ENVIRONMENTAL OVERVIEW OF THE CONCEPTUAL ELBOW RIVER DAM AT MCLEAN CREEK

Submitted to:

Alberta Environment and Sustainable Resource Development
Resilience & Mitigation Branch
Edmonton, Alberta

Submitted by:

AMEC Environment & Infrastructure
Calgary, Alberta

February 2015

CW2174

09 February 2015
CW2174

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Attention: Heather Ziober, C.E.T., C.C.C.A.
Project Manager, Resilience & Mitigation Branch

Dear Heather:

Re: Environmental Overview of McLean Creek (MC1)

AMEC Environment & Infrastructure, a division of AMEC Americas Limited (AMEC) (now Amec Foster Wheeler Environment & Infrastructure) is pleased to present Alberta Environment and Sustainable Resource Development the report entitled *Environmental Overview of the Conceptual Elbow River Dam at McLean Creek*.

If you have any questions or concerns, please feel free to contact me at the information provided below.

Yours truly,

AMEC Environment & Infrastructure

J. Bennett

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jb/cc

EXECUTIVE SUMMARY

Conceptual Project Design

The flood mitigation project (the Project) proposed for the McLean Creek site is an earth fill dam across the mainstem of the Elbow River, immediately upstream of its confluence with McLean Creek. The conceptual design incorporates a reservoir (a small permanent pond and a Full Supply Level reservoir), a combined concrete outlet/spillway structure for discharging normal and flood flows, an auxiliary earth cut channel spillway to protect the dam from extreme floods, and the relocation of local infrastructure including of a portion of Highway 66. The Project site is located in the Green Zone on crown land approximately 10 km upstream of the Town of Bragg Creek.

Environmental Overview:

This environmental overview of the Project summarizes the environmental resources and associated land uses that could be affected if the Project were to be developed. The Study Area used for this report was approximately a one kilometer buffer around the Project facilities. Environmental conditions were identified based on a desktop review and several field reconnaissance surveys. The study objectives were to provide:

- a description of potential environmental and social issues that may arise if the Project is to proceed;
- identify data gaps; and
- discuss potential mitigation measures.

Data were collected and reviewed for the disciplines shown in Table 1:

Table 1: Desktop Review and Data Collection by Discipline

Water	Land	Social
Groundwater	Soils	Historical Resources
Surface Water Quality	Vegetation	Non-traditional Land Use
Fish and Aquatics	Wildlife	Engagement of Government Stakeholders

Findings:

If the Project is to proceed past the conceptual design stage, an environmental impact assessment will be required. The following are key issues that would require further investigation and active management:

- Project design
    - ❑ Public safety for land users and infrastructure located downstream of the dam is a concern.

- Operating regime would have to be determined because it has a direct influence on the potential environmental effects that could arise from the Project.

- Regulatory processes
  - The *Alberta Environmental Protection and Enhancement Act* (EPEA) and the Natural Resources Conservation Board processes for project review and environmental assessment would be triggered. Other regulatory requirements to be met include the *Alberta Water Act*, the Federal *Fisheries Act* and the Federal *Navigation Protection Act*.
  - The regulatory timeline, including post-approval permits and authorizations could take 2 ½ to 5 years.
- Listed species
  - Potential effects on listed species, particularly bull trout and grizzly bear, need to be characterized and quantified.
  - Predicting effects on these species, and managing them appropriately requires robust site-specific and regional data.
  - The dam would create a barrier to movement for fish and other aquatic species that would require mitigation (e.g., inclusion of a fish passage structure in the design).
  - Project facilities could create a barrier to movement for animals, such as grizzly bear, alter movement patterns, and result in changes in habitat availability.
  - Mitigation and offsets for several species may be required at a regional scale rather than simply at the local scale.
- Existing land uses
  - The area is currently used for a wide variety of purposes - recreation, forestry, and infrastructure. Developing the Project would affect these uses and may preclude several of them from occurring in the Project footprint.
  - Current users appear to place a high social value on the area in its present state and additional site-specific information would be required to characterize the current level of use and potential changes.
  - Engagement is recommended.
- Historical Resources
  - Zones of moderate and high archaeological potential were identified within the footprint of the proposed reservoir.
  - Project footprints that cannot avoid damage to valuable historical resources would have an extended regulatory timeline to be factored into project planning, including restrictions on winter fieldwork.
  - A separate palaeontological assessment would likely be required.

The development of a new flood storage dam at McLean Creek would present several environmental and social challenges that would require in-depth study and a lengthy data collection period to address. The final design would require measures to mitigate the environmental and social impact of the proposed scheme.

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1.0 INTRODUCTION

The flood control plan proposed for the McLean Creek site is an earth fill dam across the mainstem of the Elbow River with an associated reservoir (the Project). The conceptual design also includes a combined concrete outlet/spillway structure for discharging normal and flood flows and an auxiliary earth cut channel spillway to protect the dam from extreme floods. The site is located in the Green Zone on crown land approximately 10 km upstream of the Town of Bragg Creek and immediately upstream of the confluence of McLean Creek with the Elbow River. A more detailed description of the conceptual design and proposed operation can be found in AMEC's 2014 report entitled: Southern Alberta Flood Recovery Mitigation Measures: Appendix F – Elbow River Dam at McLean Creek.

A dam on the Elbow River at McLean Creek would result in the construction of flow regulation structures that trigger Alberta Regulation 111/93 EPEA Environmental Assessment (Mandatory and Exempted Activities) Regulation that requires an EIA be completed for a dam greater than 15 m in height.

This report presents an environmental overview of the conceptual Project. It summarizes the environmental resources and associated land uses that could be affected if the Project was to be developed. Environmental conditions within the Study Area were determined with a desktop review of existing information and the completion of several field reconnaissance surveys. The objectives of the environmental overview are to describe the local environment, including:

- a description of potential environmental and social issues that may arise if the Project is to proceed;
- identification of data gaps; and
- discussion of potential mitigation measures.

The disciplines for which data were collected and reviewed include:

- water (groundwater, surface water quality, fish and aquatics);
- land (soils, vegetation and wildlife); and
- social (historical resources, non-traditional land use and engagement of government stakeholders).

2.0 PROJECT DESCRIPTION

This project description is based on AMEC's 2014 report entitled: Southern Alberta Flood Recovery Mitigation Measures: Appendix F – Elbow River Dam at McLean Creek. A more detailed description of the design and proposed operation can be found there.

The Elbow River dam site at McLean Creak would be located in the Green Zone on crown land approximately 10 km upstream of the Town of Bragg Creek, and immediately upstream of the confluence of McLean Creek with the Elbow River.

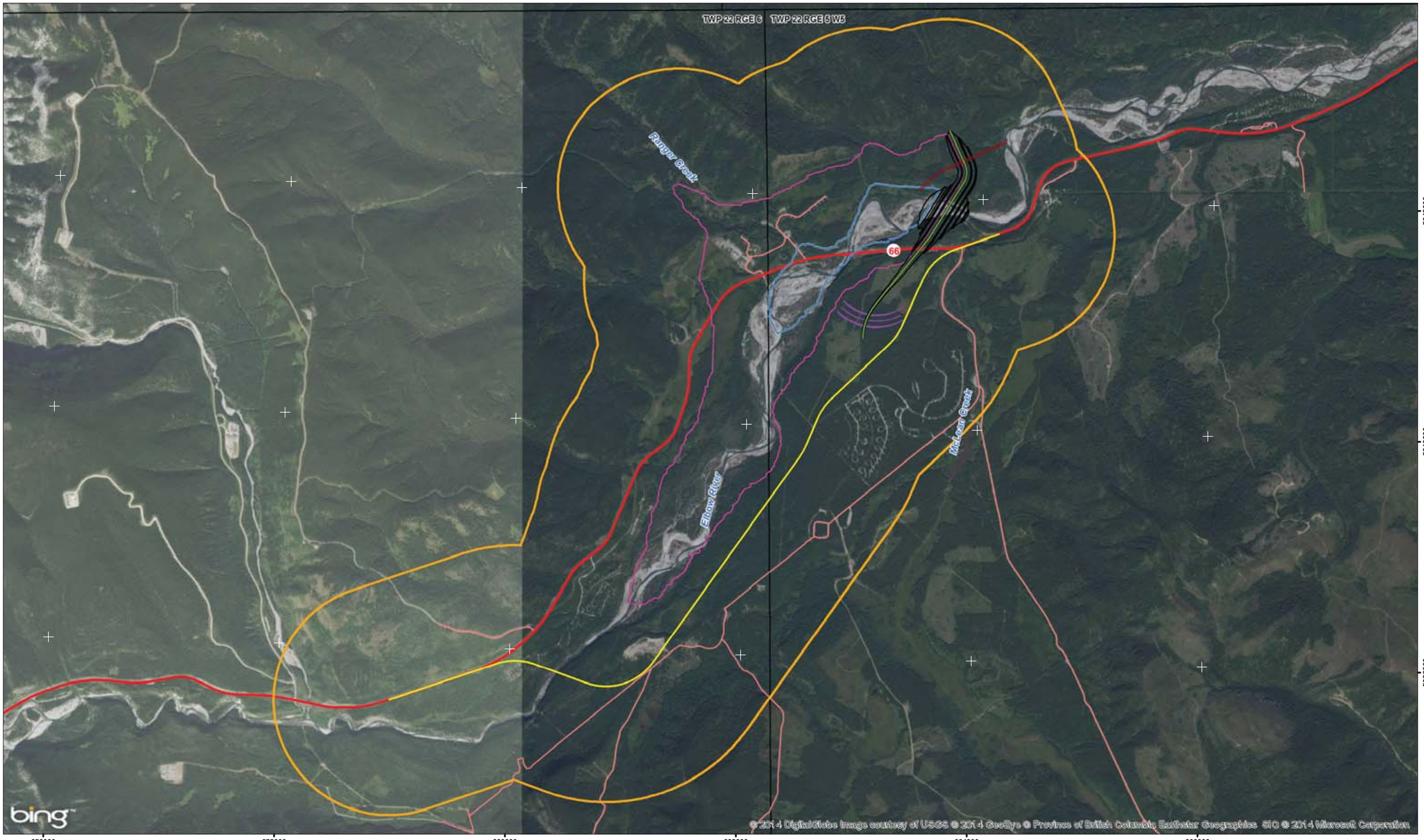
2.1 Conceptual Project Design

As currently envisioned, the conceptual Project (the Project) is designed as an earth fill dam across the main stem of the Elbow River. It includes a combined concrete outlet/service spillway structure for discharging normal and flood flows, and includes an auxiliary earth cut channel spillway to protect the dam from extreme floods which could otherwise result in dam overtopping and catastrophic failure. The dam site and reservoir area are shown in Figure 2.1-1. The proposed dam would traverse a river gorge, which is approximately 110 m wide at the base and is steep walled for a height of approximately 28 m.

The outlet structure would be a gated conduit through the dam. The gates would typically be left in the wide open position thereby allowing free passage of flow with a minimum reservoir level during normal flow conditions. The gates would be strategically closed during flood events thereby holding back a significant portion of the flow as temporary reservoir storage.

The conceptual design includes a small permanent pool in the valley bottom containing approximately 4,000 dam^3 of water as dead storage. This storage is intended to prevent larger bottom sediment, which is carried by the river from reaching and plugging the intake area. The conceptual design does not include a low level outlet to release the dead storage.

The resulting reservoir would inundate a portion of the existing Kananaskis Highway 66 including a bridge crossing on the Elbow River. A potential highway and bridge relocation route around the south side of the reservoir is illustrated on Figure 2.1-1. This relocation route is considered as part of the Project for this environmental overview.



Legend

Study Area	Highway	**Proposed Infrastructure**
Base Reservoir Water Level (1399m)	Road	Main Structure
100 Year Flood Water Level (1422m)		Auxillary Earth Cut Spillway
Main Embankment Crest - El. 1429.5m	Combined Permanent Outlet / Spillway Structure	Highway 66 Realignment

N 250 0 250 500
Metres
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch
ESRD
McLean Creek Environmental Overview

McLean Creek
Flood Protection Project
Conceptual Layout

DATE: December 2014
ANALYST: TR
QA/QC: TR BH JB
PDF: Fig2.1-1 Conceptual Layout 14-12-05

Figure 2.1-1

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2.2 Potential Operational Regime

The Project could have an effect on flood flows in the Elbow River. Potential changes are discussed below.

The conceptual design includes control gates on outlet conduits that would enable the operator to regulate discharge from the upper basin and thus reduce the risk of flooding downstream. The conceptual design also includes an auxiliary spillway that is required to ensure that, in the event of an extreme flood, the integrity or safety of the dam is not compromised.

Figure 2.2-1 shows the effect of the Project on the flood frequency estimates for the Elbow River basin at McLean Creek. Up to a 10% Annual Exceedance Probability (AEP) (1 in 10 year) event, there would be very little attenuation of the flood hydrograph. For events greater than 10% AEP, and up to a 1% AEP flood, the discharge in the Elbow River would be limited to approximately 250 m^3/s to 260 m^3/s. Beyond the 1% AEP, the discharge would increase rapidly as shown in Figure 2.2-1.

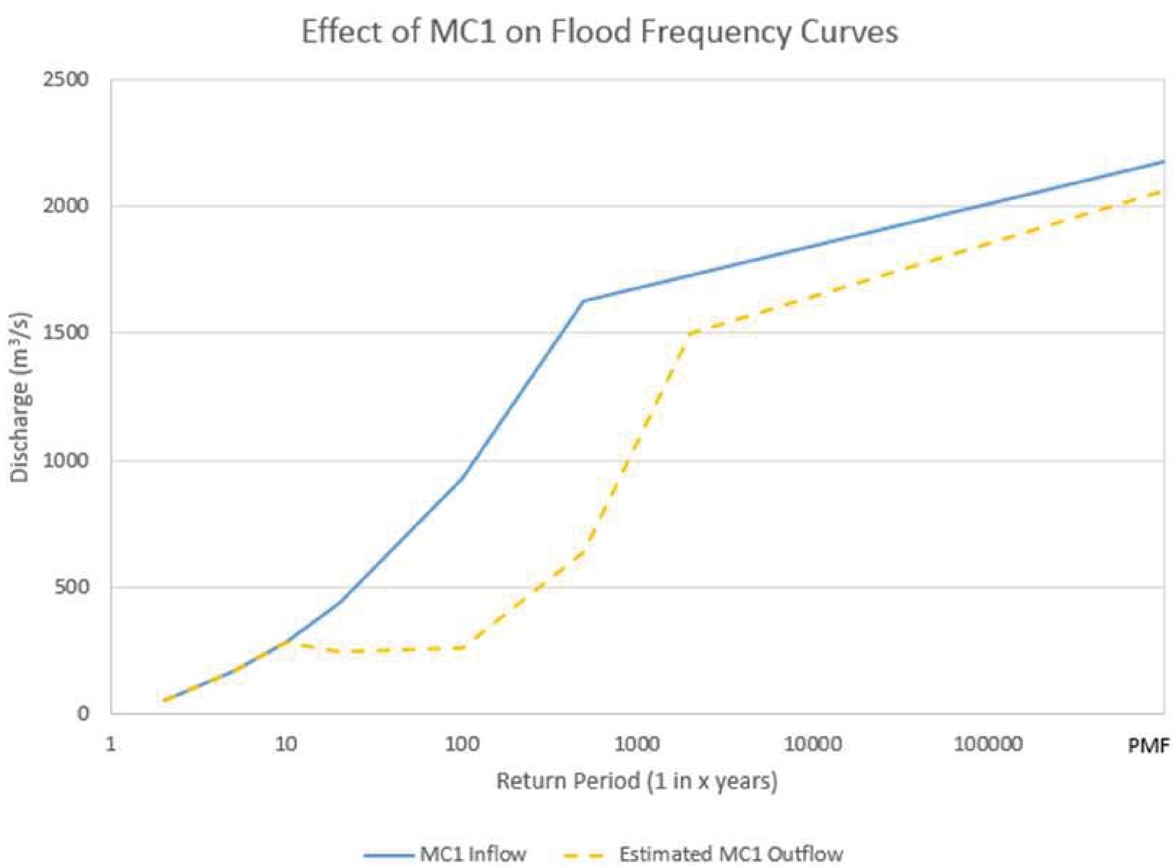


Figure 2.2-1: Effect of McLean Creek (MC1) Conceptual Dam on Flood Frequency Curves

Post construction there would be three potential scenarios for the operation of the dam:

1. Non flood conditions (flows not exceeding 170 m^3/s in the basin).
2. Flood conditions (flows exceeding 170 m^3/s but not exceeding 1,625 m^3/s).
3. Extreme flood conditions (flows exceeding 1,625 m^3/s).

Note that the potential trends discussed below are based on the proposed structure design and operations that have been assessed at a conceptual level. These values will require modification based on the results of future design and impact assessments.

2.2.1 Non Flood Conditions

Under normal summer conditions, all sluice gates would be left wide open such that the service spillway would pass all summer, non-flood flows. With the exception of evaporation losses from the permanent pool, which would be near zero, water flowing into the reservoir would flow out through the outlet structure. The effect on the hydrology would therefore be minimal. Evaporation losses would need to be estimated during an environmental impact assessment, if the Project was to proceed.

2.2.2 Flood Conditions

If flood flows in the Elbow River exceed 440 m^3/s (approximately a 1 in 20 year or 5% AEP flood event) (Table 2.2.-1) and the reservoir level rises to 1,407.0 m, 4 of the 6 sluice gates would be shut to attenuate the flood hydrograph. The water level would therefore rise in the reservoir.

2.2.3 Extreme Flood Conditions

If the level in the reservoir reaches a level of 1,423.0 m (the level expected in a 1% AEP flood), the gates would be strategically reopened to increase discharge through the outlet structure and to therefore reduce the risk that the auxiliary spillway would be required to pass flood flows. The combined permanent outlet/spillway structure has been sized to manage all floods up to the 0.2% AEP (1 in 500 year) flood event. In events exceeding a 0.2% AEP flood, the auxiliary spillway would be activated.

Table 2.2-1: Elbow River Dam at McLean Creek Pertinent Operations Data

Description (Peak Values)	Summer	Winter	Floods			
	July Mean	January Mean	20-year	100-year	500-year	PMF
Peak Reservoir Inflow Rate (m^3/s)	13.4	3.0	440	930	1,625	2,175
Permanent Outlet/Spillway Structure Outflow Rate (m^3/s)	13.4	3.0	250	260	636	780
Auxiliary Spillway Outflow Rate (m^3/s)	0	0	0	0	0	1,280
Reservoir Water Surface Elevation (m)	1,399.0	1,401.5	1,407.0	1,423.0	1,426.5	1,429.0
Total Contained Water Volume (dam^3)	4,000	5,000	12,000	47,000	62,000	72,000

2.2.4 Safety

The Project has been conceptually designed to minimize reservoir fluctuations during normal flow and smaller flood conditions. However, reservoir fluctuations would be notable for larger floods (e.g., reservoir rise of 8 m during 5% AEP and 24 m during 1% AEP). Also, the rate of reservoir rise could be rapid for larger floods (e.g., 1 m per hour for sustained period of 12 hours or larger during 1% AEP. Associated safety risks to area users would need to be addressed as part of a future assessment. The maximum rise and the potential rate of rise increase as the size of flood increases.

2.3 Regulatory Overview

The activities associated with construction of flood mitigation measures such as dyking or dams on the Elbow River will require a number of permits, licenses, authorizations and approvals from a variety of regulatory bodies. The main regulatory agencies and major approvals that will likely be required for Project construction based on current and existing information are summarized in Table 2.3-1**,** and discussed further below.

Table 2.3-1: Regulatory Overview

Regulator	Legislation	Requirements/Process	Estimated Length of Time for Process[1]
Provincial			
ESRD	EPEA Environmental Assessment Mandatory and Exempted Activities Regulation 111/93	Under EPEA an environmental impact assessment (EIA) is required for a dam greater than 15 m in height, as specified in the mandatory and exempted activities regulation.	0.5 – 1 year to deem an application complete before the NRCB process begins
Natural Resources Conservation Board (NRCB)	*Natural Resources Conservation Board Act*	The NRCB review process is triggered when a water management project requires an EIA.	1 – 3 years to review and make a determination on a project
ESRD	*Alberta Water Act*	Authorization/approval	Variable
	Alberta Water Act	License	Variable
	Public Lands Act	Dispositions following the Environmental Field Report (EFR) process	5 – 8 months
Alberta Culture (AC)	*Historical Resources Act*	Application for clearance	Depends on requirements; for historic resources impact assessment, expect 4 to 6 months from initial application for clearance.
Other			
Stakeholders		Third Party Agreements	Variable

Regulator	Legislation	Requirements/Process	Estimated Length of Time for Process[1]
Federal			
Fisheries and Oceans Canada (DFO)		Authorization pursuant to the *Fisheries Act* (habitat and fish passage)	90 days post-filing, providing submission is complete.
Transport Canada		Navigation Protection Act (NPA)	n/a
Miscellaneous Federal Acts		*Migratory Birds Convention Act* (MBCA)	n/a
		Species at Risk Act (SARA)	n/a

Note:
n/a - Not available at this time

2.3.1 Major Alberta Environmental Review Requirements

A dam on the Elbow River at McLean Creek would result in the construction of flow regulation structures that trigger Alberta Regulation 111/93 EPEA Environmental Assessment (Mandatory and Exempted Activities) Regulation that requires an EIA be completed for a dam greater than 15 m in height. The EIA process (preparation and review), combined with the NRCB process discussed below, could take between 2 to 5+ years for these types of projects. Some projects have taken longer. Prior to submitting a project application, the preparation of an EIA requires a solid understanding of the existing environment, which typically requires four seasons of field work (i.e., 1 year) to gather baseline data. An additional 6 to 12 months would be required to analyze the data and complete the impact assessment, including writing the report. Once the project application and supporting EIA have been submitted for review, ESRD would make a determination of completeness. This review process includes the issuance of supplemental information requests (SIRs). Depending on the number of SIRs and the number of rounds of SIRs, this process could take 6 to 12 months. ESRD then deems the EIA complete and the NRCB review process (below) proceeds.

2.3.1.1 Natural Resources Conservation Board

The NRCB process is triggered when a water management project requires an EIA. After ESRD deems an EIA complete it is passed to the NRCB for review. The NRCB then completes the review and hearing process. At the completion of the process, the NRCB sends its determination to cabinet, which reviews the report and issues its final approval decision.
The whole NRCB review period could take 1.5 to 3 years, depending on the level of public interest in the Project.

2.3.2 Additional Requirements

If the cabinet decision decides the Project can proceed, additional permits and authorizations are then required. These are briefly discussed below.

2.3.2.1 Alberta Water Act

Approval under the Alberta *Water Act* would be required for activities that could affect surface and subsurface water management including construction in, under or adjacent to water bodies. Pre-development and post-development aquatic environmental assessments would be necessary as part of the application for approval.

Reporting required to be included in a *Water Act* application would include detailed design drawings, hydrotechnical analyses (including reservoir stage/area, discharge rating, hydrographs and water levels upstream and downstream of the project area). It is also likely that a dam breach analysis would be required.

A *Water Act* license would also be required for all water diversions (withdrawal or storage) of surface water.

The timeframe for approvals can take upwards of a month and depends on the complexity of the scheme and whether there are any objections by anyone who is directly affected by the scheme.

2.3.2.2 Federal Fisheries Act

As of 25 November 2013, amendments to the *Fisheries Act* proposed in Bill C-38 are now in force. Proponents are responsible for avoiding and mitigating the serious harm to fish that could result from their projects. When proponents are unable to completely avoid or mitigate serious harm to fish such that some residual serious harm to fish remains, they must seek an authorization under paragraph 35(2)(b) of the *Fisheries Act* to carry on a work, undertaking or activity.

The construction of a dam or an off-stream diversion could cause serious harm to fish even after the application of avoidance and mitigation measures. This would then require development of a plan to undertake offsetting measures to counterbalance the unavoidable residual serious harm to fish. Offsetting plans are negotiated on a case-by-case basis and may require consultation with Aboriginal groups, as well as other stakeholders (e.g., the province on crown lands). At least four seasons (i.e., 1 year) of baseline data collection is typically required.

The dam or off-stream storage projects could cause lasting changes to habitat. To evaluate the potential residual serious harm to fish and to identify the appropriate measures for avoidance, mitigation and offsetting, a plan would be required to obtain an authorization. New DFO policies will measure the success of offset objectives by quantifying the changes in productive capacity. Significant post-construction monitoring would likely be required to determine this change.

The offsetting plan is to be included as part of the proponent's application for authorization under paragraph 35(2)(b) of the *Fisheries Act*. A letter of credit issued by a recognized Canadian financial institution must be included with the offsetting plan. The letter ensures that if conditions of the authorization are not completed, DFO can access funds to implement all remaining elements of the plan. The amount of the letter of credit should be sufficient to complete the offsetting plan and monitoring program.

While the total time line is estimated to be two years, one year is for baseline data collection, which would like be done as part of the data collection for the EIA. The second year is for working with DFO to reach agreement on the mitigation and offsetting plan. This work would likely be done concurrently with the EIA preparation and NRCB review. The final offsetting plan and letter of credit could reasonably be expected to be complete within six months of project approval by cabinet.

2.3.2.3 Federal Navigation Protection Act

The amendments to the *Navigable Waters Protection Act* (NWPA) came into force in April 2014, under a new legislative name entitled the *Navigation Protection Act* (NPA).

Under the NPA only watercourses identified on the *List of Scheduled Waters* require an approval; the Elbow River is not included on the list. However, the right to navigate is still protected under common law and should be considered as there is documented canoeing use of the Elbow River.

2.3.2.4 Others

These projects are likely to require land use dispositions (from ESRD) as well as clearance under the *Historical Resources Act* by Alberta Culture and Tourism (ACT) prior to any clearing or construction activities. Typically these processes occur after the Project has received approval and may take from 2 to 9 months. They occur in parallel.

2.3.3 Canadian Environmental Assessment Act

Some projects would require a federal environmental review, as noted in Table 2.3-2. At this point it is unclear if the Project would trigger a federal review process. As the design progresses, the reservoir surface area and the volume of water to be diverted will be determined.

Table 2.3-2: Federal Environmental Review

Regulator	Legislation	Requirements/Process	Estimated Length of Time for Process†
Canadian Environmental Assessment Agency (the Agency)	Canadian *Environmental Assessment Act*, 2012 Regulations Designating Physical Activities SOR/2012-147	Environmental assessment (EA) is triggered when a new dam would result in a reservoir with a surface area that would exceed the annual mean surface area of a water body by 1,500 ha or more. An EA is triggered when a new diversion structure moves 10,000,000 m^3/year or more of water from a natural water body into another natural water body.	1 to 3 years (coordinated with NRCB process)

Note:
† not including surveys or studies to support applications.

As well as the projects listed in the *Regulations Designating Physical Activities*, if a project receives federal funding, then an environmental review is also required. It is unknown at this time if the Project would receive federal funding. If required, the environmental review would be carried out by the Canadian Environmental Assessment Agency. It would most likely be coordinated with the NRCB review (described above). Joint federal/provincial reviews have been held several times for water management projects in Alberta, and the NRCB and the Agency have established a good working relationship. The inclusion of a joint review process should not increase the NRCB review time for a project.

2.3.4 Regulatory Timelines

Overall, the regulatory process for either of these options could take between 2.5 and 6 years, as shown in Table 2.3-3.

Table 2.3-3: Potential Regulatory Timeline

Preparation of EIA	Environmental Review	Post-approval Permits and Authorizations	Total
18 to 24 months	18 to 36 months	3 to 9 months	29 to 69 months

3.0 ENVIRONMENTAL OVERVIEW

The flood control plan proposed for the McLean Creek site is a dam across the Elbow River with an associated reservoir. The site is located approximately 10 km upstream of the Town of Bragg Creek and immediately upstream of the confluence of McLean Creek with the Elbow River. The Study Area for this environmental overview is a one kilometer buffer around the Project facilities and highway relocation.

The following sections summarize the environmental resources and associated land uses that could be affected if the Project was to be developed. Existing environmental conditions within the Study Area were determined with a desktop review of existing information and the completion of several field reconnaissance surveys.

3.1 Hydrogeology

The construction of the dam, reservoir, associated facilities, and possible periodic flooding could affect groundwater resources and users in the area. This section describes the key hydrogeologic resources of the area, the potential impacts of the proposed Project and the best management practices and possible mitigative measures to reduce impacts. Should the Project proceed beyond the conceptual stage, data gaps are identified that should be filled prior to preparing a formal environmental impact assessment.

Methods are provided in Appendix A.

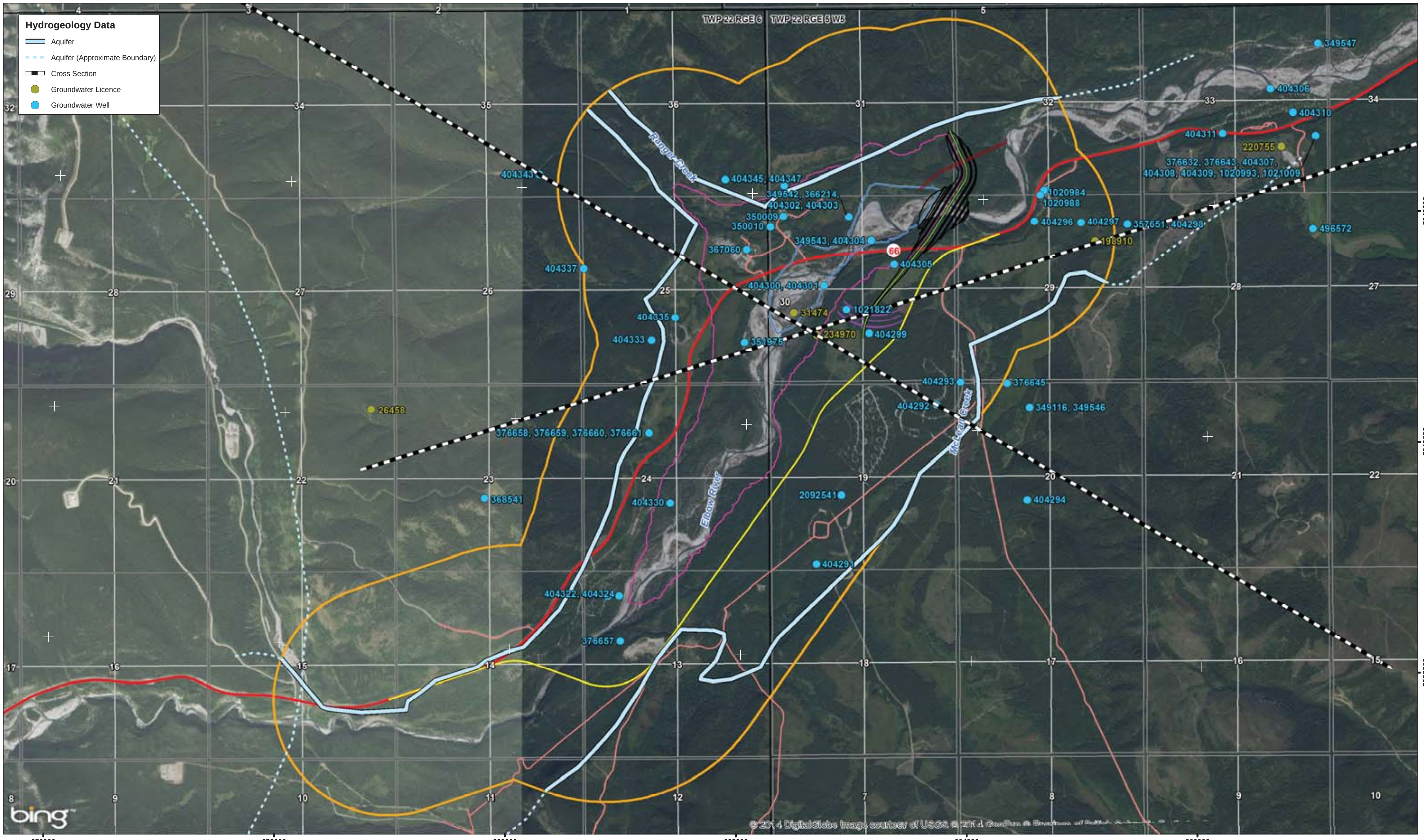
3.1.1 Results

3.1.1.1 Main Water Bodies and Drainage

McLean Creek is one of several tributaries of the Elbow River that define the drainage patterns in and around the Study Area (Figure 3.1-1). Other tributaries include Canyon Creek, Prairie Creek, Powderface Creek, Silvester Creek, Ranger Creek and Connop Creek. Several other smaller seasonal water bodies flow into these creeks and the Elbow River. These water bodies and their catchments form part of the Elbow River sub-basin, which drains from west to east towards a confluence with the Bow River in the City of Calgary. Elevations in the area range from over 2,100 m above mean sea level (asl) to the west of the Study Area at Prairie Mountain, to below 1,400 m asl along the banks of the Elbow River to the east of the Study Area, near the boundary between Rocky View County and the Municipal District of Foothills.

3.1.1.2 Surficial Geology

The surficial geology in the area is described by Bayrock and Reimchen (1980). Fine and coarse-grained fluvial deposits consisting of gravel, sand and minor silt beds occur beneath and immediately adjacent to the Elbow River and tributaries. The surrounding low-lying areas in the Elbow River valley contain glaciofluvial outwash sands and gravels. The fluvial and glaciofluvial deposits are more than 30 m thick in some areas.



Legend

- Study Area
- Base Reservoir Water Level (1399m)
- 100 Year Flood Water Level (1422m)
- Highway
- Road

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment

N 250 0 250 500
Metres
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Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch
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McLean Creek Environmental Overview

Hydrogeology Overview

DATE:	December 2014
ANALYST: NH	QA/QC: TR ST JB
PDF:	Fig3.1-1 Hydrogeo Overview 14-12-10

Figure 3.1-1

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Valley slopes contain thin deposits of glacial till and higher elevations are covered by a thin veneer of bedrock and till-derived soil and rock creep colluvium above bedrock. Glaciolacustrine deposits of less than 10 m thickness occur in the far northeastern portions of the Study Area, and small, localised deposits of rock-slide material and talus rock debris can be found throughout the Study Area along steep slopes (Figure 3.1-2).

3.1.1.3 Bedrock Geology

According to Green (1970), bedrock in the Study Area consists of the Tertiary-Cretaceous Brazeau formation, the Blackstone and Wapiabi Formations of the Cretaceous Alberta Group, undifferentiated marine deposits of Mesozoic age, and upper Paleozoic carbonates. The major mapped formations, listed in order of increasing age, are as follows:

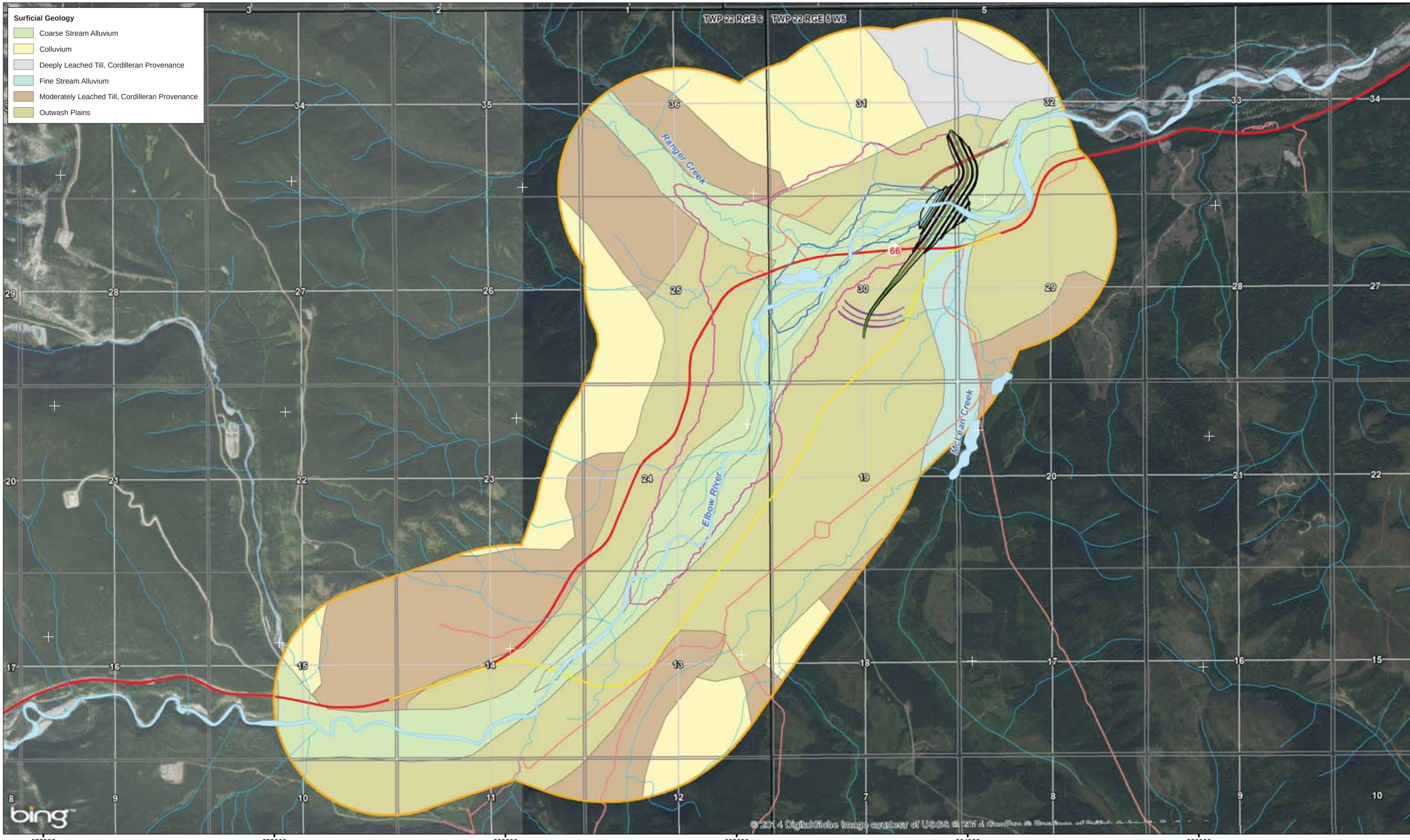
- the Brazeau Formation, which consists of thick-bedded terrestrial sandstones and mudstones with occasional tuff and coal beds;
- the Blackstone Formation, which contains thin-bedded sandstone and shale of marine origin;
- the Wapiabi Formation, which consists of marine-deposited shale, siltstone and fine-grained, thin-bedded glauconitic sandstone;
- interbedded calcareous and siliceous mudstones and sandstones and minor coal deposits of Mesozoic age (Triassic and Jurassic periods); and
- limestone, dolostone and a variety of other carbonaceous and calcareous rocks deposited during the upper Paleozoic (Devonian, Carboniferous and Permian periods).

The Tertiary and Cretaceous deposits subcrop mainly in the eastern half of the Study Area, and the mapped Mesozoic and Paleozoic bedrock units occur to the west (Figure 3.1-3). These formations exhibit a high degree of deformation and the geological boundaries between them are defined by steep thrust faults. The Paleozoic bedrock units form an anticlinal fold to the west in the areas near Moose Mountain and Prairie Mountain. The bedrock geological structures in the Study Area are aligned roughly north-south, orthogonal to the west-east regional deformation.

The bedrock topography is roughly similar to that of the land surface, except in the Elbow River Valley, where surficial sediments can be more than 30 m thick.

3.1.1.4 Major Aquifers

The fluvial and glaciofluvial sand and gravel deposits that occur adjacent to the Elbow River form the main surficial aquifers in the area. These deposits are not extensively used as groundwater supplies as they are in direct connection to surface water bodies and are closed to future development, they have a limited available drawdown, and can be vulnerable to impacts from surface.



Legend

Study Area	Highway	**Proposed Infrastructure**
Base Reservoir Water Level (1399m)	Road	Main Structure
100 Year Flood Water Level (1422m)		Auxillary Earth Cut Spillway

Main Embankment Crest - El. 1429.5m
Combined Permanent Outlet / Spillway Structure
Highway 66 Realignment

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McLean Creek Environmental Overview

Surficial Geology

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PDF: Fig3.1-2 Surficial Geology 14-12-08

Figure 3.1-2

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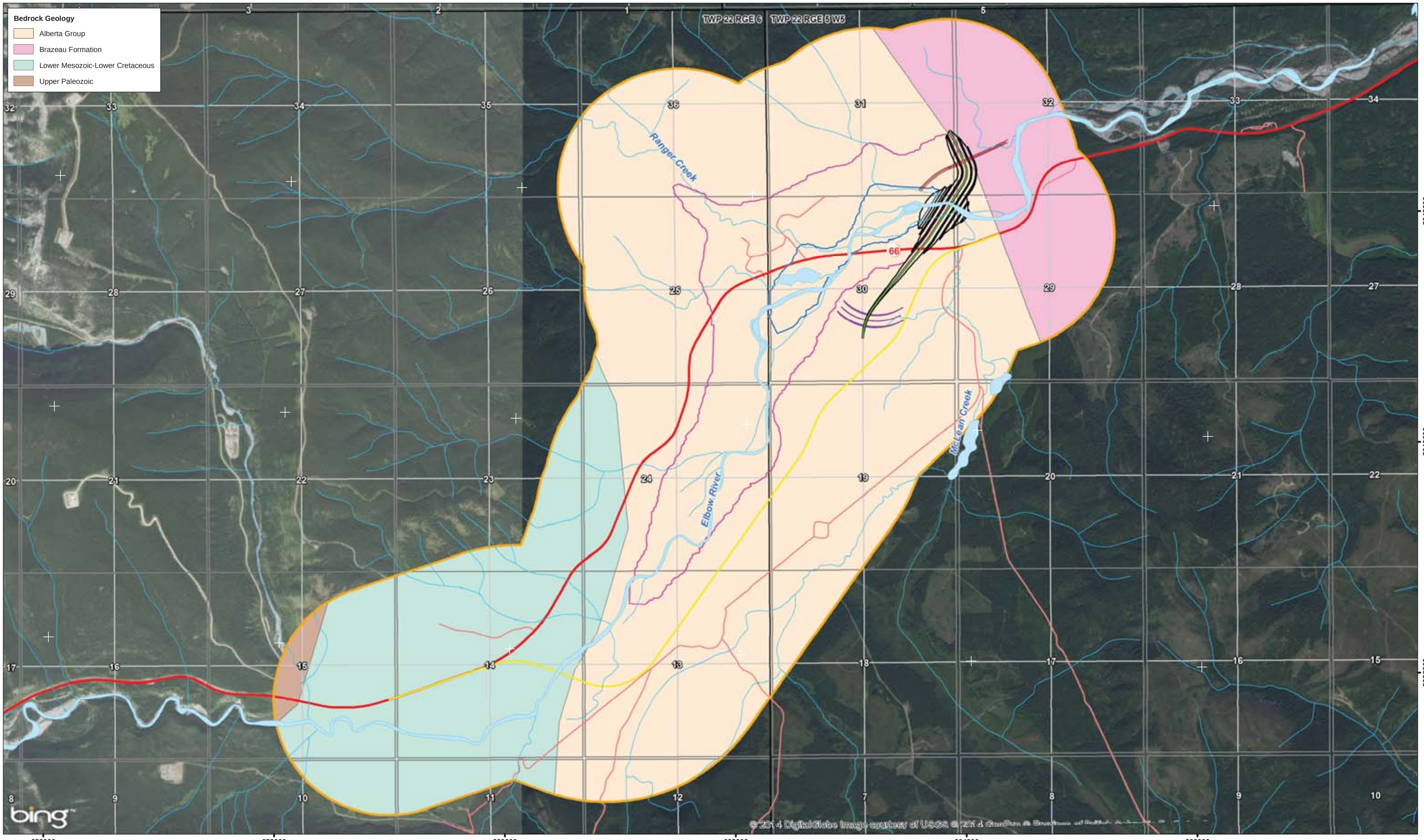


Legend

- Study Area
- Base Reservoir Water Level (1399m)
- 100 Year Flood Water Level (1422m)
- Highway
- Road

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment

N 250 0 250 500 Metres 1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD McLean Creek Environmental Overview	Bedrock Geology	DATE: December 2014 ANALYST: NH QA/QC: TR ST JB PDF: Fig3.1-3 Bedrock Geology 14-12-02	Figure 3.1-3 amec

S:\Gis\Projects\CW2174_Flood_Mitigation\ArcGIS\MC1_EnvReview\Fig3.1-3 Bedrock Geology.mxd

Sandstone units within the Brazeau Formation are the main bedrock aquifers and are the most utilized for water supplies by the landowners and facility operators in the area. Clay-rich tills and glaciolacustrine surficial deposits act as confining layers, as do the mudstone units within the bedrock.

Numerous springs occur in the hydrogeology Study Area and are most likely discharge points for perched aquifers within the Brazeau formation, or at the base of surficial deposits. A number of springs and flowing shot holes have been observed in the northwest portions of the Study Area. A large spring in the Canyon Creek valley has an estimated discharge of 75 L/s (1,000 Imperial gallons per minute [Igpm]) and discharges at several locations. The springs are known to release hydrogen sulphide gas and spring waters contain sulphides and sulphur bacteria colonies. These springs are believed to issue from Paleozoic limestone which contain karst features, in which groundwater flow can be preferentially focused within integrated conduit systems formed by fracturing and dissolution. Figure 3.1-1 contains an air photo map of the Study Area, showing the footprint of the proposed flood control structures, cross-section traces, areal extent of identified aquifers, and other relevant hydrogeological features. Figures 3.1-4 and 3.1-5 contain the hydrogeologic cross-sections.

3.1.1.4.1 Parameters

Hydrogeological mapping by Borneuf (1980) indicates that aquifer yields in the area range from 4.5 to 22.7 L/min (1 to 5 Igpm) in the bedrock aquifers in the eastern portions of the Study Area and between 22.7 and 2,300 L/min (5 and 500 Igpm) in the surficial sands and gravels adjacent to the Elbow River and McLean Creek. In the northwestern portions of the Study Area, bedrock aquifer yields are estimated to be between 22.7 and 2,300 L/min (5 and 500 Igpm) based on more limited data and high discharges from springs issuing from the Paleozoic carbonate bedrock.

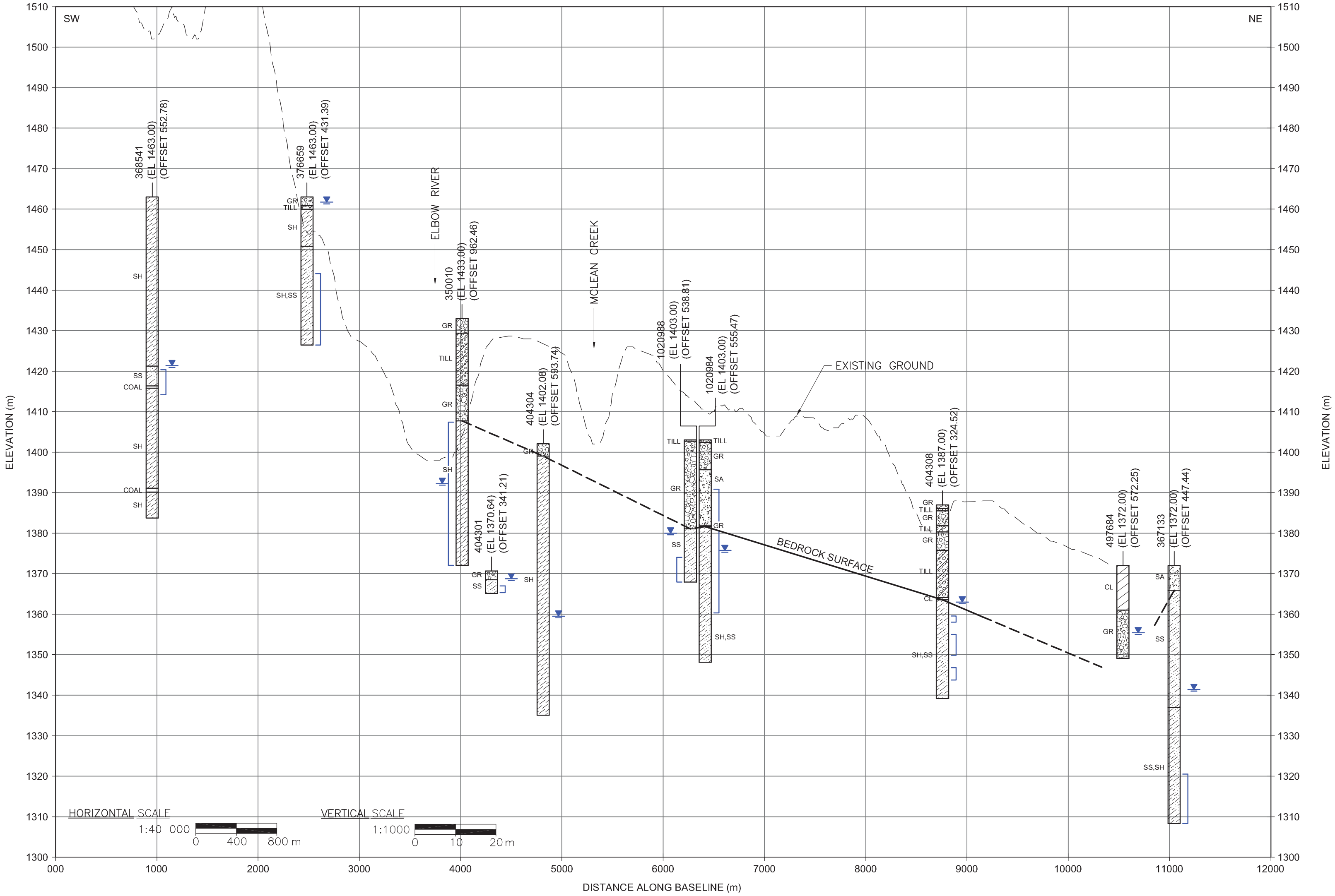
Table 3.1-1 contains a summary of pumping test data from drilling logs included in the Alberta ESRD water well database (ESRD 2014). Transmissivity values are estimated based on an approximation derived from simple drawdown and pumping rate data by Logan (1964). The relation is given as:

$$T = 1.22\ Q / s \qquad (1)$$

Where Q is pumping rate (L^3/t) and s is drawdown (L).

Transmissivities values range between 700 and 2,000 m^2/day for the surficial sand and gravel aquifers and 1 and 44 m^2/day for the sandstone bedrock aquifers. Hydraulic conductivities are calculated and included in Table 3.1-1 based on the transmissivities and assumed aquifer thicknesses.

Figure 3.1-6 shows the location of wells where pumping tests were conducted.



LEGEND:

- CL — CLAY
- SS — SANDSTONE
- SH — SHALE
- SA — SAND
- GR — GRAVEL
- TILL — TILL
- SA,CL — SAND/CLAY
- SA,GR — SAND/GRAVEL
- SH,SS — SHALE/SANDSTONE
- SCREENED INTERVAL
- STATIC WATER LEVEL AT THE TIME OF COMPLETION

NOTES:

1. WELLS LABELLED BY WELL I.D. ON DRILL LOGS.
2. VERTICAL SCALE HAS A 40X EXAGGERATION.
3. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

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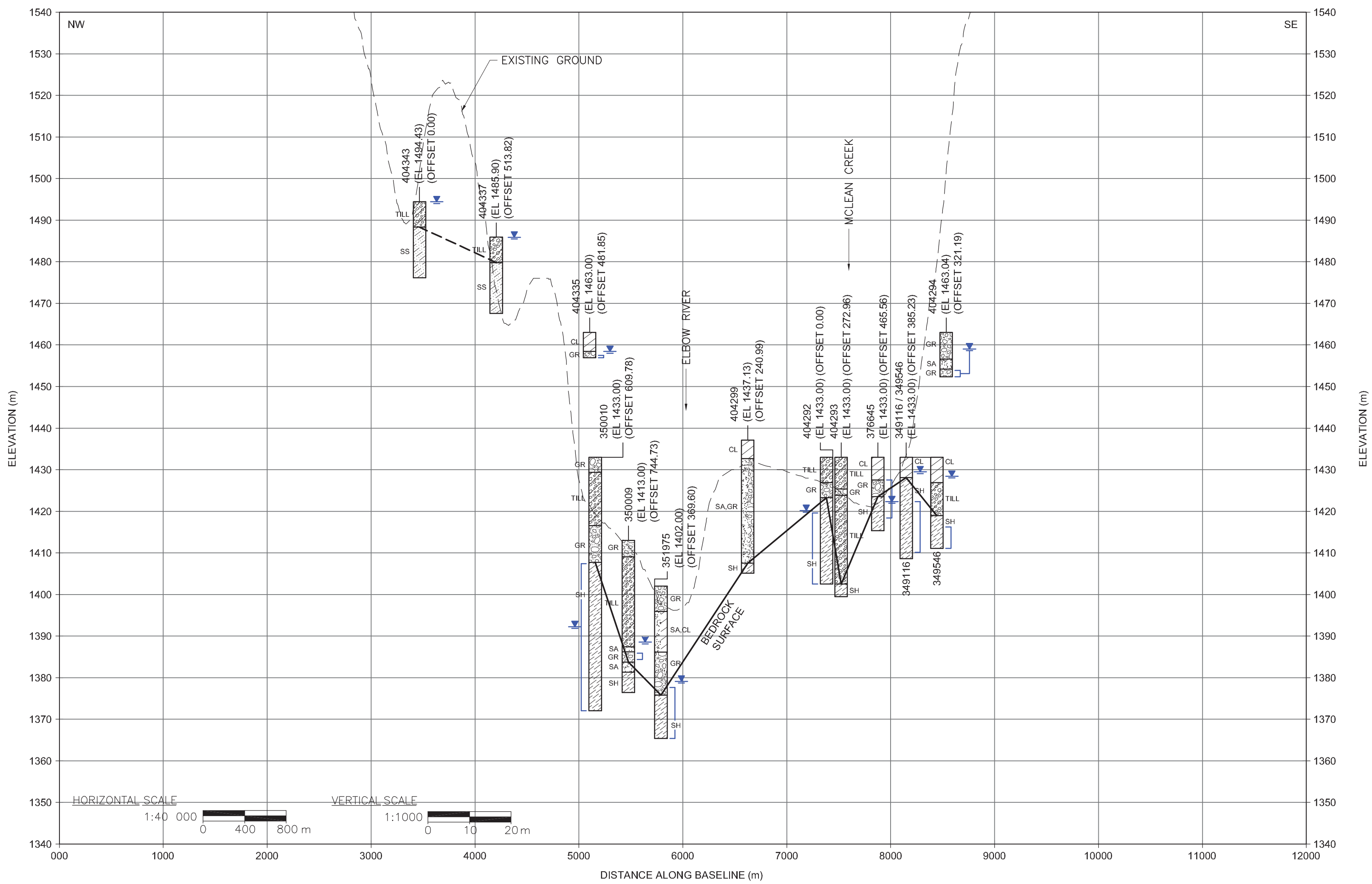
CLIENT: RESILIENCE AND MITIGATION BRANCH ESRD

PROJECT: MCLEAN CREEK ENVIRONMENTAL OVERVIEW

TITLE: SW - NE CROSS SECTION

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
DECEMBER 2014	CW2174	2174–D10.dwg	3.1.4	A



LEGEND:

CL	CLAY
SS	SANDSTONE
SH	SHALE
SA	SAND
GR	GRAVEL
TILL	TILL
SA,CL	SAND/CLAY
SA,GR	SAND/GRAVEL
SH,SS	SHALE/SANDSTONE

SCREENED INTERVAL

STATIC WATER LEVEL AT THE TIME OF COMPLETION

NOTES:

1. WELLS LABELLED BY WELL I.D. ON DRILL LOGS.
2. VERTICAL SCALE HAS A 40X EXAGGERATION.
3. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

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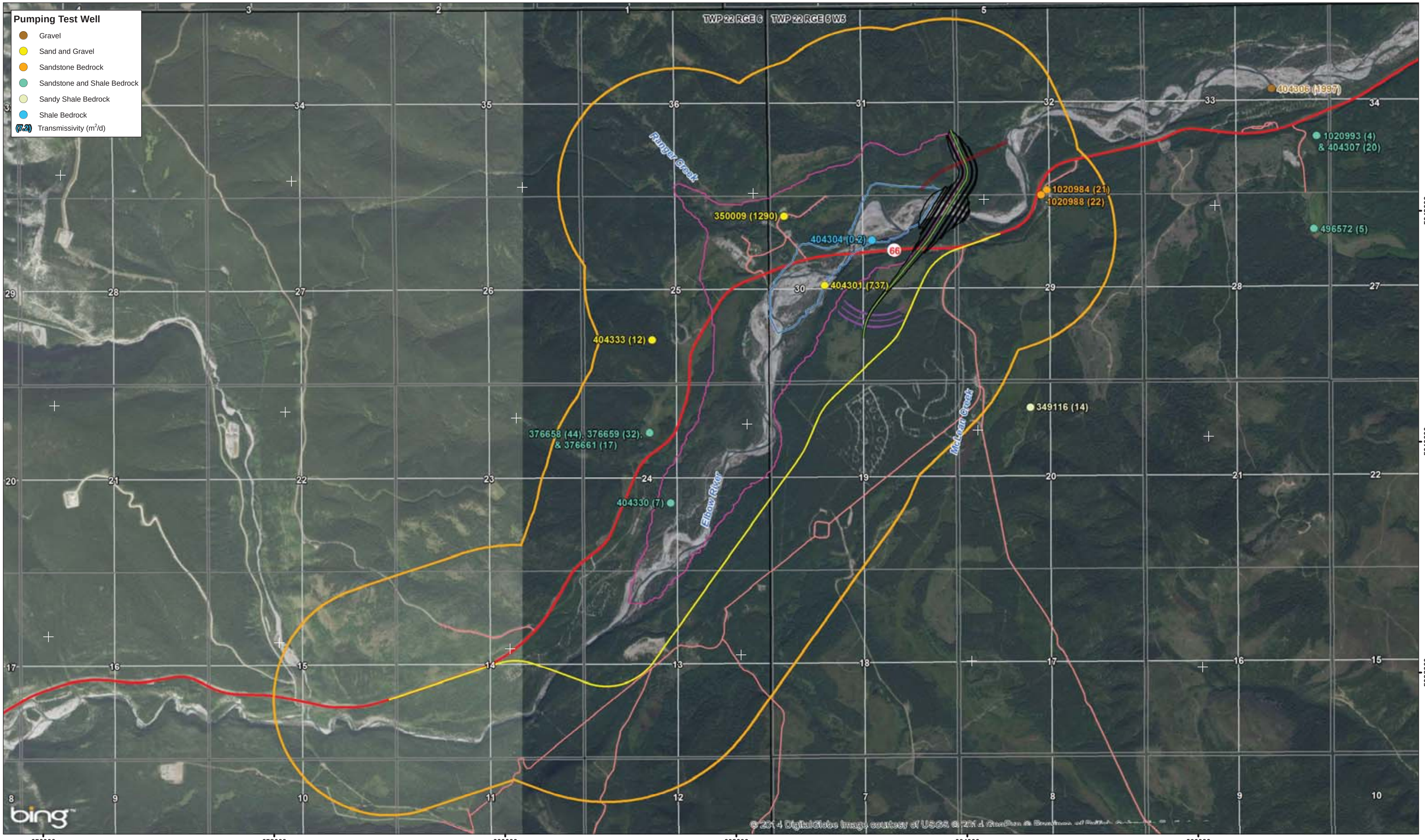
CLIENT: RESILIENCE AND MITIGATION BRANCH ESRD

PROJECT: MCLEAN CREEK ENVIRONMENTAL OVERVIEW

TITLE: NW - SE CROSS SECTION

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
DECEMBER 2014	CW2174	2174–D10.dwg	3.1.5	A



S:\Gis\Projects\CW2174_Flood_Mitigation\ArcGIS\MC1_EnvReview\Fig3.1-6 Pumping Test Data.mxd

Legend

- Study Area
- Base Reservoir Water Level (1399m)
- 100 Year Flood Water Level (1422m)
- Highway
- Road

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment

N 250 0 250 500
Metres
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD

McLean Creek Environmental Overview

Pumping Test Data

DATE:	December 2014
ANALYST:	NH
QA/QC:	TR ST JB
PDF:	Fig3.1-6 Pumping Test Data 14-12-08

Figure 3.1-6

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Table 3.1-1: Summary of Pumping Tests

Well ID	Location	Date	Depth (m)	Well Owner	Static Level (m)	Test Rate (L/min)	Test Duration	Drawdown	Recovery	Transmissivity (m^2/d) (Logan, 1964 approximation)	Aquifer	Aquifer Thickness (m)	Hydraulic Conductivity Estimate (m/s)
349116	NW-20-22-5W5	1995-10-13	24.38	ELBOW VALLEY CAMPGROUNDS #2824	3.51	18.18	120	2.32	68% in 30min	14	sandy shale bedrock	12.2	1.3E-05
350009	NW-30-22-5W5	1997-08-28	36.58	KANANASKIS COUNTRY #3259	24.44	95.47	240	0.13	100% in 5min	1290	sand and gravel	7.3	2.1E-03
376658	NW-24-22-6W5	1979-09-13	30.48	ALTA ENV #WELL 3	3.08	22.73	60	0.91	55% in 24min.	44	sandstone bedrock	23.1	2.2E-05
376659	NW-24-22-6W5	1979-09-14	36.58	ALTA PARKS & REC #WELL 4	1.68	4.55	30	0.25	36% in 30min.	32	sandstone and shale bedrock	15.9	2.3E-05
376661	NW-24-22-6W5	1979-09-11	24.38	ALTA PARKS & REC #WELL 1	2.56	13.64	60	1.41	43% in 25min	17	sandstone and shale bedrock	12.2	1.6E-05
404301	5-30-22-5W5	1981-02-20	5.49	WHISSEL ENT	1.98	486.43	2880	1.16	82% in 13 min.	737	sand and gravel	3.2	2.7E-03
404304	11-30-22-5W5	1972-08-08	67.06	ALTA FOREST SVC	42.98	4.55	120	36.64	-	0.2	shale bedrock	63.7	4.0E-08
404306	0-33-22-5W5	1967-10-19	13.41	ALTA FORESTRY DIV #WELL 2	5.85	68.19	360	0.06	100% in 3min.	1997	gravel	7.3	3.2E-03
404307	SE-33-22-5W5	1966-10-31	31.7	ALTA LANDS & FORESTS	6.1	13.64	360	1.22	75% in 30min.	20	sandstone and shale bedrock	12.2	1.9E-05
404330	6-24-22-6W5	1972-08-14	16.76	ALTA FOREST SVC #WELL 2	13.41	25	60	6.1	-	7	sandstone and shale bedrock	7.6	1.1E-05
404333	SW-25-22-6W5	1973-09-08	9.75	RIVER LOVE GROUP CAMP	0	45.46	60	6.4	62% in 60 min.	12	sand and gravel	9.8	1.5E-05
496572	NE-28-22-5W5	2000-07-18	37.49	CONNOP, JIM	14.87	26.14	120	9.11	93% in 120 min.	5	sandstone and shale bedrock	10.4	5.6E-06
1020984	NE-29-22-5W5	2005-06-03	54.86	CAMP HORIZON	27.16	27.28	1440	2.26	91% in 2640 min.	21	sandstone bedrock	10.1	2.4E-05
1020988	NE-29-22-5W5	2003-05-08	35.05	CAMP HORIZON	22.86	13.64	1440	1.09	100% in 1260 min.	22	sandstone bedrock	8.8	2.9E-05
1020993	SE-33-22-5W5	2005-03-14	47.24	ALTA INFRASTRUCTURE	7.13	18.18	1450	7.74	100% in 300 min.	4	sandstone and shale bedrock	8.2	5.8E-06
341384	SW-35-22-5W5	2000-10-18	60.98	MATHESON G./ISINCLAIR T. #4208	29.39	5.00	160	7.89	98% in 120 min.	1	shale bedrock	31.6	4.1E-07
361161	SW-35-22-5W5	1991-12-06	26.52	MATHESON, GARY	8.09	4.55	720	4.45	100% in 360 min.	2	sandstone bedrock	16.2	1.3E-06
374873	NE-34-22-5W5	1993-11-24	18.29	GRAHAM, TERRY	5.58	36.37	120	2.77	94% in 12 min.	23	shale bedrock	10.1	2.7E-05
378457	6-35-22-5W5	1994-05-06	25.30	MATHESON, GARY	22.80	54.55	120	0.23	74% in 120 min.	417	gravel	2.2	2.2E-03

It should be noted that these test pumping rates are sometimes limited by capabilities of the equipment that are available to the drillers and by the objectives of the drilling programs. The Logan (1964) approximation used to obtain hydraulic parameter estimates assumes long-term steady state pumping conditions and is applied here for comparison purposes only. In applying equation (1) to short duration pumping tests such as those performed by the drilling contractors, the estimates of transmissivity can be in error by as much as 50%. Furthermore, the information obtained from driller's logs in the water well database is not verified by ESRD.

Water Well Database and Active GW Diversion Licences

Within the hydrogeology study area, the Alberta ESRD water well database lists 65 unique water well identifiers. Of these, 42 of these appear to represent unique water wells that have not been recorded as "abandoned". The database also contains record of four flowing geophysical "shot holes" in the northwestern Study Area, and one flowing shot hole in the southwest near McLean Creek. The area is sparsely populated and the majority of the wells are owned by Alberta Ministry of Parks, Recreation and Tourism, Alberta Forestry, and a small number of private recreational facilities.

Records for three wells in the area list an oil company as the well owner, including Husky (ID# 497684), Shell (ID# 368541), and Chevron (ID# 404335). The Chevron and Shell wells are indicated as for "Industrial" use, and the Husky well was for camp water supply. Neither of these wells is known to be currently licensed.

It is possible that only a subset of the records listed in the water well database represent wells currently in operation. The locations of the water wells in the Study Area are shown in Figure 3.1-6. The well records from the Study Area are presented in Appendix B-1.

There are five current groundwater licenses in the Study Area, corresponding to seven diversion points, as summarized in Table 3.1-2.

Table 3.1-2: Groundwater Licenses in the Study Area

Approval ID	Priority	Licensee	Point of Diversion	Volume (m^3)	Diversion Rate (m^3/d)	Purpose
26458	1989-11-08-003	BOW FOREST AREA	16-25-022-06-5	4,536.4	32.73	Municipal
220755	2005-05-26-001	ALBERTA INFRASTRUCTURE, CALGARY	SE-33-022-05-5	4,920	13.5	Other Purpose Specified by the Director
31474	1980-06-06-002	ALBERTA TOURISM, PARKS AND RECREATION	05-30-022-05-5	1,230	163.66	Recreation
31474	1980-06-06-003	ALBERTA TOURISM, PARKS AND RECREATION	05-30-022-05-5	0	163.66	Recreation
198910	2003-07-09-001	EASTER SEALS CAMP HORIZON	NE-29-022-05-5	4,000	15.5	Recreation

Approval ID	Priority	Licensee	Point of Diversion	Volume (m^3)	Diversion Rate (m^3/d)	Purpose
234970	1989-11-08-003	ALBERTA TOURISM, PARKS AND RECREATION	SW-30-022-05-5	3,690	54.64	Recreation
198910	2003-07-09-001	EASTER SEALS CAMP HORIZON	NE-29-022-05-5	4,000	20.5	Recreation

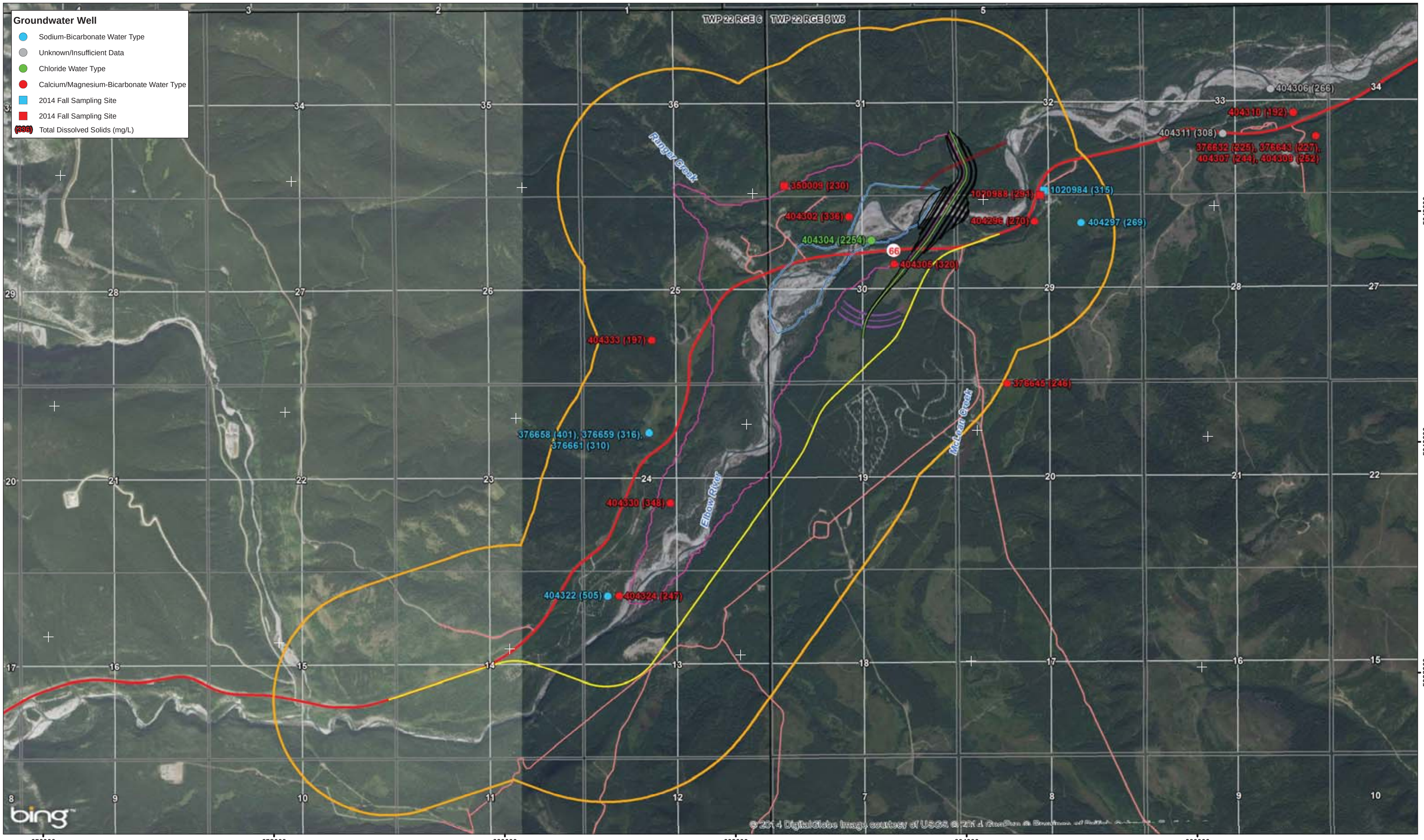
3.1.1.4.2 Groundwater Flow Directions

Lateral groundwater flow direction data are not currently available for the surficial (overburden) and bedrock aquifers within the Study Area. Groundwater levels are available from many of the well drilling reports, but the levels were measured at different times since the 1970s and are, therefore, not useful for interpreting groundwater flow directions. AMEC (2014) completed geotechnical standpipes in mostly till material both north and south of the proposed dam, but groundwater flow direction in the till was not conclusive. Borneuf (1980), however, reports that generally groundwater level trends in both drift and bedrock sediments show the influence of the surface topography, resulting in groundwater movement towards the streams and rivers. Wells on the east side of the Study Area (Jim Connop ID# 496572 and AB Infrastructure ID# 1020993) that are screened in the bedrock (shale and sandstone) had water levels that indicate groundwater flows laterally towards the river.

Also, Borneuf (1980) comments that in bedrock aquifers, nonpumping water levels are fairly deep while water levels in surficial sediments are fairly shallow. This indicates that the vertical movement of groundwater is downward. Wells located immediately south of the proposed dam and screened in the bedrock exhibited groundwater levels between 21.64 and 27.16 m below ground surface (bgs). Water levels in wells ID# 1020984 and 1020988 exhibited comparable water levels from 2009 to 2014 (Appendix B-2). One well (ALTA Parks & Rec ID# 349543) screened partially in the overburden about 1 km west of the proposed dam and next to the Elbow River had a shallow groundwater level (1.83 m bgs). In the same area, a well (Kananaskis Country#3259 ID#350009) screened in the bedrock had a groundwater level of 24.44 m bgs. Based on these readings, the vertical groundwater movement is downward from the surficial sediments to the bedrock.

3.1.1.4.3 Aquifer Water Quality

Laboratory analysis was conducted on groundwater samples collected on 31 October 2014 from three wells (Camp Horizon ID#1020984, Camp Horizon ID#1020988, Kananaskis Country #3259 ID#350009) within the Study Area (Figure 3.1-7). The field sheets and photos of these wells are presented in Appendix B-3 and B-4, respectively. The groundwater samples were analyzed for routine parameters (including major cations and anions), dissolved and total metals, sulphides, nutrients, phenols, and coliforms. The laboratory report is in Appendix B-5 and the results are presented in Table 3.1-3. All the concentrations were below the Federal Guidelines for Drinking Water Quality (Health Canada 2014).



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Legend

Study Area
Base Reservoir Water Level (1399m)
100 Year Flood Water Level (1422m)
Highway
Road

Proposed Infrastructure

Main Structure
Auxillary Earth Cut Spillway
Main Embankment Crest - El. 1429.5m
Combined Permanent Outlet / Spillway Structure
Highway 66 Realignment

N 250 0 250 500
Metres
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch
ESRD
McLean Creek Environmental Overview

Chemistry Data

DATE: December 2014
ANALYST: NH
QA/QC: TR ST JB
PDF: Fig3.1-7 Chemistry Data 14-12-05

Figure 3.1-7

amec

Table 3.1-3: Groundwater Analytical Results (Wells Sampled on 31 October 2014)

Parameter Name	Date Sampled	Matrix ID	Units	Result MDL	CDWQG MAC	Well ID		
						1020984	1020988	350009
						Result	Result	Result
Ammonia, Total (as N)	10/31/2014	Water	mg/L	0.05	---	<0.050	<0.050	<0.050
Colour, True	10/31/2014	Water	CU	5	---	<5.0	<5.0	<5.0
Coliform Bacteria - Fecal	10/31/2014	Water	CFU/100mL	1	ND	<1	<1	<1
Phenols (4AAP)	10/31/2014	Water	mg/L	0.001	---	<0.0010	0.0028	0.0020
Sulphide (as S)	10/31/2014	Water	mg/L	0.0015	---	<0.0015	<0.0015	0.0352
MPN - Total Coliforms	10/31/2014	Water	MPN/100mL	1	---	<1	<1	<1
Total Kjeldahl Nitrogen	10/31/2014	Water	mg/L	0.2	---	<0.20	<0.20	<0.20
Phosphorus (P)-Total	10/31/2014	Water	mg/L	0.005	---	<0.0050	<0.0050	0.0064
Turbidity	10/31/2014	Water	NTU	0.1	---	0.18	<0.10	47.4
Mercury (Hg)-Dissolved	10/31/2014	Water	mg/L	0.000005	---	<0.0000050	<0.0000050	<0.0000050
Aluminum (Al)-Dissolved	10/31/2014	Water	mg/L	0.001	---	0.0010	0.0017	<0.0010
Antimony (Sb)-Dissolved	10/31/2014	Water	mg/L	0.0001	0.006	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	10/31/2014	Water	mg/L	0.0001	0.010	<0.00010	<0.00010	<0.00010
Barium (Ba)-Dissolved	10/31/2014	Water	mg/L	0.00005	1.0	0.142	0.208	0.0978
Boron (B)-Dissolved	10/31/2014	Water	mg/L	0.01	5	0.027	0.015	0.012
Cadmium (Cd)-Dissolved	10/31/2014	Water	mg/L	0.00001	0.005	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Dissolved	10/31/2014	Water	mg/L	0.0001	0.05	<0.00010	<0.00010	<0.00010
Copper (Cu)-Dissolved	10/31/2014	Water	mg/L	0.0001		0.00316	0.0359	0.00028
Lead (Pb)-Dissolved	10/31/2014	Water	mg/L	0.00005	0.010	0.000338	0.00168	<0.000050
Nickel (Ni)-Dissolved	10/31/2014	Water	mg/L	0.0001		0.00015	0.00034	0.00014
Selenium (Se)-Dissolved	10/31/2014	Water	mg/L	0.0001	0.05	0.00039	0.00055	0.00044
Silver (Ag)-Dissolved	10/31/2014	Water	mg/L	0.00001	---	<0.000010	<0.000010	<0.000010
Uranium (U)-Dissolved	10/31/2014	Water	mg/L	0.00001	0.02	0.000312	0.000511	0.000260
Zinc (Zn)-Dissolved	10/31/2014	Water	mg/L	0.005	---	<0.0050	0.0193	<0.0050
Chloride (Cl)	10/31/2014	Water	mg/L	0.1	---	4.34	3.65	2.92
Calcium (Ca)-Dissolved	10/31/2014	Water	mg/L	0.1	---	41.4	69.7	58.3
Iron (Fe)-Dissolved	10/31/2014	Water	mg/L	0.03	---	<0.030	<0.030	<0.030
Magnesium (Mg)-Dissolved	10/31/2014	Water	mg/L	0.1	---	10.9	17.7	14.7

Parameter Name	Date Sampled	Matrix ID	Units	Result MDL	CDWQG MAC	Well ID		
						1020984	1020988	350009
						Result	Result	Result
Manganese (Mn)-Dissolved	10/31/2014	Water	mg/L	0.005	---	<0.0050	<0.0050	0.0091
Potassium (K)-Dissolved	10/31/2014	Water	mg/L	0.5	---	0.60	0.92	0.70
Sodium (Na)-Dissolved	10/31/2014	Water	mg/L	1	---	65.6	10.8	4.0
Ion Balance	10/31/2014	Water	%		---	91.7	89.1	93.2
TDS (Calculated)	10/31/2014	Water	mg/L		---	315	291	230
Hardness (as CaCO3)	10/31/2014	Water	mg/L		---	148	247	206
Nitrate and Nitrite (as N)	10/31/2014	Water	mg/L	0.054	10	0.583	1.82	0.143
Nitrate (as N)	10/31/2014	Water	mg/L	0.05	10	0.541	1.82	0.143
Nitrite (as N)	10/31/2014	Water	mg/L	0.02	1	0.042	<0.020	<0.020
pH	10/31/2014	Water	pH	0.1	---	8.23	8.25	8.24
Conductivity (EC)	10/31/2014	Water	uS/cm	3	---	502	474	408
Bicarbonate (HCO3)	10/31/2014	Water	mg/L	5	---	367	345	235
Carbonate (CO3)	10/31/2014	Water	mg/L	5	---	<5.0	<5.0	<5.0
Hydroxide (OH)	10/31/2014	Water	mg/L	5	---	<5.0	<5.0	<5.0
Alkalinity, Total (as CaCO3)	10/31/2014	Water	mg/L	5	---	301	283	193
Sulfate (SO4)	10/31/2014	Water	mg/L	0.5	---	8.81	10.0	32.8
Mercury (Hg)-Total	10/31/2014	Water	mg/L	0.000005	0.001	<0.0000050	0.0000063	<0.0000050
Aluminum (Al)-Total	10/31/2014	Water	mg/L	0.015	---	<0.015	<0.015	0.015
Antimony (Sb)-Total	10/31/2014	Water	mg/L	0.0005	0.006	<0.00050	<0.00050	<0.00050
Arsenic (As)-Total	10/31/2014	Water	mg/L	0.0005	0.010	<0.00050	<0.00050	<0.00050
Barium (Ba)-Total	10/31/2014	Water	mg/L	0.00025	1.0	0.149	0.222	0.102
Boron (B)-Total	10/31/2014	Water	mg/L	0.05	5	<0.050	<0.050	<0.050
Cadmium (Cd)-Total	10/31/2014	Water	mg/L	0.00005	0.005	<0.000050	<0.000050	<0.000050
Chromium (Cr)-Total	10/31/2014	Water	mg/L	0.0005	0.05	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	10/31/2014	Water	mg/L	0.0005		0.00412	0.0573	<0.0010
Lead (Pb)-Total	10/31/2014	Water	mg/L	0.00025	0.010	0.00034	0.00194	0.00137
Nickel (Ni)-Total	10/31/2014	Water	mg/L	0.0005	---	<0.00050	0.00071	<0.00050
Selenium (Se)-Total	10/31/2014	Water	mg/L	0.0005	0.05	<0.00050	0.00066	<0.00050
Silver (Ag)-Total	10/31/2014	Water	mg/L	0.00005	---	<0.000050	<0.000050	<0.000050

Parameter Name	Date Sampled	Matrix ID	Units	Result MDL	CDWQG MAC	Well ID		
						1020984	1020988	350009
						Result	Result	Result
Uranium (U)-Total	10/31/2014	Water	mg/L	0.00005	0.02	0.000349	0.000618	0.000281
Zinc (Zn)-Total	10/31/2014	Water	mg/L	0.02	---	<0.020	0.025	<0.020
Calcium (Ca)-Total	10/31/2014	Water	mg/L	0.5	---	46.9	80.9	64.6
Iron (Fe)-Total	10/31/2014	Water	mg/L	0.15	---	<0.15	<0.15	15.4
Magnesium (Mg)-Total	10/31/2014	Water	mg/L	0.5	---	13.4	21.9	17.3
Manganese (Mn)-Total	10/31/2014	Water	mg/L	0.025	---	<0.025	<0.025	0.087
Potassium (K)-Total	10/31/2014	Water	mg/L	2.5	---	<2.5	<2.5	<2.5
Sodium (Na)-Total	10/31/2014	Water	mg/L	5	---	78.8	13.4	<5.0

Note:
CDWQG MAC - Canadian Drinking Water Quality Guidelines - Maximum Allowable Concentration.

The water was identified as being sodium-calcium-bicarbonate (well ID# 1020984) and calcium-magnesium-bicarbonate (well ID# 1020988 and ID# 350009). Borneuf (1980) reports that surficial groundwater is usually calcium-bicarbonate and that bedrock groundwater is typically calcium-magnesium-bicarbonate. The sodium content in groundwater may be due to contact with the shale units which are in direct contact with the sandstone aquifers. The Total Dissolved Solids (TDS) concentrations obtained from the samples (230 to 315 mg/L) are in the low end of TDS concentrations detected in surficial and bedrock aquifers (Borneuf 1980).

Historical chemistry data were obtained for 14 wells in the Study Area (Table 3.1-4). Six of the fourteen wells exhibited calcium-bicarbonate or calcium-magnesium-bicarbonate water. The remaining locations contained sodium, potassium and/or sulphate as important constituents. The TDS in the historical samples ranged from 192 to 2,254 mg/L, but the average value (380 mg/L) was closer to the minimum.

The wells in the Study Area were assessed on whether they are groundwater under the direct influence of surface water (GWUDI) sources in accordance with the Assessment Guideline for GWUDI (AENV 2006). The criteria consist of 1) sensitive setting 2) proximity to surface water, 3) well construction and 4) water quality. Within the Study Area, some of the wells are in a sensitive area because the production zones are less than 15 m below ground surface and some wells are in an unconfined aquifer. Some wells appear to be located within 100 m of an open water feature. The integrity of the surface seal of some wells is uncertain. Further hydrogeological investigation would be required to confirm that the groundwater sources are GWUDI. Because there is some uncertainty, it is assumed that all the well sources are GWUDI at this time.

3.1.2 Discussion

3.1.2.1 Potential Project Effects

During construction of the dam and spillway, excavation through surficial gravels and/or shallow bedrock could intercept perched aquifers, possibly creating issues with short-term groundwater seepage control and management. AMEC (2014) noted gravel zones beneath the clay till in the area which may be a highly conductive zone of water seepage. A similar problem was observed at the Chain Lakes Dam spillway following construction in the 1960s, so groundwater seepage and control was taken into consideration in planning for construction of a new spillway (AMEC 2013).

Another possible impact could occur during flood control operations. Well owners/operators downstream of the facilities could be affected in the long term as any changes in the river level may be reflected in the levels of their wells, particularly if the wells are completed in surficial aquifers. Most wells in the Study Area are completed in bedrock aquifers.

Some wells are located within the permanent pond and 100 year flood footprint. If the wells are left open, hydraulic short-circuiting could occur between the surface water and confined aquifer water. This short-circuiting could impact the groundwater chemistry of the area.

Table 3.1-4: Historical Groundwater Chemistry Data

WELL ID No:	376632	376643	376645	376658	376658	376659	376659	376661	376661	404296	404296	404297	404302	404304	404305	404306	404307	404307	404307	404309	404310	404311	404322	404322	404324	404330	404333
WQ Constituent\ Samp. Date	**1982-03-12**	**1982-03-12**	**1977-12-13**	**1979-09-17**	**1979-09-17**	**1979-09-17**	**1979-09-17**	**1979-09-12**	**1979-09-12**	**1972-08-09**	**1982-07-26**	**1977-05-10**	**1983-02-07**	**1972 -08-08**	**1974-11-20**	**1970-06-25**	**1970-06-25**	**1984-04-17**	**1984-11-16**	**1984-03-05**	**1972-05-18**	**1970-06-25**	**1978-08-21**	**1972-08-11**	**1978-08-21**	**1972-08-14**	**1973-09-09**
Ion Balance	---	---	---	---	---	---	---	---	---	---	0.95	1.06	0.92	---	0.98	---	---	0.9	0.96	0.93	---	---	1	---	0.99	---	---
SAR	0.5	0.6	---	---	---	1.3	1.3	0.7	0.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Total Alkalinity	219.0	196.0	144	223	223	194	194	185	185	246	244	262	314	1,446.0	290	179	303	234	232	241	166	241	387	284	241	214	152
TDS	225.0	227.0	246	401	401	316	316	310	310	366	270	269	336	2,254	320	266	372	237	244	252	192	308	505	525	247	348	197
Calcium	52.0	53.0	48.0	30.0	30.0	---	---	---	---	32.0	50.0	43.0	94.0	5	104.0	---	---	35.0	48.0	45.0	58.0	---	56.0	25.0	68.0	28.0	42.0
Chloride	---	5.0	1.0	ND	ND	ND	ND	ND	ND	7.0113	ND	ND	12.0168	160.2	ND	2.0	2.0	ND	5.0	ND	---	2.0	54.1	39.1	ND	1.0	ND
Nitrate-N	---	0.0	0.3	0.0	0	---	---	---	---	---	---	---	---	---	ND	---	---	---	---	---	0	---	---	---	---	---	ND
Sodium	16.0	18.0	22.0	71.0	71.0	35.0	35.0	21.0	21.0	---	40.0	57.0	7.0	---	2.001	---	---	45.0	31.0	38.0	3.8	---	128.0	---	5.0	---	3.0
No_2 + No_3	---	ND	---	---	---	ND	ND	ND	ND	0.2	0.2	ND	0.3	ND	---	---	---	ND	ND	ND	---	---	0.63	0.2	ND	0.1	---
Iron	0.2	4.5	0.33	0.3	0.3	0.3	0.3	0.1	0.1	-0.1	0.06	1.98	0.03	0.9	0.1	0.07	0.07	0.7	0.13	1.27	0.07	0.04	0.44	1.1	0.12	1.2	0.6
Conductivity	380.0	380	427	390	390	350	350	310	310	436	465	480	624	3,050	400	335	493	440	447	451		431	904	680	453	435	360
Fluoride	0.1	0.2	0.3	0.85	0.85	0.18	0.18	0.75	0.75	0.45	0.18	0.19	0.13	1.7	0.17	---	---	0.16	0.15	0.14	0.14	---	1.09	0.68	0.11	0.16	0.4
PH	8.2	7.4	7.5	8.4	8.4	8.3	8.3	8.5	8.5	8	8.4	8.1	7.6	8.4	8.3	---	---	8.1	8.1	7.8	8.5	---	8	7.5	7.9	7.4	8.1
SiO_2	---	---	---	---	---	---	---	---	---	---	7.1	8.9	8.7	---	---	---	---	7.5	9.2	6.8	---	---	7.3	---	8	---	---
Bicarbonate	267.0	239.0	175.0	267.0	267.0	237.0	237.0	216.0	216.0	---	291.0	319.0	382.0	---	354.0	---	---	285.0	283.0	294.0	159.0	---	472.0	---	294.0	---	185.0
Carbonate	---	---	---	---	---	---	---	---	---	---	ND	---	---	---	---	---	---	---	---	---	7.0	---	---	---	---	---	---
Magnesium	14.0	14	15.0127	---	---	40.0	40.0	51.0	51.0	9.0	11.0	11.0	17.0	2.0	11.0	---	---	8.0	12.0	10.0	14.2	---	16.0	13.0	17.0	12.0	19.0
Nitrite-N	---	---	ND	---	---	---	---	---	---	---	ND	ND	ND	---	ND	---	---	ND	ND	ND	---	---	ND	---	ND	---	ND
Potassium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	---	0.82	0.716	0.92	---	0.612	---	---	122.8	0.82	0.82	0.408	---	1.432	---	0.716	---	0.82
Sulphate	10.0	17.0	70.1	29.0	29.0	5.0	5.0	19.0	19.0	ND	20.0	ND	15.0	125.2	25.0	76.1	17.0	7.0	8.0	12.0	29.0	36.1	16.0	43.1	ND	30.0	37.1
Total Hardness	192.0	190	184	95	95	125	125	160	160	118	170	154	305	24	307	174	24	120	169	154	203	141	204	119	240	125	182

Note:
ND – Non-detection.

3.1.2.2 Potential Mitigation Measures

The following mitigation measures could be used to address potential seepage and groundwater control problems that could occur during and following construction:

- delineation of any perched aquifers that could be intersected by construction activities;
- calculation of accurate estimates of hydrogeologic parameters and potential groundwater seepage rates;
- a dewatering system could be put in place during the construction phase that is capable of removing groundwater at extraction rates equal to and exceeding the estimated groundwater seepage rates, taking into consideration appropriate factors of safety; and
- water could be diverted from the construction area so as not to impact downstream natural water quality.

If it becomes apparent that groundwater seepage will continue beyond construction activities and during operation of the Project, then a permanent drain system or similar groundwater control structure could be included in the dam/spillway design.

Changes in groundwater levels due to changing river levels could require the following mitigation measures:

- adjustment/lowering of pumps in affected private water wells;
- possible abandonment of seriously affected wells and installation of replacement wells; and
- transfer of groundwater licenses to replacement wells or alternate wells.

During construction activities, the wells within the permanent pool and 100 year flood footprints should be inspected to confirm the status of each well. If necessary, the wells would require decommissioning to prevent hydraulic short-circuiting between the surface water and groundwater.

3.1.2.3 Data Gaps

Design of groundwater control and seepage management systems requires site specific measurements of hydrogeological parameters, not just estimates. The extent and geometry of any saturated subsurface materials that are intersected, including perched aquifers, would have to be delineated by field investigations, including borehole drilling, monitoring well installation, and groundwater well monitoring. Existing pumping test data would have to be analyzed using standard analytical methods. However, much of the existing pumping test data from the water well database is of short duration with incomplete data and may contain errors. For this reason, it may be necessary to conduct new pumping tests in existing wells close to the construction area. Additional wells may need to be installed for testing purposes in areas with few wells.

Downstream effects on well water levels would have to be properly understood prior to construction. Possible downstream effects can be assessed by monitoring changes in well water levels and river levels with time to determine if there is a direct relationship between groundwater and the river. Continuous monitoring is usually a part of the conditions of maintaining a Water Act license, but domestic wells are not as closely monitored or may not require a license.

3.1.3 Literature Cited

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3.2 Surface Water Quality

The Project site is located upstream of the small community of Bragg Creek in the upper watershed of the Elbow River. The drainage surface in the upper watershed is primarily over natural areas with some use for outdoor recreation and livestock grazing.

This section describes the key surface water quality parameters of the area, the potential impacts of the proposed Project, best management practices and possible mitigative measures to reduce impacts. Should the Project proceed past the conceptual stage, data gaps are identified that should be filled to complete a full environmental impact assessment.

Methods can be found in Appendix A.

3.2.1 Results

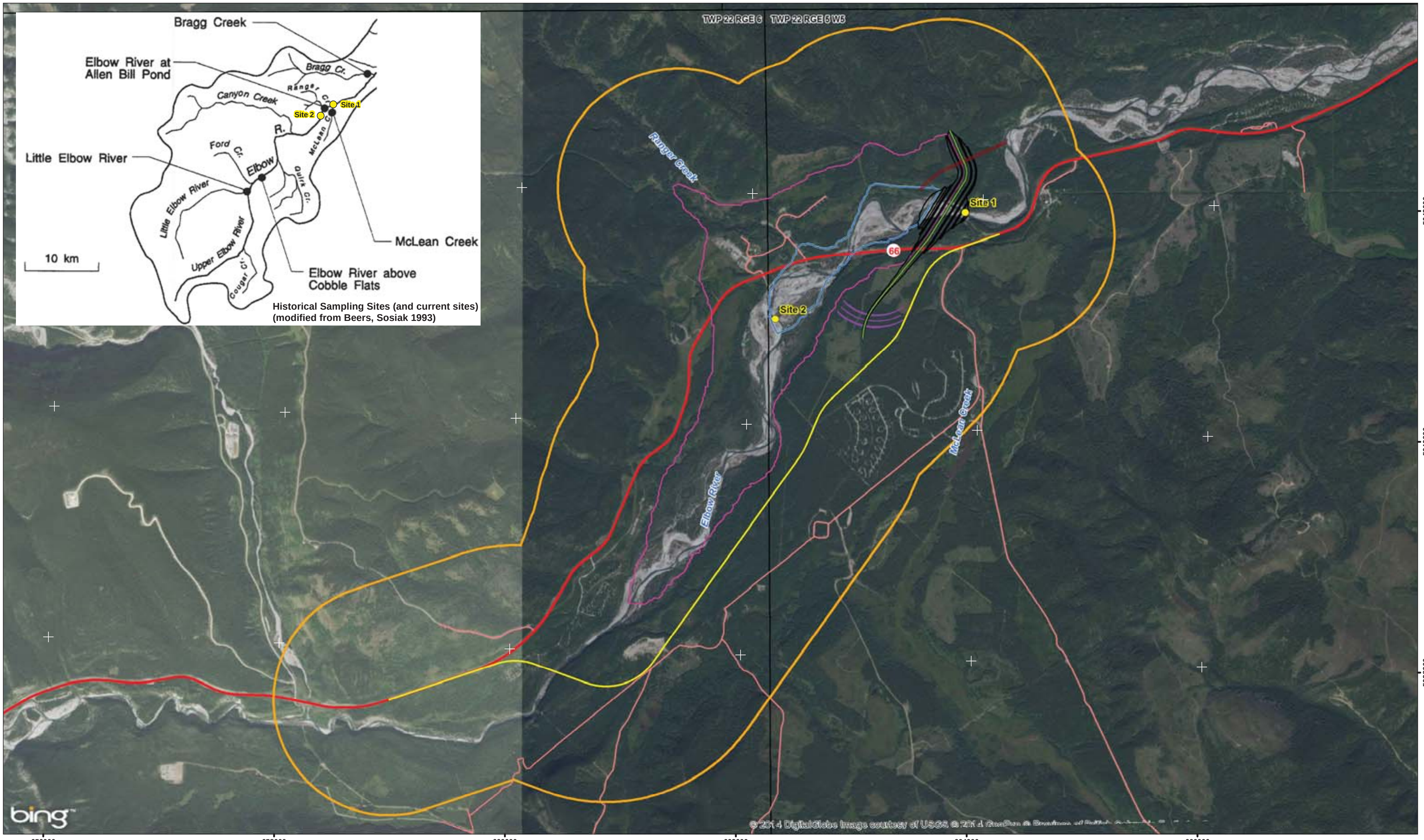
The majority of water quality studies completed in the Elbow River are related to the Glenmore Reservoir and the river reach immediately upstream of the reservoir (Sosiak 1999; Sosiak and Dixon 2004, 2006). These studies showed that the water quality in the Elbow River, upstream of Glenmore Reservoir, deteriorates as it flows downstream, mostly due to land development and agricultural activities. Currently water quality supplied to the Glenmore Reservoir is of an acceptable level.

Surface water quality information in the Study Area is unavailable with the exception of two sampling events done in the winter of 1988-89 and found in Alberta Environment protection Report (Beers and Sosiak 1993) and repeated in 2003-04 by the University of Calgary. The sampling sites were located upstream (at Cobble Flats) and downstream (at Allan Bill Pond) from the proposed Project. Samples were tested for major ions, nutrients, metals, and microbiological characteristics (University of Calgary 2003). Sample sites are shown in Figure 3.2-1.

The limited number of water quality parameters discussed in the historical studies showed low concentrations that are typical for upstream reaches of mountainous streams. Nutrients (nitrogen and phosphorus) did not vary between upstream and downstream sites. However, total dissolved solids (TDS) and conductivity showed increases between upstream and downstream sites. This same pattern was observed in calcium concentrations.

The river is well mixed, and has a healthy dissolved oxygen level. The late fall 2014 sampling event shows that the water quality in the Study Area is of high quality (Table 3.2-1), no exceedances were recorded for all parameters except the presence of microbiological characteristics (Total Coliforms and E.Coli).

Recent studies in the Upper Elbow River (Sosiak and Dixon 2004) found ruminant markers in all sampling locations. These results confirm that ruminant animals are present upstream from all locations where such markers were found, even in the headwaters in the Elbow River at Cobble Flats. These ruminants could be either cattle or ruminant wildlife such as sheep or deer. No human markers were found at headwaters sites (Sosiak and Dixon 2006) and the results provide no evidence that coliforms in the Upper Elbow River are related to human sources, such as septic tank leachate. The sampling results from fall 2014 at the Project site also show presence of E.Coli and Total Coliforms in water samples (Table 3.2-1).



Legend

- Study Area
- Base Reservoir Water Level (1399m)
- 100 Year Flood Water Level (1422m)
- Highway
- Road

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment
- 2014 Fall Sampling Site

N 250 0 250 500
Metres
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD

McLean Creek Environmental Overview

Water Quality Sampling Sites

DATE: November 2014
ANALYST: NH
QA/QC: TR ST JB
PDF: Fig3.2-1 WQ Sampling Sites 14-11-28

Figure 3.2-1

amec

S:\Gis\Projects\CW2174_Flood_Mitigation\ArcGIS\MC1_EnvReview\Fig3.2-1 WQ Sampling Sites.mxd

The limited data indicated an increased role of groundwater in upper Elbow River surface water chemistry. This is shown by typical increases in TDS concentrations on a seasonal basis in 1989 – 1993, as well as in 2002 – 2003 studies. These results support the existence of surface and groundwater interactions, likely through alluvium deposits under and near the river channel.

3.2.2 Discussion

Potential effects on surface water quality from dam construction and creation of a permanent reservoir approximately 2 km long with maximum width of about 450 m are associated with changes in hydrologic regime of the Elbow River. Typical effects associated with the reservoir, or upstream area, would be related to slower stream velocities, creation of a deeper water body that would collect sediments, water level fluctuations in the reservoir and potential erosion of reservoir banks. The potential effects of the Project on water quality downstream of the dam includes changes to the sediment transport regime and a potential increase in organic matter content from soils erosion and vegetation decomposition.

The reservoir would be constructed for flood protection. Thus, a substantial water level fluctuation would be a part of the normal operating regime. At the maximum forecasted flood event of 1:100 years the reservoir size would enlarge to the length of approximately 5 km with the maximum width approaching more than 1 km (the full supply level). The hydrologic and potential erosion effects at the full supply level are assumed to be much larger compared to effects from creation of the permanent pond.

Potential changes to surface water quality would consider impacts from natural and anthropogenic influences, and the major water quality parameters that could be affected include:

- Water temperature and dissolved oxygen;
- Total suspended solids (TSS);
- Nutrients (nitrogen and phosphorus); and
- Microbiology (Total and fecal coliforms).

All of these parameters are related to soil erosion and sediment transport. Most of potential contaminants would originate in the watershed and adhere to soil particles or sediments in streams.

Table 3.2-1: Water Quality Analytical Results for McLean Creek

Parameter	Units	Guidelines			Sampling sites				MDL
		Aquatic Life		Canadian Drinking Water Quality (GCDWQ)	Site 1	Site 2	Site 1 (Duplicate)	Site 4 (Field Blank)	
		CCME (2014)	ESRD (2014)	Health Canada 2012	05-Nov-14	05-Nov-14	05-Nov-14	05-Nov-14	
Field Measured									
Temperature	°C	-	[b1]	≤15 [c1]	3.6	3.7	-	-	-
Specific Conductivity	µS°C/cm	-	-	-	396	395	-	-	-
Dissolved Oxygen (DO)	mg/L (ppm)	6.5 or 9.5 [a1]	6.5 or 9.5	-	9.2	**10.3**	-	-	-
Conventional Parameters and Major Ions									
Alkalinity, Total (as CaCO3)	mg/L (ppm)	-	-	-	141	142	140	<5.0	5
Bicarbonate	mg/L (ppm)	-	-	-	170	170	170	<5.0	5
Calcium, Total	mg/L (ppm)	-	-	-	53	53.1	52.7	<0.50	0.5
Carbonate	mg/L (ppm)	-	-	-	<5.0	<5.0	<5.0	<5.0	5
Chloride	mg/L (ppm)	120	120	≤250 [c1]	0.54	0.44	0.41	<0.10	0.1
Conductivity	µS°C/cm	-	-	-	386	387	386	<3.0	3
Hardness (as CaCO3)	mg/L (ppm)	-	-	-	198	197	194	<0.50	1.3
Magnesium, Total	mg/L (ppm)	-	-	-	14.3	14.1	14.1	<0.10	0.1
pH	pH Units	6.5 to 9.0	6.5 to 9.0	6.5 to 8.5 [c1]	8.33	8.33	8.31	6.58	0.1
Potassium, Total	mg/L (ppm)	-	-	-	<0.50	<0.50	<0.50	<0.50	0.5
Sodium, Total	mg/L (ppm)	-	-	≤200 [c1]	1.3	1.3	1.3	<1.0	1
Sulphate	mg/L (ppm)	-	[b4]	≤500 [c1]	66.8	67	66.3	<0.50	0.5
Total dissolved solids	mg/L (ppm)	-	-	≤500 [c1]	224	224	221	<1.0	-
Total suspended sediments	mg/L (ppm)	[a2]	[b2]	-	<3.0	<3.0	<3.0	<3.0	3
Turbidity	NTU	-	[b3]	1 [c2]	0.26	0.27	0.26	<0.10	0.1
Nutrients and Organics									
Ammonia, Total (as N)	mg/L (ppm)	7.0 - 48.3 [a3]	[b5]	-	<0.050	<0.050	<0.050	<0.050	0.05
Nitrate (as N)	mg/L (ppm)	2.9 [a4]	3	10 [c3]	0.151	0.131	0.131	<0.050	0.05
Nitrate and Nitrite (as N)	mg/L (ppm)	-	-	-	0.151	0.131	0.131	<0.054	0.054
Nitrite (as N)	mg/L (ppm)	0.06 [a5]	[b6]	1 [c3]	<0.020	<0.020	<0.020	<0.020	0.02
Orthophosphate-Dissolved (as P)	mg/L (ppm)	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	0.005
Total Kjeldahl Nitrogen	mg/L (ppm)	-	-	-	<0.20	<0.20	<0.20	<0.20	0.2
Phosphorus, Total	mg/L (ppm)	[a6]	[b7]	-	<0.0050	<0.0050	<0.0050	<0.0050	0.005
Total Metals									
Aluminum	µg/L (ppb)	5 or 100 [a7]	-	100 [c4]	8.3	7.8	6.6	<5	5
Antimony	µg/L (ppb)	-	-	6 [c2]	<0.4	<0.4	<0.4	<0.4	0.4
Arsenic	µg/L (ppb)	5	5	10 [c2]	<0.4	<0.4	<0.4	<0.4	0.4
Barium	µg/L (ppb)	-	-	1,000 [c2]	48.3	46.3	48.8	<3	3
Beryllium	µg/L (ppb)	-	-	-	<1	<1.0	<1	<1	1
Boron	µg/L (ppb)	1500	1500	5,000 [c2]	<50	<50	<50	<50	50
Cadmium	µg/L (ppb)	[a8]	[b8]	5 [c2]	<0.01	<0.01	<0.01	<0.01	0.01
Chromium	µg/L (ppb)	1 [a9]	-	50 [c2]	<1	<1.0	<1	<1	1
Cobalt	µg/L (ppb)	-	-	-	<2	<2.0	<2	<2	2
Copper	µg/L (ppb)	[a10]	7 or [b8]	≤1,000 [c1]	<1	<1.0	<1	<1	1
Iron	µg/L (ppb)	300	-	≤300 [c1]	12	11	<10	<10	10
Lead	µg/L (ppb)	[a11]	[b8]	10	<0.1	<0.1	<0.1	<0.1	0.1

Parameter	Units	Guidelines			Sampling sites				MDL
		Aquatic Life		Canadian Drinking Water Quality (GCDWQ)	Site 1	Site 2	Site 1 (Duplicate)	Site 4 (Field Blank)	
		CCME (2014)	ESRD (2014)	Health Canada 2012	05-Nov-14	05-Nov-14	05-Nov-14	05-Nov-14	
Total Metals (cont)									
Manganese	µg/L (ppb)	-	-	≤50 c1	<2	<2.0	<2	<2	2
Mercury	µg/L (ppb)	0.026	0.005 b9	1 c2	<0.005	<0.005	0.013	0.018	0.005
Molybdenum	µg/L (ppb)	73	73	-	<5	<5	<5	<5	5
Nickel	µg/L (ppb)	a12	b8	-	<2	<2	<2	<2	2
Selenium	µg/L (ppb)	1	1	10 c2	0.61	0.64	0.61	<0.4	0.4
Silver	µg/L (ppb)	0.1	0.1	-	<0.02	<0.2	<0.02	<0.02	0.02
Uranium	µg/L (ppb)	15	15	20 c2	0.39	0.39	0.4	<0.1	0.1
Vanadium	µg/L (ppb)	-	-	-	<1	<1	<1	<1	1
Zinc	µg/L (ppb)	30	30	≤5,000 c1	<4	<4	<4	<4	4
Dissolved Metals									
Aluminum	µg/L (ppb)	-	50b10	-	<5	<5	<5	<5	5
Antimony	µg/L (ppb)	-	-	-	<0.4	<0.4	<0.4	<0.4	0.4
Arsenic	µg/L (ppb)	-	-	-	<0.4	<0.4	<0.4	<0.4	0.4
Barium	µg/L (ppb)	-	-	-	45.6	44	45.6	<3	3
Beryllium	µg/L (ppb)	-	-	-	<1	<1	<1	<1	1
Boron	µg/L (ppb)	-	-	-	<50	<50	<50	<50	50
Cadmium	µg/L (ppb)	-	-	-	<0.01	<0.01	<0.01	<0.01	0.01
Chromium	µg/L (ppb)	-	-	-	<1	<1	<1	<1	1
Cobalt	µg/L (ppb)	-	-	-	<2	<2	<2	<2	2
Copper	µg/L (ppb)	-	-	-	<1	<1	<1	<1	1
Iron	µg/L (ppb)	-	300	-	<10	<10	<10	<10	10
Lead	µg/L (ppb)	-	-	-	<0.1	<0.1	<0.1	<0.1	0.1
Manganese	µg/L (ppb)	-	-	-	<2	<2	<2	<2	2
Mercury	µg/L (ppb)	-	-	-	0.0077	0.0418	0.0173	0.0185	0.005
Molybdenum	µg/L (ppb)	-	-	-	<5	<5	<5	<5	5
Nickel	µg/L (ppb)	-	-	-	<2	<2	<2	<2	2
Selenium	µg/L (ppb)	-	-	-	0.69	0.7	0.64	<0.4	0.4
Silver	µg/L (ppb)	-	-	-	<0.02	<0.02	<0.02	<0.02	0.02
Uranium	µg/L (ppb)	-	-	-	0.42	0.4	0.41	<0.1	0.1
Vanadium	µg/L (ppb)	-	-	-	<1	<0.1	<1	<1	1
Zinc	µg/L (ppb)	-	-	-	<4	9.9	<4	<4	4
Biological Parameters									
Coliform Bacteria - Fecal	CFU/100mL	-	-	-	2	1	5	<1	1
MPN - E. Coli	MPN/100mL	-	-	None detectable per 100mL	**1**	**1**	**4**	<1	1
MPN - Total Coliforms	MPN/100mL	-	-	None detectable per 100mL	**31**	**23**	**29**	<1	1

Note:
Values highlighted and bolded exceed the water quality guidelines.

Part 1. Water Quality Guidelines for the Protection of Aquatic Life

CEQG (CCME - Federal)

a1 = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.
a2 = Guideline assumes clear flow conditions and is based on the following:
Clear flow - Maximum increase of 25 mg/L (TSS) or 8 NTU (turbidity) from background levels for any short-term exposure (e.g., 24-h period).
Maximum average increase of 5 mg/L (TSS) or 2 NTU (turbidity) from background levels for longer term exposures (e.g., > 24-h).
High flow - Maximum increase of 25 mg/L (TSS) or 8 NTU (turbidity) from background levels at any time when background levels are between 25 and 250 mg/L (TSS) or 80 NTU (turbidity). Should not increase more than 10% of background levels when background is >250 mg/L (TSS) or >80 NTU (turbidity).
a3 = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15oC) and 48.3 mg/L (pH= 6.5, temperature= 5oC).
a4 = Guideline is expressed as nitrate-N.
a5 = Guideline is expressed as nitrite-N.
a6 = The trophic status of lakes is assessed using the total phosphorus concentrations. The Canadian Trigger Ranges are as follows: ultra-oligotrophic - <0.004 mg/L; oligotrophic - 0.004 to 0.01 mg/L; mesotrophic - 0.01 to 0.02 mg/L; meso-eutrophic - 0.02 to 0.035 mg/L; eutrophic - 0.035 to 0.1 mg/L; and hyper-eutrophic - >0.1 mg/L.
a7 = Guideline = 5 µg/L at pH < 6.5, [Ca2+] < 4 mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5, [Ca2+] ≥4 mg/L and DOC ≥ 2 mg/L.
a8 = The short-term benchmark concentration of 1.0 µg·L-1 is for waters of 50 mg CaCO3·L-1 hardness. At other hardness values, the benchmark can be calculated with the equation:
Benchmark = 10{1.016(log[hardness]) – 1.71}, valid for hardness between 5.3 and 360 mg CaCO3·L-1.
a9 = Guideline is for hexavalent chromium (Cr_{VI}) because its guideline is more stringent than the trivalent chromium (Cr_{III}) guideline of 8.9 µg/L.
a10 = Copper guideline is dependent on [CaCO3] with a minimum of 2 µg/L. Guideline = $e^{0.8545[\ln(hardness)]-1.465}$*0.2.
a11 = Lead guideline is dependent on [$CaCO_3$]. Guideline = $e^{1.273[\ln(hardness)]-4.705}$.
a12 = Nickel guideline is dependent on [$CaCO_3$]. Guideline = $e^{0.76[\ln(hardness)]+1.06}$.

AWQG (Alberta Environment - Environment and Sustainable Resource Development)

b1 = Thermal additions should not alter thermal stratification or turnover dates, exceed maximum weekly average temperatures, nor exceed maximum short term temperatures.
b2 = During clear flows or for clear waters: Maximum increase of 25mg/L from background for any short term exposure (e.g., 24 hours). Maximum average increase of 5mg/L from background levels for longer term exposure.
During high flow or for turbid waters: Maximum increase of 25mg/L from background levels at anytime when background levels are between 25 and 250mg/L. Should not increase more than 10% of background levels when background is greater than or equal to 250mg/L.
b3 = For clear waters: Maximum increase of 8NTU from background for any short term exposure (e.g., 24 hours). Maximum average increase of 2 NTU from background levels for longer term exposures (greater than 24 hours).
For high flow or turbid waters: Maximum increase of 8NTU from background levels at any time when background levels are between 8 and 80NTU. Should not increase more than 10% of background levels when background greater or equal to 80NTU.
b4 = Varies with hardness
b5 = Varies with pH and temperature; Total NH_3 guideline (as N) N= (0.019/f)*0.8224; f=1/10[(pka-ph)+1], where f=un-ionized ammonia fraction.
b6 = Varies with chloride concentration.
b7 = Narrative; varies by water body type and nitrogen/phosphorus fluctuations in relation to aquatic health.
b8 = Equation, varies with hardness: acute guideline for copper, chronic guideline for lead, acute/chronic guidelines for cadmium and nickel.
b9 = Acute guideline for mercury is 0.013 µg/L.
b10 = Acute: 100 mg/L, if pH <6.5, guideline = (e $^{(1.6-3.327(pH)+0.402(pH)n2)}$)*1000; Chronic: 50 mg/L, if pH <6.5, guideline = (e $^{(1.6-3.327(pH)+0.402(pH)n2)}$)*1000.

Part 2. Water Quality Guidelines for Human Consumption

GCDWQ (Health Canada - Federal)

c1 = Aesthetic objective.
c2 = Maximum allowable concentration (MAC).
c3 = Guideline corresponds to nitrate-N and nitrite-N.
c4 = A health-based guideline for aluminum in drinking water has not been established.
Operational guidance values of less than 100 µg/L total aluminum for conventional treatment plants and less than 200 µg/L total aluminum for other types of treatment systems are recommended.

Water Temperature and Dissolved Oxygen

Water temperature is likely to increase in the permanent pool, which is typical of any reservoir. In contrast, the concentration of dissolved oxygen within the reservoir is likely to decrease as temperature rises, with associated effects on saturation, and potential increases in organic matter content and nutrients. The latter effects are associated with sediment accumulation as particulate organic matter and nutrients are washed into the reservoir from the surrounding watershed along with soil erosion.

As water is released from the reservoir, the warmer water will increase downstream temperatures but dissolved oxygen concentrations will increase due to water aeration and should reach a 100% saturation levels in the immediate vicinity of the reservoir outflow.

Total Suspended Solids and Sediments (TSS)

Under normal conditions (i.e., non-flood conditions), the reservoir would pick up sediments from the upstream reach of the river. The increase of sediment loadings would likely relate mostly to mineral components, sand and clay, with small amount of organic matter, similar to pre-Project flood conditions. The soil characteristics and effects of creating a permanent pond upstream of the dam are discussed in Section 3.4. The addition of sediments could also occur along the reservoir banks due to local erosion from wave action in the reservoir. Soil loss around the perimeter of the permanent pond, up to the full supply level, would create suspended matter consisting of mineral organic particles, followed by the addition of soil nutrients and soil organic matter to water within the reservoir. The addition of nutrients and organic matter to the water could increase concentrations of nitrogen and organics in water leaving the reservoir.

Sediments would settle in the reservoir. As a result, sediment loadings downstream from the dam would be reduced.

Nutrients

Nutrients could be introduced to the reservoir through sheet runoff and erosion in river reaches upstream of the Project. Nutrients would adhere to soils particles, which would then settle at the bottom of the reservoir. Thus, through sedimentation of suspended particles nutrients would remain in the reservoir and downstream loadings in water released from the reservoir would be reduced.

Microbiology

Total Coliforms and E.Coli are found in the Study Area; in the upstream Elbow River sampling sites and particularly in tributaries. Sources could be cattle or wildlife, with the coliforms entering streams from watershed runoff. These could accumulate in the reservoir and a potential increase in microbiological effects on water quality could be considered.

3.2.3 Potential Mitigation Measures

Potential impacts to surface water quality are related to changes in total suspended solids and sediments, as well as nutrients that can bind to the sediments. The operating regime for the Project will ultimately determine the severity and extent of sediment changes within the reservoir and downstream discharges. Best management practices would include the development and implementation of an erosion and sediment control plan (ESC plan) for the Project. In accordance with recommendations provided in the Elbow River Basin Water Management Plan (2009) the ESC plan should be designed with maximum soil erosion rate target of 2t/ha/yr where disturbed land has a direct connection to a water body (i.e., there is no buffer and no interception of overland flow). The ESC plan would apply to all construction sites and would endure for the life of the project (during and post construction phases).

3.2.4 Data Gaps

The historical data from 1988 till 2003 are available for upstream of the Study Area and within the Study Area. The data provide information on both the main stem of the Elbow River and its major tributaries. The latter represents water quality that originates in the watershed and, in most cases, the water quality in tributaries is different from the main channel of the river.

The historical data set is sparse and does not include all seasons. As a result, it is difficult to identify seasonal patterns, particularly during spring freshet and high water level conditions. Recent data collection has been limited and current water quality conditions may have changed from historical, as land use changes have occurred within the watershed. Seasonal sampling would be required for at least the beginning, peak, and post flood conditions at the Project site to assess loadings of sediments, nutrients, and organic matter. These data would be necessary to predict changes to water quality parameters within the reservoir and for water released from the reservoir during operations.

The historical data are found in several sources, including those from ESRD, the City of Calgary, and the University of Calgary. Prior to conducting an environmental impact assessment, the data would have to be entered into a database to be processed and analyzed in terms of water quality seasonality and temporal trends.

3.2.5 Literature Cited

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3.3 Fisheries and Aquatic Resources

The construction of the Project and possible loss of aquatic habitat, including changes to river flows could affect fish and aquatic species. This section describes the key surface fisheries and aquatic resources of the area, the potential impacts of the proposed Project, best management practices and possible mitigative measures to reduce impacts. Should the Project proceed past the conceptual stage, data gaps are identified that should be filled to complete a full environmental impact assessment.

Methods are provided in Appendix A.

3.3.1 Results

The headwaters of the Elbow River are located in the Front Range of the Rocky Mountains. The river flows out of Elbow Lake with the ultimate source being Rae Glacier. The Study Area is located in Kananaskis Country approximately 40 km downstream (i.e., northeast) from the headwaters. The proposed dam would be situated on the Elbow River immediately upstream from the confluence of McLean Creek, approximately 11 km downstream of Elbow Falls. The Elbow River watershed area above Elbow Falls is approximately 437 sq. km and includes the Little Elbow River and Quirk Creek sub-basins.

The Elbow River and four tributaries are located within the Study Area: Ranger Creek and unnamed tributaries A, B and C (Figure 3.3-1). In the vicinity of the proposed Project, Elbow River and tributaries are Class C watercourses based on ESRD's *Code of Practice for Watercourse Crossings – Calgary Area Map* (ESRD 2012). Given the Class C designation, the Restricted Activity Period (RAP) for this watercourse extends from 1 September to 15 August.

Fisheries Resources

Fisheries information obtained from the FWMIS database (ESRD 2014a) shows a total of 7 fish species are documented within the Study Area. This includes: brook trout (*Salvelinus fontinalis)*, brown trout (*Salmo trutta*), bull trout (*Salvelinus confluentus)*, cutthroat trout (*Oncorhynchus clarkii*), mountain whitefish (*Prosopium williamsoni*), rainbow trout (*Oncorhynchus mykiss*), and longnose dace (*Rhinichthys cataractae*).

Special Status Species

Native 'pure-strain' westslope cutthroat trout (*Oncorhynchus clarkii lewisi*), a subspecies of cutthroat trout, are listed as 'Threatened' provincially and federally (ESRD 2014b and GC 2014, respectively). No pure-strain westslope cutthroat trout have been reported in the Elbow River and are unlikely to occur in the Study Area (ESRD 2006, AWCTRT 2013).

Bull trout are listed as 'Threatened' by Alberta's Endangered Species Conservation Committee and are protected under the provincial *Wildlife Act* (ESRD 2014b). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) list bull trout as "Threatened", although bull trout are currently not listed under Schedule 1 of the federal *Species at Risk Act* (COSEWIC 2014, GC 2014).

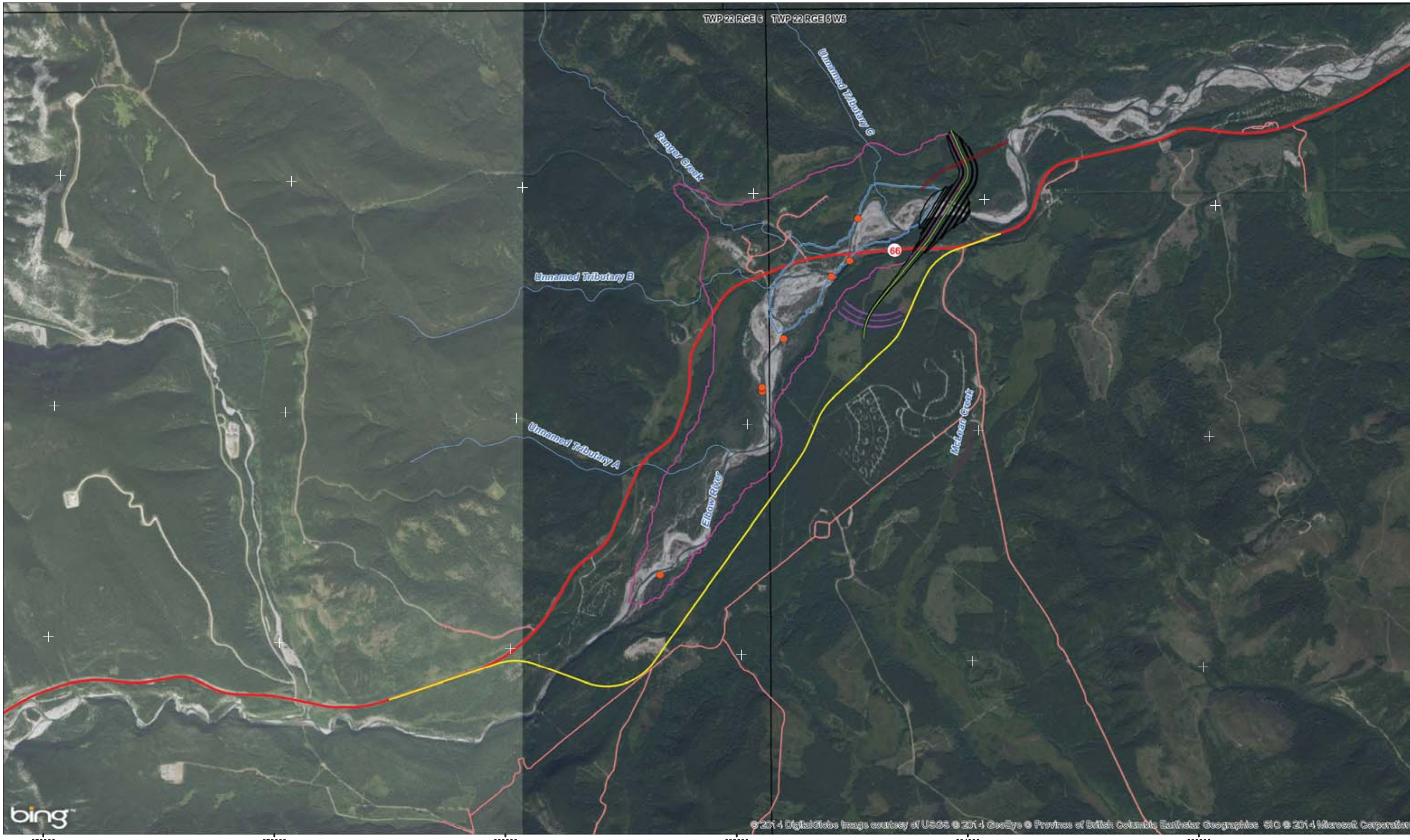
No other species reported within Elbow River and tributaries are listed provincially or federally (COSEWIC 2014, ESRD 2014b and GC 2014).

Aquatic Habitat

The aquatic habitat within each of the watercourses (Elbow River, Ranger Creek and unnamed tributaries A, B and C) is described in this section.

Elbow River

Within the Study Area, the Elbow River flows in an irregular meandering channel pattern through a wide flood plain. The river is frequently braided with associated transitory depositional features (mid-channel, point and side bars) and islands. The river is prone to lateral erosion and migration during flood events. Elevated bars, large woody debris jams, and channel bed scouring are evident within the Study Area. Habitat along this portion of the Elbow River is predominately riffle and run with the occasional pool. Fish cover is primarily composed of surface turbulence, boulder/cobble, water depth and woody debris.



Legend

Base Reservoir Water Level (1399m)
100 Year Flood Water Level (1422m) (Aquatics Study Area)
Highway
Road

Proposed Infrastructure

Main Structure
Auxillary Earth Cut Spillway
Main Embankment Crest - El. 1429.5m
Combined Permanent Outlet / Spillway Structure
Highway 66 Realignment
Redd

N
250 0 250 500
Metres
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch
ESRD
McLean Creek Environmental Overview

Aquatic Study Area and Bull Trout Redd Locations

DATE: November 2014	
ANALYST: TR	QA/QC: TR RF JB
PDF: Fig3.3-1 Redd Locations 14-11-28	

Figure 3.3-1

amec

S:\Gis\Projects\CW2174_Flood_Mitigation\ArcGIS\MC1_EnvReview\Fig3.3-1 Redd Locations.mxd

A spawning survey was conducted within the Study Area in fall 2014. On the Elbow River, a total of ten bull trout redds were identified (Figure 3.3-1). The dominant and subdominant redd substrate were large cobble (128 to 256 mm) and small cobble (64 to 128 mm), respectively. Water depths ranged from 0.18 m to 0.50 m. The size of the redds ranged from 1.0 m to 2.7 m in length and 0.5 m to 1.0 m wide. The majority of the redds were found in side channels and were in proximity to instream woody debris and/or along vertical banks that provided shade/cover.

Along the surveyed section, the watercourse has a mean channel width of 132 m and a mean wetted width of 26 m. The recorded water depths within the Study Area range from 0.1 m to 1.10 m (Appendix C, Figures C-1a to C-1d). Stream bed material is predominantly large gravel (24%), small cobble (24%) and large cobble (21%). The remaining substrate includes boulder (15%), small gravel (10%), bedrock (4%) and fines (1%) (Appendix C, Figures C-1a to C-1d). Banks alternate from sloping to vertical with eroding sections in areas of concentrated flow, i.e., on outside channel bends. There are limited bank sections that contain undercuts.

Riparian vegetation along the river is composed of lodgepole pine (*Pinus contorta*) and white spruce (*Picea glauca*) with an understory of buffaloberry (*Shepherdia canadenis*), alder (Alnus spp), juniper (*Juniperus* sp) and bearberry *(Arctostaphylos alpian)*.

The overall habitat quality for all life stages for salmonids within the Study Area is rated good. Areas suitable for salmonid spawning are common throughout the Study Area, based on the availability of clean gravel/small cobble substrate, adequate water flows and depths (i.e., riffle habitats). Bull trout typically select areas influenced by ground water upwellings over gravel/cobble (16 to 64 mm) with low levels of fine sediment, and are generally found at tailouts of pools and the head of riffles (ESRD 2009). Cutthroat trout prefer similar habitat, i.e., low gradient streams with cold, well oxygenated water and clean unsilted gravels at the edge of pools (ESRD 2006). Rainbow trout generally prefer clean substrate between 4 to 100 mm at the head of riffle habitat or the downstream edges of pools for redd construction (Ford *et al*. 1995, Raleigh *et al*. 1984). Mountain whitefish broadcast spawn over a wide variety of substrates ranging from sand to boulders, prefer substrates free of silt and algae, and use habitats ranging from shallow riffles to deep water pool habitat (Ford *et al*. 1995).

The Study Area provides good rearing habitat for salmonids based on a diversity of cover and available lower water velocity areas. Bull trout young-of-year (YOY) prefer stream margins with heterogeneous structure, low velocity backwaters and side channels (ESRD 2009). Juvenile bull trout prefer pool and run habitats with velocities breaks (ESRD 2009). Juvenile cutthroat trout prefer water depths <0.4-0.75 m and velocities 0.25-0.5 m/s; silt-free, cobble/gravel substrate with cover (Hickman and Raleigh 1982). Rainbow trout prefer silt-free rocky substrate in riffle-run areas with well vegetated stream banks and abundant instream cover (Raleigh *et al*. 1984). Juvenile mountain whitefish are typically found in shallow backwater areas and stream margins with overhanging cover (Ford *et al.* 1995).

Adult feeding opportunities are also rated as good due to areas of adequate water depths, lower water velocity, and cover complexity. Adult bull trout prefer similar habitats as juveniles; i.e., low velocity areas that provide appropriate temperatures, protective cover and access to food sources (ESRD 2009). Cutthroat trout prefer pools formed by boulders or large woody debris with fast adjacent water and amply cover (ESRD 2006).

Overwintering habitat is rated as moderate. Bull trout prefer overhead cover with deep stable water, low velocities and lack of anchor ice (ESRD 2009). Adult cutthroat trout will congregate in deep pools while juveniles will overwinter by boulders and other large Instream structures (ESRD 2006). Within the Study Area along the Elbow River, there are numerous deep, low velocity areas.

Ranger Creek

Ranger Creek is the largest tributary located within the Study Area. The creek generally flows south in an irregular wandering pattern and is frequently confined to a steep forested valley. Close to the confluence of the Elbow River, the creek winds through the Elbow District Office compound prior to entering the river immediately downstream of the Highway 66 bridge. Approximately 40 m upstream from the confluence, a beaver dam has created an impediment to fish migration to and from the Elbow River (Appendix C, Figure C-2, Plate 2). This structure is not permanent and may allow passage during higher flow levels. Beaver activity is also evident at other locations along the creek creating additional impoundments; however, no other impediments to fish were observed. The majority of the creek provides good habitat complexity for fish.

On Ranger Creek, a total of 14 transects were surveyed over a distance of approximately 1.5 km in fall 2014. The average wetted width within the Study Area is 2.9 m and bank heights ranged from 0.2 to 10.0 m. Not including the areas impounded by beaver dams, water depths ranged from < 0.1 to 0.5 m. Impounded areas are relatively small and have water depths ranging from 0.7 to 1.0 m deep.

Substrate is predominantly fines (28%), large gravel (25%) and small gravel (24%). Small cobble (11%), large cobble (9%), boulder (1%) and bedrock (1%) are also present within the Study Area. Substrate embeddedness is low to moderate. Overall cover for large bodied fish is low (10%) and primarily provided by large woody debris, overhanging vegetation and small woody debris.

The overall habitat quality for salmonids in Ranger Creek is rated as moderate. Salmonids require riffle habitat over gravel substrate with low levels of fine materials for spawning (Langhorne *et al.* 2001). Small and large gravels suitable for spawning are available throughout the study reach; however, they were often embedded with fine material. As a result, spawning habitat for salmonids is rated as moderate. Rearing and holding habitat for salmonids is rated as poor to moderate. Juvenile rainbow trout prefer depths ranging from 0.3 to 1.2 m and adults prefer deeper water (Ford *et al.* 1995). Both juvenile and adult bull trout seek cover (i.e., woody debris, undercut banks) and prefer deep pools (Roberge *et al. 2002*). Water depths and the amount of cover in Ranger Creek are generally not adequate for salmonid rearing and holding.

Overwintering habitat for salmonids is rated as poor because areas of sufficient depth are limited and likely become isolated in the winter. Dissolved oxygen within these pools likely becomes depleted during winter and might not be able to support salmonids.

Overall habitat quality in Ranger Creek for small-bodied forage fish is rated as moderate to good. Longnose dace prefer gravel to boulder substrate in riffle sections for spawning, rearing and holding (Roberge *et al.* 2002). Riffle sections over coarse substrate are abundant within Ranger Creek. Overwintering for small-bodied forage fish is rated as moderate. The beaver impoundments and occasional pools likely provide overwintering habitat for longnose dace, which are generally tolerant of low dissolved oxygen levels (Langhorne *et al*. 2001).

Unnamed Tributary A

This unnamed tributary flows down the east facing slope of the Elbow River valley and crosses Highway 66 before entering the Elbow River. At the upstream end of the Study Area, the stream flows through a culvert beneath Highway 66 and then flows a short distance down the toe of the valley slope before winding its way through the forested flood plain. Five transects were surveyed over a distance of approximately 600 m. Transects 1 to 3 near the confluence are primarily flat and low velocity run habitat with sections of undefined channel and banks. Transects 4 and 5 at the upstream extent of the Study Area are dominated by higher velocity run and riffle habitat.

Fine sediment are the dominant substrate throughout the study reach (55%) and coarse substrate is only associated with steeper gradient at the upstream extent of the Study Area. Average wetted width was 1.3 m and depths ranged from < 0.1 to 0.3 m. The culvert's outlet at the Highway 66 crossing is perched approximately 0.3 m above the stream's water surface. Fish cover was limited (5%) and exclusively provided by small woody debris and large woody debris. Flow from the tributary becomes subsurface underneath a gravel bar prior to entering into the Elbow River (Appendix C, Figure C-3, plate 1 and 2).

Both the gravel bar and perched culvert are migration barriers to fish passage in this tributary.

The overall habitat quality for salmonids within the tributary is poor due to the high percentage of fine substrate, especially at the downstream reach near the confluence. Salmonids require clean gravel substrate for spawning with a low level of fine material (Roberge *et al.* 2002). The riffle sections with suitable substrate void of fine material are shallow (depths ranging from 0.08-0.17 m); therefore, are poor habitat for spawning salmonids. No pools were observed throughout the Study Area and fish cover is very low.

Habitat quality for holding and rearing of salmonids is also rated as poor. The average maximum depth of all survey transects is 0.2 m, the tributary does not provide adequate habitat complexity, and it does not provide suitable fish cover. Flow within this unnamed tributary is likely seasonal and probably freezes to the bottom in the winter. There are no areas with adequate water depths for overwintering salmonids.

The habitat may provide holding and rearing habitat for longnose dace; however, overwintering potential is low. Forage fish spawning habitat is moderate. Areas of coarse substrate preferred by longnose dace are present in some sections of the tributary within the Study Area.

Unnamed Tributary B

Unnamed tributary B originates on the west side of Hwy 66, south of the Elbow Ranger Station compound. The stream is fed by a small aquifer and then travels in an easterly direction before crossing Highway 66. The stream then travels a short distance before flowing through a perched culvert beneath a washed out service road. The water plunges 5 m from the perched culvert onto a gravel bar adjacent to the Elbow River. The perched culvert is a barrier to fish passage at all times of the year (Appendix C, Figure C-4, Plate 1). Water exiting the culvert flows subsurface through a gravel bar into the river creating a second migration barrier. Prior to the 2013 flood event, the tributary flowed from the now perched culvert into Allen Bill Pond.

The habitat along the tributary is characterized by small sections of run and riffles with occasional shallow pools or flats. The mean channel width and wetted width are 7.0 m and 1.2 m, respectively. The maximum water depth is 0.2 m. Four transects were surveyed over a distance of approximately 500 m. Approximately 300 m upstream of the confluence with the Elbow River, the flow in the tributary ceases and the channel becomes discontinuous creating isolated pool habitat. The channel is completely dry approximately 450 m upstream of the confluence and no defined channel is evident 500 m up gradient from the river.

Dominant substrate within the Study Area is large gravel (30%) and small gravel (23%) that is low to moderately embedded in fine material (19%). Cover available for fish is low (5%) and is provided by large woody debris, small woody debris and overhanging vegetation.

The overall habitat quality for all fish species within unnamed tributary B is rated as poor. Spawning within the unnamed tributary is rated as poor for salmonids. Shallow depths, a high proportion of fine substrates, lack of pools and limited fish cover contribute to this rating; in addition to migration barriers at the confluence with the Elbow River.

Rearing and holding habitat for salmonids is rated as poor. The tributary does not provide sufficient depth, cover or habitat complexity preferred by juvenile and adult salmonids. Areas where flow was observed is likely seasonal and probably freezes to the bottom in the winter. As a result, overwintering quality is rated as poor. At higher flows, the tributary could provide holding and rearing habitat for forage fish species. Coarse substrate could also provide spawning habitat for fish species such as longnose dace.

Fisheries potential for the unnamed tributary is nil due to the permanent barrier at its downstream extent.

Unnamed Tributary C

Unnamed tributary C is located downstream of where Highway 66 crosses the Elbow River. The tributary flows down a forested northeast facing slope of the Elbow River valley before entering the river. The majority of the tributary is confined to a steep forest draw creating an incised channel. Once the tributary meets the Elbow River flood plain, the topography gives way to a gentler slope. Within this 50 m wide floodplain area, the tributary fans out over land with no defined channel. Recent flooding resulted in the watercourse flowing through this vegetated area. This shallow section of water likely impedes fish movements. At the confluence of the Elbow River, the tributary plunges over a 1.5 m vertical bank before entering the river (Appendix C, Figure C-5, Plate 1). This drop creates a barrier to fish passage.

Habitat within the tributary is primarily shallow (< 0.1 m) run. The average wetted width is 1.6 m and bank heights range from 0.4 to 1.3 m. Fish cover is low (20%), provided in the upstream sections mostly by fallen mature trees caused by slumping valley walls. Gradient increases in the upstream reach result in step-pool morphology. Residual pools in this area range from 0.3-0.4 m deep.

The unnamed tributary provides poor overall habitat for salmonids and small-bodied forage fish due to the barriers at its lower extent. Otherwise, there is habitat within this watercourse that could provide spawning and rearing habitats; more so, at higher water flows. This tributary does not have sufficient depths to potentially hold adult salmonids. The residual pools at the upstream extent of the Study Area could provide habitat for forage fish during open-water seasons, but likely freezes to the bottom during the winter.

3.3.2 Discussion

The selection of valued ecosystem components (VECs) would assist in discussing the potential effects of the Project on fisheries and aquatic resources in an environmental impact assessment. Likely VECs would include:

- *Bull trout*: currently listed as “Threatened” by Alberta’s Endangered Species Conservation Committee, and protected under the provincial *Wildlife Act* (ESRD 2014b).
- *Other sport fish documented in the vicinity of the project*: brook trout, brown trout, cutthroat trout, mountain whitefish and rainbow trout are popular recreational sport fishes.
- *Sport fish habitat in the project footprint*: critical bull trout spawning habitat will be affected or will no longer be accessible with the construction of the proposed dam; this spawning habitat is also likely used by other sport fish found in the vicinity of the Project as they share the same spawning habitat requirements.
- *Benthic invertebrates*: are the primary food source of local fish species and are indicators of change in water quality.

Potential Project Effects

Potential Project effects would include:

- fish habitat alteration or loss;
- disruption of fish migration and passage, and
- changes in water and sediment quality.

Fish Habitat Alteration or Loss

A direct loss to fish habitat would occur beneath the footprint of the dam structure. Fish habitat behind the dam would be inundated with water, which will change stream (i.e., lotic) habitat to a lake (i.e., lentic) environment.

Impounding the Elbow River would also cause sedimentation and erosion. The shoreline of the reservoir would be susceptible to wave action, which would cause erosion. As discussed in Section 3.2, sediment would be retained in the reservoir. However, water released below the dam could cause scouring of the river bed and banks, which would increase sediment loads downstream of the dam and cause sediments to accumulate on the river channel substrate, changing the existing habitat function. Salmonids use clean, well-oxygenated gravel substrates to spawn and are particularly sensitive to sediment loading (i.e., siltation). Silt could fill the interstitial spaces of the gravel and cover eggs, which impairs egg oxygen gas exchange during incubation. Bull trout spawning has been documented within the Project footprint. The loss and alteration of spawning habitat could affect the productive capacity of the system.

Changing from a lotic to a lentic system and increased sedimentation would also alter the composition and abundance of the benthic community within the reservoir. This change in composition and abundance could deplete the food source for resident fish.

Disruption of Fish Migration and Passage

The proposed dam structure would create a barrier to fish passage and isolate approximately 11 km of river from the proposed dam site upstream to Elbow Falls. Preventing access to this section of river could affect the productive capacity of the system. This section of river provides habitat suitable for all sport fish species at all life stages. Important bull trout spawning habitat has been documented within this reach of river. Other resident sport fish species likely utilize the same habitat for spawning.

Changes in Water and Sediment Quality

Changes in aquatic health result from changes in water and sediment quality characteristics for constituents that have the potential to directly affect fish or benthic invertebrates. Changes in water and sediment quality caused by the Project could potentially occur due to increases in erosion/sedimentation and change to the hydrological flow regime. Potential water quality changes important to fish and aquatic resources include changes in water temperature, dissolved oxygen, nutrients, suspended sediment and metals.

Changes in water temperature could arise within the Project's impounded area and downstream where impounded water is released. Changes in water temperature could affect water chemistry (e.g., dissolved oxygen concentrations), growth and biological processes, toxicity of some substances, spawning times and locations, and productivity of aquatic organisms. Dissolved oxygen is essential for the survival of most aquatic biota. Decreases in dissolved oxygen could affect the health and productivity of aquatic organisms.

Nutrient enrichment could stimulate growth of plants and algae, which could subsequently lead to the degradation of aquatic habitat through physical changes (e.g., excessive plant or algal growth over gravel substrate), and through changes to water quality (e.g., reduced dissolved oxygen and water clarity).

Elevated concentrations of suspended sediments from increased erosion/sedimentation could affect fish directly by impairing respiration, altering behaviour (e.g., migration patterns), changing feeding efficiency and predator detection, and indirectly by altering primary production and benthic invertebrate production that fish depend on for food.

Metal mobilization could occur in impoundments through erosion/sedimentation and the decomposition of organic materials. At sufficient concentrations, certain metals/metalloids (such as mercury) could be harmful to aquatic biota.

Mitigation

Effects of the Project would be determined through an environmental impact assessment if the Project moves past the conceptual stage and detailed design, including the operational plan, is finalized. To minimize effects on fisheries and aquatic resources, efforts should be made to minimize the size of the Project footprint within the aquatic environment, and incorporate fish passage into the design of the dam. The dam spillway should also be designed to minimize scouring of the river channel and banks downstream of the dam. In general, best management practices should be implemented to minimize effects on fisheries and aquatic resources during the construction and operational phases of the Project.

Data Gaps

To support an environmental impact assessment and obtain provincial and federal approvals, additional data collection would be required. Data collection would be broken down into four components: spring spawning surveys and habitat assessments, fish migration study, fish tissue toxicology, periphyton collection, and benthic invertebrate collection.

Spring spawning surveys and habitat assessments would be required to document seasonal fish use within the Project area and identify important or critical fish habitat. A fish tagging program would be conducted to confirm whether Elbow Falls continues to act as a permanent barrier to fish migration since the 2013 flood event. Metals analysis on sentinel fish species (i.e., longnose dace) within the Elbow River would be essential for monitoring effects on fish health. The collection of periphyton and benthic invertebrate samples would provide earlier detection of potential effects on biota compared to monitoring fish. This would also provide multiple lines of evidence of effects attributable to Project construction and operation.

Fish, periphyton and benthic invertebrate collections would occur in the fall when annual population numbers or densities would be the highest.

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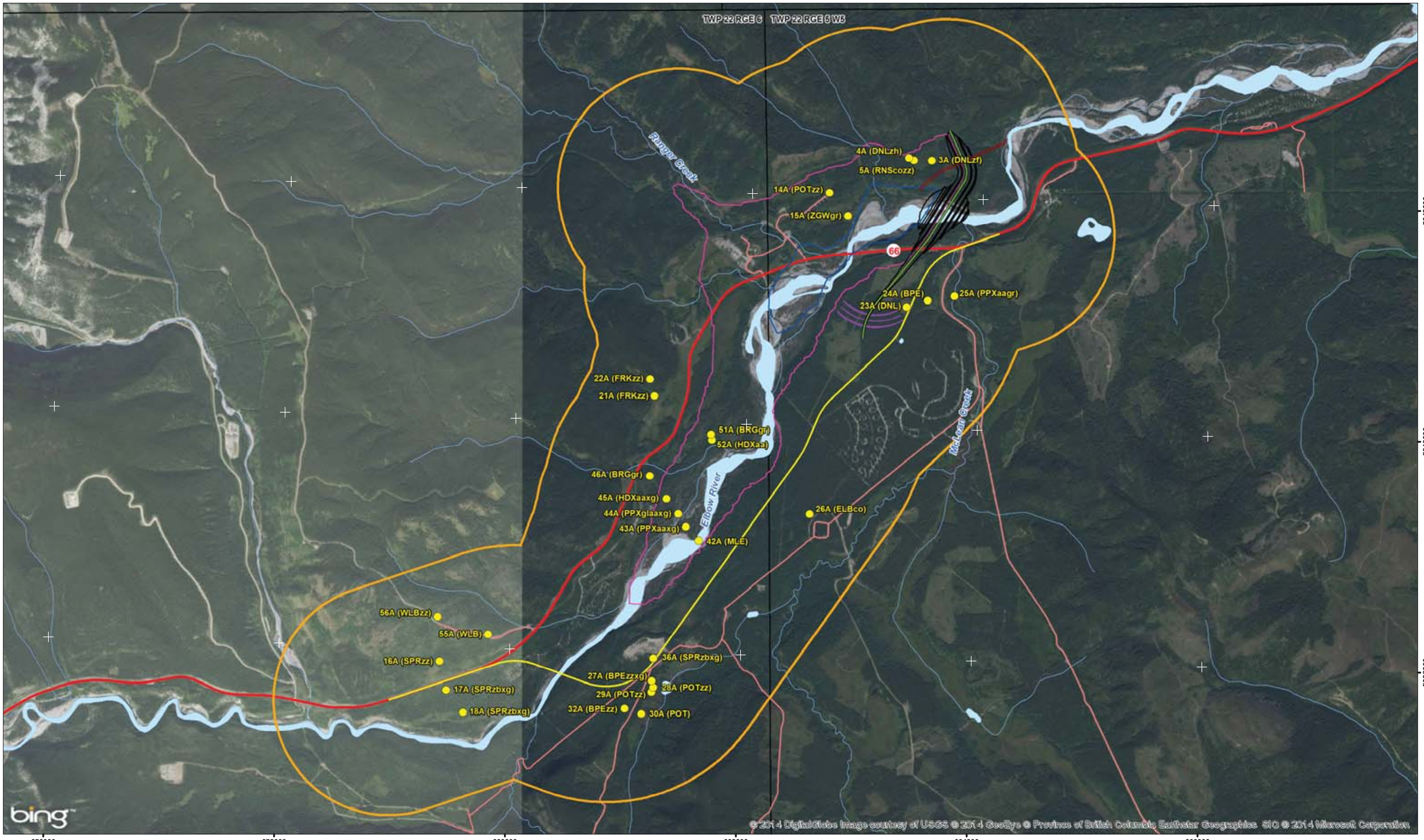
3.4 Soils and Terrain

The construction of the Project and potential impacts to soils - erosion, admixing, rutting, compaction and increased stoniness – are discussed. This section describes the key soil resources of the area, the potential impacts of the proposed Project, best management practices and possible mitigative measures to reduce impacts. Should the Project proceed past the conceptual stage, data gaps are identified that should be filled to complete an environmental impact assessment.

Methods are provided in Appendix A.

3.4.1 Results

The Project is located within the Montane Subregion of the Rocky Mountain Natural Region of Alberta (Natural Regions Committee 2006). The Study Area covers 2,607 ha. Soil inspection sites are shown on Figure 3.4-1 and data are presented in Appendix D-1.



Legend

- Study Area
- Base Reservoir Water Level (1399m)
- 100 Year Flood Water Level (1422m)
- Highway
- Road

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment
- Soil Inspection Point

N

250 0 250 500

Metres

1:30,000

Note : Coordinates in UTM Zone 11 NAD83

Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch

ESRD

McLean Creek Environmental Overview

Soil Inspection Sites

DATE:	November 2014
ANALYST: NH	QA/QC: TR PB JB
PDF:	Fig3.4-1 Soil Inspection Sites 14-11-26

Figure 3.4-1

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3.4.1.1 Physiography and Surficial Geology

The Rocky Mountain Natural Region is characterized by mountains and foothills, which are separated by deep glacial valleys. The climate has short cool summers and cold winters with significant snowfall. The Montane Subregion supports Lodgepole pine, Douglas fir and aspen on colluvial[1] and morainal[2] parent materials on the mountain and hillslopes. Fluvial[3] and glaciofluvial[4] parent materials are common along the major valley drainages. Physiographic subdivisions within the region are shown in Table 3.4-1.

Table 3.4-1: Physiographic Subdivisions

Region	Section	Elevation (masl)	District	Surficial Materials	Surface Expression
Rocky Mountain Foothills	Southern Foothills	1200-1800	Southern Foothills	Morainal and colluvial	veneer, blanket over ridged bedrock

Source: Pettapiece (1986).

3.4.1.2 Description of Landforms (Terrain) in the Study Area

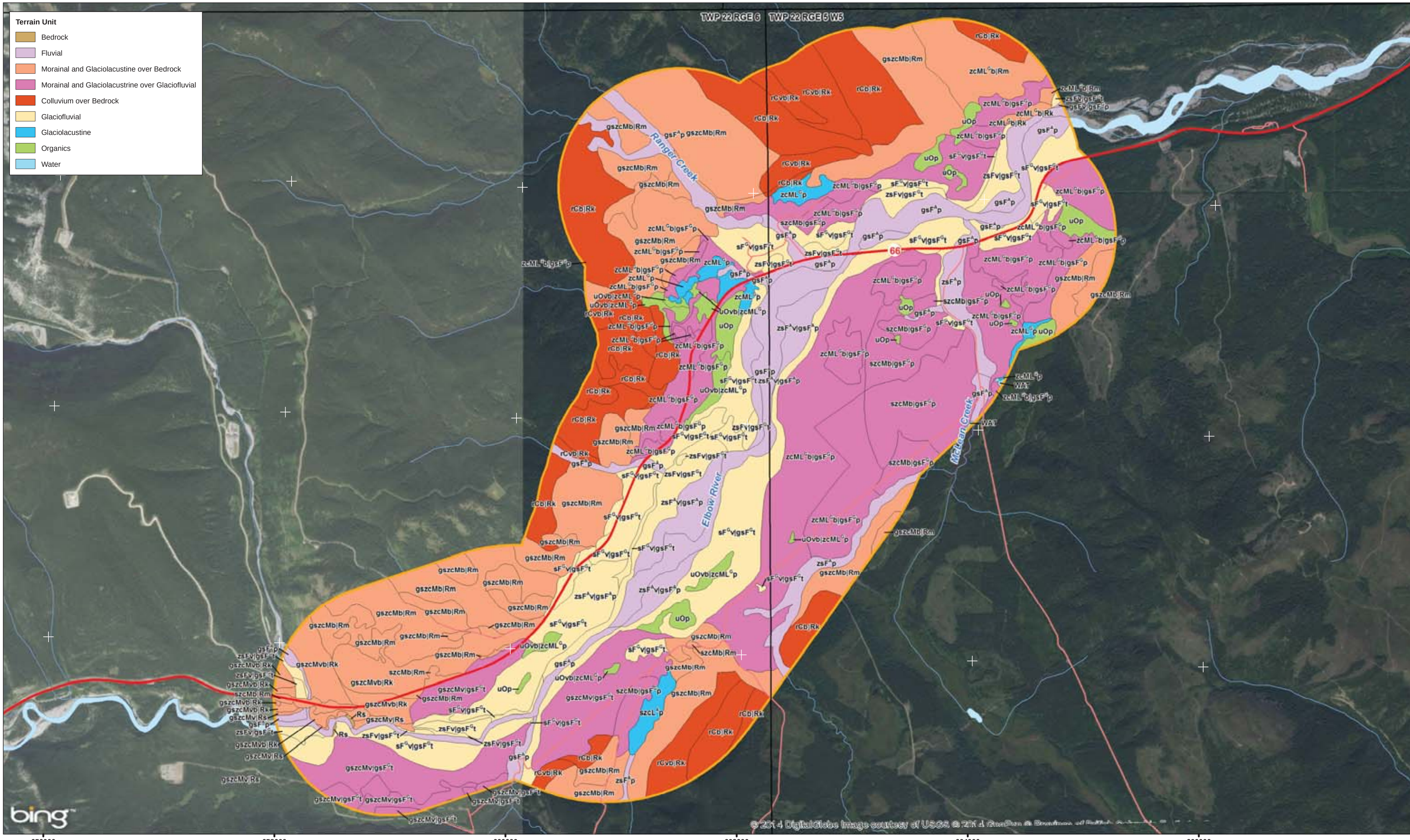
The terrain map is presented in Figure 3.4-2. Table 3.4-2 provides a summary of landforms and their areas in the Study Area.

3.4.1.3 Organic Plains (Peatlands)

Organic terrain units are characterized as peatlands having the water table at or near the surface for at least part of the year. Organic landforms within the Study Area were all interpreted to be fens. As opposed to the stagnant conditions found in bogs, fens have varying degrees of surface or sub-surface lateral flow that produce a relatively nutrient-rich, oxygenated environment (Beckingham and Archibald 1996). Fens have developed on accumulations of poor to moderately decomposed organic materials and consist primarily of mosses and sedges. The total area of fen deposits is 3% (51 ha) of the Study Area.

Deep fens (>160 cm of organic), which is the dominant category in the Study Area, are associated with Darnell (DNL) soils. Shallow fens occur where where peat thickness was less than 160 cm, and are associated with Mitford (MTF) soils.

[1] Material deposited to their current location by gravity induced movement.
[2] Material deposited directly by glacial ice
[3] Materials transported and deposited by streams and rivers.
[4] Material deposited in front of or in contact with glacial ice.



Legend
- Study Area
- Highway
- Road

N 250 0 250 500
Meters
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch
ESRD
McLean Creek Environmental Overview

Terrain Units

DATE: November 2014		
ANALYST: NH	QA/QC: TR PB JB	
PDF: Fig3.4-2 Terrain Units 14-11-26		

Figure 3.4-2

amec

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Table 3.4-2: Landform Areas within the Study Area

Terrain Label[1]	Landform	ha	%
Organic Plains (Peatland)		**63.25**	**2.43**
uOp	fibric, mesic, humic organic plain	39.79	1.53
uOvb|zcML^{G}p	fibric, mesic, humic organic veneer/blanket over silty, clayey morainal + glaciolacustrine plain	23.46	0.90
Fluvial Plains		**294.639**	**11.30**
gsF^{A}p	gravelly, sandy, fluvial (active) plain	195.97	7.52
zsF^{A}p	silty, sandy, fluvial (active) plain	42.32	1.62
zsF^{A}v|gsL^{A}p	silty, sandy fluvial (active) veneer over gravelly, sandy, fluvial (active) plain	56.35	2.16
Glaciolacustrine and Lacustrine		**32.95**	**1.26**
zcMLGp	silty, clayey morainal + glaciolacustrine plain	22.46	0.86
szcL^{A}p	sandy, silty, clayey, lacustrine (active) - plain (beaver ponds)	10.49	0.40
Morainal and Glaciolacustrine Veneers and Blankets over Glaciofluvial Plains and Terraces		**747.42**	**22.35**
gszcMv|sgF^{G}t	gravelly, sandy, silty, clayey morainal blanket over sandy, gravelly, glaciofluvial terrace	164.74	6.32
zcML^{G}b|sgF^{G}p	silty, clayey morainal + glaciolacustrine blanket over sandy, gravelly, glaciofluvial plain	449.30	17.23
szcMb|gsF^{G}p	sandy, silty, clayey morainal blanket over gravelly, sandy glaciofluvial plain	133.38	5.12
Glaciofluvial Plains and Terraces		**582.68**	**22.35**
zsFv|sgF^{G}t	silty, sandy fluvial veneer over sandy, gravelly, glaciofluvial terrace	73.35	2.81
sF^{G}v|sgF^{G}t	sandy, glaciofluvial veneer over gravelly, sandy glaciofluvial terrace	337.33	12.94
Colluvium over Bedrock		**371.68**	**14.26**
rCb|Rk	rubbly colluvial blanket over moderately steep bedrock	285.44	10.95
rCvb|Rk	rubbly colluvial veneer/blanket over moderately steep bedrock	86.24	3.31
Morainal and Glaciolacustrine Veneers and Blankets over Bedrock		**685.07**	**26.28**
gszcMb|Rm	gravelly, sandy, silty, clayey morainal blanket over rolling bedrock	584.46	22.42
gszcMvb|Rk	gravelly, sandy, silty, clayey morainal veneer/blanket over moderately steep bedrock	37.77	1.45
szcMb|Rm	sandy, silty, clayey morainal blanket over rolling bedrock	7.30	0.28
szcMv|Rm	sandy, silty, clayey morainal blanket over rolling bedrock	1.10	0.04
gszcMv|Rs	gravelly, sandy, silty clayey morainal veneer over steep bedrock	3.89	0.15
zcML^{G}b|Rm	silty, clayey morainal + glaciolacustrine blanket over moderately steep bedrock	46.94	1.80
zcML^{G}b|Rk	silty, clayey morainal + glaciolacustrine blanket over steep bedrock	3.60	0.14
Bedrock		**0.51**	**0.02**
Rs	steep bedrock	0.51	0.02
WAT	Open Water	0.70	0.03
	Totals	**2,606.89**	**100.00**

Note:
[1] Terrain labels follow *Terrain Classification System for British Columbia* Version 2 (Howes and Kenk, 1997).

3.4.1.4 Fluvial Plains

Fluvial (alluvial) plains are active in the Study Area. The Elbow River and some of its tributaries are braided streams and have active channel movement. Riparian vegetation is established in areas where flooding is very rare, or in and around inactive channels. Much of the floodplain showed evidence of recent flood deposition caused by the 2013 flood event.

Areas closest to the main channel are gravelly with some interstitial sand. Most fine material (<2 mm) is washed away from the areas that experience seasonal flooding. A silty or sandy fluvial veneer over gravel occurs in areas of periodic but not seasonal flooding. Silty/sandy fluvial deposits that are largely devoid of >2 mm fragments are furthest from the main channel and experience the fewest flooding events with the lowest water velocity.

Fluvial deposits cover 11% (295 ha) of the Study Area and include areas with flowing surface water.

3.4.1.5 Glaciolacustrine and Lacustrine

Glaciolacustrine

Glaciolacustrine material (zcMLGp**)** is formed from deposits on the margins of glacial lakes (i.e., lakes formed by ice dams) (Howes and Kenk 1997). Most glaciolacustrine material occurs as veneers and blankets over glaciofluvial material or over bedrock. The fine clayey glaciolacustrine material contains few coarse fragments and is associated with and generally indistinguishable from a fine clayey till ("Lacustrotill") that also occurs in the area. This "Lacustrotill" is associated with Elbow (ELB) and Robinson (RNS) soils (MacMillan 1987). In a small portion of the Study Area (<1%) glaciolacustrine materials are considered to be an independent unit because depth to the underlying material is at least 3 meters.

Lacustrine

Lacustrine materials (szcLAp) are formed from sediments that settled out of suspension or that accumulated at the margin of fresh waterbodies as a result of wave action (Howes and Kenk 1997). Lacustrine materials in the Study Area have resulted directly from beaver activity forming a series of ponds and inundated areas along McLean Creek.

3.4.1.6 Morainal Veneers and Blankets

Morainal material is an accumulation of heterogeneous rubbly material, including angular blocks of rock, boulders, pebbles and clay, which has been transported and deposited by a glacier or ice-sheet (Gregorich *et al.* 2001). The morainal material in the Study Area occurs as a veneers or blankets over rolling or moderately steep bedrock between the ridges and colluviated slopes; and the glaciofluvial plains and fluvial plains. This material is generally moderately fine textured and is a stony variant of Dunvargan Till (Brierley *et al.* 2006; MacMillan 1987). It is the predominant till in the south and southwest portions of the Study Area and is associated with the Spruce Ridge (SPR) and Willoughby (WLB) soil series. Because morainal soils occur only as veneers or blankets, they are quantified with their respective underlying terrain (glaciofluvial plains and terraces or bedrock) described below.

3.4.1.7 Glaciofluvial Plains and Terraces

Morainal and Glaciolacustrine Veneers and Blankets over Glaciofluvial Plains and Terraces

Glaciofluvial deposits were moved by glaciers and deposited by streams from melting ice. These deposits are commonly well sorted and stratified (Turchenek and Lindsay 1982). These deposits occur as terraces in the Study Area where historical or active incision by the Elbow River and its tributaries has created exposed glaciofluvial steep-sided escarpments. Glaciofluvial terraces occurring nearest to the Elbow River may underlie an inactive silty-sandy fluvial veneer created by historic floods, or a non-gravelly, sandy glaciofluvial veneer. Where fluvial incision has not altered glaciofluvial deposits in the Study Area, the surface expression is that of a glaciofluvial plain. These landforms occur further away from the Elbow River and its tributaries.

Glaciofluvial terraces are commonly overlain by blankets and veneers of morainal or glaciolacustrine deposits. Glaciofluvial deposits are found in 44% (1,158 ha) of the Study Area.

3.4.1.8 Colluvium over Bedrock

Colluvial deposits are created directly by gravity induced movement and do not involve any medium of transportation such as wind, water or glacial ice. Water, ice or snow may be present at the time of deposition in the case of mudflows, or snow avalanches (Howes and Kenke 1997).

In the Study Area, colluvim occurs as a veneer or blanket overlying steeply sloped bedrock and is mostly comprised of rock fragments and interstitial material (<2 mm) that was physically weathered from upslope bedrock and transported down slope. In some areas, morainal deposits from upslope were transported down slope (i.e., colluviated till).

Colluvial deposits overlying bedrock are found in 14% (372 ha) of the Study Area.

3.4.1.9 Morainal and Glaciolacustrine Veneers and Blankets over Bedrock

Given the mountainous and high relief terrain in the Study Area, bedrock is often at or near the surface and is more influential to the surface expression than the overlying unconsolidated material. Where the surface expression is rolling (Elongate hillocks with slopes dominantly between 5 – 26% (Howes and Kenk, 1997)) the overlying material generally occurs as a blanket (>100cm). Where the surface expression is moderately steep (50% – 70%) to steep (>70%) the unconsolidated surficial material may occur as a veneer (10 cm – 1m), a blanket, or it may be absent (e.g., in the occurrence of bedrock outcrops). Exposed bedrock may occur as secondary terrain units on moderate or steep slopes.

Till and glaciolacustrine deposits overlying bedrock comprise 26% (685 ha) of the Study Area.

3.4.1.10 Bedrock

Bedrock outcrops tend to occur on the steepest slopes where river incision has exposed rock faces. In steep bedrock terrain units, bedrock accounts for most (>90%) of the surface.

3.4.1.11 Terrain and Soil Correlation

Terrain map units have been correlated with soil map units in the Study Area, as shown in Table 3.4-3.

Table 3.4-3: Terrain Unit and Soil Map Unit Correlation in the Study Area

<table>
<tr><th>SMU</th><th>Soil Series1</th><th>Subgroup</th><th>Soil Series 2</th><th>Subgroup</th><th>Inclusions</th><th>Terrain Label</th><th>Dominant Terrain Unit</th><th>ha</th><th>%</th></tr>
<tr><td>BPE1</td><td>BPE</td><td>O.EB</td><td></td><td></td><td>BRG</td><td>szcMb|gsF^{G}p</td><td>sandy, silty, clayey morainal blanket over gravelly, sandy glaciofluvial plain</td><td>54</td><td>2.1</td></tr>
<tr><td>BPE2</td><td>BPEgl</td><td>GL.EB</td><td></td><td></td><td>BRG</td><td>szcMb|gsF^{G}p</td><td>sandy, silty, clayey morainal blanket over gravelly, sandy glaciofluvial plain</td><td>14</td><td>0.6</td></tr>
<tr><td>BPE3</td><td>BPE</td><td>O.EB</td><td>DIS</td><td>-</td><td>BRG</td><td>szcMb|gsF^{G}p</td><td>sandy, silty, clayey morainal blanket over gravelly, sandy glaciofluvial plain</td><td>65</td><td>2.5</td></tr>
<tr><td>BRG1</td><td>BRG</td><td>E.EB</td><td></td><td></td><td>ELB, RNS</td><td>sF^{G}v|sgF^{G}t</td><td>sandy, glaciofluvial veneer over gravelly, sandy glaciofluvial terrace</td><td>256</td><td>9.8</td></tr>
<tr><td>BRG3</td><td>BRG</td><td>E.EB</td><td>DIS</td><td>-</td><td>ELB, RNS</td><td>sF^{G}v|sgF^{G}t</td><td>sandy, glaciofluvial veneer over gravelly, sandy glaciofluvial terrace</td><td>69</td><td>2.7</td></tr>
<tr><td>BRK1</td><td>BRK</td><td>-</td><td></td><td></td><td>SPR, WLB</td><td>Rs</td><td>steep bedrock</td><td>1</td><td><0.1</td></tr>
<tr><td>DIS1</td><td>DIS</td><td>-</td><td>BRG</td><td>E.EB</td><td>ELB, RNS</td><td>sF^{G}v|sgF^{G}t</td><td>sandy, glaciofluvial veneer over gravelly, sandy glaciofluvial terrace</td><td>12</td><td>0.4</td></tr>
<tr><td>DIS2</td><td>DIS</td><td>-</td><td>PPXgr</td><td>CU.R</td><td>HDX</td><td>gsF^{A}p</td><td>gravelly, sandy, fluvial (active) plain</td><td>26</td><td>1.0</td></tr>
<tr><td>DIS3</td><td>DIS</td><td>-</td><td>SPR</td><td>O.GL</td><td>WLB</td><td>szcMb|Rm</td><td>sandy, silty, clayey morainal blanket over rolling bedrock</td><td>8</td><td>0.3</td></tr>
<tr><td>DNL1</td><td>DNL</td><td>TY.M</td><td>MTF</td><td>T.M</td><td>POT</td><td>uOp</td><td>fibric, mesic, humic organic plain</td><td>40</td><td>1.5</td></tr>
<tr><td>ELR1</td><td>ELB/RNS</td><td>D.GL</td><td></td><td></td><td>BRG,POT</td><td>zcML^{G}b|sgF^{G}p</td><td>silty, clayey morainal + glaciolacustrine blanket over sandy, gravelly, glaciofluvial plain</td><td>273</td><td>10.5</td></tr>
<tr><td>ELR3</td><td>ELB/RNS</td><td>D.GL</td><td>DIS</td><td>-</td><td>BRG,POT</td><td>zcML^{G}b|sgF^{G}p</td><td>silty, clayey morainal + glaciolacustrine blanket over sandy, gravelly, glaciofluvial plain</td><td>51</td><td>2.0</td></tr>
<tr><td>ELR4</td><td>ELB/RNS</td><td>D.GL</td><td>BRG</td><td>O.EB</td><td>POT</td><td>zcML^{G}b|sgF^{G}p</td><td>silty, clayey morainal + glaciolacustrine blanket over sandy, gravelly, glaciofluvial plain</td><td>172</td><td>6.6</td></tr>
<tr><td>ELR5</td><td>ELB/RNS</td><td>D.GL</td><td>BRK</td><td>-</td><td>BRG, POT</td><td>zcML^{G}b|Rk</td><td>silty, clayey morainal + glaciolacustrine blanket over steep bedrock</td><td>4</td><td>0.1</td></tr>
<tr><td>FRK1</td><td>FRK</td><td>O.EB</td><td></td><td></td><td>SPR, WLB</td><td>rCb|Rk</td><td>rubbly colluvial blanket over moderately steep bedrock</td><td>278</td><td>10.7</td></tr>
<tr><td>FRK2</td><td>FRKgl</td><td>GL.EB</td><td></td><td></td><td>SPR, WLB</td><td>rCb|Rk</td><td>rubbly colluvial blanket over moderately steep bedrock</td><td>8</td><td>0.3</td></tr>
<tr><td>FRK4</td><td>FRKzz</td><td>O.MB</td><td>FRKxl</td><td>O.EB</td><td>SPR, WLB</td><td>rCvb|Rk</td><td>rubbly colluvial veneer/blanket over moderately steep bedrock</td><td>86</td><td>3.3</td></tr>
<tr><td>HDX2</td><td>HDX</td><td>O.R</td><td>HDXgl</td><td>GL.R</td><td>PPX</td><td>zsFv|sgF^{G}t</td><td>silty, sandy fluvial veneer over sandy, gravelly, glaciofluvial terrace</td><td>73</td><td>2.8</td></tr>
<tr><td>MLE1</td><td>MLE</td><td>O.R</td><td></td><td></td><td>PPX</td><td>gsF^{A}p</td><td>gravelly, sandy, fluvial (active) plain</td><td>125</td><td>4.8</td></tr>
<tr><td>MTF1</td><td>MTF</td><td>T.M</td><td>POT</td><td>O.HG</td><td>DNL</td><td>uOvb|zcML^{G}p</td><td>fibric, mesic, humic organic veneer/blanket over silty, clayey morainal + glaciolacustrine plain</td><td>9</td><td>0.4</td></tr>
<tr><td>MTF2</td><td>MTF</td><td>T.M</td><td>DNL</td><td>T.M</td><td>POT</td><td>uOvb|zcML^{G}p</td><td>fibric, mesic, humic organic veneer/blanket over silty, clayey morainal + glaciolacustrine plain</td><td>14</td><td>0.5</td></tr>
<tr><td>POT1</td><td>POT</td><td>O.HG</td><td></td><td></td><td>MTF</td><td>zcML^{G}p</td><td>silty, clayey morainal + glaciolacustrine plain</td><td>22</td><td>0.9</td></tr>
<tr><td>POT2</td><td>POT</td><td>O.HG</td><td></td><td></td><td>ELB, RNS</td><td>szcL^{A}p</td><td>sandy, silty, clayey, lacustrine (active) - plain (beaver ponds)</td><td>10</td><td>0.4</td></tr>
<tr><td>PPX1</td><td>PPX</td><td>CU.R</td><td></td><td></td><td>HDX</td><td>zsF^{A}v|gsL^{A}p-B</td><td>silty, sandy fluvial (active) veneer over gravelly, sandy, fluvial (active) plain</td><td>56</td><td>2.2</td></tr>
<tr><td>PPX2</td><td>PPXgl</td><td>GLCU.R</td><td></td><td></td><td>HDGgl</td><td>zsF^{A}p</td><td>silty, sandy, fluvial (active) plain</td><td>42</td><td>1.6</td></tr>
<tr><td>PPX4</td><td>PPXgr</td><td>CU.R</td><td></td><td></td><td>HDX</td><td>gsF^{A}p</td><td>gravelly, sandy, fluvial (active) plain</td><td>46</td><td>1.8</td></tr>
<tr><td>SPR1</td><td>SPR</td><td>O.GL</td><td>WLB</td><td>E.DYB</td><td>FRK</td><td>gszcMb|Rm</td><td>gravelly, sandy, silty, clayey morainal blanket over rolling bedrock</td><td>485</td><td>18.6</td></tr>
<tr><td>SPR3</td><td>SPRxg</td><td>O.GL</td><td>WLBxg</td><td>E.DYB</td><td>FRK</td><td>gszcMv|sgF^{G}t</td><td>gravelly, sandy, silty, clayey morainal blanket over sandy, gravelly, glaciofluvial terrace</td><td>165</td><td>6.3</td></tr>
<tr><td>SPR4</td><td>SPRxl</td><td>O.GL</td><td>WLBxl</td><td>E.DYB</td><td>FRK</td><td>gszcMvb|Rk</td><td>gravelly, sandy, silty, clayey morainal veneer/blanket over moderately steep bedrock</td><td>38</td><td>1.4</td></tr>
<tr><td>SPR5</td><td>SPRxl</td><td>O.GL</td><td>BRK</td><td>-</td><td>FRK</td><td>gszcMv|Rs</td><td>gravelly, sandy, silty clayey morainal veneer over steep bedrock</td><td>4</td><td>0.1</td></tr>
<tr><td>WLB1</td><td>WLB</td><td>E.DYB</td><td>SPR</td><td>O.GL</td><td>FRK</td><td>gszcMb|Rm</td><td>gravelly, sandy, silty, clayey morainal blanket over rolling bedrock</td><td>66</td><td>2.5</td></tr>
<tr><td>WLB3</td><td>WLBzz2</td><td>O.MB</td><td>SPR</td><td>O.GL</td><td>FRK</td><td>gszcMb|Rm</td><td>gravelly, sandy, silty, clayey morainal blanket over rolling bedrock</td><td>33</td><td>1.3</td></tr>
<tr><td>WAT</td><td>WAT</td><td></td><td></td><td></td><td>POT</td><td>Water</td><td>open water</td><td>1</td><td><0.1</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Total</td><td>2,607</td><td>100</td></tr>
</table>

3.4.1.12 Soils

Soil types were taxonomically identified using the Canadian System of Soil Classification (Soil Classification Working Group 1998), which has five taxonomic levels: Order, Great Group, Subgroup, Family and Series. A brief description of the soil orders and great groups mapped in the Study Area is presented in Table 3.4-4. A summary of the soil types mapped in the Study Area is presented in Table 3.4-5.

Table 3.4-4: Soil Orders and Great Groups in the Study Area

Order	Great Group	Distinguishing Characteristics
Brunisolic Sufficient development to exclude from the Regosolic order, but lack degrees or kinds of development specified for other orders.	• Dystric Brunisol • Eutric Brunisol • Melanic Brunisol	• Ah <10 cm; pH <5.5 • Ah < 10 cm; pH >5.5 • Ah > 10 cm; pH ≥5.5
Gleysolic Features indicative of periodic or prolonged water saturation, and reducing conditions-mottling and gleying.	• Gleysol • Humic Gleysol • Luvic Gleysol	• Ah ≤10 cm, no Bt • Ah ≥10 cm, no Bt • Has a Btg, usually has an Ahe or an Aeg
Luvisolic Light colored eluvial horizons-Ae; illuvial B horizons of silicate clay translocation- Bt; developed under forest vegetation.	• Gray Luvisol	• May or may not have Ah • Has Ae and Bt, usually MAST[1] ≤8°C
Organic Composed dominantly of organic materials; most are water saturated for prolonged periods.	• Fibrisol • Mesisol	• Dominantly fibric • Dominantly mesic
Regosolic Weak pedogenic development; no recognizable B horizon > 5 cm thick.	• Regosol • Humic Regosol	• Ah horizon < 10 cm • Ah horizon ≥ 10 cm

Notes:
[1] MAST = Mean Annual Soil Temperature.
Source: Soil Classification Working Group (1998).

Table 3.4-5: Extent of Great Groups in Study Area

Soil Order	Great Groups	Soil Series	ha	%
Luvisols	Gray Luvisol	SPR, ELB, RNS	1,191	45.7
Brunisols	Dystric Brunisol, Eutric Brunisol, Melanic Brunisol	BPE, FRK	930	35.7
Organic	Fibrisol, Mesisol	DNL, MTF	63	2.4
Gleysols	Gleysol, Humic Gleysol, Luvic Gleysol	POT	33	1.3
Regosol	Regosol, Humic Regosol	MLE, HDX, PPX	342	13.1
Disturbed	-	-	46	1.7
Open Water	-	-	<1	>0.1
Bedrock	-	-	<1	>0.1
		Total	**2,607**	**100.0**

A description of each of the soil orders is provided below.

Luvisolic Soils

Luvisolic soils are moderately well to imperfectly drained and are found throughout the Study Area. The parent materials include till and glaciolacustrine deposits. Luvisolic soils dominate the areas between the floodplains / glaciofluvial terraces and the steeper (colluvium dominated) slopes. Luvisolic soil map units cover 46% (1,191 ha) of the Study Area.

Luvisolic soil series were differentiated on the basis of parent material and percent of coarse fragments.

- Elbow [ELB] and Robinson [RNS] soils in the Study Area are formed on fine to moderately fine deposits found on level topography to gentle slopes, and are well to imperfectly drained. ELB has glaciolacustrine (GLLC) parent material while RNS has morainal till (TILL). This "Lacustrotill" is often mixed and it is difficult if not impossible to delineate the GLLC deposits from the TILL deposits. Therefore, these are mapped together as Elbow-Robinson SMU [ELR]. Pothole soils are similar but are of poorer drainage and are classified as gleysols.
- Spruce Ridge [SPR] soils are formed on gravelly, moderately fine textured morainal till (TILL) deposits on gentle to moderately steep slopes. Spruce Ridge soils sometimes occur as a veneer of blanket over glaciofluvial GLFL deposits due to soil creep moving till deposits to lower slop positions where GLFL terraces occur.

Brunisolic Soils

Brunisols are variably textured mineral soils with minimal soil profile development. Brunisol soil map units occur on 36% (930 ha) of the Study Area. Soil classification of Brunisols at the soil subgroup level is based in part on pH. Soil analytical results indicated that the Brunisols in the region are mainly Eluviated Dystric Brunisols of the three different soil series (Frank [FRK], Beaupre [BPE], and Willoghby [WLB]) and their variants. While soil profile development and drainage is similar between these soil series, they differ based on parent material type.

- Frank [FRK] soils are Eluviated Eutric Brunisols formed on very gravelly, medium textured colluvium and are generally well to rapidly drained. Frank soils occur on moderately steep to very steep slopes or at the base of moderately steep to very steep slopes.
- Beaupre [BPE] soils are formed on fine to moderately coarse morainal till and are generally well to moderately well drained.
- Bragg Creek [BRG] soils are formed on gravelly – moderately fine to moderately coarse glaciofluvial deposits on level terraces that are often steeply incised by the Elbow River and its tributaries.

- Willoughby [WLB] soils are formed on gravelly, medium textured glaciofluvial deposits on gentle to moderately steep slopes. Willoughby soils sometimes occur as a veneer of blanket over glaciofluvial deposits due to soil creep moving till deposits to lower slope positions where glaciofluvial terraces occur.

Organic Soils

Organic soils are prevalent in the lower elevation areas under wetland conditions. These soils are composed primarily of organic materials at various stages of decomposition, and include poorly drained landforms commonly known as peatlands or muskeg. Organic soils have developed on poorly to very poorly drained depressional and level topography, and they remain saturated most of the year. A soil is classified as organic if it has greater than 40 cm of partially (mesic) to highly (humic) decomposed organic material, or greater than 60 cm of weakly decomposed (fibric) organic material (Soil Classification Working Group 1998). Organic soil map units cover 63 ha (2.4%) in the Study Area. These soils have developed on fibric, mesic and humic materials.

Organic soils associated with fen landforms occur on level or depressional terrain under very poor drainage conditions. Fens are supplied by both precipitation and groundwater and therefore have a pH $\geq$4.0. These soils are classified as the Darnel (DNL) series when peat thickness is greater than 160 cm, or as Mitford [MIT] soils with a peat thickness less than 160 cm. Mitford soils overlie glaciolacustrine, glaciofluvial, or morainal till materials and cover 24 ha (<1%) of the Study Area. Darnel soils (>160 cm peat) account for 144 ha (1.5%) of the Study Area.

Gleysolic Soils

Gleysolic soils have developed in close association with organic soils in the Study Area. Soils associated with peatlands are generally peaty phase gleysols (>30 cm of organic at surface).

Non-peaty gleysols occur in depressional and level areas with a higher water table or at seepage areas along lower slopes. The dominant gleysols in the Study Area are of the Pothole Creek [POT] dominant soil map units. These soils account for <2% (33 ha) of the Study Area. POT soils generally form on fine to moderately fine glaciolacustrine (GLLC) soils and are often associated with Elbow and Robinson soils. A layered variant [POTzzxg] occurs where it overlies very coarse-gravelly glaciofluvial deposits.

Soil map unit POT2 delineates active lacustrine soils in areas affected by beaver activity.

Regosolic Soils

Regosols identified in the Study Area have no profile development because they are formed on very rapidly drained coarse textured soils with high percentage of coarse fragments, and/or are in active floodplains disturbed by periodic flooding. Drainage in regosolic soils is generally well to very rapid but the water table can be highly variable in floodplain areas and proximity to active channels. Regosolic soils account for 13% (342 ha) of the Study Area. Three variants are mapped:

- Hillsdale [HDX] soils are home to Soil Correlation Area 15 (SCA 15) (Brierly *et al.* 2006). These are Orthic Regosols on moderately coarse fluvial over gravelly – moderately coarse glaciofluvial.
- McLean Creek [MLE] soils are Orthic Regosols formed on very gravelly, very coarse fluvial parent materials.
- Pipestone [PPX] soils are home to SCA 15. These are Cumulic Regosols or Gleyed Cumulic Regosols.

Soil Series and Variants in the Study Area

Soil profiles representative of soil series names in the Study Area are presented in Appendix D-1. Table 3.4-6 provides a list of the soil series names and associated variants occurring within the Study Area. Criteria and symbols for indicating these variants were applied according to the CAESA Soil Inventory Working Group (2001). Two letter suffixes designate variants of series (e.g., BPEgl is the gleyed variant of the Beaupre soil series). Suffix definitions are as follows:

- **aa –** Not modal for soil correlation area;
- **co –** Coarse (greater than 10% coarse fragments or one textural group coarser than modal);
- **gl –** Gleyed variant of a specified soil series (gleyed soil with distinct mottling within 50 cm of surface);
- **xg** – Gravel at 30-99 cm;
- **xl –** Lithic at 30-99 cm;
- **zb –** Brunisolic;
- **zf** – Fibric;
- **zh –** Humic;
- **zg –** Gravelly variant;
- **zr –** Regosolic; and
- **zz –** Atypical variant.

Table 3.4-6: Soil Series and Variants in the Study Area

Soil Series	SCA	SS Code	Upper parent material	Upper Texture	Lower Parent Material	Lower Texture	Subgroup	Drainage	Notes
BEAUPRE	16	BPExg	TILL	MF	TILL	GRMF	O.EB	WELL	
BEAUPRE	16	BPEzz	TILL	MF			O.EB	WELL	
BEAUPRE	16	BPEzzgl	TILL	MF	TILL		GL.EB	MOD WELL	
BRAGG CREEK	16	BRG	GLFL	ME	GLFL	VGVC	E.EB	RAPID	
BEDROCK	N/A	BRK	BRUN						
DISTURBED	16	DIS	ANTH						
DARNELL	16	DNL	FNPT				TY.M	V. POOR	
DARNELL	16	DNLzf	FNPT				TY.F	V. POOR	
DARNELL	16	DNLzh	FNPT				ME.H	V. POOR	
ELBOW	16	ELB	GLLC	FI			D.GL	WELL	Associated with Robinson
ELBOW	16	ELBco	GLLC	MF			D.GL	WELL	Associated with Robinson
FRANK	16	FRKzz1	COLL	VGME			O.EB	WELL	
FRANK	16	FRKzz2	COLL	VGME			O.MB	WELL	
HILLSDALE	15	HDXaaxg	FLUV	MC	GLFL	GRMC	O.R	RAPID	In SCA 15
MCLEAN CREEK	*16	MLE	GLFL	VGVC			O.R	RAPID	
MITFORD	16	MTF	FNPT		UNDF		T.M	V. POOR	
POTHOLE CREEK	15	POTzaa	GLLC	MF			O.HG	POOR	
POTHOLE CREEK	15	POTaazz	GLLC	MF			O.G	POOR	
POTHOLE CREEK	15	POTaazg	GLLC	GRMF			O.HG	POOR	
POTHOLE CREEK	15	POTzzxg	GLLC	MF	GLFL	VGVC	O.G	POOR	
PIPESTONE	16	PPXaa	FLUV	MEMF			CU.R	WELL	
PIPESTONE	16	PPXaagl	FLUV	MEMF			GLCU.R	MOD WELL	
ROBINSON	16	RNS	TILL	FI			D.GL	WELL	Associated with Elbow
SPRUCE RIDGE	16	SPR	TILL	GRMF			O.GL	WELL	Luvisolic associated with Willoughby

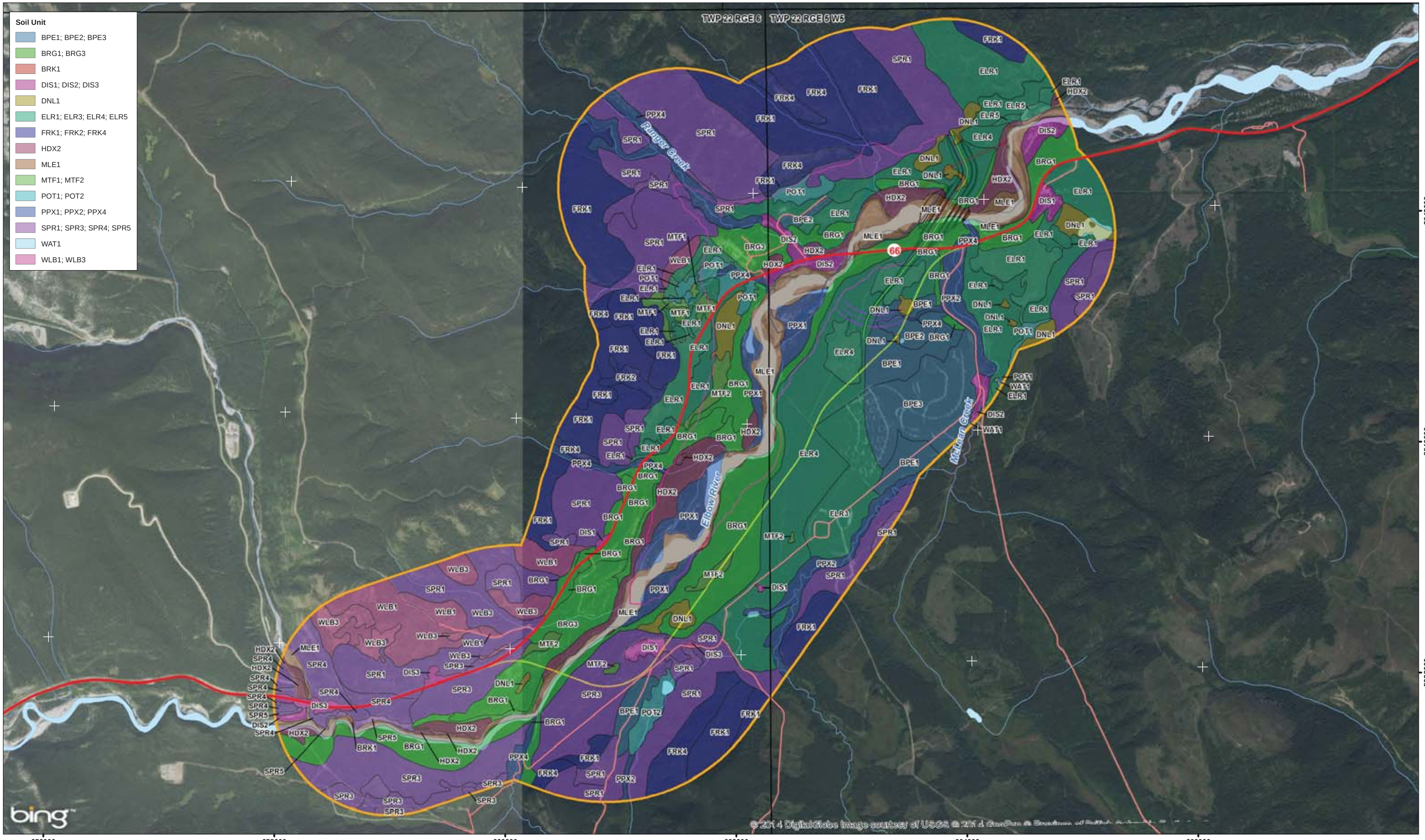
Soil Series	SCA	SS Code	Upper parent material	Upper Texture	Lower Parent Material	Lower Texture	Subgroup	Drainage	Notes
SPRUCE RIDGE	16	SPRzb	TILL	GRMF			BR.GL	WELL	Luvisolic associated with Willoughby
SPRUCE RIDGE	16	SPRzz	TILL	GRMF			D.GL	WELL	Luvisolic associated with Willoughby
SPRUCE RIDGE	16	SPRxl	TILL/BRUN	GRMF			D.GL	WELL	Luvisolic associated with Willoughby
WILLOUGHBY	16	WLB	TILL	GRME			E.DYB	WELL	Brunisolic associated with Spruce Ridge
WILLOUGHBY	16	WLBzz1	TILL	GRME			O.DYB	WELL	Brunisolic associated with Spruce Ridge
WILLOUGHBY	16	WLBzz2	TILL	GRME			O.MB	WELL	Brunisolic associated with Spruce Ridge

Note:
* New soil series named in this project.

3.4.1.13 Soil Map Units

Soil units mapped in the Study Area are comprised of soils extensive enough to be distinguished separately at the scale of mapping and are based on published information (AVI, surficial geology) and ground truthing through soil inspections in the field. Figure 3.4-3 presents the soils map at a scale of 1:35 000.

Specific map units are indicated using symbols such as BPE1 (Beaupre 1 map unit), which consists of the soil series code plus a numerical suffix that differentiates map units based on their different subdominant components. The composition and series proportion for individual map units are presented in Table 3.4-7. The most common soil units in the Study Area are: luvisols (45%), brunisols (36%) and regosolic soils (13%).Organic soils, gleysols, disturbed lands, exposed bedrock and open water each account for less than 3% of the Study Area.



Legend

- Study Area
- Base Reservoir Water Level (1399m)
- 100 Year Flood Water Level (1422m)
- Highway
- Road

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment

N 250 0 250 500
Meters
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD

McLean Creek Environmental Overview

Baseline Soil Units

DATE: November 2014	
ANALYST: NH	QA/QC: TR PB JB
PDF: Fig3.4-3 Baseline Soil Units 14-11-26	

Figure 3.4-3

amec

S:\Gis\Projects\CW2174_Flood_Mitigation\ArcGIS\MC1_EnvReview\Fig3.4-3 Baseline Soil Units.mxd

Table 3.4-7: Extent of Soil Map Units in the Study Area

Soil	Dominant Soil Series					Sub-Dominant Soil Series					Minor inclusions			
Map Unit	Soil [1] Series	% of Map Unit	Parent [2] Material	Texture[3]	Drainage	Soil Series	% of Map Unit	Parent [2] Material	Texture[3]	Drainage	<10%	Vegetation[4]	ha	%
BPE1	BPE	90	TILL	MF	WELL						BRG	b1	53.5652	2.05
BPE2	BPEgl	90	TILL	MF	MOD WELL						BRG	b1	14.4018	0.55
BPE3	BPE	60	TILL	MF	WELL	DIS	30	ANTH			BRG	b1	65.4122	2.51
BRG1	BRG	90	GLFL/GLFL	ME/VGVC	RAPIDLY						ELB, RNS	d3	256.3856	9.83
BRG3	BRG	60	GLFL/GLFL	ME/VGVC	RAPIDLY	DIS	30	ANTH			ELB, RNS	d3	69.4293	2.66
BRK1	BRK	90	BRUN								SPR, WLB	-	0.5084	0.02
DIS1	DIS	60	ANTH			BRG	30	GLFL/GLFL	ME/VGVC	RAPIDLY	ELB, RNS	d3	11.5114	0.44
DIS2	DIS	60	ANTH			PPXgr	30	FLUV	GRME	WELL	HDX	d3	25.6408	0.98
DIS3	DIS	60	ANTH			SPR	30	GRMF	WELL		WLB	b3	8.4072	0.32
DNL1	DNL	70	FNPT		VERY POOR	MTF	20	FNPT/GLLC	/FI	VERY POOR	POT	k2	39.7917	1.53
ELR1	ELB/RNS	90	GLLC+TILL	FI	WELL						BRG,POT	b1	272.9461	10.47
ELR3	ELB/RNS	60	GLLC+TILL	FI	WELL	DIS	30	ANTH			BRG,POT	b1	50.8435	1.95
ELR4	ELB/RNS	60	GLLC+TILL	FI	WELL	BRG	30	GLFL/GLFL	ME/VGVC	RAPIDLY	POT	b1	172.4466	6.62
ELR5	ELB/RNS	60	GLLC+TILL	FI	WELL	BRK	30	BRUN			BRG, POT	b1	3.6018	0.14
FRK1	FRK	90	COLL	VGME	WELL						SPR, WLB	b3,b2	277.6795	10.65
FRK2	FRKgl	90	COLL	VGME	WELL						SPR, WLB	b3,b2	7.7567	0.30
FRK4	FRKzz	60	COLL	VGME	WELL	FRKxl	30	COLL/BRUN	VGME		SPR, WLB	b3,b2	86.2429	3.31
HDX2	HDX	60	FLUV/GLFL	MC/GRMC	WELL	HDXgl	30	FLUV/GLFL	MC/GRMC	MOD. WELL	PPX	d3	73.3543	2.81
MLE1	MLE	90	FLUV	VGVC	RAPIDLY						PPX	h1	124.6677	4.78
MTF1	MTF	70	FNPT/GLLC	FI	VERY POOR	POT	20	GLLC/TILL	MF	POOR	DNL	k2	9.2686	0.36
MTF2	MTF	70	FNPT/GLLC	FI	VERY POOR	DNL	20	FNPT		VERY POOR	POT	k2	14.19	0.54
POT1	POT	90	GLLC/TILL	MF	POOR						MTF	k2	22.4641	0.86
POT2	POT	90	LACU/TILL	MF	VERY POOR						ELB, RNS	k2	10.485	0.40
PPX1	PPX	90	FLUV/FLUV	MEMF/VGVC	WELL						HDX	d3	56.3483	2.16
PPX2	PPXgl	90	FLUV	MEMF/VGVC	MOD WELL						HDGgl	d3	42.317	1.62
PPX4	PPXgr	90	FLUV	GRME	WELL						HDX	d3	45.6652	1.75
SPR1	SPR	60	TILL	GRMF	WELL	WLB	30	TILL	GRMF		FRK	b3	484.8911	18.60
SPR3	SPRxg	60	TILL/GLFL	GRMF/VGVC	WELL	WLBxg	30	TILL/GLFL	GRME/VGVC		FRK	b3	164.7398	6.32
SPR4	SPRxl	60	TILL/BRUN	GRMF	WELL	WLBxl	30	TILL/BRUN	GRME/VGVC		FRK	b3	37.7677	1.45
SPR5	SPRxl	60	TILL/BRUN	GRMF	RAPID	BRK	30	BRUN			FRK	b3	3.8911	0.15
WLB1	WLB	60	TILL	GRME	WELL	SPR	30	TILL	GRMF	WELL	FRK	b3	66.4755	2.55
WLB3	WLBzz2	60	TILL	GRME	WELL	SPR	30	TILL	GRMF	WELL	FRK	b3	33.0934	1.27
WAT	WAT	90	Water								POT	-	0.7034	0.03

Notes:

1 Table 3.4-6

2 TILL-morainal till, GLFL/GLFL- glaciofluvial over glaciofluvial (stratified texture), BRUN - undifferentiated bedrock, ANTH - anthropogenic, GLLC+TILL- glaciolacustrine and till (lacustrotill), COLL- Colluvium, FLUV/GLFL - fluvial over glaciofluvial, FNPT/GLLC - fen peat over glaciolacustrine, FLUV/FLUV - fluvial over fluvial (stratified textures), FLUV - fluvial, TILL/GLFL - morainal till over glaciofluvial, TILL/BRUN - morainal till over undifferentiated bedrock.

3 MF - moderately fine, ME/VGVC - medium over very gravelly, very coarse, FI - fine, very coarse, MEMF/VGVF - medium to moderately fine over very gravelly very coarse, GRMF - gravelly, moderately fine, GRME - gravelly, medium VGME – very gravelly, medium, MC/GRMC - moderately coarse over gravelly, moderately coarse, GRME/VGVC - gravely medium over very gravelly, very coarse.

4 Vegetation (ecosite phase): b1- Lodgepole pine/ bearberry/hairy wild rye, b2- Aspen/ bearberry/hairy wild rye, b3- Aspen/white spruce/lodgepole pine bearberry/hairy wild rye, d3- Aspen/white spruce/lodgepole pine/low-bush cranberry/wild sarsaparilla, d4- white spruce/low-bush cranberry/wild sarsaparilla, k2- Shrubby rich fen.

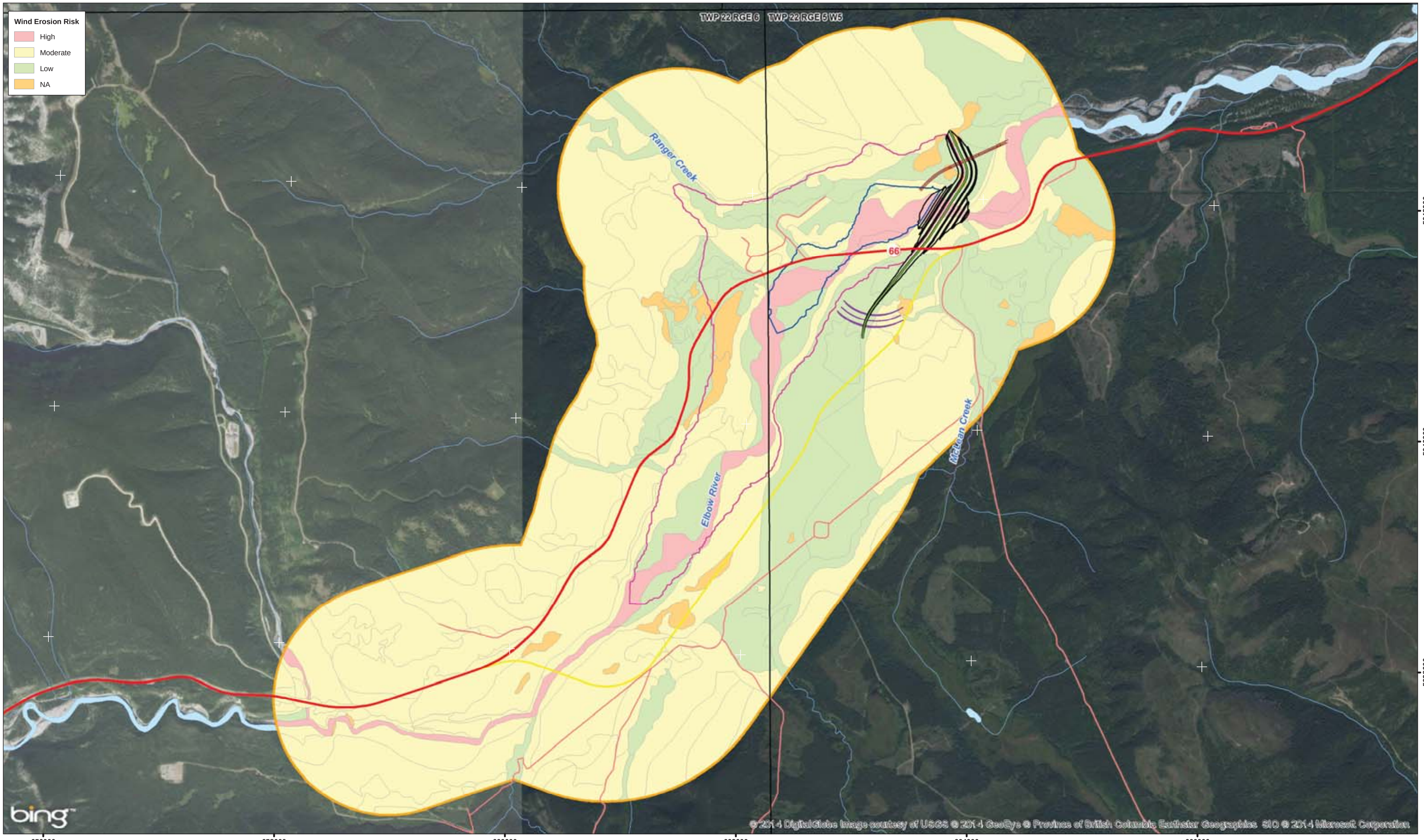
3.4.1.14 Soil Erosion Risk

Soil erosion risk ratings for wind and water were assigned and mapped by soil series, with reference to the topographical expression (water erosion) and soil texture (wind erosion) of the mapped soils. These areas are presented in Table 3.4-8. The risk to wind and water erosion in the Study Area is interpreted to increase with increasing slope steepness (water) and exposure of soil faces (wind and water).

Table 3.4-8: Soil Types and Water Erosion Risk

Soil Series Code	Soil Series Name	Wind Erosion	Water Erosion Risk		
			<5% Slope	5-9% Slope	>9% Slope
BPE	Beaupre	Moderate	Low	Moderate	High
BPEgl	Beaupre-GL	Moderate	Low	Moderate	High
DNL	Darnell	N/A	N/A	N/A	N/A
ELB	Elbow	Low	Low	Moderate	High
FRK	Frank	Moderate	Moderate	High	High
FRKgl	Frank-GL	Moderate	Moderate	High	High
FRKzz	Frank-ZZ	Moderate	Moderate	High	High
HDX	Hillsdale	Moderate	Moderate	High	High
MLE	McLean Creek	High	Moderate	High	High
MTF	Mitford	N/A	N/A	N/A	N/A
POT	Pothole Creek	Low	Low	Moderate	High
PPX	Pipestone	Low	Low	Moderate	High
PPXgl	Pipestone-GL	Low	Low	Moderate	High
PPXgr	Pipestone-GR	Low	Low	Moderate	High
SPR	Spruce Ridge	Moderate	Moderate	Moderate	High
SPRxg	Spruce Ridge-XG	Moderate	Moderate	Moderate	High
SPRxl	Spruce Ridge-XL	Moderate	Moderate	Moderate	High
RNS	Robinson	Low	Low	Moderate	High
WLB	Willoughby	Moderate	Moderate	Moderate	High
WLBzz2	Willoughby-ZZ	Moderate	Moderate	Moderate	High

Erosion potential ratings were assigned to the dominant soil series of the map unit. A wind erosion risk map is presented in Figure 3.4-4 and a water erosion potential map is presented in Figure 3.4-5. Tables 3.4-9 and 3.4-10 provide wind and water erosion risk ratings calculated for each map unit in the Study Area, respectively.



Legend

Study Area
Base Reservoir Water Level (1399m)
100 Year Flood Water Level (1422m)
Highway
Road

Proposed Infrastructure

Main Structure
Auxiliary Earth Cut Spillway
Main Embankment Crest - El. 1429.5m
Combined Permanent Outlet / Spillway Structure
Highway 66 Realignment

N 250 0 250 500
Meters
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch
ESRD
McLean Creek Environmental Overview

Soils Wind Erosion Risk

DATE: November 2014
ANALYST: NH
QA/QC: TR PB JB
PDF: Fig3.4-4 Wind Erosion Risk 14-11-26

Figure 3.4-4

amec

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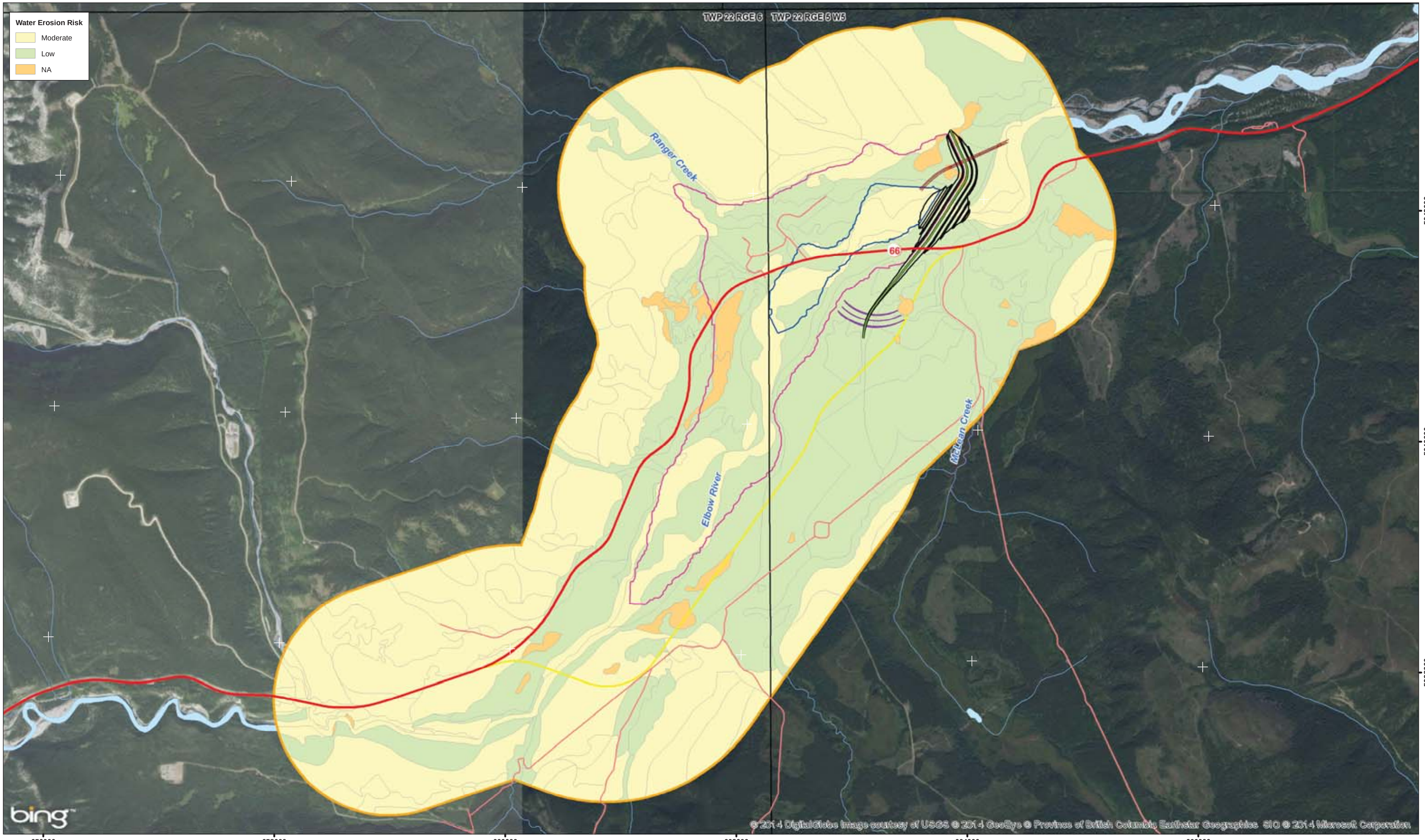

Legend

Study Area
Base Reservoir Water Level (1399m)
100 Year Flood Water Level (1422m)
Highway
Road

Proposed Infrastructure

Main Structure
Auxillary Earth Cut Spillway
Main Embankment Crest - El. 1429.5m
Combined Permanent Outlet / Spillway Structure
Highway 66 Realignment

N 250 0 250 500
Meters
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD

McLean Creek Environmental Overview

Soils Water Erosion Risk

DATE: November 2014
ANALYST: NH
QA/QC: TR PB JB
PDF: Fig3.4-5 Water Erosion Risk 14-11-26

Figure 3.4-5

amec

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Table 3.4-9: Wind Erosion of Soil Map Units

Soil Map Unit	Risk Rating	Dominant Soil Series	% of Soil Map Unit	ha	%
BPE1	Moderate	Beaupre	90	54	2.1
BPE2	Moderate	Beaupre-GL	90	14	0.6
BPE3	Moderate	Beaupre	60	65	2.5
BRG1	Moderate	Bragg Creek	90	256	9.8
BRG3	Moderate	Bragg Creek	60	69	2.7
BRK1	N/A	Bedrock	90	1	0.0
DIS1[1]	Moderate	Disturbed	60	12	0.4
DIS2[1]	Low	Disturbed	60	26	1.0
DIS3[1]	Moderate	Disturbed	60	8	0.3
DNL1	Negligible	Darnell	70	40	1.5
ELR1	Low	Elbow/Robinson	90	273	10.5
ELR3	Low	Elbow/Robinson	60	51	2.0
ELR4	Low	Elbow/Robinson	60	172	6.6
ELR5	Low	Elbow/Robinson	60	4	0.1
FRK1	Moderate	Frank	90	278	10.7
FRK2	Moderate	Frank-GL	90	8	0.3
FRK4	Moderate	Frank-ZZ	60	86	3.3
HDX2	Moderate	Hillsdale	60	73	2.8
MLE1	High	McLean Creek	90	125	4.8
MTF1	Negligible	Mitford	70	9	0.4
MTF2	Negligible	Mitford	70	14	0.5
POT1	Low	Pothole Creek	90	22	0.9
POT2	Low	Pothole Creek	90	10	0.4
PPX1	Low	Pipestone	90	56	2.2
PPX2	Low	Pipestone-GL	90	42	1.6
PPX4	Low	Pipestone-GR	90	46	1.8
SPR1	Moderate	Spruce Ridge	60	485	18.6
SPR3	Moderate	Spruce Ridge-XG	60	165	6.3
SPR4	Moderate	Spruce Ridge-XL	60	38	1.4
SPR5	Moderate	Spruce Ridge-XL	60	4	0.1
WLB1	Moderate	Willoughby	60	66	2.5
WLB3	Moderate	Willoughby	60	33	1.3
WAT	N/A	Water	90	1	0.0
			Total	**2,607**	**100.0**

Note:
[1] Rating pertains to undisturbed portions of map polygon.

Table 3.4-10: Water Erosion of Soil Map Units

Soil Map Unit	Risk Rating	Dominant Soil Series	% of Soil Map Unit	ha	%
BPE1	Low	Beaupre	90	54	2.1
BPE2	Low	Beaupre-GL	90	14	0.6
BPE3	Low	Beaupre	60	65	2.5
BRG1	Low	Bragg Creek	90	256	9.8
BRG3	Low	Bragg Creek	60	69	2.7
BRK1	N/A	Bedrock	90	1	<0.1
DIS1[1]	Low	Disturbed	60	12	0.4
DIS2[1]	Low	Disturbed	60	26	1.0
DIS3[1]	Moderate	Disturbed	60	8	0.3
DNL1	Negligible	Darnell	70	40	1.5
ELR1	Low	Elbow/Robinson	90	273	10.5
ELR3	Low	Elbow/Robinson	60	51	2.0
ELR4	Low	Elbow/Robinson	60	172	6.6
ELR5	Low	Elbow/Robinson	60	4	0.1
FRK1	Moderate	Frank	90	278	10.7
FRK2	Moderate	Frank-GL	90	8	0.3
FRK4	Moderate	Frank-ZZ	60	86	3.3
HDX2	Moderate	Hillsdale	60	73	2.8
MLE1	Moderate	McLean Creek	90	125	4.8
MTF1	Negligible	Mitford	70	9	0.4
MTF2	Negligible	Mitford	70	14	0.5
POT1	Low	Pothole Creek	90	22	0.9
POT2	Low	Pothole Creek	90	10	0.4
PPX1	Low	Pipestone	90	56	2.2
PPX2	Low	Pipestone-GL	90	42	1.6
PPX4	Low	Pipestone-GR	90	46	1.8
SPR1	Moderate	Spruce Ridge	60	485	18.6
SPR3	Moderate	Spruce Ridge-XG	60	165	6.3
SPR4	Moderate	Spruce Ridge-XL	60	38	1.4
SPR5	Moderate	Spruce Ridge-XL	60	4	0.1
WLB1	Moderate	Willoughby	60	66	2.5
WLB3	Moderate	Willoughby	60	33	1.3
WAT	N/A	Water	90	1	<0.1
			Total	**2,607**	**100.0**

Note:
[1] Rating pertains to undisturbed portions of map polygon.

Generally, mineral soils having a loamy to clay soil texture (Beaupre, Frank, Hillsdale & Spruce Ridge) have a moderate risk of wind erosion. The McLean Creek soil series has a coarse-textured (sand) surface layer and is ranked as having a high wind erosion risk.

Organic soils (Darnell and Mitford) are generally rated as having negligible wind and water erosion risk due to their level topography and moist condition, unless the soil face (at an excavation) is exposed or dried. Gleysolic soil units (Pothole Creek) are rated as having a low risk to erosion due to their organic surface layer, level topography, and clayey subsoil.

In all cases, slope gradient affects the potential for water erosion in the Study Area. Most of the mineral soils are found on level to undulating terrain with moderate to gentle slopes (<9%) in the Elbow River Valley. Areas with steep slopes (≥9%) and high water erosion potential occur further from the river or in the south portion of the Study Area where the river and its tributaries are more incised and the valley walls are steeper. Steep slopes have a relatively small spatial extent .Table 3.4-11 presents the area and percentage of the Study Area and the associated risk to wind and water erosion.

Table 3.4-11: Wind and Water Erosion Ratings for Soils

Water Erosion Rating	ha	%	Wind Erosion Rating	ha	%
Low	1,173.5	1,173.5	Low	702.8	27.0
Moderate	1,369.0	1,369.0	Moderate	1,715.0	65.8
High	0.0	0.0	High	124.7	4.8
Negligible	63.3	2	Negligible	63.3	2.4
Non-Soil Areas (Open Water, Bedrock)	1.2	>0.1	Non-Soil Areas (Open Water, Bedrock)	1.2	>0.1
Total			**Total**	**2,607**	**100%**

3.4.2 Discussion

3.4.2.1 Potential Project- Impacts

Construction of the Project facilities (e.g., dam, roads, borrow pits; permanent and temporary structures and laydown areas) could alter soils within the Study Area. Potential impacts from Project construction include:

- erosion of medium to moderately coarse textured topsoil by wind and water;
- admixing of topsoil with subsoil which can decrease topsoil quality;
- soil rutting and compaction during construction and reclamation; and
- movement of excess stones to the soil surface.

The physical loss of topsoil due to erosion lowers the capability of the land by decreasing soil fertility of the associated root zone. The severity of the problem is directly related to the proportion of soil lost and is affected by the removal of vegetation and the exposure of bare soil to wind and rain.

Admixing topsoil with subsoil can degrade topsoil quality due to lower nutrient and soil organic matter levels and increased calcareousness of the subsoil. The decrease in topsoil quality is detrimental to the soil's productive capability to support a vegetative cover.

Rutting may be a problem if prolonged periods of rain occur during construction, and can result in both compaction and admixing problems. The capability of a soil to support plant growth can be altered when the topsoil is compacted. Compaction restricts root penetration and elongation, as well as restricting air and water movement through the soil.

Many of the soils within the Study Area have a high percentage of coarse fragments at or near the surface. Grading activities during construction can bring stones in excess of natural conditions to the ground surface, particularly in areas where a non-stony surficial deposit overlies a stony deposit that is within the depth of grading. Excess stones can damage construction and landscaping equipment, as well as reducing soil capability and decreasing reclamation success.

Conservation of soil quality and quantity are required under Section 3 of the *Soil Conservation Act* (RSA 2010).

3.4.2.2 Potential Mitigation Measures

Soil Erosion

Soil erosion can be prevented by adopting best management practices (BMPs) which include:

- develop and implement an Erosion and Sediment Control (ESC) plan;
- install temporary runoff barriers such as sediment fencing, envirologs or vegetated earthen diversion berms;
- stabilizing soil stockpiles and areas of steep slopes with hydroseeding with tackifier or use of erosion control blankets;
- minimize soil handling during periods of strong winds or heavy rain; and
- revegetate disturbed areas.

Admixing

Best management practices include:

- topsoil stripping will include the forest duff (LFH) layers;
- soils associated with glaciofluvial and fluvial deposits are strongly calcareous. Due to their alkaline pH, calcareous soils can potentially lower topsoil quality by immobilizing plant nutrients for growth. Extra caution should be executed to ensure no admixing in these areas; and
- soil handling activities inspected by a qualified environmental inspector to ensure the use of appropriate soil conservation practices.

Topsoil Rutting and Compaction

- Suspend or modify operations in wet conditions where rutting problems could jeopardize topsoil quality;
- Heavy equipment will be restricted on finer-textured soils during wet or very moist soil conditions;
- In wet areas within floodplains, use of wide-tracked equipment or similar should be considered where appropriate, to minimize rutting;
- In areas to be revegetated, subsoiling or deep-ripping followed by discing may be required prior to topsoil placement; and
- To minimize rutting and compaction of organic soils, all construction activities occurring in or around organic soils should be limited to winter months when the ground is adequately frozen.

Increased Surface Stoniness

- Ensure topsoil is not overstripped in areas identified as having potentially gravelly subsoils; and
- If excess stones are brought to the surface, stones that are larger or in greater abundance than the pre-disturbance condition will be picked. Stones picked from the Study Area can either be used for erosion control in drainages or in undisturbed areas, or hauled away for disposal.

3.4.2.3 Data Gaps

A survey intensity level of 2 (SIL 2) would be required to meet EIA guidelines. This would require (at minimum) an additional 100 soil inspection points in the Study Area. Based on data collected in this field survey, baseline soil and terrain mapping would be revised if necessary to reflect changes to soil map polygons. Further soil analytical data would be gathered in field sampling and analyzed to determine the baseline land capability and the suitability of the soil for reclamation.

Additional field sampling and laboratory analyses would be required in the 1 km buffer around the Study Area and beyond should this area be expanded.

3.4.3 Literature Cited

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3.5 Vegetation

The construction of the dam, reservoir, associated facilities and possible periodic flooding may remove and inundate vegetation. This section describes the key vegetation and wetland resources of the area, the potential impacts of the proposed dam, and the best management practices and possible mitigative measures to reduce impacts. Should the Project proceed beyond the conceptual stage, data gaps are identified that should be filled prior to preparing a formal environmental impact assessment.

Methods are provided in Appendix A.

3.5.1 Results

The Project is located within the Montane Subregion of the Rocky Mountain Natural Region of Alberta (Natural Regions Committee 2006) which represents a transition from the aspen (*Populus tremuloides*)-white spruce (*Picea glauca*) –dominated boreal mixedwood forest to lodgepole pine (*Pinus contorta*) dominated forests. The area is characterized by mixed forests of lodgepole pine, aspen and white spruce. Balsam poplar *(Populus balsamifera)* is also present particularly along rivers and large creeks. Black spruce (*Picea mariana*) and tamarack (*Larix laricina*) common on wet sites in the northern part of the subregion, are not as prevalent in the south. Understory species typical of the subregion include shrubs such as low-bush cranberry (*Viburnum edula*), prickly rose (*Rosa acicularis*), green alder (*Alnus crispa*), and Canada buffalo berry (*Sheperdia canadensis),* the herb wild sarsaparilla (*Arailia nudicalus*) and grasses such as marsh reed grass (*Calmagrostis canadensis*) and hairy wild rye (*Elymus innovatus*).

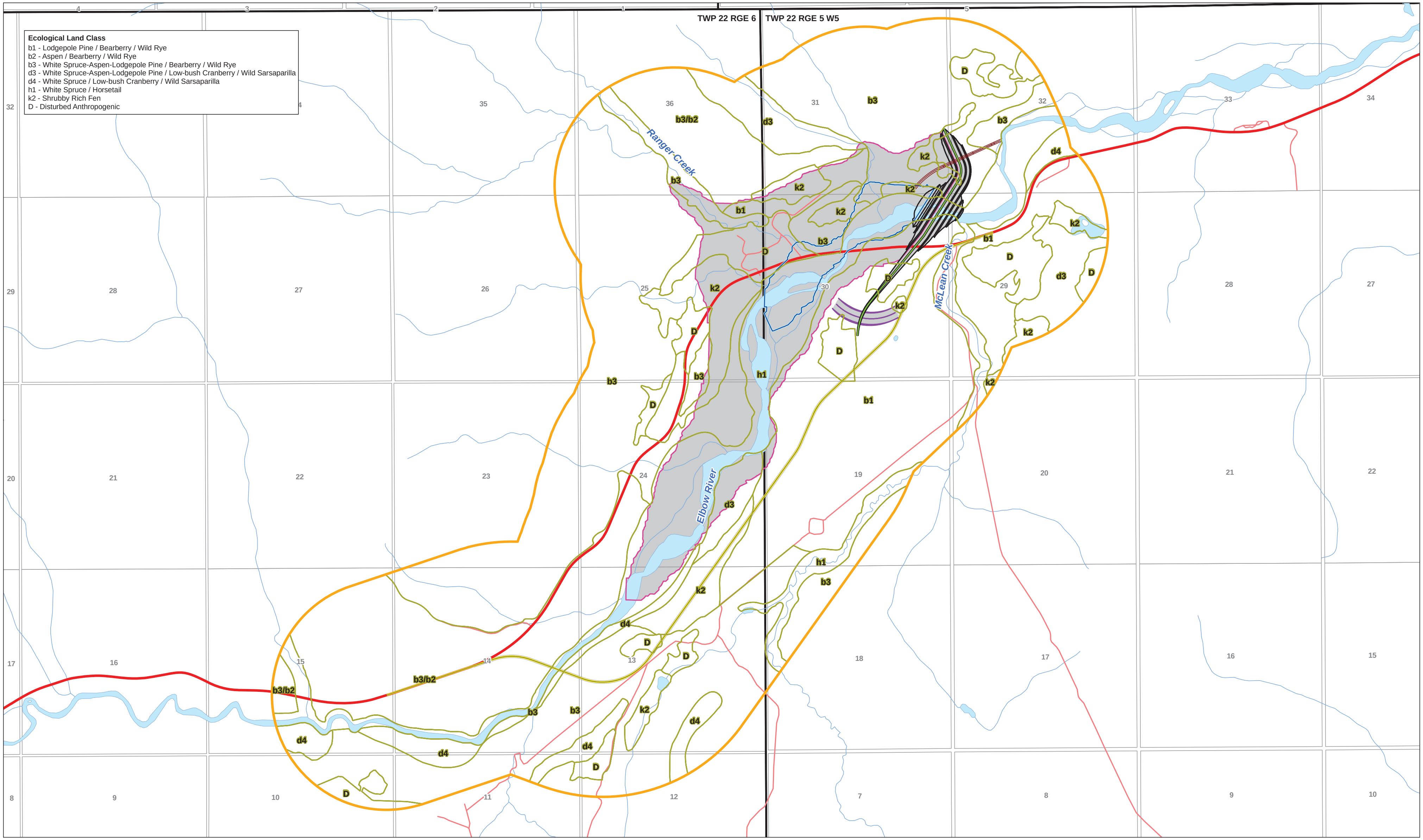
The climate is cooler in the summer and warmer in the winter than the northern Boreal Forest Region due to less influence from cold Arctic air masses and more frequent modification by chinook winds.

3.5.1.1 Habitat distribution

The Study Area is forested by a mixture of lodgepole pine, white spruce and aspen. The vegetation is provisionally classified into ecological land classes according to the system developed by Archibald *et al.* (1996) for southwestern Alberta. Seven ecosites phases and one disturbed land class are identified and mapped (Figure 3.5 -1). The conceptual project would affect approximately 439 ha (17%) of the Study Area (Table 3.5-1). The following descriptions provide the main characteristics of each and the area potentially affected by the Project. Dominant species at the inspection sites are listed in Appendix E.

Lodgepole pine/bearberry/hairy wild rye

This ecosite phase is located on glaciolacustine and till deposits primarily on the south side of the Elbow River and along McLean Creek. The characteristic tree species is lodgepole pine in closed stands. Shrubs include Canada buffaloberry and dwarf bilberry (*Vaccinium caespitosum).* Typical herbs are bearberry (*Arctostaphylos uva-ursi)* and hairy wild rye (*Elymus innovatus)* with a stair-step moss (*Hylocomium splendens)* ground cover. The well drained medium textured soils are typically classed as Brunisols. Land use in the area consists of the McLean Creek campground, cattle grazing, forest harvesting and a borrow pit. The proposed Project would disturb approximately 419 ha (15%) of this ecosite.



Legend

Study Area	Highway
Base Reservoir Water Level (1399m)	Road
100 Year Flood Water Level (1422m)	Project Facilities and 100 Year Flood Water Extent
Ecological Land Class	

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment

N

250 0 250 500

Metres

1:30,000

Note : UTM Zone 11 NAD83

Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch
ESRD
McLean Creek Environmental Overview

Ecological Land Classes

DATE: November 2014

ANALYST: NH QA/QC: TR DR JB

PDF: Fig3.5-1 Ecol Land Cl 14-12-03

Figure 3.5-1

amec

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Table 3.5-1: Distribution of Ecological Land Classes

Ecological Land Class	Baseline	Change	
	(ha)	(ha)	(%)
Lodgepole pine/ bearberry/hairy wild rye – b1	419	62	15
Aspen/ bearberry/hairy wild rye – b2	148	1	<1
Aspen/white spruce/ lodgepole pine bearberry/hairy wild rye – b3	1,244	98	8
Aspen/white spruce/ lodgepole pine/low-bush cranberry/wild sarsaparilla – d3	97	12	12
white spruce/ low-bush cranberry/wild sarsaparilla – d4	85	<1	<1
Shrubby rich fen – k2	153	65	43
White spruce/horsetail – h1	302	166	55
Disturbed anthropogenic – D	160	35	17
Total	**2,608**	**439**	**17**

Aspen/bearberry/hairy wild rye

This ecosite phase is located on colluvium deposits primarily on the north side of the Elbow River on the upper hills and ridges. The characteristic tree species is aspen in open stands. Shrubs include Canada buffaloberry and prickly rose (*Rosa acicularis).* Typical grasses are hairy wild rye (*Elymus innovatus)* and pine grass (*Calamagrostis rubescens)*. The well drained coarse gravelly textured soils are typically classed as Brunisols. Cattle grazing and recreational trails are common land uses.

Aspen/white spruce/ lodgepole pine bearberry/hairy wild rye

This ecosite phase is located on till and colluvium deposits primarily on the north side of the Elbow River on the hills and ridges above the valley. All three tree species - aspen, white spruce and lodgepole pine - are present in closed to open stands. Shrubs include Canada buffaloberry and prickly rose. Typical dwarf shrubs are bearberry and hairy wild rye grass with a stair-step moss ground cover. The well drained coarse gravelly textured soils are typically classed as Brunisols. Cattle grazing, Paddy’s Flat campgrounds and recreational trails are common land uses.

Aspen/white spruce/ lodgepole pine/low-bush cranberry/wild sarsaparilla

This ecosite phase is located on glaciofluvial deposits primarily on terraces on both sides and adjacent to the Elbow River. White spruce and lodgepole pine are characteristic in closed stands. Shrubs include Canada buffaloberry and prickly rose. Typical herbs are bunchberry and hairy wild rye grass with a stair-step moss ground cover. The coarse gravelly textured soils are rapidly drained and are typically classed as Luvisols and Brunisols. Land use includes cattle grazing and recreational trails.

White spruce/ low-bush cranberry/wild sarsaparilla

This ecosite phase is located on till deposits on some north facing slopes on both sides of the Elbow River. The typical herb is bunchberry with a stair-step moss ground cover. The coarse gravelly textured soils are well drained and are typically classed as Luvisols.

White spruce/horsetail

This ecosite phase is located on the floodplain of the Elbow River where many stands were damaged and/or washed out by the floods in 2013. White spruce and balsam poplar with occasional aspen pine are characteristic in open to closed stands. Shrubs include willow, Canada buffaloberry and prickly rose. Typical herbs are common horsetail (*Equisetum arvense)* and meadow horsetail (*Equisetum pratense)*. The coarse gravelly textured soils are rapidly drained and much of the area downstream of Paddy's Flat consists of bare gravel bars.

Shrubby Rich Fen

This ecosite phase is located on organic deposits on depressional areas of terraces on both sides and adjacent to the Elbow River. Willow (*Salix* sp.) and dwarf birch (*Betula pumila)* are characteristic shrubs with scattered stunted white spruce. Grasses include sedges (*Carex* sp.) and marsh reed grass (*Calamagrostis canadensis).* The ground is covered with several mosses including golden moss (*Tomenthypnum nitens),* peat moss (*Sphagnum* sp.) and brown moss (*Drepanocladus* sp.). The peaty soils are poor to very poorly drained and are typically classed as Fibrisols and Mesisols.

Disturbed anthropogenic

Disturbed areas are made up of clear-cut blocks located on the south side of the Elbow River on either side of McLean Creek in former stands of lodgepole pine/ bearberry/hairy wild rye, the Ranger Station and a borrow pit south of the river. The blocks have been reforested with lodgepole pine seedlings. Willow shrubs with grasses (hairy wild rye and marsh reed grass) are common. The borrow pit has not been revegetated.

3.5.1.2 Rare Plants

Fourteen rare plant species have been identified in the Study Area, thirteen bryophytes and one vascular plant (Table 3.5-2). The majority of the species are ranked S2, known from 20 or fewer occurrences or vulnerable to extirpation due to other factors (Appendix E, Table E-2) and were collected between 1962 and 1965. Due to the late timing of the field survey, a rare plant survey was not conducted and the current status of the plants is unknown.

Table 3.5-2: List of Potential Rare Plant Species

Scientific Name	Common Name	Rank
Anastrophyllum michauxii	Liverwort	S1
Brachythecium frigidum	Moss	SU
Bryum algovicum	Moss	S2
Bryum turbinatum	Moss	S2
Dichelyma falcatum	Moss	S2
Dicranella subulata	Awl-leaved fork moss	S2
Dicranum tauricum	Broken-leaf moss	S1S2
Didymodon fallax	Fallacious screw moss	S2
Hygroamblystegium tenax	Moss	S2
Jaffueliobryum raui	Moss	S1
Orthotrichum affine	Moss	SU
Phaeophyscia sciastra	Dark shadow moss	S2S4
Psora tuckermanii	Brown-eyed scale	S2
Ranunculus glaberrimus	Early buttercup	S2S3

3.5.1.3 Old Growth Forest

Historical Wildfire Perimeter Data from 1931-2012 (ESRD 2012) shows that there were no wildfires within the Study Area during this period, hence there is the potential that old growth forest may be present.

3.5.2 Discussion

3.5.2.1 Potential Project Effects

For vegetation, potential Project effects are divided into the area affected by the dam, reservoir and associated facilities (i.e., upstream area) and the area located downstream of the dam site.

Upstream Area

Clearing of vegetation from all Project facility locations (i.e., the dam, permanent pond and the full supply level) would remove ecological land classes, and may remove rare plants and old growth forest. Potential water impoundment could permanently raise the water table resulting in a change from upland forest to lowland forest and wetland species. Fluctuating water levels in the reservoir area create a zone around the perimeter that would be unsuitable for plant growth.

Weed species could be introduced from construction traffic activities. Regular maintenance traffic accessing the Project site post-construction could also be a source of weeds.

Downstream Area

Potential seepage adjacent to the dam could raise the water table and create open water areas that would result in changes in the ecosites from upland forest to lowland forest and wetland species. The dam operation would cause a reduction in flood peaks. The change in the downstream hydrological regime could result in changes to riparian vegetation species and also effect recruitment and survival of balsam poplar.

3.5.2.2 Potential Mitigation Measures

The following measures are recommended to reduce impacts to existing vegetation:

General

- clear vegetation prior to reservoir filling;
- coordinate clearing with Spray Lakes Sawmills Ltd. forest harvesting plans;
- control dust by establishing speed limits on access roads and applying dust suppressants including water as needed;
- service and fuel mobile construction equipment at least 30 m from water bodies;
- prepare emergency response plans to deal with potential spills, fire and weather related emergencies;
- salvage, store and replace topsoil;
- install erosion and sediment control measures;
- reclaim and revegetate disturbed areas in a timely manner to minimize erosion; and
- revegetate with an appropriate plant mix, using native species where possible.

Wetlands

- avoid crossing wetlands, if possible;
- cross wetlands in winter; and
- use swamp mats or corduroy for temporary wetland crossings.

Rare Plants

- avoid rare plants, if possible; and
- if rare plants are found consider exclusion fencing, snow bridges, transplants, seed collections, etc.

Old Growth

- avoid old growth forest, if possible; and
- minimize clearing for staging or laydown areas.

Weeds

- identify and control any area with existing weed infestation;
- use weed free soil and materials in construction;
- use certified weed free seed mixes in reclamation;
- ensure that the machinery used in the construction is washed thoroughly prior to arrival to prevent the spread of noxious and prohibited noxious weeds; and
- implement weed controls where noxious and prohibited noxious weeds become established.

3.5.3.3 Data Gaps

The following data gaps should be filled to conduct a formal environmental impact assessment on vegetation.

Baseline vegetation data is required for:

- Ecological Land Classes. Current ortho-rectified photography for the Study Area should be obtained to ensure the most recent forest vegetation and any land use changes are depicted. Alberta Vegetation Inventory maps and Spray Lakes Sawmills forest harvest plans should be obtained. Vegetation classification to the level of ecosite phase should be undertaken to more accurately assess potential effects on vegetation.
- Detailed surveys should be conducted in representative areas of each vegetation type. Surveys should focus on areas of potential disturbance and inundation. Surveys should be conducted mid-growing season (i.e., early to mid-July) to maximize the number of plant species that can be identified and aid in the classification.
- In addition to the field surveys, available vegetation management and recreation area management plans (Walkinshaw 2008 and Government of Alberta 2012) should be reviewed and ESRD biologists consulted for appropriate vegetation management throughout the Project's life.
- *Wetlands*
  Detailed surveys of potentially effected wetlands should be conducted concurrent with the vegetation work. Disturbance to wetlands will require approval under the Water Act. Compensation may also be required as described in the Alberta Wetland Policy (GoA 2013), pending release of detailed implementation plans.
- *Rare Plants and Rare Ecological Communities*
  Rare plant and rare ecological communities surveys should also be conducted in representative vegetation types and areas with high potential. Rare species occurrences reported in the ACIMS records should be visited and confirmed. Two rare plant surveys should be conducted during a growing season; in the spring (i.e., June) and late summer (i.e., early to mid-August) (Alberta Native Plant Council 2012).

- *Old Growth Forest*
  Surveys of old growth forest should be conducted concurrent with vegetation to confirm the status and location of stands.
- *Weeds*
  Surveys of weeds should be conducted concurrent with vegetation to confirm the location of any infestations.

3.5.3 Literature Cited

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3.6 Wildlife

The construction of the dam, reservoir, associated facilities and possible periodic flooding may remove and inundate wildlife habitat, alter available habitat and habitat effectiveness, as well as change wildlife mortality in the area. This section describes the key wildlife and habitat resources of the area, the potential impacts of the proposed Project and the best management practices and possible mitigative measures to reduce impacts. Should the Project proceed beyond the conceptual stage, data gaps are identified that should be filled prior to preparing a formal environmental impact assessment.

Methods are provided in Appendix A.

3.6.1 Results

The Project facilities would be situated within two distinct subregions within the Rocky Mountain Natural Region: the Montane Natural Subregion and the Subalpine Natural Subregion (NRC 2006). As a result, there may be a relatively high diversity of animal species in the area from both Natural Subregions.

The Study Area contains a diverse and complex mosaic of habitats, which can support a variety of wildlife species. River banks, dominated by spruce, pine stands, riparian wetlands and shrubbery, provide suitable habitat for a diverse avian community, including grouse, waterfowl, flycatchers, warblers, and owls. The rock fields and wetlands adjacent to the river may also provide suitable habitat for reptile and amphibian species. Small mammals, such as chipmunks, voles, and shrews, will also use these habitats.

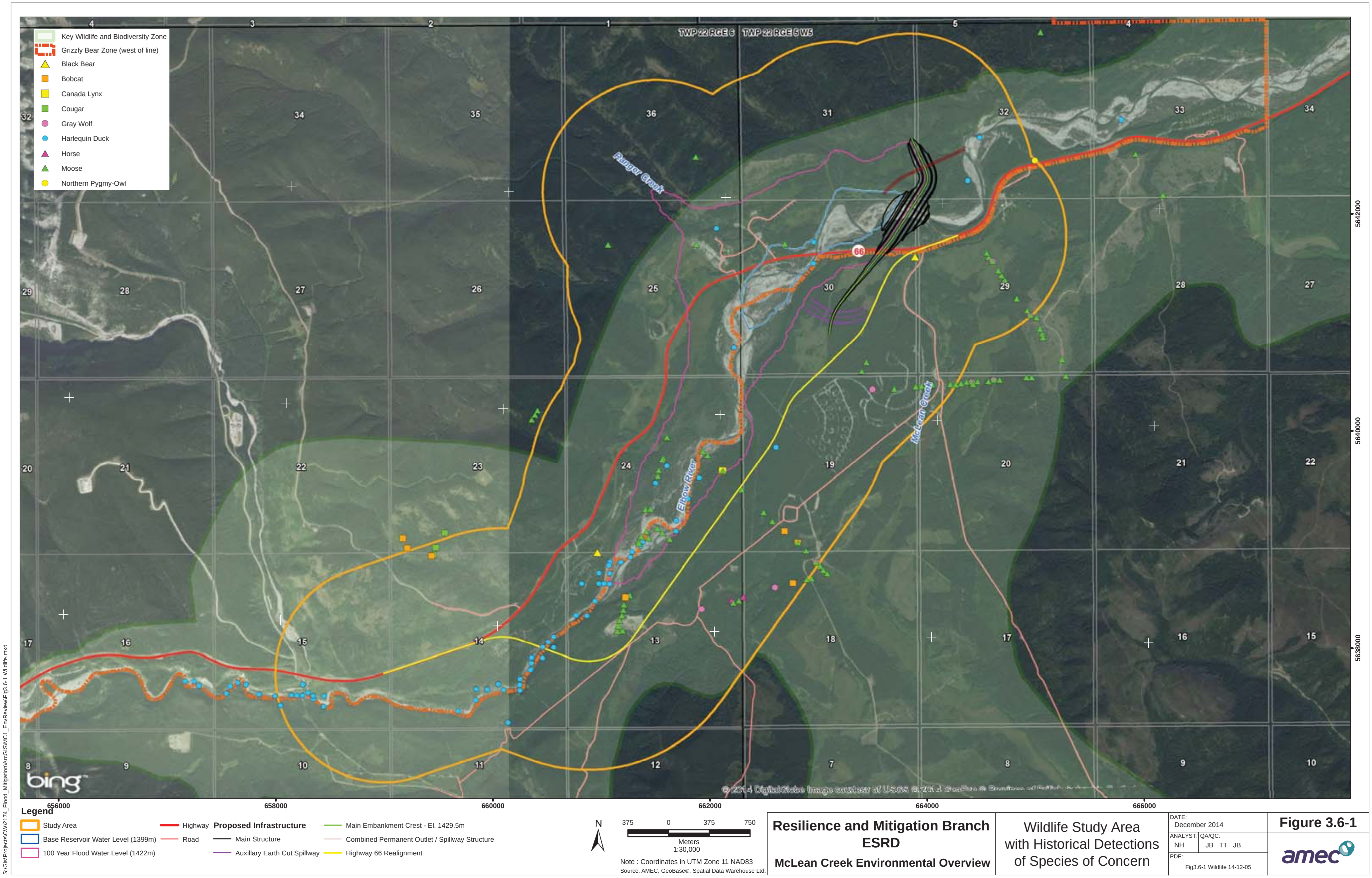
Two provincially designated Wildlife Sensitivity Zones are found within the Study Area (Figure 3.6-1):

- Grizzly Bear Zone; and
- Key Wildlife and Biodiversity Zone.

These Wildlife Sensitivity Zones impose timing and construction constraints on the Project, as per the Government of Alberta *Approval Standards: Enhanced Approval Process* (Government of Alberta 2013), the details of which are provided in Table 3.6-1.

Additionally, a Mountain Goat and Bighorn Sheep Zone is located approximately 5 km to the west of the Study Area.

The nearest Alberta Biodiversity Monitoring Institute (ABMI) survey location is located in close proximity on the north side of the Study Area boundary. The actual geographic location of ABMI monitoring sites is confidential; however, based on publicly available coordinates monitoring site may be located within the Study Area or up to 7.5 km north. No winter tracking nor breeding bird count data are available from this station (ABMI 2014).



Key Wildlife and Biodiversity Zone
Grizzly Bear Zone (west of line)
Black Bear
Bobcat
Canada Lynx
Cougar
Gray Wolf
Harlequin Duck
Horse
Moose
Northern Pygmy-Owl
TWP 22 RGE 6
TWP 22 RGE 5 W5
Ranger Creek
Elbow River
McLean Creek
66
656000
658000
660000
662000
664000
666000
5642000
5640000
5638000
© 2014 DigitalGlobe Image courtesy of USGS
Legend
Study Area
Base Reservoir Water Level (1399m)
100 Year Flood Water Level (1422m)
Highway
Road
Proposed Infrastructure
Main Structure
Auxillary Earth Cut Spillway
Main Embankment Crest - El. 1429.5m
Combined Permanent Outlet / Spillway Structure
Highway 66 Realignment
N
375 0 375 750
Meters
1:30,000
Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.
Resilience and Mitigation Branch
ESRD
McLean Creek Environmental Overview
Wildlife Study Area
with Historical Detections
of Species of Concern
DATE:
December 2014
ANALYST: NH
QA/QC: JB TT JB
PDF:
Fig3.6-1 Wildlife 14-12-05
Figure 3.6-1
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Table 3.6-1: Wildlife Sensitivity Zones within the Project Area

Sensitive Feature	Species of Concern	Desired Outcomes	Approval Standards and Operating Procedures (ESRD EAP 28 Mar 2013)	Restricted Activity Period (RAP)				
				Date	Location	Level of Disturbance (m)		
						Low	Medium	High
Grizzly Bear Zone	Grizzly bear	A) Reduce all sources of human-caused mortality.	Approval Standard 100.9.3.1. Develop access using Class III, IV, or V route, unless specified in a higher level access (i.e., Integrated Landscape Management) plan.	N/A				
		B) Reduce human-bear conflicts.	Approval Standard 100.9.3.2. Design all access routes as dead-ends, unless otherwise specified in a higher level access (e.g., Integrated Landscape Management) plan. Routes, which loop through the area, are not permitted.					
		C) Avoid development within key habitats (local and landscape scales) and key seasons.	Approval Standard 100.9.3.3. Access and pipeline routes shall not parallel permanent watercourses/riparian habitat by at least 200 m, except for vehicle or pipeline crossings.					
		D) Maintain high value and low mortality risk habitat areas.	Approval Standard 100.9.3.4. If new access, which is attached to the existing arterial all-weather access road, is less than 100 m from the arterial all-weather access road then the new access can be developed using Class III to V access. See EAP for further details (Government of Alberta 2013).					
		E) Avoid development of grizzly bear attractants (all sources).	Approval Standard 100.9.3.5. Where materials are available, place rollback across the entire pipeline/easement width for at least 40% of the linear distance or the length of the ROW. No individual section of rollback shall exceed 250 m in length. The break between sections of rollback shall be a minimum of 25 m.					
			Approval Standard 100.9.3.6. Sites (e.g., plant sites, sumps) shall be constructed within 100 m of an existing arterial all-weather permanent access.					
Key Wildlife and Biodiversity Zone	Ungulate species, riparian biodiversity	A) Protect the integrity of ungulate winter ranges, river corridors and biodiversity areas where species tend to concentrate.	Approval Standard 100.9.6.1. No activity is permitted from January 15th to April 30th. Some exceptions under favourable ground conditions. Refer to the Enhanced Approval Process for exceptions (Government of Alberta 2013).	North of Hwy 1: 15 Jan – 30 Apr	No activity[2]			
		B) Protect locally and regionally-significant wildlife movement corridors.	Approval Standard 100.9.6.2. Well sites, pipeline installations, plant sites and camps shall maintain a minimum 100 m buffer to the edge of valley breaks. In the absence of well-defined watercourse valley breaks, a 100 m buffer from the permanent watercourse bank applies.					
		C) Protect areas with rich habitat diversity and regionally-significant habitat types and habitat diversity.						
		D) Protect hiding and thermal cover.						
		E) Protect the complex biological structure and processes of identified riparian areas.	Approval Standard 100.9.6.3. Unless specified in a higher level access (i.e. Integrated Landscape Management) plan, develop access using Class IV or V routes only. See EAP for exceptions (Government of Alberta 2013).					
		F) Reduce excessive mortality of wildlife from all sources.						
		G) Protect ungulate energy reserves, body condition and reproductive potential.	Approval Standard 100.9.6.4. Access routes shall not parallel permanent watercourses/riparian habitat by at least 200 m, excluding approaches to watercourse crossings as required to meet road grade requirements.	South of Hwy 1 and West of Hwy 2: 15 Dec – 30 Apr				
			Approval Standard 100.9.6.5. Where materials are available, place rollback across the entire pipeline/easement width for at least 40 percent of the linear disturbance or the length of the ROW. No individual section of rollback shall exceed 250 m in length. The break between sections of rollback shall be a minimum of 25 m.					
			Approval Standard 100.9.6.6. Unless specified in a higher level access (i.e., Integrated Landscape Management) plan, design all access routes as dead-ends. Routes which loop through the area are not permitted.					
			Approval Standard 100.9.6.7. Sites (e.g., plant sites, sumps) shall be constructed within 100 m of an existing arterial all-weather permanent access.					

The Fisheries and Wildlife Management Information System (FWMIS) database search was conducted using the online Internet Mapping Framework tool developed by Alberta Environment and Sustainable Resource Development (ESRD) to identify any wildlife species of concern historically detected within the Study Area (ESRD 2011b). Results identified four wildlife species of concern: bobcat (*Lynx rufus*), Canada lynx (*Lynx Canadensis*), harlequin duck (*Histrionicus histrionicus*), and northern pygmy-owl (*Glaucidium gnoma*) (Figure 3.6-1). All of these species are listed as Sensitive in Alberta (ESRD 2010a).

A list of all wildlife species of concern known or with the potential to breed during some portion of the year within the Project area was developed using regional and provincial references (ESRD 2013a; Eder and Kennedy 2011; Fisher *et al.* 2007; Semenchuk 2007) and is provided in Table 3.6-2. Status of the listed species is based on regulatory status as designated by Alberta Environment and Sustainable Resource Development (ESRD), the Alberta Endangered Species Conservation Committee (ESCC), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and the federal *Species at Risk Act* (SARA) and corresponding Schedules. Definitions for these designations are provided in Table 3.6-3.

Table 3.6-2: Wildlife Species of Concern with the Potential to Breed in the Project Area

Common Name	Scientific Name	ESRD 2010	ESCC 2014	COSEWIC 2014	SARA 2014
Amphibians & Reptiles					
Western painted turtle	*Chrysemys picta bellii*	Sensitive	-	Not at Risk	-
Wandering garter snake	*Thamnophis elegans*	Sensitive	-	-	-
Red-sided garter snake	*Thamnophis sirtalis*	Sensitive	-	-	-
Long-toed salamander	*Ambystoma macrodactylum*	Sensitive	Special Concern	Not At Risk	-
Western toad	*Anaxyrus boreas*	Sensitive	-	Special Concern	Schedule 1
Columbia spotted frog	*Rana luteiventris*	Sensitive	-	-	-
Birds					
Horned grebe	*Podiceps auritus*	Sensitive	-	-	-
Pied-billed grebe	*Podilymbus podiceps*	Sensitive	-	-	-
Northern pintail	*Anas acuta*	Sensitive	-	-	-
Green-winged teal	*Anas crecca*	Sensitive	-	-	-
Lesser scaup	*Aythya affinis*	Sensitive	-	-	-
Harlequin duck	*Histrionicus histrionicus*	Sensitive	Special Concern	-	-
Sora	*Porzana carolina*	Sensitive	-	-	-
Sharp-tailed grouse	*Tympanuchus phasianellus*	Sensitive	-	-	-
Great blue heron	*Ardea herodias*	Sensitive	-	-	-
Osprey	*Pandion haliaetus*	Sensitive	-	-	-

Common Name	Scientific Name	ESRD 2010	ESCC 2014	COSEWIC 2014	SARA 2014
Birds (cont)					
Broad-winged hawk	*Buteo platypterus*	Sensitive	-	-	-
Bald eagle	*Haliaeetus leucocephalus*	Sensitive	-	Not At Risk	-
Northern harrier	*Circus cyaneus*	Sensitive	-	Not At Risk	-
American kestrel	*Falco sparverius*	Sensitive	-	-	-
Northern pygmy-owl	*Glaucidium gnoma*	Sensitive	-	-	-
Barred owl	*Strix varia*	Sensitive	Special Concern	-	-
Great gray owl	*Strix nebulosa*	Sensitive	-	Not At Risk	-
Common nighthawk	*Chordeiles minor*	Sensitive	-	Threatened	Schedule 1
Red-naped sapsucker	*Sphyrapicus nuchalis*	Undetermined	-	-	-
Black-backed woodpecker	*Picoides arcticus*	Sensitive	-	-	-
Pileated woodpecker	*Dryocopus pileatus*	Sensitive	-	-	-
Olive-sided flycatcher	*Contopus cooperi*	May be at Risk	-	Threatened	Schedule 1
Western wood-pewee	*Contopus sordidulus*	Sensitive	-	-	-
Least flycatcher	*Empidonax minimus*	Sensitive	-	-	-
Eastern phoebe	*Sayornis phoebe*	Sensitive	-	-	-
Cassin’s vireo	*Vireo cassinii*	Undetermined	-	-	-
Clark’s nutcracker	*Nucifraga columbiana*	Sensitive	-	-	-
Barn swallow	*Hirundo rustica*	Sensitive	-	Threatened	-
Brown creeper	*Certhia americana*	Sensitive	-	-	-
Western tanager	*Piranga ludoviciana*	Sensitive	-	-	-
Brewer’s sparrow	*Spizella breweri*	Sensitive	-	-	-
Baltimore oriole	*Icterus galbula*	Sensitive	-	-	-
Mammals					
Canada lynx	*Lynx canadensis*	Sensitive	-	Not At Risk	-
Bobcat	*Lynx rufus*	Sensitive	-	-	-
Fisher	*Martes pennanti*	Sensitive	-	-	-
Long-tailed weasel	*Mustela frenata*	May Be At Risk	-	Not At Risk	-
Wolverine	*Gulo gulo*	May Be At Risk	Data Deficient	Special Concern	No Schedule
Grizzly bear	*Ursus arctos*	At Risk	Threatened	Special Concern	No Schedule
Water vole	*Microtus richardsoni*	Sensitive	-	-	-
Little brown bat	*Myotis lucifugus*	Secure	-	Endangered	-
Long-legged bat	*Myotis volans*	Undetermined	-	-	-
Hoary bat	*Lasiurus cinereus*	Sensitive	-	-	-
Silver-haired bat	*Lasionycteris noctivagans*	Sensitive	-	-	-

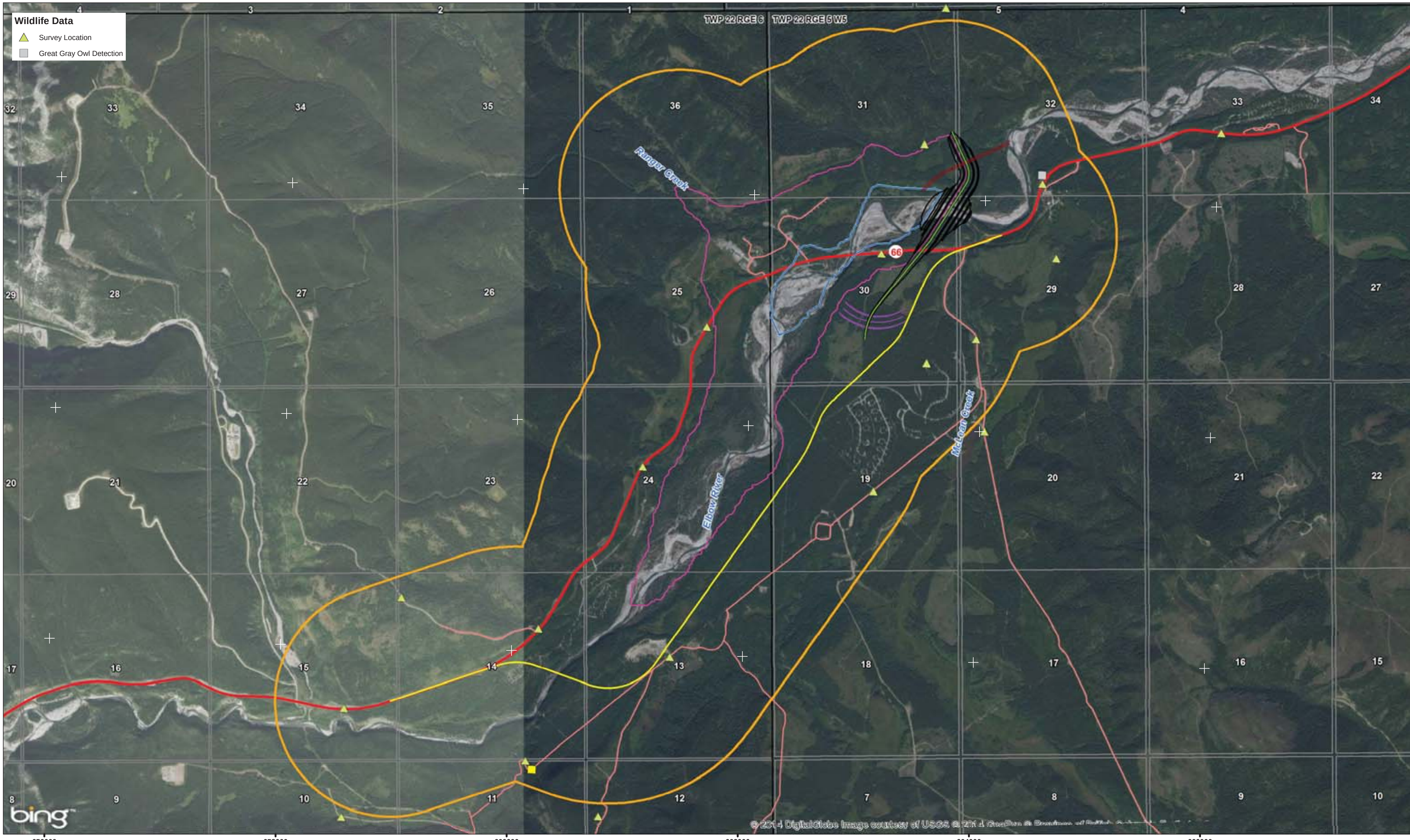
Table 3.6-3: At Risk Definitions (ESRD 2010; ESCC 2014; COSEWIC 2014; SARA 2014)

General Status of Alberta Wild Species (ESRD) • *At Risk* – Any species known to be at risk after formal detailed status assessment and legal designation as *Endangered* or *Threatened* in Alberta. • *May Be At Risk* – Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment. • *Sensitive* – Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk. • *Undetermined* – Any species for which insufficient information, knowledge or data is available.
Alberta Endangered Species Conservation Committee (ESCC) • *Species at Risk* – A species at risk of extinction or extirpation (endangered or threatened), or a species that needs special management attention to prevent it from becoming at risk. • *Endangered* – A species facing imminent extirpation or extinction. • *Threatened* – A species likely to become endangered if limiting factors are not reversed. • *Species of Special Concern* – A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events. • *Data Deficient* – A species for which there is insufficient scientific information to support status designation.
Committee on the Status of Endangered Wildlife in Canada (COSEWIC) • *Endangered* – A species facing imminent extirpation or extinction. • *Threatened* – A species likely to become endangered if limiting factors are not reversed. • *Special Concern* – A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events. • *Not at Risk* – A species that has been evaluated and found to be not at risk. • *Indeterminate* – A species for which there is insufficient scientific information to support status designation.
***Species at Risk Act* (SARA)** • *Schedule 1* – Official list of wildlife species at risk in Canada, classified as extirpated, endangered, threatened, or a special concern. Classification coincides with COSEWIC designations. Once listed, measures to protect and recover the species are implemented. • *Schedule 2* – Species designated as threatened by COSEWIC prior to October 1999 but must be reassessed before they can be considered for addition to Schedule 1. • *Schedule 3* – Species designated as a special concern by COSEWIC prior to October 1999 but must be reassessed before they can be considered for addition to Schedule 1.

Amphibian Survey

Boreal chorus frog (*Pseudacris maculata*) and wood frog (*Rana sylvatica*) were the only detections during the amphibian survey and were heard at 5 and 8 sites, respectively (Figure 3.6-2). Although boreal chorus frog call were not heard overlapping, at a few sites wood frogs were heard in full chorus. Both these species are listed as Secure in Alberta. Due to the late spring in 2014, the survey was most likely too early in the season for detecting toad species.

During the amphibian survey, one barred owl (*Strix varia*) and one great gray owl (*Strix nebulosa*) were detected incidentally near survey sites 13 and 6, respectively (Figure 3.6-3).



Legend

Study Area
Base Reservoir Water Level (1399m)
100 Year Flood Water Level (1422m)
Highway
Road

Proposed Infrastructure

Main Structure
Auxillary Earth Cut Spillway
Main Embankment Crest - El. 1429.5m
Combined Permanent Outlet / Spillway Structure
Highway 66 Realignment

N

400 0 400 800
Meters
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD

McLean Creek Environmental Overview

Amphibian Survey Locations

DATE: December 2014
ANALYST: NH
QA/QC: JB TT JB
PDF: Fig3.6-2 Amphibians 14-12-05

Figure 3.6-2

amec

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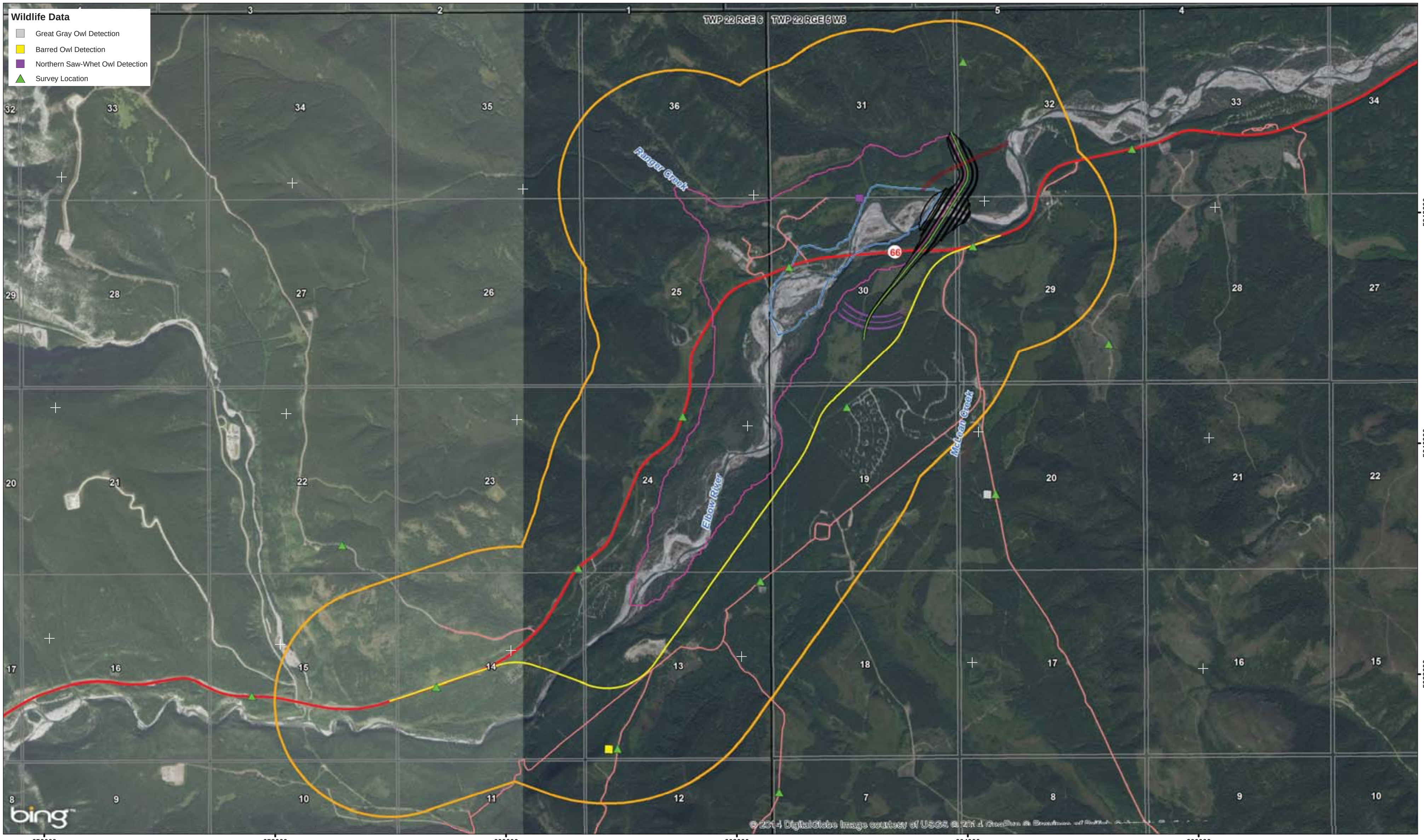

Legend

Study Area	Highway	**Proposed Infrastructure**	Main Embankment Crest - El. 1429.5m
Base Reservoir Water Level (1399m)	Road	Main Structure	Combined Permanent Outlet / Spillway Structure
100 Year Flood Water Level (1422m)		Auxillary Earth Cut Spillway	Highway 66 Realignment

N

400 0 400 800

Meters

1:30,000

Note : Coordinates in UTM Zone 11 NAD83

Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch
ESRD

McLean Creek Environmental Overview

Owl Survey Locations and Detections

DATE: December 2014

ANALYST: NH

QA/QC: JB TT JB

PDF: Fig3.6-3 Owls 14-12-05

Figure 3.6-3

amec

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Owl Survey

Two owl species were detected during the survey: one barred owl was heard calling in the southern part of the Study Area while one great gray was heard near McLean Creek (Figure 3.6-3). Additionally, one northern saw-whet owl (*Aegolius acadicus*) was detected incidentally north of Highway 66 near Ranger Creek. The northern saw-whet owl is listed as Secure in the province. The barred and the great gray owl are both listed as Sensitive.

Aerial Beaver Survey

During the aerial beaver survey, two beaver dams and six beaver lodges were detected in the Study Area. With the exception of an old dam on Ranger Creek, beaver activity was concentrated along McLean Creek (i.e., outside the 100-year flood water level) (Figure 3.6-4). Based on the assumption that one food cache indicates one beaver colony and that an average colony in Canada holds 5.7 beavers (RIC 1998), the estimated population within the Study Area is 34 beavers.

A few of the tributaries on the west side of the Elbow River no longer have flow as a result of the 2013 flood event and thus, the potential for suitable beaver habitat north of Highway 66 within the Study Area is limited. No signs of beaver activity on the Elbow River were observed during the survey; however, beavers could still inhabit the banks along the river.

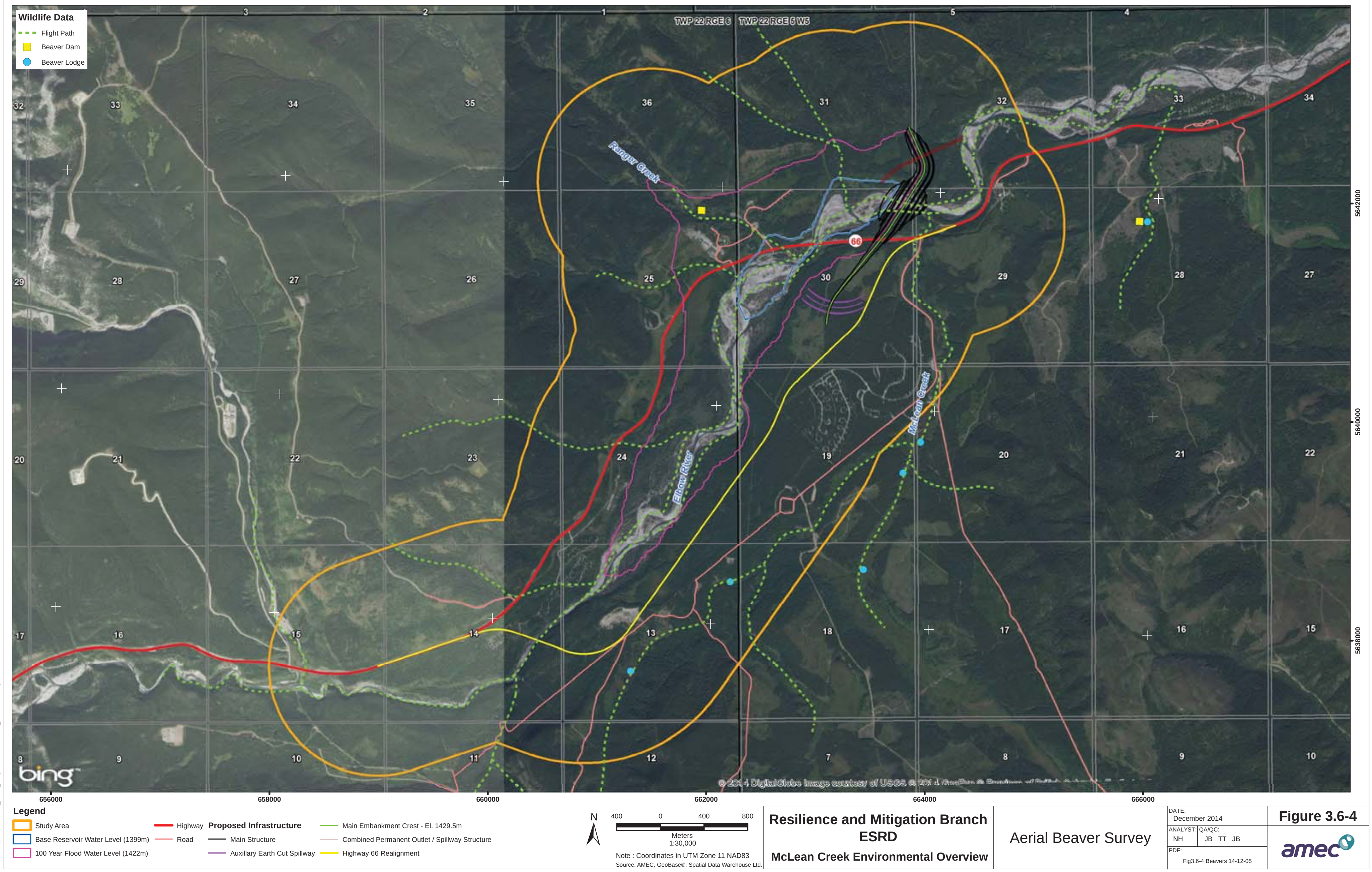
During the survey, one adult bull moose was detected incidentally northeast of the McLean Creek Campground.

Raptor Habitat Survey

The Study Area is dominated by pine and spruce stands interspersed with some poplars. No high quality raptor nesting habitat (e.g., large, old deciduous trees in coniferous stands, or vice versa) was identified and no raptor stick nests were detected. Based on the survey results, the larger birds of prey, such bald eagle (*Haliaeetus leucocephalus*), are unlikely to breed in the area; however, smaller raptors, like osprey (*Pandion haliaetus*) and American kestrel (*Falco sparverius*), could find suitable nesting and foraging habitat within the Study Area.

3.6.2 Discussion

A number of wildlife species occur in this area and effects of the Project would vary by species and would depend on habitat use and relative abundance within and near the areas proposed for development. Project details remain at the conceptual level. The following discussion of potential effects is largely qualitative, based on professional judgment supported by the information collected to date.



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Resilience and Mitigation Branch ESRD **McLean Creek Environmental Overview**	Aerial Beaver Survey	DATE: December 2014 ANALYST: NH QA/QC: JB TT JB PDF: Fig3.6-4 Beavers 14-12-05	**Figure 3.6-4** amec

Valued Ecosystem Components (VEC) were selected based on existing information for known species distributions and historical detections in the area and listed species (i.e., species listed under the federal Species at Risk Act (SARA 2014), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2014), and/or provincially listed wildlife species of concern by the ESRD (ESRD 2010a), and/or by the Alberta Endangered Species Conservation Committee (ESCC 2014)) that are most at risk to potential Project effects. Four individual wildlife species and one species community (Table 3.6-4) were selected as VECs to discuss potential Project effects

Table 3.6-4: Wildlife Species Selected as VECs and Selection Rationale

Species	Rationale for Selection
Ungulates (e.g., moose, elk, deer sp.)	• Project is located in a Key Wildlife and Biodiversity Zone as the area is identified by ESRD as important ungulate winter ranges, river corridors, and biodiversity areas where species tend to concentrate.
Grizzly Bear	• Listed as Special Concern by COSEWIC (2014), Threatened by ESCC (2014), and At Risk in Alberta (ESRD 2010a); and • Project is located in a designated Grizzly Bear Zone as the area is identified by ESRD as core grizzly bear habitat.
Harlequin Duck	• Listed as Special Concern by ESCC (2014) and as Sensitive in Alberta (ESRD 2010a); and • This affected section of the Elbow River may be important habitat for Harlequin ducks.
Beaver	• Representative as a semi-aquatic species that will be impacted by the altered aquatic environment as a result of the proposed dam.
Western Toad	• Listed as Sensitive in Alberta (ESRD 2010a), as Special Concern by COSEWIC (2014), and on Schedule 1 of SARA (2014); • Important indicator for changes in riparian and aquatic habitats; • Specialized habitat requirements; and • Increased potential for mortality from changes to wetland habitats.

Potential impacts to these VECs are discussed below. Additionally, other wildlife species of concern or species groups also anticipated to be impacted by Project effects are discussed briefly.

3.6.2.1 Ungulates

Four ungulate species could be affected by the Project: moose (*Alces americanus*), elk (*Cervus elaphus*), white-tailed deer (*Odocoileus virginianus*), and mule deer (*Odocoileus hemionus*). All four species are listed as Secure in Alberta (ESRD 2010a).

The Project would be located within a Key Wildlife and Biodiversity Zone (Figure 3.6-1). The purpose of these zones is to protect the integrity of ungulate winter ranges, rivers and movement corridors, and biodiversity areas where species tend to concentrate (Government of Alberta 2013), in particular moose, elk, and deer species. To this end, a restricted activity period (RAP) is in place for such zones. South of Highway 1 the RAP is from 15 December to 30 April. During this time no activity is permitted within the zones, except with prior approval from ESRD

(Table 3.6-1). Approval standards and operating procedures apply for any activities as outlined in the *Approval Standards: Enhanced Approval Process* (Government of Alberta 2013).

Moose

Historically, moose have frequently been recorded within the Study Area (3.6-1) and one was detected northeast of the McLean Creek Campground during the beaver survey. The abundant detections of moose in triangular patterns south of Elbow River are most likely due to winter tracking survey methodology, which follows triangle transects; hence the locations of these detections likely do not reflect established movement corridors in the Project area (Figure 3.6-1).

Mixed forest stands that provide forage and shelter are the most valuable to moose. The typical pattern of moose habitat selection includes open deciduous and deciduous-dominant upland stands and aquatic areas with high quality forage in spring and summer, to more closed canopy areas as summer progresses and forage quality changes (Arsenault 2000; Peek 1998; Telfer 1988; Hauge and Keith 1981). Moose shift to closed canopy habitat as winter progresses and this is probably triggered by greater snow hardness, density and accumulation in open areas (Peek 1998; Forbes and Theberge 1993; Allen *et al.* 1991; Hundertmark *et al.* 1990; Thompson and Vukelich 1981; Rolley and Keith 1980; Peek *et al.* 1976; Peek 1971). Winter habitat is generally considered to be of critical importance to the overall health of moose populations and high value winter habitats include shrub-dominated cover types (particularly willow) for food, and conifer-dominated cover types for shelter (thermal refuge) and security (screening from predators and human disturbance).

Potential effects to moose could include loss of cover due to clearing of forested habitat from the potential flooded areas; sensory disturbance during construction, which may reduce habitat effectiveness; and potential alteration of movement corridors due to flooded areas or re-alignment of Highway 66, which may increase vehicle collisions.

Habitat loss could occur within the Key Wildlife and Biodiversity Zone (Figure 3.6-1), which would likely remove areas supporting rich habitat diversity important for moose and other ungulates.

The re-alignment of the road could take six months while the construction of the dam could last for two years. Although moose can habituate to constant and low intensity disturbances (Sopuck and Vernam 1986), the prolonged construction activity could affect moose distribution and abundance in the Study Area. These effects would be most significant during winter months where ungulates are in a negative energy balance between forage intake and energy expended on metabolism, thermoregulation and movement. Additionally, sensory disturbance could alter moose movement corridors within the Study Area if animals alter their movement patterns to avoid anthropogenic disturbances or newly created physical barriers (i.e., the dam, the permanent pond and the re-alignment of Highway 66). A reservoir could impact movement corridors on the north side of Elbow River near the dam and hinder movements between valleys. Relocating the highway to south of the river could fragment existing habitat.

Elk and Deer

Elk usually prefer upland forest and prairies and near the Rocky Mountains they tend to move to higher elevations in spring and lower elevations in fall (Pattie and Fisher 1999). Mule deer are commonly found in coulees, dry brushland and alpine tundra while white-tailed deer are often found near mixtures of open area and protective cover such as riparian woodlands or forests (Pattie and Fisher 1999). Both species are common near streamside situations and areas with young successional vegetative forests that support much of the vegetation these species thrive on (Pattie and Fisher 1999). Although generally less associated with riparian areas than moose, similar effects could occur for elk and deer (i.e., loss of cover loss, potential decrease in habitat effectiveness due to sensory disturbance, alteration of movement corridors, and increased vehicle collisions).

3.6.2.2 Grizzly Bear

Grizzly bears' habitat associations are most often strongly seasonal and typically reflect local plant development, therefore in mountainous regions this results in seasonal elevational migrations (COSEWIC 2012). However, influences related to human activities and developments are increasingly taking precedence over biophysical features as determinants of grizzly bear habitat quality and have led to functional habitat loss throughout much of the species' range (COSEWIC 2012).

Although no historical detections of grizzly bear are recorded in FWMIS, they are commonly seen in the area (e.g., one was incidentally observed during a soil survey in the Study Area in 2014) and the Project is located in core grizzly bear habitat, as designated by a Grizzly Bear Zone, located north and west of the Elbow River (Figure 3.6-1). The purpose of the zone is to avoid development within key habitats and minimize human-bear conflicts and mortalities (Table 3.6-1; Government of Alberta 2013). Approval standards and operating procedures apply for any activities as outlined in the *Approval Standards: Enhanced Approval Process* (Government of Alberta 2013).

Project effects to grizzly bear could include loss of habitat due to clearing of forested habitat from the Project footprint, including from the potential flooded areas, and sensory disturbance during construction, which may reduce habitat effectiveness. Although the road re-alignment could lead to bear mortalities due to collisions with vehicles, the conceptual new location of Highway 66 is closer to existing disturbances (i.e., the McLean Creek Campground) and the bears likely tend to avoid this area due to anthropogenic noise (e.g., quads and other recreational activities). Conversely, reclaiming the current location of the highway could potentially restore habitat effectiveness on the west side of the Elbow River within the Study Area. Notwithstanding, clearing of forested habitat from the potential flooded areas could constitute a loss of core grizzly bear habitat and the planned construction period of two years for the dam would most likely impact bear distribution and abundance within the area in addition to increase the risk of bear-human interaction and, potentially, human-induced grizzly mortalities.

3.6.2.3 Harlequin Duck

Harlequin ducks are listed as Sensitive in Alberta (ESRD 2010b). Harlequin ducks spend 8-10 months of the year in rocky coastal habitats of the Pacific Northwest and pairs migrate inland to breed (Smith and Smith 2003). In Alberta, they are found in suitable habitat in the mountains and foothills, arriving in late April or early May (Cooke *et al*. 2000). Harlequin ducks generally nest within 5m of swift flowing, clear mountain streams with suitable nesting cover on islands or stream banks (Smith 1999).

The effect of human disturbance on harlequins is poorly understood. Generally, harlequins are affected by activities that occur along the shoreline, such as fishing, hiking and anything that results in the destruction of nests, or nest sites (MacCallum 2001). Habitat loss from activities such as damming, brush removal, channelization, rip rap, and road construction can influence habitat quality and breeding success (MacCallum 2001; Robertson *et al.* 1999). Habitat requirements are quite specific, and their energy output in foraging for invertebrates in fast flowing waters is higher than most dabblers or divers. Due to the low populations and low recruitment of harlequins, cumulative impacts can have a large impact on breeding success and population numbers (ESRD 2010b). Habitat suitability can be reduced by activities affecting hydrology (stream flow: channels and damming), water quality (sedimentation), and streamside vegetation (ESRD 2010b).

Although harlequin ducks have been historically detected within the Study Area, no harlequin ducks were incidentally detected during any of the 2014 surveys. This is likely due to the timing of field surveys. The historical detections of harlequin duck are concentrated directly near the conceptual new river crossing of Highway 66 in the southern portion of the Study Area (Figure 3.6-1), yet suitable habitat is available in the near vicinity along the Elbow River. Due to the length of proposed construction on the roadway and the dam, the Project could affect existing harlequin duck populations

3.6.2.4 Beaver

The beaver is an important traditional use and subsistence species and beaver impoundments play an important role in promoting amphibian populations and waterfowl habitat (Karraker and Gibbs 2009; Stevens *et al.* 2007).

Although beavers could inhabit the banks along the Elbow River, the banks are fairly steep in the Study Area, which is a likely explanation for the lack of beaver activity observed on the Elbow River. One old/inactive dam was observed on Ranger Creek, but otherwise beaver activity was concentrated primarily along McLean Creek (i.e., outside of the 100 year flood level). Based on the detected number of active lodges in the area, an estimated 34 beavers occupy the Project area. No old or inactive lodges, indicative of historic activity in the Project area, were observed.

As a result, the proposed clearing of forested habitat from the potential flooded areas and the creation of a base reservoir is likely not going to have a negative effect on beaver activity in the area. The planned operating regime of the dam is not known at this point, but it is likely that fluctuating water levels in the base reservoir will make it unsuitable as beaver habitat.

The relocation of Highway 66 could affect beaver habitat as the new alignment runs close to identified lodges, especially in the southern section of the road (Figure 3.6-4). Sensory disturbance during construction and some habitat loss would be anticipated.

3.6.2.5 Western Toad

The western toad is designated as a species of Special Concern by COSEWIC (2014) and is listed on Schedule 1 of SARA (2014). In Alberta, the western toad is listed as Sensitive (ESRD 2010a). Western toads have highly specific habitat requirements and rely on riparian and wetland habitats for most of the year (Fisher *et al.* 2007; Russell and Bauer 2000). Adults disperse from spawning habitats after the breeding season and may be found in adjacent terrestrial areas throughout the year. Hibernation sites are typically associated with sandy soils (i.e., pine habitat). The Study Area contains ample pine forest habitat, indicating potential overwintering habitat. Suitable breeding habitat for the western toad may be present in the Study Area within and adjacent to ponds, stream edges, or the shallow margins of lakes. Western toads will forage in a variety of habitats, including forested areas, roadside ditches, and clearcuts (COSEWIC 2002). Western toads are most common in southern British Columbia, but are also found in the Rocky Mountains sub-alpine regions in areas up to 2,300 m (COSEWIC 2002). Declines in western toad populations may be the result of degradation of wetland and riparian habitat, contaminated water, predation and the stocking of fishless lakes, clearing of upland habitat, disease, and climatic conditions (COSEWIC 2002).

Amphibians are generally not affected by sensory disturbances unless approached; however, during the breeding season, extended periods of loud noise related to construction activities and vehicle traffic immediately adjacent to breeding ponds may disrupt amphibian breeding if the noise is loud enough such that calls cannot be heard by conspecifics (i.e., other members of the same species). On average, western toads move up to 600 m from breeding ponds to foraging and over wintering areas (Jones 1999). However, they can move large distances of 1-2 km, and up to 5 km from breeding ponds, but home ranges typically vary depending on habitat quality (COSEWIC 2002).

The dam could potentially impede western toad movements to and from breeding and foraging habitats, and from overwintering sites. Direct amphibian mortality could occur as a result of vehicular traffic or incidental destruction of hibernation sites during construction. Indirect mortality could result from the alteration of aquatic and overwintering habitats. Drainage patterns could be affected by the Project footprint.

3.6.2.6 Other non-VEC Species or Species Groups

Bovids

Mountain goat (*Oreamnos americanus*) and big-horned sheep (*Ovis canadensis*) are both listed as Secure in Alberta (ESRD 2010a). They prefer mountainous areas with steep slopes and rocky cliffs close to appropriate food and water sources (Pattie and Fisher 1999). This preferred habitat is not present within the Study Area and their known range is approximately 5 km away. There are no historical records within the Study Area, and no incidental observations occurred during field surveys.

Large carnivores

Large carnivore species that have the potential to occur in the Study Area include Canada lynx (*Lynx canadensis*), black bear (*Ursus americanus*), bobcat (*Lynx rufus*), cougar (*Puma concolor*), and gray wolf (*Canis lupus*). Of these, the Canada lynx and bobcat are listed as Sensitive in Alberta (ESRD 2010a). Each of these five species have been historically detected in the Study Area (Figure 3.6-1), although none of the species were incidentally detected during any of the 2014 surveys.

Similar to the potential effects to grizzly bear, habitat loss and sensory disturbance could affect large carnivores. Whereas lynx tolerate some habitat change and human disturbance (Todd 1985), other carnivores are more sensitive to sensory disturbance and tend to avoid anthropogenic interactions (e.g., cougar and wolf). The construction of the dam and the re-alignment of the road could impact distribution and abundance of large carnivores in the area. The new location of Highway 66 could lead to higher wildlife mortalities due to vehicle collisions if these animals currently use this corridor east of the Elbow River.

Terrestrial Furbearers

Several furbearer species may be present in the Study Area and include small canids such as red fox (*Vulpes vulpes*) and coyote (*Canis latrans*), and mustelid species like the long-tailed weasel (*Mustela nivalis*), fisher (*Martes pennanti*), and wolverine (*Gulo gulo*). Of these furbearers, long-tailed weasel, fisher and wolverine are species of concern. Both long-tailed weasel and fisher have been designated as Sensitive in Alberta, while wolverine is listed as May Be At Risk (ESRD 2010a) and as Special Concern by COSEWIC (2014).

The long-tailed weasel prefers open country, such as agricultural areas or grassy slopes (Pattie and Fisher 1999) and as such would most likely be present in the more open habitats south of Elbow River and east of McLean Creek. Hence this species is not expected to be impacted by the Project.

Fisher is an important furbearer species for traditional use and patterns of habitat use by fisher are diverse, including forest or woodland dominated landscape mosaics; however, they most commonly occur in mature conifer-dominated forests (Ray 2000). The fisher has a relatively low tolerance to human disturbances and reaction to humans is usually one of avoidance (Powell and Zielinski 1994). Hence, the habitat effectiveness within the Study Area could be reduced during the construction period for this species. Additionally, loss of habitat due to clearing of forested habitat from the potential flooded areas could affect fisher.

Wolverines are found in low densities and over large home ranges that can vary from 6,500 to 100,000 ha in a variety of habitats (Ruggiero *et al.* 2007; Petersen 1997). Wolverines are elusive creatures that typically occupy remote habitats with a minimum of human disturbance (Whitman *et al.* 1986; Slough 2007). Hence, given the existing level of disturbance (i.e., the presence of Highway 66 and McLean Creek Campground, including recreational activities such as the frequent use of all-terrain vehicles), it is not likely that the area currently supports many wolverines.

Small Mammals

Small mammals represent important prey species for many carnivores, including Canada lynx, fisher and coyote (Pattie and Fisher 1999). Numerous species of small mammals may potentially occur within the Study Area (e.g., snowshoe hare, red squirrel, and microtine rodents). One rodent species of concern could potentially occur in tributaries to the Elbow River, namely the water vole (*Microtus richardsoni*) as this species prefers subalpine, swift streams with gravelly bottoms (Pattie and Fisher 1999). The water vole is listed as Sensitive in Alberta (ESRD 2010a). Dens are dug along edges of streams or waterbodies and alteration of the aquatic environment could result in potential flooding or ebbing of habitat for this species.

Raptors

Five raptor species of concern may potentially breed within the Study Area and include osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), northern harrier (*Circus cyaneus*), broad-winged hawk (*Buteo platypterus*), and American kestrel (*Falco sparverius*). All are migratory species. With the exception of the northern harrier, which prefers fen and open habitat, these raptor species require mature and/or upland forest stands for nesting. No raptor species were incidentally detected during any survey completed in 2014 by AMEC and no high quality raptor nesting habitat was identified within the Study Area.

Ospreys nest in large trees adjacent to fish bearing waters. This species exhibits some tolerance to human activity and will nest on artificial structures adjacent to large rivers, repeatedly using the same nests over a number of years (Semenchuk 1992). Ospreys may nest along the Elbow River where suitably large trees are present. Ospreys are listed as Sensitive in Alberta (ESRD 2010a). The osprey prefers open nest sites in trees close to shallow waters rich in fish and would thus, most likely breed in pine or spruce trees along the Elbow River (Poole *et al*. 2002).

Bald eagles occur in low densities in Alberta and are listed as Sensitive in the province (ESRD 2010a) and as Not at Risk by COSEWIC (2014). Similar to the osprey, bald eagles nest in large trees adjacent to fish bearing waters. In northern Alberta, most bald eagle nests are located within 200 m of watercourses. Due to the absence of large, old trees within the Study Area, it is not likely that bald eagles will breed in the area.

The northern harrier is listed as Sensitive in Alberta (ESRD 2010a) and as Not at Risk by COSEWIC (2014). The northern harrier prefers low shrubs and marshlands for nesting and is known for its distinctive hunting style, a low flying soar over fens and marshlands (Semenchuk 1992). Northern harriers are ground nesters, and preferred nesting habitats are in shrublands with tall vegetation in open areas, such as upland meadows or marshes (Massey *et al.* 2008).

The broad-winged hawk is not common in Alberta and has been designated as Sensitive in the province (ESRD 2010a). This species requires large stands of mature and old growth forests (ESRD 2010a; Semenchuk 1992) and will return to the same area each year to nest. They ususally nest near forest opening and bodies of water far from areas of human disturbance (Goodrich *et al.* 2014).

The American kestrel was recently designated in 2010 as Sensitive in Alberta (ESRD 2010a). This species requires open country such as fields and meadows for hunting. American kestrels will commonly use human-modified environments and they are often observed sitting on powerlines (ESRD 2013a; Smallwood *et al.* 2009). Nests are made in secondary cavities such as woodpecker holes and they will also readily use nest boxes (Smallwood *et al.* 2009). The American kestrel favors open areas with short ground vegetation and sparse trees (Smallwood and Bird 2002) and is thus, most likely to nest in the more open areas south of Elbow River or in the vicinity of cutblocks within the Study Area.

Habitat loss, and human presence and disturbance could reduce habitat effectiveness for some raptor species. Raptor mortality could occur directly from vehicle collisions and vegetation clearing during the early raptor nesting period. Potential indirect mortality includes the destruction of nest sites during construction clearing and the loss of suitable nesting locations. No quantitative information is available on the reaction distance from disturbance for raptors. Flushing distances will vary depending on vegetation cover. In open habitats some raptors will flush at distances of up to 500 m from human activity. Breeding raptors are less likely to flush than non-breeding adults (Steidl 1994). Also, flushing distance is typically lower for juvenile birds as these birds show more tolerance to disturbance (Dhindsa and Boag 1989; Stalmaster and Newman 1978).

Pine forest interspersed by cutblocks, which dominates the Study Area, is not optimal habitat for large raptors. Although no raptors or active nests were detected in the Study Area, mature tree stands along the Elbow River may provide breeding opportunities for smaller raptors such as kestrel or hawks. In the event a raptor nest is detected, ESRD recommends a setback distance for an active sensitive raptor species nest of 1,000 m, between 15 March and 15 July (ESRD 2011a).

Waterfowl & Shorebirds

A number of waterfowl and shorebird species of concern may potentially breed in or near wetland ponds and rivers throughout the Project area. These include: green-winged teal (*Anas crecca*), horned grebe (*Podiceps auritus*), pied-billed grebe (*Podilymbus podiceps*), and sora (*Porzana carolina*).

The green-winged teal is a dabbling duck which prefers wooded pond and stream habitats. This species nests in upland areas within dense cover, typically in shrubs or sedges (Semenchuk 2007). Suitable breeding habitat for green-winged teal may occur in upland habitats along watercourses. The green-winged teal has been designated as Sensitive in Alberta (ESRD 2010a).

The horned grebe breeds in shallow ponds and marshes, and build their nests along the edge of emergent vegetation near open water (COSEWIC 2009; Semenchuk 2007). The horned grebe is listed as Sensitive in Alberta as the species is sensitive to wetland degradation and is experiencing population declines in the province (ESRD 2010a). Horned grebes are also listed as a species of Special Concern by COSEWIC (2014).

Similar to the horned grebe, the pied-billed grebe breeds within shallow ponds and marshes. Nests are usually built along the edge of emergent vegetation near open water (Semenchuk 2007). The pied-billed grebe is a solitary nester that can potentially breed in shallow wetlands and fen habitats. Pied-billed grebes are listed as Sensitive in Alberta (ESRD 2010a).

The sora has been listed as Sensitive in Alberta due to large population declines that have occurred since 1994 as a result of losses of wetland habitat (ESRD 2010a). This species prefers a mix of shallow and moderately deep water with emergent vegetation.

No green-winged teal, horned grebes, pied-billed grebe or soras were incidentally detected during any 2014 surveys completed by AMEC.

Damming the Elbow River will affect hydrology within the region. Impacts to stream flows could have a negative or positive affect depending on the species. As the Project development will result in a significant increase of open water in the area, the Project area could create habitat for migratory waterfowl and shorebirds.

Upland Game Birds

Upland game birds that may potentially occur in the Study Area include, white-tailed ptarmigan (*Lagopus leucura*), the ruffed grouse (*Bonasa umbellus*), spruce grouse (*Dendragapus canadensis*), dusky grouse (*Dendragapus obscurus*), and sharp-tailed grouse (*Tympanuchus phasianellus).* Of these species, only the sharp-tailed grouse is a species of concern. All species are year-round residents in the region, yet none of the species were incidentally detected during any 2014 surveys.

The sharp-tailed grouse is listed as Sensitive in Alberta (ESRD 2010a). Sharp-tailed grouse can be found in a variety of habitats throughout Alberta, though they are typically found in open areas, and preferred nesting habitats are shrub-dominated with dense grass cover and tall vegetation for nest concealment (Goddard *et al.* 2009).

Sensory disturbances and habitat removal, particularly from the realignment of Highway 66, could impose negative impacts on grouse species in the area. In addition, the dam could remove suitable breeding habitat. Reaction distance to disturbance is not defined for the sharp-tailed grouse. Operational activities (e.g., vehicles) could disrupt game bird calling and active nesting around the highway.

Songbirds

A wide range of songbird species of concern may breed within suitable habitats throughout the Study Area, such as the olive-sided flycatcher (*Contopus cooperi*), the common yellowthroat (*Geothlypis trichas*), and the eastern phoebe (*Sayornis phoebe*). No songbird species of concern were incidentally detected during the 2014 surveys.

The common yellowthroat has been designated as Sensitive in Alberta (ESRD 2010a). This species prefers open habitat such as riparian shrublands and wetland areas (Semenchuk 2007), and they are commonly detected in association with fens in the boreal forest. Nests are typically located in dense wetland vegetation, such as sedges, reeds or cattails (BAM 2014).

The eastern phoebe has been designated as Sensitive in Alberta (ESRD 2010a). This species prefers open wooded areas in a variety of forest types and are often found near water (Semenchuk 2007). Eastern phoebes historically built their nests on rock outcrops and other natural niches, though now they typically prefer to nest in or on built structures in rural and riparian areas, such as bridges, barns, and culverts (BAM 2014).

Olive-sided flycatchers are a SARA-listed (Schedule 1) species with a status of “Threatened” because of a long-term and widespread population decline (Kotliar 2007). The provincial listing for this species is May be at Risk (ESRD 2010a). Olive-sided flycatchers prefer openings near water or wetlands, along edges and over forest canopies (Kotliar 2007). This species tends to be seen conspicuously perched on the top of tall trees and snags while foraging for insects (COSEWIC 2007; Kotliar 2007).

Songbird species of concern can be expected to avoid areas with high noise levels and human activity. Operational activities (e.g., vehicles, and dam operations) may disrupt songbird calling and active nesting around Highway 66 and the dam site. Noise is considered the most important factor resulting in decreased bird densities near human developments, and the Project area may experience reduced use of adjacent habitats by some species (Bayne *et al.* 2008). Habitat use by forest birds is greatly dependent on species-specific tolerances to disturbance. If Project facilities, such as the highway and the dam, experience high levels of human activity and operational noise levels habitat effectiveness for forest birds could be reduced up to 300 m into the surrounding forest (Bayne *et al.* 2008). Songbirds may experience indirect mortality risk from habitat loss due to vegetation clearing and construction and increased levels of predation and parasitism in habitats adjacent to clearings and linear rights of way (Thompson *et al.* 2008; Newton 1998). Mitigation measures such as minimizing vegetation clearing during the breeding season will minimize effects to these species. For southern Alberta, the migratory bird nesting and rearing period is from 15 April to 15 August (Gregoire pers. comm. 2014). Clearing within the nesting window may be undertaken with approval from ESRD and the Canadian Wildlife Service (CWS), provided that a pre-construction nesting survey is completed for the area to be cleared. Should an active nest be found during a pre-construction nest survey, ESRD and/or CWS must be contacted to determine the proper course of action.

As habitat requirements and nesting sites vary greatly between the many songbird species that may breed in the Study Area, it is difficult to determine impacts on songbird populations as some species will be affected positively and some negatively.

Nightjars

The common nighthawk (*Chordeiles minor*) is the only nightjar species of concern that may potentially occur within the Project area. They have been designated as Threatened by COSEWIC (2014), are on Schedule 1 of SARA (2014), and are listed as Sensitive in Alberta (ESRD 2010a).

Common nighthawks are most active at sundown and occur in a variety of habitats throughout the boreal forest. Breeding sites include open habitats where the ground is devoid of vegetation, such as burns, forest clearings, logged areas, rocky outcrops, quarries, and gravel roads and rooftops (COSEWIC 2007). In addition to being found in open habitats, common nighthawks are also found in mixedwood, coniferous, and pine forests. As such, common nighthawks may use a wide variety of both natural and disturbed habitats throughout the Study Area.

A number of reasons have been suggested for this species' decline, including declines in insect populations due to large-scale insecticide use, fire suppression, changes in harvesting practices that reduce the number of open areas in forested habitats, cultivation and cattle grazing, terrestrial predators, collisions with motor vehicles, and a reduction in flat gravel roofs in urban areas (COSEWIC 2007).

Common nighthawks are an adaptable species. Clearing activities throughout the area could lead to some increases in suitable habitat. Common nighthawks tend to prefer open ground for nesting sites, where there is no vegetation present, or short grassy areas (Allen and Peters 2012). Natural daytime roosting sites for males tend to consist of areas with a low canopy height, and a roost tree height greater than that of the surrounding canopy (Fisher *et al.* 2004).

Woodpeckers

Six woodpecker species may potentially occur within the Study Area. Four of these are relatively common and include downy woodpecker (*Picoides pubescens*), hairy woodpecker (*Picoides villosus*), three-toed woodpecker (*Picoides tridactylus*), and northern flicker (*Colaptes auratus*).

Two species are listed as Sensitive in Alberta (ESRD 2010a): the pileated woodpecker (*Dryocopus pileatus*) and the black-backed woodpecker (*Picoides arcticus*). No woodpecker species were incidentally detected during any of the 2014 surveys.

Pileated woodpeckers are non-migratory and are generally associated with mature and old growth mixedwood forests (Schieck and Hobson 2000), though they are also known to use older coniferous and deciduous forests (Bock and Lepthien 1975). In Alberta, pairs generally require stands with greater than 40 ha of mature forest to satisfy nesting and foraging requirements (Acorn and Fisher 1998). Pileated woodpeckers prefer standing live trees with a wide radius (>50 cm dbh) for foraging, though they will also select large dead or dying trees (Semenchuk 1992). Habitat removal may affect nesting and foraging habitat for woodpeckers. Pileated woodpecker habitat use is not limited by proximity to human activities or by the location of roads and Project activities are not expected to affect use of adjacent habitats if suitable foraging and nesting sites are available. Operational activities (e.g., vehicles) could disrupt woodpecker calling and active nesting around the dam and Highway 66.

The black-backed woodpecker is a fire specialist, with recent burns providing optimal nesting and foraging habitat for the species (Semenchuk 2007). Because the black-backed woodpecker utilizes recent burn areas, it is not expected to be impacted by the Project as there is no burn area within the Study Area.

Owls

Eight owl species may potentially breed within the Study Area. Five of these species are relatively common and considered Secure in Alberta (ESRD 2010a) including: great-horned owl (*Bubo virginianus*), northern hawk owl (*Surnia ulula*), long-eared owl (*Asio otus*), boreal owl (*Aegolius funereus*), and northern saw-whet owl (*Aegolius acadicus*). The remaining three owl species, the barred owl (*Strix varia*), the northern pygmy owl (*Glaucidium californicum*), and the great gray owl (*Strix nebulosa*) have special status in Alberta and are ranked as Sensitive (ESRD 2010a). Most owls are year-round residents within their ranges, with the exception of the long-eared and northern saw-whet owls, which migrate south during the winter. An owl call-playback survey was conducted in April 2014. Both the barred owl and the great gray owl were detected within the Study Area.

The barred owl has been designated as Sensitive in Alberta (ESRD 2010a), and has also been listed as a species of Special Concern by the Alberta Endangered Species Conservation Committee (ESCC 2014). Barred owls require large, continuous blocks of mature mixedwood forests with high canopy closure and typically nest in tree cavities (EMCLA 2011; Livezey 2007), though abandoned hawk nests, the tops of hollow trees, and squirrel nests may also be used (Livezey 2007). This species was detected twice during the owl survey in April 2014.

The northern pygmy owl is designated as Sensitive in Alberta (ESRD 2010a). Its habitat ranges from deciduous bottomlands to high-elevation coniferous forests and it nests in both natural cavities and those excavated by woodpeckers (Denver and Petersen 2000). Although this species has been historically detected in the Study Area, it was not detected during the 2014 surveys.

Great gray owls are listed as Sensitive in Alberta (ESRD 2010a) and as Not at Risk by COSEWIC (2014). Great gray owls do not build their own nests, but rather they rely on pre-existing nest structures such as large abandoned stick nests (e.g., hawk and raven nests), natural depressions on broken-topped snags, and artificial nesting structures (ESRD 2013a). The irruptive nature (i.e., irregular migratory events) of great gray owls often results in high variability in the abundance and distribution of this species in some parts of its range (Ehrlich *et al*. 1988). This species was detected twice in 2014; once during the owl survey in April 2014 and once during the amphibian survey in April 2014.

Suitable nesting and foraging habitat for owls could be affected through direct habitat loss and decreased habitat effectiveness. Some owl species are capable of tolerating considerable noise and disturbance if humans are not visible (Hayward and Verner 1994). Intermittent or new disturbances could cause disruption of habitat use and nest desertion if sustained over time. Operational activities (e.g., vehicles), could disrupt owl calling and active nesting around the highway and the dam. Large disruptions to owl movement are not expected, though movement patterns may be altered as owls take advantage of new clearings. Young owls are also frequently recorded foraging along roadways, linear corridors, and in the vicinity of human activity (Loos and Kerlinger 1993). Direct mortality could occur through collision with vehicles.

Although Project developments could impose sensory disturbances to the owl species and convert a portion of land to open water, suitable forest habitat surrounding the direct construction activities is present and the owl species are expected to utilize available surrounding habitat.

Should vegetation clearing be required, a pre-construction sweep of the area to be cleared would be required between 15 February – 30 April for non-migrating raptors (i.e., owls) (Boukall, pers. comm. 2014). Should an active nest be found during a pre-construction nest survey, ESRD must be contacted to determine the proper course of action.

Bats

Six bat species may occur in the Study Area: big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), long-legged bat (*Myotis volans*), long-eared bat (*Myotis evotis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*). No bat species were incidentally detected during any 2014 survey.

Non-migratory Bats

The little brown, long-eared, long-legged and big brown bats are non-migratory species that hibernate in caves. In Alberta, the little brown, big brown, and long-eared bats are listed as Secure, and the long-legged bat as Undetermined (ESRD 2010a). However, all bat species in North America that hibernate could be susceptible to white-nose syndrome (Foley *et al.* 2011), and as such, little brown bats were recently listed as Endangered by COSEWIC (2014) due to the threat of this disease on hibernating bat species. The little brown bat is the most common bat species in Alberta (ESRD 2013a). In remote areas, colonies and roosts are found in large hollow trees. Hibernacula are usually cool, dark, humid places in which the air does not move (e.g., caves, natural cavities or under peeling bark on old trees (Pattie and Fisher 1999)). The big brown bat often roosts in tree cavities, large crevices or old buildings. This species typically inhabits forests and often hibernates in caves during the winter (Pattie and Fisher 1999). Suitable caves that could be used as hibernacula for the little brown, big brown, long-eared and long-legged bats were not detected within the Study Area. However, there are no data on bats within the Study Area, so there could be potential hibernacula in rocky outcrops or caves nearby.

Migratory Bats

The hoary and silver-haired bats are both migratory species that do not over-winter in Alberta. Both of these bat species are listed as Sensitive in Alberta (ESRD 2010a). The hoary bat is considered a tree bat because it is primarily a foliage-roosting species, and will roost in the branches of large shrubs and trees (ESRD 2013a; Nagorsen and Brigham 1993). The hoary bat tends to roost high in trees with most sites being 8 to 12 m above the ground (ESRD 2013a; Nagorsen and Brigham 1993). Since they rarely occur in caves, it is unknown whether white-nose syndrome will be a major source of mortality for migratory tree-dwelling species such as the hoary and silver-haired bats (Foley *et al.* 2011). Silver-haired bat roosting sites are located within small crevices behind peeling bark or cavities in partially decayed trees (Nagorsen and Brigham 1993).

The Project footprint is unlikely to affect roosting sites such as caves, and the existing pine and spruce dominated vegetation in the Study Area provides minimal habitat requirements for bats as most forest-dwelling bats prefer mature or old growth forests for roosting (Perry *et al.* 2007). Additionally, as many bat species occur in forested areas near rocky outcrops or waterbodies (Pattie and Fisher 1999), the conversion of land into open water as a result of the Project is not expected to greatly impact any bat species negatively.

Amphibians

In addition to western toad (discussed above), the only other Sensitive amphibian species that could occur within the Study Area are the Columbia spotted frog (*Rana luteiventris)* and the long-toed salamander (*Ambystoma macrodactylum*) (ESRD 2010a). The long-toed salamander is also listed as Special Concern by ESCC (2014).

In Alberta, the long-toed salamander occurs within the Montane region from alpine (2,800 m elevation) to sub-alpine (1,075 m elevation) habitats, prefers shallow areas of permanent ponds, and are found under rocks and woody debris near ponds (Russel and Bauer 2000).

The Columbia spotted frog is found near permanent bodies of cold water in mountainous areas, usually in mixed coniferous forests or subalpine forests from 995 m to 2,150 m (Russel and Bauer 2000).

Effects to these species could be similar to western toad. The dam could constitute a movement barrier between breeding, foraging habitats and from overwintering sites. Direct amphibian mortality could occur as a result of vehicular traffic or incidental destruction of hibernation sites during construction. Indirect mortality could result from the alteration of aquatic and overwintering habitats. Drainage patterns could be affected by the Project footprint.

Reptiles

The wandering garter snake (*Thamnophis elegans*) and red-sided garter snake (*Thamnophis sirtalis*) are the only reptiles with the potential to breed within the Study Area. These species are ranked as Sensitive in Alberta (ESRD 2010a) and are not federally listed. Wandering garter snakes' home range is extremely variable. They occupy communal dens in the winter and can be found in naturally occurring crevices or abandoned burrows of small animals (Russel and Bauer 2000). This species is often found near water and may be found within close proximity to streams and ponds, or in urban and farm areas (Russel and Bauer 2000).

The red-sided garter snake may be found within close proximity to streams and ponds, within forests or in urban and farm areas (Russell and Bauer 2000). No snakes or highly suitable hibernating habitat was detected during the 2014 field surveys.

If present, garter snakes could be affected by habitat removal for the new proposed highway route, as well as displacement from the area around the dam. Garter snakes use natural crevices, and burrows of small mammals for hibernation. These sites could be lost during construction and operations of the Project.

3.6.2.7 Mitigation

If the Project proceeds beyond the conceptual stage, specific features to reduce potential effects on wildlife species and their habitat during construction and operations could be incorporated into the Project design. The following general mitigation measures would help to reduce the potential for habitat loss, maintain habitat effectiveness and wildlife movement, and decrease wildlife mortality. Mitigation measures follow a hierarchal approach based on avoidance, minimization and finally restitution of effects, as described in the Government of Canada publication *Addressing Species at Risk Act Considerations Under the Canadian*

Environmental Assessment Act for Species Under the Responsibility of the Minister responsible for Environment Canada and Parks Canada (Government of Canada 2010):

- To protect the integrity of ungulate winter ranges; rivers and movement corridors, and biodiversity areas where species tend to concentrate, the RAP for the Key Wildlife and Biodiversity Zone should be adhered to (i.e., no activity from 15 December to 30 April). Additionally, approval standards and operating procedures apply for any activities as outlined in the *Approval Standards: Enhanced Approval Process* (Government of Alberta 2013).
- To protect key grizzly bear habitat, minimize human-grizzly bear conflicts and bear mortalities, approval standards and operating procedures that apply for any activities undertaken in a Grizzly Bear Zone, as outlined in the *Approval Standards: Enhanced Approval Process,* should be followed (Government of Alberta 2013).
- Minimize habitat destruction activities at times of the year when there is a higher risk to disturbing nesting birds during the nesting and rearing periods and is consistent with both federal and provincial expectations (i.e., the *Migratory Birds Convention Act* and the *Alberta Wildlife Act*, respectively).
- For migratory birds, these higher risk times are from 15 April to 15 August in southern Alberta (Gregoire pers. comm. 2014).
- For non-migratory birds (i.e., owls) these higher risk times are from 15 February to 30 April in Alberta (Boukall, pers. comm. 2014).
- For raptors these higher risk times are from 15 March to 15 July (ESRD 2011a) and recommended setback distances for an active sensitive raptor species nest is 1,000 m during this time period.
- Clearing within the above nesting windows may be undertaken pending approval from ESRD and Canadian Wildlife Services (CWS), provided that a pre-construction nesting survey is completed a maximum of seven days prior to activity for the area to be cleared. Should an active nest or occupied denning site be found during a pre-construction nest survey, vegetation clearing and/or construction activities will be suspended, pending consultation with ESRD Fish and Wildlife officials.
- Dust control measures should be implemented as needed to prevent effects to adjacent breeding and foraging habitat.
- Culverts should be installed where ephemeral drainages cross roads and kept clear of debris to allow for movement of amphibians and small mammals.
- Native, non-palatable plant species should be planted at culvert entrances to encourage wildlife passage and use of these crossings.
- Noise reduction mechanisms on construction vehicles should be used, such as properly maintained construction equipment and noise bafflers such as mufflers.
- Road speeds should be limited as appropriate to minimize the potential for vehicle-wildlife collisions.

- Warning signs should be posted at all Project access points to warn motorists of wildlife hazards.
- All food wastes should be fenced and/or stored in bear-proof containers to prevent wildlife access to food wastes, as per the Alberta BearSmart program, and then trucked offsite for disposal.
- To reduce the potential for harm to both humans and wildlife, environmental and wildlife awareness programs should be included in site orientations for all Project personnel to ensure awareness of the hazards associated with feeding wildlife and vehicle-wildlife collisions are understood.

3.6.2.8 Data Gaps

A review of existing historical data, supplemented with field data collected for the Project concluded that a limited amount of quantitative data is available within the Study Area. Additional wildlife surveys would be required to sufficiently identify existing wildlife constraints and to accurately determine Project-specific impacts to wildlife and wildlife resources for an environmental impact assessment. Suggested surveys would, at minimum, include:

- winter track count survey;
- aerial ungulate surveys;
- grizzly bear DNA survey (e.g., genetic sampling from hair);
- breeding bird point count;
- waterfowl migratory and brood survey;
- bat acoustic survey;
- common night-hawk survey;
- owl call-playback (repeated to get repeat surveys in the same breeding season and to better target optimal breeding times);
- amphibian survey (repeated to get repeat surveys in the same breeding season and to better target optimal breeding times); and
- remote camera surveys.

Following the *Sensitive Species Inventory Guidelines* (ESRD 2013b), most of the field studies would entail repeat surveys (i.e., 2-3 surveys) to ensure adequate identification and protection of wildlife species of concern and their habitat. The suggested surveys would provide valuable information on:

- habitat use and habitat occupancy for wildlife species of concern occurring within the Project area; and
- terrestrial movement corridors through the Study Area.

Habitat suitability refers to the ability of the landscape to provide specific life requisites for a particular species or species group, such as food, cover and reproductive requirements. Habitat

Suitability Index (HSI) models represent hypotheses of seasonal or year-round species-habitat relationships. HSI models should be applied to evaluate baseline conditions and to provide a more detailed assessment of changes in habitat availability as a result of proposed Project activities for VECs within the Study Area.

Baseline data obtained from field surveys should be used in conjunction with habitat suitability modelling for a comprehensive environmental impact assessment on wildlife as a result of Project activities.

3.6.3 Literature Cited

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3.7 Historical Resources

In Alberta, historical resources are protected by the *Historical Resources Act* (HRA) (Government of Alberta 2000), which is administered by ACT. Under section 1(e) of the HRA, historical resources are defined as:

> *any work of nature or of humans that is primarily of value for its palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific or aesthetic interest including, but not limited to, a palaeontological, archaeological, prehistoric, historic or natural site, structure or object.*

Historical resources like archaeological and palaeontological sites are finite and non-renewable; because those within and near development footprints may be negatively affected, ACT requires screening of projects to ensure that conflicts are avoided and/or managed. This screening is initiated by applying for HRA clearance through ACT's online system. For developments affecting lands which lack historical resource sensitivity, the resulting review will result in clearance to proceed, but, in cases where sensitive areas are involved, ACT will issue HRA requirements that must first be fulfilled. These requirements typically involve a Historical Resources Impact Assessment (HRIA) designed to identify and characterize any historical resources that would be affected by the development. At this stage, the proponent may alter the development footprint to avoid these effects, but, where this is not possible, additional HRA requirements may be issued specifying mitigative measures to compensate for unavoidable damages to these historical resources. These measures commonly involve further study by means such as archaeological excavation prior to the initiation of development.

This section summarizes the current state of historic resources data within the proposed reservoir footprint. The footprint was delineated using LiDAR elevation data to project flood waters reaching full supply level (FSL) height behind a 50-m-high dam. The historical resources regulatory process and its implications for the proposed Project are also discussed.

Methods are provided in Appendix A.

3.7.1 Results

3.7.1.1 Archaeological Site Types

Archaeological sites in Alberta are generally divided into three chronological categories: precontact, protohistoric and historic. Precontact sites date from about 12,000 years ago to A.D. 1500; this is the period when only aboriginal peoples and cultures were present in the region. Sites typically yield artifacts reflecting the stone, bone and ceramic technologies these groups used, as well as animal and sometimes plant remains from food gathering and preparation activities. Site types include campsites dominated by evidence of domestic and habitation activity, hunting and butchering sites associated with capturing and processing game, and quarry sites where stone for tools was acquired and worked. More rarely, sites associated with ceremonial and spiritual activity are found; examples include stone cairns, alignments and effigies, as well as occurrences of rock art.

Protohistoric sites in Alberta date to the short period between A.D. 1500 and 1750, when aboriginal trade networks brought European goods to the region, but European explorers and colonizers had yet to reach it. The range of site types is similar to the precontact period but with the additional of elements of European technology, such as metal implements.

Historic sites date to after A.D. 1750, when European explorers and colonizers began to appear in the region. They include a broad range of domestic, subsistence, industrial and other site types reflecting the diverse populations and rapid changes characteristic of this period.

Protohistoric sites are rare throughout the province, including the Eastern Slopes region of the Canadian Rockies, where the Project would be situated; however, precontact and historic sites have been identified throughout the Eastern Slopes, suggesting the potential for more such sites in the Study Area.

3.7.1.2 Record Review

The September 2014 version of the *Listing of Historic Resources* indicated that the western boundary of the reservoir footprint is intersected by two adjacent legal subdivisions (LSDs) bearing HRVs of 4a and 5a, respectively (Government of Alberta 2014). These LSDs also adjoin two listed LSDs that lie just beyond the reservoir footprint’s west edge; again, they have HRVs of 4a and 5a. Another pair of LSDs with HRVs of 4a and 5a is located less than 1 km from the reservoir footprint's southeast boundary.

Review of ACT's records determined that the three LSDs with historical resource values (HRVs) of 4a are associated with three previously identified archaeological sites; the three adjacent LSDs with HRVs of 5a have these designations because their proximity to these sites suggests they also contain archaeological materials. ACT's records indicated that these sites were found by two of the four previous HRIAs that intersected the reservoir footprint. Based on the associated reports and site forms, these HRIAs and the sites that they located are described below. A number of other archaeological studies are known to have encompassed parts of this area, including a 1972 survey sponsored by the University of Calgary and a number of subsequent studies sponsored by the Archaeological Survey of Alberta during the 1970s and 1980s. However, reports for this latter group of studies were not available for review.

Although multiple previous studies have occurred in and around the Study Area, it is important to note that they offer limited information on its historical resources. Much of this previous work dates to the first decade after the enactment of the HRA in 1973. As such, methodologies varied widely and often included approaches of limited effectiveness. Additionally, many of these studies involved assessment of highway corridors, which, as linear developments, typically encompass small, non-representative areas. There are some early HRIAs associated with block developments in this region, but their low returns may reflect the methodological limitations common to such early studies.

HRIA, Government of Alberta, Southern Alberta Provincial Parks and Campgrounds Mitigation, Permit 77-046

Undertaken in 1977, this HRIA was conducted to identify and assess historical resources affected by planned facilities within several provincial parks and campgrounds across southern Alberta (Quigg 1977). It included investigation of an approximately 380-ha footprint associated with the proposed McLean Creek Campground. This footprint extended over portions of Township 22, Ranges 5 and 6, west of the 5th Meridian. It flanked the southeastern boundary of the reservoir footprint, overlapping with it along the southeastern side of the Elbow River.

This study incorporated surface examination via pedestrian traverse, as well as subsurface investigation in the form of 18 shovel tests. Little to no information is provided on how these investigations were targeted. A single precontact archaeological site, EfPq-3, was identified as a campsite based on the recovery of several artifacts from a shovel test on a terrace immediately north of McLean Creek; it is located in the LSD with an HRV of 4a that lies a short distance southeast of the reservoir footprint.

HRIA, Government of Alberta, 1979 Southern Alberta Highway Archaeological Survey, Permit 79-068

Undertaken in 1979, this HRIA was part of a program to identify and assess historical resources affected by planned highway improvement and campground projects across southern Alberta

(Gryba 1980). It included investigation of an 11.5-km-long segment of Secondary Road 553 (now Highway 66) which extended over portions of Townships 21 to 23, Ranges 5 to 7, west of the 5th Meridian. This right-of-way intersected the reservoir footprint along 1.9 km of its route, and an additional 3.7 km flanked the northwestern edge.

This HRIA incorporated surface examination of the entire right-of-way via vehicle and pedestrian traverse, followed by subsurface investigation through shovel testing of selected localities. These localities were chosen based on the permit holder's previous experience along the nearby Secondary Road 554 (now Highway 68) right-of-way, where archaeological sites commonly occurred in sheltered, south-facing areas on elevated landforms including terraces, saddles and knolls. No archaeological sites were identified within the reservoir footprint. However, four precontact campsites were visited along this right-of-way. These included EfPq-2, initially identified in the 1972 University of Calgary survey of this area, as well as EfPq-4, EfPq-5 and EfPq-6, newly discovered by this HRIA. EfPq-2 and EfPq-4 are of pertinence to the McLean Creek Site, as they lie in the two LSDs with HRVs of 4a that sit on or near the reservoir footprint's west boundary. Both are on an Elbow River terrace located no more than 250 m from the northwestern edge of the reservoir's footprint.

HRIA, Alberta Recreation and Parks, 1979 Kananaskis Country Development Projects, Permit 79-125

Undertaken in 1979, this HRIA was designed to identify and assess historical resources at eight planned recreational facilities within Kananaskis Country (McCullough 1980). It included three alternative locations for the proposed Ford Creek Campground; one of these, a parcel of approximately 5 ha, was located within Township 22, Range 6, west of the 5th Meridian, falling entirely within the proposed project footprint.

This study incorporated surface examination of the entire right-of-way via pedestrian traverses at 50-m intervals, coupled with subsurface investigation through shovel testing every 50 m along these transects. No archaeological sites were found.

HRIA, Government of Alberta, 1982 Archaeological Survey of Alberta Highways and Recreation Area Developments, Permit 82-072

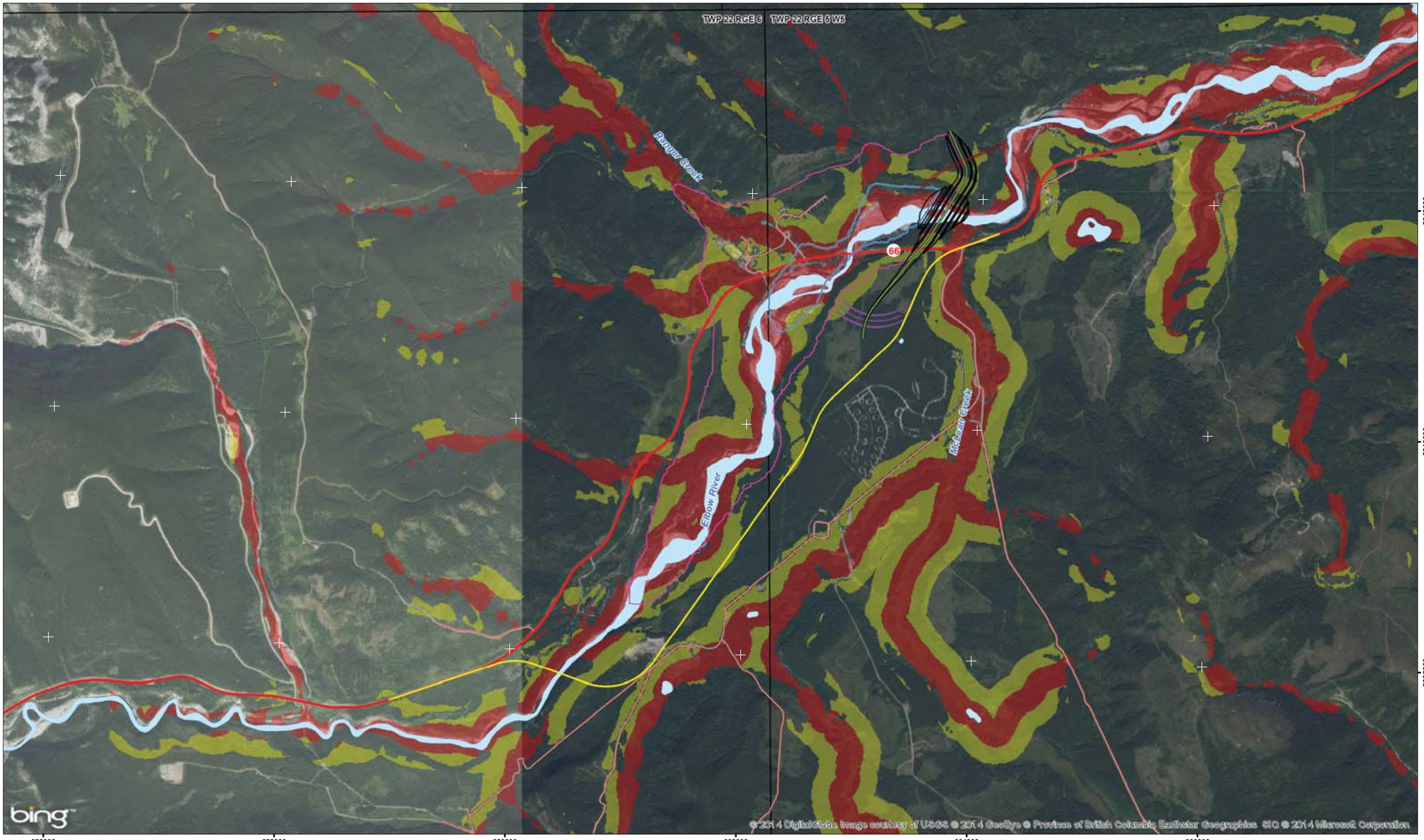
Undertaken in 1982, this HRIA was part of a program to identify and assess historical resources affected by planned highway projects, gravel pits and recreation facilities across Alberta (Gryba 1983). It included investigation of an approximately 9.3-km-long corridor associated with a proposed cross-country ski trail for use in the 1988 Winter Olympics. With a route flanking segments of Bragg and Ranger creeks, it extended over Townships 22 and 23, Ranges 5 and 6, west of the 5th Meridan. Only the most southeasterly extent intersected with the reservoir footprint.

This study incorporated surface examination of the entire right-of-way via vehicle and pedestrian traverse, followed by subsurface investigation through shovel testing of selected areas. Criteria for selection of shovel testing localities were not itemized, but landforms in close proximity to water, such as terraces, were a focus for this HRIA. No sites were located, but the report noted that the steepness of the proposed trail route, coupled with its heavy forest cover, would have not been attractive to game animals or human groups.

3.7.1.3 Predicting Archaeological Potential

Because the previous historical resource data were limited, a predictive model was created to identify zones of moderate and high archaeological potential in the reservoir footprint (Figure 3.7-1). This model utilized physical variables that correlate with archaeological site location, focusing on proximity to water sources, low slope angles, and elevated, well-drained landforms. Despite the absence of previously identified sites within the reservoir footprint, the model identified many zones of high archaeological potential due solely to the ubiquity and proximity of drainage features in this area. The model also found extensive zones of moderate archaeological potential in places more removed from water but integrating relatively flat but well-drained and elevated terrain. The large areas encompassed within the zones of moderate and high archaeological potential are extensive to the point that the presence of multiple previously undetected sites is possible.

On 29 September 2014 a field visit was undertaken to evaluate the efficacy of the model, both by observing if it accurately identified moderate- to high-potential landforms and by determining the basis for any shortcomings in its ability to do so. The field visit showed that, while the moderate- to high-potential zones identified by the model are generally consistent with firsthand assessments of the associated terrain, these zones could be usefully refined. The model's main limitation is its inability to accurately pick out microtopographic features, such as knolls and ridges, which often integrate archaeological sites in this region (e.g., Gryba 1980). This issue can be easily rectified with high-resolution LiDAR data. The lack of high-resolution LiDAR in the creation of the original model also makes it overly reliant on hydrological data when identifying archaeological potential. If high-resolution LiDAR is obtained for the Project area, then the model can be changed to more accurately identify zones of moderate to high archaeological potential, increasing its utility for any future HRIAs.



Legend

- Base Reservoir Water Level (1399m)
- 100 Year Flood Water Level (1422m) (Archaeology Study Area)
- Highway
- Road

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment

Archaeological Potential

- High
- Moderate

N 250 0 250 500
Metres
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD

McLean Creek Environmental Overview

Archaeological Potential

DATE: December 2014	
ANALYST: TR	QA/QC: TR GH JB
PDF: Fig3.7-1 Archy Potential 14-12-01	

Figure 3.7-1

amec

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In addition to allowing assessment of the model, the field visit also resulted in identification of an archaeological site within the reservoir footprint. Designated EfPq-10 by ACT, this site consisted of a quartzite chopping tool which was observed eroding out of the bank of a terrace overlooking an intermittent tributary of the Elbow River; this location placed it within one of the model's high-potential zones. This find supports the model's identification of high archaeological potential, confirming that previously unrecorded archaeological resources are likely in the Study Area.

3.7.2 Discussion

Historic resources within the Study Area could be affected by both the construction and operation of the proposed Project. Damage to these resources could result from ground-altering activities undertaken during the construction phase, such as vegetation clearing, grubbing, surface stripping, and excavation. Historical resources could also be affected by flooding within the reservoir; sedimentation of submerged landforms and erosion of exposed shoreline and basin landforms present particular concerns. The extent of these effects could extend across the entirety of the proposed reservoir, requiring accurate data on its area at full supply level, as well as consideration of historical resources throughout this zone.

Issues regarding historic resources which could affect the Project moving forward are largely time related. As outlined above, there is an extended regulatory trajectory for projects involving footprints that cannot avoid damage to valuable historical resources, and this timeline must be factored into planning for this Project, with particular attention to ACT restrictions on winter fieldwork.

3.7.2.1 Mitigation Measures

Should the Project move forward, under the terms of the HRA the Project should be referred to ACT for review. This process is initiated with a Historical Resources Application. This application must include GIS data on the finalized Project footprint, as well as information of the nature and extent of the disturbance that the proposed development will entail.

Following review of these materials, ACT will issue either a clearance letter or HRA requirements that must be fulfilled in order to receive clearance. In contexts like the Study Area, where previous data are limited and potential for historic resources is substantial, these requirements can be expected to include separate HRIAs for archaeological and palaeontological resources; the former would include consideration of historic sites and structures. Issuance of HRA requirements can take up to two months following application.

Any required HRIAs must be undertaken by qualified professionals who can hold the necessary ACT permits. Applications for Archaeological Research Permits require a package incorporating the same information as the Historical Resources Application, as well as specifics on areas targeted for investigation and methods that will be used to evaluate these areas. Applications for Archaeological Research Permits may take up to 10 business days to process; the resulting permit usually requires that fieldwork take place over a maximum period of two months and under frost- and snow-free conditions.

The subsequent post-field phase requires cataloguing, analysis and interpretation of any artifacts and data collected during the field phase; these steps take varying amounts of time depending on the frequency and nature of the historical resources identified during the HRIA's field phase. ACT requires these findings to be discussed in a final report conforming to their standards. Time required to produce a final report again varies depending on the nature and complexity of the fieldwork and its findings.

If at this point none of the historical resources identified by the HRIAs are deemed valuable by ACT, they will be assigned an HRV of 0, no further study will be required, and clearance will be issued. However, if they are deemed valuable (i.e., they receive an HRV other than 0), avoidance or mitigation of Project effects will be necessary. Dams often involve mitigation due to difficulties in altering the project footprint. Under these circumstances, ACT will issue new HRA Requirements, typically specifying recovery of data through excavation of the affected historical resources, with permitting, reporting and reviewing procedures again proceeding as above and with similar timelines.

3.7.2.2 Data Gaps

The limited coverage provided by previous archaeological studies within the Study Area, means there is a significant lack of data about the Project's potential effects on historical resources, both during initial construction and subsequent flooding of the reservoir. This paucity of information, coupled with the presence of LSDs bearing HRVs of 4a and 5a, strongly suggests that ACT will require an archaeological HRIA prior to development. The *Listing of Historic Resources* does not currently include any LSDs with HRVs indicative of palaeontological value; however, this situation likely reflects lack of previous palaeontological assessment, a data gap which ACT may want to see addressed through a separate palaeontological HRIA.

3.7.3 Literature Cited

Government of Alberta. 2000. *Historical Resources Act*. Queen's Printer. Edmonton.

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Gryba, E.M.1980. *Highway Archaeological Survey (South), 1979, Final Report, Permit 79-068*. Consultant's report on file, Alberta Culture and Tourism, Edmonton.

Gryba, E.M. 1983. A*rchaeological Investigations, Eastern Slopes Region, Sites EdPp-21, EdPp-22, EfPq-5, EfPq-6, Final Report, Permit 82-128*. Consultant's report on file, Alberta Culture and Tourism, Edmonton.

McCullough, E.J. 1980. *Historical Resources Impact Assessment, Kananaskis Country Development Projects, Final Report, Permit 79-125*. Consultant's report on file, Alberta Culture and Tourism, Edmonton.

Quigg, J.M.1977. *1977 Government Campground Mitigation Work for Southern Alberta, Final Report, Permit 77-046*. Consultant's report on file, Alberta Culture and Tourism, Edmonton.

3.8 Land Use

The construction and operation of the Project could result in the removal of existing recreational facilities, the flooding of vegetation and wildlife habitat, and associated changes to existing land and resource use in the area. This section describes the key land and resources uses, the potential impacts of the proposed Project, and the best management practices and possible mitigative measures to reduce these impacts. Should the Project proceed beyond the conceptual stage, data gaps that should be filled prior to preparing an environmental impact assessment are identified.

Results are presented for land use planning and management; non-consumptive and consumptive use; access; and current land uses.

Methods are provided in Appendix A.

3.8.1 Results

3.8.1.1 Land Use Planning and Management

Project facilities would be constructed on Crown land within the provincial Green Zone. The McLean Creek site is located within Kananaskis Country, which is predominately a recreation area consisting of public lands and Provincial Parks. Kananaskis Country is part of the Kananaskis Improvement District (KID), an unincorporated municipal district, which provides local government and municipal services to the residents of Kananaskis Country. Its secondary purpose is to work with the Province of Alberta in land use and resource management. The Improvement District provides services to the area in conjunction with Alberta Tourism, Parks, and Recreation and with ESRD (KID 2013).

The management of Kananaskis Country is described in a number of plans and policies that include:

- The South Saskatchewan Regional Plan (SSRP) (GoA 2014a);
- The Kananaskis Country Recreation Policy (GoA 1999);
- The Kananaskis Country Sub-Regional Integrated Resource Plan (IRP) (Alberta Forestry 1986); and
- The Kananaskis Country Provincial Recreational Areas Management Plan (GoA 2012).

Developed within the context of Alberta's Land Use Framework (LUF), the South Saskatchewan Regional Plan (SSRP) outlines the long-term vision for the region and focuses on cumulative effects management as a way to balance social, economic and environmental considerations and outcomes (GoA 2014a). The SSRP supports the continuation of Kananaskis Country as a protected and important recreational and tourism area with the potential to become a major tourist draw for Alberta (GoA 2014a). Current land uses in the area include timber harvesting, petroleum, recreation, cattle grazing, and off-highway vehicle (OHV) use.

The Kananaskis Country Recreational Policy sets out the approach to sustainable recreation management of Kananaskis Country within the context of integrated resource and environmental management. The policy itemizes a number of planning requirements, including forest, water and protected area management plans and describes guidelines and restrictions on development and ownership within Kananaskis (GoA 1999).

The Kananaskis Country Sub-Regional IRP provides direction for resource management and describes the allocation, use and coordinated management of natural resources within Kananaskis (Alberta Forestry 1986). This IRP will be reviewed and incorporated, where necessary, under the umbrella of the larger regional plan (SSRP). Until this time, however, this IRP will remain in effect (GoA 2014a).

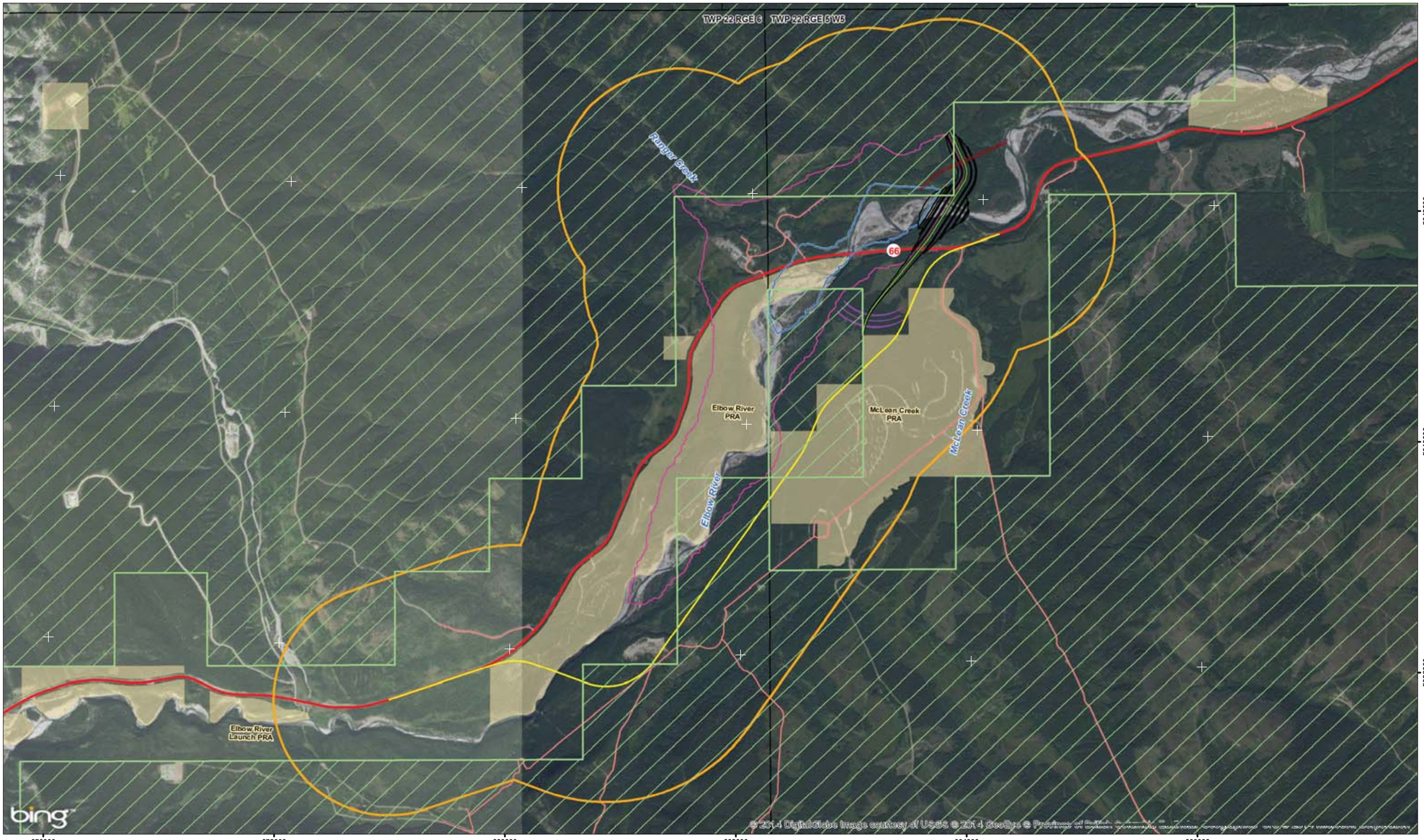
The Kananaskis Country Provincial Recreational Areas Management Plan prioritizes the management of Provincial Recreation Areas (PRAs) in the Kananaskis area and provides background information and management intent statements, objectives and strategies for the area (GoA 2012).

3.8.1.2 Non-Consumptive Recreation Use

The Elbow River valley is one of the busiest parts of Kananaskis Country, with nearly 500,000 visitors annually. The popularity and accessibility of the Elbow River valley is due, in part, to paved access, good scenery and extensive facilities and trail systems (GoA 2012). The Government of Alberta reports that 80% of the recreational use of Kananaskis Country along the Elbow River valley is by day users and 20% is by campers. The Elbow Valley campgrounds are approaching or are at high occupancy levels. In 2003-2004, the Elbow Valley recreation sites experienced 360,000 day users and 81,700 campers annually (GoA 2012).

3.8.1.2.1 Parks, Protected Areas and Environmentally Significant Areas

There are three Provincial Recreation Areas (PRAs) and one Environmentally Significant Area (ESA) within the Study Area (Figure 3.8-1).



Legend

Study Area
Base Reservoir Water Level (1399m)
100 Year Flood Water Level (1422m)
Highway
Road

Proposed Infrastructure

Main Structure
Auxillary Earth Cut Spillway
Main Embankment Crest - El. 1429.5m
Combined Permanent Outlet / Spillway Structure
Highway 66 Realignment
Provincial Recreation Area (PRA)

Environmentally Significant Area

Level of Significance
Provincial
ESA 8

N 250 0 250 500
Metres
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD

McLean Creek Environmental Overview

Parks, Protected and Environmentally Significant Areas

DATE: December 2014
ANALYST: TR
QA/QC: TR BH JB
PDF: Fig3.8-1 Parks ESA 14-12-02

Figure 3.8-1

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Provincial Recreation Areas

PRAs are established with a goal of providing access and staging areas to high quality, safe, and enjoyable recreational experiences while protecting significant natural, cultural, and scenic values within and adjacent to these areas (GoA 2012). Currently, there are three in the vicinity of the Project: McLean Creek, Elbow River and Elbow River Boat Launch PRAs.

The SSRP, the Bragg Creek Provincial Park Management Plan and the Kananaskis Country Provincial Recreational Areas Management Plan all outline the future consolidation of the Elbow Valley PRAs with Bragg Creek Provincial Park into what will be renamed Elbow Valley Provincial Park. McLean Creek PRA will remain a separate PRA to continue to accommodate OHV use in the McLean Creek Public Land Use Zone (PLUZ) (GoA 2012).

McLean Creek PRA

McLean Creek PRA is located south of Highway 66, along a public access road. Ninety-four percent (230 ha) of McLean Creek PRA falls within the Study Area (Table 3.8-1).

Table 3.8-1: PRAs within the Project Study Area

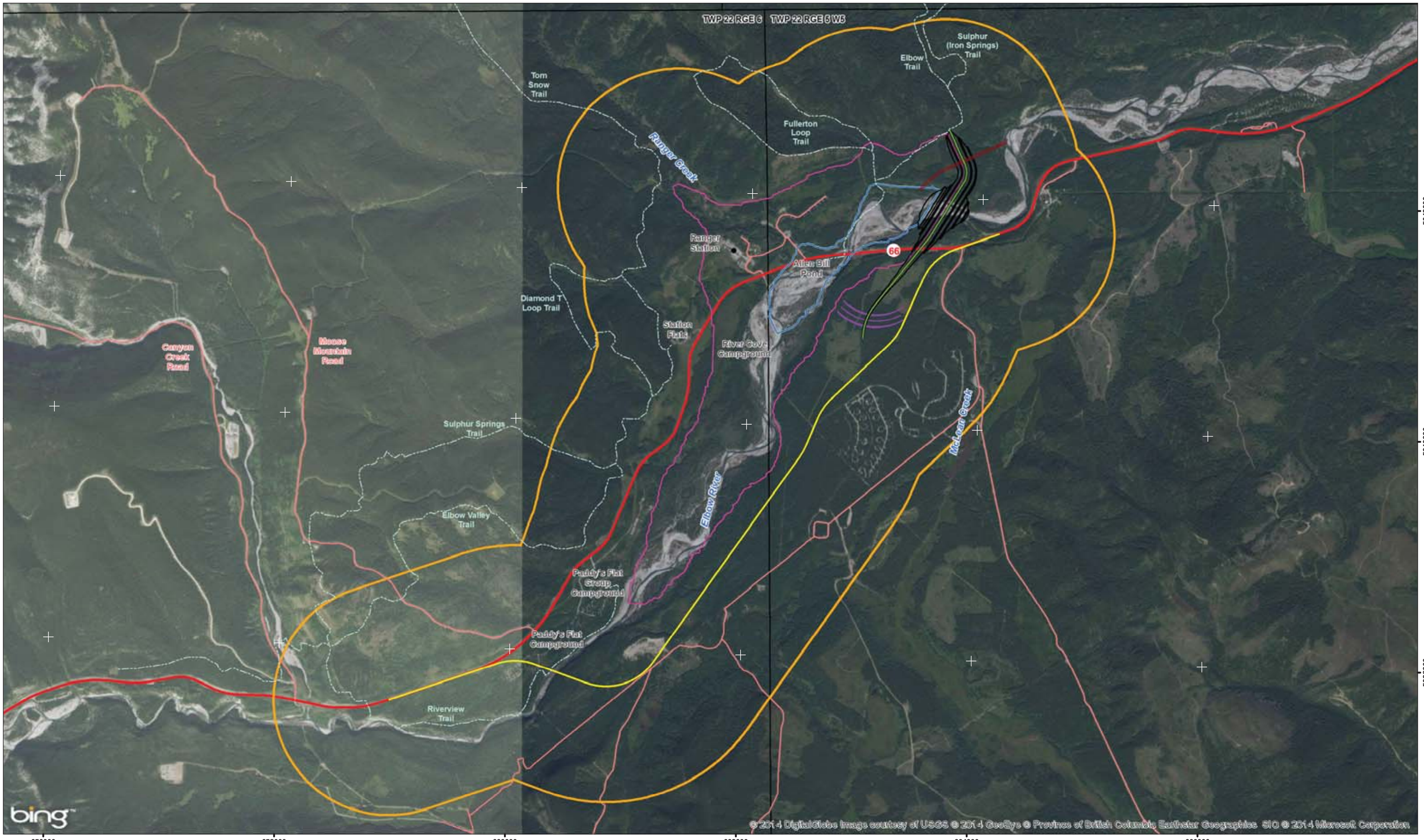
PRA	Total area (ha)	Area (ha) within Study Area	% of Study Area	% of PRA
Elbow River	237	237	9	100
McLean Creek	245	230	9	94
Elbow River Boat Launch	12	3	<1	25

Facilities within the PRA include the McLean Creek campground, which features 170 serviced and un-serviced sites and a campground kiosk. Day use areas within the PRA include McLean staging area for OHV use, McLean pond, and several front country trails (Alberta Parks 2014). This PRA did not incur any damage from the 2013 floods.

Elbow River PRA

The Elbow River PRA is located on the north and south side of Highway 66. The entire PRA falls within the Study Area (Table 3.8-1).

This PRA contains extensive facilities and trails, including Paddy's Flats group and public campgrounds, River Cove group campground, Station Flats and Allen Bill Pond day use areas, and numerous trail systems utilized for hiking, mountain biking, trail running, and horseback riding (Alberta Parks 2014) (Figure 3.8-2). These are described briefly below:



Legend

Study Area	Highway
Base Reservoir Water Level (1399m)	Road
100 Year Flood Water Level (1422m)	Trail

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment

N

250 0 250 500

Metres

1:30,000

Note : Coordinates in UTM Zone 11 NAD83

Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD

McLean Creek Environmental Overview

Trails, Recreation Sites, Residences and Infrastructure

DATE: December 2014

ANALYST: TR

QA/QC: TR BH JB

PDF: Fig3.8-2 Trails 14-12-05

Figure 3.8-2

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- There are two campgrounds associated with Paddy's Flats, the first of which is a group camping facility while the second offers public camping for both tent and trailers. The campgrounds offer standard serviced campsites with water, vault toilets, fire pits, and tables. Both campgrounds are seasonal use sites only (May to October) (Alberta Parks 2014).
- River Cove group campground was destroyed during the 2013 flood, and is currently closed to the public. Flood related repairs are currently under way by Alberta Tourism, Parks & Recreation to fully recover the campground and associated access (Storie pers. comm. 2014).
- Station Flats is a hiking, mountain biking and horseback trailhead located on the north side of Highway 66. It has a small gravelled parking lot and vault toilets.
- Allen Bill Pond was also destroyed during the 2013 flood; however, some facilities still remain intact, including vault toilets and several reconstructed trailheads. Prior to the 2013 flood, Allen Bill Pond was stocked with rainbow trout and was a popular destination in Kananaskis. Staff observations from 2012 indicated frequent or occasional congestion and crowding on weekends (GoA 2012). Recreational use patterns have likely changed since the 2013 flood.
- There are a number of recreational trails located within the Elbow Valley PRA, including the Elbow River trail, the Allen Bill Pond trailheads and parts of the Fullerton Loop trail, all of which have been altered and subsequently recovered since the 2013 flood (Storie pers. comm. 2014).

Elbow River Boat Launch PRA

The Elbow River Boat Launch PRA is located south of Highway 66, immediately upstream from the Elbow Falls PRA. The Elbow River Boat Launch PRA contains 12 ha, of which 3 ha are within the Study Area (Table 3.8-1). Facilities include fire pits and pit toilets (Alberta Parks 2014). This PRA did not incur any damage from the 2013 floods.

Environmentally Significant Areas (ESAs)

ESAs are established in areas that contribute to the long-term maintenance of biological diversity, soil, water, and other natural processes. ESAs may contain rare or unique elements that require special management consideration due to their conservation needs. The intent of ESAs is to help inform land use planning and policy at local, regional, and provincial scales. They do not represent government policy and are not areas that require legal protection (Fiera 2009).

ESA 8, located within the Rocky Mountain Natural Region, overlaps the Study Area. (Figure 3.8-1). The ESA contains 45 elements of conservation concern, including birds, mammals, insects, and vegetation and hydrologically important as it includes riparian areas containing headwater streams. Other important characteristics include large natural areas, rare or unique landforms, and sites of recognized significance, including three Provincial Parks. ESA

8 encompasses a total land base of 94,799 ha, of which 1,256 ha falls within the Study Area, accounting for 48% of the Study Area, and 1% of the total ESA land base.

3.8.1.2.2 Other Non-Consumptive Recreation Uses

Land based non-consumptive recreational activities that occur in the Study Area could include OHV use, snowmobiling, horseback riding, mountain biking, hiking, target shooting, camping (both random and designated), wildlife viewing, and photography. The three PRAs discussed earlier would be popular areas for a variety of these non-consumptive recreational uses.

Non-consumptive recreational use is also permitted within designated PLUZs. PLUZs are areas of public land managed under the authority of the Forest Act to assist in the management of industrial, commercial and recreational land uses and resources (ESRD 2014). The McLean Creek PRA is a staging area for OHV use. The McLean Creek PLUZ, established in 1979, includes a number of designated trails for OHV's of various sizes and types (ESRD 2014). The McLean Creek PLUZ was established specifically for OHV use and has been identified as one of the priority areas for the Backcountry Trail Flood Rehabilitation Program. This program prioritizes the restoration of 2013 flood-damaged trails (GoA 2014b). Trails that would be affected by Project facilities include parts of the Elbow and Fullerton Loop trails, Paddy's Flats interpretive trail, the River View trail, and a number of OHV trails associated with the McLean Creek PLUZ.

Water based non-consumptive recreational activities that may occur in the Study Area include canoeing, jet-boating, and commercial rafting. Commercial rafting outfitters access the portion of the Elbow River at the Elbow River Boat Launch PRA, which is located downstream from Elbow Falls (Alberta Tourism, Parks and Recreation pers. comm. 2014).

3.8.1.3 Consumptive Recreation Uses

Consumptive outdoor recreation activities include fishing, berry picking, hunting (big game and game bird), and trapping. The administrative units for these activities are registered fur management areas (RFMAs) 2562 and 298; wildlife management unit (WMU) 406; and fish management zone (FMZ) Eastern Slopes 1 (ES1).

Open seasons, defined as specific times of the year where hunting is permitted, are for archery hunting of white-tail deer, mule deer, moose and elk. An open rifle season in WMU 406 is for trophy big horned sheep. A majority of big game rifle hunting in WMU 406 is on draw, meaning that resident hunters need to apply for a special license to hunt big game animals (GoA 2013). Upland bird and waterfowl hunting is also permitted within WMU 406, and includes open seasons for geese; ducks; coots; snipes; pheasant; ruffed, blue and spruce grouse; and ptarmigan (GoA 2013).

Six outfitters operate within WMU 406, and hold a total of 61 allocations for the following species: black bear (4), elk (4), mule deer (30), moose (7), and white-tail deer (16) (Brick pers. comm. 2014).

The watersheds in the Fish Management Zone ES1 consist of alpine and foothill lakes with clear, cold rivers and tributaries. The most common sport fish are:

- Arctic Grayling;
- Trout (Brook Trout, Brown Trout, Bull Trout, Cutthroat Trout, Rainbow Trout, and Lake Trout);
- Whitefish (Lake Whitefish and Mountain Whitefish);
- Northern Pike;
- Walleye; and
- Yellow Perch (ESRD 2013).

The Study Area falls within two RFMAs, #2562 and #298, held by Dee W. Barrus and Jerry Ear, respectively. Therefore, trapping may occur within the Study Area. Precise locations of trap lines for the RFMAs are not known, as trap line information is proprietary and not made publicly available in Alberta. Direct consultation with trappers is required to obtain this information.

3.8.1.4 Access

Highway 66 is a multi-use corridor that runs north-south through the area.

As the only paved vehicular access to the recreational services and facilities along the Elbow River, Highway 66 experiences a high degree of seasonal traffic from mid-May to mid-December. The highway is closed to vehicle traffic each year from mid-December to mid-May at Elbow Falls, approximately 3 kilometres east of the Beaver Flats camp ground.

Traffic flows on Highway 66, west of the intersection of Highway 66 and Highway 22, have remained fairly stable over the past number of years. Reported counts of average annual daily traffic (AADT), defined as average two-way traffic volume per day across one calendar year, increased moderately from 2008 to 2012, from 1,370 to 1,570, and then dropped back to 2008 levels in 2013 (1,360) (Cornerstone Solutions Inc. 2014).

Two other roads in the southern portion of the Study Area – Moose Mountain road and Canyon Creek road - move traffic north off Highway 66. Both roads are publically accessible. Moose mountain road is closed seasonally between 1 December and 14 May.

A portion of the Study Area south of the Elbow River is located within the McLean Creek Public Land Use Zone (PLUZ). As a designated area for OHV’s of various sizes and types, the PLUZ contains designated trails for OHV use, a majority of which are located south of the McLean Creek campground.

3.8.1.5 Existing Residences and Infrastructure

Located on the north side of Highway 66 along Ranger Creek, the Elbow Ranger Station consists of a main complex that houses three departments (Alberta Forestry Protection

Services, Alberta Parks and Recreation, Alberta Fish and Wildlife), a dining hall, eight seasonal bunk houses, eleven permanent residences, two mobile homes (permanent and seasonal), water and sewage treatment plants, a helicopter pad, a cold compound storage building, as well as several additional storage buildings (AMEC 2014; Alberta Tourism, Parks & Recreation pers. comm. 2014) (Figure 3.8-2).There is also an administration building and garage on site that is occupied year round by the campground facility operators for eastern Kananaskis Country (Storie pers. comm. 2014).

During peak season, the seasonal and permanent residences can house as many as 150 people. The permanent residences are occupied by employees from Alberta Parks, Forestry Protection, as well as campground facility operators for eastern Kananaskis Country (Storie pers. comm. 2014). The water and sewage treatment plants provide services for the Elbow Ranger Station, as well as the Elbow Valley campgrounds in the area.

The Elbow Ranger Station area is also used to stockpile firewood for the entire valley (Alberta Tourism, Parks & Recreation pers. comm. 2014).

3.8.1.6 Forestry

The Study Area is within the forest management agreement area (FMA) held by Spray Lakes Sawmills (1980) Ltd. It is located within two Forest Management Units (FMU): (FMU) B10 held by Spray Lakes Sawmills, which has full rights to both coniferous and deciduous forests, and FMU B11 that is government managed.

3.8.1.7 Dispositions

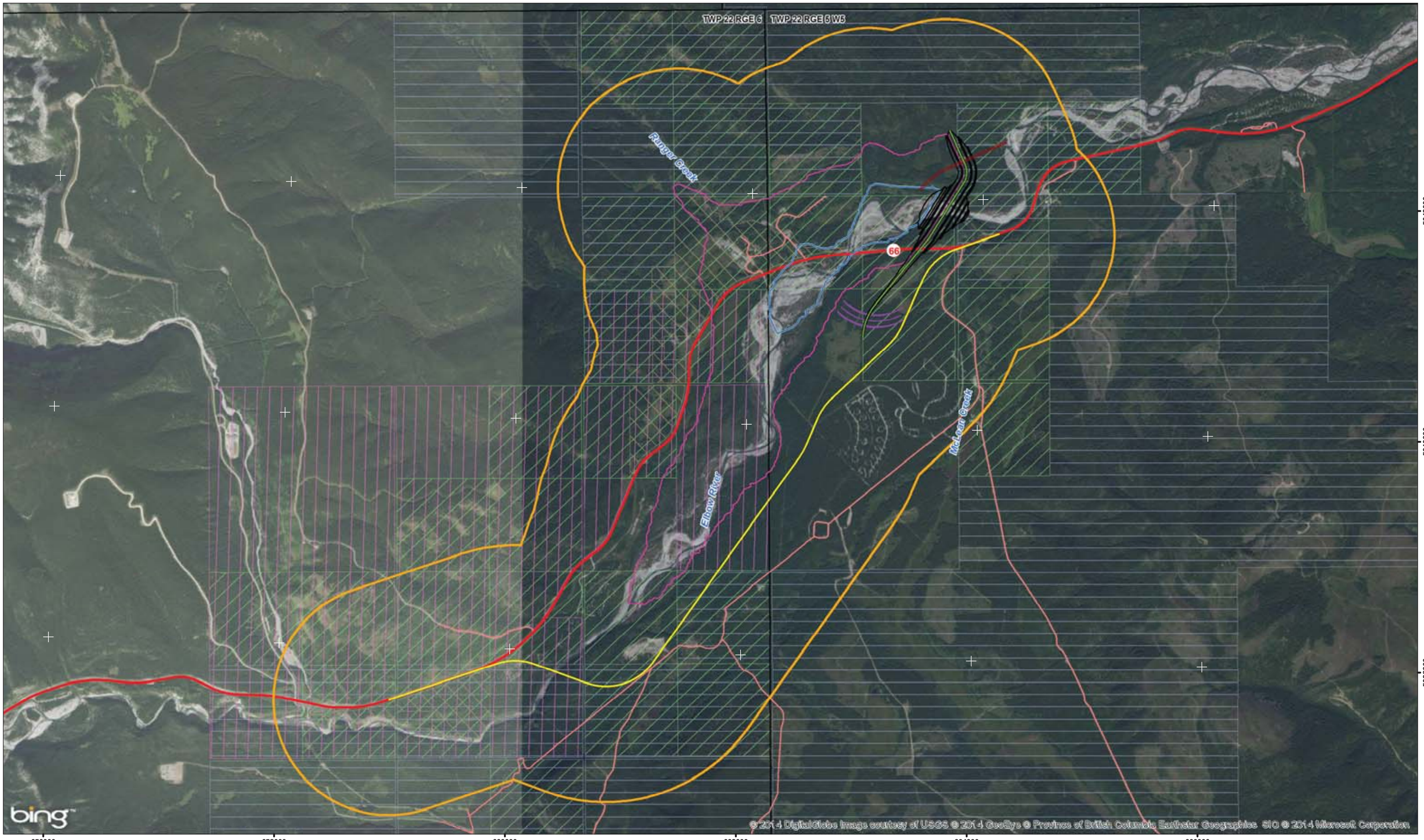
A land surface activities search (using the DIDs) identified 36 land use dispositions within the Study Area (Altalis 2014) (Table 3.8-2). Dispositions include:

- one consultative notation (CNT);
- one department license of occupation (DLO);
- one department miscellaneous lease (DML);
- three dispositions reservations (DRS);
- five easements (EZE);
- four licenses of occupation (LOC);
- two pipeline installations (PIL);
- five pipeline agreements (PLA);
- two mineral surface leases (MSL); and
- one recreational campsite (REC 2811) held by the Easter Seals Society.

Additionally, there are several roadway related dispositions including two roadways (RDS) and three registered roadways (RRD). Recently approved dispositions include two Alberta Tourism, Parks & Recreation easements (PEZ) for flood related reconstruction, including the reconstruction of the Elbow River crossing (100001) and a new overhead powerline for McLean Creek campground (140001).

There are a total of four protective notations (PNTs) within the Study Area (Table 3.8-3) (Figure 3.8-3). The Rocky Mountain Forest Reserve Central Office – Rangeland District Department of ESRD holds three of these, including:

- two grazing allotment areas, the Elbow (970058) and McLean Creek Range (930439) allotments, and
- a PNT (140043) for the expansion of the Sheep River Provincial Park.



Legend

- Study Area
- Base Reservoir Water Level (1399m)
- 100 Year Flood Water Level (1422m)
- Highway
- Road

Proposed Infrastructure

- Main Structure
- Auxillary Earth Cut Spillway
- Main Embankment Crest - El. 1429.5m
- Combined Permanent Outlet / Spillway Structure
- Highway 66 Realignment

Protective Notation

- PNT090086
- PNT140043
- PNT930439
- PNT970058

N 250 0 250 500
Metres
1:30,000

Note : Coordinates in UTM Zone 11 NAD83
Source: AMEC, GeoBase®, Spatial Data Warehouse Ltd.

Resilience and Mitigation Branch ESRD

McLean Creek Environmental Overview

Protective Notations

DATE: December 2014	**Figure 3.8-3**
ANALYST: TR	QA/QC: TR BH JB
PDF: Fig3.8-3 PNTs 14-12-04	amec

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Table 3.8-2: Land Use Dispositions in the Study Area

Surface Activity	Surface Activity Code	Purpose	Disposition Holder
140022	CNT	Residential Buffer	Calgary Office – Forestry and Emergency Response Division of ESRD, Wildfire Management Branch
920400	DLO	Access Road	Alberta Filmworks Incorporated
920078	DML	Commercial Development	Alberta Filmworks Incorporated
392	DRS	Firefighting Base Camp	Calgary Office – Forestry and Emergency Response Division of ESRD, Wildfire Management Branch
120006	DRS	Structural Development	Alberta Tourism, Parks & Recreation
810028	DRS	Sand and Gravel Removal	Alberta Tourism, Parks & Recreation
100002	EZE	Powerline	FortisAlberta Inc.
140080	EZE	Powerline	FortisAlberta Inc.
840116	EZE	Powerline	FortisAlberta Inc.
890421	EZE	Powerline	FortisAlberta Inc.
920204	EZE	Powerline	FortisAlberta Inc.
001390	LOC	Access Road	Husky Oil Operations Ltd.
031314	LOC	Access Road	Husky Oil Operations Ltd.
130222	LOC	Access Road	Shell Canada Ltd.
920040	LOC	Access Road	Cougar Oil and Gas Canada Inc.
130225	MSL	Sump Site	Shell Canada Ltd.
781267	MSL	Wellsite and Access Road	Shell Canada Ltd.
100001	PEZ	Rebuild Elbow River Crossing due to Wash out	FortisAlberta Inc.
140001	PEZ	Construction of new overhead powerline to restore electrical service to McLean Creek Campground. Previous powerline has been destroyed by June 2013 flood.	FortisAlberta Inc.
020191	PIL	Valve Site and Access Road	Shell Canada Ltd.
020209	PIL	Pipeline Installation	Husky Oil Operations Ltd.
5098	PLA	Pipeline	ATCO Gas & Pipeline Ltd (South)
012826	PLA	Pipeline	Husky Oil Operations Ltd.
043624	PLA	Pipeline	Husky Oil Operations Ltd.

Surface Activity	Surface Activity Code	Purpose	Disposition Holder
800574	PLA	Pipeline	Shell Canada Ltd.
860739	PLA	Pipeline	Shell Canada Ltd.
970058	PNT	Grazing Allotment Area (#53 Elbow Grazing Allotment)	Rocky Mountain Forest Reserve Central Office – Rangeland District Department of ESRD
090086	PNT	Multiple Resource Concern (This location may fall within an area of foothills fescue grassland)	Blairmore Office – Land Use Area – Lands Division Department of ESRD
140043	PNT	Provincial Park Potential (Sheep River Provincial Park Expansion)	Rocky Mountain Forest Reserve Central Office – Rangeland District Department of ESRD
930439	PNT	Grazing Allotment Area (#65 McLean Creek Range Allotment)	Rocky Mountain Forest Reserve Central Office – Rangeland District Department of ESRD
790062	RDS	Road – North Fork Road	Transportation & Civil Engineering, Technical Standards Branch, Highway and Roadside Planning, Admin for Land & Native Issues
800100	RDS	Road – Moose Dome Road	Transportation & Civil Engineering, Technical Standards Branch, Highway and Roadside Planning, Admin for Land & Native Issues
2811	REC	Recreational Campsites	Alberta Easter Seals Society
8110268	RRD	Road	Transportation & Civil Engineering, Technical Standards Branch, Highway and Roadside Planning, Admin for Land & Native Issues
8110269	RRD	Road	Transportation & Civil Engineering, Technical Standards Branch, Highway and Roadside Planning, Admin for Land & Native Issues
9010663	RRD	Road	Transportation & Civil Engineering, Technical Standards Branch, Highway and Roadside Planning, Admin for Land & Native Issues
		Total	**36**

Table 3.8-3: PNTS within the Study Area

PNT	Total area (ha)	Area (ha) within Study Area	% of Study Area	% of PNT
970058	20,420	785	30	4
930439	10,666	1,258	48	12
140043	332	152	6	46
090086	98,853	1,534	59	2

The Study Area covers 4% (785 ha) of PNT 970058 and 12% (1,258 ha) of PNT 930439 respectively. Land use restrictions for both PNTs include the prohibition of any agricultural dispositions.

Land use restrictions on land held under PNT 140043 include the prohibition of coal, metallic, and industrial mineral surface dispositions and commercial forestry activities. Additionally, while existing sand and gravel applications will be honored, (as of 22 July 2014), no new surface material explorations (SMEs) and surface material leases (SMLs) applications will be permitted. Similarly, all petroleum and natural gas surface applications will be honored, and surface access will be prohibited for all applications after 22 July 2014. Forty-six percent (152 ha) of PNT 140043 intersects the Study Area.

PNT 090086 intersects 59% (1,534 ha) of the Study Area. Described as a multiple resource concern, this PNT has the potential to contain foothills fescue grassland. PNT 090086 is held by the Blairmore (Land Use Area) Lands Division Department of ESRD. All proponents must adhere to obligations and directions regarding minimizing surface disturbance described by the Alberta Energy Regulator (AER 2014).

3.8.2 Discussion

Potential impacts to land and resource use valued components for non-consumptive recreational use, including parks, protected, and environmentally significant areas; consumptive uses (hunting, fishing and trapping), access, land use dispositions holders, existing residences & infrastructure, and forestry, are discussed below. Impacts have been identified based on the current Project description, which is at a conceptual level. To provide a thorough understanding of the potential extent of effects of the Project on existing land and resource users, consultation with a number of stakeholders is recommended, including:

- Kananaskis Improvement District;
- Spray Lakes Sawmills Ltd.;
- Public recreational users of the area;
- Holders of affected dispositions;
- Relevant government departments – ESRD, Alberta Tourism, Parks & Recreation; Alberta Infrastructure, Alberta Transportation, Alberta Parks;
- Outfitters registered in WMU 406;

- RFMA holders;
- Commercial Rafting Outfitters;
- Recreational associations e.g., West Bragg Creek Trails Association and Kananaskis Trails Advisory Group;
- Forestry operators; and
- Non-governmental organizations with interests in the environment.

3.8.2.1 Non Consumptive Recreation Use

Impacts to non-consumptive recreation uses include a loss of recreational areas for potential users, access restrictions and temporary facility closures.

3.8.2.1.1 Parks, Protected and Environmentally Significant Areas

Provincial Recreation Areas

All three PRAs within the Study Area would be affected. Potential impacts to these recreational areas and facilities would include the flooding of some recreational areas and removal and relocation of other facilities. Project facilities (the dam, permanent pool and full supply level) would directly affect both the Elbow River and McLean Creek PRAs. Flooding of these recreational areas would result in a loss of the recreational areas to potential users. Access to the Elbow River Boat Launch PRA would be affected during the realignment of Highway 66.

Elbow River PRA

Within the Elbow River PRA, 125 ha would be directly affected Project facilities, including the permanent pond and the fully supply level area (Table 3.8-4).

Table 3.8-4: PRAs within Project Facilities

PRA	Area (ha) intersecting Project Footprint	% of Project Footprint
Elbow River	125	28.5
McLean Creek	7	1.6

The Allen Bill Pond facilities, which were damaged by the 2013 flood, would need to be removed as they would be located within the permanent pond dead storage (base reservoir) area. Based on the conceptual design, the proposed McLean Creek dam site and permanent pond would have similar recreational amenities as Allen Bill Pond.

The River Cove group campground would be located within the full supply level area. As it would experience flooding at times, it would need to be removed or relocated.

Paddy’s Flats group and public campgrounds are located above the full supply level, however, some impacts are anticipated as a result of the planned Highway 66 realignment. Impacts could include restricted access and seasonal closures during construction, and restricted access following the realignment of Highway 66.

Based on the conceptual design, Station Flats and associated facilities would remain intact; however, access from the east would no longer exist.

Restricted access during construction would affect recreational users to facilities and trails on the north side of the proposed reservoir, including Station Flats day use area and Paddy's Flats campgrounds; as well as users of the McLean Creek PLUZ.

McLean Creek PRA

The realigned Highway 66 would pass through sections of the north end of McLean Creek PRA, based on the conceptual design. A small section (7 ha of 245 ha) of the McLean Creek PRA would be directly affected by Project facilities, including the highway realignment and the full supply level area (Table 3.8-4). Within McLean Creek PRA, and located adjacent to the proposed realignment and auxiliary spillway, is the McLean Creek campground. Depending on timing, campground closures may be required during construction. (Alberta Tourism, Parks & Recreation pers. comm. 2014).

Elbow River Boat Launch PRA

Project facilities would not directly affect the Elbow River Boat Launch PRA. However, existing access west of Mclean Creek would be restricted until the realignment of Highway 66 is complete. This would prevent water-based recreationalists from launching at the existing Elbow river boat launch. Restricted access to the Elbow River boat launch during dam construction and highway realignment could impact commercial rafting outfitters, canoeists, and jet-boaters that use the river.

Environmentally Significant Areas

The Project facilities could directly affect 134 ha of ESA #8. Where direct impacts could occur (e.g., location of the dam and permanent pool) the area could be cleared. Clearing may extend up to the full supply level. Clearing would alter the ecosystem within ESA 8 by removing vegetation and wildlife habitat.

3.8.2.2 Consumptive Recreation

Consumptive recreation includes hunting, fishing, trapping and forestry.

Potential impacts on game animals, upland game bird species and waterfowl, and related effects on hunting success rates could arise from habitat loss, habitat fragmentation, sensory disturbances and direct mortality due the construction of the Project, including highway realignment. The construction of the dam would remove key wildlife corridors on the north side of the reservoir, making it difficult for wildlife to travel east-west or move between several valleys

(AMEC 2014). The resulting change in big game movement and density could affect hunter motivation, as well as subsequent success rate. These impacts would be similar for registered outfitters in WMU 406 who access the area.

Impacts to sport fish as a result of the dam would likely include habitat loss and interruption of movement corridors for fish species. The subsequent effect on population numbers could alter the success rate of fishermen, thereby changing recreation opportunities. Additionally, access to the river will be restricted both during construction of the dam, and may continue to be restricted after the realignment of Highway 66.

Both positive and negative effects on trapping, and related activities, could occur as a result of the Project. Potential negative impacts include dispersion of furbearers away from disturbance, noise and people, reduction in RFMA land base, loss of access and the subsequent effects to furbearer populations for trapping. Improved access via linear corridors could facilitate easier access for trappers to their trapping areas.

Impacts to forestry stakeholders include restricted access during construction of the highway realignment, particularly to forestry roads located just off the McLean Creek staging area and the portion of Highway 66 west of McLean Creek.

3.8.2.3 Access

During construction of the Project, noticeably more traffic on Highway 66 is anticipated. This could adversely affect recreational users of the highway. Additionally, it is anticipated that throughout construction, there will be road closures, which could restrict access, recreational, industrial and forestry related, to the portion of Highway 66 west of McLean Creek. Road closures would prevent recreationalists from accessing the facilities and trails associated with the McLean Creek, Elbow River and Elbow River Boat Launch PRAs, as well as the McLean Creek PLUZ.

3.8.2.4 Existing Residences & Infrastructure

If the Project proceeds, a new location for the Ranger Station and associated infrastructure will need to be determined. The impact of the Project would be the potential de-commissioning and relocation of facilities, where feasible, and the associated costs.

3.8.2.5 Land Use Dispositions

Impacts to land use dispositions include access restrictions and potential disruptions to associated land based activities during the construction phase of the Project.

Areas of the PNTs that are located within the footprint of the Project facilities are shown in Table 3.8-5. Potential impacts to the two grazing leases (PNTs 970058 and 930439) could include a permanent loss of land base for cattle grazing (162 ha) and access restrictions during the construction phase of the Project.

Table 3.8-5: PNTs within Project Facilities

PNT	Area (ha) intersects Project Footprint	% of Project Footprint
970058	130	30
930439	32	7
140043	43	10
090086	244	56

Potential impacts to the Sheep River Provincial Park Expansion (PNT 140043) include access restrictions and a reduction in land base (43 ha) for the proposed provincial park expansion. Avoidance of these impacts could entail relocation of the expansion plans.

Impacts to PNT 090086 could include land use disturbance to the foothills fescue grassland area. Currently, there are a several guiding principles in place to help minimize disturbance of native prairie in Alberta (AER 2014).

3.8.2.6 Potential Mitigation Measures

The following mitigation measures could reduce impacts to existing land and resource uses and users:

- develop and implement an access management and traffic management plan with neighbouring industrial stakeholders, other government agencies and recreational stakeholders, to understand concerns and implement access management controls accordingly;
- advance and on-going communication of Project construction and closure schedules to recreational stakeholders;
- adequate and up-to-date signage, particularly at key staging locations;
- redirect recreationalists to other day use areas, campgrounds and boat launches in the area;
- consult with the appropriate Alberta Fish and Wildlife branch within ESRD to develop appropriate information for recreational hunters and fishers of Project schedules and locations, including providing maps, well before project activities proceed;
- retain a section of the existing Highway 66 to provide access from the west to those remaining facilities (if any) associated with the Paddy’s Flats campgrounds and Station Flat’s day use area;
- relocate the River Cove campsite;
- advance and ongoing communication with the affected RFMA holders;
- compensation, as necessary, for the affected RFMA holders in accordance with the Alberta Trappers Compensation Board guidelines and associated proof of lost revenue;

- advance and ongoing communication with inter-related governmental departments regarding the status and planning of decommissioning and relocating/re-building station infrastructure;
- consultation with all disposition holders and associated government departments to resolve specific issues related to dispositions and its holders;
- if the Project cannot avoid land based disturbance to grazing permits PNT 970058 and 930439, compensation may be required;
- potential relocation of PNT 140043 (Sheep River Provincial Park expansion);
- impacts to PNT 090086 may include land use disturbance to the foothills fescue grassland area. To minimize disturbance, several principles, as outlined in *Principles for Minimizing Surface Disturbance in Native Prairie and Parkland Areas* (AER 2014) are applicable, including, but not limited to:
  - ❑ avoidance or minimal disturbance, where possible;
  - ❑ coordination of industrial activities;
  - ❑ reduction of cumulative effects;
  - ❑ predevelopment planning, design and assessment;
  - ❑ conservation or replacement of soil;
  - ❑ public consultation;
  - ❑ reclamation through the use of natural recovery; and
  - ❑ reclamation monitoring.
- develop additional access depending on aggregate demand and future maintenance required for the dam;
- the construction of a recreational site associated with the McLean Creek dam could help mitigate the impacts associated with the removal of Allen Bill Pond;
- the McLean Creek dam site permanent pond could be designed to provide similar recreational purposes as the existing Allen Bill Pond, including serving as a fishing spot. This could mitigate some of the impacts to sport fishing and recreational users; and
- best management practices and guidelines should be applied to avoid and minimize the loss of habitat for the animals and plants identified as elements of concern under ESA #8, as well as progressively reclaim disturbed areas where feasible and practical.

3.8.2.7 Data Gaps

Existing data gaps should be filled to conduct a full environmental impact assessment for the Project. Data gaps are related to both project design and secondary data collection and include:

- Project design would need to progress past the conceptual level to identify:
  - The extent that recreational facilities and trails would be removed and/or relocated. For example, it is not known if River Cove group campground could be relocated to an adjacent area, or if it would be removed permanently. Also, while the realignment of Highway 66 would create impacts to Paddy's Flats campgrounds, the nature of these impacts, in terms of closures, removal or relocation, have not been confirmed; and
  - The nature and extent of access restrictions and potential access creation during and following construction of the Project is not fully known. For example, a section of the existing Highway 66 could be retained to provide access from the west to existing and/or new facilities along the north side of the reservoir impoundment area. It is also unknown if additional access would be created to access borrow sources.
- Baseline land use data is required, including:
  - Up-to-date and quantifiable data on recreational use in the Elbow River/McLean Creek area, PRA and provincial park expansion plans in the area;
  - Detailed information on the damage and recovery of trails impacted by the 2013 flood;
  - Detailed inventory of the Elbow Valley Ranger Station infrastructure. Also, the extent and capacity to which the Ranger Station and its associated infrastructure are currently used as well as the development of a potential relocation plan; and
  - precise trap line areas and associated trapping activities within the Study Area are currently unknown. Additional consultation with the RFMA holders is required.

3.8.3 Literature Cited

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3.9 Stakeholder Engagement

Consultation for the environmental overview was focused on meetings with government agencies; no contact was made with the general public or specific stakeholders to discuss the potential Project. Meetings were held with:

- AT (Operations, including Calgary District Office, Bridges – Lethbridge, Southern Transportation Network) on 31 October in Calgary;
- Alberta Tourism, Parks and Recreation (ATPR) (Kananaskis Region, including Infrastructure Operations/Support, Park Ecology, Planning, Operations Section) on 4 November in Cochrane; and
- ESRD (Operations Infrastructure, including Southern Operations and Water Projects Management) on 4 November in Calgary.

In addition, completed questionnaires were received from:

- ESRD Wildfire Management (Elbow Firebase); and
- ESRD Forestry and Lands Approvals (South Saskatchewan Region).

Information provided at these meetings and from the questionnaires has been organized into the environmental topics discussed in this report, with other topics of discussion included at the end. The comments presented in this section were gathered from the meetings and questionnaires and are not the opinion of AMEC staff. The questionnaire can be found in Appendix F.

Methods are provided in Appendix A.

3.9.1.1 General Comments

- Construction – Looking at new facilities in a pristine area that is highly valued for its trees, wildlife, vegetation and water. (AT)
- Alberta Government has a lot of experience dealing with droughts and irrigation, but very little with flood mitigation. (AT)

3.9.1.2 Hydrogeology Comments

- Reduced sediment downstream of the dam will change the sediment loads in the Elbow River. River will try to pick up sediment downstream, which will increase downstream erosion. (ATPR)

3.9.1.3 Surface Water Quality Comments

None.

3.9.1.4 Fisheries and Aquatic Resources Comments

- Bull and westslope cutthroat trout are listed species found in the area. (ATPR)
- Head pressure from reservoir means a very large structure will be needed so that fish can pass through. (ATPR)
- Operations – Constant pond level would enhance fishing in the reservoir (as opposed to a variable level dam). However, it would likely decrease fly fishing opportunities downstream. (ATPR)
- Operations – Currently good conductivity up and downstream for aquatic species (fish and birds). (ATPR)
- Operations – Installing a dam has the potential to affect fish movement and change environment downstream (habitat, effects on crossings, etc.). (AT)
- Operations – Reduced sediment downstream has implications for fish spawning and various ecosystems; potential long-term effects of starving the downstream areas of sediment. (ATPR)
- Operations – Need to confirm potential effects on upstream flows. (ATPR)
- Operations – Need to look at potential effects on fish and navigable waters. (ESRD - Infrastructure Operations)
- Operations – Sediment load in the dead storage area could create potential overwintering issues for fish. (ESRD - Infrastructure Operations)

3.9.1.5 Soils and Terrain Comments

- Valley channels are much wider now than what's shown in the aerial photo (taken pre-flood). (ATPR)

3.9.1.6 Vegetation Comments

- Operations – Asked how often the area would be inundated – if it would be enough to kill all vegetation and habitat in the area. (ATPR)
- Operations – Asked if the area within the 100-year floodplain would be clearcut because of the potential for trees to be damaged by sediment if left in place and the area floods. If not removing trees and there's no major construction, could likely continue to use most of the facilities on the north side. (ATPR)

3.9.1.7 Wildlife Comments

- Operations – Building a reservoir/dam would restrict wildlife movement up and down McLean Creek. (ATPR)

- Operations – Removing trees/vegetation in the floodplain and reservoir area will remove sensitive habitat; there are rare bird and wildlife species in the area. Wetlands will lose their potential for habitat/breeding grounds for amphibians and wetland birds. (ATPR)
- Operations – High ungulate diversity in the area; these species would be affected by removing security cover, particularly in areas of high human use. (ATPR)

3.9.1.8 Historical Resources Comments

- There will be effects on historical resources in the area. (ATPR)

3.9.1.9 Land Use Comments

- Much of the land in the area is public land administered by ESRD, it's not park lands. There are grazing leases, some oil & gas. (ATPR)
- Potential effects on range resource values and the associated industry and public interests. (ESRD – Forestry)
- Current land use for the MC1 area would likely change as the risk factors for recreation use would be too high with the dam and reservoir. (ATPR)
- Legal description of lands will have to be changed (for the new ranger station location). (ATPR)
- Ranger station – Lots of facilities on this site (ATPR, ESRD – Wildlife Management):
  - ❑ About 10 residences – some permanent, some seasonal.
  - ❑ ESRD wildfire management base – major part of the overall fire program for the northern end of the Management Area. Includes dining complex and staff residences used 6-8 months/year (typically March to October).
  - ❑ Main base for rescue in the summer.
  - ❑ Base of operations during emergency events – can't have a base of operations in a flood risk area.
  - ❑ Base for year-round contractor for all the eastern K County campgrounds (office and shops). (They also have bases at the Sheep, Bow Valley Provincial Park and Peter Lougheed stations).
  - ❑ Potential for 100-150 people to be based from the station during peak periods.
  - ❑ ATPR has facilities and storage at the station; use the area to stockpile all firewood for the entire valley.
  - ❑ ATPR uses the site year-round. ESRD is a bigger user, but only use the station seasonally.
  - ❑ Water and sewage treatment plans for area campsites are nearby.
  - ❑ Venturers Society has a storage area/camp onsite.
  - ❑ ESRD Fish & Wildlife has a seizure freezer and area onsite.
  - ❑ Old ESRD office onsite is closed.

- Easter Seals Camp Horizon and campground are upstream of the site. (ATPR)
- Area is used to capacity in terms of parking lots and facilities. Need new data on area usage; most current data on use is from 2001. AT has exit counters on exits from recreational areas to the highways. (ATPR)
- Area is very highly valued for recreational use, particularly for off-road vehicles. (ATPR)
- Project has potential effects on Public Land recreation trails and staging areas, sand and gravel resources, etc. (ESRD – Forestry)
- Construction – Discussed berming the ranger station, but ATPR suggested that the drainage couldn't be bermed and that the berm would still cover some of the facilities. (ATPR)
- Construction – McLean Creek Campground would need to be closed during construction because of proximity to the construction site – it's an off-road use campground, so there would be liability and safety issues. Suggested it would be a good base for the construction camp. (ATPR)
- Construction – Closing the McLean Creek Campground would create more random camping in the area as it's the only base for off-road use camping in K Country. (ATPR)
- Construction – Campground operator would need to be compensated for lost revenue because of closed campgrounds. (ATPR)
- Construction – New parking areas would need to be created for day use. (ATPR)
- Construction – Asked if there would be offsets for recreational use. (ATPR)
- Construction – Lots of special events (typically annual) occur in this area that would be affected; often staged from Station Flats. (ATPR)
- Operations – McLean Creek Campground – There are some campsites along the river not shown in the aerial photo that would be affected. The majority of the campground would not be affected. Campgrounds in the flood plain on the north side would need to be closed permanently (i.e., River Cove). (ATPR)
- Operations – If the highway is realigned as shown, it will be very close to the McLean Creek Campground. (ATPR)
- Operations – If the purpose of the dam is to protect downstream areas (including Bragg Creek and Calgary), then recreation use in the area may suffer. (AT)
- Operations – There are commercial rafting outfits that may be affected; they launch upstream of the dam/reservoir during high-flow times. (ATPR)
- Operations – Extensive trail system in the area of MC1 would be affected; many of the trailheads are in the proposed reservoir area. (ATPR)
- Operations – Need to consult with area users to determine what type of day use facilities should be added/left in place (e.g., picnicking, trails, etc.) (ATPR)

- Operations – Reservoir could be used for non-motorized activities such as fishing and paddling. Reservoir will likely be used for swimming (even if not designed for swimming, it will likely happen anyways). (ATPR)
- Operations – There could be adjacent picnicking onshore, but the areas would have to be designed so they could be easily reclaimed if there is a flood. Would need to be planned based on modelling of the various flood levels. (ATPR)
- Operations – If reservoir is also used for water storage (not just flood control), no facilities could be built in the floodplain but it could still potentially be used for recreational activities. ESRD - Infrastructure Operations would determine operating rules in cooperation with ATPR. (ESRD - Infrastructure Operations)

Traditional Land Use

- MC1 project is more complex than SR1 because it's not on private lands, and the land is used extensively by First Nations for traditional activities. (ATPR)

3.9.1.10 Road and Infrastructure Comments

- Construction – Major highway construction through new territory. (AT)
- Construction – Good to see the new section of Highway 66 will be in operation before the old section is decommissioned. (AT)
- Construction – Bridge washed out during 2013 flood was just replaced; it will be removed. (AT)
- Construction – Stay away from culverts; use free-span bridges instead – in the last flood, every road with a culvert was washed out. Floating debris plugs the culvert and then changes the water flow. (ATPR)
- Construction – Potential effects of hauling materials in for construction – depends on where the material comes from and the route taken to access the site. (ATPR)
- Construction – Sewer and water mains as well as power distribution in the area would need to be realigned. (ATPR)
- Construction – There is no ESRD infrastructure in the area to be affected by construction. However, there's the potential to affect downstream projects such as SR1 or the Calgary tunnel. (ESRD - Infrastructure Operations)
- Operations – There are benefits to keeping the existing road for local use (e.g., to access the permanent pond for recreation opportunities). (AT)
- Operations – Potential for bridges/roads to be washed out if flow isn't managed properly. (AT)

- Operations – The auxiliary earth channel has the potential to take out the new Highway 66 alignment and the McLean Creek road – access to the area could then be an issue, and people could be stuck in the area because there wouldn't be enough time to evacuate. (ATPR, ESRD - Infrastructure Operations)
- Operations – A 19-m water level would affect the sewage treatment plant; water plant is up the hill so it would not be affected by the reservoir. (ATPR)
- Operations – Potential for dead storage to be filled with sediment in about 50 years, creating a maintenance issue.

3.9.1.11 Government Resources Comments

- ATPR would like to do a number of studies relating to resources and use in the area, but they are currently lacking funds for these studies. If the Project goes ahead, so should these studies. (ATPR)
- Relocation of the ranger station would allow for creation of a new upgraded fire base and office facility. (ESRD – Wildfire Management)
- Construction – Lack of available government resources to deliver the MC1 project as well as SR1 or any other potential project. (AT, ESRD - Infrastructure Operations)
- Construction – Cost of removing the ranger station estimated at $1.2 million, but to replace in a new location would be $30-40 million for the infrastructure and land. Station needs to be in operation 24/7/365, so would have to build a new one and have it operational before the existing facility is decommissioned; the move would have to be in the off-season. (ATPR, ESRD – Wildfire Management)
- Construction – Need to ensure cost of replacing all infrastructure is included in estimates - $30-40 million suggested for ATPR components. (ATPR)
- Most land in the area is allocated in some type of agreement (e.g., RFMA, oil & gas disposition, grazing), and there would need to be compensation for any land used for a new ranger station. (ATPR)
- Construction – Cost of building a fishway could be almost as expensive as building the spillway. (ESRD - Infrastructure Operations)
- Operations – If the existing road outside of the floodplain is kept in place, there will be more highway to maintain and additional liability. (AT - Lethbridge) Differing opinion: No real effect on highway maintenance (AT – Calgary).
- Operations – ESRD will own the dam and structures, but AT will operate and maintain them. (AT)
- Operations – ESRD would be responsible for year-round maintenance, and adequate resources for maintenance would be required – not sure where funding will come from for these types of projects. Resources would be more critical for MC1 than for SR1 as this one is onstream storage. (ESRD - Infrastructure Operations)

- Operations – Lack of resources for long-term maintenance of any new facilities; new facilities are being added to AT's maintenance list, but additional maintenance funds are not being provided. (AT)
- Operations – Important to take into account increased operations costs for the reservoir/dam as well as any other new facilities. (ATPR)
- Operations – Would need to coordinate with Glenmore Reservoir and other reservoir operators in the area. Coordination is essential; more dams is not necessarily better. (ESRD - Infrastructure Operations)
- Operations – Easier to operate if only being used for flooding, but should look at the potential for water storage as well. (ESRD - Infrastructure Operations)

3.9.1.12 Consultation Process Comments

- Water experts at AT have not been consulted about the Project. (AT)
- AT needs to have more input on whether the dam is a good idea or not. (AT)
- Extensive consultation process would be required – with First Nations, affected government agencies, recreational users in the area. Need to look at current/future use, as well as how people feel about the MC1 project. (ATPR)

3.9.2 Discussion

Below is a synopsis of key issues identified during the government stakeholder meetings. Potential implications of these issues are noted below; further details on potential project effects and possible mitigation related to the disciplines in this overview are discussed under the appropriate sections of this report.

- Project would be constructed in a pristine area highly valued for its trees, wildlife, vegetation and water.
- Effects on the upstream and downstream environments – sediment load changes (implications on downstream erosion, fish spawning habitat), connectivity/conductivity (implications on movement of fish and wildlife, commercial use of river for rafting), crossings (see hydrogeology, fish & aquatic resources, wildlife and land use sections for further details).
- Effects on listed and rare species and their habitat – bull and westslope cutthroat trout, grizzly bear (implications on habitat quality and availability) (see fish & aquatic resources and wildlife sections for further details).
- Effects of sediment load in the reservoir dead storage area (implications on overwintering fish) (see fish & aquatics resources section for further details).
- Design of the reservoir/spillway to ensure safe and effective passage of fish both upstream and downstream (implications to cost of spillway to ensure safe fish passage) (see fish & aquatics resources section for further details).

- Effects on habitat in the floodplain from initial flooding of the reservoir as well as potential inundation of the floodplain (implications of removing vegetation and wetlands which affects security cover and habitat/breeding grounds for amphibians and wetland birds as well as wildlife) (see wildlife section for further details).
- Construction effects from traffic, noise, road safety, closure/relocation of designated recreation sites/campgrounds and parking areas, and limited trail access (implications on recreation use at and in vicinity of the MC1 footprint, and the potential for increased use in other areas not designated for these uses). During operations, there would potentially be different and possibly fewer recreational activities available (see land use section for further details).
- New water- and land-based recreation opportunities will be created by the dam and reservoir during operations (e.g., non-motorized boating, fishing, hiking, camping, day use area, trails) (see land use section for further details).
- Potential effects on a number of area land users and disposition holders (e.g., First Nations; campground operators; forestry, grazing, oil & gas exploration and development, and aggregate leaseholders) (implications on their ability to use the land, and compensation for loss of use) (see land use section for further details).
- Relocation of the ranger station and related infrastructure (implications on delivery of key emergency services, campground operations, utilities for the area, operation of other groups that use the facilities) (see land use section for further details).
- Need for consultation with potentially affected recreational users, First Nations, disposition holders and other government agencies (potential implications on schedule, particularly with First Nations consultation, as well as potential for public outcry about effects on the environment as well as recreation use in the area).
- Cost of moving current infrastructure, utilities and operations at the ranger station (implications relate to capital costs and potential timing of the move so that critical services are not interrupted).
- Construction of, and ongoing operations and maintenance of, new facilities (reservoir/dam, roads, infrastructure, recreation areas) (implications on government resources and budgets).
- Potential for the new Highway 66 alignment and access roads to be washed out in the event of a larger-than-planned flood event (implications on ability to access the area and potential rescue operations).

Key benefits of the Project noted from this consultation include the following:

- new recreation activities in the area; and
- upgraded fire base and ranger station facilities.

Identified data gaps from this consultation are as follows:

- further studies on recreation use in the area are needed to get a better understanding on potential users;
- input needed from discipline experts in the various government departments; and
- input needed from recreation users, land & resource users and First Nations that use the resources in this area.

4.0 SUMMARY

The flood control plan proposed for the McLean Creek site is an earth fill dam across the mainstem of the Elbow River with an associated reservoir (the Project). The conceptual design also includes a combined concrete outlet/spillway structure for discharging normal and flood flows and an auxiliary earth cut channel spillway to protect the dam from extreme floods. The site is located in the Green Zone on crown land approximately 10 km upstream of the Town of Bragg Creek and immediately upstream of the confluence of McLean Creek with the Elbow River. A more detailed description of the conceptual design and proposed operation can be found in AMEC's 2014 report entitled: Southern Alberta Flood Recovery Mitigation Measures: Appendix F – Elbow River Dam at McLean Creek.

A dam on the Elbow River at McLean Creek would result in the construction of flow regulation structures that trigger Alberta Regulation 111/93 EPEA Environmental Assessment (Mandatory and Exempted Activities) Regulation that requires an EIA be completed for a dam greater than 15 m in height. The EIA process (preparation and review), combined with the NRCB process discussed below, could take between 2 to 5+ years for these types of projects. Some projects have taken longer.

This report presents an environmental overview of the Project. It summarizes the environmental resources and associated land uses that could be affected if the Project was to be developed. The Study Area used for this environmental overview was a one kilometer buffer around the Project facilities and highway relocation. Environmental conditions within the Study Area were determined with a desktop review of existing information and the completion of several field reconnaissance surveys. The objectives of the environmental overview are to describe the local environment, including:

- a description of potential environmental and social issues that may arise if the Project is to proceed;
- identification of data gaps; and
- discussion of potential mitigation measures.

The disciplines for which data was collected and reviewed include:

- water (groundwater, surface water quality, fish and aquatics);
- land (soils, vegetation and wildlife); and
- social (historical resources, non-traditional land use and engagement of government stakeholders).

4.1 Hydrogeology

The hydrogeology section describes the hydrogeologic resources, including surficial and bedrock geology, aquifers and water wells, of the area. During construction of the Project, excavation through surficial gravels and/or shallow bedrock could intercept perched aquifers, possibly creating issues with short-term groundwater seepage control and management. Well owners/operators downstream of the facilities could be affected in the long term as any changes in the river level may be reflected in the levels of their wells, particularly if the wells are completed in surficial aquifers. Most wells in the Study Area are completed in bedrock aquifers. If wells which are located within the permanent pond and 100 year flood footprint are left open, hydraulic short-circuiting could occur between the surface water and confined aquifer water. This could impact the groundwater chemistry of the area.

Mitigation could include:

- additional study to delineate any perched aquifers and calculate accurate estimates of hydrogeologic parameters and potential groundwater seepage rates;
- project planning during construction to include a dewatering system and water diversion from the construction area; and
- monitoring of private water wells, with the possibility of compensation (i.e., installation of replacement wells).

To complete an environmental assessment, site specific measurements of hydrogeological parameters are required for the design of groundwater control and seepage management systems. Existing pumping test data would have to be analyzed using standard analytical methods, and it may be necessary to conduct new pumping tests in existing or new wells.

4.2 Surface Water Quality

Water quality in the Elbow River, upstream of Glenmore Reservoir, deteriorates as it flows downstream, mostly due to land development and agricultural activities. Historical studies showed low concentrations that are typical for upstream reaches of mountainous streams. Nutrients (nitrogen and phosphorus) did not vary between upstream and downstream sites. However, total dissolved solids (TDS) and conductivity showed increases between upstream and downstream sites. Results provide no evidence that coliforms in the Upper Elbow River are related to human sources, such as septic tank leachate. Limited data indicated an increased role of groundwater in upper Elbow River surface water chemistry.

The major surface water quality parameters that could be affected by the Project are related to soil erosion and sediment transport, and include:

- water temperature and dissolved oxygen;
- total suspended solids (TSS);
- nutrients (nitrogen and phosphorus); and
- microbiology (Total and fecal coliforms).

The operating regime for the Project will ultimately determine the severity and extent of sediment changes within the reservoir and downstream discharges. Best management practices would include the development and implementation of an erosion and sediment control plan

(ESC plan) for the Project following recommendations provided in the Elbow River Basin Water Management Plan.

To complete an environmental assessment additional work is required. The historical data set does not include all seasons so it is difficult to identify seasonal patterns, particularly during spring freshet and high water level conditions. The data set would have to be processed and analyzed for water quality seasonality and temporal trends. Recent data collection has been limited and current water quality conditions may have changed from historical, as land use changes have occurred within the watershed. Seasonal sampling would be required for at least the beginning, peak, and post flood conditions at the Project site to assess loadings of sediments, nutrients, and organic matter.

4.3 Fisheries and Aquatic Resources

In the vicinity of the proposed Project, the Elbow River and its tributaries are Class C watercourses with a Restricted Activity Period (RAP) from 1 September to 15 August. A total of 7 fish species are documented within the Study Area: brook trout (*Salvelinus fontinalis)*, brown trout (*Salmo trutta*), bull trout (*Salvelinus confluentus)*, cutthroat trout (*Oncorhynchus clarkii*), mountain whitefish (*Prosopium williamsoni*), rainbow trout (*Oncorhynchus mykiss*), and longnose dace (*Rhinichthys cataractae*).

Bull trout are historically found in the Elbow River, and ten redds (spawning areas) were found during the fall 2014 survey. Bull trout are listed as 'Threatened' by Alberta's Endangered Species Conservation Committee and are protected under the provincial *Wildlife Act* (ESRD 2014). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) list bull trout as "Threatened", although bull trout are currently not listed under Schedule 1 of the federal *Species at Risk Act* (COSEWIC 2014, GC 2014).

The overall habitat quality for all life stages for salmonids within the Study Area is rated good in the Elbow River and moderate in Ranger Creek. The overall habitat quality for salmonids within unnamed tributaries A, B, and C is poor.

Potential Project effects would include:

- fish habitat alteration or loss;
- disruption of fish migration and passage, and
- changes in water and sediment quality.

Based on the conceptual design, critical bull trout spawning habitat would be affected or would no longer be accessible with the construction of the Project; this spawning habitat is also likely used by other sport fish found in the vicinity of the Project as they share the same spawning habitat requirements. The loss and alteration of spawning habitat could affect the productive capacity of the system. Mitigation measures could include changes to Project design, such as the inclusion of fish passage. Ultimately, the operating regime for the Project will determine the severity and extent of changes within the reservoir and downstream discharges.

To support an environmental impact assessment and obtain provincial and federal approvals, additional data collection would be required. This would include: spring spawning surveys and habitat assessments, fish migration study, fish tissue toxicology, periphyton collection, and benthic invertebrate collection.

4.4 Soils and Terrain

The Project is located within the Montane Subregion of the Rocky Mountain Natural Region of Alberta. The Montane Subregion supports Lodgepole pine, Douglas fir and aspen on colluvial[5] and morainal[6] parent materials on the mountain and hillslopes. Fluvial[7] and glaciofluvial[8] parent materials are common along the major valley drainages. Luvisolic, brunisols, organic, gleysolic, and regosol soils are found in the Study Area. Organic soils are associated with fen landforms. Wind and water erosion ratings for soils were calculated, and the majority of the Studay area (> 50%) area classified as moderate for both.

Potential impacts to soils as a result of the Project could include erosion, admixing, rutting, compaction and an increased stoniness. Mitigation measures include best management practices such as an erosion and sediment control (ESC) plan.

4.5 Vegetation

The Study Area is located in a transition zone moving from the aspen (*Populus tremuloides*)-white spruce (*Picea glauca*) –dominated boreal mixedwood forest to lodgepole pine (*Pinus contorta*) dominated forests. The rolling hills and ridges which make up the topography are underlain by sandstone and shale along the edge of the Rocky Mountains. Surficial deposits consist of moraine with organic areas in valleys and wet depressions. The climate is cooler in the summer and warmer in the winter than the northern Boreal Forest Region due to less influence from cold Arctic air masses and more frequent modification by chinook winds. Seven ecosites phases and one disturbed land class are identified and mapped. Fourteen rare plant species have been identified in the Study Area, thirteen bryophytes and one vascular plant. The majority of the species are ranked S2, known from 20 or fewer occurrences or vulnerable to extirpation due to other factors. There is potential for old growth forest in the area.

Upstream of the dam within the reservoir area, loss of ecological land classes could occur as a result of clearing and water impoundment. As well, weed species could be introduced by construction activities. Downstream of the dam, changes in the water table could change the ecosites from upland forest to lowland forest and wetland species. Mitigation would focus on best management practices, such as avoiding old growth forest, wetlands and rare plants, if possible; clearing vegetation prior to reservoir filling, erosion and sediment control measures, and a weed management plan.

[5] Material deposited to their current location by gravity induced movement.
[6] Material deposited directly by glacial ice.
[7] Materials transported and deposited by streams and rivers.
[8] Material deposited in front of or in contact with glacial ice.

Additional baseline vegetation data is required for an environmental impact assessment, including surveys for rare plants and rare ecological communities.

4.6 Wildlife

Changes to and loss of vegetation communities will result in changes to wildlife habitat. As well the dam could present a barrier to wildlife movement in an important corridor. The Study Area contains a diverse and complex mosaic of habitats, which can support a variety of wildlife species. A provincially designated Wildlife Sensitivity Zone for Grizzly bear and a Key Wildlife and Biodiversity Zone along to Elbow River are found within the Study Area. Additionally, a Mountain Goat and Bighorn Sheep Zone is located approximately 5 km to the west of the Study Area. River banks, dominated by spruce, pine stands, riparian wetlands and shrubbery, provide suitable habitat for a diverse avian community, including grouse, waterfowl, flycatchers, warblers, and owls. The rock fields and wetlands adjacent to the river may also provide suitable habitat for reptile and amphibian species. Small mammals, such as chipmunks, voles, and shrews, will also use these habitats.

Four wildlife species of concern: bobcat (*Lynx rufus*), Canada lynx (*Lynx Canadensis*), harlequin duck (*Histrionicus histrionicus*), and northern pygmy-owl (*Glaucidium gnoma*) have historically been detected in the Study Area, and all are listed as Sensitive[9] in Alberta.

For an environmental impact assessment, valued ecosystem components (VECs) that could be used include ungulates (moose, elk and deer species), grizzly bear, harlequin duck, beaver, and Western toad. Potential impacts from the Project could include loss of habitat and movement corridors, sensory disturbance, reduced habitat effectiveness, and increased wildlife mortality. If the Project proceeds beyond the conceptual stage, specific features to reduce potential effects on wildlife species and their habitat during construction and operations could be incorporated into the Project design. Best management practices (e.g., minimizing human-bear encounters, adhering to set back distances and restricted activity periods, and posting road speeds) would be typical mitigation measures.

Additional wildlife information – presence and use of the area – is required for an environmental impact assessment. Modeling of the habitat suitability - the ability of the landscape to provide specific life requisites for a particular species or species group, such as food, cover and reproductive requirements – should be undertaken.

4.7 Historical Resources

Historical resources like archaeological and palaeontological sites are finite and non-renewable; because those within and near development footprints may be negatively affected, ACT requires screening of projects to ensure that conflicts are avoided and/or managed.

[9] *Sensitive* – Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.

Because historical resource data were limited, a predictive model was created to identify zones of moderate and high archaeological potential in the reservoir footprint. A field visit in fall 2014, to assess the effectiveness of the model, also resulted in identification of an archaeological site within the reservoir footprint. This find supports the model's identification of high archaeological potential, confirming that previously unrecorded archaeological resources are likely in the Study Area.

Historic resources within the Study Area could be affected by both the construction and operation of the proposed Project. Damage to these resources could result from ground-altering activities undertaken during the construction phase, such as vegetation clearing, grubbing, surface stripping, and excavation. Historical resources could also be affected by flooding within the reservoir; sedimentation of submerged landforms and erosion of exposed shoreline and basin landforms present particular concerns. The extent of these effects could extend across the entirety of the proposed reservoir, requiring accurate data on its area at full supply level, as well as consideration of historical resources throughout this zone.

There is an extended regulatory trajectory for projects involving footprints that cannot avoid damage to valuable historical resources, and this timeline must be factored into planning for this Project, with particular attention to ACT restrictions on winter fieldwork.

A separate palaeontological HRIA would likely be required by ACT.

4.8 Land Use

The construction and operation of the Project could result in the removal of existing recreational facilities, the flooding of vegetation and wildlife habitat, and associated changes to existing land and resource use in the area.

The McLean Creek site is located within Kananaskis Country, which is predominately a recreation area consisting of public lands and Provincial parks. Project facilities would be constructed on Crown land within the provincial Green Zone. The Elbow River valley is one of the busiest parts of Kananaskis Country, with nearly 500,000 visitors annually. The popularity and accessibility of the Elbow River valley is due, in part, to paved access, good scenery and extensive facilities and trail systems (GoA 2012). Current land uses in the area include timber harvesting, petroleum, recreation, cattle grazing, and OHV use.

Impacts could include loss of land, including recreational areas; access restrictions and temporary facility closures.

Project facilities (the dam, permanent pool and full supply level) would directly affect both the Elbow River and McLean Creek Provincial Recreation Areas. Flooding within these recreational areas would result in a loss of the recreational areas to potential users. Access to the Elbow River Boat Launch PRA would be affected during the realignment of Highway 66. Based on the conceptual design, the proposed McLean Creek dam site and permanent pond would have similar recreational amenities as Allen Bill Pond, which was damaged by the 2013 flood. Almost half (48%) of the Study Area is located within Environmentally Significant Area (ESA) 8. ESAs are established in areas that contribute to the long-term maintenance of biological diversity, soil, water, and other natural processes.

Potential impacts on game animals, upland game bird species and waterfowl, and related effects on hunting and trapping success rates could arise from habitat loss, habitat fragmentation, sensory disturbances and direct mortality due the construction of the Project, including highway realignment. Impacts to sport fish as a result of the dam could include habitat loss and interruption of movement corridors for fish species. The subsequent effect on population numbers could alter the success rate of fishermen, thereby changing recreation opportunities.

Access to the river could be restricted during construction of the Project, and noticeably more traffic on Highway 66 is anticipated. This could adversely affect recreational users of the highway. Additionally, it is anticipated that throughout construction, there will be road closures, which could restrict access, recreational, industrial and forestry related, to the portion of Highway 66 west of McLean Creek.

If the Project proceeds, a new location for the Ranger Station and associated infrastructure would be necessary. Located on the north side of Highway 66 along Ranger Creek, the Elbow Ranger Station main complex serves staff from Alberta Forestry Protection Services, Alberta Parks and Recreation, Alberta Fish and Wildlife. Other infrastructure on site includes seasonal and permanent residences, water and sewage treatment plants, and a helicopter pad. During peak season, the Ranger Station can house as many as 150 people.

There were 36 land use dispositions identified within the Study Area. Potential impacts to land use disposition holders include access restrictions and potential disruptions to associated land based activities during the construction phase of the Project.

If the Project were to proceed, baseline land use data on the type and extent of recreational use, actual consumptive use (hunting, trapping and fishing), and current access patterns would be required. An analysis of Environmentally Significant Areas values from the 2014 would also be necessary. Consultation with disposition holders and other land users is recommended as part of an environmental impact assessment.

4.9 Stakeholder Engagement

Consultation for the environmental overview was focused on meetings with government agencies:

- AT (Operations, including Calgary District Office, Bridges – Lethbridge, Southern Transportation Network) on 31 October in Calgary;
- ATPR (Kananaskis Region, including Infrastructure Operations/Support, Park Ecology, Planning, Operations Section) on 4 November in Cochrane; and

- ESRD (Operations Infrastructure, including Southern Operations and Water Projects Management) on 4 November in Calgary.

In addition, completed questionnaires were also received from:

- ESRD Wildfire Management (Elbow Firebase); and
- ESRD Forestry and Lands Approvals (South Saskatchewan Region).

Key issues identified during this process included questions about the Project design and operation regime, its effect on natural resources (water and land), its effect on existing infrastructure (campgrounds, roads, utilities, etc.), and its effect on the current users of the area.

Key benefits of the Project noted from this consultation include.

- new recreation activities in the area; and
- upgraded fire base and ranger station facilities.

Identified data gaps identified from this consultation were:

- further studies on recreation use in the area are needed to get a better understanding on potential users;
- input needed from discipline experts in the various government departments; and
- input needed from recreation users, land & resource users and First Nations that use the resources in this area.

4.10 Preliminary Findings of Key Environmental and Social Issues

If the Project is to proceed past the conceptual design stage, an environmental impact assessment will be required. At this point in time, the following key issues will require further investigation and management:

- Project design
    - ❑ Public safety for land users and infrastructure located downstream of the dam is a concern.
    - ❑ Operating regime will have a direct influence on the potential environmental effects that could arise as a result of the Project.
- Regulatory processes
    - ❑ The *Alberta EPEA* and the Natural Resources Conservation Board processes for project review and environmental assessment would be triggered. Other regulatory requirements to be met include the Alberta Water Act, the Federal *Fisheries Act* and the Federal *Navigation Protection Act*. The regulatory timeline, including post-approval permits and authorizations could take between 2 ½ to 5 years.

- Potential effects on listed species, particularly bull trout and grizzly bear
    - ❑ Predicting effects on these species, and managing them appropriately requires robust site-specific and regional data. Mitigation/offsets may be required at a regional scale rather than simply at the local scale.
- Existing land use
    - ❑ The area is used currently for a wide variety of purposes – recreation, forestry, and infrastructure. The development of the Project would have an impact on these uses and may preclude several of them. Additional information is required to characterize the level of use. However, at this time it appears that users currently place a high social value on the area in its present state.

4.11 Literature Cited

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Appendix A

Methods

Appendix A: Methods

HYDROGEOLOGY

Desktop

A desktop study was conducted prior to performing fieldwork. The desktop study included collecting available geological and hydrogeological information for the local Study Area (**Figure 3.1-1**) and revising the conceptual model. Information on groundwater conditions was also drawn from the preliminary geotechnical investigation of the Elbow River Dam (AMEC 2014).

Information from the Alberta Research Council was obtained for the main water bodies, drainage, surficial geology, bedrock geology, and main aquifers. Surficial geology data was obtained from Bayrock and Reimchen (1980) and bedrock information was gathered from Green (1970). Regional hydrogeology was drawn from Borneuf (1980).

The Alberta ESRD water well database provided locations of existing groundwater wells in the Study Area. A water well drilling report was extracted and reviewed for each well in the database. The reports include information such as owner, lithology encountered, depth to groundwater, well screen interval, pumping test rate and drawdown during pumping, and chemistry data, although not all reports included all of this information.

Fieldwork

The information from the desktop study was used to plan the fieldwork portion of the study. A one-day field visit on 31 October 2014 included the inspection and monitoring of three groundwater wells (Camp Horizon ID#1020984, Camp Horizon ID#1020988, Kananaskis Country#3259 ID#350009) to obtain current hydrogeological data. These wells were selected for inspection because of the completeness of their reports and their proximity to the proposed dam. AMEC staff met with the representatives of the well owners onsite, who also assisted with the field work.

The fieldwork consisted of measuring groundwater levels in the three wells and collecting groundwater samples for laboratory analysis. Field sheets were completed for each visited well (Appendix B-3). Photographs (Appendix B-4) and GPS coordinates were taken at each well. The representative of the Camp Horizon wells provided AMEC with groundwater levels from wells ID#1020984 and ID#1020988 since 2009 (Appendix B-1). The samples, along with a completed chain-of-custody, were sent to ALS Laboratories in Calgary for analysis.

SURFACE WATER QUALITY

Desktop

The upstream reach of the Elbow River was studied over a substantial period of time starting in 1988. Thus, a substantial historical data set available along the river. The majority of the studies in the river was concentrated in immediate vicinity and upstream from the City of Calgary and included Glenmore Reservoir being the water supply for the city. Some of the studies included the headwaters of the Elbow River upstream from Bragg Creek but in much less intensity.

The first study was published in 1993 and data had been obtained in 1988 to 1990 (Beers and Sosiak, 1993). Samples were taken in the mainstem of Elbow River and in tributaries as well: from downstream to upstream (Bragg Creek, McLean Creek, and Lott Creek). The mainstem site of interest in the study was near Bragg Creek, Allen Bill Pond, and further upstream – above Cobble Flats and in the Little Elbow River (**Figure 2.2-1**).

The City of Calgary and Alberta Environment (AENV) conducted intensive basin-wide sampling of the upper Elbow River and its tributaries from 1999 to 2003, inclusive (Sosiak and Dixon, 2004). The objectives of these sampling events were to:

- Describe spatial and temporal trends in the concentration of key water quality indicators; and
- Identify factors that could be contributing to water quality deterioration.

This program included grab sampling of the Elbow River and its major tributaries near their mouths. The main focus of the study was on potential effects upstream from the City of Calgary. Samples were also taken and analyzed upstream of Bragg Creek and at Cobble Flats, as well as in the Elbow River upstream tributaries at the mouths of Bragg Creek, McLean Creek, Prairie Creek, and Little Elbow River. Some additional analysis and conclusions from the results provided in this study were summarized in Sosiak and Dixon (2006).

The most recent study within the same reach of the Elbow River between the headwaters and Bragg Creek and downstream to the City of Calgary was provided by the Environmental Science Program of the University of Calgary. The study's goal was a comparison of the results found in previous events, particularly 1988/89, with the 2002/03 sampling. The sampling also covered the upstream reach of interest and included sampling of the Elbow River at Cobbles Flats, near Allen Bill Pond, and Bragg Creek (University of Calgary, 2003).

All studies used a similar generic set of water quality parameters and listed in Table A-1.

Table A-1
Water Quality Parameters

Field Parameters	Cations	Anions
–Dissolved oxygen –Electrical conductivity –pH –Water temperature	–Sodium –Potassium –Magnesium –Calcium	–Bicarbonate –Chloride –Sulphate
	Nutrients	**Metals/Microelements**
Total dissolved solids Total suspended solids/sediments Microbiological parameters	–Total phosphorus –Total Kjeldahl nitrogen (TKN)	–Total –Dissolved

Field Survey

A field program was carried out during site reconnaissance and represents conditions in late fall. The hydrological conditions were typical for the fall season with low flow and potentially groundwater discharge to the river. In this season the water is typically clear with no visible sediment transport and no sheet flow from the adjacent drainage areas.

The field investigation was undertaken on 6 November 2014. Two water quality samples were collected from the Elbow River along with a duplicate. One sample, identified as Site 1, was collected from just upstream of the confluence of McLean Creek and the Elbow River (**Figure 2.2-1**). The duplicate water quality sample (Site 3) was also taken at this sampling location. The second water quality site was located upstream of Site 1 and was identified as Site 2. A field blank was conducted at Site 2.

The water at both sites was recorded as being clear with no observed aquatic vegetation within the channel. The banks conditions were dominated by riparian deposited substrate consisting mostly of cobbles and boulders and little to no vegetation. Areas further removed from the banks of the Elbow River contained primarily coniferous forest with scattered deciduous trees.

In-situ measurements were taken at all sites using an YSI Professional Plus™ multimeter. The multimeter was calibrated as per manufacturer's instructions. The probe was submerged to approximately 15 cm below the surface and readings were taken once all readings were stabilized.

Clean and sterile sample bottles received from the laboratory were first labelled and sorted into individual coolers. The laboratory also provided an appropriate number of preservatives (1:1 sulphuric, hydrochloric, and nitric acid). Care was taken to label bottles appropriately and provide the correct number of preservatives all within the same cooler.

Water samples were taken using the clean-hands/dirty-hands technique as outlined in the National Field Manual for the Collection of Water Quality Data (USGS 1998) and the Aquatic Ecosystems Field Sampling Protocols (AENV 2006). In this method, a sampling assistant (dirty-hands) passed bottles from the cooler to the sampler (clean-hands). The water samples were collected by plunging the sample bottle with the neck facing down through the water column to approximately half of the depth of the stream and then slowly rotating the bottle to collect the samples. The sampler would unscrew the sterile bottle and fill the bottle to within 5 mL of the top. If required, the assistant would hold the bottle while the sampler added an appropriate acid preservative and then sealed the bottle with the clean cap. This process would be repeated until all bottles, except those requiring filtering, were filled with sample.

Filtering for dissolved metals was conducted at each site using a sterile Watera™ 0.45 µm disposable filter. A sterile 60 mL syringe was used to collect water from the stream and the contents were injected to the filter and allowed to fill the sample bottle. Once the water was filtered, the appropriate preservative was added and the receptacle was capped. All bottles were then be kept in coolers until they were delivered to the lab later that day which was within the recommended holding times for the samples (APHA 2005).

Water samples along with a duplicate were sent for laboratory analysis of routine parameters, including alkalinity, hardness, total dissolved solids, total suspended solids, turbidity, major ions, pH, electrical conductivity, nitrate, nitrite, total iron, total manganese, and turbidity. Water samples were also tested for ammonia, ortho-phosphate, total Kjeldahl nitrogen, total and dissolved metals, and total and fecal coliforms.

Quality assurance/quality control (QA/QC) methods used to ensure the quality of surface water samples include the following:

- Field blank - used to detect sample contamination during the collection, shipping and analysis of samples; and
- Duplicate field sample - used to detect variability at a site and as a check on field sampling methodology.

Samples were analyzed by ALS Laboratory in Calgary and results of analysis along with duplicates, field blanks and detection limits are presented in **Table A-2**.

FISHERIES AND AQUATIC RESOURCES

Study Area

The Study Area encompassed the full supply level of the proposed dam, which includes sections of the Elbow River, Ranger Creek, and three other unnamed tributaries of the Elbow River.

Background Information Review

Historical information sources were reviewed to establish and compile existing information on fisheries resources within the Elbow River and tributaries, within the Study Area. Primary literature sources included:

- Fluvial Bull Trout Redd Surveys on the Elbow, Sheep and Highwood Rivers, Alberta – Trout Unlimited Canada (AAR, 2008); and
- Alberta Environment Sustainable Resource Development (ESRD) Fish and Wildlife Management Information System (FWMIS) database (ESRD, 2014a).

All assessment information was cross-referenced to provincial and federal listings (ESRD, 2014b; GC, 2014) to determine if fish species identified in the Study Area are listed as special status species.

Field Survey

Aquatic habitat assessments were conducted from the 20 to 22 October 2014 by AMEC aquatic biologists. The Elbow River was assessed from the proposed dam location to the upstream extent of the Study Area. The habitat for Ranger Creek and the unnamed tributaries were delineated from the confluence of the Elbow River upstream to the proposed full supply level of the dam (**Figure 3.3-1**). A bull trout redd survey was conducted in conjunction with the aquatic habitat assessments on the Elbow River. The field survey methods are described in the following sections.

Aquatic Habitat Assessment

Procedures used for the fish habitat assessment were in accordance to standard protocols outlined in Alberta Environment's *Guide to the Code of Practice for Watercourse Crossings* (AENV, 2001) and described in Alberta Transportation's (AT) *Fish Habitat Manual* (AT, 2009).

For each watercourse, a number of transects were completed based on the length of the stream section assessed. At each transect, the following physical parameters were measured:

- Channel width;
- Wetted width;
- Water depth;
- Percent composition of pool/riffle/run/flat habitat type
- Bank heights/shape/texture;
- Riparian vegetation; and
- Substrate composition.

Other general stream features were based on observations over the entire study area, such as channel pattern, presence and types of bars, and percent composition of instream cover types. In-situ water quality parameters were recorded and included water temperature, dissolved oxygen concentration, specific conductance, and pH.

Geographic coordinates were recorded at all sites with a hand-held global positioning system (GPS) receiver. Digital photographs were taken facing upstream, downstream, left bank, and right bank at each transect and along the Study Area at important habitat features.

Redd Survey

Bull trout redd surveys were conducted by four biologists wading the Elbow River. The biologists were spread out evenly across the river channel and carefully moved downstream scanning the river bottom. Redds were identified as conspicuous circular to oblong patches of recently cleaned substrate that contrast the surrounding substrate. Redds typically have a depression from the surrounding substrate and may have a 'mound' on the downstream end of the disturbance. Identified redds were measured, photographed and had their location geo-referenced with a GPS.

SOILS AND TERRAIN

Desktop

Previous to and in conjunction with the soils field program, a review of existing surficial geology and soil survey information for the Study Area was completed and included:

- Surficial Geology of the Alberta Foothills and Rocky Mountains, NTS 74D (GIS Data, polygon features; Bayrock, L.A. and Reimchen, T.H.F., 1980);
- Bedrock Geology of Alberta (GIS Data, Polygon features; Prior, G.J.; Hathway, B.; Glombick, P.M.; Pana, D.I.; Banks, C.J.; Hay, D.C.; Schneider, C.L.; Grobe, M.; Elgr, R.; Weiss, J.A., 2013)
- Soil Survey of the Calgary Urban Perimeter (Bulletin No. 54; MacMillan, R.A., 1987)
- Soil Survey of the Municipal District of Rocky View (Alberta Soil Survey Report No. 53; Fawcett, M.D., Turchenek, L.W., MacMillan, R.A., Nikiforuk, W.L., Delorme, R., and Dejong, B., 1994); and
- Soil Series Information for Reclamation Planning in Alberta (Pedocan 1993).

<u>Field Survey</u>

A field reconnaissance soils survey was completed within the Study Area at a survey intensity level 3 or 1 inspection per 90 ha (AENV 2009). Approximately 29 soil inspections were completed within the Study Area (2,607 ha). UTM coordinates of soil inspection locations are provided in **Appendix D-1**. Accessibility to inspection sites was by vehicle on roads and on foot via seismic cut lines or recreational trails. Inspection points were excavated using a spade shovel and a hand-held Dutch auger. Upland sites were excavated up to 1 m or to the depth where parent material was encountered. Some upland sites were excavated only to upper subsoil where coarse fragment content was too high to excavate the full depth in a reasonable amount of time. Organic (peatland) soils were augured up to 2.2 m or to the depth of mineral soil.

Soil inspection sites and sampling locations for the 2014 soil surveys are illustrated in **Figure 2.4-1**. Detailed soil profile data is provided in **Appendix D-1**.

Soil pedons were classified for mineral and organic soils (Soil Classification Working Group 1998). Site attributes recorded during field observations included landform, surficial materials, slope class, topography, surface stoniness, drainage condition, depth to water table, land use, and vegetative cover (dominant vegetation). Soil pedons were described based on aspect, horizon thickness and sequence, color, texture, structure, consistence, coarse fragments, mottles, roots, surface stoniness, calcareousness, salinity (presence of salt crystals), and profile drainage conditions. The von Post degree of decomposition and the general botanical composition of peat layers were determined for organic soil materials. The pH of water squeezed from the surface layer of organic soils was determined with pH paper or a field pH meter to assist with preliminary evaluation of nutrient status and wetland type. Following soil description, the soils were taxonomically classified to the subgroup level using the Canadian System of Soil Classification (Soil Classification Working Group 1998).

Analytical Program

A total of 20 soil samples were analyzed from diagnostic soil horizons to provide representative samples of the soil series encountered in the Study Area. The samples were placed in clean plastic bags, labeled and kept in a cooler on ice packs before being sent to the laboratory for analyses. Selected samples were air dried, crushed, and passed through a 2 mm sieve before analysis. Samples were analyzed for some or all of the following soil parameters:

- Bulk density;
- pH by water (1:2 ratio) in soil;
- pH by 0.01 M $CaCl_2$ (1:2 ratio) in soil;
- Electrical conductivity (saturated paste);
- Soluble cations and anions in the saturation extract;
- Particle size analysis and texture;
- Sodium adsorption ratio;
- Organic carbon;
- Organic nitrogen;
- Inorganic carbon ($CaCO_3$ equivalent);
- Exchangeable cations; and
- Percent base saturation.

Analytical results, reference methods and method detection limits pertaining to the various sample analyses are provided in **Appendix D-2**.

Soil Classification and Mapping

Study Area Soil Mapping

A map unit represents portions of the landscape that together have attributes varying within more or less narrow limits (Mapping Systems Working Group 1981). The goal of mapping is to subdivide the landscape into homogeneous units consisting of one main soil type.

Soil survey information additional to field inspection data for the Study Area was obtained from published surficial geology spatial data and aerial 3D imagery. This information was used to subdivide the Study Area into soil map units (SMUs), which are a defined and named repetitive grouping of soil bodies occurring together in an individual and characteristic pattern over the soil landscape. The SMUs at a scale of 1:3,000 were produced by this process.

The soil correlation area (SCA) is a concept developed in Alberta to provide a framework for differentiating and naming soil series across the province (CAESA Soil Inventory Working

Group 1998). A SCA is a geographic entity having an appropriately limited range of climatic parameters that restricts the use of a soil series name (Brierley et al. 2006). It is used to identify areas of similar soil climate and landscape ecology, thereby facilitating standardization and correlation of soil mapping procedures, development of soil maps, and interpretations regarding soil uses. Soils information was correlated to current soil series names in SCA 16 based on parent material type, soil subgroup and topographic features as outlined in the Alberta Soil Names File, Generation 3 (Brierley et al. 2006; CAESA Soil Working Group 2001).

The SMU names were derived from the dominant soil series that occur within the unit boundaries, as well as other significant soils that occurred within a SMU. For example, Spruce Ridge SMUs were named either SPR-1, SPR-3, or SPR-4. The three letter code (SPR) is the soil series short-hand notation for Spruce Ridge soils which are the dominant soil series within the SPR1, SPR3, and SPR4 SMUs. The dominant soil series will account for 60% to 90% of the soils within each polygon. The dominant soil types in each polygon are supplements by secondary soil series which account for 20% and 30% of the polygon and inclusion which account for < 10% of the soil polygon. The differences between SPR1, SPR2, and SPR3 are reflected by variants in the primary soil series (e.g., SPR vs. SPRxg) and/or the makeup of the secondary soil series and inclusions. For example, SPR 1 is described as 70% SPR with 20% WLB and < 10% FRK. SPR 2 is described as 70% SPRxg (over gravel) with 30% WLB and < 10% FRK.

Study Area Landscape (Terrain) Mapping

Landform refers to the surface expression of surficial or parent geological materials and their method of deposition (Soil Classification Working Group 1998). Landform (or terrain) description is generally based on a terrain analysis of relief, elevation, drainage, and material modifying processes, as well as the nature of the material. Terrain information was acquired along with soil information during the field soil survey. Landform, surficial material, slopes, and drainage characteristics were subsequently applied in the development of SMUs. Although soils were characterized to a depth of 1 m for mapping purposes (or 1.6 m in the case of organic soils), information about materials below these depths was included in terrain descriptions. For this reason regional and site information from geotechnical investigations, surficial geology, bedrock geology, interpretation of aerial photography, and review of published sources was applied to the interpretation of terrain conditions.

Terrain polygons have the same spatial boundaries as the soil polygons for consistency. Terrain map units and their labels follow the methodology of *Terrain Classification System for British Columbia* Version 2 (Howes and Kenk 1997).

Soil Sensitivity to Wind Erosion

Sensitivity to wind erosion is derived through an equation that accounts for the surface roughness and aggregation, soil resistance to movement, drag velocity of surface wind, soil moisture, shear resistance, and available moisture of the soil surface (Coote and Pettapiece 1989). The resulting ratings are based on soil under agricultural production with no cover. In the forested setting, wind erosion risk is affected by tree cover, wind velocity, and soil texture. Soils with a sandy texture are more susceptible to wind erosion than those with a clay texture (**Table A-2**). Organic soils have a negligible risk to wind erosion unless they present an open face or are dry. The ratings were applied to the soil series based on the soil texture of the surface horizons (approximately 10 to 20 cm). Where the wind erosion susceptibility fell between two classes, the rating applied to the soil series in Pedocan (1993) was used.

Table A-2
Classes of Wind Erosion Susceptibility Based on Soil Texture

Wind Erosion Class	Soil Texture
High	Very fine sand, coarse sand, loamy sand, gravely sand, dry humic organic materials
Moderate	Sandy loam, fine sandy loam, loam, silt loam, sandy clay loam, sandy clay, mesic organic soil
Low	Silt, silty clay loam, clay loam, silty clay, clay, heavy clay, fibric organic material

Sources: Coote and Pettapiece (1989), Pedocan Land Evaluation Ltd. (1993)

Soil Sensitivity to Water Erosion

Sensitivity to water erosion is estimated through the modified Universal Soil Loss Equation (USLE). The modified USLE takes into account the erosivity of rainfall and snowmelt, soil erodibility, slope length and steepness, crop cover and management and conservation practices (Tajak and Coote 1993). Erosivity for rainfall and snowmelt has been estimated for various parts of the province including the Study Area. Slope length is considered, as well as topographical expression, as very long slopes may increase the erosion potential of fine-grained material just as steep slopes also increase erosion potential. The soil erodibility factor (K factor) and the length-slope factor (LS factor) have been estimated for various topographical expressions and slope lengths. The rating system used to evaluate soils is based on the approximate R, K, and LS values presented in both Pedocan (1993) and Tajek and Coote (1993) for various soil textures, slopes, and length of slopes found in each map unit in the Study Area. Fine-textured soils in the silty clay loam to clay loam range have a K factor of approximately 0.060 to 0.065. More sandy soils have a K factor of 0.031. The rating system used for mineral soils in the Study Area is shown in **Table A-3**. Organic soils have negligible water erosion.

Table A-3
Water Erosion Potential and Associated Potential Soil Losses for Mineral Soils

Water Erosion Potential	Slope Class	Slope %	Slope Length (m)	LS Factor	K Factor
Low	1 to 3	<5	0 to 500	0.5 to 0. 8	0.031 to 0.065
Moderate	4	5 to 9	50 to 500	0.8 to 2.2	0.031 to 0.065
High	5+	9+	50 to 500	2.2 to 3.5	0.040 to 0.065

Sources: Pedocan (1993); Tajek and Coote (1993)

VEGETATION

Review of Existing Information

Historical information on rare plant species in the project Study Area was obtained from the ACIMS database. Information on provincial plant species of concern within the Lower Foothills Subregion and federally listed species within the Study Area, as identified below:

- By the ACIMS on the tracking list for rare vascular and non vascular plant species (ACIMS 2014), which are typically ranked from S1-S3;
- Within Alberta as At Risk and May be at Risk (ESRD 2010);
- Within Alberta as Species At Risk by Alberta Endangered Species Conservation Committee (ESCC 2014);
- As Threatened or Endangered under the *Wildlife Act* (Government of Alberta 2010); and
- As Special Concern, Threatened, or Endangered under the federal *Species at Risk Act* (SARA; SARA 2014) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; COSEWIC 2014).

In addition to the plant species of concern listed above, uncommon plant species may occur. Currently these plant species are not considered rare; however, information on their distribution in the province is lacking. These species included:

- Those species listed on the ACIMS Watch List, which are typically ranked from S3 (ACIMS 2014); and
- Those species listed within Alberta as Sensitive (ESRD 2010).

Air Photo Interpretation

Colour air photographs of the Study Area were obtained from ESRD at a scale of 1:24 000 taken 21 August 2013 following the major flood event along the Elbow River. The photos were of good quality with no cloud cover. Individual tree crowns were clearly evident with sharp definition. Stereo pairs examined under either two or four power stereoscopic vision to identify and outline ecological land classes according to Archibald et al (1996).

Field Inspection

On 9 October field inspections were completed at 20 sites. At each site the following information was collected:

- Ecological land class (dominant overstorey species or disturbance type);
- Location;
- Dominant species, trees, shrubs and herbs that could be identified this late in the season; and
- Other information (land use, erosion, flooding, etc.).

Photos were taken of the various land classes.

Map Preparation

The ecological land class lines and annotation from the 2013 photos were transferred visually using planimetric detail to a mosaic map. The map units were compared to the field data and revised as necessary.

WILDLIFE

Desktop Review

Information was collected from:

- Previous wildlife studies and technical reports relevant to the region;
- Data and recommendations from regional initiatives, such as the Alberta Biodiversity Monitoring Institute (ABMI), and consultation with regulators;
- FWMIS;
- Relevant regulatory documents, scientific literature and academic studies; and
- Wildlife distribution maps and sensitivity zones.

Field Surveys

Field surveys included one amphibian and one owl survey completed in the area in Spring 2014, and a combined aerial beaver and raptor habitat survey completed in late Fall 2014.

<u>Amphibian Survey</u>

The amphibian survey was completed on 30 April 2014. Survey methodologies for the amphibian survey were based on currently established protocols in Alberta (ESRD 2013a; Takats and Priestley 2002). A total of 19 sites were surveyed and located at a minimum spacing of 0.8 km along cutlines or existing roads (**Figure 3.6-1**). Environmental conditions were recorded upon arrival at each survey site. The survey began 30 minutes after sunset and lasted approximately 3 hours. At each site, a 1 minute quiet down period was followed by a 4 minute listening period. Any other wildlife detected during this survey were recorded as incidentals. Calls were identified to species and a qualitative assessment was made of the number of amphibians present according to the following criteria:

- Individual calls can be counted, not overlapping;
- Individual calls are still distinguishable, but calls beginning to overlap; or
- Full chorus, calls are constant, continuous and overlapping.

Owl Call-playback Survey

The owl call-playback survey was also completed on 30 April 2014. Survey methodologies for the owl survey were based on currently established protocols in Alberta (ESRD 2013a) and commenced 30 minutes after sunset and lasted approximately 3 hours as the majority of detections can be expected in this timespan (Takats et al. 2001). A total of 16 sites were surveyed during the owl call-playback survey. All sites were surveyed at intervals of 1.6 km or greater along cutlines or existing roads within the Study Area (**Figure 3.6-2**). At each survey site, the calls of seven owl species were broadcast over a 10-minute period. Upon arrival at each site, an initial 1 minute quiet down period was followed by a 2-minute listening period, and recording broadcasts consisting of 20 seconds of calls for each species. Calls were broadcast using a game caller. Broadcast calls followed an ascending order of species body size and included northern saw-whet, northern pygmy, boreal, long-eared, barred, great gray, and great horned owls. The calls of species were broadcast individually and followed by a 1 minute listening period. This process was performed until all calls were broadcast. At each location, a 3-minute listening period followed the end of the broadcast.

Each calling owl was identified to species, and its location was estimated using a compass bearing and an assessment of its distance from the survey site. Distance was estimated using the following criteria:

- Close (C): <100 m;
- *Medium (M):* 100 to 300 m; and
- *Far (F):* >300 m.

Aerial Beaver Survey

The aerial beaver survey was completed on 31 October 2014. The survey focused on identifying the presence of beaver fall food caches and dams near lodges to determine beaver presence and spatial distribution. The survey methodology followed those outlined in Resource Inventory Committee (1998). A helicopter was flown approximately 100 m above ground-level, at ground speeds of 80 to 100 km/hr, and along predetermined creeks and watercourses within the Study Area (**Figure 3.6-3**). Food caches were identified based on the presence of green branches at the lodge or fresh beaver activity (mud) at the lodge. Each lodge was recorded and the location was fixed using a hand held GPS unit.

Aerial Raptor Habitat Survey

The aerial raptor habitat survey was completed the same day as the beaver survey (31 October) and followed methodologies for currently established protocols in Alberta (ESRD, 2013a). Transects spaced 500 m apart throughout the Study Area were flown via helicopter east-west to assess the presence of suitable raptor nesting habitat.

HISTORICAL RESOURCES

Alberta Culture and Tourism (ACT) maintains a *Listing of Historic Resources* (ACT 2014) that is a register of all lands in the province known to contain valuable historical resources; it also integrates some lands where valuable historical resources have yet to be found but potential for such resources has been identified. Lands not included in the *Listing* are those known through previous assessment to lack valuable historical resources or those that have yet to be assessed. The latter scenario is why HRA requirements are often issued for lands that are not currently part of the listing.

The publicly accessible version of the listing is updated regularly and made available at AC's web site (ACT 2014). In order to protect valuable historic resources, it does not indicate their exact locations but instead lists legal subdivisions (LSDs) where such resources are known or have the potential to occur. These LSDs are classified using the following historic resource values (HRVs):

- HRV1 – designated under the HRA as a provincial historic resource and/or by UNESCO as a World Heritage Site and/or owned by AC for historic resource protection and promotion purposes – these lands receive the highest level of protection.
- HRV2 – designated under the HRA as a municipal or registered historic resource.
- HRV3 – contains a significant historic resource that will likely require avoidance.
- HRV4 – contains a historic resource that may require avoidance.
- HRV5 – believed to contain a historic resource.

The lands flagged in the listing are also categorized by type of historical resource, as follows:

- a. archaeological;
- c. cultural;
- gl. geological;
- h. historic;
- n. natural; and
- p. palaeontological.

This overview involved consulting the September 2014 version of the listing to determine if the Study Area encompasses any LSDs that have been assigned HRVs (ACT 2014). It also involved a review of records that AC does not make accessible to the public; these included reports on previous HRIAs that passed near or through parts of the study area, as well as archaeological site inventory forms documenting finds in its vicinity.
Due to the limited amount of previous assessment in the study area, a predictive model to identify moderate to high archaeological potential was created. This model used physical variables that commonly show a consistent relationship with archaeological site location (e.g., proximity to water, slope, elevation, drainage, etc.) to identify areas likely to contain such sites.

LAND USE

A desktop review of relevant data was followed up by a field visit to confirm secondary data research. Baseline data for land and resource use was collected from provincial government departments (i.e. Alberta Tourism, Parks and Recreation, ESRD, AT, and Alberta Energy) and through online sources and databases including the Alberta Geographic Land Information Management Planning System (GLIMPS), and the Digital Integrated Dispositions (DIDs) databases (Alberta Energy 2014; Altalis 2014).

Crown tenures (dispositions) were identified using the GLIMPs and DIDs databases. Trapping, forestry, wildlife management areas, fishing zones, parks, protected areas, and environmentally significant areas were identified by overlaying spatial layers for those components within the area.

Land and resource use issues associated with the project were scoped and subsequently were used to inform the identification of key valued components, including land use planning and management, parks, protected and environmentally significant areas, access, recreation, land use dispositions, existing residences and infrastructure, and forestry.

STAKEHOLDER ENGAGEMENT

Consultation for the environmental overview was limited to meetings with government agencies; no contact has been made with the general public or specific stakeholders to discuss the potential project.

In coordination with the ESRD Resilience & Mitigation Branch, meetings were arranged with specific government agencies with interests in the Elbow River watershed, and the McLean Creek area in particular. Initial meetings were held with AT and Alberta Tourism, Parks and Recreation (ATPR), both of whom were interviewed during the Southern Alberta Flood Recovery Mitigation Study. Participants at the meeting suggested that we meet with a number of other ESRD branches as well, including Infrastructure Operations, Public Lands, and Forestry. It was also suggested to meet with the Kananaskis Country Interdepartmental Consultative Committee (KCICC), which includes representatives of a number of potentially affected departments, at their quarterly meeting. Unfortunately, there wasn’t room on the KCICC November meeting agenda for AMEC to present their questionnaire. The ESRD Resilience & Mitigation Branch also arranged a meeting with representatives from ESRD Forestry, Wildfires and Lands for 18 November, but that meeting was cancelled and written answers to the questionnaire provided instead.

To date, meetings have been held with:

- AT (Operations, including Calgary District Office, Bridges – Lethbridge, Southern Transportation Network) on 31 October 2014 in Calgary.
- ATPR (Kananaskis Region, including Infrastructure Operations/Support, Park Ecology, Planning, Operations Section) on 4 November 2014 in Cochrane.

- ESRD (Operations Infrastructure, including Southern Operations and Water Projects Management) on 4 November 2014 in Calgary.

The questionnaire and a map of the project area were provided in advance of the meetings, and the questions discussed in detail at the meetings.

At the meetings, the project and reasons for it were introduced by the ESRD Resilience & Mitigation representative, after which AMEC provided more detailed information on the dam, reservoir and adjacent areas likely to be affected.

Once information on the project was provided, the following questions were asked:

- Have you been contacted by a government agency or consultant for information relating to how the recent flooding of the Elbow River affected your infrastructure, services and resources?
- How familiar are you with the proposed McLean Creek Dam/Reservoir (MC1) flood mitigation option?
- If MC1 is developed, how do you think the Project footprint and related construction activities could affect the resources, service delivery and infrastructure of your government agency at this location and elsewhere within the Elbow River watershed?
- If MC1 is developed, how do you think the Project footprint and related operations of the MC1 dam and reservoir could affect the resources, service delivery and infrastructure of your government agency at this location and elsewhere within the Elbow River watershed?
- If MC1 is developed, do you anticipate any positive effects from the MC1 dam and reservoir on the resources, service delivery and infrastructure of your government agency at this location and elsewhere within the Elbow River watershed? If yes, please describe.
- Do you have any questions or comments that you would like to provide to AMEC for inclusion in AMEC's environmental overview of the McLean Creek dam/reservoir concept at the McLean Creek site? If yes, we will document your input and try to answer any questions you may have.

Questionnaires with these same questions were also filled out by:

- ESRD Wildfire Management (Elbow Firebase); and
- ESRD Forestry and Lands Approvals (South Saskatchewan Region).

A copy of the map was provided with the questionnaire (Drawing F1).

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Appendix B

Hydrogeology

Appendix B1

Water Well Drilling Reports

Table B-1-1. Locations of Existing Wells in Study Area

Well ID	LSD	SEC	TWP	RGE	M	DEPTH (m)	STATIC LEVEL (m)	ELEVATION (ft)	Elevation (m)	E	N	ATS Location
404291	13	18	22	5	5	24.38	---	4726	1441	662635.5	5638805.5	13-18-22-5W5
404292	NE	19	22	5	5	30.48	12.8	---	---	663641.3	5640213.6	NE-19-22-5W5
404292	NE	19	22	5	5	20.27	---	---	---	663641.3	5640213.6	NE-19-22-5W5
404293	16	19	22	5	5	33.53	---	---	---	663842.5	5640414.8	16-19-22-5W5
2092541	SW	19	22	5	5	29.59	---	---	---	662836.7	5639409	SW-19-22-5W5
349116	NW	20	22	5	5	24.38	3.51	---	---	664446	5640213.6	NW-20-22-5W5
349546	NW	20	22	5	5	21.95	4.57	---	---	664446	5640213.6	NW-20-22-5W5
376645	13	20	22	5	5	17.68	10.67	---	---	664244.8	5640414.8	13-20-22-5W5
404294	SW	20	22	5	5	10.67	3.96	4800	1463	664446	5639409	SW-20-22-5W5
496572	NE	28	22	5	5	37.49	14.87	---	---	666860	5641823	NE-28-22-5W5
357651	NE	29	22	5	5	54.86	21.64	---	---	665250.6	5641823	NE-29-22-5W5
404296	NW	29	22	5	5	18.29	---	4600	1402	664446	5641823	NW-29-22-5W5
404297	NH	29	22	5	5	30.48	22.86	4420	1348	664848.3	5641823	NH-29-22-5W5
404298	NE	29	22	5	5	54.86	26.82	---	---	665250.6	5641823	NE-29-22-5W5
1020984	NE	29	22	5	5	54.86	27.16	---	---	664509	5642078	NE-29-22-5W5
1020988	NE	29	22	5	5	35.05	22.86	---	---	664490	5642054	NE-29-22-5W5
349542	NW	30	22	5	5	45.72	4.57	---	---	662836.7	5641823	NW-30-22-5W5
349543	11	30	22	5	5	13.72	1.83	---	---	663037.8	5641621.9	11-30-22-5W5
349543	11	30	22	5	5	13.11	2.13	---	---	663037.8	5641621.9	11-30-22-5W5
350009	NW	30	22	5	5	36.58	24.44	---	---	662271	5641809	NW-30-22-5W5
366214	NW	30	22	5	5	0	---	---	---	662836.7	5641823	NW-30-22-5W5
404299	3	30	22	5	5	32	---	4715	1438	663037.8	5640817.2	3-30-22-5W5
404300	5	30	22	5	5	5.49	2.59	4590	1399	662635.5	5641219.6	5-30-22-5W5
404301	5	30	22	5	5	5.49	1.98	4300	1311	662635.5	5641219.6	5-30-22-5W5
404302	NW	30	22	5	5	0	---	---	---	662836.7	5641823	NW-30-22-5W5
404303	NW	30	22	5	5	0	---	---	---	662836.7	5641823	NW-30-22-5W5
404304	11	30	22	5	5	67.06	42.98	4600	1402	663037.8	5641621.9	11-30-22-5W5
404305	0	30	22	5	5	1.52	---	---	---	663239	5641420.7	0-30-22-5W5
1021822	SW	30	22	5	5	30.48	2.44	---	---	662836.7	5641018.4	SW-30-22-5W5
349547	NE	33	22	5	5	21.03	6.1	---	---	666860	5643432.3	NE-33-22-5W5
376632	SE	33	22	5	5	27.43	---	---	---	666860	5642627.7	SE-33-22-5W5
376643	SE	33	22	5	5	27.43	14.42	---	---	666860	5642627.7	SE-33-22-5W5
404306	0	33	22	5	5	13.41	5.85	---	---	666457.7	5643030	0-33-22-5W5
404307	SE	33	22	5	5	31.7	6.1	---	---	666860	5642627.7	SE-33-22-5W5
404308	SE	33	22	5	5	47.85	23.87	---	---	666860	5642627.7	SE-33-22-5W5
404309	SE	33	22	5	5	24.38	---	---	---	666860	5642627.7	SE-33-22-5W5
404310	7	33	22	5	5	0	---	4480	1366	666658.8	5642828.9	7-33-22-5W5

404311	SW	33	22	5	5	0	---	---	---	666055.4	5642627.7	SW-33-22-5W5
1020993	SE	33	22	5	5	47.24	7.13	---	---	666860	5642627.7	SE-33-22-5W5
1021009	SE	33	22	5	5	27.43	6.71	---	---	666860	5642627.7	SE-33-22-5W5
376657	12	13	22	6	5	18.29	---	---	---	660954.2	5638094.2	12-13-22-6W5
404322	13	13	22	6	5	31.09	28.04	4700	1433	660954.2	5638496.5	13-13-22-6W5
404324	13	13	22	6	5	16.76	---	4900	1494	660954.2	5638496.5	13-13-22-6W5
368541	6	23	22	6	5	79.25	42.06	---	---	659747.2	5639301.2	6-23-22-6W5
376658	NW	24	22	6	5	30.48	3.08	---	---	661155.4	5639904.6	NW-24-22-6W5
376658	NW	24	22	6	5	30.48	3.08	---	---	661155.4	5639904.6	NW-24-22-6W5
376659	NW	24	22	6	5	36.58	1.65	---	---	661155.4	5639904.6	NW-24-22-6W5
376659	NW	24	22	6	5	36.58	1.68	---	---	661155.4	5639904.6	NW-24-22-6W5
376660	NW	24	22	6	5	35.05	0	---	---	661155.4	5639904.6	NW-24-22-6W5
376661	NW	24	22	6	5	24.38	1.13	---	---	661155.4	5639904.6	NW-24-22-6W5
376661	NW	24	22	6	5	24.38	2.56	---	---	661155.4	5639904.6	NW-24-22-6W5
404330	6	24	22	6	5	16.76	13.41	4700	1433	661356.5	5639301.2	6-24-22-6W5
350010	16	25	22	6	5	60.96	41.15	---	---	662161.2	5641715.2	16-25-22-6W5
350010	16	25	22	6	5	60.98	---	---	---	662161.2	5641715.2	16-25-22-6W5
351975	SE	25	22	6	5	36.58	22.86	---	---	661960	5640709.4	SE-25-22-6W5
367060	NE	25	22	6	5	0	---	---	---	661960	5641514	NE-25-22-6W5
404333	SW	25	22	6	5	9.75	0	---	---	661155.4	5640709.4	SW-25-22-6W5
404335	6	25	22	6	5	6.1	4.57	4800	1463	661356.5	5640910.6	6-25-22-6W5
404337	9	26	22	6	5	18.29	0	4875	1486	660551.9	5641312.9	9-26-22-6W5
404343	2	35	22	6	5	18.29	0	4903	1495	660149.5	5642117.5	2-35-22-6W5
404345	2	36	22	6	5	24.38	---	4676	1426	661758.8	5642117.5	2-36-22-6W5
404347	2	36	22	6	5	24.38	---	4727	1441	661758.8	5642117.5	2-36-22-6W5
341384	SW	35	22	5	5	60.98	29.39	---	---	669274.1	5642627.7	SW-35-22-5W5
361014	SW	35	22	5	5	24.39	---	---	---	669274.1	5642627.7	SW-35-22-5W5
361015	SW	35	22	5	5	42.68	---	---	---	669274.1	5642627.7	SW-35-22-5W5
361161	SW	35	22	5	5	26.52	8.09	---	---	669274.1	5642627.7	SW-35-22-5W5
367133	SW	35	22	5	5	63.72	19.43	---	---	669274.1	5642627.7	SW-35-22-5W5
374873	NE	34	22	5	5	18.29	5.58	---	---	668469.3	5643432.3	NE-34-22-5W5
378457	6	35	22	5	5	25.30	22.80	---	---	669475.2	5642828.9	6-35-22-5W5
497684	NE	34	22	5	5	23.17	16.46	---	---	668469.3	5643432.3	NE-34-22-5W5

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID: 341384
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 2000/11/21

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON G./ISINCLAIR T. #4208	P.O. BOX 303 BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910308 Longitude -114.596081
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
7.92		Clay
27.43		Loamy Gravel
60.96		Black Silty Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 4.55 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2000/10/24	5.00	29.38

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
60.96 m		2000/10/18	2000/10/18

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	60.96

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 28.35 m

Well Casing/Liner
Plastic
Size OD : 12.70 cm
Wall Thickness : 0.556 cm
Top at : 24.38 m
Bottom at : 60.96 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
27.43	36.58	0.478		15.24
42.67	60.96	0.000		0.00

Perforated by Saw

Annular Seal Driven
Placed from 0.00 m to 28.35 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 341384
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2000/11/21

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON G./ISINCLAIR T. #4208	P.O. BOX 303 BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910308 Longitude -114.596081
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 4.55 L/min
Recommended Pump Intake Depth (From TOC) 57.91 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
2000/10/24	2:24 AM	29.38 m

Method of Water Removal

Type Pump
Removal Rate 5.00 L/min
Depth Withdrawn From 57.91 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
29.38	0:00	33.53
33.11	10:00	32.70
33.65	20:00	32.02
33.90	30:00	31.48
34.09	40:00	31.04
34.23	50:00	30.68
34.37	60:00	30.39
34.52	70:00	30.15
34.68	80:00	29.95
34.87	90:00	29.77
34.98	100:00	29.77
35.15	110:00	29.63
35.27	120:00	29.51
35.42	130:00	
35.87	140:00	
36.60	150:00	
37.27	160:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 349116
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ELBOW VALLEY CAMPGROUNDS #2824	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	20	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888427 Longitude -114.665146
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.91		Silty Sand
4.88		Clay & Sand
5.49		Gray Clay
24.38		Dark Gray Sandy Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 18.18 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1995/10/19	18.18	3.51

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
24.38 m		1995/10/13	1995/10/13

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	24.38

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 8.23 m

Well Casing/Liner
Plastic
Size OD : 12.70 cm
Wall Thickness : 0.635 cm
Top at : 4.57 m
Bottom at : 22.86 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
10.67	22.86	0.635		15.24

Perforated by Saw

Annular Seal Driven
Placed from 8.23 m to 8.84 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 349116
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ELBOW VALLEY CAMPGROUNDS #2824	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	20	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888427 Longitude -114.665146
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 18.18 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 22.86 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
WATER ANALYSIS TDS 300 PPM IRON <0.5 PPM HARDNESS 5 GRAINS

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1995/10/19	12:00 AM	3.51 m

Method of Water Removal

Type Pump
Removal Rate 18.18 L/min
Depth Withdrawn From 22.86 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
4.60	1:00	4.95
4.69	2:00	4.77
4.78	3:00	4.75
4.80	4:00	4.72
4.82	5:00	4.69
4.93	10:00	4.55
5.00	15:00	4.46
5.10	20:00	4.38
5.22	30:00	4.25
5.33	40:00	
5.42	50:00	
5.50	60:00	
5.61	75:00	
5.69	90:00	
5.76	105:00	
5.83	120:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 349542
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	ALLEN BILL POND				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Municipal

Type of Work
New Well-Abandoned

Plugged 1983/07/14
Plugged with Puddled Clay
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.61		Topsoil
3.05		Clay & Gravel
45.72		Black Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1983/07/14	2.27	4.57

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
45.72 m		1983/07/11	1983/07/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	45.72

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Puddled Clay
Placed from 3.05 m to 45.72 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 349542
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	ALLEN BILL POND				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
hole abandoned,and cemented

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1983/07/14	12:00 AM	4.57 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 2.27 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 349543
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	ALLEN BILL POND		AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	11	30	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Drilling Information

Method of Drilling
Cable Tool

Type of Work
New Well

Proposed Well Use
Municipal

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
2.74	Yes	Water Bearing Gravel
13.72		Black Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1983/07/27	90.92	1.83

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
13.72 m		1983/07/26	1983/07/27

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	13.72

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 2.13 m

Well Casing/Liner
Steel
Size OD : 10.80 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 13.72 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
3.05	4.57	0.000		0.00

Perforated by Unknown

Annular Seal Driven
Placed from 0.30 m to 2.13 m
Amount

Other Seals

Type	At (m)

Screen Type Stainless Steel
Size OD : 10.16 cm

From (m)	To (m)	Slot Size (cm)
3.05	4.57	0.064

Attachment Unknown
Top Fittings Welded Bottom Fittings Other

Pack
Type Unknown Grain Size
Amount 0.00 Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID 349543
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	ALLEN BILL POND		AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	11	30	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 11.58 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
WELL RECLAIMED 2005/12/19 SEE WELL ID #1475518

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1983/07/27	12:00 AM	1.83 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 90.92 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID	349543
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2006/01/03

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MD LANDSCAPING	205 CHARLESWORTH AVE	COCHRANE	ALBERTA	CA	T4C 2B7

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	11	30	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Unknown

Type of Work
Old Well-Abandoned

Plugged 2005/12/19
Plugged with Bentonite Product
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
		2.13

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
13.11 m			

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Steel
Size OD : 16.83 cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Unknown
Size OD : 11.43 cm
Wall Thickness : cm
Top at : 0.00 m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by Unknown

Annular Seal Unknown
Placed from m to m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
WILLIAM PENROD

Company Name
M&M DRILLING CO. LTD.

Certification No
A000187

Copy of Well report provided to owner
Yes

Date approval holder signed
2005/12/20

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID: 349543
GoA Well Tag No.
Drilling Company Well ID
Date Report Received: 2006/01/03

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MD LANDSCAPING	205 CHARLESWORTH AVE	COCHRANE	ALBERTA	CA	T4C 2B7

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	11	30	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained: Field

Elevation m
How Elevation Obtained: Survey-Air

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

ALLEN BILL POND, ABANDONED C/W BENTONITE CHIPS FROM BOTTOM TO TOP. GPS# N-50-54-03.2, W-114-41-12.3 (21.1).

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
	12:00 AM	2.13 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type: Unknown
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: WILLIAM PENROD
Certification No: A000187
Company Name: M&M DRILLING CO. LTD.
Copy of Well report provided to owner: Yes
Date approval holder signed: 2005/12/20

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 349546
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	MCLEAN CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	20	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888427 Longitude -114.665146
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Drilling Information

Method of Drilling
Cable Tool

Type of Work
New Well

Proposed Well Use
Municipal

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.61		Topsoil
6.10		Clay
14.02		Clay & Rocks
21.95	Yes	Black Water Bearing Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1983/07/25	68.19	4.57

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
21.95 m		1983/07/22	1983/07/25

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	21.95

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 14.33 m

Well Casing/Liner
Steel
Size OD : 10.80 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 21.95 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
16.76	21.95	0.318		30.48

Perforated by Torch

Annular Seal Driven
Placed from 14.02 m to 14.33 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 349546
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	MCLEAN CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	20	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888427 Longitude -114.665146
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 15.24 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Well Disinfected Upon Completion
Gas Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1983/07/25	12:00 AM	4.57 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 68.19 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

[View in Imperial] [Export to Excel]

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 349547
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	GOOSEBERRY CAMP				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.917778 Longitude -114.630675
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Municipal

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
9.14		Gravel & Boulders
11.28		Gray Shale
11.58	Yes	Water Bearing Coal
13.72		Green Shale
14.33	Yes	Water Bearing Coal
21.03		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1983/07/17	227.30	6.10

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
21.03 m		1983/07/15	1983/07/17

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	21.03

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 9.45 m

Well Casing/Liner
Steel
Size OD : 10.80 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 21.03 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
11.58	20.73	0.318		30.48

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 9.45 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 349547
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	GOOSEBERRY CAMP				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.917778 Longitude -114.630675
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 18.29 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1983/07/17	12:00 AM	6.10 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 227.30 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 350009
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1997/09/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KANANASKIS COUNTRY#3259	P.O. BOX 280 EXSHAW		AB	CA	T0L 2C0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Municipal

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.96		Gravel & Boulders
17.07		Clay & Boulders
25.60		Clay & Gravel
26.82	Yes	Water Bearing Sand & Gravel
29.26		Coarse Grained Gravel
31.70		Sand & Gravel
36.58		Black Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 90.92 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1997/08/28	95.47	24.44

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
36.58 m		1997/08/14	1997/08/28

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	36.58

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 26.52 m

Well Casing/Liner
Steel
Size OD : 12.70 cm
Wall Thickness : 0.478 cm
Top at : 25.91 m
Bottom at : 29.87 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by Unknown

Annular Seal Drive Shoe
Placed from 0.00 m to 26.52 m
Amount

Other Seals

Type	At (m)

Screen Type Stainless Steel
Size OD : 13.34 cm

From (m)	To (m)	Slot Size (cm)
27.13	28.65	0.127

Attachment Telescoped
Top Fittings Neoprene (Figure K)
Bottom Fittings Plug

Pack
Type Natural
Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	350009
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1997/09/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KANANASKIS COUNTRY#3259	P.O. BOX 280 EXSHAW		AB	CA	T0L 2C0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Field

Elevation m
How Elevation Obtained
Survey-Air

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 90.92 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 26.82 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD Gamma
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
WATER ANALYSIS TDS 225 IRON <.5 HARD 11

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
1997/08/28	7:12 AM	24.44 m

Method of Water Removal

Type Pump
Removal Rate 95.47 L/min
Depth Withdrawn From 26.82 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
24.50	5:00	24.44
24.51	10:00	
24.51	15:00	
24.52	20:00	
24.53	30:00	
24.53	40:00	
24.53	50:00	
24.53	60:00	
24.54	75:00	
24.55	90:00	
24.56	105:00	
24.57	120:00	
24.57	150:00	
24.57	180:00	
24.57	210:00	
24.57	240:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	350010
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1997/09/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KANANASKIS COUNTRY	P.O. BOX 280 EXSHAW		AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	25	22	6	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.904846 Longitude -114.696824
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Survey-Air

Drilling Information

Method of Drilling
Cable Tool

Type of Work
Test Hole

Proposed Well Use
Unknown

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.66		Boulders
6.40		Brown Clay & Boulders
10.67		Gray Clay & Boulders
12.19		Gray Clay & Rocks
16.46		Gray Clay & Boulders
24.38		Brown Boulders
25.30		Gray Boulders
25.60		Gray Clay
60.96		Black Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1997/08/21	0.45	41.15

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
60.96 m		1997/08/18	1997/08/21

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	60.96

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.394 cm
Bottom at : 25.60 m

Well Casing/Liner
Unknown
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by Unknown

Annular Seal Bentonite & Cement
Placed from 25.60 m to 60.96 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID: 350010
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1997/09/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KANANASKIS COUNTRY	P.O. BOX 280 EXSHAW		AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	25	22	6	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.904846 Longitude -114.696824
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Survey-Air

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
WELL LOCATION CORRECTED FROM NW-30-22-5-5 TO LSD16-25-22-6-5 AS PER RECLAMATION INFORMATION 08/05/28

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1997/08/21	12:00 AM	41.15 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 0.45 L/min
Depth Withdrawn From 60.96 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	350010
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2008/09/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA FOREST SERVICE			AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	25	22	6	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.904846 Longitude -114.696824
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Survey-Air

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Unknown

Type of Work
Old Well-Abandoned

Plugged 2008/05/28
Plugged with Other
Amount 31.00 Bags

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
60.98		Old Well

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
60.98 m			

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Unknown
Size OD : 16.83 cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Unknown
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from m to m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN DRILLER11

Certification No
11

Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	350010
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2008/09/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA FOREST SERVICE			AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	25	22	6	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.904846 Longitude -114.696824
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Survey-Air

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

CASING AND/OR LINER NOT REMOVED BEFORE PLUGGING, REASON FOR PLUGGING - NO LONGER REQUIRED, RECLAIMED WITH WYO-BEN ENVIROPLUG MEDIUM 31 BAGS - POURED FROM BAG @ 5 MINS/BAG, WORK DONE BY ALLAN MACKAY - AM MACKAY CONT. / BRYCE ROWE - ROWE WATER SYSTEMS

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN DRILLER11

Certification No
11

Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

Government of Alberta

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View in Imperial | Export to Excel

GIC Well ID	351975
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1990/09/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STATION FLATS	ELBOW FALLS				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	25	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.895801 Longitude -114.699675
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Gravel
15.85		Sandy Clay
26.21		Gravel
36.58		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1990/08/10	36.37	22.86

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
36.58 m		1990/08/06	1990/08/10

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	36.58

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 26.21 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.544 cm
Top at : 24.38 m
Bottom at : 36.58 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
24.38	36.58	0.318		15.24

Perforated by Machine

Annular Seal Driven
Placed from 0.00 m to 26.21 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
GOODISON WATER WELL DRILLING

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 351975
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1990/09/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STATION FLATS	ELBOW FALLS				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	25	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.895801 Longitude -114.699675
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1990/08/10	12:00 AM	22.86 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 36.37 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
GOODISON WATER WELL DRILLING

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	357651
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1991/03/07

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CAMP HORIZON	BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	29	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903070 Longitude -114.653700
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
22.56		Clay & Gravel
25.30		Brown Sandstone
26.52		Brown Shale
27.74		Brown Sandstone
28.35		Gray Sandstone
29.26		Brown Sandstone
41.76		Gray Sandstone
46.33		Gray Shale
49.68		Gray Sandstone
51.82		Gray Shale
54.86		Gray Sandstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 45.46 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1991/02/27	54.55	21.64

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
54.86 m		1991/02/27	1991/02/27

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	54.86

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.620 cm
Bottom at : 23.77 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.396 cm
Top at : 19.20 m
Bottom at : 54.86 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
24.38	48.77	0.000		0.00

Perforated by Torch

Annular Seal Drive Shoe
Placed from 0.00 m to 23.77 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
AERO DRILLING & CONSULTING LTD.

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	357651
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1991/03/07

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CAMP HORIZON	BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	29	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903070 Longitude -114.653700
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 45.46 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
1991/02/27	12:00 AM	21.64 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 54.55 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AERO DRILLING & CONSULTING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID: 361014
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1991/11/29

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON, GARY	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Unknown

Type of Work
Test Hole-Abandoned

Plugged 1991/11/01
Plugged with Cuttings
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
11.58		Sandy Clay
18.29		Clay
24.38		Black Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
24.38 m		1991/11/01	1991/11/01

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	24.38

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack

Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ELGIN EXPLORATION COMPANY LIMITED

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID	361014
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1991/11/29

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON, GARY	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ELGIN EXPLORATION COMPANY LIMITED

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	361015
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1991/11/29

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON, GARY	GEN DEL, BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Unknown

Type of Work
Test Hole-Abandoned

Plugged 1991/11/01
Plugged with Cuttings
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
12.50		Sandy Clay
15.54		Clay
17.37		Sandstone
42.67		Black Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
42.67 m		1991/11/01	1991/11/01

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	42.67

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
ELGIN EXPLORATION COMPANY LIMITED

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 361015
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1991/11/29

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON, GARY	GEN DEL, BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ELGIN EXPLORATION COMPANY LIMITED

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID: 361161
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1991/12/23

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON, GARY	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Combination

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.88		Sand & Gravel
26.52		Soft Sandstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 4.55 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1991/12/06	4.55	10.06

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
26.52 m		1991/12/04	1991/12/06

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	26.52

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 6.10 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.544 cm
Top at : 2.13 m
Bottom at : 26.52 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
8.23	26.21	0.318		15.24

Perforated by Saw

Annular Seal Driven
Placed from 0.00 m to 6.10 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HERTZ DRILLING COMPANY LTD.

Copy of Well report provided to owner | Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	361161
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1991/12/23

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON, GARY	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 4.55 L/min
Recommended Pump Intake Depth (From TOC) 23.47 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
PUMPTEST CONDUCTED BY HERTZ DRILLING ON DEC 6-7 1991 IS ON DISK IN FILE.

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HERTZ DRILLING COMPANY LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	361161
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1991/12/23

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON, GARY	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1991/12/06	12:00 AM	10.06 m

Method of Water Removal

Type Pump
Removal Rate 4.55 L/min
Depth Withdrawn From 24.38 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
10.29	1:00	14.51
10.34	2:00	13.49
10.36	3:00	13.29
10.39	4:00	12.96
10.44	6:00	12.66
10.49	8:00	12.66
10.54	10:00	12.58
10.61	13:00	12.32
10.67	16:00	12.09
10.90	20:00	11.89
	24:00	11.88
11.10	25:00	
	31:00	11.88
11.51	32:00	
	38:00	11.86
13.41	40:00	
	48:00	11.85
13.74	50:00	
	55:00	11.58
13.90	60:00	
	72:00	10.92
14.05	80:00	
	88:00	10.67
14.20	100:00	
	103:00	10.63
14.33	120:00	
	124:00	10.61
	144:00	10.49
14.51	150:00	
14.51	180:00	10.36
	212:00	10.06
14.51	240:00	10.06
	267:00	10.06
	288:00	10.06
14.51	300:00	
	309:00	10.06
	327:00	10.06
	344:00	10.06
14.51	360:00	10.06
14.51	420:00	
14.51	480:00	
14.51	540:00	
14.51	600:00	
14.51	660:00	
14.51	720:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well	Certification No
UNKNOWN NA DRILLER	1

Company Name	Copy of Well report provided to owner	Date approval holder signed
HERTZ DRILLING COMPANY LTD.		

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 366214
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1992/10/06

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KOPP, BRAD/MEGAN	BAG 1, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	366214
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1992/10/06

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KOPP, BRAD/MEGAN	BAG 1, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	367060
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1992/09/14

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
HUMPHREY, DAVID\SHERRY	BAG 1, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	25	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903033 Longitude -114.699676
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 367060
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1992/09/14

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
HUMPHREY, DAVID\SHERRY	BAG 1, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	25	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903033 Longitude -114.699676
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	367133
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1992/12/21

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BARRETT, ED	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Combination

Type of Work
New Well

Proposed Well Use
Domestic & Stock

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Sand & Gravel
35.05		Soft Sandstone Stringers
63.70		Hard Sandstone & Shale Ledges

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 4.55 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1992/11/12	6.82	30.48

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
63.70 m		1992/11/11	1992/11/12

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	63.70

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 27.13 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.544 cm
Top at : 2.74 m
Bottom at : 63.70 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
51.51	63.70	0.025		7.62

Perforated by Machine

Annular Seal Shale Trap & Bentonite
Placed from 32.00 m to 35.05 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HERTZ DRILLING COMPANY LTD.

Copy of Well report provided to owner | Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 367133
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1992/12/21

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BARRETT, ED	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 4.55 L/min
Recommended Pump Intake Depth (From TOC) 60.96 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1992/11/12	12:00 AM	30.48 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Pump
Removal Rate 6.82 L/min
Depth Withdrawn From 60.96 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HERTZ DRILLING COMPANY LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 367133
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1992/12/21

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BARRETT, ED	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Combination

Proposed Well Use
Domestic & Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Sand & Gravel
35.05		Soft Sandstone Stringers
63.70		Hard Sandstone & Shale Ledges

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 4.55 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1992/11/12	6.82	30.48

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
63.70 m		1992/11/11	1992/11/12

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	63.70

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 27.13 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.544 cm
Top at : 2.74 m
Bottom at : 63.70 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
51.51	63.70	0.025		7.62

Perforated by Machine

Annular Seal Shale Trap & Bentonite
Placed from 32.00 m to 35.05 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HERTZ DRILLING COMPANY LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	367133
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1992/12/21

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BARRETT, ED	GEN DEL, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	35	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910530 Longitude -114.596018
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 4.55 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 60.96 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1992/11/12	12:00 AM	30.48 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Pump
Removal Rate 6.82 L/min
Depth Withdrawn From 60.96 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HERTZ DRILLING COMPANY LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 368541
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1993/02/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SHELL/NABORS 24E#CAMP WELL	CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	06	23	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.882959 Longitude -114.731298
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Industrial

Type of Work
New Well

Plugged 1993/03/25
Plugged with Unknown
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
41.76		Dark Gray Shale
46.63		Gray Sandstone
47.24		Coal
71.93		Dark Gray Shale
72.85		Coal
79.25		Dark Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 22.73 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1992/12/23	22.73	42.06

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
79.25 m		1992/12/23	1992/12/23

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	79.25

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.620 cm
Bottom at : 12.19 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 60.96 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
42.67	48.77	0.157		15.24

Perforated by Torch

Annular Seal Drive Shoe
Placed from 0.00 m to 12.19 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AERO DRILLING & CONSULTING LTD.

Copy of Well report provided to owner | Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 368541
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1993/02/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SHELL/NABORS 24E#CAMP WELL	CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	06	23	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.882959 Longitude -114.731298
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 22.73 L/min
Pump Installed Yes
Depth m
Recommended Pump Intake Depth (From TOC) 57.91 m
Type SUB
Make GOULD
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Well Disinfected Upon Completion
Gas Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1992/12/23	12:00 AM	42.06 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 22.73 L/min
Depth Withdrawn From 79.25 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AERO DRILLING & CONSULTING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID	374873
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1994/01/28

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GRAHAM, TERRY	10512 WILLIOW GREEN DR SE, CALGARY				T2J 1P6

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	34	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.917771 Longitude -114.607639
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Drilling Information

Method of Drilling
Cable Tool

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Gray Clay & Rocks
6.71		Gravel & Boulders
18.29		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 36.37 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1993/11/24	36.37	1.95

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
18.29 m		1993/11/15	1993/11/24

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	18.29

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 6.71 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.544 cm
Top at : 6.10 m
Bottom at : 18.29 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
6.71	16.76	0.792		0.00

Perforated by Machine

Annular Seal Bentonite Chips/Tablets
Placed from 2.44 m to 3.05 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
BAKER WATER WELLS

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	374873
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1994/01/28

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GRAHAM, TERRY	10512 WILLIOW GREEN DR SE, CALGARY				T2J 1P6

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	34	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.917771 Longitude -114.607639
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 36.37 L/min
Recommended Pump Intake Depth (From TOC) 16.76 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1993/11/24	7:12 AM	1.95 m

Method of Water Removal

Type Bailer
Removal Rate 36.37 L/min
Depth Withdrawn From 6.71 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
2.13	0:00	4.72
2.95	1:00	2.93
3.25	2:00	2.53
3.44	3:00	2.33
3.67	4:00	2.21
3.84	5:00	2.18
3.98	6:00	2.15
4.09	7:00	2.15
4.18	8:00	2.14
4.23	9:00	2.14
4.28	10:00	2.14
4.36	12:00	2.13
4.41	14:00	
4.47	16:00	
4.51	18:00	
4.58	20:00	
4.60	25:00	
4.65	30:00	
4.67	35:00	
4.69	40:00	
4.69	50:00	
4.70	60:00	
4.71	75:00	
4.72	90:00	
4.72	105:00	
4.72	120:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
BAKER WATER WELLS

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	376632
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1982/03/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GOOSEBERRY PARK#WELL 2	BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 50.910546 Longitude -114.630674

How Location Obtained

Not Verified

Elevation m

How Elevation Obtained

Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
27.43 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	27.43

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m

Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment

Top Fittings Bottom Fittings

Pack

Type Grain Size

Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	376632
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1982/03/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GOOSEBERRY PARK#WELL 2	BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.630674
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 376643
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1982/04/27

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA ENV #WELL 1	GOOSEBERRY INFO CENTRE		AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.630674
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
1.52		Gravel
5.79		Brown Clayey Till & Rocks
12.19		Gray Clayey Till & Rocks
14.63		Mixed Clay & Gravel
15.85		Gray Shale
17.37		Gray Hard Sandstone
18.29		Gray Hard Shale
19.20		Gray Hard Sandstone
24.38		Gray Hard Shale
25.60		Gray Hard Sandstone
26.21		Gray Hard Shale
27.43		Gray Hard Sandstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1982/03/11	13.64	14.42

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
27.43 m		1982/03/11	1982/03/12

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	27.43

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.478 cm
Bottom at : 16.46 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.000 cm
Top at : 14.63 m
Bottom at : 27.43 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
21.03	27.43	0.318		20.32

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 16.15 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
BIG QUILL DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 376643
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1982/04/27

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA ENV #WELL 1	GOOSEBERRY INFO CENTRE		AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.630674
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well
ABANDONED WELL: SEE WELL ID#1021009.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1982/03/11	12:00 AM	14.42 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 13.64 L/min
Depth Withdrawn From 26.21 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
BIG QUILL DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

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GIC Well ID 376645
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FOREST SVC	MCLEAN CREEK			CANADA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	13	20	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.890234 Longitude -114.668006
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
5.49		Gray Silt
9.45		Coarse Grained Gravel
17.68		Fractured Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1977/12/12	9.09	10.67

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
17.68 m		1977/12/12	1977/12/13

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	17.68

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Steel
Size OD : 13.97 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 14.63 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
5.49	14.63	0.318		30.48

Perforated by Torch

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HI-RATE DRILLING COMPANY LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 376645
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FOREST SVC	MCLEAN CREEK			CANADA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	13	20	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.890234 Longitude -114.668006
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1977/12/12	12:00 AM	10.67 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type
Removal Rate 9.09 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HI-RATE DRILLING COMPANY LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	376657
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1980/11/03

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #5	PADDY'S FLAT			CANADA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	12	13	22	6	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.872110 Longitude -114.713959
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well-Abandoned

Plugged 1980/09/17
Plugged with Cement
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.91		Topsoil
4.57		Gravel & Boulders
18.29		Hard Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
18.29 m		1980/09/17	1980/09/17

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	18.29

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack

Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HI-RATE DRILLING COMPANY LTD.

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Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | **Export to Excel**

GIC Well ID: 376657
GoA Well Tag No.
Drilling Company Well ID
Date Report Received: 1980/11/03

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #5	PADDY'S FLAT			CANADA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	12	13	22	6	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.872110 Longitude -114.713959
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

DRILLER REPORTS BLOW OUT @ 60' @ 10-15 GPM. WATER NO GOOD SULFATES. WELL WAS ABANDONED & CEMENTED DUE TO PRESENCE OF HYDROGEN SULPHIDE.

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
HI-RATE DRILLING COMPANY LTD.

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Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 376658
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA ENV #WELL 3	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
2.74		Gravel
26.21		Gray Hard Sandstone
30.48		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1979/09/22	22.73	3.08
1979/09/22	22.73	3.08

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
30.48 m		1979/09/12	1979/09/13

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	30.48

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.478 cm
Bottom at : 12.19 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 30.48 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
17.68	30.48	0.318		15.24

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 12.19 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

GIC Well ID 376658
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

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Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA ENV #WELL 3	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 376658
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA ENV #WELL 3	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1979/09/22	12:00 AM	3.08 m

Method of Water Removal

Type Pump
Removal Rate 22.73 L/min
Depth Withdrawn From 12.19 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1979/09/22	12:00 AM	3.08 m

Method of Water Removal

Type Pump
Removal Rate 22.73 L/min
Depth Withdrawn From 12.19 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
0.31	0:00	
0.45	1:00	0.75
0.52	2:00	0.65
0.58	3:00	0.60
0.63	4:00	0.56
0.66	5:00	0.53
0.69	6:00	0.51
0.72	7:00	0.49
0.74	8:00	0.48
0.75	9:00	0.47
0.77	10:00	0.46
0.78	11:00	0.45
0.79	12:00	0.44
0.80	13:00	0.44
0.81	14:00	0.43
0.82	15:00	0.43
0.82	16:00	0.43
0.83	17:00	0.42
0.83	18:00	0.42
0.84	20:00	0.42
0.85	22:00	0.41
0.85	24:00	0.41
0.87	30:00	
0.88	34:00	
0.89	40:00	
0.89	45:00	
0.90	50:00	
0.91	55:00	
0.91	60:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner — Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

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GIC Well ID 376659
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #WELL 4	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
2.13		Shattered Gravel
3.05		Till
12.19		Gray Shale
14.94		Gray Sandstone
15.54		Gray Shale
17.68		Gray Sandstone
17.98		Gray Shale
18.90		Gray Sandstone
19.81		Gray Shale
20.12		Gray Sandstone
21.64		Gray Shale
21.95		Gray Fine Grained Sandstone
23.16		Gray Shale
24.38		Gray Sandstone
26.21		Gray Shale
27.13		Gray Sandstone
32.00		Gray Shale
33.83		Gray Sandstone
36.58		Gray Sandy Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1979/09/13	18.18	1.65
1979/09/23	4.55	1.68

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
36.58 m		1979/09/13	1979/09/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	36.58

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.478 cm
Bottom at : 12.50 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.000 cm
Top at : 11.89 m
Bottom at : 36.58 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
18.90	36.58	0.318		15.24

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 12.50 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 376659
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #WELL 4	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well
LINER CHANGES ARE MADE BY THE DRILLER DEC 3/80.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1979/09/13	12:00 AM	1.65 m

Method of Water Removal

Type Air
Removal Rate 18.18 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1979/09/23	12:00 AM	1.68 m

Method of Water Removal

Type Pump
Removal Rate 4.55 L/min
Depth Withdrawn From 12.80 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
0.16	0:00	0.25
0.19	1:00	0.20
0.20	2:00	0.19
0.21	3:00	0.18
0.22	4:00	0.18
0.22	5:00	0.17
0.23	6:00	0.17
0.23	8:00	0.17
0.24	9:00	0.17
0.24	10:00	0.16
0.24	12:00	0.16
0.24	15:00	0.16
0.24	20:00	0.16
0.25	25:00	0.16
0.25	30:00	0.16

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

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GIC Well ID 376659
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #WELL 4	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID: 376660
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #WELL 2	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.05		Gravel
14.02		Gray Hard Shale
16.46		Coarse Grained Sandstone
18.59		Gray Hard Shale
20.12		Gray Hard Sandstone
26.21		Gray Hard Shale
27.74		Gray Hard Sandstone
28.96		Gray Hard Shale
30.78		Gray Sandstone
35.05		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1979/09/11	68.19	0.00

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
35.05 m		1979/09/11	1979/09/12

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	35.05

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.478 cm
Bottom at : 13.11 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 35.05 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
12.19	35.05	0.318		15.24

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 12.80 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 376660
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #WELL 2	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow Yes
Rate 0.00 L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1979/09/11	12:00 AM	0.00 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 68.19 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 376661
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #WELL 1	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
1.83		Gravel
9.75		Gray Hard Shale
10.36		Gray Hard Sandstone
12.80		Gray Hard Shale
13.11		Gray Hard Sandstone
16.46		Gray Hard Shale
17.07		Hard Sandstone
17.37		Gray Hard Shale
20.73		Gray Coarse Grained Sandstone
24.38		Gray Hard Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1979/09/11	27.28	1.13
1979/09/22	13.64	2.56

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
24.38 m		1979/09/11	1979/09/11

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	24.38

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.478 cm
Bottom at : 12.50 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.000 cm
Top at : 10.67 m
Bottom at : 24.38 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
12.19	24.38	0.318		15.24

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 12.50 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 376661
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #WELL 1	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 376661
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC #WELL 1	PADDY'S FLAT				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888386 Longitude -114.711110
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1979/09/11	12:00 AM	1.13 m

Method of Water Removal

Type Air
Removal Rate 27.28 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1979/09/22	12:00 AM	2.56 m

Method of Water Removal

Type Pump
Removal Rate 13.64 L/min
Depth Withdrawn From 12.19 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
0.78	0:00	1.41
0.97	1:00	1.08
1.10	2:00	0.97
1.18	3:00	0.90
1.24	4:00	0.85
1.28	5:00	0.84
1.32	6:00	0.83
1.34	7:00	0.83
1.36	8:00	0.83
1.37	9:00	0.82
1.38	10:00	0.82
1.39	11:00	0.82
1.39	12:00	0.82
1.40	13:00	0.82
1.40	14:00	0.82
1.41	16:00	0.82
1.41	18:00	0.81
1.41	20:00	0.81
1.41	23:00	
	25:00	0.81
1.41	26:00	
1.41	29:00	
1.41	35:00	
1.41	40:00	
1.41	45:00	
1.41	50:00	
1.41	55:00	
1.41	60:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SATELLITE DRILLING LTD.

Copy of Well report provided to owner — Date approval holder signed

Government of Alberta

Water Well Drilling Report

[View in Imperial] [Export to Excel]

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GIC Well ID	378457
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1994/05/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON, GARY	P.O. BOX 303 BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	06	35	022	05	5				

Measured from Boundary of
316.99 m from North
284.99 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.911297 Longitude -114.594349
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.05		Clay
5.49		Sand
10.06		Gray Clay
24.99		Gravel
25.30		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 45.46 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1994/05/06	54.55	22.80

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
25.30 m		1994/05/05	1994/05/06

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	25.30

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Steel
Size OD : 13.97 cm
Wall Thickness : 0.620 cm
Top at : 0.00 m
Bottom at : 24.99 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
22.25	24.99	0.318		25.40

Perforated by Torch

Annular Seal Bentonite Chips/Tablets
Placed from 0.00 m to 10.67 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M&M DRILLING CO. LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	378457
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1994/05/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MATHESON, GARY	P.O. BOX 303 BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	06	35	022	05	5				

Measured from Boundary of
316.99 m from North
284.99 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.911297 Longitude -114.594349
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 45.46 L/min
Recommended Pump Intake Depth (From TOC) 24.38 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORT HARD WATER, TDS APP 350.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1994/05/06	12:00 AM	22.80 m

Method of Water Removal

Type Pump
Removal Rate 54.55 L/min
Depth Withdrawn From 24.38 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
22.80	0:00	
22.87	1:00	22.95
22.88	2:00	22.95
22.88	3:00	22.94
22.89	4:00	22.94
22.89	5:00	22.94
22.90	6:00	22.94
22.91	7:00	22.93
22.91	8:00	22.93
22.91	9:00	22.93
22.91	10:00	22.93
22.91	12:00	22.92
22.92	14:00	22.92
22.92	16:00	22.92
22.94	20:00	22.92
22.94	25:00	22.91
22.95	30:00	22.91
22.96	35:00	22.91
22.96	40:00	22.90
22.98	50:00	22.89
22.97	60:00	22.88
22.99	75:00	22.87
23.01	90:00	22.87
23.02	105:00	22.86
23.03	120:00	22.86

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M&M DRILLING CO. LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

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GIC Well ID: 404291
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
#658267					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	13	18	022	05	5				

Measured from Boundary of
94.49 m from North
749.81 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.876730 Longitude -114.693092
How Location Obtained: Not Verified

Elevation 1440.48 m
How Elevation Obtained: Survey-Transit

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Industrial

Type of Work
Flowing Shot Hole

Plugged: 1968/12/15
Plugged with: Plug & Cement
Amount:

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate ____ L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
24.38 m		1968/12/01	1968/12/15

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	24.38

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
OTHER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404291
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
#658267					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	13	18	022	05	5				

Measured from Boundary of
94.49 m from North
749.81 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.876730 Longitude -114.693092
How Location Obtained
Not Verified

Elevation 1440.48 m
How Elevation Obtained
Survey-Transit

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLED BY TELEDYNE EXPLORATION LTD

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
OTHER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404292
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1985/04/17

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	MCLEAN'S DAY USE SHELTER				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	19	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888426 Longitude -114.676711
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Clay & Gravel
9.75		Gravel
11.28		Fractured Shale
30.48		Black Sand

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1985/03/14	3.41	12.80

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
30.48 m		1985/03/14	1985/03/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	30.48

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.620 cm
Bottom at : 13.41 m

Well Casing/Liner
Plastic
Size OD : 11.58 cm
Wall Thickness : 0.544 cm
Top at : 12.19 m
Bottom at : 30.48 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by Machine

Annular Seal Drive Shoe
Placed from 0.00 m to 13.41 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALKEN BASIN DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID 404292
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1985/04/17

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC	MCLEAN'S DAY USE SHELTER				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	19	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888426 Longitude -114.676711
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 15.24 m
Pump Installed Yes
Depth m
Type HAND
Make
H.P. .5
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS WATER IS MEDIUM HARD

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1985/03/14	12:00 AM	12.80 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Pump
Removal Rate 3.41 L/min
Depth Withdrawn From 28.96 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALKEN BASIN DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	404292
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2009/07/30

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA FOREST SERVICE			ALBERTA	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	19	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888426 Longitude -114.676711
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Unknown

Type of Work
Old Well - Abandoned

Plugged 2006/07/06
Plugged with Other
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
20.27 m			

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Size OD : cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Unknown
Size OD : 16.84 cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by Unknown

Annular Seal Unknown
Placed from m to m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN DRILLER11

Certification No
11

Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID: 404292
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 2009/07/30

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA FOREST SERVICE			ALBERTA	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	19	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.888426 Longitude -114.676711
How Location Obtained: Not Verified

Elevation m
How Elevation Obtained: Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Well Disinfected Upon Completion
Gas Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

WORK COMPLETED BY ALLAN MCCKAY -AM MACKAY CONTRACTRS LTD. BAROID HOLE PLUG (COURSE GRADE - 0.375 INCH) WAS USED TO PLUG HOLE. POURED FROM BAG @5MIN/BAG. CASING WAS NOT REMOVED.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN DRILLER11

Certification No
11

Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID	404293
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1985/04/17

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC#CAMPGROUND 1	MCLEAN CAMPGROUND				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	19	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.890234 Longitude -114.673852
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well-Abandoned

Plugged 1985/03/14
Plugged with Cement
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
7.62		Clay & Gravel
9.14		Gravel
30.48		Clay & Gravel
33.53		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
33.53 m		1985/03/13	1985/03/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	33.53

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack

Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALKEN BASIN DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 404293
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1985/04/17

Well Identification and Location
Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC#CAMPGROUND 1	MCLEAN CAMPGROUND				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	19	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.890234 Longitude -114.673852
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information
Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
FINE SAND & GRAVEL AT 25-30' WATER 2 GPM, UNABLE TO SCREEN

Yield Test
Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal
Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification
Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER
Certification No
1
Company Name
ALKEN BASIN DRILLING LTD.
Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 404294
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1971/12/06

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA LANDS & FORESTS	BEAVER FLATS REC AREA				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	20	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.881195 Longitude -114.665143
How Location Obtained
Map

Elevation 1463.04 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.40		Gravel & Boulders
8.84		Sand
10.67		Pea Gravel

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1970/09/18	145.47	3.96

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
10.67 m			1970/09/18

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	10.67

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.478 cm
Bottom at : 9.14 m

Well Casing/Liner
Steel
Size OD : 11.58 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 10.67 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
9.14	10.67	0.000		0.00

Perforated by

Annular Seal Driven & Grouted
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SCHMIDT DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID: 404294
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1971/12/06

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA LANDS & FORESTS	BEAVER FLATS REC AREA				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	20	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.881195 Longitude -114.665143
How Location Obtained
Map

Elevation 1463.04 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed Yes
Depth m
Type HAND
Make BEATTY
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1970/09/18	12:00 AM	3.96 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Pump
Removal Rate 145.47 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
SCHMIDT DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	404296
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1982/07/29

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KINSMEN CAMP HORIZON	P.O. BOX 37 BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	29	022	05	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 50.903070 Longitude -114.665141

How Location Obtained

Field

Elevation 1402.08 m

How Elevation Obtained

Estimated

Drilling Information

Method of Drilling

Unknown

Proposed Well Use

Domestic

Type of Work

Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
18.29 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	18.29

Surface Casing (if applicable)

Size OD : 0.00 cm

Wall Thickness : 0.000 cm

Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm

Wall Thickness : 0.000 cm

Top at : 0.00 m

Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m

Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment

Top Fittings

Bottom Fittings

Pack

Type

Grain Size

Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

UNKNOWN NA DRILLER

Company Name

UNKNOWN DRILLER

Certification No

1

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID: 404296
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1982/07/29

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KINSMEN CAMP HORIZON	P.O. BOX 37 BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	29	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903070 Longitude -114.665141
How Location Obtained: Field

Elevation 1402.08 m
How Elevation Obtained: Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level ____ cm
Is Artesian Flow ____
Rate ____ L/min
Is Flow Control Installed ____
Describe ____

Recommended Pump Rate ____ L/min
Recommended Pump Intake Depth (From TOC) ____ m
Pump Installed ____ Depth ____ m
Type ____ Make ____ H.P. ____
Model (Output Rating) ____

Did you Encounter Saline Water (>4000 ppm TDS) ____ Depth ____ m
Gas ____ Depth ____ m
Well Disinfected Upon Completion ____
Geophysical Log Taken ____
Submitted to ESRD
Sample Collected for Potability ____ Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type ____
Removal Rate ____ L/min
Depth Withdrawn From ____ m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner | Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID: 404297
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1977/05/12

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KINSMEN CAMP HORIZON	P.O. BOX 37 BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NH	29	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903070 Longitude -114.659421
How Location Obtained
Not Verified

Elevation 1347.22 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1977/05/10		22.86

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
30.48 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	30.48

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

[View in Imperial] [Export to Excel]

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 404297
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1977/05/12

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KINSMEN CAMP HORIZON	P.O. BOX 37 BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NH	29	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903070 Longitude -114.659421
How Location Obtained
Not Verified

Elevation 1347.22 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well
SAMPLE FROM KITCHEN TAP

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1977/05/10	12:00 AM	22.86 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

[View in Imperial] [Export to Excel]

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 404298
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1987/09/28

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KINSMEN CAMP HORIZON	P.O. BOX 540 BRAGG CREEK		AB	CA	T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	29	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903070 Longitude -114.653700
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.61		Till
7.32		Coarse Grained Gravel
18.29		Fine Grained Gravel
21.34		Coarse Grained Gravel & Boulders
30.48		Yellow Sandstone
33.53		Gray Siltstone
39.62		Fractured Sandstone
42.67		Bentonitic Shale
47.24		Gray Sandstone
48.46		Brown Sandstone
52.43		Gray Sandstone
54.86		Green Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 45.46 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1987/09/15	54.55	26.82

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
54.86 m		1987/09/15	1987/09/15

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	54.86

Surface Casing (if applicable)
Steel
Size OD : 16.84 cm
Wall Thickness : 0.478 cm
Bottom at : 21.34 m

Well Casing/Liner
Plastic
Size OD : 13.97 cm
Wall Thickness : 0.630 cm
Top at : 0.00 m
Bottom at : 54.86 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by Other

Annular Seal Driven
Placed from 21.03 m to 21.34 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 404298
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1987/09/28

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KINSMEN CAMP HORIZON	P.O. BOX 540 BRAGG CREEK		AB	CA	T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	29	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903070 Longitude -114.653700
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 45.46 L/min
Recommended Pump Intake Depth (From TOC) 51.82 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
WATER AT 90-100' @ 5 GPM, AT 110-130' @ 7 GPM. WELL RECONDITIONED: SEE WELL ID#1020984.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1987/09/15	12:00 AM	26.82 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 54.55 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 404299
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1979/12/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	03	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.894030 Longitude -114.685282
How Location Obtained
Map

Elevation 1437.13 m
How Elevation Obtained
Survey-Transit

Drilling Information

Method of Drilling
Combination

Proposed Well Use
Domestic

Type of Work
Dry Hole

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.57		Clay
29.57		Sand & Gravel
32.00		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
32.00 m		1979/11/05	1979/11/06

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	32.00

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings | Bottom Fittings

Pack

Type | Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
GOODISON WATER WELL DRILLING

Copy of Well report provided to owner | Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 404299
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1979/12/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	03	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.894030 Longitude -114.685282
How Location Obtained
Map

Elevation 1437.13 m
How Elevation Obtained
Survey-Transit

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
GOODISON WATER WELL DRILLING

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	404300
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1979/12/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	05	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.897646 Longitude -114.691003
How Location Obtained
Map

Elevation 1399.03 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Combination

Type of Work
New Well

Proposed Well Use
Municipal

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.27		Sand & Gravel
5.49		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1979/11/08		2.59

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
5.49 m		1979/11/07	1979/11/08

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	5.49

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Steel
Size OD : 16.84 cm
Wall Thickness : 0.478 cm
Top at : 0.00 m
Bottom at : 4.57 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
3.05	4.57	0.318		15.24

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
GOODISON WATER WELL DRILLING

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID: 404300
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1979/12/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PARKS & REC					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	05	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.897646 Longitude -114.691003
How Location Obtained
Map

Elevation 1399.03 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1979/11/08	12:00 AM	2.59 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
GOODISON WATER WELL DRILLING

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	404301
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1981/02/28

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
WHISSEL ENT	1323 48 AVE NE, CALGARY				T2E 5T4

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	05	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.897646 Longitude -114.691003
How Location Obtained
Map

Elevation 1310.64 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
2.13		Gravel & Boulders
5.18		Sand & Gravel
5.49		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1981/02/17	486.43	1.98

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
5.49 m		1981/02/12	1981/02/20

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	5.49

Surface Casing (if applicable)
Steel

Size OD : 21.92 cm
Wall Thickness : 0.818 cm
Bottom at : 3.96 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type Stainless Steel

Size OD : 17.78 cm

From (m)	To (m)	Slot Size (cm)
3.66	5.49	0.198

Attachment
Top Fittings Packer
Bottom Fittings Bail

Pack

Type
Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
WEBSTER & WEBSTER

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

GIC Well ID	404301
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1981/02/28

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
WHISSEL ENT	1323 48 AVE NE, CALGARY				T2E 5T4

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	05	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.897646 Longitude -114.691003
How Location Obtained
Map

Elevation 1310.64 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
WEBSTER & WEBSTER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 404301
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1981/02/28

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
WHISSEL ENT	1323 48 AVE NE, CALGARY				T2E 5T4

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	05	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.897646 Longitude -114.691003
How Location Obtained
Map

Elevation 1310.64 m
How Elevation Obtained
Estimated

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1981/02/17	12:00 AM	1.98 m

Method of Water Removal

Type: Pump
Removal Rate: 486.43 L/min
Depth Withdrawn From: 3.05 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
2.97	1:00	2.31
	1:30	2.29
2.97	2:00	2.27
	2:30	2.26
2.98	3:00	2.25
	3:30	2.23
2.98	4:00	2.23
	4:30	2.23
	5:00	2.22
2.98	6:00	
2.98	8:00	2.21
	9:00	2.20
2.99	10:00	2.20
	11:00	2.19
	12:00	2.19
2.99	13:00	2.19
3.00	16:00	
3.00	20:00	
3.05	25:00	
3.05	32:00	
3.10	40:00	
3.05	50:00	
3.02	64:00	
3.05	80:00	
3.05	100:00	
3.06	120:00	
3.06	150:00	
3.09	190:00	
3.09	240:00	
3.09	300:00	
3.11	380:00	
3.11	480:00	
3.11	600:00	
3.11	780:00	
3.15	900:00	
3.15	1140:00	
3.12	1380:00	
3.12	1740:00	
3.12	2160:00	
3.14	2880:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
WEBSTER & WEBSTER

Copy of Well report provided to owner | Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial   Export to Excel

GIC Well ID 404302
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1988/11/28

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
FAIRWEATHER/ MOFFATT	BAG 1, ELBOW RANGER STN				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner   Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 404302
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1988/11/28

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
FAIRWEATHER/ MOFFATT	BAG 1, ELBOW RANGER STN				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 404303
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1989/08/21

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FORESTRY	BAG 1, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack

Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	404303
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1989/08/21

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FORESTRY	BAG 1, BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903069 Longitude -114.688145
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	404304
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1973/02/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FOREST SVC	NATURAL RESOUCES BLDG, EDMONTON			CANADA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	11	30	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.901262 Longitude -114.685284
How Location Obtained
Map

Elevation 1402.08 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Unknown

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.05		Sandy Gravel & Boulders
67.06		Black Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1972/08/08	4.55	42.98

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
67.06 m			1972/08/08

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	67.06

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.396 cm
Bottom at : 3.35 m

Well Casing/Liner
Steel
Size OD : 11.58 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 39.62 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M.E. LAWSON WATER WELLS

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 404304
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1973/02/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FOREST SVC	NATURAL RESOUCES BLDG, EDMONTON			CANADA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	11	30	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.901262 Longitude -114.685284
How Location Obtained
Map

Elevation 1402.08 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level: cm
Is Artesian Flow:
Rate: L/min
Is Flow Control Installed:
Describe:

Recommended Pump Rate: 0.00 L/min
Recommended Pump Intake Depth (From TOC): 0.00 m
Pump Installed:
Depth: m
Type:
Make:
H.P.:
Model (Output Rating):

Did you Encounter Saline Water (>4000 ppm TDS): Depth: m
Gas: Yes Depth: m
Well Disinfected Upon Completion:
Geophysical Log Taken:
Submitted to ESRD:
Sample Collected for Potability:
Submitted to ESRD: Yes

Additional Comments on Well
GAS PRESENT AT 123'.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1972/08/08	12:00 AM	42.98 m

Method of Water Removal

Type: Pump
Removal Rate: 4.55 L/min
Depth Withdrawn From: 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
	1:00	55.84
	2:00	55.29
	3:00	54.74
	4:00	54.19
	5:00	53.64
	6:00	53.10
	7:00	52.55
	8:00	52.00
	9:00	51.45
	10:00	50.90
	60:00	29.57
	120:00	19.20

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M.E. LAWSON WATER WELLS

Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

GIC Well ID	404305
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1974/11/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CTRELL, BRIAN	P.O. BOX 68 BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	00	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.899454 Longitude -114.682424
How Location Obtained
Field

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
1.52 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	1.52

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	404305
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1974/11/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CTRELL, BRIAN	P.O. BOX 68 BRAGG CREEK				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	00	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.899454 Longitude -114.682424
How Location Obtained
Field

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

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Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID: 404306
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FORESTRY DIV #WELL2	GOOSEBERRY FLAT REC AREA				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	00	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.914162 Longitude -114.636397
How Location Obtained
Field

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.88		Gravel & Boulders
13.11		Gravel
13.41		Hard Rocks

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1967/10/19	68.19	5.85

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
13.41 m			1967/10/19

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	13.41

Surface Casing (if applicable)
Steel
Size OD : 11.58 cm
Wall Thickness : 0.000 cm
Bottom at : 12.50 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Cement/Grout
Placed from 0.00 m to 4.57 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
CORALTA DRLG

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

GIC Well ID: 404306
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

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Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FORESTRY DIV #WELL2	GOOSEBERRY FLAT REC AREA				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	00	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.914162 Longitude -114.636397
How Location Obtained
Field

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed Yes
Depth m
Type HAND
Make BEATTY
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1967/10/19	12:00 AM	5.85 m

Method of Water Removal

Type Bailer
Removal Rate 68.19 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
5.85	1:00	5.91
5.91	2:00	5.85
5.91	3:00	5.85
5.91	4:00	
5.91	10:00	
5.91	60:00	
5.91	180:00	
5.91	300:00	
5.91	360:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
CORALTA DRLG

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404307
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA LANDS & FORESTS	NATURAL RESOURCES BLDG, EDMONTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.630674
How Location Obtained
Field

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
1.52		Brown Clay
5.49		Sandy Clay & Rocks
7.62		Pea Gravel
9.45		Sand & Gravel
13.72		Shale
14.02		Sandstone
23.16		Hard Shale
25.91		Sandstone
31.70		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1966/10/31	13.64	6.10

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
31.70 m			1966/10/31

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	31.70

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Steel
Size OD : 11.58 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 26.21 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
13.72	25.91	0.000		0.00

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
CORALTA DRLG

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404307
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA LANDS & FORESTS	NATURAL RESOURCES BLDG, EDMONTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.630674
How Location Obtained
Field

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1966/10/31	12:00 AM	6.10 m

Method of Water Removal

Type Pump
Removal Rate 13.64 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
6.40	1:00	7.01
6.71	2:00	6.58
6.89	3:00	6.64
7.19	4:00	6.58
7.32	5:00	6.49
7.32	6:00	
7.32	7:00	
7.32	8:00	
7.32	9:00	
7.32	10:00	6.43
	30:00	6.40
7.32	60:00	
7.32	120:00	
7.32	240:00	
7.32	360:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
CORALTA DRLG

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	404308
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1983/01/18

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
HYDROGEOLOGICAL CONSULTANTS	10704 181 ST, EDMONTON				T5S 1K8

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.630674
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.91		Gravel
1.52		Clay & Rocks
5.18		Gravel
6.71		Clay & Rocks
11.28		Cemented Gravel
22.86		Gravelly Clay & Rocks
23.47		Brown Clay
27.43		Green Shale
28.96		Green Sandstone
32.00		Gray Shale
37.19		Blue Sandstone
40.23		Blue Shale
43.28		Sandstone
47.85		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 45.46 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1982/12/17	54.55	23.87

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
47.85 m		1982/12/16	1982/12/17

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	47.85

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.478 cm
Bottom at : 25.91 m

Well Casing/Liner
Steel
Size OD : 11.58 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 47.85 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
27.43	28.96	0.318		30.48
32.00	37.19	0.000		0.00
40.23	43.28	0.000		0.00

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M&M DRILLING CO. LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	404308
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1983/01/18

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
HYDROGEOLOGICAL CONSULTANTS	10704 181 ST, EDMONTON				T5S 1K8

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.630674
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 45.46 L/min
Recommended Pump Intake Depth (From TOC) 42.67 m
Pump Installed Yes
Depth m
Type SUB
Make GOULDS
H.P. 3/4
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS WATER IS MEDIUM HARD

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1982/12/17	12:00 AM	23.87 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 54.55 L/min
Depth Withdrawn From 46.63 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M&M DRILLING CO. LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID: 404309
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1984/02/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PUBLIC WORKS SUPPLY & SVC	P.O. BOX 1080 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.630674
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
24.38 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	24.38

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack

Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404309
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1984/02/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PUBLIC WORKS SUPPLY & SVC	P.O. BOX 1080 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.630674
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID: 404310
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CANNOP CREEK CAMPGROUND					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	07	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.912354 Longitude -114.633536
How Location Obtained
Not Verified

Elevation 1365.50 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID: 404310
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CANNOP CREEK CAMPGROUND					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	07	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.912354 Longitude -114.633536
How Location Obtained
Not Verified

Elevation 1365.50 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID: 404311
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1970/06/29

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KINSMEN CAMP HORIZON					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.642117
How Location Obtained: Field

Elevation m
How Elevation Obtained: Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings　Bottom Fittings

Pack
Type　Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner　Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 404311
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1970/06/29

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KINSMEN CAMP HORIZON					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910546 Longitude -114.642117
How Location Obtained
Field

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	404322
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1973/02/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA LANDS & FORESTS	PADDY'S FLAT REC AREA, BOW RIVER FOREST				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	13	13	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.875726 Longitude -114.713960
How Location Obtained
Map

Elevation 1432.56 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.88		Sandy Gravel & Boulders
13.72		Fractured Shale & Rocks
31.09		Shale & Sandstone Ledges

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1972/08/11	18.18	28.04

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
31.09 m			1972/08/11

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	31.09

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.396 cm
Bottom at : 13.72 m

Well Casing/Liner
Steel
Size OD : 11.58 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 30.48 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
24.38	30.48	0.000		0.00

Perforated by

Annular Seal Driven & Grouted
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M.E. LAWSON WATER WELLS

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404322
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1973/02/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA LANDS & FORESTS	PADDY'S FLAT REC AREA, BOW RIVER FOREST				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	13	13	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.875726 Longitude -114.713960
How Location Obtained
Map

Elevation 1432.56 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD

Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1972/08/11	12:00 AM	28.04 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Pump
Removal Rate 18.18 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M.E. LAWSON WATER WELLS

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	404324
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1978/08/11

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PADDY'S FLAT CAMPGROUND					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	13	13	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.875726 Longitude -114.713960
How Location Obtained
Not Verified

Elevation 1493.52 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
16.76 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	16.76

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404324
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1978/08/11

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PADDY'S FLAT CAMPGROUND					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	13	13	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.875726 Longitude -114.713960
How Location Obtained
Not Verified

Elevation 1493.52 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	404330
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1973/02/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FOREST SVC #WELL2	PADDYS FLAT REC AREA, BOW RIVER FOREST				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	06	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.882962 Longitude -114.708248
How Location Obtained
Map

Elevation 1432.56 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.96		Sandy Gravel & Boulders
5.79		Fractured Shale
13.41		Sandstone
16.76		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1972/08/14	25.00	13.41

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
16.76 m			1972/08/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	16.76

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.478 cm
Bottom at : 3.96 m

Well Casing/Liner
Steel
Size OD : 11.58 cm
Wall Thickness : 0.396 cm
Top at : 0.00 m
Bottom at : 16.76 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
12.19	16.76	0.000		0.00

Perforated by

Annular Seal Driven & Grouted
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M.E. LAWSON WATER WELLS

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 404330
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1973/02/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA FOREST SVC #WELL2	PADDYS FLAT REC AREA, BOW RIVER FOREST				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	06	24	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.882962 Longitude -114.708248
How Location Obtained: Map

Elevation 1432.56 m
How Elevation Obtained: Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level ____ cm
Is Artesian Flow ____
Rate ____ L/min
Is Flow Control Installed ____
Describe ____

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed ____ Depth ____ m
Type ____ Make ____ H.P. ____
Model (Output Rating) ____

Did you Encounter Saline Water (>4000 ppm TDS) ____ Depth ____ m
Gas ____ Depth ____ m
Well Disinfected Upon Completion ____
Geophysical Log Taken ____
Submitted to ESRD
Sample Collected for Potability ____ Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1972/08/14	12:00 AM	13.41 m

Method of Water Removal

Type: Pump
Removal Rate: 25.00 L/min
Depth Withdrawn From: 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
	1:00	14.33
	2:00	13.41
	3:00	12.74
	4:00	12.25
	5:00	11.73
	6:00	11.43
	7:00	11.16
	8:00	10.79
	9:00	10.52
	10:00	10.27
	60:00	8.23

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: UNKNOWN NA DRILLER
Certification No: 1
Company Name: M.E. LAWSON WATER WELLS
Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	404333
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1973/11/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
RIVER LOVE GROUP CAMP					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	25	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.895801 Longitude -114.711115
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
9.75		Sand & Gravel

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1973/09/08	45.46	0.00

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
9.75 m			1973/09/08

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	9.75

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.478 cm
Bottom at : 9.75 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Driven
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M.E. LAWSON WATER WELLS

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	404333
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1973/11/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
RIVER LOVE GROUP CAMP					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	25	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.895801 Longitude -114.711115
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1973/09/08	12:00 AM	0.00 m

Method of Water Removal

Type Pump
Removal Rate 45.46 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
	1:00	6.40
	2:00	4.88
	3:00	3.83
	4:00	3.40
	5:00	3.28
	6:00	3.20
	7:00	3.15
	8:00	3.12
	9:00	3.10
	10:00	3.07
	60:00	2.44

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
M.E. LAWSON WATER WELLS

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID	404335
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1979/09/11

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CHEVRON STANDARD #RIG WELL	400 5 AVE SW, CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	06	25	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.897609 Longitude -114.708255
How Location Obtained
Map

Elevation 1463.04 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Cable Tool

Type of Work
New Well

Proposed Well Use
Industrial

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
4.57		Clay
6.10		Gravel

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 136.38 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1979/08/02	136.38	4.57

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
6.10 m		1979/08/02	1979/08/02

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	6.10

Surface Casing (if applicable)
Steel
Size OD : 17.78 cm
Wall Thickness : 0.587 cm
Bottom at : 5.49 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Driven
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
TAKS & SONS DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID	404335
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1979/09/11

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CHEVRON STANDARD #RIG WELL	400 5 AVE SW, CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	06	25	022	06	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.897609 Longitude -114.708255
How Location Obtained
Map

Elevation 1463.04 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 136.38 L/min
Recommended Pump Intake Depth (From TOC) 5.49 m
Pump Installed Yes
Type SUB
Depth m
Make STARITE
H.P. 3/4
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
1979/08/02	12:00 AM	4.57 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Pump
Removal Rate 136.38 L/min
Depth Withdrawn From 4.88 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
TAKS & SONS DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID	404337
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SHELL CAN#752					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	09	26	022	06	5				

Measured from Boundary of
426.72 m from North
320.04 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.902863 Longitude -114.721766
How Location Obtained
Not Verified

Elevation 1485.90 m
How Elevation Obtained
Survey-Transit

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Industrial

Type of Work
Flowing Shot Hole

Plugged 1975/05/19
Plugged with Cement
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Clay & Rocks
18.29		Sandstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1975/08/01	4.55	0.00

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
18.29 m			1975/05/19

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	18.29

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
OTHER

Certification No
1

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Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404337
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SHELL CAN#752					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	09	26	022	06	5				

Measured from Boundary of
426.72 m from North
320.04 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.902863 Longitude -114.721766
How Location Obtained
Not Verified

Elevation 1485.90 m
How Elevation Obtained
Survey-Transit

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLED BY SHELL PARTY #4

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1975/08/01	12:00 AM	0.00 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type
Removal Rate 4.55 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
OTHER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404343
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SHELL CAN#768					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	02	35	022	06	5				

Measured from Boundary of
688.85 m from North
746.76 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.907788 Longitude -114.727886
How Location Obtained
Not Verified

Elevation 1494.43 m
How Elevation Obtained
Survey-Transit

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Industrial

Type of Work
Flowing Shot Hole

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Clay & Rocks
18.29		Sandstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1975/08/10	4.55	0.00

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
18.29 m		1975/08/10	

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	18.29

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
OTHER

Certification No
1

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Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404343
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SHELL CAN#768					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	02	35	022	06	5				

Measured from Boundary of
688.85 m from North
746.76 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.907788 Longitude -114.727886
How Location Obtained
Not Verified

Elevation 1494.43 m
How Elevation Obtained
Survey-Transit

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLED BY SHELL PARTY #4

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
1975/08/10	12:00 AM	0.00 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type
Removal Rate 4.55 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
OTHER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	404345
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
#658251					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	02	36	022	06	5				

Measured from Boundary of
472.14 m from North
646.18 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.909733 Longitude -114.703406
How Location Obtained
Not Verified

Elevation 1425.24 m
How Elevation Obtained
Survey-Transit

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Industrial

Type of Work
Flowing Shot Hole

Plugged 1968/12/15
Plugged with Plug & Cement
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
24.38 m		1968/11/29	1968/12/15

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	24.38

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
OTHER

Certification No
1

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Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID: 404345
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
#658251					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	02	36	022	06	5				

Measured from Boundary of
472.14 m from North
646.18 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.909733 Longitude -114.703406
How Location Obtained
Not Verified

Elevation 1425.24 m
How Elevation Obtained
Survey-Transit

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level ______ cm
Is Artesian Flow ______
Rate ______ L/min
Is Flow Control Installed ______
Describe ______

Recommended Pump Rate ______ L/min
Recommended Pump Intake Depth (From TOC) ______ m
Pump Installed ______ Depth ______ m
Type ______ Make ______ H.P. ______
Model (Output Rating) ______

Did you Encounter Saline Water (>4000 ppm TDS) ______ Depth ______ m
Gas ______ Depth ______ m
Well Disinfected Upon Completion ______
Geophysical Log Taken ______
Submitted to ESRD
Sample Collected for Potability ______ Submitted to ESRD ______

Additional Comments on Well
DRILLED BY TELEDYNE EXPLORATION LTD

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal
Type ______
Removal Rate ______ L/min
Depth Withdrawn From ______ m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
OTHER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 404347
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
#656252					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	02	36	022	06	5				

Measured from Boundary of
605.94 m from North
798.27 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.908531 Longitude -114.705569
How Location Obtained
Not Verified

Elevation 1440.79 m
How Elevation Obtained
Survey-Transit

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Industrial

Type of Work
Flowing Shot Hole

Plugged 1968/12/15
Plugged with Plug & Cement
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
24.38 m		1968/11/29	1968/12/15

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	24.38

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
OTHER

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 404347
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
#656252					

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	02	36	022	06	5				

Measured from Boundary of
605.94 m from North
798.27 m from East

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.908531 Longitude -114.705569
How Location Obtained
Not Verified

Elevation 1440.79 m
How Elevation Obtained
Survey-Transit

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLED BY TELEDYNE EXPLORATION LTD

Yield Test

Taken From Ground Level | Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
OTHER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 496572
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2000/08/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CONNOP, JIM	P.O. BOX 690 BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	28	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903140 Longitude -114.630677
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
2.44		Clay & Rocks
10.67		Gravel
13.41		Shale
14.63		Sandstone
21.03		Shale
21.64		Sandstone
26.82		Shale & Sandstone Ledges
30.48		Sandstone
31.70		Shale
33.53		Sandstone
34.44		Shale
35.36		Sandstone
37.49		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 18.18 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2000/07/24	26.14	14.87

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
37.49 m		2000/07/17	2000/07/18

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	37.49

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 12.19 m

Well Casing/Liner
Plastic
Size OD : 12.55 cm
Wall Thickness : 0.655 cm
Top at : 9.75 m
Bottom at : 37.49 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
26.82	37.19	0.318		15.24

Perforated by Saw

Annular Seal Bentonite Chips/Tablets
Placed from 0.00 m to 12.19 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	496572
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2000/08/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CONNOP, JIM	P.O. BOX 690 BRAGG CREEK				T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	28	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903140 Longitude -114.630677
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 18.18 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 25.91 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 1.25'.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
2000/07/24	12:00 AM	14.87 m

Method of Water Removal

Type Pump
Removal Rate 26.14 L/min
Depth Withdrawn From 35.05 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
14.89	0:00	
17.20	1:00	19.73
17.70	2:00	18.50
17.97	3:00	17.90
18.26	4:00	17.48
18.67	5:00	17.23
18.98	6:00	17.04
19.27	7:00	16.87
19.44	8:00	16.72
19.62	9:00	16.68
19.82	10:00	16.61
20.10	12:00	16.51
20.30	14:00	16.43
20.51	16:00	16.39
20.79	20:00	16.30
21.08	25:00	16.19
21.25	30:00	16.13
21.41	35:00	16.02
21.59	40:00	16.00
21.84	50:00	15.94
21.98	60:00	
22.72	75:00	15.77
23.25	90:00	15.65
23.69	105:00	15.56
24.00	120:00	15.51

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID	497684
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2001/02/14

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
HUSKY OIL/PRECISION 509#CAMP	CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	34	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.917771 Longitude -114.607639
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
10.97		Clay
23.16		Gravel

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 68.19 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2001/01/16	68.19	16.46

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
23.16 m		2001/01/16	2001/01/16

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	23.16

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.620 cm
Bottom at : 23.16 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Driven & Bentonite
Placed from 0.00 m to 23.16 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
AERO DRILLING & CONSULTING LTD.

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	497684
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2001/02/14

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
HUSKY OIL/PRECISION 509#CAMP	CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	34	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.917771 Longitude -114.607639
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 68.19 L/min
Recommended Pump Intake Depth (From TOC) 21.34 m
Pump Installed Yes
Depth m
Type SUB
Make GOULD
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 3'.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
2001/01/16	12:00 AM	16.46 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 68.19 L/min
Depth Withdrawn From 22.86 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AERO DRILLING & CONSULTING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 1020984
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CAMP HORIZON	P.O. BOX 540	BRAGG CREEK	AB	CA	TOL 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	29	022	05	5				3011

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903100 Longitude -114.654000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Municipal

Type of Work
Reconditioned

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.61		Till
7.32		Coarse Grained Gravel
21.03		Fine Grained Gravel
21.34		Gravel & Boulders
30.48		Yellow Sandstone
36.58		Gray Sandstone
39.62		Fractured Sandstone
42.67		Bentonitic Shale
47.24	Yes	Gray Water Bearing Sandstone
48.46	Yes	Brown Water Bearing Sandstone
52.73	Yes	Gray Water Bearing Sandstone
54.86		Green Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 18.18 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2005/06/03	27.28	27.16

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
54.86 m		2005/06/03	2005/06/03

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 21.34 m

Well Casing/Liner
Plastic
Size OD : 12.70 cm
Wall Thickness : 0.556 cm
Top at : 12.19 m
Bottom at : 54.86 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
42.67	54.86	0.478		15.24

Perforated by Saw

Annular Seal Driven & Grouted
Placed from 12.19 m to 42.67 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS

Company Name
AARON DRILLING INC.

Certification No
VA4996

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID	1020984
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CAMP HORIZON	P.O. BOX 540	BRAGG CREEK	AB	CA	TOL 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	29	022	05	5				3011

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903100 Longitude -114.654000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 18.18 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 51.82 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Well Disinfected Upon Completion
Gas Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLERS WELLID 339206,ORIGINAL WELL LOG #404298 PUMP TEST MONITORED BY DATA LOGGER Q20 INTERP BY GROUNDWATER EX.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
2005/06/03	12:00 AM	27.16 m

Method of Water Removal

Type Pump
Removal Rate 27.28 L/min
Depth Withdrawn From 51.82 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
27.92	10:00	28.28
28.19	100:00	27.98
28.44	300:00	27.81
28.70	600:00	27.68
28.90	900:00	27.58
29.42	1440:00	27.49
	2640:00	27.37

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS

Certification No
VA4996

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

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GIC Well ID: 1020988
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CAMP HORIZON	P.O. BOX 540	BRAGG CREEK	AB	CA	T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	29	022	05	5				2972

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903100 Longitude -114.654000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Municipal

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Till
21.95		Gravel
26.21		Brown Sandstone
35.05	Yes	Gray Water Bearing Sandstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 9.09 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2003/05/08	13.64	22.86

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
35.05 m		2003/05/08	2003/05/08

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 23.77 m

Well Casing/Liner
Plastic
Size OD : 12.70 cm
Wall Thickness : 0.556 cm
Top at : 22.86 m
Bottom at : 35.05 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
28.96	35.05	0.478		15.24

Perforated by Saw

Annular Seal Driven & Grouted
Placed from m to 27.43 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS

Company Name
AARON DRILLING INC.

Certification No
VA4996

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID: 1020988
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received:

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CAMP HORIZON	P.O. BOX 540	BRAGG CREEK	AB	CA	T0L 0K0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	29	022	05	5				2972

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.903100 Longitude -114.654000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 9.09 L/min
Recommended Pump Intake Depth (From TOC) 32.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLERS WELLID 339207, TDS 440, IRON <0.5, HARD 12. PUMP TEST MONITORED BY DATA LOGGER Q20 INTERP BY GROUNDWATER EX.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
2003/05/08	12:00 AM	22.86 m

Method of Water Removal
Type Pump
Removal Rate 13.64 L/min
Depth Withdrawn From 33.53 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
23.52	10:00	23.56
23.73	100:00	23.20
23.91	600:00	22.92
23.94	1260:00	22.86
23.95	1440:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS
Company Name
AARON DRILLING INC.

Certification No
VA4996
Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 1020993
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA INFRASTRUCTURE	802 620 7 AVE SW	CALGARY	AB	CA	T2P 0Y8

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				5631

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910400 Longitude -114.631000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Type of Work
New Well

Proposed Well Use
Municipal

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
1.83		Gravel
5.79		Clay & Rocks
7.92		Clay
14.94		Gravel
16.46		Gray Shale
19.20		Sandstone
20.12		Gray Shale
31.09	Yes	Water Bearing Sandstone
33.83		Siltstone
35.05		Sandstone
36.88		Gray Shale
45.11	Yes	Water Bearing Sandstone
47.24		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 13.64 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2005/03/15	18.18	7.13

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
47.24 m		2005/03/14	2005/03/14

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 17.98 m

Well Casing/Liner
Plastic
Size OD : 12.70 cm
Wall Thickness : 0.556 cm
Top at : 10.67 m
Bottom at : 47.24 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
36.58	47.24	0.478		15.24

Perforated by Saw

Annular Seal Driven & Grouted
Placed from m to 35.05 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type Unknown
Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS

Company Name
AARON DRILLING INC.

Certification No
VA4996

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

GIC Well ID 1020993
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA INFRASTRUCTURE	802 620 7 AVE SW	CALGARY	AB	CA	T2P 0Y8

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				5631

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910400 Longitude -114.631000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 13.64 L/min
Recommended Pump Intake Depth (From TOC) 45.72 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLERS WELLID 339513,Q20 INTERP BY GROUNDWATER EX WATER ANALYSIS DONE BY WSH LABS.

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
2005/03/15	12:00 AM	7.13 m

Method of Water Removal
Type Pump
Removal Rate 18.18 L/min
Depth Withdrawn From 45.72 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
10.85	10:00	10.42
13.85	100:00	7.52
14.41	300:00	6.96
14.64	620:00	6.71
14.87	1450:00	

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS
Company Name
AARON DRILLING INC.

Certification No
VA4996
Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID: 1021009
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA INFRASTRUCTURE	802 620 7 AVE SW	CALGARY	AB	CA	T2P 0Y8

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910400 Longitude -114.631000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
Old Well-Abandoned

Plugged 2005/03/15
Plugged with Bentonite Product
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
27.43		Old Well

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2005/03/15		6.71

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
27.43 m		2005/03/15	2005/03/15

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Unknown
Size OD : cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Unknown
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by Unknown

Annular Seal Bentonite Chips/Tablets
Placed from 0.00 m to 27.43 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS

Company Name
AARON DRILLING INC.

Certification No
VA4996

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 1021009
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALTA INFRASTRUCTURE	802 620 7 AVE SW	CALGARY	AB	CA	T2P 0Y8

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	33	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.910400 Longitude -114.631000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

DRILLERS WELLID 339514, ORIGINAL WELL ID 376643 DRILLED IN '82' BY BIG QUILL FOR ATA ENV. WELL PUMP AND LINER WERE PULLED. WELL WAS CHLORINATED AND FILLED FULL LENGTH WITH BENTONITE. SURFACE CASING WAS CUT OFF AT 8' BELOW GRADE.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
2005/03/15	12:00 AM	6.71 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Unknown
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS

Certification No
VA4996

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 1021822
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SLIMDOR CONTRACTING	42 GRIFFIN IND PARK	COCHRANE	AB	CA	T4C 0A3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.895700 Longitude -114.688000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well-Abandoned

Plugged 2008/08/02
Plugged with Bentonite Product
Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.66		Gravel
30.48		Black Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2008/08/02	1.14	2.44

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
30.48 m		2008/08/02	2008/08/02

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 5.49 m

Well Casing/Liner
Unknown
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by Unknown

Annular Seal Bentonite Chips/Tablets
Placed from 5.49 m to 30.48 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS

Company Name
AARON DRILLING INC.

Certification No
VA4996

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 1021822
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SLIMDOR CONTRACTING	42 GRIFFIN IND PARK	COCHRANE	AB	CA	T4C 0A3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	30	022	05	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.895700 Longitude -114.688000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
SURFACE CASING COULD NOT BE PULLED, AARON WELL ID 340041, WELL FINISH - CASING

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
2008/08/02	12:00 AM	2.44 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
2.44	0:00	30.48

Method of Water Removal

Type Bailer & Air
Removal Rate 1.14 L/min
Depth Withdrawn From 30.48 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
BRAD MEYERS

Certification No
VA4996

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 2092541
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA FOREST SERVICE			AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	19	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.881200 Longitude -114.688000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Unknown

Type of Work
Old Well-Abandoned

Plugged 2006/07/06
Plugged with Other
Amount 97.08 Feet

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
29.59 m			

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Unknown
Size OD : 16.83 cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Unknown
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from m to m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN DRILLER11

Certification No
11

Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner

Date approval holder signed
2006/06/06

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 2092541
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA FOREST SERVICE			AB	CA	

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	19	22	5	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.881200 Longitude -114.688000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

DRILLING REPORT FOR ORIGINAL WELL NOT HELD IN GIC. WORK COMPLETED BY ALLAN MCCKAY -AM MACKAY CONTRACTRS LTD. 5 BAGS OF BAROID HOLE PLUG (COURSE GRADE - 0.375 INCH) WAS USED TO PLUG HOLE. CASING WAS NOT REMOVED.

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN DRILLER11

Certification No
11

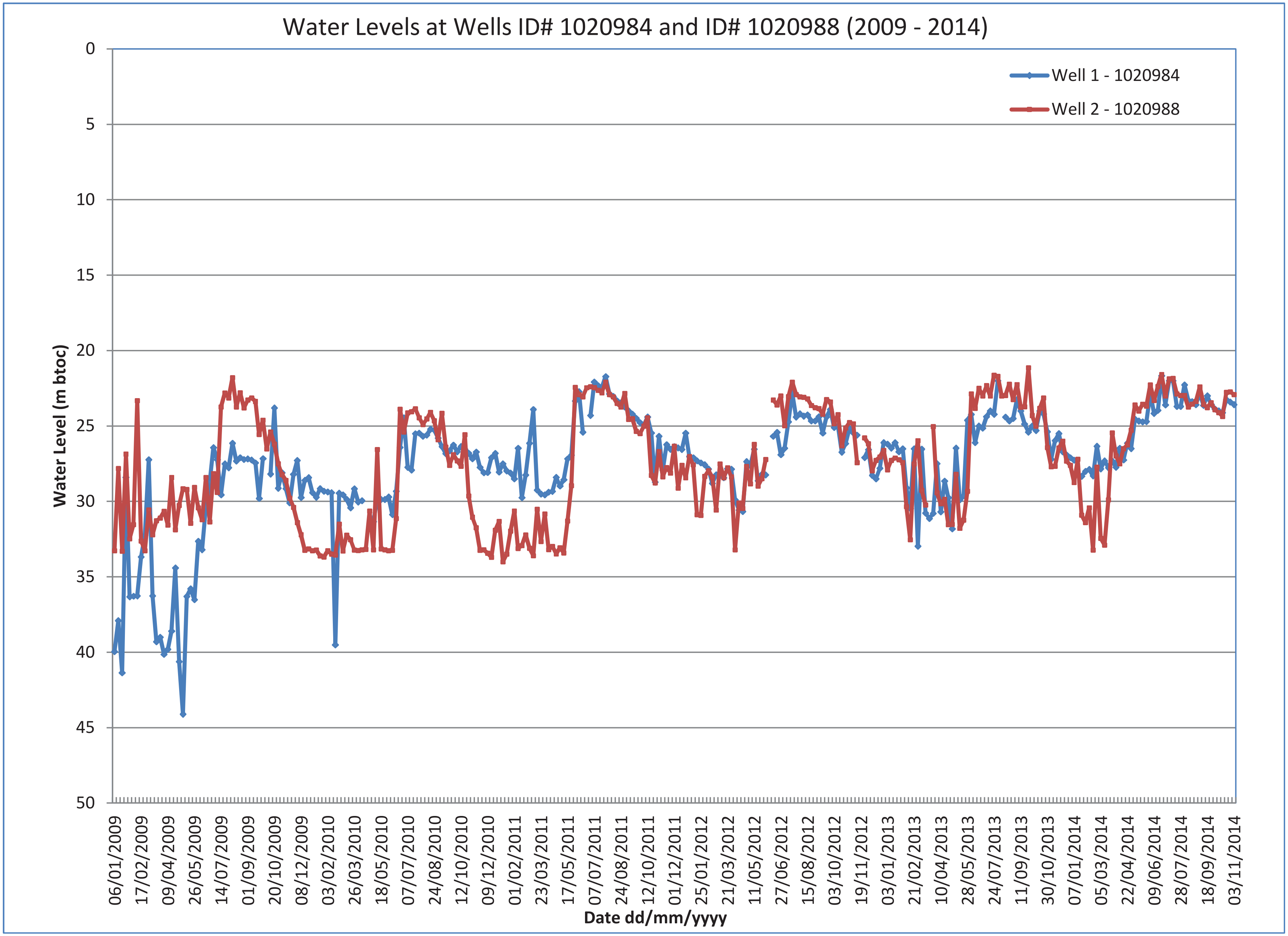
Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner

Date approval holder signed
2006/06/06

Appendix B2

Water Levels at Wells ID# 1020984 and ID#1020988



Water Levels at Wells ID# 1020984 and ID# 1020988 (2009 - 2014)
Well 1 - 1020984
Well 2 - 1020988
Water Level (m btoc)
0
5
10
15
20
25
30
35
40
45
50
06/01/2009
17/02/2009
09/04/2009
26/05/2009
14/07/2009
01/09/2009
20/10/2009
08/12/2009
03/02/2010
26/03/2010
18/05/2010
07/07/2010
24/08/2010
12/10/2010
09/12/2010
01/02/2011
23/03/2011
17/05/2011
07/07/2011
24/08/2011
12/10/2011
01/12/2011
25/01/2012
21/03/2012
11/05/2012
27/06/2012
15/08/2012
03/10/2012
19/11/2012
03/01/2013
21/02/2013
10/04/2013
28/05/2013
24/07/2013
11/09/2013
30/10/2013
07/01/2014
05/03/2014
22/04/2014
09/06/2014
28/07/2014
18/09/2014
03/11/2014
Date dd/mm/yyyy

Appendix B3

Groundwater Sampling Field Reports

Groundwater Sampling Field Report

amec

Client: Alta. Gov.	**Project No.** CW2174	**Well ID:** Aaron Drilling # 3259
	Facility: McLean Creek	**Date (d.m.y.)** 31 October 2014
Sampled By (print): D. Parsons / Hasan Kamal		**Signature:**

Site Description ☐ Monitoring Well ☑ Extraction Well ☐ Irrigation Well ☐ Spring ☐ Borehole ☐ Probe ☐ Other:

Air Temp (°C): ~15°C — Weather: Sunny, cool, mod. wind.

Well Locked? ☐ Yes ☑ No — Damaged/Repairs Needed:

Stickup: ~ 0.9 m (metres above ground level) — Well Inside Diameter (ID): ☐ 2 inch ☐ 4 inch ☑ Other: 6 in.

Site Remarks (nearby wells pumping, tide, stream stage, etc.):

Notes:

Water Level Data Measurement Units: metres

Static Depth to Water (mbTOC) / Time: 24.45 m 12:00 — Total Depth (mbTOC): > 60 m ?

Measurement Method: ☑ E-Tape ☐ Steel Tape ☐ Other: — Serial #

	Prior to purging	At end of sampling	Remarks
Time (hh:mm)			
Depth to Water (mbTOC)			
Tape Correction			

Notes:

Field WQ Data WQ Meter/Probe Type: — Serial #

Purge Method: ☐ Grab ☐ Waterra ☐ Bailer ☐ Pump — Description/Model/Serial #

Purge Depth (mbTOC):

Casing Volume (L): [____(TD) - ____(DTW)] x 3.14 x [____(ID)/2]^2 x [____(unit conv. Factor)] = — ☐ Well goes dry while purging

Volume to Purge (L):

Parameter	Initial					Final	Remarks
Time (hh:mm)							
☐ Cum. Vol. ☐ Pump Rate							
pH ☐ Temp. Compensated							
Temperature (°C)		No					
Dissolved Oxygen ( )		Field					
Conductivity ( )		Readings.					
Redox Potential/Eh ( )							
Turbidity (NTU)							
Colour/Appearance							Brown c rusty particles.
Odour							None.
Other:							

Actual Volume Purged (L): — Flow-through cell used (Y/N):

Notes:

Sample Data Sample Method: ☐ Grab ☐ Waterra ☐ Bailer ☐ Pump — Description/Model/Serial #

Sample Depth (mbTOC):

Field Sample ID (unique ID on bottles)	Result Code	Date (d.m.y)	Time (hh:mm)	Bottles (total to lab)	Filtered (0.45 µm)	Lab Name	Remarks
3259		31.10.14	12:30	8	0	ALS	Dis. Metals + Dis Hg → not filtered or preserved

Sample ID may be up to 15 characters. Sample Result Code, Date and Time must be entered. Result Codes: PO - Primary Sample, D# - Duplicate Sample, S# - Split Sample (for when samples are sent to more than one lab), FB# - Field Blank, TB# - Trip Blank, EB# - Equipment Rinsate, FS# - Field Spike.

Groundwater Sampling Field Report

amec

Client: Alta. Gov.	**Project No.**	**Well ID:** 1020988
	Facility: Easter Seals Horizon	**Date (d.m.y.)** 31.10.14
Sampled By (print): D. Parsons / H. Kanel	**Signature:**	

Site Description ☐ Monitoring Well ☑ Extraction Well ☐ Irrigation Well ☐ Spring ☐ Borehole ☐ Probe ☐ Other:

Air Temp (°C): ~10°C	Weather: Sunny, cool.
Well Locked? ☑ Yes ☐ No	Damaged/Repairs Needed:
Stickup: ~0.9 m (metres above ground level)	Well Inside Diameter (ID): ☐ 2 inch ☐ 4 inch ☑ Other: ~6"

Site Remarks (nearby wells pumping, tide, stream stage, etc.): Horizon Camp Well #2 – best producer. Sampled from raw water tap in manhole by Chad Keer

Notes:

Water Level Data Measurement Units: metres

Static Depth to Water (mbTOC) / Time: —	Total Depth (mbTOC): ~35 m
Measurement Method: ☐ E-Tape ☐ Steel Tape ☐ Other:	Serial #

	Prior to purging	At end of sampling	Remarks
Time (hh:mm)			
Depth to Water (mbTOC)			
Tape Correction			

Notes:

Field WQ Data WQ Meter/Probe Type: | Serial #

Purge Method: ☑ Grab ☐ Waterra ☐ Bailer ☐ Pump | Description/Model/Serial #

Purge Depth (mbTOC):

Casing Volume (L): [____(TD) - ____(DTW)] x 3.14 x [____(ID)/2]^2 x [____(unit conv. Factor)] = | ☐ Well goes dry while purging

Volume to Purge (L):

Parameter	Initial					Final	Remarks
Time (hh:mm)		10:00					
☐ Cum. Vol. ☐ Pump Rate							
pH ☐ Temp. Compensated		6.58					
Temperature (°C)		5.5					
Dissolved Oxygen (units:)							
Conductivity (units: µS)		700					
Redox Potential/Eh (units:)							
Turbidity (NTU)							
Colour/Appearance							
Odour							
Other: TDS (ppm)		618					

Actual Volume Purged (L): | Flow-through cell used (Y/N):

Notes:

Sample Data Sample Method: ☐ Grab ☐ Waterra ☐ Bailer ☐ Pump | Description/Model/Serial #

Sample Depth (mbTOC):

Field Sample ID (unique ID on bottles)	Result Code	Date (d.m.y)	Time (hh:mm)	Bottles (total to lab)	Filtered (0.45 µm)	Lab Name	Remarks
1020988		31.10.14	10:00	8	0	ALS	Dis Metals + Dis. Hg – not filtered/p[illegible]

Sample ID may be up to 15 characters. Sample Result Code, Date and Time must be entered. Result Codes: PO - Primary Sample, D# - Duplicate Sample, S# - Split Sample (for when samples are sent to more than one lab), FB# - Field Blank, TB# - Trip Blank, EB# - Equipment Rinsate, FS# - Field Spike.

Groundwater Sampling Field Report

amec

Client: Alta. Gov.	**Project No.** CW2174	**Well ID:** 1020984
	Facility: Easterseals Horizon Camp	**Date (d.m.y.)** 31.10.14
Sampled By (print): D. Parsons / H. Rommel	**Signature:**	

Site Description ☐ Monitoring Well ☑ Extraction Well ☐ Irrigation Well ☐ Spring ☐ Borehole ☐ Probe ☐ Other:

Air Temp (°C): ~10°C	Weather: Sunny, cool.
Well Locked? ☑ Yes ☐ No	Damaged/Repairs Needed: —
Stickup: ~0.9m. (metres above ground level)	Well Inside Diameter (ID): ☐ 2 inch ☐ 4 inch ☐ Other: ~6"

Site Remarks (nearby wells pumping, tide, stream stage, etc.): Horizon Camp well #1 – not as good producer as well #2. Sampled from raw water tap by Chad Keen

Notes:

Water Level Data Measurement Units: metres

Static Depth to Water (mbTOC) / Time: | Total Depth (mbTOC): ~55 m.

Measurement Method: ☐ E-Tape ☐ Steel Tape ☐ Other: | Serial #

	Prior to purging	At end of sampling	Remarks
Time (hh:mm)			
Depth to Water (mbTOC)			
Tape Correction			

Notes:

Field WQ Data WQ Meter/Probe Type: | Serial #

Purge Method: ☐ Grab ☐ Waterra ☐ Bailer ☐ Pump | Description/Model/Serial #

Purge Depth (mbTOC):

Casing Volume (L): [____(TD) - ____(DTW)] x 3.14 x [____(ID)/2]^2 x [____(unit conv. Factor)] = | ☐ Well goes dry while purging

Volume to Purge (L):

Parameter	Initial					Final	Remarks
Time (hh:mm)		10:15					
☐ Cum. Vol. ☐ Pump Rate							
pH ☐ Temp. Compensated		7.68					
Temperature (°C)		8.7					
Dissolved Oxygen (units:)							
Conductivity (units: µS.)		512					
Redox Potential/Eh (units:)							
Turbidity (NTU)							
Colour/Appearance							
Odour							
Other: TDS (ppm)		470					

Actual Volume Purged (L): | Flow-through cell used (Y/N):

Notes:

Sample Data Sample Method: ☐ Grab ☐ Waterra ☐ Bailer ☐ Pump | Description/Model/Serial #

Sample Depth (mbTOC):

Field Sample ID (unique ID on bottles)	Result Code	Date (d.m.y)	Time (hh:mm)	Bottles (total to lab)	Filtered (0.45 µm)	Lab Name	Remarks
1020984		31.10.14	10:15	8	0	ALS	Dis Metals + Dis Hg not filtered/preserved

Sample ID may be up to 15 characters. Sample Result Code, Date and Time must be entered. Result Codes: PO - Primary Sample, D# - Duplicate Sample, S# - Split Sample (for when samples are sent to more than one lab), FB# - Field Blank, TB# - Trip Blank, EB# - Equipment Rinsate, FS# - Field Spike.

Appendix B4

Photographs

Photo 1:
Study area

Description:
Highway near Station Flats Looking East

Photo 2:
Well ID#1020984

Description:
Close-up of Well at Easter Seals (Kinman) Camp

Photo 3:
Well ID#1020988

Description:
Close-up of Well at Easter Seals (Kinman) Camp

Photo 4:
Well ID# 1020988

Description:
Well ID#1020988 in red box. Elbow River in the valley below (obscured by trees) looking southwest

	**Photo 5:** Manhole with Raw Water Taps. Old unused well in hole.
	Description: Manhole at Easter Seals Camp from which water from Well ID#1020984 and 1020988 was sampled.

Appendix B5

Laboratory Results

AMEC Environment & Infrastructure
ATTN: DAVID PARSONS
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3

Date Received: 31-OCT-14
Report Date: 03-NOV-14 16:56 (MT)
Version: FINAL

Client Phone: 403-248-4331

Certificate of Analysis

Lab Work Order #: L1541134

Project P.O. #: NOT SUBMITTED
Job Reference: CW2174
C of C Numbers: 14-409484
Legal Site Desc:

Lyudmyla Shvets
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1541134-1 1020988							
Sampled By: DP/HK on 31-OCT-14 @ 10:00							
Matrix: GWATER							
Dissolved Metals (ABT1)							
Dis. Mercury in Water by CVAAS (Low)							
Mercury (Hg)-Dissolved	<0.0000050		0.0000050	mg/L		03-NOV-14	R3045131
Dissolved Metals in Water by CRC ICPMS							
Aluminum (Al)-Dissolved	0.0017		0.0010	mg/L		02-NOV-14	R3043889
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L		02-NOV-14	R3043889
Arsenic (As)-Dissolved	<0.00010		0.00010	mg/L		02-NOV-14	R3043889
Barium (Ba)-Dissolved	0.208		0.000050	mg/L		02-NOV-14	R3043889
Boron (B)-Dissolved	0.015		0.010	mg/L		02-NOV-14	R3043889
Cadmium (Cd)-Dissolved	<0.000010		0.000010	mg/L		02-NOV-14	R3043889
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L		02-NOV-14	R3043889
Copper (Cu)-Dissolved	0.0359		0.00010	mg/L		02-NOV-14	R3043889
Lead (Pb)-Dissolved	0.00168		0.000050	mg/L		02-NOV-14	R3043889
Nickel (Ni)-Dissolved	0.00034		0.00010	mg/L		02-NOV-14	R3043889
Selenium (Se)-Dissolved	0.00055		0.00010	mg/L		02-NOV-14	R3043889
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L		02-NOV-14	R3043889
Uranium (U)-Dissolved	0.000511		0.000010	mg/L		02-NOV-14	R3043889
Zinc (Zn)-Dissolved	0.0193		0.0050	mg/L		02-NOV-14	R3043889
Total Metals (ABT1)							
Total Mercury in Water by CVAAS (Low)							
Mercury (Hg)-Total	0.0000063		0.0000050	mg/L		03-NOV-14	R3045131
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	<0.015	DLA	0.015	mg/L		02-NOV-14	R3043889
Antimony (Sb)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Arsenic (As)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Barium (Ba)-Total	0.222	DLA	0.00025	mg/L		02-NOV-14	R3043889
Boron (B)-Total	<0.050	DLA	0.050	mg/L		02-NOV-14	R3043889
Cadmium (Cd)-Total	<0.000050	DLA	0.000050	mg/L		02-NOV-14	R3043889
Chromium (Cr)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Copper (Cu)-Total	0.0573	DLA	0.00050	mg/L		02-NOV-14	R3043889
Lead (Pb)-Total	0.00194	DLA	0.00025	mg/L		02-NOV-14	R3043889
Nickel (Ni)-Total	0.00071	DLA	0.00050	mg/L		02-NOV-14	R3043889
Selenium (Se)-Total	0.00066	DLA	0.00050	mg/L		02-NOV-14	R3043889
Silver (Ag)-Total	<0.000050	DLA	0.000050	mg/L		02-NOV-14	R3043889
Uranium (U)-Total	0.000618	DLA	0.000050	mg/L		02-NOV-14	R3043889
Zinc (Zn)-Total	0.025	DLA	0.020	mg/L		02-NOV-14	R3043889
Total Metals in Water by ICPOES							
Calcium (Ca)-Total	80.9		0.50	mg/L		02-NOV-14	R3042509
Iron (Fe)-Total	<0.15		0.15	mg/L		02-NOV-14	R3042509
Magnesium (Mg)-Total	21.9		0.50	mg/L		02-NOV-14	R3042509
Manganese (Mn)-Total	<0.025		0.025	mg/L		02-NOV-14	R3042509
Potassium (K)-Total	<2.5		2.5	mg/L		02-NOV-14	R3042509
Sodium (Na)-Total	13.4		5.0	mg/L		02-NOV-14	R3042509
Miscellaneous Parameters							
Ammonia, Total (as N)	<0.050		0.050	mg/L		03-NOV-14	R3044094
Colour, True	<5.0		5.0	CU		31-OCT-14	R3040968
Coliform Bacteria - Fecal	<1		1	CFU/100mL		31-OCT-14	R3046070
Phenols (4AAP)	0.0028		0.0010	mg/L		03-NOV-14	R3043552
Sulphide (as S)	<0.0015		0.0015	mg/L		03-NOV-14	R3045308
MPN - Total Coliforms	<1		1	MPN/100mL		31-OCT-14	R3046070
Total Kjeldahl Nitrogen	<0.20		0.20	mg/L		03-NOV-14	R3045868
Phosphorus (P)-Total	<0.0050		0.0050	mg/L		03-NOV-14	R3045254

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1541134-1 1020988							
Sampled By: DP/HK on 31-OCT-14 @ 10:00							
Matrix: GWATER							
Turbidity	<0.10		0.10	NTU		01-NOV-14	R3041368
Routine Water Analysis							
Chloride (Cl)							
Chloride (Cl)	3.65		0.10	mg/L		31-OCT-14	R3042228
Dissolved Metals by ICPOES							
Calcium (Ca)-Dissolved	69.7		0.10	mg/L		02-NOV-14	R3042509
Iron (Fe)-Dissolved	<0.030		0.030	mg/L		02-NOV-14	R3042509
Magnesium (Mg)-Dissolved	17.7		0.10	mg/L		02-NOV-14	R3042509
Manganese (Mn)-Dissolved	<0.0050		0.0050	mg/L		02-NOV-14	R3042509
Potassium (K)-Dissolved	0.92		0.50	mg/L		02-NOV-14	R3042509
Sodium (Na)-Dissolved	10.8		1.0	mg/L		02-NOV-14	R3042509
Ion Balance Calculation							
Ion Balance	89.1	BL:INT		%		03-NOV-14	
TDS (Calculated)	291			mg/L		03-NOV-14	
Hardness (as CaCO3)	247			mg/L		03-NOV-14	
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	1.82		0.054	mg/L		02-NOV-14	
Nitrate-N							
Nitrate (as N)	1.82		0.050	mg/L		31-OCT-14	R3042228
Nitrite-N							
Nitrite (as N)	<0.020		0.020	mg/L		31-OCT-14	R3042228
Sulfate (SO4)							
Sulfate (SO4)	10.0		0.50	mg/L		31-OCT-14	R3042228
pH, Conductivity and Total Alkalinity							
pH	8.25		0.10	pH		03-NOV-14	R3044908
Conductivity (EC)	474		3.0	uS/cm		03-NOV-14	R3044908
Bicarbonate (HCO3)	345		5.0	mg/L		03-NOV-14	R3044908
Carbonate (CO3)	<5.0		5.0	mg/L		03-NOV-14	R3044908
Hydroxide (OH)	<5.0		5.0	mg/L		03-NOV-14	R3044908
Alkalinity, Total (as CaCO3)	283		5.0	mg/L		03-NOV-14	R3044908
L1541134-2 1020984							
Sampled By: DP/HK on 31-OCT-14 @ 10:15							
Matrix: GWATER							
Dissolved Metals (ABT1)							
Dis. Mercury in Water by CVAAS (Low)							
Mercury (Hg)-Dissolved	<0.0000050		0.0000050	mg/L		03-NOV-14	R3045131
Dissolved Metals in Water by CRC ICPMS							
Aluminum (Al)-Dissolved	0.0010		0.0010	mg/L		02-NOV-14	R3043889
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L		02-NOV-14	R3043889
Arsenic (As)-Dissolved	<0.00010		0.00010	mg/L		02-NOV-14	R3043889
Barium (Ba)-Dissolved	0.142		0.000050	mg/L		02-NOV-14	R3043889
Boron (B)-Dissolved	0.027		0.010	mg/L		02-NOV-14	R3043889
Cadmium (Cd)-Dissolved	<0.000010		0.000010	mg/L		02-NOV-14	R3043889
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L		02-NOV-14	R3043889
Copper (Cu)-Dissolved	0.00316		0.00010	mg/L		02-NOV-14	R3043889
Lead (Pb)-Dissolved	0.000338		0.000050	mg/L		02-NOV-14	R3043889
Nickel (Ni)-Dissolved	0.00015		0.00010	mg/L		02-NOV-14	R3043889
Selenium (Se)-Dissolved	0.00039		0.00010	mg/L		02-NOV-14	R3043889
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L		02-NOV-14	R3043889
Uranium (U)-Dissolved	0.000312		0.000010	mg/L		02-NOV-14	R3043889
Zinc (Zn)-Dissolved	<0.0050		0.0050	mg/L		02-NOV-14	R3043889
Total Metals (ABT1)							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1541134-2 1020984							
Sampled By: DP/HK on 31-OCT-14 @ 10:15							
Matrix: GWATER							
Total Mercury in Water by CVAAS (Low)							
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		03-NOV-14	R3045131
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	<0.015	DLA	0.015	mg/L		02-NOV-14	R3043889
Antimony (Sb)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Arsenic (As)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Barium (Ba)-Total	0.149	DLA	0.00025	mg/L		02-NOV-14	R3043889
Boron (B)-Total	<0.050	DLA	0.050	mg/L		02-NOV-14	R3043889
Cadmium (Cd)-Total	<0.000050	DLA	0.000050	mg/L		02-NOV-14	R3043889
Chromium (Cr)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Copper (Cu)-Total	0.00412	DLA	0.00050	mg/L		02-NOV-14	R3043889
Lead (Pb)-Total	0.00034	DLA	0.00025	mg/L		02-NOV-14	R3043889
Nickel (Ni)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Selenium (Se)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Silver (Ag)-Total	<0.000050	DLA	0.000050	mg/L		02-NOV-14	R3043889
Uranium (U)-Total	0.000349	DLA	0.000050	mg/L		02-NOV-14	R3043889
Zinc (Zn)-Total	<0.020	DLA	0.020	mg/L		02-NOV-14	R3043889
Total Metals in Water by ICPOES							
Calcium (Ca)-Total	46.9		0.50	mg/L		02-NOV-14	R3042509
Iron (Fe)-Total	<0.15		0.15	mg/L		02-NOV-14	R3042509
Magnesium (Mg)-Total	13.4		0.50	mg/L		02-NOV-14	R3042509
Manganese (Mn)-Total	<0.025		0.025	mg/L		02-NOV-14	R3042509
Potassium (K)-Total	<2.5		2.5	mg/L		02-NOV-14	R3042509
Sodium (Na)-Total	78.8		5.0	mg/L		02-NOV-14	R3042509
Miscellaneous Parameters							
Ammonia, Total (as N)	<0.050		0.050	mg/L		03-NOV-14	R3044094
Colour, True	<5.0		5.0	CU		31-OCT-14	R3040968
Coliform Bacteria - Fecal	<1		1	CFU/100mL		31-OCT-14	R3046070
Phenols (4AAP)	<0.0010		0.0010	mg/L		03-NOV-14	R3043552
Sulphide (as S)	<0.0015		0.0015	mg/L		03-NOV-14	R3045308
MPN - Total Coliforms	<1		1	MPN/100mL		31-OCT-14	R3046070
Total Kjeldahl Nitrogen	<0.20		0.20	mg/L		03-NOV-14	R3045868
Phosphorus (P)-Total	<0.0050		0.0050	mg/L		03-NOV-14	R3045254
Turbidity	0.18		0.10	NTU		01-NOV-14	R3041368
Routine Water Analysis							
Chloride (Cl)							
Chloride (Cl)	4.34		0.10	mg/L		31-OCT-14	R3042228
Dissolved Metals by ICPOES							
Calcium (Ca)-Dissolved	41.4		0.10	mg/L		02-NOV-14	R3042509
Iron (Fe)-Dissolved	<0.030		0.030	mg/L		02-NOV-14	R3042509
Magnesium (Mg)-Dissolved	10.9		0.10	mg/L		02-NOV-14	R3042509
Manganese (Mn)-Dissolved	<0.0050		0.0050	mg/L		02-NOV-14	R3042509
Potassium (K)-Dissolved	0.60		0.50	mg/L		02-NOV-14	R3042509
Sodium (Na)-Dissolved	65.6		1.0	mg/L		02-NOV-14	R3042509
Ion Balance Calculation							
Ion Balance	91.7			%		03-NOV-14	
TDS (Calculated)	315			mg/L		03-NOV-14	
Hardness (as CaCO3)	148			mg/L		03-NOV-14	
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.583		0.054	mg/L		02-NOV-14	
Nitrate-N							
Nitrate (as N)	0.541		0.050	mg/L		31-OCT-14	R3042228

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1541134-2 1020984							
Sampled By: DP/HK on 31-OCT-14 @ 10:15							
Matrix: GWATER							
Nitrite-N							
Nitrite (as N)	0.042		0.020	mg/L		31-OCT-14	R3042228
Sulfate (SO4)							
Sulfate (SO4)	8.81		0.50	mg/L		31-OCT-14	R3042228
pH, Conductivity and Total Alkalinity							
pH	8.23		0.10	pH		03-NOV-14	R3044908
Conductivity (EC)	502		3.0	uS/cm		03-NOV-14	R3044908
Bicarbonate (HCO3)	367		5.0	mg/L		03-NOV-14	R3044908
Carbonate (CO3)	<5.0		5.0	mg/L		03-NOV-14	R3044908
Hydroxide (OH)	<5.0		5.0	mg/L		03-NOV-14	R3044908
Alkalinity, Total (as CaCO3)	301		5.0	mg/L		03-NOV-14	R3044908
L1541134-3 3259							
Sampled By: DP/HK on 31-OCT-14 @ 12:30							
Matrix: GWATER							
Dissolved Metals (ABT1)							
Dis. Mercury in Water by CVAAS (Low)							
Mercury (Hg)-Dissolved	<0.0000050		0.0000050	mg/L		03-NOV-14	R3045131
Dissolved Metals in Water by CRC ICPMS							
Aluminum (Al)-Dissolved	<0.0010		0.0010	mg/L		02-NOV-14	R3043889
Antimony (Sb)-Dissolved	<0.00010		0.00010	mg/L		02-NOV-14	R3043889
Arsenic (As)-Dissolved	<0.00010		0.00010	mg/L		02-NOV-14	R3043889
Barium (Ba)-Dissolved	0.0978		0.000050	mg/L		02-NOV-14	R3043889
Boron (B)-Dissolved	0.012		0.010	mg/L		02-NOV-14	R3043889
Cadmium (Cd)-Dissolved	<0.000010		0.000010	mg/L		02-NOV-14	R3043889
Chromium (Cr)-Dissolved	<0.00010		0.00010	mg/L		02-NOV-14	R3043889
Copper (Cu)-Dissolved	0.00028		0.00010	mg/L		02-NOV-14	R3043889
Lead (Pb)-Dissolved	<0.000050		0.000050	mg/L		02-NOV-14	R3043889
Nickel (Ni)-Dissolved	0.00014		0.00010	mg/L		02-NOV-14	R3043889
Selenium (Se)-Dissolved	0.00044		0.00010	mg/L		02-NOV-14	R3043889
Silver (Ag)-Dissolved	<0.000010		0.000010	mg/L		02-NOV-14	R3043889
Uranium (U)-Dissolved	0.000260		0.000010	mg/L		02-NOV-14	R3043889
Zinc (Zn)-Dissolved	<0.0050		0.0050	mg/L		02-NOV-14	R3043889
Total Metals (ABT1)							
Total Mercury in Water by CVAAS (Low)							
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		03-NOV-14	R3045131
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	0.015	DLA	0.015	mg/L		02-NOV-14	R3043889
Antimony (Sb)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Arsenic (As)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Barium (Ba)-Total	0.102	DLA	0.00025	mg/L		02-NOV-14	R3043889
Boron (B)-Total	<0.050	DLA	0.050	mg/L		02-NOV-14	R3043889
Cadmium (Cd)-Total	<0.000050	DLA	0.000050	mg/L		02-NOV-14	R3043889
Chromium (Cr)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Copper (Cu)-Total	<0.0010	DLB	0.0010	mg/L		02-NOV-14	R3043889
Lead (Pb)-Total	0.00137	DLA	0.00025	mg/L		02-NOV-14	R3043889
Nickel (Ni)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Selenium (Se)-Total	<0.00050	DLA	0.00050	mg/L		02-NOV-14	R3043889
Silver (Ag)-Total	<0.000050	DLA	0.000050	mg/L		02-NOV-14	R3043889
Uranium (U)-Total	0.000281	DLA	0.000050	mg/L		02-NOV-14	R3043889
Zinc (Zn)-Total	<0.020	DLA	0.020	mg/L		02-NOV-14	R3043889
Total Metals in Water by ICPOES							
Calcium (Ca)-Total	64.6		0.50	mg/L		02-NOV-14	R3042509

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1541134-3 3259							
Sampled By: DP/HK on 31-OCT-14 @ 12:30							
Matrix: GWATER							
Total Metals in Water by ICPOES							
Iron (Fe)-Total	15.4		0.15	mg/L		02-NOV-14	R3042509
Magnesium (Mg)-Total	17.3		0.50	mg/L		02-NOV-14	R3042509
Manganese (Mn)-Total	0.087		0.025	mg/L		02-NOV-14	R3042509
Potassium (K)-Total	<2.5		2.5	mg/L		02-NOV-14	R3042509
Sodium (Na)-Total	<5.0		5.0	mg/L		02-NOV-14	R3042509
Miscellaneous Parameters							
Ammonia, Total (as N)	<0.050		0.050	mg/L		03-NOV-14	R3044094
Colour, True	<5.0		5.0	CU		31-OCT-14	R3040968
Coliform Bacteria - Fecal	<1		1	CFU/100mL		31-OCT-14	R3046070
Phenols (4AAP)	0.0020		0.0010	mg/L		03-NOV-14	R3043552
Sulphide (as S)	0.0352	RRV	0.0015	mg/L		03-NOV-14	R3045308
MPN - Total Coliforms	<1		1	MPN/100mL		31-OCT-14	R3046070
Total Kjeldahl Nitrogen	<0.20		0.20	mg/L		03-NOV-14	R3045868
Phosphorus (P)-Total	0.0064		0.0050	mg/L		03-NOV-14	R3045254
Turbidity	47.4		0.10	NTU		01-NOV-14	R3041368
Routine Water Analysis							
Chloride (Cl)							
Chloride (Cl)	2.92		0.10	mg/L		31-OCT-14	R3042228
Dissolved Metals by ICPOES							
Calcium (Ca)-Dissolved	58.3		0.10	mg/L		02-NOV-14	R3042509
Iron (Fe)-Dissolved	<0.030		0.030	mg/L		02-NOV-14	R3042509
Magnesium (Mg)-Dissolved	14.7		0.10	mg/L		02-NOV-14	R3042509
Manganese (Mn)-Dissolved	0.0091		0.0050	mg/L		02-NOV-14	R3042509
Potassium (K)-Dissolved	0.70		0.50	mg/L		02-NOV-14	R3042509
Sodium (Na)-Dissolved	4.0		1.0	mg/L		02-NOV-14	R3042509
Ion Balance Calculation							
Ion Balance	93.2			%		03-NOV-14	
TDS (Calculated)	230			mg/L		03-NOV-14	
Hardness (as CaCO3)	206			mg/L		03-NOV-14	
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.143		0.054	mg/L		02-NOV-14	
Nitrate-N							
Nitrate (as N)	0.143		0.050	mg/L		31-OCT-14	R3042228
Nitrite-N							
Nitrite (as N)	<0.020		0.020	mg/L		31-OCT-14	R3042228
Sulfate (SO4)							
Sulfate (SO4)	32.8		0.50	mg/L		31-OCT-14	R3042228
pH, Conductivity and Total Alkalinity							
pH	8.24		0.10	pH		03-NOV-14	R3044908
Conductivity (EC)	408		3.0	uS/cm		03-NOV-14	R3044908
Bicarbonate (HCO3)	235		5.0	mg/L		03-NOV-14	R3044908
Carbonate (CO3)	<5.0		5.0	mg/L		03-NOV-14	R3044908
Hydroxide (OH)	<5.0		5.0	mg/L		03-NOV-14	R3044908
Alkalinity, Total (as CaCO3)	193		5.0	mg/L		03-NOV-14	R3044908

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	Dissolved metals and mercury - Sample was Filtered and Preserved at the laboratory

Sample Parameter Qualifier Key:

Qualifier	Description
BL:INT	Balance Reviewed: Interference Or Non-Measured Component
DLA	Detection Limit adjusted for required dilution
DLB	Detection Limit was raised due to detection of analyte at comparable level in Method Blank.
DLM	Detection Limit Adjusted due to sample matrix effects.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-CL	Water	Chloride (Cl)	APHA 4110 B-Ion Chromatography

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography

COLOUR-TRUE-CL	Water	Colour (True) by Spectrometer	APHA 2120 Color

This analysis is carried out using procedures adapted from APHA Method 2120 "Color". Colour (True Colour) is determined by filtering a sample through a 0.45 micron membrane filter followed by analysis of the filtrate using the platinum-cobalt colourimetric method. Aparent Colour is determined without prior sample filtration. Colour is pH dependent. Unless otherwise indicated, reported colour results pertain to the pH of the sample as received, to within +/- 1 pH unit.

FCC-MF-CL	Water	Fecal Coliform Count-MF	APHA 9222B MF

This analysis is carried out using procedures adapted from APHA Method 9222 "Membrane Filter Technique for Members of the Coliform Group". Coliform bacteria is enumerated by culturing and colony counting. A known sample volume is filtered through a 0.45 micron membrane filter. The test involves an initial 24 hour incubation at 44.5 degrees C of the filter with the appropriate growth medium. This method is specific for thermotolerant bacteria (Fecal) and is used for non-turbid water with a low background bacteria level.

HG-D-L-CVAA-CL	Water	Dis. Mercury in Water by CVAAS (Low)	EPA 245.1

This analysis is carried out using procedures adapted from Method 245.1 by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to a purge and trap concentration step and final reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic absorbance spectrophotometry (CVAAS).

HG-T-L-CVAA-CL	Water	Total Mercury in Water by CVAAS (Low)	EPA 245.1

This analysis is carried out using procedures adapted from Method 245.1 by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to a purge and trap concentration step and final reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic absorbance spectrophotometry (CVAAS).

IONBALANCE-CL	Water	Ion Balance Calculation	APHA 1030E
MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

MET-DIS-ICP-CL	Water	Dissolved Metals by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-CL	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

MET-TOT-ICP-CL	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion using a hotblock (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference**
N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NH4-CL	Water	Ammonia-N	APHA 4500 NH3F-Colorimetry

Ammonia is determined using the Phenate colorimetric method. Result includes both ionized (NH4+) and un-ionized (NH3) ammonia present in the sample.

ALS Test Code	Matrix	Test Description	Method Reference**
NO2-CL	Water	Nitrite-N	APHA 4110 B-Ion Chromatography

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
NO3-IC-CL	Water	Nitrate-N	APHA 4110 B-Ion Chromatography

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance

ALS Test Code	Matrix	Test Description	Method Reference**
P-T-COL-CL	Water	Total P in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

ALS Test Code	Matrix	Test Description	Method Reference**
PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320

All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample’s capacity to neutralize acid
Conductivity measurement is based on the sample’s capacity to convey an electric current

ALS Test Code	Matrix	Test Description	Method Reference**
PHENOLS-4AAP-ED	Water	Phenols (4AAP)	AB ENV.06537-COLORIMETRIC

This analysis is carried out using procedures adapted from ENVIRODAT VMV 06537 689, Method Code 154, in "Methods Manual for Chemical Analysis of Water and Wastes" published by the Alberta Environmental Centre. This automated method is based on the distillation of phenol and subsequent reaction of the distillate with alkaline ferricyanide and 4-aminoantipyrine to form a red complex which is measured at 505 nm.

ALS Test Code	Matrix	Test Description	Method Reference**
SO4-CL	Water	Sulfate (SO4)	APHA 4110 B-Ion Chromatography

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHIDE-ED	Water	Sulphide	APHA 4500 -S E-Auto-Colorimetry
TC-MPN-CL	Water	Total Coliform	APHA 9223B

This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.
Recommended Holding Time:
Sample: 1 day
Reference: APHA

ALS Test Code	Matrix	Test Description	Method Reference**
TKN-F-CL	Water	Total Kjeldahl Nitrogen by Fluorescence	APHA 4500-NORG (TKN)

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

ALS Test Code	Matrix	Test Description	Method Reference**
TURBIDITY-CL	Water	Turbidity	APHA 2130 B-Nephelometer

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
ED	ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
14-409484			

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3
Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-CL	**Water**							
Batch R3042228								
WG1987191-10 DUP		**L1541318-4**						
Chloride (Cl)		12.8	12.4		mg/L	3.3	20	01-NOV-14
WG1987191-11 DUP		**L1541327-6**						
Chloride (Cl)		133	134		mg/L	0.8	20	01-NOV-14
WG1987191-12 DUP		**L1541329-10**						
Chloride (Cl)		74.8	75.5		mg/L	0.9	20	01-NOV-14
WG1987191-13 DUP		**L1541329-36**						
Chloride (Cl)		26.6	26.7		mg/L	0.2	20	01-NOV-14
WG1987191-3 DUP		**L1540559-19**						
Chloride (Cl)		243	245		mg/L	0.7	20	31-OCT-14
WG1987191-4 DUP		**L1540559-39**						
Chloride (Cl)		71.7	71.3		mg/L	0.5	20	31-OCT-14
WG1987191-5 DUP		**L1540559-59**						
Chloride (Cl)		37.3	37.6		mg/L	0.8	20	31-OCT-14
WG1987191-6 DUP		**L1540786-4**						
Chloride (Cl)		43.8	43.8		mg/L	0.1	20	31-OCT-14
WG1987191-7 DUP		**L1541177-1**						
Chloride (Cl)		4.25	4.23		mg/L	0.6	20	31-OCT-14
WG1987191-9 DUP		**L1541294-4**						
Chloride (Cl)		43.4	43.3		mg/L	0.3	20	01-OCT-14
WG1987191-2 LCS								
Chloride (Cl)			94.4		%		90-110	31-OCT-14
WG1987191-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	31-OCT-14
COLOUR-TRUE-CL	**Water**							
Batch R3040968								
WG1986697-2 LCS								
Colour, True			101.8		%		85-115	31-OCT-14
WG1986697-1 MB								
Colour, True			<5.0		CU		5	31-OCT-14
FCC-MF-CL	**Water**							
Batch R3046070								
WG1987933-1 MB								
Coliform Bacteria - Fecal			<1		CFU/100mL		1	31-OCT-14
HG-D-L-CVAA-CL	**Water**							

Quality Control Report

Workorder: L1541134 Report Date: 03-NOV-14

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3
Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-D-L-CVAA-CL	**Water**							
Batch R3045131								
WG1987772-4 DUP		**L1541134-1**						
Mercury (Hg)-Dissolved		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	03-NOV-14
WG1987772-1 MB								
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	03-NOV-14
HG-T-L-CVAA-CL	**Water**							
Batch R3045131								
WG1987772-4 DUP		**L1541134-1**						
Mercury (Hg)-Total		0.0000063	<0.0000050	RPD-NA	mg/L	N/A	20	03-NOV-14
WG1987772-1 MB								
Mercury (Hg)-Total			<0.0000050		mg/L		0.000005	03-NOV-14
MET-D-CCMS-CL	**Water**							
Batch R3043889								
WG1987614-2 CRM		**TMRM**						
Aluminum (Al)-Dissolved			96.4		%		80-120	02-NOV-14
Antimony (Sb)-Dissolved			98.5		%		80-120	02-NOV-14
Arsenic (As)-Dissolved			97.8		%		80-120	02-NOV-14
Barium (Ba)-Dissolved			99.7		%		80-120	02-NOV-14
Boron (B)-Dissolved			92.1		%		80-120	02-NOV-14
Cadmium (Cd)-Dissolved			97.1		%		80-120	02-NOV-14
Chromium (Cr)-Dissolved			99.0		%		80-120	02-NOV-14
Copper (Cu)-Dissolved			95.6		%		80-120	02-NOV-14
Lead (Pb)-Dissolved			99.6		%		80-120	02-NOV-14
Nickel (Ni)-Dissolved			98.8		%		80-120	02-NOV-14
Selenium (Se)-Dissolved			99.7		%		80-120	02-NOV-14
Silver (Ag)-Dissolved			101.2		%		80-120	02-NOV-14
Uranium (U)-Dissolved			98.5		%		80-120	02-NOV-14
Zinc (Zn)-Dissolved			97.9		%		80-120	02-NOV-14
WG1987614-3 DUP		**L1541134-3**						
Aluminum (Al)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	02-NOV-14
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	02-NOV-14
Arsenic (As)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	02-NOV-14
Barium (Ba)-Dissolved		0.0978	0.0906		mg/L	7.7	20	02-NOV-14
Boron (B)-Dissolved		0.012	0.012		mg/L	0.1	20	02-NOV-14
Cadmium (Cd)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	02-NOV-14
Chromium (Cr)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	02-NOV-14

Quality Control Report

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3
Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R3043889								
WG1987614-3 DUP		**L1541134-3**						
Copper (Cu)-Dissolved		0.00028	0.00022	J	mg/L	0.00006	0.0002	02-NOV-14
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	02-NOV-14
Nickel (Ni)-Dissolved		0.00014	0.00011	J	mg/L	0.00003	0.0002	02-NOV-14
Selenium (Se)-Dissolved		0.00044	0.00044		mg/L	0.4	20	02-NOV-14
Silver (Ag)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	02-NOV-14
Uranium (U)-Dissolved		0.000260	0.000264		mg/L	1.4	20	02-NOV-14
Zinc (Zn)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	02-NOV-14
WG1987614-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	02-NOV-14
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-14
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-14
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-14
Boron (B)-Dissolved			<0.010		mg/L		0.01	02-NOV-14
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-14
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-14
Copper (Cu)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-14
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	02-NOV-14
Nickel (Ni)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-14
Selenium (Se)-Dissolved			<0.00010		mg/L		0.0001	02-NOV-14
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-14
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	02-NOV-14
Zinc (Zn)-Dissolved			<0.0040		mg/L		0.004	02-NOV-14
MET-DIS-ICP-CL	**Water**							
Batch R3042509								
WG1987254-2 CRM		**TMRM**						
Calcium (Ca)-Dissolved			99.3		%		80-120	02-NOV-14
Iron (Fe)-Dissolved			93.2		%		80-120	02-NOV-14
Magnesium (Mg)-Dissolved			99.8		%		80-120	02-NOV-14
Manganese (Mn)-Dissolved			95.4		%		80-120	02-NOV-14
Potassium (K)-Dissolved			94.9		%		80-120	02-NOV-14
Sodium (Na)-Dissolved			94.7		%		80-120	02-NOV-14
WG1987254-3 DUP		**L1541134-1**						
Calcium (Ca)-Dissolved		69.7	71.4		mg/L	2.4	20	02-NOV-14
Iron (Fe)-Dissolved		<0.030	<0.030	RPD-NA	mg/L	N/A	20	02-NOV-14

Quality Control Report

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3

Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-CL	**Water**							
Batch R3042509								
WG1987254-3 DUP		**L1541134-1**						
Magnesium (Mg)-Dissolved		17.7	18.3		mg/L	3.0	20	02-NOV-14
Manganese (Mn)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	02-NOV-14
Potassium (K)-Dissolved		0.92	0.98		mg/L	5.8	20	02-NOV-14
Sodium (Na)-Dissolved		10.8	11.2		mg/L	3.9	20	02-NOV-14
WG1987254-4 DUP		**L1536881-6**						
Calcium (Ca)-Dissolved		226	219		mg/L	3.0	20	02-NOV-14
Iron (Fe)-Dissolved		<0.030	<0.030	RPD-NA	mg/L	N/A	20	02-NOV-14
Magnesium (Mg)-Dissolved		65.0	64.5		mg/L	0.7	20	02-NOV-14
Manganese (Mn)-Dissolved		0.185	0.179		mg/L	3.6	20	02-NOV-14
Potassium (K)-Dissolved		1.10	1.06		mg/L	3.5	20	02-NOV-14
Sodium (Na)-Dissolved		18.6	18.0		mg/L	3.0	20	02-NOV-14
WG1987254-1 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	02-NOV-14
Iron (Fe)-Dissolved			<0.030		mg/L		0.03	02-NOV-14
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	02-NOV-14
Manganese (Mn)-Dissolved			<0.0050		mg/L		0.005	02-NOV-14
Potassium (K)-Dissolved			<0.50		mg/L		0.5	02-NOV-14
Sodium (Na)-Dissolved			<1.0		mg/L		1	02-NOV-14
MET-T-CCMS-CL	**Water**							
Batch R3043889								
WG1987256-2 CRM		**TMRM**						
Aluminum (Al)-Total			96.4		%		80-120	02-NOV-14
Antimony (Sb)-Total			98.5		%		80-120	02-NOV-14
Arsenic (As)-Total			97.8		%		80-120	02-NOV-14
Barium (Ba)-Total			99.7		%		80-120	02-NOV-14
Boron (B)-Total			92.1		%		80-120	02-NOV-14
Cadmium (Cd)-Total			97.1		%		80-120	02-NOV-14
Chromium (Cr)-Total			99.0		%		80-120	02-NOV-14
Copper (Cu)-Total			95.6		%		80-120	02-NOV-14
Lead (Pb)-Total			99.6		%		80-120	02-NOV-14
Nickel (Ni)-Total			98.8		%		80-120	02-NOV-14
Selenium (Se)-Total			99.7		%		80-120	02-NOV-14
Silver (Ag)-Total			101.2		%		80-120	02-NOV-14
Uranium (U)-Total			98.5		%		80-120	02-NOV-14

Quality Control Report

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3
Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-CL	**Water**							
Batch R3043889								
WG1987256-2 CRM		**TMRM**						
Zinc (Zn)-Total			97.9		%		80-120	02-NOV-14
WG1987256-3 DUP		**L1541134-1**						
Aluminum (Al)-Total		<0.015	<0.015	RPD-NA	mg/L	N/A	20	02-NOV-14
Antimony (Sb)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	02-NOV-14
Arsenic (As)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	02-NOV-14
Barium (Ba)-Total		0.222	0.216		mg/L	2.8	20	02-NOV-14
Boron (B)-Total		<0.050	<0.050	RPD-NA	mg/L	N/A	20	02-NOV-14
Cadmium (Cd)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	02-NOV-14
Chromium (Cr)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	02-NOV-14
Copper (Cu)-Total		0.0573	0.0571		mg/L	0.4	20	02-NOV-14
Lead (Pb)-Total		0.00194	0.00193		mg/L	0.3	20	02-NOV-14
Nickel (Ni)-Total		0.00071	<0.00050	RPD-NA	mg/L	N/A	20	02-NOV-14
Selenium (Se)-Total		0.00066	0.00051	J	mg/L	0.00015	0.001	02-NOV-14
Silver (Ag)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	02-NOV-14
Uranium (U)-Total		0.000618	0.000580		mg/L	6.4	20	02-NOV-14
Zinc (Zn)-Total		0.025	0.023		mg/L	5.8	20	02-NOV-14
WG1987256-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	02-NOV-14
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	02-NOV-14
Arsenic (As)-Total			<0.00010		mg/L		0.0001	02-NOV-14
Barium (Ba)-Total			<0.000050		mg/L		0.00005	02-NOV-14
Boron (B)-Total			<0.010		mg/L		0.01	02-NOV-14
Cadmium (Cd)-Total			<0.000010		mg/L		0.00001	02-NOV-14
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	02-NOV-14
Copper (Cu)-Total			0.00020	MB-LOR	mg/L		0.0001	02-NOV-14
Lead (Pb)-Total			<0.000050		mg/L		0.00005	02-NOV-14
Nickel (Ni)-Total			<0.00010		mg/L		0.0001	02-NOV-14
Selenium (Se)-Total			<0.00010		mg/L		0.0001	02-NOV-14
Silver (Ag)-Total			<0.000010		mg/L		0.00001	02-NOV-14
Uranium (U)-Total			<0.000010		mg/L		0.00001	02-NOV-14
Zinc (Zn)-Total			<0.0040		mg/L		0.004	02-NOV-14
MET-TOT-ICP-CL	**Water**							

Quality Control Report

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3
Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-TOT-ICP-CL	**Water**							
Batch R3042509								
WG1987256-2 CRM		**TMRM**						
Calcium (Ca)-Total			92.0		%		80-120	02-NOV-14
Iron (Fe)-Total			87.8		%		80-120	02-NOV-14
Magnesium (Mg)-Total			95.5		%		80-120	02-NOV-14
Manganese (Mn)-Total			89.5		%		80-120	02-NOV-14
Potassium (K)-Total			89.3		%		80-120	02-NOV-14
Sodium (Na)-Total			90.6		%		80-120	02-NOV-14
WG1987256-3 DUP		**L1541134-1**						
Calcium (Ca)-Total		80.9	78.4		mg/L	3.1	20	02-NOV-14
Iron (Fe)-Total		<0.15	<0.15	RPD-NA	mg/L	N/A	20	02-NOV-14
Magnesium (Mg)-Total		21.9	21.4		mg/L	2.5	20	02-NOV-14
Manganese (Mn)-Total		<0.025	<0.025	RPD-NA	mg/L	N/A	20	02-NOV-14
Potassium (K)-Total		<2.5	<2.5	RPD-NA	mg/L	N/A	20	02-NOV-14
Sodium (Na)-Total		13.4	12.7		mg/L	5.6	20	02-NOV-14
WG1987256-4 DUP		**L1541294-1**						
Calcium (Ca)-Total		508	468		mg/L	8.0	20	02-NOV-14
Iron (Fe)-Total		<0.15	<0.15	RPD-NA	mg/L	N/A	20	02-NOV-14
Magnesium (Mg)-Total		448	412		mg/L	8.4	20	02-NOV-14
Manganese (Mn)-Total		<0.025	<0.025	RPD-NA	mg/L	N/A	20	02-NOV-14
Potassium (K)-Total		6.9	6.4		mg/L	7.6	20	02-NOV-14
Sodium (Na)-Total		16.9	15.4		mg/L	9.0	20	02-NOV-14
WG1987256-1 MB								
Calcium (Ca)-Total			<0.10		mg/L		0.1	02-NOV-14
Iron (Fe)-Total			<0.030		mg/L		0.03	02-NOV-14
Magnesium (Mg)-Total			<0.10		mg/L		0.1	02-NOV-14
Manganese (Mn)-Total			<0.0050		mg/L		0.005	02-NOV-14
Potassium (K)-Total			<0.50		mg/L		0.5	02-NOV-14
Sodium (Na)-Total			<1.0		mg/L		1	02-NOV-14
NH4-CL	**Water**							
Batch R3044094								
WG1987646-3 DUP		**L1536604-1**						
Ammonia, Total (as N)		0.218	0.226		mg/L	3.3	20	03-NOV-14
WG1987646-7 DUP		**L1536604-14**						
Ammonia, Total (as N)		0.321	0.316		mg/L	1.7	20	03-NOV-14
WG1987646-2 LCS								

Quality Control Report

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3
Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH4-CL	**Water**							
Batch R3044094								
WG1987646-2 LCS								
Ammonia, Total (as N)			97.9		%		85-115	03-NOV-14
WG1987646-6 LCS								
Ammonia, Total (as N)			105.7		%		85-115	03-NOV-14
WG1987646-1 MB								
Ammonia, Total (as N)			<0.050		mg/L		0.05	03-NOV-14
WG1987646-5 MB								
Ammonia, Total (as N)			<0.050		mg/L		0.05	03-NOV-14
WG1987646-4 MS		**L1536604-13**						
Ammonia, Total (as N)			82.4		%		75-125	03-NOV-14
WG1987646-8 MS		**L1541134-3**						
Ammonia, Total (as N)			94.4		%		75-125	03-NOV-14
NO2-CL	**Water**							
Batch R3042228								
WG1987191-10 DUP		**L1541318-4**						
Nitrite (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	01-NOV-14
WG1987191-3 DUP		**L1540559-19**						
Nitrite (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	31-OCT-14
WG1987191-4 DUP		**L1540559-39**						
Nitrite (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	31-OCT-14
WG1987191-5 DUP		**L1540559-59**						
Nitrite (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	31-OCT-14
WG1987191-7 DUP		**L1541177-1**						
Nitrite (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	31-OCT-14
WG1987191-2 LCS								
Nitrite (as N)			98.6		%		90-110	31-OCT-14
WG1987191-1 MB								
Nitrite (as N)			<0.020		mg/L		0.02	31-OCT-14
NO3-IC-CL	**Water**							
Batch R3042228								
WG1987191-10 DUP		**L1541318-4**						
Nitrate (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	01-NOV-14
WG1987191-3 DUP		**L1540559-19**						
Nitrate (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	31-OCT-14
WG1987191-4 DUP		**L1540559-39**						
Nitrate (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	31-OCT-14
WG1987191-5 DUP		**L1540559-59**						
Nitrate (as N)		<0.050	<0.050		mg/L			31-OCT-14

Quality Control Report

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3
Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-IC-CL	**Water**							
Batch R3042228								
WG1987191-5 DUP		**L1540559-59**						
Nitrate (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	31-OCT-14
WG1987191-7 DUP		**L1541177-1**						
Nitrate (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	31-OCT-14
WG1987191-2 LCS								
Nitrate (as N)			94.4		%		90-110	31-OCT-14
WG1987191-1 MB								
Nitrate (as N)			<0.050		mg/L		0.05	31-OCT-14
P-T-COL-CL	**Water**							
Batch R3045254								
WG1987814-3 DUP		**L1541134-3**						
Phosphorus (P)-Total		0.0064	0.0067		mg/L	4.5	20	03-NOV-14
WG1987814-2 LCS								
Phosphorus (P)-Total			97.3		%		80-120	03-NOV-14
WG1987814-1 MB								
Phosphorus (P)-Total			<0.0050		mg/L		0.005	03-NOV-14
PH/EC/ALK-CL	**Water**							
Batch R3044908								
WG1987765-2 DUP		**L1538204-2**						
pH		8.19	8.26	J	pH	0.06	0.2	03-NOV-14
Conductivity (EC)		1990	1990		uS/cm	0.1	10	03-NOV-14
Bicarbonate (HCO3)		607	612		mg/L	0.8	20	03-NOV-14
Carbonate (CO3)		<5.0	<5.0	RPD-NA	mg/L	N/A	20	03-NOV-14
Hydroxide (OH)		<5.0	<5.0	RPD-NA	mg/L	N/A	20	03-NOV-14
Alkalinity, Total (as CaCO3)		498	502		mg/L	0.8	20	03-NOV-14
WG1987765-1 LCS								
pH			7.03		pH		6.9-7.1	03-NOV-14
Conductivity (EC)			92.7		%		90-110	03-NOV-14
Alkalinity, Total (as CaCO3)			97.5		%		85-115	03-NOV-14
PHENOLS-4AAP-ED	**Water**							
Batch R3043552								
WG1987560-2 LCS								
Phenols (4AAP)			103.0		%		85-115	03-NOV-14
WG1987560-1 MB								
Phenols (4AAP)			<0.0010		mg/L		0.001	03-NOV-14
SO4-CL	**Water**							

Quality Control Report

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3
Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-CL	**Water**							
Batch R3042228								
WG1987191-10 DUP		**L1541318-4**						
Sulfate (SO4)		31.9	31.2		mg/L	2.0	20	01-NOV-14
WG1987191-3 DUP		**L1540559-19**						
Sulfate (SO4)		21.1	21.2		mg/L	0.6	20	31-OCT-14
WG1987191-4 DUP		**L1540559-39**						
Sulfate (SO4)		69.4	69.2		mg/L	0.3	20	31-OCT-14
WG1987191-5 DUP		**L1540559-59**						
Sulfate (SO4)		4.89	4.81		mg/L	1.6	20	31-OCT-14
WG1987191-6 DUP		**L1540786-4**						
Sulfate (SO4)		1920	1920		mg/L	0.3	20	31-OCT-14
WG1987191-7 DUP		**L1541177-1**						
Sulfate (SO4)		8.26	8.29		mg/L	0.3	20	31-OCT-14
WG1987191-9 DUP		**L1541294-4**						
Sulfate (SO4)		1910	1910		mg/L	0.0	20	01-OCT-14
WG1987191-2 LCS								
Sulfate (SO4)			94.8		%		90-110	31-OCT-14
WG1987191-1 MB								
Sulfate (SO4)			<0.50		mg/L		0.5	31-OCT-14
SULPHIDE-ED	**Water**							
Batch R3045308								
WG1987823-4 DUP		**L1541134-3**						
Sulphide (as S)		0.0352	0.0328		mg/L	7.1	20	03-NOV-14
WG1987823-1 MB								
Sulphide (as S)			<0.0015		mg/L		0.0015	03-NOV-14
TC-MPN-CL	**Water**							
Batch R3046070								
WG1987933-1 MB								
MPN - Total Coliforms			<1		MPN/100mL		1	31-OCT-14
TKN-F-CL	**Water**							
Batch R3045868								
WG1987918-3 DUP		**L1541134-1**						
Total Kjeldahl Nitrogen		<0.20	<0.20	RPD-NA	mg/L	N/A	20	03-NOV-14
WG1987918-2 LCS								
Total Kjeldahl Nitrogen			81.2		%		75-125	03-NOV-14
WG1987918-1 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	03-NOV-14

Quality Control Report

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3
Contact: DAVID PARSONS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TKN-F-CL	**Water**							
Batch R3045868								
WG1987918-4 MS		**L1541134-1**						
Total Kjeldahl Nitrogen			78.0		%		70-130	03-NOV-14
TURBIDITY-CL	**Water**							
Batch R3041368								
WG1986837-4 DUP		**L1541134-3**						
Turbidity		47.4	47.2		NTU	0.4	15	01-NOV-14
WG1986837-2 LCS								
Turbidity			98.5		%		85-115	01-NOV-14
WG1986837-1 MB								
Turbidity			<0.10		NTU		0.1	01-NOV-14

Quality Control Report

Workorder: L1541134 Report Date: 03-NOV-14

Client: AMEC Environment & Infrastructure
140 QUARRY PARK BLVD SE
CALGARY AB T2C 3G3

Contact: DAVID PARSONS

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
J	Duplicate results and limits are expressed in terms of absolute difference.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

Af

L1541134-COFC

nber: 14 - 409484

Page 1 of 1

Report To	David Parsons
Company:	AMEC E+I
Contact:	
Address:	140 Quarry Pk Blvd SE, Calgary T2C 3G3
Phone:	403-248-4331

Report Format / Distribution

Select Report Format: [x] PDF [x] EXCEL [ ] EDD (DIGITAL)

Quality Control (QC) Report with Report [x] Yes [ ] No

[ ] Criteria on Report - provide details below if box checked

Select Distribution: [x] EMAIL [ ] MAIL [ ] FAX

Email 1 or Fax: david.parsons@amec.com

Email 2

Select Service Level Below (...Time (TAT) is not available for all tests)

- R [ ] Regular (Standard TAT if received by 3pm)
- P [x] Priority (2-4 business days if received by 3pm)
- E [ ] Emergency (1-2 business days if received by 3pm)
- E2 [ ] Same day or weekend emergency if received by 10am – contact ALS for surcharge.

Specify Date Required for E2,E or P:

Invoice To

Same as Report To [x] Yes [ ] No

Copy of Invoice with Report [x] Yes [ ] No

Company:

Contact:

Invoice Distribution

Select Invoice Distribution: [x] EMAIL [ ] MAIL [ ] FAX

Email 1 or Fax

Email 2

Project Information

ALS Quote #: Bottle Order # BR131711

Job #: CW 2174

PO / AFE:

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

Approver ID: | Cost Center:

GL Account: | Routing Code:

Activity Code:

Location:

ALS Contact:

Sampler: D. Parsons, H. Kanel.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Routine	Sulfide	Dis. Metals + Hg	Tot. Metals + Hg	Nutrients / Phenols etc. as per bottle order		Bacteriology (Coliforms)							Number of Containers
	1020988	31-Oct-14	10:00	G.water	X	X	X	X	X		X							
	1020984	"	10:15	"	X	X	X	X	X		X							
	3259	"	12:30	"	X	X	X	X	X		X							

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? [ ] Yes [ ] No

Are samples for human drinking water use? [ ] Yes [ ] No

Special Instructions / Specify Criteria to add on report (client Use)

Pls analyze for all parameters specified for bottle order # BR131711. Dissolved Metals + Hg sample has not been filtered or preserved. Pls filter in the lab.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen [ ] SIF Observations Yes [ ] No [ ]

Ice packs Yes [ ] No [ ] Custody seal intact Yes [ ] No [ ]

Cooling Initiated [ ]

INITIAL COOLER TEMPERATURES °C: 9

FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: [signature]	Date: 31/10/14	Time:	Received by: [signature]	Date: Oct 31	Time: 2:56	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY   YELLOW - CLIENT COPY

NA FM-0326a v06 Front/03 October 2013

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Appendix C

Fish and Aquatic Resources

General Watercourse Survey Data

Stream Name: Elbow River			Site: Elbow	UTM Location:11U 662359E 5641305N	
Date: 20 Oct 2014	Time: 8:45	Site Length (m): 6000	Access: Foot	Agency: AMEC	Crew: HC/ST/RF/DF/KL

Chemical Data

Water Temperature (°C): 3.5	pH: 8.5	Conductivity (µS/cm): 360
Time of Temperature (24h): 8:45	Turbidity: Clear	Dissolved Oxygen (mg/L): 11.55

Watercourse Characteristics

Pattern: IR	Islands: N	Bars:SIDE/MID
Coupling: PC	Confinement: FC	Gradient: -

Transect Information

Transect	T1	T2	T3	T4	T5
Easting	662359	662658	662869	662915	663116
Northing	5641305	5641310	5641521	5641822	5641925
Watercourse Channel					
Channel width (m) – top of bank	160	127	54	116	196
Channel width (m) – to 1:2 high water	-	-	-	-	-
Wetted width (m)	24.0	35.0	32.0	28.4	16.2
Depth @ 25% width	0.28	0.44	0.60	0.47	0.80
Depth @ 50% width	0.47	0.27	0.20	0.35	0.50
Depth @ 75% width	0.52	0.38	0.35	0.40	0.25
Maximum Depth (m)	0.52	0.47	0.60	0.50	1.10
Pool/Riffle/Run/ Flat/Rapid	0/40/60/0	0/30/60/10	10/25/50/15	0/15/80/5	0/10/90/0
Left Bank					
Height (m)	0.5	2.0	2.0	2.0	1.5
Shape	S	V	V	V	V
Texture	G,C	F,G,C,Bo	G,C,Bo	F,G,C	F,G,C
Riparian vegetation	G,C	G,M	G,M	G,M	G,M
Bank Stability	US	MU	S	US	US
Right Bank					
Height (m)	1.0	2.0	0.8	1.5	0.8
Shape	V	S	V	S	S
Texture	G,C	F,G,C	F,G,C,Bo	G,C,Bo	G,C
Riparian vegetation	NONE	NONE	M	NONE	NONE
Bank Stability	MU	MU	MU	S	S
Bed Material (Dominance)					
Organic materials	-	-	-	-	-
Fine sediments (<2mm)	TR	-	-	-	-
Small gravel (2-16mm)	-	10	10	15	20
Large gravel (18-64mm)	10	15	40	60	35
Small cobble (64-128mm)	15	25	15	20	10
Large cobble (128-256mm)	60	25	15	5	10
Boulder (>256mm)	15	20	20	-	25
Bedrock	-	5	-	-	-

Watercourse Cover Data (%) **Total Cover: 15** **Crown Closure: NONE**

Undercut bank: TR	Large woody debris: 10	Surface turbulence: 55	Instream Vegetation: -
Small woody debris: 5	Boulder: TR	Overhanging vegetation: -	Depth of the watercourse: 30
Turbidity: -			

Habitat Evaluation

Watercourse provides good habitat for fish species at all life stages. Areas of depth providing potential overwintering habitat and suitable spawning substrates were observed throughout the study reach. Fish cover is low and provided mainly by depth and surface turbulence. Along the margins, small and large woody debris provide some fish cover. Evidence of scour and erosion from recent high flows was observed throughout the study reach. Channel width included gravel bars deposited during recent flooding.

Plate 1: Facing upstream from transect 1 showing typical riffle and run habitat. 20 October 2014

Plate 2: Rapid habitat and deep pool providing potential overwintering habitat. 20 October 2014

Plate 3: Run and pool habitat immediately upstream of highway 66 bridge crossing. 20 October 2014

Plate 4: Typical run habitat and riffles associated with gravel bars. 20 October 2014

Notes:
Channel Pattern: TM = tortuous meanders, ME = regular meanders, IM = irregular meanders, IR = irregular wandering, SI = sinuous, ST = straight
Coupling: DC = decoupled, PC = partially coupled, CO = coupled
Islands: N = none, O = occasional, I = irregular, F = frequent, S = split, AN = anastomosing
Confinement: EN = entrenched, CO = confined, FC = frequently confined, OC = occasionally confined, UN = unconfined, NA = not applicable
Bars: N = none, SIDE = sediment deposition intermittent along the sides of streams, DIAG = mid-stream sediment deposition diagonally aligned to stream axis, MID = mid-stream sediment deposition aligned parallel to stream axis, SPAN = sediment deposition continuous along the sides of stream, BR = sediment deposition forms a number of small channels separated by bars
Shape: U = undercut banks, V = vertical, S = sloping, O = overhanging
Texture: F = fines, G = gravels, C = cobbles, B = boulders
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	**SURVEY DATE: 20 OCTOBER 2014**
DATE: DECEMBER 2014	**JOB No.: CW2174**
SUMMARY OF PHYSICAL AND CHEMICAL DATA ELBOW RIVER	**Figure C-1a**

General Watercourse Survey Data					
Stream Name: Elbow River		Site: Elbow		UTM Location:11U 662359E 5641305N	
Date: 20 Oct 2014	Time: 8:45	Site Length (m): 6000	Access: Foot	Agency: AMEC	Crew: HC/ST/RF/DF/KL
Chemical Data					
Water Temperature (°C): 3.5	pH: 8.5			Conductivity (µS/cm): 360	
Time of Temperature (24h): 8:45	Turbidity: Clear			Dissolved Oxygen (mg/L): 11.55	
Watercourse Characteristics					
Pattern: IR	Islands: N			Bars:SIDE/MID	
Coupling: PC	Confinement: FC			Gradient: -	
Transect Information					
Transect	**T6**	**T7**	**T8**	**T9**	**T10**
Easting	663343	663555	663841	661815	662091
Northing	5641717	5641935	5641889	5639696	5639790
Watercourse Channel					
Channel width (m) – top of bank	-	220	70	106	96.5
Channel width (m) – to 1:2 high water	65.0	-	-	-	-
Wetted width (m)	13.0	21.6	33.8	34.5	28.9
Depth @ 25% width	0.51	0.56	0.90	0.23	0.42
Depth @ 50% width	1.0	0.65	0.63	0.35	0.52
Depth @ 75% width	>1.1	0.47	0.45	0.34	0.55
Maximum Depth	1.1	0.70	0.90	0.43	0.55
Pool/Riffle/Run/ Flat/Rapid	0/5/70/25	0/20/50/30	0/5/85/10	0/30/60/10	5/25/65/5
Left Bank					
Height (m)	1.0	2.0	20	0.5	1.5
Shape	S	S	V	S	V
Texture	F,G,C,Bo	F,G,C,Bo	Be	F,G,C,Bo	F,G,C,Bo
Riparian vegetation	NONE	G,M	G,S,M	G,M	G,C
Bank Stability	S	MU	MS	MU	MU
Right Bank					
Height (m)	20	0.3	0.5	1.0	1.5
Shape	V	S	S	S	S
Texture	F,Be	F,G,C,Bo	F,C,Bo	F	G,C,Bo
Riparian vegetation	G,C	G,M	M	G,M	G,C
Bank Stability	US	S	S	S	MS
Bed Material (Dominance)					
Organic materials	-	-	-	-	-
Fine sediments (<2mm)	5	-	-	-	-
Small gravel (2-16mm)	15	10	5	10	15
Large gravel (18-64mm)	10	10	10	30	40
Small cobble (64-128mm)	5	15	30	40	30
Large cobble (128-256mm)	5	25	40	15	15
Boulder (>256mm)	10	40	5	5	-
Bedrock	50	-	10	-	-
Watercourse Cover Data (%)	**Total Cover: 15**		**Crown Closure: NONE**		
Undercut bank: TR	Large woody debris: 10		Surface turbulence: 55	Instream Vegetation: -	
Small woody debris: 5	Boulder: TR		Overhanging vegetation: -	Depth of the watercourse: 30	
Turbidity: -					

Notes:
Channel Pattern: TM = tortuous meanders, ME = regular meanders, IM = irregular meanders, IR = irregular wandering,
SI = sinuous, ST = straight
Coupling: DC = decoupled, PC = partially coupled, CO = coupled
Islands: N = none, O = occasional, I = irregular, F = frequent, S = split, AN = anastomosing
Confinement: EN = entrenched, CO = confined, FC = frequently confined, OC = occasionally confined, UN = unconfined, NA = not applicable
Bars: N = none, SIDE = sediment deposition intermittent along the sides of streams, DIAG = mid-stream sediment deposition diagonally aligned to stream axis, MID = mid-stream sediment deposition aligned parallel to stream axis, SPAN = sediment deposition continuous along the sides of stream, BR = sediment deposition forms a number of small channels separated by bars
Shape: U = undercut banks, V = vertical, S = sloping, O = overhanging
Texture: F = fines, G = gravels, C = cobbles, B = boulders
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable

Plate 5: Bank erosion and woody debris providing cover for fish. 20 October 2014

Plate 6: Typical run habitat, side bar and eroded bank. 20 October 2014

Plate 7: Facing downstream near transect 7 showing typical rapid habitat. 20 October 2014

Plate 8: Bedrock bank observed in sections throughout the study reach. 20 October 2014

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	**SURVEY DATE: 20 OCTOBER 2014**
DATE: DECEMBER 2014	**JOB No.: CW2174**
SUMMARY OF PHYSICAL AND CHEMICAL DATA ELBOW RIVER	**Figure C-1b**

General Watercourse Survey Data					
Stream Name: Elbow River			Site: Elbow	UTM Location:11U 662359E 5641305N	
Date: 20 Oct 2014	Time: 8:45	Site Length (m): 6000	Access: Foot	Agency: AMEC	Crew: HC/ST/RF/DF/KL
Chemical Data					
Water Temperature (°C): 3.5	pH: 8.5			Conductivity (μS/cm): 360	
Time of Temperature (24h): 8:45	Turbidity: Clear			Dissolved Oxygen (mg/L): 11.55	
Watercourse Characteristics					
Pattern: IR	Islands: N			Bars:SIDE/MID	
Coupling: PC	Confinement: FC			Gradient: -	
General Watercourse Survey Data					
Transect	**T11**	**T12**	**T13**	**T14**	**T15**
Easting	662203	662125	662199	662217	662197
Northing	5640013	5640307	5640655	5640920	5641201
Watercourse Channel					
Channel width (m) – top of bank	79	105	240	100	340
Channel width (m) – to 1:2 high water	-	-	-	-	-
Wetted width (m)	21.2	40.8	14.46	17.9	36
Depth @ 25% width	0.50	0.54	0.49	0.35	0.42
Depth @ 50% width	0.40	0.25	0.50	0.58	0.50
Depth @ 75% width	0.35	0.45	0.50	0.42	0.45
Maximum Depth (m)	0.50	0.56	0.50	0.58	0.50
Pool/Riffle/Run/ Flat/Rapid	0/10/55/35	0/45/45/10	0/10/20/70	0/30/50/20	0/20/50/30
Left Bank					
Height (m)	0.5	2.0	1..0	0.5	15
Shape	S	V	S	S	V
Texture	G,C,Bo	F	F,C,Bo	G,C,Bo	F,G,C
Riparian vegetation	G,S,M	G,C	G,M	M	G,M
Bank Stability	MS	MU	S	S	MS
Right Bank					
Height (m)	30	1.0	0.5	2.0	0.5
Shape	V	S	S	S	S
Texture	Be	G,C,Bo	G,C,Bo	G,C,Bo	G,C,Bo
Riparian vegetation	M	G,M	G,M	M	G,S,M
Bank Stability	S	S	S	MS	US
Bed Material (Dominance)					
Organic materials	-	-	-	-	-
Fine sediments (<2mm)	-	-	-	-	5
Small gravel (2-16mm)	10	10	5	-	5
Large gravel (18-64mm)	20	40	5	30	25
Small Cobble (64-128mm)	50	30	10	45	40
Large cobble (128-256mm)	10	15	30	15	20
Boulder (>256mm)	TR	5	50	10	5
Bedrock	10	-	-	-	-
Watercourse Cover Data (%)	**Total Cover: 15**			**Crown Closure: NONE**	
Undercut bank: TR	Large woody debris: 10		Surface turbulence: 55	Instream Vegetation: -	
Small woody debris: 5	Boulder: TR		Overhanging vegetation: -	Depth of the watercourse: 30	
Turbidity: -					

Notes:
Channel Pattern: TM = tortuous meanders, ME = regular meanders, IM = irregular meanders, IR = irregular wandering, SI = sinuous, ST = straight
Coupling: DC = decoupled, PC = partially coupled, CO = coupled
Islands: N = none, O = occasional, I = irregular, F = frequent, S = split, AN = anastomosing
Confinement: EN = entrenched, CO = confined, FC = frequently confined, OC = occasionally confined, UN = unconfined, NA = not applicable
Bars: N = none, SIDE = sediment deposition intermittent along the sides of streams, DIAG = mid-stream sediment deposition diagonally aligned to stream axis, MID = mid-stream sediment deposition aligned parallel to stream axis, SPAN = sediment deposition continuous along the sides of stream, BR = sediment deposition forms a number of small channels separated by bars
Shape: U = undercut banks, V = vertical, S = sloping, O = overhanging
Texture: F = fines, G = gravels, C = cobbles, B = boulders
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable

Plate 9: Riffle habitat transitioning into rapids. 20 October 2014

Plate 10: Typical riffle habitat near transect 14. 20 October 2014

Plate 11: Redd observed in side channel near transect 13. Note clean gravel substrate and cover provided by small woody debris. 20 October 2014

Plate 12: Rapid habitat over cobble and boulder substrate. 20 October 2014

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	**SURVEY DATE: 20 OCTOBER 2014**
DATE: DECEMBER 2014	**JOB No.: CW2174**
SUMMARY OF PHYSICAL AND CHEMICAL DATA ELBOW RIVER	**Figure C-1c**

General Watercourse Survey Data					
Stream Name: Elbow River			Site: Elbow	UTM Location:11U 662359E 5641305N	
Date: 21 Oct 2014	Time: 8:45	Site Length (m): 6000	Access: Foot	Agency: AMEC	Crew: HC/ST/RF/DF/KL
Chemical Data					
Water Temperature (°C): 3.5	pH: 8.5			Conductivity (µS/cm): 360	
Time of Temperature (24h): 8:45	Turbidity: Clear			Dissolved Oxygen (mg/L): 11.55	
Watercourse Characteristics					
Pattern: IR	Islands: N			Bars:SIDE/MID	
Coupling: PC	Confinement: FC			Gradient: -	
Transect Information					
Transect	**T16**	**T17**	**T18**	**T19**	**T20**
Easting	661035	661198	661443	661695	661754
Northing	5638430	5638679	5638857	5639018	5639305
Watercourse Channel					
Channel width (m) – top of bank	169	106	80	85	129
Channel width (m) – to 1:2 high water	-	-	-	-	-
Wetted width (m)	25.8	17.4	11.6	15.0	24.9
Depth @ 25% width	0.23	0.35	0.79	0.45	0.35
Depth @ 50% width	0.49	0.50	0.85	0.49	0.54
Depth @ 75% width	0.58	0.54	0.55	0.38	0.49
Maximum Depth (m)	0.58	0.50	0.79	0.49	0.54
Pool/Riffle/Run/ Flat/Rapid	0/10/90/0	5/0/65/30	5/15/45/35	10/2065/5	5/50/30/15
Left Bank					
Height (m)	2.5	1.5	3.5	1.5	1.5
Shape	V	V	V	V	V
Texture	F,G,C,Bo	G,C,Bo	F,G,C	G,C,Bo	G,C
Riparian vegetation	M	M	M	S,M	M
Bank Stability	US	MU	US	MU	US
Right Bank					
Height (m)	2.5	1.0	0.5	16	6.0
Shape	V	S	S	V	V
Texture	F,G,C,Bo	G,C,Bo	G,C,Bo	F,G,C,Be	F,G,C,Bo
Riparian vegetation	M	C	M	M	C
Bank Stability	US	S	MS	US	US
Bed Material (Dominance)					
Organic materials	-	-	-	-	-
Fine sediments (<2mm)	-	-	5	-	-
Small gravel (2-16mm)	10	15	10	10	10
Large gravel (18-64mm)	40	10	20	15	20
Small Cobble (64-128mm)	30	20	15	25	20
Large cobble (128-256mm)	15	15	30	40	30
Boulder (>256mm)	5	40	25	10	10
Bedrock	-	-	-	-	10

Watercourse Cover Data (%)	Total Cover: 15		Crown Closure: NONE
Undercut bank: TR	Large woody debris: 10	Surface turbulence: 55	Instream Vegetation: -
Small woody debris: 5	Boulder: TR	Overhanging vegetation: -	Depth of the watercourse: 30
Turbidity: -			

Plate 13: Facing upstream from transect 18 showing typical run habitat and debris piles along the margins. 21 October 2014

Plate 13: Debris pile along the left downstream bank near transect 16. Similar debris piles were observed throughout the study reach. 21 October 2014

Plate 14: Braided channel flow around mid and side bars. 21 October 2014

Plate 15: Rapids over bedrock shelves and deep pool potentially providing overwintering habitat for fish. 21 October 2014

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	**SURVEY DATE: 21 OCTOBER 2014**
DATE: DECEMBER 2014	**JOB No.: CW2174**
SUMMARY OF PHYSICAL AND CHEMICAL DATA **ELBOW RIVER**	**Figure C-1d**

General Watercourse Survey Data					
Stream Name: Ranger Creek			Site: Ranger	UTM Location: 11U 662730E 464145N	
Date: 22-Oct-2014	Time: 9:30	Site Length (m): 1500	Access: Foot	Agency: AMEC	Crew: HC/KL
Chemical Data					
Water Temperature (˚C): 1.9	pH: 8.28			Conductivity (μS/cm): 235	
Time of Temperature (24h): 9:30	Turbidity: Low			Dissolved Oxygen (mg/L): 12.60	
Watercourse Characteristics					
Pattern: IR	Islands: O			Bars: SIDE/MID	
Coupling: PC	Confinement: OC			Gradient: -	
Transect Information					
Transect	**T1**	**T2**	**T3**	**T4**	**T5**
Easting	662730	662620	662518	662420	662380
Northing	5641545	6541502	5641553	5641549	5641641
Watercourse Channel					
Channel width (m) – top of bank	4.7	4.8	6.2	4.0	5.0
Channel width (m) – to 1:2 high water	-	-	-	-	-
Wetted width (m)	4.70	3.26	3.35	2.45	2.87
Depth @ 25% width	0.70	0.15	0.28	0.23	0.20
Depth @ 50% width	0.84	0.21	0.17	0.12	0.35
Depth @ 75% width	0.88	0.13	0.04	0.05	0.23
Maximum Depth (m)	0.88	0.22	0.33	0.24	0.39
Pool/Riffle/Run/ Flat/Impoundmenet	0/0/0/50/50	0/15/40/45/0	10/20/40/30	10/20/70/0/0	20/30/50/0/0
Left Bank					
Height (m)	10.0	0.47	0.25	0.45	1.20
Shape	V	V	S	V	V
Texture	Be	F	F,G,C	F,G,C,Bo	F,G,C
Riparian vegetation	M	G,S,M	M	G,S,M	G,S,M
Bank Stability	MU	S	S	S	MU
Right Bank					
Height (m)	0.30	0.37	0.68	0.60	0.20
Shape	S	V	U	V	S
Texture	F	F	F	F,G,C,Bo	F,G,C
Riparian vegetation	G,S,C	G,S,M	C	G,S,M	S,C
Bank Stability	S	S	S	MS	MS
Bed Material (Dominance)					
Organic materials	5	-	-	-	-
Fine sediments (<2mm)	55	45	30	25	40
Small gravel (2-16mm)	5	15	30	20	25
Large gravel (18-64mm)	5	20	25	30	10
Small cobble (64-128mm)	10	15	10	10	15
Large cobble (128-256mm)	-	5	5	10	10
Boulder (>256mm)	-	-	-	5	TR
Bedrock	10	-	-	-	-
Watercourse Cover Data (%):	**Total Cover: 10**		**Crown Closure: Low**		
Undercut bank: 10	Large woody debris: 50		Surface turbulence: -	Instream Vegetation: -	
Small woody debris: 20	Boulder: -		Overhanging vegetation: 20	Depth of the watercourse: TR	
Turbidity: -					
Habitat Evaluation					

Notes:
Channel Pattern: TM = tortuous meanders, ME = regular meanders, IM = irregular meanders, IR = irregular wandering, SI = sinuous, ST = straight
Coupling: DC = decoupled, PC = partially coupled, CO = coupled
Islands: N = none, O = occasional, I = irregular, F = frequent, S = split, AN = anastomosing
Confinement: EN = entrenched, CO = confined, FC = frequently confined, OC = occasionally confined, UN = unconfined, NA = not applicable
Bars: N = none, SIDE = sediment deposition intermittent along the sides of streams, DIAG = mid-stream sediment deposition diagonally aligned to stream axis, MID = mid-stream sediment deposition aligned parallel to stream axis, SPAN = sediment deposition continuous along the sides of stream, BR = sediment deposition forms a number of small channels separated by bars
Shape: U = undercut banks, V = vertical, S = sloping, O = overhanging
Texture: F = fines, G = gravels, C = cobbles, B = boulders
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable

Plate 1: Confluence of Ranger Creek and Elbow River. 22 October 2014

Plate 2: Beaver dam and footbridge upstream of confluence with the Elbow River. 22 October 2014

Plate 3: Facing downstream from transect 1 showing flat habitat due to beaver activity. 22 October 22

Plate 4: Facing upstream from transect 5 showing riffle habitat over coarse substrate. 22 October 2014

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	SURVEY DATE: 21 OCTOBER 2014
DATE: DECEMBER 2014	JOB No.: CW2174
SUMMARY OF PHYSICAL AND CHEMICAL DATA RANGER CREEK	Figure C-2a

General Watercourse Survey Data					
Stream Name: Ranger Creek			Site: Ranger	UTM Location: 11U 662730E 464145N	
Date: 22-Oct-2014	Time: 9:30	Site Length (m): 1500	Access: Foot	Agency: AMEC	Crew: HC/KL
Chemical Data					
Water Temperature (°C): 1.9	pH: 8.28			Conductivity (µS/cm): 235	
Time of Temperature (24h): 9:30	Turbidity: Low			Dissolved Oxygen (mg/L): 12.60	
Watercourse Characteristics					
Pattern: IR	Islands: O			Bars: SIDE/MID	
Coupling: PC	Confinement: OC			Gradient: -	
Transect Information					
Transect	**T6**	**T7**	**T8**	**T9**	**T10**
Easting	662274	662169	662048	661936	661820
Northing	5641678	5641700	5641718	5641764	5641723
Watercourse Channel					
Channel width (m) – top of bank	5.1	4.6	9.0	5.0	5.1
Channel width (m) – to 1:2 high water	-	-	-	-	-
Wetted width (m)	2.50	2.50	1.50	5.00	3.30
Depth @ 25% width	0.08	0.23	0.07	0.12	0.12
Depth @ 50% width	0.14	0.25	0.11	0.10	0.15
Depth @ 75% width	0.11	0.27	0.20	0.07	0.15
Maximum Depth	0.14	0.28	0.20	0.12	0.16
Pool/Riffle/Run/ Flat/Impoundment	25/20/55/0/0	10/20/70/0/0	10/40/50/0/0	0/10/10/80/0	15/5/80/0/0
Left Bank					
Height (m)	0.60	0.90	1.20	1.40	1.90
Shape	U	V	V	V	V
Texture	F,G,C	F,G	F	F,G,C	F,G,C
Riparian vegetation	G,S,M	G,M	C	G,S,	G,C
Bank Stability	MU	MS	MS	US	US
Right Bank					
Height (m)	0.53	0.90	1.50	0.40	1.30
Shape	S	V	V	S	S
Texture	F,G,C	F,G,C	F,G	F,G,C	G,C,Bo
Riparian vegetation	S	G,S,C	C	G,S,M	G,S,M
Bank Stability	S	MU	US	MS	MS
Bed Material (Dominance)					
Organic materials	-	-	-	-	-
Fine sediments (<2mm)	20	25	20	30	30
Small gravel (2-16mm)	30	30	25	30	30
Large gravel (18-64mm)	25	15	35	40	35
Small cobble (64-128mm)	10	10	15	TR	5
Large cobble (128-256mm)	10	15	5	-	TR
Boulder (>256mm)	5	5	TR	-	TR
Bedrock	-	-	-	-	-
Watercourse Cover Data (%):	**Total Cover: 10**			**Crown Closure: Low**	
Undercut bank: 10	Large woody debris: 50		Surface turbulence: -	Instream Vegetation: -	
Small woody debris: 20	Boulder: -		Overhanging vegetation: 20	Depth of the watercourse: TR	
Turbidity: -					

Notes:
Channel Pattern: TM = tortuous meanders, ME = regular meanders, IM = irregular meanders, IR = irregular wandering,
SI = sinuous, ST = straight
Coupling: DC = decoupled, PC = partially coupled, CO = coupled
Islands: N = none, O = occasional, I = irregular, F = frequent, S = split, AN = anastomosing
Confinement: EN = entrenched, CO = confined, FC = frequently confined, OC = occasionally confined, UN = unconfined, NA = not applicable
Bars: N = none, SIDE = sediment deposition intermittent along the sides of streams, DIAG = mid-stream sediment deposition diagonally aligned to stream axis, MID = mid-stream sediment deposition aligned parallel to stream axis, SPAN = sediment deposition continuous along the sides of stream, BR = sediment deposition forms a number of small channels separated by bars
Shape: U = undercut banks, V = vertical, S = sloping, O = overhanging
Texture: F = fines, G = gravels, C = cobbles, B = boulders
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable

Plate 5: Facing upstream from transect 6 at typical run habitat and fish cover provided by overhanging vegetation. 22 October 2014

Plate 6: Facing downstream from transect 7 showing typical riffle habitat. 22 October 2014

Plate 7: Pool providing potential overwintering habitat between transects 8 and 9. 22 October 2014

Plate 8: Beaver dam causing small impoundment between transects 9 and 10. 22 October 2014

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	**SURVEY DATE: 21 OCTOBER 2014**
DATE: DECEMBER 2014	**JOB No.: CW2174**
SUMMARY OF PHYSICAL AND CHEMICAL DATA RANGER CREEK	**Figure C-2b**

General Watercourse Survey Data					
Stream Name: Ranger Creek		Site: Ranger		UTM Location: 11U 662730E 464145N	
Date: 22-Oct-2014	Time: 9:30	Site Length (m): 1500	Access: Foot	Agency: AMEC	Crew: HC/KL
Chemical Data					
Water Temperature (˚C): 1.9	pH: 8.28			Conductivity (µS/cm): 235	
Time of Temperature (24h): 9:30	Turbidity: Low			Dissolved Oxygen (mg/L): 12.60	
Watercourse Characteristics					
Pattern: IR	Islands: O			Bars: SIDE/MID	
Coupling: PC	Confinement: OC			Gradient: -	
Transect Information					
Transect	**T11**	**T12**	**T13**	**T14**	**Mean**
Easting	661720	661641	661576	661464	-
Northing	5641754	5641839	5641952	5641999	-
Watercourse Channel					
Channel width (m) – top of bank	5.0	5.3	5.4	9.0	5.6
Channel width (m) – to 1:2 high water	-	-	-	-	-
Wetted width (m)	1.30	2.80	2.90	1.80	2.87
Depth @ 25% width	0.20	0.16	0.06	0.20	0.20
Depth @ 50% width	0.15	0.11	0.07	0.40	0.23
Depth @ 75% width	0.16	0.13	0.12	0.47	0.22
Maximum Depth (m)	0.26	0.27	0.12	0.47	0.29
Pool/Riffle/Run/ Flat/Impoundment	0/80/20/0/0	0/40/60/0/0	0/60/40/0/0	20/30/50/0/0	9/28/45/15/4
Left Bank					
Height (m)	0.25	0.75	0.30	0.47	1.43
Shape	S	V	S	S	-
Texture	F,G,C	F,G,C	F,G	F,G,C	-
Riparian vegetation	C	G,S,C	G,S	G,S,M	-
Bank Stability	MU	US	MS	MS	-
Right Bank					
Height (m)	0.15	0.80	0.90	1.30	0.71
Shape	S	V	V	U	-
Texture	F,G,C	F,G,C,Bo	F,G	F,G	-
Riparian vegetation	C	G,S,C	G,S,C	G,S,C	-
Bank Stability	MU	MU	US	US	-
Bed Material (Dominance)					
Organic materials	-	-	-	-	-
Fine sediments (<2mm)	15	15	30	10	28
Small gravel (2-16mm)	25	20	30	20	24
Large gravel (18-64mm)	20	25	35	25	25
Small Cobble (64-128mm)	15	15	5	15	11
Large cobble (128-256mm)	10	25	TR	30	9
Boulder (>256mm)	-	TR	-	TR	1
Bedrock	-	-	-	-	1
Watercourse Cover Data (%):	**Total Cover: 10**		**Crown Closure: Low**		
Undercut bank: 10	Large woody debris: 50		Surface turbulence: -	Instream Vegetation: -	
Small woody debris: 20	Boulder: -		Overhanging vegetation: 20	Depth of the watercourse: TR	
Turbidity: -					

Notes:
Channel Pattern: TM = tortuous meanders, ME = regular meanders, IM = irregular meanders, IR = irregular wandering, SI = sinuous, ST = straight
Coupling: DC = decoupled, PC = partially coupled, CO = coupled
Islands: N = none, O = occasional, I = irregular, F = frequent, S = split, AN = anastomosing
Confinement: EN = entrenched, CO = confined, FC = frequently confined, OC = occasionally confined, UN = unconfined, NA = not applicable
Bars: N = none, SIDE = sediment deposition intermittent along the sides of streams, DIAG = mid-stream sediment deposition diagonally aligned to stream axis, MID = mid-stream sediment deposition aligned parallel to stream axis, SPAN = sediment deposition continuous along the sides of stream, BR = sediment deposition forms a number of small channels separated by bars
Shape: U = undercut banks, V = vertical, S = sloping, O = overhanging
Texture: F = fines, G = gravels, C = cobbles, B = boulders
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable

Plate 9: Facing upstream from transect 11 showing typical run habitat and overhanging vegetation providing cover for fish. 22 October 2014

Plate 10: Facing upstream from transect 12 showing undercut bank and large woody debris fish cover. 22 October 2014

Plate 11: Facing upstream from transect 13 showing typical riffle habitat. 22 October 2014

Plate 12: Unstable and slumping bank at transect 14. 22 October 2014

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	**SURVEY DATE: 21 OCTOBER 2014**
DATE: DECEMBER 2014	**JOB No.: CW2174**
SUMMARY OF PHYSICAL AND CHEMICAL DATA RANGER CREEK	**Figure C-2c**

General Watercourse Survey Data						
Stream Name: Unnamed Tributary to Elbow River		Site: Drainage 1		UTM Location: 11U 661738E 5639750N		
Date: 21-Oct-2014	Time: 11:00	Site Length (m): 600	Access: Foot	Agency: AMEC	Crew: ST/HC/KL/DF	
Chemical Data						
Water Temperature (°C): 5.2	pH: 7.76			Conductivity (µS/cm): 329		
Time of Temperature (24h): 13:00	Turbidity: Low			Dissolved Oxygen (mg/L): 11.53		
Watercourse Characteristics						
Pattern: IR	Islands: O			Bars: SIDE		
Coupling: DC	Confinement: OC			Gradient: -		
Transect Information						
Transect	**T1**	**T2**	**T3**	**T4**	**T5**	**Mean**
Easting	661738	661604	661499	661372	661245	-
Northing	5639750	5639711	5639648	5639598	5639578	-
Watercourse Channel						
Channel width (m) – top of bank	1.6	2.0	3.5	2.5	4.5	2.8
Channel width (m) – to 1:2 high water	-	-	-	-	-	-
Wetted width (m)	0.9	0.5	2.6	1.2	1.3	1.3
Depth @ 25% width (LDB)	0.15	0.04	0.24	0.08	0.15	0.13
Depth @ 50% width	0.13	0.05	0.29	0.11	0.14	0.14
Depth @ 75% width (RDB)	0.11	0.06	0.28	0.09	0.13	0.13
Maximum Depth (m)	0.18	0.10	0.30	0.11	0.16	0.17
Pool/Riffle/Run/ Flat	0/0/0/100	0/0/80/20	0/0/0/100	0/40/60/0	0/45/55/0	0/17/39/44
Left Bank						
Height (m)	0.20	0.50	0.60	0.15	0.60	0.41
Shape	S	S	S	S	V	-
Texture	F	F	F	G	F,C	-
Riparian vegetation	G,S,M	G,S,M	G,S,M	M	G,M	-
Bank Stability	MS	S	S	S	MU	-
Right Bank						
Height (m)	0.40	0.40	0.50	0.40	0.50	0.44
Shape	S	S	S	S	V	-
Texture	F	F	F	G	F,C	-
Riparian vegetation	G,S,M	G,S,M	G,S,M	M	G,M	-
Bank Stability	MS	S	S	S	MU	-
Bed Material (Dominance)						
Organic materials	20	70	-	-	-	18
Fine sediments (<2mm)	70	30	100	55	20	55
Small gravel (2-16mm)	5	-	-	30	30	13
Large gravel (18-64mm)	5	-	-	10	20	7
Small cobble (64-128mm)	TR	-	-	5	15	4
Large cobble (128-256mm)	-	-	-	-	10	2
Boulder (>256mm)	-	-	-	-	5	1
Bedrock	-	-	-		-	-
Watercourse Cover Data (%)		**Total Cover: 5%**		**Crown Closure: Moderate**		
Undercut bank: TR	Large woody debris: 40		Surface turbulence: TR		Instream Vegetation: -	
Small woody debris: 60	Boulder: -		Overhanging vegetation: -		Depth of the watercourse: -	
Turbidity: -						
Habitat Evaluation						

Watercourse has poor connectivity to the Elbow River due to subterranean flow near the confluence. At time of survey, low flow levels resulted in a large gravel bar separating the creek from the river causing a migration barrier for fish. Watercourse transitions from undefined flow with organic or fine substrate at the downstream transects to defined channelized flow with coarse substrate at the upstream transects. Gradient at transects 1-3 is low resulting in stagnant or flat fish habitat. Gradient increases further upstream causing a higher proportion of riffle and run habitat.

Notes:
Channel Pattern: TM = tortuous meanders, ME = regular meanders, IM = irregular meanders, IR = irregular wandering, SI = sinuous, ST = straight
Coupling: DC = decoupled, PC = partially coupled, CO = coupled
Islands: N = none, O = occasional, I = irregular, F = frequent, S = split, AN = anastomosing
Confinement: EN = entrenched, CO = confined, FC = frequently confined, OC = occasionally confined, UN = unconfined, NA = not applicable
Bars: N = none, SIDE = sediment deposition intermittent along the sides of streams, DIAG = mid-stream sediment deposition diagonally aligned to stream axis, MID = mid-stream sediment deposition aligned parallel to stream axis, SPAN = sediment deposition continuous along the sides of stream, BR = sediment deposition forms a number of small channels separated by bars
Shape: U = undercut banks, V = vertical, S = sloping, O = overhanging
Texture: F = fines, G = gravels, C = cobbles, B = boulders
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable

Plate 1: Subterranean flow through large gravel bar immediately upstream of confluence with Elbow River resulting in a fish migration barrier. 21 October 2014

Plate 2: Facing downstream at confluence of drainage with Elbow River showing gravel bar and fish migration barrier. 21 October 2014

Plate 3: Facing upstream from transect 3 showing low gradient flat habitat with organic and fines substrate. 21 October 2014

Plate 4: Facing downstream from transect 5 showing defined channel and banks with coarse substrate. 21 October 2014

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	SURVEY DATE: 21 OCTOBER 2014
DATE: DECEMBER 2014	JOB No.: CW2174
SUMMARY OF PHYSICAL AND CHEMICAL DATA UNNAMED TRIBUTARY TO ELBOW RIVER	Figure C-3

General Watercourse Survey Data						
Stream Name: Unnamed Tributary to Elbow River			Site: Drainage 2	UTM Location: 11U 662139E 5641202N		
Date: 21-Oct-2014	Time: 13:20	Site Length (m): 500	Access: Foot	Agency: AMEC	Crew: ST/HC	
Chemical Data						
Water Temperature (˚C): 6.6	pH: 8.21			Conductivity (µS/cm): 544		
Time of Temperature (24h): 14:26	Turbidity: low			Dissolved Oxygen (mg/L): 10.98		
Watercourse Characteristics						
Pattern: IR	Islands: N			Bars: SIDE		
Coupling: PC	Confinement: FC			Gradient: -		
Transect Information						
Transect	**T1**	**T2**	**T3**	**T4**	**T5**	**Mean**
Easting	662139	662057	661926	661796	-	-
Northing	5641202	5641262	5641309	5641356	-	-
Watercourse Channel						
Channel width (m) – top of bank	7.4	4.2	13.0	3.5	-	7.0
Channel width (m) – to 1:2 high water	-	-	-	-	-	-
Wetted width (m)	1.66	0.77	1.20	DRY	-	1.2
Depth @ 25% width	0.04	0.07	0.02	DRY	-	0.04
Depth @ 50% width	0.03	0.10	0.02	DRY	-	0.05
Depth @ 75% width	0.05	0.10	0.10	DRY	-	0.08
Maximum Depth (m)	0.05	0.22	0.10	DRY	-	0.12
Pool/Riffle/Run/ Flat	0/40/60/0	10/30/60/0	5/10/15/70	DRY	-	5/2745/23
Left Bank						
Height (m)	0.96	1.10	0.91	1.00	-	0.99
Shape	S	V	S	V	-	-
Texture	F,G	F,G,C	F,G,C	-	-	-
Riparian vegetation	G,S,C,	G,S,C	G,S,M	-	-	-
Bank Stability	S	S	MS	-	-	-
Right Bank						
Height (m)	0.87	1.50	1.15	1.15	-	1.56
Shape	V	V	V	V	-	-
Texture	F	F	F,G,C	-	-	-
Riparian vegetation	G,S	G,S,C	G,S,C	-	-	-
Bank Stability	S	US	MS	-	-	-
Bed Material (Dominance)						
Organic materials	10	-	-	-	-	3
Fine sediments (<2mm)	20	15	30	10	-	19
Small gravel (2-16mm)	20	20	30	20	-	23
Large gravel (18-64mm)	35	25	30	30	-	30
Small cobble (64-128mm)	10	25	10	25	-	18
Large cobble (128-256mm)	5	10	-	15	-	8
Boulder (>256mm)	-	5	-	-	-	1
Bedrock	-	-	-	-	-	-

Watercourse Cover Data (%)	Total Cover: 5	Crown Closure: Low	
Undercut bank: -	Large woody debris: 60	Surface turbulence: -	Instream Vegetation: -
Small woody debris:30	Boulder: -	Overhanging vegetation: 10	Depth of the watercourse: -
Turbidity: -			

Habitat Evaluation

Watercourse has seasonal flow resulting in poor connectivity and migration barrier. Culvert at Elbow River confluence is perched 5 m preventing fish from entering the drainage. Between transects 3 and 4 the channel becomes isolated pools transitioning into a dry channel bed. Due to limited flow, watercourse likely freezes to the bottom in winter months. No large bodied fish potential and small bodied forage fish habitat is isolated as flow decreases.

Plate 1: 5 m perched culvert at confluence with Elbow River presenting a fish migration barrier. 21 October 2014

Plate 2: Facing upstream from transect 1 showing riffle and run habitat over coarse substrate. 21 October 2014

Plate 3: Facing upstream from transect 3 limited flow near the upstream end of the study reach. 21 October 2014

Plate 4: Dry channel bed at transect 4. 21 October 2014

Notes:
Channel Pattern: TM = tortuous meanders, ME = regular meanders, IM = irregular meanders, IR = irregular wandering, SI = sinuous, ST = straight
Coupling: DC = decoupled, PC = partially coupled, CO = coupled
Islands: N = none, O = occasional, I = irregular, F = frequent, S = split, AN = anastomosing
Confinement: EN = entrenched, CO = confined, FC = frequently confined, OC = occasionally confined, UN = unconfined, NA = not applicable
Bars: N = none, SIDE = sediment deposition intermittent along the sides of streams, DIAG = mid-stream sediment deposition diagonally aligned to stream axis, MID = mid-stream sediment deposition aligned parallel to stream axis, SPAN = sediment deposition continuous along the sides of stream, BR = sediment deposition forms a number of small channels separated by bars
Shape: U = undercut banks, V = vertical, S = sloping, O = overhanging
Texture: F = fines, G = gravels, C = cobbles, B = boulders
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	SURVEY DATE: 21 OCTOBER 2014
DATE: DECEMBER 2014	JOB No.: CW2174
SUMMARY OF PHYSICAL AND CHEMICAL DATA UNNAMED TRIBUTARY TO ELBOW RIVER	Figure C-4

General Watercourse Survey Data				
Stream Name: Unnamed Tributary to Elbow River		Site: Drainage 3	UTM Location: 11U 663085E 5642061N	
Date: 21-Oct-2014	Time: 13:30	Site Length (m): 500	Access: Foot	Agency: AMEC	Crew: DF/KL

Chemical Data		
Water Temperature (°C): 5.6	pH: 8.56	Conductivity (μS/cm): 261
Time of Temperature (24h): 14:52	Turbidity: low	Dissolved Oxygen (mg/L): 11.84
Watercourse Characteristics		
Pattern: SI	Islands: N	Bars: SIDE
Coupling: PC	Confinement: CO	Gradient: -

Transect Information						
Transect	**T1**	**T2**	**T3**	**T4**	**T5**	**Mean**
Easting	663085	663027	663027	663062	662999	-
Northing	5642061	5642140	5642252	5642353	5642421	-
Watercourse Channel						
Channel width (m) – top of bank	3.3	2.8	3.5	2.8	2.0	2.9
Channel width (m) – to 1:2 high water	-	-	-	-	-	-
Wetted width (m)	2.20	1.40	2.40	0.90	0.90	1.56
Depth @ 25% width	0.03	0.12	0.08	0.09	0.06	0.08
Depth @ 50% width	0.04	0.10	0.07	0.11	0.05	0.07
Depth @ 75% width	0.08	0.07	0.08	0.07	0.05	0.07
Maximum Depth (m)	0.08	0.12	0.08	0.11	0.06	0.09
Pool/Riffle/Run	10/40/50	5/25/70	5/40/55	0/25/75	30/20/50	10/30/60
Left Bank						
Height (m)	0.30	1.30	0.50	1.10	0.90	0.82
Shape	S	V	U	V	U	-
Texture	F,G,C	F,G,C,	F,G,C	F,G,C	F,G,C	-
Riparian vegetation	G,C	G,M	G,M	G,S,M	G,S,C	-
Bank Stability	US	MU	MU	MU	MS	-
Right Bank						
Height (m)	0.40	0.80	0.40	0.40	0.60	0.52
Shape	S	V	U	S	U	-
Texture	F,G,C	F,G,C	F,G,C	F,G,C	F,G,C	-
Riparian vegetation	G,C	G,C	G,M	G,S,M	G,S,C	-
Bank Stability	MU	MU	MU	MU	MS	-
Bed Material (Dominance)						
Organic materials	-	-	-	-	-	-
Fine sediments (<2mm)	20	35	45	40	40	36
Small gravel (2-16mm)	20	25	15	25	30	23
Large gravel (18-64mm)	25	15	15	15	15	17
Small cobble (64-128mm)	30	5	20	10	10	15
Large cobble (128-256mm)	5	15	5	10	5	8
Boulder (>256mm)	-	15	-	TR	-	3
Bedrock	-	-	-	-	-	-

Watercourse Cover Data (%)	Total Cover: 20	Crown Closure: Moderate	
Undercut bank: 10	Large woody debris: 50	Surface turbulence: -	Instream Vegetation: -
Small woody debris:35	Boulder: -	Overhanging vegetation: 5	Depth of the watercourse: -
Turbidity: -			

Habitat Evaluation

A 1.5 m drop from the watercourse into the Elbow River presents a migration barrier for fish entering the tributary from the river. Between the confluence and transect 1, the watercourse is undefined overland flow. Evidence of an old, dry channel was observed. Upstream of transect 1 the watercourse is confined by slumping valley walls. Large sections of large woody debris were present throughout the study due to fallen mature trees caused by slumping. At the upstream extent of the study reach, fish habitat is alternating step-pools separated by run habitat. Flow is likely seasonal and freezes to the bottom during winter months.

Plate 1: Confluence of unnamed tributary and Elbow River. Tributary flow drops approximately 1.5 m before entering the Elbow River.21 October 2014

Plate 2: Dry abandoned channel near the mouth of the unnamed tributary. Channel abandonment resulted in undefined, overland flow. 21 October 2014

Plate 3: Facing downstream from transect 3 showing shallow run and riffle habitat. 21 October 2014

Plate 4: Large Woody debris near transect 4. Slumping and unstable valley walls resulted in fallen mature trees into the channel. 21 October 2014

Notes:
Channel Pattern: TM = tortuous meanders, ME = regular meanders, IM = irregular meanders, IR = irregular wandering, SI = sinuous, ST = straight
Coupling: DC = decoupled, PC = partially coupled, CO = coupled
Islands: N = none, O = occasional, I = irregular, F = frequent, S = split, AN = anastomosing
Confinement: EN = entrenched, CO = confined, FC = frequently confined, OC = occasionally confined, UN = unconfined, NA = not applicable
Bars: N = none, SIDE = sediment deposition intermittent along the sides of streams, DIAG = mid-stream sediment deposition diagonally aligned to stream axis, MID = mid-stream sediment deposition aligned parallel to stream axis, SPAN = sediment deposition continuous along the sides of stream, BR = sediment deposition forms a number of small channels separated by bars
Shape: U = undercut banks, V = vertical, S = sloping, O = overhanging
Texture: F = fines, G = gravels, C = cobbles, B = boulders
Riparian Vegetation: N = none, G = grasses, S = shrubs, C = coniferous, D = deciduous, M = mixed C and D types
Bank Stability: S = stable, MS = moderately stable, MU = moderately unstable, US = unstable

CLIENT: ENVIRONMENT AND SUSTAINABLE RESOURCES	SURVEY DATE: 21 OCTOBER 2014
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SUMMARY OF PHYSICAL AND CHEMICAL DATA UNNAMED TRIBUTARY TO ELBOW RIVER	Figure C-5

Appendix D

Soils and Terrain

Appendix D1

Soils Data

SITE_NO	EASTING	NORTHING	ELEV	ECOSITE	SURF_EXP	SLOPE_PER	SLOPE_POS	SLP_CLS	SLOPE_LGTH	ASPECT	COL_CHG	PM_1	PM_TEX_2	PM_DEP_1	PM_2	PM_TEX_2	PM_DEP_2	ORDER	SUBGRP	SOIL_SER	HORIZ_NO	HORIZ	DEP_INT	THICK	COL_MOIS	COL_MUNS	TEX	STRUC	CONS	CF_%	MOTT	SALT	CARB	pH	MIN_TS	ORG	LFH	UP_TOT	SURF_STO	DRAINAGE	MOIS_REG	NUT_REG	LAND_USE	EROS	PIT_TYPE	HOR_CUR	VERT_CUR	WAT_TAB	SAMPLE_ID	NOTES
3A	663542	5642325	1412		level		level	1	4			FNPT		0-160				O	TY.F	DNLzf	1	Of	0-160	160												160		160		v. poorly	subhydric	med	wetland		detailed	linear	linear	10 cm		
4A	663343	5642344			level		depression	1	1			FNPT		0-160				O	ME.H	DNLzh	1	Of	0-30	30														0		v. poorly	subhydric	med	wetland		detailed			15		peatland 150 meters * 50 meters
																					2	Om	30-90	60																										
																					3	Oh	90-160	70																										
5A	663387	5642324	1411		inclined	20	mid	2	2	145	P	TILL	MF	0-70				L	O.GL	RNScozz	1	LFH	8-0	8											9			9		well	mesic	med	woodland		detailed	concave	concave			
																					2	Ae	0-9	9	m	2.5Y 5/3	SL	smpl	fr	<2, sr, g							8													
																					3	Bt	9-34	25	m	2.5Y 5/4	CL	smsb	fr	2-5, sr, g																				
																					4	C	34-70	36	m	2.5Y 4/3	CL	ma	vfi	<2, sr, g																				
14A	662663	5642027	1414		Level	14	toe	2	2	2	G	GLLC	MF	0-70	GLFL	GRVC	70-100	G	O.G	POTzz	1	Of	25-0	25											5	25		30		poorly	hygric	rich	woodland		detailed	concave	concave	55		edge of depressional area. IICg: no sample in suspension.
																					2	Ahg	0-5	5	m	10YR 3/1	SiL	wfgr	fr																					
																					3	Bg	5-22	17	m	2.5Y 6/2	SiL	smsb	fr	<2, sa, g	fmd																			
																					4	Cg	22-70	48	m	5Y 4/1	SiL	ma	fi	<2, sa, g																				
																					5	IICg	70-100	30	w		LS	ma	nst	40-50, sr, g																				
15A	662828	5641829	1393		level	<2	level	2	4	5	G	GLLC	GRMF	0-55				R	O.HR	POTgr	1	LFH	9-0	9											45		9	54		mod well	subhygric	rich	woodland		detailed	linear	linear			No mottles or gleying. Deep Ah horizon
																					2	Ah	0-45	45	m	10YR 3/1	SiL-SiCL	mmgr	fr	<2, sr, g																				
																					3	C	45-55	10	m	2.5Y 5/3	SiCL	ma	fr	20-30, sr, g																				
16A	659392	5637881			inclined	15	upper	6	4	140	G	TILL	GRMF	0-30				L	D.GL	SPRzz	1	LF	2-0	2											7		2	9		well	mesic	med	woodland		detailed	linear	linear			near 10m ephemral draw. Moderate erosion.
																					2	Ahe	0-7	7	m	10YR 3/3	L	mmgr	fr	10-20, sr/sa, g-c																				
																					3	Bt	7-30	23	m	2.5Y 5/3	CL	mfsbk	fi	30-40, sr/sa, g-c																				
17A	659455	5637630	1478		undulaitng	7	undulating	4	3	160	G	TILL	GRMF	0-30	GLFL	GRMC	30-40	L	BR.GL	SPRzbxg	1	LF	2-0	2											9		2	11		well	submesic	med	woodland		detailed	linear	linear		17A-LF	sampled (5)
																					2	Ahe	0-9	9	m	10YR 3/2	SL	wfgr	fr	20-30, sa, g																			17A-Ahe	
																					3	Bm	9-21	12	m	10YR 5/4	SL	wfsb	fr	30-40, sa, g-c																			17A-Bm	
																					4	Bt	21-30	9	m	10YR 4/4	CL	mmsb	fr	30-40, sa, g-c																			17A-Bt	
																					5	IICk	30-40	10	m	2.5Y 4/2	SL	ma	fr	40-50, sr, g-c			m																17A-IICk	
18A	659607	5637440			terraced	40	Upper	7	2	140	G	TILL	GRMF	0-57	GLFL	GRVC	57-100	L	BR.GL	SPRzbxg	1	LFH	11-0	11											9		11	20		well	mesic	rich	woodland		detailed	convex	convex			earthworms in Ah
																					2	Ahe	0-9	9	m	10YR 3/2	vfSL	mmgr	fr	10-20, sa, g-c																				
																					3	Bm	9-24	15	m	10YR 5/4	SL	mmsbk	fr	10-20, sa, g-c																				
																					4	Bt	24-57	33	m	10YR 4/4	CL	mmsbk	fr	20-30, sa, g-c																				
																					5	IICk	57-70	13	m	2.5Y 3/1	fSL	ma	fr	40-50, r/sr, g-c			vs																	
21A	661195	5640228			inclined	3	lower	3	2	265	F	COLL	GRMF	0-100				B	O.MB	FRKzz	1	LF	3-0	3											38		3	41	0	well	mesic	rich	improved pasture		detailed	convex	linear			grassland surrounded by woods. Earthworms.
																					2	Ah	0-38	38	m	10YR 2/1	SiL	smgr	fr	<2, sa, g-c																				
																					3	Bm	38-57	19	m	2.5Y 4/2	SiCL-SiL	wfsbk	fr	<2, sa, g-c																				
																					4	C1	57-75	18	m	2.5Y 4/2	CL	ma	fr	20-30, a, g																				
																					5	C2	75-100	25	m	2.5Y 4/2	SiCL	ma	fi	<2, sa, g																				
22A	661151	5640372	1478		inclined	3	mid	6	4	92	P	COLL	GRMF	0-30				B	E.DYB	FRKzz	1	LF	5-0	5											9		5	14	3	rapidly	submesic	poor	woodland		detailed	convex	linear			% CF's in Ae are mostly gravel with one cobble. Auger refusal @30. slopes=20-35%
																					2	Ae	0-9	9	m	2.5Y 6/2	SL	wmpl	fr	30-40, a/sa, g-c																				
																					3	Bm	9-30+	21	m	2.5Y 6/3	SL	wmsb	fr	30-40, a/sa, g																				
23A	663358	5641054	1420		level	0	level	1	1			FNPT		0-120				M	TY.M	DNL	1	Of	0-60	60														0	0	v.poorly	subhydric	med	wetland		detailed				23A-Of	do not have auger extension speculate that is depper than 160.
																					2	Om	60-140	60												160														
24A	663539	5641113	1423		undulating	10	upper	5	3	250		TILL	FI	0-75				B	O.DYB	BPE	1	LFH	7-0	7													7	7	0	mod well	submesic	poor	woodland		detailed	convex	convex			Bm looks like bt, no Ae
																					2	Bm	0-14	14	m	10YR 5/4	SiCL	smsb	fi																					
																					3	C	14-50	31	m	2.5Y 5/2	SiC	ma	vfi																					
																					4	Ck	50-75	25	m	2.5Y 5/2	SiC	ma	vfi				m																	
25A	663770	5641158			Level		level	4				FLUV	GRMC	0-75				R	O.R	PPXaagr	1	C1/LFH	0-8	8	m	10YR 3/1	fSL	ma	fr	10-20							8	8		mod well	subhygric	rich	woodland		detailed	linear	linear		25A-C1	very dark (coal?) - new flood deposit. Reworked till? Sampled
																					2	C2	8-23	15	m	10YR 2/1	L	ma	fr	30-40																			25A-C2	
																					3	Ck1	23-55	32	m	2.5Y 3/2	fSL	ma	fr	5-10			m																25A-Ck1	
																					4	Ck2	55-75	20	m	2.5Y 3/1	fSL	ma	fr	10-20			w																25A-Ck2	
26A	662563	5639235			undulating	5	mid	4	4	255	G	GLLC	MC	0-100				L	O.GL	ELBco	1	LFH	12-0	12											9		12	21	0	mod well	submesic	med	woodland		detailed	linear	linear			C2 has sand lenses. C1 has loamy sand pockets.
																					2	Ae	0-9	9	m	7.5Y 7/3	LS	wfpl	fr	0																				
																					3	Bt	9-18	9	m	7.5Y 4/4	CL	w,sb	fi	0																				
																					4	Ck	18-65	47	m	2.5Y 5/2	S	sg	L	0			w																	
																					5	Ckgj	65-100	35	m	2.5Y 4/2	L	ma	fr	0			w																	
27A	661232	5637755			undulating	4	mid	3	1	110	G	TILL	MC	0-30	TILL	GRMF	30-50	B	E.EB	BPEzzxg	1	LFH	8-0	8											14		8	22	1	well	mesic	med	woodland		detailed	concave	concave			Auger refusal @ 50 cm
																					2	Ahe	0-5	5	m	10YR 4/3	L	wfpl	fr	2-5, sa, g																				
																					3	Ae	5-14	9	m	10YR 6/3	vfSL	scpl	fr	2-5, sa, g																				
																					4	Bm	14-30	16	m	7.5YR 4/4	vfSL	wfsbk	fr	2-5, sa, g																				
																					5	IICk	30-50	20	m	10YR 5/4	CL	ma	fr	20-30, r/sr, g			m																	
28A	661248	5637699	1459		level	<2	depression	2	2	80	P	LACU	FI	0-65				G	O.G	POTzz	1	Of	5-0	5											7	5		12	0	poorly	hygric	med	woodland		detailed	concave	concave	30		Mr. grizzly bear was lovely. Edge of depression/pond
																					2	Ahg	0-7	7	w	10YR 3/1	CL	mmgr	sst	0																				
																					3	Bg	7-25	18	w	10YR 4/1	SiCL	ma	sst	0	mmd																			
																					4	Cg	25-65	40	w	2.5Y 4/1	SiC	ma	st	0	mff																			
29A	661232	5637658			level		level	1	1			LACU	MF	0-100				G	O.G	POTzz	1	LF	5-0	5											7		5	12	0	v. poorly	subhydric	med	wetland		detailed					Beaver flooded area
																					2	Ahg	0-7	7	w	10YR 3/1	SiCL	ma	ss	0																			29A-Ahg	
																					3	Bg	7-55	48	w	10YR 4/2	SiCL	ma	s	0	mff																		29A-Bg	
																					4	Cg	55-100	45	w	10YR 4/1	SiCL	ma	s	0	fff																		29A-Cg	
30A	661152	5637469				0	Level	1	1			LACU	MF	0-80				G	O.HG	POT	1	Of/Ahg	0-18	18	w	10YR 3/2	SiL	ma	ss	0						18		18	0	v.poorly	subhydric	rich	wetland		detailed			30		reworked till. Beaver flats wetland
																					2	Bg	18-50	32	w	2.5Y 4/1	SiCL	ma	s	0	mfd																			
																					3	Cg	50-80	30	w	2.5Y 3/1	SiCL	ma		0	mcp																			
32A	661007	5637510	1476		inclined	27	mid	6	4	316	P	TILL	MC	0-100				B	O.DYB	BPEzz	1	LFH	9-0	9											4		9	13	3	well	submesic	med	woodland		detailed	concave linear				stones and boulders on surface. Wavy horizons.
																					2	Ae	0-4	4	m	7.5YR 5/2	L	wfpl	fr	10-20, sr/sa, g																				
																					3	Bm	4-15	11	m	7.5YR 5/4	L	mmsb	fr	5-10 sr/sa, g																				
																					4	BC	15-45	30	m	2.5Y 5/3	L	mmsb	fr	2-5, sr/sa, g																				
																					5	C	45-100	55	m	2.5Y 6/3	SL	ma	fr	2-5, sr/sa, g																				
36A	661244	5637954	1456		level	<2	level	2	3	40	F	TILL	M	0-35	GLFL	GRMF	35-45	L	BR.GL	SPRzbxg	1	LFH	6-0	6											5		6	11	2	well	submesic	med	woodland		detailed	linear	linear			Slopes towards gravel pit <2%. Auger refusal @ 45 cm. adjacent to gravel pit. Top of IIC horizon assessed=likely fines seeped in from above then more gravel.
																					2	Ahe	0-5	5	m	7.5YR 4/3	L	mmgr	fr	<2, r/sr, g-c																				
																					3	Bm	5-12	7	m	7.5YR 4/6	SiL	wfsb	fr	<2, r/sr, g-c																				
																					4	Ae	12-23	11	m	7.5YR 6/3	SiL	smpl	fr	2-5, r/sr, g-c																				
																					5	Bt	23-35	12	m	7.5YR 5/4	CL	mmsb	fi	2-5, r/sr, g-c																				
																					6	IIC	35-45	10	m	10YR 4/3	CL	ma	fr	30-40, r/sr, g-c																				
42A	661609	5638983	1427		level	<1	Level	2	6	40		FLUV	VGVC	0-100				R	O.R	MLE	1	Ck	0-100	100	m	2.5Y 4/2	cS	ma	L	80, r, g-s			vs					0	5	rapidly	xeric	poor	wetland	w3	detailed	linear	linear			flood plain, mostly gravel to cobbles.
43A	661495	5639099	1431		level	<2	level	2	1	50		FLUV	MC	0-65	GLFL	GRMC	65-100	R	O.R	PPXaaxg	1	L	1-0	1													1	1	0	rapidly	mesic	rich	woodland		detailed	linear	linear			dry channel 15m south = erosion (water severe. Depositional @ soil pit.
																					2	Ck1	0-9	9	m	2.5Y 5/1	S	sg	L				vs																	
																					3	Ck2	9-12	3	m	2.5Y 5/2	LS	m	vfr	0																				
																					4	Ck3	12-45	32	m	2.5Y 5/2	S	mfpl	vfr	0																				
																					5	Ck4	45-65	20	m	2.5Y 4/2	LfS	sfpl	vfr	0																				
																					6	IICk5	65-100	35	m	2.5Y 5/2	S	sg	L	40-50 r, g-c																				
44A	661427	5639209			level	<2	level	1	1			FLUV	VC	0-48	GLFL	VGVC	48+	R	GL.R	PPXglaaxg	1	LF	1-0	1													1	1	0	mod well	subhygric	rich	woodland	w3	detailed	linear	linear			floodplain
																					2	Ckgj	0-48	48	m	2.5Y 4/2	LfS	wcpl	fr	<1, r/sr, g	cmd		vs																44A-Ckgj	
																					3	IICkgj	48+		m	2.5Y 4/2	LfS	ma	fr	30-40, r/sr, g-c	fmf		vs																44A-IICkgj	
45A	661320	5639339	1417		undulating	2	level	2	4	310	P	FLUV	VC	0-33	GLFL	GRVC	33-50	R	CU.R	HDXaaxg	1	Ck1	0-7	7	m	2.5Y 4/2	vfS	mmpl	fr	<1, r, g			vs		5		4	9	0	well	mesic	rich	woodland		detailed	linear	linear			gently undulating. Recently flooded, depositional. Ck1 from 2013 flood.
																					2	Aheb	7-12	5	m	2.5Y 4/1	SiL	ma	fr	<1, r, g			vs																	
																					3	Ck2	12-22	10	m	2.5Y 5/1	fS	ma	fr	<1, r, g			vs																	
																					4	LFHb	22-26	4									s																	
																					5	Ck3	26-33	7	m	2.5Y 4/2	LfS	ma	fr				vs																	
																					6	IICk4	33-50+	17+	m	2.5Y 4/1	LS	ma	fr	40-50, r/sr, g-c			vs																	
46A	661171	5639532			terraced	2	level		1		G	GLFL	GRMF	0-40				B	O.DYB	BRGgr	1	LFH	6-0	6											3		6	9	1	rapidly	submesic	med	woodland		detailed	linear	linear		46A-LFH	sampled.
																					2	Ah	0-3	3	m	10YR 2/1	L	wfgr	fr	10-20, r/sr, g-c																			not deep enough	
																					3	Bm1	3-13	10	m	10YR 4/4	SiL	wfsbk	fr	10-20, r/sr, g-c																			46A-Bm1	
																					4	Bm2	13-28	15	m	10YR 4/3	L	wfsbk	fr	30-40, r/sr, g-c																			46A-Bm2	
																					5	Ck	28-40	12	m	2.5Y 5/3	CL	wfsbk	fr	40-50, r/sr, g-c			s																	
51A	661692	5639906			terraced	30	crest	6	1	200		GLFL	GRMC	0-32				B	O.DYB	BRGgr	1	LFH	8-0	8													8	8	3	rapidly	submesic	poor	woodland			linear	linear			GF terrace
																					2	Bm1	0-8	8	m	10YR 5/4	L	wfsbk	fr	20-30, r/sr, g-c																				
																					3	Bm2	8-19	11	m	10YR 4/4	SiL	wfsbk	fr	30-40, r/sr, g-c																				
																					4	C	19-32	13	m	10YR 3/2	SL	ma	fr	30-40, r/sr, g																				
52A	661701	5639860	1428		undulating	2	lower	3	1	25		FLUV	ME	0-80				R	CU.R	HDXaa	1	LFH	1-0	1													1	1	0	well	mesic	rich	woodland		detailed	linear	linear			Flood plain, gently undulating. Auger refusal @ 80cm, R or FG. @80cm=feels like bedrock.
																					2	Ck1	0-3	3	m	2.5Y 6/2	SiL	ma	fr	0			w																	
																					3	LFHb	3-6	3																										
																					4	Ck2	6-28	22	m	2.5Y 5/2	SiL	ma	fr	0			s																	
																					5	Ahkb1	28-36	8	m	2.5Y 3/1	SiL	ma	fr	0			vs																	
																					6	Ck3	36-48	12	m	2.5Y 4/2	SiL	ma	fr	0			vs																	
																					7	Ahkb2	48-51	3	m	2.5Y 3/1	SiL	ma	fr	0			vs																	
																					8	Ck4	51-80	29	m	2.5Y 5/1	vfSL	ma	fr	0			vs																	
55A	659807	5638121	1506		inclined	13	upper	6	4	182	P	TILL	GRMF	0-27				B	E.DYB	WLB	1	LFH	6-0	6											2		6	8	2	well	submesic	med	woodland		detailed	convex	convex			discontinuous Ae horizon <2cm. Structures very hard to determine with high CF%
																					2	Ae	0-2	2	m	10YR 6/2	SL		fr	30-40, sa, g-c																				
																					3	Bm	2-13	11	m	10YR 6/4	CL		fr	30-40, sa, g-c																				
																					4	C	13-27	14	m	2.5Y 5/2	SCL		fr	40-50, sa, g-c																				
56A	659364	5638264			undulating	5	lower	4		55		TILL	VGME	0-25				B	O.DYB	WLBzz	1	LFH	3-0	3													3	3	1	well	submesic	med	woodland		detailed	concave	linear			thin- discontinueous <2cm Ae. CF% too high for structure.
																					2	Bm	0-25	25	m	10YR 5/3	SiL	ma	fr	50-60, sr/sa, g-c																				

Appendix D2

Soil Laboratory Results

Final Analytical Report

Attention: **Patrick Borden**

AMEC Environment & Infrastructure
140 Quarry Park Blvd. SE
Calgary, AB T2C 3G3

Results for File: **EC-68281**

Project Number: **CW2174.MC1.ENV**
Project Name: **McClean Creek Flood Mitigation Asses.**

Date Received: 2014/10/06
Date of Report: 2014/10/20
Sublet Data: Attached

Report reviewed by:

Jesse Dang, B.Sc.
Manager
Laboratory Services

Kristine Connor
Client Services Representative
Laboratory Services

** All samples will be disposed of after 30 days following analysis. Please contact the lab if you require additional sample storage time. (Samples deemed hazardous will be returned to the client at their own expense or disposal will be arranged.) **

AMEC Environment & Infrastructure, Edmonton Chemistry
5667 - 70 Street, Edmonton, Alberta, Canada T6B 3P6
Tel: (780) 436-2152
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Soil Analysis

Final

Project No. CW2174.MC1.ENV **File No.** EC-68281

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14239 46A-Bm1 2014/10/01 0:00	14-14239-D 46A-Bm1 Lab Duplicate	14-14240 46A-Bm2 2014/10/01 0:00	14-14241 46A-Ck 2014/10/01 0:00
MS	2014/10/20	pH (1:1 H2O)	pH units	McKeague 4.11	0.01	5.71	5.70	6.24	7.23
MS	2014/10/20	pH (1:2 CaCl2)	pH units	McKeague 3.11	0.01	4.99	5.01	5.51	---
MS	2014/10/20	Conductivity (1:1 H2O)	mS/cm	McKeague 4.12	0.001	0.100	0.099	0.214	0.260
TY	2014/10/17	Calcium	meq/L	McKeague 3.21	0.01	1.83	1.81	3.42	3.93
TY	2014/10/17	Magnesium	meq/L	McKeague 3.21	0.01	0.66	0.66	1.28	1.26
TY	2014/10/17	Sodium	meq/L	McKeague 3.21	0.01	0.25	0.25	0.33	0.30
		Sodium Adsorption Ratio (SAR)		Calculation	0.10	0.22	0.23	0.21	0.18

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14244 25A-C1/LFH 2014/10/02 0:00	14-14245 25A-C2 2014/10/02 0:00	14-14246 25A-Ck1 2014/10/02 0:00	14-14247 25A-Ck2 2014/10/02 0:00
MS	2014/10/20	pH (1:1 H2O)	pH units	McKeague 4.11	0.01	7.10	7.50	7.47	7.34
MS	2014/10/20	Conductivity (1:1 H2O)	mS/cm	McKeague 4.12	0.001	0.457	0.294	0.251	0.004
TY	2014/10/17	Calcium	meq/L	McKeague 3.21	0.01	6.91	5.55	4.25	6.23
TY	2014/10/17	Magnesium	meq/L	McKeague 3.21	0.01	1.97	2.07	1.02	1.51
TY	2014/10/17	Sodium	meq/L	McKeague 3.21	0.01	0.16	0.19	0.24	0.34
		Sodium Adsorption Ratio (SAR)		Calculation	0.10	< 0.10	< 0.10	0.15	0.17

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14249 44A-Ckgj 2014/10/01 0:00	14-14250 44A-IICkgj 2014/10/01 0:00	14-14252 17A-Ahe 2014/10/01 0:00	14-14253 17A-Bt 2014/10/01 0:00
MS	2014/10/20	pH (1:1 H2O)	pH units	McKeague 4.11	0.01	7.67	7.77	5.67	6.87
MS	2014/10/20	Conductivity (1:1 H2O)	mS/cm	McKeague 4.12	0.001	0.236	0.145	---	0.255
TY	2014/10/17	Calcium	meq/L	McKeague 3.21	0.01	4.61	3.30	---	2.93
TY	2014/10/17	Magnesium	meq/L	McKeague 3.21	0.01	1.24	1.05	---	1.26
TY	2014/10/17	Sodium	meq/L	McKeague 3.21	0.01	0.16	0.18	---	0.15
		Sodium Adsorption Ratio (SAR)		Calculation	0.10	< 0.10	0.12	---	0.10

Soil Analysis

Final

Project No. CW2174.MC1.ENV **File No.** EC-68281

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14254 / 17A-Bm / 2014/10/01 0:00	14-14255 / 17A-IICk / 2014/10/01 0:00	14-14256 / 29A-Ahg / 2014/10/02 0:00	14-14257 / 29A-Bg / 2014/10/02 0:00
MS	2014/10/20	pH (1:1 H2O)	pH units	McKeague 4.11	0.01	5.46	7.01	5.75	5.82
MS	2014/10/20	pH (1:2 CaCl2)	pH units	McKeague 3.11	0.01	4.67	---	---	---
MS	2014/10/20	Conductivity (1:1 H2O)	mS/cm	McKeague 4.12	0.001	0.069	0.215	---	0.223
TY	2014/10/17	Calcium	meq/L	McKeague 3.21	0.01	1.17	3.43	---	1.72
TY	2014/10/17	Magnesium	meq/L	McKeague 3.21	0.01	0.50	1.26	---	0.72
TY	2014/10/17	Sodium	meq/L	McKeague 3.21	0.01	0.11	0.17	---	0.22
		Sodium Adsorption Ratio (SAR)		Calculation	0.10	0.12	0.11	---	0.20

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14258 / 29A-Cg / 2014/10/02 0:00
MS	2014/10/20	pH (1:1 H2O)	pH units	McKeague 4.11	0.01	5.88
MS	2014/10/20	Conductivity (1:1 H2O)	mS/cm	McKeague 4.12	0.001	0.160
TY	2014/10/17	Calcium	meq/L	McKeague 3.21	0.01	1.01
TY	2014/10/17	Magnesium	meq/L	McKeague 3.21	0.01	0.48
TY	2014/10/17	Sodium	meq/L	McKeague 3.21	0.01	0.20
		Sodium Adsorption Ratio (SAR)		Calculation	0.10	0.23

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14238 / 46A-LFH / 2014/10/01 0:00	14-14238-D / 46A-LFH / Lab Duplicate	14-14239 / 46A-Bm1 / 2014/10/01 0:00	14-14239-D / 46A-Bm1 / Lab Duplicate
JP	2014/10/15	Total Kjeldhal Nitrogen (TKN)	mg/kg (ppm)	APHA 4500N-c	0.5	6440	5920	---	---
JP	2014/10/14	Calcium Carbonate	%	ICARDA/NARC 5.3	0.10	---	---	0.78	0.94
AP	2014/10/15	Texture - Sand	%	McKeague 2.12	1	---	---	38	---
AP	2014/10/15	Texture - Silt	%	McKeague 2.12	1	---	---	42	---
AP	2014/10/15	Texture - Clay	%	McKeague 2.12	1	---	---	20	---

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14240 / 46A-Bm2 / 2014/10/01 0:00	14-14241 / 46A-Ck / 2014/10/01 0:00	14-14242 / 23A-Of / 2014/10/02 0:00	14-14243 / 23A-Om / 2014/10/01 0:00
JP	2014/10/15	Total Kjeldhal Nitrogen (TKN)	mg/kg (ppm)	APHA 4500N-c	0.5	---	---	9960	4290
JP	2014/10/14	Calcium Carbonate	%	ICARDA/NARC 5.3	0.10	2.19	11.0	---	---
AP	2014/10/15	Texture - Sand	%	McKeague 2.12	1	50	56	---	---
AP	2014/10/15	Texture - Silt	%	McKeague 2.12	1	26	22	---	---
AP	2014/10/15	Texture - Clay	%	McKeague 2.12	1	24	22	---	---

ANALYTICAL REPORT

Soil Analysis

Final

Project No. CW2174.MC1.ENV

File No. EC-68281

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14244 25A-C1/LFH 2014/10/02 0:00	14-14245 25A-C2 2014/10/02 0:00	14-14246 25A-Ck1 2014/10/02 0:00	14-14247 25A-Ck2 2014/10/02 0:00
JP	2014/10/15	Total Kjeldhal Nitrogen (TKN)	mg/kg (ppm)	APHA 4500N-c	0.5	2820	---	---	---
JP	2014/10/14	Calcium Carbonate	%	ICARDA/NARC 5.3	0.10	< 0.10	12.0	10.6	14.9
AP	2014/10/15	Texture - Sand	%	McKeague 2.12	1	64	76	68	60
AP	2014/10/15	Texture - Silt	%	McKeague 2.12	1	24	20	20	24
AP	2014/10/15	Texture - Clay	%	McKeague 2.12	1	12	4	12	16

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14249 44A-Ckgj 2014/10/01 0:00	14-14250 44A-IICkgj 2014/10/01 0:00	14-14251 17-LF 2014/10/01 0:00	14-14252 17A-Ahe 2014/10/01 0:00
JP	2014/10/15	Total Kjeldhal Nitrogen (TKN)	mg/kg (ppm)	APHA 4500N-c	0.5	---	---	7350	1900
JP	2014/10/14	Calcium Carbonate	%	ICARDA/NARC 5.3	0.10	20.3	10.7	---	---
AP	2014/10/15	Texture - Sand	%	McKeague 2.12	1	66	50	---	40
AP	2014/10/15	Texture - Silt	%	McKeague 2.12	1	30	46	---	42
AP	2014/10/15	Texture - Clay	%	McKeague 2.12	1	4	4	---	18

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14253 17A-Bt 2014/10/01 0:00	14-14254 17A-Bm 2014/10/01 0:00	14-14255 17A-IICk 2014/10/01 0:00	14-14256 29A-Ahg 2014/10/02 0:00
JP	2014/10/15	Total Kjeldhal Nitrogen (TKN)	mg/kg (ppm)	APHA 4500N-c	0.5	---	---	---	4910
JP	2014/10/14	Calcium Carbonate	%	ICARDA/NARC 5.3	0.10	2.93	1.01	4.91	---
AP	2014/10/15	Texture - Sand	%	McKeague 2.12	1	36	36	47	22
AP	2014/10/15	Texture - Silt	%	McKeague 2.12	1	28	40	33	48
AP	2014/10/15	Texture - Clay	%	McKeague 2.12	1	36	24	20	30

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	Lab #: / Client ID: / Sample Date: / MDL	14-14257 29A-Bg 2014/10/02 0:00	14-14258 29A-Cg 2014/10/02 0:00
JP	2014/10/14	Calcium Carbonate	%	ICARDA/NARC 5.3	0.10	1.67	1.35
AP	2014/10/15	Texture - Sand	%	McKeague 2.12	1	22	22
AP	2014/10/15	Texture - Silt	%	McKeague 2.12	1	44	40
AP	2014/10/15	Texture - Clay	%	McKeague 2.12	1	34	38

Quality Control Standard

Project No. CW2174.MC1.ENV **File No.** EC-68281

Soil Analysis

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	MDL	Analyzed Value	Advisory Range	Target Value	Reference No.
MS	2014/10/20	pH (1:1 H2O)	pH units	BCME	0.01	7.02	5.67-8.51	7.09	SS#19
MS	2014/10/20	pH (1:2 CaCl2)	pH units	McKeague 3.11	0.01	7.06	4.83-8.97	6.90	SS#19
MS	2014/10/20	Conductivity (1:1 H2O)	mS/cm	McKeague 4.12	0.001	0.775	0.717-1.332	1.025	SS#19
TY	2014/10/17	Calcium	meq/L	McKeague 3.21	0.01	19.5	8.56-20.85	14.71	SS#19
TY	2014/10/17	Magnesium	meq/L	McKeague 3.21	0.01	8.15	3.77-9.11	6.44	SS#19
TY	2014/10/17	Sodium	meq/L	McKeague 3.21	0.01	11.1	7.60-11.25	9.43	SS#19

Soil Analysis

Analyst	Date of Analysis (yyyy/m/d)	Analytical Parameter	Units	Reference Method	MDL	Analyzed Value	Advisory Range	Target Value	Reference No.
JP	2014/10/15	Total Kjeldhal Nitrogen (TKN)	mg/L(ppm)	APHA 4500N-D	0.1	11.0	6.70-11.30	9.0	QC-NUT-2-D2-NUT01114
JP	2014/10/14	Calcium Carbonate	%	ICARDA/NARC 5.3	0.10	4.83	3.51-5.27	4.39	SS # 19
AP	2014/10/15	Texture - Sand	%	McKeague 2.12	1	46	37-56	46	SS#18b
AP	2014/10/15	Texture - Silt	%	McKeague 2.12	1	28	25-34	29	SS#18b
AP	2014/10/15	Texture - Clay	%	McKeague 2.12	1	26	12-36	24	SS#18b

Analytical Comments

Project No. CW2174.MC1.ENV **File No.** EC-68281

All Analytical results pertain to samples analyzed as received.

APHA: Standard Method for the Examination of Water and Wastewater, 2005. 21st Ed. American Public Health Association.

ICARDA/NARC - Soil and Plant Analysis Laboratory Manual. Second Edition. 2001. Jointly published by the International Center for Agricultural Research in the Dry Areas (ICARDA) and the National Agricultural Research Center (NARC)

McKeague: Manual on Soil Sampling and Methods of Analyses. Can. Soc. Soil Sci. Ottawa.

MDL - Method Detection Limit

amec EARTH & ENVIRONMENTAL

EG-68281 SRB 20 **Chain of Custody Record/Analysis Request**

Tracking #:

ISSUING OFFICE:	Calgary
Project Name:	McClean Creek Flood Mitigation Asses.
Job No.:	CW2174.MC1.ENV
Project Manager:	Patrick Borden
Phone No.:	403.815.2907
Sampler:	Patrick Borden

QUOTED PRICE

☐ YES

Please attach a copy of the quote

☒ NO

Quote #:

Client Sample ID	AMEC E & E Lab Sample ID (FOR LAB USE ONLY)	Date Collected (yyyy/mm/dd)	Matrix	1L Bottle	250 mL Jar	40 mL Vial	1L Polyethylene	Bag	TOC	TKN	Texture Hydrometer	PH (1:1) water	pH (.01 MCaCl2)	EC	SAR	Calcium Carbonate Equivalent	50% RUSH (Please Notify Lab!)	100% RUSH (Please Notify Lab!)
46A-LFH	14-14238	########	soil/sed					X	X	X	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~		
46A-Bm1	9	########	soil/sed					X			x	x	x	x	x	x		
46A-Bm2	40	########	soil/sed					X			x	x	x	x	x	x		
46A-Ck	1	########	soil/sed					X			x	x		x	x	x		
23A-Of	2	########	soil/sed					X	x	x								
23A-Om	3	########	soil/sed					X	x	x								
45A-C1/LFH	4	########	soil/sed					X	X	X	x	x		x	x	x		
45A-C2	5	########	soil/sed					X			x	x		x	x	x		
45A-Ck1	6	########	soil/sed					X			x	x		x	x	x		
45A-CK2	7	########	soil/sed					X			x	x		x	x	x		
44A-LFH	8	########	soil/sed					X	x	x								
44A-Ckgj	9	########	soil/sed					X			x	x		x	x	x		
44A-IICkgj	50	########	soil/sed					X			x	x		x	x	x		
17-LF	1	########	soil/sed					X	x	x								
17A-Ahe	2	########	soil/sed					X	x	x	x	x						
17A-Bt	3	########	soil/sed					X			x	x		x	x	x		
17A-Bm	4	########	soil/sed					X			x	x	x	x	x	x		
17A-IICk	5	########	soil/sed					X			x	x		x	x	x		

Receiver's Comments

10.2°C

RELINQUISHED BY:	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
Signature:	Signature: [signature]	Signature:	Signature:
Printed Name: Patrick Borden	Printed Name: Brekelaye Eporwe	Printed Name:	Printed Name:
Firm: AMEC Earth & Environmental	Firm: AMEC	Firm:	Firm:
Date/Time: 03/10/2014 0:00	Date/Time: OCT. 06 2014 9:15am	Date/Time:	Date/Time:

Comments:

1 of 2 - Final COC to be emailed to Colin Castor

amec EARTH & ENVIRONMENTAL

Chain of Custody Record/Analysis Request

Tracking #:

ISSUING OFFICE:	Calgary
Project Name:	McClean Creek Flood Mitigation Asses.
Job No.:	CW2174.MC1.ENV
Project Manager:	Patrick Borden
Phone No.:	403.815.2907
Sampler:	Patrick Borden

ANALYSIS REQUIRED (Note preferred method)

Client Sample ID	AMEC E & E Lab Sample ID FOR LAB USE ONLY	Date Collected yyyy/mm/dd	Matrix	1L Bottle	250 mL Jar	40 mL Vial	1L Polyethylene	Bag			TOC	TKN	Texture Hydrometer	PH (1:1) water	pH (.01 MCaCl2)	EC	SAR	Calcium Carbonate Equivalent					50% RUSH (Please Notify Lab!)	100% RUSH (Please Notify Lab!)
29A-Ahg	14-14256	########	soil/sed					X			x	x	x	x										
29A-Bg	7	########	soil/sed					X					x	x		X	X	X						
29A-Cg	8	########	soil/sed					X					x	x		X	X	X						
		########	soil/sed					X																
		########	soil/sed					X																
		########	soil/sed					X																
		########	soil/sed					X																
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		########	soil/sed					X																
		########	soil/sed					X																
		########	soil/sed					X																

QUOTED PRICE

☐ YES

Please attach a copy of the quote

☒ NO

Quote #:

Receiver's Comments

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature:	Signature:	Signature:	Signature:
Printed Name: Patrick Borden	Printed Name:	Printed Name:	Printed Name:
Firm: AMEC Earth & Environmental	Firm:	Firm:	Firm:
Date/Time: 03/10/2014 0:00	Date/Time:	Date/Time:	Date/Time:

Comments:

2 of 2 - Final COC to be emailed to Colin Castor

Castor, Colin

From: Borden, Patrick
Sent: October-08-14 7:45 AM
To: Castor, Colin
Subject: RE: McClean Creek Flood Mitigation Asses.

Hi Collin,

I just checked my data sheet and we did not pull a sample for 44A-LFH so you may strike it from the COC.

Thanks!

Patrick

From: Castor, Colin
Sent: October-08-14 7:32 AM
To: Borden, Patrick
Cc: Connor, Kristine
Subject: RE: McClean Creek Flood Mitigation Asses.

Just checking back in on this Pat, if I don't hear word by EOD I'll just move forward ion the file without the sample.

Colin.

From: Castor, Colin
Sent: October-07-14 8:30 AM
To: Borden, Patrick
Cc: Connor, Kristine
Subject: RE: McClean Creek Flood Mitigation Asses.

Hey Pat,

I'm back in office today so just following up on this missing sample.

Colin.

From: Eporwei, Dienelaye
Sent: October-06-14 3:38 PM
To: Borden, Patrick
Subject: RE: McClean Creek Flood Mitigation Asses.

We are missing sample 44A-LFH.We got in 20 samples instead of 21 like on the Coc. How would you like us proceed.

Cheers,
Dienelaye

From: Borden, Patrick
Sent: October-06-14 2:38 PM
To: Eporwei, Dienelaye; Heeraman, Deo A
Cc: Connor, Kristine
Subject: RE: McClean Creek Flood Mitigation Asses.

Hi.

I double checked the data sheets and the site is 25 A so the bags and the COC should also be 25A.

Thanks!

Patrick

From: Eporwei, Dienelaye
Sent: October-06-14 2:35 PM
To: Heeraman, Deo A
Cc: Connor, Kristine; Borden, Patrick
Subject: RE: McClean Creek Flood Mitigation Asses.

One more things, for the samples I marked on the CoC, the bags say "25" not "45". Please can you confirm the correct number? Thanks.

Cheers,
Dienelaye

From: Heeraman, Deo A
Sent: October-06-14 2:11 PM
To: Eporwei, Dienelaye
Cc: Connor, Kristine; Borden, Patrick
Subject: RE: McClean Creek Flood Mitigation Asses.

Hi Dienelaye,
No changes required. Please go ahead with analysis.
Regards,
Deo..

From: Eporwei, Dienelaye
Sent: October-06-14 12:23 PM
To: Heeraman, Deo A; Borden, Patrick
Cc: Connor, Kristine
Subject: RE: McClean Creek Flood Mitigation Asses.

Hi Deo/Patrick,
Here it is;

Cheers,
Dienelaye

From: Heeraman, Deo A
Sent: October-06-14 12:16 PM
To: Borden, Patrick; Eporwei, Dienelaye
Cc: Connor, Kristine
Subject: RE: McClean Creek Flood Mitigation Asses.

Hi Kristine,
Can you send me a copy of the COC forms for a final look.
Thanks,
Deo.

From: Borden, Patrick
Sent: October-06-14 12:13 PM

To: Eporwei, Dienelaye; Heeraman, Deo A
Cc: Connor, Kristine
Subject: RE: McClean Creek Flood Mitigation Asses.

Hi Deo,

Did you want to make any changes to the COC for Mclean Creek?

Thanks,

Patrick

From: Eporwei, Dienelaye
Sent: October-06-14 12:12 PM
To: Borden, Patrick
Cc: Connor, Kristine
Subject: McClean Creek Flood Mitigation Asses.

Hi Patrick,
We got your samples in today and I noticed you indicated that the final CoC will be sent to Colin. Colin is away today, so if you can send it to me that will be great. Thanks.

Have a great day!

Dienelaye Eporwei
Supplies Coordinator
AMEC Environment & Infrastructure
5667 70 Street, Edmonton, AB, T6B 3P6, Canada
Tel 780-436-2152 x 4568
dienelaye.eporwei@amec.com
amec.com

AMEC Environment & Infrastructure
ATTN: JESSE DANG
5667 70 Street NW
EDMONTON AB T6B 3P6

Date Received: 10-OCT-14
Report Date: 20-OCT-14 12:22 (MT)
Version: FINAL

Client Phone: 780-940-4147

Certificate of Analysis

Lab Work Order #: L1531136

Project P.O. #: 2220
Job Reference: EC-68281
C of C Numbers:
Legal Site Desc:

Brian Morgan
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1531136-1 14-14238~(46A-LFH)							
Sampled By: CLIENT on 01-OCT-14							
Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							
Inorganic Carbon	0.12		0.10	%	15-OCT-14	15-OCT-14	R2988789
Total Organic Carbon	16.2		0.10	%	15-OCT-14	15-OCT-14	R2988789
CaCO3 Equivalent	1.00		0.80	%	15-OCT-14	15-OCT-14	R2988789
Total Carbon by combustion method							
Total Carbon by Combustion	16.3		0.1	%	14-OCT-14	14-OCT-14	R2988795
L1531136-2 14-14242~(23A-OF)							
Sampled By: CLIENT on 01-OCT-14							
Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							
Inorganic Carbon	0.26		0.10	%	15-OCT-14	15-OCT-14	R2988789
Total Organic Carbon	37.6		0.10	%	15-OCT-14	15-OCT-14	R2988789
CaCO3 Equivalent	2.13		0.80	%	15-OCT-14	15-OCT-14	R2988789
Total Carbon by combustion method							
Total Carbon by Combustion	37.8		0.1	%	14-OCT-14	14-OCT-14	R2988795
L1531136-3 14-14243~(23A-OM)							
Sampled By: CLIENT on 01-OCT-14							
Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							
Inorganic Carbon	0.11		0.10	%	15-OCT-14	15-OCT-14	R2988789
Total Organic Carbon	43.1		0.10	%	15-OCT-14	15-OCT-14	R2988789
CaCO3 Equivalent	0.94		0.80	%	15-OCT-14	15-OCT-14	R2988789
Total Carbon by combustion method							
Total Carbon by Combustion	43.2		0.1	%	14-OCT-14	14-OCT-14	R2988795
L1531136-4 14-14244~(25A-C1/LFH)							
Sampled By: CLIENT on 01-OCT-14							
Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							
Inorganic Carbon	0.89		0.10	%	15-OCT-14	15-OCT-14	R2988789
Total Organic Carbon	10.4		0.10	%	15-OCT-14	15-OCT-14	R2988789
CaCO3 Equivalent	7.39		0.80	%	15-OCT-14	15-OCT-14	R2988789
Total Carbon by combustion method							
Total Carbon by Combustion	11.3		0.1	%	14-OCT-14	14-OCT-14	R2988795
L1531136-5 14-14251~(17-LF)							
Sampled By: CLIENT on 01-OCT-14							
Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							
Inorganic Carbon	<0.10		0.10	%	15-OCT-14	15-OCT-14	R2988789
Total Organic Carbon	31.4		0.10	%	15-OCT-14	15-OCT-14	R2988789
CaCO3 Equivalent	<0.80		0.80	%	15-OCT-14	15-OCT-14	R2988789
Total Carbon by combustion method							
Total Carbon by Combustion	31.4		0.1	%	14-OCT-14	14-OCT-14	R2988795

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1531136-5 14-14251~(17-LF)							
Sampled By: CLIENT on 01-OCT-14							
Matrix: SOIL							
L1531136-6 14-14252~(17A-AHE)							
Sampled By: CLIENT on 01-OCT-14							
Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							
Inorganic Carbon	<0.10		0.10	%	15-OCT-14	15-OCT-14	R2988789
Total Organic Carbon	4.69		0.10	%	15-OCT-14	15-OCT-14	R2988789
CaCO3 Equivalent	<0.80		0.80	%	15-OCT-14	15-OCT-14	R2988789
Total Carbon by combustion method							
Total Carbon by Combustion	4.7		0.1	%	14-OCT-14	14-OCT-14	R2988795
L1531136-7 14-14256~(29A-AHG)							
Sampled By: CLIENT on 02-OCT-14							
Matrix: SOIL							
Total Organic Carbon -Inorg & Total C							
Inorganic and Organic Carbon							
Inorganic Carbon	<0.10		0.10	%	15-OCT-14	15-OCT-14	R2988789
Total Organic Carbon	6.47		0.10	%	15-OCT-14	15-OCT-14	R2988789
CaCO3 Equivalent	<0.80		0.80	%	15-OCT-14	15-OCT-14	R2988789
Total Carbon by combustion method							
Total Carbon by Combustion	6.5		0.1	%	14-OCT-14	14-OCT-14	R2988795

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-INORG-ORG-SK	Soil	Inorganic and Organic Carbon	SSSA (1996) P455-456

When carbonates are decomposed with acid in an open system, carbon dioxide is released to the atmosphere. The decrease in sample weight resulting from CO2 loss is proportional to the carbonate content of the soil.

Reference:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	SSSA (1996) P. 973-974

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1531136 Report Date: 20-OCT-14

Client: AMEC Environment & Infrastructure
5667 70 Street NW
EDMONTON AB T6B 3P6
Contact: JESSE DANG

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-INORG-ORG-SK	**Soil**							
Batch R2988789								
WG1971769-1 DUP		**L1528827-9**						
Inorganic Carbon		0.59	0.62		%	5.5	20	15-OCT-14
CaCO3 Equivalent		4.93	5.21		%	5.5	25	15-OCT-14
WG1971769-5 DUP		**L1531522-1**						
Inorganic Carbon		1.94	1.95		%	0.7	20	15-OCT-14
CaCO3 Equivalent		16.2	16.3		%	0.7	25	15-OCT-14
WG1971769-9 DUP		**L1531522-13**						
Inorganic Carbon		5.58	5.59		%	0.1	20	15-OCT-14
CaCO3 Equivalent		46.5	46.6		%	0.1	25	15-OCT-14
WG1971769-10 IRM		**0.1%IC**						
Inorganic Carbon			112.0		%		60-140	15-OCT-14
CaCO3 Equivalent			112.4		%		60-140	15-OCT-14
WG1971769-11 IRM		**0.4%IC**						
Inorganic Carbon			95.9		%		80-120	15-OCT-14
CaCO3 Equivalent			96.0		%		80-120	15-OCT-14
WG1971769-2 IRM		**0.1%IC**						
Inorganic Carbon			130.3		%		60-140	15-OCT-14
CaCO3 Equivalent			130.9		%		60-140	15-OCT-14
WG1971769-3 IRM		**0.4%IC**						
Inorganic Carbon			102.0		%		80-120	15-OCT-14
CaCO3 Equivalent			102.1		%		80-120	15-OCT-14
WG1971769-6 IRM		**0.1%IC**						
Inorganic Carbon			125.4		%		60-140	15-OCT-14
CaCO3 Equivalent			125.9		%		60-140	15-OCT-14
WG1971769-7 IRM		**0.4%IC**						
Inorganic Carbon			93.9		%		80-120	15-OCT-14
CaCO3 Equivalent			94.1		%		80-120	15-OCT-14
WG1971769-12 MB								
Inorganic Carbon			<0.10		%		0.1	15-OCT-14
CaCO3 Equivalent			<0.80		%		0.8	15-OCT-14
WG1971769-4 MB								
Inorganic Carbon			<0.10		%		0.1	15-OCT-14
CaCO3 Equivalent			<0.80		%		0.8	15-OCT-14
WG1971769-8 MB								
Inorganic Carbon			<0.10		%		0.1	15-OCT-14
CaCO3 Equivalent			<0.80		%		0.8	15-OCT-14
C-TOT-LECO-SK	**Soil**							

Quality Control Report

Client: AMEC Environment & Infrastructure
5667 70 Street NW
EDMONTON AB T6B 3P6
Contact: JESSE DANG

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TOT-LECO-SK	**Soil**							
Batch R2988795								
WG1971762-1 DUP		**L1528827-9**						
Total Carbon by Combustion		33.2	34.1		%	2.5	20	14-OCT-14
WG1971762-4 DUP		**L1531522-1**						
Total Carbon by Combustion		3.2	3.0		%	6.8	20	14-OCT-14
WG1971762-7 DUP		**L1531522-13**						
Total Carbon by Combustion		6.0	5.9		%	1.6	20	14-OCT-14
WG1971762-2 IRM		**08-109_SOIL**						
Total Carbon by Combustion			106.0		%		80-120	14-OCT-14
WG1971762-5 IRM		**08-109_SOIL**						
Total Carbon by Combustion			109.4		%		80-120	14-OCT-14
WG1971762-8 IRM		**08-109_SOIL**						
Total Carbon by Combustion			105.6		%		80-120	14-OCT-14
WG1971762-3 MB								
Total Carbon by Combustion			<0.1		%		0.1	14-OCT-14
WG1971762-6 MB								
Total Carbon by Combustion			<0.1		%		0.1	14-OCT-14
WG1971762-9 MB								
Total Carbon by Combustion			<0.1		%		0.1	14-OCT-14

Quality Control Report

Client: AMEC Environment & Infrastructure
5667 70 Street NW
EDMONTON AB T6B 3P6

Contact: JESSE DANG

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1531136-COFC

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC #

Report To	
Company:	AMEC Earth & Environmental, Chemistry Dept.
Contact:	Kristine Connor
Address:	5667-70 Street, Edmonton, AB T6B 3P6
Phone:	Fax:
Invoice To	Same as Report ? ☑ Yes ☐ No
Hardcopy of Invoice with Report?	☐ Yes ☑ No
Company:	
Contact:	
Address:	
Phone:	Fax:
Lab Work Order # (lab use only)	

Report Format / Distribution	
☐ Standard ☐ Other	
☑ PDF ☑ Excel ☐ Digital ☐ Fax	
Email 1:	kristine.connor@amec.com
Email 2:	jesse.dang@amec.com
Email 3:	
Client / Project Information	
Job #:	EC-68281
PO / AFE:	2220
LSD:	
Quote #:	
ALS Contact:	Maureen Olinek
Sampler:	

Service Requested (Rush for routine analysis subject to availability)
- ◉ Regular (Standard Turnaround Times - Business Days)
- ○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
- ○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
- ○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	TOC	Number of Containers
	~~Eight~~ samples (see attached for highlighted list)			Soil	X	1
	Seven					

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Please list both IDs on report. Samples sent ground.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Colin Castor	Date (dd-mmm-yy)	Time (hh-mm)	Received by: 4l	Date: 10/Oct/14	Time: 9:06	Temperature: 18 °C	Verified by: 4l	Date: 10/Oct/14	Time: 9:06	Observations: Yes / No ? If Yes add SIF

FileNbr	SampleName	LabNbr	DateSampled	Description
EC-68281	46A-LFH	14-14238-	2014/10/01	Soil
EC-68281	46A-Bm1	~~14-14239-~~	2014/10/01	Soil
EC-68281	46A-Bm2	~~14-14240-~~	2014/10/01	Soil
EC-68281	46A-Ck	~~14-14241-~~	2014/10/01	Soil
EC-68281	23A-Of	14-14242-	2014/10/02	Soil
EC-68281	23A-Om	14-14243-	2014/10/01	Soil
EC-68281	25A-C1/LFH	14-14244-	2014/10/02	Soil
EC-68281	25A-C2	~~14-14245-~~	2014/10/02	Soil
EC-68281	25A-Ck1	~~14-14246-~~	2014/10/02	Soil
EC-68281	25A-Ck2	~~14-14247-~~	2014/10/02	Soil
EC-68281	44A-LFH	~~14-14248-~~	2014/10/01	Soil
EC-68281	44A-Ckgj	~~14-14249-~~	2014/10/01	Soil
EC-68281	44A-IICkgj	~~14-14250-~~	2014/10/01	Soil
EC-68281	17-LF	14-14251-	2014/10/01	Soil
EC-68281	17A-Ahe	14-14252-	2014/10/01	Soil
EC-68281	17A-Bt	~~14-14253-~~	2014/10/01	Soil
EC-68281	17A-Bm	~~14-14254-~~	2014/10/01	Soil
EC-68281	17A-IICk	~~14-14255-~~	2014/10/01	Soil
EC-68281	29A-Ahg	14-14256-	2014/10/02	Soil
EC-68281	29A-Bg	~~14-14257-~~	2014/10/02	Soil
EC-68281	29A-Cg	~~14-14258-~~	2014/10/02	Soil

Appendix E

Vegetation

Table E-1
Dominant Species in Each Ecosite Phase

ECOSITE PHASE	b1			b2		b3					d3			d4	h1	k2				Disturbed
SITE #	V02	V08	V20	V01	V26	V03	V09	V10	V19	V21	V06	V18	V27	V04	V14	V05	V07	V13	V15	V23
SPECIES																				
Trees																				
Pinus contorta	+	+	+		+	+	+	+	+	+		+	+	+						
Populus tremuloides				+	+	+	+	+	+	+					+					
Picea glauca							+	+		+	+	+	+	+	+					
Populus balsamifera															+					
Shrubs																				
Vaccinium caespitosum	+	+																		
Sheperdia Canadensis	+		+	+		+	+		+	+	+		+							
Alnus crispa	+																			
Rosa acicularis		+		+	+		+			+	+				+					
Juniperus communis				+					+		+									
Juniperus horizontalis				+																
Symphoricarpus albus							+								+					
Salix sp.															+	+	+			+
Betula pumila																+	+		+	
Herbs and dwarf shrubs																				
Fragaria virginiana	+						+						+							
Arctostaphylos uva-ursi		+	+			+			+		+									
Cornus canadensis		+					+						+	+						
Elymus innovatus		+	+		+	+	+		+	+	+	+								+
Calamagrostis rubescens		+			+			+												
Phleum pratense				+																
Festuca scabrella				+																
Pyrola asarifolia								+												
Linnaea borealis																				
Calamagrostis canadensis																+				+
Carex utricularia																	+		+	
Equisetum arvense															+					
Equisetum pratense															+					
Carex aquatilis																		+		
Moss																				
Hylocomium splendens	+	+	+								+	+	+	+						
Pleurozium schreberi					+			+			+									
Sphagnum sp.																	+			
Tomenthypnum nitens																	+	+	+	
Drepanocladus sp.																			+	

Table E-2
The Standard Subnational Status Rank For Plants (SRank)

Rank	Definition
SX	• Taxon is believed to be extirpated from the province. • Not located despite intensive searches of historical sites and other appropriate habitat. • Virtually no likelihood that it will be rediscovered.
SH	• Known from only historical records but still some hope of rediscovery. • Evidence that the taxon may no longer be present but not enough to state this with certainty.
S1	• Known from five or fewer occurrences or especially vulnerable to extirpation because of other factors.
S2	• Known from twenty or fewer occurrences or vulnerable to extirpation because of other factors.
S3	• Known from 100 or fewer occurrences, or somewhat vulnerable due to other factors, such as restricted range, relatively small population sizes, or other factors.
S4	• Apparently secure. • Taxon is uncommon but not rare. • Potentially some cause for long term concern due to declines or other factors.
S5	• Secure – taxon is common, widespread, and abundant.
NSR	• Element not yet ranked.

Appendix F

Engagement

Resilience and Mitigation Branch: AESRD

Elbow River Watershed Flood Mitigation and Water Storage Questionnaire

The Alberta Government's Resilience & Mitigation Branch (GoA) is considering flood mitigation and water storage concepts in the Elbow River basin. One flood mitigation and water storage concept is a dam and reservoir located just upstream of the confluence of the Elbow River and McLean Creek in the McLean Creek Recreation Area, in Kananaskis Country. The GoA has contracted AMEC Environment & Infrastructure (AMEC) to prepare an environmental overview of the McLean Creek site.

We are currently collecting environmental information in the area of McLean Creek on fish, water quality, soils and terrain, and wildlife. This will supplement desktop reviews as part of the environmental overview.

We contacted your government department earlier in the year to find out how you were affected by the 2013 flooding event that occurred in the Elbow River watershed. Now AMEC would like to talk with you and other selected government department stakeholders to provide an overview of the proposed McLean Creek (MC1) flood mitigation option and to understand how this flood mitigation option, if adopted, could affect your department's resources, infrastructure and service delivery in the Elbow River basin during the construction and operations phase of MC1, if this flood mitigation options is pursued in the future.

Your response to the following questions will provide valuable information to AMEC in our evaluation of the MC1 flood mitigation option.

Government Department: ______________________________

Questionnaire completed by: ______________________________

PRIOR CONTACT ABOUT 2013 FLOOD EVENT IN THE ELBOW RIVER WATERSHED

1. **Have you been contacted by a government agency or consultant for information relating to how the recent flooding of the Elbow River affected your infrastructure, services and resources?**
   _____ Yes _____ No

If yes, please provide a brief summary of who contacted you and what information you provided.

CONTACT REGARDING PROPOSED MCLEAN CREEK FLOOD MITIGATION IN ELBOW RIVER WATESHED

2. **How familiar are you with the proposed McLean Creek Dam/Reservoir (MC1) flood mitigation option?**
   Attached is an aerial photo that shows the MC1 conceptual footprint and adjacent areas that would be potentially affected during construction and operations.

3. **If MC1 is developed, how do you think the Project footprint and related construction activities could affect the resources, service delivery and infrastructure of your government agency at this location and elsewhere within the Elbow River watershed?**

4. **If MC1 is developed, how do you think the Project footprint and related operations of the MC1 dam and reservoir could affect the resources, service delivery and infrastructure of your government agency at this location and elsewhere within the Elbow River watershed?**

5. **If MC1 is developed, do you anticipate any positive effects from the MC1 dam and reservoir on the resources, service delivery and infrastructure of your government agency at this location and elsewhere within the Elbow River watershed? If yes, please describe.**

6. **Do you have any questions or comments that you would like to provide to AMEC for inclusion in AMEC's environmental overview of the McLean Creek dam/reservoir concept at the McLean Creek site? If yes, we will document you input and try to answer any questions you may have.**

Thank you for your participation in this interview. If you have any questions or would like further information on this study, please contact:

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