Aquatic Environment Assessment
Rosedale, Cambria, Lehigh and East Coulee

Drumheller Resiliency and Flood Mitigation Program

Prepared for:

Drumheller Resiliency and Flood Mitigation Office
Drumheller, Alberta

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1.0 INTRODUCTION

The Town of Drumheller (Drumheller) is located within the Red Deer River valley in southeastern Alberta. Historically, Drumheller has experienced numerous floods. Over the last 30 years, flooding occurred in 1991, 2005, 2013, and 2018 which resulted in significant flood damage. The Drumheller Resiliency and Flood Mitigation Program (DRFM Program) aims to complete a flood mitigation system that provides flood protection; is easily maintainable, erosion resistant and accommodates deterioration over time; minimizes encroachments on the river and associated afflux; minimizes impacts on private land; and, considers the existing and future pathways and amenities. Specifically, the DRFM Program plans to improve existing structural measures such as berms and dikes along the river banks as well as construct new structures.

The DRFM Program identified six areas proposed for flood mitigation which extend through approximately 22 km of the Red Deer River valley, including a portion of the Rosebud River. The four areas addressed in this report are shown in Figure 1 and include:

- Rosedale;
- Cambria;
- Lehigh; and
- East Coulee.

The Red Deer River valley is oriented from northwest to southeast and the Red Deer River is generally referenced as draining eastwards. Within this context, and for the purpose of this report, the riverbanks are referenced as north bank (or left bank when looking downstream) or south bank (or right bank when looking downstream).

The Rosedale study area encompasses both the Rosebud River and Red Deer River. The Rosebud River reach is from the railway crossing within SW-28-28-19 W4M to the Red Deer River confluence. The Red Deer River reach is from the confluence of Rosebud River to the downstream (east) extent of Pinters Campground at NE-21-28-19 W4M.

The Cambria study area is located along the south (or right) bank of the Red Deer River from 500 m upstream of the Highway 10 bridge (SE-22-28-19 W4M) to 900 m downstream (SE-15-28-19 W4M).

The Lehigh study area is located along the north (or left) bank of the Red Deer River with the upstream extent located approximately 300 m upstream of the Village of Lehigh within SE-6-28-18 W4M. The downstream extent is located approximately 400 m southeast of Lehigh within NW-32-27-18 W4M.

The East Coulee study area is located along the north (or left) bank of the Red Deer River with the upstream extent located on River Drive in the Village of East Coulee (SW-32-27-18 W4M). The project area follows the east bank approximately 200 m downstream of the Highway 569 bridge located within SE-28-27-18 W4M.

R20 R19 R18 R17 W4

T28

T27

Drumheller / Dinosaur Valley

Rosedale

Cambria

Lehigh

East Coulee

Rosebud River

Red Deer River

Willow Creek

Willow Creek

Township Road 280

Range Road 190

Range Road 180

849

10X

10

573

570

569

56

5693000

5693000

384000 388000 392000 396000 400000

Project Location
- East Coulee
- Lehigh
- Cambria
- Rosedale
- Aquatic Assessment

- Community
- Waterbody
- Watercourse
- Highway
- Road

S:\Gis\Projects\CW2384_Drumheller_FloodMitigation\ArcGIS\01_Fisheries\Fig 01 DFM Location Plan Landscape.mxd ANALYST: helen.brandreth 20-11-20 12:56:47 PM

Projection: NAD 1983 UTM Zone 12N
QA/QC: HB MK LH
Sources: AB TPR, Centre for Cadastral Management, Geomatics Canada
- Contains information licensed under the Open Government licence – Alberta, Canada.

DRUMHELLER RESILIENCY AND FLOOD MITIGATION OFFICE

Drumheller Resiliency and Flood Mitigation Program

Drumheller Flood Mitigation Location Plan

0 600 1,200
Metres
1:55,000

N

wood.

November 2020

Figure 1

1.1 Scope of Work

The DRFM office retained Wood Environment & Infrastructure Solutions (Wood) to undertake the aquatic environment assessment and assist in the preparation of the regulatory applications for the project. The proposed works are subject to the requirements of the provincial *Water Act* and the federal *Fisheries Act*. This report provides baseline information regarding the aquatic environment in the vicinity to the proposed works and is intended to support the Alberta Environment and Parks (AEP) *Water Act* application and Fisheries and Oceans Canada (DFO) Request for Project Review submission. In addition, this report provides Qualified Aquatic Environment Specialist (QAES) recommendations intended to protect the aquatic biota in Red Deer River during the proposed works.

This report contains the following components:

- results of the aquatic assessment;
- fish habitat evaluation;
- an overview of potential impacts to fish and fish habitat from the proposed works;
- mitigation measures including QAES recommendations; and
- a summary of regulatory considerations under the *Fisheries Act* and *Water Act* for the proposed project.

2.0 METHODS

2.1 Background Information Review

Prior to completing the field survey, background information on the fisheries resources in the Red Deer and Rosebud rivers were obtained from the Fish and Wildlife Internet Mapping Tool (FWIMT) database (AEP 2020a).

2.2 Field Survey

An aquatic field assessment was completed on 30 and 31 October 2020 by a Wood QAES. The field survey methods described in the following sections are in accordance with standard protocols outlined in the *Guide to the Code of Practice for Watercourse Crossings* (AENV 2001) and Alberta Transportation's *Fish Habitat Manual* (Alberta Transportation 2009).

2.2.1 Study Area

Each study area was delineated relative to the proposed project areas to include 200 m of upstream habitat and 1,000 m of downstream habitat. This area encompasses the anticipated zone of influence, based on the location of proposed works and the substrate characteristics of the system (AENV 2001). A total of 31 transects were surveyed over the four study areas.

2.2.2 Aquatic Habitat

At each watercourse transect, the following physical parameters were measured where available: channel width, wetted width, water depth, bank shape/texture, riparian vegetation, and bed material composition. Other general stream features such as channel pattern, presence of bars, bank stability and percent composition of instream cover types were based on observations over the entire study area. Geographic coordinates were recorded at all transects with a hand-held global positioning system (GPS) receiver. Digital photographs were taken to document dominant stream characteristics and any unique habitat features.

A detailed fish habitat map was completed for each study area. Instream habitat and bank types were described using the classification system developed for small and large rivers (Appendix A; R.L.&L. 1994 in Alberta Transportation 2009).

2.2.3 Fish Habitat Evaluation

Fish habitat within each study area was evaluated based on its potential to support spawning, rearing, holding and overwintering. Habitat potential was rated as Critical, Important, Marginal or Unsuitable for three main fish species groups; small-bodied forage fish, large-bodied forage fish (i.e., sucker species) and sport fish. The evaluation was based on the habitat characterization, general fish life history requirements

and professional judgement. A table summarizing habitat preferences of resident Red Deer and Rosebud rivers fish species is provided in Appendix B. The criteria used were adapted from DFO's *Habitat Conservation and Protection Guidelines* (DFO 1998) as follows:

- Critical – the aquatic habitat is vital in sustaining a viable fish population of a species of management concern, or a commercial, recreational or aboriginal fishery. This would include habitat that is rare or uncommon, and essential in the completion of a fish's lifecycle.
- Important – the aquatic habitat is used by fish for multiple life stages including spawning, rearing, holding and overwintering, but is not deemed to be critical in sustaining a viable fish population. Important habitat provides the necessary physical and biological requirements to support one or more parts of a fish's life cycle.
- Marginal – the aquatic habitat has a low productive capacity and a limited contribution to overall fish production in the system. Marginal habitat typically provides the minimum physical and biological attributes for fish to carry out part of its life cycle. Fish use of marginal habitat is out of necessity, as preferred habitat is not available.
- Unsuitable – the aquatic environment does not provide the basic habitat requirements to allow the completion of any part of a fish's lifecycle.

3.0 AQUATIC HABITAT CHARACTERISTICS AND FISHERIES RESOURCES

General and local watershed characteristics, resident species and fish habitat are described in the sections below. Field data, habitat information and photo documentation of the study area are provided in Appendix C.

3.1 Watershed and Channel Characteristics

The Red Deer River watershed is the largest sub-basin of the South Saskatchewan River basin (RDRWA 2009), however, it only contributes around 20% to the annual flow of the South Saskatchewan River (Alberta Lake Sturgeon Recovery Team 2011). The Red Deer River originates from the Drummond Glacier in Banff National Park and flows generally eastward over 700 km to the Alberta-Saskatchewan border (RDRWA 2009). The only major water management structure altering the flow of the Red Deer River is Dickson Dam, which was constructed in 1983 (RDRWA 2009). The river begins as a unproductive, mountain stream with gravel/cobble substrate and transitions to a primarily mobile sand substrate, warm, productive prairie river as it travels towards the Saskatchewan-Alberta border (RDRWA 2009).

3.2 Stream Classification

At the study area locations, the Red Deer River is a mapped Class C waterbody based on AEP's *Code of Practice for Watercourse Crossings – Brooks Management Area Map* (ESRD 2006). The restricted activity period (RAP) for this classification extends from 16 April to 30 June. Within the Rosedale study area, the Rosebud River is a mapped Class C Waterbody with a RAP extending from 16 April to 15 July (ESRD 2006).

3.3 Study Areas

Within the study areas, the Red Deer River flows in an irregular meandering pattern past side bars, mid-channel bars and occasional islands. The river is partially coupled and occasionally confined by steep bedrock banks. No migration barriers for fish were observed over the approximate 17 km of the river that was boated to reach the four study areas. Discharge at the time of the survey was 12.5 m^3/s, the river was well oxygenated with dissolved oxygen concentrations ranging from 8.90 to 8.98 mg/L, water temperature ranged from 1.9 to 2.1 °C, conductivity was 520 µS/cm, and the water clarity was turbid with secchi depth of 0.42 m. All water quality parameters were within guideline ranges for the protection of aquatic life (CCME 2018; GOA 2018).

Within the study area, the Rosebud River includes the last 320 m of the watercourse before is discharges into the Red Deer River.

3.3.1 Rosedale

Within the Rosedale study area, the mean channel and wetted widths of the Red Deer River were 111.8 and 81.8 m, respectively (Appendix C, Figure C-1.0). Upstream of the Roper Road bridge, the channel widens and is generally moderate quality and depth run. Immediately upstream of the bridge piers the depth increases due to scouring and erosion creating a small area of high quality run habitat (Appendix D, Figure D-1). Approximately 50 m downstream of the bridge the confluence with the Rosebud River creates a shallow sand bar along the south (right) bank and backwater habitat (Appendix D, Figure D-1). Downstream of the confluence, the habitat along the north (left) bank of the Red Deer River is uniform

and consists of low to moderate quality run with limited instream cover. Coarse substrates are limited with the exception of the gravel/cobble bar located downstream of transect 4 (Appendix D, Figure D-1). At the downstream extent of the study area, the habitat complexity increases with several small mid-channel gravel bars surrounded by riffles located amongst the run habitat (Appendix D, Figure D-1). The Star Mine Suspension Bridge crosses this reach of the study area but is out of the active channel and has no effects to the river characteristics. Approximately 340 m downstream, an island splits the channel creating a narrow and shallow run/riffle habitat along the south (right) bank and moderate to high quality run in the main channel (Appendix D, Figure D-1). A large area of deposition along the south (right) bank is forming due to reduced water velocity behind the island and has created a deep backwater just downstream (Appendix D, Figure D-1). Further downstream, the south (right) bank transitions to steep bedrock and the habitat becomes uniform moderate to high quality run.

The south (right) bank within the study area is typically depositional whereas the north (left) bank is erosional or bedrock canyon (Appendix D, Figure D-1). Downstream of the study area, the south (right) bank transitions to become erosional and canyon bedrock whereas the north (left) bank becomes sloping and depositional.

Fish cover within the study area is limited and predominantly provided by turbidity and depth. Coarse bed material is rare and interstitial spaces are typically filled by sand further limiting cover. Woody debris, and aquatic vegetation cover were rare and overhanging vegetation was not encountered during the aquatic survey. Water clarity at the time of survey was low; however, based on the substrate characteristics of the Red Deer River, higher turbidity during the spring and summer likely increase cover during high-water stages.

The Rosebud River at the upstream extent of the study area has a channel width of 11.0 m, wetted width of 6.6 m and a maximum depth of 0.4 m (Appendix C, Figure C-1.0). The habitat is entirely composed of shallow run, with substrates comprised of fine materials with isolated highly embedded coarse materials. Both banks were sloping and moderately unstable. Cover opportunities for fish within the Rosebud River were limited to turbidity and overhanging vegetation.

3.3.2 Cambria

Within the Cambria study area, the mean channel and wetted widths were 101 m and 75 m, respectively (Appendix C). Erosion and scour has created the deepest run and backwater habitat observed within the four study areas with a max depth of 3.6 m. Downstream of the abandoned railway bridge piers, the habitat along the south (right) bank of the Red Deer River is uniform and consists of low and moderate quality run with limited instream cover. Habitat under the Highway 10 bridge was composed of uniform moderate depth run habitat over fine substrate. Mid-channel gravel/cobble bars provide coarse substrates and some cover opportunities between transects T3 and T4 (Appendix D, Figure D-2). Habitat complexity downstream of the study area remains low with the habitat composed entirely of run. A large island is located approximately 475 m downstream that splits that channel into a small side channel along the north (left) bank and the main flow along the south (right) bank (Appendix D, Figure D-2).

Banks were sloping and ranged in height from 2.5 to 10 m. The banks generally alternated between erosional and depositional with interspersed sections of bedrock canyons. The banks were composed of fines with the exception of canyon sections that were composed of bedrock. The south (right) bank at the Highway 10 bridge is armoured with rip rap (Appendix D, Figure D-2). Riparian vegetation throughout the study area was primarily composed of grasses and shrubs.

Bed material was dominated by fines with cobbles and gravel as the sub-dominant substrates. Cobble and gravel were dominant in areas of increased flow velocities along outside bends whereas fines and gravels were typically found along the river margins in low velocity areas.

Fish cover opportunities were low and provided by turbidity and depth. Rafted woody debris on side and mid-bars may provide additional cover during higher water conditions. Shrubs located along the banks may also provide overhanging vegetation cover during high water.

3.3.3 Lehigh

Within the Lehigh study area, proposed flood mitigation works extend along the north (left) bank of the Red Deer River. The mean channel and wetted widths were 106.8 and 91.0 m, respectively (Appendix C). The habitat along the north (left) bank for the upstream half of the study area is uniform and consists of low and moderate quality run with limited instream cover. The channel features in this section are depositional in nature with gravel and sand side-bars (Appendix D, Figure D-3). At the east end of the Village of Lehigh, the river turns and this area contains several mid-channel gravel/cobble bars and associated riffle habitat (Appendix D, Figure D-3). Downstream of this bend, the habitat transitions with the deep high quality run habitat located along the north (left) bank and the south (right) side transitions to become shallow run with depositional banks (Appendix D, Figure D-3). Highway 10 parallels the river through this section and the east bank is armoured with rip rap (Appendix C, Figure C-3.1, Photo 5). The rip rap through this section provides coarse substrates and cover opportunities for fish of all species. Overall habitat complexity throughout the Lehigh study area is low with the habitat almost entirely composed of run.

Banks were either vertical or sloping and ranged in height from 2.0 to 10 m. The banks generally alternated between erosional and depositional with interspersed sections of bedrock canyons. The banks were composed of fines with the exception of canyon sections that were composed of bedrock. The riparian vegetation throughout the study area was primarily composed of grasses and shrubs.

Bed material was dominated by fines with cobbles and gravel as the sub-dominant substrates. Small areas of clean cobble and gravels were observed in the riffle habitat, however, these had fines in the interstitial spaces and were moderately embedded.

Fish cover opportunities were limited and predominantly provided by turbidity and depth. Coarse material, such as broken bedrock pieces along the margins of canyon banks, likely provide additional cover during high water conditions. Woody debris and aquatic vegetation cover opportunities were rare and overhanging vegetation was not observed during the survey.

3.3.4 East Coulee

Within the East Coulee study area, the mean channel and wetted width of the Red Deer River were 130.4 and 108.3 m, respectively (Appendix C, Figure C-4.0). The upstream extent of the study area is located in a wide, shallow section of the river with mid-channel gravel/cobble bars and a island that divides the river (Appendix D, Figure D-4). The main channel flows along the north (left) bank predominantly composed of moderate quality run habitat. The side channel along the south (right) bank contains small riffle habitat units interspersed with shallow run (Appendix D, Figure D-4). Downstream the north (left) bank transitions to a depositional type habitat with shallow run along the margins of the river and sloping, relatively stable banks composed of fines (Appendix C, Figure C-4.0). Deeper, high quality run habitat is located along the south (right) canyon and bedrock bank within this section (Appendix D, Figure D-4). The habitat becomes shallow across the entire width of the river around the old wooden Atlas Coal Mine Bridge (Appendix D, Figure D-4). Substrate within this area contained a higher percentage of fines than other areas surveyed likely due to the low velocity and wide wetted width (Appendix C, Figure C-4.0). Habitat remained shallow to moderate run downstream of the Highway 10 bridge crossing where East Coulee project study area ends. Overall, the habitat complexity within the East Coulee project area is higher than other sections with more mid and side bars, islands and habitat diversity.

The north (left) bank within the study area alternates between erosional and depositional in nature whereas the south (right) bank contains areas with bedrock canyon (Appendix D, Figure D-4). Both banks at the Highway 10 bridge are armoured with rip rap and armouring is also present downstream of the East Coulee where Highway 570 closely parallels the river (Appendix D, Figure D-4).

Fish cover within the East Coulee study area is limited and predominantly provided by turbidity and depth. Coarse material is rare and interstitial spaces are typically filled by sand further limiting cover. Woody debris was observed rafted onto mid and side bars and could provide cover opportunities during higher water conditions. Aquatic vegetation cover opportunities were rare and overhanging vegetation was not observed during the survey.

3.4 Fisheries Resources

3.4.1 Fish Community

Within 20 km of the proposed works, 26 fish species have been historically documented in the Red Deer River and Rosebud River including seven sport fish, five sucker species, seven small-bodied forage fish, and one invasive species (Table 1; AEP 2020a).

Table 1: Fish Species Historically Documented within 20 km of the Proposed Works

Common Name	Species Code	Scientific Name
Sport Fish		
Burbot	BURB	*Lota lota*
Goldeye	GOLD	*Hiodon alosoides*
Lake sturgeon	LKST	*Acipenser fulvescens*
Northern pike	NRPK	*Esox lucius*

Common Name	Species Code	Scientific Name
Mooneye	MOON	*Hiodon tergisus*
Sauger	SAUG	*Stizostedion canadense*
Walleye	WALL	*Sander vitreus*
Sucker Species		
Longnose sucker	LNSC	*Catostomus catostomus*
Quillback	QUIL	*Carpiodes cyprinus*
Shorthead redhorse	SHRD	*Moxostoma macrolepidotum*
Silver redhorse	SLRD	*Moxostoma anisurum*
White sucker	WHSC	*Catostomus commersoni*
Forage Fish		
Emerald shiner	EMSH	*Notropis atherinoides*
Flathead chub	FLCH	*Platygobio gracilis*
Lake chub	LKCH	*Couesius plumbeus*
Longnose dace	LNDC	*Rhinichthys cataractae*
River shiner	RVSH	*Notropis blennius*
Spottail shiner	SPSH	*Notropis hudsonius*
Trout-perch	TRPR	*Percopsis omiscomaycus*
Invasive Species		
Prussian Carp	PRCR	*Carassius gibelio*

3.4.2 Special Status Species

Of the species historically documented within the vicinity of the proposed works, lake sturgeon (*Acipenser fulvescens*) are listed Threatened by Alberta's Endangered Species Conservation Committee (AEP 2016). Lake sturgeon are not currently listed under Schedule 1 of the federal *Species at Risk Act;* however, the Saskatchewan-Nelson River population is listed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2017; GC 2019).

3.5 Red Deer River Fish Habitat Evaluation

A summary of the fish habitat evaluations for small-bodied forage fish, sucker species and sport fish species is provided in Table 2.

Table 2: Summary of Fish Habitat Quality within the Red Deer River Study Areas

Habitat Type	Forage Fish Species	Sucker Species	Sport Fish Species
Overall habitat quality	Important	Important	Important
Rearing (juvenile)	Important	Important	Important
Holding (adult)	Important	Important	Important
Spawning	Important	Marginal	Important
Overwintering	Important	Important	Important

3.5.1 Lake Sturgeon

Within Alberta, lake sturgeon are only found in the Bow River, the North and South Saskatchewan rivers, Oldman River, and the Red Deer River (Langhorne et al. 2001). Lake sturgeon have been documented near the Roper Road bridge within the Rosedale study area and approximately 6 km downstream of East Coulee study area (AEP 2020a).

Riverine habitat requirements for lake sturgeon are generally described as deep (>3 m), low velocity holding areas with access to high-gradient areas for spawning (COSEWIC 2017). Adult lake sturgeon have been found to congregate and overwinter along outside river bends greater than 5 m deep and in runs greater than 3 m (Alberta Lake Sturgeon Recovery Team 2011). Lake sturgeon have been shown to complete large migrations (>500 km), which are likely associated with spawning movements (Alberta Lake Sturgeon Recovery Team 2011). Limited information about spawning in Alberta is available, however, spawning typically occurs during spring as water temperature approaches 11°C within or immediately downstream of rapids (Stewart and Watkinson 2004; Alberta Lake Sturgeon Recovery Team 2011). Optimal spawning habitat is described as substrate comprised of gravel or cobble in current velocities ranging from 0.5 to 1.3 m/s (Peterson et al. 2006).

Habitat within the study area is generally shallow (<2 m), low velocity run over substrate composed primarily of fines with some coarse materials. One area of moderate depth (3 to 3.6 m) was found near Cambria by the bridge piers at the upstream end of the study area. These areas are likely scour holes created by the flow regimes around the three piers and thus are relatively small. The areas of high quality run habitat throughout the study area were typically located along the outside bends of the river. These areas contained low velocity run habitat with depths ranging from 1.0 to 2.6 m, however, this habitat lacks depth for preferred holding or overwintering habitat of lake sturgeon. No areas of increased gradient or rapid habitat was observed within the study areas. Therefore, habitat within the study areas is rated Important as it likely provides habitat for sturgeon and a migration route but lacks the physical attributes required to support critical life stages (i.e., overwintering, spawning) (Table 2). No habitat within the Red Deer River in Alberta has been identified as critical habitat for lake sturgeon and mapped as a Class A waterbody based on documented sturgeon use (ESRD 2006; Alberta Lake Sturgeon Recovery Team 2011).

3.5.2 Sport Fish

Within the study areas, the habitat is classified as Important for sport fish. Areas of high quality run provide suitable holding and rearing habitat; however, the areas lacks cover and habitat diversity. Walleye (*Sander vitreus*) and sauger (*Stizostedion canadense*) prefer turbid regions of the river with dark waters, logs and associated hiding cover (Ford et al. 1995). Northern pike (*Esox lucius*) prefer slow to moderate current with ample aquatic vegetation (Harvey 2009). Adult burbot (*Lota* lota) prefer to hold in deep (>3 m) pools and low velocity habitat, which were limited within the study areas (Nelson and Paetz 1992). Juvenile burbot rearing habitat typically constitutes rocky shorelines, which were occasional throughout the study areas in the form of side and mid-bars (Ford et al. 1995). Goldeye (*Hiodon alosoides*) and mooneye (*Hiodon tergisus*) are typically found suspended in moderate to deep run within large, turbid rivers such as the Red Deer River (Langhorne et al. 2001). Due to the midwater to surface feeding habits of goldeye and mooneye, depth and substrate type are generally unimportant habitat requirements (Stewart and Watkinson 2004).

The Red Deer River generally does not provide optimal spawning habitat for resident sport fish. Walleye, and sauger typically require coarse substrate free of fine materials, while northern pike spawn on flooded terrestrial grasses or instream, aquatic vegetation or woody debris (Ford et al. 1995; McMahon 1999; Hartman 2009; Harvey 2009). Fine substrates were present throughout the study areas, however, the riffle habitats were dominated by clean coarse substrates providing some spawning opportunities for walleye and sauger. Instream vegetation and woody debris was limited to small areas of filamentous algae growing on coarse substrates, and rafted woody debris along the shallow margins of the river. The banks within the study areas were typically greater than 1 m in height limiting potential for flooded terrestrial vegetation to provide spawning opportunities for northern pike. Burbot spawn on a variety of substrates ranging from boulders to fines and organic material in areas with no current (Ford et al. 1995). Due to the flow conditions of the habitat within the study areas, there is limited optimal burbot spawning habitat. Goldeye and mooneye eggs are semi-buoyant and incubate as they float downstream suspended in the water column (Scott and Crossman 1973). Therefore, the habitat type and substrate are generally unimportant in terms of goldeye and mooneye spawning habitat requirements.

Within the study areas, the deep runs and backwater areas provide abundant overwintering habitat for sport fish of all species.

3.5.3 Sucker Species

Overall habitat for sucker species within the study areas is rated Important (Table 2). Silver redhorse (*Moxostoma anisurum*), shorthead redhorse (*Moxostoma macrolepidotum*) and quillback *(Carpoides cyprinus)* prefer sandy or gravel substrate and slow-moving water for rearing and holding habitat (Langhorne et al. 2001; Stewart and Watkinson 2004). White sucker (*Catostomus commersoni*) are closely associated with overhead cover (e.g., woody debris) in pool habitat which is lacking within the study areas (Twomey et al. 1984). Sucker species typically spawn in shallow riffle habitat over gravel substrate (Langhorne et al. 2001). Spawning opportunities for sucker species are limited within the study areas due to a lack of preferred habitat and substrate size.

Within the study areas, depths frequently exceed 1.5 m providing abundant overwintering habitat for sucker species.

3.5.4 Forage Fish

Overall habitat quality within the study areas for forage fish is Important (Table 2). The study areas likely supports all life stages of the various forage fish listed in Table 1. Coarse substrates and low velocity habitat along the margins or backwaters provide suitable holding, rearing and spawning habitat for forage fish species such as lake chub (*Couesius plumbeus*), longnose dace (*Rhinichthys cataractae*) and trout-perch (*Percopsis omiscomaycus*) (Langhorne et al. 2001; Stewart and Watkinson 2004). Emerald shiner (*Notropis atherinoides*) and spottail shiners (*Notropis hudsonius*) school in large rivers typically midwater or near the surface (Stewart and Watkinson 2004). The study areas provides abundant depth and flow for overwintering forage fish.

3.6 Rosebud River Fish Habitat Evaluation

A summary of the fish habitat evaluations for small-bodied forage fish, sucker species and sport fish species is provided in Table 3.

Table 3: Summary of Fish Habitat Quality within the Rosebud River

Habitat Type	Forage Fish Species	Sucker Species	Sport Fish Species
Overall habitat quality	Important	Marginal	Marginal
Rearing (juvenile)	Important	Marginal	Marginal
Holding (adult)	Important	Marginal	Marginal
Spawning	Important	Unsuitable	Marginal
Overwintering	Important	Marginal	Marginal

3.6.1 Sport Fish

The habitat within the surveyed reach of the Rosebud River is classified as marginal for sport fish. The habitat was entirely composed of shallow, low quality run habitat with minimal cover. The habitat provides marginal holding, rearing and overwintering opportunities for sportfish of all species due to the lack of depth, habitat diversity, and cover. No suitable spawning habitat for lake sturgeon, walleye or sauger was observed as the substrates were composed of fines with isolated pieces of highly embedded coarse materials. No instream vegetation or woody debris was observed that could provide northern pike spawning habitat. Goldeye and mooneye may utilize the habitat for spawning due to the semi-buoyant nature of their eggs.

3.6.2 Sucker Species

Overall habitat for sucker species within the Rosebud River is rated as Marginal (Table 3). Spawning habitat for sucker species were not observed within the surveyed reach due to a lack of preferred riffle habitat and substrate composition. The lack of depth and cover within the surveyed reach limits the rating for adult holding to marginal for holding, overwintering and rearing habitat.

3.6.3 Forage Fish

Overall habitat quality within the surveyed reach for forage fish is Important (Table 3). The surveyed reach likely supports all life stages of the forage fish listed in Table 1. The low velocity run habitat provides suitable holding, and rearing for forage fish species such as lake chub, flathead chub, and trout-perch (Langhorne et al. 2001). The shallow depths and lack of cover would likely limit the holding potential for schooling species such as emerald shiner and spottail shiners as the large schools would be easily preyed upon by birds and larger fish. The limited amount of coarse substrates precludes the spawning habitat for forage fish species such as lake chub, longnose dace and emerald shiner which prefer gravel or cobble dominant areas (Langhorne et al. 2001; Stewart and Watkinson 2004). The confluence between the Red Deer and Rosebud rivers provides optimal spawning habitat for spottail and river shiners. These species prefer to spawn over sand or gravel at confluences or low velocity habitats (Nelson and Paetz 1992; Joynt and Sullivan 2003). The Rosebud River likely provides sufficient depth and flow to overwinter forage fish.

4.0 PROJECT DESCRIPTION

The project design will consist of the construction of new dykes and berms, reinforcing of structure of existing berms and dykes along the river bank and installation of erosion protection measures. Berm footprints in relation to active channel of the Red Deer and Rosebud rivers are unknown at this time. Further details with regards to scheduling and evaluation of impacts of the works can be provided once dyke design information is provided.

4.1 Scheduling of Works

The preliminary schedule anticipates construction from 2021 to 2024. Instream construction should be scheduled to take place outside of the fisheries RAP. Within the study area locations, the Red Deer River has a RAP that extends from 16 April to 30 June and the Rosebud River has a RAP extending from 16 April to 15 July (ESRD 2006). Upstream and downstream fish passage is expected to be maintained for the duration of the works.

5.0 POTENTIAL IMPACTS TO FISH AND FISH HABITAT

Potential risks to fish and fish habitat from the proposed works include the following:

- release of sediment and harmful substances;
- interruption of fish movements and sensitive life stages;
- permanent loss of fish habitat; and
- the spread of aquatic invasive species (AIS) and disease.

The following sections discuss each of these potential effects in further detail. Section 6.0 outlines specific mitigation measures to prevent or limit these effects on the aquatic environment. Additional mitigation guidance provided by DFO is presented in Appendix E. Construction should follow all applicable guidance provided by AEP and DFO.

5.1 Release of Sediment and Harmful Substances

Sediment and other harmful substances (fuel, grease) have the potential to be released through the erosion of exposed surface soils, bank erosion, disturbances of the channel bed, refuelling activities, equipment leaks, and exposed grease or accidental spills from heavy and light equipment operating in and around the river.

Direct effects to fish from siltation include physiological responses (increased cough reflex, gill trauma, and stress), and population level responses from decreased quality/availability of spawning habitat and increased egg mortality (Anderson et al. 1996). Fish species that utilize clean, well-oxygenated gravel substrates to spawn are particularly sensitive to sediment loading. This can fill the interstitial spaces of the gravel and cover eggs, which impairs egg gas exchange during incubation. Indirectly, increased sediment loads can decrease habitat quality and decrease the production of benthic invertebrates, which fish depend on for food.

Based on federal and provincial water quality guidelines (CCME 2002; GOA 2018), low concentrations or short exposure periods generally result in minor effects that revert to normal conditions (i.e., sediment concentrations return to background levels) once the instream work is complete.

The implementation of proper erosion and sediment control measures, including worksite isolation and a turbidity/total suspended solids (TSS) monitoring plan (Section 6.1), are expected to satisfy associated requirements under the federal *Fisheries Act,* the Alberta *Water Act*, and the provincial *Environmental Protection and Enhancement Act*.

A spill or leak of petroleum products can also result in changes to aquatic habitat (water and sediment quality) and negatively affect fish health. Preventative measures are detailed in Section 6.3.

5.2 Interruption of Fish Movements and Sensitive Life Stages

Fish movement may vary from localized movements to large migration between essential habitats. Migrations typically occur during spawning periods but also can occur in response to seasonal changes (e.g., water temperature, dissolved oxygen concentrations) or during changes in a species life cycle (e.g., downstream movement of juveniles to rearing habitat) (DFO 2007).

The disruption of fish migration and passage may occur directly through instream construction activities (e.g., use of isolated construction techniques) or indirectly by increasing localized flow velocities and sediment releases. Provincial RAPs are designed to ensure that any disturbance occurs outside of sensitive periods of the reproductive life cycle (i.e., spawning, egg incubation, fry emergence) of resident fish species (Alberta Transportation 2009). The RAP for the Red Deer River at the proposed project area extends from 16 April to 30 June and the RAP for the Rosebud River is 16 April to 15 July (ESRD 2006).

5.3 Loss of Fish Habitat

Habitat within the proposed project footprint is primarily run varying from 0.3 to 2.0 m in depth. The substrate is primarily composed of fine materials or embedded coarse substrate. The banks are either sloping and moderately unstable to stable or vertical and unstable. At the downstream end of the Lehigh the east bank is armoured with rip rap.

Habitat within the study areas is important for most resident fish species with deep high quality run habitat providing holding, rearing and overwintering potential for sport fish and sucker species. Shallow margin habitats area provide limited spawning opportunities for sport fish and sucker species due to lack of preferred substrate and habitat types. The shallow low velocity margin provides habitat for forage fish to fulfil all life history stages. Although the habitat along the margins within the study areas may provide the basic requirements for all fish species to carry out their life cycle; these habitat types are common both within the surveyed reach and regionally.

Depending on the scale and nature of the proposed Flood Mitigation Project, a *Fisheries Act* authorization from DFO may be required. The federal *Fisheries Act* prohibits "any work, undertaking or activity that results in harmful alteration, disruption or destruction of fish habitat (HADD)". DFO defines HADD as "any temporary or permanent change to fish habitat that directly or indirectly impairs the habitat's capacity to support one or more life processes of fish" (DFO 2019a).

Depending on the extent of impacts, fisheries offset may be required. A quantification of the extent of HADD provides one of the main factors that determine the offsets required in order to maintain the fisheries productivity of the Red Deer River and Rosebud River.

The extent of HADD is based in-part on the footprint of the works below the ordinary high-water mark, which is defined on the basis of the 1:2 year flood level. The footprint is the total area of the bed of a waterbody that is covered by the structure or fill.

The footprint of the proposed works below the ordinary high-water mark will be evaluated once the design of the works is provided. The loss of fish habitat (estimated in square metres) can then be determined.

5.4 Aquatic Invasive Species and Disease

AIS are *"…species non-indigenous to a particular region or body of water that impact or pose threats to the environment, the economy and human health. AIS pose a huge threat to freshwater resources and are one of the leading causes of biodiversity loss worldwide"* (AEP 2018).

Examples of AIS that pose potential threats to Alberta aquatic environments include Prussian carp, New Zealand mudsnails, quagga mussels, zebra mussels, flowering rush, purple loosestrife, Eurasian water milfoil, and *Didymosphenia geminata* (i.e., Didymo). A full list of potential Alberta AIS is provided in the *Fisheries (Alberta) Act* (GOA 2016).

Whirling disease is an invasive aquatic disease identified in Alberta. The disease is caused by *Myxobolus cerebralis,* a microscopic parasite of salmonid fish, including trout and whitefish. In 2017, the Canadian Food Inspection Agency declared the Bow, Oldman and Red Deer River watersheds infected with whirling disease. The red zone delineation for the Red Deer River extends from Dickson Dam to the confluence with the Blindman River near Red Deer (AEP 2020b). The study areas is located in the white zone, defined as "*…does not have any whirling disease susceptible species, has no confirmed high profile aquatic invasive species and represents lower risk due to lower population base and less activity/use.*" (AEP 2017).

6.0 MITIGATION MEASURES

All construction activities must adhere to contract specifications and be performed in accordance with established best management practices for construction around stream environments. All construction activities should be conducted in compliance with the *Measures to Protect Fish and Fish Habitat* (DFO 2019b) and will meet or exceed the QAES recommendations outlined below.

6.1 Total Suspended Solids/Turbidity Monitoring

TSS/turbidity monitoring should be conducted during instream construction to ensure any isolation structures are effectively preventing silt laden materials from entering the river. Procedures and guidelines to be applied during instream monitoring are outlined in *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2018) and the provincial *Environmental Quality Guidelines for Alberta Surface Waters* (GOA 2018).

The monitoring protocols should follow Alberta Transportation's *Special Provision – Turbidity* (Alberta Transportation 2017) provided in Appendix F. Due to the wetted width of the Red Deer River exceeding 60 m at the project area, hourly turbidity sampling will be completed at transects 90 m, 180 m and 270 m downstream of the construction area. Work completed along the Rosebud River will have sampling conducted at transects 30 m, 60 m and 90 m downstream (Alberta Transportation 2017).

In the event of a turbidity exceedance, all instream construction activities will immediately stop, and a contingency plan will be implemented. Construction will only resume after readings at all sampling locations return to levels below the guideline value. Following an exceedance, the on-site QAES conducting the monitoring and the contractor will determine cause of the release and further mitigation will be implemented to prevent further exceedances. This may include a change in construction approach (e.g., reduced pace of work, use of different equipment), alteration of the isolation structure (e.g., installation of additional turbidity curtain) or implementation of sediment control practices (e.g., sediment bags).

The extent and duration of the plume will be documented and reported immediately to AEP's Energy & Environmental Response Line (1-800-222-6514). A 7-day letter will be completed and submitted to AEP for all exceedances.

6.2 Bank Erosion and Sediment Control Measures

To prevent erosion and sediment releases into the river, control measures must consider site drainage and the use of sediment fences, V-ditches, berms, isolations, and other suitable techniques where necessary. Specifically, the approach areas for equipment access are areas of potential sediment release. These areas will be monitored closely and if the potential for sediment release is identified, appropriate erosion and sediment controls installed.

Any rock placed to prevent bank erosion will be clean and free of fine materials. Placement of this material will be done at a controlled pace to limit mobilization of the surrounding sediment.

If the construction site must be abandoned for extended periods of time (due to material shortages, weather, etc.), banks will be stabilized and/or covered with geotextile fabric in a manner that limits the erosion and siltation risk to the adjacent watercourse. Material stockpiles and/or spoil piles will be stabilized, and the appropriate erosion control measures implemented to mitigate sediment runoff. These measures must consider the possibility of high flow events and address these risks accordingly. Periodic inspection and maintenance will be completed to ensure temporary erosion and sediment controls are functional, and to implement remedial measures as required.

6.3 Accidental Petroleum Product Spills

Specific controls are stipulated in the following sections to prevent the introduction of petroleum products to the aquatic environment.

6.3.1 Equipment, Equipment Maintenance and Storage

During the project, various pieces of construction equipment may be utilized, stored and maintained on-site. Construction crews will ensure that equipment is brought onto the site clean and in good condition to reduce the possibility of fuel, oil and fluid spills. In addition, biodegradable lubricants and hydraulic fluids will be used for any machinery operating in or near the adjacent watercourse. All fuel storage areas will be located as described in Section 6.3.2 and fuel contained within an appropriate fuel storage tank.

6.3.2 Maintenance and Refuelling Areas

If machinery maintenance is required, suitable trucks and containers for the fuel, oils, lubricants and antifreeze required for maintenance purposes will be used. Apart from pumps, equipment with limited mobility and emergency equipment, all other equipment will be fuelled and maintained in an area greater than 100 m from the watercourse. In the event that the 100 m buffer zone cannot be maintained, suitable containment measures (e.g., containment berms, pads, trays) must be used to prevent spills from reaching the adjacent river.

On-site fuel storage will be done using industry standards and all fuel pumps must be self-contained in the service trucks. Designated fuelling trucks on-site should contain the following items:

- spill kit(s); and
- containers for used oil filters, oil, lubricants, antifreeze, and other fluids and wastes.

6.3.3 Equipment Requirements

Prior to bringing equipment onto site, an inspection of the equipment will be conducted and the documentation recorded. The inspection should focus on the following items:

- equipment is clean (free of mud, dirt and oil);
- equipment is free of weeds and weed seeds;
- equipment is in good working order;

- equipment is using biodegradable fluids and lubricants where applicable;
- a drip pan is available for equipment;
- contractor has a spill kit; and
- employees are trained on the refuelling, maintenance, and emergency spill response procedures.

6.4 Fish Movements and Sensitive Life Stages

The wetted widths of the Red Deer River within the project areas is greater than 60 m and the proposed construction activities will be restricted to the banks. Therefore, the proposed works will be restricted to near-shore areas and will not prevent fish migration/passage as the majority of river will remain open during construction activities. If isolation structures that block upstream/downstream passage are required to complete work along the Rosebud River, these structures will be in place for no longer than 14 days if work is being completed outside the RAP or three days if within the RAP. If the construction schedule necessitates these structure remain instream for longer then additional means to allow fish passage must be included to the work area.

If isolation structures are required during construction, any fish stranded within the isolations will be relocated. Following completion of the isolation structure(s), a qualified environmental professional will be retained to execute the fish rescue. This work will follow the requirements of AEP's Fish Research Licence. All fish will be removed live from the isolated area prior to instream work and be placed in a downstream location that prevents them from being further disturbed by the proposed construction activities. Site isolation will be coordinated with the fish relocation contractor to prevent undue stress or stranding of fish located within the isolation.

A QAES will be monitoring all instream construction activities to ensure turbidity/TSS levels downstream do not exceed the federal or provincial Environmental Quality Guidelines for Surface Waters (CCME 2018; GOA 2018). No change to the local flow regimes is anticipated to occur from the construction activities.

All proposed instream works will be scheduled to be completed outside of the RAP to minimize potential impacts to fish migration and/or sensitive life stages. Construction may be conducted in the RAP in areas that are dry.

6.5 Aquatic Invasive Species and Disease

To prevent the spread of AIS and fish disease in Alberta, AEP has developed a decontamination protocol for all watercraft and in-water equipment (AEP 2017). This protocol is currently mandatory for government staff, contractors and Fish Research Licence holders. Decontamination instruction for industrial and construction operations is provided in Appendix D of the *Alberta Decontamination Protocol* (AEP 2017). The selected contractor (and their environmental consultant) will review these protocols before starting work, and ensure their equipment is disinfected to the required level.

7.0 REGULATORY CONSIDERATIONS

7.1 DFO Request for Review

The project will require a submission to DFO for Request for Project Review to determine whether the proposed works will result in a HADD. If DFO deems the project as a HADD, a *Fisheries Act* authorization will be required and appropriate compensation will be proposed. AEP will be updated accordingly.

7.2 Water Act

Consideration of a project's potential effects on the aquatic environment is a required component for determining if works meet the definition of an "Activity", therefore, requiring a review and approval under the provincial *Water Act*. An "Activity" includes anything "that is conducted by a licensee in or on a works that is the subject of a licence and that is owned or operated by the licensee" and "that impairs or may impair the exercise of rights of any household user, traditional agriculture user or other licensee, or causes or may cause a significant adverse effect on the aquatic environment, human health, property or public safety" (GOA 2017). The construction and maintenance of flood mitigation structures meets the definition of an "Activity" and, therefore, will require an approval under the *Water Act*.

8.0 CONCLUSION

The following conclusions are based on this aquatic environment assessment:

- the footprint of the proposed works below the ordinary high-water mark will be evaluated once the design of the works is provided. The loss of fish habitat (estimated in square metres) can then be determined. Depending on the extent of impacts, fisheries offset compensation may be required;
- once the project design is provided and the instream footprint determined, an application will be submitted to DFO to determine if the project will result in a HADD;
- if the project is deemed a HADD by DFO, a *Fisheries Act* authorization will be required and appropriate fish habitat offset compensation will need to be determined;
- the habitat within the project footprint is not considered critical, as similar fish habitat is available both locally and regionally within the Red Deer River and Rosebud River;
- this aquatic environment assessment can be revised to further evaluate impacts to fish and fish habitat, once the design of the works is provided; and
- final construction approvals will be subject to DFO and AEP project review.

Measures to reduce the potential of serious harm to fish include:

- instream works will be completed outside of the RAP, minimizing the potential impacts to sensitive life stages of resident fish;
- turbidity/TSS monitoring will be completed during instream works to prevent direct effects to fish from siltation and the sedimentation of downstream habitat;
- fish passage will be maintained throughout the construction of the project,
- fish rescues will be conducted to remove fish if isolated work areas are required;
- best practices for working near and within watercourses will be incorporated to minimize the potential for hydrocarbon spills; and
- to prevent the spread of AIS, contractors will follow decontamination requirements for industrial and construction operations outlined in the *Alberta Decontamination Protocol*.

9.0 CLOSURE

This report is based on the information and conditions available at the time of completion as referenced throughout the report. Wood has performed its services in a manner consistent with the standard of care and skill ordinarily exercised by members of the profession practicing in Alberta at the time that the services were performed. If you have any questions, please feel free to contact the undersigned at 403-660-3668.

Yours truly,

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Appendix A

Large River Classification

Table A-1: Large River Habitat Classification System

Type	Symbol	Description
MAJOR HABITAT TYPES		
Unobstructed channel	U	Single main channel, no permanent islands, side bars occasionally present, limited development of exposed mid-channel bars at low flow
Singular island	S	Two channels around single, permanent island, side and mid-channel bars often present at low flow
Multiple island	M	More than two channels and permanent islands, generally extensive side and mid-channel bars at low flow
BANK HABITAT TYPES		
Armoured/Stable	A1	Largely stable and at repose; cobble/small boulder/gravel predominant; uniform shoreline configuration; bank velocities low-moderate; instream/overhead cover limited to substrate and turbidity
	A2	Cobble/large boulder predominant; irregular shoreline due to cobble/boulder outcrops producing BW habitats; bank velocity low (BW)/moderate; instream/overhead cover from depth, substrate and turbidity
	A3	Similar to A2 with more boulder/bedrock; very irregular shoreline; bank velocities moderate-high with low velocity BW/eddy pools providing instream cover; overhead cover from depth/ turbidity
	A4	Artificial riprap substrates consisting of angular boulder-sized fill; often associated with high velocity areas; shoreline usually regular; instream cover form substrate; overhead cover from depth/turbulence
Canyon	C1	Banks formed by valley walls; cobble/boulder bedrock; stable at bank-water interface; typically deep/high velocity water offshore; abundant velocity cover from substrate/bank irregularities
	C2	Steep, stable bedrock banks; regular shoreline; moderate-deep/moderate-fast water offshore; occasional velocity cover from bedrock fractures
	C3	Banks formed by valley walls, primarily fines with some gravel/cobble at base; moderately eroded at bank-water interface; mod-high velocities; no instream cover
Depositional	D1	Low relief, gently sloping bank; shallow/slow offshore; primarily fines; instream cover absent or consisting of shallow depressions or embedded cobble/boulder; generally associated with bars
	D2	Similar to D1 with gravel/cobble substrate; some areas of higher velocities producing riffles; instream/overhead cover provided by substrate/turbulence; often associated with bars/shoals
	D3	Similar to D2 with coarser substrates (cobble/boulder); boulders often imbedded; moderate-high velocities offshore; instream cover abundant from substrate; overhead cover from turbulence

Type	Symbol	Description
Erosional	E1	High, steep eroded banks with terraced profile; unstable; fines; moderate-high offshore velocity; deep immediately offshore; instream/overhead cover form submerged bank material/ vegetation/depth
	E2	Similar to E1 without the large amount of instream vegetative debris; offshore depths shallower
	E3	High, steep eroding banks; loose till deposits (gravel/cobble/sand); moderate-high velocities and depths; instream cover limited to substrate roughness; overhead cover provided by turbidity
	E4	Steep, eroding/slumping highwall bank; primarily fines; moderate-high depths/velocities; instream cover limited to occasional BW formed by bank irregularities; overhead cover from depth/turbidity
	E5	Low, steep banks, often terraced; fines; low velocity; shallow-moderate; no instream cover; overhead cover from turbidity
	E6	Low slumping/eroding bank; substrate either cobble/gravel or silt with cobble/gravel patches; moderate depths; moderate-high velocities; instream cover form abundant debris/boulder; overhead cover from depth/turbidity/overhanging vegetation
SPECIAL HABITAT FEATURES		
Pool	P	Discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour
Tributary confluence [sub-classified according to tributary flow and wetted width at mouth at the time of the survey]		
	TC	Confluence area of tributary entering mainstem
	TC1	Intermittent flow, ephemeral stream
	TC2	Flowing, width <5 m
	TC3	Flowing, width 5 to 15 m
	TC4	Flowing, width 16 to 30 m
	TC5	Flowing, width 31 to 60 m
	TC6	Flowing, width >60 m
Shoal	SH	Shallow (<1 m deep), submerged areas in mid-channel or associated with depositional areas around islands/side bars
	SHC	Submerged area of coarse substrates
	SHF	Submerged area of fine substrates
Backwater	BW	Discrete, localized area exhibiting reverse flow direction and, generally, lower velocity than main current; substrate similar to adjacent channel with more fines
Rapid	RA	Area with turbulent flow, broken surface (standing waves, chutes, etc.), high velocity (>1 m/s), armoured substrate (large boulder/bedrock) with low fines
Snye	SN	Discrete section of non-flowing water connected to a flowing channel only at its downstream end, generally formed in a side channel or behind a peninsula (bar)
Slough	SL	Non-flowing waterbody isolated from flowing waters except during flood events; oxbows
Log Jam	LJ	Accumulation of woody debris; generally located on island tips, heads of side channels, stream meanders; provide excellent instream cover

Table A-2: Small River or Stream Habitat Classification and Rating System

Channel Unit	Type	Class	Map Symbol	Description
Falls			FA	Highest water velocity; involves water falling over a vertical drop; impassable to fish
Cascade			CA	Extremely high gradient and velocity; extremely turbulent with entire water surface broken; may have short vertical sections, but overall is passable to fish; armoured substrate; may be assoc. with chute (RA/CH)
Chute			CH	Area of channel constriction, usually due to bedrock intrusions; associated with channel deepening and increased velocity
Rapids			RA	Extremely high velocity; deeper than riffle; substrate extremely coarse (large cobble/boulder); instream cover in pocket eddies and associated with substrate
Riffle			RF	High velocity/gradient relative to run habitat; surface broken due to submerged or exposed bed material; shallow relative to other channel units; coarse substrate; usually limited instream or overhead cover for juvenile or adult fish (generally ≤0.5 m deep)
Run (Glide)			R	Moderate to high velocity; surface largely unbroken; usually deeper than RF; substrate size dependent on hydraulics
	Depth/ Velocity			Run habitat can be differentiated into one of four types: deep/slow, deep/fast shallow/slow, or shallow/fast
		1	R1	Highest quality/deepest run habitat; generally deep/slow type; coarse substrate; high instream cover from substrate and/or depth (generally >1.0 m deep)
		2	R2	Moderate quality/depth; high-mod instream cover except at low flow; generally deep/fast or moderately deep/slow type (generally 0.75 to 1.0 m deep)
		3	R3	Lowest quality/depth; generally shallow/slow or shallow/fast type; low instream cover in all but high flows (generally 0.5 to 0.75 m deep)
Flat			FL	Area characterized by low velocity and near-uniform flow; differentiated from pool habitat by high channel uniformity; more depositional than R3 habitat
Pool			P	Discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour
		1	P1	Highest quality pool habitat based on size and depth; high instream cover due to instream features and depth; suitable holding water for adults and for overwintering (generally >1.5 m deep)
		2	P2	Moderate quality; shallower than P1 with high-mod instream cover except during low flow conditions, not suitable for overwintering
		3	P3	Low quality pool habitat; shallow and/or small; low instream cover at all but high flow events

Channel Unit	Type	Class	Map Symbol	Description
Impoundment		1-3	IP (1-3)	Includes pools which are formed behind dams; tend to accumulate sediment/organic debris more than scour pools; may have cover associated with damming structure; identify as Class 1, 2 or 3 as for scour pools
	Dam			Three types of impoundments are based on dam type; debris, beaver and landslide
Backwater			BW	Discrete, localized area of variable size exhibiting reverse flow direction; generally produced by bank irregularities; velocities variable but generally lower than main flow; substrate similar to adjacent channel with higher percentage of fines
Snye			SN	Discrete section of non-flowing water connected to a flowing channel only at its downstream end; generally formed in a side-channel or behind a peninsula
Boulder garden			BG	Significant occurrence of large boulders providing significant instream cover; always in association with an overall channel unit such as a riffle (RF/BG) or run (e.g., R1/BG)

Appendix B

Fish Habitat Requirements

Table B-1: Habitat Requirements of Resident Fish Species within the Vicinity of the Proposed Works

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
SPORT FISH				
Burbot (*Lota lota*) BURB WINTER/EARLY SPRING	Spawn during the winter and early spring (Jan to April) beneath the ice or open water . Boulders, cobble, or gravel with small amount of silt, sand and detritus; shallow bays or on shoals of lakes and rivers; no current; clear water; 0.3-3 m deep. Burbot are mass spawners- a group of 10-12 male and female gather over gravelly, near-shore shoals or shallow, sandy area. Spawning occurs only at night. Preferred spawning temperature is between 0.6-1.7^{0}C. Eggs are semi-buoyant when laid and become demersal within a few days sinking to the substrate in the interstitial spaces- preferred substrate is interstices of sand, gravel, and cobble free of silt and debris.	Juveniles occur along rocky shores and weedy areas of tributary streams. Found in littoral regions of lakes and in shallow regions of streams and rivers where they forage for benthic invertebrates. Preferred cover types are rocks, cobble, vegetation and logs. Juveniles eat primarily crayfish and aquatic insects and secondarily fish. Optimum temperature for growth is between 15.6-18.3^{0}C.	Cold parts of lakes and in large and small streams; diet consists of fish and aquatic insect larvae as well as whitefish eggs; adults are night feeders and voracious predators. Preferred cover type is darker waters at depth.	Deep water of lakes and large rivers. Sensitive to DO levels with acute lethal DO limit >2 mg/L.
Goldeye (*Hiodon alosoides*) GOLD SPRING The oldest specimen is thought to be 13 years old.	Occurs in the spring, May to June. Spawn when temps are between 10-12.8^{0}C. Turbid rivers or pool or backwater areas.	Presumably similar to adult stage.	Found in quiet waters of lakes, large rivers, ponds and marshes, muddy shallows of large lakes. Tolerate turbid water; feed on a variety of sources, including zooplankton, and aquatic and aerial insects.	Deep areas of lakes and rivers.

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
Goldeye *(cont'd)*	The spawning act has never been seen because of the turbid nature of the spawning ground but it is assumed spawning occurs at night. Eggs are semi buoyant. Eggs are released and incubated while suspended in the water column.		Nocturnal and the eyes, which have rods only, no cones, and reflect light , are adapted to dim light conditions and their turbid habitat. Feed extensively at the surface in the summer. Commercial importance.	
Lake sturgeon (*Acipenser fulvescens*) LKST SPRING Have been around for 200 million years.	Likely occurs in late spring, May to June. After lake sturgeon mature (20-25 yrs old), they spawn every 5 years. Water depth 0.6-4.9 m in areas of swift water or rapids often at the foot of a waterfall. Spawn over rocky substrate. No nests are constructed, adhesive eggs are scattered and adhere to rocks and logs. Optimum spawning temperatures is between 13-18^{0}C. Sturgeon generally leave lakes on the spawning migration not long after the spawning rivers are free of ice and they sometimes move under the ice; they can migrate up to 250 miles for spawning, often 80 miles though. Feeding ceases for the whole spawning period.	Shallow bottom areas of lakes and rivers; feed on bottom for clams, snails, insect larvae, some fish and plant material; mud and mud/ gravel substrate. Yearlings may gather in large schools in shallow river mouths or adjacent bays during late summer and early fall. After their first year, juveniles are found in the same habitat as adults.	Feed on bottom for clams, snails, insect larvae, some fish and plant material. Highly productive shoal areas of large lakes and rivers. Bottom dwellers- mud or gravel and mud substrate.	Deep wintering areas of large rivers and lakes.

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
Northern pike (*Esox lucius*) NRPK SPRING	Occurs in early spring, during or shortly after the ice clears; shallow marshes connected to rivers and lakes or flooded vegetation in shallow bays and rivers; water velocity <0.1 m/s; water depth 0.2-0.4 m. Temp between 8-12^{0}C. Fish tend to migrate up tributaries to shallow marshes and wetlands or shallow shoreline inundation. Eggs are broadcast and adhere to vegetation, only a few eggs (5-60) are released at a time, they are released at different locations and not al at the same time.	Prefer dense submergent and emergent vegetation (>30% cover) in the calm bays of sloughs, marshes and lakes and in the back eddies or mouths of (low gradient) tributary streams; water depth <4 m. Stay in the macrophyte areas, do not venture into the macrophyte-open water interface.	Prefer shallow, weedy, clear waters primarily in lakes and marshes; common in streams with slow to moderate current with ample aquatic vegetation and fine substrate; diet consists of fish, crustacean, minnows, insects and young muskrats and ducks. Rarely venture below the thermocline, they prefer the interface between vegetation and open water. Larger individuals frequent lower vegetation densities and small individuals frequent higher vegetation densities. High turbidity reduces the ability for adults to feed.	Typically deep water; dissolved oxygen >3-4 mg/L. Juveniles are able to handle lower DO than adults.
Mooneye (*hiodon tergisus*) MOON SPRING Are known to live up to 11 years.	Spring spawners, April to May. Spawn in sheltered, clear water. Spawn in midwater and eggs are buoyant.	Presumably similar to adult stage.	Found where there is an abundance of food supply: aquatic and terrestrial invertebrates, and small fishes. Less tolerant to turbid waters than the goldeye. Midwater to surface feeder, more common than goldeye in less turbid and slower moving water. Males die earlier than females. Although often found in non-flowing waters, it feeds mostly in swift waters. No commercial importance.	

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
Sauger (*Stizostedion canadense*) SAUG SPRING/SUMMER Found in Bow, Milk, N & S Saskatchewan, Red Deer, St. Mary (not found in lakes in AB).	Occurs in the spring, may to June immediately after walleye spawn. May use shoals of gravel to rubble; turbid rivers. Temperatures about 3.9-6.1^{0}C. Spawning occurs at night in water 2-12 ft (61-366 cm) deep. Eggs are broadcast and fall into spaces between gravel or boulders.	Presumably similar to adult stage. Feed on zooplankton and aquatic insects.	Found in slow flowing rivers; tolerant of turbid waters; backwater areas and mouths of tributary streams; feed on bottom dwelling fishes and insects. Saugers lie in substrate when inactive (in contrast, walleye swim and rest above substrate). They are sight predators and negatively phototrophic. Generally smaller in size than walleye.	Same as walleye.
Walleye (*Sander vitreus*) WALL SPRING Often associated with pike, yellow perch. White suckers often orient themselves in walleye schools and behave as part of it.	Inlet streams or tributaries; rocky shoals in lakes; boulder to coarse gravel substrate; water velocities 0.73-1.5 m/s; mid-April to late May. Spawning occurs at night. Prefer shallow shoreline areas, shoals, riffles, and dam faces with rocky substrate and slow wave action or currents. Shortly after ice break-up, temp between 6-11^{0}C.	Turbid or dark water; slow velocity for juveniles using banks and logs for cover; gravel-cobble substrate; avoiding submerged vegetation. Similar to adults. Preferred cover type- turbid regions, dark waters, logs and banks. Optimum temperature for growth is 22-28^{0}C. Primarily feed on zooplankton, aquatic insects, section varies with juvenile and prey size.	Tolerant of a great range of environmental conditions; most abundant in large, shallow, and turbid lakes; frequent large streams, provided they are deep and turbid enough with ample hiding cover; diet consists of fish and aquatic invertebrates. Preferred substrate is gravel-cobble and avoid submergent vegetation. Optimum temperature for growth between 20-24^{0}C. Primarily feed on fish and secondly on aquatic insects.	Deep pools; minimum DO levels of >6 mg/L.

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
NON-SPORT FISH				
Emerald shiner (*Notropis atherinoides*) EMSH EARLY SPRING/EARLY SUMMER Maximum 3-4 year life span.	Spawns in late spring to early summer (Jun/August). Broadcast spawners and female carries up to 3,000 eggs per spawning season. Eggs hatch in 24-36 hrs.	Aggregate in large schools in inshore waters sometimes near docks, piers and river mouths.	Pools and runs of medium to large rivers with sand or gravel substrates and open waters of lakes; preferred water temperature range 9-23^{0}C. Pelagic feeder, follows rise of plankton to surface at dusk and sinking of plankton at dawn ; move into surface water at night and drop down to deeper water during the day. Schooling species. Along shallow shorelines in autumn, open water during rest of the year. Also eats algae, fish eggs and small juveniles, worms and invertebrates.	Move into deeper water for overwintering.
Flathead chub (*Platygobio gracilis*) FLCH SUMMER Can live as long as 10 yr, sexually mature at ~4 yrs (18 cm).	Likely occurs in the summer; July/ August. May be fractional spawners. Not enough research. Little or no sexual dimorphism. Semi-buoyant eggs afloat until hatching occurs. Newly-hatched fry are weak swimmers, so strong currents are required to keep fry suspended so that they do not settle to the bottom and become buried.	Presumably similar to adult stage.	Found in large rivers with high seasonal silt load. Frequent backwaters or river margins; Turbid, flowing waters of main stem rivers; Riffle and runs. Feeds on a wide variety of organisms, probably by sight and by the gustatory (taste buds) on the barbells; Barbells help. Feed on terrestrial and aquatic insects and occasionally fish. Prefer gravel, sand and clay/silt substrate.	Flathead chub use of refugia in high or low flows or during winter is unknown. Presumably in deeper water with adequate flow. DO is greater than 2.0 mg/L.

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
Flathead chub *(cont'd)*			The importance of terrestrial insects to the diets of flathead chubs is consistent with the fact that the species occurs in turbid waters where low light penetration results in low primary production and hence, a low abundance of aquatic invertebrates.	
Lake chub (*Couesius plumbeus*) LKCH SUMMER Few live more than 5 yrs. Large minnow commonly reaching 102 mm; Largest recorded was 227 mm.	June to mid-August. Migrate from lakes to tributary streams in early spring and spawn when temperatures 14-19^{0}C. No nests, non-adhesive eggs are deposited among cobble and boulder.	Presumably similar to adult stage. Feed on plankton.	Cool water in both lakes and streams, wide range of depths from 15 cm shoals in streams to rocky habitats along lakeshores. Food preference variable but typically insects, zooplankton, and algae; some large LKCH will eat fish. Sight-feeding predator. Instream cover consists of coarse substrate, vegetation, woody debris, submergent and emergent vegetation. Prefers runs, flats and pools in rivers, in lakes prefer <2 m depth.	DO is greater than 1.0 mg/L. Presumably in deeper water.
Longnose dace (*Rhinichthys cataractae*) LNDC SPRING/SUMMER Often associated with LKCH, hybrids have been documented.	May to early August. Riffle areas containing gravel substrate. Males are highly territorial when guarding spawning area. Eggs are expelled, fertilized and deposited between coarse substrate, male expels female from territory.	The young fish live in quiet, shallow water at the edge of rivers or lakes until they are about 4 months old, when they move into faster and deeper water.	Rivers, small creeks and occur in fast flowing streams; Can also occur in lakes over boulder or gravel substrate. Prefer riffle habitat in boulder, cobble, rubble substrate. Feeds on aquatic insects. Prefer instream cover between 25-75% and preferred instream cover is bedrock, boulder, rubble and cobble substrate.	DO is greater than 2.0 mg/L. Presumably in deeper water.

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
Longnose sucker (*Catostomus catostomus*) LNSC SPRING Scales are unreliable to use for aging.	Spawn from late May to early July; Enter spawning stream as soon as temperature exceeds 5^0C. Occurs in shallow, moderately flowing water over a coarse gravel to cobble substrate. The spawning act is repeated numerous times broadcasting small numbers of tiny sticky eggs with each trial. Shallows of streams or areas of lakes; gravel substrate; water depth 0.15-0.28 m. Spawn before white sucker. Move upstream between noon and midnight with the greatest number moving in the evening hours. A female moves from quiet water near shore into group of males near stream centre. 2-4 males crowd around one female, clasping or beating against her with their anal fins and thrashing about. The spawning act last 3-5s and may occur 6-40 times per hour. Male develops large red lateral line during spawning.	Fry remain within gravel for 1-2 weeks then disperse to bottoms of deeper, cooler lakes and clear rivers. Fry feed on zooplankton and diatoms. Often in association with vegetation and sandy substrates.	Adult fish feed primarily on bottom invertebrates such as immature insects, freshwater shrimp, small clams and crustaceans; Plants, algae and detritus.	Presumably occurs in deeper sections of large lakes and rivers.

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
Quillback (*Carpoides cyprinus*) QUIL SPRING	Nothing is known of their spawning habits in Alberta. Elsewhere they migrate into tributary streams; May-July; fine substrate. In Manitoba, spawning occurred over coarse to fine gravel in riffles during high discharge periods and moved to deeper water with sand substrate as water levels declined. Eggs are broadcast over substrate;	Presumably similar to adult stage.	In Alberta, they are found in sluggish and usually turbid river but not in lakes. Benthic feeders; Feed on bottom invertebrates, insects and organic material. Except as noted for spawning, they prefer low water velocities and sand to silt substrate.	Presumably occurs in lakes and large rivers.
River shiner (*Notropis blennius*) RVSH SUMMER	Probably occurs in July and August.	Presumably similar to adult stage.	Found in large streams; sandy and gravel substrates.	Presumably in deeper water with adequate flow.
Spottail shiner (*Notropis blennius*) SPSH SPRING/EARLY SUMMER 4-5 yr lifespan;.	Probably June to August; over sandy shoals. Spawns over sand or gravel at the mouths of streams and rivers, female release up to 3,000 eggs, eggs settle on bottom, no nest or parental care.	Presumably similar to adult stage.	Common in large lakes, rivers and streams; schools found in open water of lakes; feed on plankton, aquatic insects, and bottom fauna. Lakes, rivers and streams with slow to moderate current and sand, gravel, mud or silt substrates; preferred water temperature range 13-22^{0}C.	Presumably in deeper water with adequate flow.
Shorthead redhorse (*Moxostoma macrolepidotum*) SHRD SPRING	Spawning occurs in clear streams, during spring, mostly late May starting at water temperature of 10^{0}C. Migrates out of large bodies of water into smaller rivers or streams to spawn on gravelly riffles.	Presumably similar to adult stage.	Pools, runs and riffles in small to large rivers with sand and gravel substrates, and lake shallows; preferred water temperature range 26-27.5^{0}C. Bottom feeders, sucks up bottom material and straining out invertebrates.	Presumably occurs in lakes and large rivers.

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
Shorthead redhorse *(cont'd)* Intolerant of pollution and siltation; tolerant of high water temperature (37°C); moderately intolerant of turbidity.	Spawning occurs at night or early morning. Males arrive first and establish and defend territories, spawning lasts a few days, no next is built, eggs are scattered and abandoned.			
Silver redhorse (*Moxostoma anisurum*) SLRD SPRING	Spawn in clear, swift water when temperatures reaches 13.3^{0}C. Spawn in the main channel of turbid rivers at water depth of 0.3-0.9 m over gravel to rubble substrate. They apparently do not ascend tributary streams to spawn. Occurs during late spring.	Slow flowing waters; hard or soft bottoms; associated with overhanging banks.	Frequents large rivers, also found in lakes. Feed on invertebrates; small fish and crayfish are seen occasionally in the stomachs of larger fish. In deeper, lower velocity water over finer grained substrates than shorthead redhorse.	Presumably occurs in lakes and large rivers.
Trout-perch (*Percopsis omiscomaycus*) TRPR SPRING Females live as long as 4 years, males 3 years;	Early spring; shallow streams and lake shores. Spawning occurs at night , close to the surface, near the edges of streams or lakes. Several males cluster around and press close to the sides of the female. Eggs and milt are released together. After fertilization, the eggs sink and stick to the bottom or whatever they contact. Eggs hatch in about one week. Large females and most males die after spawning but a few individuals live to spawn twice.	Presumably similar to adult stage.	Deep lakes, slow rivers and shallow streams. Typically in turbid water; diet consists of aquatic insects and crustaceans. Feed at night in the warm shallows and move offshore at daylight.	DO greater than 2.0 mg/L.

Fish Species	Spawning	Rearing (Juvenile)	Holding (Adult)	Overwintering
White sucker (*Catostomus commersoni*) WHSC SPRING Scales are unreliable to use for aging. The position of the sucker's mouth enables it to swim in a sharply pointed downward angle while feeding.	Spawn in spring (early May to early June). Adults migrate from lakes into gravelly streams when steam temperature first reaches 10^0C. Shallow water; occasionally in rapids. Preferred spawning velocity is 30-60 cm/s; they select moderate stream velocities for spawning. Fertilized eggs adhere to gravel in riffles or drift downstream where they adhere to the substrate in areas with water of slow velocities.	Fry emerge 9-11 days after hatching and drift downstream at night. Fry (12 mm) feed on surface plankton and other invertebrates near the surface. At 16-18 mm, when the mouth moves from terminal to ventral, there is a shift to bottom feeding.	Adults are bottom feeders; prefer warm, shallow lakes and tributary rivers of large lakes. Optimum white sucker habitat is assumed to have a pool to riffle ration of 1:1. pH ranges from 5 to 9. Pools and riffles of creeks and rivers, warm shallow lakes and embayments of larger lakes usually at depths of 6-9 m.	Presumably occurs in lakes and large rivers.

Note:
References available upon request.

Appendix C

Site Assessment Data

General Watercourse Survey Data										
Watercourse Name: Red Deer River and Rosebud River		Site: Rosedale		Start: 12U 386753 5697539 End: 12U 387983 5697010						
Date: 30-Oct-21	Site Length (m): 2km	Watercourse Class: Class C		Watercourse RAP: Red Deer River April 16 to June 30 Rosebud River April 16 to July 15						
Chemical Data										
Water Temperature (°C): 2.1	pH: 8.64	Conductivity (µS/cm): 520	Velocity (m/s):-							
Time of Temperature (24h): 17:45	Turbidity: Turbid	Dissolved Oxygen (mg/L): 8.90	Discharge (m^3/s):12.5							
Watercourse Characteristics										
Pattern: Irregular Meandering	Islands: Occasional		Bars: Side and Mid-bars							
Coupling: Partially Coupled	Confinement: Occasionally Confined		Gradient: 1%							
Migration barriers: None										
Transect Information	**Rosebud River**	**Red Deer River**								
Transect	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**Mean**
Easting	386770	386678	387003	387262	387527	387844	388046	388018	388273	-
Northing	5697659	5697986	5697990	5698174	5698054	5697630	5696912	5696524	5696228	-
Watercourse Channel										
Channel width (m) – top of bank	11.0	138	130	115	100	110	123	95	83	111.8
Channel width (m) – 1:2 high water	9.5	125	128	107	88	102	115	78	75	102.3
Wetted width (m)	6.6	115	76.5	86	62	97	76	70	72	81.8
Depth @ 25% width	0.2	0.6	0.9	0.8	0.7	0.5	0.4	0.6	0.5	0.6
Depth @ 50% width	0.4	0.8	1.1	1.1	1.7	0.7	0.5	1.4	0.7	1.0
Depth @ 75% width	0.3	0.7	0.3	1.8	1.3	1.7	0.3	0.7	0.9	1.0
Maximum Depth (m)	0.4	0.9	1.3	2.0	2.0	1.7	0.7	1.6	1.0	1.4
Pool/Riffle/Run/Backwater	0/0/100/0	0/0/95/5	0/5/90/5	0/0/0100/0	0/0/100/0	0/0/100/0	0/10/90/0	0/5/90/5	0/0100/0	0/2.5/95.6/1.9
Ordinary High Water Height (m)	0.8	1.10	1.20	1.20	1.20	1.20	1.1	1.2	1.2	1.2
Left Bank										
Height (m)	3.0	3.3	3.5	7.0	7.0	5.0	2.3	2.7	3.0	4.2
Shape	Sloping	Sloping	Vertical	Vertical	Vertical	Vertical	Vertical	Sloping	Sloping	-
Texture	Fines	Fines	Fines	Fines/Bedrock	Fines/Bedrock	Fines/Bedrock	Fines	Fines/Gravel	Fines	-
Riparian vegetation	G/S	G/S	G/S/D	G	G	G	G/S	G/S	G/S/D	-
Bank Stability	Moderately Unstable	Moderately Stable	Unstable	Stable	Moderately Stable	Moderately Stable	Moderately Unstable	Stable	Stable	-
Right Bank										
Height (m)	3.1	3.0	2.7	3.7	2.5	3.0	2.4	6.0	6.0	3.7
Shape	Sloping	Sloping	Sloping	Vertical	Sloping	Vertical	Vertical	Vertical	Vertical	-
Texture	Fines/Boulders	Fines	Fines/Gravel/Cobble	Fines	Fines	Fines	Fines	Fines/Bedrock	Fines/Bedrock	-
Riparian vegetation	G/S	G/S	G/S	G/S	G/S	G/S	G/S	G	G/S	-
Bank Stability	Moderately Unstable	Moderately Stable	Moderately Stable	Unstable	Moderately Stable	Moderately Unstable	Moderately Unstable	Stable	Stable	-
Bed Material										
Organic materials	0	0	0	0	0	0	0	0	0	0
Fine sediments (<2mm)	94	40	45	40	50	55	55	53	65	50.4
Small gravel (2-16mm)	2	5	15	5	5	0	10	10	5	6.9
Large gravel (18-64mm)	2	10	15	10	10	10	20	20	15	13.8
Small cobble (64-128mm)	2	30	25	30	30	30	15	15	10	23.1
Large cobble (128-256mm)	0	15	0	15	5	5	0	0	0	5.0
Boulder (>256mm)	0	0	0	0	0	0	0	2	5	0.9
Bedrock	0	0	0	0	0	0	0	0	0	0
Substrate Embeddedness	High	Moderate	Moderate	Moderate	High	High	High	High	High	-

Watercourse Cover Data (%)	Total Cover:30	Crown Closure: None	
Undercut bank: 0	Large woody debris: 1	Surface turbulence: 1	Instream Vegetation: 1
Small woody debris: 1	Boulder: 6	Overhanging vegetation: 0	Depth of the watercourse: 35
Turbidity:55	Other: None		

Habitat Evaluation	Small-Bodied Forage Fish	Large-Bodied Forage Fish	Sport Fish (BURB GOLD LKST, MOON, NRPK, WALL, SAUG)
Rearing	Important	Important	Important
Holding	Important	Important	Important
Spawning	Important	Marginal	Important
Overwintering	Important	Important	Important
Overall Habitat Rating	Important	Important	Important

Fisheries Potential	
Fish Bearing Potential	Yes
Documented Fish Species	Burbot, ,Emerald Shiner, Flathead Chub, Goldeye, Lake Chub, Lake Sturgeon, Longnose Dace, Longnose Sucker, Mooneye, Northern Pike, Prussian Carp, Quillback, River Shiner, Sauger, Shorthead Redhorse Sucker, Silver Redhorse Sucker, Spottail Shiner, Trout Perch, Walleye, White Sucker, are present in the Red Deer River within 20km of the Project location.

Notes:
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types, W= wetland
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable
Substrate Embeddedness: UE = Unembedded, L = Low, M = Moderate, H = High, N/A = Not Applicable
Sport fish: BURB= Burbot, GOLD = Goldeye, LKST = Lake Sturgeon, MOON = Mooneye, NRPK = Northern Pike, WALL=Walleye, SAUG = Sauger

CLIENT: Town of Drumheller	**DATE: 11 November 2020**
PROJECT: Drumheller Flood Resiliency and Flood Mitigation Program	**JOB No.: CW2384**
SUMMARY OF PHYSICAL AND CHEMICAL DATA - ROSEDALE - RED DEER AND ROSEBUD RIVERS	**FIGURE C-1.0**

Photo 1: View upstream from Transect 1 on the Rosebud River.30 October 2020.

Photo 2: View downstream from Transect 1 on the Rosebud River.30 October 2020.

Photo 3: View of the Rosebud River showing the shallow run habitat and fine substrate .30 October 2020.

Photo 4: View downstream of the confluence of the Rosebud River and the Red Deer River showing the shallow run habitat. 30 October 2020.

Photo 5: View upstream from the confluence of the Rosebud River and the Red Deer River. 30 October 2020.

Photo 6: View downstream from the confluence of the Rosebud River and the Red Deer River from the shallow sandbar. 30 October 2020.

CLIENT: Town of Drumheller	**DATE: 11 November 2020**
PROJECT: Drumheller Flood Mitigation Rosedale – Rosebud River	**JOB No.: CW2384**
PHOTO DOCUMENTATION	**FIGURE C-1.1**

Photo 7: View downstream from transect 2 on the Red Deer River showing the Roper Road Bridge and the confluence with the Rosebud River. 30 October 2020.

Photo 8: View downstream from transect 3 on the Red Deer River. 30 October 2020.

Photo 9: View upstream from transect 5 on the Red Deer River. 30 October 2020.

Photo 10: View upstream showing the gravel and cobble bar between transect 6 and 7 and the riffle and shallow run habitat

Photo 11: View of the right downstream bank and gravel bar at transect 7 on the Red Deer River. 30 October 2020

Photo 12: View upstream from transect 9 on the Red Deer River. 30 October 2020.

CLIENT: Town of Drumheller	**DATE: 11 November 2020**
PROJECT: Drumheller Flood Mitigation Rosedale – Red Deer River	**JOB No.: CW2384**
PHOTO DOCUMENTATION	**FIGURE C-1.2**

General Watercourse Survey Data								
Watercourse Name: Red Deer River		Site: Cambria		Start: 12U 389161 5695752 End:12U 389610 5694578				
Date: 30-Oct-21	Site Length (m): 2km	Watercourse Class: Class C		Watercourse RAP: Red Deer River April 16 to June 30				
Chemical Data								
Water Temperature (°C): 2.1	pH: 8.64	Conductivity (µS/cm): 520	Velocity (m/s):-					
Time of Temperature (24h): 17:45	Turbidity: Turbid	Dissolved Oxygen (mg/L): 8.90	Discharge (m^3/s):12.5					
Watercourse Characteristics								
Pattern: Irregular Meandering	Islands: Occasional		Bars: Side and Mid-bars					
Coupling: Partially Coupled	Confinement: Occasionally Confined		Gradient: 1%					
Migration barriers: None								
Transect Information								
Transect	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**Mean**
Easting	389199	389320	389382	389538	389880	390389	390941	-
Northing	5695704	5695325	5694956	5694770	569440	5694092	5693874	-
Watercourse Channel								
Channel width (m) – top of bank	80	92	127	105	100	105	98	101.0
Channel width (m) – 1:2 high water	72	74	105	97	84	95	86	87.6
Wetted width (m)	55	64	87	88	75	82	73	74.9
Depth @ 25% width	1.5	1.5	0.5	1.3	2.2	0.6	0.4	1.1
Depth @ 50% width	1.7	2.0	1.0	0.8	1.3	0.3	1.3	1.2
Depth @ 75% width	1.4	1.8	0.6	0.6	0.8	1.0	1.2	1.1
Maximum Depth (m)	1.9	2.0	1.0	1.3	2.2	1.0	1.4	1.5
Pool/Riffle/Run/Backwater	0/0/95/5	0/0/95/5	0/0/98/2	0/0/0100/0	0/0/100/0	0/0/100/0	0/0/100/0	0/0/98.3/1.7
Ordinary High Water Height (m)	1.2	1.3	1.3	1.1	1.4	1.2	1.1	1.2
Left Bank								
Height (m)	10	1.9	3.0	3.2	4.2	3.0	3.1	4.1
Shape	Vertical	Sloping	Sloping	Sloping	Sloping	Sloping	Sloping	-
Texture	Bedrock	Fines	Fines	Fines	Fines	Fines	Fines	-
Riparian vegetation	G	G/S	G/S/D	G/S/D	G/S/D	G/S	G/S	-
Bank Stability	Stable	Stable	Stable	Stable	Stable	Stable	Stable	-
Right Bank								
Height (m)	3.0	5.1	5.0	4.3	8.0	3.0	2.5	4.4
Shape	Sloping	Sloping	Sloping	Sloping	Sloping	Sloping	Sloping	-
Texture	Fines	Fines	Fines	Fines	Fines/Bedrock	Fines	Fines	-
Riparian vegetation	G/S	G/S	G/S/D	G/S	G	G/S	G/S	-
Bank Stability	Stable	Moderately Stable	Moderately Unstable	Stable	Stable	Stable	Stable	-
Bed Material								
Organic materials	0	0	0	0	0	0	0	0
Fine sediments (<2mm)	50	50	45	45	40	50	40	45.7
Small gravel (2-16mm)	5	5	5	5	5	5	5	5.0
Large gravel (18-64mm)	5	5	10	10	20	15	20	12.1
Small cobble (64-128mm)	25	25	25	25	20	25	20	23.6
Large cobble (128-256mm)	15	15	15	15	15	5	15	13.6
Boulder (>256mm)	0	0	0	0	0	0	0	0
Bedrock	0	0	0	0	0	0	0	0
Substrate Embeddedness	High	High	Moderate	Moderate	Moderate	High	Moderate	-

Watercourse Cover Data (%)	Total Cover:30	Crown Closure: None	
Undercut bank: 0	Large woody debris: 1	Surface turbulence: 1	Instream Vegetation: 2
Small woody debris: 1	Boulder: 5	Overhanging vegetation: 0	Depth of the watercourse: 35
Turbidity:55	Other: None		

Habitat Evaluation	Small-Bodied Forage Fish	Large-Bodied Forage Fish	Sport Fish (BURB GOLD LKST, MOON, NRPK, WALL, SAUG)
Rearing	Important	Important	Important
Holding	Important	Important	Important
Spawning	Important	Marginal	Important
Overwintering	Important	Important	Important
Overall Habitat Rating	Important	Important	Important

Fisheries Potential	
Fish Bearing Potential	Yes
Documented Fish Species	Burbot, ,Emerald Shiner, Flathead Chub, Goldeye, Lake Chub, Lake Sturgeon, Longnose Dace, Longnose Sucker, Mooneye, Northern Pike, Prussian Carp, Quillback, River Shiner, Sauger, Shorthead Redhorse Sucker, Silver Redhorse Sucker, Spottail Shiner, Trout Perch, Walleye, White Sucker, are present in the Red Deer River within 20km of the Project location.

Notes:
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types, W= wetland
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable
Substrate Embeddedness: UE = Unembedded, L = Low, M = Moderate, H = High, N/A = Not Applicable
Sport fish: BURB= Burbot, GOLD = Goldeye, LKST = Lake Sturgeon, MOON = Mooneye, NRPK = Northern Pike, WALL=Walleye, SAUG = sauger

CLIENT: Town of Drumheller	**DATE: 11 November 2020**
PROJECT: Drumheller Flood Resiliency and Flood Mitigation Program	**JOB No.: CW2384**
SUMMARY OF PHYSICAL AND CHEMICAL DATA - CAMBRIA - RED DEER RIVER	**FIGURE C-2.0**

Photo 1: View upstream from Transect 1 on the Red Deer River.30 October 2020.

Photo 2: View upstream showing the bridge piers located between Transect 1 and Transect 2 on the Red Deer River. 30 October 2020.

Photo 3: View upstream from Transect 2 on the Red Deer River showing the Highway 10 bridge. 30 October 2020.

Photo 4: View of the west bank at Transect 3 from the middle of the Red Deer River. 30 October 2020.

Photo 5: View of the west bank at Transect 4 from the middle of the Red Deer River. 30 October 2020.

Photo 6: View downstream from Transect 6 on the Red Deer River. 30 October 2020.

CLIENT: Town of Drumheller	**DATE: 11 November 2020**
PROJECT: Drumheller Flood Mitigation Cambria – Red Deer River	**JOB No.: CW2384**
PHOTO DOCUMENTATION	**FIGURE C-2.1**

General Watercourse Survey Data							
Watercourse Name: Red Deer River		Site: Lehigh		Start: 12U 394081 5690868 End:12U 394852 5689913			
Date: 31-Oct-21	Site Length (m): 2km	Watercourse Class: Class C		Watercourse RAP: Red Deer River April 16 to June 30			
Chemical Data							
Water Temperature (°C): 1.9	pH: 8.62	Conductivity (µS/cm): 515	Velocity (m/s):-				
Time of Temperature (24h): 14:15	Turbidity: Turbid	Dissolved Oxygen (mg/L): 8.98	Discharge (m^3/s): 12.5				
Watercourse Characteristics							
Pattern: Irregular Meandering	Islands: Occasional		Bars: Side and Mid-bars				
Coupling: Partially Coupled	Confinement: Occasionally Confined		Gradient: 1%				
Migration barriers: None							
Transect Information							
Transect	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**Mean**
Easting	395095	394932	394657	394230	393967	394107	-
Northing	5689380	5689741	5690100	5690149	5690646	5691087	-
Watercourse Channel							
Channel width (m) – top of bank	101	102	95	138	109	96	106.8
Channel width (m) – 1:2 high water	90	88	85	130	105	92	98.3
Wetted width (m)	87	79	78	127	97	78	91.0
Depth @ 25% width	1.5	0.6	1.3	1.0	1.4	0.6	1.1
Depth @ 50% width	1.1	1.0	1.0	0.8	0.8	1.6	1.1
Depth @ 75% width	1.2	1.9	1.4	0.3	0.8	2.1	1.3
Maximum Depth (m)	1.5	1.9	2.0	1.0	1.5	2.1	1.7
Pool/Riffle/Run/Backwater	0/0/100/0	0/0/100/0	0/0/100/0	0/5/95/0	0/0/100/0	0/0/100/0	0/0.8/99.2/0
Ordinary High Water Height (m)	1.0	1.1	1.3	1.2	1.4	1.4	1.2
Left Bank							
Height (m)	3.5	10	10	2.5	4.1	7.0	6.2
Shape	Sloping	Sloping	Sloping	Sloping	Sloping	Vertical	-
Texture	Fines	Fines/Cobble/Boulder	Fines/Cobble/Boulder	Fines	Fines/Gravel	Fines	-
Riparian vegetation	G/S	G/S	G/S	G/S/D	G/S	G	-
Bank Stability	Moderately Unstable	Stable	Stable	Moderately Stable	Moderately Unstable	Unstable	-
Right Bank							
Height (m)	3.2	2.0	3.3	4.0	5.2	2.0	3.3
Shape	Vertical	Vertical	Vertical	Sloping	Sloping	Sloping	-
Texture	Fines	Fines	Fines	Fines	Fines	Fines	-
Riparian vegetation	G/S	G/S	G/S	G/S	G/S	G/S	-
Bank Stability	Unstable	Unstable	Unstable	Moderately Unstable	Moderately Stable	Stable	-
Bed Material							
Organic materials	0	0	0	0	0	0	0
Fine sediments (<2mm)	55	30	30	45	55	55	45.0
Small gravel (2-16mm)	5	5	5	20	5	5	7.5
Large gravel (18-64mm)	15	10	10	25	15	15	15.0
Small cobble (64-128mm)	20	30	30	5	25	25	22.5
Large cobble (128-256mm)	5	20	20	5	0	0	8.3
Boulder (>256mm)	0	5	5	0	0	0	1.7
Bedrock	0	0	0	0	0	0	0
Substrate Embeddedness	High	Moderate	Moderate	Moderate	High	High	-
Watercourse Cover Data (%)		**Total Cover:30**	**Crown Closure: None**				
Undercut bank: 0	Large woody debris: 1		Surface turbulence: 1			Instream Vegetation: 2	
Small woody debris: 1	Boulder: 5		Overhanging vegetation: 0			Depth of the watercourse: 35	
Turbidity:55	Other: None						

Habitat Evaluation	Small-Bodied Forage Fish	Large-Bodied Forage Fish	Sport Fish (BURB GOLD LKST, MOON, NRPK, WALL, SAUG)
Rearing	Important	Important	Important
Holding	Important	Important	Important
Spawning	Important	Marginal	Important
Overwintering	Important	Important	Important
Overall Habitat Rating	Important	Important	Important

Fisheries Potential	
Fish Bearing Potential	Yes
Documented Fish Species	Burbot, ,Emerald Shiner, Flathead Chub, Goldeye, Lake Chub, Lake Sturgeon, Longnose Dace, Longnose Sucker, Mooneye, Northern Pike, Prussian Carp, Quillback, River Shiner, Sauger, Shorthead Redhorse Sucker, Silver Redhorse Sucker, Spottail Shiner, Trout Perch, Walleye, White Sucker, are present in the Red Deer River within 20km of the Project location.

Notes:
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types, W= wetland
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable
Substrate Embeddedness: UE = Unembedded, L = Low, M = Moderate, H = High, N/A = Not Applicable
Sport fish: BURB= Burbot, GOLD = Goldeye, LKST = Lake Sturgeon, MOON = Mooneye, NRPK = Northern Pike, WALL=Walleye, SAUG = Sauger

CLIENT: Town of Drumheller	**DATE: 11 November 2020**
PROJECT: Drumheller Flood Resiliency and Flood Mitigation Program	**JOB No.: CW2384**
SUMMARY OF PHYSICAL AND CHEMICAL DATA - LEHIGH - RED DEER RIVER	**FIGURE C-3.0**

Photo 1: View upstream from Transect 6 on the Red Deer River. 31 October 2020.

Photo 2: View of the East bank at Transect 5 from the Red Deer River. 31 October 2020.

Photo 3: View downstream from Transect 4 on the Red Deer River showing the gravel and cobble bars and the shallow run and riffle habitat. 31 October 2020.

Photo 4: View upstream from Transect 3 on the Red Deer River. 31 October 2020.

Photo 5: View downstream from Transect 3 on the Red Deer River. 31 October 2020.

Photo 6: View upstream from Transect 1 on the Red Deer River. 31 October 2020.

CLIENT: Town of Drumheller	**DATE: 11 November 2020**
PROJECT: Drumheller Flood Mitigation Lehigh – Red Deer River	**JOB No.: CW2384**
PHOTO DOCUMENTATION	**FIGURE C-3.1**

General Watercourse Survey Data			
Watercourse Name: Red Deer River		Site: East Coulee	Start: 12U 395278 5689149 End: 12U 397085 5687757
Date: 31-Oct-21	Site Length (m): 2km	Watercourse Class: Class C	Watercourse RAP: April 16 to June 30

Chemical Data			
Water Temperature (°C): 1.9	pH: 8.62	Conductivity (µS/cm): 515	Velocity (m/s):-
Time of Temperature (24h): 14:15	Turbidity: Turbid	Dissolved Oxygen (mg/L): 8.98	Discharge (m^3/s):12.5

Watercourse Characteristics		
Pattern: Irregular Meandering	Islands: Occasional	Bars: Side and Mid-bars
Coupling: Partially Coupled	Confinement: Occasionally Confined	Gradient: 1%
Migration barriers: None		

Transect Information										
Transect	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**Mean**
Easting	395209	395373	395537	395884	396208	396758	397279	397781	398263	-
Northing	5689174	5688849	5688530	5688294	5688004	5687772	5687617	5687392	5687095	-
Watercourse Channel										
Channel width (m) – top of bank	105	160	126	110	157	120	108	128	160	130.4
Channel width (m) – 1:2 high water	100	156	116	101	143	106	100	111	145	119.8
Wetted width (m)	96	140	103	96	134	98	66	102	140	108.3
Depth @ 25% width	1.1	0.3	0.4	1.4	0.4	1.1	0.5	0.5	0.6	0.7
Depth @ 50% width	0.9	0.2	0.5	1.1	0.1	1.4	0.6	0.9	0.7	0.7
Depth @ 75% width	0.6	0.4	0.3	0.6	0.6	0.5	0.7	1.4	0.8	0.7
Maximum Depth (m)	1.3	0.4	0.5	1.9	0.7	1.6	0.7	1.4	0.8	1.0
Pool/Riffle/Run/Backwater	0/2/98/0	0/2/98/0	0/0/98/2	0/0/100/0	0/0/100/0	0/0/100/0	0/0/100/0	0/0/100/0	0/0/100/0	0/0.4/99.6/0
Ordinary High Water Height (m)	0.9	1.3	1.5	1.4	1.6	1.6	0.9	1.5	1.4	1.3
Left Bank										
Height (m)	3.4	6.0	4.2	4.0	4.1	1.3	1.9	11.0	4.0	4.4
Shape	Sloping	Sloping	Sloping	Sloping	Vertical	Sloping	Sloping	Sloping	Sloping	-
Texture	Fines	Fines/Gravel/Cobble	Fines	Fines	Fines	Fines	Fines	Fines/Cobble/Bedrock	Fines	-
Riparian vegetation	G/S/D	G/S	G/S	G/S	G/S	G/S	G/S	G/S	G/S	-
Bank Stability	Moderately Unstable	Moderately Stable	Stable	Moderately Stable	Unstable	Moderately Stable	Stable	Moderately Stable	Stable	-
Right Bank										
Height (m)	4.0	2.0	3.7	6.0	1.9	4.0	2.2	3.0	3.0	3.3
Shape	Sloping	Sloping	Sloping	Sloping	Vertical	Vertical	Vertical	Sloping	Sloping	-
Texture	Fines	Fines	Fines	Fines	Fines	Fines	Fines/Gravel/Cobble	Fines	Fines	-
Riparian vegetation	G/S/D	G/S	G/S	G/S	G/S	G/S	G/S/D	G/S	G/S	-
Bank Stability	Moderately Unstable	Moderately Unstable	Moderately Stable	Unstable	Stable	Unstable	Unstable	Moderately Unstable	Moderately Stable	-
Bed Material										
Organic materials	0	0	0	0	0	0	0	0	0	0
Fine sediments (<2mm)	50	30	30	40	75	50	50	45	45	46.1
Small gravel (2-16mm)	5	5	5	5	15	5	10	5	15	7.8
Large gravel (18-64mm)	15	10	10	20	5	15	20	10	15	13.3
Small cobble (64-128mm)	20	30	30	20	5	20	15	30	25	21.7
Large cobble (128-256mm)	10	25	25	10	0	10	5	10	0	10.6
Boulder (>256mm)	0	5	5	5	0	0	0	0	0	1.7
Bedrock	0	0	0	0	0	0	0	0	0	0
Substrate Embeddedness	High	Moderate	Moderate	Moderate	High	High	High	Moderate	Moderate	-

Watercourse Cover Data (%)	Total Cover:35	Crown Closure: None	
Undercut bank: 0	Large woody debris: 2	Surface turbulence: 1	Instream Vegetation: 1
Small woody debris: 2	Boulder: 4	Overhanging vegetation: 0	Depth of the watercourse: 40
Turbidity:50	Other: None		

Habitat Evaluation	Small-Bodied Forage Fish	Large-Bodied Forage Fish	Sport Fish (BURB GOLD LKST, MOON, NRPK, WALL, SAUG)
Rearing	Important	Important	Important
Holding	Important	Important	Important
Spawning	Important	Marginal	Important
Overwintering	Important	Important	Important
Overall Habitat Rating	Important	Important	Important

Fisheries Potential	
Fish Bearing Potential	Yes
Documented Fish Species	Burbot, ,Emerald Shiner, Flathead Chub, Goldeye, Lake Chub, Lake Sturgeon, Longnose Dace, Longnose Sucker, Mooneye, Northern Pike, Prussian Carp, Quillback, River Shiner, Sauger, Shorthead Redhorse Sucker, Silver Redhorse Sucker, Spottail Shiner, Trout Perch, Walleye, White Sucker, are present in the Red Deer River within 20km of the Project location.

Notes:
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types, W= wetland
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable
Substrate Embeddedness: UE = Unembedded, L = Low, M = Moderate, H = High, N/A = Not Applicable
Sport fish: BURB= Burbot, GOLD = Goldeye, LKST = Lake Sturgeon, MOON = Mooneye, NRPK = Northern Pike, WALL=Walleye, SAUG = Sauger

CLIENT: Town of Drumheller	**DATE: 11 November 2020**
PROJECT: Drumheller Flood Resiliency and Flood Mitigation Program	**JOB No.: CW2384**
SUMMARY OF PHYSICAL AND CHEMICAL DATA - EAST COULEE - RED DEER RIVER	**FIGURE C-4.0**

Photo 1: View upstream from Transect 2 on the Red Deer River. 31 October 2020.

Photo 2: View of the East bank at Transect 2 from the middle of the Red Deer River. 31 October 2020.

Photo 3: View upstream from Transect 4 on the Red Deer River showing the gravel and cobble bars and the shallow run and riffle habitat. 31 October 2020.

Photo 4: View of the closed wooden bridge downstream of Transect 5 and the east bank from the middle of the Red Deer River. 31 October 2020.

Photo 5: View downstream from Transect 6 showing the Highway 10 bridge on the Red Deer River. 31 October 2020.

Photo 6: View downstream from Transect 8 showing the armored East bank and Highway 570. 31 October 2020.

CLIENT: Town of Drumheller	**DATE: 11 November 2020**
PROJECT: Drumheller Flood Mitigation East Coulee – Red Deer River	**JOB No.: CW2384**
PHOTO DOCUMENTATION	**FIGURE C-4.1**

Appendix D

Fish Habitat Maps

R19 W4

T28

Projection: NAD 1983 UTM Zone 12N
QA/QC: HB MK RF
Sources: AB TPR, Centre for Cadastral Management, Geomatics Canada, DRFM (High Resolution 2019 Aerial Imagery, Orthophoto 2019)
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DRUMHELLER RESILIENCY AND FLOOD MITIGATION OFFICE

Drumheller Resiliency and Flood Mitigation Program

Red Deer River and Rosebud River Fish Habitat Map Rosedale

0 100 200
Metres
1:8,000

N

wood.

January 2021

Figure D-1

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R19

W4

T28

5695000

28500 m
28400 m
28300 m
28200 m
28100 m
28000 m
27900 m
27800 m
27700 m
27600 m
27500 m
27400 m
27300 m
27200 m
27100 m
27000 m
26900 m
26800 m
26700 m
26600 m
26500 m
26400 m
26300 m
26200 m
26100 m
26000 m
25900 m
25800 m
25700 m
25600 m
25500 m
25400 m
25300 m
25200 m

T1
T2
T3
T4
T5

C2
R1
E5
R3
R2
BW
D1
A3

Cambria

Red Deer River

849
10

Bank Type
Transect Marker
R1 Highest Quality Run Habitat
R2 Moderate Quality Run Habitat
R3 Low Quality Run Habitat
BW Backwater Habitat
A# Armoured Bank
C# Canyon Bank
D# Depositional Bank
E# Erosional Bank
Large Woody Debris
Small Woody Debris
Bridge Pier
Gravel/Cobble Bar
Sand Bar
Flow Direction
Highway
River Stationing

Projection: NAD 1983 UTM Zone 12N
QA/QC: HB MK RF
Sources: AB TPR, Centre for Cadastral Management, Geomatics Canada, DRFM (High Resolution 2019 Aerial Imagery, Orthophoto 2019)
- Contains information licensed under the Open Government licence – Alberta, Canada.

DRUMHELLER RESILIENCY AND FLOOD MITIGATION OFFICE

Drumheller Resiliency and Flood Mitigation Program

Red Deer River Fish Habitat Map Cambria

0 70 140
Metres
1:7,000

N

wood.

January 2021

Figure D-2

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R18

W4

T28

T27

5690000

Lehigh

Red Deer River

Bank Type
Transect Marker
R1 Highest Quality Run Habitat
R2 Moderate Quality Run Habitat
R3 Low Quality Run Habitat
RF Riffle Habitat
A# Armoured Bank
C# Canyon Bank
D# Depositional Bank
E# Erosional Bank
Large Woody Debris
Small Woody Debris
Beaver Lodge
Gravel/Cobble Bar
Sand Bar
Flow Direction
Highway
River Stationing

Projection: NAD 1983 UTM Zone 12N
QA/QC: HB MK RF
Sources: AB TPR, Centre for Cadastral Management, Geomatics Canada, DRFM (High Resolution 2019 Aerial Imagery, Orthophoto 2019)
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DRUMHELLER RESILIENCY AND FLOOD MITIGATION OFFICE

Drumheller Resiliency and Flood Mitigation Program

Red Deer River Fish Habitat Map Lehigh

0 80 160
Metres
1:7,000

N

wood.

January 2021

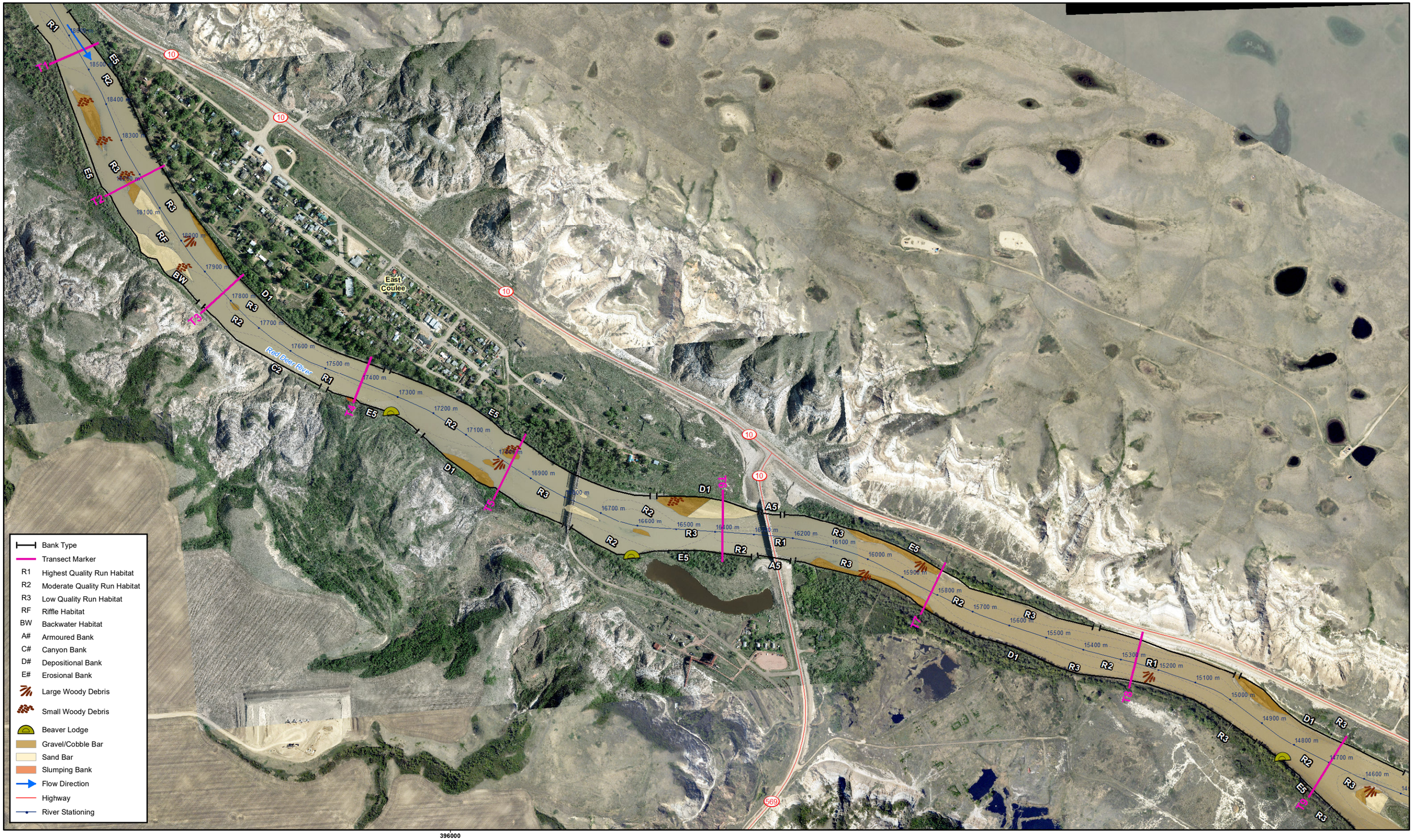
Figure D-3

S:\Gis\Projects\CW2384_Drumheller_FloodMitigation\ArcGIS\01_Fisheries\Fig D-3 Lehigh.mxd ANALYST: helen.brandreth 21-01-06 1:56:13 PM

R18

W4

T27



S:\Gis\Projects\CW\2384_Drumheller_FloodMitigation\ArcGIS\01_Fisheries\Fig D-4 East Coulee.mxd ANALYST: helen.brandreth 21-01-06 1:17:07 PM

Projection: NAD 1983 UTM Zone 12N
QA/QC: HB MK RF
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DRUMHELLER RESILIENCY AND FLOOD MITIGATION OFFICE

Drumheller Resiliency and Flood Mitigation Program

Red Deer River Fish Habitat Map East Coulee

0 100 200 Metres 1:9,000

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wood.

January 2021

Figure D-4

Appendix E

DFO Measures to Avoid Causing Harm

The following mitigation measures have been adapted from DFO's *Measures to Protect Fish and Fish Habitat* (DFO 2019a).

Prevent the Death of Fish

- Avoid killing fish by means other than fishing;
- Avoid using explosives in or near water; and
- Plan instream work, undertakings or activities to respect provincial timing windows.

Maintain Riparian Vegetation

- Maintain an undisturbed vegetated buffer zone between areas of on-land activity and the high-water mark of any water body;
- Use existing trails, roads or cut lines wherever possible;
- Avoid unnecessary tree removal; and
- Use swamp mats or pads to prevent soil compaction.

Carry Out Works, Undertakings and Activities on Land

- Avoid conducting any work, undertaking or activities in water;
- Place fill or other temporary or permanent structures above the high-water mark;
- Use temporary or established vehicle crossings to avoid fording of the watercourse;
- Avoid disturbing or removing materials from the banks, shoreline or waterbody bed; and
- Avoid building structures in areas that may result in erosion or scouring of the watercourse bed/ banks, and in areas that are inherently unstable (e.g., bends, meanders, floodplains, alluvial fans or braided reaches).

Maintain Fish Passage

- Maintain fish passage by avoiding changes to water levels or flows; and
- Avoid obstructing or interfering with the movements or migrations of fish.

Ensure Proper Sediment Control

- Avoid introducing sediment and deleterious substances into the water;
- Develop and implement an erosion and sediment control (ESC) plan that includes:
- The installation of effective ESC measures to stabilize erodible areas and prevent erosion of exposed soils;
- Regular inspection and maintenance of installed measures over all phases of the project;
- Maintenance of ESC measures until all disturbed areas have been permanently stabilized;
- The installation of settling basins or using a filtration system for water flowing onto the site and water being diverted or pumped from the from the site. This should include the retention of runoff water to allow sediment settling before release. If dewatering is required, it should be done gradually to prevent sediment resuspension and/or bank destabilization;

- Dispose of and stabilize any excavated material above the high-water mark of any nearby waterbodies to prevent sediment re-entry;
- Monitor weather forecasts or advisories to avoid scheduling work within wet, windy and rainy periods that may result in higher flow volumes and/or increased erosion and sedimentation risk;
- Regularly monitor the watercourse for signs of sedimentation and take corrective actions as required;
- Use biodegradable ESC materials whenever possible and remove non-biodegradable controls once the site has stabilized;
- Operate machinery on land and in stable, dry areas;
- Contain sediment-laden water to prevent dispersal into adjacent watercourses;
- If watercourse crossings are required, install clear span structures that can accommodate expected high water flows and do not impact the bed or banks of the watercourse; and
- Limit impacts to stream or shoreline banks.

Prevent Entry of Deleterious Substances in Water

- Avoid depositing any deleterious substance in the watercourse;
- Develop a response plan to be implemented in the event of a spill or accidental release;
- Keep an emergency spill kit on-site;
- If a release occurs, stop work and contain the spill to prevent dispersal;
- Report any spills of sewage, oil, fuel or other deleterious material that occur near or directly into a waterbody;
- Ensure clean-up efforts are suitably applied and do not result in further alteration of the bed and/or banks of the watercourse;
- Dispose of clean-up materials and contaminated materials in the appropriate manner;
- Plan activities near water so that deleterious material and chemicals (e.g., grout, paint, primers, degreasers, solvents, concrete, blasting abrasives, etc.) do not enter the watercourse;
- Ensure all machinery is clean and free of fluid leaks to prevent the release of deleterious substances;
- Wash, refuel and service machinery in a way that prevents the potential release of deleterious substances;
- Dispose all waste materials (including construction, demolition, excavation, and logging debris) above the high-water mark to prevent entry into nearby watercourses; and
- Ensure that building materials used in a watercourse are handled and treated in a manner that prevents the release or leaching of substances that may be deleterious to fish.

Appendix F

Alberta Transportation's Special Provision – Turbidity

Special Provision - Turbidity

1. DEFINITIONS

Instream Construction Activity	Any planned instream construction activity below the high water mark that has the potential to result in additional turbidity in the watercourse. This would include the installation and removal of isolation measures (i.e., cofferdams, berms, silt curtains, etc.), placing of riprap in the water, bank excavation, etc.
Isolated Construction Activity	Any planned construction activity that occurs when working in-stream within a stable site isolation measure (i.e., coffer dams, berms, silt curtains, etc.).
Site Isolation	The placement, erecting or installation of a system whose function is to assure sediment produced from construction activities is contained to the isolated work site.
Visually Conspicuous Plume	A plume of suspended solids that can be visually observed in the watercourse.
Accidental Occurrence	Any situation, beyond the Contractor's control, that results in elevated turbidity levels in excess of the specified compliance limits. This would include situations like the unexpected breaching of a cofferdam due to flood conditions exceeding the design levels.

2. SAMPLING AND TESTING

The Contractor is responsible for all sampling and testing of Total Suspended Solids (TSS) as specified herein.

Prior to the start of Construction, the Contractor shall determine the normally occurring linear relationship between Total Suspended Solids (TSS) and turbidity in the watercourse as per the *Conversion Relationship between Nephelometric Turbidity Units (NTU) into mg/L for Alberta Transportations' Turbidity Specification*.

- *http://www.transportation.alberta.ca/Content/docType245/Production/The%20conversion%20of%20Nephelometric%20Turbidity%20Units.pdf*

Laboratory results and the linear relationship will be sent to the Consultant for review prior to initiating the program. During construction, the Contractor shall:

- Measure suspended solids in NTU accurate to within 2% of the calibration solution of the equipment;

- Convert NTU into mg/L to establish the relationship specific to the site; and

- Measure upstream and downstream NTU levels within a maximum period of 30 minutes of each other, or as directed by the Department, unless there is a sediment release (see monitoring frequency below).

The Consultant shall be afforded full access to facilities for random quality assurance inspection. The results of the Consultant's quality assurance testing will serve to monitor the Contractor's quality control program.

3. SAMPLING FREQUENCY

Sampling shall occur from 30 minutes prior to daily construction activities until 30 minutes after construction activities have been completed. All sampling information shall be compiled in a daily report. The frequency of total suspended solid sampling by the Contractor shall be in accordance with the following:

Table 1 Sampling Frequency

Site Condition	Sampling Frequency
Instream Construction Activities and Accidental Occurrences	• During construction hours, sample at a minimum of once every hour at all compliance transects. • If an exceedance or plume is observed, sampling shall be done within the plume until TSS levels have returned to acceptable background levels for two consecutive sampling events. • No sampling events shall occur during Accidental Occurrences until it is safe to do so.
Isolated Construction Activities	• When the Contractor is working within site isolation samples will be taken at all transects at three hour intervals, during construction hours. • If sample results have not exceeded 5 mg/L above background levels for five consecutive active construction days, the sample frequency may be reduced to a minimum of twice per day, as directed by the Consultant.

4. COMPLIANCE MONITORING

Compliance monitoring is dependent on the type of the watercourse. There are five types of watercourses:

- Systems such as lakes, reservoirs and wetlands where velocities are less than 0.5 m/s;
- Watercourses where the wetted width is less than 3 m;
- Watercourses where the wetted width is between 3 m and 10 m;
- Watercourses where the wetted width is between 10 m and 50 m, and
- Watercourses where the wetted width is greater than 50 m.

Table 2 summarizes the compliance monitoring locations for each watercourse. For watercourses water depth less than 1 m, one measurement will be taken at 50% of the depth for each sample point along the transect. For watercourses greater than 1 m deep, two (2) measurements will be taken at 20% and 80% of water depth at each sample point along the transect and the results averaged.

Table 2 Compliance Monitoring Locations

Watercourse Type	Number of Transects	Sample Points Along Transect
Systems such as lakes, reservoirs and wetlands where velocities are less than 0.5 m/s.	Transect 1: the lesser of 5 m, or the maximum surface dimension of the waterbody.	5 m intervals around the circumference of the turbidity barrier.
	Transect 2: 20 m from Transect 1 (dependent on the size of the waterbody.	
	Transect 3: 20 m from Transect 2 (dependent on the size of the waterbody.	
Wetted width <= 3 m	Background: upstream of the work area	50% of wetted width at each transect
	Transect 1: 1 stream width from work area	
	Transect 2: 2 stream widths from work area	
	Transect 3: 3 stream widths from work area	
Wetted width > 3 m and <=10 m	Background: upstream of the work area	33% and 67% of wetted width at each transect
	Transect 1: 1 stream width from work area	
	Transect 2: 2 stream widths from work area	
	Transect 3: 3 stream widths from work area	
Wetted width > 10 m and <=50 m	Background: upstream of the work area	25%, 50%, and 75% of wetted width at each transect
	Transect 1: 30 m downstream from work area	
	Transect 2: 60 m downstream from work area	
	Transect 3: 90 m downstream from work area	
Wetted width greater than 50 m	Background: upstream of the work area	25%, 50%, and 75% of wetted width transect
	Transect 1: 50 m downstream from work area	
	Transect 2: 125 m downstream from work area	
	Transect 3: 225 m downstream from work area	

5. VISUAL PLUME MONITORING

In the event that a visually conspicuous plume is observed, the Contractor shall immediately cease all Work, undertake mitigation measures, contact the Consultant, and promptly initiate a plume TSS monitoring program in accordance with the following:

- All Work that may have a direct or indirect effect on water quality will cease during all plume occurrences.

- A sample must be taken from the middle of the plume and as close to the source of the plume as possible (within safety limits).

- Monitoring will be done at all transects, and the plume sampling point, as often as feasible (a minimum of an hourly basis), and will continue until two consecutive monitoring events show no compliance exceedances.

6. COMPLIANCE CRITERIA

Criteria are set by the current versions of the Environmental Quality Guidelines for Alberta Surface Waters, which are based on the Canadian Council of Ministers of the Environment.

Following completion of each TSS monitoring event, the Contractor will know if the construction activities are within compliance limits as defined below in Table 3. This will be accomplished as follows:

- The results for each of the upstream sample points will be averaged to determine a background TSS (mg/L) for each event.

- The average TSS concentration (mg/L) shall be calculated for each of the downstream transects (cross sections). The average value for each transect will be compared to the background TSS concentration (mg/L). If the result for any transect exceeds the limits in Table 3, the project is not in compliance. The average value for any transect is calculated as the arithmetic average of the sample points in that transect.

- Any differences will be compared with the TSS Compliance Criteria to determine if the construction works (i.e. isolated or instream construction activities) are within compliance.

The Contractor's operations shall utilize equipment, labour, and procedures that ensure that the levels of suspended solids are maintained below the following levels:

Table 3 Maximum Allowable Increase of Total Suspended Solids

Site Conditions (Background TSS)	Exceedance Levels (TSS in Excess of Normal Background Levels)
TSS < 25 mg/L	• A maximum instantaneous increase of 25 mg/L over background levels at any time. • An average increase of >5 mg/L over background levels for greater than 24 hours.
TSS 25 mg/L – 250 mg/L	• A maximum instantaneous increase of 25 mg/L from background levels at any time.
TSS > 250mg/L	• Maximum instantaneous increases of 10% of background levels at any time.

The Contractor shall notify the Consultant at least 48 hours (2 calendar days) prior to the start of any Instream Construction Activity.

In the event of a measurement is over the Exceedance Levels listed in Table 3, or an Accidental Occurrence that results in a visually conspicuous plume of sediment, the Contractor shall cease all Work that may have a direct or indirect impact on water quality and immediately initiate mitigation actions. The Contractor shall immediately notify the Consultant and call the Alberta Energy and Environment Response line at 1-800-222-6514.

If an exceedance occurs during Isolated Construction Activity and a reduced sampling program is in effect, the sampling frequency must be reset to the requirements, as listed in Table 1, where the sampling frequency is to return to three hour intervals during construction hours.

7. RECORD KEEPING

A detailed record of the sampling completed for the TSS monitoring program during Instream Construction Activity and Isolated Construction Activity shall be kept by the Contractor and reported to the Consultant in a weekly summary format. The Contractor shall ensure that daily sampling records are up-to-date and kept onsite at all times during the period in which the monitoring program is in effect. Upon completion of the Construction Activities, the Contractor shall also forward a final report containing all sampling and testing data to the Consultant. The weekly summary report shall include at a minimum:

- Brief description of the works and types of construction activities completed during the sampling period.

- Date and time of each sample.
- Weather conditions at the time of each sample.
- Changes of depth of flow at the upstream transect.
- Documentation of daily NTU instrument calibrations.
- Both turbidity (NTU) and TSS (mg/L) for each sample taken.
- The daily average value (mg/L TSS) of the upstream background samples.
- The daily average value (mg/L TSS) for each downstream transect (all three sites per transect combined).
- Documentation of all non-compliance instances, including the level of exceedance, the duration of exceedance, the mitigation measures taken, verification of the reporting of the exceedance and any related communications with regulators regarding the exceedance event, and future measures to be taken to avoid or control further exceedances.
- Description of events or circumstances that may have prevented or hindered completion of the TSS monitoring program.

PAYMENT

- Payment for sampling, testing and reporting of TSS for Instream Construction Activity and Isolated Construction Activity will be made at the unit price bid per day for 'Total Suspended Solids (TSS) Testing', for each day that testing is mandated. Payment will be full compensation for all testing as required to establish the linear relationship between TSS and NTU as well as for each 24 hr. period; including labour, equipment, tools and incidentals necessary to complete the work to the satisfaction of the Consultant.
- All costs associated with sampling, testing and reporting of TSS associated with Accidental Occurrences will be considered incidental to the Work, and no separate or additional payment will be made.