Park

Field Investigations

Habitat Inventory

North Saskatchewan River

Pisces (2006; Appendix F this document) conducted field investigations at the proposed North Saskatchewan River crossing on 24 and 25 November 2005 (Figure 4.6) in support of a previous environmental assessment (Spencer Environmental 2007) in support of the North Edmonton Ring Road Functional Plan. The habitat in the NSR was categorized using the Large River Classification System (O'Neil and Hildebrand 1986 in Pisces 2006). A Lowrance X-16 depth sounder was used to determine water depth throughout the study section and to identify deep water areas that would be suitable lake sturgeon holding habitat.

Moran Lake / Horsehills Creek

Field investigations at the site were conducted on 17 October 2007 (Pisces 2007; Appendix F this document). The primary objective of the Moran Lake/Horsehills Creek assessment was to determine the potential for fish to be present in Moran Lake. The presence of fish, especially sport fish, is largely dependent on surface connection to known fish-bearing waters. As such, the study area encompassed the entire Lake Moran drainage downstream from the lake to Horsehills Creek.

Streambank and Channel Assessment

North Saskatchewan River

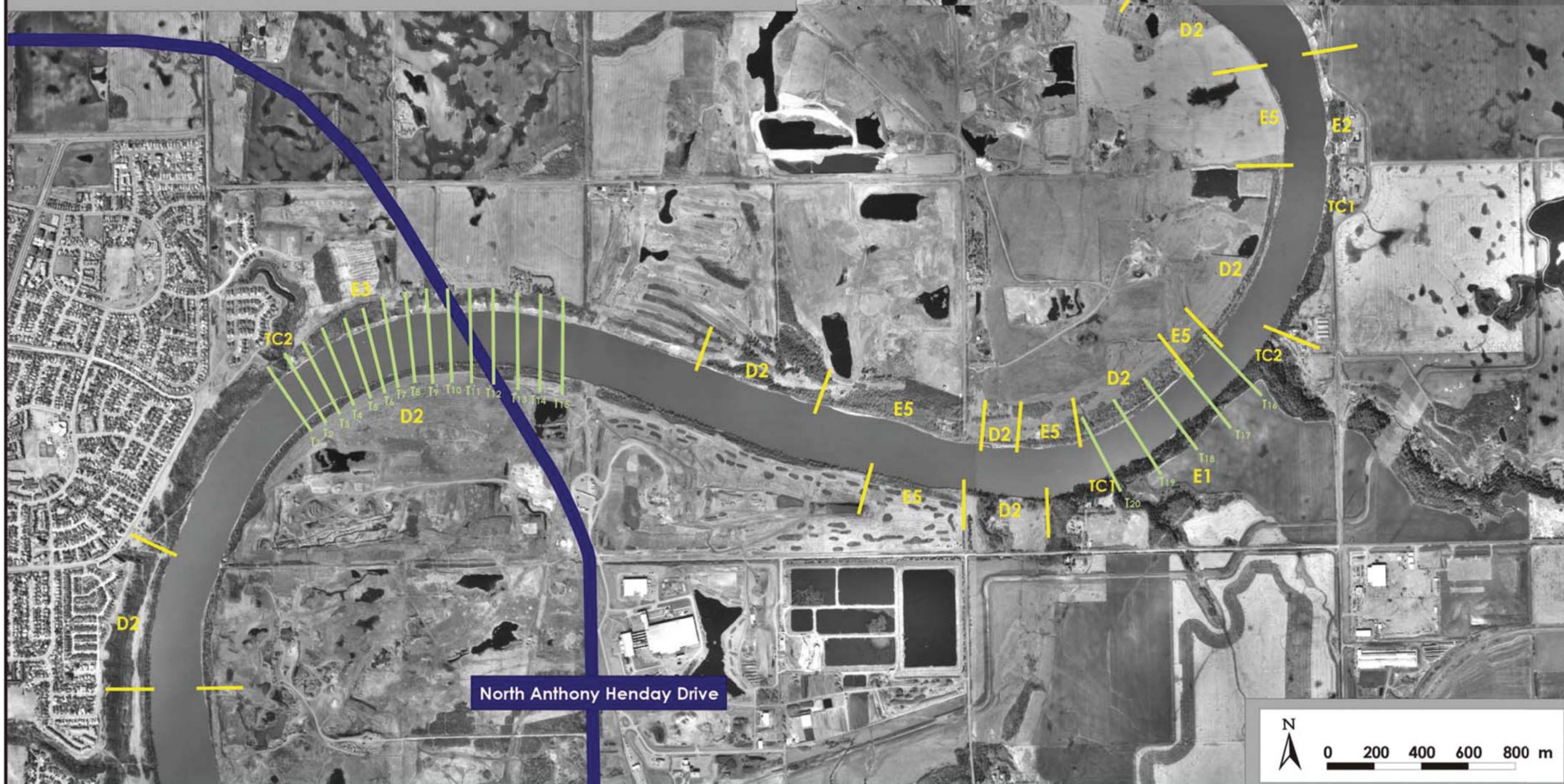
A total of 15 transects, at 80 m intervals, were established across the river channel at and adjacent to the proposed crossing site (Figure 4.6). Channel cross sections at each transect were determined using a Lowrance X-16 depth sounder. One deep water habitat area was also identified as potential sturgeon holding habitat approximately 2.5 km downstream of the proposed NEAHD crossing site and five channel cross sections were determined at that location (Pisces 2006).

Figure 4.6

Fish habitat for NSR near proposed NEAHD Crossing

(Pisces 2006)

Habitat type	Length (m)	% of total length
D2 – depositional – low relief, gravel/cobble, cover from substrate/turbulence	7620	42.74
E1 – erosional – high steep eroding bank, unstable, fines, cover from submerged bank material	1200	6.73
E2 – erosional – similar to E1 without large amounts of instream debris	1135	6.37
E3 – erosional – high steep eroding bank, gravel/cobble/sand, cover limited to substrate roughness	2375	13.32
E5 – erosional – low, steep bank often terraced, fines, no instream cover	5490	30.79
TC – tributary confluence	10	0.06



Transect

Habitat Boundary

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

PISCES ENVIRONMENTAL CONSULTING SERVICES LTD.

Source: Pisces (2006)

Highway 216/16 Alignment

Pisces Environmental Consulting Services Ltd. (Pisces) conducted an assessment of the fisheries resources and habitat of three watercourses within the local study area including an unnamed tributary to the North Saskatchewan River (NSR)(also known as Gold Bar Creek), an unnamed tributary to Oldman Creek and Oldman Creek (2009; Appendix F this document)(Table 4.20; Figure 4.1). Clover Bar Creek in the project area was not deemed suitable fish habitat and Fulton Creek to the south of Whitemud Drive was not included in the assessment study area. In addition, five waterbodies within the project study area were selected as potential study sites from review of aerial photographs, but during field inspection it was determined that three of those contained no water. Two waterbodies (Waterbody B and C; Table 4.20; Figure 4.1) with fish habitat potential were assessed. For their assessment, Pisces undertook field investigations to determine the habitat characteristics at each site. Their complete report is available in Appendix F.

Table 4.20. Fisheries Assessment Site Locations (Pisces 2009; Appendix F)

Study sites	Legal land description	NAD 83 GPS coordinates
Highway 216 crossing (BF 76108) over the unnamed tributary to the NSR (Gold Bar Creek, approximately 7.8 km upstream of the confluence with the NSR	WSW 28-52-23 W4	344586E 5932463N
Highway 16 crossing over the unnamed tributary to Oldman Creek, approximately 1 km upstream of Oldman Creek	SSW 13-53-23 W4	349737E 5938118N
Highway 16 crossing (BF 296) over Oldman Creek, approximately 7.3 km upstream of the confluence with the NSR.	SSE 13-53-23 W4	350932E 5938103N
Waterbody A (dry-no further study req'd)	SE 09-53-23 W4	344789E 5936867N
Waterbody B	SW 04-53-23 W4	344879E 5935623N
Waterbody C	NW 35-52-23 W4	345160E 5934750N
Waterbody D (dry-no further study req'd)	NE 28-52-23 W4	344714E 5933227N
Waterbody E (dry-no further study req'd)	NW 29-52-23 W4	344510E 5933104N

Field Investigations

Fish Presence

Pisces (2009; Appendix F this document) conducted fish sampling at the study sites shown in Table 4.20 on 27 June to 06 July, 20 and 27 August and 03 September 2008. Depending on the habitat to be surveyed, fish presence was determined with the use of

Gee minnow traps or a Smith-Root LR-24 electrofisher. All fish captured during sampling were enumerated, identified to species and measured to the nearest millimeter (fork length) and weighed to the nearest gram.

Three Gee minnow traps were placed in Waterbody B (Figure 4.1) and 4 minnow traps were placed in Waterbody C (Figure 4.1) to survey for fish presence. The traps were spaced across the waterbodies and checked after 24 and 48 hours of set time. Total trapping time in Waterbody B was 144 hrs and 192 hrs in Waterbody C.

Electrofishing was used as a sampling method for the unnamed tributary to the North Saskatchewan River (Gold Bar Creek), the unnamed tributary to Oldman Creek and Oldman Creek. The unnamed tributary to the North Saskatchewan River (Gold Bar Creek) was surveyed immediately downstream of the Highway 216 crossing for a distance of 273 m (Figure 4.1). The unnamed tributary to Oldman Creek and Oldman Creek were surveyed immediately downstream of their respective Highway 16 crossings for a distance of 281 m and 400 m, respectively (Figure 4.1).

Habitat Inventory

Watercourse habitat was inventoried using the stream habitat inventory method based on the O'Neil Method (O'Neil and Hildebrand 1986 in Pisces 2009) (Appendix F), which is suited to small- to medium- sized rivers displaying distinct channel units. The procedure divides the stream channel into a continuous series of habitat types based on differentiation in specific features such as depth, velocity, and surface flow pattern. A total of 330 m of the unnamed tributary to the North Saskatchewan River (Gold Bar Creek) habitat was inventoried (extending 273 m downstream to 57 m upstream of the existing Highway 216 crossing and 443 m of the tributary to Oldman Creek habitat was inventoried (extending 281 m downstream to 162 m upstream of the existing crossing). Fish habitat in Oldman Creek was inventoried in a section extending 400 m downstream of the highway crossing, but was not accessible upstream of the Highway 16 crossing due to ongoing construction activity, unrelated to this project.

General habitat conditions of Waterbodies B and C were determined through physical measurements including the dimensions of the pond, several depths to determine the maximum depth and basic bathymetry (Appendix F).

Streambank and Channel Assessment

The midpoint along the width of the highway was selected as the centerline for streambank and channel assessment for all three watercourses. Six transects were established on each of the three watercourses across the channel with three transects located upstream and three transects located downstream of the crossing. Location and length of transects on the watercourses are described in the full report in Appendix F. The channels of all three watercourses were classified using the Rosgen method of channel type classification. A complete description of the Rosgen method is included in the standard procedures described in the report (Appendix F).

4.1.7.2 Description

Manning Drive to Highway 16 East

Literature Review

North Saskatchewan River

The NSR near the City of Edmonton is cool-water habitat (Allan 1984 in Pisces 2006) and the majority of the river is classified at Class C habitat (Alberta Environment 2000 in Pisces 2006). Class C habitat is considered moderately sensitive and broadly distributed within Alberta (Alberta Environment 2000 in Pisces 2006). Sections of the NSR in and around Edmonton are classified as Class A habitat, which is considered highly sensitive habitat that is critical to fish population viability (Alberta Environment 2000 in Pisces 2006). The proposed North Saskatchewan River crossing site (Section 29-53-23-4), has recently been re-classified as Class C habitat (Daryl Watters, pers. comm.; Pisces 2009; Appendix F this document) pursuant to Alberta's *Code of Practice for Watercourse Crossings*. The amended Code of Practice maps are in error and do not reflect this change. A Class C waterbody is subject to a restricted activity period of 16 September to 31 July. During that restricted activity period, no instream activity can occur without the consent of the Provincial government, contingent on the advice of a Qualified Aquatic Environment Specialist. DFO may have other timing requirements.

Fish Presence in the North Saskatchewan River

A variety of fish species have been reported in the NSR in and around the City of Edmonton (Pisces 2006; Appendix F this document). A 1984 report listed nine sport fish species in the NSR: northern pike, walleye, goldeye, sauger, mooneye, yellow perch, lake sturgeon, mountain whitefish and bull trout (Allan 1984 in Pisces 2006). In addition, larger bodied coarse fish and forage fish are abundant in the NSR on a year-round basis. This includes white sucker, longnose sucker, shorthead redhorse, longnose dace, lake chub, emerald shiner, trout-perch, spottail shiner, fathead minnow, spoonhead sculpin, brook stickleback and river shiner (Allan 1984, RL&L 1989, Pisces 2005 in Spencer Environmental 2007).

Lake sturgeon within the NSR is one of two sub-populations in Alberta (Pisces 2006; Appendix F this document). The provincial status of lake sturgeon is currently "At Risk". Federally, the status of lake sturgeon is being reviewed, with a most recent COSEWIC assessment listing the species as 'Endangered' (COSEWIC 2006). Lake sturgeon are not currently listed under the *Species at Risk Act*, however, inclusion into Schedule 1 of SARA is expected in the near future. Until they are formally listed, lake sturgeons are not federally protected as an endangered species.

An assessment of lake sturgeon populations in the North Saskatchewan River was conducted by Watters in 1992; the study concentrated on a 240 kilometer section extending from approximately 110 kilometer upstream of Edmonton to approximately 130 kilometers downstream of the city (Pisces 2006; Appendix F). Abundance was low and individuals appeared to have a grouped distribution with fish concentrated in a few specific locations (Watters 1993 in Pisces 2006). Common habitat characteristics at these preferential sites were a back eddy below a gravel bar or island, with deep water (>3.8 m) adjacent to the river bank (Watters 1993 in Pisces 2006). Lake sturgeons are generally sedentary in nature exhibiting localized feeding and overwintering movements (ASRD 2002 in Pisces 2006). However, spawning migrations, occurring every 4 to 7 years for females and every 2 or 3 years for males, can cover long distances. ASRD (2002 in Pisces 2006) references tag return data from Watters (unpubl. data.) showing downstream movement of over 500 kilometers and upstream movement of approximately 400 kilometers in the North Saskatchewan River.

Moran Lake/Horsehills Creek

Fish species historically known to be present in Horsehills Creek include burbot (Lota lota), longnose sucker (Catostomus catostomus), and white sucker (Catostomus commersoni), and it is likely that cyprinid species also utilize the habitat of the creek (Darryl Waters pers. comm.) (Pisces 2007; Appendix F this document). In addition, as a tributary to the North Saskatchewan River, Horsehills Creek may provide seasonal habitat for migratory species from the river.

Field Investigations

North Saskatchewan River

The NSR channel at the proposed crossing was classified as “U”, unobstructed channel (Pisces 2006; Appendix F this document). Habitat within the channel was classified as either depositional or erosional (Figure 4.6). The immediate vicinity of the proposed crossing is characterized by a high, steep eroding bank on the Right Upstream Bank (RUB) and a low relief, gently sloping bank on the Left Upstream Bank (LUB). The stream bank and channel assessment results are summarized in Table 4.21. Channel cross-sections for each transect are available in Appendix F of this document.

Table 4.21. Summary Assessment of the 15 Transects Adjacent to NSR Crossing (From Pisces 2006; Appendix F)

Transect	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DISTANCE D/S FROM TRANSECT (M)	0	80	160	240	320	400	480	560	640	720	800	880	960	1040	1120
Right Upstream Bank (RUB)															
Bank Height (m)	1.8	1.5	2.2	1.2	2.2	2.1	2.1	2.4	2.1	2.2	1.9	2.0	2.1	2.1	1.8
Angle/slope (^{o})	80	90	75	80	80	70	75	75	70	70	80	75	75	70	70
Water Contact (m)	0	2.5	0	0	0	0	1	0	1	0	0	0	0	0	0
Bank Cover (WD, OB, OV, AV, BL)[a]	-	-	OV/ WD	OB	-	-	BL	-	-	OB	-	-	-	-	-
Bank Vegetation (grass, shrub, tree, exposed)	Exp/ Gr	Exp/ Gr	Gr/ Sh	Gr/ Sh	Exp/ Sh	Exp/ Gr	Exp/ Sh	Gr/ Exp	Gr/ Exp	Gr/ Sh	Gr/ Exp	Sh/ Gr	Gr/ Exp	Exp/ Gr	Exp/ Gr
Bank Composition (FN, GR, CB, BL)[b]	FN/ CB	FN	FN	FN	FN	FN/ CB	FN/ BL	FN/ CB	FN/ CB	FN/ CB	FN/ CB	FN/ CB	FN/ CB	FN/ CB	FN/ CB
Streambed Composition (FN, GR, CB, BL)[b]	CB/ GR	BL/ CB	FN	CB /FN	FN/ CB	CB/ GR	BL/ CB	FN/ CB	CB/ GR	CB/ GR	CB/ FN	CB/ GR	CB/ GR	CB/ GR	CB/ GR
Left Upstream Bank (LUB)															
Bank Height (m)	1.6	1.3	1.5	2.1	1.5	1.4	1.5	2.5	2.8	2.8	3.0	4.1	6.6	4.2	5.5

Transect	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Angle/slope (°)	35	75	70	80	60	60	70	70	70	70	60	65	60	70	75
WATER CONTACT (M)	0	0	0	0	0	0	0	1	0	0	1	-	-	-	-
Bank Cover (WD, OB, OV, AV, BL)[a]	-	-	-	OV	-	WD	-	WD	-	-	WD	WD	-	WD	WD
Bank Vegetation (grass, shrub, tree, exposed)	Gr	Gr	Gr/ Sh	Exp/ Tr	Exp/ Sh	Gr/ Sh	Exp/ Tr	Tr/ Sh	Tr/ Gr	Tr/ Gr	Tr/ Exp	Tr/ Gr	Gr/ Sh	Exp/ Sh	Exp/ Gr
Bank Composition (FN, GR, CB, BL)[b]	FN	FN	FN	FN/ CB	FN	FN	FN	FN	FN	FN	FN	FN	FN	FN	FN
Streambed Composition (FN, GR, CB, BL)[b]	CB	CB/ GR	GR/ CB	CB/ GR	FN/ CB	CB/ FN	CB/ FN	CB/ FN	CB/ FN	CB/ FN	CB/ FN	CB/ FN	CB/ FN	FN/ CB	FN/ CB
Other Features															
Wetted Width (m)	198	201	205	221	226	215	218	218	219	221	227	228	223	226	226
Bank Full Width (m)	202	203	205	222	228	217	223	221	224	225	229	231	230	228	230

[a] WD = woody debris ; OB = overhanging bank; OV = overhanging vegetation; AV = aquatic vegetation; BL = boulder cover
[b] FN = fines; GR = gravel; CB = cobble; BL = boulder; BR = bedrock

The average width of the NSR near the proposed crossing was 221 m, and the average water depth was 1.5 m, with depths of 2 m rarely exceeded.

Moran Lake/Horsehills Creek

The field assessment found no evidence of a defined outlet channel from Moran Lake, though according to 1:50000 Map Sheet 83H/11, an outflow channel exists at the north end (Pisces 2007; Appendix F this document). The topography to the east and south of Moran Lake is higher in elevation than the lake indicating that the outflow cannot be anywhere but on the north end. As such, the drainage was followed according to the map; there was no evidence of a defined channel for most of the area connecting Moran Lake to Horsehills Creek (Pisces 2007). The outflow channel only becomes defined as it nears the 18th Street crossing and for the remaining distance to the Horsehills Creek confluence.

There is no record of fish sampling in Moran Lake. The possibility that lake may support forage fish (cyprinid species and brook stickleback) cannot be precluded, but given the lack of a defined channel connecting the lake to Horsehills Creek, it seems highly unlikely. There is virtually no potential for fish to move into the lake from Horsehills Creek.

Highway 216/16 Alignment

Fish Presence

During electrofishing surveys on the three watercourses within the project study area, three fish species were recorded utilizing habitat at the sites surveyed. Those species included brook stickleback (*Culaea inconstans*), fathead minnow (*Pimephales promelas*) and white sucker (*Catostomus commersoni*). A summary of fish captured from the unnamed tributary to the North Saskatchewan River (NSR), unnamed tributary to Oldman Creek and Oldman Creek is presented in Table 4.22.

Table 4.22. Summary of Fish Captured from the Unnamed Tributary to the NSR (Gold Bar Creek), Unnamed Tributary to Oldman Creek and Oldman Creek (Source: Pisces 2009; Appendix F)

	Unnamed tributary to NSR (Gold Bar Creek)				Unnamed tributary to Oldman Creek				Oldman Creek			
Species	n	Fork Length (mm)			n	Fork Length (mm)			n	Fork Length (mm)		
		Mean	Min	Max		Mean	Min	Max		Mean	Min	Max
Brook stickleback	13	47.2	39	67	31	43.1	23	59	5	40.4	34	52
Fathead minnow	7	37.7	30	46	29	32.4	21	50	6	68	57	75
White sucker	0	N/A	N/A	N/A	15	102	60	159	31	132	76	182

Two species; brook stickleback (*Culaea inconstans*) and fathead minnow (*Pimephales promelas*), were sampled from Waterbodies B and C using Gee minnow traps (Table 4.23).

Table 4.23. Summary of Fish Captured during Sampling Survey of Waterbody B and C (Source: Pisces 2009; Appendix F)

Waterbody	Date	Species	n	Fork Length (mm)		
				Mean	Min	Max
B	Sept.11/08	Brook stickleback	7	45.7	37	55
	Sept.12/08	Brook stickleback	26	49.1	41	55
C	Sept.11/08	Brook stickleback	19	43.9	33	54
		Fathead minnow	12	36.9	32	44
	Sept.12/08	Brook stickleback	15	46.7	39	51
		Fathead minnow	25	45.32	36	58

Habitat

Unnamed Tributary to the North Saskatchewan River (NSR) (Gold Bar Creek)

The habitat within the study section of the unnamed tributary to the NSR (Gold Bar Creek) comprised of approximately 30% Class 3 Run (R3), 60% Class 3 Flat (F3) and the remaining habitat was nearly all Class 2 Flat (F2) (Table 4.24; Appendix F). Cover for fish was adequate and was split between overhanging vegetation (10.7%), aquatic vegetation (6.4%) and overhanging bank (5.1%) (Table 4.24). The substrate was composed mainly of fine material (90%) with small amounts of gravel (9%). The stream bank vegetation varied between grass, shrubs with grass, trees with grass, and trees with shrubs. Grassy vegetation was the most abundant (44%).

Table 4.24. Summary Habitat Inventory of the Unnamed Tributary to the NSR (Gold Bar Creek) (Source: Pisces 2009; Appendix F)

HABITAT COMPOSITON					
Type[a]	RF	R3	F2	F3	Total
Area (m^2)	3	103.4	31.2	205	342.6
% Area	0.9	30.2	9.1	59.8	100
# of Units	1	7	2	12	22

COVER						
Type[b]	WD	OB	OV	AV	Total	
Area (m^2)	4.6	17.5	36.7	22	80.9	
% Area	1.34	5.12	10.72	6.43	23.6	
SUBSTRATE COMPOSITION						
Type[c]	FN	GR	CB	BL	BR	Total
Area (m2)	307.24	30.5	2.34	2.52	0	342.6
% Area	89.7	8.9	0.7	0.7	0	100
RIPARIAN VEGETATION						
Type[d]	Gr	Sh/Gr	Tr/Gr	Tr/Sh	Total	
Length (m)	147	73	53.1	57	288.2	
% Length	44.5	22.1	16.1	17.3	100	
OTHER FEATURES						
Length of Section (m):	330.1					
Mean Habitat Width (m):	1.04					
Total Section Area (m^2):	343.6					
Unstable Bank (m):	2 (0.3%)					
Beaver Dams	1 (area=1m^2)					

[a] Habitat Composition Type: RF (Riffle), R3 (Class 3 Run), F2 (Class 2 Flat), F3 (Class 3 Flat)

[b] Cover Composition Type: WD (woody debris), OB (overhanging bank), OV (overhanging vegetation), AV (aquatic vegetation)

[c] Substrate Composition Type: FN (fines), GR (gravel), CB (cobble), BL (boulder), BR (bedrock

[d] Riparian Vegetation Type: Gr (grass), Sh (shrubs), Tr (trees)

Unnamed Tributary to Oldman Creek

The habitat present within the study section of the unnamed tributary to Oldman Creek was composed of Class 3 Run (R3) (68% of the area), Class 1 Run (R1) (29% of the area) and riffle (RF) (3% of the area) (Table 4.25; Appendix F). Nearly the entire length of the study section was channelized containing rip rap within the streambed. Cover for fish was abundant (35%) and the majority was aquatic vegetation (30.2%). The remaining cover was mostly provided by overhanging vegetation (3.8%) (Table 4.25). Approximately three quarters of the substrate was composed of fine material with nearly all the remaining substrate being cobble. Nearly all the streambanks were composed of a mixture of cobble armouring and grass.

Oldman Creek

Oldman Creek comprised of flat habitat, but with variations in depth. Class 2 Flat (F2) was the most common type representing 48% of the study section area. Class 3 Flat (F3) represented 35% and Class 1 Flat (F1) represented 17% of the study section area (Table 4.26; Appendix F). Cover for fish was plentiful. Overhanging vegetation (19%), aquatic vegetation (6%), overhanging bank (35), small amounts of boulder garden (1.5%) and woody debris cover (0.5%) were all present (Table 4.26). The substrate was composed almost entirely of fine material with small amounts of gravel and boulder representing 94.2%, 3.8% and 2%, respectively. Riparian vegetation was composed of nearly all grass with the remaining 20% comprised of exposed soil with a mixture of grass and shrubs.

Table 4.25. Summary Habitat Inventory for the Unnamed Tributary to Oldman Creek (Source: Pisces 2009; Appendix F)

HABITAT COMPOSITON						
Type[a]	RF	R1	R3	Total		
Area (m^2)	23.3	216	514.5	753.8		
% Area	3.1	28.7	68.3	100		
# of Units	2	1	18	21		
COVER						
Type[b]	WD	OB	OV	AV	BG	Total
Area (m^2)	0.5	8.3	28.9	227.7	14.1	279.5
% Area	0.1	1.1	3.8	30.2	1.9	37.1
SUBSTRATE COMPOSITION						
Type[c]	FN	GR	CB	BL	BR	Total
Area (m2)	559.5	16	151.8	26.4	0	753.8
% Area	74.2	2.1	20.1	3.5	0	100
RIPARIAN VEGETATION						
Type[d]	Gr	Sh/Gr	Tr/Gr	Tr/Sh	Total	
Length (m)	104	134	25	180	443	
% Length	23.5	30.2	5.6	40.6	100	
OTHER FEATURES						
Length of Section (m):	443					
Mean Habitat Width (m):	1.7					
Total Section Area (m^2):	753.8					
Unstable Bank (m):	9 (1%)					

[a] Habitat Composition Type: RF (Riffle), R1 (Class 1 Run), R3 (Class 3 Run)

[b] Cover Composition Type: WD (woody debris), OB (overhanging bank), OV (overhanging vegetation), AV (aquatic vegetation), BG (boulder garden)

[c] Substrate Composition Type: FN (fines), GR (gravel), CB (cobble), BL (boulder), BR (bedrock

[d] Riparian Vegetation Type: Gr (grass), Sh (shrubs), Tr (trees)

Table 4.26. Summary of Habitat Inventory of Oldman Creek

HABITAT COMPOSITON						
Type	F1	F2	F3	Total		
Area (m^2)	240	689.2	492.5	1502.2		
% Area	16.9	48.5	32.8	100		
# of Units	2	13	12	27		
COVER						
Type	WD	OB	OV	AV	BG	Total
Area (m^2)	7.7	44.9	269.4	92.3	21.6	435.8
% Area	0.5	3.2	19	6.5	1.5	30.7
SUBSTRATE COMPOSITION						
Type	FN	GR	CB	BL	BR	Total
Area (m2)	1339.9	27.8	0	54	0	1421.7
% Area	94.2	2	0	3.8	0	100
RIPARIAN VEGETATION						
Type	Gr	Exp/Gr	Exp/Sh	Total		
Length (m)	297.6	24	55	399.6		
% Length	79	6.4	14.6	100		

OTHER FEATURES	
Length of Section (m):	376.6
Mean Habitat Width (m):	3.8
Total Section Area (m^2):	1430.4
Beaver Dams	2 dams (8.7m^2 in total)

[a] Habitat Composition Type: F1 (Class 1 Flat), F2 (Class 2 Flat), F3 (Class 3 Flat)

[b] Cover Composition Type: WD (woody debris), OB (overhanging bank), OV (overhanging vegetation), AV (aquatic vegetation), BG (boulder garden)

[c] Substrate Composition Type: FN (fines), GR (gravel), CB (cobble), BL (boulder), BR (bedrock)

[d] Riparian Vegetation Type: Gr (grass), Sh (shrubs), Tr (trees), Exp (exposed)

Streambank and Channel

Unnamed Tributary to the North Saskatchewan River (NSR) (Gold Bar Creek)

The stream banks of the unnamed tributary to the NSR were composed almost entirely of fines with only a small proportion present at the furthest upstream transect. Streambed was also found to be predominately fines with a few small areas of gravel present. Bank vegetation was mostly grass or grass with shrubs. The mean wetted width was 1.82 m, whereas the mean bank full width was 2.6 m over all transects (Table 4.27; Appendix F). The average bank height was 0.76 m and average bank slope was 69 degrees (Table 4.27).

Table 4.27. Summary of the Stream Bank Assessment for 6 transects on the Unnamed Tributary to the NSR (Source: Pisces 2009; Appendix F)

Transect	1	2	3	4	5	6
Distance from centreline (m)	-93.5[1]	-73.5	-53.5	53.5	73.5	93.5[2]
Right Upstream Bank (RUB)						
Bank Height (m)	0.3	0.8	0.8	0.45	0.7	0.7
Angle/slope (^{o})	35	70	75	40	80	80
Water Contact (m)	0.2	0.05	0.15	0.1	0	0
Bank Cover (WD, OB, OV, AV, BG)[a]	AV	AV, OV	OV	OV	OB, OV	OV
Bank Vegetation (grass, shrub, tree, exposed)[b]	SH, Gr	SH, Gr	SH, Gr	SH, Gr	SH	SH
Bank Composition (FN, GR, CB, BL)[c]	FN	FN	FN	FN	FN	FN, GR
Streambed Composition (FN, GR, CB, BL)[d]	FN	FN, GR	FN	FN	GR, FN	FN
Left Upstream Bank (LUB)						
Bank Height (m)	0.25	0.9	1.2	0.3	0.7	0.5
Angle/slope (^{o})	30	70	85	45	20	60
WATER CONTACT (M)	0.1	0	0	0.1	0.6	0.9
Bank Cover (WD, OB, OV, AV, BL)	AV	AV, OB	OB, OV	WD, AV	none	none
Bank Vegetation (grass, shrub, tree, exposed)	SH, Gr	Gr	Gr	TR, SH	Gr	SH, Gr
Bank Composition (FN, GR, CB, BL)	FN	FN	FN	FN	FN	FN, GR
Streambed Composition (FN, GR, CB, BL)	FN	FN, GR	FN, GR	FN	GR, FN	GR, FN
Other Features						
Wetted Width (m)	1.9	1.6	1.8	2.8	1.3	1.5
Bank Full Width (m)	2.8	1.9	2.5	3.1	3.0	2.3
Mean Depth (m)	0.13	0.22	0.16	0.3	0.05	0.12

[a] Bank Cover: WD (woody debris), OB (overhanging bank), OV (overhanging vegetation), AV (aquatic vegetation), BG (boulder garden)

[b] Bank Vegetation: Gr (grass), Sh (shrubs), Tr (trees), Exp (exposed)

[c] Bank Composition: FN (fines), GR (gravel), CB (cobble), BL (boulder),

[d] Streambed Composition: FN (fines), GR (gravel), CB (cobble), BL (boulder), BR (bedrock)

Unnamed Tributary to Oldman Creek

The stream banks of the unnamed tributary to Oldman Creek were composed almost entirely of cobble rip rap, except at transects 5 and 6 (Table 4.28). The streambed was a mix of fine material and cobble (rip rap armouring) for the majority of the transects. Bank vegetation was comprised of almost all grass except for the exposed areas that were armoured (Table 4.28). The mean wetted width was 1.32 m and the mean bank full width was 2.18 m over all transects (Table 4.28). The average bank height was 0.43 m and average bank slope was 49.5 degrees (Table 4.28).

Table 4.28. Summary of Stream Bank Assessment for 6 transects on the Unnamed Tributary to Oldman Creek (Source: Pisces 2009; Appendix F)

Transect	1	2	3	4	5	6
Distance from centreline (m)	-85.5	-65.5	-45.5	45.5	162	187
Right Upstream Bank (RUB)						
Bank Height (m)	0.3	0.15	0.3	0.55	0.5	0.4
Angle/slope (^{o})	30	15	35	30	80	80
Water Contact (m)	0	0	0	0	0	0
Bank Cover (WD, OB, OV, AV, BG)[a]	AV, OV	AV, OV	OV	AV, OV	OV	OV
Bank Vegetation (grass, shrub, tree, exposed)[b]	Gr, Exp	Gr, Exp	Gr, Exp	Exp, Gr	Gr	Gr
Bank Composition (FN, GR, CB, BL)[c]	CB	CB	CB	CB	FN	FN
Streambed Composition (FN, GR, CB, BL)[d]	FN	FN	CB, FN	FN, CB	FN, GR	GR, FN
Left Upstream Bank (LUB)						
Bank Height (m)	0.2	0.15	0.2	0.45	0.55	0.5
Angle/slope (^{o})	10	15	35	30	45	90
WATER CONTACT (M)	0.6	0.2	0	0	0.1	0
Bank Cover (WD, OB, OV, AV, BL)	AV, OV	AV, OV	none	AV, OV	OV	OV
Bank Vegetation (grass, shrub, tree, exposed)	Gr, Exp	Gr, Exp	Exp, Gr	Exp, Gr	Gr	Gr
Bank Composition (FN, GR, CB, BL)	CB	CB	CB	CB	FN	FN
Streambed Composition (FN, GR, CB, BL)	FN	FN	CB, FN	FN, CB	FN, GR	GR, FN
Other Features						
Wetted Width (m)	1.9	2.1	1.1	1.1	1.0	0.7
Bank Full Width (m)	3	2.6	1.3	3.2	1.6	1.4
Mean Depth (m)	0.17	0.12	0.08	0.05	0.06	0.03

[a] Bank Cover: WD (woody debris), OB (overhanging bank), OV (overhanging vegetation), AV (aquatic vegetation), BG (boulder garden)

[b] Bank Vegetation: Gr (grass), Sh (shrubs), Tr (trees), Exp (exposed)

[c] Bank Composition: FN (fines), GR (gravel), CB (cobble), BL (boulder),

[d] Streambed Composition: FN (fines), GR (gravel), CB (cobble), BL (boulder)

Oldman Creek

The stream banks and the streambed of Oldman Creek were composed of boulder rip rap near the highway culverts. Transects 3 and 4 stream banks and streambeds were mostly fine material with small amounts of gravel. Bank vegetation was mostly exposed near the culverts due to rip rap armouring (Table 4.29). The mean wetted width was approximately 4.23 m and the mean bank full width was 7.45 m over all transects (Table 4.29). Bank full widths average higher than what the mean bank full width would be for the majority of the downstream study section of Oldman Creek due to construction done to widen the channel at the downstream end of the two highway culverts. The average bank height was 1.01 m and average bank slope was 44.4 degrees (Table 4.29).

Table 4.29. Summary of the Stream Bank Assessment for 4 transects on Oldman Creek (Source: Pisces 2009; Appendix F)

Transect	1	2	3	4
Distance from centreline (m)	-45[1]	-45[2]	-70	-100
Right Upstream Bank (RUB)				
Bank Height (m)	1.2	1.25	0.8	0.9
Angle/slope (°)	30	45	45	40
Water Contact (m)	0	0	0	0
Bank Cover (WD, OB, OV, AV, BG)[a]	BL	BL	none	AV
Bank Vegetation (grass, shrub, tree, exposed)[b]	Exp	Exp	Exp, Sh	Gr
Bank Composition (FN, GR, CB, BL)[c]	BL	BL	FN, GR	FN
Streambed Composition (FN, GR, CB, BL)[d]	BL	FN	FN, GR	FN
Left Upstream Bank (LUB)				
Bank Height (m)	1.3	1	0.8	0.8
Angle/slope (°)	30	45	45	75
WATER CONTACT (M)	0	0.12	0	0
Bank Cover (WD, OB, OV, AV, BL)	BL	OV, AV	none	OV, AV
Bank Vegetation (grass, shrub, tree, exposed)	Exp	Gr	Exp, Sh	Gr
Bank Composition (FN, GR, CB, BL)	BL	FN	FN, GR	FN
Streambed Composition (FN, GR, CB, BL)	BL	FN	FN, GR	FN
Other Features				
Wetted Width (m)	10	2	1.9	3
Bank Full Width (m)	18	5	3.4	3.4
Mean Depth (m)	0.7	0.25	0.2	0.19

[a] Bank Cover: WD (woody debris), OB (overhanging bank), OV (overhanging vegetation), AV (aquatic vegetation), BG (boulder garden)

[b] Bank Vegetation: Gr (grass), Sh (shrubs), Tr (trees), Exp (exposed)

[c] Bank Composition: FN (fines), GR (gravel), CB (cobble), BL (boulder),

[d] Streambed Composition: FN (fines), GR (gravel), CB (cobble), BL (boulder), BR (bedrock)

Waterbodies B and C

Depth measurements and corresponding UTM locations for Waterbodies B and C were recorded on 12 September 2008 (Table 4.30). Waterbody B had a mean depth of 0.39 m and Waterbody C had a mean depth of 1.34 m.

Table 4.30. Depth Measurements for Waterbodies B and C

Waterbody	Dimensions	Depth (m)	Description	UTM Location (NAD 83)
B	165 m in length (W to E) 90 m in width (N to S)	0.40	West	344828E 5935623N
		0.40	Approx. centre of pond	344879E 5935623N
		0.37	East	344958E 5935638N
C	800 m in length (SW to NE) 159 m in width (NW to SE)	1.37	Southwest	344995E 5934653N
		1.34	Approx. centre of pond	345160E 5934750N
		1.30	Northeast	345226E 5934762N

4.2 Socio-economic Resources

4.2.1 Current Land Use and Zoning (includes Aboriginal Lands)

4.2.1.1 Methods

Land use was determined through review of current land use maps, land ownership maps, City of Edmonton Zoning Bylaw maps, air photos and observations collected during field surveys. Results are summarized below by key stakeholder and/or land use categories.

4.2.1.2 Description

Aboriginal Lands

The nearest known aboriginal burial site is located approximately 12 km west of the NEAHD project area at the Rossdale Flats area (105th St and River Valley Road) in the City of Edmonton. The nearest existing First Nations Reserve is the Enoch Reserve, located approximately 27 km west of the project area, west of the City of Edmonton

Agriculture and Industrial

The majority of the NEAHD project area is under agriculture and industrial land use. Agricultural lands are located throughout the project study area between Manning Drive and Highway 16 and adjacent to Highways 216 and 16. The southeast section of the TUC, between the North Saskatchewan River and the Yellowhead Trail east, is zoned AG, DC2, IH (heavy industrial) or IM (medium industrial). The Edmonton Waste Management Centre (EWMC) and Clover Bar landfill are located near this section of the TUC. EWMC is zoned DC2 (site specific development control), while the landfill and sewage lagoons are zoned AG. Towards Highway 16, there is an industrial research area, a truck yard, an asphalt/paving equipment storage site, a fiberglass manufacturer and the Worthington BP plant (formerly Celanese Canada Ltd.).

West of EWMC and Clover Bar landfill are gravel extraction sites. These areas are zoned AG, and fall under the flood plain protection zone. The City of Edmonton's North Saskatchewan River Redevelopment Plan (Bylaw 7188) boundary includes the North Saskatchewan River Valley crossing and Moran Lake in the project area

In addition, HFP Acoustical Consultants Corp. (2009) identified three industrial parks in the NEAHD project study area during their acoustical assessment. Those parks include the Maple Ridge Industrial Park, located west of Highway 216 and south of Sherwood Park Freeway, Strathmoor Industrial Park, located south of Highway 16 and west of Broadmoor Boulevard, and Griffon Industrial Park, located north of Highway 16 and west of Clover Bar Road (HFP 2009).

Residential

Three residential communities were identified as the closest residential dwellings to the NEAHD project area (HFP 2009). Those communities include: 1) Maple Ridge (west of Highway 216 and south of Sherwood Park Freeway); 2) Lakeland Village (southeast of the YHT/Cloverbar Road Interchange); and 3) Village on the Lake (east of Highway 216 and north of Wye Road). Specifically, the closest dwellings to the proposed highway alignment upgrade are located in the Maple Ridge community on the west side of Highway 216, between Whitemud Drive and Sherwood Park Freeway (HFP 2009). Other communities located in the regional project area include several Sherwood Park communities bordering the east side of Highway 216 between Whitemud Drive and Baseline Road. The communities of Emerald Hills and Lakeland Village are located near the Highway 16/Clover Bar Road interchange (HFP 2009). The only other residential area close to the project area is the Fraser community located near 153 Avenue and the proposed Highway 216/153 Avenue interchange (HFP 2009).

Rail Lines

The proposed NEAHD project will cross four (4) CN Rail tracks and two (2) CP Rail tracks. The City of Edmonton also plans to extend the LRT line north to 153 Avenue and beyond. Each of the crossings will be grade separated.

4.2.2 Outdoor Recreation

4.2.2.1 Methods

Existing recreational land within the NEAHD project area, including the North Saskatchewan River Valley, was determined by reviewing the City of Edmonton River Valley and Recreation website, observations during site reconnaissance visits and field surveys. Comments during the public consultation sessions also helped identify types of informal use.

4.2.2.2 Description

No formal outdoor recreation occurs within the NEAHD project study area. From the public open house sessions, it was determined that some local residents used the study area for such activities such as nature appreciation (e.g., bird watching) in the vicinity of the wetland areas and dog-walking. There is no formal outdoor recreation infrastructure within the North Saskatchewan River Valley at the proposed bridge crossing over the river. The north river bank is steep with a few informal trails on the slope and at the base of the slope. Most of those trails are likely wildlife trails and infrequently used by the public for nature appreciation, dog-walking and hiking. There are no informal trails on the south, more gently sloped and heavily vegetated, river bank Informal recreation likely occurs in this area in the form of nature appreciation, dog-walking and hiking on informal trails. Motorized and unmotorized boating activities occur on the North Saskatchewan River in the City of Edmonton, including in the project area. Plans for future recreational opportunities are highlighted in the River Valley Alliance (RVA) action plan and ribbon of green document for the North Saskatchewan River valley in Edmonton. The NSR valley is important to the City of Edmonton for recreation.

4.2.3 Noise

4.2.3.1 Methods

HFP Acoustical Consultants Corp. (HFP 2009) conducted a traffic noise assessment for the proposed NEAHD roadway upgrade project area. Baseline noise monitoring was conducted at three (3) receptor locations along the proposed NEAHD alignment including one (1) location in the Maple Ridge community located west of Highway 216 and south of Sherwood Park Freeway, one (1) location in Lakeland Village southeast of the Yellowhead Trail/Clover Bar Road Interchange, and one (1) located in the Village on the Lake located east of Highway 216 and north of Wye Road. The selected baseline monitoring locations were among the closest receptors to the NEAHD project in the noise assessment study area (Figure 4.7, Table 4.31).

Table 4.31. Distance and Orientation of the Baseline Monitor Locations from NEADH [Source: HFP (2009), Appendix K]

Monitor Location	Closest Highway Component	Distance and Direction from Closest Highway Component	
		Distance (meters)	Direction
#1 – 6610 Meridian St, Edmonton	AHD south of Sherwood Park Freeway	50	West
#2 – 1048 Lakeland Cr, Sherwood Park	Yellowhead Trail east of Clover Bar Road	185	South
#3 – 419 Village Grove, Sherwood Park	Wye Road exit ramp to northbound AHD	250	North

Traffic noise predictions for NEAHD were calculated by computer noise modeling, using the Cadna A environmental noise prediction software program (HFP 2009; Appendix K this document). The traffic noise algorithms used by that program are very similar to other traffic noise models used in North America, including Canada Mortgage and Housing Corporation (CMHC) road traffic noise model and the Ontario Ministry of the Environment (MOE) Stamson road traffic noise model (HFP 2009, Appendix K). Outdoor sound propagation effects included in the computer model calculations for road traffic noise included: distance dissipation, ground attenuation values typical of spring/summer/fall seasonal conditions were used in the traffic noise model. That was done because residents are typically more sensitive to environmental noise during those seasonal conditions, since they are generally outdoors more frequently and may have their windows open more often (HFP 2009, Appendix K).

Traffic noise prediction results were based on NEAHD traffic volumes forecasted for 2041 (Stage 1) and the associated arterial roads, interchanges and flyovers. The day/night traffic volume split used for all roadways was 80% during the daytime and 20% during the nighttime (HFP 2009, Appendix K).

Once predicted noise levels had been calculated for the monitoring stations, those values were compared to Alberta Transportation's noise attenuation guideline for primary highways under provincial jurisdiction within cities and urban areas (HFP 2009, Appendix K). That guideline specifies a noise limit of 65 dBA Leq (24-hour) for

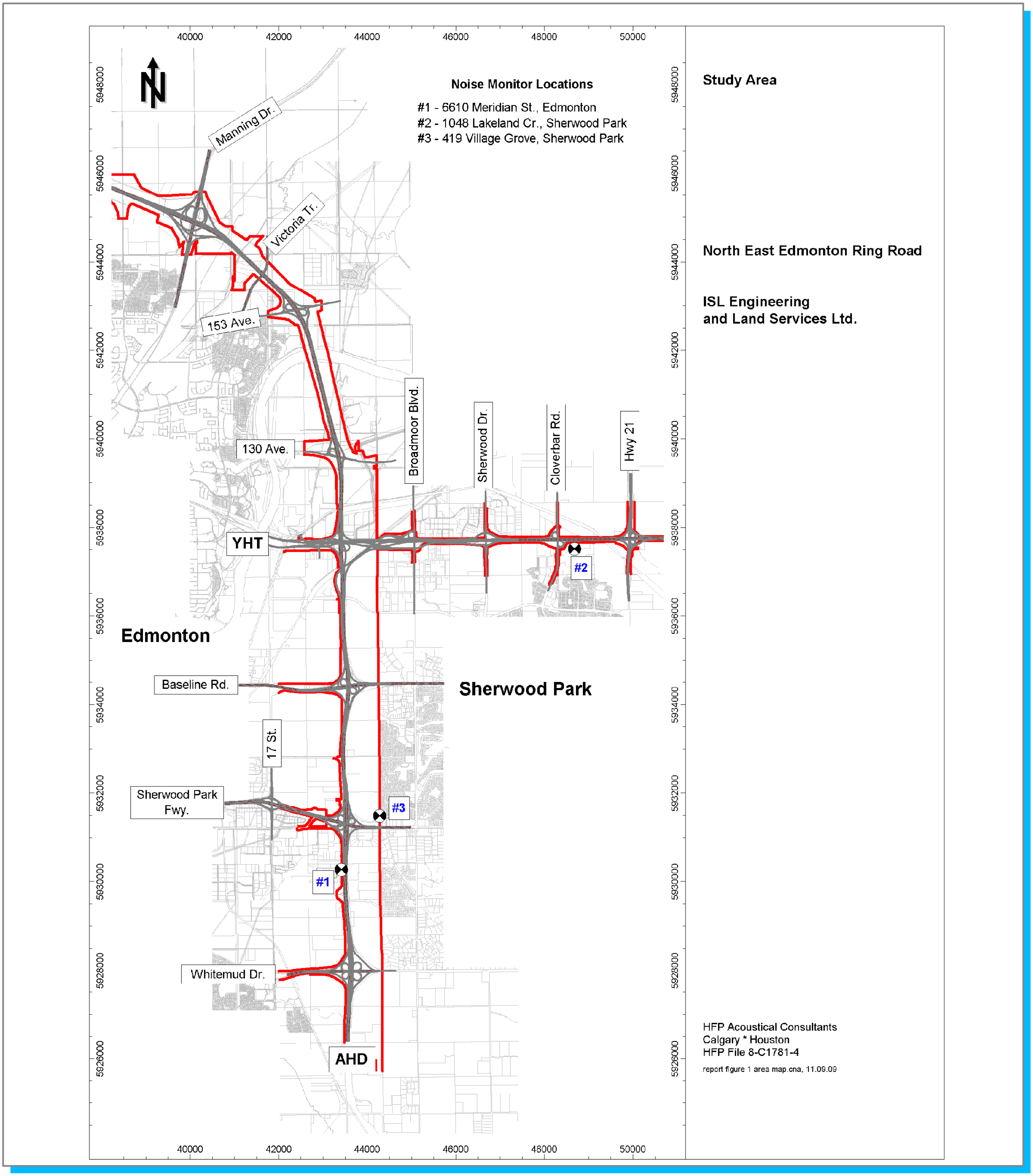


Figure 4.7 Noise Monitor Locations in NEAHD Study Area

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highways, which are improved or constructed through cities and urban areas. That noise limit is the applicable noise criterion for the NEAHD project. The guideline indicates that the measurement location for traffic noise is 2 m inside a residential property line adjacent to the highway. It also indicates that any noise mitigation measures to reduce traffic noise must be cost-effective, technically practical, broadly supported by the affected residents and fit into overall provincial priorities.

4.2.3.2 Description

Existing baseline traffic noise levels for the three monitoring stations are shown in Table 4.32. One location, monitor location #1 (Figure 4.7), currently exceed AT's noise attenuation guideline of 65 dBA L_{eq} (Table 4.32).

Table 4.32. Measured Ambient and Predicted (2041) Traffic Sound levels at the Noise Monitor Locations [Source: HFP (2009), Appendix K]

Monitor Location	Predicted Sound Level (dBA L_{eq})								
	Daytime			Nighttime			24-hour		
	Current	2041	Change	Current	2041	Change	Current	2041	Change
#1	70.4	71.2	+0.8	67.4	68.1	+0.7	69.6	70.4	+0.8
#2	60.5	64.4	+3.9	57.5	61.4	+3.9	59.7	63.9	+3.9
#3	57.2	58.8	+1.6	54.2	55.8	+1.6	56.4	58.0	+1.6

There are two residential areas on the west side of Highway 216: Fraser (near the 153 Avenue Interchange) and Maple Ridge (near the Sherwood Park Freeway Interchange). The predicted 2041 traffic sound level at the closest existing dwelling in the Fraser community is 58 dBA L_{eq} (24-hour), which is below AT's guideline noise limit (HFP 2009).

The predicted 2041 traffic sound level at the closest dwelling in Maple Ridge (Monitor Location #1, Figure 4.7) was 70 dBA L_{eq} (24-hour), which is 5 dBA L_{eq} higher than the AT guideline noise limit of 65 dBA L_{eq}. The existing traffic sound level at this dwelling is also approximately 70 dBA L_{eq} (24-hour) (Table 4.32). Most of the land use in areas adjacent to Yellowhead Trail between Highway 216 and Highway 21 is predominantly commercial and industrial, although there are two residential communities near the Clover Bar Road Interchange: Emerald Hills and Lakeland Village (HFP 2009). The predicted 2041 traffic sound level at the closest dwelling in this area (Monitor Location #2) is 64 dBA L_{eq} (24-hour), which is just within the AIT guideline noise limit. The current traffic sound level at this dwelling is approximately 60 dBA $L_{eq.}$ (24-hour) (Table 4.32).

4.2.4 Heritage Resources

4.2.4.1 Methods

The advanced functional plan for NEAHD includes three distinct segments of roadway, each of which has had historical resources investigations conducted at different times.

Manning Drive to Highway 16 East

In June and October 2006, the Archaeology Group (2007) undertook an HRIA in support of the NAHD alignment (from Highway 16 West to Highway 16 East), including the unconstructed section of the current NEAHD functional planning study from Highway 16 northward to Manning Drive.

Highway 216/16 Alignment

In November and December 1996, Alberta Archaeology Company conducted a Historical Resources Impact Assessment (HRIA) for Highway 16 between the East side of the North Saskatchewan River (in SW 17-53-23-W4M) to the Elk Island Park Boundary (in NE 12-53-22-W4M). That HRIA included the segment of the current NEAHD project area between 17 Street and Highway 21.

In May and June 2003, Altamira Consulting (2003) conducted an HRIA for the Southeast Anthony Henday Drive alignment (from Calgary Trail eastward to Highway 14/216). That HRIA included the section of the current NEAHD functional planning study area between Highway 16 and Whitemud Drive.

4.2.4.2 Description

No unrecorded burials, unrecorded collections, or any information about the presence of any sites of historical, paleontological, or special interest were found within the NEAHD project area. The three HRIAs previously conducted in the NEAHD project area concluded that no further historical resources impact assessment or mitigation work was warranted. Alberta Culture and Community Spirit's Historic Resources Management Branch determined no further work is required and provided clearance for all three HRIA's (Appendix K).

5.0 POTENTIAL IMPACTS AND MITIGATION MEASURES

Impact and mitigation analysis for the proposed Northeast Anthony Henday project described in this chapter focuses on the existing infrastructure of Highway 216 between Whitemud Drive and Yellowhead Trail and Highway 16 between Highways 216 and 21 (Highway 216/16 alignment) and the proposed new roadway and bridges for the remaining segment of Edmonton's Ring Road between Manning Drive and Yellowhead Trail (Highway 16 East), between Manning Drive and Highway 16 East.

Impact and mitigation analysis including the North Saskatchewan River crossing, was previously described in the North Leg- Anthony Henday Drive Environmental Assessment prepared by Spencer Environmental Management Services Ltd. (2007), however, relevant information from that document is repeated here. This environmental assessment also includes updated geotechnical information for the bridge crossing and provides fisheries information with respect to the special status species, lake sturgeon.

Interactions of specific project activities in the site preparation, construction, operation/maintenance and reclamation phases of the project with VECs are summarized in Table 5.1. Following is a description of the interactions that have potential to result in an impact.

Impacts to VECs are discussed in terms of the project stages during which they would occur (e.g. construction/operation, reclamation). That is because there are impacts related to each stage. Because the interaction matrix was completed based on a detailed project description for most project components, potential impacts can be selectively identified. The potential for several impacts to occur was eliminated during project planning.

Table 5.1. VEC Analysis Matrix

			Project Activities												
			Site Preparation					**Construction**					**Operation**		**Abandonment**
			Clear and grub right-of-way	Establish staging area(s)	Locate and protect utility lines	Coordinate access and public safety	Install silt fences	Construct stormwater ponds	Construct bridge over river, outfalls, culverts	Grade and compact new roadbed	Pave new road	Reclamation	Roadway Operation	Maintenance	Abandon and reclaim old roadbeds
Valued Ecosystem Components	**Valued Ecosystem Components**	**Soils/Geology/Geomorphology**	√	√	√		√	√	√	√		√		√	√
		Hydrology/Surface Water Quality	√	√			√	√	√	√		√		√	√
		Air Quality	√					√		√	√		√		
		Vegetation	√	√			√	√	√			√		√	√
		Wildlife	√	√				√	√	√		√		√	√
		Fisheries and Aquatic Resources	√	√			√		√			√		√	
	Valued Social Components	**Land Disposition and Zoning**				√									√
		Noise	√	√				√	√	√	√	√	√		
	Valued Heritage Components	**Heritage Resources**	√					√	√	√					

5.1 Biophysical Resources

5.1.1 Geology/Geomorphology

Potential impacts to geology and geomorphological resources include:

- slope instability from roadway construction activities.

A detailed analysis of each impact follows below and is summarized at the end of this section in Table 5.2

5.1.1.1 Slope Stability

North Saskatchewan River Crossing

Impact

Stability analysis of the existing north and south slopes of the North Saskatchewan River (NSR) was conducted during EBA's preliminary geotechnical assessment (EBA 2008). The north slope was analyzed to have a factor of safety of 1.1, while the south slope was assessed to have a high factor of safety due to the low and relatively flat slope associated with the river terrace deposits (EBA 2009). The steep north bank of the NSR at the proposed crossing site is located on an outside bend of the river and has a history of instability. The north bank is also approximately 34 m higher in elevation than the south bank requiring cut slopes of up to approximately 16 m deep for the north bridge approach and an 11 m fill for the south bridge abutment (EBA 2008).

The proposed geometry of the north headslope will require stabilization for the lower portion of the slope. Some form of toe berm with erosion protection was considered to be the most practical from a geotechnical perspective. If an under-slung pedestrian walkway is constructed, the toe berm will also increase the factor of safety of the entire slope to 1.3. The toe berm dimensions used in the stability analysis is a guideline and may be refined based on final bridge design. Depending on detailed designs of the roadway approach and bridge, impacts to slope stability on the north river bank was rated as adverse, minor, local, constant, high probability, permanent and predictable.

The south bank of the river is relatively shallow and is on the inside bend of the river, therefore, it is not being undercut by the river. There is no history of slope instability on the south side of the river. Approach fill design head slopes of 2H1:1V is considered feasible for the bridge abutments on the south side of the river (EBA 2009). Approach fills will be built with suitable fill and placed and compacted to AT standards. With these measures in place, impacts to slope stability on the south river bank are rated as negligible.

Mitigation Measures and Residual Impact

Timing of installation of the slope stabilization (i.e. toe berm or other) on the north side of the river is important. Risks involved with excavating the slope prior to stabilization of the lower portion of the north slope can be reduced by limiting disturbance and construction traffic along the slope prior to and during construction of the toe berm and monitoring the performance of the slope during construction. If placement of a toe berm is not acceptable due to regulatory restrictions, stabilization of the lower portion of the headslope will be expensive and provide additional challenges. This would likely require examining post-tensioned anchors installed into the bedrock in greater detail (EBA 2009).

While slope stability issues at this location will most certainly be resolved during the ensuing stages of project design, the residual impact rating for the north bank remains in this EA as adverse, minor, local, constant, highly probable, permanent and predictable in order to meet the technical requirements of the EA process and EA content.

The reasons for leaving that rating are as follows:

- bridge and road designs are still conceptual,
- detailed designs are not available at this time for review, and
- the location is proximate to the important fish-bearing North Saskatchewan River.

The residual impact to slope stability on the south bank remains negligible.

Table 5.2. Summary of Impacts and Mitigation for Geology/Geomorphology

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Affect on slope stability from NEAHD bridge and roadway construction			
• North bank	Adverse, minor, local, constant, high probability, permanent and predictable	• Follow geotechnical recommendations in detailed design phase	• Adverse, minor, local, constant, high probability, permanent and predictable
• South bank	Negligible		Negligible

5.1.2 Soils

Potential impacts related to soils resources include:

- soil erosion,
- loss of topsoil,
- compaction of soils by heavy equipment, and
- accidental hazardous materials spills near or on unpaved surfaces resulting in soil contamination.

A detailed analysis of each impact follows below and is summarized in Table 5.3.

5.1.2.1 Soil Erosion

Impact

In areas where existing vegetative cover is cleared, exposed soils, particularly fine-textured soils, would likely be susceptible to water and wind erosion. Much of the terrain in the vicinity of the proposed NEAHD project area, is relatively level terrain, with the exception of areas north and south of the existing Highways 16 and 21 interchange located near Oldman Creek and at the North Saskatchewan River crossing. Excavation of some soils along the proposed right-of-way may lead to surface erosion, especially where the water table is near the surface or where soils have coarse textures.

Fine-textured soil types in the NEAHD project area are more susceptible to wind and water erosion than coarse-textured soil types, particularly if they are located on steep slopes. Risk of water erosion is generally low in the flat areas, however, soils on slopes are particularly susceptible to erosion as a result of surface runoff. The project study area will include areas adjacent to the North Saskatchewan River Valley where there are steep slopes. Construction will also occur near wetlands, however, the majority of those areas are on relatively level terrain. If eroded materials are transported as sediment into the river, Oldman Creek, unnamed tributaries and wetlands, soil erosion could have adverse secondary impacts on water quality. Impacts of wind and water erosion on soils and soil stability in the proposed NEAHD project area are rated as adverse, minor, local, short-term, occasional, reversible, low probability of occurrence and predictable.

Mitigation Measures and Residual Impact

Temporary and permanent erosion control measures, as described in AT's "Design Guidelines for Erosion and Sediment Control for Highways" (Alberta Transportation 2003), will be employed during the project. Stockpiled soils that are susceptible to wind erosion will be stabilized (e.g., tackifier, erosion netting, hydroseeding, silt fences and gabions) as soon as possible and no later than two months after stockpiling. Following soil replacement and grading, erosion control will involve hydroseeding, erosion netting, silt fences, gabions, straw bales, etc., depending on the slope and location, until vegetative cover becomes re-established. Disturbed areas will be reseeded with an appropriate seed mix as soon as possible after construction. Permanent erosion control features will remain. All mitigation measures will be inspected and maintained until vegetation cover is established. Monitoring both the erosion control measures and progress of re-vegetation will further minimize impacts. Particular attention will be placed on monitoring of disturbed areas immediately adjacent to the North Saskatchewan River, Oldman Creek, unnamed tributaries and wetlands to ensure that sufficient vegetation cover becomes established to provide erosion protection.

The native clay and clay till are generally erodible. Permanent cut and fill slopes will be topsoiled and revegetated as soon as possible to reduce potential slope erosion. In deep cuts, installation of erosion mats or other appropriate erosion control measures will be provided to limit erosion. Final grading above the slope will be graded to direct runoff water to areas away from the slope. In addition, water flow in roadway ditches will be evaluated and appropriate erosion protection measures will be provided. Considering these measures, the potential for loss of soils due to wind and water erosion within the working areas will be negligible over the short and long-terms.

5.1.2.2 Loss of Topsoil

Impact

Fertile topsoil is a limited resource and its conservation is of concern from both a regulatory and ecological perspective. While some lands will be converted from their current agricultural use to a roadway, conservation of topsoil will be a focal point of the reclamation program. The objective of soils management for this project will be to maintain the current capability of soils in the project area, primarily by minimizing disturbance and reclaiming disturbed areas. This will involve minimizing the land area that will be affected by construction, or used for equipment storage and maintenance.

For many soil units along the proposed NEAHD right-of-way, the transition from topsoil to subsoil layers is evident from colour or textural change and salvage depth can be easily determined in the field. In other soil units, the transition is less distinct and there is potential for the topsoil and subsoils to become mixed, thereby affecting the original soil characteristics and soil fertility. In addition, if there are differences in textures between topsoils and subsoils, mixing can cause adverse effects on soil drainage and compactability. Gleysolic areas within the study area are often saline to the surface and care will be taken to ensure that topsoil from these areas is not mixed with topsoil from adjacent upland areas.

Topsoil and subsoil will be stripped and stockpiled separately for later use in site reclamation. An environmental inspector will be present on site when stripping topsoil to ensure appropriate salvage depths are determined in areas where the transition to subsoil is unclear and the area involved is large. Such precautions will help reduce the potential for mixing of topsoil and subsoil layers and the impacts of construction on topsoil quantities and quality would be negligible.

Mitigation Measures and Residual Impact

Stripping and stockpiling mineral soils as indicated above, under guidance of an environmental inspector, and using the soils for reclamation efforts within the area after construction completion will ensure the impact remains negligible.

5.1.2.3 Topsoil and Sub-soil Compaction

Impact

Compaction could occur on sub-soils and fine topsoils where heavy equipment will be operating and after grading and placement of soils during reclamation. The potential impact will be a slower rate of plant regeneration, or, more generally, a reduced capability for effective reclamation. Local drainage patterns can also be modified if compaction occurs such that pre-existing terrain contours are changed. Soil compaction is rated as an adverse, minor to major, local, long-term, constant, reversible, high probability of occurrence and predictable impact. The impact severity could be rated as major if soils immediately adjacent to the North Saskatchewan River, Oldman Creek, unnamed tributaries and wetlands were compacted such that riparian vegetation could not regenerate.

Mitigation Measures and Residual Impact

In areas where there will not be major changes in topographic conditions such as embankment fills, disturbed slopes will be graded so that pre-existing contours are restored in the reclaimed sites to effectively maintain existing drainage to the extent possible. Sub-soils will be ripped and fine topsoils will be disked after they are replaced in reclaimed areas to reduce compaction effects. In areas where major topographic changes will occur (e.g., cut slopes, embankment fills), the contractor will ensure geotechnical stability is maintained and will provide site specific erosion control that is consistent with overall drainage patterns. With these measures, the residual impact will be negligible.

5.1.2.4 Contaminated Soil Disturbance

Impact

The NEAHD project area, particularly south of the North Saskatchewan River in the more industrial area, has undergone a long history of different land uses, some of which have had or do have the potential for soil contamination. Areas of contamination could be disturbed by roadway construction activities. Thurber's (2009b) Limited Phase I ESA conducted in the project area identified the following areas of potential environmental concern:

- the presence of three cemeteries including two funeral homes; two cemeteries and a funeral home along the west side of Highway 16 between Sherwood Park Freeway and Whitemud Drive and a third cemetery with a funeral home south of 167 Avenue and east of 34 Street;
- a petroleum refinery (Petro-Canada) to the west of Highway 216 between Baseline Road and Highway 16;
- the presence of a past landfill (Lafarge location) just south of Highway 16 on the east side of 17 Street;
- an active landfill facility (Edmonton Waste Management Centre) immediately east of Meridian Street north of Highway 16;

- three petroleum terminals (Enbridge, Kinder Morgan and Shell) along the west side of Highway 216 from just south of Baseline Road to Highway 16;
- known groundwater contamination between Hayter Road and Highway 16, west of Meridian Street (former Celanese plant; see Section 5.1.3.2 below);
- past and present borrow pit activities, including fill, between Highway 16 and the North Saskatchewan River near Meridian Street;
- various petroleum storage tanks located at rural residences, borrow pits and commercial facilities;
- numerous railway lines, including a railway yard, oriented parallel to or crossing the study area;
- one current (Salisbury Store) and three past petroleum service stations along Highways 216 and 16;
- extensive oil and gas facilities including: past wells, active disposal wells, approximately 111 known pipeline crossings, several adjacent pipeline corridors and forty-three reported spills/incidents near the study area; and
- hydrocarbon odours encountered during geotechnical testing in the vicinity of an abandoned pipeline east of the Highway 16/216 interchange.

In addition, the former Celanese plant site (now Worthington B.P.) was identified as a contaminated site. Ecomark Ltd. previously carried out a Phase I ESA at that site and a Phase II ESA for that site is being conducted by Alberta Transportation (Thurber 2009b).

Without confirmation of the presence of contaminated soils and their location, roadway construction activities could potentially disturb contaminated soils in the areas identified during any soil disturbance activities. There is also potential for the contaminated soils to adversely impact other areas in the region if they are moved off-site without proper de-contamination. Impacts from disturbing soils on contaminated sites would be rated as adverse, major to minor, local (if soil remains within project area) to regional (if contaminated soil is moved off-site), long-term, occasional, reversible, high probability, and predictable.

Mitigation Measures and Residual Impact

Thurber (2009b) concluded that a sampling and testing program consistant with a Phase II ESA is required to further investigate the areas identified as having potential environmental concern. Until the results of that assessment are available and mitigation measures identified, residual impacts to soils from contamination remain adverse, major to minor, local (if soil remains within project area) to regional (if contaminated soil is moved off-site), long-term, occasional, reversible, high probability, and predictable. Once a Phase II ESA is completed, and mitigation measures and a risk management plan are developed, this will likely become a positive residual impact.

5.1.2.5 Soil Contamination from Accidental Spills

Impact

Fuels or lubricants spilled over soils at the staging areas during equipment maintenance or refueling, when stored on-site or in the event of an accident on-site (e.g., leaking hydraulic hoses) can cause localized soil contamination. If spills are large, there is potential for the material to spread over a larger area, placing the North Saskatchewan River, Oldman Creek, unnamed tributaries, wetlands and soils in surrounding areas at risk and raising the possibility of contamination. Fuels and other hazardous chemicals will be stored away from all watercourses and in a protected location with secondary containment to reduce spill potential. Equipment will be refueled and serviced to ensure that deleterious substances do not enter any watercourse and curbside catch basins, if any are present, will be hoarded appropriately to avoid hazardous material entering the stormwater system. Wherever possible, biodegradable oils and lubricants will be used in equipment. Only minor equipment repairs will be completed in the field; major repairs will take place at a central location such as the staging areas, or off-site. Excess paving and concrete materials will be handled and disposed of appropriately and concrete vehicles will not be washed on-site. Accidental spills from equipment working on-site will be handled by following provincial best-management practices and codes of practice. If standard operating practices are followed, little potential exists for large spills; however, should one occur, the spill will be contained and disposed of following provincial guidelines. Potential for hazardous materials spills is, therefore, negligible.

Mitigation Measures and Residual Impact

No mitigation measures other than standard operating procedures and provincial hazardous materials spill regulations are needed. Spill kits will be carried on equipment or stored at nearby work locations and all personnel will be trained to respond appropriately to a spill. The contractor will develop an Environmental Construction Operations Plan (ECO Plan) including an emergency spill response to ensure that those spills that meet the criteria for the Alberta *Environmental Protection and Enhancement Act* (*EPEA*) regulatory reporting are quickly and effectively cleaned up. Such measures will reduce the ability for a spill to spread and increase the efficiency of a clean-up. The residual impact remains as originally assessed, negligible.

Table 5.3. Summary of Impacts and Mitigation for Soils

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Soil erosion	Adverse, minor, local, short-term, occasional, reversible, low probability, predictable	• Employ erosion control methods, as described in AT's "Design Guidelines for Erosion and Sediment Control for Highways" (2003), such as tackifier, erosion netting, hydroseeding, silt fences and gabions, on any bare slopes or stockpiled soils. • Stockpiled soils will be stabilized as soon as	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		possible and no later than two months after stockpiling. • Temporary erosion control measures will remain in place until vegetation established • Monitor erosion control and revegetation • Monitor disturbed areas adjacent to the NSR, Oldman Creek, unnamed tributaries and wetlands • Following construction, stabilize exposed soils by planting with approved seed mixtures	
Topsoil and sub-soil mixing	Negligible	• Topsoil and subsoil will be stockpiled separately • Environmental inspector or experienced contractor to ensure appropriate salvage depths are determined • Use the soil for reclamation within the area	Negligible
Soil compaction	Adverse, minor to major, long-term, predictable	• Disturbed areas graded to pre-existing contours • Sub-soils will be ripped and fine topsoils will be disked to reduce compaction • Ensure geotechnical stability and site-specific erosion control maintained consistent with overall drainage patterns at cut slopes and embankment fills	Negligible
Disturbance of contaminated soils	Adverse, major to minor, local to	• Confirmation of contaminated soils	Adverse, major to minor, local to

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
	regional, long-term, occasional, reversible, high probability, and predictable	areas unknown to-date • Phase II ESA to be undertaken to confirm contaminated soils sites	regional, long-term, occasional, reversible, high probability, and predictable *Once a Phase II ESA is completed, and mitigation measures and a risk management plan are developed, this will likely become a positive residual impact.
Accidental spill of hazardous materials	Negligible	• Fuel and hazardous materials will be stored away from any waterbody • Refueling will occur away from any waterbody • Curbside catch basins, if any are present, will be hoarded • Biodegradable oils and lubricants will be used in equipment wherever possible • Excess paving and concrete material will be properly handled and disposed of appropriately • Concrete vehicles will not be washed on-site • Spill kits will be carried and all personnel will be trained in spill kit use and immediate response • An ECO plan, including an emergency spill response, is in place	Negligible

5.1.3 Hydrology/Surface Water Quality

Construction of the proposed NEAHD project will occur adjacent to the east side of the North Saskatchewan River, and adjacent to Oldman, Gold Bar, Clover Bar and Fulton Creeks, tributaries and through upland areas containing wetlands. Potential impacts to local drainages and wetlands are, therefore, of primary importance with respect to the proposed project. Identified issues included the following potential impacts:

- Sedimentation
- Contaminated groundwater
- Altered river hydraulics
- Altered drainage patterns
- Accidental release of hazardous materials
- increased loading of stormwater on Edmonton’s stormwater facilities.

A detailed analysis of each impact follows below and is summarized in Table 5.4.

5.1.3.1 Sedimentation

Impact

Sedimentation of the North Saskatchewan River, Gold Bar Creek, Clover Bar Creek, Oldman Creek, tributaries and wetlands could result from construction and operation of the NEAHD. Sediment from roadway construction could enter the waterbodies and affect water quality in the short-term. Construction areas not immediately adjacent to waterbodies could also generate sediments into the waterbodies, including the North Saskatchewan River, during wet conditions. Uncontrolled water runoff from areas cleared of vegetation of areas of fill material could carry sediments into wetlands, tributaries, creeks and the river. Increased sediment levels in the NSR could lead to an adverse effect on downstream areas and aquatic habitat. Standard construction practices will be followed in any area to be disturbed by construction, including the use of erosion protection measures (i.e., silt fencing, rip rap) on slopes susceptible to erosion. This will help limit the potential release of eroded sediment into wetlands, drainages and the NSR. Sedimentation of watercourses or wetlands would be an adverse and minor impact. The impact could occur during construction of the bridge where the potential could be greatest but could extend into the operational phase of the project so could be constant. The geographical extent would be regional as sediment loads could travel downstream. The construction impacts would be short-term, but, in the absence of mitigation measures, it would persist during operation making it a constant impact through the life of the project. Mitigation measures in the form of increased erosion controls in areas prone to erosion and sedimentation is possible, making the impact reversible. The probability of this type of impact during construction is high. This is a predictable impact associated with construction in and adjacent to drainages.

Mitigation Measures and Residual Impact

Current hydrological and surface water quality characteristics of the project area will be maintained using sedimentation controls near waterbodies. The contractor will develop an Environmental Construction Operations (ECO) plan that will meet the requirements of Alberta Transportation. The standard erosion and sedimentation control measures discussed above will be employed as well as those outlined in AT's "Design Guidelines for Erosion and Sediment Control for Highways" (Alberta Transportation 2003) to minimize the migration of material into waterbodies. Standard construction techniques such as postponing clearing activities adjacent to watercourses until immediately before construction is scheduled to start, hand-clearing bank slopes and the use of standard erosion control techniques (silt fencing, sediment traps, straw bales) on open slopes during construction will help reduce the potential incidence of sediment released. To prevent the erosion and sedimentation of waterbodies from occurring over the long term, vegetation will be established on disturbed areas immediately after construction activities are completed (progressive reclamation). Standard erosion control techniques (silt fencing, sediment traps, straw bales) will be kept in place to control erosion while vegetation is becoming established. Considering these measures, the residual impact for sedimentation will be reduced to negligible; however, monitoring and maintenance of erosion and sedimentation controls must be carried out until vegetation becomes established.

5.1.3.2 Contaminated Groundwater

Impact

Thurber (2009b) conducted a Limited Phase I ESA in the project area to identify areas of potential environmental concern and confirmed that there is an area of known groundwater contamination at the former Celanese property (now Worthington B.P.). The area contains a groundwater contamination plume from the area of a former herbicide plant located west of Meridian Street between Hayter Road and Highway 16. That plume is known to be moving northwest under Hayter Road. The contaminated groundwater is currently recovered and sent to a disposal well on the former herbicide plant property. Thurber (2009b) also determined there is a deep groundwater plume present on the north end of the former Celanese facility that extends towards the EPCOR Clover Bar Generating Station. Impacts to groundwater from contamination would be adverse, major to minor, regional, long-term, constant, reversible, high probability of occurrence and predictable.

Mitigation Measures and Residual Impact

A Phase II ESA for the Worthington B.P. site is currently being conducted by Alberta Transportation (Thurber 2009b). Until the results of that assessment are available and mitigation measures identified, residual impacts to groundwater from contamination remain adverse, major to minor, regional, long-term, constant, reversible, high probability of occurrence and predictable. Once a Phase II ESA is completed, and mitigation measures and a risk management plan are developed, this will likely become a positive residual impact.

5.1.3.3 Altered River Hydraulics

Impact

Construction of NEAHD will require installation of new bridges where the road intersects the North Saskatchewan River. The installation of these structures will require construction of bank abutments and in-stream piers. The north bank abutment will be constructed on the steep north bank, which is on an outside bend of the river. The high water flow rates associated with an outside bend with the potential presence of debris and/or ice in the water can cause severe scouring along the riverbank, and may potentially cause damage to the proposed north bank abutment. The North Saskatchewan River is also subject to flooding, which could also cause significant amounts of riverbank scouring and erosion on the north and south banks.

Previously, the local floodplain was delineated by Northwest Hydraulic Consultants in their hydraulic assessment to aid in bridge design (NHC 2001 in Spencer Environmental 2007). There are typically two flood seasons on the river (spring, associated with ice breakup in mid-March to early May, and early summer associated with heavy rainstorms and generally larger flooding in June through mid-July). More recently, Golder Associates (2009) conducted a bathymetric survey and determined the hydrotechnical design parameters of the river crossing for the preliminary design drawings. Based on their modeling results, Golder recommends the bridge be designed to accommodate maximum flood levels consistent with the historic flood of 1915 at 5,800 m^3/s. The recommended design high water elevation is 618.0 m geodetic with 11 m gauge rise over mean bed. The minimum bottom flange elevation of 620 m at left bank and 619 m at right bank with 2 m of freeboard near the thalweg is also recommended. Estimated scour depth is 603 m ultimate elevation. With respect to bridge pier locations, piers should not be placed within 15 m of the left (north bank to avoid drift collection between the pier and the bank (Golder 2009). With these measures in place, impacts to river hydraulics from bridge construction are rated as negligible.

Mitigation Measures and Residual Impact

No further mitigation measures are required and the residual impact remains negligible.

5.1.3.4 Altered Drainage Patterns

Impact

The potential for surface and groundwater drainage patterns to be altered by road development is also a concern. This can occur if topography and groundwater recharge and discharge areas are altered during construction activities. The ground surface in the project study area (Highway 216/16 alignment), including the north section of the Anthony Henday extending from Highway 16 to the North Saskatchewan River (NSR), is mainly flat to gently undulated. The south bank of the NSR is approximately 30 m lower than the north bank. Surface drainage is typically towards existing sloughs, creeks and roadway ditches (McElhanney 2001 in Spencer Environmental 2007). Considering that most major drainages in the project study area will be accommodated in existing channels and new crossing structures (Appendix A), significant alteration to surface water drainage is unlikely.

Groundwater recharge and discharge areas have not been identified in the functional planning phase of this project, however, general groundwater levels were measured by EBA Engineering Consultants Ltd. (2009) at the North Saskatchewan River crossing. Water levels measured on 04 September 2008 ranged from 1.9 to 33.7 m below the existing surface. Near AHD and 153 Avenue, groundwater levels were at 1.9 m below the existing surface, indicating that the stabilized groundwater levels at that site is relatively high and close to the surface.

Groundwater levels fluctuate seasonally and year to year in response to climatic conditions and may vary when construction commences. Groundwater seepage may occur at varying depths below the ground surface and the rate of seepage will depend on soil type. Seepage is expected to be at a lower flow rate in clay, clay fill and clay till compared to extensive wet, sandy areas where the seepage flow rate will be higher and slope erosion could become a problem. Any increased instability to the banks of the NSR downstream of the project that result from stormwater from the project (roadside ditches, catch basin and bridge deck) would be an adverse minor to major impact depending on the success of erosion control and other factors. The impact would be major if groundwater seepage, and associated frost effects, cause possible slope instability. The adverse impact would be regional because the downstream areas of the NSR could be affected. The duration of the adverse impact would be long-term as corrective action would take time to implement. The impact frequency would be constant throughout the project. The impact would, however, be reversible. The probability of occurrence, without successful erosion control would be high. This would be a predictable impact.

Mitigation Measures and Residual Impact

To ensure existing surface drainage patterns will be maintained in all areas, reclaimed land will be contoured to resemble the original terrain conditions that existed prior to project construction and properly installed crossing structures at watercourses will be used. All existing hydrologic connections will be maintained (Appendix A). This is particularly important when stormwater management pond locations are selected to replace impacted wetlands within the road upgrade alignment. Considering these measures, residual impacts to surface and groundwater drainage will be reduced to negligible.

5.1.3.5 Introduction of Deleterious Substances

Impact

Fuels, oils and lubricants used in construction equipment can degrade aquatic habitat or harm aquatic species if released to surface waterbodies. Introduction of deleterious substances produced during construction/demolition and operation of the project could result in deterioration of water quality in the North Saskatchewan River, Oldman Creek, Fulton Creek, Gold Bar Creek, Clover Bar Creek, tributaries and wetlands located in the project area. The federal *Fisheries Act* prohibits the introduction of deleterious substances to fish-bearing waters, including the North Saskatchewan River, Gold Bar Creek, Oldman Creek, the tributary to Oldman Creek, and a recent amendment to the *Migratory Birds Convention Act* prohibits release of deleterious substances into waters frequented by migratory birds. The deposition of hazardous materials, such as petroleum products, into waterbodies can lead to a reduction in water quality, which, in turn, can adversely affect aquatic vegetation and aquatic organisms. In the case of the North Saskatchewan River, Gold Bar Creek, Oldman Creek, unnamed tributaries and wetlands in the project study area, deleterious substances could adversely affect those waterbodies.

For roadway operation, a stormwater management system with appropriate application of stormponds and erosion and sedimentation control will be utilized. Vegetated roadside ditches will provide some removal of suspended solids and, combined with erosion and sedimentation control measures, are expected to meet or exceed Alberta Environment stormwater quality requirements, prior to the stormwater entering the North Saskatchewan River.

In the event of a hazardous materials spill into a waterbody, the impact will be adverse and major because a hazardous materials spill during construction and operation of the project could travel downstream quite quickly and affect downstream water quality. The impact, therefore would be regional in nature. In the event of a spill, the impact would likely be short-term and this type of impact would be rare in nature. The impacts to populations of receptors (organisms) in the creeks or river would be reversible over time. The probability of occurrence is considered low because although Highway 216 and 16 are both considered to be a Dangerous Goods Route, a relatively short segment of the road will cross the North Saskatchewan River rather than paralleling it and there is a very low frequency of spills that occur currently along those routes. The impact is predictable.

Mitigation Measures and Residual Impact

Best management practices for handling and storage of hydrocarbons and other hazardous products will be utilized. Temporary and permanent erosion and sedimentation controls will be used during construction of NEAHD. Spill kits will be carried on equipment or stored nearby work locations and all personnel will be trained to respond appropriately to a spill.

Refueling or maintenance of construction equipment will not be permitted near any waterbody and any curbside catch basins, if present. Wherever possible, biodegradable oils and lubricants will be used in equipment. Equipment operating near water will have spill kits at hand or nearby in the work area so that accidental release of such materials can be quickly and effectively controlled. All personnel will be trained to respond to a spill and be familiarized with spill kits and their locations. As a result, the potential for an accidental release during construction would be minimal. Excess paving and concrete materials will be handled and disposed of appropriately and concrete and paving vehicles will not be washed on site. The residual impact for hazardous materials spills during construction will remain negligible.

In the unlikely event of a hazardous materials spill, the stormwater management system, in combination with appropriate erosion and sedimentation control measures until vegetation has re-established, will be able to temporarily store a hazardous materials spill originating from the roadway surface during roadway operation to prevent the spill from entering any waterbodies or watercourses within the project study area. With those mitigation measures in place, the residual impact to water quality and fish and fish habitat from roadway operation and hazardous material spills would remain negligible.

5.1.3.6 Increased Loading on Existing Stormwater Facilities

Impact

Edmonton's stormwater management systems have been developed to accommodate urban growth, but may not necessarily have the capacity to deal with stormwater flows generated by NEAHD. Urban development, including roadway construction, increases the volume and rate of runoff because of an increase in impervious surface on the landscape.

There is abundant space within the project study area for stormwater management ponds and surface drainage, which are the preferred means to deal with surface water management. Due to the proximity of NEAHD to the heliport at CFB/ASU Edmonton, restrictions are placed on the types and sizes of ponds that can be placed along Highway 16 between just west of 17 Street to the west and just west of Highway 21 to the east. Those restrictions are to discourage birds from using stormwater management facilities, thereby reducing the potential of bird/helicopter collisions. Within that 8 km radius bird hazard area, large stormwater management ponds are discouraged (McElhanney 2001 in Spencer Environmental 2007). The use of wet/dry ponds must meet the following requirements and have DND approval-in-principle:

- Ponds must discharge water quickly, between two to four days.
- Small wet ponds in the bottom of larger dry ponds will retain water for longer periods and will be irregularly shaped.
- Narrow channels and small wet ponds address water quality requirements and may be lined with taller vegetation and rocky shores to discourage use by birds.

Twenty-one (21) stormwater management ponds are proposed in the current NEAHD functional planning study Stormwater Management Plan (Appendix A). The number and location of those ponds could change and will be finalized during the detailed design phase of this project. As such, stormwater flows will be accommodated within the project study area, and will be managed using culverts and controlled flows through pond outlet control structures. Assuming these measures, the impact of stormwater flows on existing systems will be negligible.

Mitigation Measures and Residual Impact

Existing drainage patterns will be maintained and the runoff retention system will be designed so that event flows will not exceed current inputs into the existing downstream system. With those measures in place, the residual impact to stormwater facilities will remain negligible.

Table 5.4. Summary of Impacts and Mitigation for Hydrology/Surface Water Quality

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Sedimentation	Adverse, minor, constant during operation, regional, short-term, reversible, high probability, predictable	• Clearing will be postponed until immediately before construction is scheduled to start • Use of standard erosion control techniques on open slopes • Vegetation will be established on disturbed areas immediately after construction • Standard erosion control techniques will be kept in place until vegetation is established • Monitor and maintain erosion and sedimentation controls until vegetation established	Negligible
Contaminated groundwater at the former Celanese site (now Worthington B.P.)	Adverse, major to minor, regional, long-term, constant, reversible, high probability of occurrence and predictable	• Extent of groundwater contamination and mitigation measures to be determined • Phase II ESA underway by Alberta Transportation	Adverse, major to minor, regional, long-term, constant, reversible, high probability of occurrence and predictable *Once a Phase II ESA is completed, and mitigation measures and a risk management plan

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
			are developed, this will likely become a positive residual impact.
Altered River Hydraulics from new bridge crossing	Negligible	• Follow Golder's (2009) recommended bridge design parameters • Ensure bank erosion protection utilized on north bank	Negligible
Altered drainage patterns	Adverse, minor to major, regional in nature, long-term but reversible, constant, high probability if occurrence without adequate drainage planning, predictable	• Reclaim and recontour land to resemble original terrain • Confirm requirements for permanent slope drainage during detailed design • Identify and confirm groundwater discharge and recharge areas • Maintain existing hydrologic connections	Negligible
Hazardous Material deposition	Adverse, major, regional, short-term, rare, reversible over time, low probability of occurrence, predictable	• Refueling or maintenance will not be permitted near any waterbody • Curbside catch basins, if any are present, will be hoarded • Biodegradable oils and lubricants will be used in equipment wherever possible	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		• Spill kits will be available and personnel will be trained in their use • Excess paving and concrete material will be disposed appropriately • Concrete delivery and paving vehicles will not be parked on site	
Increased loading on existing stormwater facilities from NEAHD construction	Negligible	• Storage facilities will contain flows in excess of storm system capacity until capacity becomes available • Construct small wet/dry ponds within the DND's bird restriction zone • Assess permanent slope drainage requirements during final design stages	Negligible

5.1.4 Air Quality

Potential impacts to air quality during construction and operation of NEAHD could be caused by:

- construction-generated dust and smoke,
- asphalt and concrete batch plant emissions during construction, and
- vehicle emissions during roadway operation.

These impacts and recommended mitigation measures to reduce the severity of their effect are described below, and are summarized in Table 5.6.

5.1.4.1 Construction Generated Dust and Smoke

Impact

Dust is typically generated during general roadway construction activities, but the volume of dust is dependent on the intensity and timing of the dust-generating activity. The impact of dust on air quality depends on the proximity of potential receptors as well as the volume of dust generated. For the proposed project, dust will mainly be generated intermittently throughout the entire construction period from clearing, earthworks and construction traffic within the project area. As construction is scheduled during the dry summer months, there is potential for significant dust volumes at this time of year.

Residents in the communities of Maple Ridge on the west side of Highway 216 between Whitemud Drive and Sherwood Park Freeway, Sherwood Park communities bordering the east side of Highway 216 between Whitemud Drive and Baseline Road, Emerald Hills and Lakeland Village near the Highway 16/Clover Bar Road interchange, and Fraser community located near 153 Avenue and the proposed Highway 216/153 Avenue interchange, are likely to be most affected by construction dust. Dust monitoring and standard dust control measures such as watering down dusty areas, especially during dry, windy days, will be adhered to in order to minimize dust impacts in adjacent residential and public areas. Assuming these measures, the impact from construction generated dust will be negligible.

AT does not permit burning cleared vegetation during roadway construction. Considering this burning restriction, the impact to air quality from smoke will be negligible.

Mitigation Measures and Residual Impact

No further mitigation measures are required other than following standard road construction dust monitoring and control measures as mentioned above. All dust monitoring and dust control measures will be outlined in the proponent's Environmental Construction Operations (ECO) plan for this project. Burning of cleared vegetation will not be permitted. The impact of dust and smoke on air quality remains negligible.

5.1.4.2 Asphalt and Concrete Batch Plant Emissions

Impact

Emissions from construction activities, such as the use of portable asphalt plants, could adversely impact air quality in the project area. The use of permanent asphalt plants is preferred, however, if portable asphalt plants will be utilized, those must meet Environment Canada's air quality emission standards. All permanent asphalt and concrete batch plats utilized for this project must also meet Environment Canada's air quality emission standards. Considering these mitigative measures, the impact from asphalt plant emissions will be negligible.

Mitigation Measures and Residual Impact

No further mitigation is required and the residual impact will remain negligible.

5.1.4.3 Vehicle Emissions

Impact

Vehicle emissions from operation of NEAHD could adversely impact air quality in the project area. Emissions from internal combustion engines in Canada are regulated by Environment Canada and Transport Canada pursuant to the federal *Canadian Environmental Protection Act* 1999 (CEPA 1999). Concentrations of contaminants including CO, NO_x and $PM_{2.5}$ could exceed federal and provincial air quality guidelines given the volume of traffic predicted for NEAHD for a future population of 1.6 million in 2041. Based on year 2041 vehicle emission factors and projected traffic volumes, concentrations of CO and NO_2 exhaust pollutants attributable to the proposed NEAHD are predicted to not exceed their applicable ambient air quality objectives (RWDI 2009). Maximum 24-hour concentrations of $PM_{2.5}$ were predicted to be less than 0.9 $\mu g/m^3$ beyond 50 m from the roadway. These levels are less than Alberta's Ambient Air Quality Objectives (30 $\mu g/m^3$), even with the inclusion of representative elated background concentrations (the 90^{th} percentile 24-hour $PM_{2.5}$ concentration is 15.6 $\mu g/m^3$). That conclusion holds true when the predicted concentration values of CO, NOx and $PM_{2.5}$ area combined with existing elevated (90^{th} percentile) measured ambient background concentrations. The predicted concentrations represent maximum conditions at the worst case receptors for the entire NEAHD alignment. Concentration profiles at other downwind locations along the proposed roadway would be expected to experience lower contaminant concentrations due to either lower traffic volumes or increased downwind distance from the roadways.

Concentrations attributable to construction of NEAHD are presented for the sensitive receptors identified within the project study area (Table 5.5). A line of worst-case receptors spaced 50m apart and at right angles to the roadway was drawn 700m into the surrounding residential area from the worst-case portion of roadway in the southeast quadrant of the Anthony Henday Drive and Sherwood Park Freeway intersection. A second receptor profile was selected for the Anthony Henday Drive and Whitemud Drive intersection, located in the southwest quadrant of the intersection. These receptor groups represent the maximum contaminant concentration profile along the proposed NEAHD. Along with the determination of the worst-case section of roadway, a screening-level review was also conducted for any existing sensitive receptors. Existing residences are, at their closest, located approximately 60m away from the free-flow portion of the proposed NEAHD. Beyond this distance, concentrations attributing to the roadway are predicted to continually decrease. Considering those results, impacts to those locations approximately 60 m away from reduced air quality from vehicle emissions will be negligible.

Table 5.5. Ambient Air Quality and Predicted Concentrations Attributable to the Proposed NEAHD in 2041 at Five Identified Receptors for CO, NO_2 and $PM_{2.5}$

Contaminant	Averaging Period	Predicted Concentration Attributable to NAHD in 2041 ($\mu g/m^3$)					Objective ($\mu g/m^3$)
		Training Centre	Residential Receptor 1	Residential Receptor 2	Residential Receptor 3	Residential Receptor 4	
CO	1-hr	1,064	848	1,998	1,080	1,013	15,000
NO_2	1-hr	106	85	119	108	101	400
$PM_{2.5}$	24-hr	0.47	0.39	0.86	0.50	0.51	50

Table 5.6. Summary of Impacts and Mitigation for Air Quality

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Dust and smoke generation from road construction activities	Negligible	None beyond these standard measures: • Burning of cleared vegetation will not be permitted • Minimize dust generation by wetting down dusty areas during construction activities	Negligible
Asphalt and concrete batch plant emissions	Negligible	• None beyond standard Environment Canada air quality emission standards	Negligible
Vehicle emissions during NEAHD operation	Negligible	• None beyond standard federal and provincial air quality standards	Negligible

5.1.5 Vegetation

Potential impacts related to vegetation include the following:

- Loss or alteration of native plant communities
- Loss of wetland habitat
- Loss of rare plants of special status species or unique plant communities
- Damaged vegetation from road salt
- Introduction of weedy or invasive species in disturbed areas
- Contamination due to accidental spills

These impacts, and mitigation measures to reduce their magnitude, are described more fully in the sections below and in Table 5.8.

5.1.5.1 Loss or Alteration of Native Upland and Riparian Vegetation

Impact

Of the total 116.79 ha of existing vegetation types in the study area, approximately 60.52 ha of native upland and riparian vegetation (not including weedy crop and wet crop) is available in the NEAHD project area. Approximately 29.40 ha (48.6%) of the available native upland and riparian vegetation will be directly impacted by project activities (Note: stormwater management ponds and any other impact areas proposed for outside the study area surveyed were not included in the impact analysis). The largest treed stands to be impacted are mature deciduous woodlots located along Highway 216 between Baseline Road and Wye Road (Sites S72 and S35a; Figure 4.2a-f). Although trembling aspen and balsam poplar are not unique or rare plant communities in this ecoregion, in urban areas it has become more isolated and patchily distributed and more native upland areas are being removed for development. Despite some of the sites being previously disturbed, they still provide important habitat patches for wildlife species living in the fragmented rural-urban fringe along the outskirts of Edmonton.

The largest area of riparian habitat to be directly impacted by the NEAHD project footprint is located along Oldman Creek and the unnamed tributary to Oldman Creek which both cross Highway 16 just west of Highway 21 (Sites S7 and S8; Figure 4.2a-f).

Loss of native upland plant communities in the NEAHD project area would be adverse, but minor. It would be minor because relatively little upland native vegetation is being removed in relation to the area of native upland vegetation remaining in the area. The impact would be local in nature but permanent as there are no plans or legislative triggers to encourage restoration of upland vegetation. The impact would be occasional and limited to areas cleared for construction. That loss is reversible if upland revegetation occurs, and the impact is predictable.

Mitigation Measures and Residual Impact

The proposed project footprint avoids approximately 51.4% of the native upland and riparian habitat in the project vicinity. To lessen the impact on native upland plant communities during construction, equipment storage, maintenance and refueling in areas that support native plant communities will be prohibited. Prior to construction, marking the clearing limits with snow fence or highly-visible flagging will help minimize the extent of vegetation loss. Vegetation clearing restrictions will include: 1) only hand clearing is allowed within 30 m of a waterbody, including wetlands; 2) no equipment is allowed to cross any waterbody during clearing operations; 3) trees shall not be allowed to fall into a waterbody; and 4) retain an undisturbed vegetation buffer between the construction site and watercourse to prevent sedimentation. The residual impact to native upland plant communities will be adverse, minor, permanent and predictable to negligible; minor because of the inherent loss of native vegetation in the area and negligible for vegetated areas that are highly disturbed and contain many weedy species.

5.1.5.2 Loss of Wetland Habitat

Impact

Construction of NEAHD will require draining and filling of wetlands within the project area (Highway 216/16 alignment upgrade), an activity for which approval may be required under Alberta's *Water Act*.

There are approximately 56.27 ha of wetland habitat available within the NEAHD project study area. Approximately 29.31 ha of that wetland habitat will be directly impacted by NEAHD construction (Table 5.7), representing 52.1% of the wetland habitat available within the NEAHD project study area (Note: stormwater management ponds and any other impact areas proposed for outside the study area surveyed were not included in the impact analysis). Those wetlands range from to Class II (wet meadow) wetlands to Class VIII (shrub wetland). All wetland types provide diverse plant communities, which provide important wildlife habitat. They also play a role in groundwater recharge and discharge processes. Most of the individual wetland areas are relatively small, however, cumulatively, the wetland area that will be lost within the NEAHD project area is regionally significant. That is because such areas can support high biodiversity and provide important ecological functions such as water quality control and water supply. The significance of local and regional wetland loss is also recognized by Alberta Environment through approvals required under the Alberta *Water Act* for filling and draining wetlands and compensating for wetlands lost. A detailed list of each wetland by site, type, class and areas impacted by NEAHD construction is available in Table 5.7. Without mitigation for wetland function at the impacted sites and the associated upland areas, NEAHD construction will result in an adverse, major, regional, permanent, but reversible with compensation, highly probable and predictable impact.

Table 5.7. Wetland Area (ha) Directly Impacted by the Proposed NEAHD Alignment

Wetland Class[a]	**Class Name**	**Vegetational Zone**	**Area Impacted (ha)**
II	Temporary pond	Wet meadow	2.39
III	Seasonal pond	Shallow marsh	4.38
IV	Semi-permanent pond	Deep marsh	3.83
V	Permanent ponds and lakes	Permanent open water	18.08
VII	Fen	Fen (alkaline bog)	0.52
VIII[b]	Shrub wetland	Shrub wetland	0.11
Total			**29.31**

[a] After Stewart and Kantrud (1971): I-ephemeral, II-temporary, III-seasonal, IV- semipermanent, V-permanent, VIII- shrub wetland

[b]VIII – new classification added by Spencer Environmental

Mitigation Measures and Residual Impact

Compensation is defined as action taken to offset negative impacts of undertakings on the functions and/or area of a particular wetland (North American Wetlands Conservation Council (Canada) 1998 in Spencer Environmental 2007). In order of preference, Alberta Environment will accept compensation in the form of:

- the restoration of previously drained wetlands;
- rehabilitation of degraded, yet still existing natural wetlands; or
- construction, ongoing maintenance and monitoring of compensatory wetlands.

If avoidance is not possible, existing wetlands (either the affected wetland or other adjacent habitat) can be supplemented or enhanced, or if this is not feasible, new wetland habitat can be created. Considering the proposed project footprint, 29.31 ha of wetlands will be directly impacted by NEAHD construction. Since compensation ratios are determined on a case-by-case basis, the contractor will confirm the compensation ratio for this project with Alberta Environment during the *Water Act* application and wetland compensation process because of changes to Alberta's wetland policy and regulator's requirements since 2001.

At the detailed design stage, and in preparation for approval pursuant to Alberta's *Water Act*, a wetland compensation plan will be prepared including all wetland areas and adjacent functional upland zones (FUZ) directly impacted by NEAHD construction. Wetland FUZ is the upland area surrounding the wetland that contributes to wetland function. Specifically, adjacent uplands can function as sediment or pollution filters, shoreline stabilizers and visual screens for wildlife (Connecticut River Joint Commissions 2000; Fischer and Fischenich 2000 in Spencer Environmental 2007). They can also function as wildlife habitat in their own right. In recognition of this integral relationship between wetlands and surrounding uplands, many government wetland policies and legislation also address the importance of surrounding uplands. The contribution of adjacent uplands to wetland function will, therefore, also be assessed and considered in future decisions regarding wetland compensation.

Until detailed design and the wetland compensation plan are completed, the residual impact to wetland habitat from roadway construction will be adverse, minor to negligible in the long term, permanent and predictable. The residual impact will be negligible in the long term. This assessment assumes successful wetland compensation (i.e., functioning compensatory wetlands) in the local area [i.e., as close as possible to original wetland(s)]. All wetlands and associated FUZ directly impacted by the proposed project will be appropriately compensated using an approach negotiated with Alberta Environment during detailed design to achieve no net loss of wetland area and function. If the compensatory wetlands do not become functioning wetlands then the residual impact would be minor.

5.1.5.3 Salt Impacts to Vegetation During NEAHD Operation

Impact

Once the road is constructed and operational, it will need to be maintained for the safety of the travelling public. Salt will be applied to the highway in winter conditions to prevent ice build-up on the road surface.

The road salt runoff could adversely impact upland plant communities or wetlands. Such an adverse impact, however, is rated as minor because any contamination of vegetation will be local in extent and of short-term to long-term duration depending on the amount and frequency of road salt application (road salt will be regularly used in winter conditions). The probability of occurrence from road salt is high and predictable considering roadway maintenance and operation history.

Mitigation Measures and Residual Impact

A salt management plan pursuant to Environment Canada's *Code of Practice for the Environmental Management of Road Salts* (2004) will be implemented to minimize salt use on roadways where and when possible. That plan will include response procedures to react to uncontrolled releases of road salts that could result in environmental impacts and monitoring procedures to ensure the plan's effectiveness. With these measures in place, the impact to vegetation from road salt will be reduced to negligible.

5.1.5.4 Introduction of Weedy Species

Impact

In many locations, weedy species have become established and, in some instances, are quite widespread (see Section 4.1.5). Although mature weeds will be removed during grubbing, their seeds will remain in the stockpiled topsoils to be used in reclamation. Weeds could become established in these reclaimed areas, supported by the seed bank in the topsoils. Weedy species can also be spread through the movement of seeds and rhizomes deposited on equipment while working in several different areas. Facilitating establishment of weedy species, particularly in areas adjacent to native vegetation, in wetlands and along the North Saskatchewan River, Oldman Creek and associated watercourses, is undesirable as it could reduce the value of the wildlife habitat or create an ongoing maintenance issue. Because of the proximity to the North Saskatchewan River, Oldman Creek, associated watercourses and wetlands, the use of herbicides may not be an option for weed control if it becomes necessary.

Preventing weed establishment in the first place may be the best and most economical opportunity for weed management. Unmitigated, the spread of weedy species within reclaimed areas will have an adverse, minor, regional, permanent, constant, reversible, high probability of occurrence and predictable effect on habitat values and maintenance costs.

Mitigation Measures and Residual Impact

Precautions, such as cleaning equipment used in weedy areas before moving into new construction areas will help reduce the potential transfer and spread of weedy species. Using weed control on soil stockpiles left for periods sufficient for the maturation of weeds will prevent additional seed deposition in topsoils. More generally, some weed control may be required until target vegetation species becomes established, but the need for such measures can be assessed through monitoring. Areas seeded with native seed will not be fertilized. An action plan will be developed to control spread of noxious, restricted and nuisance weeds. Considering these measures, the residual impacts will be reduced to negligible.

5.1.5.5 Loss of Special Status Plant Species

Impact

Manning Drive to Highway 16 East

Two rare plant species were observed within the TUC between Manning Drive and Highway 16 East: *Osmorhiza longistylis*, smooth sweet cicely (S2 species) [one location (Site N12 on Figure 4.2a-f)] and *Muhlenbergia racemosa*, marsh muhly (S1 species)[one location (Site N17 north NSR bank; Figure 4.2a-f)]. Of the two locations with rare plants in this section of the project area, the smooth sweet cicely at Site N12 will be directly impacted by NEAHD construction. The marsh muhly at Site N17 is located outside the proposed construction limits, however, if the construction limits change or an outfall structure is constructed at that site it will also be directly impacted by the NEAHD roadway project. Destroying these plant species during construction will result in an adverse, major, local, occasional, permanent, reversible, highly probable and predictable impact.

Highway 216/16 Alignment

Vegetation investigations for this project undertaken on 08 to 12 June 2008 and 25 and 26 June 2009 targeted special status native plant communities and special status plant species. No special status native plant communities were identified, however, fifteen (15) plant species with "special status" were identified within the project limits. All 15 of those species are S3 (uncommon) plant species (20-100 occurrences within the province of Alberta) (high bush-cranberry, Pennsylvania buttercup, common reed, slender-beak sedge, rough-water horehound, peachleaf willow, America wintercress, white wintergreen, spreading woodfern, tufted-yellow loosestrife, Labrador bedstraw, water mudwort, purple peavine, awlfruit sedge and marsh willowherb) (Table 4.11) and were identified in the project area.

Loss of special status plant species to the project in this section of the project area would be an adverse impact but minor because all of the species involved in this section of the project area are S3 species. The adverse impact would be local in geographic extent because the locations of the occurrences are known and static. Specific UTM locations of S3 species were not taken during the rare plant surveys, but rather the site location was recorded. Twelve sites (S3, S7, S8, S24, S25, S39, S58, S61, S65, S71, S72 and S86; Figure 4.2a-f) containing seven S3 species (marsh marigold, rough-water horehound, awlfruit sedge, highbush cranberry, Labrador bedstraw, peachleaf willow and tufted yellow loosestrife; Table 4.11) will be impacted by the project footprint. The impact would be permanent and occasional, limited to construction, and predictable due to the site location information available from the vegetation surveys.

Mitigation Measures and Residual Impact

Manning Drive to Highway 16 East

Appropriate mitigation will be developed to avoid or minimize the impact to the two rare S1 and S2 plant species, located at Sites N17 on the north shore of the NSR and N12 near the 130 Avenue interchange. Where rare plants will be directly impacted, one viable option is to transplant the plants from the area to a suitable area, away from future disturbance. In addition, seeds will be collected from the plants and donated to the seed bank at the Devonian Botanic Garden. If the plants will be transplanted, they will be excavated with a large root ball in order to ensure the soil microorganisms and fungi critical to plant survival are moved to the new location with the plant. The transplanted plants should then be monitored to ensure they become established at the new site. Considering these measures, the residual impact to the species would be negligible.

Mitigation measures are not typically implemented for loss of S3 plant species. The overall loss of S3 species remains an adverse, minor, permanent, occasional and predictable impact.

5.1.5.6 Accidental Spills of Contaminants

Impact

Fuel or lubricant spills can occur during refueling or as a result of equipment failure of accidents (e.g. broken hydraulic hose). Should spills occur in areas with natural vegetation, soils or surface waters (e.g., river, creek, tributaries, wetlands), these features could be contaminated with hydrocarbon and heavy metals which, in turn, could result in plant mortality. Most spills would likely be small in nature, but if uncontrolled, could spread over large areas. That issue is particularly pertinent in working areas near waterbodies , including wetlands. Equipment will be refueled and maintained in a central location away from any waterbody preferably on a paved or graveled area. Wherever possible, biodegradable oils and lubricants will be used in equipment. If fuel is stored on site, tanks will be carried or readily accessible to equipment working on site and at the refueling/maintenance area. Construction personnel will be trained in the use of spill kits. Should a spill occur, personnel will be instructed to immediately contain and attempt to prevent the spread of the spilled material, particularly if near the North Saskatchewan River, Gold Bar Creek, Clover Bar Creek, Oldman Creek, unnamed tributaries and wetlands. With these measures implemented, the impact of a contaminant spill on vegetation will be negligible.

Mitigation Measures and Residual Impact

No further mitigation is required beyond the standard measures described above. The contractor will develop an Environmental Construction Operations Plan (ECO Plan), including an emergency spill response, to ensure any spills are quickly and effectively cleaned up and spills of a certain size will be reported as required by Alberta's *Environmental Protection Enhancement Act* (*EPEA*). The residual impact is negligible.

Table 5.8. Summary of Impacts and Mitigation for Vegetation

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Loss or alteration of upland native plant communities	Adverse, minor, local, permanent, occasional, reversible, high probability of occurrence, predictable	• To the greatest extent possible, avoid aligning NEAHD through native plant communities and refine clearing limits • Clearly mark clearing limits with snow-fence or highly visible flagging • Adhere to vegetation clearing restrictions including: 1) only hand clearing is allowed within 30 m of a waterbody; 2) no equipment is allowed to cross any waterbody during clearing operations; 3) trees shall not be allowed to fall into a waterbody; and 4) retain an undisturbed vegetation buffer between the construction site and watercourse to reduce the	Adverse, minor, permanent, predictable to negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		potential for sedimentation • Prohibit equipment storage, maintenance and refueling in areas that support native plant communities	
Loss of wetland habitat	Adverse, major, regional, permanent, but reversible with compensation, high probability, predictable	• Where possible, wetlands should be avoided • Where avoidance of wetlands is not possible, enhance existing sites or create similar wetlands in nearby areas to achieve no net loss of wetland habitat and function • Confirm required compensation ratio with Alberta Environment • Complete wetland compensation plan in support of Alberta *Water Act* approval for draining and filling wetlands • Liase with City of Edmonton regarding potential wetland compensation sites within the City • Incorporate native shrubs and trees in mitigation	Adverse, minor, permanent, predictable to negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		wetlands	
Effects of road salt on adjacent vegetation during roadway operation	Negligible	• Implement a salt management plan pursuant to the *Code of Practice for the Environmental Management of Road Salts*	Negligible
Introduction of weedy or invasive species	Adverse, minor, regional, permanent, constant, reversible, high probability of occurrence, predictable	• Develop action plan to control spread of weedy species in reclaimed areas • Clean equipment used in weedy areas before moving into new areas • Use weed control on soil stockpiles left for long periods • Use weed control in disturbed areas until desired vegetation is established • Re-vegetate cleared areas as soon as possible with native vegetation	Negligible
Loss of rare plant species S1 (marsh muhly and S2 (smooth sweet-cicely) species	Adverse, major, local, occasional, permanent, reversible, highly probable and predictable impact.	• Avoid areas with rare plants where possible and mark clearly in the field • For areas impacted, transplant the plants with large root ball to an area away from	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		future disturbance • Monitor transplants to ensure viability • Collect seeds and donate to the Devonian Botanic Garden	
Seven S3 species	Adverse, minor, permanent, occasional, predictable	Mitigation measures are not typically implemented for loss of S3 plant species	Adverse, minor, permanent, occasional, predictable
Loss of vegetation as a result of contamination from fuel and lubricants	Negligible	• Standard construction practices • Maintain and refuel equipment away from any waterbody • Biodegradable oils and lubricants will be used in equipment wherever possible • Store on-site fuels in secure tanks with some form of spill protection • Ensure spill kits are readily available at refueling/maintenance areas • Carry spill kits or make readily accessible • Train personnel in use of spill kits and immediate response	Negligible

5.1.6 Wildlife

Potential impacts to wildlife from the proposed project include:

- habitat loss,
- habitat alienation during and post-construction,
- mortality from road construction,
- mortality or disturbance to special status wildlife species,
- blockage or impediment to wildlife movements during construction and operation of NEAHD, and
- animal/vehicle collisions.

These impacts and recommended mitigation measures to reduce the severity of their effect are described below, and are summarized in Table 5.10.

5.1.6.1 Loss of Wildlife Habitat

Impact

Most of the land within the NEAHD project study area has been cleared for cultivation or subjected to other types of indirect human disturbance such as industrial, commercial and residential land use. Based on the proposed project footprint, approximately 29.45 ha of native upland vegetation and wetland habitat will be impacted within the project area. This represents 23.8% of the upland and wetland habitats available in the project area.

Removal of the treed habitats would lead to the loss of some nesting, natal and brood rearing habitat for several migratory birds and other wildlife, but similar habitats are available in the regional study area. Based on the relatively small amount of treed habitat impacted by the project and the availability of similar habitat in surrounding areas, the impact of the project on wildlife habitat will be adverse, minor, local, permanent, highly probable and predictable.

The potential loss or alteration of wetlands, which provide habitat for aquatic and semi-aquatic birds, mammas and amphibians, is considered a significant adverse impact. Adverse impacts will include direct affects resulting from drainage and road development. Although most of the wetlands impacted are relatively small and are scattered throughout the project area, the breeding bird surveys undertaken in Spring 2006 and 2008 suggest that they are locally important for waterfowl and other migratory water birds. Considering the proportion of wetland habitat loss from within the NEAHD project study area, and provincial as will as federal concerns about wetland loss, the extent of wetland loss will be an adverse, major, local, permanent, highly probable and predictable impact.

Mitigation Measures and Residual Impact

Prior to construction, marking the clearing limits with snowfence or highly-visible flagging will help minimize the extent of vegetation loss. Reclaiming areas of surface disturbance by planting native species to replace upland habitat will help minimize the relatively small area of native habitat lost and the residual impact to treed upland habitat will be reduced to negligible.

Wetland compensation will be consistent with the objectives of the Alberta Interim Wetland Policy (1993). Although some opportunities are available to restore wetlands remaining in the project study area, much of the lost habitat will likely have to be replaced with created wetlands. A variety of wetland types, which include seasonal, semi-permanent and permanent ponds, will be developed. The strategy will involve creating wetland complexes that contain various pond classes and sized to provide habitat for dabbling ducks, diving ducks and other wetland wildlife. In addition, areas supporting dense native plant communities will be established in and around these wetlands to provide upland nesting cover for waterfowl. Because ducks will nest a considerable distance from the water, upland nesting habitat will extend from the edge of the water into upland habitat.

Incorporation of treed and shrub communities with created wetlands will enhance wetland function (i.e., functional upland zone) and partly compensate for lost upland habitat. The addition of upland habitat to these sites will benefit wildlife by creating nesting habitat for migratory songbirds, as well as adding suitable habitat for raptors, amphibians and small-bodied mammals (e.g., mice and voles). Equipment storage, maintenance and refueling in the vicinity of wetland and treed and shrub habitat will be prohibited.

Although the replacement of wildlife habitat affected by the proposed alignment upgrade will substantially reduce the impact of habitat loss, there will be a loss of function while habitats created as part of a compensation program become established. The residual impact of wetland habitat loss and function will be adverse, minor, permanent and predictable to negligible after compensation.

5.1.6.2 Construction Disturbance and Habitat Alienation Effects

Impact

The activity and noise associated with construction can prevent sensitive wildlife species from using adjacent habitat and travelling through wildlife movement corridors. This habitat alienation effect reduces the amount of habitat available to individuals and could impede movement for large- and medium-sized animals, although in the case of construction, the impact would be temporary. Some undisturbed natural habitat will remain in areas adjacent to the project area in the table lands north and south of the river and in the river valley, providing alienated individuals with alternative areas of suitable habitat. The area of the North Saskatchewan River Valley in the vicinity of the proposed bridge crossing may be blocked during construction, however, forcing large- and medium-sized animals to detour around the construction area. The north river bank is relatively steep, leaving few options for wildlife to detour other than the base of the slope and occasional terraces and ravines that would allow them to move to and from the top-of-bank and upland areas. In addition, the north bank is south-facing, therefore, a favoured habitat in winter for deer. Construction activities during the winter could cause deer to avoid the area. The south bank provides more options for animals to detour around the bridge construction area because the bank is shallower and movement in the area is less restricted by topography compared to the north bank. The south bank, however, does have more industrial development, limiting areas in which wildlife may move. The impact to wildlife from habitat alienation would be adverse, minor to major, reversible and predictable.

Alienation of wildlife during construction activities would be an adverse minor impact because the Highway 216/16 alignment is an existing alignment. The adverse impact during construction would be local in extent, of short-term duration, reversible, high probability of occurrence and predictable.

Mitigation Measures and Residual Impact

To mitigate the effect of disturbance and habitat alienation, particularly on species that are sensitive to disturbance, night shifts will be minimized and the construction schedule within the North Saskatchewan River Valley will be kept to a minimum. Maintaining wildlife passage under the new bridge during construction would allow wildlife to move through the area along the North Saskatchewan River at night rather than detouring around the construction area. If bridge construction occurs during winter, maintaining passage through the construction area would also maintain access to over-wintering areas for deer. Considering these measures, the residual impact would be minor to negligible, short-term, reversible, highly probable and predictable.

5.1.6.3 Mortality During Construction

Impact

Clearing of natural vegetation can cause wildlife mortality, particularly during the spring breeding season when the mobility of many species is restricted. At these times, adults remain close to dens and nest sites, and young are not yet able to move long distances. If mortality is high during spring, local populations may suffer short-term declines. This effect is even more dramatic in populations already at low levels, as is the case for some special status species. Migratory bird nests are protected under the federal *Migratory Birds Convention Act (MBCA)*, which states that nests cannot be disturbed or removed during the breeding season. There are also legal implications for mortality caused by clearing. Both the federal *Migratory Birds Convention Act (MBCA)* and the Alberta *Wildlife Act* prohibit activities that will lead to the destruction or disturbance of nesting sites of migratory birds. A recent amendment to the *MBCA* further protects disturbance to individual migratory birds. Direct mortality and nest site disturbance resulting from construction activity and clearing would contravene those Acts. Construction activities adjacent to wetlands might introduce deleterious substances into those wetlands, which could lead to direct mortality of wildlife species. That would result in an adverse impact, as the MBCA prohibits release of a substance that is harmful to migratory birds in waters or areas frequented by them.

Construction involving vegetation clearing during the breeding period (15 April to 31 July) has the potential to impact many species, particularly birds, as both adults of nesting individuals may care for young reducing their ability to escape, which in turn makes them vulnerable to injury or mortality during clearing activities. Mortality may also result later in the breeding season when fledgling (feathered young that are not yet able to fly) depend on vegetative cover for protection until they are able to fly. The impact of high mortality rates on wildlife populations resulting from construction activities would be adverse, minor to major, permanent and predictable, depending in the species affected.

Mitigation Measures and Residual Impact

Vegetation clearing should be scheduled for the fall or winter months to avoid the spring breeding period (15 April to 31 July), thereby minimizing the potential for mortality. This clearing should involve not only tree removal, but also removal of all ground cover and brush piles to prevent ground nesting birds from using the area. If vegetation clearing cannot be avoided during the spring breeding period, then the area may be surveyed by a professional biologist and, if there are no active nests, the biologist may give the proponent clearance to clear vegetation and Environment Canada and Alberta Sustainable Resource Development will be notified. By fall, most species would be mobile and could easily evade construction equipment. In winter, many migratory species will not be present, further reducing the risk. In addition to avoiding vegetation clearing in the spring, clearing limits should be marked with highly visible flagging or fencing to minimize accidental removal of habitat and prevent introduction of deleterious substances associated with the risk of wildlife mortality. With these measures in place, the impact would be reduced to negligible.

5.1.6.4 Loss of Special Status Species

Impact

Based on preliminary design information, approximately 62.61 ha of native upland, riparian and wetland vegetation will be impacted within the project area. This represents 50.5 % of the upland and wetland habitats available in the project area. Unless clearing occurs during the breeding season, it is unlikely that construction activities have the potential to directly impact most of the special status species known or suspected to use habitat in the regional study area. Construction may, however, alienate some special status species that use the area.

Of the 10 special status species potentially using habitat in the NEAHD project area, one amphibian species (Canadian toad) (provincially ranked as May Be at Risk) and nine special status bird species (all provincially ranked as Sensitive) including American white pelican, least flycatcher, northern harrier, sora, common yellowthroat, horned grebe, lesser scaup, pied-billed grebe and green winged teal were confirmed in the NEAHD study area during the 2006 and 2008 wildlife survey seasons. Two Canadian toad individuals were heard calling from a naturalized man-made pond in a gravel extraction area west of Meridian Street (Site A8b; Figures 4.4a-b). Attempts to determine if Canadian toads successfully bred (through tadpole surveys in 2006) were unsuccessful, however, the sandy soils and the presence of pocket gopher burrows around the wetland, located in the North Saskatchewan River floodplain, suggest that the area is potentially good Canadian toad breeding and hibernating habitat. Canadian toads are known to utilize pocket gopher burrows for winter hibernation. Considering the east end of the wetland will be directly impacted by the proposed roadway construction activities, there is potential to destroy Canadian toads and their breeding and hibernating habitat, which would negatively affect local Canadian toad populations. The impact to the Canadian toad habitat from NEAHD construction would be adverse, major, local, long-term, occasional, irreversible, high probability and predictable.

Although the area of upland, riparian and wetland habitats impacted will be relatively large on a local scale, regionally there is similar habitat available for most bird species. If a loss did occur, it would be of local or regional/national extent, depending on the species. Such a loss would be permanent to upland locations scheduled for removal. With wetlands lost to the project, however, these are to be compensated for so, in the case of wetland dependent bird species, the loss could be temporary. The frequency of the impact would be occasional and reversible, depending on habitat conditions. The probability of occurrence is high.

Mitigation Measures and Residual Impact

Because evidence of breeding was not confirmed for the Canadian toad at Site A8b (Figure 4.4a-b) and it is unknown at this time whether compensation for the naturalized man-made wetland will be required under Alberta's *Water Act* and the Interim Wetland Policy (1993), the contractor will coordinate with Alberta Environment and Alberta Sustainable Resource Development during detailed design to confirm their requirements in this case. The results of those negotiations will be included in the contractor's wetland compensation plan in support of their *Water Act* application for draining and filling wetlands in the project area.

In addition to the above-mentioned mitigation measures, the Fish and Wildlife Division of Alberta Sustainable Resource Development has developed setback distance guidelines for selected wildlife species, including the Canadian toad (Fish and Wildlife Division 2001). Recommended restricted activity dates and setback distances for human structures created, soils disturbed, or long-term vegetation disturbance, including roadway construction are listed in Table 5.9 below.

Table 5.9. Recommended Restricted Activity Dates and Setback Distances (Fish and Wildlife Division 2001)

			Setback Distance by Land Use Category
Species	**Wildlife Key Area**	**Restricted Activity Dates**	**Human Structures Created, Soils Disturbed, or Long-term Vegetation Disturbance (e.g. road)**
Canadian Toad	Ponds Used for Living, Breeding or Hibernating	Year Round	100 m

Areas to be cleared will be confirmed during the detailed design phase of the project. Vegetation clearing, including ground cover and brush piles, will be avoided during the breeding bird season (15 April to 31 July). With these measures, residual impacts to all potential special status species in the project area will be reduced to negligible.

5.1.6.5 Disruption of Wildlife Movement Corridors

Impact

Large-and medium-sized mammals such as deer, moose and coyotes move between isolated patches of treed and wetland habitats in the project corridor for food and cover. Those animals frequently move between sites using linear patches of trees and shrubs in hedgerows and along small and large watercourses, including the North Saskatchewan River Valley. Smaller animals such as amphibians, shrews, mice, voles, hares and squirrels also use sheltered strips as dispersal corridors. The project study area is a relatively undeveloped linear corridor containing patches of habitat and natural areas dispersed with agricultural lands, arterials and collector roadways and may act as a 'stepping stone' for wildlife moving along the northern fringes of the City (Figure 6.2; Spencer Environmental 2006).

Highway 216/16 alignment

Three wildlife movement corridors were identified along Highway 216 (Figure 5.3) within the proposed project study area. Those corridors are associated with wooded areas/patches that connect with drainage areas and wetlands. One additional location along Highway 16 was also deemed a wildlife crossing based on the abundance of deer tracks adjacent to the highway and presence of coyote tracks in a culvert in that particular area during the wildlife tracking survey conducted by Spencer Environmental on 31 January 2009. That particular crossing is associated with an existing drainage to the North Saskatchewan River (Figure 5.3). No existing passage structures are in place at any of the above-mentioned corridors. Minimal removal of vegetation along the proposed highway alignment upgrade (Highway 216/16 alignment) due to roadway construction is planned, therefore, disturbance to wildlife in the vicinity of the identified corridors will be temporary and specific to the construction stage. Considering the poor existing passage conditions and minimal disturbance to the existing habitat patches, impacts of the proposed roadway alignment to medium- to large-sized animals will be negligible.

North Saskatchewan River

The North Saskatchewan River Valley is a major wildlife corridor within the study area, providing a linkage between habitats for large- and medium-sized mammals such as deer, moose and coyotes. Wildlife movement in the North Saskatchewan River Valley at the proposed bridge crossing location is mainly located at the top-of-bank and along lower terraces and riverbank areas. The presence of the proposed bridge, including the approaches to the river valley, has potential to interrupt existing local and regional movement patterns. If the bridge were to function as a barrier to animal movement the upstream valley reach would be effectively isolated from the downstream reaches and the remainder of the valley system. If that were to occur, animals such as deer may be forced to cross over Anthony Henday Drive, creating potential for increased vehicle/animal collisions (see Section 6.1.6.6. below).

Bridge design for the advanced functional planning study has incorporated bridge design guidelines developed for large-to medium-sized animals consistent with current literature on the subject and as exhibited by the bridge constructed over the North Saskatchewan River for Southwest Anthony Henday Drive. Those guidelines were previously outlined in Spencer Environmental (2007) but are reiterated reference:

- A bridge with minimum valley-intruding abutments is preferred as it affords animals more movement choices.
- Provide for animal passage on both sides of the river.
- Overhead clearance at the underpass should be minimum height of 4 m (will accommodate moose and deer and accounts for snow depth).
- At the underpass, if terrain is steeply sloped, a path should be graded to provide a nearly level surface with a minimum width of 4 m. The path should have a substrate composed of softer earth or organic material. These two measures will encourage deer and other species to use the underpass. Hard surfaces will deter deer.
- Preferably, any graded path should be separated from any future recreational trails planned to pass under the bridge. This can be done by establishing vegetation screening between trails.
- Parallel, shade-tolerant shrub communities should be planted in borders along the sides of the wildlife path in order to provide animals with security and encourage path use. This planting strategy assumes that construction under the bridge will result in disturbance of the existing vegetation or that shade provided by the bridge will result in loss of some existing plant communities.
- Where the wildlife path parallels the river there should be a minimum of 6 m of vegetation maintained between the river bank and the wildlife path. If this is not naturally present, the vegetation should be established through plantings.
- To provide for wildlife security, a 30 m wide riparian zone should be maintained or constructed at the approaches to the underpass facility.
- The distance between vegetation belts on either side of the crossing should be no further than 60 m.
- To provide additional security the area of daylight between the bridge decks should be planted with suitable shrub species.

To further encourage ungulates to use the underpass and minimize the potential for vehicle/animal collisions, fencing may be considered to direct animals under the bridge and would extend a minimum of 0.8 km past frequently used areas. Fencing would be at least 2.7 m high, jump outs would be included and mesh with 50 to 150 mm openings would be securely installed along the bottom to prevent passage by small animals. The mesh would be installed on the inside of the posts (i.e., the side furthest from the highway) and fencing would be regularly maintained, as any weak areas will be exploited by wildlife.

Considering those measures, impacts to wildlife movement would be limited to the time required to complete the proposed project and to the time it takes wildlife to become accustomed to the presence of the new bridge and highway alignment. The impact to wildlife movement is expected to be adverse, minor and local. It would be adverse if wildlife movement is impeded more than the current situation. It would be short-term to long-term because it may take longer than one year for the wildlife to become accustomed to the presence of the new bridge and passage opportunities. It would be constant during construction and operation of the bridge and highway alignment. Given enough time for the wildlife to adjust to the presence of the bridge, the impact to wildlife movement corridors will be reversible, highly probable and predictable.

Mitigation Measures and Residual Impact

To ensure impacts remain minor, night shifts will be minimized during construction to provide opportunities for wildlife to pass through the area without disturbance. Workers will be instructed not to harass wildlife observed in the construction zone. The residual impact would remain adverse, minor, local, short-term to long-term, reversible, highly probable and predictable.

5.1.6.6 Animal/Vehicle Collisions

Impact

Collisions between medium- to large-sized animals and vehicles can be important as mortality for those species can be increased and a risk to public safety and property cost could be posed. As described above in Section 4.1.6.2, there are three (3) areas that appear to be major large animal wildlife corridors (along Highway 216; Maps 1-11; Appendix L) and one major wildlife crossing (along Highway 16; Maps 1-11; Appendix L).

Alberta Transportation (2009) deer-collision data shows that deer-vehicle collisions are frequent along Highway 16 between 17 Street and Sherwood Drive. Records show that other areas along Highway 16 also experience wildlife-vehicle collisions (Figure 4.5). Many of those collisions along Highway 16 are associated with existing drainages of the North Saskatchewan River, tributaries of the North Saskatchewan River, Oldman Creek and tributaries of Oldman Creek. That is expected as animals will often use watercourses as movement corridors.

The North Saskatchewan River valley acts as a major wildlife corridor through the region, including the proposed bridge crossing site. Regardless of the bridge design, because deer currently move along the top-of-bank on the north and south sides of the river, at the cultivated/wooded ecotone, there is potential for animals to attempt to cross over the bridge approaches rather than move downslope into the river valley and under the bridge. This is particularly true for the steep north river bank where the steepness of the slope may further discourage animals from going under the bridge. The traffic volumes predicted for the roadway, and experience in other wooded areas of the city, indicate that deer attempting to cross the road would lead to some deer/vehicle collisions. High numbers of collisions can adversely affect local deer populations and represent a safety hazard for motorists. Unmitigated, the potential for high numbers of deer/vehicle collisions near the North Saskatchewan River is rated as an adverse, major, local/regional, permanent, highly probable and predictable impact.

Mitigation Measures and Residual Impact

Northeast Anthony Henday Drive will be lit at night, which will increase the visibility to motorists of large wildlife that may move across the roadway during night conditions. The roadway right-of-way will comprise an open area with limited tree and shrub vegetation cover immediately adjacent to the roadway. That will also make moving wildlife more visible to motorists thereby reducing the potential for collisions with vehicles. Smaller animals will be able to use drainage culverts beneath the roadway although these will not be designed and located specifically to convey specific species. In addition to the bridge design recommendations for wildlife passage described in Section 6.1.6.5 above, ungulate fencing will be placed along both bridge approaches to the river. Native shrubs will be established in selected places along fences, and at the toe of the bridge abutment side slopes, to further encourage animals to move down into the valley at the bridge approaches, rather than upslope and away from the river. Deer/vehicle collisions will be monitored, and if required, additional measures, such as placement of deer crossing signs or other public education efforts taken. Incorporation of the above-described measures into detailed design will reduce the potential impact associated with increase deer mortality to minor to negligible, local/regional, permanent, highly probable and predictable.

Table 5.10. Summary of Impacts and Mitigation for Wildlife

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Loss of natural upland treed habitats Loss of wetland habitats	Adverse, minor, local, permanent, high probability, predictable Adverse, major, local, permanent, high probability, predictable	• Mark clearing limits prior to clearing • Revegetate any disturbed areas as soon as possible using native species • Comply with Alberta Interim Wetland Policy (1993) wetland compensation requirements	Negligible • Adverse, minor, permanent, predictable to negligible after compensation
Habitat alienation from construction activities	Adverse, minor to major, local, short-term during construction, reversible, high probability, predictable	• Minimize night shifts and maintain wildlife passage • Prohibit the harassment of wildlife during	Minor to negligible, local, short-term, reversible, high probability, predictable

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		construction	
Direct wildlife mortality during construction	Adverse, minor to major, regional to provincial/national, permanent, occasional, irreversible, high probability of occurrence and predictable	• Do not clear vegetation in the period 15 April to 31 July • Clearing to include all trees, ground cover and brush piles • Clearly mark clearing limits prior to clearing	Negligible
Loss of special status species			
• Canadian Toad	Adverse, major, local, long-term, occasional, irreversible, high probability and predictable •	• Confirm areas to be cleared • Consult with Alberta Environment and Alberta Sustainable Resource Development to confirm status of Canadian toad and compensation requirements • Adhere to Alberta Sustainable Resource Development's setback distance guidelines for Canadian toad	Negligible
• American	Adverse, minor to	• Do not clear	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
white pelican, least flycatcher, northern harrier, sora, common yellowthroat, horned grebe, lesser scaup, pied-billed grebe and green-winged teal	major, local/regional/national, permanent for uplands, occasional, irreversible, high probability of occurrence, predictable	vegetation in the period of 15 April to 31 July • Clearing to include all trees, ground cover and brush piles • Clearly mark clearing limits prior to clearing • Revegetate upland areas associated with wetlands/riparian areas	
Disruption of wildlife movement corridors during construction and operation			
• Highway 216/16 alignment	Negligible	• Minimize night shifts during construction and maintain wildlife passage • Establish a policy prohibiting the harassment of wildlife during construction	Negligible
• North Saskatchewan River Valley	Adverse, minor, local/regional, short-term to long-term, constant, high probability, predictable	• Incorporate detailed design elements in wildlife passage under bridge • Install fencing to funnel	Adverse, minor, local/regional, short-term to long-term, constant, high probability, predictable

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		wildlife under bridge	
Wildlife/Vehicle collisions	Adverse, major, local/regional, permanent, high probability, predictable	• Install lighting along alignment • Keep roadway right-of-way clear of tree and shrub vegetation for better motorist visibility of moving animals • Place ungulate fencing in select locations at the bridge crossing site • Install shrubs to encourage animals to move downslope • Take additional measures as required	Minor to negligible, local/regional, high probability, predictable

5.1.7 Fish and Aquatic Resources

Activities that could potentially affect fish or aquatic habitat are:

- direct habitat alteration or loss,
- fish entrapment within coffer dams,
- increased suspended sediment levels,
- mortality or disturbance to special status fish species,
- introduced deleterious materials into the North Saskatchewan River, and
- changes to channel morphology.

Impacts, mitigation measures and residual impacts are summarized in Table 5.11.

5.1.7.1 Direct Habitat Alteration of Loss

Impact

With any work in or near streams/watercourses, there is potential for the harmful alteration, disruption or destruction (HADD) of fish habitat. Any project resulting in HADD requires authorization under the *Act*, and the HADD must be compensated such that the disturbed area is restored or replaced with equivalent habitat. The proposed North Saskatchewan River crossing site (Section 29-53-23-4), has recently been re-classified as Class C habitat (Pisces 2009 - letter from Daryl Watters; Appendix F this document) pursuant to Alberta's *Code of Practice for Watercourse Crossings*. The amended Code of Practice maps are in error and do not reflect this change. A Class C waterbody is subject to a restricted activity period of 16 September to 31 July. During that restricted activity period, no instream activity can occur without the consent of the Provincial government, contingent on the advice of a Qualified Aquatic Environment Specialist. Fisheries and Oceans Canada (DFO) may have other timing requirements.

North Saskatchewan River

Construction activities associated with the proposed new bridge crossing will result in instream disturbance in the North Saskatchewan River. Two (2) outfalls, one on the north bank and one on the south bank will be constructed adjacent to the east side of the bridge. This will cause instream disturbance and result in HADD. The total area of fish habitat lost to outfall structures, bridge piers and abutments cannot be determined until detailed design is completed for the proposed bridge and stormwater facilities. It is expected that the quantity of habitat lost will be small in comparison to what is typically available in the North Saskatchewan River and is not a sufficient loss to affect local or regional fish populations, including lake sturgeon. In addition, the loss would not occur during spawning season for any fish species of concern to Fisheries and Oceans Canada (DFO), owing to the time restrictions mentioned above. The impact of direct alteration of loss of habitat in the NSR from bridge pier, abutment and outfall construction, therefore, is rated as adverse, minor, permanent and predictable. It is rated minor because the structures will occupy only small areas of the total habitat available.

Oldman Creek, Tributary to Oldman Creek and Unnamed tributary to the NSR

Two (2) stormwater outfalls are proposed for the Oldman Creek in the study area along Highway 16: one on the east bank of Oldman Creek on the north side of Highway 16 and one on the west bank of Oldman Creek on the south side of Highway 16 (Appendix A). In addition, one (1) outfall is proposed for the tributary to Oldman Creek located north of Highway 16 and 2 outfalls are proposed for the Unnamed tributary to the NSR (Gold Bar Creek) on the east side of Highway 216 (Appendix A). Oldman Creek and the tributary to Oldman Creek are designated as Class C water bodies and the tributary to the NSR is mapped as a Class D waterbody according to Alberta Environment's *Code of Practice for Outfall Structures on Water Bodies* St. Paul Management area map. The Restricted Activity Period (RAP) for Class C waterbodies is from 16 September to 31 July, where Class D waterbodies have no RAP. Depending on final detailed designs, if an outfall is constructed on the above-mentioned waterbodies, HADD could potentially result. The impact of direct alteration or loss of habitat at Oldman Creek, tributary to Oldman Creek and Unnamed tributary to the NSR from potential outfall construction is rated as adverse, minor, permanent and predictable.

Mitigation Measures and Residual Impact

Application for an Authorization will be made to DFO once detailed designs are available for the proposed bridge and outfall structures. The contractor will be required to work in consultation with DFO and Alberta Environment during detailed design to ensure minimal impacts to fish habitat and to calculate the amount of HADD. An appropriate compensation plan for the HADD will be developed with DFO to ensure no net loss of fish habitat.

North Saskatchewan River

Alberta Transportation developed a list of submission requirements for proponents with respect to the potential for the project to be constructed in a Design-Build-Finance-Operate (DBFO) delivery model. Their requirements included: a) design and construction plan, b) fish habitat compensation plan, and c) DFO communications plan for the North Saskatchewan River crossing. In addition, AT, in consultation with Alberta Sustainable Resource Development (ASRD) and Pisces Environmental Consulting Services, developed several conceptual fish habitat compensation plans for DFO's consideration. Creation of physical habitat works in the channel in the vicinity of the proposed bridge crossing may be the most preferred compensation concept relative to DFO's compensation hierarchy. Those physical habitat works may include the enhancement of rearing habitat, fish habitat diversity, and/or construction of spawning beds for walleye, whitefish or lake sturgeon. Dependent on the final impacts on lake sturgeon, it may be appropriate to link fish habitat compensation to activities that are part of a lake sturgeon recovery strategy. Recovery strategies for lake sturgeon are currently being developed by ASRD and DFO. Considering these measures and assuming the measures are successful, the residual impact of HADD would be reduced to negligible.

Oldman Creek, Tributary to Oldman Creek and Unnamed tributary to the NSR

The contractor will be required to work in consultation with DFO and Alberta Environment during detailed design to ensure minimal impacts to fish habitat and to calculate the amount of HADD. An appropriate compensation plan for the HADD will be developed with DFO to ensure no net loss of fish habitat. Techniques described in Alberta Transportation's "Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta" (2009) will be implemented. Considering these measures, the residual impact of HADD would be reduced to negligible.

5.1.7.2 Fish Entrapment within Coffer Dams

Impact

Coffer dams will be used to isolate instream bridge pier construction areas in the North Saskatchewan River. The ponded area within the coffer dams will be dewatered to create dry working conditions for bridge pier construction. Fish trapped in the ponded area could be stranded during this process, posing a source of mortality for fish. The impact would likely vary depending on the species of fish and timing of dam construction, but generally, entrapment would result in an adverse, minor, temporary and predictable impact on fish populations.

Mitigation Measures and Residual Impact

All fish trapped inside the coffer dams will be salvaged by a qualified aquatic specialist and returned to the North Saskatchewan River. The appropriate fish collection permits will be obtained prior to the commencement of the fish salvage program. All fish captured in the coffer dams will be identified and enumerated. Considering these measures, the residual impact of increased fish mortality related to the coffer dams would be reduced to negligible.

5.1.7.3 Release of Sediments During Construction

Impact

Sediment could be created from surface runoff over disturbed ground around the proposed bridge and outfall sites along the North Saskatchewan River, Gold Bar Creek, Clover Bar Creek, Oldman Creek, and tributaries within the project study area, including access trails and staging areas, during, and after construction. In the absence of appropriate erosion control measures, there would be potential for that sediment to enter the North Saskatchewan River, particularly from the steep north bank on an outside bend of the river. The release of sediments into the river could have adverse effects of fish health and fish behavior. Increased levels of total suspended solids (TSS) in the water column may lead fish to exhibit avoidance response (Waters 1995 in Spencer Environmental 2007), although some fish species may use elevated TSS for cover (Gregory *et al* 1993 in Spencer Environmental 2007). An increase in TSS may also lead to physiological stress that can result in respiratory difficulty and, in extreme cases, mortality. These effects are dependent on the concentration of TSS to which fish are exposed and the length of exposure (Newcombe and Jenson 1995 in Spencer Environmental 2007), although the individual species differ.

The generation of sediment during bridge and outfall construction could also have adverse effects on in-stream habitat. Sedimentation of in-stream habitat can lead to a decrease in habitat quality and quantity. Deposition of sediment can result in the infilling in interstitial spaces and the smothering of spawning habitat for species that spawn over coarse substrate. Additionally, sedimentation can have indirect effects on fish populations through its impacts to water quality, aquatic invertebrate health, vegetative growth and other factors that may support the fish community. With standard sediment and erosion control measures in place, and following best practice guidelines, the above impacts to fish and fish habitat will be adverse, negligible to minor, temporary and predictable. However, it unmitigated, those same impacts would be major.

Mitigation Measures and Residual Impact

To prevent adverse impacts to fish and fish habitat resulting from sedimentation, appropriate temporary and permanent erosion control measures, as outlined in the "Code of Practice for Watercourse Crossings" (Alberta Environment 2000) will be utilized. AT's "Design Guidelines for Erosion and Sediment Control for Highways" (Alberta Transportation 2003) will also be employed during the project. Techniques described in Alberta Transportation's Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta (2009) will be implemented. Revegetation of embankments will occur immediately following construction and demolition. In the event of an earthwork requiring more than one year to settle before final grading and surfacing, those structures will also be immediately revegetated following earthmoving and grading. Earthworks construction will be suspended when precipitation events dictate. The impact of sedimentation on fish and fish habitat from instream NSR-bridge construction activities may be managed by confining instream "wet" construction activities (e.g., construction of coffer dams) to non-critical fisheries periods (01 August to 15 September). In addition, coffer dams and other earthwork devices for facilitating construction "in the dry" will be constructed from materials as specified in any fisheries authorizations issued by DFO. Water from within the coffer dams will be allowed to settle prior to pumping out of the coffer dam.

For additional mitigation measures specifically related to the creation of sediment, see those listed under Soil Erosion (Section 6.1.2.1). Implementation of these mitigation measures will reduce the severity of impacts to negligible.

5.1.7.4 Disturbance of Special Status Species

Impact

As previously reported in the North Leg – Anthony Henday Drive Environmental Assessment (2007), one of two Alberta sub-populations of lake sturgeon occur in the North Saskatchewan River and appropriate sturgeon habitat is located within the vicinity of the proposed North Saskatchewan River crossing site. The fish habitat assessment completed for the proposed crossing site confirmed that while deep water habitat, identified as preferential lake sturgeon habitat, was present within the study area, it was located approximately 2.5 km downstream from the proposed crossing (Pisces 2005 in Spencer Environmental 2007). Habitat that would be directly impacted by the proposed bridge comprises moderate depth, placid run habitat that is common and widespread throughout the NSR in the City of Edmonton (Pisces 2005 in Spencer Environmental 2007). Therefore, considering the proposed crossing site relative to the location of the preferential deep water lake sturgeon habitat located 2.5 km downstream, impacts to lake sturgeon and their habitat is expected to be negligible.

Mitigation Measures and Residual Impact

It is expected that lake sturgeon will be listed on Schedule 1 of the *Species at Risk Act (SARA)* in the near future. If that becomes the case, then additional mitigation and compensation measures may be required by DFO.

Considering the current status of the lake sturgeon and location of preferential deep water habitat outside of the project location, no further mitigation measures are required and the residual impact remains negligible.

5.1.7.5 Introduction of Deleterious Substances

Impact

The proposed NEAHD will be designated as a Dangerous Goods Route. The potential impact to fish and fish habitat resulting from an incident whereby hazardous materials were introduced into the North Saskatchewan River (and Gold Bar, Clover Bar, and Oldman and tributaries if included in stormwater management facility detailed design) would depend, of course, on the type and quantity of material spilled. With construction activity and roadway operation near water, potential exists for accidental spills of fuel, oil and other materials that may be toxic to fish or other aquatic organisms. Refueling or maintenance of construction equipment will not be permitted near the North Saskatchewan River, Gold Bar Creek, Clover Bar Creek, Oldman Creek or tributaries within the project study area. Spill kits will be contained and disposed of following provincial guidelines. Potential for hazardous materials spills during construction is, therefore, negligible.

For roadway operation, safeguards have been incorporated in the bridge design and stormwater management system that would reduce the potential for a spill to reach a receiving water body. Specifically, bridge and roadway run-off and spills will be captured in the vegetated swales and ponds. Despite those safeguards, it is still possible, given the nature of vehicle accidents that spilled hazardous material could enter the North Saskatchewan River (and Oldman, Clover Bar and Fulton Creeks if included in stormwater management facility detailed design) and the impact from roadway operation could be as severe as an adverse, major, short-term, predictable impact.

Mitigation Measures and Residual Impact

No mitigation measures are required other than following standard operating procedures and provincial hazardous material spill regulations. Spill kits will be carried on equipment or stored at nearby work locations and all personnel will be trained to respond appropriately to a spill. The residual impact for hazardous materials spills during construction will remain negligible.

The stormwater management system has the capacity to temporarily store a hazardous material spill originating from the bridge deck, approaches to the bridge and from the roadway surface in general during roadway operation. The Contractor will develop a site-specific response plan employing standard practice by way of first response teams. This would further mitigate any impact to fish from a hazardous material spill. With those mitigation measures in place, the potential impact to fish and fish habitat from roadway operation and hazardous material spills would be negligible.

5.1.7.6 Channel Morphology

Impact

In some cases, bridge piers can increase stream velocity to the point that they create velocity barriers to fish passage upstream or cause changes to the riverbed, and therefore fish habitat, downstream. Buckland and Taylor Ltd., Bridge Engineering (McElhanney

2001 in Spencer Environmental 2007) completed a bridge assessment for the proposed crossing of the North Saskatchewan River and found that placement of 2 to 3 piers in the river channel have no significant effect on the hydrology of the site. Impacts to river hydrology will be further minimized if the bridge piers are aligned to the flow of the river, the bridges are designed to allow fish passage and shore protection is included at the bridge abutments. Any potential for instream construction to interfere with fish passage will be fully mitigated by following DFO specifications regarding the width of channel to remain open. With these measures in place, impacts to channel morphology will be negligible.

Mitigation Measures and Residual Impact

Confirm expected effects of bridge pier hydraulics during bridge detailed design to ensure there is no impact to fish and fish habitat in the North Saskatchewan River. Residual impacts to channel morphology from bridge construction and operation will remain negligible.

Table 5.11. Summary of Impacts and Mitigation for Fish and Aquatic Habitat

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Direct habitat alteration or loss • North Saskatchewan River • Oldman Creek, tributary to Oldman Creek and Unnamed tributary to NSR (Gold Bar Creek)	Adverse, minor, permanent, predictable	• Contractor to work in consultation with DFO and Alberta Environment during detailed design to minimize impacts to fish and minimize HADD • Apply for DFO Authorization once detailed designs are complete for the bridge and outfalls • Confirm outfall location on Oldman Creek, tributary to Oldman Creek and tributary to NSR (Gold Bar Creek) • Follow Alberta Transportation's	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta (2009).	
Fish entrapment within coffer dams	Adverse, minor, temporary, predictable	• Salvage any fish within coffer dams and release back to the NSR • Document results of salvage program	Negligible
Increased sediment levels	Adverse, negligible to major, temporary, predictable	• Use appropriate temporary and permanent erosion control measures • Follow AT's "Design Guidelines for Erosion and Sediment Control for Highways" • Follow Alberta Environment's "Code of Practice for Outfall Structures on Waterbodies" (2003) • Follow Alberta Transportation's Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta (2009). • Isolate instream work areas (e.g., coffer dams)	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		• Allow sediment-laden water in coffer dams to settle prior to pumping out • Revegetate immediately following construction • Monitor erosion controls until vegetation re-established	
Introduction of deleterious materials into the NSR • Roadway construction • Roadway operation	Negligible Adverse, major, short-term, predictable	• Follow standard operating procedures and provincial hazardous material spill regulations • Maintain and refuel equipment away from waterbodies • Store on-site fuels in secure tanks with appropriate spill containment • Ensure spill kits are readily available at refueling/maintenance area • Train personnel in use of spill kits immediate response • Develop a site-specific response plan	Negligible (construction and operation)
Changes to channel morphology from bridge construction	Negligible	• Align bridge piers to flow of river • Design bridges to	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
and operation		allow for fish passage • Provide shore protection at the bridge abutments • Confirm expected bridge pier hydraulic effects during bridge detailed design	

5.2 Socio-economic Resources

5.2.1 Aboriginal Lands

Impact

The nearest known aboriginal burial site is located west of the NEAHD project area at the Rossdale Flats area (105 Street and River Valley Road), located approximately 10 km from the NEAHD project area, in the City of Edmonton. The nearest existing First Nations Reserve is the Enoch Reserve located approximately 8km from the NEAHD project area. There are no First Nations treaty rights or traditional uses being exercised within the project area. There are no hunting or trapping activities permitted within the City of Edmonton or the TUC, therefore, the proposed project does not have the potential to cause an adverse impact to First Nations with respect to these traditional uses since First Nations have not been actively exercising these rights in the area for a considerable length of time (D. Carter, pers.comm). Based on that information, there will be no infringement of First Nations treaty rights or traditional uses as a result of the proposed project, therefore, the impact of the project on aboriginal lands is negligible (Table 5.11).

Table 5.12. Summary of Impacts and Mitigation for Aboriginal Lands

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Disturbance to any known or undocumented Aboriginal Lands	Negligible	None required	Negligible

Mitigation Measures and Residual Impact

No further mitigation measures are required, therefore, the residual impact remains negligible.

5.2.2 Outdoor Recreation

As part of the conceptual bridge design for the North Saskatchewan River crossing, an under-slung pedestrian walkway may be suspended under the bridge. That walkway would connect proposed pathways on the north and south sides of the river and be part of the greater recreational trail system presently in Edmonton's river valley. Creation of new recreational opportunities will result in a positive, major, permanent and predictable impact (Table 5.12).

Mitigation Measures and Residual Impact

No mitigation is required and the residual impacts remain positive, major, permanent and predictable.

Table 5.13. Summary of Impacts and Mitigation for Outdoor Recreation

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Creation of new recreational opportunities: • Suspension of an under-slung pedestrian crossing under proposed NSR bridge	Positive, major, permanent, predictable	None required	Positive, major, permanent, predictable

5.2.3 Noise

Impact

HFP Acoustical Consultants prepared an assessment of noise levels anticipated on the NEAHD at the 1.6 million-person horizon, a target population anticipated to occur approximately 32 years in the future (2041) (Appendix K).

HFP provided in their report subjective comparisons relating increased noise to human perception. An increase of 3 dBA or less is barely perceptible, an increase of 5 dBA is noticeable, an increase of 10 dBA corresponds to a halving or doubling in perceived loudness and an increase of 20 dBA represents a four-fold difference in perceived loudness. The predicted sound level increases associated with forecasted traffic volumes in 2041, which are representative of the worst-case noise impact from NEAHD (Highway 216/16 alignment), range from approximately 59 to 71 dBA Leq and predicted nighttime sound levels ranging from approximately 56 to 68 dBA Leq. The predicted 24-hour sound levels range from approximately 58 to 70 dBA Leq. The predicted increase in traffic noise over current values is 1 to 4 dB Leq (Appendix K). These predictions were targeted for the population and traffic volumes anticipated in 2041 and represent worst-case noise from NEAHD operation. Residents living immediately adjacent to the NEAHD project study area would perceive this as a significant increase if they were to occur suddenly, however, as noise is expected to increase with city growth over time, the impact would be adverse, minor, local, permanent, highly probable and predictable (Table 5.14).

Mitigation Measures and Residual Impact

Almost all the residential communities in the study area are currently affected by noise from existing traffic on Highway 216, 16 and/or associated interchanges. These include several communities on the west side of Sherwood Park (adjacent to Highway 216), the Emerald and Lakeland Village communities (adjacent to YHT near Clover Bar Road), and the Maple Ridge community (adjacent to Highway 216). The results of the acoustic assessment of the NEAHD proposed alignment indicate that future traffic noise in these areas is expected to increase by 1 to 4 dBA Leq over current sound levels. The predicted NEAHD sound levels for 2041 traffic are expected to meet the AT guideline noise limit of 65 dBA Leq (24-hour) at all nearby residence locations, with one exception. Compliance with the guideline noise limit is also expected at residences located further from the NEERR highways and interchanges, since traffic noise levels will be lower at greater distances. The closest residence to the NEAHD project area is in the Maple Ridge community located approximately 50 m from Highway 216 and will be about the same distance from AHD. Current traffic sound levels at this location are about 5 dBA Leq above the AT noise limit, and future NEAHD traffic noise is expected to exceed the AT noise limit by a similar amount. Traffic noise mitigation measures would be required to reduce current and future traffic noise at this dwelling, however, this and other nearby dwellings in the Maple Ridge area may be removed at a future date pending a potential change of the land use to industrial. Since the AT noise attenuation guideline does not require traffic noise mitigation for land uses other than residential, future removal of the dwellings would relieve the need for future noise mitigation in the Maple Ridge area. The residual impact will be negligible. Noise conditions will be monitored periodically, so appropriate mitigative action can be taken (e.g., noise walls and/or berms). With monitoring, the residual impact of noise on adjacent resident for the NEAHD alignment will be reduced to negligible.

Table 5.14. Summary of Impacts and Mitigation for Noise

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Increase in noise levels in neighbourhoods abutting the NEAHD study area (Highway 216/16 alignment) from NEAHD operation in 2041	Adverse, minor, local, permanent, highly probable, predictable	• Monitor noise levels periodically, and if warranted, include noise attenuation (e.g., noise walls and/or berms) in planning for ultimate stage	Negligible

5.3 Heritage Resources

Impact

Excavation and pile construction will be required during NEAHD roadway and bridge construction activities. Those activities could potentially disturb existing historical sites, however, due to the disturbed nature of the project area, no impacts to existing historical resources are expected to result from the proposed project. Impacts to heritage resources will be negligible.

Mitigation Measures and Residual Impact

Impacts, mitigation measures and residual impacts are summarized in Table 5.15. No unrecorded burials, unrecorded collections, or any information about the presence of any sites of historical, paleontological, or special interest were found within the NEAHD project area. The HRIAs conducted for the project area concluded that no further historical resources impact assessment or mitigation work was warranted (Appendix K). Alberta Culture and Community Spirit's Historic Resources Management Branch determined no further work is required and provided clearance for work in all sections of the project area to proceed. If archaeological, paleontological or historical resources are encountered during NEAHD construction activities, the Heritage Resources Management Branch and the Royal Tyrell Museum will be notified immediately. Residual impacts remain as originally assessed (negligible).

Table 5.15. Summary of Impacts and Mitigation for Historical Resources

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Disruption to or destruction of historical resources	Negligible	• If potential heritage resources discovered, suspend work and contact Heritage Resources Management Branch and Royal Tyrell Museum	Negligible

6.0 CLIMATE CHANGE

Environmental assessment of proposed projects under the *Canadian Environmental Act* (*CEAA*) requires that climate change be addressed. Two climate change considerations should be analyzed for each proposed project (CEAA 2009):

1) Greenhouse Gas (GHG) Considerations: where a proposed project may contribute to GHG emissions; and
2) Impacts Considerations: where climate change may affect a proposed project.

For the proposed NEAHD project, an analysis of those two climate change considerations follows.

6.1 Greenhouse Gas (GHG) Considerations: Where a Project May Contribute to GHG Emissions

Emissions from internal combustion engines in Canada are regulated by Environment Canada and Transport Canada pursuant to the federal *Canadian Environmental Protection Act* 1999 (CEPA 1999). Stringent emissions and fuel standards have been harmonized with US federal standards and exhaust emission limits for on-road vehicles and engines have been implemented (DieselNet 2009). Considering that fuel and engine technology will continue to improve and that current and future vehicles will thus likely emit fewer emissions, traffic using NEAHD is not expected to exceed jurisdictional emissions criteria now or in the future. Results from air quality modeling conducted in support of the proposed project show that based on year 2041 vehicle emission factors and projected traffic volumes, concentrations of CO and NO_2 exhaust pollutants attributable to the proposed NEAHD are predicted to not exceed their applicable ambient air quality objectives [see Section 4.1.4.2 and RWDI's (2009) report in Appendix G of this document]. Maximum 24-hour concentrations of $PM_{2.5}$ were predicted to be less than 0.9 $\mu g/m^3$ beyond 50 m from the roadway. These levels are less than Alberta's Ambient Air Quality Objectives (30 $\mu g/m^3$), even with the inclusion of representative elevated background concentrations (the 90^{th} percentile 24-hour $PM_{2.5}$ concentration is 15.6 $\mu g/m^3$). That conclusion sustains when the predicted concentration values of CO, NOx and $PM_{2.5}$ area combined with existing elevated (90^{th} percentile) measured ambient background concentrations. The predicted concentrations represent maximum conditions at the worst case receptors for the entire NEAHD alignment. Concentration profiles at other downwind locations along the proposed roadway would be expected to experience lower contaminant concentrations due to either lower traffic volumes or increased downwind distance from the roadways. Based on this information, there are no identified GHG considerations to be assessed in greater detail and no further analysis is required.

6.2 Impacts Considerations: Where Climate Change May Affect a Project

The proposed NEAHD project is not located in an area known to be sensitive to climate change [i.e., Arctic regions or near a large body of water (CEAA 2009)]. Our analysis indicates that the proposed project's sensitivity to climate change is limited to the potential changes to precipitation patterns in Alberta in the future and the ability of the proposed stormwater management system to handle those changes.

Current scientific modeling for the prairie provinces in Canada predicts that the mean temperature across the prairies is expected to increase by 2-4ºC, compared with a 1961-1990 reference period, and total precipitation is expected to increase by up to 15% (Schneider *et. al.* 2009). Most of the precipitation gains are expected to occur in the winter and spring (Schneider *et. al*. 2009).

When considering historical data for the Alberta prairies and central mixedwood regions, directional trends observed over the past 50 years actually show an opposite trend where precipitation has decreased approximately 15% (Schneider *et. al.* 2009). Even if precipitation amounts do increase slightly as the models predict for the future, climate change is expected to result in an overall drying of most regions of Alberta during the growing season due to evaporative effects of increased heating (Schneider *et. al.* 2009). The key consideration, then, for this analysis, is not total precipitation but frequency of major storm events, which is an important design feature of stormwater management systems.

The stormwater management facilities associated with the proposed project are designed to the current standard of a 1:100-year event (see Section 2.2.4). It is not known if the frequency of these or larger events will increase consistently in future to a point that requires design changes. If prevailing frequencies do change, or if design standards change, the proposed facilities and other facilities and systems in the region may require modification. Until additional, and more certain, climate change information is available for the project area specifically, the current 1:100 year-event design-standard for stormwater management systems is assumed to be adequate and not pose a risk to the public or the environment. Based on this information, there are no identified impact considerations to be assessed in greater detail and no further analysis is required.

7.0 CUMULATIVE EFFECTS

Cumulative effects assessment must be considered in all CEAA assessments, but only for those project effects considered to have a measurable adverse effect on a resource or VEC (Axys Environmental Consulting Ltd. *et al*. 2001). Within our classification, permanent effects of minor or major magnitude would be considered measurable. Measurable project effects could be expected to combine with the effects of other human activities within the region to affect the resource over a larger area.

7.1 Existing Development in the NEAHD Project Area

The NEAHD project area is located in a vibrant urban setting that crosses through two municipal jurisdictions: the City of Edmonton and the County of Strathcona (Sherwood Park). The new section of NEAHD proposed between Manning Drive and Highway 16 East will be located in the northeastern urban fringe of the City of Edmonton within the Transportation Utility Corridor (TUC). The proposed NEAHD project is consistent with the TUC's objective to concentrate impacts within the corridor rather than across the landscape. Existing land use in that area comprises a mixture of residential, agricultural and industrial (heavy, medium and light) and is currently undergoing a period of growth. The project area on the north side of the North Saskatchewan River contains existing and developing neighbourhoods (e.g., Fraser, Kirkness, Brintnell, McConachie and Pilot Sound Neighbourhoods) to the west of the TUC. Gorman Industrial West and East areas are located immediately adjacent to the southwest side of the TUC, east of Manning Drive. Evergreen Neighbourhood is an established neighbourhood to the northeast of the TUC amongst agricultural lands, however, in general, that northeastern corner of the City is identified as urban growth and industrial/business areas in the City of Edmonton's Municipal Development Plan (City of Edmonton 2010).

South of the North Saskatchewan River is dominated by existing industrial and commercial land uses including the Edmonton Waste Management Centre (EWMC) and Clover Bar Landfill and sewage lagoons. West of EWMC and Clover Bar landfill are gravel extraction sites. Towards Highway 16, there is an industrial research area, a truck yard, an asphalt/paving equipment storage site, a fiberglass manufacturer and the Worthington BP plant (formerly Celanese Canada Ltd.). The north (City of Edmonton and south (Strathcona County) sides of Highway 16 from 17 Street to Highway 21 and the east and west sides of Highway 216 to Whitemud Drive comprise a mixture of land uses including existing and developing residential, industrial, commercial and agricultural.

Overall, cumulative urban development in the City of Edmonton and Sherwood Park has had an adverse impact on the environment and in some way (positive/negative) has affected all or some of the VECs discussed in this environmental assessment. Best practices during development will have mitigated some of the adverse impacts, but some residual impacts remain including potentially contaminated soil in the industrial areas as well as a confirmed contaminated groundwater plume at the former Celanese plant (now Worthington B.P.). Positive impacts would include the development of improved stormwater management systems and water quality in neighbourhoods, including naturalized stormwater management ponds, and replacing removed native vegetation on City-owned property according to the City of Edmonton's Corporate Tree Management Policy.

7.2 Future Development in the NEAHD Project Area

In addition to continuing residential neighbourhood, industrial and commercial development in northeast Edmonton and in Strathcona County (Sherwood Park), several infrastructure projects are planned. In addition to the proposed NEAHD roadway completion, extension of Victoria Trail and the Light Rail Transit system in northeast Edmonton across the TUC and NEAHD are planned in the relatively near future. South of the North Saskatchewan River, 137 Avenue has been identified as a future transportation corridor (North of Yellowhead Area Concept Plan 2003). New residential areas are planned for south of Highway 16 in Sherwood Park, as well as the new Strathcona Community Hospital.

7.3 Cumulative Effects

Table 7.1 summarizes the permanent residual impacts remaining after mitigation for the NEAHD project. In the absence of mitigation measures, the proposed project will have two major impacts and several minor impacts. There is one potential positive residual impact. For the most part, the minor impacts could be reduced to a negligible level through mitigation; however, there were instances where mitigation would not sufficiently minimize the project effect resulting from the NEAHD project. The remaining issues include:

- Affect on slope stability from new bridge crossing,
- Disturbance of contaminated soils,
- Disturbance of contaminated groundwater,
- Loss or alteration of upland native plant communities,
- Loss of wetland habitat (vegetation and wildlife) and function may not be fully replaced if the compensatory wetlands do not become functional wetlands over the long-term, and
- Loss or alteration of upland native habitat.
- Disruption of wildlife movement corridors during construction and operation of the new bridges

The potential cumulative impacts relative to these issues are discussed below.

Table 7.1. Permanent Residual Impacts Remaining after Mitigation for the NEAHD Project

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Geology/Geomorphology			
Affect on slope stability from North	Adverse, minor, local, constant, high	• Follow geotechnical	Adverse, minor, local, constant, high

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Saskatchewan River crossing bridge • North Bank	probability, permanent and predictable	recommendations in detailed design phase	probability, permanent and predictable
Soils			
Disturbance of contaminated soils	Adverse, major to minor, local to regional, long-term, occasional, reversible, high probability, and predictable	• Confirmation of contaminated soils areas unknown to-date • Phase II ESA to be undertaken to confirm contaminated soils sites	Adverse, major to minor, local to regional, long-term, occasional, reversible, high probability, and predictable *Once a Phase II ESA is completed, and mitigation measures and a risk management plan are developed, this will likely become a positive residual impact.
Hydrology/Surface Water Quality			
Contaminated groundwater at the former Celanese site (now Worthington B.P.)	Adverse, major to minor, regional, long-term, constant, reversible, high probability of occurrence and predictable	• Extent of groundwater contamination and mitigation measures to be determined • Phase II ESA underway by Alberta Transportation	Adverse, major to minor, regional, long-term, constant, reversible, high probability of occurrence and predictable *Once a Phase II ESA is completed, and mitigation measures and a risk management plan are developed, this will likely become a positive residual impact.
Vegetation			
Loss or alteration of upland native plant communities	Adverse, minor, local, permanent, occasional, reversible, high probability of	• To the greatest extent possible, avoid aligning NEAHD through native plant	Adverse, minor, permanent, predictable to negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
	occurrence, predictable	communities and refine clearing limits • Clearly mark clearing limits with snow-fence or highly visible flagging • Adhere to vegetation clearing restrictions including: 1)only hand clearing is allowed within 30 m of a waterbody; 2) no equipment is allowed to cross any waterbody during clearing operations; 3) trees shall not be allowed to fall into a waterbody; and 4) retain an undisturbed vegetation buffer between the construction site and watercourse to reduce the potential for sedimentation • Prohibit equipment storage, maintenance and refueling in areas that support native plant communities • Reclaim areas of surface disturbance by planting native species to replace upland habitat that is associated with	

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		wetlands	
Loss of wetland habitat	Adverse, major, local, permanent, but reversible with compensation, high probability, predictable	• Where possible, wetlands should be avoided • Where avoidance of wetlands is not possible, enhance existing sites or create similar wetlands in nearby areas to achieve no net loss of wetland habitat and function • Confirm required compensation ratio with Alberta Environment • Complete wetland compensation plan in support of Alberta *Water Act* approval for draining and filling wetlands • Liase with City of Edmonton regarding potential wetland compensation sites within the City • Incorporate native shrubs and trees in mitigation wetlands	Adverse, minor, permanent, predictable to negligible
Wildlife			
Loss of natural upland treed habitats • Loss of wetland habitat	Adverse, major, local, permanent, high probability, predictable	• Comply with Alberta Interim Wetland Policy (1993) wetland compensation requirements	Adverse, minor, permanent, predictable to negligible after compensation
Disruption of wildlife movement corridors	Adverse, minor, local/regional,	• Incorporate detailed design	Adverse, minor, local/regional,

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
during construction and operation • North Saskatchewan River Valley	short-term to long-term, constant, high probability, predictable	elements in wildlife passage under bridge • Install fencing to funnel wildlife under bridge	short-term to long-term, constant, high probability, predictable
Outdoor Recreation			
Creation of new recreational opportunities: • Potential for suspension of an under-slung pedestrian crossing under proposed NSR bridge	Positive, major, permanent, predictable	None required	Positive, major, permanent, predictable

7.3.1 Geology/Geomorphology

Construction of the two NEAHD bridges over the North Saskatchewan River will not have negative cumulative effect on slope stability in the river valley. There are no other known future river crossing projects in the project area, and, with detailed bridge design and confirmation of slope stability measures for the north river bank, it is expected that the adverse minor impact to slope stability will be reduced to negligible.

7.3.2 Soils

Several areas of potential soil contamination were identified by a Phase I Environmental Screening Assessment (Thurber 2009b) in the project area. Areas of potential soil contamination are not unexpected due to the high level of industrial and commercial development in parts of the project area. Once a Phase II ESA is conducted to confirm areas of soil contamination, appropriate mitigation measures will be taken to decontaminate soils during construction to prevent spreading the contaminated soils over a larger area. Contaminated soils leaving the site will also be disposed of at appropriate disposal sites. With those measures in place, there would be a positive cumulative effect in the project area as soil quality would be improved and contaminated soils would not be moved to other areas in the region.

7.3.3 Hydrology

A contaminated groundwater plume has been confirmed at the former Celanese plant (now Worthington B.P.)[(Thurber (2009b)]. The area contains a groundwater contamination plume from the area of a former herbicide plant located west of Meridian Street between Hayter Road and Highway 16. That plume is known to be moving northwest under Hayter Road. The contaminated groundwater is currently recovered and sent to a disposal well on the former herbicide plant property. Thurber (2009b) also determined there is a deep groundwater plume present on the north end of the former Celanese facility that extends towards the EPCOR Clover Bar Generating Station. Alberta Transportation is currently conducting a Phase II ESA to determine the extent of the groundwater contamination. With appropriate mitigation, decontaminating the groundwater and preventing further contamination at this site would have a positive cumulative effect on hydrology in the project area.

7.3.4 Vegetation

7.3.4.1 Upland and Riparian Vegetation

Of the 61.43 ha of native upland and riparian vegetation available in the NEAHD project area, approximately 29.45 ha (23.8%) will be directly impacted by project activities The largest treed stands to be impacted are mature deciduous woodlots located along Highway 216 between Baseline Road and Wye Road (Sites S72 and S35a; Figure 4.2a-f). Although trembling aspen and balsam poplar are not unique or rare plant communities in this ecoregion, in urban areas it has become more isolated and patchily distributed and more native upland areas are being removed for development. Despite some of the sites being previously disturbed, they still provide important habitat patches for wildlife species living in the fragmented rural-urban fringe along the outskirts of Edmonton. Removal of native upland and riparian vegetation in the project area will result in a negative cumulative effect when considering other future developments that will also remove native upland vegetation.

7.3.4.2 Wetland Habitat

There are approximately 62.5 ha of wetland habitat available within the NEAHD project study area. Approximately 33.16 ha of that wetland habitat will be directly impacted by NEAHD construction, representing 53% of the wetland habitat available within the NEAHD project study area. Those wetlands range from to Class II (wet meadow) wetlands to Class VIII (shrub wetland). All wetland types provide diverse plant communities, which provide important wildlife habitat. They also play a role in groundwater recharge and discharge processes. Most of the individual wetland areas are relatively small, however, cumulatively, the wetland area that will be lost within the NEAHD project area is regionally and locally significant and represents a negative cumulative effect. That is because such areas can support high biodiversity and provide important ecological functions such as water quality control and water supply. The significance of local and regional wetland loss is also recognized by Alberta Environment through approvals required under the Alberta *Water Act* for filling and draining wetlands and compensating for wetlands lost. That cumulative effect will become negligible or even positive over time if wetland compensation from this project is successful in replacing lost wetland habitat and function. On-site wetland compensation opportunities for this project may be limited by Department of National Defence requirements.

7.3.5 Wildlife

7.3.5.1 Loss of Wetland Habitat

See Section 7.3.5.2 above.

7.3.5.2 Wildlife Movement Corridors

The North Saskatchewan River Valley is a major wildlife corridor within the study area, providing a linkage between habitats for large- and medium-sized mammals such as deer, moose and coyotes. Wildlife movement in the North Saskatchewan River Valley at the proposed bridge crossing location is mainly located at the top-of-bank and along lower terraces and riverbank areas. The presence of the proposed bridge, including the approaches to the river valley, has potential to interrupt existing local and regional movement patterns. If the bridge were to function as a barrier to animal movement the upstream valley reach would be effectively isolated from the downstream reaches and the remainder of the valley system, resulting in a negative cumulative effect. With a bridge design that includes conveyance for wildlife, that cumulative effect will become negligible.

7.3.6 Outdoor Recreation

A positive cumulative effect of the NEAHD project is possible if, in the long-term, an under-slung pedestrian walkway bridge is suspended under the new NEAHD bridges. That pedestrian bridge would provide linkage for any future City of Edmonton recreational trail systems on the north and south sides of the North Saskatchewan River.

7.4 Summary

In summary, although there are several major and minor residual impacts remaining for the NEAHD project, with appropriate mitigation, they are not expected to have a negative cumulative impact on the environment in the existing urban project area.

8.0 SUMMARY ASSESSMENT

8.1 Summary of Impacts

Most impacts identified in this assessment of the proposed Northeast Anthony Henday Drive alignment upgrade, construction and operation were assessed as negligible, largely due to the already disturbed nature of the project area due to agricultural land use, the existing roadway and the location of the project in the eastern urban fringe of the City of Edmonton. Those residual impacts assessed as positive or adverse major or minor are summarized in Table 8.1.

8.1.1 Summary of Major Impacts

In the absence of mitigation measures, the proposed project would result in several potential major adverse impacts. Once mitigation has been applied, however, most impacts will be reduced to a negligible level. Table 8.1 summarizes those major adverse residual impacts remaining after application of mitigation measures targeting project activities that could adversely affect soil, groundwater, vegetation and wildlife. A Limited Phase I Environmental Screening Assessment (ESA) conducted in the project area identified several areas of potential environmental concern including soil and groundwater contamination. A Phase II ESA is required to confirm areas of soil and groundwater contamination. Until that confirmation is made, the impact will remain adverse, major.

8.1.2 Summary of Minor Impacts

In the absence of mitigation, the roadway will have several minor impacts. For the most part, the minor impacts could be reduced to a negligible level through mitigation, however, there were instances where mitigation would not sufficiently minimize the project effect. Table 8.1 summarizes those impacts for which mitigation cannot be reduced to a negligible level. These include the following:

- Affect on slope stability from NEAHD bridge and roadway construction.
- Loss or alteration of upland native habitat.
- Loss of wetland habitat (vegetation and wildlife) and function may not be fully replaced if the compensatory wetlands do not become functional wetlands over the long-term.
- Disruption of wildlife movement corridors in the North Saskatchewan River Valley from placement of a bridge structure in a previously unimpeded area.

While slope stability issues at the north bank of the North Saskatchewan River will most certainly be resolved during the ensuing stages of project design for the bridge crossing, the impact rating for the north bank remains in this EA as adverse, minor, permanent and predictable in order to meet the technical requirements of the EA process and EA content.

The reasons for leaving that rating are as follows:

- bridge and road designs are still conceptual,
- detailed designs are not available at this time for review, and
- the location is proximate to the important fish-bearing North Saskatchewan River.

Positive impacts listed in Table 8.1 resulting from the project related to outdoor recreation potential. The following will occur:

- Construction of an under-slung pedestrian walkway under the proposed bridge crossing may be developed for pedestrians and cyclists.
- Connections to proposed pathways on the north and south sides of the North Saskatchewan River.

Additional positive outcomes of the proposed project include:
- Increased efficiency of Edmonton's transportation network over the next 25 years or more.
- Increased capacity to meet the needs of the City of Edmonton's urban growth.

Table 8.1. Summary of Positive and Adverse Residual Impacts Resulting from the Proposed Northeast Anthony Henday Drive Alignment Upgrade

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Geology/Geomorphology			
Affect on slope stability from North Saskatchewan River crossing bridge • North Bank	Adverse, minor, local, constant, high probability, permanent and predictable	• Follow geotechnical recommendations in detailed design phase	Adverse, minor, local, constant, high probability, permanent and predictable
Soils			
Disturbance of contaminated soils	Adverse, major to minor, local to regional, long-term, occasional, reversible, high probability, and predictable	• Confirmation of contaminated soils areas unknown to-date • Phase II ESA to be undertaken to confirm contaminated soils sites	Adverse, major to minor, local to regional, long-term, occasional, reversible, high probability, and predictable *Once a Phase II ESA is completed, and mitigation measures and a risk management plan are developed, this will likely become a positive residual impact.
Hydrology/Surface Water Quality			

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Contaminated groundwater at the former Celanese site (now Worthington B.P.)	Adverse, major to minor, regional, long-term, constant, reversible, high probability of occurrence and predictable	• Extent of groundwater contamination and mitigation measures to be determined • Phase II ESA underway by Alberta Transportation	Adverse, major to minor, regional, long-term, constant, reversible, high probability of occurrence and predictable *Once a Phase II ESA is completed, and mitigation measures and a risk management plan are developed, this will likely become a positive residual impact.
Vegetation			
Loss or alteration of upland native plant communities	Adverse, minor, local, permanent, occasional, reversible, high probability of occurrence, predictable	• To the greatest extent possible, avoid aligning NEAHD through native plant communities and refine clearing limits • Clearly mark clearing limits with snow-fence or highly visible flagging • Adhere to vegetation clearing restrictions including: 1)only hand clearing is allowed within 30 m of a waterbody; 2) no equipment is allowed to cross any waterbody during clearing operations; 3) trees shall not be allowed to fall into	Adverse, minor, permanent, predictable to negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		a waterbody; and 4) retain an undisturbed vegetation buffer between the construction site and watercourse to reduce the potential for sedimentation • Prohibit equipment storage, maintenance and refueling in areas that support native plant communities • Reclaim areas of surface disturbance by planting native species to replace upland habitat that is associated with wetlands	
Loss of wetland habitat	Adverse, major, local, permanent, but reversible with compensation, high probability, predictable	• Where possible, wetlands should be avoided • Where avoidance of wetlands is not possible, enhance existing sites or create similar wetlands in nearby areas to achieve no net loss of wetland habitat and function • Confirm required compensation ratio with Alberta Environment • Complete wetland compensation plan in support of Alberta *Water Act*	Adverse, minor, permanent, predictable to negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		approval for draining and filling wetlands • Liase with City of Edmonton regarding potential wetland compensation sites within the City • Incorporate native shrubs and trees in mitigation wetlands	
Wildlife			
Loss of natural upland treed habitats • Loss of wetland habitat	Adverse, major, local, permanent, high probability, predictable	• Comply with Alberta Interim Wetland Policy (1993) wetland compensation requirements	Adverse, minor, permanent, predictable to negligible after compensation
Disruption of wildlife movement corridors during construction and operation • North Saskatchewan River Valley	Adverse, minor, local/regional, short-term to long-term, constant, high probability, predictable	• Incorporate detailed design elements in wildlife passage under bridge • Install fencing to funnel wildlife under bridge	Adverse, minor, local/regional, short-term to long-term, constant, high probability, predictable
Outdoor Recreation			
Creation of new recreational opportunities: • Potential for suspension of an under-slung pedestrian crossing under proposed NSR bridge	Positive, major, permanent, predictable	None required	Positive, major, permanent, predictable

8.2 Mitigation Measures

The primary mitigation measures developed to address the above-mentioned major and minor impacts are described in this section of the report. To conform to the organization of the preceding chapters, mitigation has been organized by VECs.

8.2.1 Geology/Geomorphology

In order to mitigate potential slope instability from roadway and bridge construction activities, implement the following measures:

- Follow geotechnical recommendations in detailed design phase.
- Build approach fills with suitable fill and placed and compacted to AT's standards.

8.2.2 Soils

In order to mitigate loss of topsoil from construction activities and from erosion, soil compaction and loss of soils characteristics, the following measures will be undertaken:

- Minimize the footprint of construction activities.
- Confirm areas of contaminated soils and de-contaminate and dispose of appropriately as necessary.
- Strip topsoil from work areas and stockpile for reclamation.
- Reclaim areas of surface disturbance.
- Employ temporary and permanent erosion control measures.
- Minimize traffic in areas with soils that are susceptible to compaction (wet).
- Rip subsoil prior to replacing topsoils.
- Maintain current drainage patterns.
- Sample wetland areas to determine salinity levels and TSS prior to stripping.
- Use any saline soils for reclaiming low areas.

8.2.3 Hydrology

In order to avoid compromising water quality of the groundwater, North Saskatchewan River, Gold Bar Creek, Clover Bar Creek, Oldman Creek, unnamed tributaries and wetlands through sedimentation or contaminated spills during construction:

- Confirm extent of groundwater contamination at the Worthing B.P. site (formerly Celanese plant) and mitigate appropriately.
- Do not store fuel, hazardous material or equipment or maintain or refuel equipment near waterbodies and watercourses.
- Employ erosion and sediment control measures to reduce the potential for sedimentation (e.g., silt fences, berms, etc) as outlined in the contractor's Environmental Construction Operations (ECO) plan.
- Immediately following construction, rapidly reclaim disturbed areas.
- Leave a vegetation buffer wherever possible to reduce the transfer of sediments to nearby waterbodies and watercourses.

8.2.4 Vegetation

In order to mitigate adverse impacts to native plant communities, the following measures will be undertaken:

- The roadway footprint will be adjusted, to the extent technically feasible, to avoid areas of native plant communities, especially wetlands.
- Disturbed areas, especially those located adjacent to drainages and wetlands and those with potential for long-term erosion, should be revegetated with plantings of native species.
- Fuel, hazardous material and equipment storage and equipment maintenance and refueling will be prohibited in areas supporting native plant communities.

8.2.5 Wildlife

Implementing the measures listed below will mitigate the potential loss of upland and wetland habitats:

- Losses to wetland habitat will be mitigated by creating habitat in stormwater management facilities, where possible in the project study area, in a compensation ratio to be confirmed with Alberta Environment during detailed design.
- The passage by small mammals and amphibians will be considered in the design of crossing structures in wetland areas and drainages.
- Clearing of natural habitats, including wetlands, will be prohibited during the period 15 April to 31 July.

8.2.6 Fish and Aquatic Resources

In order to mitigate potential sedimentation impacts on fish habitat and potential to interfere with upstream passage of fish, the following mitigation measures will be implemented:

- Temporary and permanent surface erosion controls described by AT's "Design Guidelines for Erosion and Sediment Control for Highways" (2003) will be implemented during and post-construction and disturbed areas adjacent to drainages will be re-vegetated as soon as possible following construction.
- Erosion and sediment control materials will be available on site during construction.
- No instream construction activities will occur during the timing restriction period for the North Saskatchewan River (16 September to 31 July).
- Instream bridge pier construction areas will be isolated with coffer dams.
- All fish trapped inside the coffer dams will be salvaged by a qualified aquatic specialist and returned to the North Saskatchewan River.
- Sediment-laden water from coffer dams will be allowed to settle prior to pumping out.
- Erosion and sedimentation from adjacent surface disturbances will be reduced by following Alberta Environment's "Code of Practice for Watercourse Crossings"

(2000) and “Code of Practice for Outfall Structures on Waterbodies” (2003) and through the construction of temporary settling ponds and management of post-development stormwater flows into surface waterbodies.

8.3 Monitoring and Follow-up Requirements

The following construction and post-construction monitoring initiatives will be included as part of the project and will be included in those plans. Some of those monitoring programs are noted in Chapter 5 as mitigation measures.

Geomorphology

- Depending on detailed design, develop an appropriate monitoring program to detect slope instability on the north bank of the North Saskatchewan River at the bridge crossing so that corrective action can be taken. Ensure slope stability is maintained in the project area during construction and roadway operation.

Soils

- During project construction activities, monitor temporary and permanent erosion control measures to ensure they are adequate, including adjacent to wetlands, the North Saskatchewan River, Gold Bar Creek, Clover Bar Creek, Oldman Creek and unnamed tributaries and wetlands.

Hydrology and Surface Water Quality

- During construction, monitor erosion controls and river isolation techniques to minimize potential for sediment release.

- Post-construction, monitor long-term hydrological performance of vegetated swales and extended detention ponds.

Air Quality

- During construction, monitor apparent dust volumes to ensure dust control measures are adequate.

Vegetation

- Post-construction, monitor vegetation re-establishment in the project area until well-established.

- Monitor soil stockpiles and reclaimed areas for noxious, restricted and nuisance weeds establishment and determine whether weed-control is required.

- Monitor success [wetland type and function (e.g., wildlife habitat)] of created naturalized stormwater management facilities.

Wildlife

- Post-construction, monitor the number of animal/vehicle collisions on NEAHD in the project area, particularly at the river crossing, to assess the level of effectiveness of ungulate fencing and the wildlife passage under the bridge.

Fish

- Monitor instream sediments during construction.
- Salvage, identify and enumerate fish trapped inside coffer dams.

Noise

- Monitor noise levels periodically, and if warranted, include noise attenuation in planning for ultimate stage.

8.4 Environmental Protection Planning

A project specific Environmental Protection Plan (EPP) with alignment sheets is provided in Appendix L. To implement certain mitigation measures, the following plans will be developed during the preliminary and detailed engineering phases:

- The contractor will be required to develop an Environmental Construction Operations (ECO) Plan that will be satisfactory to all applicable federal and provincial authorities as well as Alberta Transportation.
- Erosion and sediment control plans will be developed for the North Saskatchewan River crossing. Those plans will consider the crossing structure type and methods of construction. The plans will also consider short-and long-term erosion and sediment control for the NSR, Gold Bar Creek, Oldman Creek, unnamed tributary to Oldman Creek, Clover Bar Creek and unnamed waterbodies and wetlands.
- Detailed revegetation /reclamation plans will be developed for the main right-of-way, for the NSR crossing, stormwater management wetlands and compensation wetlands.

8.5 Final Summary and Conclusions

The Environmental Assessment (EA) resulted in the following summary assessment and conclusions.

Most of the proposed NEAHD project study area is through relatively flat to gently undulating terrain comprised of cultivated farm or pasture lands and scattered woodland and wetland areas. The exception is the deeply incised North Saskatchewan River Valley where a major new river crossing will be constructed as a component of the NEAHD project. There is a significant elevation difference between the north and south banks, with the north bank rising approximately 30 m higher than the south bank.

The north bank of the North Saskatchewan River has a history of slope instability, however, extensive geotechnical investigations, bathymetric analysis and recommended hydrotechnical design parameters development have been conducted in support of the NEAHD advanced functional planning study. It is assumed that any remaining residual minor impacts with regards to north bank slope stability will be resolved during the detailed design phase of the project. River hydraulics are not expected to be negatively effected by the proposed instream bridge piers and increased bank erosion is not expected.

Due to relatively level terrain, and the absence of significant drainage, surface erosion is not a major concern in the tablelands to the north and south of the North Saskatchewan River. Surface erosion and sedimentation are significant concerns on the north bank of the river due to the steepness and instability of that slope and the potential to reduce water quality in the North Saskatchewan River.

A Limited Phase I Environmental Screening Assessment (ESA) conducted in the project area identified several areas of potential environmental concern including soil and groundwater contamination. A Phase II ESA is required to confirm areas of soil contamination.

With regard to groundwater contamination, the former Celanese plant site (now Worthington B.P.) contains a confirmed groundwater contamination plume from the area of a former herbicide plant located west of Meridain Street between Hayter Road and Highway 16. There is also a deep groundwater plume on the north end of the facility that extends toward the EPCOR Clover Bar Generating Station. Alberta Transportation is currently conducting a Phase II ESA to confirm the extent of groundwater contamination.

Stormwater management design for NEAHD addresses stormwater quantity and quality management as well as spill containment throughout the roadway right-of-way areas. The proposed stormwater management system will include a combination of conveyance systems including: ditches, culverts, storm sewers, outlet control structures, drop and river outfall structures, and creek and river crossings. Storage/treatment systems will include: dry ponds, natural and constructed wetlands and vegetated swales with erosion control devices.

Of the 61.42 ha of native upland and riparian vegetation available in the NEAHD project area, approximately 29.45 ha (23.8%) will be directly impacted by the proposed NEAHD project footprint. The largest areas of treed stands to be impacted are poplar mix woodlots located south of the proposed North Saskatchewan River crossing and north of 130 Avenue in the NEAHD project study area (Figure 4.2a-f). The largest area of riparian habitat to be directly impacted by the NEAHD project footprint is located along Oldman Creek and the unnamed tributary to Oldman Creek. Both cross Highway 16 just west of Highway 21. The area of upland and riparian habitat impacted is locally significant, providing habitat for a wide variety of wildlife and vegetation species.

Seventeen (17) "special status" plant species were identified within the project limits. Of those, 15 are considered uncommon (S3). Mitigation measures are not typically implemented for the loss of S3 plant species. The remaining two rare plant species, marsh muhly (*Muhlenbergia racemosa)* and smooth sweet cicely (*Osmorhiza longistylis),* were observed within the NEAHD project study area between Manning Drive and Highway 16 East and may be directly impacted by the project. Marsh muhly is classified as an S1 species in Alberta, meaning there are five or fewer occurrences in the province and smooth sweet cicely is classified as an S2 species in Alberta, meaning there area 6-20 occurrences in the province. Smooth sweet cicely will be directly impacted by NEAHD construction and marsh muhly, although it is currently located outside the proposed construction limits, may be impacted if the construction limits change or an outfall structure is constructed at that site. Appropriate mitigation will be developed to avoid or minimize the impact to the sites containing the S1 and S2 species. One viable option is to transplant the plants from their respective areas to a suitable area, away from future disturbance. In addition, seeds will be collected from the plants and donated to the seed bank at the Devonian Botanical Garden near Devon, Alberta.

There are approximately 62.5 ha of wetland habitat within the NEAHD project study area. Approximately 33.16 ha of that wetland habitat will be directly impacted by roadway construction, representing 53% of the wetland habitat available within the study area (Note: stormwater management ponds and any other impact areas proposed for outside the study area surveyed were not included in the impact analysis). The potential loss or alteration of wetlands is considered a significant impact. Adverse impacts will include direct effects resulting from drainage and road development. All wetlands and associated functional upland zone (FUZ) directly impacted by the proposed project will be appropriately compensated using an approach negotiated with Alberta Environment during detailed design to achieve no net loss of wetland area and function.

Two Canadian toad (provincially ranked as May Be at Risk) individuals were heard in May 2006 calling from a naturalized man-made pond in a gravel extraction area west of Meridian Street. Attempts to determine if Canadian toads successfully bred (through tadpole surveys in 2006) were unsuccessful, however, the sandy soils and the presence of pocket gopher burrows around the wetland, located in the North Saskatchewan River floodplain, suggest that the area is potentially good Canadian toad breeding and hibernating habitat. Because evidence of breeding was not confirmed for the Canadian toad, it is unknown at this time whether compensation for the naturalized man-made wetland will be required under Alberta's *Water Act* and the Interim Wetland Policy (1993). The contractor will need to coordinate with Alberta Environment and Alberta Sustainable Resource Development during detailed design to confirm their requirements in this case.

Some impacts to wildlife will remain despite mitigation measures. As discussed above, significant amounts of native upland and wetland habitat will be removed, thereby having a negative impact on local, and possibly regional, wildlife populations. Wildlife movement through the North Saskatchewan River valley will be impacted by bridge construction activities in the short-term, however, over the long-term wildlife passage will be maintained with the inclusion of a wildlife corridor under the bridge along the banks of the river.

Impacts to fish and fish habitat in the North Saskatchewan River should be minimized with appropriate bridge construction mitigation measures, however, there will likely be a relatively small HADD from bridge abutment and pier footprints. There may be additional HADD from construction of new outfalls on the north and south river banks adjacent to the east side of the proposed bridge.

The predicted NEAHD sound levels for 2041 traffic are expected to meet the AT guideline noise limit of 65 dBA Leq (24-hour) at all nearby residence locations, with one exception. The closest residence to the NEAHD project area is in the Maple Ridge community. It is about 50 m from Highway 216 and will be about the same distance from Anthony Henday Drive. Current traffic sound levels at that location are about 5 dBA Leq above the AT noise limit, and future NEAHD traffic noise is expected to exceed the AIT noise limit by a similar amount. Traffic noise mitigation measures (e.g., noise berms/walls) would be required to reduce current and future traffic noise at this dwelling, however, this and other nearby dwellings in the Maple Ridge area may be removed at a future date pending a potential change of the land use to industrial. Since the AT noise attenuation guideline does not require traffic noise mitigation for land uses other than residential, future removal of the dwellings would relieve the need for future noise mitigation in the Maple Ridge area.

In summary, the project traverses an area with only a few environmental sensitivities, although the matters of slope stability in the North Saskatchewan River Valley, soil and groundwater contamination, native plant communities and wetlands and wetland wildlife habitats do have some outstanding concerns. Those concerns can be addressed by development of detailed mitigation measures during the detailed design phase of the project. A wetland compensation plan detailing how wetland losses will be compensated for will ensure no net loss of wetland habitat and function in the long-term.

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Appendix A: Functional Planning Study Stormwater Management Plan

Appendix B: Terms of Reference

Appendix C: Public Consultation

Appendix D: Geotechnical Assessment

Appendix E: Soils Assessment

Appendix F: Fish and Aquatic Resources Assessment

Appendix G: Air Quality Assessment

Appendix H: Vegetation Survey

Appendix I: Wildlife Species Potentially Found in the Study Area and Wildlife Tracking

Appendix J: Noise Assessment

Appendix K: Heritage Resources

Appendix L: Environmental Protection Plan (EPP)