# APPENDIX IR15-1 DRAFT GROUNDWATER MONITORING PLAN

Stantec

Appendix IR15-1 Draft Groundwater Monitoring Plan
May 2019

**SPRINGBANK OFF-STREAM RESERVOIR PROJECT**
**Draft Groundwater Monitoring Plan**

Prepared for:
Alberta Transportation

Prepared by:
Stantec Consulting Ltd.

May 2019

# Table of Contents

**LIST OF TABLES**



**LIST OF FIGURES**

## Abbreviations

| | |
|---|---|
| 3D CSM | 3D Conceptual Site Model |
| ACO | Aboriginal Consultation Office |
| AEP | Alberta Environment and Parks |
| AGS | above ground surface |
| AWWID | Alberta Water Well Information Database |
| BGP | base of groundwater protection |
| BTEX | benzene, toluene, ethylbenzene and xylene |
| CALA | Canadian Association for Laboratory Accreditation |
| DEM | digital elevation model |
| DFO | Fisheries and Oceans Canada |
| DO | dissolved oxygen |
| DOC | dissolved organic carbon |
| EC | electrical conductivity |
| ECO Plan | Environmental Construction Operation Plan |
| EPEA | *Environmental Protection and Enhancement Act* |
| GWMP | groundwater monitoring plan |
| LAA | local assessment area |
| m ASL | metres above sea level |
| m BGL | metres below ground level |
| ORP | oxidation-reduction potential |
| PDA | Project development area |
| PS1 | Parameter Suite 1 |
| PS2 | Parameter Suite 2 |

| | |
|---|---|
| PS3 | Parameter Suite 3 |
| QA/QC | quality assurance / quality control |
| RAA | regional assessment area |
| TDR | technical data report |
| TDS | total dissolved solids |
| the Project | Springbank Off-stream Reservoir Project |
| TLRU | traditional land and resource use |
| TUS | Traditional Use Study |
| UCL | upper confidence limit |
| US EPA | United States Environmental Protection Agency |

# 1.0 INTRODUCTION

This document describes the groundwater management plan (GWMP) for construction and operation of the Springbank Off-stream Reservoir Project (the Project). Based on the EIA conclusions, and associated regulatory and legislative requirements, mitigation and monitoring of groundwater will be undertaken.

This plan is preliminary, since the specific regulatory requirements for the monitoring program have not yet been finalized. In general, such details are included as conditions to Approvals or Licenses which have yet to be granted for the Project. It is expected that further engagement with regulators, Indigenous groups, and other stakeholders will be required to finalize all details of this plan.

## 1.1 GOALS AND OBJECTIVES OF THE GWMP

The objectives of the GWMP are to:

- collect groundwater data to support long term, ongoing management of groundwater conditions in the LAA and RAA
- support the management of construction-related effects
- confirm that Project effects during operations are consistent with expectations and can be managed with planned and implemented mitigation measures
- provide a means for detection of unexpected changes to groundwater quantity or quality such that the need for implementation of additional mitigation measures is identified
- demonstrate appropriate due diligence and compliance with regulatory requirements

# 2.0 REGULATIONS, APPROVALS AND GUIDELINES

Specifics regarding the regulatory conditions for the GWMP will be reviewed in accordance with the terms and conditions of Approvals or Licenses issued for the Project. It is anticipated that some components of the Project may require short-term Approvals/Licenses for activities related to construction (e.g., dewatering activities) and such requirements will be considered during the applicable timeframe.

Long-term requirements as stipulated within the Approval for operation of the Project will also be incorporated into the ongoing GWMP. The Regulations, Approvals and Guidelines section of the final GWMP will list relevant provincial and federal regulations, guidelines and approval conditions relevant to groundwater monitoring and provide a concordance table of how they are addressed in the plan.

## 2.1 PROVINCIAL AGENCY RESPONSIBILTIES AND REPORTING REQUIREMENTS

### 2.1.1 Construction and Dry Operations

Alberta Transportation will be responsible for final development of the GWMP and implementation during the construction phase and for a period of three years post-construction during the dry operations phase of the Project. After that, AEP will implement the WMMP during dry operations. The reporting requirements (i.e., number of reports, timing) will be determined following Project approval.

### 2.1.2 Flood and Post-Flood Operations

AEP will be responsible for implementing the GWMP during both flood and post-flood operation phases of the Project. The reporting requirements (i.e., number of reports, timing) will be determined following Project approval.

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# 3.0 REGULATORY, INDIGENOUS AND PUBLIC STAKEHOLDER INPUT

Engagement with stakeholders, including landowners, municipalities, infrastructure companies and others has been ongoing since the fall of 2014. Alberta Transportation's engagement with Indigenous groups also began in 2014 and with the five Treaty 7 First Nations in accordance with the Government of Alberta's Guidelines on Consultation with First Nations on Land and Natural Resource Management (2014) and the First Nation Consultation Plan approved by the Aboriginal Consultation Office (ACO).

## 3.1 GROUPS ENGAGED

Table 3-1 lists the Indigenous groups that have been engaged on the Project.

**Table 3-1 Indigenous Groups Identified for Engagement**

| Indigenous Group or Organization | Distance from Project |
|---|---|
| **Treaty 7 Nations** | |
| Tsuut'ina Nation | 619 m |
| Stoney Nakoda Nations (Bearspaw First Nation, Chiniki First Nation, and Wesley First Nation) | 28 km |
| Siksika Nation | 78 km |
| Piikani Nation | 144 km |
| Kainai First Nation (Blood Tribe) | 170 km |
| **Treaty 6 Nations** | |
| Ermineskin Cree Nation | 204 km |
| Louis Bull Tribe | 207 km |
| Montana First Nation | 194 km |
| Samson Cree Nation | 198 km |
| **Other** | |
| Foothills Ojibway | No Reserve |
| Ktunaxa Nation | 180 km |
| Métis Nation of Alberta, Region 3 | N/A |
| Métis Nation British Columbia | N/A |

### 3.1.1 Issues Identified

Issues, concerns and recommendations related to effects of the Project were reported by Indigenous groups through the Indigenous engagement program. Engagement with the Indigenous groups potentially affected by the Project is ongoing and will continue as the Project progresses. Alberta Transportation will review Traditional Use Study (TUS) reports as they are made available by Indigenous groups. Relevant Traditional Land and Resource Use (TLRU) information, concerns, and recommendations received after the EIA has been filed will be used for project planning and implementation purposes, where applicable.

Generally, issues and concerns related to effects of Project development on groundwater, as reported by Indigenous groups through the review of Project-specific and publicly-available TLRU information, include:

- potential effects on water quantity or quality within water wells used for potable and/or agricultural purposes
- potential effects on groundwater dependent springs
- potential for increased flooding of land related to groundwater discharge
- changes in groundwater quantity or quality that in turn affect groundwater dependent traditional uses

### 3.1.2 Economic Opportunities

Alberta Transportation is committed to Indigenous participation in the Project including training, employment and contracting opportunities. Alberta Transportation is preparing an “Indigenous Participation Plan” for the Project. The goal of this Plan is to create training and contracting opportunities with interested Indigenous groups potentially affected by the Project. Alberta Transportation aims to obtain Indigenous comment and feedback on the draft Plan, the final draft of which will identify how that feedback has been incorporated.

# 4.0 PROJECT DESCRIPTION

The Project consists of the construction and operation of an off-stream reservoir to divert and retain a portion of Elbow River flows during a flood. The diverted water will be released back to Elbow River in a controlled manner after the flows in Elbow River decrease sufficiently to accommodate the release of water from the reservoir. The off-stream reservoir will not hold a permanent pool of water.

## 4.1 PROJECT COMPONENTS

The primary Project components are:

- a diversion structure on the main channel and floodplain of Elbow River
- a diversion channel to transport partially diverted floodwater into the reservoir
- an off-stream dam to temporarily retain the diverted floodwater
- a low-level outlet in the dam to return retained water through the existing unnamed creek and back to the river when AEP Operations determines conditions are appropriate.

## 4.2 PROJECT PHASES

The primary Project components will be constructed and operated under four phases. The groundwater monitoring plan will begin during the construction phase and continue into operational phases.

### 4.2.1 Construction

The Project is scheduled to be functionally operational (able to accommodate a 1:100-year flood event) for floods after two years of construction and be completely constructed (able to accommodate the design flood) after three years of construction.

### 4.2.2 Dry Operations

Dry operation refers to Project operation between floods. During dry operation, the diversion inlet gates will close, and the service spillway gates will open. The outlet structure will remain open to carry the flow of the unnamed creek over which the dam will be built. The outlet gate system and its operation will be checked according to a routine maintenance schedule to be developed by AEP. Water draining from the base of the dam will flow through unnamed creek and back into Elbow River.

The associated access roads, emergency spillway and reservoir will be inspected at the same time and repaired, if necessary. The maintenance schedule will also include inspections of the diversion structure and the river channel upstream of it, the maintenance building, the floodplain berm, and the auxiliary spillway. Repairs and debris management will be completed as necessary.

### 4.2.3 Flood Operations

AEP Operations will be in communication with the City of Calgary Glenmore Dam operators in advance of and during the flood season each year. The need for flood operations will be determined through this communication, which will be informed by forecasted and measured flows on Elbow River at the diversion structure and upstream. AEP Operations staff, in communication with the City of Calgary Glenmore dam operators, will decide on when to open the diversion gates to commence diversion of flood water flows in excess of 160 $m^3/s$ to the off-stream reservoir.

### 4.2.4 Post-Flood Operations

During post-flood operations, the diversion inlet gates are closed, and the service spillway gates are open (lowered to the river bed). The gates of the outlet structure are opened to allow the floodwater retained in the reservoir to drain through the low-level outlet into the unnamed creek and then into Elbow River. The outlet structure gates would remain open after the reservoir has drained.

# 5.0 HYDROGEOLOGICAL SETTING

The hydrogeologic setting of the RAA is summarized in the following sections in order to provide context for the draft GWMP. A more detailed description of the hydrogeologic setting of the RAA is presented in the Hydrogeology Technical Data Report Update (provided as Appendix IR42-1 in the response to AEP IR42 and Appendix IR14-1 in CEAA IR3-14).

## 5.1 REGIONAL TOPOGRAPHY AND DRAINAGE

The ground surface topography of the expanded RAA (with respect to the groundwater RAA described in the EIA) is depicted by the digital elevation model (DEM) in Figure 5-1. Outlines of the Hydrogeology PDA/LAA and Tsuut'ina Nation Reserve are also shown as overlays for reference. Areas of higher elevation are denoted by red, and they grade down to areas of low elevation, denoted by blue as shown on the colour scale. The topographic elevation ranges from approximately 1,365 m ASL on the bedrock ridges in the southwest corner of the RAA to approximately 1,125 m ASL along Elbow River at the eastern boundary.

The topography on the north side of the RAA consists of a series of ridges and valleys that are oriented northwest to southeast. The topography of most of the RAA is generally controlled by the bedrock structure, particularly in the southwest, and to a lesser extent, the patterns of glacial sediment deposition modify the topography in lower areas. Prominent ridges through the assessment area are a result of formations that are more resistive to weathering; the valleys in between the ridges are more easily weathered or recessive.

Near the modern river channels, fluvial erosion and deposition is the primary control agent. Near Elbow River and Jumpingpound Creek, the terrain is incised with one or more fluvial terraces within the river valleys. Hummocky regions have low to moderate relief, with gentle slopes that vary between 2% and 15%. Areas with low relief are underlain by till or glaciolacustrine sediments, while areas of moderate relief are underlain by till and glaciofluvial sediments. Outcrops of bedrock occur along ridges in the lower areas of the RAA and are moderately weathered and fractured, but they are covered by a thick sequence of unconsolidated sediment.

There are topographic highs in areas both north and south of Elbow River in the southwest portion of the RAA; these are interpreted to be deformed bedrock features with a thin veneer of overlying unconsolidated sediment.

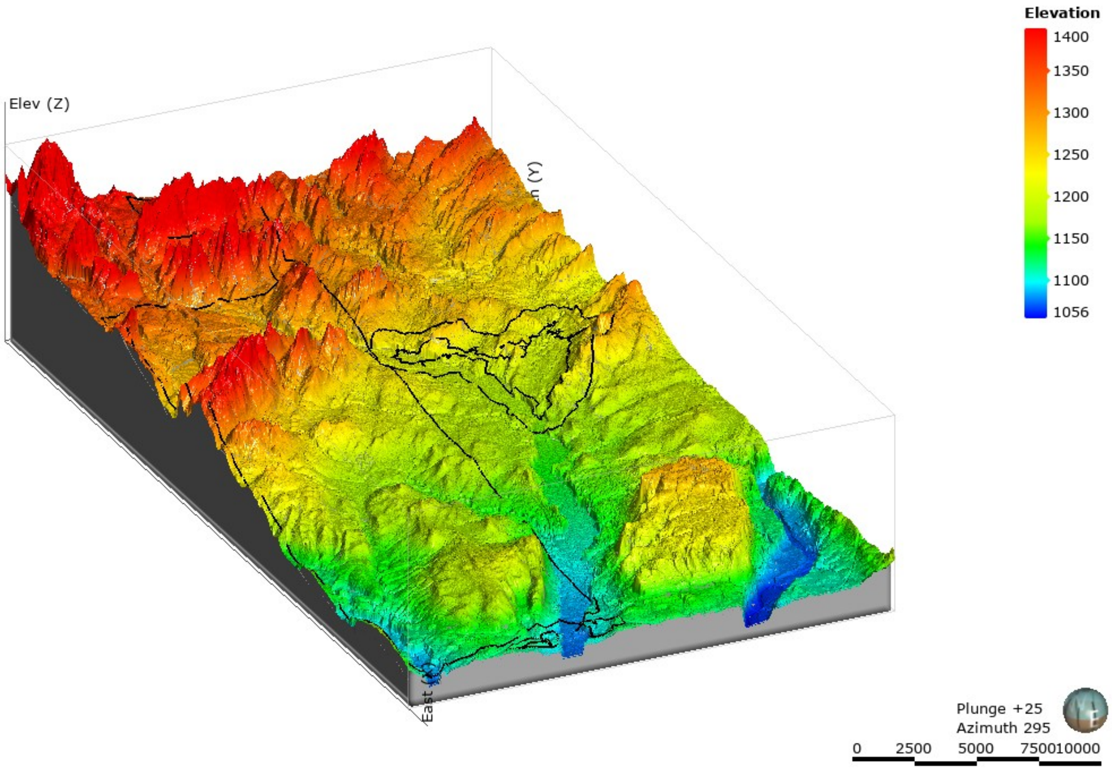



**Figure 5-1 Topography of the Expanded Regional Assessment Area**

## 5.2 REGIONAL HYDROGEOLOGIC SETTING

### 5.2.1 Conceptual Hydrostratigraphic Framework

The conceptual hydrostratigraphic framework for the LAA and RAA is based on the 3D conceptual site model (3D CSM) developed for the baseline groundwater assessment. Figure 5-2a presents an oblique view of the 3D CSM looking from the east with the expanded RAA boundary shown overlain on the model and air photograph for reference. Figure 5-2a also shows the Tsuut'ina Nation Reserve land as a transparent polygon on the air photograph for reference. Figure 5-2b shows the same view with a transparent model domain with all the lithological interval data integrated into the 3D environment. The detail on Figure 5-2b depicts the multi-coloured interval data representing different geological media projected onto each borehole trace.

The black intervals represent undifferentiated bedrock material as was reported in borehole logs from the AWWID. This convention is used to present the bedrock as a single volume in the 3D CSM. However, in the Project-specific boreholes where the bedrock lithology has been described in detail, the more porous and permeable intervals (sandstone and siltstone) are depicted in red, while the less permeable intervals are depicted in grey (claystone, mudstone and shale). Above the bedrock, the unconsolidated deposits are depicted on the borehole traces as follows:

- yellow – basal silt, sand and gravel
- green – till
- dark brown – glaciolacustrine clay
- orange – recent fluvial sand and gravel

Minor coals seams and thin bentonite beds were also noted in some boreholes but are not visible at the scale of the figure.

A regional stratigraphic column that shows the generalized stratigraphy beneath the expanded RAA is depicted in Figure 5-3. Brief descriptions of each stratigraphic unit, and a discussion of the additional salient features of the model are presented in the following subsections.

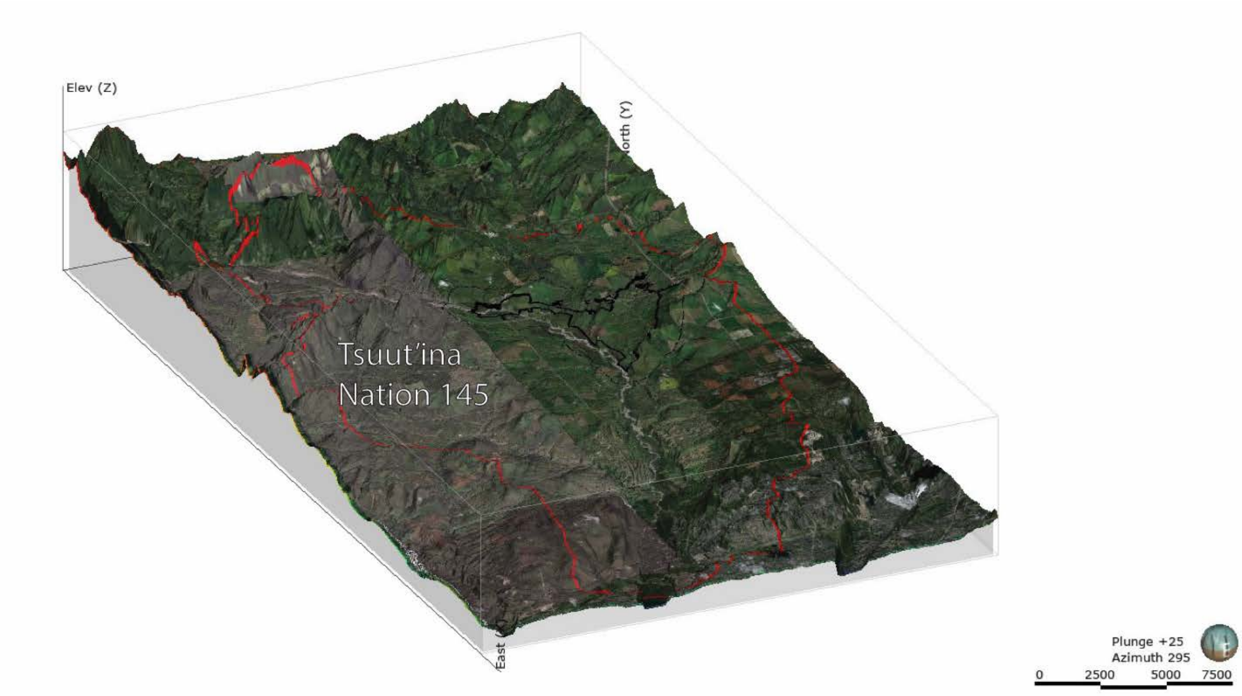



**Figure 5-2a Oblique Angle Overview of 3D CSM**

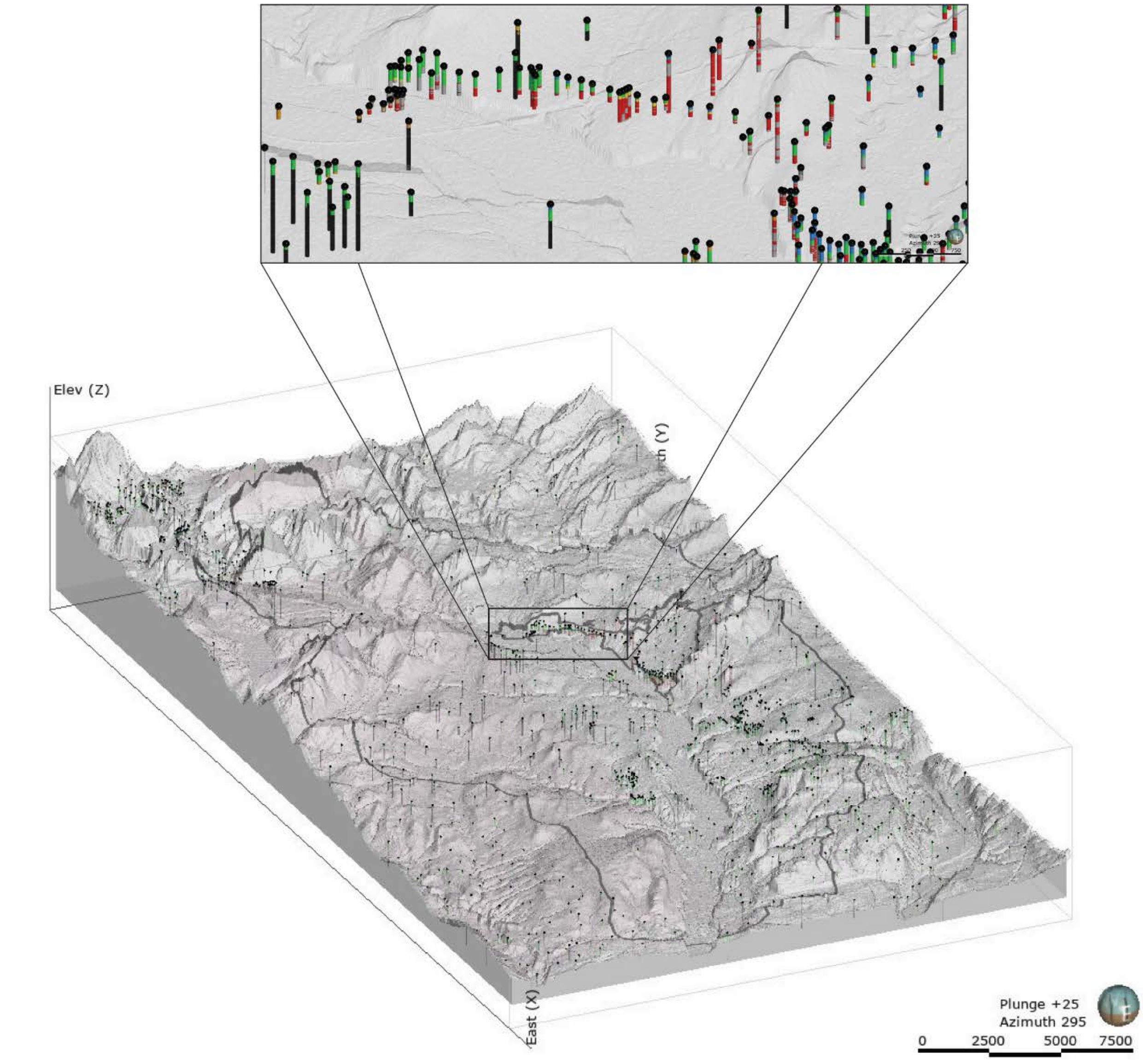



**Figure 5-2b Overview of 3D CSM Subsurface Data Distribution**

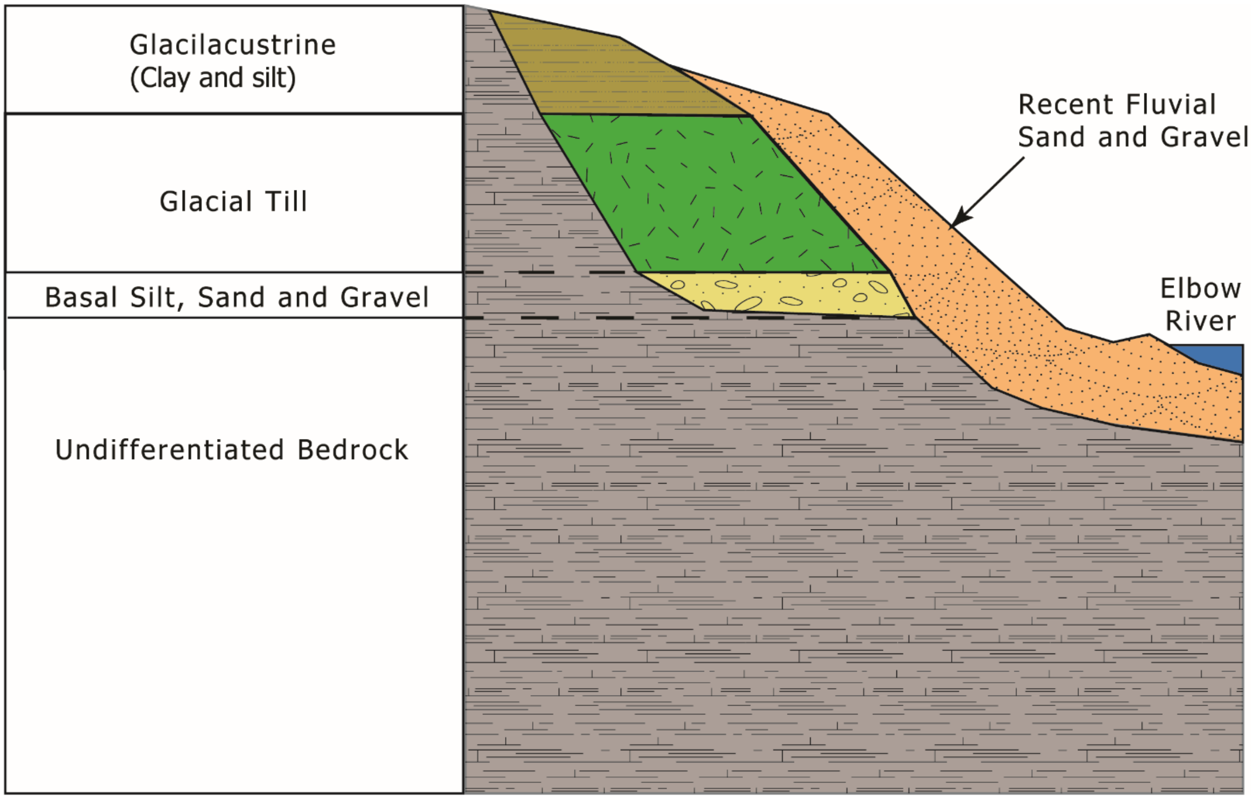



**Figure 5-3 Regional Stratigraphic Column**

### 5.2.2 Bedrock

The bedrock surface within the expanded RAA was shaped by tectonism and associated formation of the Rocky Mountains to the west, glacial erosion/deposition, and erosional incision of modern-day river channels. The RAA is in the disturbed belt which forms a transitional zone (foothills) between the Rocky Mountains to the west and prairie to the east. Bedrock topography is depicted in Figure 5-4. Outlines of the Tsuut'ina Nation Reserve and the Hydrogeology PDA/LAA are also shown as overlays for reference.

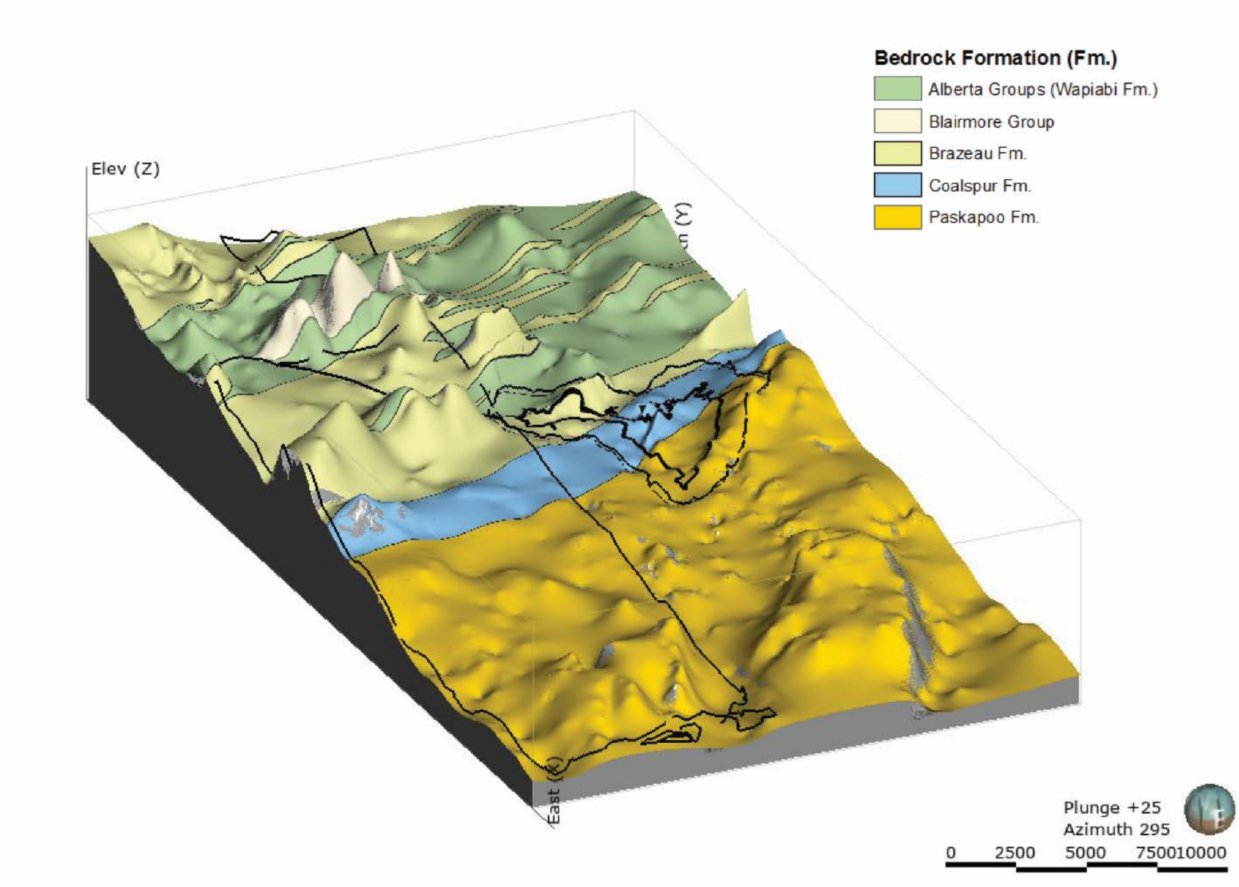



**Figure 5-4 Bedrock Topography and Subcrop Formations**

The bedrock units encountered beneath the quaternary deposits are presented below from oldest to youngest. This generally coincides with how they appear from west to east across the RAA except for the Blairmore Group:

- The lower Cretaceous Blairmore Group dominantly composed of fluvial sediments. The two fluvial formations belonging to the upper Blairmore Group include the Beaver Mines and Mill Creek formations (Langenberg et al. 2000). This unit subcrops over a small topographically elevated area in the southwest of the RAA.
- The upper Cretaceous-aged Wapiabi Formation of the Alberta Group is generally composed of shale and mudstone with minor siltstone, except for the Chungo and Marshybank Members, which are sandstone dominated (Pana and Elgr 2013).

- The upper Cretaceous-aged Brazeau Formation is composed primarily of sandstone and laminated siltstone, along with olive green mudstone and granule to pebble conglomerate in the lower part. The upper part is composed of greenish-grey to dark grey mudstone, siltstone and greenish-grey sandstone. Thin coal and coaly shale beds and thin bentonite layers also occur in the upper part (Prior et al. 2013). In the foothills, the Brazeau Formation is the approximate lateral equivalent of the Scollard Formation on the plains (Hamblin 2010).
- The Upper Cretaceous-to-Tertiary aged Coalspur Formation formed as a marginal marine fluvial infill of the foreland basin. The Coalspur Formation is composed of thinly bedded to massive sandstone, siltstone, light grey to olive green mudstone, shale, coaly shale, coal seams and minor volcanic tuff in the lower portions (Pana and Elgr 2013).
- The Tertiary-aged Paskapoo Formation is made up of thick tabular sandstone, siltstone and mudstone (Glass 1990). The sandstones are fine to coarse grained and are cliff forming. The Paskapoo Formation also contains a substantial amount of shale, carbonaceous shale, siltstone, rare coals seams and shell beds (Pana and Elgr 2013). In the central Rocky Mountains and foothills, the Paskapoo Formation is dominated by recessively weathering, grey to greenish-grey mudstone and siltstone with subordinate pale grey, thick- to thin-bedded, commonly cross-stratified sandstone; minor conglomerate; mollusc coquina; and coal (Prior et al. 2013). The Paskapoo Formation is the primary bedrock aquifer in the Elbow River watershed. Due to the stratigraphy of the layers of sandstone and shale within this formation, multiple aquifers occur at various depths in the rock (Waterline 2011). In the RAA, the yield value for the Paskapoo Formation aquifer is 35 $m^3$/day to 175 $m^3$/day (Waterline 2011).

The approximate subcrop boundaries of the bedrock units are presented in Figure 5-4 and are based on regional mapping by Pana and Elgr (2013), except for the contact between the Coalspur and Brazeau Formations. This contact was reinterpreted by Jerzykiewicz (1997) based on observation and description of the entrance conglomerate in outcrop along Highway 22. The entrance conglomerate marks the boundary between these two formations, and its presence was confirmed in the field Project-specific data gathering.

In the 3D CSM, the bedrock units are not differentiated from one another in a plan sense or vertically for the following reasons:

- All bedrock units were found to have similar lithologies (alternating sandstone, siltstone and claystone) and were inferred to have similar hydraulic properties.
- Significant fracturing was noted in the bedrock, but no spatial relationships between fracture angle, intensity or connectivity could be identified.
- No spatial correlation in hydraulic conductivity values was noted.

- Regional mapping by HCL (2002) indicates that the permeable units of the Brazeau, Coalspur and Paskapoo Formations have the same range of apparent transmissivity in the RAA.
- Significant marker horizons or distinguishing lithological characteristics required to make positive formation assignments were not identified on the borehole logs or in the core at the depths of the investigation.

The bedrock descriptions consist of varying thicknesses of alternating siltstone, sandstone mudstone and claystone. Descriptions of each of these lithological units are as follows:

- Grey to brown, fine to medium-grained sandstone ranges from completely unlithified to well cemented and dry. Significant fracturing was noted in many intervals, with oxidation common along fracture planes. The upper sandstone beds beneath the unconsolidated deposits are highly weathered. Thicknesses of individual sandstone beds range from thin, centimetre-scale beds to a maximum of 15.3 m and an average thickness of 2.5 m.
- Grey to brown and, in some intervals, greenish-grey siltstone occurs and is extremely weak and friable to well cemented. It is highly fractured in some intervals, with oxidation along fracture planes. The average thickness of the interbedded siltstone beds is 2.5 m.
- Medium grey to brown claystone, generally blocky and not fissile-like shale, dry except where fractures are saturated occurs. Fracturing varies from completely unfractured to, more often, highly fractured with oxidation and alteration of clay along fractures. Claystone is interbedded with the other lithologies described above, with an average thickness of 1.9 m for each of the interbedded layers.

Based on regional mapping by Pana and Elgr (2013), the Brazeau thrust fault is in the western portion of the LAA between the proposed diversion structure and the existing Highway 22 bridge; however, it was not identified in borehole or outcrop during the course of the field program. The thrust fault (reverse fault dipping less than 45°) has pushed the hanging wall block in the west over the footwall block in the east. Thrust faults in the region result in older formations being thrust over younger formations. Although the fault was not identified, steeply dipping bedding angles were noted in the western portions of the LAA compared to sub-horizontal bedding in the east. This transition may mark the approximate location of the thrust fault.

### 5.2.3 Basal Silt, Sand and Gravel

In some portions of the LAA, a coarser grained unit occurs above the bedrock at the base of the till. This unit is most prominent near the Elbow River valley and consists of a mixture of brown sand, silt and gravel with variable fines. The distribution of the basal silt, sand and gravel deposits is shown in yellow in Figure 5-5. Outlines of the Tsuut'ina Nation Reserve and the Hydrogeology PDA/LAA are also shown as overlays for reference. While this unit may be more widespread within the RAA than the distribution shown, the data density in the LAA was sufficient based on Project-specific data to allow correlation and mapping of this unit.

This unit was described in outcrop along Elbow River as generally 0.5 m to 1.0 m thick and consisting of clast-dominated diamicton. White and orange staining was noted, which indicated oxidation and mineral precipitation processes.

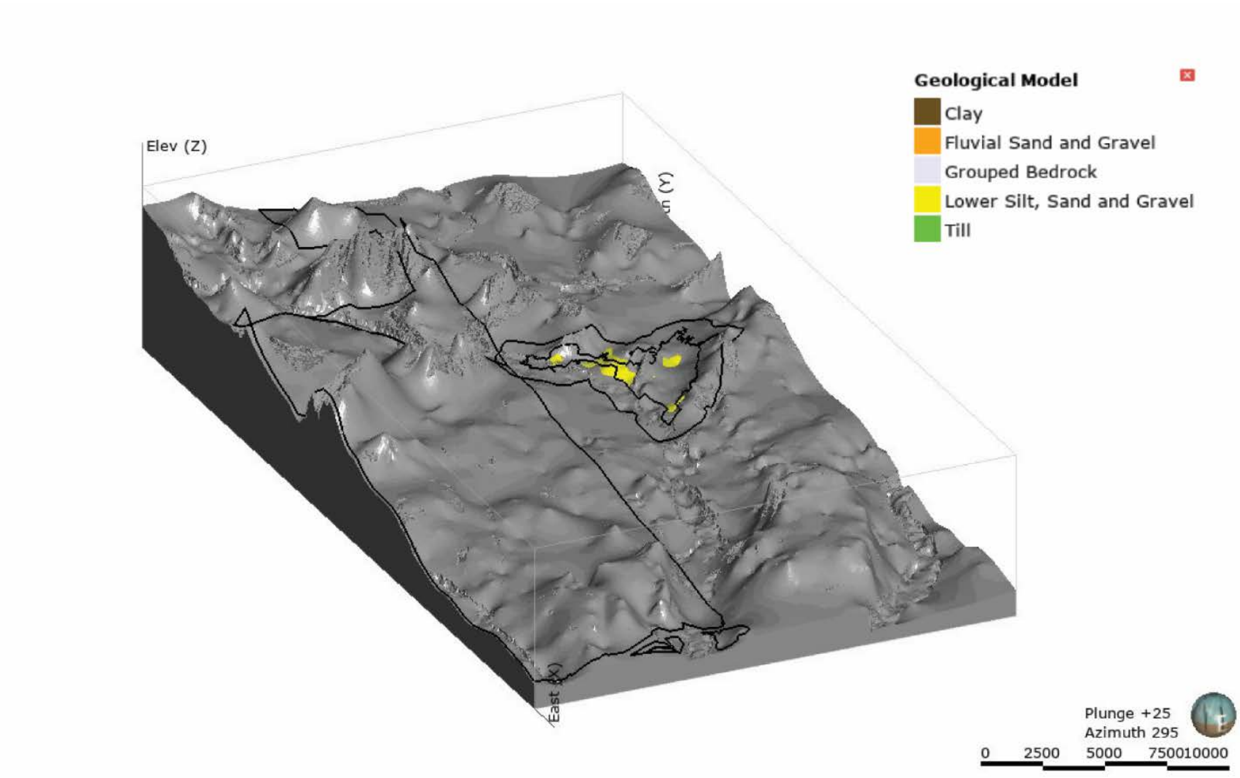



**Figure 5-5 Distribution of Basal Silt, Sand and Gravel**

### 5.2.4 Till

The unconsolidated deposits present beneath the majority of the RAA consist of Pleistocene Age glaciolacustrine clay and till (Fenton et al. 2013; Moran 1986). In the RAA, the till material was deposited by glacial ice as basal or lateral moraines. Based on the field observations and laboratory grain size analyses completed as part of the geotechnical drilling program, the till in the LAA is composed of a heterogeneous mixture of approximately equal parts clay and silt, a lower proportion of sand, and minor gravel. Silt and sand lenses are also present within the heterogeneous matrix. The till is described as generally stiff to very stiff or hard, medium to high plastic clay with silt and more minor sand.

Two main till sub-units are summarized as follows:

- Brown-grey subglacial till is dark brown to grey sandy, silty, clay with variable gravel. The till is hard with low to medium plasticity. The brown-grey subglacial till was encountered throughout the dam and diversion footprint. Cobble-sized clasts within the matrix were rounded to sub-rounded sandstones and carbonates.
- Upper brown till is a massive, matrix-supported, olive brown to brown, medium plastic clay, clay and silt with sand content increasing with depth. This unit was encountered in boreholes in the dam footprint and eastern portion of the diversion channel.

The till sub-units described above and shown in Figure 5-6 have not been modelled in the CSM due to their uncertain structure and because they share similar aquifer/aquitard properties. Outlines of the Tsuut'ina Nation Reserve and the Hydrogeology PDA/LAA are also shown in Figure 5-6 as overlays for reference.

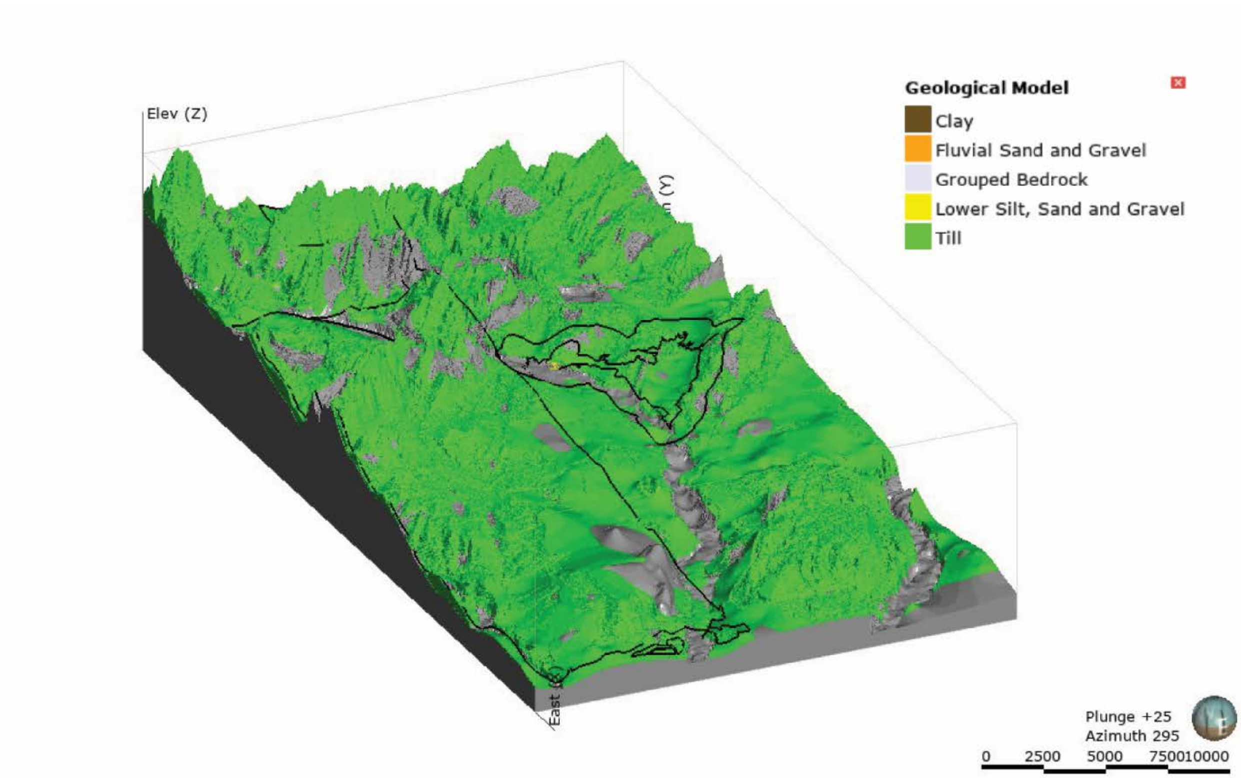



**Figure 5-6 Distribution of Till**

### 5.2.5 Glaciolacustrine Deposits

Glaciolacustrine clay overlies the till in the low-lying areas of the LAA. The silty clay was deposited in Glacial Lake Calgary, a proglacial lake formed by ice damming during the last deglaciation. The glaciolacustrine deposits have been named the Calgary Formation (Moran 1986).

The distribution of this unit is presented in blue in Figure 5-7. Outlines of the Tsuut'ina Nation Reserve and the Hydrogeology PDA/LAA are also shown as overlays for reference. Within the LAA, the glaciolacustrine clay averaged 5.3 m thick in the boreholes where it was encountered.

Based on the field observations and laboratory grain size analyses, the glaciolacustrine clay in the LAA is composed of 50-70% clay, 30-40% silt and a minor proportion of sand. Typical of a lacustrine deposit, the clay was found to be laminated with silt and fine sand. This layering has resulted in the following:

- relatively high hydraulic conductivities and anisotropy ratios (horizontal hydraulic conductivity
- vertical hydraulic conductivity) compared to the underlying till
- groundwater preferentially flows through the silt

The laminations and rhythmic bedding of the glaciolacustrine deposits can be observed along the banks of Elbow River in the RAA.

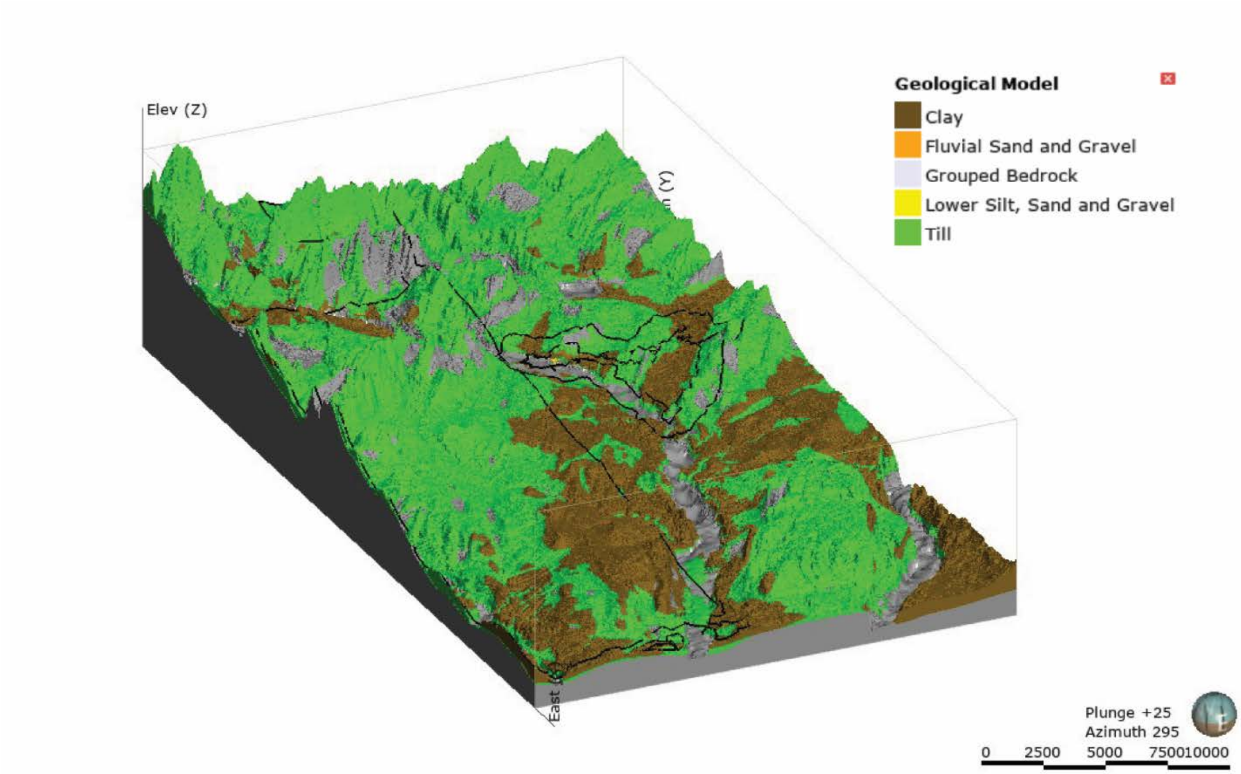



**Figure 5-7 Distribution of Glaciolacustrine Deposits**

### 5.2.6 Recent Fluvial Deposits

Post-glacial fluvial channel sediments are in the Elbow River valley that extends across the RAA and in the Jumpingpound Creek channel in the western portion of the RAA. These sediments developed as the high-energy rivers, eroded and exported material from upstream areas and deposited coarse alluvium (sand and gravel) in the river channel. Localized areas of overbank deposits consisting of fluvial silt are also present (Moran 1986). The deposition of alluvium over Quaternary deposits or bedrock in the valleys resulted in the formation of alluvial aquifers, which are an important source of groundwater for the river and residents.

The alluvial aquifers provide temporary storage for water from Elbow River and Jumpingpound Creek during floods; the water is naturally released back into the rivers from bank storage after a flood recedes. Groundwater from the alluvial aquifer of Elbow River is essential in maintaining baseflow. Yields for the Elbow River alluvial aquifer range from 175 m3/day to 2,500 m3/day (Waterline 2011).

Recent fluvial deposits are depicted in orange in Figure 5-8. Outlines of the Tsuut'ina Nation Reserve and the Hydrogeology PDA/LAA are also shown as overlays for reference. The fluvial deposits in this area are brown and grey silty gravel with more minor sand, cobbles and boulders.

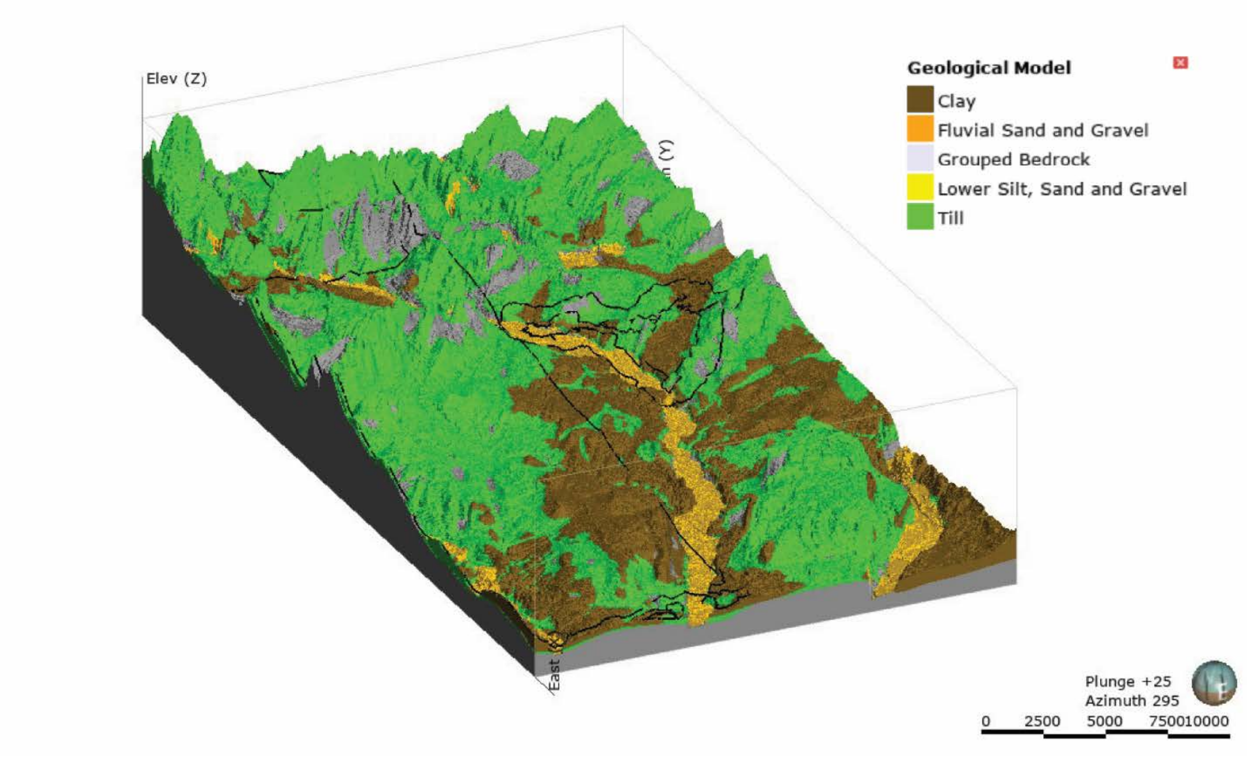



**Figure 5-8 Distribution of Recent Fluvial Deposits**

## 5.3 EXISTING GROUNDWATER AND SURFACE WATER USE

Groundwater use in the expanded RAA is primarily from shallow bedrock aquifers with some wells also completed in the recent fluvial deposits along Elbow River. Regional mapping by HCL (2002) indicate yields from the bedrock aquifers in the disturbed belt range from 10 $m^3$/day to 75 $m^3$/day. Yields from wells completed in the recent fluvial deposits along Elbow River are expected to range from 175 $m^3$/day to 2,500 $m^3$/day (Waterline 2011).

The base of groundwater protection (BGP) is an estimate of the elevation of the base of the geological formation in which the groundwater is deemed useable with a total dissolved solids (TDS) concentration of less than 4,000 mg/L. West of the RAA, the BGP is defined as the base of the Paskapoo Formation; however, because the RAA lies within the disturbed belt of the Rocky Mountains, the AGS has set an arbitrary BGP of 600 m BGL.

Water well drillers records for groundwater wells completed in the expanded RAA were queried from the AWWID. A total of 2,140 unique well records were identified within the expanded RAA. A number of well record types were removed from the raw data such as abandoned test holes, dry holes, piezometers, and seismic test holes, which are not reflective of groundwater use.

A total of 1,708 water well drilling records remained after removing irrelevant data. The proposed use of the wells associated with the AWWID drilling records within the expanded were as follows:

- 1,458 for domestic use
- 71 for stock use
- 75 for domestic and stock use
- 15 for commercial purposes
- 16 for industrial purposes
- 5 for irrigation purposes
- 9 for municipal use
- 59 for unknown use

Water well depths ranged from 1.5 m to 246 m BGL. Figure 5-9 presents a histogram of the total depth recorded on the drilling records. The number of wells completed in bedrock and unconsolidated units are also summarized in the figure. A total of 83 well records were for wells installed in unconsolidated deposits with completion depths ranging from 0 to 50 m BGL.

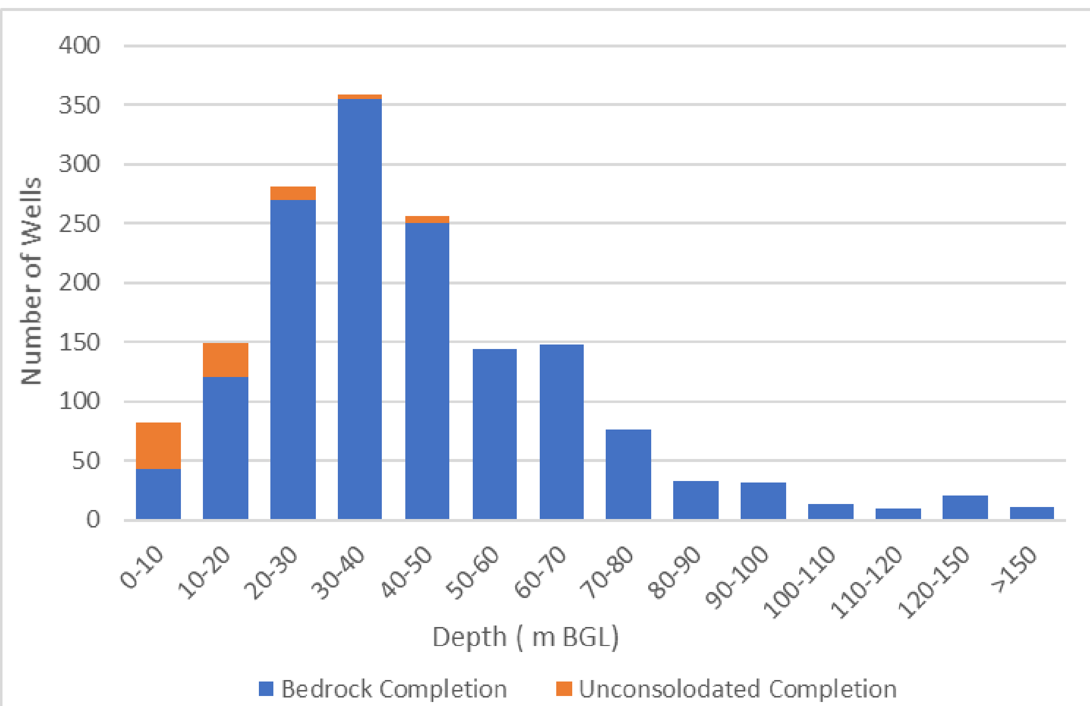



**Figure 5-9 Histogram of Water Well Depth in the RAA**

## 5.4 IMPLICATIONS FOR THE GROUNDWATER MONITORING PLAN

Based on the hydrostratigraphic framework and summary of groundwater use presented above, the following factors were considered during development of the draft GWMP:

- The hydrogeologic setting in the RAA is complex and consists of a series of unconsolidated deposits overlying bedrock. The GWMP describes monitoring of both unconsolidated and bedrock hydrostratigraphic units.
- The distribution of the unconsolidated units is highly variable across the RAA, but generally consist of low permeability deposits in areas outside of river valleys. Higher permeability deposits are generally confined to the Elbow River valley and within some of the smaller tributary valleys. The GWMP considers the variable distribution of the unconsolidated deposits and describes monitoring in both permeable units (potential aquifers) and low permeability units (aquitards).
- Bedrock in the RAA is also variable and heterolithic, generally consisting of interbedded sequences of fine-and-coarse grained deposits varying from mudstones to sandstones. When the position of monitoring wells is better constrained, the completion interval for the monitoring well will need to carefully consider the lithology encountered during drilling/installation to reflect the uppermost interval most likely to be used domestic/agricultural use.
- Groundwater use for domestic and agricultural purposes in the RAA is sourced from both unconsolidated and bedrock units. However, use from the bedrock units dominates, particularly for wells with depths greater than 10 m. As such, the draft GWMP considers monitoring of the deeper bedrock units, particularly in areas distant from Project infrastructure, such that unexpected change in groundwater levels can be detected in hydrostratigraphic units currently being used for domestic and agricultural purposes.

# 6.0 GROUNDWATER EFFECTS MITIGATION

## 6.1 MITIGATION MEASURES FOR EFFECTS ON GROUNDWATER QUANTITY

### 6.1.1 Mitigation During Construction and Dry Operations

Construction dewatering, if required, would be done locally and according to the terms and conditions of dewatering licences issued by AEP (where applicable and if required) and best management practices. This would be included as part of the ECO Plan (Environmental Construction Operation Plan) prepared by the contractor. Standard construction dewatering methods will be used, including methods to cut off excessive seepage where trenches extend below the water table in order to mitigate preferential flow paths. Other mitigation measures are as follows:

- Water will be discharged in a manner to avoid erosion using turbidity barriers, containment berms and settling ponds. Construction dewatering, if required, will be in accordance with the terms and conditions of *Water Act* approval and the federal *Fisheries Act* and *Navigable Waters Protection Act*.
- Alberta Transportation's *Civil Works Master Specifications for Construction of Provincial Water Management* Projects - Care of Water Section 02240 will include using cofferdams, pumping systems, sumps, pipelines, channels, flumes, drains, and other dewatering works to permit construction.
- Total suspended solids (TSS) levels will be controlled using silt fences and turbidity barriers. TSS levels will be monitored by carrying out frequent water quality testing.
- Construction dewatering will be limited through construction planning.
- Existing water wells within the off-stream reservoir footprint will be decommissioned and plugged off to prevent groundwater contamination.
- Regional-scale effects on groundwater quantity can be mitigated by allowing seepage in the diversion channel (when it is dry) to infiltrate back into the subsurface, or flow back into Elbow River through surface water drainage pathways.

Effects on groundwater quantity as a result of construction dewatering would not be entirely mitigated at a local scale because dewatering deliberately seeks to temporarily lower the groundwater table in the PDA in order to facilitate construction. The amount of time required for construction dewatering can be minimized through diligent construction planning. Groundwater that is collected during dewatering would be returned to the local watershed to mitigate regional-scale effects on groundwater quantity.

Groundwater that seeps into the diversion channel (when dry) would remain within the watershed, although potentially travelling through a more tortuous route. Regional-scale effects on groundwater quantity can be mitigated by allowing seepage in the diversion channel to infiltrate back into the subsurface, or flow back into Elbow River through surface water drainage pathways.

### 6.1.2 Mitigation During Flood and Post-Flood Operations

Because the Project itself is a mitigation measure, changes in groundwater quantity is a result of intentional changes in surface water redirection and retention in the PDA. No specific mitigation for the temporary changes in groundwater quantity necessary.

## 6.2 MITIGATION FOR EFFECTS ON GROUNDWATER QUALITY

### 6.2.1 Mitigation During Construction and Dry Operations

As was the case for effects on groundwater quantity, the secondary effects on groundwater quality related to changes in groundwater flow patterns would not be entirely mitigated because dewatering activities deliberately seek to lower the water table (and in turn affect groundwater flowpaths, potentially resulting in changes in groundwater quality). The amount of time required for construction dewatering can be minimized through construction planning which in turn would limit the duration of the residual effects. Other mitigation measures will be completed as follows:

- A care of water plan will be developed to manage dewatering and discharge of water on the construction site.
- At locations where flows from care of water operations are discharged into waterbodies, water quality will be tested at discharge locations and TSS monitored.
- Construction dewatering may be reduced through construction planning.

### 6.2.2 Mitigation During Flood and Post-Flood Operations

Existing water wells within the off-stream reservoir footprint will be decommissioned and plugged off to prevent groundwater contamination and to prevent flood waters from infiltrating into nearby water wells. Thus, water in the reservoir following floods would not interact with groundwater through open wells (as a vertical conduit), but they would only interact by slower direct infiltration through shallow surficial sediments, which are of low permeability.

# 7.0 PROPOSED GROUNDWATER MONITORING PROGRAM

In developing a groundwater monitoring program, a balance must be struck between several factors such that a robust, yet practical to implementation program is achieved. The main factors considered in this groundwater monitoring program include:

- hydrogeologic setting and use of groundwater in the RAA
- expected spatial extent of effects on groundwater for both dry and flood operations
- spatial density of monitoring (the number and locations of monitoring wells)
- frequency of monitoring
- monitoring groundwater levels and collection of groundwater samples for assessing water quality
- analytical parameters to be measured
- practical field constraints, including (for example) seasonal access to monitoring wells and instrumentation limitations

## 7.1 GROUNDWATER MONITORING PROGRAM DESIGN

Since the potential interactions that could lead to effects on groundwater resources vary depending upon the specific location and during Project phases, the groundwater monitoring program has varying levels of rigour, which reflects the changes in the potential interactions that are relevant during each of the phases. Some of the potential Project interactions are not applicable during all times; therefore, the details of the GWMP will change over time. For example, construction dewatering leading to changes in groundwater levels is not a potential interaction during dry or flood operations because as all the infrastructure would already be built and construction dewatering would not be required. The following are the potential interactions for each phase:

- During baseline data collection, there will be highly rigourous baseline monitoring (already ongoing) prior to any Project disturbances. The intent of baseline monitoring is to understand a wide range of hydrochemical parameters and their potential natural variability in location and time. The baseline monitoring program would seek to understand local seasonal variation in water levels and hydrochemistry. This program needs to be robust to establish a point of comparison that could be used to assess changes that could be attributable to the Project.

- During construction, there will be medium rigour monitoring, but generally it will be localized around construction activities that could lead to disturbances to the groundwater system (e.g. construction dewatering, deep excavations).
- During dry operations, there will be low rigour monitoring to confirm consistency with baseline conditions and to observe potential longer-term regional trends that are not related to Project activities (e.g., effects of long-term precipitation trends).
- During flood and post-flood operations, there will be highly rigourous monitoring to observe potential effects on groundwater both near and far Project infrastructure.

## 7.2 TIERED GROUNDWATER MONITORING LOCATIONS

The density and distribution of groundwater monitoring wells will be based on the need to detect potential changes to groundwater levels and quality that could arise from interactions between the Project and groundwater resources. The siting of monitoring wells will consider the expected extent of effects on groundwater for dry and flood operations.

Simulation results from the updated numerical groundwater model (see Section 5 of the Hydrogeology TDR Update, Appendix IR42-1 in the response to AEP IR42 and also in the response to CEAA IR3-14, Appendix IR14-1) were reviewed to understand the potential areas over which effects on groundwater could be expected. Under dry operations, the simulated extent of potential effects will be limited to areas near the diversion channel, due to dewatering. Under flood operations, effects on groundwater are expected to be limited to areas near the diversion channel and off-stream reservoir. In the case of both dry and flood operations, potential effects on groundwater will be limited to within the LAA. Thus, monitoring wells sited within the LAA will be able to detect change related to potential Project effects.

Groundwater monitoring well locations are also selected to allow for characterization of “background” water quality in areas anticipated to be unaffected by Project interactions. Monitoring well locations would also be selected based on the location of existing users of groundwater, such that some locations are able to provide “early warning” for changes in groundwater prior to those effects reaching existing users. Some existing wells (either Project specific monitoring wells, or previously existing domestic wells) could be retained for incorporation into the monitoring program, depending upon their location, depth, and potential risk of inundation during a flood event.

Three monitoring tiers will be established based loosely around the associated geographic coverage:

- Tier 1 monitoring wells or piezometers will be shallow and located within or immediately adjacent to Project infrastructure (dam, diversion intake and channel). Piezometers (for pore pressure monitoring) will be used for geotechnical monitoring within the Project components.

- Tier 2 monitoring wells will be shallow and within or very near the wetted perimeter of the off-stream reservoir. They will be installed in the unconsolidated deposits, augmented with bedrock wells in areas near bedrock outcrops.
- Tier 3 monitoring wells would be situated between the Project infrastructure and potential receptors. These monitoring wells would be installed within unconsolidated or bedrock units depending upon local groundwater use and potential aquifers of interest. The main purpose of these monitoring wells would be to provide early detection of potential effects on groundwater that are propagating outward from the LAA. These monitoring wells would also be potentially used to discriminate between changes to groundwater levels arising from a flood or precipitation event, versus those which can be attributed to operation of the Project.

Figure 7-1 presents a conceptual layout of a groundwater monitoring network comprising monitoring wells assigned to each tier. Monitoring well locations have not yet been finalized and will need to consider practical field constraints, land access and other potential issues.

In Figure 7-1, the Tier 1 monitoring wells are shown within the dam structure. These wells would be expected to fall within an area where Project effects are expected (during dry and flood operations). Additional Tier 1 monitoring wells may be included near the diversion inlet and along the diversion channel. The locations will be finalized based on geotechnical and dam safety requirements.

In Figure 7-1, the Tier 2 monitoring wells are shown across much of the LAA, including some wells within the wetted area of the reservoir (i.e., the area of the reservoir that would be inundated during a design flood). These wells would be expected to fall within or very near to areas where Project effects are expected (during dry and flood operations). Some of these wells would be decommissioned following the construction phase of the Project, once a sufficient baseline data set has been collected. Wells near the wetted perimeter (i.e., the edge of the area inundated during a design flood) of the off-stream reservoir may be left in place during dry operations and flood operations because these locations are unlikely to be inundated with surface water.

In Figure 7-1, the Tier 3 monitoring wells are shown both north and south of Elbow River. These wells are situated in areas outside of the expected areas where Project effects could occur (however they could still detect effects from a flood or precipitation). Wells closest to Elbow River would be situated within the alluvial deposits and thus are directly connected to Elbow River, and they would be expected to experience changes in levels or quality during and after a flood. Changes in these wells would be associated with natural effects of a flood and could be used to help differentiate flood-related effects from those attributable to the Project. Other wells south of the Project would be situated in upland areas outside the alluvial deposits, and they would not be in direct communication with Elbow River. Tier 3 wells will provide the ability to detect changes that could potentially propagate outward from the LAA in the direction of domestic and agricultural well users.

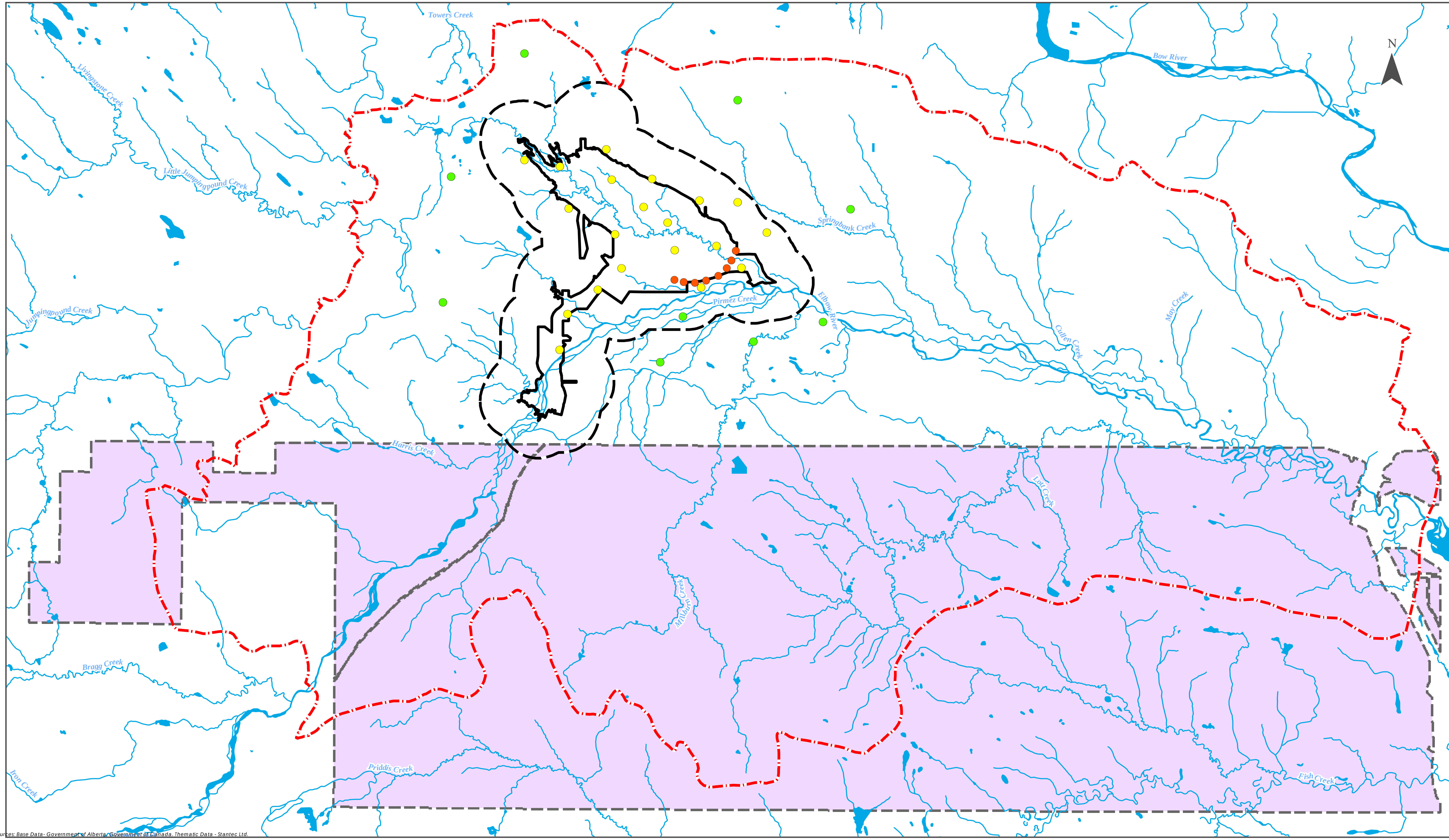
## 7.3 ANALYTICAL PARAMETER SUITES

Analytical parameter suites refer to groups of analytes that will be measured either in the field or by the laboratory (or both) receiving the groundwater samples. Analytical parameter suites have been developed to enable characterization of potential changes in groundwater quality through both general measures of groundwater quality (e.g. electrical conductivity (EC)), and through measures of groundwater quality specific to a given chemical compound (e.g. nitrate).

The parameter suite to be applied during the monitoring program will vary depending upon the Project phase and monitoring tier. Three parameter suites have been defined for the GWMP:

- Parameter Suite 1 (PS1) contains data on temperature and electrical conductivity (insitu).
- Parameter Suite 2 (PS2) contains data on general potability parameters, major ions, bacteriological parameters, dissolved organic carbon (DOC).
- Parameter Suite 3 (PS3) contains data on dissolved metals, hydrocarbons, other Project specific parameters (e.g., methylmecury and/or organic pesticides) including volatile organics and nutrients).

The parameter suites to be measured on an ongoing, scheduled basis will be defined. Escalation to a higher parameter suite could still occur during a given event, should the results from the lower, scheduled parameter suite suggest that further analysis is required. For example, should electrical conductivity (as part of PS1) exhibit an unexpectedly elevated reading, then analysis of PS2 could then be implemented to provide further information regarding which specific chemical parameter is contributing to the elevated electrical conductivity.




Groundwater Monitoring Network
- Tier 1
- Tier 2
- Tier 3

Regional Assessment Area
Project Development Area
Local Assessment Area
Tsuu T'ina

0 1 2
kilometres
NAD 1983 3TM 114

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Conceptual Groundwater Monitoring Network Layout

Figure 7-1

## 7.4 FREQUENCY OF MONITORING

The frequency of monitoring for measurement of groundwater levels and collection of groundwater samples for water quality analysis will be depend on:

- the phase of the Project under consideration. Project Phases requiring higher levels of monitoring rigour (e.g., flood operations) will have a higher frequency of events.
- the tier of monitoring well under examination. In general, monitoring wells within the Tier 1 category will have a higher frequency of monitoring relative to the Tier 3 monitoring wells.
- the parameter suite that is under examination. General or bulk parameters (PS1) will have a higher frequency of monitoring than PS2 or PS3.

The planned frequency of monitoring for groundwater levels and quality is been defined at three levels:

- near-continuous measurement (C) of levels and quality through data logging probes that automatically collect and record at high frequency intervals. Telemetry systems could optionally be deployed for some or all wells with data loggers such that near real time monitoring possible.
- intermittent (I) measurement of routine, scheduled monitoring at set frequency (e.g. semi-annually)
- event (E) based measurement in response to a flood or other operational event (e.g. maintenance) where groundwater could be affected. Frequency during event to be assessed based on accessibility, safety and other constraints.

## 7.5 OVERVIEW OF GROUNDWATER MONITORING PROGRAM

Figure 7-2 illustrates the implementation of Monitoring Tiers, Parameter Suites, and Monitoring Frequency into an overall program that provides varying levels of monitoring rigour over the Project Phases.

| | | Baseline | | | |
|---|---|---|---|---|---|
| | Well Count | Levels | PS1 | PS2 | PS3 |
| Tier 1 | TBD | | | | |
| Tier 2 | ~20 | C | C | I | I |
| Tier 3 | ~12 | C | C | I | I |

Higher Rigour

| | | Construction | | | |
|---|---|---|---|---|---|
| | Well Count | Levels | PS1 | PS2 | PS3 |
| Tier 1 | TBD | C | C | I | |
| Tier 2 | ~20 | C | C | I | I |
| Tier 3 | ~12 | C | C | | |

Medium Rigour

| | | Dry Operations | | | |
|---|---|---|---|---|---|
| | Well Count | Levels | PS1 | PS2 | PS3 |
| Tier 1 | TBD | C | C | I | |
| Tier 2 | ~20 | I | I | I | |
| Tier 3 | ~12 | I | I | | |

Lower Rigour

| | | Flood / Event Operations | | | |
|---|---|---|---|---|---|
| | Well Count | Levels | PS1 | PS2 | PS3 |
| Tier 1 | TBD | C | C | I | I |
| Tier 2 | ~20 | C | C | I | I |
| Tier 3 | ~12 | C | C | I | |

Highest Rigour

**Figure 7-2 Overview Summary of Groundwater Monitoring Program**

In general, the level of monitoring rigour would vary as follows (highest to lowest rigour):

- Flood and post-flood operations requires the highest rigour of monitoring because this is when the most Project interactions are applicable and when effects on groundwater are most likely to be observable.
- Baseline monitoring requires a high rigour of monitoring that starts prior construction of the Project and extends until construction is completed.
- Construction monitoring requires a medium rigour of monitoring that is implemented during construction. This monitoring is more focused on Project interactions that could potentially arise in a localized area due to construction activities (e.g., monitoring around a particular location undergoing construction dewatering).
- Dry operations monitoring has the lowest rigour of monitoring and occurs during dry operations between floods. This lower level of monitoring reflects the fewer Project interactions that are applicable when the Project is not in operation and flood water is not being retained within the off-stream reservoir.

## 7.6 MONITORING WELL INSTALLATION AND DEVELOPMENT

All monitoring wells to be included in the GWMP have been or, in the case of proposed wells, will be developed following completion. Development is conducted to remove drilling fluids (if used) and fine-grained materials from around the filter pack in order to improve the hydraulic efficiency of the filter pack and improve hydraulic communication between the filter pack and geologic formation. The objective of the well development is to provide more representative groundwater samples and improved hydraulic conductivity estimates. The well development protocol is determined based on the drilling method used and the unit that the monitoring well is completed in. Based on the installation, one or more of the following methods have been or will be employed:

1. air-lifting refers to using compressed air to remove water from the monitoring well until turbidity is reduced and little or no fines are present (generally only used during mud or air rotary drilling).
2. over-pumping refers to the water level in the monitoring well that is being repeatedly drawn down and allowed to recover until turbidity has been reduced and little or no fines are present.
3. bailing refers to groundwater being s removed manually from the monitoring well by using a disposable bailer or inertial pump until turbidity is reduced and little or no fines are present; bailing is the most common method for low yielding monitoring wells.

## 7.7 GROUNDWATER SAMPLING PROTOCOLS

The following field procedures will be used during monitoring to measure groundwater levels and to collect the groundwater samples:

1. Headspace vapours will be measured at each monitoring well.
2. The depth to water at each monitor well will be measured and recorded.
3. Each monitor well will be purged using its own dedicated inertial pump system or bailer until three well volumes are removed or until they are dry.
4. Water samples will be collected into laboratory supplied containers within a day of purging (unless additional time is required for water level recovery) and will be labeled at the time of collection with the site number, the date of collection, sampling personnel involved, and the analysis required.
5. Field measurements of combustible headspace vapours, dissolved oxygen (DO), oxidation-reduction potential, pH, electrical conductivity and temperature will be made at the time of sample collection.

6. Quality assurance/quality control (QA/QC) samples will be collected at a rate of approximately 10% of the total samples. Duplicate samples for quality control will be obtained by rinsing a clean container with formation water, discarding the rinse water and then collecting the required sample volume. The sample will be split into two aliquots and placed into two different bottles with one bottle identified under a different sample name and the second bottle under the regular sample number. The laboratory will not be informed of the nature of the sample. Demineralized water blanks will also be collected during the sampling periods to determine bottle cleanliness and the effects of sample transport, handling, and collection techniques. All QA/QC water samples will be given realistic sample numbers and submitted as groundwater samples.
7. The samples will be delivered to a Canadian Association for Laboratory Accreditation (CALA) accredited laboratory using standard chain of custody protocols.

# 8.0 CONCEPTUAL GROUNDWATER RESPONSE PLAN

A conceptual groundwater response plan describes the actions that would be taken should monitoring results suggest that Project-related effects on groundwater quantity or quality are suspected. Once a trigger for either groundwater levels or groundwater quality has been confirmed, further follow up actions will be implemented to confirm and manage the effects as required to mitigate effects to human and/or ecological receptors.

Triggers define when further response actions may be required to investigate and confirm that a Project-related effect has indeed occurred. Activation of a trigger does not necessarily confirm that a Project-related effect has occurred; rather, activation of a trigger causes an immediate investigation and follow up prior to the next routine, scheduled monitoring event.

## 8.1 GROUNDWATER LEVEL TRIGGERS

Triggers for groundwater levels will be established based upon the expected variability that would be defined during the baseline monitoring program. It is expected that some monitoring well locations would naturally have a higher variability than others. Monitoring wells that are installed near Elbow River and within the alluvial deposits would exhibit a seasonal trend similar to surface water, with additional precipitation event-based “spikes”. Monitoring wells that are installed deeper into bedrock would exhibit a more muted seasonal variability as these deeper flow systems may not be directly influenced by the surface water flow regime.

## 8.2 GROUNDWATER QUALITY TRIGGER VALUES

### 8.2.1 Control Limits

After a sufficient baseline dataset has been established at a monitoring well (approximately eight monitoring events), trigger values will be determined for parameters that are naturally present at detectible concentrations (e.g., chlorides) to identify changes in groundwater quality that fall outside of the baseline conditions. The baseline historical groundwater monitoring data for each well will be screened and outliers removed prior to the calculation of each upper confidence limit (UCL). Results that are more than two standard deviations above or below the mean of the historical data will be considered outliers. The UCL will be calculated as follows:

UCL = x + Z*s

Where:

x = sample mean

Z = multiplier (a value of 4.5 is considered appropriate for groundwater monitoring (Gibbons, 1999))

s = sample standard deviation

US EPA (1989) indicated that the overall confidence levels for the control limits calculated using Z=4.5 is 95% based on a minimum of eight historical monitoring events.

Where the standard deviation is very large or very small, the coefficient of variation (Cv) will be calculated for the UCL as follows:

Where Cv < 0.05 UCL = 1.225*x

Where Cv > 0.5 UCL = 3.25*x

UCL values for parameters that are not naturally present in groundwater (e.g., BTEX, F1-F3 hydrocarbons) will be considered to be equal to the lesser of five times the laboratory reportable detection limit or the referenced guideline for that parameter.

### 8.2.2 Temporal Trend Analysis

UCL trigger values will not be determined for monitoring wells where impacts are currently above the relevant guidelines. Instead, triggers at monitor wells in the affected areas will be based on increasing temporal trends in groundwater quality over four monitoring events.

Non-parametric trend analysis will be conducted for each groundwater monitoring well to determine changes in groundwater quality that may be due to Project operations. Trend analysis will be conducted for select analytes that are most indicative of potential changes in groundwater quality related to Project operations. The results of the trend analysis will be included in the annual groundwater monitoring reports for the Project.

## 8.3 GROUNDWATER RESPONSE ACTIVITIES

The exceedance of trigger values (either the UCL or an increasing trend) at any monitoring well will prompt actions to confirm the exceedance, identify possible causes of the elevated concentrations and implement management or management measures, if required. Triggers will include either of the upper control limits or increasing trends observed over four monitoring events at any of the monitoring wells.

The staged response to a trigger exceedance follows:

1. reevaluate field and laboratory QA/QC data to identify potential issues that could result in anomalous concentrations and have the lab recheck the results and reanalyze the sample
2. identify potential well integrity issues that could result in anomalous concentrations

3. re-sample (confirmatory sampling) the monitoring well in question and analyze to verify the concentration
4. increase the sampling frequency for the affected monitoring well if the trigger is confirmed

Follow-up action will then be initiated to further address the exceedance. If the trigger exceedance is confirmed, AEP (as operator of the Project) will initiate one or more of the following actions:

- evaluate the potential sources or causes of the parameter concentration increases
- conduct a field assessment which may include installing additional monitoring wells to delineate the extent of impacts, both horizontally and vertically
- implement appropriate management controls to mitigate the impact
- identify, design and implement appropriate engineering control or remedial measures

Continued follow-up monitoring would also be part of the overall response to the confirmation of an exceedance of a trigger. If sampling frequency is increased in response a trigger exceedance, higher frequency monitoring will continue for the monitoring well, or group of wells, until such time that it is no longer deemed necessary. Higher frequency monitoring will be used to assess the effectiveness of management activities. Monitoring frequency would revert to the standard frequency if:

- stable or decreasing trend are noted at the monitoring well(s) over four monitoring events and/or
- parameter concentrations return to values within their historical range or the range of background values.

**SPRINGBANK OFF-STREAM RESERVOIR PROJECT**
**DRAFT GROUNDWATER MONITORING PLAN**

Conceptual Groundwater Response Plan
May 2019

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