FINAL REPORT – OCT 9, 2012

Port Alberni Port Authority

Highway 19 Connector to Highway 4 via Horne & Lacey Lake Route Study

Conceptual Design and Cost Estimate

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#12-354

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1.0 EXECUTIVE SUMMARY

R. F. Binnie and Associates Ltd. was hired by the Port Alberni Port Authority to carry out a conceptual design study for a new highway route into Port Alberni. The proposed new road would start at the Horne Lake Intersection on Highway 19 and connect with Highway 4 near the Coombs Country Candy Store. The route would travel along the north side of Horne Lake traverse over the hump near Lacey Lake, and connect with Highway 4. Mapping from Island Timberlands was utilized to prepare the conceptual design.

The scope of the work was as follows:

- Determine if there is a viable route from the Coombs Country Candy to Horne Lake that will meet an 80km/h design speed
- Determine an approximate cost for the route
- Provide comments on the feasibility and pros and cons of this route

Binnie did find a route meeting an 80km/h design criteria. The route begins at the Coombs Country Candy Store just east of Port Alberni on Highway 4. It crosses the E and N Railroad, continues on the west side of Lacey Lake, then utilizes an existing logging road that connects with the existing Horne Lake Road at the Horne Lake Caves Provincial Park. This is called Segment 1 in the report. A bridge is required to cross the Qualicum River that enters into the northwest end of Horne Lake. This route also requires a soil steel structure for the railroad crossing. The length of Segment 1 is 13.75 kilometres and the maximum elevation attained is 400 metres. Binnie did find a route meeting an 80 km/h design speed both vertically and horizontally. This design is based on contour maps provided by Island Timberlands. The contours and digital modeling were used to determine the volume of soils that would have to be excavated to provide the required road. Binnie did not do any geotechnical investigations to determine if the soil is rock or dirt and for the purpose of this report, we have determined the excavation volumes as if it was all dirt. In the event the material is rock, then the volumes will be significantly less, but the unit price for drilling and blasting rock is higher. Past experience has shown that using a lower unit price for dirt with a greater volume is relatively equal to having a higher unit price for rock with less volume.

From the Horne Lake Caves, the route basically follows the existing route to the Illusion Lake Road. Binnie did not do any engineering on this route. The existing road is in relatively good shape with a fairly flat profile and a 9 to 10 metre road width. Some widening and straightening of the alignment would be required to attain an 80km/hr. design speed, but the construction looked to be relatively simple. The complication with this segment is that there are many accesses from the road to private cabins along the lake, and some of the accesses are fairly steep. In addition, there is evidence of significant rock falls along the road and the stability of the upper rock slopes is not known. A new two lane bridge was recently constructed by the BC Hydro dam at the outlet end of the lake, which should suffice for the new route. The distance from the Horne Lake Caves to Illusion Lake or Segment 2 is 9.4 kilometres and appears to be mostly relatively easy construction.

From the Illusion Lake Intersection to Highway 19 is Segment 3. This leg of the route is common to the work Binnie did previously for the Haggard Connector Study and the engineering from that study is used to calculate the approximate cost of this segment. The length of this segment is 4.12 kilometres.

The total distance of the route that was studied in this report is 27.27 kilometres and if travelling at the design speed of 80km/h the time to travel from Highway 19 to the Coombs Country Candy would be just less than 21 minutes. The distance from the Qualicum Interchange to the Horne Lake turn off on Highway 19 is 14.2 kilometres and if travelling at the design speed of 110km/h a total travel time of about 8 minutes. The combined distance from the Qualicum Interchange to the Coombs Country Candy via the Horne Lake Route is 41.5 kilometres with a travel time of 29 minutes. The travel distance on the existing route from the Qualicum Interchange to the Coombs Country Candy Store is 35 kilometres with a travel time of 30 minutes if traffic attains an average speed of 70km/h.

For Southbound traffic on Highway 19, or traffic travelling from Courtenay to the West Coast, the distance would be 27.27 kilometres vs. 49 kilometres on the existing route. The travel time for the new route would be 21 minutes vs. 37 minutes using the existing Highway 4, a saving of 16 minutes one way assuming an average speed of 80 km/h.

Binnie has not done a Cost Benefit Analysis for this route although there will be some significant challenges associated with it such as:

- The route goes very close to Lacy Lake and through the Cherry Creek Watershed area. A road through the watershed would have an impact on the watershed and the environment.
- There are about two dozen cabins along the north shore of Horne Lake with direct access to the existing Horne Lake Road. A Highway adjacent to the cabins would have a negative social impact in terms of noise and access.
- The route will require a bridge estimated at about 70 metres long crossing the Qualicum River that enters into the lake.
- The road design crosses the railroad on a fairly flat skew, which requires a soil steel structure about 70 to 80 metres long
- There may be unstable geotechnical conditions on the existing road above segment 2.

The approximate cost of the segments is as follows:

- Segment 1 (13.75 km) - $36,441,000
- Segment 2 (9.4 km) - $9,400,000
- Segment 3 (4.1 km) $4,120,000

- **Total Estimated Cost = $49,961,000.**

In comparison, the Haggard Route to Loon Lake was estimated at $37.6 million dollars. The main difference in the costs is that the Haggard Route is only 20.2 kilometres of new road construction, whereas the Lacey Lake Route is 27.27 kilometres. The Haggard route utilizes 5 kilometres of existing Highway 4 from the top of the hump to the Coombs Country Candy.

There may be a route that connects the Haggard route to the Lacey Lake route, but Binnie was not able to fully explore this within the terms of reference of this assignment. This could possibly be the preferred route as it would have little impact on the cabins around Horne Lake and could accomplish all of the goals of a new route. The length of the road though would remain at about 25 or 26 kilometres and therefore more costly than the Haggard Route which utilizes existing Highway 4.

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2.0 INTRODUCTION

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The scope of the work was as follows:

- Determine if there is a viable route from the Coombs Country Candy to Horne Lake that will meet an 80km/h design speed
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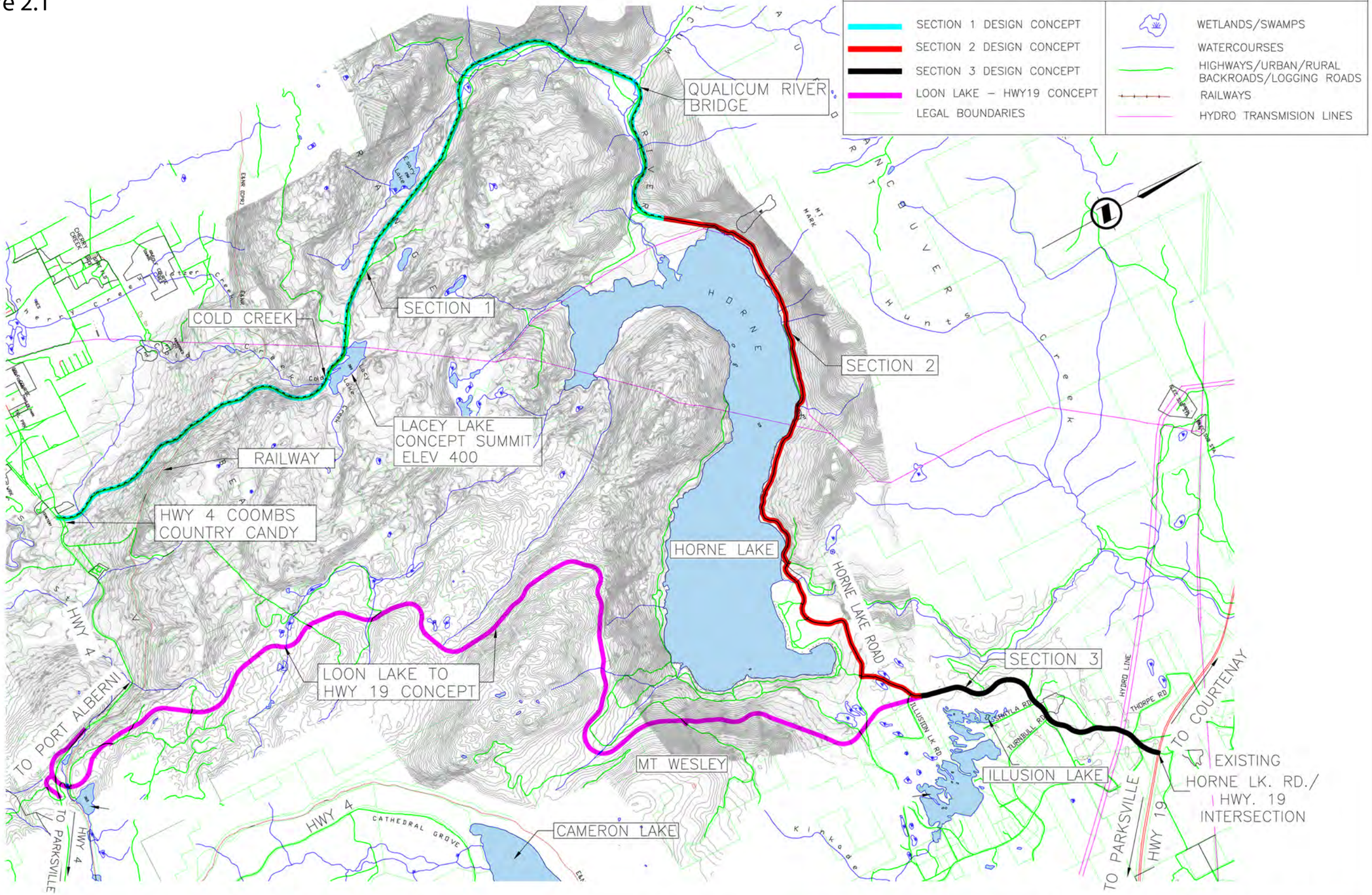
The proposed route is split into three segments as shown in **Figure 2.1** on the following page and described below:

- Segment 1 – Coombs Country Candy Store to Horne Lake Caves
- Segment 2 - Horne Lake Caves to Illusion Lake
- Segment 3 - Illusion Lake Intersection to Highway 19

Figure 2.1



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Engineering • Project Management • Contracting
• Bowser • Courtenay • Qualicum Beach • Prince George • Sechelt • Squamish • Surrey •

CLIENT: Port Alberni Port Authority

DRAWING DESCRIPTION: Horne Lake Connector - Conceptual Design
Hwy4 (Coombs Country Candy) via Lacey Lake to Hwy19 (Horne Lake Rd. Intersection)

SURVEYED BY
DRAWN BY K.W.
DESIGNED BY E.B./K.W.
CHECKED BY E.B./M.N.

SCALES: NOT TO SCALE

DATE July 18, 2012
DRAWING No.
KEY PLAN
SHEET 1 OF 10
REV.
DESTROY ALL PRINTS BEARING PREVIOUS No.

3.0 DESIGN PARAMETERS

3.1 DESIGN

The design parameters for this project were obtained from the B.C. Supplement to TAC Geometric Design Guide for a Rural Conventional Undivided (RCU) Roadway Class. The previous MOT Highway Engineering Design Manual (Green Book) and the TAC Geometric Design Guide for Canadian Roads (TAC) were also drawn upon to provide design parameters for items not found in the B.C. Supplement to TAC Geometric Design Guide.

3.2 TYPICAL CROSS-SECTION

The cross-section consists of two 3.6 m lanes with 1.5 m wide paved shoulders and 0.5 m of gravel shoulders. The 1.5 m of paved shoulders is the minimum width required for a shoulder bikeway. Additional cross-section elements are shown in **Figure 3.1** below.

Much of the alignment is inaccessible at this stage of the design so an assumption was made that all the material to be removed for road construction is dirt excavation, not solid rock. This then increases the cut volume dramatically. If the excavation encountered is actually solid rock, then the volume of excavated material would be roughly 50% less than the volume of dirt because of the steeper cut slopes in rock. Rock excavation is roughly 2 times the cost of dirt excavation so for estimating purposes, classifying all the excavation as dirt will provide a reasonable cost estimate for the excavation work.

An allowance has not been made for a truck climbing lane. The need for a truck climbing lane will be determined in further studies.

Clear zones and recovery zones have not been applied to the cross section elements, but will have to be considered in the ultimate design. A Clear Zone distance of 8.0m and 4:1 Fill Slopes will likely be required for an 80 km/h design speed. Where this is not feasible concrete roadside barrier would be provided.

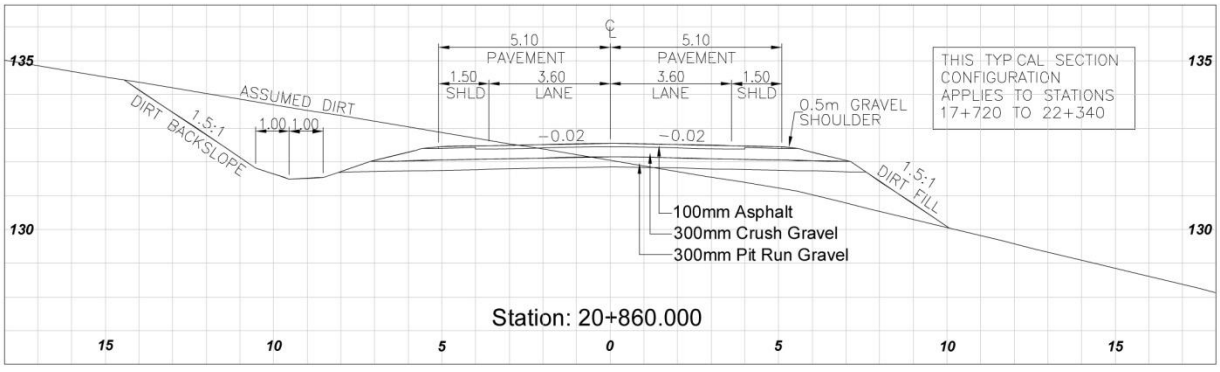


Figure 3.1: Typical Highway Cross Section

The typical section assumes 1.5:1 cut and fill slopes which would need to be confirmed during future geotechnical investigations. A 2:1 cut and fill slope may be required which would create a larger project footprint and cost. A standard pavement structure consisting of 100mm of asphalt pavement has been assumed but would also need to be confirmed by the geotechnical investigation.

3.3 HORIZONTAL ALIGNMENT

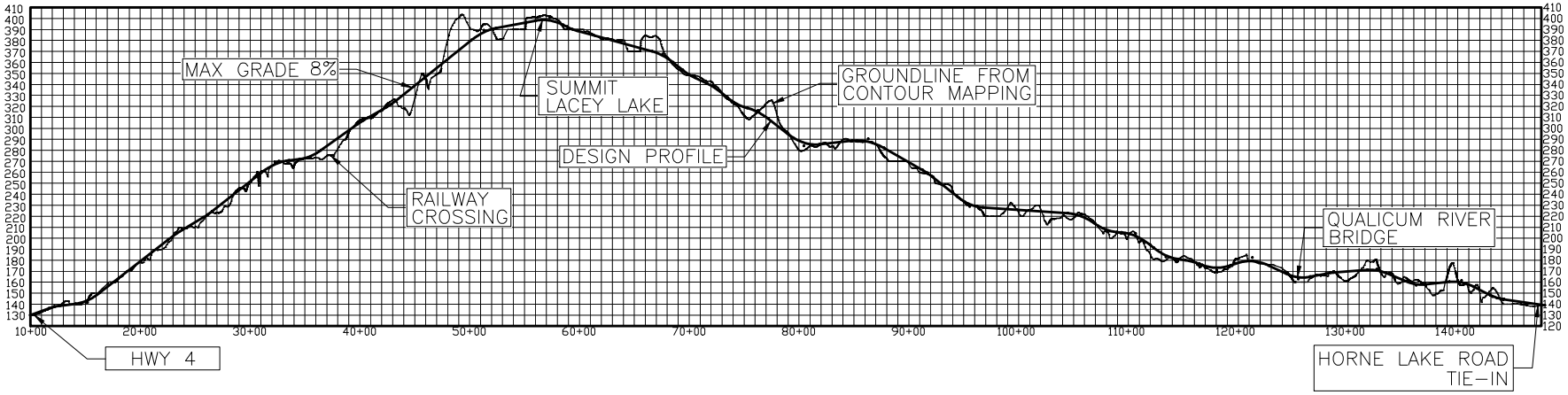
A minimum radius of 250 m and a maximum super elevation of 6% have been used as per Table 330.01.04 from the B.C. Supplement to TAC Geometric Design Guide which achieves an 80 km/hr design speed however it may be advantageous to have some curves designed to a lesser design speed to reduce some of the larger excavation areas. Advisory curve warning signs can be provided at the curves that do not meet the 80 km/h design speed.

3.4 VERTICAL ALIGNMENT

TAC recommends a maximum grade of 8% for a Rural Conventional Undivided (RCU) highway in mountainous terrain. The previous MoT Highway Engineering Design Manual recommended a maximum grade of 10% for RCU in mountainous terrain. For this design we have achieved a maximum of 8% throughout. The proposed profile is shown in **Figure 3.2** on the following page.

Figure 3.2

HORNE LAKE CONNECTOR
CONCEPTUAL DESIGN
SECTION 1 – PROFILE
HWY 4 TO HORNE LAKE ROAD



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CLIENT: **Port Alberni Port Authority**

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Horne Lake Connector - Conceptual Design
Hwy4 (Coombs Country Candy) via Lacey Lake to Hwy19 (Horne Lake Rd. Intersection)

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DRAWN BY K.W.
DESIGNED BY E.B./K.W.
CHECKED BY E.B./M.N.

SCALES
0 1:2000 80m

DATE July 18, 2012
DRAWING No.
SEC1–PROFILE
SHEET 1 OF 1
REV.
DESTROY ALL PRINTS BEARING PREVIOUS No.

3.6 INTERSECTION DESIGN

We were concerned that diverting up to 3,500 vehicles per day into the Horne Lake Intersection from the south may affect the level of service. We did do a preliminary traffic study on the intersection and found that the left turn movement onto the Horne Lake Connector would operate at a Level of Service "C", but the overall intersection will operate at a Level of Service "B". An interchange may be required at this location in the future, depending on the growth in traffic on Highway 19 and the Connector.

At the Coombs Country Candy end of the project, a detailed analysis would have to be done to determine the best location for an intersection with Highway 4.

We have not talked directly with the timber companies operating within the project limits, but have made an allowance for 4 intersections along the route to provide access for resource roads.

3.7 STRUCTURAL DESIGN

The new route crosses the existing railroad tracks below Lacey Lake. Although the railroad is not currently active, we have made an allowance for the highway to pass over the railroad. We have allowed $700,000 to construct a bridge plate pipe arch over the tracks.

This route will also require a bridge crossing the Qualicum River, approximately 70 metres long.

3.8 DRAINAGE DESIGN

There are some creeks, which will require large diameter pipes. At Cold Creek, which drains Lacey Lake we are crossing a gully and have assumed a 2,000 mm pipe through the embankment fill. For the remaining alignment we have projected culverts at a nominal spacing of 300metres and nominal size alternating between 1000mm and 600mm along the entire project length to establish the drainage costs.

3.9 CONCRETE ROADSIDE BARRIER

This project is a combination of side hill cuts, small through cuts, and some gentle rolling land on the east end of the project. We have made an allowance for barrier in the areas of high embankment fills.

4.0 ALIGNMENT OPTIONS AND CONSTRUCTION COSTS

The terms of reference for the project suggested looking for a route along the north side of the lake. There is an existing public road to the Horne Lake Caves Provincial Park and upgrading the road to highway standards from Highway 19 to the Horne Lake Caves is relatively inexpensive, notwithstanding geotechnical issues. From the Horne Lake Caves, there is a very steep logging road which parallels the shore of Horne Lake. Binnie investigated this route and found that attempting to design a highway adjacent to the lake would be very difficult because of the steepness of the terrain. A much easier and cheaper option in our view was to follow the existing logging road that parallels and then crosses the Qualicum River and then heads towards Lacey Lake.

The design has been developed with three segments with Segment 1 being from Coombs Country Candy to Horne Lake Caves Provincial Park, Segment 2 from the Horne Lake Caves to Illusion Lake Road, and Segment 3 from Illusion Lake Road to Highway 19.

The Segment 3 estimate, based on previous work done for the Haggard Route is shown in **Table 1**. With all contingencies, the cost to build 4.12 kilometres of road is 3.36 Million dollars or about $815,000/km. Binnie will use an estimate of $1 million/kilometre for estimating the cost of Segments 2 and 3. The total length of Segment 2 is 13.52 kilometres; therefore the cost is 13.52 Million dollars.

The Segment 1 estimate is shown in **Table 2**.

SEGMENT 3: HORNE LAKE CONNECTOR QUANTITY SUMMARY TOTAL LENGTH = 4.12 km				
	Quantity	**Unit**	**Price**	**Extended**
Mobilization	LS	LS	$100,000	$100,000
Traffic Management	LS	LS	$60,000	$60,000
Quality Management	LS	LS	$60,000	$60,000
Clearing and Grubbing	11.2	ha	$12,000	$134,400
Logging Road Severance				
Access Intersection	1	ea	$100,000	$100,000
New Logging Road	100	m	$500.00	$50,000
Pavement	3,749	tonnes	$105.00	$393,645
Gravel				
25mm	16,635	m3	$17.00	$282,795
SGSB	18,368	m3	$13.00	$238,784
Shoulder	103	m3	$25.00	$2,575
Excavation				
Type A				
Stripping	10,000	m3	10	$100,000
Type A/D mixed	44,660	m3	15.75	$703,395
Culverts				
600 dia	140	m	$300.00	$42,000
1000 dia	130	m	$400.00	$52,000
			Sub-Total	**$2,319,594**
Contingency 16%				$371,135
Detailed Design 7%				$162,372
Construction Supervision 10%				$231,959
Project Management 4%				$92,784
Management Reserve 5%				$115,980
Property Acquisition 3%				$69,588
Total cost Segment 3 – 4.12 kilometres			**Total**	**$3,363,411**
ROUNDED ESTIMATE (Assumes $1 M / km)				**$4,120,000**

Table 1: Segment 3 Quantity Summary and Estimate

SEGMENT 1: HORNE LAKE CONNECTOR QUANTITY SUMMARY				
TOTAL LENGTH = 13.75 km				
	Quantity	Unit	Price	Extended
Mobilization	LS	LS	$1,000,000	$1,000,000
Traffic Management	LS	LS	$500,000	$500,000
Quality Management	LS	LS	$700,000	$700,000
Clearing and Grubbing	64	ha	$12,000	$768,000
Logging Road Severance				
Access Intersection	3	ea	$100,000	$300,000
New Logging Road	300	m	$500.00	$150,000
Pavement	14,015	tonnes	$105.00	$1,471,575
Guardrail	2500	ea	$250.00	$625,000
Gravel				
25mm	52,133	m3	$17.00	$886,261
SGSB	58,082	m3	$13.00	$755,066
Shoulder	343	m3	$25.00	$8,575
Excavation				
Stripping	100,000	m3	10	$1,000,000
Type D excavation	1,337,503	m3	10	$13,375,030
Culverts				
2000dia Creek Crossing	63	m	$800	$50,400
Railway Crossing	1	LS	$700,000	$700,000
600 dia	460	m	$300.00	$138,000
1000 dia	460	m	$400.00	$184,000
Bridge Crossing Qualicum River	720	m2	3,500	$2,520,000
			Sub-Total	**$25,131,907**
Contingency 16%				$4,021,105
Detailed Design 7%				$1,759,233
Construction Supervision 10%				$2,513,191
Project Management 4%				$1,005,276
Management Reserve 5%				$1,256,595
Property Acquisition 3%				$753,957
Total cost Segment 1 – 13.75 kilometres			**Total**	**$36,441,265**
ROUNDED ESTIMATE				**$36,441,000**

Table 2: Segment 1 Quantity Summary and Estimate

The above table contains contingencies at the same percentages used by the Wolski and ND Lea estimating methods. We have roughly calculated the areas of land required from the various owners, but have not made an attempt to cost the purchase of the land. Similar to the Wolski estimate we have allowed a contingency of 3% of the construction cost for the purchase of land.

It is worth noting that with this design, there is a large surplus of excavation over embankment. This will undoubtedly change when the geotechnical investigation determines the rock/soil horizons. The total unadjusted excavation is 1,337,503 cubic metres and the total embankment is 808,747 cubic metres. Although the cost of a truck climbing lane has not been included in the cost estimate, this large surplus could be used to widen the embankments and provide for a truck lane as required.

It should also be noted that a portion of the surplus rock on the project could be crushed for road gravels and pavement aggregate. We did not do any geotechnical testing to prove suitability, nor was any acid rock testing done.

The alignment options that were researched for this assignment were quite limited. We were able to find an alignment that met the criteria that has a reasonable cost estimate. This is not to say that with more investigation that there is not a better option in the same vicinity. From Highway 19 to Horne Lake, we more or less followed the existing alignment trying to make the best use of road right of way as much as possible, and achieving the design speed requirements.

5.0 CONCLUSION

This study shows that there is a route along the north shore of Horne Lake connecting with Coombs Country Candy at Highway 4 that meets an 80km/hr design speed.

More detailed work would need to be done to develop this concept into a viable design such as but not limited to survey, public consultation, design, environmental review, and liaison with all stakeholders.

Some of the benefits of the new route are as follows:

- The highway will meet current design standards for an 80km/h design speed and will have 1.5 metre wide paved shoulders.
- The new highway will provide a safer route for motorists which will result in less collisions and fewer delays
- There will be fewer delays due to weather events as the area has mostly been logged and the right of way will be cleared to minimize the likelihood of trees falling onto the roadway.
- The travel time for motorists travelling from the south island heading to the west coast will be equal to or marginally less than that of the existing route. For those travelling from the north island to the west coast, the travel time will be about 20 minutes less each way.

The cost of the new route has been estimated at 49.96 million dollars. This estimate is largely based on 2012 unit prices. Some of the unit rates may seem low; however the prices do reflect the terrain and type of road to be built. The road is a new route, so drilling, blasting, earth moving, gravelling and paving costs may be lower as the work can be executed without delays caused by traffic.

5.1 NEXT STEPS

The following items are suggested next steps that should be considered to further the design.

- A meeting with the Ministry of Transportation should be held to discuss the viability of this route.
- Further design and analysis should be considered for alternate routes such as the combination of the Haggard and Lacey Lake Routes to determine if this would be more viable.
- A more detailed design of Segment 2 including a benefit-cost analysis should be performed.
- Once a preferred route is selected, survey data such as Lidar or low level aerial photography should be obtained and a Preliminary Design should be completed. The Preliminary Design will provide a greater level of design detail and will result in a more accurate construction cost estimate. Geotechnical, environmental and property constraints should also be identified as part of the Preliminary Design.