APPENDIX A

ROAD EVALUATION -

PRINCE RUPERT TO GRASSY POINT

October 15, 1982

ROAD EVALUATION -
PRINCE RUPERT TO GRASSY POINT

As part of its Western LNG Project, Dome Petroleum Limited proposes to construct a road on the Tsimpsean Peninsula from Prince Rupert to its LNG port facility near Grassy Point. Over the last ten years a number of possible road routes from Prince Rupert to Port Simpson have evolved and been examined by the B.C. Ministry of Transportation and Highways and others. Of the four potential routes examined, three routes involve a ferry crossing while the preferred route is an all land route. At this time the road being considered is a private road but it could be upgraded to a public road if cost sharing is provided by others.

What follows here is an overview of the environmental setting of the Tsimpsean Peninsula to provide sufficient background for discussion of the plausible routes and an indication of the preferred route. No actual field work was conducted. Instead, published information (listed under references) and maps were reviewed to obtain this overview information.

Physiography

The Tsimpsean Peninsula can be divided into two main physiographic divisions - the Coastal Lowland and the Central Highland (Figure 1).

The Coastal Lowland found along the Western coastland and west of Tuck Inlet is generally flat (averaging 760 m) with gently undulating "micro-topography". It is characterized by a surface alternating between bedrock and coastal muskeg. Steep slopes associated with ridge tops are promi-

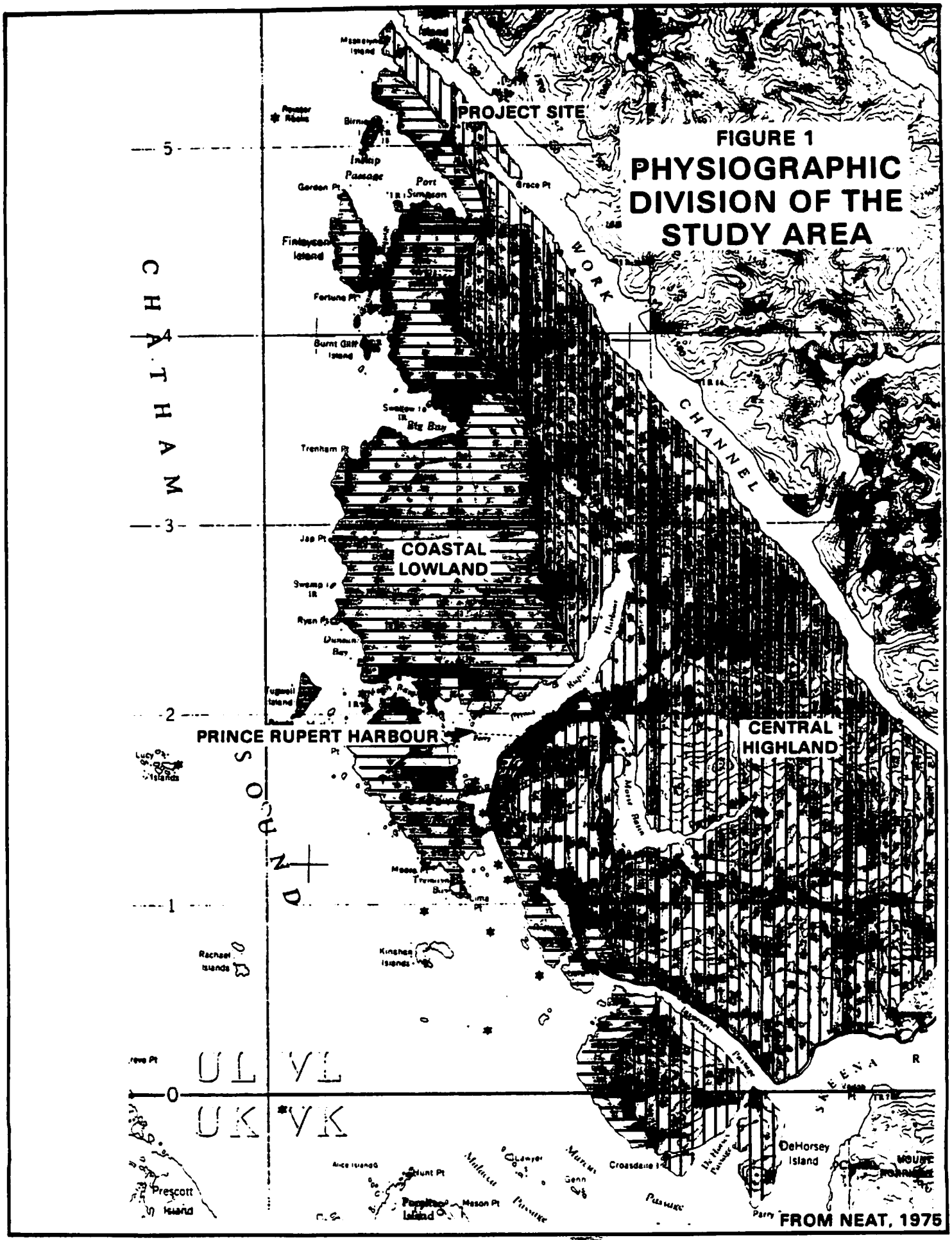


FIGURE 1

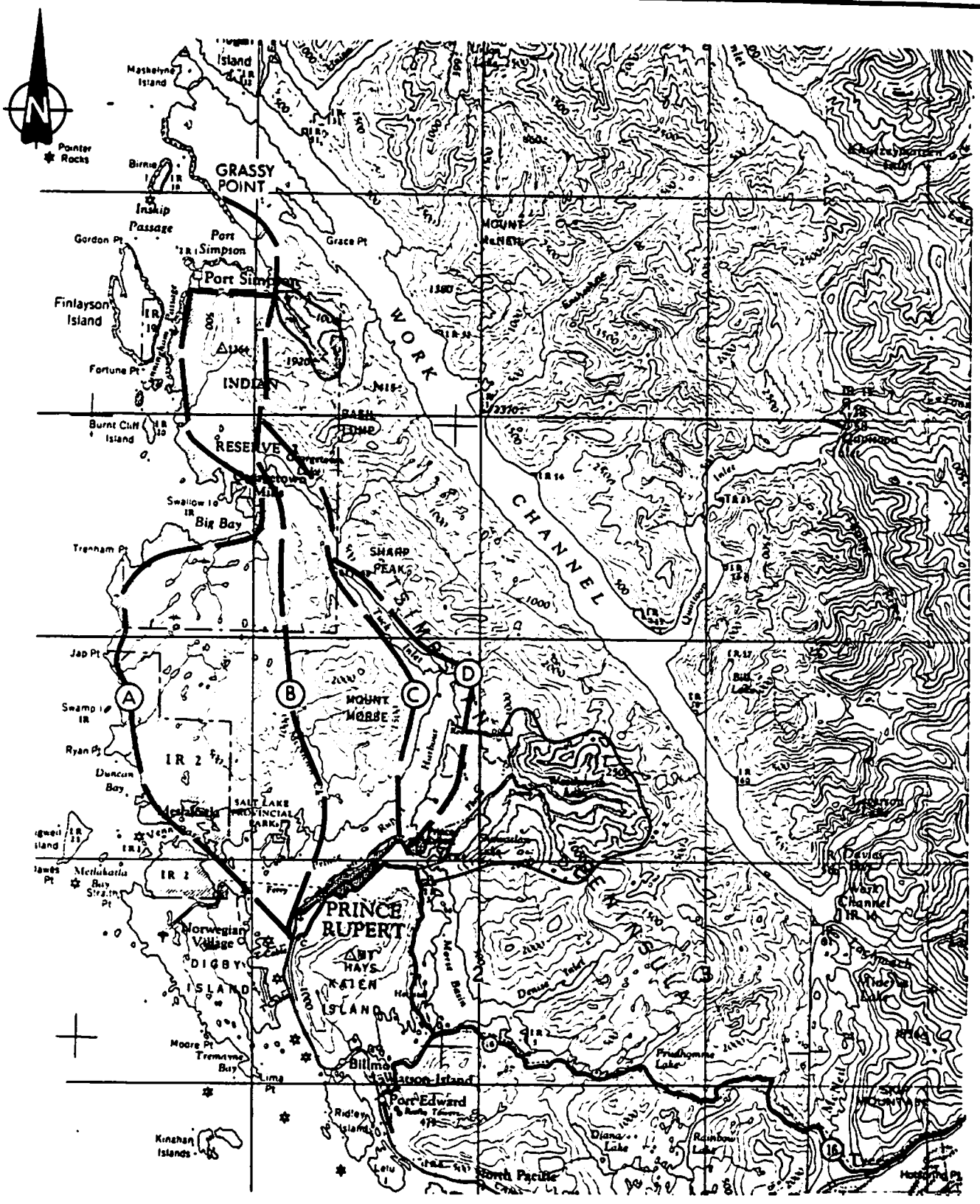
PHYSIOGRAPHIC DIVISION OF THE STUDY AREA

FROM NEAT, 1975

nent on the outer coast and adjacent to Big Bay (B.C. Highways, 1975). Normally, slopes do not exceed 30 percent although some small steep ridges may occur locally. All routes studied would traverse the Coastal Lowlands, north of Georgetown Lake up to Grassy Point. Figure 2 depicts the four proposed routes which could service the project. Two routes, A and B, would be built entirely within the Coastal Lowland. Modifications to Route A to bring it further inland, and to Route B to join Routes C, D north of Tuck Inlet, thereby avoiding Big Bay were not considered as they each also involve a ferry-road link. The preference is for an all land route.

The Central Highland found east of Coastal Lowland is characterized by more rugged terrain with rounded hills of 914 m and slopes exceeding 30 percent. These hills may be dissected by glaciated streams with moderate to gentle gradients, frequent rapids and small waterfalls before reaching the coastal lowlands. Major valleys trend northwest with minor drainages flowing in a northeast-southwest direction.

The valley walls of the Central Highland are steep, often close to their angle of repose. A number of debris slides are associated with Leading Peak and Basil Lump whose steep slopes skirt the eastern edge of an existing logging road. Debris slides are common on slopes greater than 30 percent. Routes C and D would occur primarily in the Central Highland until they are north of Georgetown Lake when they would be within the Coastal Lowland.



WATER SHED

NOTE
ROUTE "D" IS PREFERRED ROAD ALIGNMENT

DOME PETROLEUM LIMITED
CALGARY ALBERTA CANADA

PROJECT	WESTERN L.N.G.
PREPARED BY	
TITLE	FIGURE 2 PROPOSED ROAD ALTERNATIVES PRINCE RUPERT - GRASSY POINT
SCALE	
CONTR. DWG. NO.	
DOME DWG. NO.	A-WLP-100-22
REV	0

Soils

The soils of the Tsimpsean Peninsula that have developed are primarily a function of high rainfall and year-round cool temperatures but to a lesser extent drainage and slope. The primary soils groups found in the peninsula are organic soils, podzols, regosols and gleysols.

Organic soils are found primarily in areas of poor drainage. There are two dominant groups, the mesic fibrisols and the lithic fibrisols. Mesic fibrisols are open bog soils with undecomposed sphagnum on the top horizon and partly decomposed organic material in the middle and lower horizons. These soils usually are greater than 1.5 m thick.

Lithic fibrisols generally are less than 1.5 m thick with undecomposed organic material in the top and bottom horizons. These soils are associated with bog vegetation - lodgepole pine, yellow cedar and blanket bogs at higher elevations (B.C. Highways, 1975).

Podzolic soils are well drained mineral soils with an organic surface horizon with a well-developed B horizon. Podzolic soils are under forest or heath vegetation.

Regosolsic soils are associated with well-drained alluvial floodplain materials. Regols are weakly developed exhibiting a poorly-developed profile with a relatively thin organic top horizon.

Gleysolic soils are associated with freshwater and low salinity marshes. They are characterized by fine silt and mud of considerable depth. In general organic, regosolic and gleysols are more sensitive to disturbance than the podzolic soils.

Vegetation Communities

The vegetation of the Tsimpsean Peninsula belongs to Coastal Western Hemlock zone, west subzone (Krajina, 1965) and is composed of forest, muskeg, maritime and montane communities.

The two most common forests, the cedar-hemlock and hemlock-cedar, have relatively low diversity and productivity and contain few or no rare species (B.C. Highways, 1975). For construction purposes hemlock-cedar forests are preferrable to cedar-hemlock forests since the latter generally are associated with poorly drained soils with higher organic content. The slopes most susceptible to land slides are those forests over lithic organic soils on steep west-facing mountain sides as found on the east side of Tuck Inlet.

Riparian forest commonly found along the terraces and floodplains along major river valleys below 457 m have high diversity and productivity and may contain several rare plant species. The majority of riparian forest is found along McNichol, Salmon Bight and Stumaun Creeks. Disturbance to this vegetation can result in high stream erosion and resultant sedimentation.

The coastal forest is a relatively narrow belt near sea level with shingle beaches following streams to a more continuous forest belt on the lower mountainous slopes (B.C. Highways, 1975). Elsewhere in low areas and poorly drained areas are muskeg and scrub plants. The muskeg consists of raised bogs, blanket bogs, islands of bog forests and pit pools, small lakes and rivulets. Raised bogs which generally occur on relatively flat low lying land usually have shallow peat deposits although very deep peat is not uncommon.

Bog forest is scattered throughout the muskeg and can be small or large wooded islands. These islands are a transition zone between bog and closed forest. Blanket bogs, considered as part of montane communities, include lush alpine sedge forb meadows, heaths or other communities that have become established on talus slopes, rock outcrops, cliffs and wet runnels.

Maritime terrestrial vegetation is found on the numerous tidelands of the highly dissected coastline. This land water interface may take the form of beach, bluff, headlands, mudflat or marsh. Shingle beaches are more predominate than sand beaches. Shingle beaches consist of tide-washed coarse gravels and cobbles, some sand and the occasional boulders. Shingle beaches often front tidal marshes or salt marshes. These are found along the head of Tuck Inlet and margins of unprotected bogs. Tidal marshes border the shoreline of Tuck Inlet and the harbours along the coast. Big Bay is a good example of a tidal marsh. These are basically lowland meadows providing important habitat for deer, bear and waterfowl.

Montane vegetation is considered any vegetation above 457 m. None of the proposed routes would interact with this vegetation.

Freshwater aquatic vegetation is usually associated with muskeg vegetation although Georgetown Lake and Little Georgetown Lake contains submerged floating or emersed aquatic plants.

Wildlife

Western hemlock-cedar forest supports a variety of wildlife including blue grouse, Sitka blacktailed deer, black bear, wolf, numerous small mammals and their predators and many bird species. This forest provides summer habitat for the larger mammals and for many birds.

Cedar-western hemlock forest is similar to the above habitat except that western-red cedar is the dominant tree. Generally the soil's poor drainage and high inorganic content provides more lush undergrowth which has greater value for herbivores, particularly deer. Otherwise habitat is similar to that of western hemlock-cedar forest.

Riparian forest found on terraces and along rivers and creeks provides "edge effect" between different habitat types. Consequently it provides a greater wildlife diversity than the surrounding forest. There is lush ground cover which provides an important source of food for Sitka black-tail deer during spring and summer. The abundant arboreal lichens provide ample food for deer during winter months. The Sitka spruce forests provide important bald eagle habitat. Other bird species, insectivores, thrive on the abundant insect fauna associated with this wet habitat. Numerous small mammals and their predators are found where undergrowth is denser and more diverse.

Coastal muskeg found in the lowland areas has low productivity habitat and is not of great significance to wildlife other than Sandhill Cranes, Canada geese and loons which use it for nesting. Deer and bear frequent these areas during spring and fall to take advantage of abundant forbes and berries. Insectivorous birds are attracted to masses of flying insects hatched in pools and pit ponds during spring and summer.

Logged-over areas may create an "edge effect" depending on the stage of succession reached. Often open areas are valuable for deer (early spring) when forbs and buds form and for black bear in the fall when berries become available.

Aquatic and semi-aquatic communities include the coastal littoral zone and freshwater creeks and lakes. Although the proposed road corridors do not directly cross these habitats, their proximity to them could have detrimental effects.

The coastal littoral zone includes estuaries, tidal mud flats and tidal marshes. This is a highly productive area for wildlife, some of which depend upon the area seasonally. Areas potentially affected would be Melville Arm and Douglas Point, a small salt marsh on the western shore of Tuck Inlet and two larger ones on the eastern shore oppose Tuck Point and Big Bay. Big Bay is particularly important to migratory waterfowl. Freshwater creeks and lakes include Salmon Bight Creek, McNichol Creek and Georgetown Lake and Neaxtoalk Lake. The lakes are of significance to waterfowl species as well as to river otters and muskrats.

Aquatic Ecology

In general, although fisheries resources of the northern Tsimpsean Peninsula are not of high value, specific locations exist where they have great importance. These areas include: Prince Rupert Harbour, Tuck Inlet, McNichol Creek, Salmon Bight Creek, Silver Creek, the Georgetown River system, Lahon Creek, Big Bay, Stumaun Creek and Port Simpson Harbour.

Prince Rupert Harbour is a typical shallow water marine community. Two intertidal environments on the north shore, Douglas Point and Schreiber Point, are the areas most likely be affected by Routes B and C.

Douglas Point is just east of Melville Arm, which is a large estuary for McNichol Creek. This estuary is considered a valuable area for McNichol Creek salmon (B.C. Highways, 1975) and would be susceptible to disturbance. Schreiber Point has steeply sloping exposed bedrock shores and, although it likely supports a highly diversified subtidal community, it would be able to withstand minor habitat disruptions (B.C. Highways, 1975).

McNichol Creek is the largest of three salmon streams on the Tsimspean Peninsula and drains 23.8 square kilometres. The creek originates in the hills between Mount Morse and traverses Mission Mountain and flows southeast descending onto the Coastal Lowlands and entering Melville Arm. Riparian vegetation is dense with overhanging cedar and hemlock predominating. McNichol Creek has moderate to high capability for supporting anadromous fish populations (B.C. Highways, 1975). There are no large waterfalls to obstruct fish passage. Fish species found in McNichol Creek include pink and coho salmon, Dolly Varden, coastal cutthroat trout and steelhead. Only Route B would interface with McNichol Creek.

Salmon Bight Creek drains 19.2 square kilometres north from Mount Morse discharging in Salmon Bight of Big Bay. Cedar and western hemlock are the predominate vegetation types along with some muskeg areas. There is a large waterfall approximately 3.0 kilometres from the mouth and two smaller falls at 1.6 kilometres and 0.8 kilometres upstream

from the mouth (B.C. Highways, 1975). The two smaller falls probably do not act as barriers to coho or steelhead but the larger one does. Although little is known about the species present, it is expected that coastal cutthroat, Dolly Varden and salmon exist. Only Routes A and B would traverse this watershed.

All proposed routes would traverse the Georgetown Creek system. The Georgetown Creek, which is the largest on the Peninsula, drains 56.9 square kilometres of mountainous terrain; it is crossed by Routes A and B. Lake Georgetown, 3.52 kilometres in length and an 8.9 kilometre shoreline, is the largest lake north of Prince Rupert. Little Georgetown Lake, 1.44 kilometres long with a 3.8 kilometre shoreline, lies in a steep-walled portion of a valley southeast of Georgetown Lake. Several small streams to the north and east discharge into Georgetown Lake. Georgetown Lake has steep shores with considerable areas of marsh at each end, particularly the exit.

Georgetown Creek, which drains west from Georgetown Lake, has a steep gradient, boulder and bedrock substrates and two large waterfalls between the Lake and Big Bay. As well, there are man-made control and diversion structures. The stream running south from Georgetown Lake has a waterfall 823 metres above the lake (B.C. Highways, 1975). From the falls upstream to the outlet of Little Georgetown Lake there are long ponds. Logjams have created a short braided section where the river swings to the north.

Although Georgetown Lake is inaccessible to anadromous fish, there probably are cutthroat trout, steelhead and coho. Spawning areas are found at small stream mouths along eastern and northern portions of the lake. Spawning may also

occur in lower reaches of upper Georgetown Creek. Although there is little known about the fisheries of the Georgetown Lake system, there is considerable potential for fisheries management.

Big Bay, a wide shallow bay on the west coast of Tsimpsean Peninsula, has abundant salt marshes, eelgrass beds and extensive intertidal area. Salmon Creek, Georgetown Creek and several other small freshwater coastal streams flow into the bay. This bay with its extensive habitat provides abundant forage and protective cover for small fish. The eelgrass provides optimum conditions for herring spawning and egg survival. This bay has also been described by Fisheries Canada as a primary nursery area for Skeena River salmon stocks. None of the routes actually cross Big Bay but Routes A and B would be located near its shoreline. Big Bay has also historically been used by local natives and for herring roe on kelp farming.

Lahon (Pearl Harbour) Creek, with a drainage area of 17.6 square kilometres, drains the area between the Georgetown Lake and Stumaun Creek watersheds, including the western slopes of leading Peak and Mount Bear. It flows westward in a narrow, meandering valley through muskeg-covered coastal lowlands discharging onto a large intertidal flat north of Big Bay. Logging operations have deterioriated the fisheries capability of the stream through erosion, bank failures and culvert washouts. The lower 2.7 km of the stream have steep gradient and pools with predominately boulder substrate. There is a high waterfall 213 m upstream of the existing road crossing. Fish species found include pink and coho salmon and steelhead and cutthroat trout. All routes cross Lahon Creek. Route A crosses near its mouth and Routes B, C and D cross it southeast of Mount Griffin.

Stumaun Creek has two forks which flow northwest and each exhibit quite different characteristics. The creek branches near the high tide mark with the eastern fork, which drains 6.1 square kilometres of mountainous terrain having a steep gradient. The western fork, which drains 3 square kilometres of low hills has a moderate gradient. The east fork, with its poor supply of gravel substrate and a water supply dam for Port Simpson is located 1.5 km upstream of the mouth has limited potential for sustaining anadromous fish. The west fork on the other hand has abundant gravel substrate between the frequent debris jams which is suitable for pink or chum salmon spawning. Other fish species include Dolly Varden, coastal cutthroat and steelhead trout. The west fork has been altered through the removal of streambank vegetation and minor diversions by the existing logging road which Routes B, C and D would generally follow. All routes would cross Stumaun Creek on the portion of road going from Port Simpson to Grassy Point.

Stumaun Bay into which Stumaun Creek flows is relatively flat with large areas of sand and mud flats overlying fluvial gravels. Stumaun Bay's large eelgrass beds make it particularly important habitat for spawning herring. Numerous other fish species are present. All routes would be near the coastline of Stumaun Bay on the way to Grassy Point but none would cross it.

All routes would cross the Neaxtoalk Creek north of Neaxtoalk Lake which drains a small watershed north of Stumaun Bay. Although little is known about fish species present in this system, local residents indicate that there are cutthroat trout with possibly some salmon.

The Alternate Routes

As indicated earlier, four alternative routes (see Figure 2) were considered as feasible routes for a road or ferry/road access from Prince Rupert to the LNG port facility at Grassy Point. All routes are the same for that portion of the road from the mouth of Stumaun Creek to the LNG facility project site near Grassy Point. Routes B, C and D have a common route near Georgetown Lake. A description of each route considered follows.

Route A

Route A, approximately 44.3 km, would follow the western coastline of the Tsimpsean Peninsula through Metlakatla, north of Georgetown Mills, to Port Simpson before terminating at Grassy Point. Route A would commence at the existing Airport Ferry Terminal at Pillsbury Point and proceed in a northwest direction through Venn Passage to Metlakatla. Thence the route would proceed over land to the west of Prospect Hill and head north along the west coast south of Big Bay. The road would then proceed east and follow around Big Bay, avoid Georgetown Mills and head northwest to Port Simpson. At this point the road would head east then north following the west shore past Stumaun Bay, cross Neaxtoalk Creek, for approximately 7.1 km to the project site. This route would cross 24 watercourses.

Route B

Route B, approximately 34.3 km would provide the most direct route from Prince Rupert to the LNG port facility. This route would commence with a 5.4 km ferry crossing from the existing airport ferry terminal at Pillsbury Point to a new terminal at Douglas Point east of Melville Arm and

adjacent to the mouth of McNichol Creek. Thence the road would proceed directly north of the west side of McNichol Creek floodplain through a gentle pass (675 feet) then into the Salmon Creek Valley. The road would approach the mouth of Salmon Creek then proceed north skirting the tidal marshes of Big Bay and cross Georgetown Creek one-half mile east of Georgetown Mills. Thence the route swings northeast and skirts the base of Leading Peak. The road would then follow the existing Port Simpson Band logging road, cross the headwaters of Lahon Creek and descend the western fork of Stumaun Creek to Stumaun Bay. At this point a 4.9 km road would coincide with the Route A road to the project site. This route would cross 12 watercourses.

Route C

Route C, approximately 33.5 km, would follow the north shore of Prince Rupert Harbour and would run along the west side of Tuck Inlet to the project site. The route would require a 2.3 km ferry crossing from a new terminal in the Seal Cove area to a terminal at or east of Schreiber Point. Thence the route proceeds north between the flank of Mount Morse and Prince Rupert Harbour. Following the base of the mountain, the route cuts across the mouth of Tuck Inlet following its shoreline to its head. Thence the route swings northeast and follows Georgetown Creek to the eastern shore of Georgetown Lake. The road would cross Georgetown Creek at the mouth of the Georgetown Lake with at least a 21.3 m span bridge. At this point the road would climb the headwaters of Georgetown Lake drainage system and skirting Basil Lump connect with the Port Simpson Band logging road leading to Stumaun Bay. The road would coincide with Route B from the base of Leading Peak and Route A from Stumaun Bay to the project site. This route would cross 18 watercourses.

Route D

Route D, the only all land road, approximately 39.5 km, would pass along the north side of Prince Rupert up the east side of Tuck Inlet to join Route C just north of the head of Tuck Inlet.

The route would cross Fern Passage via a bridge and proceed northeast around Shawatlan Lake. Then the route proceeds north following the coastline. At Laurier Cove the route swings east, crosses Silver Creek and follows the east side of Tuck Inlet to its head where the route connects with an existing 2.6 km logging road owned by Goodwin Johnson Ltd. This road extends from the head of Tuck Inlet on the eastern shores to Little Georgetown Lake. There is a 3.5 km distance from a point southeast of Little Georgetown Lake crossing Georgetown Creek to the east shore of Georgetown Lake where no logging road exists. Once on the eastern shore of Georgetown Lake, Route D coincides with Route C by following the existing Port Simpson Indian Band Road. This road extends from the eastern shore of Georgetown Lake down the west fork of Stumaun Creek to the south shore of Port Simpson Harbour. At this point the route coincides with Route A. This route crosses 15 watercourses.

Rationale for Route Selection

As indicated in the introduction, this evaluation of the four alternative routes is not meant to be a detailed impact assessment but rather an overview identifying the preferred route and potential environmental and engineering problems. In determining the best route from Prince Rupert to the LNG facility near Grassy Point, the following criteria were used:

1. Terminal Points

The proposed route must connect Prince Rupert with Dome's proposed LNG facility near Grassy Point. In doing so, a road would provide road/ferry access to Port Simpson.

2. Engineering Constraints

Any proposed roads must be built to meet specific codes and to do so must consider geotechnical and hydrological limitations for constructing the road and bridges or causeways where required, i.e., actively eroding slide areas, etc. The road, as proposed now, would be a private road but with cost sharing provided by others, the road could be upgraded and operated as a public road.

3. Environmental Constraints

Any proposed road must be constructed and operated to avoid or protect environmentally sensitive areas, i.e., sensitive habitat, tidal marshes, shingle beaches, riparian vegetation.

4. Compatibility of Road with Proposed Pipeline and Powerline

Consideration was given to the feasibility of locating the road in a common corridor with the powerline and pipeline and, in particular, the possibility of each of these being contiguous with one another.

5. Security of Service

Consideration was given to the advantages and disadvantages of an all land road or ferry/land road. It is Dome's preference to have an all land road because it would provide uninterrupted, all-year access to the terminal independent of weather conditions. Also, in the event of a failure at the plant or along either the pipeline or powerline, an all land road would provide ready and easy access to the area.

6. Cost of Construction

Consideration was given to the cost of construction of each route. Projected costs include costs for new terminals, bridges, new road and upgrading of existing roads. Since routes follow the same corridor north of Stumaun Creek, the costs to construct this portion of the road are not considered.

Using these criteria, the four routes were evaluated. The sections of the route which are common, north of Tuck Inlet for B, C and D and north of Port Simpson, for all routes are discussed separately.

Route A

Route A, approximately 44.3 km long, is the longest and least direct of the four routes. It has an 8.16 km ferry connection from the existing ferry terminal at Pillsbury Point to Metlakatla. It is the only route that would require all new construction.

Route A is located entirely within the Coastal Lowlands and consequently could cause detrimental effects on coastal muskeg areas, particularly open bogs. Muskeg soils are generally poor road construction materials (Slaney, 1972) and can pose serious engineering constraints as a result of lack of drainage, organic soils, flooding and erosion.

Route A follows the coastline and would encounter tidal marshes, shingle beaches and mud flats, particularly at Big Bay. These are valuable not only for their vegetation but also for the habitat they provide for migratory waterfowl and seasonal habitat for large mammals such as deer, bears and wolves. Construction of a road along the coast could separate these habitats from the upland forests which are also utilized by large mammals during other times of the year.

Route A would cross 24 creeks including Salmon Bight and Georgetown Creeks. Riparian vegetation, found along the banks of Salmon Bight Creek, provides seasonal habitat for deer and bear.

Numerous archaeological sites exist along this route and they would have to be preserved or salvaged.

The Port Simpson Indian Band have expressed opposition to this route for environmental reasons.

Although this route would provide access to the LNG facility via Prince Rupert, Metlakatla and Port Simpson, it would not provide access for the proposed pipeline and powerline which would lie to the east. This route is the longest and would require all new road. Cost estimates to construct this route are shown in Table 1.

Route B

Route B, approximately 34.3 km long, would leave from the existing ferry terminal at Pillsbury Point and go to a new terminal at or near Douglas Point, an approximate distance of 4.5 km. Approximately 23.4 km would be new construction and 10.9 km would be upgrading of the existing logging road.

Route B is located entirely within the Coastal Lowlands. Although it does not encounter as much coastal muskeg as A, it still does cross some muskeg which would pose the same engineering constraints as outlined above.

This route traverses the McNichol Creek Valley east of Mission Mountain. This could require side cutting of Mission Mountain with the possibility of erosion or slides. Otherwise, the stability of the terrain should not create serious problems.

Although over 30 percent of the vegetation crossed by Route B is riparian forest (B.C. Highways, 1975), it also crosses sensitive coastal muskeg vegetation.

Melville Arm is a very important estuary of McNichol Creek, the largest and most important salmon spawning creek on the Tsimpsean Peninsula. This estuary also provides important habitat for migratory birds. The riparian forest found along McNichol Creek is used extensively by deer in winter. Route B also runs near the tidal marshes and mudflats of Big Bay and could have an indirect negative effect on waterfowl habitat through construction and operation of the road.

TABLE 1

SUMMARY OF HIGHWAY COSTS (1981 "000" $) OVER 20 YEARS
GRAVEL SURFACE 7.3 m WIDE

Connection to Port Simpson	POTENTIAL ROUTES A	B	C	D
Subgrade Construction	$ 8,060	$ 4,216	$ 3,100	$ 5,456
Subgrade Reconstruction		1,519	1,612	1,612
Culverts	930	775	899	1,085
Small Bridges	3,100	1,798	1,488	1,829
Surfacing	2,480	2,201	2,170	2,387
Clearing and Grubbing	930	806	713	837
Camp and Travel Costs	992	930	775	775
Project Overhead, Supervision Mobilization, etc.	961	930	682	744
Engineering, Surveys and Construction Supervision	1,147	1,085	961	1,085
TOTAL ROAD CONSTRUCTION	$ 18,600	$ 14,260	$ 12,400	$ 15,810
New Ferry Costs	$ 930	$ 930	$ 930	$ (620)
Ferry Terminals	620	620	930	(930)
Bridge at Fern Passage				6,200
TOTAL INITIAL COST	$ 20,150	$ 15,810	$ 14,260	$ 20,460

NOTE: Table derived from cost estimates derived by F.F. Slaney by escalating to 1981 $'s by 12% per annum.

Route B crosses 12 watercourses of which McNichol and Salmon Bight Creeks are the most important. Five of these watercourses are in that section of the road common with Routes A, C and D.

There are three important archaeological sites around Melville Arm which must be preserved (NEAT, 1975).

This route would not provide access to either the pipeline or powerline which are proposed further east. Cost estimates to construct this road (see Table 1) indicate Route B is preferrable to Route A.

Route C

Route C, approximately 33.5 km, is the shortest route to the LNG facility. It would have a 2.3 km ferry crossing from a new terminal at Seal Cove to a new terminal near Schreiber Point. Approximately 20.7 km would require new construction and 12.8 km would be upgraded road. Unlike Routes A and B, Route C lies predominately within the Central Highland and only is within the Coastal Lowland north of Georgetown Lake.

Around Schreiber Point, the shore is steep and rocky with limited capability for spawning or rearing of fish or feeding of waterfowl. Route C ferry operations add congestion to the Seal Cove area.

The route would have to avoid a slide area east of Morse Mountain. Most of the area on the west side of Tuck Inlet has a slope greater than 30 percent (NEAT, 1975).

Route C crosses predominately hemlock-cedar and cedar-hemlock forests, no riparian forests and only 3.5 km of coastal muskeg (B.C. Highways, 1975). Hemlock-cedar and cedar-hemlock forests are a much preferred vegetation type for road development than the coastal muskeg. Up to kilometre 12.8, the route crosses a number of streams near their mouths but, other than these, this route should have little or no adverse environmental effect.

On the eastern slope of Georgetown Lake, Route C would encounter some valuable wildlife habitat for deer and some shore spawning. However, in comparison with Routes A and B, Route C interacts with fewer sensitive habitats. For example, deer tend to winter in the west coastal habitats of the intertidal and coastal fringe forests which would be affected more by Routes A and B than C. Since Route C does not cross much riparian forest or potential deer habitat, it would have less impact than A or B.

Route C could disturb a number of shingle beaches in protected bays along Tuck Inlet and at the head of Tuck Inlet. Although significant as a waterfowl nesting, staging area, but not particularly sensitive for wildlife habitat, protection of vegetation sensitive to disruption would be required. Route C would run adjacent to a salt marsh north of Tuck narrows on the west side of Tuck Inlet. Route C would cross 18 watercourses of which five are common with Routes B and D and two with Route A. Of these, Georgetown Creek and Stumaun Creek are the most significant.

Two archaeological sites for salvage are located along Route C. One is located south of Tuck Point and the other across from Osborn Cove (NEAT, 1975).

Although Route C does not provide all land access, it is a feasible route. It is direct and encounters few of the sensitive habitats of Routes A and B. It could provide access to the powerline if the powerline is located along the west side of Tuck Inlet north of Tuck Narrows. It would not, however, provide access to the pipeline. The main disadvantage of Route C is that it does not provide an all land route. Cost estimates (Table 1) indicate that this route would be cheaper to build than Routes A or B.

Route D

Route D, approximately 39.5 km, is the only route which is an all land route. This route would require a 335 m bridge spanning Fern Passage. It would require 26.7 km of new road construction and 12.8 km of road upgrading.

Like Route C, Route D lies predominately within the Central Highland entering the Coastal Lowland north of Georgetown Lake. Most of the east side of Tuck Inlet has slopes greater than 30 percent. Unlike the other routes, it traverses the western reaches of Lot 44 owned by the City of Prince Rupert adjacent to Prince Rupert's water supply reservoir.

The route traverses predominately hemlock-cedar, cedar-hemlock forests which are suitable for construction. It does, however, cross cedar-hemlock forest on slopes greater than 30 percent on the east side of Tuck Inlet and these are potential slide areas. The route also would run adjacent to tidal marsh areas at Laurier and Osborn Coves. Routing the road away from these to steeper shelving, rocky beach would avoid impact on these sensitive areas. Route D would cross riparian forest found along Silver Creek, an important deer habitat.

Route D would cross 15 watercourses (excluding Fern Passage crossing) of which five are common with Route B and C and two are common with Routes A, B and C. Silver Creek and Stumaun Creek are the significant watercourses. Route D would avoid a significant waterfowl nesting and staging area at the head of Tuck Inlet.

Route D could impinge upon a number of archaeological sites requiring salvage or preservation on the east coast of Prince Rupert Harbour, Pethick Point and Laurier Cove, and north of Osborn Cove (NEAT, 1975).

Although this route is longer (and costlier) than Route C, it is the only all land route. This road could provide access for the proposed pipeline and powerline during the construction and operation of all facilities. As well this road would minimize the number of separate rights-of-way on the Tsimpsean Peninsula through the use of a common corridor wherever possible. Cost estimates (Table 1) indicate that this Route would cost more than Route C.

Routes Common to A, B, C and D

Route C and D coincide on the eastern shore of Georgetown Lake and they coincide with Route B north of Georgetown Lake near the base of Leading Peak. There should be no direct serious effects on Georgetown Lake as long as road upgrading is kept to the existing road, away from the lakeshore. As well, provisions should be made to divert runoff from the lake. Disturbance to the small stream on the east side of Georgetown Lake should be kept to a minimum to avoid interference with the resident trout.

Routes B, C and D would all interact with Lahon Creek, a salmon bearing stream. Any upgrading of the existing road should include construction of a high bridge which would span the creek and discourage pedestrian access to the creek. Areas disturbed during construction should be revegetated to minimize erosion and the possibility of siltation.

The existing Port Simpson Band road follows the west fork of the Stumaun Creek, an important salmon stream. The available spawning habitat lies within a metre of this road. If either Route B, C or D are to be built and upgrading of this road was to occur, consideration should be given to locating a new right-of-way on higher ground away from the immediate stream valley otherwise widening of the existing road should occur on the uphill side of the road to minimize siltation (B.C. Highways, 1975). As well, reforestation of the banks and construction of drop structures should be implemented.

The Goodwin Johnson Ltd. road and the Port Simpson Band road would require changes in grade and modifications to the bends which are often too steep or sharp, respectively. As well, Port Simpson Band road has fallen into disrepair and would require considerable upgrading (Tera, 1978).

At Stumaun Bay, all routes would coincide. From south of Stumaun Bay, the routes would cross Stumaun Creek near its mouth, follow around Stumaun Bay, cross a small creek, then cross Neaxtoalk Creek. Although little is known about the fisheries of Neaxtoalk Creek, standard mitigative measures should be utilized to minimize impact of construction.

The Preferred Route

As indicated earlier, the preferred route is Route D. Route C is an acceptable alternative, Route B is less desirable and Route A is the least desirable.

Route A is the least acceptable route, primarily because of its impact on some of the most valuable habitat areas on the Tsimpsean Peninsula and in particular, Big Bay. Route A would impact more archaeological sites than any of the other routes. As well, the lack of gravel accumulations (Slaney, 1972) and the considerable muskeg pose substantial engineering problems. Route A would require the longest ferry ride of three ferry/road routes.

Route B is more acceptable than Route A but it too is less preferrable than Routes C or D. As with Route C, Route B would impact upon valuable habitat areas of Big Bay, Melville Arm and McNichol Creek. Route B would cross considerable coastal muskeg and riparian forest, the former posing potential engineering problems and the latter potential winter habitat for deer and other animals in the spring and summer. Route B would require a new terminal somewhere near Douglas Point in the Melville Arm area. This estuary has been identified as very important for fishery and migratory birds (NEAT, 1974; B.C. Highways, 1975) and susceptible to environmental damage by constructing a terminal. Melville Arm also has three archaeological sites which must be preserved.

Route C is preferrable to Routes A or B since it is further east from important habitat areas along the west coast. Route C crosses primarily hemlock-cedar, cedar-hemlock forests which are most resilient to disturbance. Route C crosses no riparian forest and approximately 3.5 km

of coastal muskeg (B.C Highways, 1975). Route C would disturb shingle beaches along Tuck Inlet and there is the potential to interact with very sensitive vegetation along the margins of protected bays. Route C would require a ferry trip which is shorter than those of either Routes A or B. New terminals would be required near Schreiber Point, and near Seal Cove. There should be no major environmental concerns with the terminal at Schreiber Point but there could be interference between the sea plane traffic and a new ferry at Seal Cove. There are only two archaeological sites requiring salvage which could be affected by Route C.

Route D is the only route which is all land. Route D crosses primarily hemlock-cedar, cedar-hemlock forest although riparian forest does occur along Silver Creek. Route D has the potential to interact with the salt marshes and estuarine habitat along Laurier and Osborne Coves, and to a limited extent, on the east side of Tuck Inlet. If the route is located away from salt marsh by routing it on the rocky shore, the impact would be reduced. Route D would traverse the western portion of Lot 44 but would not affect the water quality of Shawatlan Lake. Although Route D would cost more than Route C (or B), it is the preferred route because it would provide unlimited 24-hour access to the LNG facility site. As well, the road would be useful in the construction and operation of the pipeline and powerline. By selecting Route D, it is possible that the powerline, pipeline and road could all be built within a corridor on continguous rights-of-way. In doing so, the width of right-of-way required for each could be reduced by sharing working space during construction. Careful routing will be required to ensure adequate space for each facility, particularly on some of the steep slopes on the east side of Tuck Inlet.

A number of archaeological sites along the east side of Prince Rupert Harbour up to Laurier Cove would be affected by Route D.

The bridge crossing at Fern Passage could cause interference with the seaplane terminal at Seal Cove but with proper planning, location and navigational aids the impact can be minimized.

CONCLUSION

Studies conducted to date indicate that there are at least four feasible routes between Prince Rupert and Port Simpson. Of these only one would provide all land access and it is this route, Route D, which is Dome's preferred route. Although more costly than the other routes (see Table 1), the benefits to Dome (and residents of Port Simpson) would outweigh the costs. An all land route would provide unlimited 24-hour access, even in poor weather. Such a road could be useful during construction of the proposed pipeline and powerline and during operation of the LNG terminal facility, the pipeline and the powerline. As well, the use of a common corridor for all three utilities would have advantages over three separate corridors such as: the possibility of reduced right-of-way widths for each facility through the sharing of working space, less clearing requirements, less disruption to critical or sensitive habitats near Tuck Inlet and along Stumaun Creek, easier maintenance of each facility, and in the event of disruption of service to either the powerline or pipeline, easier and quicker access.

The question of a private versus a public road should be resolved before too much engineering and survey work is done. If the road were to be public (as opposed to present scheme of a private road), consideration would have to be given to the government policy requirements of a high pressure pipeline in or adjacent to a highway right-of-way and cost sharing.

As well, there would be numerous benefits to the residents of Port Simpson including better (and cheaper) access to Prince Rupert, continuous access to better medical facilities in Prince Rupert, additional tourist trade, and better access to job opportunities. Less desirable impacts

could be changes to the population makeup of Port Simpson through the influx of people, or added social problems. Close liaison must be maintained with the people of Port Simpson to ensure that potential negative impacts will be eliminated or minimized and the benefits realized.

Additional work is underway to determine feasibility of a corridor through Tsimpsean Peninsula and whether it could accommodate a road, powerline and pipeline. Liaison with Port Simpson, Prince Rupert, other interested government agencies and between companies should be maintained to identify and resolve concerns.

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