Fall Riverine Habitat Inventory of the Red Deer & Rosebud Rivers in 08/09/10/11-29-20 W4M and 20/29-28-19 W4M

Resiliency and Flood Mitigation Program

Submitted to:

Drumheller Resiliency and Flood Mitigation Office
Drumheller, Alberta

SweetTech Engineering Consultants
Calgary, Alberta

Submitted by:

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Calgary, Alberta

FINAL
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1 INTRODUCTION

1.1 Project Overview

The Town of Drumheller has developed a Resiliency and Flood Mitigation Program (RFMP) to mitigate flooding along the Red Deer and Rosebud Rivers. Riverine habitat inventories were completed next to three sections proposed for mitigation works. These were: Nacmine, Northern Drumheller, and Wayne Valley (Figure 1). The Town of Drumheller has chosen to construct or, upgrade existing dikes and river bank erosion structures, and armour banks along the Red Deer and Rosebud rivers to protect the town‘s infrastructure from further bank sloughing associated with floods. Bank stabilization and flood protection works are planned for 2021.

Applied Aquatic Research Ltd. (AAR) was retained by SweetTech Engineering Consultants (SweetTech) to determine whether any adverse effects would be experienced by aquatic resources within either river as a consequence of instream construction. This included completion of a fall riverine habitat inventory next to each affected section of channel, potential effects of instream construction on fishes and their habitat, appropriate mitigation measures to protect aquatic resources within the Red Deer and Rosebud Rivers. In addition, AAR will prepare and submit all necessary regulatory approvals and notifications before the start of construction.

1.2 Regulatory Requirements

1.2.1 Fisheries Act

Fisheries and Oceans Canada (DFO), through the *Fisheries Act*, is the federal authority responsible for protecting all fishes and their habitat. Criteria to protect fishes and their habitat are presented in the ‘Projects near Water’ and ‘Measures to Avoid Causing Harm to Fish and Fish Habitat’ guidelines (DFO 2019a, b). Projects that could trigger harmful alteration, disruption, or destruction (HADD) of fish habitat, or do not meet the criteria of the guidelines must be reviewed by DFO. Regardless of whether a project undergoes review by DFO, best management practices during construction must be followed to avoid HADD to fishes and their habitat. If a project is deemed by DFO to have the potential to cause HADD then authorization under the *Fisheries Act* is required prior to the commencement of construction.

1.2.2 Water Act

Provincially, the project is regulated by the Alberta *Water Act.* Approval under the *Water* Act is required to perform flood mitigation along the Red Deer and Rosebud Rivers. At present, *Water Act* approval takes on average 6-8 months to obtain. Under the *Water Act*, the Red Deer River is a Class C watercourse, with a restricted activity period (RAP) for works instream from April 16 to June 30. The Rosebud River is also a Class C watercourse and has a RAP for instream works from April 16 to July 15. The RAP takes into account periods during which instream activities are considered high risk for resident fish populations, and protects the most sensitive developmental stages of spring- and fall-spawning fishes present in the area (GOA 2016a).

1.2.3 Navigable Protection Act

The Navigation Protection Program (NPP) division of Transport Canada (TC) administers and enforces the federal Navigation Protection Act (NPA). Transport Canada protects the public right of navigation in scheduled navigable waters, and regulatory approval is required for works that pose a substantial risk of interference with navigation. As per the Request for Proposal (RFP), navigable water approval is required. This may take up 6 months to review (GOC 2020a). If flood mitigation along the Red Deer and Rosebud River banks meets the criteria to be deemed a “Minor Works” under the *Minor Works and Waters Order*, approval and public notice may not be required (GOC 2020a).

SWEETTECH ENGINEERING CONSULTANTS

AAR Environmental Services

DRUMHELLER
RESILIENCY AND FLOOD MITIGATION OFFICE

FALL RIVERINE HABITAT INVENTORY

North

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20.2311.009
JAN. 8, 2021

REFERENCE:
1. AERIAL IMAGE RETRIEVED FROM BING

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SCALE NOTATIONS INDICATED ARE BASED ON AN ISO A1 DRAWING FORMAT

THIS DRAWING IS PREPARED FOR THE SOLE USE OF THE TOWN OF DRUMHELLER
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FIG.1 MAP OF PROPOSED FLOOD MITIGATION

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2 APPROACH

2.1 Riverine and Bankside Habitat Inventory

On October 20, 2020, a biologist and field assistant completed a fall riverine habitat inventory within two sections of the Red Deer River (Nacmine and Northern Drumheller) and one section of the Rosebud River (Wayne Valley) (Figure 1). Fish habitat potential and riverine habitat parameters were qualified and quantified within the mitigation footprint. The section of channel investigated encompassed the predicted zone-of-influence (ZOI) of the flood mitigation works (bank armouring, upgrading erosion control, dike construction etc.), defined as "the area of the water body where 90% of the sediment discharged as a result of the [instream] works will be deposited" (GOA 2016b). The extent of this zone depends on various parameters, which include channel gradient, width, depth, morphology (shape and roughness), water velocity, discharge, presence of hydraulic controls, or the abundance of instream vegetation.

Physical parameters including channel and wetted widths, water depth, bank height, shape, and stability, plus substrate composition/embeddedness were quantified throughout each section. Substrate was classified into 6 categories using a modified Wentworth particle scale (fines <2 mm, small gravel 2–16 mm, large gravel 17-64 mm, cobble 64–256 mm, boulder >256 mm, and bedrock [Orth 1983]). Discharge was measured using a Price AA current meter and top-setting wading rod. Water temperature, conductivity, pH, and dissolved oxygen concentration were measured *in situ* with a YSI Professional Plus Quattro™ multiparameter meter.

Watercourse and riparian vegetation characteristics that affect fish habitat potential were described within each section. These include instream and overhead cover, type and composition. When present, limiting factors or unique features (*e.g.,* ground water intrusion or appreciable bank erosion) were mapped, photographed, and described. Habitat units throughout each sections were identified, described, and counted where discernible. Fish habitat was rated as high, moderate, or low according to its potential to support spawning, rearing, overwintering, and migration of resident fishes. A photographic record of the watercourse was compiled and is appended (Appendix A).

2.2 Fish Population Inventory

A desktop review of riverine habitat and fish capture records for the Red Deer and Rosebud Rivers were conducted using the Fisheries and Wildlife Management Information System (FWMIS) database (Alberta Environment and Parks [AEP] 2020a). In addition, AAR's past riverine habitat and fish population inventories were consulted from their in-house library. Given availability of data and information regarding fish presence in the Rosebud and Red Deer Rivers, electrofishing was not completed. Rather, the river sections were traversed with a jet boat and assessed for fish habitat including areas of deposition and erosion and other parameters such as depth, riverbed substrate, and potential overwintering habitat.

3 RESULTS

3.1 Red Deer River

3.1.1 Channel Characteristics

The Red Deer River runs west to east and traverses all five of Alberta's major ecoregions (Alberta Parks 2015). It originates in the headwaters of the Rocky Mountains and flows into the South Saskatchewan River. Proposed flood mitigation works in the Red Deer River comprise two sections; Nacmine and Northern Drumheller, which span 2.3 and 1.4 km of bank, respectively. The river has a moderate gradient (<1%), flows regularly and is confined by the river valley in these locations.

3.1.1.1 Nacmine

Water clarity was low-moderate given preliminary stages of ice formation and presence of frazil ice throughout the water column. Water was cold (0.6°C), with high conductivity (439.7 μS/cm), slightly basic pH (7.98), and DO was saturated. Discharge was 28.16 m^3/s at Drumheller, measured at the Highway 9 Bridge (AEP 2020b). These water quality parameters can support a variety of cool water fish species year-round.

Through the section investigated, average water depth was 1.0 m, with a maximum of 2.6 m (Plates 1 and 2). Depths were visibly shallower at the upstream extent of the reach. Bank stability varied from high to low and were sloped to vertical in shape. The left bank in this reach is located along an outside meander. Along the left bank flow was faster and deeper and sections of erosion were observed. Slightly undercut, sloping banks in combination with gravel bars were common in this location (Plate 3). Flow along the right bank was slow, shallow, and predominantly depositional (Plate 4). Substrate was primarily fines however gravel/cobble bars were interspersed throughout. Six pools, deep enough to support overwintering habitat (≥1.5m) were observed. Pool habitat units were most common throughout the left side of the channel; one located downstream of a snye. A deep run unit (1.3-1.7 m depth), spanning approximately 300 m was observed along the left channel (Figure 2). Minimal instream vegetation was identified throughout this reach.

3.1.1.2 Northern Drumheller

Average water depth at this location was 0.8 m ranging from 0.45 to 2.5 m. Sheet ice along the surface of the river and frazil ice within the water column were present (Plate 5). Water was cold (1.5°C), with high specific conductivity (442.4 μS/cm), alkaline pH (9.59), and saturated DO. Discharge was 30.99 m^3/s (AEP 2020b).

Substrate throughout the reach investigated consisted predominantly of fines with and patches of embedded gravel, cobble, and boulder throughout. The left bank was primarily sloping, vegetated and depositional; however, sections of erosion are present upstream (Plate 6). A large gravel bar along the right bank is present at the upstream extent of the reach (downstream of the Newcastle Boat Launch) (Plate 7). The right bank transitions from sloping to vertical moving downstream. Previous stabilization works and placement of Class I and II rip-rap was observed along the right bank upstream of the Highway 9 Bridge (Plate 8). Within the ZOI are five pools that varied in depth from 1.5 to 2.5 m. Multiple gravel bars along both banks were observed at the downstream extent of the Drumheller section. A long riffle unit spans the river under the bridge followed by a deep pool (>2 m) downstream along the right bank. The left side of the channel is shallow (< 0.3 m) and gravel, cobble and boulder with varying degrees of embeddedness comprise substrate downstream from the bridge (Figure 3).

Michichi Creek

Michichi Creek flows south from the Michichi Reservoir before eventually draining into the Red Deer River, about 500 m upstream from the Highway 9 Bridge (Plate 9). The reach investigated comprised 380 m of channel from the confluence of the Red Deer River. Substrate of Michichi Creek consisted almost entirely of fines (95%) with small amounts of gravel present (Plate 10). Rip-rap was observed along outside bends of Michichi Creek from previous erosion protection works. Banks were sloped and vegetated with willows (Plate 11). Average channel and wetted widths were 3.2 and 5.1 m, respectively. The channel throughout was shallow: from 0.04 to 0.12 cm deep. A weir was observed at the upstream extent of the reach, which has since been used as a beaver dam (Plate 12). The height of the beaver dam is 2 m and currently acts as a barrier to fish migration upstream. Groundwater intrusion along both banks was identified and aquatic vegetation was present throughout.

Chemistry parameters were not measured in Michichi Creek given insufficient depth, high sediment load and ice cover. Although not measured, a visual discharge inspection was completed and approximated at 0.001-0.003 m^3/s. According to Alberta Rivers (Michichi Creek at Drumheller) stream gauge, flow totalled 0.00125 m^3/s at the time of the assessment (AEP 2020b).

SWEETTECH ENGINEERING CONSULTANTS

AAR Environmental Services*

DRUMHELLER RESILIENCY AND FLOOD MITIGATION OFFICE

FALL RIVERINE HABITAT INVENTORY

North

1:3000

20.2311.009

JAN. 8, 2021

REFERENCE:

1. AERIAL IMAGE FROM 2019 (PROVIDED BY DRUMHELLER RESILIENCY AND FLOOD MITIGATION OFFICE)

LEGEND:

DEPOSITIONAL ENVIRONMENT[1] –

EROSIONAL ENVIRONMENT[2] –

POOLS[3] –

MODEL CROSS SECTION –

DEFINITIONS:

1. DEPOSITIONAL ENVIRONMENT: A SECTION OF CHANNEL WHERE MATERIAL/SEDIMENT BEING TRANSPORTED IS DEPOSITED.
2. EROSIONAL ENVIRONMENT: A SECTION OF CHANNEL WHERE THE RIVER BED AND/OR BANKS ARE ERODING.
3. POOLS: A PORTION OF THE CHANNEL WITH ABOVE AVERAGE WATER DEPTHS AND BELOW AVERAGE VELOCITIES
4. SNYE: A SIDE POOL WHICH ENTERS A STREAM AT IT'S DOWNSTREAM END.

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SCALE:1:3,000 METRES

SCALE NOTATIONS INDICATED ARE BASED ON AN ISO A1 DRAWING FORMAT

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FIG.2 RED DEER RIVER HABITAT UNITS

FALL RIVERINE HABITAT INVENTORY

North

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FIG.3 RED DEER RIVER & MICHICHI CRK. HABITAT UNITS

REFERENCE:

1. AERIAL IMAGE FROM 2019 (PROVIDED BY DRUMHELLER RESILIENCY AND FLOOD MITIGATION OFFICE)

LEGEND:

- DEPOSITIONAL ENVIRONMENT[1] —
- EROSIONAL ENVIRONMENT[2] —
- POOLS[3] —
- RIFFLE[4] —
- MODEL CROSS SECTION —

DEFINITIONS:

1. DEPOSITIONAL ENVIRONMENT: A SECTION OF CHANNEL WHERE MATERIAL/SEDIMENT BEING TRANSPORTED IS DEPOSITED.
2. EROSIONAL ENVIRONMENT: A SECTION OF CHANNEL WHERE THE RIVER BED AND/OR BANKS ARE ERODING.
3. POOLS: A PORTION OF THE CHANNEL WITH ABOVE AVERAGE WATER DEPTHS AND BELOW AVERAGE VELOCITIES
4. RIFFLE: A PORTION OF THE CHANNEL WITH HIGH VELOCITIES THAT ARE RELATIVELY SHALLOW AND TURBULENT

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M:\Projects\20.2311.009_1 Fish\CADD\Drawing Set\1_ST-REPORT FIGS\FIG-202311009_1-FISH.dwg, FIG.3, 2021/01/08 03:02 pm User

3.1.2 Fish Presence

According to FWMIS, the Red Deer River supports 37 species of cold and cool water fishes (Table 1). Of these, Bull Trout, Rainbow Trout, Sauger, and Lake Sturgeon are species of management concern. Spoonhead Sculpin are currently listed as “May be at Risk” under the Alberta Wild Species General Status Listing (AEP 2017).

Bull Trout are listed as a “Threatened” species in Alberta, under the Alberta Wildlife Act (AEP 2014). Bull trout populations are most commonly found within the Rocky Mountain and Dry Mixedwood subregions. Historically, their range in the Red Deer River extended as far downstream as the Highway 27 Bridge, approximately 10 km west of Morrin, Alberta (ACA and AEP 2009). Their current range is predominantly confined to areas west of Red Deer and it is highly unlikely that Bull trout populations will be encountered during instream construction.

Athabasca strain Rainbow Trout are listed as “Endangered” under Schedule 1 of the Species at Risk Act (SARA) and “At Risk” under the Alberta Wild Species General Status listing (GOC 2019, AEP 2017). Most Rainbow Trout populations are found in small, cold headwater streams within the Athabasca drainage (COSEWIC 2014). No Rainbow Trout have been captured within 5 km of the mitigation footprint and most Rainbows captured in the Red Deer River are non-native, Montana-strained trout.

Sauger reside in large, turbid rivers and migrate from wintering habitat to smaller tributaries in late May to early June for spawning. Sauger are broadcast spawners, laying eggs over areas of unembedded gravel and will typically start to spawn when water temperatures reach between 3.9 and 6.1°C at night (Joynt and Sullivan 2003). Females will typically be flanked by one or more males before releasing up to 40 000 eggs which, once fertilized, will settle into the gravel substrate and hatch after a 25 to 29 day incubation period (Scott and Crossman 1973).

Lake Sturgeon have been captured within 5km of the project footprint and are currently listed as “Threatened” under the Alberta Wildlife Act and “At Risk” under the Alberta Wild Species General Status Listing (AEP 2014, 2017) (Table 1). Populations of Lake Sturgeon have declined and are currently at or below critical sustainability levels, in large part to habitat fragmentation, degradation, and over-harvesting. Lake Sturgeon live in both the North and South Saskatchewan River systems and require clean, deep rivers with adequate flow and enough depth to over-winter (AEP 2014). Adult Lake Sturgeon prefer deep pools (4-7m) within the channel thalweg for feeding and wintering habitat, with slow flow and silt/rock substrate (SRD 2002; ESRD 2011). Typically they do not move between feeding and wintering sites apart from migrating for spawning activities, demonstrating clumped distribution within suitable pools (ESRD 2011).

The RAP of the Red Deer River is from April 16 to June 30 to protect spring spawning fishes that may reside within the watercourse. Spring spawning sport fish species captured within 5 km of the proposed Red Deer River mitigation footprints include, Goldeye, Mooneye, Northern Pike, Burbot, Walleye, and Sauger. Forage fish, including, Emerald Shiner, Lake Chub, Longnose Dace, Pearl Dace, Longnose Sucker, Quillback, Trout-Perch, White Sucker, Shorthead Redhorse, Silver Redhorse, and Prussian Carp have also been captured in close proximity to the mitigation footprints and are also spring spawners.

Table 1: List of fishes reported from the Red Deer River and their presence near sites of flood mitigation (AEP 2020).

Common Name	Scientific Name[1]	Captured within 5 km of site	Spawning Timing[4]	Approximate Hatching Timing[4]	Status
Brook Trout	*Thymallus arcticus*	**No**	Sep-Nov	Feb-Jun	Exotic/alien[3]
Bull Trout x Brook Trout Hybrid	*Culaea inconstans*	**No**	May-Jul	Jun-Aug	Secure[2]
Bull Trout	*Salvelinus confluentus*	**No**	Feb-Mar	Mar-Apr	Threatened[2], At Risk[3]

Common Name	Scientific Name[1]	Captured within 5 km of site	Spawning Timing[4]	Approximate Hatching Timing[4]	Status
Brown Trout	*Salmo Trutta*	**No**	Oct-Dec	Mar-Apr	Exotic/alien[3]
Brook Stickleback	*Culaea inconstans*	**No**	May-July	May-Aug	Secure[3]
Burbot	*Lota*	**Yes**	Feb-Mar	Mar-Apr	Secure[2]
Cutthroat Trout	*Oncorhynchus clarki*	**No**	May-Jun	June-Aug	At Risk[3]
Emerald Shiner	*Notropis atherinoides*	**Yes**	Jun-Aug	June-Aug	Secure[2]
Flathead Chub	*Platygobio gracilis*	**Yes**	Jul-Aug	Jul-Aug	Secure[2]
Finescale Dace	*Phoxinus neogaeus*	**No**	Jun-Jul	Jun-Aug	Undetermined[3]
Goldeye	*Hiodon alosoides*	**Yes**	May-Jul	May-Aug	Secure[2]
Lake Chub	*Couesius plumbeus*	**Yes**	Apr–Aug	Apr-Sep	Secure[2]
Lake Sturgeon	*Acipenser fulvescens*	**Yes**	Apr-Jun	Apr-Jun	Threatened[2], At Risk[3]
Lake Whitefish	*Coregonus clupeaformis*	**Yes**	Sep-Nov	Apr-May	Secure[2]
Longnose Dace	*Rhinichthys cataractae*	**Yes**	May–Aug	May-Aug	Secure[2]
Longnose Sucker	*Catostomus*	**Yes**	May–Jul	May-Jul	Secure[2]
Mountain Sucker	*Catostomus platyrhynchus*	**No**	Jun-Jul	Jun-Aug	Secure[3]
Mountain Whitefish	*Prosopium williamsoni*	**Yes**	Sep-Nov	Mar-Apr	Secure[2]
Mooneye	*Hiodon tergisus*	**Yes**	Apr-Jun	Apr-Jul	Secure[2]
Northern Pike	*Esox Lucius*	**Yes**	Mar-Apr	Mar-Apr	Secure[2]
Prussian Carp	*Carassius gibelio*	**Yes**	Apr-Aug	Unknown	Exotic/alien[3]
Pearl Dace	*Margariscus margarita*	**Yes**	May-Jun	Jun-Jul	Secure[2]
Quillback	*Carpiodes cyprinus*	**Yes**	May-Jul	May-Aug	Undetermined[3]
Rainbow Trout	*Oncorhynchus mykiss*	**No**	Apr-Jun	Jul-Sep	At Risk[3], Endangered[5]
River Shiner	*Notropis blennius*	**Yes**	Jul-Aug	Jul-Sep	Undetermined[3]
Sauger	*Sander canadense*	**Yes**	May-Jun	Jun-Jul	Sensitive[2]
Shorthead Redhorse	*Moxostoma macrolepidotum*	**Yes**	May-Jun	May-Jun	Secure[3]
Silver Redhorse	*Moxostoma anisurum*	**Yes**	May-Jun	May-Jun	Undetermined[3]
Slimy Sculpin	*Cottus cognatus*	**No**	May-Jun	Jun-Jul	Secure[3]
Spoonhead Sculpin	*Cottus ricei*	**No**	Aug-Sep	Sep-Oct	May Be at Risk[3]
Spottail Shiner	*Notropis hudsonius*	**No**	Jun-Jul	Jun-Aug	Secure[3]
Trout-perch	*Percopsis omiscomaycus*	**Yes**	May-Aug	May-Aug	Secure[2]
Walleye	*Sander vitreus*	**Yes**	Apr-May	Apr-Jun	Secure[2]
White Sucker	*C. commersoni*	**Yes**	May–Jul	May-Jul	Secure[2]
Yellow Perch	*Perca flavescens*	**No**	Mar-May	Mar-June	Secure[2]

Notes:

1. Scientific nomenclature of fishes follows Nelson and Paetz (1992)
2. Species listed under the *Wildlife Act* (AEP 2014)
3. Alberta Wild Species General Status Listing (AEP 2017)
4. Fish of Alberta (Joynt and Sullivan 2003)
5. Species listed under Schedule 1 of the Species at Risk Act (GOC 2019)

3.1.3 Riverine Habitat Inventory

Fish habitat investigated throughout the Nacmine and Northern Drumheller sections was diverse. Habitat was dominated by long run units, interspersed by short riffle and pool sections. From Red Deer to Drumheller, the river has a shallow gradient of 0.8 m/km, resulting in slower flow, increased sediment deposition and warmer water (AENR 1981). As such it is cool water habitat and consequently all salmonids are absent from the river through and downstream from the City of Drumheller (Table 1).

3.1.3.1 Nacmine

Pools throughout the ZOI were associated with outside meander bends and had sufficient depth to support fishes over-winter (1.5 m to 2.6 m). Presence of deep run units were also observed, potentially acting as migration corridors between overwintering pools. Substrate in every pool investigated consisted primarily of fine substrate, with little to no presence of gravel and cobble. The thalweg followed the left bank closely along a straight section flowing east. Fish cover is moderate given presence of deep pool units combined with long, deep run units; however, turbulence is minimal, lack of large substrate and instream vegetation was negligible reducing the value of cover for fishes at bankside.

Multiple sand bars and areas of erosion are common along the left bank of the Red Deer River in this reach. Most of the right channel was shallower (0.5 m), flowing slower, and predominantly depositional. This section provides moderate habitat for resident fishes. It provides summer feeding and nursery habitat for all, along with early and late winter potential for larger sport fishes. Spawning habitat was low-moderate given high proportion of fine substrate, with minimal gravel, cobble, boulder, and instream vegetation present.

3.1.3.2 Northern Drumheller

Channel depth throughout the Northern Drumheller section was slightly shallower than the upstream Nacmine section and less pools were observed. The thalweg transitions from the left bank to the right bank along a meandering, east flowing section of the river. Turbulence is also present in a riffle unit beneath the Highway 9 Bridge, offering an additional source of cover. Instream vegetation was minimal and only assessed along the right bank, just upstream of the Highway 9 bridge.

Similar to the Nacmine section, substrate was almost entirely fines with the exception of gravel, cobble, and boulder presence within riffle sections. Although the channel is shallow in this reach, multiple pools exceeding depths suitable to support overwintering habitat were present, the deepest located downstream of the riffle unit beneath the Highway 9 Bridge. Spawning habitat was moderate in this reach, given the greater diversity of habitat units.

Spawning and wintering habitat for Lake Sturgeon in the Nacmine and Northern Drumheller sections of the Red Deer River is low-moderate, given relatively shallow depths in both pools and thalweg.

Michichi Creek

At the confluence with the Red Deer River, Michichi Creek flows very slowly and has an average depth of 10 cm. A large beaver dam (originally a dike structure), impeding fish migration upstream was observed 380 m upstream from the confluence with the Red Deer River. The only pool observed was a beaver pond located downstream of the dam. Although Brook Stickleback, Finescale Dace, Fathead Minnow, Lake Chub, and Prussian Carp have been captured in Michichi Creek (AEP 2020a), it is likely these species inhabit and overwinter in the Red Deer River, or other larger tributaries, and enter the creek in the spring during peak discharges.

Water quality in this creek is very poor, as a result of high sediment load, and low discharge contributing to low dissolved oxygen levels. Spawning habitat in this creek is rated as low given lack of large substrate, low flows, and minimal depths, especially in the winter.

3.2 Rosebud River

3.2.1 Channel Characteristics

The Rosebud River originates in the Parklands Subregion of west-central Alberta and drains into the Red Deer River, southeast of Drumheller. Proposed flood mitigation works in the Rosebud River span 1.2 km throughout the winding Wayne Valley. The river has a gentle gradient (1%), flows in a meandering pattern, and is confined by the river valley towards its confluence with the Red Deer River.

Through the section investigated, water depth averaged 0.32 m. Depth was uniform, however deeper run sections and pools were also observed. Water clarity was low as a result of a thin layer of ice along the surface of the river. Water was cold (1.2°C), conductivity high (1080 μS/cm), alkaline pH (8.11), and saturated DO. Discharge measured manually totalled 0.30 m^3/s which greatly differed from the Alberta Rivers stream gauge (Rosebud River at Redland) measurement of 0.68 m^3/s (AEP 2020b). The Government of Canada (GOC) has an ice warning attached to their hydrometric station data and ice formation may cause an overestimation of flow using their rating curve system (GOC 2020b).

Substrate at the upstream extent of the reach consisted predominantly of fines, however gravel, cobble, and boulder were present near the bridge (Plate 13). Slopes were vertical to sloping in shape and bank erosion was present throughout, displayed by undercut and sloughing banks (Plates 14 and 15). Channel width ranged from 8-12 m and consisted of a long run unit, combined with short riffle units and gravel bars (Plate 16). Long, relatively deep runs and pools were assessed (1-1.5m) as these sections are most likely to provide overwintering habitat for fish species. The right side of the channel was shallower, flowing slower, and consisted mostly of fine riverbed substrate.

3.2.2 Fish Presence

According to FWMIS, the Rosebud River supports 18 species of cold and cool water fishes (AEP 2020, Table 2). All fish species present in the Rosebud River are also found in the Red Deer River with the exception of Fathead Minnow. The only species of management concern in the Rosebud River is Sauger, which is listed as "Sensitive" under the Alberta Wild Species General Status (AEP 2017).

Table 2: List of fishes reported from the Rosebud River and their presence near sites of flood mitigation (AEP 2020).

Common Name	Scientific Name[1]	Captured within 5 km of site	Spawning Timing[4]	Approximate Hatching Timing[4]	Status
Brook Stickleback	*Culaea inconstans*	**No**	May-July	May-Aug	Secure[3]
Burbot	*Lota lota*	**Yes[6]**	Feb-Mar	Mar-Apr	Secure[2]
Flathead Chub	*Platygobio gracilis*	**Yes**	Jul-Aug	Jul-Aug	Secure[2]
Fathead Minnow	*Pimephales promelas*	**No**	Apr-Aug	Apr-Sep	Secure[3]
Goldeye	*Hiodon alosoides*	**Yes**	May-Jul	May-Aug	Secure[2]
Lake Chub	*Couesius plumbeus*	**Yes[6]**	Apr–Aug	Apr-Sep	Secure[2]
Longnose Dace	*Rhinichthys cataractae*	**Yes[6]**	May–Aug	May-Aug	Secure[2]
Longnose Sucker	*Catostomus*	**Yes**	May–Jul	May-Jul	Secure[2]
Mountain Whitefish	*Prosopium williamsoni*	**Yes[6]**	Sep-Nov	Mar-Apr	Secure[2]
Northern Pike	*Esox Lucius*	**Yes[6]**	Mar-Apr	Mar-Apr	Secure[2]
Prussian Carp	*Carassius gibelio*	**Yes[6]**	Apr-Aug	Unknown	Exotic/alien[3]
Pearl Dace	*Margariscus margarita*	**Yes[6]**	May-Jun	Jun-Jul	Secure[2]
Quillback	*Carpiodes cyprinus*	**Yes**	May-Jul	May-Aug	Undetermined[3]
Sauger	*Sander canadense*	**Yes**	May-Jun	Jun-Jul	Sensitive[3]
Shorthead Redhorse	*Moxostoma macrolepidotum*	**Yes**	May-Jun	May-Jun	Secure[3]
Spottail Shiner	*Notropis hudsonius*	**No**	Jun-Jul	Jun-Aug	Secure[3]
Walleye	*Sander vitreus*	**Yes**	Apr-May	Apr-Jun	Secure[2]
White Sucker	*C. commersoni*	**Yes**	May–Jul	May-Jul	Secure[2]

Notes:

1. Scientific nomenclature of fishes follows Nelson and Paetz (1992)
2. Species listed under the *Wildlife Act* (AEP 2014)
3. Alberta Wild Species General Status Listing (AEP 2017)
4. Fish of Alberta (Joynt and Sullivan 2003)
5. Species listed under Schedule 1 of the Species at Risk Act (GOC 2019)
6. Captured in the Red Deer River (AEP 2020a)

FALL RIVERINE HABITAT INVENTORY

North

1:2000
20.2311.009
JAN. 8, 2021

REFERENCE:

1. AERIAL IMAGE FROM 2019 (PROVIDED BY DRUMHELLER RESILIENCY AND FLOOD MITIGATION OFFICE)

LEGEND:

DEPOSITIONAL ENVIRONMENT –
EROSIONAL ENVIRONMENT –
POOLS –
MODEL CROSS SECTION –

DEFINITIONS:

1. DEPOSITIONAL ENVIRONMENT: A SECTION OF CHANNEL WHERE MATERIAL/SEDIMENT BEING TRANSPORTED IS DEPOSITED.
2. EROSIONAL ENVIRONMENT: A SECTION OF CHANNEL WHERE THE RIVER BED AND/OR BANKS ARE ERODING.
3. POOLS: A PORTION OF THE CHANNEL WITH ABOVE AVERAGE WATER DEPTHS AND BELOW AVERAGE VELOCITIES

50 0 50
SCALE:1:2,000 METRES

SCALE NOTATIONS INDICATED ARE BASED ON AN ISO A1 DRAWING FORMAT

FIG.4 ROSEBUD RIVER HABITAT UNITS

3.2.3 Riverine Habitat Inventory

The section of the Rosebud River investigated is located approximately 870 m upstream of its confluence with the Red Deer River. No visible barriers to fish migration were observed in this reach implying potential for fish species in the Red Deer River to migrate up the river. A school of approximately 30 young-of-the-year (YOY) fish were seen swimming along the shallow left bank of the river, just west of the downstream bridge. A larger fish (species unknown) was also spotted in this location, verifying fish inhabit this specific reach of the river.

Water quality in the Rosebud River is sufficient to support cool water fishes, potentially year round. Spawning habitat is rated as moderate, given presence of gravel and cobble, instream vegetation and sufficient flow necessary for broadcast spawners. The Rosebud River provides potential spawning habitat for Sauger and Mountain Whitefish. Both species broadcast their eggs within fast flowing, moderately deep (up to 2m+) sections of rivers and smaller tributaries (Joynt and Sullivan 2003). It is possible that Mountain Whitefish and Sauger use this portion of the Rosebud River for spawning as deep, fast flowing sections with unembedded substrate were observed within the footprint.

4 DISCUSSION

4.1 Effect of Construction on Fishes and Their Habitat

Scheduling for construction has not been released. Works may potentially occur during the Red Deer and Rosebud River RAPs. Should an inadvertent release of sediment enter a watercourse, it has the potential to cause harm to fishes and their habitat within overwintering pools downstream by affecting their behavior directly and by altering streambed habitat (CCME 2002). Fishes that have moved into winter habitat within and downstream of the construction footprint could be vulnerable to displacement. Additionally, any sediment mobilized from the flood mitigation activities could compromise potential gravel and cobble spawning habitat downstream by filling interstitial spaces and impairing its suitability for spring and/or fall spawning fishes.

4.2 Mitigation Measures

To reduce risk and avoid HADD to resident fishes and their habitat associated with erosion protection works, the following mitigation measures must be implemented:

- All equipment and materials that will come into contact with water must arrive on site clean (i.e., free of dirt, aquatic vegetation, etc.) to prevent the transfer of biota (such as whirling disease) between watersheds.
- Storage of loose fill or materials in the channel and adjacent to the banks must be avoided, and erosion sediment controls (*i.e.*, silt fence) must be installed to prevent wind and water erosion of materials into the channel.
- A team led by a qualified aquatic environmental specialist (QAES) will be on site to oversee construction activities and monitor water quality (turbidity / total suspended solids -TSS) at vertical stations spaced evenly across transects established upstream (background) and downstream to quantify and qualify the extent of any sediment mobilized downstream during isolation of the workspace and any instream construction.
- To minimize sedimentation, quarry rock should be free of dust and dirt before being placed in a watercourse. Not only will this minimize risk of mobilizing a sediment plume, it will also reduce the chance of a frazil ice blizzard that could displace fishes wintering in pools downstream from the works;
- Instream work areas should be suitably isolated from the watercourses. If required, water must be continuously pumped around the isolation to maintain stream flow.

- After installation of the isolation, a fish rescue under a research license issued by AEP must be completed within the isolation prior to any dewatering or construction activities. All fish captured will be returned into suitable habitat within the same watercourse.

- Construction crews will minimize the duration and amount of disturbance of the bed and banks of the water body to the extent possible.

- Erosion and sedimentation must be minimized during instream works.

- Water pumped from the isolated work space should be filtered through riparian vegetation or left to settle in a sump before release to the channel downstream.

- Any pumps used to move water around the isolation will be equipped with appropriately sized fish screens according to DFO's Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO 2020). Pump outflows should be situated such that they do not cause erosion and sedimentation.

- Upon completion of the construction, the quantity and productive capacity of the aquatic environment at and next to the sites of flood mitigation must be equivalent or exceed that which existed before.

Equipment Operation

When equipment is operated within 100 m of a watercourse, the following precautions will be taken by the Contractor:

- All operators and the construction foreman must be trained to check for spills and leaks, and contain spills or leaks from equipment;

- Stationary equipment will be placed within secondary containment (e.g. spill trays or impermeable berm);

- All fuel and lubricant service vehicles will be equipped with spill kits appropriate to contain the volume of liquids carried;

- Equipment for in-stream use will use vegetable-based hydraulic oil;

- Vehicles and equipment will not be refueled within 100 m of a watercourse, unless approved by designated personnel and measures are established to prevent and contain spills (spill kits deployed, absorbent materials ready for deployment); and

- Fuel, oil, or other hazardous materials will not be stored within 100 m of a watercourse.

4.3 Isolation Plan

Prior to commencing work, a QAES will inspect all potential locations of instream construction and advise the proponent if isolation will be required. Areas within Michichi Creek, the Red Deer River and Rosebud River or adjacent that may become inundated with water during project work will be isolated. Potential isolation techniques will consist of diversion channels to direct the flow away from the workspace. Isolations may be constructed of the following materials or their combination:

- Sandbags/mega bags;
- Aquadams/portadams;
- Turbidity curtains;
- An outer face of riprap lined with a less pervious geo-synthetic or finer grained substrate;
- In-channel or floodplain gravels; or
- Some combination of the above.

Fish Removal Methods

Following isolation of the construction areas a fish rescue will be conducted. Water chemistry parameters (*i.e.*, temperature, dissolved oxygen, conductivity, etc.) and site conditions will be assessed prior to fish rescue to determine the appropriate electrofishing settings. Fishes within the isolation will be captured using a backpack electrofisher, boat/float electrofishing unit, and/or minnow traps. Electrofishing efforts will be distributed evenly throughout the isolated area until two consecutive passes (of active fishing methods) produce a zero catch. Sufficient fishing effort must be conducted to ensure maximum removal of fish from the isolated area.

Netting and handling of fish will be limited to the extent possible. If fish are immobilized by electrofishing, they will be transferred to a plastic container containing fresh river water until they can be processed. Rescued fish will only be held long enough (<1 hr) to be identified by species, their fork length measured, and weight recorded. Fish will be released unharmed into similar habitat (*i.e*., quality and depth) outside the workspace.

In addition to the general mitigation measures, the following mitigation measures are recommended. These have been adapted from DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2019b).

- When possible, in-stream work activities will be timed to respect the RAP in order to protect sensitive life stages of resident fish;
- Activities and works in waterbodies will be designed and planned such that disturbance to aquatic habitat is minimized and sensitive spawning habitats are avoided and impacts to *Species at Risk Act* (SARA) listed aquatic species and their critical habitat are avoided;
- Activities near water will be planned such that deleterious materials will not enter the watercourse;
- Crews will ensure that material used during project work activities has been handled and treated in a manner to prevent the release or leaching of substances into the water that may be deleterious to fish;
- In-water activities, or associated in-water structures, will not interfere with fish passage;
- Water intakes or outlet pipes will be screened to prevent entrainment or impingement of fish. Screens shall adhere to the *DFO's Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater* (DFO 2020);
- Construction of isolation structures should take place outside of the RAP whenever possible. When this is not possible, a fish redd survey will be conducted by a QAES and in-stream work shall not proceed where fish redds are located; and
- Any natural structure that contributes to fish habitat (*i.e*., woody debris, root wads, large boulders) should be stockpiled and replaced close to their original positions after construction;

Water Management within Isolation

Following the installation of isolation measures and removal of fish from the isolated area, dewatering may be required to prepare the workspace for construction activities. During dewatering, water will be pumped using a diesel- or gas-powered pump. The pump will be placed in such a way that in the event of a spill, deleterious substances will not enter the watercourse. The water will be discharged using a diffusion device to reduce the potential for erosion and scour. A sediment control device (*i.e*., filter bag) will be placed on the end of the discharge hose to contain any sediment suspended in the water. If a filter bag is used, it will be properly sized to match the pumping pressure. Water should be discharged into established vegetation, stable sediments, or settling ponds to further reduce the potential for erosion and sedimentation. Water diverted around the isolation will return to the waterbody downstream; if ice is present, the water shall be returned under the ice.

Where required, pumping systems shall be sized appropriately to accommodate water quantities, with back-up pumps and generators on site and operational. All pumps shall have a capacity greater than expected flows to manage increases in flow or equipment failure. During dewatering, pumping systems will be monitored to ensure proper function.

4.4 Turbidity Monitoring Plan

A QAES will monitor water quality using turbidity as a proxy for total suspended solids (TSS). The QAES will monitor turbidity during all instream work (*i.e.,* any work below the high water mark) to quantify the magnitude, duration, and extent of sediment mobilized during construction. The intent of the monitoring work is to ensure that sediment generated by the work does not compromise downstream habitat.

The effects of project work on aquatic resources can be quantified by measurement of the concentration of total suspended solids (TSS; mg/L) in the affected water column. TSS can only be determined through laboratory analysis of water samples; therefore, turbidity (measured in nephelometric turbidity units [NTU]) is commonly used as a field proxy for TSS because it can be measured *in-situ*. Before work commences, a QAES will determine the linear relationship between TSS and turbidity in the river. This relationship will be developed using the Conversion Relationship between Nephelometric Turbidity Units (NTU) into mg/L for Alberta Transportations' Turbidity Specification (GoA 2017). Laboratory results and the linear relationship will be sent to the Consultant for review prior to initiating the monitoring program.

The provincial Environmental Quality Guidelines for Alberta Surface Waters and federal Canadian Council of Ministers for the Environment (CCME) Guidelines state that during clear flow, turbidity should not increase more than 8 NTU above background for any short-term exposure (*i.e.*, <24-hr period), and with a maximum average increase of 2 NTU from background for longer term exposures (CCME 2014; Table 3).

Turbidity monitoring will be conducted based on the site conditions and sampling frequencies summarized in Table 3. Sampling shall commence 30 minutes prior to daily construction activities until 30 minutes after construction activities have been completed.

Table 3: Required Sampling Frequency for TSS Monitoring.

Site Condition	Monitoring 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 [1] until it is safe to do so.
Isolated Construction Activities	• When the Contractor is working within the 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 two consecutive active construction days, monitoring is no longer required unless a visually conspicuous plume is observed, the isolation works are altered, or as directed by the Consultant.

Note: [1]Accidental Occurrences: 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.

Approach

A background transect will be established upstream of each work site in order to determine baseline turbidity levels in the watercourse. Three sampling points will be distributed across the channel and the results of each point will be averaged to determine background TSS (mg/L) levels. Background measurements will be taken once per day, unless changing weather, flow conditions, or upstream activities warrant updated background measurements.

Three compliance monitoring transects will be established 50 m, 125 m, and 225 m downstream of the work site. If required, an additional downstream transect may be established to encompass the predicted ZOI. The extent of the ZOI varies considerably between watercourses, and depends on various parameters including channel gradient, width, depth, morphology (shape and roughness), water velocity, discharge, and instream vegetation. The ZOI will be determined by the QAES at the time of construction.

At each transect, a minimum of three sampling points will be distributed evenly across the channel width. Where water depths are less than 1 m, samples will be taken at 50% water depth. Where water depths are greater than 1 m, two samples taken at 20% and 80% water depth will be collected and averaged for that location.

Criteria are set by the current versions of the Environmental Quality Guidelines for Alberta Surface Waters (GoA 2018), which are based on the Canadian Council of Ministers of the Environment (CCME 2014). A summary of these guidelines is presented in Table 4.

Table 4: TSS/Turbidity Guidelines for the Protection of Aquatic Life (adapted from GoA 2018).

Site Condition	Compliance Criteria
During Clear Flows or Clear Waters (Background Levels 0-25 mg/L)	A maximum increase of 25 mg/L from background levels for any short-term exposure (*i.e.*, 24-hr period). A maximum average increase of 5 mg/L from background levels for longer term exposures (*i.e.*, between 24-hr and 30 days).
During High Flows or Turbid Waters (Background Levels 25-250 mg/L)	A maximum increase of 25 mg/L over background levels at any time.
Background Levels > 250 mg/L	A maximum increase of 10% above background levels at any time.

Compliance criteria states that each sample point along a transect will be compared to CCME short-term exposure guidelines. This ensures there are no exceedances at any sampling point. If a plume is observed construction will stop, the source will be identified, and construction methods will be altered as required. Construction will only resume after readings at all sampling locations have returned to background readings.

5 CLOSURE

The statements and conclusions reported are accurate and address requirements of the Alberta *Water Act* and the federal *Fisheries Act*.

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Appendix A Photo Plates

Nacmine

Plate 1. View upstream of the Nacmine mitigation location. Frazil ice formations observed throughout this reach.

Plate 2. View downstream of the Nacmine mitigation location.

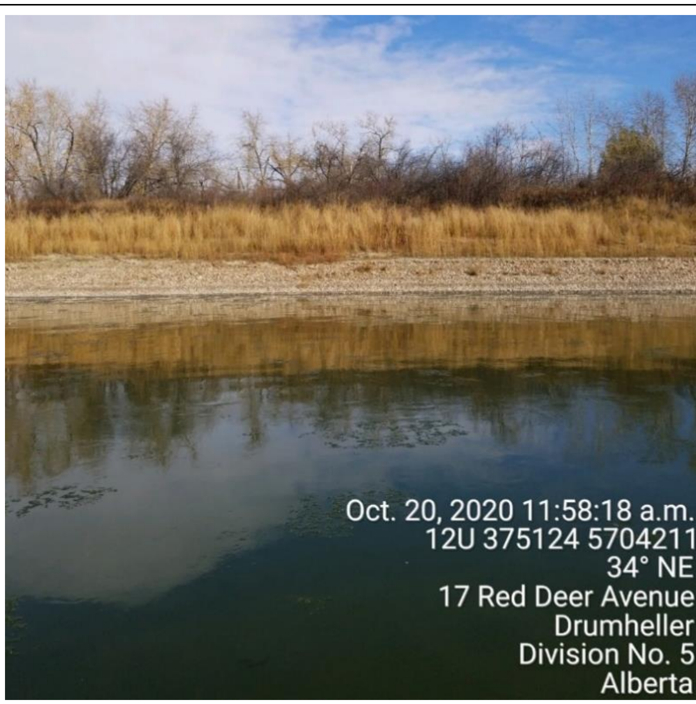


Plate 3. View of erosional feature along the left bank (gravel bar) of the Red Deer River.

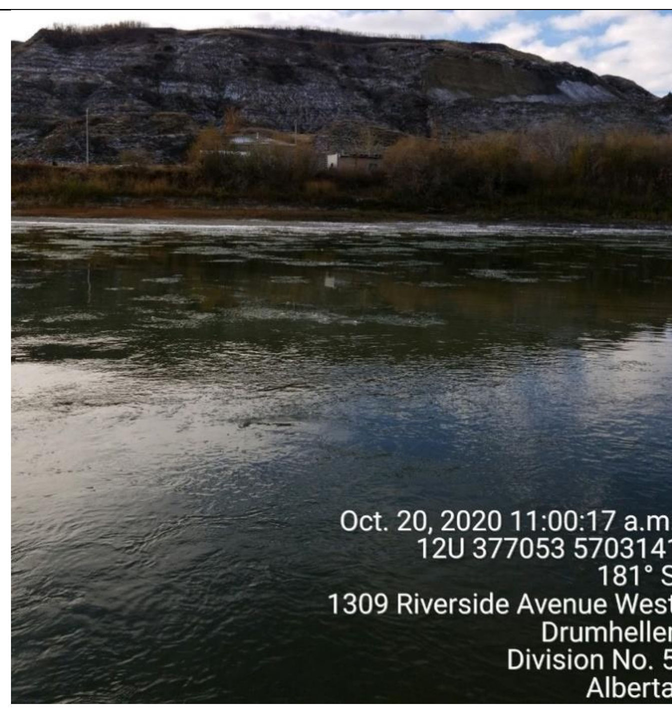


Plate 4. View of shallow, slow flowing waters along the right bank of the Red Deer River.

Northern Drumheller

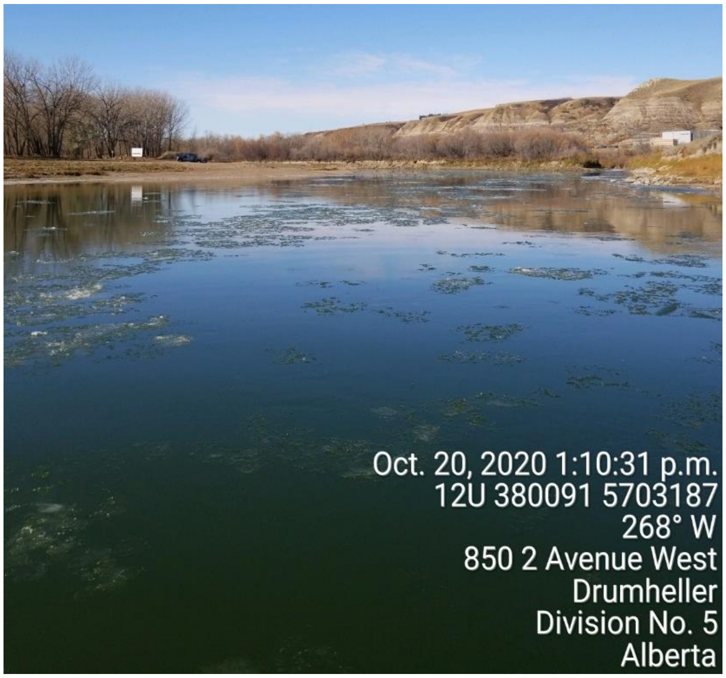


Plate 5. View of the upstream extent of Northern Drumheller reach of the Red Deer River.	Plate 6. View of erosion along the left bank of the Red Deer River and attempts of slope stabilization.

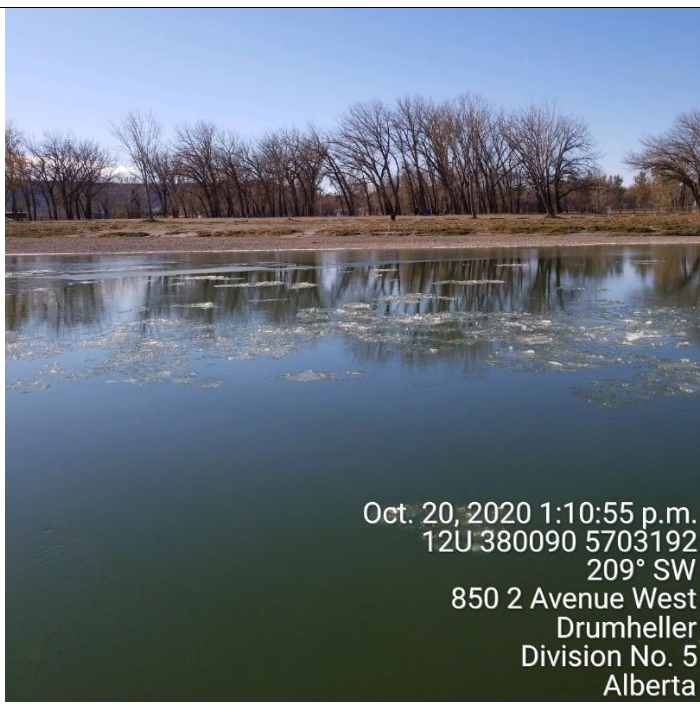
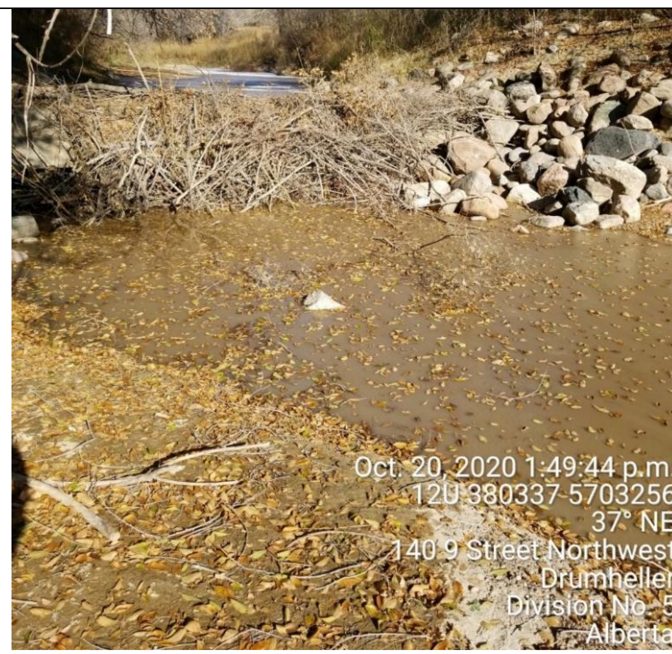
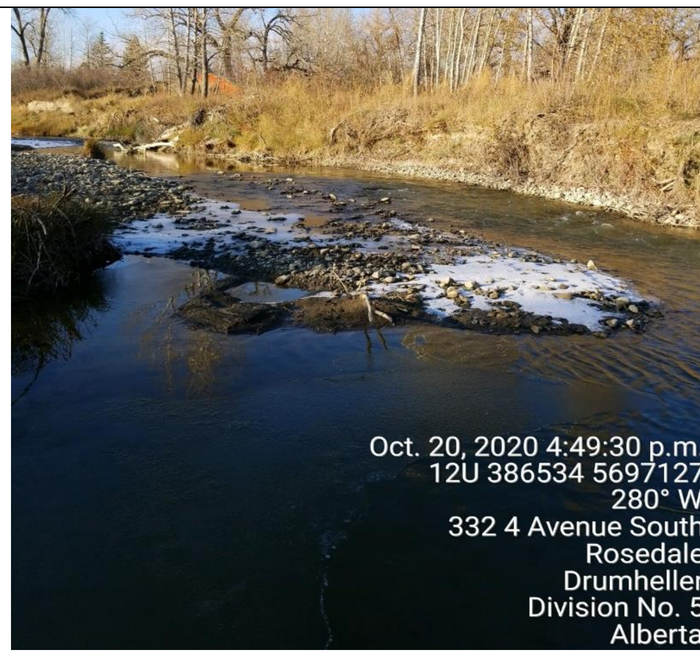



Plate 7. View of large gravel bar, common along the right bank of the Red Deer River in the Northern Drumheller section.	Plate 8. View of existing reclamation along the right bank of the Red Deer River (just upstream of HWY 9 Bridge).

Michichi Creek

	
Plate 9. View of Michichi Creek confluence with the Red Deer River.	Plate 10. View upstream of Michichi confluence with the Red Deer River.
	
Plate 11. View upstream of Michichi Creek displaying high silt load and bankside vegetation.	Plate 12. View of fish barrier (weir and beaver dam) at the upstream extent of the Michichi Creek mitigation footprint.

Rosebud River

	
Plate 13. View downstream of the Rosebud River from West 10X Bridge.	Plate 14. View upstream of the Rosebud River showing gravel/cobble bars along the right bank and slightly undercut, fully vegetated left banks.
	
Plate 15. View of erosion along the right bank of the Rosebud River, just upstream from the East 10X Bridge.	Plate 16. Gravel bar island along the right bank of the Rosebud River.