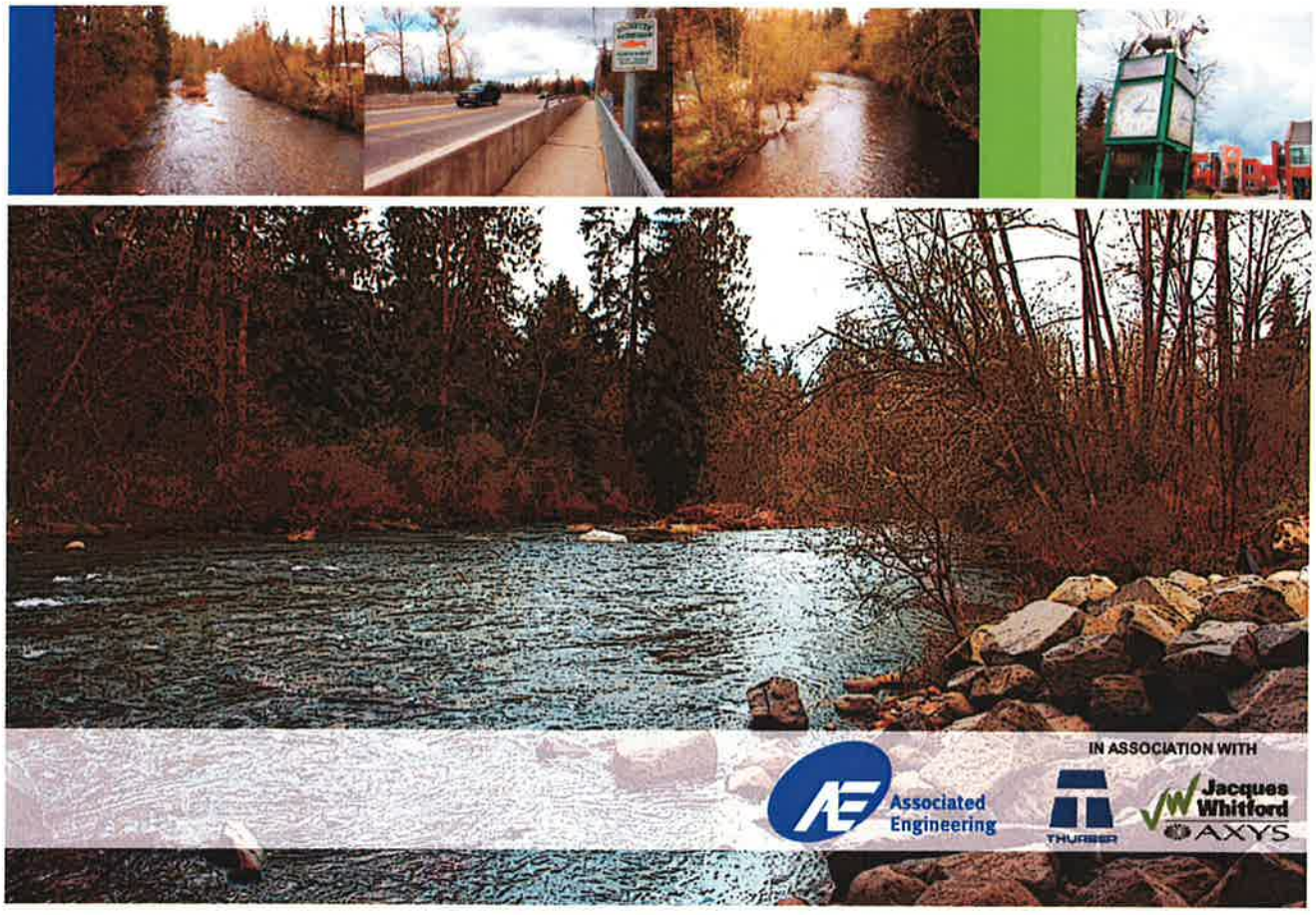
Report

District of Maple Ridge

Feasibility Study for Alouette River Crossing

August 2008



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1 Project Overview

1.1 BACKGROUND

The District of Maple Ridge is situated on the shores of the Fraser River, nestled against the Coast Mountains. The South Alouette River is an important environmental and recreational resource that divides a portion of the community. An existing bridge across the South Alouette at 232nd Street provides north-south continuity. The District is concerned that natural events, such as flooding and windstorms could prevent access to the 232nd Street crossing. Accordingly, the District is carrying out a feasibility study for a second crossing to provide access into the Silver Valley Area.

Crossing options that are considered include:

- A bridge on the 240th Street alignment with improved road access being extended north from 124th Avenue,
- A bridge on the 128th Avenue alignment with improved road access being extended west from Alouette Road.

1.2 ENVIRONMENTAL CONSIDERATIONS

One of the primary constraints related to the proposed river crossings is environmental considerations. Significant environmental features have to be protected and environmental impacts need to be kept to a minimum. These environmental features include numerous fish species, existing trees and vegetation especially in the Silver Valley, raptor and heron nests, active nests of other migratory bird species and wildlife corridors for mammal species such as black bears, cougars and black-tailed deer.

In addition, the Alouette River Valley was also part of a traditional travel corridor for First Nations people and a potential heritage site may be found.

1.3 HYDRAULIC CONSIDERATIONS

The proposed bridge alignments cross designated flood plain areas. At the 128th Avenue site the topography is steeply-sloping and a minor reduction in the river cross-section at this cross section location results in significant increase in the hydraulic gradeline (HGL) upstream. The Alouette River flow rates are controlled by a dam at the outlet of Alouette Lake, and a bypass structure to Stave Lake from near the upstream end of Alouette Lake. During extreme events the dam will pass forward flow without attenuation.

1.4 GEOTECHNICAL CONSIDERATION

The site stratigraphy varies considerably between the north and south banks of the river with significantly deeper unstable deposits on the south bank. The unstable soils greatly influence the bridge foundation

type and locations and determine the approach fill footprint opportunity and stability. Relatively steep valley walls will require assessment of slope stability.

Preloading requirements have not been determined at this stage.

1.5 ROADWAY GEOMETRICS

The roadway geometrics are based on a 60 km/h design speed. The road cross section will consist of two 4.3 m shared lanes (for cars and bicycles), one 1.5 m sidewalk on one side, and one 4.0 m shared multi-use path (for pedestrians and equestrians) on the opposite side. The maximum grade will be 6% to accommodate large trucks.

For the 240th Street alignment, access to residential properties to the west side of 240th Street has to be considered. Likewise for the 128th Avenue alignment, access to properties on the west side of the river has to be accommodated.

For the 128th Avenue alignment, with a maximum grade of 5.9%, the road profile will be as high as 24 m above the floodplain due to the difference in elevation from the river valley to the higher elevation at the tie-in point at 128th Avenue and 248th Street. Because of limited right-of-way and cost implications, in addition to constructability problems, retained earth fill walls and/ or high embankment fills will not be considered. In our opinion only an elevated structure would be constructible in this location.

1.6 BRIDGE STRUCTURE

For both the 240th Street and 128th Avenue alignments, the District has indicated that roadway embankment fills in the floodplain are not to be considered. This will require a 440 m long bridge on the 240th Street alignment and an 870 m long bridge on the 128th Avenue alignment. Clear span structures are not viable, due to excessive cost. The preliminary geotechnical investigation suggests that 30 m to 40 m long friction piles may be required; therefore, multi-span structures should consider longer spans in order to minimize foundation costs.

2 Feasibility Study

2.1 GEOTECHNICAL INVESTIGATION

The following is a summary of Thurber Engineering Ltd.'s Geotechnical Report, dated November 27, 2007, attached in **Appendix B**.

2.1.1 Anticipated Soil Conditions

According to the Geological Survey of Canada (GSC) surficial geology map, the soil conditions in the general vicinity of the proposed alignments typically comprise glacial and deltaic sediments deposited during the Pleistocene period. It can be generalized into 2 categories, namely the outwash and ice-contact gravel and sand (gravel and sand), and glaciomarine, stoney, clayey silt to silty sand (silt and clay).

GSC Open File 3511 indicates that the silt and clay deposits typically vary from 8 m to 90 m thick, depending on location. In the general vicinity of the proposed alignments, the silt and clay deposits were likely not overridden by glaciers. In addition, it noted that steep slopes comprising the silt and clay deposits are generally prone to landsliding. Based on information from nearby projects, the silt and clay deposits were generally stiff to very stiff in the upper 3 to 4 m and firm and possibly soft below.

Thurber anticipates that the silt and clay deposits will likely be encountered along the 240th Street alignment south of the river, whereas the gravel and sand deposits will likely be encountered along the 240th Street and 128th Avenue alignments north and west of the river, respectively. For the 128th Avenue alignment east of the river they anticipate that a combination of both deposits may be encountered, depending on the location.

2.1.2 Site Reconnaissance

Thurber Engineering Ltd. conducted a site reconnaissance on August 30, 2007. The purpose of the field work was to assess surficial soil conditions, hydrology and topography along the proposed alignments in order to identify potential and/ or existing geotechnical issues and/ or hazards that could affect the design. The assessment was limited to visual inspection where the site is accessible. No drilling or test pitting was conducted during this phase of the investigation. Refer to **Appendix B**, Section 5.2 and Section 5.3 for an overview description of the proposed alignments.

2.1.3 Engineering Assessment and Recommendations

Proposed 240th Street Alignment

It will be necessary to fill depressions between Sta. 241+250 and 241+320 and between Sta. 241+385 and 241+415, respectively to match the proposed road grades. Assuming the area is generally underlain by soft to firm silt and clay deposits, Thurber believes that the proposed amount of fill for the roadway embankment will likely cause significant short- and long-term settlement and may pose a risk of global instability. Detailed investigation and slope stability analyses would be required to evaluate the impact of fill placement during detailed design.

Between Sta. 241+420 and 241+855, an elevated structure (bridge) is proposed to cross the flood plain and river. The structure will be pile supported and some of the piles may extend above ground surface to the pile cap and act as columns. Due to the uncertain depth to competent bearing strata, the piles are potentially friction piles embedded within the silt and clay deposits. Based on similar soil deposits in the Lower Mainland, 610 mm diameter by 12.7 mm thick steel pipe piles driven to about 40 m are typically expected to develop an ultimate vertical resistance in the range of 3,000 kN.

Thurber estimates that 914 mm diameter friction piles driven to about 30 to 35 m will likely develop a similar resistance. These values must be confirmed during detailed design.

Cobbles, and possibly large diameter boulders, may be encountered near the river. It will be necessary to determine the elevation of the interface between the surficial granular soils and the underlying fine-grained soils in the detailed field investigation to facilitate pile design and to provide guidance to the contractor with respect to the appropriate pile installation method.

The existing trail between Sta. 241+520 to 241+695 is relatively narrow. The presence of power poles to the east makes site access challenging in this area for pile installation during construction, and possibly drilling during field investigation. Significant clearing of trees will be required to facilitate access for site investigation and/ or construction.

Proposed 128th Avenue Alignment: Elevated Structure and Embankment Combination

The contemplated embankment will require up to about 4 m of fill between Sta. 128+360 to Sta. 128+585. For conceptual design purposes, Thurber believes that the proposed fill placement may be feasible from a settlement perspective providing that the surficial granular layer is sufficiently thick. This must be confirmed during the detailed field investigation. As the contemplated embankment could potentially affect the global stability of the river bank a detailed slope stability evaluation will also be required during detailed design.

The proposed elevated structure (bridge) will be located between Sta. 128+585 and 129+450. Towards the west it may be feasible to support the west abutment on shallow foundations providing that the dense granular layer is sufficiently thick and that the location of abutment is set back sufficiently behind the crest of the existing bank. This should be confirmed during detailed design.

For the remainder of the elevated structure, the conceptual pile design recommendations for the 240th Street crossing will be applicable. Similarly, cobbles and/ or large diameter boulders may be encountered near the river crossing. Accordingly, detailed site investigation will be required to determine the appropriate pile installation method.

Previously a 5.5 to 24 m high embankment was considered between Sta. 128+745 and 129+435. Thurber indicated that the embankment fill would likely cause significant settlement if that area is underlain by compressible soils and that it would pose a risk of global instability. The embankment fill may have impacted the stability of the existing, adjacent steep river bank between Sta. 128+820 and 128+940, as well as the existing steep slope between Sta. 129+300 and 129+480. Detailed investigation and stability analyses would have been required to evaluate the impact of the embankment fill locally.

Based on the anticipated embankment fill height for such an embankment, and an assumed 2H:1V fill embankment sideslope, the toe of the embankment would have encroached on private property to the north near Sta. 128+820 and 129+300, and possibly to the south near Sta. 129+200. It would have been necessary to obtain additional right-of-way to facilitate the use of conventional fill for embankment construction.

2.1.4 Recommended Site Investigation

The requirements of the actual field program will be a function of the selected alignment, number of piers and contemplated foundation system. For the purpose of preliminary design, Thurber proposes that the following geotechnical investigation be undertaken:

- Conduct test holes at each of the abutment and pier locations for the elevated structure(s). Additional test holes should be conducted where significant fill placement is required to determine the thickness of potential compressible layer(s).
- Conduct test holes near the top of steep slopes to facilitate slope stability analyses. Where site grading fill is not required, test pitting at 50 m intervals would be adequate to determine requirements and for pavement design.
- Use Cone Penetration Tests (CPT's) with shear wave velocity measurements to profile soil conditions where fine-grained soils are anticipated. CPT will likely be advanced to depths of 50 m or more below the existing ground surface.
- Advance test holes adjacent to the CPT's, using solid stem auger to depths of about 20 m to collect samples for visual classification and other laboratory testing.

2.2 ENVIRONMENTAL INVESTIGATION

The following is a summary of Jacques Whitford AXYS Ltd.'s Environmental Report, dated January 15, 2008 attached in **Appendix A**.

2.2.1 Existing Environmental Conditions

An office-based analysis of available biophysical information was conducted to assess the potential environmental effects of the proposed crossing alignments. Both alignments were walked on October 5, 2007 to observe fish habitat, general vegetation assemblages and potential wildlife habitat along both alignments. I.R. Wilson Consultants Ltd. conducted an archaeological overview assessment (AOA) of two potential bridge alignments to identify and assess heritage resource potential. A review of archaeological predictive models in the study area was undertaken using the BC Government's Remote Access to Archaeological Data (RAAD). A file search of previously-recorded archaeological sites was conducted at the Archaeology Branch of the Ministry of Tourism, Sport and the Arts to determine the location, nature and distribution of prehistoric and historic resources in the vicinity of the project area. A review of previous archaeological assessments in the vicinity of the Alouette River was also completed. A review of background literature dealing with anthropology, history, archaeology and paleo-environment of the study region was conducted to place the study area in a cultural content.

2.2.1.1 Physical Setting

The proposed bridge is located in Maple Ridge, British Columbia. Maple Ridge is located between the north shore of the Fraser River and the Coast Mountains.

The surficial geology of Maple Ridge, in the vicinity of the proposed crossings is located within the Fort Langley Formation which consists of glacial and deltaic sediments. Maple Ridge is characterized by marine silty clay to fine sand commonly containing marine shells.

Both bridge alignment options are situated within the Dry Maritime Coastal Western Hemlock (CWHdm) bio-geo-climatic subzone. The Coastal Western Hemlock (CWH) zone is influenced by the ocean and mountains producing one of the wettest climates in Canada. The CWHdm subzone occurs at low elevations generally between sea level and 650 m above sea level. The CWHdm zone is characterized by warm, relatively dry summers and moist, mild winters. The growing season in this zone is long, with minor local water deficits.

2.2.1.2 Vegetation

The dominant tree species in the CWH zone typically include Douglas fir, western red-cedar and western hemlock. Dominant understory species typically include salal, red huckleberry, and mosses such as step-moss, lanky moss and Oregon beaked moss.

Tree species observed along both alignment options included red alder, big-leaf maple, western red-cedar, black cottonwood and Sitka spruce.

Tree species along both alignments were generally dominated by red elderberry, vine maple, salmonberry, horsetail, red huckleberry, sword fern, bracken fern, Himalayan blackberry, Indian plum, skunk cabbage, thimbleberry and trailing blackberry.

Pacific ninebark and beaked hazelnut were observed on the south bank of the South Alouette River at the crossing location of the 240th Street alignment.

British Columbia maintains Red and Blue lists for species of special management concern. Red-listed species or ecological communities are considered extirpated, endangered or threatened in BC, while blue-listed species are considered to be of special concern.

Rare species that may occur in the project area based on the BC Species Ecosystem Explorer are provided in the Table below:

Table 2-1
Rare Species

Common Name	Provincial Status
Silver hair moss	Red
Vancouver Island beggarticks	Blue
Streambank lupine	Red
Phantom orchid	Red

2.2.1.3 Fish and Aquatic Habitat

Drainages along both alignment options are tributary to the South Alouette River. The South Alouette River is a 31.63 km long river and is known to support coho salmon, chum salmon, Chinook salmon, pink salmon, sockeye salmon, anadromous and resident cutthroat trout, Dolly Varden, bull trout, steelhead trout, rainbow trout, kokanee, lake trout, brassy minnow, threespine stickleback, brown catfish, lamprey species, largescale sucker, longnose dace, longnose sucker, mountain whitefish, northern pikeminnow, peamount chub, redside shiner, and sculpin species. Bull trout are blue listed in the province's list of species at risk.

240th Street Alignment

Seven watercourses are potentially affected by the proposed 240th Street alignment including the main stem of the South Alouette River and six tributaries, Latimer Creek, three unnamed tributaries to Latimer Creek, a linear wetland and an unnamed tributary of the South Alouette River.

Refer to **Appendix A**, Section 3.3.1 for details regarding rearing, spawning, migration and overwintering habitat capacity for the various watercourses.

128th Avenue Alignment

Three watercourses were identified as either crossed by or are within 30 m of the proposed 128th Avenue alignment including Bosa Creek, an unnamed tributary of the South Alouette River and the South Alouette River.

Refer to **Appendix A**, Section 3.3.2 for details regarding rearing, spawning, migration and overwintering habitat capacity for the various watercourses.

2.2.1.4 Wildlife

During the site visit conducted October 5, 2007 a raptor and heron nest survey was conducted. No raptor or heron nests were observed; however, much of the deciduous foliage was still on trees. A detailed nest survey should be conducted during winter, while the forest canopy is less dense, to ensure no raptor or heron nests will be impacted by the preferred option.

Potentially-occurring rare wildlife species that may occur in the project area were determined from the BC Species Ecosystem Explorer. A list of potentially-occurring rare wildlife is provided in Table 3-3 in **Appendix A**. No wildlife or wildlife signs were observed at the time of the site visit.

2.2.1.5 Heritage and Cultural Resources

The project area falls within the traditional territory of the Katzie First Nation, Tsawwassen First Nation and the Sto:lo First Nation. The following summarizes the findings of the AOA carried out for this project by I.R. Wilson Consultants Ltd. (I.R. Wilson 2007).

Limited archaeological survey has been conducted on the Alouette River. However, excavations conducted at the Glenrose Cannery site on the Fraser River and at three sites within the Alouette drainage including the Carruthers site, the Park Farm site and the Telep site have yielded an archaeological sequence relevant to the area. A predictive model was developed for the general area south and north of Chilliwack, and two archaeological impact assessments and one archaeological overview assessment have been conducted in the Alouette River region. Refer to **Appendix A**, Section 3.5.

Based on the predicative model for the areas south and north of Chilliwack including Alouette River, the entire study area is identified to have high archaeological potential. The impact assessment of the rehabilitation of the Alouette dam spillway yielded three new sites. The impact assessment of a large agricultural facility was conducted at the confluence of the North and South Alouette River evaluated three existing sites and identified 14 new sites. The archaeological overview assessment for a proposed freeway alignment including two crossing of the Alouette River in 1991 identified potential for fishing and fishing processing sites on the river.

A number of traditional-use sites have been documented in the region surrounding the study area. A site of mythological significance is located within the study area. This place is the location where a one-legged man was changed to stone by the Transformer to become the master of the fish that ascend the Alouette River. The rock is located in an area locally known as Davis' Pool, which occurs in the South Alouette River between the two alignments.

2.2.2 Regulatory Requirements

2.2.2.1 Federal Legislation

Canadian Environmental Assessment Act

At the federal level in Canada, the requirement for an environmental assessment (EA) arises through the requirements of the Canadian Environmental Assessment Act (CEAA) and its supporting regulations. The federal environmental assessment process is generally triggered by one of three scenarios.

1. The project is located on federally-owned or administered lands.
2. The federal government provides funding or is the proponent of a project.
3. Federal permits and or authorizations specifically identified in the Law List Regulations pursuant to CEAA are required in respect of a project.

Where a department of the federal government has an interest in a project, it is called a Responsible Authority under CEAA.

After it has been determined by the Responsible Authority that an EA is required under CEAA, the EA process can be broken down into seven stages as follows:

1. Establish the scope of the assessment.
2. Prepare a description of the existing conditions.
3. Identify potential interactions, issues and concerns.
4. Develop residual environmental effects evaluation criteria.
5. Conduct the effects analysis and predict residual environmental effects after application of mitigation.
6. Conduct the cumulative effects assessment.
7. Undertake any required monitoring and follow-up programs.

CEAA Applicability

An Environmental Assessment (EA) under CEAA will likely be required for either alignment option. It is expected that DFO and Transport Canada would require formal authorizations under the Fisheries Act and the Navigable Water Protection Act (NWPA) and this will trigger CEAA.

Fisheries Act

Under the authority of the Federal Fisheries Act, Fisheries and Oceans Canada has decision making authority for the conservation and protection of fish and fish habitat. The

main provisions of the Act dealing with the protection of fish habitat are Sections 35 and 36. Section 36 states that no one is permitted to deposit a deleterious substance into water supporting fish. Subsection 35(1) of the Fisheries Act states that: "no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat (HADD)." However, subsection 35(2) qualifies this prohibition, in that it allows for the authorization by the Minister of Fisheries and Oceans, or through regulation, of the alteration, disruption or destruction of fish habitat (HADD).

Fisheries Act Applicability

It is expected that as a minimum DFO will require a subsection 35(2) Authorization for the new bridge over the South Alouette River. This would also trigger CEAA.

Consultation with DFO regarding the proposed bridge options could determine if DFO could issue a Letter of Advice rather than a Section 35(2) Authorization. A Letter of Advice states that a Section 35(2) Authorization can be avoided given that certain conditions, such as in-stream works reduced risk windows (August 1 to September 15), are met. Project review through a Letter of Advice would not trigger CEAA.

In order for DFO to issue a subsection 35(2) Authorization under the Fisheries Act, Maple Ridge would have to commit to a habitat compensation plan that would create or enhance enough habitat to meet DFO's "no net loss" guiding principle. DFO's preference for habitat compensation is to create or increase the productive capacity of like-for-like habitat in the same ecological unit. In the case of like-for-like compensation, DFO typically requires a habitat compensation ration of 2:1 (replacement to loss) although it can vary from this ratio.

Potential habitat compensation activities within the watersheds of Bosa and Latimer creeks Include:

1. Replacement of un-embedded closed bottom culverts with open bottom arch culverts or embedded closed bottom culverts;
2. Construction of jump pools to improve upstream fish passage past the 2 m tall falls located in Bosa Creek at its confluence with the South Alouette River;
3. Increasing the cover and in-stream habitat complexity of the channelized reach of Bosa Creek along 128th Avenue; and
4. Re-planting and stabilization of sediment sources created by development along Latimer Creek.

For the South Alouette River, in the immediate vicinity of the proposed bridge crossing, no habitat compensation options are known to exist. To identify nearby compensation opportunities, it is recommended that the proponent conduct field reconnaissance over a broader area and consult with local stakeholders and stewardship groups. Groups to consult could include the Katzie First Nation, DFO, the Ministry of Environment, the ALLCO Hatchery, the Alouette River Management Society, the Balahanian Creek Streamkeepers, and BC Hydro. Past habitat compensation work completed in other reaches of the South

Alouette River has included placement of large woody debris and creation of off channel habitat.

Navigable Waters Protection Act

The Navigable Waters Protection Act (NWPA) regulates activity in, around, under and over navigable waters. Section 3 provides that no work (including bridges) shall be built or placed in, upon, over, under, through or across navigable waters unless the work and site plans have been approved by the Minister of Transport.

Navigable Waters Protection Act Applicability

Jacques Whitford AXYS Ltd. anticipates that Transport Canada would consider the South Alouette River to be navigable, and the proposed construction of a bridge crossing would require review under the Navigable Water Protection Act. The formal approval process would trigger a CEAA assessment. Consultation with Transport Canada could determine if an informal Work Assessment could be conducted, avoiding the Formal Approval Process and avoiding triggering CEAA.

Migratory Birds Convention Act

The intent of the Migratory Birds Convention Act (MBCA) is to protect migratory birds during the nesting season and while on their way to and from their breeding grounds. The MBCA is administered by the Canadian Wildlife Service (CWS) which is a branch of Environment Canada. The provisions of the MBCA protect migratory birds by:

1. Regulating the hunting of migratory birds.
2. Prohibiting the destruction of eggs and active nests of migratory birds.
3. Prohibiting the deposit of oil, oily waters and any other substance in any waters or areas frequented by migratory birds.

Migratory Birds Convention Act Applicability

The MBCA would apply to this project. When undertaking vegetation clearing during the breeding period (March 1 to July 31), the area will need to be surveyed for the presence of migratory birds, and or nests of migratory birds. If nests are found and it is determined that the activity could damage or disturb nests, the activity will need to be either re-scheduled or altered to avoid such damage.

Species at Risk Act

The Species at Risk Act (SARA) was enacted to meet one of Canada's commitments under the International Convention on Biological Diversity and is administered by CWS. The goal of the Act is to prevent endangered or threatened wildlife from becoming extinct or lost from the wild, and to help in the recovery of these species.

SARA is not a specific trigger for CEAA but can have major influence on the environmental assessment process. In British Columbia, the interpretation of species at risk is simplified using the Red and Blue listings.

Species at Risk Act Applicability

As the project is expected to trigger an assessment under CEAA, SARA will likely play a role in the scoping of the EA that will be required. The EA will likely include more detailed baseline investigations as well as mitigation measures to protect SARA listed species.

2.2.2.2 Provincial Legislation

Water Act

The Water Act regulates the licensing, diversion, storage and use of fresh water in BC and makes provision for the alteration of natural watercourses or sources of water supply. Provisions within the Act pertain to any activity that could affect whether the volume of water flowing within a watercourse or the morphology of the watercourse channel.

Part 7 of the Water Regulation ensures protection of water quality, wildlife habitat and other water users from works performed in and about a watercourse. Guidelines have been developed by the Ministry of Environment to provide direction to conducting work in or near watercourses to ensure compliance with the Regulation. If works can be completed in compliance with Part 7 of the Water Regulation an approval need not be obtained, however a Water Act Notification would be required.

Water Act Applicability

Water Act Notifications would need to be submitted to the Ministry of Environment for the construction of road crossing by clearspan bridge or culvert. Since the proposed bridge over the Alouette River will not be a clearspan structure, its construction will require a Water Act Approval from the Ministry of Environment.

Wildlife Act

The Wildlife Act protects the active nests of indigenous bird species and the nests of bald eagle, peregrine falcon, gyrfalcon, osprey, heron and burrowing owl, whether the nests are active or inactive. Sections 5 and 6 protect prescribed species and their habitat from harm. In addition, under the Wildlife Act, if a person wounds a native wildlife species, other than prescribed wildlife, the event and the location of the wildlife in question must be reported to a conservation officer.

Wildlife Act Applicability

A detailed raptor and heron nest survey should be completed prior to the construction phase of the proposed new bridge crossing. Raptor and heron nests, and the active nests of other birds, will have to be avoided during construction of the project. The avoidance of active bird nests can be achieved by scheduling vegetation clearing to occur outside of the breeding period of March 1 to July 31. If avoidance of nests is not possible, approval under the Wildlife Act will have to be obtained.

Heritage Conservation Act

The purpose of the Heritage Conservation Act is to encourage and facilitate the protection and conservation of heritage property in British Columbia. The Act protects archaeological sites predating 1846, whether they are located on either public or private land. Section 13(2) of the Act states that archaeological sites may not be destroyed, excavated, or altered without a permit. It also states that anyone conducting ground disturbing activities is required to avoid impacting protected archaeological sites.

Heritage Conservation Act Applicability

Because the Alouette River represents a place of ritual and cultural significance, the study area s considered to have high archaeological potential. Ethnographically-identified village locations lie west of the study area and the terraces of Alouette River and Latimer Creek could yield habitation sites and or fishing and fish processing sites. A detailed archaeological impact assessment is recommended for both bridge alignments to comply with the Provincial Heritage Conservation Act. The objectives of the detailed impact assessment are to identify and evaluate the heritage resources within the proposed development area, and to assess possible impacts from the development on these sites.

2.2.3 Future Work Plan (Preliminary Design Stage)

2.2.3.1 EA Scoping and Consultation with Regulators

The District's Environmental Consultant will consult with Transport Canada and Fisheries and Oceans Canada regarding the preferred alignment option to determine the scope of the CEAA screening that is anticipated for the proposed crossing.

2.2.3.2 Biophysical Assessment

The Environmental Consultant will conduct the required biophysical assessment for the preferred alignment option. This will include a fish and habitat assessment. It may also include a rare plant survey and wildlife habitat assessment.

2.2.3.3 Heron and Raptor Nest Survey

A survey of heron and raptor nests will be done for all areas where vegetation clearing may occur including the footprint of road improvements, watercourse crossings and temporary work spaces, as required by the Wildlife Act. If the works are constructed during the bird breeding period, nest surveys would be required along the entire length of the preferred alignment, within 50 m of the centre line. Strategies to minimize and or mitigate potential effects to heron and raptor nests may be required.

2.2.3.4 Archaeological Impact Assessment

To comply with the Provincial Heritage Conservation Act a detailed archaeological impact assessment is recommended for both preliminary bridge alignments. The Environmental Consultant would acquire a single permit to include municipal and private lands so that archaeological work can be completed under one BC government permit. A Sto:lo First Nation permit is also required for archaeological investigations in this region.

Systematic shovel testing will be conducted in areas of perceived archaeological potential. Wetlands in this region are known to have potential for wet site cultural deposits. Wet deposits may require deep testing, or machine-assisted testing.

Considering the presence of an ethnographically recorded site of mythological significance, consulting with First Nations should be initiated to determine the need for a Traditional Use Study of the project area.

2.2.3.5 Environmental Assessment and Permitting

An application for CEAA Screening would be prepared and submitted to Transport Canada and Fisheries and Oceans Canada for the preferred alignment. This CEAA Screening application would also be an application for authorization under the Fisheries Act and approval under the Navigable Waters Protection Act. An application for Water Act approval/ notifications would be submitted to the BC Ministry of the Environment for the new crossing over the Alouette River and any other changes in and about a stream required for the preferred alignment.

2.2.3.6 Liaison with Associated Engineering, District of Maple Ridge, DFO, Transport Canada, Ministry of Environment and the Archaeology Branch

The project scientists would attend meetings and liaise with the project engineers, the District of Maple Ridge, DFO, the Canadian Wildlife Service, Transport Canada, the Ministry of Environment and the Archaeology Branch to obtain the necessary permits and approvals.

2.2.4 Schedule and Effort

It is anticipated that in-stream construction work for this project within the limits of the Alouette River would occur during the in-stream work window of August 1 through September 15. The remainder of the work within the floodplain can be conducted outside of the in-stream work window. To ensure adequate time for regulatory consultation, approval and construction tendering should be submitted no later than seven months prior to the start of construction. This schedule assumes four months for regulatory review and three months to complete the construction tendering, contract and mobilization. These applications will require 75% complete detailed design drawings for the proposed works.

Table 2-2
Summary of Schedule Required by Task
(Assuming Construction in 2009)

Task	Schedule
Liaison with Engineers, the District and Regulators	July 2008 – October 2009
EA Scoping and Early Consultation with Regulators	July 2008 – October 2008
Biophysical Assessment	October 2008
Raptor and Heron Nest Survey	November 2008
Archaeological Impact Assessment	October – November 2008
Environmental Assessment and Permitting	December 2008 – May 2009
- Complete EA and Permit Application	December 2008 – January 2009
- Submit Completed EA and Permit Applications	January 2009
- Complete EA Review and Permitting Process	May 2009
Construction Tender, Contract and Mobilization *	May – July 2009
Reduced Risk In-stream Work Window	August – September 2009
Total	July 2008 – October 2009

The total estimated level of effort for the environmental assessment and approvals described above is 41.5 person-days. The total cost, including professional fees and disbursements is estimated to be $40,000 +/- 20% (not including GST). This cost estimate does not include a rare plant survey, which may be required by the regulators after the EA scooping stage, or a breeding bird nest survey, which could be required if vegetation clearing was scheduled for the bird breeding window.

2.3 HYDRAULIC ANALYSIS

2.3.1 Flow Rates

Alouette River flow rates are controlled by a dam at the outlet of Alouette Lake, and a bypass structure to Stave Lake from near the upstream end of Alouette Lake. These structures are part of the Alouette Stave Ruskin hydroelectric system. The dam was established in 1928.

The 1991 Ministry of Environment Alouette River Floodplain mapping was based on an assumption of Alouette Lake dam floodgates fully open, and without power diversion or bypass to Stave Lake. BC Hydro representatives confirmed that during extreme events, the dam will pass forward flow without attenuation.

We re-assessed design flow rates through a regional analysis. The most appropriate similar catchment was Chehalis River near Harrison Mills. Refer to **Appendix C** for the regional analysis worksheet. **Table 2-3** summarizes our flow rate analysis.

Table 2-3
Alouette River Flow Rates

Gauge / Method	Max Daily m^3/s	Max Instantaneous m^3/s
08MH005 (Alouette River Near Haney)* (1912-2003)	228	312
08MH014 (Alouette Lake at the mouth) (1916-1924)	681	
08MG001 (Regional Analysis based on Chahalis River near Harrison Mills)	518.9	808.3
Floodplain mapping		528

*Dam-controlled catchment

2.3.2 Geometric Model

We obtained a copy of the HEC2 model used for floodplain mapping from the BC Ministry of Environment EcoCAT website. We imported this model into HEC-RAS version 3.1.3.

The HEC2 model is based on 1981 Alouette River survey data. We supplemented the model with river cross sections surveyed along the 128th Avenue and 240th Street alignments. The River channel surveys did not capture the entire floodplain, and the aforementioned road alignments are not perpendicular to the river flow direction. We therefore estimated the floodplain geometry based on a combination of the skewed survey measurements along the road alignments, and from contour mapping.

2.3.3 Predicted Water Levels

Existing

We ran the updated model with the flow rates as established in section 2.3.1. Flood Construction Levels (FCL's) in British Columbia are generally based on the greater of the 200-year maximum daily water level plus 0.6 metres freeboard, or the 200-year maximum instantaneous water level

plus 0.3 metres freeboard. We found the maximum instantaneous condition to produce the highest, and therefore most conservative, FCL's. We have summarized the existing 200-year water levels and FCL's in **Table 2-4**.

Table 2-4
Summary of 200-Year Water Levels and FCL's

Location	Maximum Daily Flow Rates		Maximum Instantaneous Flow Rates	
	200-yr WL	FCL	200-yr WL	FCL
128th Avenue	37.79 m	38.39 m	38.58 m	38.88 m
240th Street	31.05 m	31.65 m	31.65 m	31.95 m

Designed Condition

If the bridges are designed as open spans, with no abutments or piers within the floodplain, the bridges will cause no change in the predicted water levels resulting from the 200-year return period flow. However, such an arrangement would require a bridge span of approximately 870 m at 128th Avenue, and 440 m at 240th Street. For this reason, we also investigated the effect of a multi-span bridge assuming 30 m span lengths and associated piers within the floodplain.

We have summarized the results in **Table 2-5**.

Table 2-5
Modelled Water Level (WL) Increase

River Station	29	28.5	27	26.8
Location	253 metres upstream 128th Avenue	Upstream face 128th Ave. bridge	10 metres upstream 240th St.	Upstream face 240th St. bridge
Modelled WL, no Bridge (m)	40.67 (m)	38.58 (m)	31.56 (m)	31.65 (m)
Modelled WL, with bridge (m)	40.62 (m)	39.98 (m)	32.23 (m)	32.29 (m)
WL increase (m)	-0.05* (m)	0.4 (m)	0.67 (m)	0.64 (m)

*A water level decrease upstream of the proposed bridge crossing is unlikely. This result is likely due to limitations in model resolution.

Predicted river profiles are illustrated in Figures 6 and 7 in **Appendix C**.

2.3.4 Discussion

Should the bridge designs increase water levels, the existing Alouette River flood protection must be evaluated relative to the predicted increase in Flood Construction Level (FCL). Should the water level increases resulting from the proposed bridges render the existing flood protection inadequate, local flood protection improvements must be considered, and approvals would need to be sought through the Inspector of Dikes (Ministry of Environment) and the local diking authority.

2.3.5 Model Limitations

The model geometry is based on 1981 river survey data, supplemented with limited 2007 channel survey in the immediate area of each proposed bridge crossing. We recommend additional survey be completed prior to proceeding to the next stage of design. Survey for river modelling purposes should ideally capture the floodplain perpendicular to the direction of river flow. Additional cross sections up and downstream of each proposed bridge crossing would increase the accuracy of flow transitions.

Confidence in the modelled results may be improved through model calibration. As this current investigation did not include model calibration, and due to the limited survey, the results must be considered preliminary.

2.4 ROADWAY CONCEPT DESIGN

2.4.1 Roadway Design Criteria

Our study is based on the 60 km/h design speed specified by the District and the assumed traffic traveling across the river. For both the 240th Street and the 128th Avenue alignment options, the road cross section will consist of two 4.3 m shared lanes (for cars and bicycles), one 1.7 m sidewalk on one side, and one 4.2 m shared multi-use path (for pedestrians and equestrians) on the opposite side (refer to Figure 1 in **Appendix C**). Side slopes are assumed to be 2H:1V for both cut and fill slopes. Drainage of the road, and whether the road will have open ditches or curb and gutter with closed drainage, has not yet been confirmed but are assumed to be curb and gutter for the purpose of this report.

We have assumed that the alignment options will be straight tangent sections without curves and that they will follow the existing rights-of-way along either 240th Street in the south-north direction from Abernethy Way to 128th Avenue, or 128th Avenue in the west-east direction from Fern Avenue to 130th Avenue Connector to reduce the impact on adjacent properties.

For the purposes of this study, we have assumed that no fill will be allowed to be placed in the floodplain area and have developed our alignments and profiles accordingly. We have assumed a maximum grade of 6% to accommodate large trucks.

2.4.2 240th Street Alignment Option

The 240th Street alignment option from Abernethy Way to 128th Avenue is about a 1.1 km section in the south-north direction (refer to Figure 3 in **Appendix C**). The overall length of road on this option is shorter than the 128th Avenue option and the length of the structure required to cross the Alouette River valley is shorter than the 128th Avenue option as well. It is worth noting that the length of the crossing is still fairly significant due to the wide floodplain. The grade of the crossing will be about 3.3% so it will be fairly flat and easier for large trucks to negotiate.

On the south side of the river, the new 240th Street alignment would tie in to the existing curved access road alignment north of 124th Avenue to provide access to six residential properties to the west side of 240th Street. Note that a major road or bridge in this area may not be desirable for the residents living adjacent to the new crossing because of the increased traffic, noise, and other environmental concerns.

On the south side of the river, there would be two at-grade intersections required: one between Abernethy Way and 124th Avenue at the Y-junction, and one on 240th Street at the access road west of 124th Avenue.

On the north side of the river, the existing driveways along 240th Street would be tied into the new road to maintain property access. Providing an intersection at the north end of the bridge at 240th Street and Fern Crescent east of 240th Street would not be feasible due to poor sight distance and traffic concerns. Fern Crescent traffic would have difficulty making left turns onto 240th Street, causing traffic delays; which would affect operability of the road bridge. Based on this, we recommend that Fern Crescent be closed at 240th Street. Upgrading and extending the existing 128th Avenue eastwards to Fern Crescent would provide access to properties along 240th Street and Fern Crescent as shown on Figure 5 in **Appendix C**.

2.4.3 128th Avenue Alignment Option

The 128th Avenue alignment option from 240th Street to 248th Street is about a 1.7 km section in the west-east direction (refer to Figure 2 in **Appendix C**). The overall length of the road on this option is longer than the 240th Street option and the length of the structure required to cross the Alouette River valley is almost twice as long as the 240th Street option. The length of the structure is dictated by the width of the river and valley combined.

The alignment is constrained by the maximum design grade of 5.9% and the elevation difference between the valley at the west end of 128th Avenue at 240th Street and the top of the hill at the tie-in point at the properties west of 248th Street on 128th Avenue on the east side.

Due to limited right-of-way, large property cost implications, constructability concerns and geotechnical issues, we are of the opinion that high and narrow retained earth fill walls and or embankment fills in this area are not feasible and that the cost to construct them would likely be similar to that of an elevated bridge structure.

One of the constraints in the design of this alignment option is the maximum road grade at 6% which allows the large truck traffic to flow more freely. However, this results in an alignment that is as high as 25 m above the river valley. If a steep grade is acceptable to the District, the alignment can be adjusted to follow the existing ground more closely. However, a steeper grade would be more difficult for larger trucks to negotiate and may reduce the traffic flow of the road.

On the west side of the river, the new 128th Avenue alignment must tie into the existing 128th Avenue since it provides access to the properties in this area. Note that a major road or bridge in this area may not be desirable for the residents living adjacent to the new crossing because of the increased traffic, noise, and other environmental concerns. The new 128th Avenue alignment must also tie into Fern Crescent where a new at-grade intersection will need to be constructed as shown on Figure 4 in **Appendix C**.

On the east side of the river, the new 128th Avenue alignment must tie into the existing 128th Avenue west of 248th Street to provide continuity of road access for properties in this area. The road can end at the 248th Street intersection or it can be extended to the 130 Connector, depending on the District's future plans.

2.4.4 Property Acquisition

For both the 240th Street south-north alignment option and the 128th Avenue west-east alignment option with a 2-lane road, there will be little if any property acquisition required. Any property acquisition may be reduced or mitigated with the construction of retaining walls in place of cuts or embankment fills.

On the north end of the 240th Street alignment option, with the recommended closing of Fern Crescent, the District should construct a cul-de-sac at the end of the road which may require some property acquisition.

In all cases, construction easements will likely be required to reinstate driveways that are impacted by the new road alignments.

For the 128th Avenue Option, the property acquisition drawing showing the proposed acquisition required on the north side of the existing right-of-way to accommodate the road design is shown in Figure 4 of **Appendix C**. Driveways that may require construction easements are also shown in Figure 4 of **Appendix C**.

For the 240th Street Option, we do not foresee any additional property acquisition. However, driveways that may require construction easements are shown in Figure 5 of **Appendix C**.

2.5 BRIDGE CONCEPT DESIGN

2.5.1 Design Criteria

The following criteria were used to develop the bridge concepts.

Design Code:	CSA-S6-06 Canadian Highway Bridge Design Code (CHBDC)
Class of Highway:	Class "A"
Design Speed:	60 km/h
Roadway:	• Two designated 4.3 m travel lanes, minimum 8.6 m wide roadway between parapets • One 1.5 m wide sidewalk • One 4.2 m wide shared, multi-use path • Refer to Figure 1 in **Appendix C**
Bridge Barriers:	Concrete parapets, 810 mm high, PL-2 compliant
Pedestrian Railing:	BC Ministry of Transportation (MoT) standard steel bicycle fence, 1.4 m high

2.5.2 Bridge Length and Span Arrangement

For both the 240th Street and 128th Avenue alignments, the District has indicated that roadway embankment fills in the floodplain are not to be considered, in order to minimize environmental issues, the impact on adjacent properties and to not negatively impact the hydraulic grade line of the river upstream of the proposed bridge structure. This results in a 440 m long bridge on the 240th Street alignment and an 870 m long bridge on the 128th Avenue alignment. Clear span structures are not viable due to excessive cost and aesthetics, as such structures would appear out of proportion with the surroundings. Furthermore, there is no requirement to provide a clear span for navigation or environmental purposes. Accordingly, we investigated conventional, multi-span bridge concepts with intermediate piers.

The preliminary geotechnical investigation suggests that 30 m to 40 m long friction piles are required, given the underlying clayey subsoils. This suggests that longer spans are preferred in order to minimize foundation costs. In order to make use of standard, pre-fabricated superstructure components where possible and to minimize associated transportation and erection costs, we developed concepts using maximum intermediate span lengths of 30 m in the floodplain, where the terrain is relatively flat.

For the eastern portion of the 128th Avenue alignment, from approximately station 129+340 to 129+450 outside of the floodplain, the increasing road profile results in significantly higher piers than in the floodplain, up to 27 m. From a bridge design perspective, longer spans are more suited to structures with tall piers in order to produce a more balanced overall bridge and minimize foundation costs. The ground also rises sharply from approximately station 129+340 to 129+415, which creates difficulties from an access and constructability perspective and suggests that the slope should be spanned. Accordingly, we developed concepts using spans on the order of 60 m to 75 m in this region, to mitigate these issues.

General arrangements and typical sections of the two structures are shown on Figures 6, 7 and 8 in **Appendix C**, and described in the following sections.

2.5.3 Superstructure Concept

For the spans over the floodplain on both alignments, we developed a bridge superstructure concept using precast, pre-stressed concrete I-girders. Standard BC Ministry of Transportation and Highways Type 5 pre-stressed I-girders are typically the most economical section in this span range, due to the relatively lower material cost of concrete versus structural steel and the availability of this section from a number of local manufacturers. As a result, Type 5 I-girders have been used on numerous bridges in this span range throughout the province. The precast concrete girders will be fabricated, shipped and erected as full-length units.

For the longer spans on the eastern portion of the 128th Avenue alignment, we developed a bridge superstructure concept using steel I-girders. Steel I-girders are custom-fabricated from welded steel plates and typically used on bridges with longer spans, usually greater than 50 m. Although structural steel typically has a higher material cost than precast concrete, steel girders are relatively lighter weight than concrete girders of the same length, which results in potentially lower costs for shipping and erection. Steel girders are also readily-spliced in the field, such that each span can be fabricated in shorter segments for shipping and then joined together during erection with bolted splices form the final spans.

Both concepts utilize a cast-in-place concrete deck slab for the roadway that would be constructed from high-performance concrete containing silica fume to enhance durability. An asphalt overlay and waterproofing membrane on the roadway is included and is consistent with current Ministry of Transportation practice. Use of intermediate expansion joints and bearings would be minimized to reduce future maintenance.

2.5.4 Substructure Concept

Due to the subsurface conditions at the site, spread footings are not feasible and piling would be required. Where the bridges cross the floodplain and are relatively low, the substructure will comprise steel pipe piles that are extended above grade to support a concrete cap beam, which in turn supports the bridge superstructure. This extended pile "bent" concept utilizes a relatively small

number of large diameter piles and no footing, which minimizes environmental impact during construction since footing excavation would not be required. Since the piles derive their capacity through side friction, piles that are relatively large are preferred in order to reduce the number required per pier and minimize the penetration into the underlying soils. Larger diameter piles are also required for column strength on the higher piers.

On the eastern portion of the 128th Avenue alignment extended pile bents are not feasible given that the maximum pier height is up to 27 m. In this case, a more robust design is required. A suitable concept comprises a buried, pile-supported footing, two reinforced concrete columns above grade and a concrete cap beam to support the superstructure. This configuration would require temporary excavation during footing construction; however, the environmental impact from the excavation is not likely an issue since this type of pier would only be used outside of the floodplain.

As requested by the District, the bridge substructures have been evaluated for two lanes.

2.5.5 Construction

The concepts developed assume that construction within the floodplain is allowed and that work within the wetted perimeter, such as pile driving, would be completed during environmental window(s). The concrete I-girders could be erected by "launching" over an auxiliary steel gantry or truss, otherwise cranes would be required in the floodplain for reach. Similarly, the steel I-girders for the eastern portion of the 128th Avenue alignment would be constructed by either launching from the east abutment or by “pick-and-placing” with a crane located on the existing grade below.

Our assumed construction sequence is:

- Install piles using equipment located in the flood plain.
- Construct piers and abutments.
- Erect girders by "launching" or the use of cranes to “pick and place” individual components.
- Construct the deck slab, parapets and railings.
- Complete approach tie-ins all other works.

2.6 PRELIMINARY COST ESTIMATES

The estimated costs for the two options that we investigated are as follows:

- 240th Street Alignment $30,778,700
- 128th Avenue Alignment $71,957,550

These costs include an allowance for detailed engineering of 10%, as well as a project contingency of 20%. Details and cost breakdowns are contained in **Appendix D**.

From these cost estimates, it is evident that the 128th Avenue alignment is significantly higher cost than the 240th Street alignment, owing to the significantly longer structure and higher profile, which results in longer spans and taller piers.

2.7 RECOMMENDATIONS

We recommend the 240th Street alignment option over the 128th Avenue alignment option for the following reasons:

- The estimated construction cost for the 240th Street alignment option, at $31 million, is significantly lower than the 128th Avenue alignment option, at $72 million.
- The profile on the 240th Street alignment option, at 3.3%, is preferred over the 128th Avenue alignment option, at 5.9%, from an operational perspective.

For the purposes of this study, we conclude that conventional, multi-span bridge structures are feasible and appropriate for both crossings of the South Alouette River that we investigated. The concepts in this report represent only one feasible solution. Other bridge configurations are possible and should be considered and optimized, should the District proceed to detailed design for this project.

A Appendix A - Environmental Report

Jacques Whitford AXYS

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Environmental Overview

Of Bridge Crossing Options On The South Alouette River

At 240th Street and 128th Avenue,
Maple Ridge, BC

Associated Engineering (BC) Ltd.
Burnaby, BC

PROJECT NO. 1027886

Jacques Whitford

An Environment of Exceptional Solutions

PROJECT NO. **1027886**

REPORT TO

Mr. Dieter Diedericks
Associated Engineering (BC) Ltd.
Suite 300, 4940 Canada Way
Burnaby, BC
V5G 4M5

FOR **South Alouette Bridge Feasibility Study**

ON **Environmental Overview of Bridge Options**

January 15, 2008

Jacques Whitford AXYS Ltd.
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Jacques Whitford AXYS

Executive Summary

The Corporation of the District of Maple Ridge (Maple Ridge) is considering the construction of a new road and bridge crossing over the South Alouette River into the Silver Valley area. Two alignment options are being considered for the new crossing; the 240th Street alignment, with improved road access being extended north from 124th Avenue; or the 128th Avenue alignment, with improved road access being extended west from Alouette Road. Associated Engineering Ltd. is conducting a feasibility study for this project. Jacques Whitford AXYS Ltd. has been retained by Associated Engineering to provide an environmental overview in support of the feasibility study. This environmental overview includes a review of biophysical information, a review of regulatory requirements and development of a work plan to meet regulatory requirements.

Review of the proposed alignment options for the South Alouette Bridge indicates that an Environmental Assessment (EA) under the *Canadian Environmental Assessment Act* (*CEAA*) will likely be required for either alignment option. It is expected that Fisheries and Oceans Canada (DFO) and Transport Canada would require formal authorizations under the *Fisheries Act* and the *Navigable Waters Protection Act*, respectively, and this will trigger *CEAA*. Consultation with DFO and Transport Canada should be conducted to determine the scope of the EA that will be required. In order for DFO to issue a subsection 35(2) Authorization under the *Fisheries Act*, Maple Ridge would have to commit to a habitat compensation plan that would create or enhance enough habitat to meet DFO's "no net loss" guiding principle.

It is anticipated that instream construction work for this project would occur during the instream work window of August 1 through September 15, 2009. To ensure adequate time for regulatory consultation, approval and construction tendering; applications to DFO (*CEAA* Screening and Authorization), Transport Canada (for *NWPA* Approval) and the provincial Ministry of the Environment (*Water Act* approval) should be submitted no later than seven months prior to the start of construction (i.e. February 1, 2009). This schedule assumes four months for regulatory review and three months to complete the construction tendering, contract and mobilization. These applications will require detailed design drawings (i.e., 75% complete) for the proposed works.

The following schedule should provide Maple Ridge with adequate time to complete the environmental assessment and permitting process before the start of the reduced risk instream work window of August 1 to September 15, 2009.

Task	Schedule
Liaison With Engineers, the District, and Regulators	July 2008 – October 2009
EA Scoping and Early Consultation with Regulators	July 2008 – October 2008
Biophysical Assessment	October 2008
Raptor and Heron Nest Survey	November 2008
Archaeological Impact Assessment	October- November 2008
Environmental Assessment and Permitting	December 2008- May 2009
Complete EA and Permit Application	December 2008 – January 2009
Submit Completed EA and Permit Applications	January 2009
Complete EA Review and Permitting Process	May 2009
Construction Tender, Contract and Mobilization[1]	May – July 2009
Reduced Risk Instream Work Window	August – September 2009
Total	July 2008 – October 2009

[1]Construction Tendering, Contract and Mobilization task to be completed by the District of Maple Ridge or its representative.

The total estimated level of effort for the environmental assessment and approvals described above is 41.5 person-days (1 person = 8 hrs). The total cost, including professional fees and disbursements of about 20% of professional fees, is estimated to be $38,845 ± 20% (not including GST). This cost estimate does not include a rare plant survey, which may be required by the regulators after the EA scoping stage, or a breeding bird nest survey, which would be required if vegetation clearing was scheduled during the bird breeding period.

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1.0 INTRODUCTION

The Corporation of the District of Maple Ridge (Maple Ridge) is considering the construction of a new road and bridge crossing over the South Alouette River into the Silver Valley area. Associated Engineering Ltd. is conducting a feasibility study for this project. Jacques Whitford AXYS Ltd. has been retained by Associated Engineering to provide an environmental overview in support of the feasibility study. This environmental overview includes a review of biophysical information, a review of regulatory requirements and development of a work plan to meet regulatory requirements.

2.0 PROJECT DESCRIPTION

The main purpose for considering a new bridge crossing over the river into the Silver Valley is to provide a secondary crossing in circumstances where natural events such as flooding and wind prevent access to the existing bridge on 232 Street. Two alignment options are being considered for the new crossing (Figure 1); the 240th Street alignment, with improved road access being extended north from 124th Avenue; or the 128th Avenue alignment, with improved road access being extended west from Alouette Road. The 240th Street alignment generally follows either 240th Street or the Trans Ridge Trail. Road improvements for the 128th Avenue alignment leave Fern Crescent on the north side of the South Alouette River, in alignment with 128th Avenue, and extend east to Alouette Road. The 128th Avenue alignment also generally follows the east-west portion of the Trans Ridge Trail.

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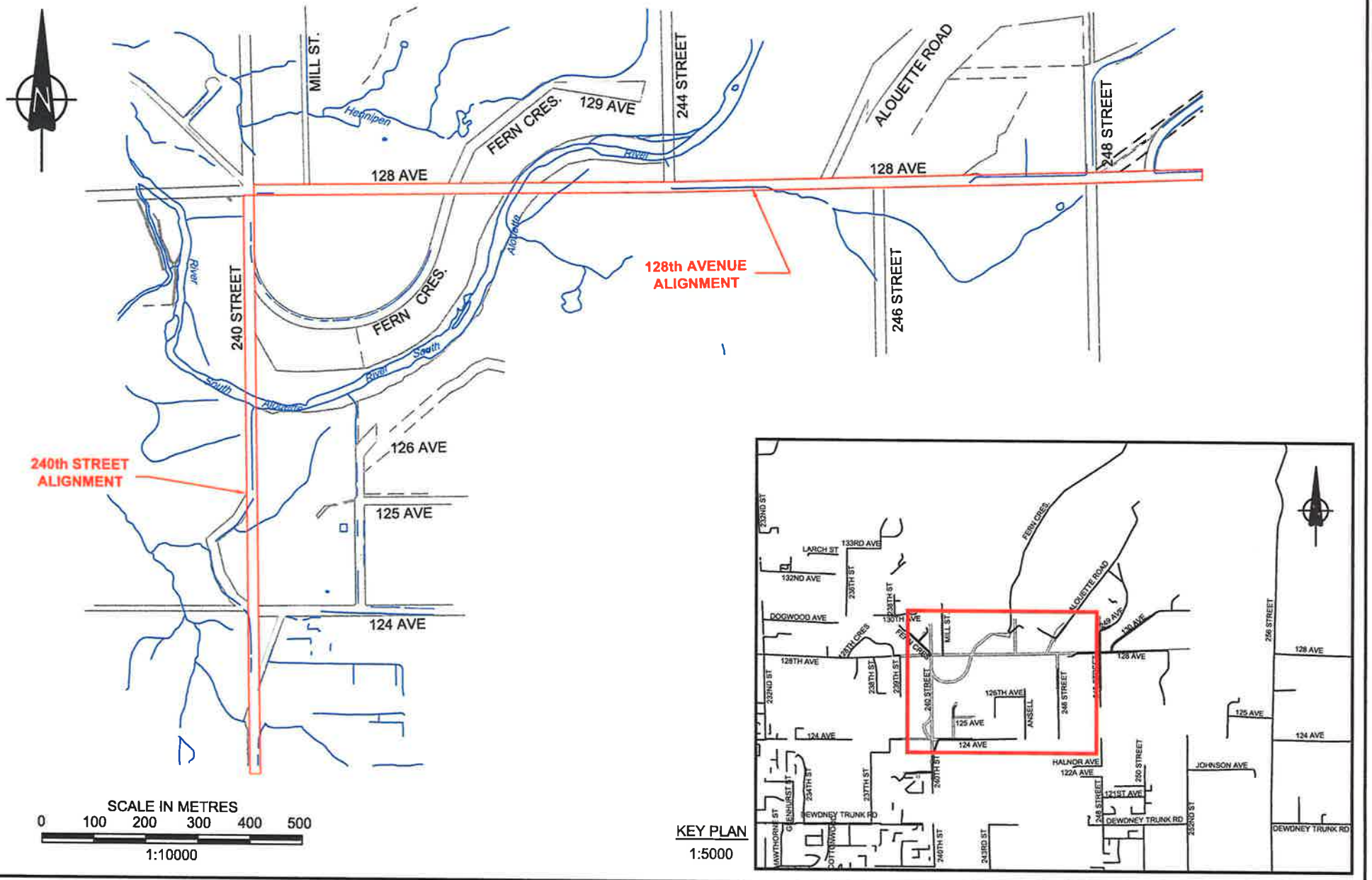


PROJECT LOCATION MAP

FEASIBILITY STUDY FOR BRIDGE OVER SOUTH ALOUETTE RIVER
240th STREET AND 128th AVENUE, MAPLE RIDGE, BC

Client: DISTRICT OF MAPLE RIDGE

Job No.:	1027886
Scale:	1:10,000
Date:	31-Oct-07
Dwn. By:	SS
App'd By:	

Fig No.: 1

Jacques Whitford AXYS

3.0 EXISTING ENVIRONMENTAL CONDITIONS

An office based analysis of available biophysical information was conducted to assess the potential environmental effects of the proposed crossing alignments. The environmental components addressed by this analysis were the physical setting, vegetation, fish and aquatic habitat, and wildlife resources. Mapping and aerial photography data where provided by Maple Ridge. Topographic survey data for the alignment and drawings of the project footprint were provided by Associated Engineering.

In addition to the desktop analysis, both alignments were walked on October 5, 2007 to observe fish habitat, general vegetation assemblages and potential wildlife habitat along both alignments. The weather conditions during this site visit were partly cloudy with light precipitation and a maximum air temperature of 13°C. Precipitation had occurred for eight consecutive days prior to the site visit.

At the request of Jacques Whitford AXYS Ltd., I.R. Wilson Consultants Ltd. conducted an archaeological overview assessment (AOA) of the two potential bridge alignments (IR Wilson 2007). This overview assessment was intended to identify and assess heritage resource potential, or the likelihood that sites are present. The AOA involved

- a review of archaeological predictive models in the study area using the B.C. Government's Remote Access to Archaeological Data (RAAD);
- a file search of previously recorded archaeological sites at the Archaeology Branch of the Ministry of Tourism, Sport and the Arts;
- a review of previous archaeological assessments in the vicinity of Alouette River; and
- a review of background literature to place the study area in a cultural content.

This AOA did not address traditional use or involve First Nation consultation.

3.1 Physical Setting

The proposed bridge is located in Maple Ridge, British Columbia. Maple Ridge is located between the north shore of the Fraser River and the Coast Mountains.

The surficial geology of Maple Ridge, in the vicinity of the proposed crossings, is within the Fort Langley Formation which consists of glacial and deltaic sediments. Maple Ridge is characteriazed by marine silty clay to fine sand, commonly containing marine shells. (Surficial Geogology Map 1484A, 1:50,000 scale)

Both bridge alignment options are situated within the Dry Maritime Coastal Western Hemlock (CWHdm) biogeoclimatic subzone. The Coastal Western Hemlock (CWH)

zone is influenced by the ocean and mountains producing, on average, one of the wettest climates in Canada. The CWHdm subzone occurs at low elevations, generally between sea level and 650 m above sea level. The CWHdm zone is characterized by warm, relatively dry summers and moist, mild winters. The growing season in this zone is long, with minor local water deficits.

3.2 Vegetation

The dominant tree species in the CWH zone typically include Douglas fir (*Pseudotsuage menziesii*), western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*). Dominant understory species typically include salal (*Gaultheria shallon*), red huckleberry (*Vaccinium parvifolium*), and mosses such as step-moss (*Hylocomium splendens*), lanky moss (*Ryhtidiadelphus loreus*) and Oregon beaked moss (*Kindbergia oregano*).

Tree species observed along both alignment options included red alder (*Alnus rubra*), bigleaf maple (*Acer macryophylla*), western redcedar (*Thuja plicata*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), paper birch (*Betula papyrifera*), western hemlock, and Sitka spruce *(Picea sitchensis).*

Understory species along both alignments were generally dominated by red elderberry (*Sambucus racemosa* spp. *pubens*), vine maple (*Acer circinatum*), salmonberry (R*ubus spectabilis*), horsetail (*Equisetum* spp.), red huckleberry, sword fern (*Polystichum munitum*), bracken fern (*Pteridium aquilinum*), Himalayan blackberry (*Rubus discolor*), Indian plum (*Oemleria cerasiformis*), skunk cabbage (*Lysichiton americanum*), thimbleberry (R*ubus parviflorus*) and trailing blackberry (*Rubus ursinus*).

Pacific ninebark (*Physocarpus capitatus*) and beaked hazelnut (*Corylus cornuta* var. *californica*) were observed on the south bank of the South Alouette River at the crossing location of the 240th Street alignment.

British Columbia maintains Red and Blue lists for species of special management concern. These lists serve two purposes: 1) to provide a list of species for consideration for more formal designation as Endangered or Threatened, either provincially under the British Columbia Wildlife Act, or nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and 2) to help set conservation priorities for species/ecological communities considered at risk in British Columbia. Red listed species or ecological communities are considered extirpated, endangered or threatened in BC while, blue listed species are considered to be of special concern.

Rare plant species typically occur in rocky bluff and wetland habitats. A rare plant survey was not conducted during the site visit, however habitats where rare plants typically were not observed, except in the linear wetland observed along the 128th Avenue alignment.

Rare species that may occur in the project area based on the BC Species Ecosystem Explorer are provided in Table 1 below (BCCDC 2007a). This list has been refined based on the habitat requirements described on E-Flora (2007). The provincial Conservation Data Centre mapping database of known occurrences does not show any known occurrences of rare plants within 5 km of the proposed alignments (BCCDC 2007b). One masked occurrence does occur to the northwest of the project within 5 km; however it is not know if this occurrence is a rare plant.

Table 3-1 Rare Plant Species Potential Occurring in the Vicinity of the Project

Species Name	Common Name	Provincial Status
Fabronia pusilla	silver hair moss	Red
Bidens amplissima	Vancouver Island beggarticks	Blue
Lupinus rivularis	streambank lupine	Red
Cephalanthera austiniae	phantom orchid	Red

3.3 Fish and Aquatic Habitat

Drainages along both alignment options are tributary to the South Alouette River. The South Alouette River is a 31.63 km long river and is known to support coho salmon (*Oncorhynchus kisutch*), chum salmon (*O. keta*), Chinook salmon (*O. tshawytscha*), pink salmon (*O. gorbushca*), sockeye salmon (*O. nerka*), anadromous and resident cutthroat trout (*O. clarki*), Dolly Varden (*Salvelinus malma*), bull trout (*Salvelinus confluentus*), steelhead trout (*O. mykiss*), rainbow trout (*O. mykiss*), kokanee (*O. nerka*), lake trout (*Salvelinus namaycush*), brassy minnow (*Hybognathus hankinsoni*), threespine stickleback (*Gasterosteus aculeatus*), brown catfish (*Ameiurus nebulosus*), lamprey species (*Lampetra* spp.), largescale sucker (*Catostomus macrocheilus*), longnose dace (*Rhinichthys cataractae*), longnose sucker (*Catostomus catostomus*), mountain whitefish (*Prosopium williamsoni*), northern pikeminnow (*Ptychocheilus oregonensis*), peamouth chub (*Mylocheilus caurinus*), redside shiner (*Richardsonius balteatus*), and sculpin species (*Cottus spp.*). Bull trout are blue listed in the province's list of species at risk.

3.3.1 240th Street Alignment

Seven watercourses are potentially affected by the proposed 240th Street alignment (i.e., occur within 30 m) including the mainstem of the South Alouette River and the following six tributaries of the South Alouette River: Latimer Creek, three unnamed tributaries to Latimer Creek, a linear wetland and an unnamed tributary of the South Alouette River (Table 3-2 and Figure 2).

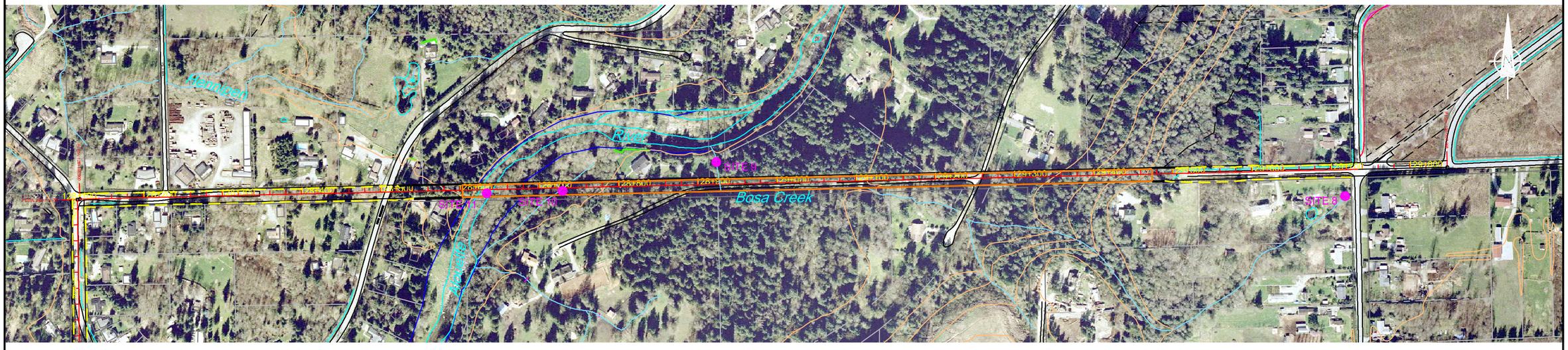
Table 3-2 Habitat Characteristics for Watercourses Along Proposed Crossing Alignments

Site No.[1]	Watercourse	Crossing Alignment	Bankfull Channel Width (m)	Channel Gradient (%)	Dominant Substrate Size
1	Latimer Cr.	240th St.	2.9	3	Gravel
2	Latimer Cr. Trib. No. 1	240th St.	0.5	21	Fines
3	Latimer Cr. Trib. No. 2	240th St.	1.3	16	Gravel
4	Latimer Cr. Trib. No. 3	240th St.	2.5	9	Gravel
5	Linear Wetland	240th St.	12	0	Fines
6	Alouette R. Trib. No. 1	240th St.	1.5	0.5	Gravel
7	Alouette River at 240th St.	240th St.	19	1	Gravel
8	Bosa Cr. Origin	128th Ave.	1.5	1	Gravel
9	Bosa Cr. at Alouette Confluence	128th Ave.	1.9	7	Gravel
10	Alouette R. Trib. No. 2	128th Ave.	3.8	1	Fines
11	Alouette R. at 128th Ave.	128th Ave.	20	2	Gravel

[1] See Figure 2 for the location of sampling sites.

SCALE IN METRES
0 25 50 75 100
1:3000

240th STREET ALIGNMENT



SCALE IN METRES
0 50 100 150 200 250
1:5000

128th AVENUE ALIGNMENT

LEGEND

- PROPOSED ROAD CENTERLINE
- PROPOSED TOE OF SLOPE
- 5m ELEVATION CONTOURS
- PROPOSED ROAD ALIGNMENT
- WATERCOURSES
- PROPOSED BRIDGE
- PROPOSED RETAINING WALL
- CADASTRAL BOUNDARIES
- WATERCOURSE SAMPLE SITE

Reference:	**Job No.:** 1027886 **Scale:** AS SHOWN **Date:** 24-Mar-08 **Dwn. By:** NP **App'd By:**	**Client:** DISTRICT OF MAPLE RIDGE **Site Address:** 240th STREET AND 128th AVENUE MAPLE RIDGE, BRITISH COLUMBIA	FEASIBILITY STUDY FOR BRIDGE OVER SOUTH ALOUETTE RIVER	WATERCOURSES ALONG THE TWO PROPOSED BRIDGE CROSSING ALIGNMENTS	**Fig No.:** 2

Jacques Whitford AXYS

R:\2008Fiscal\1027886_MapleRidge\CAD\FeasibilityStudy\1027886 D02 R0.dwg PRINTED: Mar 24, 2008

Traveling north on 240th Street, the first watercourse along this alignment is Latimer Creek (Site No. 1 in Table 3-2 and Figure 2). Latimer Creek (Watershed Code: 100-026700-06000-29900) is a 2.9 km long, 1.5 - 3 meter wide creek, which originates east of 244th Street and south of 124th Avenue (Davies 1996). Latimer Creek is known to support rainbow trout, cutthroat trout, chum salmon, coho salmon and Chinook salmon (FISS 2007). At the crossing location, Latimer Creek had an average bankfull width of 2.9 m, a channel gradient of 3% and gravel bed substrate. On the upstream side of 240th Street, Latimer Creek receives flow from road side ditches that both enter the creek at greater than 30% grade. At the location of the proposed alignment, Latimer Creek offers moderate to good habitat for salmonid rearing, spawning, over wintering and migration.

The first unnamed tributary of Latimer Creek that may be affected by the project originates approximately 32 m from the current road edge (Trib. No. 1, Site 2 in Table 3-2 and Figure 2) and would probably only have its riparian habitat affected. This tributary is approximately 60 m long and drains from a lawn. This tributary has an average channel width of 0.5 m, a gradient of 21% and fine sized substrate. Local residents indicated that this watercourse is not wetted year round. At the time of the site visit, which occurred after several days of rainfall, flow was discontinuous within the channel. Due to the gradient and ephemeral flow characteristics of this tributary, it is considered non-fish bearing but may contribute food and nutrients to Latimer Creek.

The second unnamed tributary of Latimer Creek that may be affected by the project is crossed by the proposed alignment (Trib. No. 2, Site 3 in Table 3-2 and Figure 2). This tributary has an average channel width of 1.3 m. The channel gradient at this location averages 16% with gradients increasing to as high as 22% upstream of the alignment. The stream bed substrate is predominantly gravel. The downstream portion of this tributary, which parallels the existing road is considered potentially fish-bearing due to it's connectivity to Latimer Creek; however the gradient of the upstream portion would act as a barrier to upstream fish migration.

The third unnamed tributary of Latimer Creek that may be affected by the project is also crossed by the alignment (Trib. No. 3, Site 4 in Table 3-2 and Figure 2). This tributary has an average channel width of 2.5 m, a gradient of 9% and predominantly gravels substrates. This watercourse is considered potentially fish bearing as no barriers to migration were observed.

The proposed alignment transects a linear wetland (Site 5 in Table 3-2 and Figure 2) that parallels a curved section of 240th Street. This wetland drains through a culvert, under 240th Street, into a ditch that flows within the alignment to the south bank of the South Alouette River. This ditch (Site 6 in Table 3-2 and Figure 2) is linear and was intermittently wetted at the time of the site visit. The ditch and wetland are considered potentially fish bearing due to their connectivity to the South Alouette River. However, the ditch offers poor habitat quality for salmonids due to

it's lack of complexity and intermittent flow. The outlet of the ditch was dry and elevated approximately 0.5 m above the water level of the South Alouette River at the time of the site visit, which could result in a seasonal barrier to upstream fish passage into the ditch.

One watercourse identified through available mapping as occurring about 20 m west of Site 6 (Figure 2) was not found during the site visit and is considered to be outside the potential footprint of the 240th Street Alignment.

Along the 240th Street alignment, the South Alouette River (Site 7 in Table 3-2 and Figure 2) has a bankfull width of 19 m, a gradient of 1% and predominantly gravel substrate. The South Alouette River provides excellent rearing, spawning, migration and overwintering habitat. Both banks of the South Alouette are gradually sloping and vegetation consists of a mixed mature forest.

On the north side of the South Alouette River, no watercourses are crossed by the 240th Street alignment.

3.3.2 128th Avenue Alignment

Three watercourses were identified as either crossed by or are within 30 m of the proposed 128th Avenue alignment including Bosa Creek, an unnamed tributary of the South Alouette River and the South Alouette River (Figure 2).

Traveling north on 248th Street the first watercourse potentially impacted by this alignment option is the origin of Bosa Creek (Site 8 in Table 3-2 and Figure 2; Watershed Code: 100-026700-06000-34300). The beginning of the channel begins in the middle of private property (12783 – 248th Street) approximately 28 m from the existing 128th Avenue. However it receives flow from existing roadside ditches located on the west and east sides of 248th Street via culverts. Bosa Creek at its origins is approximately 1.5 – 2.0 m wide with a 1-2% gradient. Fish presence in Bosa Creek is not known (Davies 1996).

The greatest potential for impact on Bosa Creek by the proposed 128th Avenue alignment is a reach (approximately 195 m) long which parallels 128th Avenue. It then crosses under 128th Avenue via a baffled 1.1 m long culvert and flows to the confluence with the South Alouette River.

At the confluence with the South Alouette River (Site 9 in Table 3-2 and Figure 2), Bosa Creek has an average channel width of 1.9 m and a gradient of 7%. It is characterized by riffle pool habitat and substrates dominated by gravels, secondary substrate consisted of fines. Approximately 10 m upstream of the confluence with the Alouette River there is an impassible falls (2.1 m).

A small tributary to the South Alouette River (Site 10 in Table 3-2 and Figure 2) is also crossed by the proposed alignment. This tributary is currently crossed at the proposed alignment by a small wooden bridge that is part of the Maple Ridge trail

network. It has an average channel width of 3.8 m, substrates that are dominated by fines and organics and was barely flowing at the time of the site visit. While this tributary offers poor quality fish habitat, it is potentially fish bearing due to it's connectivity with the South Alouette River.

At the proposed crossing location of the South Alouette River itself (Site 11 in Table 3-2 and Figure 2), it has an average channel width of 20 m and a gradient of 2%. Substrates in this portion of the river are dominated by gravels and boulders are subdominant. As described above, the South Alouette provides excellent salmonid habitat for rearing, spawning, wintering and migration. Both banks of the South Alouette at this location are vegetated with mature mixed coniferous/deciduous forest. The north bank is vertical while the south bank is gently sloping.

No other watercourses were observed along the 128th Avenue alignment. As with the 240th Street alignment, there are no watercourses potentially affected on the north side of the South Alouette River.

3.4 Wildlife

During the site visit conducted October 5, 2007 a raptor and heron nest survey was conducted. No raptor or heron nests were observed however much of the deciduous foliage was still on trees. A detail nest survey should be conducted during winter, while the forest canopy is less dense, to ensure no raptor or heron nests will be impacted by the preferred option.

Potentially occurring rare wildlife species that may occur in the project area were determined from the BC Species Ecosystem Explorer. A list of potentially occurring rare wildlife is provided below in Table 2. The provincial Conservation Data Centre mapping database of known occurrences does not show any known occurrences of rare wildlife within 5 km of the proposed alignments (BCCDC 2007b). One masked occurrence does occur to the northwest of the project within 5 km; however it is not know if this occurrence is a rare plant or animal. No wildlife or wildlife signs were observed at the time of the site visit.

Table 3-3 Potentially Occurring Rare Wildlife in the Vicinity of the Project

Species Name	Common Name	Provincial Status
Allogona townsendiana	Oregon Forestsnail	Red
Euphyes vestris	Dun Skipper	Blue
Ascaphus truei	Coastal Tailed Frog	Blue
Dicamptodon tenebrosus	Pacific Giant Salamander	Red
Rana aurora	Red-legged Frog	Blue
Rana pretiosa	Oregon Spotted Frog	Red
Athene cunicularia	Burrowing Owl	Red
Brachyramphus marmoratus	Marbled Murrelet	Red
Eremophila alpestris strigata	Horned Lark, *strigata* subspecies	Red
Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	Red
Falco peregrinus pealei	Peregrine Falcon, *pealei* subspecies	Blue
Icteria virens	Yellow-breasted Chat	Red
Megascops kennicottii kennicottii	Western Screech-Owl, *kennicotii* subspecies	Blue
Strix occidentalis	Spotted Owl	Red
Tyto alba	Barn Owl	Blue
Aplodontia rufa rainieri	Mountain Beaver, *rainieri* subspecies	Blue
Aplodontia rufa rufa	Mountain Beaver, *rufa* subspecies	Blue
Scapanus townsendii	Townsend's Mole	Red
Pituophis catenifer catenifer	Gopher Snake, *catenifer* subspecies	Red
Actinemys marmorata	Western Pond Turtle	Red
Sorex bendirii	Pacific Water Shrew	Red

3.5 Heritage and Cultural Resources

The project area falls within the traditional territory of the Katzie First Nation, Tsawwassen First Nation and the Sto'lo Nation. The following discussion summarizes the findings of the AOA carried out for this project by I. R. Wilson Consultants Ltd. (I.R. Wilson 2007).

Limited archaeological survey has been conducted on the Alouette River. However, excavations conducted at the Glenrose Cannery site on the Fraser River and at three sites within the Alouette drainage including the Caruthers site (DhRp 11), the Park Farm site (DhRq 22) and the Telep site (DhRq 35) have yielded an archaeological sequence relevant to the area. The Caruthers site (DhRp 11), located in the low, flat lands between the North and South Alouette rivers (approximately 7.5 km west of the proposed project) has been interpreted as a hunting and gathering base, and secondarily as a fishing camp, within the period A.D. 400-800. The Telep site (DgRq 35), located in the lowland area near the northwestward drainage from Port Hammond to the Pitt River, has been described

as a late autumn salmon and duck hunting camp and dated to circa 3,000 years B.P. The Park Farm site (DhRq 22), located in the town of Pitt Meadows (3.5 km south of the Alouette River and 3.3 km north of the Fraser River), shows signs of human occupations spanning four millennia and starting over 4000 years ago.

Very few archeological assessments have been conducted in the vicinity of the Alouette River. However, a predictive model was developed for the general area south and north of Chilliwack, and two archaeological impact assessments and one archaeological overview assessment have been conducted in the Alouette River region.

- A Predictive Model has been proposed for the areas south and north of Chiliwack including the Alouette River. The predictive model was accessed on the Ministry of Tourism, Sports and the Arts Remote Access Archaeological Data (RAAD). Based on the predicative model, the entire study area is identified to have high archaeological potential.
- An impact assessment of the rehabilitation of the Aloutette dam spillway yielded three new sites DhRo 7, DhRo 8 and DiRo 1 (Preckel and Howe 1991). DhRo 8 and DiRo 1 are both located on the shores of Alouette Lake and were identified based on surface lithic scatters. DhRo 7 is located adjacent to the Alouette River and was excavated producing 55 lithic artifacts including flakes, cobble spalls and cores.
- A recent inventory and impact assessment of a large agricultural facility was conducted at the confluence of the North and South Alouette River (Franck 2005). This assessment evaluated three existing sites including DhRp 11 (the Caruthers Site), DhRp 10 and DhRp 18. In addition, 14 new sites (DhRp 53-66) were identified. Concentrations of fire altered rock and lithic artifacts dominate these sites, though several wet deposits were also recorded. The site density clearly represents a continued and long term use of the area.
- An archaeological overview assessment was conducted for a proposed freeway alignment including two crossings of the Alouette River (Zacharias 1991). One of the proposed Alouette River freeway crossings was northeast of the current study area, while the second was very close to the current preliminary alignment at 128th Ave. Potential for fishing and fish processing sites on the river was predicted be high, and an archaeological impact assessment was recommended but never conducted (Zacharias 1991).

A number of traditional use sites have been documented in the region surrounding the study area. Most of these are located along the Pitt River, Pitt Lake and Fraser River and represent geographical features, habitation sites, resource procurement sites and places of mythological significance. One site of mythological significance, called Pɛ'lɛxən, is located within the study area. This place is the location where a one-legged man was changed to stone by the Transformer to become the master of the fish that ascend the Alouette River (Suttles 1955). The rock is located in an

area locally known as Davis' Pool which occurs in the South Alouette River between the two alignments.

4.0 REGULATORY REQUIREMENTS

The following is a discussion of the federal and provincial regulatory requirements related to the proposed bridge over the South Alouette River.

4.1 Federal Legislation

4.1.1 Canadian Environmental Assessment Act

At the federal level in Canada, the requirement for an environmental assessment (EA) arises through the requirements of the *Canadian Environmental Assessment Act* (*CEAA*) and its supporting regulations. *CEAA* requires the Government of Canada to consider the environmental effects of proposed projects before making a decision or exercising any regulatory power in association with a project. The federal environmental assessment process is generally triggered in one of three scenarios.

1. The project is located on federally owned or administered lands (such as an Indian Reserve, National Defence lands or National Park lands).
2. The federal government provides funding or is the proponent of a project. OR
3. Federal permits and/or authorizations specifically identified in the Law List Regulations pursuant to *CEAA* are required in respect of a project.

Where a department of the federal government has an interest in a project, it is called a Responsible Authority under *CEAA*.

After it has been determined by the Responsible Authority that an EA is required under *CEAA*, the EA process can be broken down into seven stages as follows.

1. Establish the scope of the assessment
2. Prepare a description of the existing conditions
3. Identify potential interactions, issues, and concerns
4. Develop residual environmental effects evaluation criteria
5. Conduct the effects analysis and predict residual environmental effects after application of mitigation
6. Conduct the cumulative effects assessment
7. Undertake any required monitoring and follow-up programs

CEAA requires that the analysis of potential effects is conducted for each Project phase (including potential malfunctions and accidents).

4.1.1.1 *CEAA* Applicability

A review of the proposed alignment options for the South Alouette Bridge indicates that an Environmental Assessment (EA) under *CEAA* will likely be required for either alignment option. It is expected that Fisheries and Oceans Canada (DFO) and Transport Canada would require formal authorizations under the *Fisheries Act* and the *Navigable Waters Protection Act*, respectively, and this will trigger *CEAA*. Consultation with DFO and Transport Canada should be conducted to determine the scope of the EA that will be required.

4.1.2 Fisheries Act

Under the authority of the Federal *Fisheries* Act, Fisheries and Oceans Canada (DFO) has decision making authority for the conservation and protection of fish and fish habitat. The main provisions of the Act dealing with the protection of fish habitat are sections 35 and 36. Section 36 states that no one is permitted to deposit a deleterious (i.e., harmful) substance into water supporting fish. Subsection 35(1) of the *Fisheries Act* states that: "no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat (HADD)." However, subsection 35(2) qualifies this prohibition, in that it allows for the Authorization by the Minister of Fisheries and Oceans, or through regulation, of the alteration, disruption or destruction of fish habitat (HADD). Operationally, decisions on whether subsection 35(2) authorizations are issued are made by regional Habitat Staff within Fisheries and Oceans Canada.

In practice almost all works that directly impact a stream, river or lake or the adjacent riparian areas could be considered a HADD of fish habitat. Under current BC guidelines, this includes any clearing or other physical work occurring within 30 m of the top-of-bank of a watercourse that supports fish, potentially supports fish or flows year-round, and 15 m of the top-of-bank of a watercourse that is intermittent or ephemeral and does not support fish.

Environmental assessments triggered by section 35(2) of the *Fisheries Act* require more information to achieve an approval than those initiated by another trigger (e.g., *Navigable Waters Protection Act)*. DFO pursues a 'net gain' policy for the management of fish habitat, in which conservation, restoration and habitat development are key goals (Department of Fisheries and Oceans 1986). Conservation of existing fish habitat is guided by the 'no net loss' principle, which commits DFO to balance unavoidable habitat loss with habitat replacement on a project-by-project basis.

Where a development will result in an impact to fish habitat, compensation can be provided through habitat creation initiatives or restoration which contribute to increasing the productive capacity of fisheries resources and achieve a 'net gain' of fish habitat. As a result, DFO review of an environmental assessment requires a

capacity of like-for-like habitat in the same ecological unit. In the case of like-for-like compensation, DFO typically requires a habitat compensation ratio of 2:1 (replacement to loss) although it can vary from this ratio.

Potential habitat compensation activities within the watersheds of Bosa and Latimer creeks include:

- replacement of unembedded closed bottom culverts with open bottom arch culverts or embedded closed bottom culverts;
- construction of jump pools to improve upstream fish passage past the 2 m tall falls located in Bosa Creek at its confluence with the South Alouette River;
- increasing the cover and instream habitat complexity of the channelized reach of Bosa Creek along 128th Avenue; and
- re-planting and stabilization of sediment sources created by development along Latimer Creek (e.g., on the west side of 239th Street, north of 128th Avenue, and at Meadowridge School on 240th Street, Davies 1996).

For the South Alouette River, in the immediate vicinity of the proposed bridge crossing, no habitat compensation options are known to exist. To identify nearby compensation opportunities, it is recommended that the proponent conduct field reconnaissance over a broader area and consult with local stakeholders and stewardship groups. Groups to consult could include the Katzie First Nation, DFO, the Ministry of Environment, the ALLCO Hatchery, the Alouette River Management Society, the Balahanian Creek Streamkeepers, and BC Hydro. Past habitat compensation work completed in other reaches of the South Alouette River has included placement of large woody debris and creation of off channel habitat.

4.1.3 Navigable Waters Protection Act

The *Navigable Waters Protection Act* regulates activity in, around, under and over navigable waters. Section 3 provides that no work shall be built or placed in, upon, over, under through or across navigable waters unless the work and site plans have been approved by the Minister of Transport. Under the *NWPA* work is defined to include such structures as bridges, dams, wharfs and telegraph or power cables and the dumping of fill or excavation of material from the bed of a navigable river. Navigable water is not defined in the Act however watercourses navigable by raft or canoe will likely be considered navigable under the *Act*.

4.1.3.1 Navigable Waters Protection Act Applicability

Based on the channel width and length of the South Alouette River Jacques Whitford anticipates that Transport Canada would consider it to be navigable. As the South Alouette River crossing location is likely navigable, the proposed construction of a bridge crossing at this location would require review under the *Navigable Waters Protection Act*. As bridges are named works under the *NWPA*, it

significant level of engineering detail to quantify effects and sufficient detail on habitat compensation opportunities to ensure that a 'net gain' of fish habitat is achieved.

4.1.2.1 Fisheries Act Applicability

It is expected that at a minimum DFO will require a subsection 35(2) Authorization for the new bridge over the South Alouette River. It is recommended that DFO be provided with the opportunity to comment on all the following project components.

240th Street Alignment:

- Construction of new bridge crossing over the South Alouette River (Site 7 on Figure 2);
- road improvements and upgrade of existing crossings of Latimer Creek (Site 1 on Figure 2) and unnamed Trib No. 2 of Latimer Creek (Site 3 on Figure 2);
- new crossings at unnamed Latimer Creek Trib No. 3 (Site 4 on Figure 2) and the Linear Wetland (Site 5 on Figure 2); and
- new road paralleling unnamed South Alouette River Trib No. 1 (Site 6 on Figure 2) for approximately 200 m.

128th Avenue Alignment:

- Construction of new bridge crossing over the South Alouette River (Site 11 on Figure 2);
- road improvements and upgrade of existing crossing of Bosa Creek (Sites 8 and 9 on Figure 2)
- new crossing of Alouette River Trib. No. 2 (Site 10 in Figure 2); and
- new road paralleling Bosa Creek for approximately 195 m.

As it is expected that a 35(2) Authorization will be required, *CEAA* will also be triggered by the project.

Consultation with DFO regarding the proposed bridge options could determine if DFO could issue a Letter of Advice rather than a Section 35(2) Authorization. A Letter of Advice states that a Section 35(2) Authorization can be avoided (*i.e.*, temporary effects will be minor and permanent effects will be negligible) given that certain conditions, such as instream-works reduced risk windows, are met. Project review through a Letter of Advice would not trigger *CEAA*.

Instream work (i.e., within the high water mark) would need to occur during the Instream Reduced Risk Window of August 1 to September 15.

In order for DFO to issue a subsection 35(2) Authorization under the *Fisheries Act*, Maple Ridge would have to commit to a habitat compensation plan that would create or enhance enough habitat to meet DFO's "no net loss" guiding principle. DFO's preference for habitat compensation is to create or increase the productive

is expected that the "Formal Approval Process" will be required and, as such, the project would trigger a *CEAA* assessment. Consultation with Transport Canada could determine if an informal Work Assessment could be conducted, avoiding the Formal Approval Process and avoiding triggering *CEAA*.

Based on the findings of the October 5, 2007 site visit, it is not anticipated that Transport Canada would consider any other watercourse along either alignment option to be navigable. As such the regulatory risk with regards to the NWPA is considered equal for both alignment options.

4.1.4 Migratory Birds Convention Act

The intent of *Migratory Birds Convention Act* (*MBCA*) is to protect migratory birds during the nesting season and while on their way to and from their breeding grounds. The *MBCA* is administered by the Canadian Wildlife Service (CWS), which is a branch of Environment Canada. The provisions of the *MBCA* protect migratory birds by:

- regulating the hunting of migratory birds;
- prohibiting the destruction of eggs and active nests of migratory birds; and
- prohibiting the deposit of oil, oily waters and any other substance in any waters or areas frequented by migratory birds.

The *MBCA* also authorizes the government to pass regulations protecting waters frequented by migratory birds.

4.1.4.1 Migratory Birds Convention Act Applicability

Since there are several species of migratory birds that may occur in the vicinity of the Project, the MBCA would apply. When undertaking vegetation clearing during the breeding period (March 1 to July 31), the area will need to be surveyed for the presence of migratory birds, and/or nests of migratory birds. If nests are found and it is determined that the activity could damage or disturb nests, the activity will need to be either re-scheduled or altered to avoid such damage.

4.1.5 Species at Risk Act

The *Species at Risk Act* (*SARA*) was enacted to meet one of Canada's commitments under the International Convention on Biological Diversity and is administered by CWS. The goal of the *Act* is to prevent endangered or threatened wildlife from becoming extinct or lost from the wild, and to help in the recovery of these species. It is also intended to manage species of special concern and to prevent them from becoming endangered or threatened.

SARA is not a specific trigger for *CEAA* but can have a major influence on the environmental assessment process. Species of flora and fauna that are listed in Schedule 1 of *SARA* are protected on federal lands as of February 27, 2006.

Although *SARA* applies primarily to all federal lands in Canada, there are provisions of *SARA* that can be applied to private and provincial crown lands where appropriate or deemed necessary to meet recovery plan efforts. In British Columbia, the interpretation of species at risk is simplified using the Red and Blue listings. Species that are provincially listed as Red or Blue have been identified as requiring special consideration for a more formal designation as Endangered or Threatened.

SARA most often increases and supplements the level of effort in relation to baseline environmental investigations that support environmental assessments. Specifically, proponents may anticipate the need to determine presence of listed species and critical habitat within the proposed development areas.

4.1.5.1 Species at Risk Act Applicability

As the Project is expected to trigger an assessment under *CEAA*, *SARA* will likely play a role in the scoping of the EA that will be required approval process. The EA may include more detailed baselines investigations as well as mitigation measures to protect *SARA* listed species.

4.2 Provincial Legislation

4.2.1 Water Act

The *Water Act* regulates the licensing, diversion, storage and use of fresh water in BC and makes provision for the alteration of natural watercourses or sources of water supply. Provisions within the *Act* pertain to any activity that could affect either the volume of water flowing within a watercourse (e.g., water use) or the morphology of the watercourse channel (e.g., construction of a bridge, installation of a culvert or intake structure, realignment of a creek channel or stabilization of a stream/river bank with any significant volume of rip rap).

Part 7 of the Water Regulation ensures protection of water quality, wildlife habitat and other water users from works performed in and about a watercourse. Guidelines have been developed by the Ministry of Environment to provide direction for conducting work in or near watercourses to ensure compliance with the Regulation. If works can be completed in compliance with Part 7 of the Water Regulation an approval need not be obtained, however a *Water Act* Notification would be required.

The Water Stewardship Division of the Ministry of Environment has the responsibility for water licensing and Water Act approvals. An approval or license must be obtained prior to any work being carried out in a stream or river. The vast majority of water use licenses are issued for domestic, irrigation or waterworks purposes. Other purposes include industrial, power, conservation, mining, stock watering and land improvement purposes.

4.2.1.1 Water Act Applicability

Water Act Notifications would need to be submitted to the Ministry of Environment for the constructions of road crossings by clearspan bridge or culvert. Unless the proposed bridge over the Alouette will be a clearspan structure, its construction will require a *Water Act* Approval from the Ministry of Environment. Instream work (i.e., within the high water mark) would need to occur during the Instream Reduced Risk Window of August 1 to September 15.

4.2.2 Wildlife Act

The Wildlife Act protects the active nests of indigenous bird species and the nests of Bald Eagle (Haliaetus leucocephalus), Peregrine Falcon (Falco peregrinus), Gyrfalcon (F. rusticolus), Osprey (Pandian haliaetus), Heron (Ardeidae spp.) and Burrowing Owl (Athene cunicalaria), whether the nests are active or inactive. Sections 5 and 6 protect prescribed species and their habitat from harm. In addition, under the Wildlife Act, if a person wounds a native wildlife species, other than prescribed wildlife, the event and the location of the wildlife in question must be reported to a Conservation Officer. If a person fails to do so, it is an offense under the Wildlife Act.

4.2.2.1 Wildlife Act Applicability

A detailed raptor and heron nest survey should be completed prior to the construction phase of the proposed new bridge crossing. Raptor and heron nests, and the active nests of other birds, will have to be avoided during construction of the Project. The avoidance of active bird nests can be achieved by scheduling vegetation clearing to occur outside the breeding period of March 1 to July 31. If avoidance of nests is not possible, Approval under the *Wildlife Act* will have to be obtained.

4.2.3 Heritage Conservation Act

The purpose of the *Heritage Conservation Act* is to encourage and facilitate the protection and conservation of heritage property in British Columbia. The *Act* protects archaeological sites predating 1846, whether they are located on either public or private land. Section 13(2) of the *Act* states that archaeological sites may not be destroyed, excavated, or altered without a permit. It also states that anyone conducting ground disturbing activities is required to avoid impacting protected archaeological sites, regardless of whether or not these sites have been previously identified or disturbed. The *Act* is administered by the Archaeology Branch in the Ministry of Tourism, Sport and Arts.

4.2.3.1 Heritage Conservation Act Applicability

The study area is considered to have high archaeological potential. Ethnographically identified village locations lie west of the study area and the terraces of Alouette River and Latimer Creek could yield habitation sites and/or fishing and fish processing sites. Given the presence of a location of mythological

significance within the study area, pools within the river could also have been used for spiritual purposes such as retreats or ritual bathing.

Due to this high archaeological potential, a detailed archaeological impact assessment is recommended for both preliminary bridge alignments to comply with the provincial *Heritage Conservation Act*. The objectives of the detailed impact assessment are to identify and evaluate the heritage resources within the proposed development area, and to assess possible impacts from the development on these sites.

5.0 WORK PLAN

5.1 Approach

Task 1 – EA Scoping and Consultation with Regulators

The District's Environmental Consultant will consult with Transport Canada and DFO regarding the preferred alignment option to determine the scope of the *CEAA* Screening that is anticipated for the proposed crossing.

Task 2 – Biophysical Assessment

Based on the scope determined in Task 1, the Environmental Consultant will conduct the required Biophysical Assessment for the preferred alignment option. This is expected to include a detailed fish and fish habitat assessment. It may also include a rare plant survey (to be conducted in the spring) and wildlife habitat assessments. These studies will be design to collect the information necessary to prepare an application for a *CEAA* Screening and all other permitting required.

Task 3 – Heron and Raptor Nest Survey

To ensure Project compliance with the *Wildlife Act*, a survey of heron and raptor nests is recommended for all areas within 50 m of where vegetation clearing may occur including the footprint of road improvements, watercourse crossings and temporary work spaces. If vegetation clearing is to occur within the bird breeding period, then a nest survey for all bird species should be conducted. Strategies to minimize and/or mitigate potential effects to bird nests (e.g., construction schedule or design changes) will be recommended as necessary.

Task 4 – Archaeological Impact Assessment

There is high archaeological potential along the Alouette River and, therefore, to comply with the provincial *Heritage Conservation Act,* a detailed archaeological impact assessment is recommended for both preliminary bridge alignments. It is suggested that a single permit be acquired for the study area to include municipal and private lands so that archaeological work can be completed under one B.C. government permit. A Sto'lo Nation permit is also required for archaeological investigations in this region.

An in-field evaluation of archaeological potential will ascertain the intensity of shovel testing required. Systematic shovel testing will be conducted in areas of perceived archeological potential; such banks of creeks and rivers, level toped ridges and well drained knolls. Wetlands in this region are known to have potential for wet site cultural deposits. Wet deposits may require deep testing, or machine assisted testing. Even within areas disturbed by housing, industrial and agricultural developments, cultural deposits/materials may still be present.

These recommendations apply solely to physical archaeological evidence of past human activity and in no way attempts to encompass any traditional land use or heritage concerns of the various First Nations people with traditional territories in the study area. Considering the presence of an ethnographically recorded site of mythological significance, consultation with First Nations should be initiated to determine the need for a Traditional Use Study of the project area.

Task 5 – Environmental Assessment and Permitting

An application for *CEAA* Screening would be prepared and submitted to Transport Canada and DFO for the preferred alignment. This *CEAA* Screening application would also be an application for Authorization under the *Fisheries Act* (including habitat compensation) and approval under the *Navigable Waters Protection Act*. Applications for *Water Act* approval/notification would be submitted to the BC Ministry of the Environment for the new crossing over the Alouette River and any other changes in and about a stream required for the preferred alignment. The results and recommendations of the detailed archaeological assessment would be detailed in an additional stand-alone report and summarized in the *CEAA* application..

Task 6 – Liaison with Associated Engineering, Maple Ridge, DFO, Transport Canada, Ministry of Environment and the Archaeology Branch

The project scientists would attend meetings and liaise with the project engineers, the District of Maple Ridge, DFO, the Canadian Wildlife Service, Transport Canada, the Ministry of Environment and the Archaeology Branch, as required to obtain the necessary permits and approvals.

5.2 Schedule and Effort

It is anticipated that instream construction work for this project would occur during the instream work window of August 1 through September 15, 2009. To ensure adequate time for regulatory consultation, approval and construction tendering; applications to DFO (*CEAA* Screening and Authorization), Transport Canada (for *NWPA* Approval) and the provincial Ministry of the Environment (*Water Act* approval) should be submitted no later than seven months prior to the start of construction (i.e., February 1, 2009). This schedule assumes four months for regulatory review and three months to complete the construction tendering, contract and mobilization. These applications will require detailed design drawings (i.e., 75%

complete) for the proposed works. These recommended submission dates should provide the District with adequate time to receive and respond to feedback from the regulatory agencies.

Table 5-1 Summary of Schedule Required by Task

Task	Schedule
Liaison With Engineers, the District, and Regulators	July 2008 – October 2009
EA Scoping and Early Consultation with Regulators	July 2008 – October 2008
Biophysical Assessment	October 2008
Raptor and Heron Nest Survey	November 2008
Archaeological Impact Assessment	October – November 2008
Environmental Assessment and Permitting	December 2008 – May 2009
Complete EA and Permit Application	December 2008 – January 2009
Submit Completed EA and Permit Applications	January 2009
Complete EA Review and Permitting Process	May 2009
Construction Tender, Contract and Mobilization[1]	May – July 2009
Reduced Risk Instream Work Window	August – September 2009
Total	July 2008 – October 2009

[1]Construction Tendering, Contract and Mobilization task to be completed by the District of Maple Ridge or its representatives

The total estimated level of effort for the environmental assessment and approvals described above is 41.5 person-days (1 person = 8 hrs). The total cost, including professional fees and disbursements of about 20% of professional fees, is estimated to be $38,845 ± 20% (not including GST). This cost estimate does not include a rare plant survey, which may be required by the regulators after the EA scoping stage, or a breeding bird nest survey, which would be required if vegetation clearing was scheduled for the bird breeding window.

6.0 CLOSURE

This report has been prepared for the sole benefit of Associated Engineering and the District of Maple Ridge. The report may not be relied upon by any other person or entity without the express written consent of Jacques Whitford AXYS Ltd, or Associated Engineering. Any uses which a third party makes of this report, or any reliance on decision made based on it, are the responsibility of such third parties. Jacques Whitford AXYS Ltd and Associated Engineering (B.C.) Ltd. accept no responsibility for damages, if any, suffered by ay third party as a result of decisions or actions based on this report.

If you have any questions or concerns about this report, please do not hesitate to contact the undersigned.

Respectfully submitted,

Jacques Whitford AXYS Ltd.

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PW/JT/mp

[File Ref: P:_CMiC Projects\1027001_to_1028000\1027886 ESP - Associated South Alouette River Feasibility Study\Draft Report\1027886 Draft Report PW_JT 2.doc]

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APPENDIX A

Photographs

Photo 1. Upstream view of Latimer Creek from the upstream side of 240th Street.

Photo 2. Upstream view of Latimer Creek's Tributary No. 1, from Latimer Creek towards the proposed 240 Street alignment.

Photo 3. Upstream view of Latimer Creek's Tributary No. 2, at the proposed crossing location for the 240th Street alignment.

Photo 4. Upstream view of Latimer Creek's Tributary No. 3, at the proposed crossing location for the 240th Street alignment.

Photo 5. **The view looking east at the linear wetland, at the proposed crossing location for the 240th Street alignment.**

Photo 6. **The right downstream bank of Alouette River Tributary No. 1, within the 240th Street alignment, about 50 m upstream of the South Alouette River.**

Photo 7 Upstream view of the South Alouette River, at the proposed crossing location for the 240th Street alignment.

Photo 8 The view looking downstream at the origin of Bosa Creek, located within 12783 – 248th Street, about 20 m south of 128th Avenue.

Photo 9 **The view looking upstream at Bosa Creek from about 50 m upstream of the South Alouette River.**

Photo 10 **Downstream view of Alouette River Tributary No. 2, at the proposed crossing location for the 128th Avenue alignment.**

Photo 11 **The right downstream bank of the South Alouette River at the proposed crossing location for the 128th Avenue alignment.**

APPENDIX B

Archaeological Overview Assessment

ARCHAEOLOGICAL OVERVIEW ASSESSMENT

District of Maple Ridge, Alouette River Bridge Conceptual Layout
Maple Ridge, B.C.

Archaeological Overview Assessment
District of Maple Ridge, Alouette River
Bridge Conceptual Layout
Maple Ridge, B.C.

Prepared for

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December 2007

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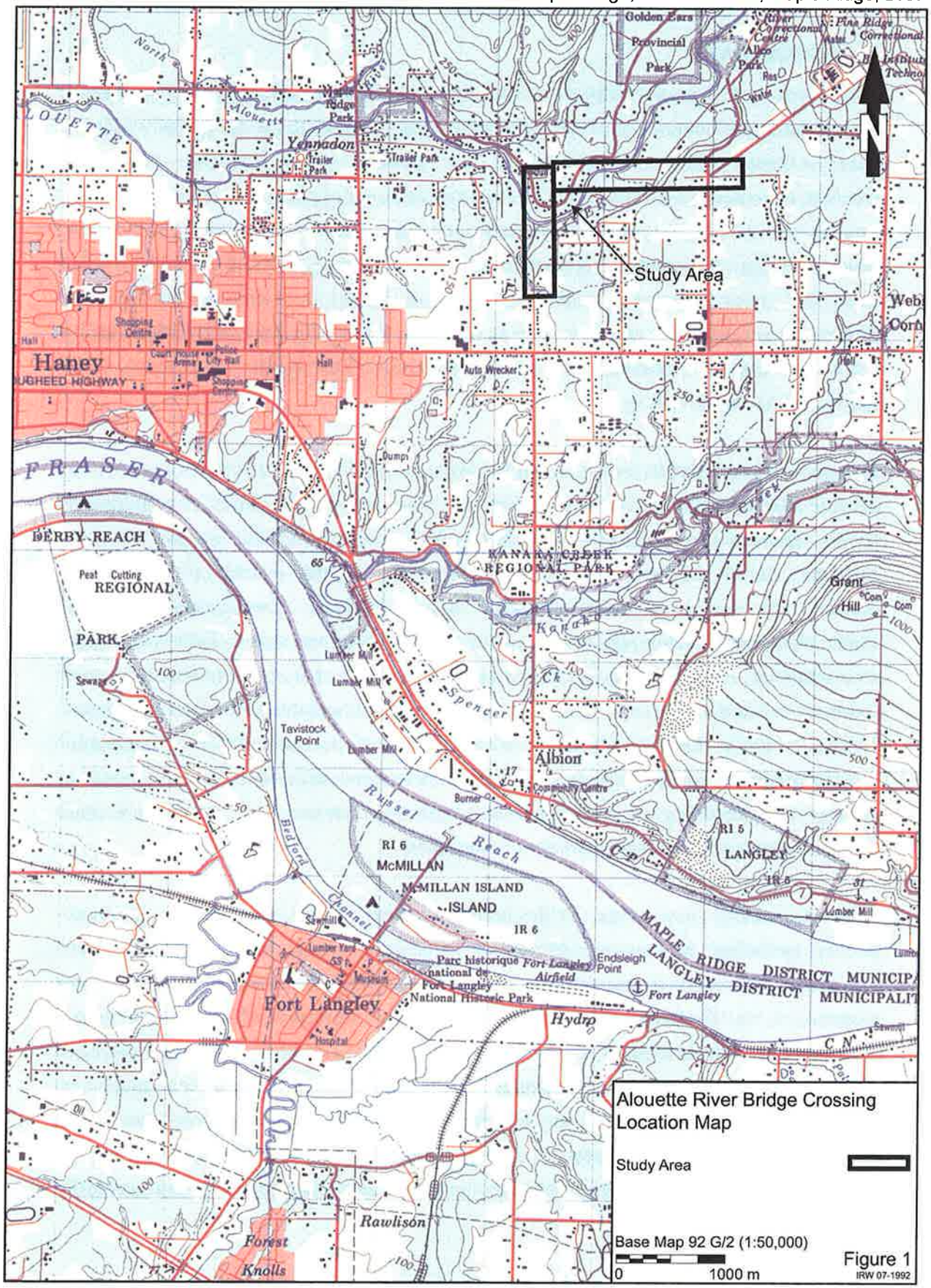
Table of Contents

1. INTRODUCTION

At the request of Jacques Whitford AXYS Ltd., I.R. Wilson Consultants Ltd. conducted an archaeological overview of two potential bridge alignments on the South Alouette River in Maple Ridge, B.C (Figure 1). One possible bridge alignment is oriented east/west, extending west along 128th Avenue and descending the south bank of the South Alouette River, crossing low-lying terrain on either side of the river. The second proposed bridge alignment is oriented north/south, extending north from 124th Avenue along 240th Street, crossing Latimer Creek and descending the south bank of the South Alouette River, crossing low-lying terrain on either side of the river. The project area is within the asserted traditional territory of the Katzie First Nation, Tsawwassen First Nation and the Sto'lo Nation.

Heritage sites and objects on private and Provincial Crown Land in British Columbia that predate 1846 are protected under the *Heritage Conservation Act*, which is administered by the Archaeology Branch of the Ministry of Tourism, Sport and the Arts. Heritage resources can be prehistoric in age (the time before written records) or they can be historic. They can be of North American Indian, European, Euro-Canadian or other ethnic affiliation. Ethnographic heritage sites are locations reported as having been used or occupied by Aboriginal people in the past, which may or may not contain any physical evidence for such an occupation or use. A reported ethnographic site found to contain physical evidence changes the site to an archaeological site enhanced by ethnographic information. Ethnographic sites with no corroborative physical evidence are not treated as heritage sites according to present heritage legislation. However, all ethnographic sites should be managed as a responsibility of developers.

There are usually three stages to the heritage resource impact assessment and review process; including an overview assessment, a detailed impact assessment, and impact mitigation. The overview assessment is intended to identify and assess heritage resource potential, or the likelihood that sites are present. The objectives of the detailed impact assessment are the identification and evaluation of heritage resources within a proposed development area, and also an assessment of possible impacts by the development on these sites. Impact mitigation is any course of action that results in the reduction or the elimination of the adverse impacts of a development. Mitigation, where required, usually involves site protection, project redesign or systematic data recovery, and normally involves archaeological excavation.


Study Area
N
Haney
Yennadon
Trailer Park
Golden Ears Provincial Park
Pine Ridge Correctional Centre
Alouette River
Alouette Park
Maple Ridge Park
Shopping Centre
Court House Annex
Police
City Hall
Auto Wrecker
Dump
Fraser
Derby Reach
Peat Cutting
Regional Park
Kanaka Creek Regional Park
Grant Hill
Lumber Mill
Spencer
Tavistock Point
Albion
Community Centre
Russel Reach
Bedford Channel
RI 6
McMillan Island
IR 6
Langley
Maple Ridge District Municipality
Langley District Municipality
Parc historique national de Fort Langley
Fort Langley National Historic Park
Fort Langley
Endsleigh Point
Airfield
Hydro
Museum
Hospital
Rawlison
Forest Knolls
Alouette River Bridge Crossing
Location Map
Study Area
Base Map 92 G/2 (1:50,000)
0
1000 m
Figure 1
IRW 07-1992

The present study was designed to satisfy the objectives of an archaeological overview assessment. The report does not address traditional use and First Nation consultation was not part of the review.

2. THE PROJECT

The proposed development is in preliminary planning stages and includes two separate conceptual layouts for bridge alignments on the South Alouette River in Maple Ridge B.C. (Figure 2). Option 1 is oriented east/west and extends west from 128th Avenue on the east side of Alouette River 1.45 km to 128th Avenue at Fern Crescent. Option 2 is oriented north/south and extends north from 124th Avenue on 240th Street 1.05 km to the intersection of 128th Avenue and Fern Crescent.

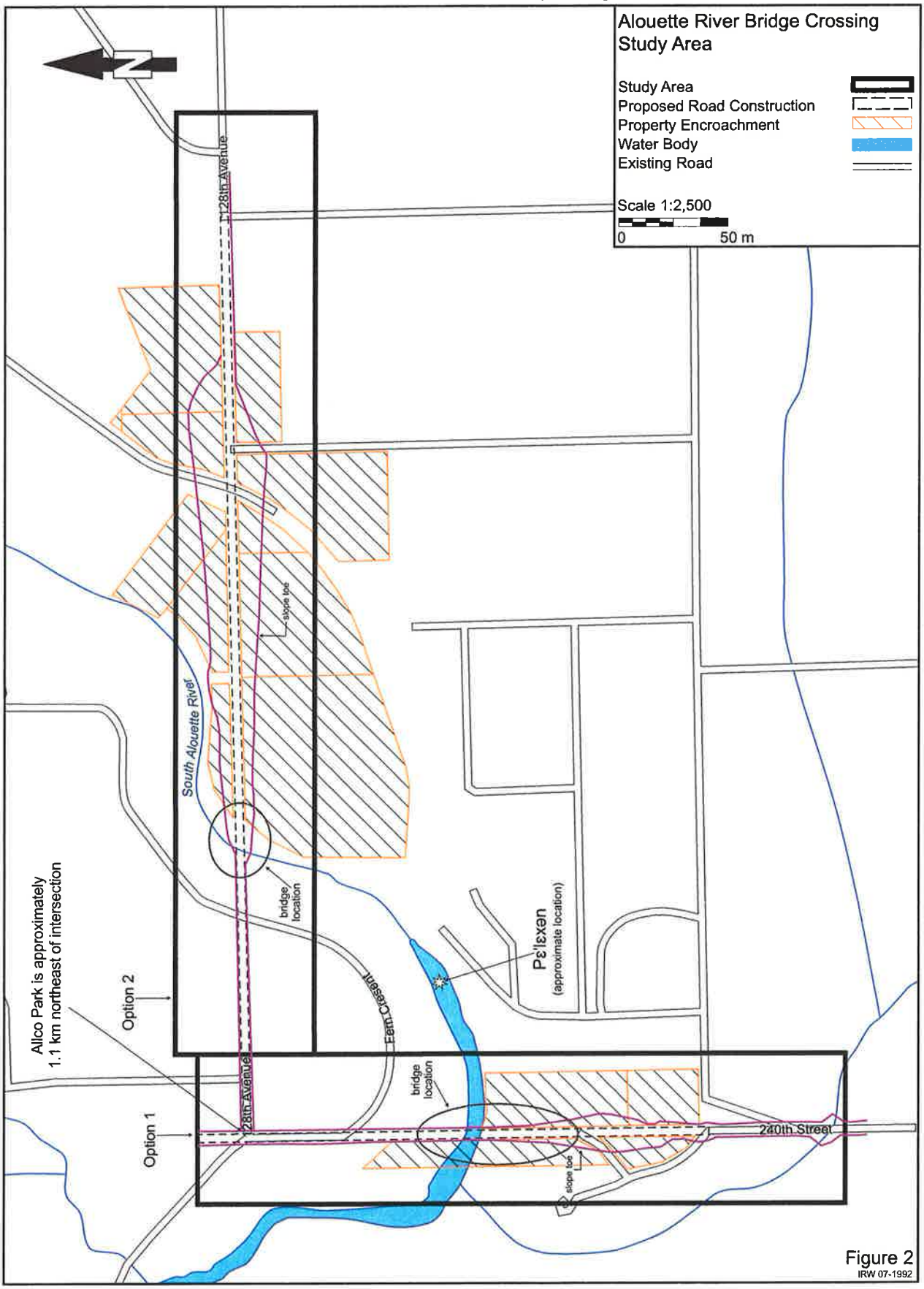


Figure 2
IRW 07-1992

3. METHODOLOGY

A review of archaeological predictive models in the study area was undertaken using the B.C. Government's Remote Access to Archaeological Data (RAAD). A file search of previously recorded archaeological sites was conducted at the Archaeology Branch of the Ministry of Tourism, Sport and the Arts to determine the location, nature and distribution of prehistoric and historic resources in the vicinity of the project area. A review of previous archaeological assessments in the vicinity of Alouette River was also completed. A review of background literature dealing with anthropology, history, archaeology and paleoenvironment of the study region was conducted to place the study area in a cultural context.

4. PROJECT AREA

4.1 Natural History

The Alouette River drains from the Coast Mountains within Golden Ears Park and flows into the northeast end of Alouette Lake. From the south end of Alouette Lake, the river divides into the North and South Alouette rivers. The South Alouette River flows through glacial sediments in a southwesterly direction to a ridge of glacial sediments where it is diverted to the west (Driver 1998). From here the South Alouette River flows west and converges with the North Alouette River. The South Alouette River continues west for 2.5 km until it converges with the Pitt River in the Pitt Lowlands. The Pitt Lowlands and South Alouette River were originally part of a slough system which is now dyked.

The geological history of the Alouette drainage area is complex. The Alouette region was covered by glacial ice between 25,000 years ago and 19,000 years ago. As the ice began to melt, coniferous forests of spruce and fir appeared in the lowlands. Between 17,500 and 14,500, glacial ice re-advanced over the lowlands. Following glacial retreat after 14,500 years ago, ocean levels rose up to 200 m above current ocean levels and much of the lowland areas along the Alouette River were covered in ocean waters. This higher sea level left thick deposits of marine clays that extend from the south end of Alouette Lake into the study area. A second glacial advance occurred between 11,500 and 11,000 years ago, after which ocean levels have remained roughly the same (Driver 1998). Pollen and plant microfossils have provided a detailed record of the vegetation and climatic changes in the Alouette region from 12,000 years ago. The microfossils indicate that following 12,000 years ago, lodgepole pine was the dominant coniferous vegetation in the Alouette River area, with small amounts of fir, spruce and alder. The pine began to decline around 10,300 years ago to be replaced by an increase in Douglas fir. Between 7,500 to 6,000 years ago, the climate became cooler and wetter, with western hemlock and cedar emerging as the dominant forest cover (Driver 1998).

The study area is in the Coastal Western Hemlock Biogeoclimatic Zone (Pojar *et al.* 1991). The climate within this region is characterized by cool temperatures and high rainfall. Western hemlock, western redcedar and Douglas fir dominate coniferous forests at lower elevations, while yellow cedar and amabilis fir are more common at higher elevations. Deciduous tree species include maple, red alder and cottonwood. Species of native wildlife common in this biogeoclimatic zone include black tailed deer, black bear, cougar and Roosevelt elk as well as a variety of smaller land mammals. Common birds

and waterfowl include blue grouse, pileated woodpecker, Steller's jay, raven, great blue heron, mallard, hooded merganser, glacous gull and Canada goose.

4.2 Ethnography and Ethnohistory

The study area falls within the traditional territory of the Katzie First Nation (Duff 1952; James 1998; Rozen 1979; Suttles 1955). The Katzie are a Coast Salish division of the Halq'emeylem language dialect. The mainland Halq'emeylem, or Halkomelem, include the Lower Fraser or Sto'lo. Dialects of the language are also spoken from Malahat to Nanoose who are part of the Island Halkomelem on Vancouver Island .

The principal winter village of the Katzie is known to have been located on the north bank of the Fraser River near Port Hammond. The name Katzie is said to have derived from this village (Suttles 1955). Most researchers have suggested that the villages were occupied for approximately half the year though archaeological evidence suggests year round use in many areas, perhaps at differing levels of intensity. Houses were typically plank houses with sloping shed roofs, though there are some reports of pit houses used in the Alouette region (Duff 1952). In the spring the eulachon would arrive on the Fraser River and the eulachon harvest would last a few weeks. As the spring waters rose, the Fraser River would flood the winter village and the Katzie dispersed to fish sturgeon from the Alouette River, Sturgeon Slough, Pitt River and Pitt Lake. Fish weirs were used on the Alouette River during the summer salmon run (Suttles 1955). A series of sloughs once joined Alouette River to Pitt River. The sloughs and the Alouette River were navigable by canoe and used to access resource procurement locations. In late summer the Katzie would return to the Fraser River to fish salmon and harvest cranberries, wapato and other plants from the Pit Lowlands. Late fall was the time for hunting land mammals prior to returning to the winter village.

The Katzie used a wide variety of objects including tools, weapons and hunting and fishing gear. These objects were manufactured by flaking stone, grinding slate and working bone, antler and shell. Plant materials were extremely important, with western redcedar being used for houses, canoes, boxes, clothing, bags, baskets and mats (Duff 1952; Suttles 1955). Blankets and clothing were sometimes woven from materials which include the hairs of dogs and mountain goats (Schulting 1994).

4.3 Archaeology

Limited archaeological survey has been conducted on the Alouette River. However, excavations conducted at the Glenrose Cannery site on the Fraser River and at three sites within the Alouette drainage including the Caruthers site (DhRp 11), the Park Farm site (DhRq 22) and the Telep site (DhRq 35) have yielded an archaeological sequence relevant to the area. The Alouette River area has been divided into five distinct periods (Reimer 1998) including the Old Cordilleran (10,000-4,500 years ago), Charles (4,500 – 3,300), Locarno Beach (3,300 – 2,350), Marpole (2,300-700) and Stselax (700 to contact). This sequence has been applied to the entire lower mainland for many years (e.g. Hamm *et al* 1984).

The Caruthers site (DhRp 11) is the closest site to the study area and is located in the low, flat lands between the North and South Alouette rivers, approximately 7.5 km west of the proposed project. It was excavated by Crowe-Swords (1974: 159) who interpreted it primarily as a hunting and gathering base and secondarily as a fishing camp. The site consists of seven distinct mounds. Materials collected from the site include ten wooden stakes from approximately 75 cm below surface. The artifact assemblage reflects similarities with Marpole and Developed Coast Salish (Whalen II and Stelax) assemblages, and was assigned to the period A.D. 400-800 (Fladmark 1982:121). In 2003, testing of the site resulted in the recovery of over 400 artifacts. The site has been significantly disturbed by agricultural developments (Franck 2003).

The Telep site (DgRq 35) is located in the lowland area near the northwestward drainage from Port Hammond to Pitt River. Peacock (1981) excavated the site in 1980-81, and described it as a late autumn salmon and duck hunting camp. The site was radiocarbon dated to circa 3,000 years before present (B.P.) and assigned to the Locarno Beach phase. Although this period is generally assumed to have a predominant maritime focus, there is also significant evidence for the movement of people along the Fraser River and for seal hunting in the Fraser Valley at this time. Peacock (1981) thus supports the assignment of the site to the Locarno Beach culture. Based on this, and on a similar interpretation at the Pitt River site, he also suggests that the supposed maritime emphasis of the period may need to be reassessed (Peacock 1981:226;230). In 2003, exploratory trenching revealed that most of the site had been impacted and destroyed in the mid-1980s (Rousseau and Will 2003).

The Park Farm site (DhRq 22) was first noted in 1982 during the construction of a barn (Spurgeon 1984). The site is located in the town of Pitt Meadows, 3.5 km south of the Alouette River and 3.3 km north of the Fraser River. Subsequently the site has been evaluated in 1984, 1992, 1994, 1996, 1998 and 2006 (Spurgeon 1984, 1992, 1994, 1996, 1998; Bond and Gordon-Walker 2006). Occupations at the site span four millennia and four culture phases from Charles to Coast Salish/ Stselax. Carbon samples recovered at the site successfully dated the earliest occupation at the site to over 4,000 years ago (Spurgeon 1984). Approximately 1,500 artifacts have been recovered and include a variety of stone projectile points, biconically perforated stone beads, pebble and cobble tools, stone knives, scrapers and abraders, hammerstone and bipolar crystal artifacts and massive quartz cores.

Duff (1956) documented artifacts recovered from near the Alouette River. A seated human figure bowl was collected from the edge of the south bank of the Alouette River in the 1930s. A local landowner collected another seated human figure bowl in 1953 from a ploughed field between Kanaka Creek and the Alouette River.

4.4 History

The Alouette River was referred to as the Lillooet River until 1914, and is identified as such on Harris' 1905 map of New Westminster and in the Gazetteer. The name was changed to avoid confusion with the Lillooet River flowing into Harrison Lake (G.P.V and Akrigg 1997). The Alouette River is included in the British Columbia Heritage Rivers Program (Ministry of Environment) due to its significance to the cultural heritage of the area.

Settlers had arrived and established farms on the Alouette River starting in the late 1800s. By the early 1900s, much of the land had been cleared and settled. A large number of the farms and industries in the Alouette drainage were owned by Japanese families up until World War II (Zacharias 1991). Alouette Lake was dammed in 1913 by BC Hydro and Power Authority which ceased the salmon spawn that had previously existed. Between 1915 to 1930 the Abernethy-Lougheed Railway crossed the Alouette River in the vicinity of the current 128th Avenue preliminary bridge alignment (Zacharias 1991). The headquarters of the Abernethy-Lougheed Logging Company was located on the Alouette at the present location of Allco Park which is 1.1 km northeast of the corner of 240th Street and 128th Avenue.

4.5 Site Types

Site types commonly recorded in the study region include habitation sites, subsistence feature sites, lithic scatters, culturally modified trees (CMTs), trails, rock art and historic sites. Many of these site types are easily recognizable with the exception of wholly and partially buried lithic scatters of stone tools. Sites may be made up of one or several of these components.

4.5.1 Habitation Sites

Prehistoric habitation sites are most common in locations adjacent to or in the immediate vicinity of bodies of water, most commonly large streams, lakes and rivers but also gullies, creeks and other small drainages. They can be indicative of large-scale villages or short-term procurement camps. Habitation sites in the Alouette region can be identified by the presence of cultural mounds (such as at DhRp 11), cultural depressions and post holes, but are most notably recognized by a combination of functional descriptors such as cache pits, lithic scatters, human burials and rock art. Habitation sites are important for the study of past lifeways and generally have high heritage significance, particularly for ethnographically documented villages. The Park Farm site (DhRq 22), the Telep site (DhRq 35) and the Caruthers site (DhRp 11) all represent habitation sites comprised of a combination of functional descriptors.

4.5.2 Lithic Scatters

Lithic scatter sites consist of scatters of stone tools and/or flakes, the result of lithic raw material processing and tool production and/or tool maintenance. Isolated lithic and/or artifact finds are included in this category. These sites are distinguished from habitation sites because of their lack of structural remains and often by their less diverse artifact assemblages, the result of less intensive and more specialized activities than reflected at village sites. Lithic scatters are frequently identified by surface lithics, although archaeological subsurface testing is required to establish the boundaries and depth of the scatter. They can reflect activities such as procurement and/or processing of food or raw materials. They can also reflect seasonal or short-term campsites, lookouts or various other activities. DhRp 53, located 8 km west of the study area, is characterized by a lithic scatter.

4.5.3 Subsistence Features

Subsistence features can include cache pits, roasting pits or fish weirs. Like habitation sites, cache pits (subterranean storage pits) and roasting pits are often found in the vicinity of a water source and are often a component of larger, multi-function sites. Fish weirs or traps are associated with rivers and creeks, but are also found in coastal settings. Subsistence features may also be associated with temporary hunting or fishing camps away from principal habitation sites. Clay lined pit features have been identified at the Caruthers site (DhRp 11), though their exact function is unknown (Franck 2005).

4.5.4 Culturally Modified Trees

In the most general sense, culturally modified trees are any trees evidencing human modification. In a more specific and commonly used sense, CMTs are trees that have been modified by aboriginal people for traditional purposes such as for bark removal, for baskets, clothing, traditional building material and so on. Trees evidencing "non-traditional" aboriginal modification such as commercial logging by aboriginals using chainsaws are generally excluded from this category. Provincial guidelines suggest most CMTs be recorded as traditional use sites unless they pre-date AD 1846. Throughout the province, stripped cedar trees are among the most common of CMT types. The study area has largely been harvested of old growth timber and few CMT sites have been recorded.

4.5.5 Rock Art Sites

Rock art sites can be classified into two basic types: pictographs and petroglyphs. Pictographs are painted images and petroglyphs are pecked or ground images in rock. Pictographs are generally red ochre stained drawings often placed in highly visible locations. Images that have been recorded in the interior include human figures, faces, boats, animals, mythological figures, directional markers and abstract images. Petroglyphs, rare in the interior and mostly a coastal phenomenon, depict similar though not identical subjects to pictographs. Petroglyphs tend to be far more difficult to identify and are thought to have a greater potential time depth than pictographs because of factors of preservation. However, no studies have been undertaken to test this assumption and little is known regarding possible functional, temporal or cultural differences between pictographs and petroglyphs. Rock art sites have been recorded on Pitt River and Pitt Lake, though no such sites are recorded on the Alouette River.

4.5.6 Petroforms

Petroforms are culturally produced rock or stone alignments, markers or structures such as cairns or fish weirs. Petroforms are frequently functional in nature, such as fish weirs, dams and canoe skids, but can be associated with human burials, such as cairns. No petroforms have been recorded in the Alouette region. However, there is potential for petroforms to be present, particularly as fish weirs.

4.5.7 Human Burials

This category includes sites which contain material remains and features associated with prehistoric mortuary practices. Interments in the historic period can also be reported in association with recorded archaeological sites. Information about historic cemeteries or individual or family interments can often be acquired through documentary research and consultation with local residents.

Prehistoric burials are difficult to identify because of their generally unmarked nature, although cairns and other related structures can be associated with burials. No evidence of human remains are recorded in the Aloutte region. This may be largely due to the lack of preservation in the soil.

4.5.8 Trails

Trails within the general project area represent transportation corridors frequently following well traveled game trails around and to lakes, rivers, creeks and other geographical features. Because of their ambiguous nature, trails are rarely identified as archaeological sites, but instead are noted as historic and/or traditional land use features. It is assumed that historic and traditional use trails were present in the study area. However, disturbances due to agricultural, industrial and residential development would have obscured any physical evidence of trail locations.

4.5.9 Historic Sites

Historic sites relate to human activities during the time period documented by written records. Historic sites in the general study area primarily relate to resource extraction such as logging and agriculture, as well as ranching activities and small scale hunting and fishing. Sites can range from large complex sites which represent a wide range of activities to task specific sites which evidence little diversity in activity. Thus, the

scientific, historic, and ethnic significance of this site type varies greatly and should be assessed on an individual basis. Such research should take into account archaeological remains, standing structures, documentary evidence, historic significance (links to important events, individuals and developments in local, regional and national history), ethnic and economic significance. Current B.C. legislation requires archaeological evaluation of all sites older than 1846 and allows more flexibility with more recent resources. However, post-1846 sites may also require archaeological work and may be protected by legislation depending on the nature and significance of the deposit. For example, historic CMTs which have been modified by First Nation peoples can be recorded archaeologically as traditional use features.

Historic sites within the general area tend to be relatively large, representing the remains of early homesteads and early logging operations, such as the Abernethy-Lougheed Logging Operation headquarters located northeast of the study area.

5. RESULTS

5.1 Previous Archaeological Assessments

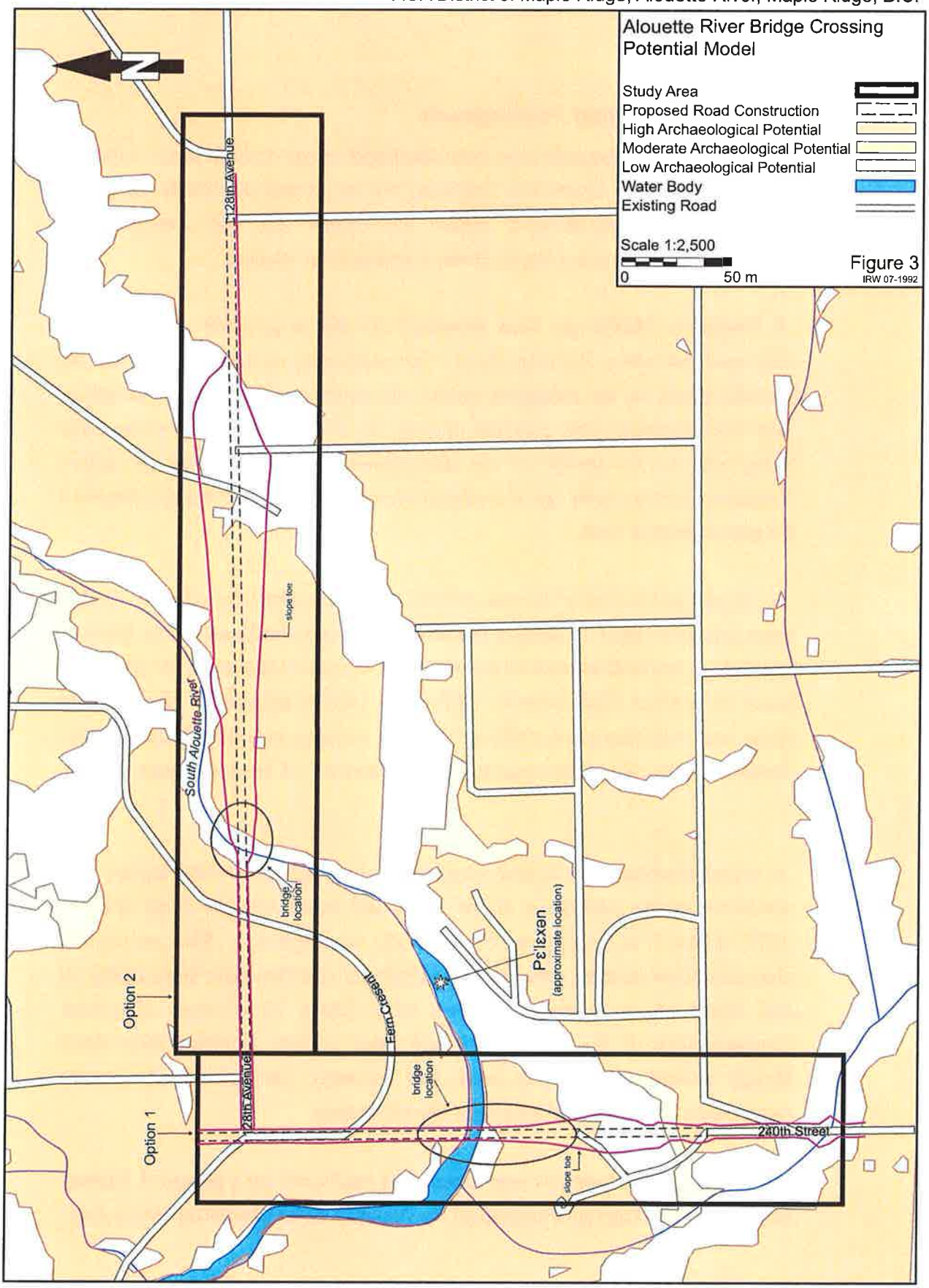
Very few archeological assessments have been conducted in the vicinity of the Alouette River. However, a predictive model was developed for the general area south and north of Chiliwack, and two archaeological impact assessments and one archaeological overview assessment have been conducted in the Alouette River region.

- A Predictive Model has been proposed for the areas south and north of Chiliwack including Alouette River. The predictive model was accessed on RAAD. Based on the predictive model, the entire study area is identified to have high archaeological potential (Figure 3). Unfortunately, neither the data being used for the model nor the accompanying report prepared by Golder Associates several years ago is available from Golder nor was it ever submitted for government review.

- An impact assessment of the rehabitation of the Alouette dam spillway yielded three new sites DhRo 7, DhRo 8 and DiRo 1 (Preckel and Howe 1991). DhRo 8 and DiRo 1 are both located on the shores of Alouette Lake and were identified based on surface lithic scatters. DhRo 7 is located adjacent to the Alouette River and was excavated yielding 55 lithic artifacts including flakes, cobble spalls and cores. The sites range in distance from 8 – 18 km northwest of option 1.

- A recent inventory and impact assessment of a large agricultural facility was conducted at the confluence of the North and South Alouette River (Franck 2005) about 9 km northwest of the study area option 1. This assessment evaluated three existing sites including DhRp 11 (the Caruthers Site), DhRp 10 and DhRp 18. In addition, 14 new sites (DhRp 53-66) were identified. Concentrations of fire altered rock and lithic artifacts dominate these sites, though several wet deposits were also recorded. The site density clearly represents a continued and long term use of the area.

- An archeological overview assessment was conducted for a proposed freeway alignment including two crossings of the Alouette River (Zacharias 1991). One


Alouette River Bridge Crossing Potential Model
Study Area
Proposed Road Construction
High Archaeological Potential
Moderate Archaeological Potential
Low Archaeological Potential
Water Body
Existing Road
Scale 1:2,500
0
50 m
Figure 3
IRW 07-1992
N
128th Avenue
slope toe
South Alouette River
bridge location
Option 2
Fern Crescent
(approximate location)
bridge location
Option 1
28th Avenue
240th Street
slope toe

of the proposed Alouette River freeway crossings was northeast of the current study area, while the second was very close to the current preliminary alignment at 128th Ave. Potential for fishing and fish processing sites on the river was predicted be high, and an archaeological impact assessment was recommended but never conducted (Zacharias 1991).

5.2 Traditional Use Sites

A number of traditional use sites have been documented in the region surrounding the study area. Most of these are located along the Pitt River, Pitt Lake and Fraser River and represent geographical features, habitation sites, resource procurement sites and places of mythological significance (Rozen 1979).

One site of mythological significance is located within the study area.

- **Pɛ'lɛxən**

This place is the location where a one-legged man was changed to stone by the Transformer to become the master of the fish that ascend the Alouette River (Suttles 1955). The rock is located in an area locally known as Davis' Pool which is less than 50 m east of the center of option 1 (Figure 3).

6. STUDY AREA EVALUATION

Because the Alouette River represents a place of ritual and cultural significance, the study area is considered to have high archaeological potential. Ethnographically identified village locations lie west of the study area and the terraces of Alouette River and Latimer Creek could yield habitation sites and/or fishing and fish processing sites. Given the presence of a location of mythological significance within the study area, pools within the river could also have been used for spiritual purposes such as retreats or ritual bathing. There is very low potential for the presence of culturally modified trees given the cleared and developed nature of lands in the study area.

7. RECOMMENDATIONS

There is high archaeological potential along the Alouette River and therefore an archaeological impact assessment (AIA) is recommended for both preliminary bridge alignments. Survey of both alignments is recommended to assist in evaluation of a preferred route in that one route may be more sensitive in terms of archaeology. It is suggested that a single permit be acquired for the study area to include municipal and private lands so that archaeological work can be completed under one B.C. government permit. A Sto'lo Nation permit is also required for archaeological investigations in this region.

As part of an AIA, an in-field evaluation of archaeological potential will ascertain the intensity of shovel testing required. Systematic shovel testing will be conducted in areas of perceived high archaeological potential such as banks of creeks and rivers, level topped ridges and well drained knolls. Wetlands in this region are known to have potential for wet site cultural material. DhRp 11, DhRp 10. DhRp 18, DhRp 53 and DhRp 62 are 7 to 8 km west of the study area and all contain wet site deposits. Wet deposits may require deep testing or machine assisted testing. Cultural deposits/materials may be present even within areas disturbed by housing, industrial and agricultural developments. The Caruthers site (DhRp 11) and the Park Farm site (DhRq 22) provide excellent examples of areas where cultural deposits have been recovered within areas of significant disturbance. In areas of impermeable surfaces, such as pavement, machine assisted testing is sometimes required. Testing in these latter areas will be undertaken on a judgemental but likely intensive basis.

These recommendations apply solely to physical archaeological evidence of past human activity and in no way attempt to encompass any traditional land use or heritage concerns of the various First Nations people with traditional territories in the study area. Considering the presence of an ethnographically recorded site of mythological significance, consultation with First Nations should be initiated to determine the need for a Traditional Use Study of the project area.

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B Appendix B - Geotechnical Report

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

November 27, 2007 File: 17-123-481

Associated Engineering (B.C.) Ltd.
Suite 300, 4940 Canada Way
Burnaby, B.C.
V5G 4M5

Attention: Dieter Diedericks, P.Eng.

FEASIBILITY STUDY - 240 STREET AND 128 AVENUE ALIGNMENTS SOUTH ALOUETTE RIVER BRIDGE, MAPLE RIDGE, B.C.

Dear Dieter:

As requested, Thurber Engineering Ltd. (TEL) has conducted a site reconnaissance and geotechnical assessment for the above project. This letter summarizes our field observations and provides preliminary geotechnical recommendations for conceptual design of the two contemplated alignments.

Use of this report is subject to the enclosed Statement of General Conditions.

1. INTRODUCTION

We understand that the District of Maple Ridge (DMR) wishes to evaluate the feasibility of constructing a bridge over the South Alouette River in the general vicinity of 240 Street and 128 Avenue.

The 240 Street option is an 1 km long, north-south alignment starting from the intersection of Abernathy Way and 240 Street to the intersection of Fern Avenue and 128 Avenue (Sta. 241+000 to 242+100). The proposed alignment generally includes nominal cut and fill placement of up to about 8 m, and construction of a 420 m long elevated structure over the existing flood plain and river. In the current study, we understand that the elevated structure may have a constant grade of about 3.4% or variable grades ranging from 0.5% to 6%.

The 128 Avenue option is an 1.7 km long, east-west alignment running from the intersection of Fern Avenue and 128 Avenue to the intersection of Alouette Road and 128 Avenue (Sta. 128+100 to 129+825). The proposed alignment generally requires up to about 7 m of cut, 24 m of fill and construction of an 160 m long elevated structure over the river and possibly flood plain.

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For conceptual design purposes, we understand that the proposed elevated structures for the two alignments will comprise three traffic lanes and a sidewalk with a total width of about 16 m and that the proposed span length will typically be about 30 m. You advised that the dead and live loads are 8,000 and 2,500 kN, respectively, per bent under service loading conditions.

Our scope of work on this project is to conduct a desktop review of available geotechnical information and a field reconnaissance, and to provide preliminary geotechnical recommendations for conceptual design of bridge foundations, cut slopes and fills, and scope of geotechnical investigation required for detailed design. Assessment of soil and groundwater contamination is not within our current scope of work.

2. BACKGROUND

In preparation of this report, we were provided with the following:

- General Arrangement Dwgs. 2007-2065-SK006 to -SK008 for the two proposed alignments from Associated Engineering Ltd.
- "*Geotechnical Engineering Services During Design, Sanitary Sewer Along 232 Street, North of 128 Avenue & Dogwood Avenue East to the South Alouette River, Maple Ridge, BC*" dated June 11, 1996 by Valley Geotechnical Engineering Services Ltd.
- "*Geotechnical Engineering Services During Design, Sanitary Sewer Across the South Alouette River East of 232 Street, Maple Ridge, BC*" dated June 25, 1996 by Valley Geotechnical Engineering Services Ltd.
- "*Geotechnical Design Recommendations, Proposed New Bridge Crossing South Alouette River 232nd Street and 130th Avenue, Maple Ridge, B.C.*" dated May 23, 1996 by Golder Associates Ltd.

3. AIRPHOTO INTERPRETATION

We reviewed historical air photos dated between 1940 and 2004 of varying scales and quality from the Geographic Information Centre at UBC. The results of our air photo review were used to assist us during the site reconnaissance.

Our air photo interpretation did not indicate the presence of historical instability or significant slope hazards at either of the proposed crossing locations. However, significant activity in the form of transport and

deposition of fluvial materials along with the associated shifting of the course of the South Alouette River were noted in the 64 year photographic record.

Immediately downstream (west) of the proposed 240 Street crossing, the active river processes were most evident in the historical photo record. In particular, a side channel formerly flowed from near the proposed south abutment location toward the west (as far as to about the east side of 239th Street) and returned to the main channel in the vicinity of 128th Avenue. The side channel was subsequently abandoned. The shifting of the river formed a large gravel bar on the northeast side of the main channel, or immediately downstream of the proposed north abutment.

In the area of the 128th Avenue Crossing, there appears to be less river channel activity compared to the 240 Street Crossing. The river channel appears to be somewhat more confined at this location. We believe that erosion of the banks is likely occurring within this area, especially immediately upstream of the proposed crossing location, but no significant shifting of the channel was noted in the available photo record.

4. ANTICIPATED SOIL CONDITIONS

According to the Geological Survey of Canada (GSC) surficial geology map, the soil conditions in the general vicinity of the proposed alignments typically comprise glacial and deltaic sediments deposited during the Pleistocene period (Fort Langley Formation). It can be generalized into 2 categories, namely the outwash and ice-contact gravel and sand (gravel and sand), and glaciomarine, stoney, clayey silt to silty sand (silt and clay).

GSC Open File 3511 indicates that the silt and clay deposits typically vary from 8 to 90 m thick, depending on location. In the general vicinity of the proposed alignments, the silt and clay deposits were likely not overridden by glaciers. In addition, it noted that steep slopes (>20°) comprising the silt and clay deposits are generally prone to landsliding. Based on information from nearby projects, the silt and clay deposits were generally stiff to very stiff in the upper 3 to 4 m and firm and possibly soft below.

We anticipate that the silt and clay deposits will likely be encountered along the 240 Street alignment south of the river, whereas the gravel and sand deposits will likely be encountered along the 240 Street and 128 Avenue alignments north and west of the river, respectively. For the 128 Avenue alignment east of the river, we anticipate that a combination of both deposits may be encountered, depending on location.

5. SITE RECONNAISSANCE

5.1 General

Messrs. Charles Ng, P.Eng., and Mike Lauder, E.I.T., of TEL conducted a site reconnaissance on August 30, 2007. The purpose of the fieldwork was to assess surficial soil conditions, hydrology and topography along the proposed alignments in order to identify potential and/or existing geotechnical issues and/or hazards that could affect the design. It should be noted that our assessment was limited to a visual inspection where the site is accessible. No drilling or test pitting was conducted during this phase of the investigation. The following sections summarize our field observations.

5.2 Overview Description of Proposed 240 Street Alignment

5.2.1 Sta. 241+000 to 241+160

The proposed alignment begins at the intersection of Abernathy Way and 240 Street. This segment coincides with the existing paved roadway of the 240 Street, in which the existing pavement was in relatively good condition. The existing road grade was relatively flat at about El. 56 m. The existing roadway crosses Latimer Creek near Sta. 241+100. We anticipate that a culvert is likely present at this location. However, this could not be visually identified in the field due to the presence of trees and other vegetation. The sideslope of the road embankment near Latimer Creek is relatively steep typically ranging from about 35° to 40° from the horizontal based on our field measurements.

An existing ditch is located along the east side of the roadway which exposed surficial soils typically comprised of discontinuous sand and gravel (possibly fill) over soft to firm silt and clay.

The GA drawing indicates that the proposed final road grade will be similar to that of the existing road. Accordingly, we do not anticipate significant upgrades will be required in this segment unless the road is widened or the profile is adjusted.

5.2.2 Sta. 241+160 to 241+320

The proposed alignment runs into an existing gravel road in this segment and the existing paved roadway diverges to the northeast to provide access for existing residences. In general, the existing road grade is relatively flat

from Sta. 241+160 to 241+250 at about El. 56 m, slopes down to about El. 49 m near Sta. 241+300 and then climbs back up to about El. 50 m at Sta. 241+320. The roadway intersects Latimer Creek again near Sta. 241+300. Although we expect a culvert crossing Latimer Creek is likely present near Sta. 241+300, it was not observed in the field.

A shallow test pit was hand-excavated on the west side of the existing gravel roadway near Sta. 241+260. The surficial soils typically comprised about 250 mm of sand and gravel (possible fill) over stiff to very stiff silt and clay.

5.2.3 Sta. 241+320 to 241+520

The proposed alignment cuts into an existing forest in this segment. Between Sta. 241+320 and 241+385, the existing grade is relatively gentle sloping down towards the north. An 8 m depression (El. 50 to 42 m) is present between about Sta. 241+385 and 241+415. The alignment reaches the crest of a steep slope (about 70° from the horizontal and perpendicular to the slope crest) near Sta. 241+415. As the alignment is at a significant skew to the slope, the existing grade along the alignment slopes down across the slope at about 22° from about El. 50 m near the crest to about El. 30 m at Sta. 241+460. The proposed alignment runs into a flood plain area beyond the toe of the slope and remains at nominally El. 30 m to Sta. 241+520.

In general, this segment is covered with vegetation and access is limited. Near Sta. 241+400, hard silt and clay with variable sand and gravel content was exposed. The steep slope is vegetated with deciduous and coniferous trees. Some of the trees were leaning, indicating that the surficial creep is likely ongoing. However, no obvious signs of significant slope instability were observed. In the flood plain area, soft organic and/or organic rich soils are estimated to be about 1 m thick and possibly more.

5.2.4 Sta. 241+520 to 241+695

The proposed alignment continues in the flood plain area in this segment where it cuts back into the existing gravel road between Sta. 241+520 and Sta. 241+540 and follows an existing equestrian trail to the end of this segment.

The existing gravel road provides access to an existing residence to the northeast. The equestrian trail is generally covered with vegetation. Along the trail, existing residences are present immediately west of the proposed

alignment, power poles on the east, and a ditch approximately 3 m west of the trail centreline. According to DMR's topographic map (Ridgeview Map), the ditch appears to coincide with Latimer Creek flowing north towards South Alouette River.

5.2.5 Sta. 241+695 to 241+720

The proposed alignment crosses over the river in this segment. On the south bank of the river, the surficial soils appear to be fluvial deposits typically comprising dense sand and gravel with some silt and traces of cobbles and boulders. Approximately 50 m upstream, 1.5 m diameter boulders were observed. On the north bank of the river, the surficial soils appear to comprise compact gravel and sand with some cobbles and a trace of silt.

5.2.6 Sta. 241+720 to 241+950

The proposed alignment continues along the equestrian trail within the flood plain area in this segment. The area is generally covered with vegetation. The existing grade remains at about El. 30 m to Sta. 241+860 and rises to about El. 33 m thereafter towards the end of the segment.

Between Sta. 241+720 and 241+750, the surficial soils appear to be similar to those encountered at the north bank. Several shallow test pits were hand-excavated along this segment. Near Sta. 241+770, the surficial soils typically comprised about 150 mm of topsoil-like materials over dense sand. Towards Sta. 241+860 near the toe of the slope, surficial soils comprised abut 150 mm of topsoil-like materials over loose to compact sand, whereas dense sand and gravel was encountered near the top of the slope.

5.2.7 Sta. 241+950 to 242+100

The proposed alignment follows Fern Road and ends at the intersection of Fern Road and 128 Avenue. The existing pavement appears to be in relatively good condition. The GA drawing indicates that the proposed final road grade will be similar to that of the existing road. Accordingly, we do not anticipate significant upgrades will be required along this segment unless the road is widened or the vertical profile is adjusted.

5.3 Overview Description of Proposed 128 Avenue Alignment

5.3.1 Sta. 128+100 to 128+360

The proposed alignment begins at the intersection of 128 Avenue and Fern Road and coincides with 128 Avenue in this segment. The existing road is paved between Sta. 128+100 and 128+220 and surfaced with gravel towards the end of this segment. The existing pavement, where present, is in relatively good condition. Existing residences are present on both north and south sides of the roadway. In addition, an existing ditch is present south of the roadway in front of the existing residences between Sta. 128+100 to 128+240.

The GA drawing indicates that the final road grade in this segment will be similar to that of the existing road and only nominal fill placement will be required locally. Accordingly, we do not anticipate significant upgrades will be required in this segment unless the road is widened or the vertical profile is adjusted.

5.3.2 Sta. 128+360 to 128+585

Beyond the gravel road, the proposed alignment follows the existing equestrian trail in this segment, where it is generally covered with vegetation. Moreover, existing residences are present on both the north and south sides of the trail. In addition, the proposed alignment crosses Fern Crescent (paved roadway) between Sta. 128+480 and 128+500.

Where encountered, the surficial soils typically comprise compact sand and gravel.

5.3.3 Sta. 128+585 to 128+640

The proposed alignment crosses the river in this segment. The west bank of the river is nearly vertical and drops from about El. 40 to 35 m. The exposed soils at the west bank typically comprise dense sand and gravel interbedded with layers of fine sand and/or cobbly gravel and sand with boulders. For reference, we observed that the existing residence immediately north of the proposed alignment appears to be located in close proximity to the nearly vertical bank. The area east of the river is generally flat, possibly a flood plain, and the surficial soils typically comprise compact to dense sand with variable gravel and silt content.

5.3.4 Sta. 128+640 to 128+920

The proposed alignment follows an equestrian trail along this segment and the area is generally is covered with significant vegetation. It should be noted that the trail is not straight and that it does not coincide with the proposed alignment throughout this segment. The existing grade is relatively flat between Sta. 128+640 and 128+730 and gradually slopes up to the east thereafter. An existing foot bridge crossing an undefined creek and an existing residence are present near Sta. 128+700 and immediately north of about Sta. 128+800, respectively.

Where the proposed alignment does not coincide with the trail, the area is generally covered with forest floor materials estimated to be about 0.6 m thick or more. Near Sta. 128+770, exposed soils typically comprised loose over compact sand and gravel with some silt.

5.3.5 Sta. 128+920 to 129+240

The proposed alignment follows an existing gravel road in this segment. The gravel road generally slopes up gently to the east. A culvert and a ditch were observed near Sta. 128+920 and parallel to the existing roadway along the south shoulder between Sta. 128+920 and 129+150, respectively. We believe that the culvert and the ditch are directing surface water flow towards the north from Bosa Creek to the South Alouette River. The proposed alignment intersects with 128 Avenue east of the river between Sta. 129+200 and 129+240.

The exposed soils in the ditch sideslope generally comprised compact sand and gravel.

5.3.6 Sta. 129+240 to 129+480

The proposed alignment returns to the equestrian trail in this segment and the area is generally covered with trees. It should be noted that the trail is not straight and that the proposed alignment does not follow the trail path throughout this segment. The existing grade gently slopes up to the north from Sta. 129+240 to 129+335 and begins to climb up a steep slope from about El. 57 m near Sta. 129+335 to about El. 83 m near Sta. 129+480 to the top of the existing slope. The topographic map indicates that the existing slope inclination is about 55° from the horizontal and possibly steeper locally near the top of the slope. In general, only a small of portion of the existing trees along the steep slope appear to be leaning and no signs of significant slope instability were observed. In addition, existing

residences are present north of the alignment near Sta. 128+300 and south of the alignment near Sta. 128+420.

Where the proposed alignment does not coincide with the trail, forest floor materials are estimated to be about 0.3 to 1 m thick. Exposed surficial soils near Sta. 128+300, as well as Sta. 128+460, typically comprised stiff sandy silt with some gravel.

5.3.7 Sta. 129+480 to 129+825

The proposed alignment coincides with 128 Avenue and ends at the intersection of 128 Avenue and 130 Connector. The existing pavement appears to be in relatively good condition, except some sealing and/or patching were observed locally between about Sta. 129+740 and 129+825. Existing residences are present along this segment and an existing ditch along the south shoulder between Sta. 129+480 and 129+700.

6. ENGINEERING ASSESSMENT AND RECOMMENDATIONS

6.1 Proposed 240 Street Alignment

According to the GA drawing, it will be necessary to fill depressions of about 6 and 8 m depth between Sta. 241+250 and 241+320 and between Sta. 241+385 and 241+415, respectively, to match the proposed road grades. Assuming the area is generally underlain by soft to firm silt and clay deposits, we believe that the proposed amount of fill for the roadway embankment will likely cause significant short- and long-term settlement and may pose a risk of global instability. Moreover, due to the presence of existing residences and/or steep slopes in the close proximity to the depressions, we believe that the proposed fill has the potential to adversely impact nearby existing facilities and structures, such as the nearby residences and/or culverts, and possibly the existing steep slope. Accordingly, we believe that it will be necessary to conduct a detailed investigation and slope stability analyses to evaluate the impact of fill placement during detailed design.

Between Sta. 241+420 and 241+855, an elevated structure is proposed to cross the flood plain and river. You advised that the proposed structure will likely be pile supported and that some of the piles may extend above ground surface to the pile cap and act as columns. We understand that your preference is to use driven 610 mm diameter by 12.7 mm thick steel pipe piles. Due to the uncertain depth to competent bearing strata, we assume that the piles are potentially friction piles embedded within the silt

and clay deposits. Based on similar soil deposits in the Lower Mainland, friction piles driven to about 40 m are typically expected to develop an ultimate vertical resistance in the range of 3,000 kN. If PDA (Pile Driving Analyzer) testing is conducted, a geotechnical resistance factor of 0.5 is considered appropriate for conceptual design purposes. For discussion purposes, we estimate that 914 mm diameter friction piles driven to about 30 to 35 m will likely develop a similar resistance. These values must be confirmed during detailed design.

It should be noted that cobbles, and possibly large diameter boulders, may be encountered near the river crossing. We expect driving closed-ended steel pipe piles through these materials may be infeasible. Accordingly, it will be necessary to determine the elevation of the interface between the surficial granular soils and the underlying fine-grained soils in the detailed field investigation to facilitate pile design and to provide guidance to the contractor with respect to the appropriate pile installation method. For conceptual design purposes, we consider that subexcavation to remove the upper granular soils in conjunction with driven or possibly drilled-in open-ended steel pipe piles to be potential options to install piles.

Beyond the elevated structure to the east, placement of 3 to 4 m of fill will be required to raise grades between Sta. 241+720 to 241+950. With limited available geotechnical information, it is difficult to comment on potential geotechnical issues in this area. If soft, compressible soils are present at or near ground surface, potential geotechnical issues that would require attention are fill settlement and possibly global instability. However, this must be confirmed during detailed design.

In addition to geotechnical issues, the proposed alignment appears to have potential access conflicts with several existing residences which must be addressed.

The existing trail between Sta. 241+520 to 241+695 is relatively narrow. In addition to the presence of power poles to the east, site access in this area for pile installation during construction, and possibly drilling during field investigation, may be challenging and will require detailed planning prior to mobilization. Furthermore, significant clearing of trees will be required to facilitate access for site investigation and/or construction.

6.2 Proposed 128 Avenue Alignment

The contemplated embankment will require up to about 4 m of fill between Sta. 128+360 to 128+585. For conceptual design purposes, we believe

that the proposed fill placement may be feasible from a settlement perspective providing that the surficial granular layer is sufficiently thick. This must be confirmed during the detailed field investigation. As the contemplated embankment could potentially affect the global stability of the river bank, a detailed slope stability evaluation will also be required during detailed design.

The proposed elevated structure will be located between about Sta. 128+585 and 128+745. Towards the west, we believe that it may be feasible to support the west abutment on shallow foundations providing that the dense granular layer is sufficiently thick and that the location of abutment is setback sufficiently behind the crest of the existing bank. This should be confirmed during detailed design. For the remainder of the elevated structure, we consider that the conceptual pile design recommendations for the 240 Street crossing to be generally applicable for this segment. Similarly, cobbles and/or large diameter boulders may be encountered near the river crossing. Accordingly, detailed site investigation will be required to determine the appropriate pile installation method.

The GA drawing indicates that a 5.5 to 24 m high embankment is contemplated between Sta. 128+745 and 129+435. Depending on the nature of the underlying soils, we believe that the embankment fill will likely cause significant settlement if the area is underlain by compressible soils and that it will pose a risk of global instability. We further envisage that the embankment fill may impact the stability of the existing, adjacent steep river bank between Sta. 128+820 and 128+940, as well as the existing steep slope between Sta. 129+300 and 129+480. Accordingly, detailed investigation and stability analyses will be required to evaluate the impact of the embankment fill locally, as well as on the general area. Alternatively, consideration could be given to using lightweight fill such as Pumice and/or Expanded Polystyrene (EPS) to reduce the potential stresses due to the construction of the proposed embankment. Additional information can be provided, if required.

Based on the proposed embankment fill height and an assumed 2H:1V fill embankment sideslope, we believe that the toe of the embankment will likely encroach on private property to the north near Sta. 128+820 and 129+300, and possibly to the south near Sta. 129+200. Accordingly, it will be necessary to obtain additional right-of-way to facilitate the use of conventional fill for embankment construction.

Between Sta. 129+440 to 129+600, the GA drawing indicates that up to about 7 m of cut will be required. We consider that the proposed cut will

likely not affect the overall stability of the existing steep slope. However, care will be required to determine a stable cut slope configuration.

7. RECOMMENDED SITE INVESTIGATION

The requirements of the actual field program will be a function of the selected alignment, number of piers and contemplated foundation system. For conceptual design purposes, we propose to conduct a test hole at each of the abutment and pier locations for the elevated structure(s). Where significant fill placement is required, addition test holes should be conducted to determine the thickness of potential compressible layer(s). In particular for the proposed 128 Avenue alignment east of the river where significant fill placement is required, we consider that the test holes should be conducted every 100 m for the preliminary assessment. Additional test holes and/or test pits may be required, depending on the variability of the soil conditions. In addition, it will be necessary to conduct test holes near the top of the steep slopes to facilitate slope stability analyses. Where site grading fill is not required, test pitting at 50 m intervals is likely adequate to determine requirements and for pavement design.

In general, we propose to use Cone Penetration Test (CPT) with shear wave velocity measurements to profile soil conditions where fine-grained soils are anticipated, as it is well suited for the anticipated soil conditions and provides continuous, reliable data for classification, strength, stiffness and consolidation characteristics of the soil. Based on the conceptual pile lengths, we anticipate that it may be necessary to advance CPT to depth of about 50 m or more below existing ground surface. Field vane shear tests will be required to calibrate the CPT data.

Adjacent to the CPTs, test holes will likely be advanced using a solid stem auger to depths up to about 20 m to collect samples for visual classification and other laboratory testing. Depending on the CPT results, it may be necessary to collect Shelby tube samples for consolidation testing to determine the consolidation characteristics of the fine-grained soils, where significant fill placement is required.

Where granular soils are anticipated, mud-rotary drilling in conjunction with Standard Penetration Tests (SPTs) may be required. Alternatively, Becker Hammer, ODEX and/or Sonic drilling could be used if cobbles and/or large boulders are anticipated. Additional information can be provided, if required.

Nonetheless, it will be necessary to prepare access roads prior to mobilization for the site investigation. For pricing purposes, we believe that track-mounted drill rig will be required to access the site(s). In general, track-mounted drill rigs are readily available for auger and mud-rotary drilling while truck-mounted rigs for Becker and Sonic drilling.

We trust that this letter provides sufficient information for your needs. Should you require clarification of any item or additional information, please contact us at your convenience.

Yours very truly,
Thurber Engineering Ltd.
David J. Tara, P.Eng.
Review Principal

Charles Ng, P.Eng.
Project Engineer

THURBER ENGINEERING LTD.

STATEMENT OF GENERAL CONDITIONS

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering or environmental consulting practices in this area. No other warranty, expressed or implied, is made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document, subject to the limitations provided herein, are only valid to the extent that this Report expressly addresses proposed development, design objectives and purposes, and then only to the extent there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation or to consider such representations, information and instructions.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS WE MAY EXPRESSLY APPROVE. The contents of the Report remain our copyright property. The Client may not give, lend or, sell the Report, or otherwise make the Report, or any portion thereof, available to any person without our prior written permission. Any use which a third party makes of the Report, are the sole responsibility of such third parties. Unless expressly permitted by us, no person other than the Client is entitled to rely on this Report. We accept no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without our express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and this report is delivered on the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by us. We are entitled to rely on such representations, information and instructions and are not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

(see over . . . .)

INTERPRETATION OF THE REPORT *(continued . . . .)*

c) Design Services: The Report may form part of the design and construction documents for information purposes even though it may have been issued prior to the final design being completed. We should be retained to review the final design, project plans and documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the report recommendations and the final design detailed in the contract documents should be reported to us immediately so that we can address potential conflicts.

d) Construction Services: During construction we must be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RISK LIMITATION

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause an accidental release of those substances. In consideration of the provision of the services by us, which are for the Client's benefit, the Client agrees to hold harmless and to indemnify and defend us and our directors, officers, servants, agents, employees, workmen and contractors (hereinafter referred to as the "Company") from and against any and all claims, losses, damages, demands, disputes, liability and legal investigative costs of defence, whether for personal injury including death, or any other loss whatsoever, regardless of any action or omission on the part of the Company, that result from an accidental release of pollutants or hazardous substances occurring as a result of carrying out this Project. This indemnification shall extend to all Claims brought or threatened against the Company under any federal or provincial statute as a result of conducting work on this Project. In addition to the above indemnification, the Client further agrees not to bring any claims against the Company in connection with any of the aforementioned causes.

7. SERVICES OF SUBCONSULTANTS AND CONTRACTORS

The conduct of engineering and environmental studies frequently requires hiring the services of individuals and companies with special expertise and/or services which we do not provide. We may arrange the hiring of these services as a convenience to our Clients. As these services are for the Client's benefit, the Client agrees to hold the Company harmless and to indemnify and defend us from and against all claims arising through such hirings to the extent that the Client would incur had he hired those services directly. This includes responsibility for payment for services rendered and pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. In particular, these conditions apply to the use of drilling, excavation and laboratory testing services.

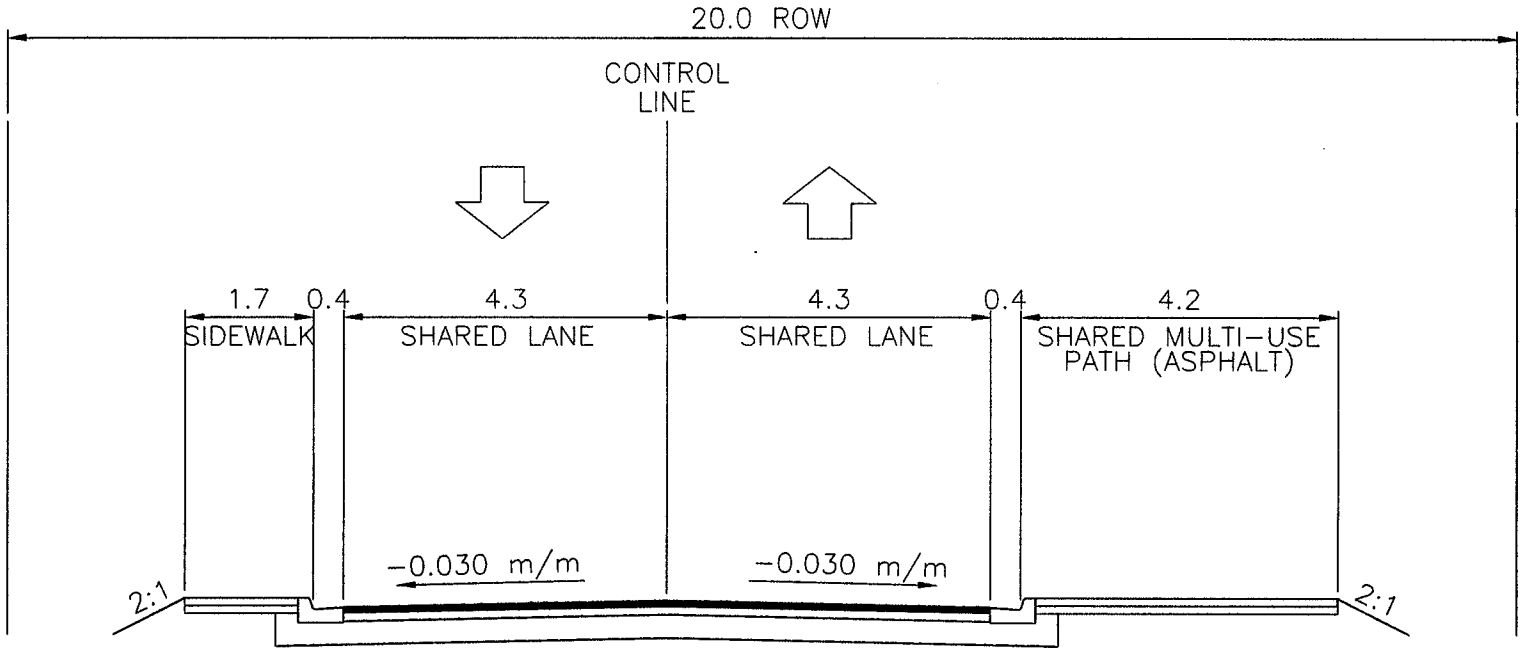
8. CONTROL OF WORK AND JOBSITE SAFETY

We are responsible only for the activities of our employees on the jobsite. The presence of our personnel on the site shall not be construed in any way to relieve the Client or any contractors on site from their responsibilities for site safety. The Client acknowledges that he, his representatives, contractors or others retain control of the site and that we never occupy a position of control of the site. The Client undertakes to inform us of all hazardous conditions, or other relevant conditions of which the Client is aware. The Client also recognizes that our activities may uncover previously unknown hazardous conditions or materials and that such a discovery may result in the necessity to undertake emergency procedures to protect our employees as well as the public at large and the environment in general. These procedures may well involve additional costs outside of any budgets previously agreed to. The Client agrees to pay us for any expenses incurred as the result of such discoveries and to compensate us through payment of additional fees and expenses for time spent by us to deal with the consequences of such discoveries. The Client also acknowledges that in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed and the Client agrees that notification to such bodies by us will not be a cause of action or dispute.

9. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on our interpretation of conditions revealed through limited investigation conducted within a defined scope of services. We cannot accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

C Appendix C - Feasibility Study Drawings



TYPICAL CROSS SECTION
128 AVE AND 240 ST. OPTIONS

District of Maple Ridge
Alouette River Crossing
Typical Section

Figure 1
Date: Oct. 30, 2007

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Associated Engineering

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Date: 2008/1/17
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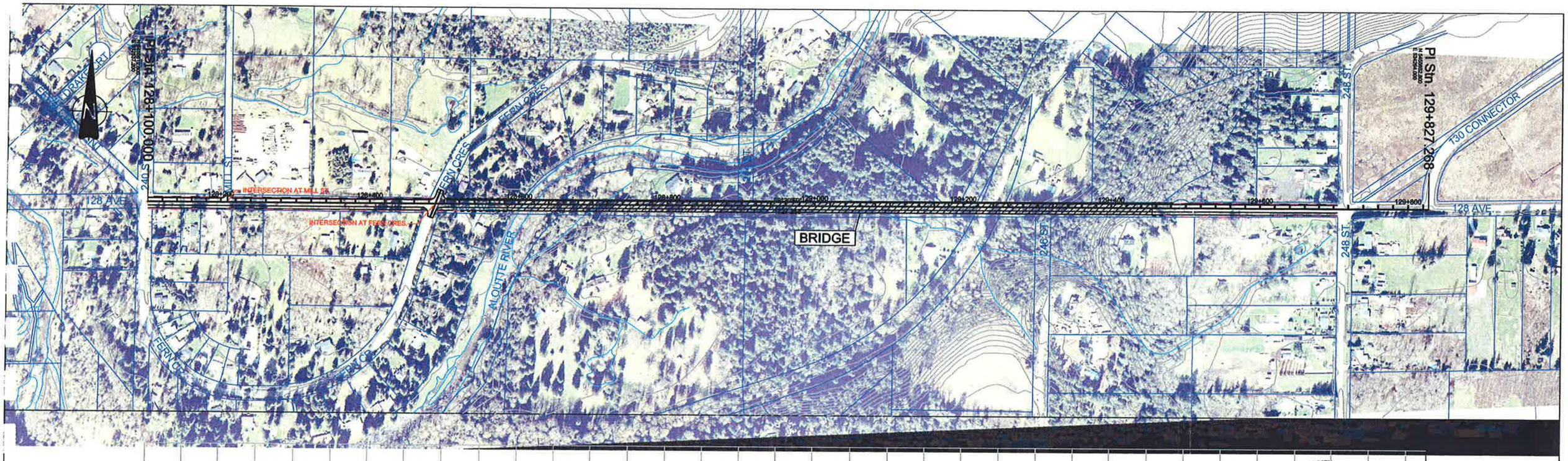

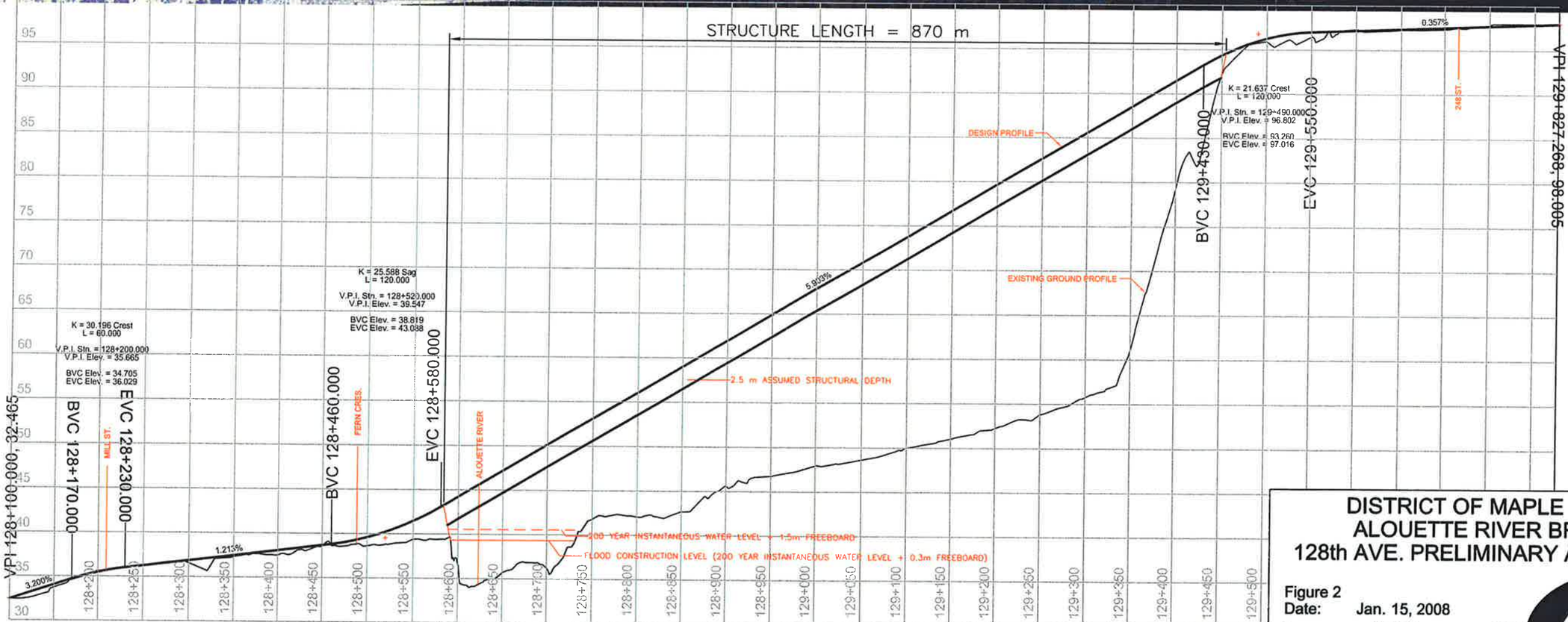

DISTRICT OF MAPLE RIDGE
ALOUETTE RIVER BRIDGE
128th AVE. PRELIMINARY ALIGNMENT

Figure 2
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Associated Engineering

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e: 2008/1/15
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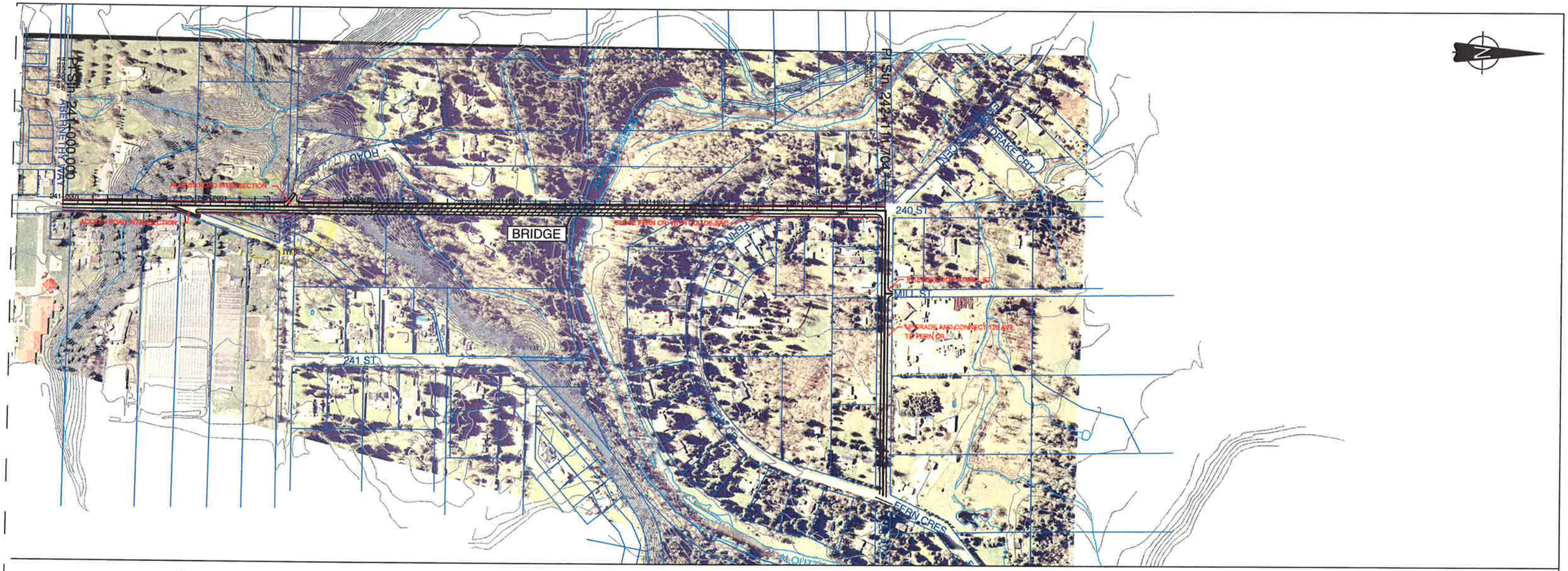

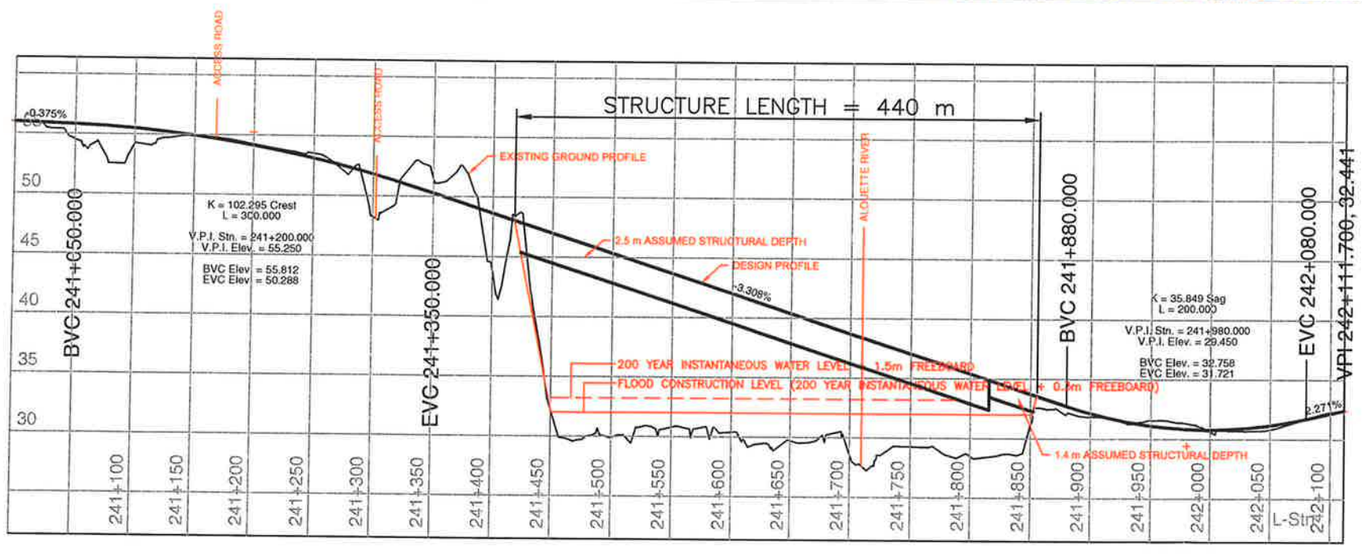

DISTRICT OF MAPLE RIDGE
ALOUETTE RIVER BRIDGE
240th ST. PRELIMINARY ALIGNMENT

Figure 3
Date: Jan. 15, 2008

0 1:5000 250

Associated Engineering

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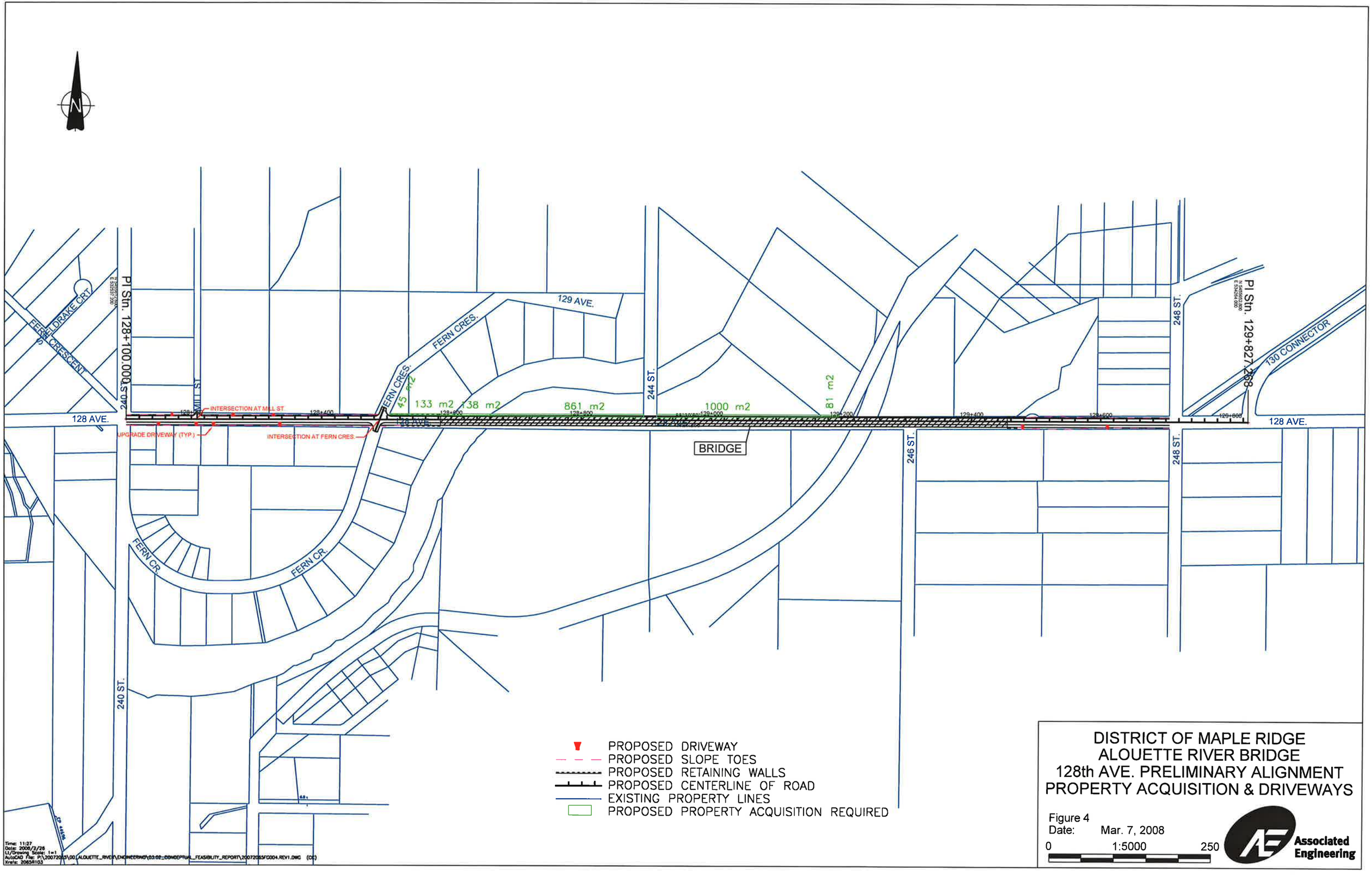
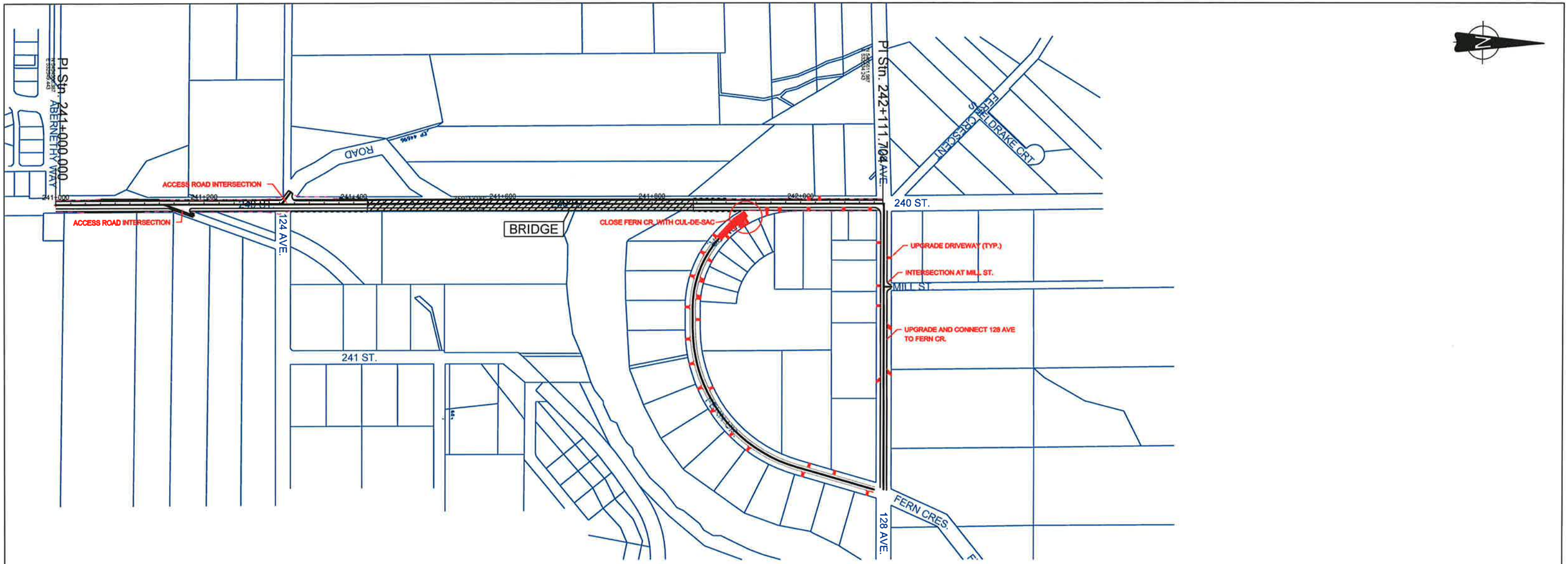


DISTRICT OF MAPLE RIDGE
ALOUETTE RIVER BRIDGE
128th AVE. PRELIMINARY ALIGNMENT
PROPERTY ACQUISITION & DRIVEWAYS

Figure 4
Date: Mar. 7, 2008

0 1:5000 250

Associated Engineering



PROPOSED DRIVEWAY
PROPOSED SLOPE TOES
PROPOSED RETAINING WALLS
PROPOSED CENTERLINE OF ROAD
EXISTING PROPERTY LINES

DISTRICT OF MAPLE RIDGE
ALOUETTE RIVER BRIDGE
240th ST. PRELIMINARY ALIGNMENT
PROPERTY ACQUISITION & DRIVEWAYS

Figure 5
Date: Mar. 7, 2008

0 1:5000 250

Associated Engineering

Time: 11:18
Date: 2008/3/26
LI/Drawing Scale: 1=1
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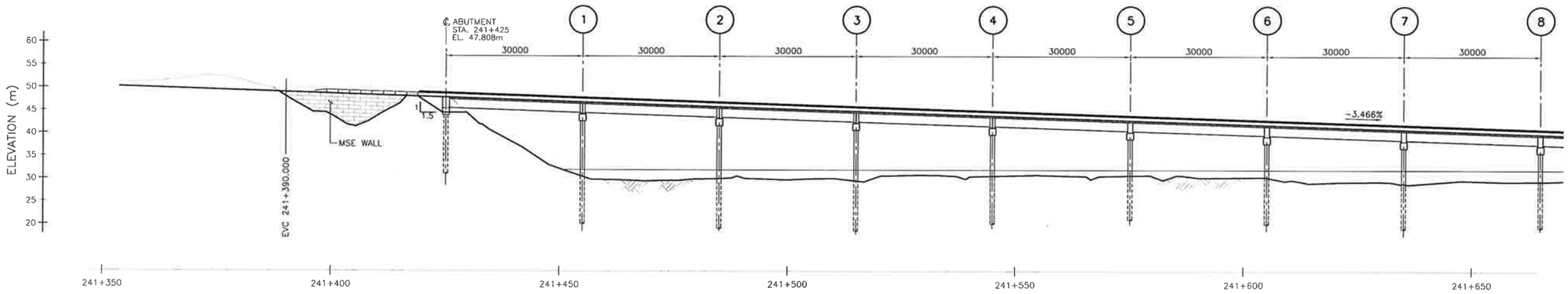

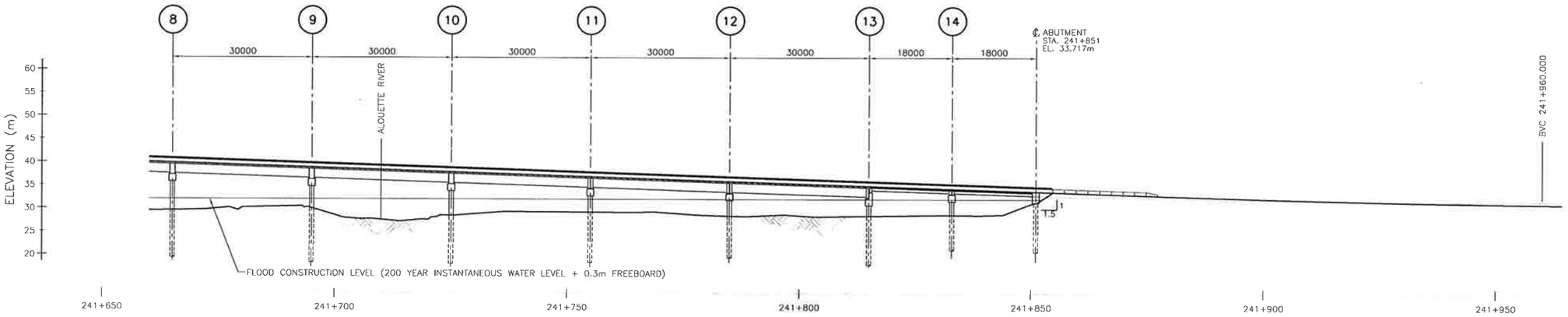

PROFILE (240 ST.)
SCALE 1:500

NO.	DATE	ENG.	BY	SUBJECT
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REVISIONS

VERIFY SCALES

BAR IS 20mm ON ORIGINAL DRAWING

0 20mm

IF NOT 20mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY

Associated Engineering

PROJECT No.	20072065	
SCALE	AS SHOWN	
DRAWN	L.J.	
DESIGNED	A.K.	
CHECKED		
APPROVED		
DATE		INITIAL

DISTRICT OF MAPLE RIDGE

240 ST. BRIDGE OPTION 2
STRUCTURAL
GENERAL ARRANGEMENT

ALOUETTE RIVER CROSSING STUDY
240 STREET. ALIGNMENT

DRAWING NUMBER	REV. NO.	SHEET
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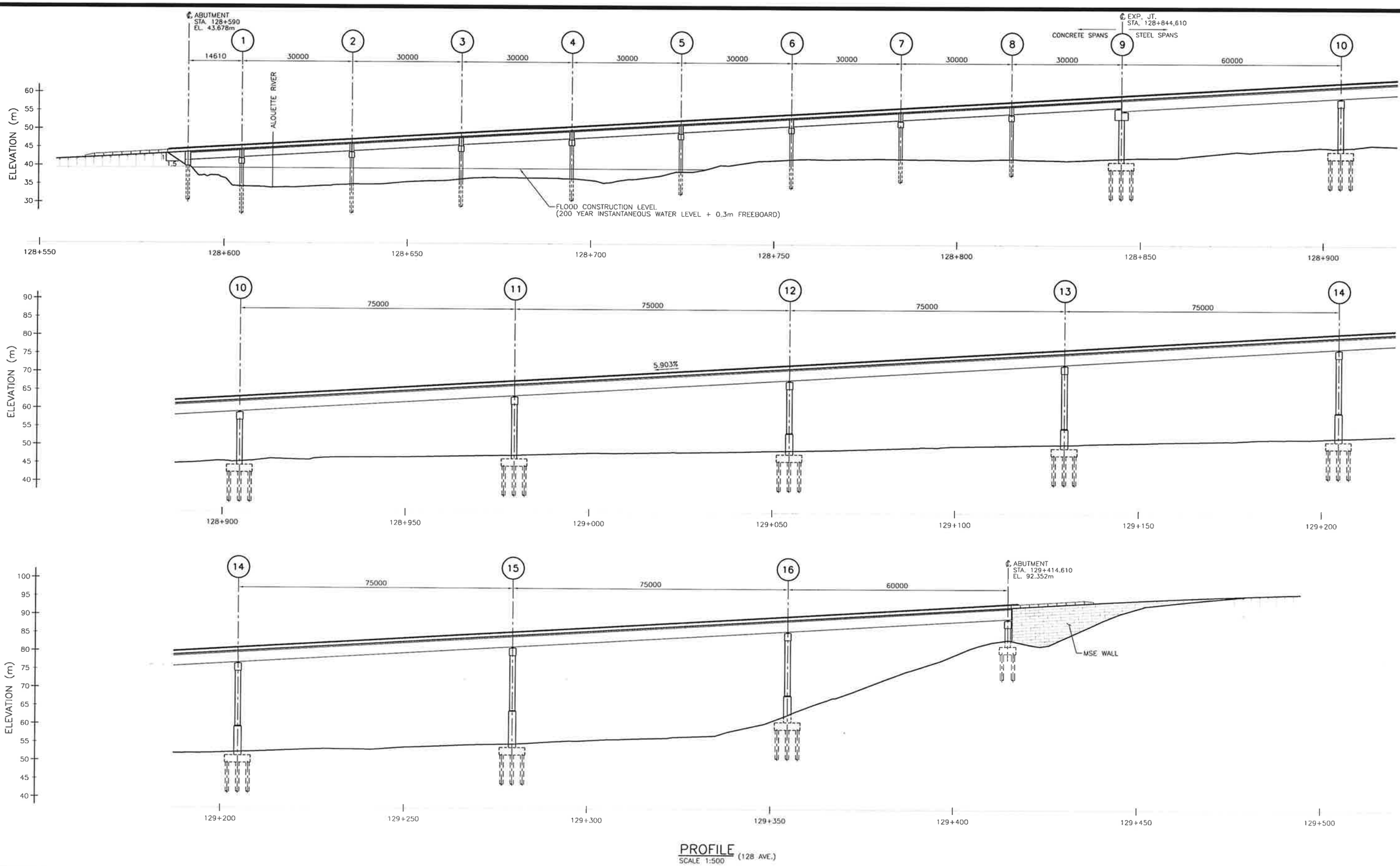

PROFILE
SCALE 1:500 (128 AVE.)

NO.	DATE	ENG.	BY	SUBJECT
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REVISIONS

VERIFY SCALES

BAR IS 20mm ON ORIGINAL DRAWING

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IF NOT 20mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY

Associated Engineering

PROJECT No.	20072065	
SCALE	AS SHOWN	
DRAWN	L.J.	
DESIGNED	A.K.	
CHECKED		
APPROVED		
DATE		INITIAL

DISTRICT OF MAPLE RIDGE

128 AVE. BRIDGE
STRUCTURAL
GENERAL ARRANGEMENT

ALOUETTE RIVER CROSSING STUDY
128 AVE. ALIGNMENT

DRAWING NUMBER	REV. NO.	SHEET
FIGURE 7	0	

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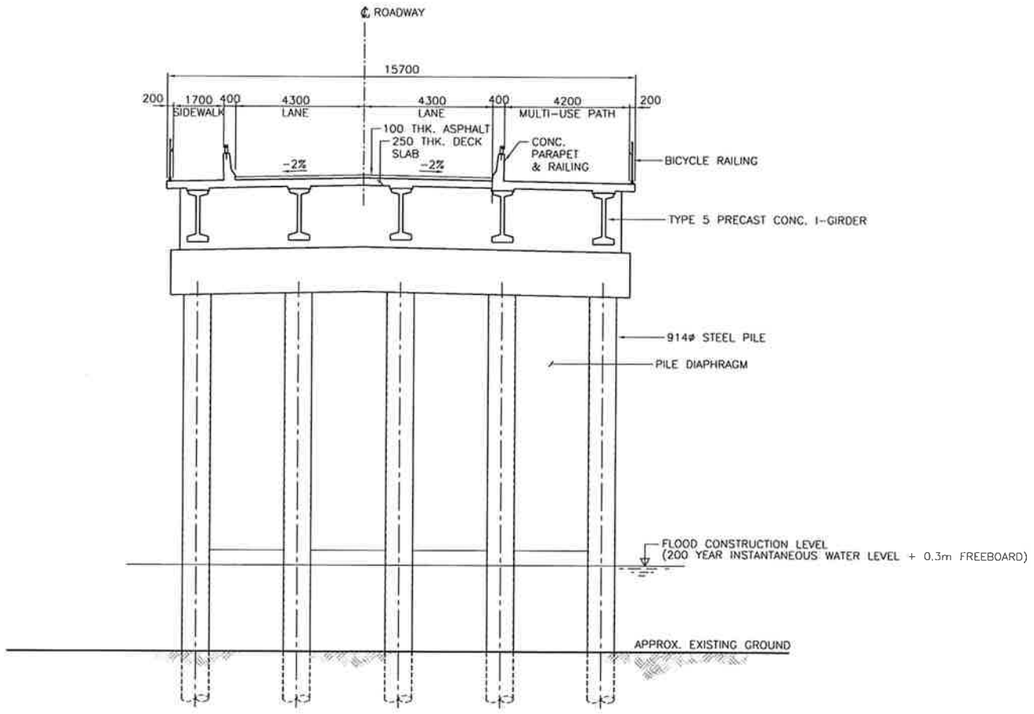
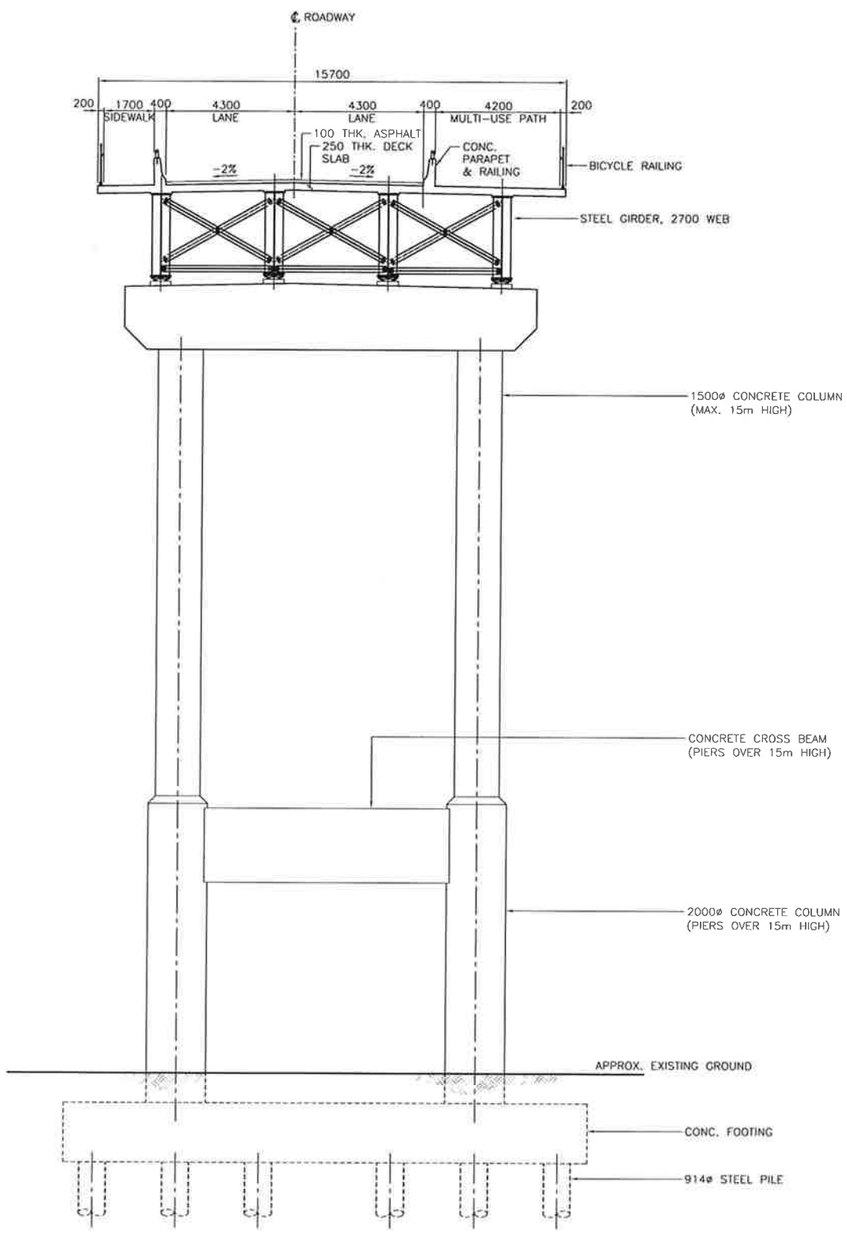
Date: 2008/1/21
Plotted By: Lisa Jones (Power Saves)
AutoCAD File: P:\20072065\02_ALOUETTE_RIVER\ENGINEERING\03.05_STRUCTURAL_NOTES_DRAWINGS\WORKING DRAWINGS\20072065-128 AVE.-FIGURE 7.DWG (LJ)



TYPICAL SECTION – MAXIMUM 30m SPANS
SCALE 1:100



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REVISIONS

VERIFY SCALES

BAR IS 20mm ON ORIGINAL DRAWING

0 —— 20mm

IF NOT 20mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY

Associated Engineering

PROJECT No.	20072065
SCALE	AS SHOWN
DRAWN	L.J.
DESIGNED	A.K.
CHECKED	
APPROVED	
DATE	INITIAL

DISTRICT OF MAPLE RIDGE

ALOUETTE RIVER CROSSING STUDY
TYPICAL SECTIONS

DRAWING NUMBER	REV. NO.	SHEET
FIGURE 8	0	

D Appendix D - Cost Estimates

CALCULATIONS

PROJECT	**DIST. OF MAPLE RIDGE - SOUTH ALOUETTE RIVER CROSSING**	PROJ. NO.	20072065
DETAILS	128th Avenue Alignment Option	BY	C.Cheng/A.Kao
	Cost Estimate (2008 Dollars)	DATE	22-Feb-08

Revised: Feb-22-2008

Item No.	Description	Unit	Quantity	Unit Rate	Total
1.0	**Grading**				
1.1	Clearing and Grubbing	m2	5,800	9.00	52,200
1.2	Organic Stripping	m3	2,200	30.00	66,000
1.3	Roadway Excavation	m3	5,200	19.00	98,800
1.4	Asphalt Pavement Saw Cutting	m	100	7.00	700
1.5	Imported Granular Fill	m3	1,900	50.00	95,000
1.6	Pavement Milling (35mm - 50mm)	m2	4,200	23.00	96,600
1.7	19mm Granular Base (100mm)	m3	4,100	55.00	225,500
1.8	75mm Select Granular Subbase (350mm)	m3	2,300	50.00	115,000
2.0	**Paving**				
2.1	Asphalt Pavement	tonne	5,600	120.00	672,000
2.2	Concrete Curb and Gutter	m	1,800	70.00	126,000
2.3	Pavement Markings	m	4,000	3.00	12,000
3.0	**Bridge Construction**				
3.1	Bridge End Fill	m3	2,000	50.00	100,000
3.2	Foundation Excavation and Backfill	m3	2,900	60.00	174,000
3.3	Piling				
3.3.1	Mobilization	L.S.	100%	L.S.	400,000
3.3.2	Supply Ø914×12.7t Steel Pipe Piles	m	5,100	850.00	4,335,000
3.3.3	Install Piles	each	147	25,000.00	3,675,000
3.4	Cast-in-Place Concrete				
3.4.1	Substructure	m3	3,300	3,000.00	9,900,000
3.4.2	Superstructure	m3	3,800	4,000.00	15,200,000
3.5	Precast Concrete				
3.5.1	Supply/Fabricate 1728 Dp. I-Girders	m	1,300	720.00	936,000
3.5.2	Ship/Erect 1728 Dp. I-Girders	L.S.	100%	L.S.	300,000
3.6	Structural Steelwork				
3.6.1	Supply/Fabricate Structural Steelwork	kg	2,020,000	4.00	8,080,000
3.6.2	Ship/Erect Structural Steelwork	L.S.	100%	L.S.	2,700,000

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CALCULATIONS

PROJECT	**DIST. OF MAPLE RIDGE - SOUTH ALOUETTE RIVER CROSSING**	PROJ. NO.	20072065
DETAILS	128th Avenue Alignment Option	BY	C.Cheng/A.Kao
	Cost Estimate (2008 Dollars)	DATE	22-Feb-08

Revised: Feb-22-2008

Item No.	Description	Unit	Quantity	Unit Rate	Total
3.7	Miscellaneous Steelwork				
3.7.1	Laminated Elastomeric Bearings	each	30	2,000.00	60,000
3.7.2	Pot Bearings	each	44	3,000.00	132,000
3.7.3	Bridge Parapet Steel Railing	m	1,664	500.00	832,000
3.7.4	Standard Steel Bicycle Fence	m	1,664	1,000.00	1,664,000
3.7.5	Expansion Joints	m	47	2,500.00	117,750
3.8	Waterproofing Membrane	m2	7,100	60.00	426,000
3.9	Asphalt Overlay	tonne	1,700	120.00	204,000
4.0	**Retaining Walls**				
4.1	MSE Retaining Wall at East Approach	m2	570	1,200.00	684,000
5.0	**Traffic Management (5% of Items 1 ~ 2)**	**L.S.**	**100%**	**L.S.**	**78,000**
6.0	**Mobilization (5% of Items 1 ~ 5)**	**L.S.**	**100%**	**L.S.**	**2,600,000**
7.0	**Miscellaneous (5% of Items 1 ~ 6)**	**L.S.**	**100%**	**L.S.**	**2,700,000**
8.0	**Engineering (10% of Items 1 ~ 7)**	**L.S.**	**100%**	**L.S.**	**5,700,000**
9.0	**Contingency (15% of Items 1 ~ 8)**	**L.S.**	**100%**	**L.S.**	**9,400,000**
Total				**$**	**71,957,550**

Notes:

- Grading and Paving quantities estimated from Figure 2
- Miscellaneous includes items that are not listed but would be required to complete the work
- Costs indicated do not include GST
- Costs do not include any environmental mitigation. Jacques Whitford provided a preliminary budget:
  - * Planning and Permitting: $47,000
  - * Monitoring: $78,000
  - * Compensation: $150,000

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CALCULATIONS

PROJECT	**DIST. OF MAPLE RIDGE - SOUTH ALOUETTE RIVER CROSSING**	PROJ. NO.	20072065
DETAILS	240th Street Alignment Option	BY	C.Cheng/A.Kao
	Cost Estimate (2008 Dollars)	DATE	22-Feb-08

Revised: Feb-22-2008

Item No.	Description	Unit	Quantity	Unit Rate	Total
1.0	**Grading**				
1.1	Clearing and Grubbing	m2	8,400	9.00	75,600
1.2	Organic Stripping	m3	2,900	30.00	87,000
1.3	Roadway Excavation	m3	8,200	19.00	155,800
1.4	Asphalt Pavement Saw Cutting	m	100	7.00	700
1.5	Imported Granular Fill	m3	9,300	50.00	465,000
1.6	Pavement Milling (35mm - 50mm)	m2	4,200	23.00	96,600
1.7	19mm Granular Base (100mm)	m3	2,300	55.00	126,500
1.8	75mm Select Granular Subbase (350mm)	m3	2,300	50.00	115,000
2.0	**Paving**				
2.1	Asphalt Pavement	tonne	4,500	120.00	540,000
2.2	Concrete Curb and Gutter	m	1,500	70.00	105,000
2.3	Pavement Markings	m	2,800	3.00	8,400
3.0	**Bridge Construction**				
3.1	Bridge End Fill	m3	2,000	50.00	100,000
3.2	Piling				
3.2.1	Mobilization (5%)	L.S.	100%	L.S.	200,000
3.2.2	Supply Ø914×12.7t Steel Pipe Piles	m	3,100	850.00	2,635,000
3.2.3	Install Piles	each	74	25,000.00	1,850,000
3.3	Cast-in-Place Concrete				
3.3.1	Substructure	m3	1,000	3,000.00	3,000,000
3.3.2	Superstructure	m3	2,000	4,000.00	8,000,000
3.4	Precast Concrete				
3.4.1	Supply/Fabricate 1728 Dp. I-Girders	m	2,000	720.00	1,440,000
3.4.2	Ship/Erect 1728 Dp. I-Girders	L.S.	100%	L.S.	500,000
3.4.3	Supply/Fabricate 550 Dp. Box Girders	m	500	720.00	360,000
3.4.4	Ship/Erect 550 Dp. Box Girders	L.S.	100%	L.S.	100,000

CALCULATIONS

PROJECT	**DIST. OF MAPLE RIDGE - SOUTH ALOUETTE RIVER CROSSING**	PROJ. NO.	20072065
DETAILS	240th Street Alignment Option	BY	C.Cheng/A.Kao
	Cost Estimate (2008 Dollars)	DATE	22-Feb-08

Revised: Feb-22-2008

Item No.	Description	Unit	Quantity	Unit Rate	Total
3.5	Miscellaneous Steelwork				
3.5.1	Laminated Elastomeric Bearings	each	35	2,000.00	70,000
3.5.2	Elastomeric Strip Bearings	each	4	500.00	2,000
3.5.3	Bridge Parapet Steel Railing	m	880	500.00	440,000
3.5.4	Standard Steel Bicycle Fence	m	880	1,000.00	880,000
3.5.5	Expansion Joints	m	31	2,500.00	78,500
3.6	Waterproofing Membrane	m^2	3,700	60.00	222,000
3.7	Asphalt Overlay	tonne	890	120.00	106,800
4.0	**Retaining Walls**				
4.1	MSE Retaining Wall at South Approach	m2	200	1,200.00	240,000
5.0	**Traffic Management (5% of Items 1 ~ 2)**	**L.S.**	**100%**	**L.S.**	**88,800**
6.0	**Mobilization (5% of Items 1 ~ 5)**	**L.S.**	**100%**	**L.S.**	**1,100,000**
7.0	**Miscellaneous (5% of Items 1 ~ 6)**	**L.S.**	**100%**	**L.S.**	**1,200,000**
8.0	**Engineering (10% of Items 1 ~ 7)**	**L.S.**	**100%**	**L.S.**	**2,400,000**
9.0	**Contingency (15% of Items 1 ~ 8)**	**L.S.**	**100%**	**L.S.**	**4,000,000**
Total					**$ 30,788,700**

Notes:

- Grading and Paving quantities estimated from Figure 2
- Miscellaneous includes items that are not listed but would be required to complete the work
- Costs indicated do not include GST
- Costs do not include any environmental mitigation. Jacques Whitford provided a preliminary budget:
  - * Planning and Permitting: $47,000
  - * Monitoring: $78,000
  - * Compensation: $150,000

E Appendix E - Alouette River Flow Rate Analysis

REGIONALIZATION FLOW ANALYSIS FOR UNGAUGED WATERSHEDS

CLIENT: client
PROJECT: Alouette River Bridge
PROJECT No.: 2007 2065

ASSOCIATED ENGINEERING (B.C.) LTD.
INITIATED BY: DH **DATE:** 11/8/2007
PREPARED BY: JT **FILENAME:** P:\20072065\00_Alouette_River\Engineering\03.00_Conceptual_Feasibility_Design\[REG-ANAL.XLS]Sheet1
CHECKED BY:

Spreadsheet Version Date: 9/25/2006

HYDROMETRIC STATION INFORMATION / WATERSHED WEIGHTING FACTORS (for explanation of weighting factor Keywords see NOTES)

Gauge No.	Hydro-logic Zone	Station Description	Latitude (deg.min)	Longitude (deg.min)	Regul-ated or Natural Flow	24 Hour Mean Flow (L/s/km²)	100 Year 24 Hr. Ratio	Instant./Daily (I/D) Ave. Three Highest	100 Yr. from Append.	from Max. Inst. Q	100 Year Unit Runoff 24 Hour (m³/s/km²)	100 Year Unit Runoff Instant. (m³/s/km²)	100 Year Daily Flow (m³/s)	100 Year Instant. Flow (m³/s)	Drainage Area (km²)	fctr	Record Length (yrs)	fctr	Hydrologic Zone (No.)	fctr	General Exposure (deg.)	fctr	Average Elevation (m)	fctr	Proximity to Study Catchment (A-D)	fctr	Amount of Attenuation (1-5)	fctr	Average Grade (1-5)	fctr	Drainage Density (1-5)	fctr	Width to Length Ratio (W:L)	fctr	Weighted Sum	Visual Inspect. Rating (poor, ok or good)	Ranking No.
															Wt	1.6		0.4		2.0		1.0		0.6		1.0		1.6		0.6		0.6		0.6	10.00		
	3	Alouette River near Haney	49.06	121.58	N										234	1.0	>20	1.0	3	1.0	225	1.0	1075	1.0	A	1.0	5	1.0	5	1.0	3	1.0	0.50	1.0	10.00		
??		Top Ranking Hydrometric Stations with a Weighted Sum higher than:		7.00 /10.00																																
8 MH014	3	Alouette River at outlet Alouette Lal	49.17	122.29	N	1130.0	2.59				2.93		588.3		201	0.8	9	0.0	3	1.0	225	1.0	1150	1.0	B	0.8	5	1.0	5	1.0	3	1.0	0.50	1.0	9.08		1
8 GA031	3	Capilano River at canyon	49.22	123.07	R	1120.0	2.05	1.64		1.94	2.30	4.45	452.3	877.5	197	0.8	26	1.0	3	1.0	180	0.7	900	1.0	C	0.5	5	1.0	5	1.0	3	1.0	0.50	1.0	8.88		2
8 MH002	3	Coquitlam River at Port Coquitlam	49.16	122.47	R	491.0	4.90	1.56		1.44	2.41	3.75	570.2	889.5	237	1.0	27	1.0	3	1.0	180	0.7	750	0.5	B	0.8	4	0.5	5	1.0	2	0.5	0.50	1.0	8.10		3
8 MG001	3	Chehalis River near Harrison Mills	49.18	121.56	N	1100.0	2.29	1.46		1.32	2.52	3.68	964.8	1408.6	383	0.4	15	0.7	3	1.0	180	0.7	900	1.0	A	1.0	4	0.5	5	1.0	3	1.0	0.50	1.0	7.82		4
8 MG013	3	Harrison River near Harrison Hot Sp	49.19	121.48	N	163.0	1.56	1.01		1.01	0.25	0.26	2001.2	2021.2	7870	0.0	44	1.0	3	1.0	135	0.4	1025	1.0	A	1.0	5	1.0	5	1.0	3	1.0	0.50	1.0	7.80		5
8 GA024	3	Cheakamus River near Mons	50.05	123.03	N	348.0	2.05	1.23	1.31	1.30	0.71	0.93	204.7	268.2	287	0.8	23	1.0	3	1.0	315	0.4	1650	0.0	C	0.5	4	0.5	5	1.0	3	1.0	0.50	1.0	7.18		6
8 GA028	3	Seymour River at Seymour Falls Da	49.26	122.58	R	752.0	2.05	1.76	1.81	1.99	1.54	3.07	228.2	454.0	148	0.4	13	0.4	3	1.0	180	0.7	775	0.5	B	0.8	5	1.0	5	1.0	1	0.0	0.25	0.5	7.10		7
		Others Considered:																																		
8 MH006	3	North Alouette River at 232nd Stree	49.15	122.35	N	1180.0	2.16	1.72	1.69	1.88	2.55	4.79	95.1	178.7	37.3	0.0	36	1.0	3	1.0	180	0.7	625	0.0	B	0.8	2	0.0	4	0.5	3	1.0	0.50	1.0	5.40		

COMMENTS:

Stations ranking 2, 3, 7 have regulated flow.
Stations ranking 5 have catchments areas greater than 1000 km².
Stations ranking 1 have less than 10 years of flow data available.
Stations ranking ? are located greater than 150 km away from the study catchment.
Stations ranking (none) are located in a different hydrologic zone than the study catchment.
Stations ranking 1 do not have any instantaneous flow records.

SELECTION: Five ranked gauging stations remain: 3, 5, 6, 7, & 9.
Of the remaining gauging stations, Station 08NE006 is the highest ranking, has the most years of record, has a catchment area approximately equal to that of the study catchment, and has the highest flow.
Therefore, to be conservative, we choose Station 08NE006 as the best comparison for the Howser Creek study catchment.
CFA computer software was used to confirm the 100 year maximum instantaneous flow for station 08NE006 (Kuskanax Creek near Nakusp).
Using CFA, the 100 year maximum instantaneous flow for station 08NE006 (Kuskanax Creek near Nakusp), was calculated to be 425 m^3/s based on the average of the 4 parametric frequency distributions.
To apply this data to the Howser Creek study catchment, a flow / area relationship was used to calculate the 100 year maximum instantaneous flow for the Howser Creek study catchment as follows: {(425 m^3/s) * [(339 km^2) / (337 km^2)] = 427.5 m^3/s}.
To be conservative, the flow of 427.5 m^3/s calculated using CFA computer software, was chosen for the Howser Creek study catchment.

HYDROMETRIC STATION INFORMATION / WATERSHED WEIGHTING FACTORS (for explanation of weighting factor Keywords see NOTES)

Gauge No.	Hydro-logic Zone	Station Description	Latitude (deg.min)	Longitude (deg.min)	Regul-ated or Natural Flow	24 Hour Mean Flow (L/s/km²)	100 Year 24 Hr. Ratio	Instant./Daily (I/D) Ave. Three Highest	100 Yr. from Append.	from Max. Inst. Q	100 Year Unit Runoff 24 Hour (m³/s/km²)	100 Year Unit Runoff Instant. (m³/s/km²)			Drainage Area (km²)	fctr	Record Length (yrs)	fctr	Hydrologic Zone (No.)	fctr	General Exposure (deg.)	fctr	Average Elevation (m)	fctr	Proximity to Study Catchment (A-D)	fctr	Amount of Attenuation (1-5)	fctr	Average Grade (1-5)	fctr	Drainage Density (1-5)	fctr	Width to Length Ratio (W:L)	fctr	Weighted Sum	Visual Inspect. Rating (poor, ok or good)	Ranking No.
		The Choice, Based on COMMENTS and SELECTION notes above:																																		
8 MG001	3	Chehalis River near Harrison Mills	49.18	121.56	N	1100.0	2.29	1.46		1.32	2.52	3.68	964.8	1408.6	383	0.4	15	0.7	3	1.0	180	0.7	900	1.0	A	1.0	4	0.5	5	1.0	3	1.0	0.50	1.0	7.82		

NOTES: Explanation of the Various Watershed Weighting Factors Keywords

DRAINAGE AREA - the area of land draining to the measurement point in km^2.
Key: input the drainage area
Score: within study catch. area x 1.2/0.9 = 1.0, 1.4/0.8 = 0.8, 1.6/0.7 = 0.6, 1.8/0.6 = 0.4, 2.0/0.5 = 0.2, otherwise 0.0

RECORD LENGTH - the number of years measurement has taken place at the gauging station.
Key: input the record length
Score: 20 yrs or greater=1.0, 15 yrs or greater = 0.7, 10 yrs or greater = 0.4, otherwise 0.0

ZONE - the hydrological zone specified by the Ministry of Environment, where the watershed lies.
Key: input the hydrologic zone
Score: exact match = 1.0, otherwise 0.0

GENERAL EXPOSURE - the general direction in degrees which the watershed faces or drains toward, north is 0 degrees increasing clockwise.
Key: N=0, NE=45, E=90, SE=135, S=180, SW=225, W=270, NW=315
Score: exact match = 1.0, plus/minus 45 deg. = 0.7, plus/minus 90 deg. = 0.4, otherwise 0.0

AVERAGE ELEVATION - the average elevation of the watershed in metres.
Key: input the elvation
Score: plus/minus 200 m = 1.0, plus/minus 400 m = 0.5, otherwise 0.0

PROXIMITY TO STUDY CATCHMENT - the degree range of longitude and latitude the gauged stream station is located on either side from the study catchment.
Key: A=within 0.5° long. & 0.25° lat., B= 1.0° long. & 0.5° lat., C= 2.0° long. & 1.0° lat., D= 3.0° long. & 1.5° lat.
Score: within range A=1.0, B=0.8, C=0.5, D=0.2, otherwise 0.0

AMOUNT OF ATTENUATION - the amount of lakes or storage the runoff must pass through before reaching the measurement point.
Key: 1=vlow, 2=low, 3=mod, 4=high, 5=vhigh
Score: exact match=1.0, one keyword higher or lower=0.5, otherwise 0.0

AVERAGE GRADE - the average overland grade of the cathment towards a watercoarse.
Key: 1=flat, 2=rolling, 3=mod, 4=steep, 5=vsteep
Score: exact match=1.0, one keyword higher or lower=0.5, otherwise 0.0

DRAINAGE DENSITY - the amount of watercourses per unit area.
Key: 1=vlow, 2=low, 3=mod, 4=high, 5=vhigh
Score: exact match=1.0, one keyword higher or lower=0.5, otherwise 0.0

WIDTH TO LENGTH RATIO - accounts for the shape of the watershed, whether it is narrow or wide.
Key: 0.25, 0.50, 0.75, 1.00, 1.25, etc...
Score: exact match=1.0, plus/minus ratio by 0.25=0.5, otherwise 0.0

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Project No.: 2007 2065 File: _____

Client: _____

Subject: Regional Analysis → Alouette near Haney

By: JT Date: Oct 17/07.

Sheet 1 of 4 Chk'd: _____ Date: _____

DESIGN NOTES

Alouette River Near Haney 49°14'21" N, 122°34'42" W

Drainage Area = 234 km².

08MH006 → North Alouette River @ 232 st, Maple Ridge 37.3 km²

49°14'34" N, 122°34'42" W

08MH014 → Alouette River @ outlet of Alouette Lake.

49°17'12" N, 122°29'12" W

→ General Exposure 0° = North Increase clockwise General drainage direction

→ Average Elevation (= metres)

→ Amount of Attenuation 1: V low 2: low 3: mod 4: high 5: v high

→ Average Grade overland slope towards a watercourse 1: flat 2: rolling 3: mod 4: steep 5: v steep

→ Drainage Density watercourses per unit area. 1: v low thru 5: v high

→ Width to Length Ratio

to 0.25, 0.5, 0.75, 1.0, 1.25, etc...

Ranks: (08 MH 005)

8 MH 014
8 GA 031
8 MH 002
8 MG 001
8 MG 013
8 GA 024
8 GA 028

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Project No.: 2007-2065. File:

Client:

Subject:

By: Date:

Sheet 2 of 4 Chk'd: Date:

DESIGN NOTES

I/D factors for: Chehalis River near Harrison Mills = 1.46.

North Alouette River @ 232nd St = 1.99

Harrison River near Harrison Hot Springs = 1.01

Cheakamus River near Mons = 1.31

average $\frac{I}{D}$ of these four guages (which are Natural Flow)

$\frac{I}{D}_{ave} = 1.415.$

Q_{100} Daily based on Alouette River at outlet of Alouette Lake

= 662.8

662.8 × 1.415 = 937.

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Project No.: 2007 2065 File:

Client:

Subject: CFA / Regional Analysis

By: JT Date: Oct 17/07

Sheet 3 of 4 Chk'd: Date:

DESIGN NOTES

Instantaneous Flows

CFA Results for Chehalis River near Harrison Mills.

14 years of data.

	GEV	3PLN	LP3	Wakeby
2	430	430	434	448
5	602	600	595	570
10	715	714	698	663
20	822	824	793	780
50	960	968	914	988
100	1060	1080	1000	1200
200	1160	1190	1090	1470
	OK	OK	OK	?

Use Q_{200} = 1190 m^3/s

Q_{200} Alouette River near Haney = $\left(\frac{234\ km^2}{383\ km^2}\right)^{0.785} \times 1190\ m^3/s$

Q_{200} = 808.3 m^3/s

Alouette River near Haney

$Q_{100} = \left(\frac{808.3}{1190}\right) / 1080 = 733.6\ m^3/s$

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Project No.: 2057 - 2065 File:

Client:

Subject: CFA / Regional Analysis

By: JT. Date: Oct 17/07.

Sheet 4 of 4 Chk'd: Date:

DESIGN NOTES

Chehalis River near Harrison Mills - Daily

	GEV	3P LN	LPIII	Wakeby	
2	54.7	49	2.25	-	
5	175	172	16	228	
10	268	270	72	373	
20	368	376	331	485	
50	516	531	2600	596	Ave
100	643	660	12700	658	654.
200	784	802	⋮	706	764
500	996	1010	⋮	754	
	Not Great	Not Great	Poor.	OK.	

Q_{100} Daily Alouette River near Haney $= \left(\frac{234\ km^2}{383\ km^2}\right)^{0.785} \times 654$

$= 444\ m^3/s.$

Q_{200} Daily Alouette River near Haney $= \left(\frac{234\ km^2}{383\ km^2}\right)^{0.785} \times 764.$

$= 518.9\ m^3/s.$