CONSOLIDATED CINOLA MINES LTD.

# STAGE 1 SUBMISSION
to
# STEERING COMMITTEE FOR DEVELOPMENT OF NEW METAL MINES

JULY 1980



IEC International Environmental Consultants Ltd.

# STAGE I SUBMISSION TO STEERING COMMITTEE FOR DEVELOPMENT OF NEW METAL MINES

Prepared for:

CONSOLIDATED CINOLA MINES LTD.

By:

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PROJECT 3073.2

10 JULY 1980

M. L. Fanning, Project Manager

T. C. Griffing, Project Principal

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# 1.0 SUMMARY

A Stage I environmental and socioeconomic impact assessment of the conceptual design of the Consolidated Cinola Mines Ltd. project has been undertaken. Mining activities covering exploration, construction, operation, and reclamation are compared with major features in with the biological and physical environment at the study area. The socioeconomic impact of the mine workforce on the regional and local communities' housing, goods, and services, is also assessed.

No overriding environmental or socioeconomic factors have been found at this stage that would preclude the mine development so long as appropriate planning and implementation procedures take into account the sensitivities that have been identified.

Consolidated Cinola Mines Ltd. is considering the feasibility of operating an open pit gold mine located 18 kilometres south of Port Clements on Graham Island. The drill-indicated ore reserves are estimated at 40 million tons which is sufficient to provide approximately 12 years of mining at an average milling rate of 10,000 tons per day. With an estimated grade of 0.059 ounces of gold per ton, some 167,000 troy ounces of gold would be produced per year.

At present, the preliminary plan is for open pit mining, however the final decision on the mining method will be based on the results of a 1,500 ft adit excavation and a 50 ton per day pilot mill which will operate for a minimum of three months.

The milling process would consist of crushing, grinding, flotation, and possibly roasting. Tailing discharges would be retained in a conventional dry land storage area located near the millsite.

The ore, waste rock, soils, and tailings may contain anomalously high levels of mercury, and other heavy metals. Further testing will be required to determine the exact nature of the minerals in the deposit and their acid-producing potential.

The minesite is located at a low elevation in the Yakoun River drainage. The predominant vegetation consists mainly of western hemlock, Sitka spruce, and western redcedar which was logged in the area in the 1960's. A small amount of mature timber will have to be removed from the pit site and the tailing pond site prior to mining.

Biological resources of significance in the Yakoun River are mainly aquatic with all five species of Pacific Salmon and three species of trout known to extensively utilize the system. The proximity of the mine to this valuable fisheries resource will necessitate extreme vigilance in the design of containment and treatment facilities. Maintenance of high quality surface and groundwater runoff into the drainage is essential to ensure adequate protection for the Yakoun River fisheries.

Economic benefits from the project are expected to accrue to Port Clements, Masset, Queen Charlotte City, Prince Rupert, and Vancouver. The Cinola project would employ 267; 144 persons at the mine, 73 at the mill, 11 at the power house and 39 for general and administrative purposes. This workforce will generate an additional 80 - 133 regional jobs in support industries. Annual wages from the mine would amount to approximately seven million dollars.

## 2.0 ACKNOWLEDGEMENTS

Information for this Stage I submission has been gathered from a wide range of sources. We would like to acknowledge the assistance of Energy Reserves Group Inc., who prepared the initial preliminary feasibility study, and Wright Engineers Ltd., who prepared the preliminary mine plan.

We would also like to thank various representatives of the Federal Ministry of the Environment, the B.C. Ministry of the Environment, the B.C. Ministry of Energy, Mines and Petroleum Resources, and the B.C. Resource Analysis Branch for their time, advice, and assistance, and for making files available.

Special thanks is due to the Atmospheric Environment Service of Canada for their installation of a temperature and precipitation station at the Cinola minesite. The contribution of others has been referenced in the text and the references (Section 8.0).

# 3.0 INTRODUCTION

## 3.1 Location

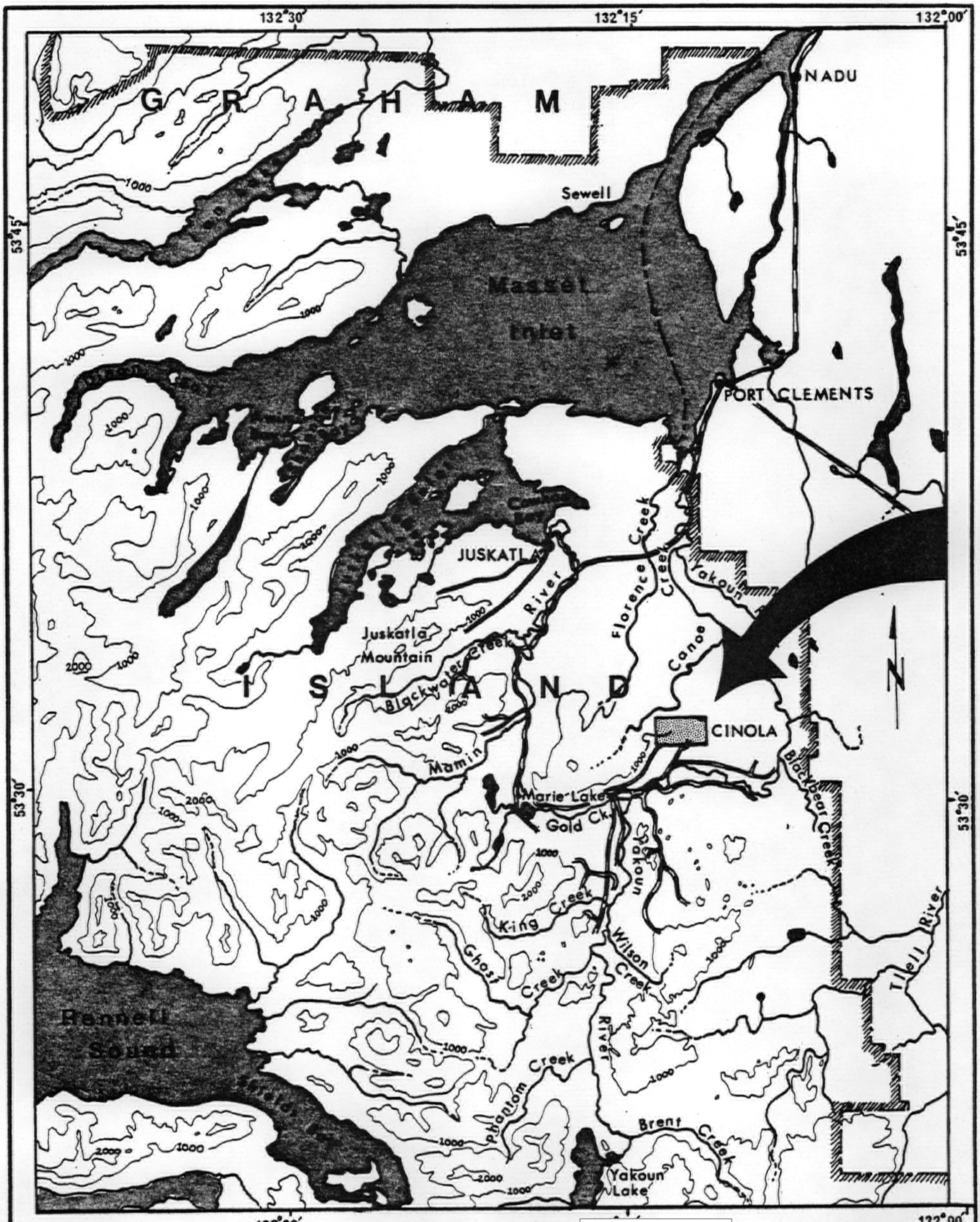
The study area is located on Graham Island, Queen Charlotte Islands, in the Yakoun River basin approximately 18 kilometres due south of Port Clements. The deposit shown on the accompanying map (Figure 3.1.1) is located at latitude 53° 32' and longitude 132° 13'.

## 3.2 History

A brief history of exploration activities on the Consolidated Cinola Mines Ltd. property is presented from a report by Robert C. Hart, Geological Consulting Engineer.

The gold deposit was discovered by Efrem Specogna, a logger from Port Clements, in 1970 and brought first to the attention of Kennco Explorations. Subsequently, Cominco, Umex, and Quintana (under option from Silver Standard) worked on the deposit prior to its acquisition by K. G. Sanders in 1977 under an option agreement with Mr. Specogna. Clear title to the property was acquired by Consolidated Cinola Mines Ltd. in 1979 when a final payment was made, (see annual report, 1979). A property map (Figure 3.2.1) dated February, 1980 shows 45 claims and 7 fractions covering an area approximately 2.3 kilometres km north/south and 3.0 kilometres km east/west.

Extensive work consisting of trenching, geological mapping, sampling, percussion drilling and metallurgical investigation was done by Quintana in 1974. This programme and a prior diamond drilling programme by Cominco in 1972 are described by G.G. Richards, in a report dated December 1974 and amended in a report by M.R. Wolfhard in September 1975. In the final report, Mr. Wolfhard concludes that within 100 ft of surface there is 13.8 million tons grading 0.058 oz. gold per ton and 3.7 million tons of internal waste.

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1 inch to 4 miles approximately

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Kilometres 5 0

LOCATION OF CONSOLIDA[TED]
CINOLA MINE LTD.'S
PROPERTY

EC

| DRAWN | DATE |
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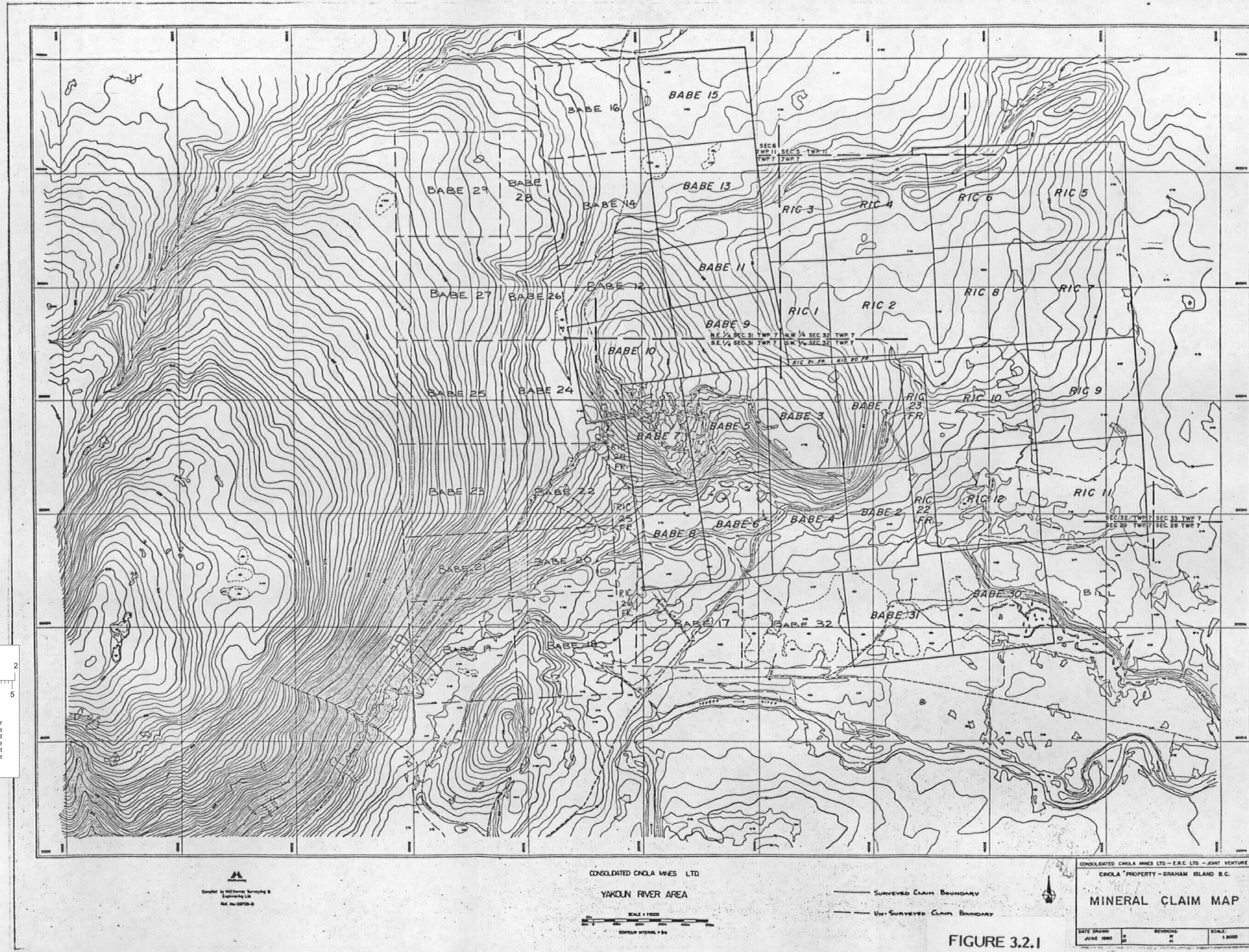
| B. GUILD | 80.05.15 |
| CHECKED | APPROVED |

FIGURE: 3.1.1
3073.2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SEC 6 TWP 11
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N.W. 1/4 SEC 32 TWP 7
S.E. 1/4 SEC 31 TWP 7
S.W. 1/4 SEC 32 TWP 7
SEC 32 TWP 7
SEC 33 TWP 7
SEC 29 TWP 7
SEC 28 TWP 7
CONSOLIDATED CINOLA MINES LTD.
YAKOUN RIVER AREA
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CONTOUR INTERVAL 5m
Surveyed Claim Boundary
Un-Surveyed Claim Boundary
CONSOLIDATED CINOLA MINES LTD. – E.R.C. LTD. – JOINT VENTURE
CINOLA PROPERTY – GRAHAM ISLAND B.C.
MINERAL CLAIM MAP
DATE DRAWN
JUNE 1980
REVISIONS
SCALE
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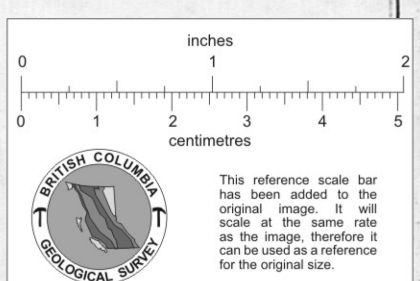
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GEOLOGICAL SURVEY
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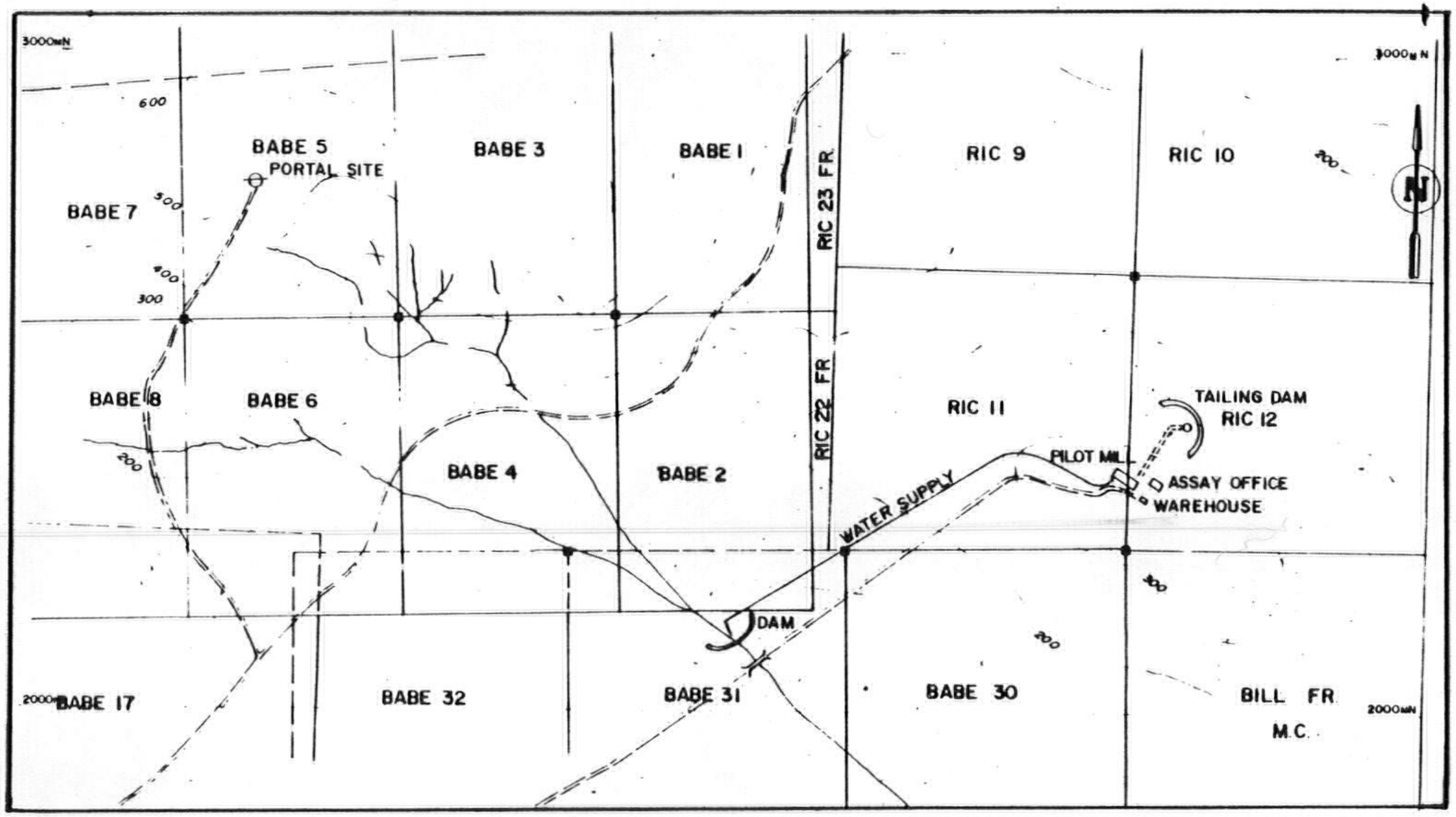
FIGURE 3.2.1

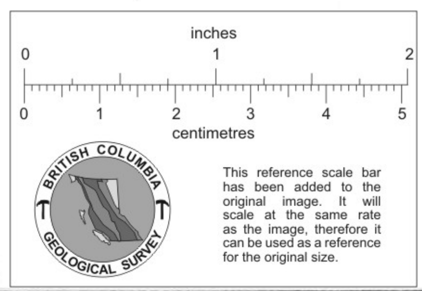
### 3.3 Brief Project Description and Schedule of Development

On 1 June 1980, Consolidated Cinola Mines Ltd. completed laboratory-scale metallurgical testing and exploratory drilling programs. The final set of drill cores were logged and split for assay. The geological data from the drilling are now being analyzed to produce a final delineation of the ore body and to provide a detailed estimate of the drill-indicated reserves.

The next step in development will be the construction of a permanent haul road by MacMillan Bloedel Limited from Branch 45 to the proposed adit site (Babe 5). A 1,500 ft adit is scheduled for the fall of 1980 to provide feed for the operation of a 50 ton per day ore pilot processing plant. The pilot plant will be erected on the RIC 11 and 12 claims, which are located on the plateau in the southeastern corner of the Cinola claim group (Figure 3.3.1). The pilot plant is scheduled for operation in fall of 1980 pending permit approval by the B. C. Waste Management Branch. The pilot work plant will be used to perfect the milling technique, to improve recovery, to enable the design of the final mill to be environmentally benign, to firmly establish ore grade, to determine final water requirements, and to identify the most environmentally appropriate means of tailings handling and disposal. It is expected that the pilot mill may be operating for a minumum period of three months.

MacMillan Bloedel Limited is scheduled to construct haul roads and to log the Cinola property in the autumn of 1980 and the winter of 1981. Detailed mine planning is scheduled for completion by December 1980. IEC International Environmental Consultants Ltd. will continue their detailed environmental and socio-economic studies that were initiated in December 1979 and the preparation of the Stage II report. A schedule of events leading to production start-up in 1983 is presented in Figure 3.3.2.

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# PRELIMINARY SITE LOCATIONS for CONSOLIDATED CINOLA MINES LTD.'S PILOT PLANT

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| FILE | PROJECT 3073.2 |
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| DWN B.G | APP |
| DATE 80.04.09 | REV |
| FIGURE | 3.3.1 |

FIGURE 3.3.2

# Project Schedule

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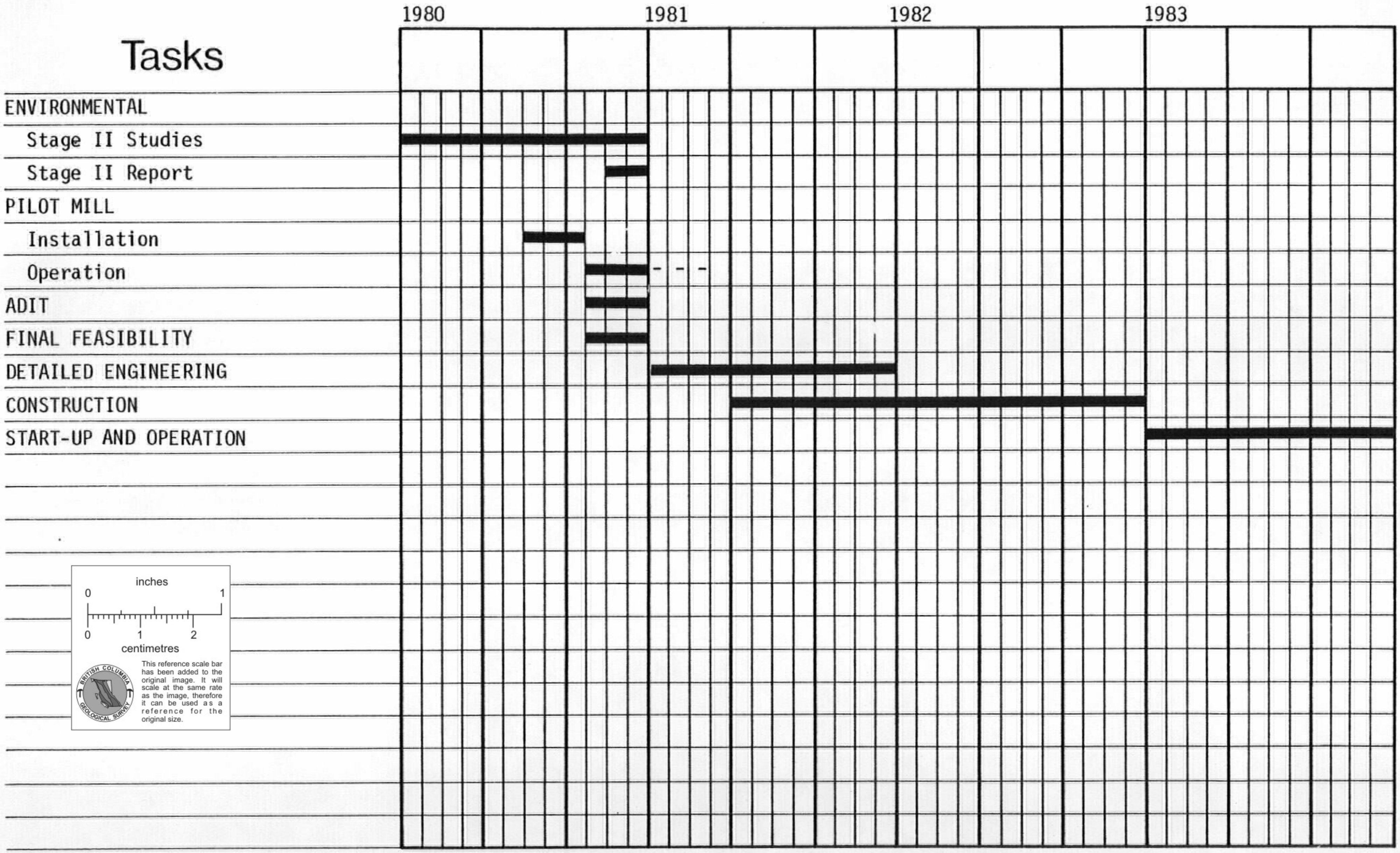


# 4.0 DESCRIPTION OF EXISTING ENVIRONMENTAL AND SOCIAL CONDITIONS

## 4.1 Physiography

The Queen Charlotte Islands lie within the Western System of the Canadian Cordillera (Holland, 1976). The Consolidated Cinola Mines Ltd. study area borders on two major subdivisions within this system: the Outer Mountain Area and the Coastal Trough.

The Skidegate Plateau of the Outer Mountain area is a dissected plateau, 16 km wide and 160 km long, whose eastward sloping surface reaches 760 m elevation (500 m in the study area). The Cinola gold deposits are located on the extreme eastern edge of the plateau, which is bounded on the east by the Queen Charlotte Lowland. The Queen Charlotte Lowland of the Coastal Trough is an area of low relief, with elevations in the study area below 150 m. Evidence of past movement of glacial ice across this lowland is shown by drumlin-like forms and flirtings, which indicate a northeast direction of travel. Drainage of the lowland surfaces is poorly organized, with muskeg common in some areas, particularly east of the Yakoun River.

The Consolidated Cinola Mines Ltd. property lies south of Masset Inlet and immediately west of the Yakoun River on Graham Island. The area is drained by the Yakoun River and several of its tributaries, including Gold, Canyon, and Hoodoo/Blackbear and Canoe Creeks. Florence Creek, which arises in the northern end of the system, drains into Yakoun Bay of Masset Inlet. The study area ranges from sea level to 500 m above sea level in the vicinity of Marie Lake. The area is rugged to flat, with soil depths usually less than 2 to 3 m over bedrock. Active logging occurs north of the area in the vicinity of Canoe and Florence Creeks. Forest harvesting occurred in the 1960's in the area north of Gold Creek along the Yakoun River and in the surrounding uplands, with regrowth up to 10 m high.

## 4.2 Land Tenure and Settlement Patterns

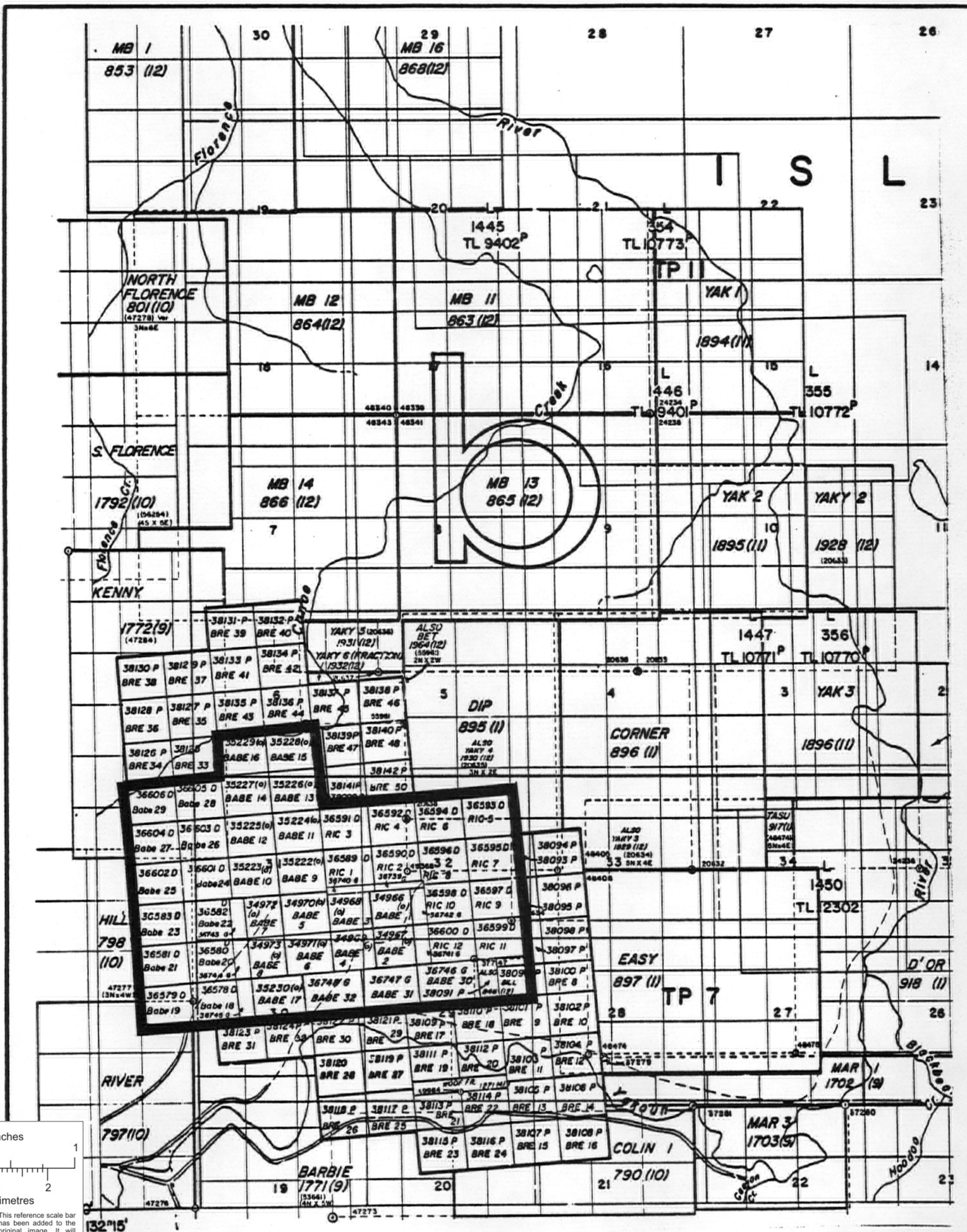
Title to most of Graham Island is held by the Crown and, within this Crown land, portions are reserved for forestry purpose, and for B. C. Ministry of Highway's gravel pits. Other land categories include Drizzle Lake Ecological Reserve, Crown leased land for grazing, three Indian Reserves, and Naikoon Provincial Park. Privately-held land is mainly in and near the communities of Masset and Port Clements, and adjacent to the unorganized hamlets of Queen Charlotte City and Tlell. One private rural subdivision has also been planned at Miller Creek, approximately 16 kilometres kilometres km north of Skidegate Mission.

Settlement of Graham Island has been largely dictated by the location of economically exploitable natural resources, location of land suitable for habitation, and access. The first resource exploited from the Graham Island area was fish. The physical locations of Masset and Queen Charlotte City presented natural, safe harbors and, as a result, fishing communities were established at these locations. In addition, Masset provides the most direct access to Prince Rupert, and, therefore, the community is the transportation hub of the Island.

Juskatla, Port Clements, and Queen Charlotte City all serve as places of residence for people involved in the timber harvesting industry, which takes place over most of Graham Island. Juskatla, in particular, is a MacMillan Bloedel Limited company town. Forest resources in the Cinola study area have been purchased and are managed by MacMillan Bloedel, Queen Charlotte Division. Mineral claims owned by Consolidated Cinola Mines Ltd. are shown on the Figure 4.2.1 and are surrounded by mineral claims held by private interests.

There is no immediately obvious reason for the location of the hamlet of Tlell. Perhaps the relatively good soil quality, flat topography, less severe climate found on the east than on the west side of the island, and the picturesque surroundings led to settlement of the hamlet.

On Graham Island, the only incorporated villages are Port Clements and Masset. Both of these communities are, therefore, responsible for developing their own land-use policies through a community plan. Such a plan has already been prepared for Masset, and a community plan for Port Clements is due to be completed by the fall of 1980. Land use planning for the unincorporated communities on Graham Island that are not part of any special reserve is provided by the Skeena-Queen Charlotte Regional District located in Prince Rupert.




CONSOLIDATED CINOLA MINES LTD.
MINERAL CLAIMS

Source: B.C. Department of Mines

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| FIGURE: 4.2.1 | |
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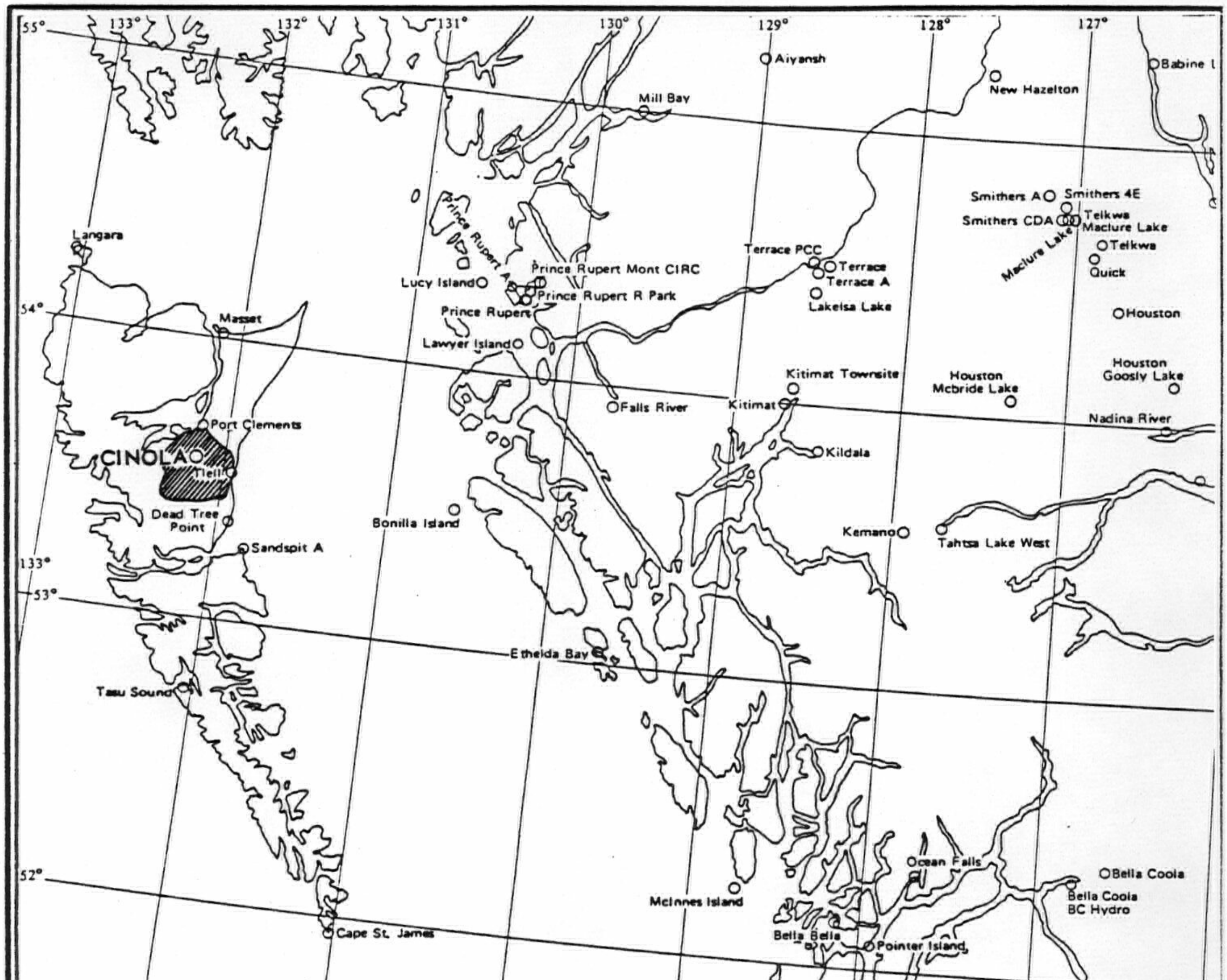
## 4.3 Climate and Meteorology

Climatic data is not abundant for the interior of Graham Island.

Table 4.3.1 summarizes the major properties of the data base, and Figure 4.3.1 shows the locations of all Atmospheric Environment Service of Canada stations that have been operated on the Queen Charlotte Islands. All stations are located at lower elevations than the Cinola property and are near open water. The Port Clements station is closest to the Cinola minesite, but is no longer in operation. Data is only available for the period from January 1967 to December 1975. The record is thus of insufficient length to allow the derivation of standard Canadian normals climatic data. The Sewell Masset Inlet station has been in operation since July 1974, and similar geographic conditions apply that will not allow direct extrapolations of data.

Canadian normals data (long term averages, or climate--by definition) are available for the Federal stations at Dead Tree Point (precipitation only), Sandspit, and Tlell. Tables 4.3.2, 4.3.3, and 4.3.4 summarize the normals data available for these stations. The data available from these stations is very similar, and a regionalization of conditions is possible. All three stations are located in the lee of the prevailing wind system, although Sandspit is more exposed to rain-bearing winds and thus receives heavier precipitation.

Table 4.3.5 summarizes the data available for Port Clements, presenting averages of the records. The B.C. Resource Analysis Branch has operated a number of basic temperature/precipitation stations in the vicinity of the Cinola mines property. The locations of all British Columbia Resource Analysis Branch stations are shown in Figure 4.3.2 and summarized in Table 4.3.6. The records collected by British Columbia Resource Analysis Branch encompass four years, and, while these records do not qualify as Canadian normals data, a comparison of these records with the Federal normals data will produce climatic summaries. Because the data currently exists only in preliminary form and may only be accessed to 1978, it is not presented in this report.




LOCATIONS OF ATMOSPHERIC ENVIRONMENT SERVICE CLIMATE STATIONS
SOURCE: A.E.S. INDEX MAPS

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FIGURE 4.3.1
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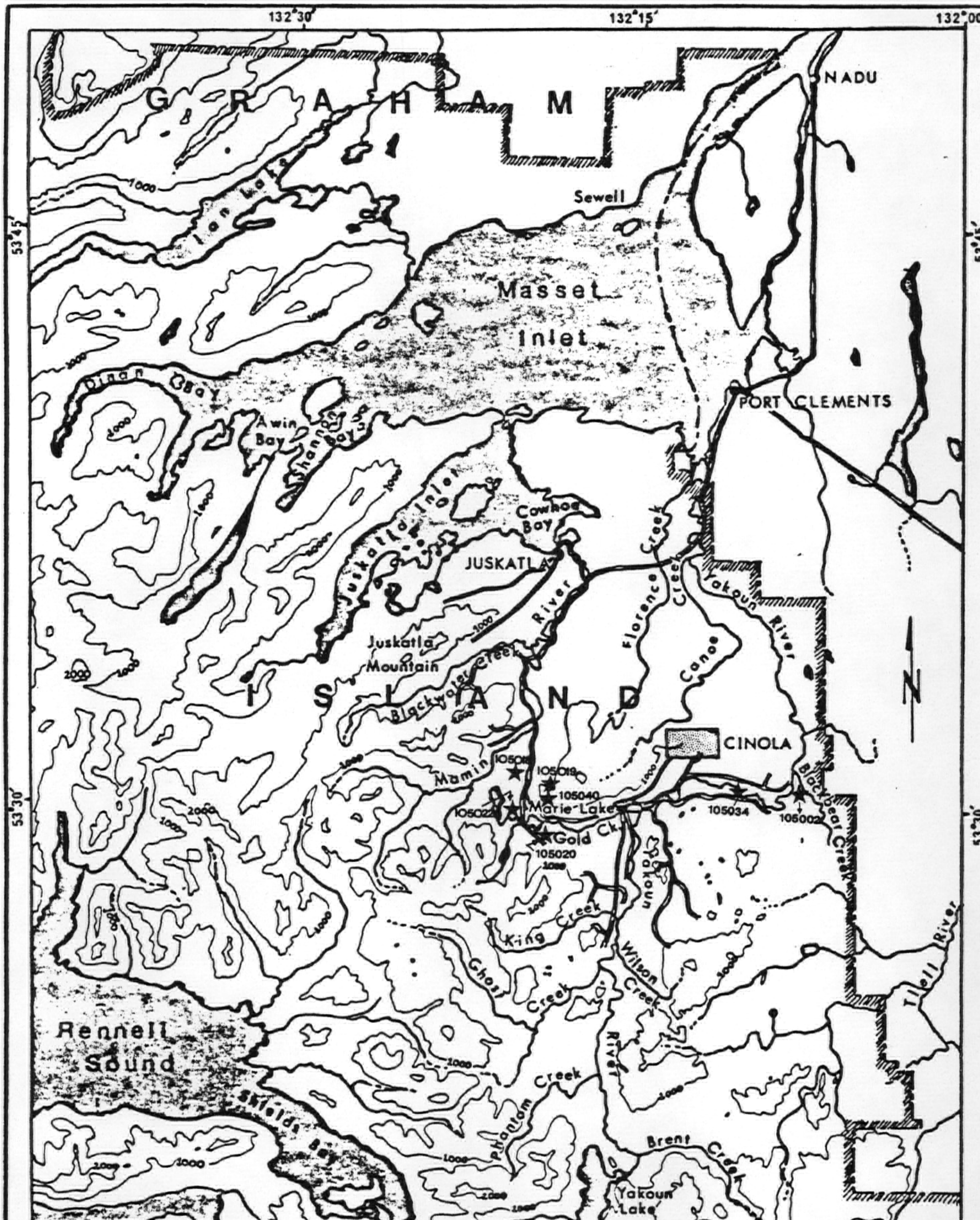
Table 4.3.1

Summary of the Climatic Data Available for the Queen Charlotte Islands

Data Source - Atmospheric Environment Service of Canada

| Station Name | Station No. | Latitude | Longitude | Elevation (m.asl) | Period of Record: Began yr | Began mo | Ended yr | Ended mo | Parameters |
|---|---|---|---|---|---|---|---|---|---|
| Cinola Property | pending | 53°32' | 132°14' | 155 | 1980 | May | present | | temp, precip |
| McClinton Creek | 1054970 | 53°40' | 132°35' | 7.6 | 1932 | 03 | 1936 | 10 | precip only |
| | | | | | 1937 | 03 | 1937 | 09 | |
| Port Clements | 1056250 | 53°41' | 132°11' | 7.6 | 1967 | 01 | 1975 | 12 | temp, precip |
| Sewell Masset Inlet | 1057A9K | 53°46' | 132°18' | 3.1 | 1974 | 07 | present | | temp, precip |
| Dead Tree Point | 1052310 | 53°22' | 131°56' | 14.3 | 1939 | 02 | 1948 | 06 | synoptic, precip |
| | | | | | 1948 | 07 | 1958 | 01 | precip only |
| Tlell | 1058190 | 53°35' | 131°57' | 6.1 | 1950 | 01 | 1957 | 03 | precip only |
| | | | | | 1957 | 04 | 1959 | 06 | temp, precip |
| | | 53°35' | 131°56' | 7.6 | 1959 | 06 | 1966 | 11 | temp, precip |
| | | 53°31' | 131°57' | 7.6 | 1966 | 11 | 1971 | 11 | temp, precip |
| | | 53°24' | 131°56' | 4.6 | 1971 | 11 | present | | temp, precip |
| Sandspit (airport) | 1057050 | 53°15' | 131°49' | 7.6 | 1945 | 09 | 1946 | 03 | S, H*, temp, precip |
| | | | | | 1946 | 04 | 1946 | 06 | hourly weather |
| | | | | | 1947 | 08 | 1948 | 07 | hourly weather |
| | | | | | 1948 | 08 | 1954 | 09 | S, H, temp, precip |
| | | | | | 1954 | 10 | 1967 | 09 | S, H, temp, pecip |
| | | | | | 1967 | 09 | 1971 | 08 | S, H, temp, precip |
| | | | | | 1971 | 08 | present | | S, H, temp, precip rate of rainfall |

*S - Synoptic, H - Hourly

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## LOCATIONS OF PROVINCIAL CLIMATE STATIONS NR. CINOLA

★ Provincial R.A.B. Stn. and No.

Study Area

| DRAWN | DATE |
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| B. GUILD | 80.05.15 |
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FIGURE: 4.3.2
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## Table 4.3.2

**Summary of Precipitation at Dead Tree Point, B.C.**
**(Precipitation Only, Source: Atmospheric Environment Service)**

| DEAD TREE POINT | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean Rainfall | (mm) | 114 | 92 | 91 | 71 | 51 | 47 | 50 | 49 | 87 | 176 | 161 | 140 | 1129 |
| Mean Snowfall | | 295 | 142 | 81 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 165 | 762 |
| Mean Total Precipitation | | 144 | 107 | 99 | 73 | 51 | 47 | 50 | 49 | 87 | 176 | 166 | 157 | 1205 |
| Greatest Rainfall in 24 Hrs | | 52 | 44 | 43 | 48 | 25 | 18 | 32 | 31 | 59 | 46 | 42 | 38 | 59 |
| No. of Years of Record | | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | |
| Greatest Snowfall in 24 Hrs | | 351 | 356 | 180 | 102 | 3 | 0 | 0 | 0 | 0 | -- | 124 | 185 | 351 |
| No. of Years of Record | | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | |
| Greatest Precipitation in 24 Hrs | | 52 | 44 | 43 | 48 | 25 | 18 | 32 | 31 | 59 | 46 | 42 | 38 | 59 |
| No. of Years of Record | | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | |
| No. of Days with Measurable Rain | | 17 | 15 | 19 | 18 | 13 | 13 | 13 | 12 | 14 | 22 | 22 | 20 | 198 |
| No. of Days with Measurable Snow | | 4 | 4 | 2 | 1 | * | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 15 |
| No. of Days with M. Precipitation | | 21 | 18 | 20 | 18 | 13 | 13 | 13 | 12 | 14 | 22 | 23 | 22 | 209 |

LATITUDE 53° 22' N LONGITUDE 131° 56' W ELEVATION 14.3 mASL

## Table 4.3.3

**Summary of Temperature and Precipitation at Sandspit, B.C.**

**(Source: Canadian Normals Data, Atmospheric Environment Service)**

| SANDSPIT | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean Daily Temperature | (deg C) | 1.9 | 3.4 | 3.9 | 5.9 | 8.8 | 11.7 | 13.9 | 14.6 | 12.8 | 8.9 | 5.4 | 3.3 | 7.9 |
| Mean Daily Maximum Temperature | | 4.3 | 5.9 | 6.7 | 8.9 | 11.9 | 14.5 | 16.7 | 17.5 | 15.7 | 11.7 | 7.9 | 5.6 | 10.6 |
| Mean Daily Minimum Temperature | | -0.5 | 0.9 | 1.1 | 2.8 | 5.8 | 8.9 | 11.2 | 11.8 | 9.9 | 6.0 | 2.8 | 0.9 | 5.1 |
| Extreme Maximum Temperature | | 12.2 | 12.2 | 13.9 | 18.9 | 21.7 | 25.0 | 26.1 | 26.7 | 22.2 | 18.9 | 15.6 | 13.3 | 26.7 |
| No. of Years of Record | | 23 | 23 | 23 | 22 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 24 | |
| Extreme Minimum Temperature | | -13.9 | -12.2 | -12.2 | -2.8 | -1.1 | 2.2 | 5.6 | 5.6 | -0.6 | -2.2 | -6.7 | -12.8 | -13.9 |
| No. of Years of Record | | 23 | 23 | 23 | 22 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 24 | |
| No. of Days with Frost | | 17 | 11 | 12 | 4 | * | 0 | 0 | 0 | * | 1 | 6 | 12 | 63 |
| Mean Rainfall | (mm) | 125 | 97 | 91 | 79 | 46 | 47 | 48 | 48 | 86 | 185 | 178 | 152 | 1182 |
| Mean Snowfall | | 302 | 142 | 104 | 15 | 3 | 0 | 0 | 0 | 0 | -- | 74 | 145 | 785 |
| Mean Total Precipitation | | 156 | 111 | 102 | 81 | 46 | 47 | 48 | 48 | 86 | 185 | 185 | 167 | 1261 |
| Greatest Rainfall in 24 Hrs | | 57 | 35 | 34 | 80 | 48 | 27 | 22 | 39 | 49 | 49 | 43 | 56 | 80 |
| No. of Years of Record | | 23 | 23 | 23 | 22 | 22 | 22 | 22 | 23 | 23 | 24 | 23 | 24 | |
| Greatest Snowfall in 24 Hrs | | 356 | 254 | 196 | 51 | 15 | 0 | 0 | 0 | 0 | 3 | 229 | 234 | 356 |
| No. of Years of Record | | 23 | 23 | 23 | 22 | 22 | 22 | 22 | 23 | 24 | 24 | 23 | 24 | |
| Greatest Precipitation in 24 Hrs | | 57 | 35 | 48 | 80 | 48 | 27 | 22 | 39 | 49 | 49 | 43 | 56 | 80 |
| No. of Years of Record | | 23 | 23 | 23 | 22 | 22 | 22 | 22 | 23 | 23 | 24 | 23 | 24 | |
| No. of Days with Measurable Rain | | 16 | 16 | 17 | 17 | 14 | 13 | 12 | 13 | 16 | 23 | 21 | 21 | 199 |
| No. of Days with Measurable Snow | | 6 | 4 | 3 | 1 | * | 0 | 0 | 0 | 0 | * | 2 | 4 | 20 |
| No. of Days with M. Precipitation | | 20 | 18 | 18 | 17 | 14 | 13 | 12 | 13 | 16 | 23 | 22 | 23 | 209 |

LATITUDE 53° 15' N    LONGITUDE 131° 49' W    ELEVATION 7.6 mASL

Table 4.3.4

Summary of Temperature and Precipitation at Tlell, B.C.
(Source: Canadian Normals Data, Atmospheric Environment Service)

| TLELL | JAN | FEB | MAR | APR. | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean Daily Temperature (deg C) | 1.8 | 3.1 | 3.7 | 5.9 | 8.8 | 11.9 | 13.8 | 14.5 | 12.3 | 8.6 | 4.7 | 2.9 | 7.7 |
| Mean Daily Maximum Temperature | 4.4 | 6.0 | 7.2 | 9.7 | 12.7 | 15.2 | 17.5 | 18.1 | 16.1 | 11.9 | 7.7 | 5.4 | 11.0 |
| Mean Daily Minimum Temperature | -0.9 | 0.7 | 0.7 | 2.1 | 4.9 | 8.5 | 10.1 | 10.9 | 8.4 | 5.2 | 1.7 | 0.4 | 4.3 |
| Extreme Maximum Temperature | 12.8 | 11.7 | 19.4 | 20.6 | 25.0 | 30.6 | 28.9 | 26.7 | 23.3 | 18.9 | 13.3 | 12.2 | 30.6 |
| No. of Years of Record | 13 | 13 | 13 | 14 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | |
| Extreme Minimum Temperature | -15.0 | -11.7 | -8.9 | -3.9 | -2.2 | 1.1 | 4.4 | 3.3 | 1.1 | -2.2 | -11.1 | -16.7 | -16.7 |
| No. of Years of Record | 13 | 13 | 13 | 14 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | |
| No. of Days with Frost | 19 | 12 | 15 | 8 | 2 | 0 | 0 | 0 | 0 | 3 | 11 | 16 | 86 |
| Mean Rainfall (mm) | 105 | 78 | 78 | 66 | 50 | 55 | 59 | 67 | 101 | 162 | 149 | 131 | 1100 |
| Mean Snowfall | 254 | 127 | 48 | 3 | 0 | 0 | 0 | 0 | 0 | -- | 48 | 142 | 622 |
| Mean Total Precipitation | 130 | 91 | 83 | 66 | 50 | 55 | 59 | 67 | 101 | 162 | 154 | 145 | 1163 |
| Greatest Rainfall in 24 Hrs | 40 | 38 | 29 | 35 | 29 | 23 | 41 | 50 | 41 | 50 | 42 | 41 | 50 |
| No. of Years of Record | 21 | 21 | 21 | 21 | 20 | 20 | 21 | 20 | 20 | 21 | 21 | 21 | |
| Greatest Snowfall in 24 Hrs | 203 | 305 | 178 | 25 | -- | 0 | 0 | 0 | 0 | 13 | 153 | 203 | 305 |
| No. of Years of Record | 21 | 21 | 21 | 21 | 20 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | |
| Greatest Precipitation in 24 Hrs | 40 | 38 | 29 | 35 | 29 | 23 | 41 | 50 | 41 | 50 | 42 | 41 | 50 |
| No. of Years of Record | 21 | 21 | 21 | 21 | 20 | 20 | 21 | 20 | 20 | 21 | 21 | 21 | |
| No. of Days with Measurable Rain | 15 | 15 | 17 | 16 | 15 | 13 | 12 | 13 | 17 | 23 | 20 | 20 | 196 |
| No. of Days with Measurable Snow | 4 | 2 | 1 | * | 0 | 0 | 0 | 0 | 0 | * | 1 | 2 | 10 |
| No. of Days with M. Precipitation | 19 | 17 | 17 | 16 | 15 | 13 | 12 | 13 | 17 | 23 | 21 | 22 | 205 |

Latitude 53° 31' N    Longitude 131° 57' W    Elevation 7.6 m ASL

Table 4.3.5

Summary of Temperature and Precipitation at Port Clements, B.C.
(Source: Canadian Normals Data, Atmospheric Environment Service)

| PORT CLEMENTS | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean Daily Temperature | (deg C) | -1.4 | 2.2 | 3.2 | 5.0 | 8.6 | 12.1 | 14.3 | 14.3 | 12.1 | 7.5 | 4.1 | 1.5 | 7.0 |
| Mean Daily Maximum Temperature | | 1.4 | 5.3 | 6.7 | 9.1 | 13.1 | 16.4 | 18.5 | 18.3 | 16.1 | 11.0 | 6.9 | 4.1 | 10.6 |
| Mean Daily Minimum Temperature | | -4.2 | -1.0 | -0.2 | 0.9 | 4.1 | 7.7 | 10.2 | 10.4 | 8.0 | 4.5 | 1.3 | 1.0 | 3.4 |
| Extreme Maximum Temperature | | 3.8 | 8.4 | 9.3 | 10.6 | 15.2 | 20.4 | 21.6 | 20.7 | 17.4 | 11.6 | 8.6 | 5.8 | 21.6 |
| No. of Years of Record | | 6 | 8 | 8 | 6 | 9 | 7 | 7 | 6 | 6 | 7 | 7 | 8 | |
| Extreme Minimum Temperature | | -3.4 | -4.2 | -1.6 | -0.7 | 2.7 | 6.7 | 9.1 | 8.9 | 6.8 | 3.2 | -2.5 | -3.8 | -3.8 |
| No. of Years of Record | | 6 | 8 | 8 | 6 | 9 | 7 | 7 | 6 | 6 | 7 | 7 | 8 | |
| No. of Days with Frost | | 26 | 17 | 19 | 12 | 2 | 0 | 0 | 0 | 0 | 3 | 11 | 19 | 109 |
| Mean Rainfall | (mm) | 73 | 87 | 115 | 114 | 61 | 63 | 45 | 82 | 113 | 176 | 185 | 170 | 1284 |
| Mean Snowfall | | 690 | 281 | 102 | 9 | 0 | 0 | 0 | 0 | 0 | 29 | 46 | 233 | 1390 |
| Mean Total Precipitation | | 142 | 115 | 129 | 115 | 61 | 63 | 45 | 82 | 113 | 179 | 190 | 193 | 1427 |
| Greatest Rainfall in 24 Hrs | | 130 | 184 | 236 | 165 | 104 | 112 | 82 | 121 | 176 | 283 | 268 | 224 | 283 |
| No. of Years of Record | | 6 | 8 | 8 | 6 | 9 | 7 | 7 | 6 | 6 | 7 | 7 | 8 | |
| Greatest Snowfall in 24 Hrs | | 1041 | 1105 | 483 | 64 | 0 | 0 | 0 | 0 | 0 | 234 | 152 | 686 | 1105 |
| No. of Years of Record | | 6 | 8 | 8 | 6 | 9 | 7 | 7 | 6 | 6 | 7 | 7 | 8 | |
| Greatest Precipitation in 24 Hrs | | 178 | 199 | 259 | 165 | 104 | 112 | 82 | 121 | 176 | 283 | 273 | 246 | 283 |
| No. of Years of Record | | 6 | 8 | 8 | 6 | 9 | 7 | 7 | 6 | 6 | 7 | 7 | 8 | |
| No. of Days with Measurable Rain | | 9 | 13 | 16 | 19 | 16 | 13 | 12 | 15 | 18 | 23 | 20 | 17 | 191 |
| No. of Days with Measurable Snow | | 10 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 24 |
| No. of Days with M. Precipitation | | 19 | 16 | 18 | 20 | 16 | 13 | 12 | 15 | 18 | 23 | 24 | 21 | 215 |

LATITUDE 53° 41' N LONGITUDE 132° 11' W ELEVATION 7.6 mASL

Table 4.3.6

Summary of the Climatic Data Available for the Queen Charlotte Islands

(Data Source: B.C. Resource Analysis Branch)

| Station Name | Station No. | Latitude | Longitude | Elevation (m.asl) | Period of Record** Began Mo. | Began Yr. | Ended Mo. | Ended Yr. | Slope° | Aspect° | Parameters |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cinola Property | - none - | 53° 32' | 132° 14' | 155 | -- | -- | -- | -- | 10± | 145± | - none - |
| Blackbear | 105002 | 53° 31' | 132° 09' | 21 | 04 | 76 | 04 | 80 | 2 | 20 | Temp, precip, wind speed, direction* |
| Mamin River | 105018 | 53° 35' | 132° 20' | 61 | 04 | 76 | present | | 5 | 150 | Temp, precip |
| Marie Lake South | 105022 | 53 32' | 132° 18' | 207 | 04 | 76 | present | | 8 | 270 | Temp, precip |
| Marie Lake Ridge | 105020 | 53° 32' | 132° 18' | 398 | 04 | 76 | 04 | 80 | 1 | 90 | Temp, precip |
| Marie Lake Hi (very windy, reduces precip catch) | 105040 | 53° 32' | 132° 18' | 468 | 04 | 76 | 04 | 80 | 1 | 90 | Temp, precip |
| Marie Lake North | 105019 | 53° 33' | 132° 17' | 226 | 04 | 76 | 04 | 80 | 12 | 0 | Temp, precip |
| Yakoun River | 105034 | 53° 31' | 132° 13' | 35 | 04 | 76 | present | | 2 | 350 | Temp, precip |

* wind data not accessible to date
** data currently accessible to 1977



IEC

No snowpack or water equivalence data have been collected by the Provincial Government on the Queen Charlotte Islands, although snow depths have been measured at each of the British Columbia Resource Analysis Branch stations on a monthly basis whenever snow was on the ground.

An Atmospheric Environment Service of Canada temperature and precipitation station was installed on the Cinola property 23 April 1980 on the Branch 45 road near the core shack.

### 4.3.1 Temperature

Tlell mean daily temperatures range between 1.8° C in January and 14.5° C in August, and the annual mean daily temperature is 7.7° C. Mean daily maximum temperatures vary between 4.4° C in January and 18.1° C in August, and mean daily minimum temperatures vary between -0.9° C and 10.9° C in January and August respectively. The extreme temperatures on record vary between 30.6° C in June and -16.7° C in December. Freezing temperatures may occur anytime between October and May, but are rarely expected, and prolonged cold periods rarely occur. Freezing temperatures are not expected between April and October, and have never been recorded between June and September.

Temperatures at Sandspit show similar patterns, and their values are nearly identical. Freezing temperatures may occur anytime between September and May, but are rare in any month. Freezing is not expected between April and November, and has never been recorded in June, July, or August.

Temperatures at Port Clements are also similar to those at Tlell and Sandspit, although daily minima have been lower at Port Clements. The Port Clements data are presented to allow comparison, but, because of data limitations, are not recommended as the best analogy for Cinola conditions.

In summary, the pattern of temperatures typical of the interior and eastern coastal region of Graham Island are most likely also typical of the Cinola property. The difference in elevation between Cinola (155 m) and the other stations (all lower than

8 m) will produce fairly predictable variations from the regional pattern. Temperature extremes probably occur with a slightly greater range at Cinola, and minimum temperatures are likely lower. Maximum temperatures likely occur at Cinola between June and August, and minimum temperatures likely occur in December and January. Freezing temperatures may occur between September and May, but occur most commonly between November and April. It is unlikely that prolonged periods of freezing occur except at the highest elevations. The frequency or possibility of inversions is impossible to predict as no relevant data are available.

### 4.3.2 Precipitation

In the interior and on the eastern coast of Graham Island, precipitation is expected nearly two days out of three, mostly as rain. At Tlell, precipitation occurs as frequently as 23 days in October or infrequently as 12 days in July. Snow occurs only between October and April, and is most common in January, normally occurring on 4 days in January. Snowfall has never been recorded between May and September. May is normally the driest month, with 55 mm of precipitation spread over 15 days, averaging 3.7 mm per day. October is the wettest month, with 162 mm spread over 23 days, averaging 7.0 mm per day. Annual precipitation totals 1,163 mm over 205 days, or an average of 5.7 mm per day. The greatest daily precipitation events have occurred in August, October, and November, as 50, 50, and 42 mm within 24 hr. The most intensive snowstorm on record occurred in February as 305 mm snow within 24 hr.

At Sandspit, precipitation follows a similar pattern, but tends to be somewhat heavier.

Precipitation patterns are similar for Port Clements. The available records suggest that snowfall is significantly greater in the interior than on the coast, resulting in greater annual total precipitation. It seems reasonable to assume that the general patterns of precipitation at Cinola Mines will parallel those along the coast, although magnitudes will be greater at Cinola, attributable both to its more interior location and to its higher elevation.

#### 4.3.3 Wind

Wind data is available at the Sandspit airport, but, because of Sandspit's exposure, winds at Sandspit are not likely representative of those at the Cinola minesite. The lack of site specific data prevents prediction of speeds, gusts, or directions. The prevailing winds blow west to east, but local topographic variations will alter this simple pattern. A continuous recording anemometer will be installed in June 1980 on the plateau site of Cinola's pilot mill. This data will provide a site specific record of wind speed and direction.

### 4.4 Air Quality

No air quality data have been collected by the Atmospheric Environment Service of Canada on the Queen Charlotte Islands to date. The nearest Federal air quality stations are Port Hardy and Prince George, which commenced operations in 1977. Data from these stations is currently available to June 1979.

No air quality data has been collected by the Provincial Government for this region to date.

Because of its remoteness, low population density, low level of industrialization, and heavy precipitation, air quality can be expected to be excellent.

An air sampling program will be initiated during the construction and operational phase of Cinola's pilot plant to determine ambient air quality conditions.

### 4.5 Surface Water

#### 4.5.1 Drainages

All the streams draining the study area flow into the Yakoun River, which forms the south and east boundaries of this area. The major streams in this drainage system are: Florence Creek, which joins the Yakoun near its mouth; Canoe Creek, which joins the Yakoun downstream from the study area; Gold Creek, which drains Marie Lake and joins the Yakoun upstream from the Cinola Mines property; Barbie Creek, which traverses the study area diagonally and drains north of the main ore body; a small unnamed creek, referred to as "Outcrop" Creek, by IEC, which drains the ore body; and two unnamed creeks, referred to as "Plateau" Creek and "Swamp" Creek by IEC, which drain the proposed pilot plant and millsite south to the Yakoun River.

### 4.5.2 Quality

There are no available records of water quality measurements for the Yakoun River or its tributaries that are relevant to the Cinola study area.

IEC initiated a sampling program for water quality analysis in December 1979 at seven stations within the Cinola study area. Three stations were located upstream of the proposed minesite on the Yakoun River, on Gold Creek, and on Barbie Creek to establish baseline conditions, while the remaining four stations were situated below the minesite on the Yakoun River, on Canoe Creek, on "Swamp" Creek, and on "Outcrop" Creek. Two additional stations at "Plateau" Creek and Florence Creek were added in March 1980 to complete the data base. Station locations are described below:

| Station | Stream | Location |
|---|---|---|
| 1 | "Outcrop" Creek | On Branch 45 approximately 1 km from Branch 40 junction |
| 2 | Canoe Creek | 1 km upstream of Yakoun River confluence |
| 3 | Gold Creek | Immediately above bridge crossing on the main Port Clements-Queen Charlotte City Road |
| 4 | "Swamp" Creek | On Branch 40, 6 km east of main road junction |
| 5 | Barbie Creek | On upper south fork apaproximately 200 m from confluence |
| 6 | Yakoun River | On Branch 40, 1 km east of main road junction |
| 7 | Yakoun River | At Water Survey of Canada gauging station |
| 8 | "Plateau" Creek | 0.5 km north of Plateau road |
| 9 | Florence Creek | Upstream of MacMillan Bloedel Road |

A comparison of IEC results (Tables 4.5.2.1 and 4.5.2.2) with the accepted standards for natural waters (Table 4.5.2.3) compiled by the Provincial Water Investigations Branch (1976) indicate that levels of most parameters were adequate for general use, drinking

Table 4.5.2.1

**Physical and Ionic Constituents of Streams within the Cinola Study Area**

December 18-19, 1979

| PARAMETER | | ABOVE MINESITE STATIONS 3 GOLD CREEK | 5 UPPER BARBIE | 6 UPPER YAKOUN | BELOW MINESITE STATIONS 1 "OUTCROP" CREEK | 2 CANOE CREEK | 4 "SWAMP" CREEK | 7 LOWER YAKOUN |
|---|---|---|---|---|---|---|---|---|
| **Physical Tests** | | | | | | | | |
| pH | | 7.00 | 5.10 | 4.70 | 7.25 | 5.00 | 6.05 | 7.90 |
| Conductance (umhos/cm) | | 66.5 | 53.5 | 51.2 | 47.3 | 50.3 | 48.1 | 46.1 |
| Color (CU) | | 75. | 220. | 110. | 45. | 90. | 60. | 75. |
| Turbidity (JTU) | | 3.6 | 0.74 | 6.1 | 0.65 | 1.6 | 4.1 | 4.1 |
| Total Dissolved Solids* | | 47. | 30. | 31. | 38. | 27. | 33. | 37. |
| Total Suspended Solids | | 6.5 | 1.5 | 7.0 | L 0.5 | 1.0 | 14. | 15. |
| Total Solids | | 53. | 32. | 38. | 38. | 28. | 47. | 52. |
| **Dissolved Anions** | | | | | | | | |
| Alkalinity | | | | | | | | |
| Bicarbonate | $HCO_3$ | 10.5 | 3.00 | 0.60 | 12.5 | 2.15 | 7.15 | 11.5 |
| Carbonate | $HO_3$ | NIL | NIL | NIL | NIL | NIL | NIL | NIL |
| Chloride | Cl | 11.0 | 4.0 | 7.1 | 7.5 | 5.10 | 8.15 | 8.15 |
| Sulfate | $SO_4$* | L 10.0 | 10. | 10. | L 10. | 10. | L 10. | L 10. |
| Nitrate | N | L 0.010 | L 0.005 | L 0.005 | L 0.010 | L 0.005 | L 0.005 | L 0.005 |
| Nitrite | N | 0.002 | 0.003 | 0.003 | 0.010 | 0.003 | 0.006 | 0.004 |
| Fluoride | F | 0.025 | L 0.020 | L 0.020 | L 0.020 | L 0.020 | L 0.020 | L 0.020 |
| Silica | $SiO_2$ | 7.06 | 3.86 | 3.74 | 4.30 | 2.15 | 3.76 | 3.57 |
| **Dissolved Cations** | | | | | | | | |
| Total Hardness | $CaCO_3$ | 13.0 | 7.60 | 8.40 | 12.0 | 6.90 | 11.9 | 10.3 |
| Calcium | Ca | 3.54 | 1.55 | 1.89 | 3.54 | 1.34 | 3.55 | 2.98 |
| Magnesium | Mg | 1.00 | 0.91 | 0.89 | 0.76 | 0.85 | 0.74 | 0.69 |
| Sodium | Na | 6.99 | 6.33 | 6.14 | 4.68 | 5.44 | 4.60 | 4.41 |
| Potassium | K | 0.61 | 0.26 | 0.32 | 0.14 | 0.16 | 0.15 | 0.18 |
| **Other Parameters** | | | | | | | | |
| Tannin & Lignin Like Compounds (as Tannic Acid) | | 3.00 | 2.96 | 2.56 | 1.28 | 5.52 | 1.40 | 1.96 |
| Total Kjeldahl Nitrogen | N | 1.85 | 2.42 | 2.60 | 2.30 | 2.03 | 3.10 | 3.30 |
| Ammonia Nitrogen | N | 0.11 | 0.11 | L 0.05 | 0.05 | 0.08 | L 0.05 | L 0.05 |
| Total Organic Carbon | C | 12. | 20. | 22. | 11. | 26. | 14. | 10. |
| Total Phosphates | $PO_4$ | L 0.06 | L 0.06 | L 0.06 | L 0.06 | L 0.06 | L 0.06 | 0.23 |
| Total Arsenic | As | 0.0025 | L 0.0005 | 0.0022 | L 0.0005 | 0.0014 | L 0.0005 | L 0.0005 |

All results expressed in mg/l (milligrams per litre) unless otherwise indicated.
L = less than
* = calculated

## Table 4.5.2.2
## Total Elemental Constituents* of Streams within the Cinola Study Area
## December 18-19, 1979

| PARAMETER | | ABOVE MINESITE STATIONS 3 GOLD CREEK | 5 UPPER BARBIE | 6 UPPER YAKOUN | BELOW MINESITE STATIONS 1 "OUTCROP" CREEK | 2 CANOE CREEK | 4 "SWAMP" CREEK | 7 LOWER YAKOUN |
|---|---|---|---|---|---|---|---|---|
| Aluminum | (0.15)** | L | L | 0.55 | 0.05 | 0.30 | 0.85 | L |
| Antimony | (0.15) | L | L | L | L | L | L | L |
| Arsenic | (0.30) | L | L | L | L | L | L | L |
| Barium | (0.001) | 0.009 | 0.013 | 0.013 | 0.015 | 0.014 | 0.016 | 0.011 |
| Beryllium | (0.003) | L | L | L | L | L | L | L |
| Bismuth | (0.5) | L | L | L | L | L | L | L |
| Boron | (0.01) | L | L | L | L | L | 0.043 | L |
| Cadmium | (0.025) | L | L | L | L | L | L | L |
| Calcium | (0.01) | 3.44 | 1.35 | 3.75 | 3.71 | 1.64 | 2.04 | 3.31 |
| Chromium | (0.03) | L | L | L | L | L | L | L |
| Cobalt | (0.02) | L | L | L | L | L | L | L |
| Copper | (0.015) | L | 0.025 | L | 0.016 | 0.019 | 0.034 | L |
| Iron | (0.030) | 0.28 | 0.58 | 0.83 | 0.92 | 0.80 | 1.16 | 0.45 |
| Lead | (0.08) | L | L | L | L | L | L | L |
| Magnesium | (0.001) | 0.77 | 0.89 | 0.91 | 1.13 | 1.01 | 1.06 | 0.84 |
| Manganese | (0.003) | 0.022 | 0.062 | 0.033 | 0.151 | 0.056 | 0.11 | 0.022 |
| Mercury | (0.0002) | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0003 | 0.0003 | 0.0002 |
| Molybdenum | (0.04) | L | L | L | L | L | L | L |
| Nickel | (0.025) | L | L | L | L | L | 0.027 | L |
| Phosphorus($PO_4$) | (0.4) | L | L | L | L | L | L | L |
| Potassium | (0.01) | 0.28 | 0.31 | 0.42 | 0.82 | 0.44 | 0.62 | 0.38 |
| Silicon($SiO_2$) | (0.08) | 4.05 | 2.18 | 4.66 | 7.34 | 4.05 | 4.55 | 4.25 |
| Silver | (0.03) | L | L | L | L | L | L | L |
| Sodium | (0.1) | 4.59 | 5.28 | 4.43 | 6.89 | 6.26 | 5.95 | 5.26 |
| Strontium | (0.001) | 0.019 | 0.011 | 0.022 | 0.019 | 0.016 | 0.017 | 0.019 |
| Tin | (0.03) | L | L | L | L | L | L | L |
| Titanium | (0.006) | L | L | 0.012 | 0.016 | L | 0.021 | 0.007 |
| Tungsten | (0.25) | L | L | L | L | L | L | L |
| Vanadium | (0.01) | L | L | L | 0.04 | L | 0.05 | L |
| Zinc | (0.015) | 0.034 | 0.051 | 0.019 | 0.045 | 0.031 | 0.058 | 0.022 |

All results expressed in parts per million.

* Most total metals values were determined using an Inductively Coupled Plasma Spectrographic Analysis on the acid digested sample. Mercury was determined using a Pharmacia Mercury Monitor (flameless atomic absorption spectrophotometry) after controlled digestion of the sample.

L = less than.

** Detection Limit

TABLE 4.5.2.3

Water Quality Criteria for Selected Parameters

| Parameter | Expected Abundance* | General Use | Drinking Water | Aquatic Life |
|---|---|---|---|---|
| (Physical) | | | | |
| color | | | 15 rel. units | preferably< 50 rel. units |
| pH | | 5.0-9.0 | 6.5-8.3 | 6.5-8.5 |
| conductance | | 500 µmho | | < 3000 µmho/cm |
| temperature | | | < 15°C | 25°C upper limit for salmonids |
| turbidity | | 3-5 JTU | 5 JTU | < 10 JTU |
| (Chemical) | | | | |
| dissolved oxygen | | | | preferably at or near saturation but must be > 5 mg/l |
| total solids | | 500 mg/l | | |
| dissolved solids | | 500-1000 mg/l | 1000 mg/l | < 5000 mg/l recommended |
| suspended solids | | | | |
| total alkalinity | | | 30-500 mg/l acceptable range | 100-120 mg/l |
| total hardness | | | 180 mg/l | |
| organic carbon | | | | |
| fluoride | 2 | | 1.5 mg/l | |
| ammonia nitrogen | 3 | | 0.5 mg/l | |
| $NO_2/NO_3$ nitrogen | 2 | 10 mg/l combined | 10 mg/l combined | > 0.5 mg/l nitrate & |
| organic nitrogen | | | | |
| kjeldahl nitrogen | | | | |
| ortho-phosphate P | 3 | | 0.2 mg/l | <0.01 mg/l orthophosphate** may encourage excessive plant growth |
| total phosphorus | 3 | | | 0.01-0.1 mg/l |
| phenol | 4 | | 0.002 mg/l | |
| sulphate | 1 | 500 mg/l | 500 mg/l | 11-90 mg/l |
| tannin & lignin | | | | <4 mg/l tannic acid suggested |
| acidity (pH8.3) | | | | pH should be within 6.5-8.5 range |
| Al | 3 | | | <0.1 mg/l |
| As | 3 | 0.1 mg/l | 0.05 mg/l | <1 mg/l |
| Cd | 3 | 0.01 mg/l | 0.01 mg/l | 0.004 mg/l |
| Ca | 1 | 200 mg/l | 200 mg/l | 15-52 mg/l |
| Cr | 3 | 0.05 mg/l | 0.05 mg/l | <0.05 mg/l |
| Cu | 3 | 1 mg/l | 1 mg/l | <0.1 mg/l (.02 mg/l LTSF) |
| Fe | 2 | 0.3 mg/l | 0.3 mg/l diss | <0.2 mg/l |
| Pb | 3 | 0.05 mg/l | 0.05 mg/l | <0.01 mg/l |
| Mg | 1 | 150 mg/l | 150 mg/l | 15-100 mg/l |
| Mn | 3 | 0.05-0.1 mg/l | 0.05 mg/l | <1 mg/l |
| Hg | 4 | 0.002 mg/l | 0.002 mg/l | <0.01 mg/l |
| Mo | 4 | not a significant pollutant | | |
| Ni | 3 | 1 mg/l | | <0.05 mg/l |
| K | 2 | | 2000 mg/l extreme permissible limit | <50 mg/l |
| Na | 1 | 50 mg/l | 270 mg/l if dietary restriction applies | 6-85 mg/l |
| V | 4 | 0.1 mg/l | | |
| Zn | 3 | 5 mg/l | 5 mg/l | <0.1 mg/l |

* - dissolved solids in potable waters
1 - major constituents (1-1000 mg/l)
2 - secondary constituents (0.01-10 mg/l)
3 - minor constituents (0.0001-0.1 mg/l)
4 - trace constituents (0.001 mg/l)
LTSF - lethal to some fish
** - This criterion, placed opposite Kjeldahl nitrogen in the WIB, 1976 report, is assumed to refer to ortho-phospate P.

Source: Water Investigations Branch, October, 1976.
3073.2

water, and aquatic life. Values that varied from the accepted standards are summarized as follows:

| Station | General Use | Drinking Water | Aquatic Life |
|---|---|---|---|
| 1 | Mn | color, Mn, | |
| 2 | pH | color, Mn, pH | color, pH |
| 3 | | color | color |
| 4 | Mn | color, Mn, pH | pH |
| 5 | | color, Mn, pH, | color, pH |
| 6 | pH, turbidity | color, pH, turbidity | color, pH |
| 7 | | color | |

The parameters most often exceeding accepted levels were pH and color. Values of pH reflecting acidic conditions (range 4.70-6.05) were found at four stations, while at the remaining three sites, values were 7.00 or higher. The abnormally low pH levels were crosschecked with the laboratory and are accurate. Future surveys will determine whether those values were anomalous. Color measurements exceeded drinking water standards at all stations and, at four sites, were higher than the level recommended for aquatic life. Manganese concentrations exceeded general use standards at two stations and drinking water standards at four stations. Turbidity exceeded recommended water quality criteria at one station.

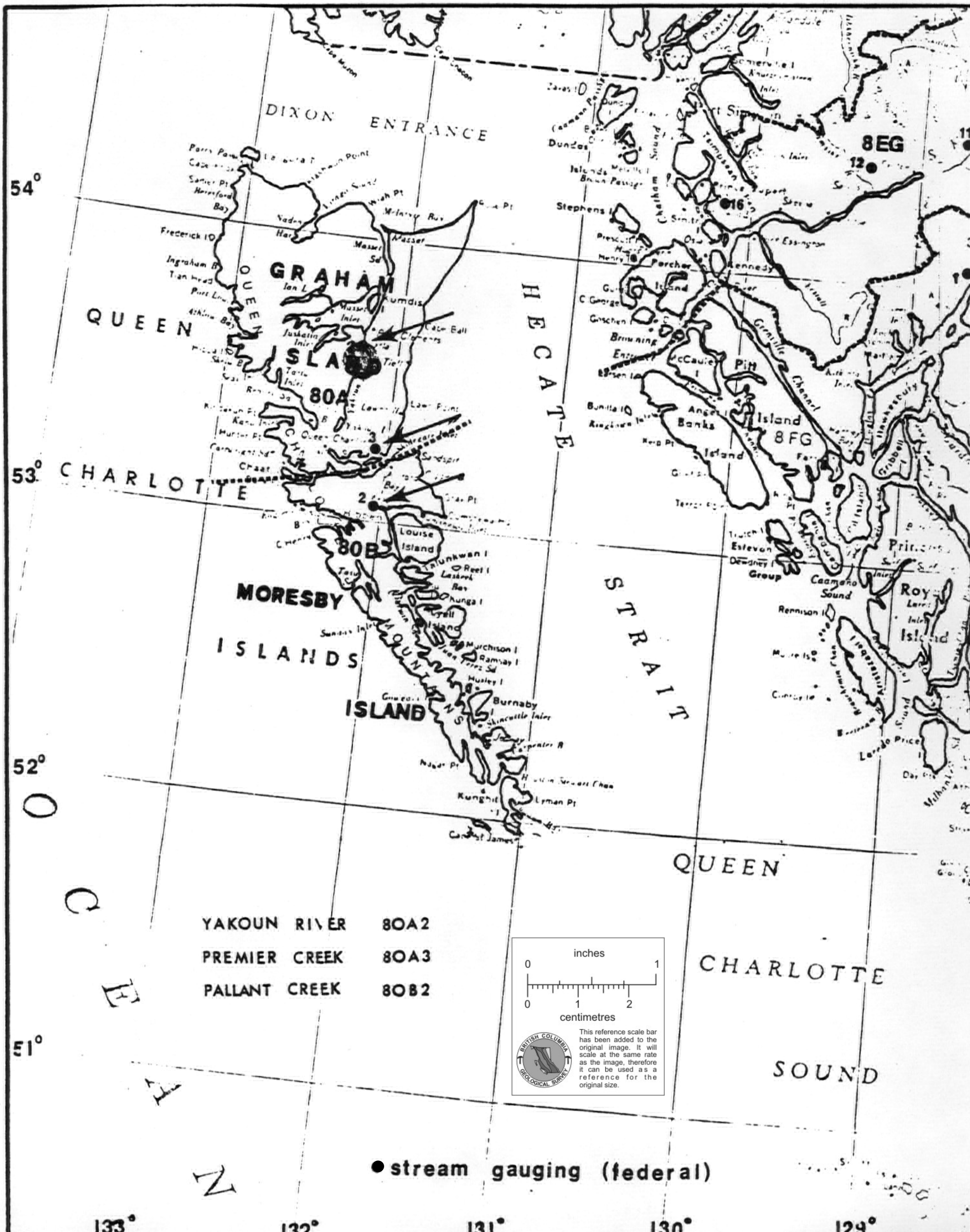
The water in the Yakoun River watershed is generally soft, of low pH, poorly buffered, and low in dissolved inorganics. The water is highly stained with organic humates.

#### 4.5.3 Hydrology

The study area is drained by the Yakoun River, which flows westward south of the proposed development, northward to the east of the study area, then into Yakoun Bay at the southeastern end of Masset Inlet.

The location of all Water Survey of Canada gauging stations on the Queen Charlotte Islands is presented in Figure 4.5.3.1.

Since 1962, Water Survey of Canada has gauged the Yakoun River at a location between Canoe and Florence Creeks. Between 1962 and 1966, stream gauging was conducted manually throughout the year. Since 1967, a continuously recording gauge has been in




LOCATIONS OF WATER SURVEY OF CANADA ACTIVE HYDROMETRIC (stream gauging) STATIONS

IEC

| DRAWN | DATE |
|---|---|
| ARTURO | 80.05.22 |
| CHECKED | APPROVED |
| FIGURE: 4.5.3.1 3073.2 | |

Table 4.5.3.1

Summary of Water Survey of Canada Station Data
Relevant for the Cinola Project

| Stream (Station No.) | Basin Area (ha) | Location | Record | Gauge Type | Type of Flow |
|---|---|---|---|---|---|
| 1. Active Stations | | | | | |
| Yakoun River (080A002) | 47700 | nr. Port Clements, Graham Island | 62-66<br>67-69 | manual continuous<br>recording continuous | natural |
| Premier Creek (080A003) | — | nr. Queen Charlotte, Graham Island | 69-70<br>71-80 | recording continuous<br>recording continuous | natural |
| Pallant Creek (080B002) | 7670 | nr. Queen Charlotte, Moresby Island | 62-64<br>65-66<br>67-80 | manual, seasonal<br>manual<br>recording continuous | natural |
| 2. Discontinued Stations | | | | | |
| Ain River (080A001) | 30800 | nr. Port Clements, Graham Island | 62-64 | manual, seasonal | natural |
| Deena River (080B001) | 5670 | nr. Queen Charlotte, Moresby Island | 62-63 | manual, seasonal | natural |
| Mathers Creek (080B003) | 7930 | nr. Sandspit Moresby Island | 62-63<br>64 | manual, seasonal<br>manual | natural |

3073.2

operation at the site. The flow at the gauged site is natural, regulated only by Yakoun Lake in its headwaters. Figure 4.5.3.2 shows the location of the gauge in relation to the Cinola site.

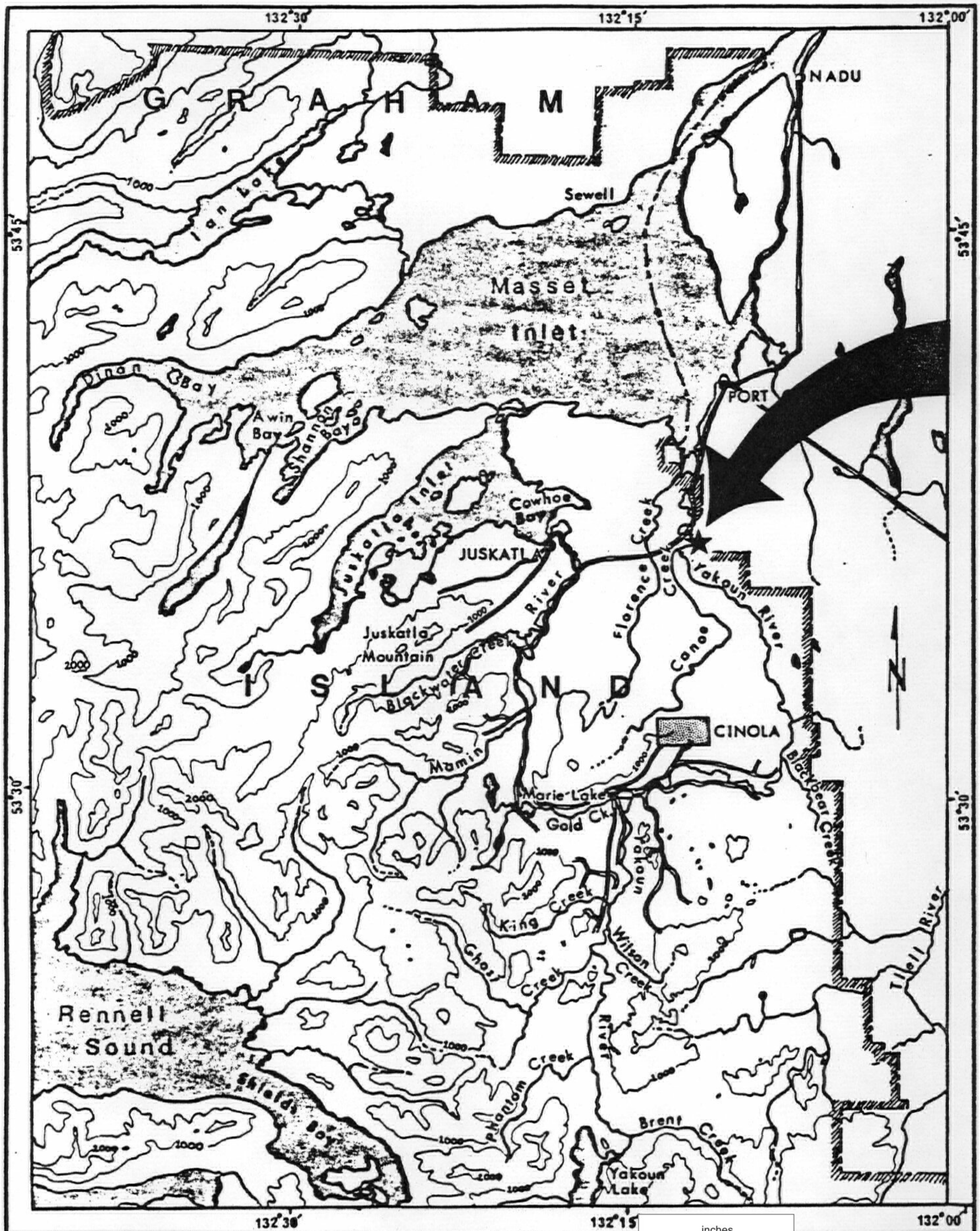
The two other Water Survey of Canada gauging stations currently in operation in the Queen Charlotte Islands are on Premier and Pallant Creeks. Table 4.5.3.1 summarizes the data available for all stations.

A summary of all data available from the Yakoun River gauging site is presented in Table 4.5.3.2.

The Yakoun River, with a mean annual flow of 34 cumecs, has ranged from a recorded daily maximum of 612 cumecs (5 December 1962) to a low of 0.46 cumecs (26 September 1965). The hydrological regime of the Yakoun River downstream from the Cinola property is depicted in Figure 4.5.3.3, the hydrograph for the site. The basin above the gauge is sufficiently large to prevent high frequency fluctuations in discharge. The streamflow regulation by Yakoun Lake produces a much less peaked hydrograph for the Yakoun River than for the smaller basins that have been gauged. Flooding may occur at the site during prolonged rainfalls that are common in October and November for this region.

Annual peak flows on the Yakoun River normally occur between October and January, and are most common in October or November. Minimum flows normally occur between July and September, and are most common in August. Maximum flows exceed minimum flows by at least two orders of magnitude, an indication that peak flows, which arise and subside rapidly, are significant geomorphic events in this area. The peak flows normally flood the treed portion of the floodplain, but are not prolonged events.

Secondary peaks in the hydrograph occur in March with spring freshet or during the early summer season caused by individual rainstorms. Flows decrease steadily from March to August, at which point much of the streambed may become exposed. Dry bed conditions have never been recorded at this site. Flows increase steadily from August to October. Once the fall rains begin, high frequency, high amplitude peaks




Scale 1:250,000
1 inch to 4 miles approximately

Miles 5 0

Kilometres 5 0

CONSOLIDATED CINOLA MINES LTD.
YAKOUN RIVER GAUGING STATION

★ Gauging Station

▒ Study Area

inches 0 1
0 1 2 centimetres

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

BRITISH COLUMBIA GEOLOGICAL SURVEY

| DRAWN | DATE |
|---|---|
| B. GUILD | 80.05.15 |
| CHECKED | APPROVED |
| | |

FIGURE: 4.5.3.2
3073.2

Table 4.5.3.2

## Yakoun River near Port Clements - Station No. 080A002

### Monthly and Annual Mean Discharges in Cubic Metres per Second for the Period of Record

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | MEAN | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1962 | -- | -- | -- | -- | -- | -- | 4.8 | 17.0 | 16.8 | 75.3 | 75.0 | 77.9 | -- | 1962 |
| 1963 | 24.7 | 47.3 | 20.7 | 13.8 | 24.0 | 9.4 | 4.5 | 1.5 | 27.6 | 100.8 | 94.6 | 54.9 | 35.1 | 1963 |
| 1964 | 66.0 | 58.3 | 28.9 | 30.3 | 18.8 | 17.2 | 14.2 | 11.4 | 24.2 | 81.5 | 41.9 | 41.6 | 36.2 | 1964 |
| 1965 | 47.8 | 45.0 | 13.9 | 14.1 | 21.5 | 8.6 | 9.3 | 2.1 | 1.4 | 73.6 | 75.0 | 70.5 | 32.0 | 1965 |
| 1966 | 52.7 | 47.6 | 65.7 | 28.2 | 35.4 | 15.9 | 5.9 | 8.9 | 30.3 | 61.4 | 58.0 | 34.5 | 37.1 | 1966 |
| 1967 | 51.2 | 70.8 | 19.0 | 13.3 | 16.3 | 7.0 | 6.4 | 3.9 | 32.6 | 63.4 | 30.9 | 59.7 | 30.9 | 1967 |
| 1968 | 55.7 | 25.5 | 39.4 | 33.7 | 12.1 | 14.0 | 4.8 | 6.4 | 28.2 | 77.3 | 74.5 | 40.2 | 32.6 | 1968 |
| 1969 | 63.1 | 76.7 | 29.7 | 61.4 | 24.9 | 10.4 | 8.2 | 14.0 | 14.8 | 21.8 | 90.0 | 74.2 | 40.5 | 1969 |
| 1970 | 45.3 | -- | -- | -- | -- | 10.8 | 6.3 | 9.2 | 14.4 | -- | -- | -- | -- | 1970 |
| 1971 | -- | -- | 45.9 | 45.0 | 22.3 | 17.8 | 9.0 | 16.0 | 26.5 | 31.1 | 58.9 | 32.3 | -- | 1971 |
| 1972 | 44.7 | 31.7 | 45.3 | 30.9 | 35.7 | 14.5 | 6.8 | 5.3 | 9.8 | 37.1 | 60.6 | 60.9 | 28.3 | 1972 |
| 1973 | 58.6 | 28.9 | 31.4 | 21.6 | 198.6 | 14.1 | 10.0 | 3.2 | 18.5 | 63.4 | 24.9 | 65.1 | 30.0 | 1973 |
| 1974 | 26.8 | 42.2 | 24.9 | 30.6 | 22.2 | 15.7 | 12.9 | 2.9 | 4.0 | 96.0 | 50.7 | 82.9 | 34.3 | 1974 |
| 1975 | 50.7 | 37.4 | 18.8 | 23.5 | 18.8 | 15.4 | 7.7 | 9.8 | 7.7 | 59.7 | 85.2 | 53.8 | 32.3 | 1975 |
| 1976 | 61.1 | 37.7 | 33.4 | 28.2 | 32.0 | 19.0 | 26.0 | 9.1 | 19.8 | 37.4 | 60.6 | 60.9 | 35.4 | 1976 |
| 1977 | 20.4 | 47.0 | 36.0 | 34.5 | 10.4 | 9.4 | 11.1 | 2.2 | 7.0 | 79.0 | 65.1 | 25.2 | -- | 1977 |
| 1978 | 16.2 | 39.4 | 27.1 | 16.2 | 11.9 | 4.9 | 1.6 | 8.5 | 26.9 | 44.7 | -- | -- | -- | 1978 |
| MEAN | 45.7 | 45.4 | 32.0 | 28.4 | 21.7 | 12.8 | 8.8 | 7.7 | 18.3 | 62.7 | 66.4 | 55.6 | 33.7 | MEAN |

LOCATION - LAT 53 36 50 N
- LONG 132 12 35 W

DRAINAGE AREA - 476.6 km$^2$
NATURAL FLOW

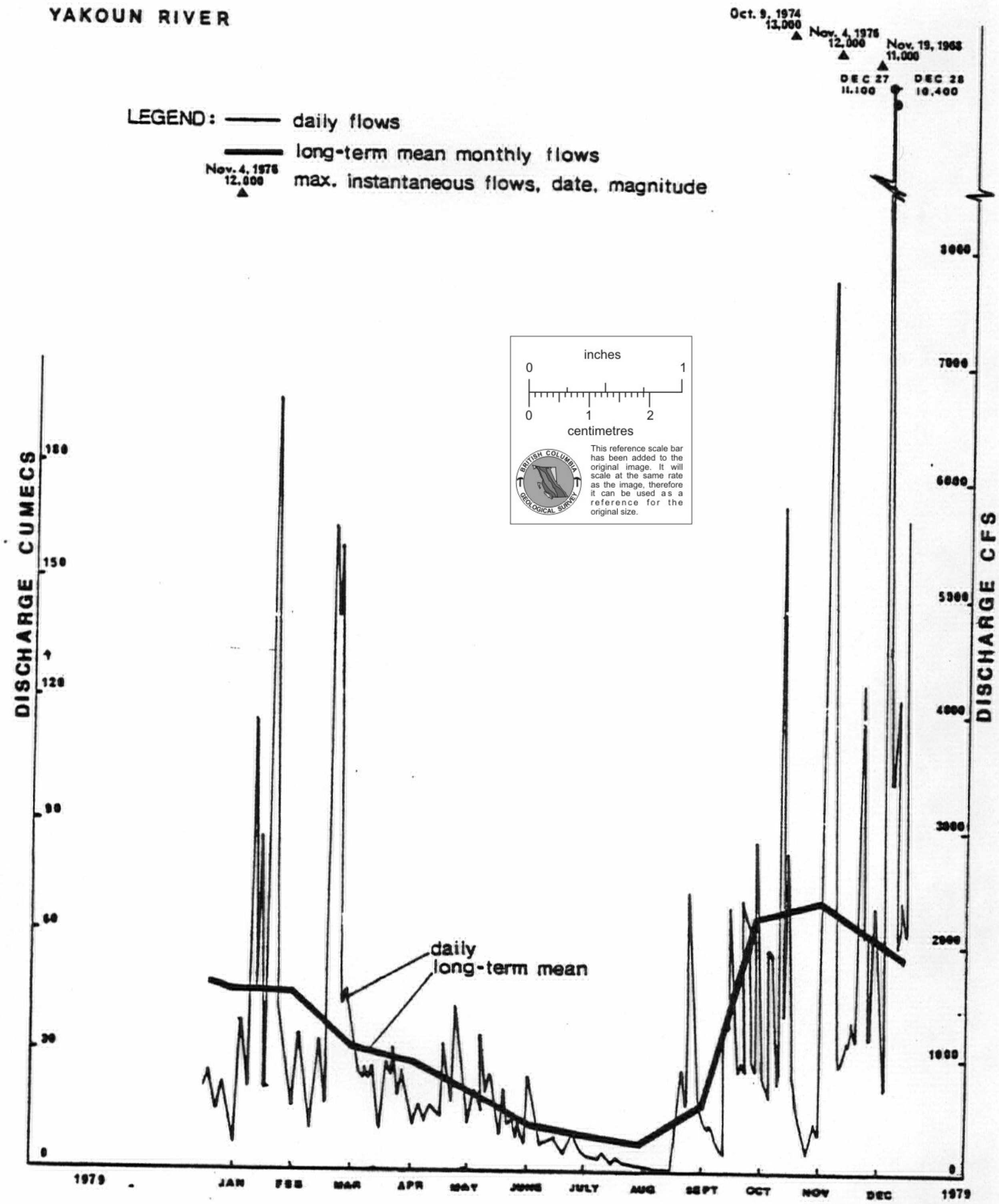
## Yakoun River near Port Clements - Station No. 080A002

### Annual Extremes of Discharge in Cumecs and Annual Total Discharge in dam$^3$ for the Period of Record

| Year | Maximum Instantaneous Discharge | Maximum Daily Discharge | Minimum Daily Discharge | Total Discharge | Year |
|---|---|---|---|---|---|
| 1962 | -- | 396.3 cumecs on 5 Dec | 2.5 cumecs on 27 July | -- | 1962 |
| 1963 | -- | 611.5 cumecs on 28 Nov | 0.9 cumecs on 30 Aug | 1112150 dam$^3$ | 1963 |
| 1964 | -- | 433.1 cumecs on 19 Oct | 5.2 cumecs on 24 Aug | 1142221 dam$^3$ | 1964 |
| 1965 | -- | 509.6 cumecs on 30 Nov | 0.5 cumecs on 28 Sept | 1006536 dam$^3$ | 1965 |
| 1966 | -- | 228.5 cumecs on 18 Oct | 3.2 cumecs on 29 July | 1166891 dam$^3$ | 1966 |
| 1967 | 226.8 cumecs on 3 Dec | 175.2 cumecs on 3 Dec | 1.9 cumecs on 18 Aug | 978165.5 dam$^3$ | 1967 |
| 1968 | 331.2 cumecs on 19 Nov | 243.5 cumecs on 19 Nov | 1.0 cumecs on 11 Aug | 1028739 dam$^3$ | 1968 |
| 1969 | 325.6 cumecs on 29 Nov | 252.2 cumecs on 29 Nov | 2.6 cumecs on 9 July | 1270505 dam$^3$ | 1969 |
| 1970 | 172.1 cumecs on 6 Jan | 131.4 cumecs on 21 Jan | 3.8 cumecs on 3 Sept | -- | 1970 |
| 1971 | 180.3 cumecs on 1 Dec | 148.3 cumecs on 1 Dec | 3.6 cumecs on 14 Aug | -- | 1971 |
| 1972 | 268.9 cumecs on 15 Jan | 221.1 cumecs on 15 Jan | 2.3 cumecs on 14 Sept | 897988 dam$^3$ | 1972 |
| 1973 | 268.7 cumecs on 23 Jan | 230.4 cumecs on 15 Jan | 2.0 cumecs on 23 Aug | 948561.5 dam$^3$ | 1973 |
| 1974 | 368.0 cumecs on 9 Oct | 345.5 cumecs on 9 Oct | 1.6 cumecs on 4 Sept | 1083013 dam$^3$ | 1974 |
| 1975 | 291.6 cumecs on 12 Nov | 233.6 cumecs on 12 Nov | 2.9 cumecs on 23 Sept | 1020104.5 dam$^3$ | 1975 |
| 1976 | 339.7 cumecs on 4 Nov | 258.8 cumecs on 4 Nov | 6.1 cumecs on 18 Aug | 1121251.5 dam$^3$ | 1976 |
| 1977 | 267.0 cumecs on 27 Oct | 232.7 cumecs on 25 Oct | 0.7 cumecs on 22 Aug | 907856 dam$^3$ | 1977 |
| 1978 | -- | 205.0 cumecs on 31 Oct | 0.9 cumecs on 14 Aug | -- | 1978 |

dam$^3$ = 1000 cumecs

IEC




HYDROGRAPH OF YAKOUN RIVER
NEAR PORT CLEMENTS
(WATER SURVEY OF CANADA DATA)

| IEC | FILE | PROJECT |
|---|---|---|
| | DWN | APP |
| | DATE | REV |
| | FIGURE 4.5.3.3 | |

3073.2

characterize the hydrograph until after spring freshet. Ice cover seldom occurs on the Yakoun River.

None of the other major streams in the study area have hydrologic records at present. The two other gauged streams on the Queen Charlotte Islands, Premier Creek (Graham Island) and Pallant Creek (Moresby Island) have similar basin characteristics to some of the major streams in the study area, The data for these creeks, therefore, is presented in Tables 4.5.3.3 and 4.5.3.4 respectively. Figures 4.5.3.4 and 4.5.3.5 are hydrographs that depict this data graphically. In these smaller basins, the flows have a much sharper and shorter response to rain storms than the Yakoun River. Otherwise, Pallant and Premier Creeks have quite similar flow regimes to the Yakoun River. Maximum flows exceed minimum flows by at least two orders of magnitude and both extremes occur with great frequency. Peak flows occur between October and January and are most common in October and November. Minimum flows occur between July and September, and are most frequent in August. Pallant and Premier Creeks rarely ice over, and do not retain a significant ice cover for long periods of time when freezing does occur.

A program to monitor flows in the study region has been initiated by IEC. Nine stations have been selected at present for flow monitoring, each consisting of a staff gauge and surveyed bench marks. Table 4.5.3.5 lists all IEC gauging stations and locations.

## Table 4.5.3.3

### Premier Creek near Queen Charlotte - Station No. 080A003

### Monthly and Annual Mean Discharges in Cubic Metres per Second for the Period of Record

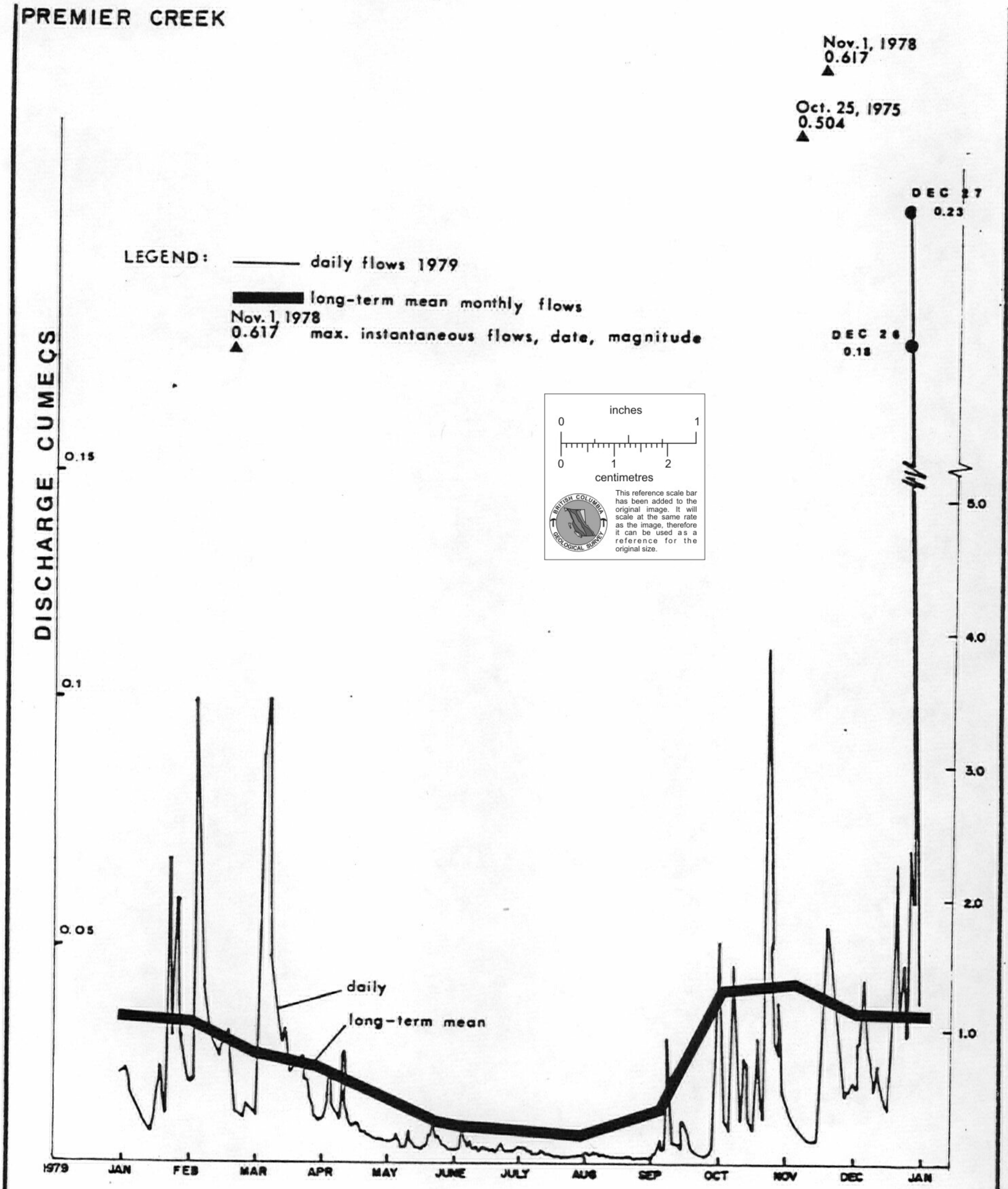
| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | MEAN | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1971 | -- | -- | .031 | .028 | .009 | -- | .004 | .006 | .012 | .021 | .034 | .016 | -- | 1971 |
| 1972 | -- | -- | -- | -- | .028 | .005 | .003 | .003 | .005 | .021 | .026 | .026 | -- | 1972 |
| 1973 | .043 | .020 | .017 | .010 | .007 | .003 | .003 | .002 | .011 | .043 | .018 | .051 | .019 | 1973 |
| 1974 | .016 | .031 | .018 | .020 | .008 | .006 | .003 | .002 | .001 | .071 | .034 | .051 | .022 | 1974 |
| 1975 | .040 | .027 | .012 | .016 | .006 | .006 | .002 | .003 | .002 | .040 | .093 | .034 | .023 | 1975 |
| 1976 | .040 | .026 | .023 | .019 | .011 | .009 | -- | -- | -- | -- | .034 | .031 | -- | 1976 |
| 1977 | .012 | .034 | .022 | .015 | .005 | .003 | .003 | .001 | .003 | .037 | .048 | .018 | -- | 1977 |
| 1978 | .009 | .019 | .011 | .007 | .004 | .002 | .001 | .004 | .016 | .028 | -- | .040 | -- | 1978 |
| MEAN | .027 | .026 | .019 | .016 | .010 | .005 | .003 | .003 | .007 | .037 | .041 | .033 | -- | MEAN |

### Premier Creek near Queen Charlotte - Station No. 080A003

### Annual Extremes of Discharge in Cumecs and Annual Total Discharge in $dam^3$ for the Period of Record

| Year | Maximum Instantaneous Discharge | Maximum Daily Discharge | Minimum Daily Discharge | Total Discharge | Year |
|---|---|---|---|---|---|
| 1971 | .272 cumecs on 5 Oct | .204 cumecs on 5 Oct | .003 cumecs on 23 July | -- | 1971 |
| 1972 | .470 cumecs on 30 Oct | .218 cumecs on 31 Oct | .002 cumecs on 22 Aug | -- | 1972 |
| 1973 | .263 cumecs on 26 Oct | .195 cumecs on 26 Oct | .002 cumecs on 25 July | 599.48 $dam^3$ | 1973 |
| 1974 | .402 cumecs on 9 Oct | .272 cumecs on 8 Oct | .001 cumecs on 31 Aug | 680.89 $dam^3$ | 1974 |
| 1975 | .504 cumecs on 25 Oct | .272 cumecs on 15 Nov | .001 cumecs on 30 Aug | 731.46 $dam^3$ | 1975 |
| 1976 | .280 cumecs on 27 Oct | .204 cumecs on 3 Nov | -- | -- | 1976 |
| 1977 | .235 cumecs on 14 Feb | .151 cumecs on 14 Feb | .001 cumecs on 19 Aug | 523.00 $dam^3$ | 1977 |
| 1978 | .617 cumecs on 1 Nov | .442 cumecs on 1 Nov | .001 cumecs on 18 July | -- | 1978 |

3073.2




**HYDROGRAPH FOR PREMIER CREEK**

(WATER SURVEY of CANADA)

IEC

| DRAWN | DATE |
|---|---|
| ARTURO | FEB. 80 |
| CHECKED B.K. | APPROVED |

FIGURE: 4.5.3.4
3073.2

Table 4.5.3.4

Pallant Creek near Queen Charlotte - Station No. 08OB002

Monthly and Annual Mean Discharges in Cubic Metres per Second for the Period of Record

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | MEAN | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1963 | – | – | – | 4.0 | 3.3 | 3.0 | 1.6 | 1.0 | 0.9 | – | – | – | – | 1963 |
| 1964 | – | – | – | 4.9 | 3.8 | 3.6 | 3.1 | 2.4 | 1.3 | – | – | – | – | 1964 |
| 1967 | – | – | – | – | – | – | – | 2.3 | 12.6 | 17.4 | 6.6 | 12.9 | – | 1967 |
| 1968 | 10.2 | 6.7 | 9.8 | 11.8 | 4.8 | 4.7 | 2.0 | 1.6 | 8.8 | 20.9 | 20.8 | 8.8 | 9.2 | 1968 |
| 1969 | 2.8 | 2.6 | 4.0 | 15.3 | 8.9 | 5.5 | 4.9 | 7.2 | 3.6 | 5.4 | 24.9 | 20.2 | 8.8 | 1969 |
| 1970 | 12.4 | 11.0 | 7.4 | 9.5 | 7.7 | 4.8 | 2.4 | 3.9 | 5.2 | 9.3 | 9.5 | 7.5 | 7.5 | 1970 |
| 1971 | 8.9 | 8.8 | 8.9 | 10.7 | 5.9 | 5.1 | 3.6 | 6.6 | 9.4 | 8.6 | 13.6 | 7.2 | 8.1 | 1971 |
| 1972 | – | – | – | – | 8.5 | 6.7 | 3.7 | 2.5 | 2.9 | 11.5 | 14.5 | 9.7 | – | 1972 |
| 1973 | 17.0 | 8.8 | 8.7 | 7.5 | 8.2 | 5.9 | 4.1 | 1.0 | 7.0 | 13.8 | 4.9 | 15.1 | 8.5 | 1973 |
| 1974 | 6.4 | 9.4 | 5.2 | 7.2 | 7.4 | 5.9 | 3.6 | 1.5 | 1.6 | 26.8 | 12.7 | 20.2 | 9.0 | 1974 |
| 1975 | 13.9 | 10.7 | 4.4 | 4.8 | 4.8 | 5.2 | 3.1 | 3.1 | 3.7 | 14.5 | 18.5 | 12.5 | 8.2 | 1975 |
| 1976 | 14.2 | 10.0 | 8.2 | 7.8 | 9.9 | 5.5 | 7.0 | 3.7 | 5.5 | 9.2 | 15.5 | 14.4 | 9.2 | 1976 |
| 1977 | 6.8 | 14.0 | 9.4 | 9.0 | 3.9 | 3.5 | 4.2 | 0.9 | 2.0 | 18.1 | 14.4 | 7.1 | 7.8 | 1977 |
| 1978 | 3.6 | 9.2 | 7.9 | 4.5 | 4.4 | 2.1 | 0.6 | 4.0 | 8.7 | 14.4 | – | – | – | 1978 |
| MEAN | 9.6 | 9.1 | 7.4 | 8.1 | 6.3 | 4.7 | 3.4 | 3.0 | 5.2 | 14.2 | 14.2 | 12.3 | 8.5 | MEAN |

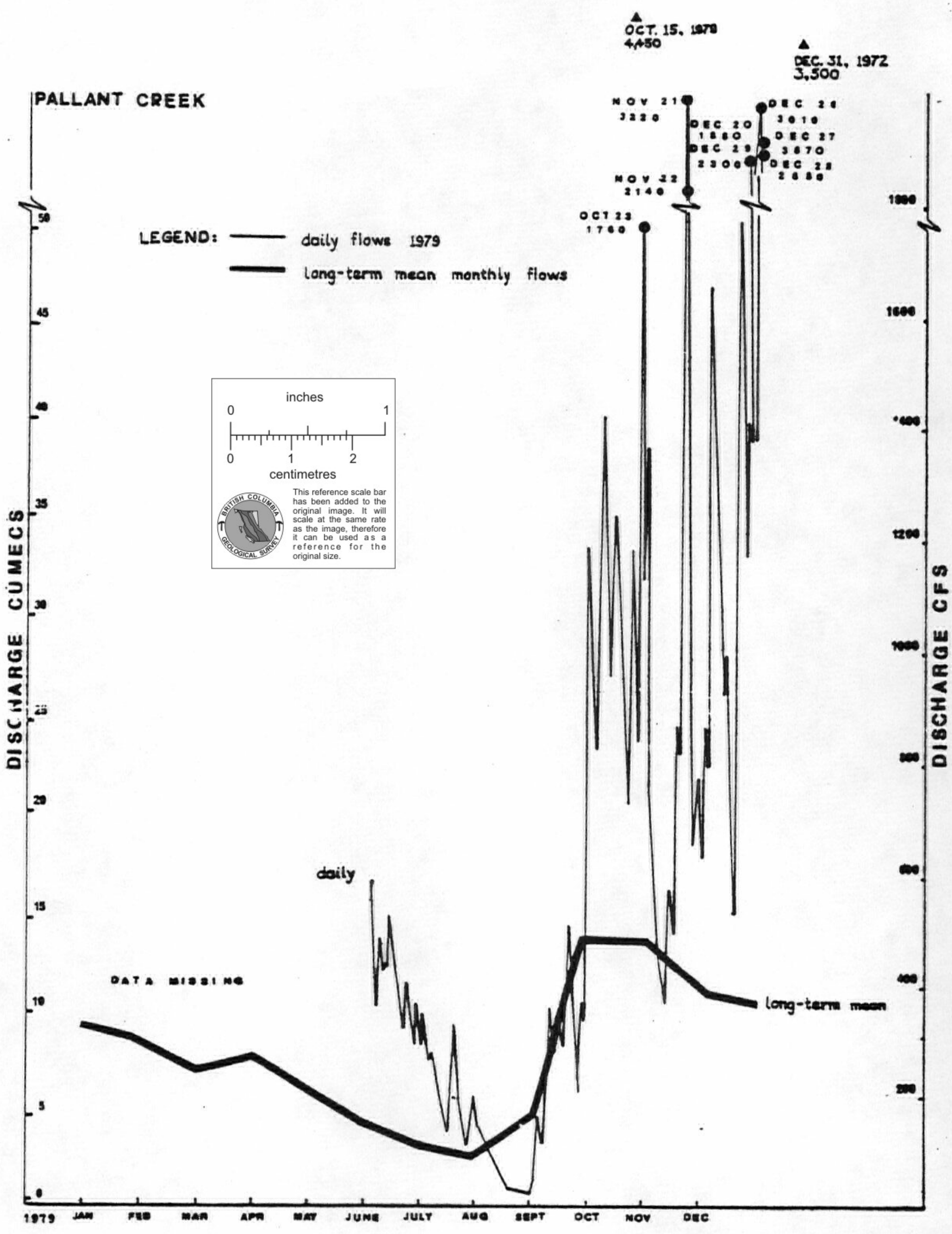
LOCATION - LAT 53 03 10 N
- LONG 132 02 20 W

DRAINAGE AREA - 76.7 $km^2$
NATURAL FLOW

Pallant Creek near Queen Charlotte - Station No. 08OB002

Annual Extremes of Discharge in Cumecs and Annual Total Discharge in $dam^3$ for the Period of Record

| Year | Maximum Instantaneous Discharge | Maximum Daily Discharge | Minimum Daily Discharge | Total Discharge | Year |
|---|---|---|---|---|---|
| 1963 | – | – | 0.8 cumecs on 11 Sept | – | 1962 |
| 1964 | – | – | 0.9 cumecs on 10 Sept | – | 1964 |
| 1967 | 63.7 cumecs on 23 Sept | 53.2 cumecs on 23 Sept | 1.3 cumecs on 7 Aug | – | 1967 |
| 1968 | 72.7 cumecs on 22 Jan | 46.4 cumecs on 23 Oct | 1.0 cumecs on 11 Aug | 292340 $dam^3$ | 1968 |
| 1969 | 83.2 cumecs on 28 Nov | 67.7 cumecs on 28 Nov | 1.5 cumecs on 5 July | 277538 $dam^3$ | 1969 |
| 1970 | 46.1 cumecs on 23 Jan | 33.4 cumecs on 23 Jan | 1.7 cumecs on 16 Sept | 238066 $dam^3$ | 1970 |
| 1971 | 55.8 cumecs on 12 Sept | 38.2 cumecs on 12 Sept | 1.2 cumecs on 15 Aug | 255345 $dam^3$ | 1971 |
| 1972 | 99.1 cumecs on 31 Dec | 44.4 cumecs on 24 Oct | – | – | 1972 |
| 1973 | 85.8 cumecs on 1 Jan | 56.3 cumecs on 22 Jan | 0.6 cumecs on 22 Aug | 268903 $dam^3$ | 1973 |
| 1974 | 126.0 cumecs on 15 Oct | 93.4 cumecs on 8 Oct | 0.7 cumecs on 4 Sept | 283705 $dam^3$ | 1974 |
| 1975 | 79.6 cumecs on 31 Oct | 43.0 cumecs on 31 Oct | 0.5 cumecs on 3 Sept | 260269 $dam^3$ | 1975 |
| 1976 | 75.0 cumecs on 3 Nov | 66.5 cumecs on 3 Nov | 2.4 cumecs on 1 Sept | 292340 $dam^3$ | 1976 |
| 1977 | 60.3 cumecs on 27 Oct | 44.2 cumecs on 27 Oct | 0.3 cumecs on 27 Aug | 244233 $dam^3$ | 1977 |
| 1978 | – | 62.3 cumecs on 31 Oct | 0.4 cumecs on 3 Aug | – | 1978 |
| MEAN | | | | 268082 $dam^3$ | MEAN |




HYDROGRAPH FOR PALLANT CREEK
(Water Survey of Canada)

| IEC | FILE | PROJECT |
|---|---|---|
| | DWN | APP |
| | DATE | REV |
| | FIGURE | 4.5.3.5 |

3073.2

Table 4.5.3.5

IEC Stream Monitoring Program for Cinola Property

Initiated 1980

| Station No. | Name | Location of Gauge |
|---|---|---|
| 1 | Outcrop Creek | Nailed to downstream side of bridge on LH side |
| 2 | Canoe Creek | Nailed to upstream side of bridge on LH side |
| 3 | Gold Creek | Driven into substrate upstream of bridge on LH side |
| 4 | Swamp Creek | Nailed to downstream end of Bridge on LH side |
| 5 | Barbie Creek | Driven into substrate downstream of junction of two small creeks on LH side |
| 6 | Upper Yakoun River | Nailed to downstream side of bridge on RH side |
| 8 | Plateau Creek | Driven in substrate below end of access road on plateau on LH side. |
| 9 | Florence Creek | Nailed to downstream side of bridge on middle support of bridge. |

### 4.5.4 Fisheries

The Yakoun River and its tributaries have historically been a major producer of both anadromous and resident fish stocks. Anadromous species include pink (Oncorhynchus gorbuscha), coho (O. kisutch), sockeye (O. nerka), spring (O. tshawytshcha), and chum (O. keta) salmon, plus steelhead (Salmo gairdnerii) and cutthroat (S. clarki) trout. Resident species include rainbow (S. gairdnerii) and cutthroat trout, and Dolly Varden char (Salvelinus malma). Two forage species, the three-spine stickleback (Gasterosteus aculeatus), and the coastrange sculpin (Cottus aleuticus) were collected during a May 1980 trapping survey.

Salmon escapement estimates and historical notes dating to 1921 for the Yakoun River are available and were reviewed in the Queen Charlotte Fisheries & Oceans Office (by Kip Slater, F&O). A more recent published escapement summary for the period 1947-79 is presented in Table 4.5.4.1 (Brown and Musgrove, 1979). Maximum, minimum, and mean escapements to the spawning grounds for pink, coho, sockeye, spring, chum salmon, and steelhead trout over this period is summarized (recorded data only) as follows:

| | Maximum | Minimum | Mean |
|---|---|---|---|
| Pink - even year | 800,000 | 35,000 | 219,250 |
| Pink - odd year | 15,000 | 500 | 4,510 |
| Coho | 35,000 | 1,500 | 8,712 |
| Sockeye | 25,000 | 750 | 8,583 |
| Spring | 15,000 | 400 | 2,318 |
| Chum | 1,500 | 25 | — |
| Steelhead | 15,000 | 1,000 | 5,400 |

Due to the variability in the size of the salmon runs and in the management techniques implemented to conserve stocks, each species will be discussed separately.

#### Pink Salmon

The Yakoun River has historically been one of the major even year pink salmon spawning rivers in B.C., second only to the Skeena River. The dominant even year

Table 4.5.4.1

Escapement Record for Yakoun River[1]

| YEAR | SOCKEYE | CHINOOK | COHO | CHUM | PINK | STEELHEAD |
|---|---|---|---|---|---|---|
| 1947 | 3,500 | 1,500 | 7,500 | — | — | — |
| 1948 | 3,500 | 750 | 15,000 | — | 325,000 | 4,000 |
| 1949 | — | — | — | — | — | — |
| 1950 | — | — | 7,500 | — | 100,000+ | — |
| 1951 | 7,500 | — | 35,000 | — | — | — |
| 1952 | 3,500 | 1,500 | 7,500 | — | 100,000+ | — |
| 1953 | — | — | — | — | — | — |
| 1954 | — | — | — | — | 100,000+ | — |
| 1955 | — | — | — | — | — | — |
| 1956 | — | 750 | 3,500 | — | 100,000+ | — |
| 1957 | 750 | 1,500 | — | 1,500 | 3,500 | — |
| 1958 | 3,500 | — | — | — | 175,000 | — |
| 1959 | 7,500 | 3,500 | 3,500 | — | 7,500 | — |
| 1960 | 7,500 | 750 | 3,500 | 400 | 35,000 | — |
| 1961 | 3,500 | 3,500 | 3,500 | — | 7,500 | — |
| 1962 | 15,000 | 1,500 | 7,500 | — | 35,000 | — |
| 1963 | 7,500 | — | 3,500 | — | 7,500 | — |
| 1964 | 15,000 | 7,500 | 15,000 | — | 300,000 | — |
| 1965 | 7,500 | 15,000 | 15,000 | 25 | 15,000 | 15,000 |
| 1966 | 3,500 | 7,500 | — | — | 800,000 | 15,000 |
| 1967 | 7,500 | 1,500 | 7,500 | — | — | 3,500 |
| 1968 | 15,000 | 1,500 | 3,500 | — | 750,000 | 3,500 |
| 1969 | 15,000 | 1,500 | 1,500 | — | — | 7,500 |
| 1970 | 25,000 | 800 | 12,000 | — | 250,000 | 6,000 |
| 1971 | 6,000 | 500 | 10,000 | — | 1,000 | 7,500 |
| 1972 | 5,000 | 1,000 | 6,000 | — | 63,000 | — |
| 1973 | 12,000 | 900 | 9,000 | — | 1,000 | 7,000 |
| 1974 | 15,000 | 1,000 | 12,000 | — | 75,000 | 3,000 |
| 1975 | 9,500 | 1,500 | 5,000 | — | 500 | 2,000 |
| 1976 | 8,000 | 700 | 7,000 | — | 150,000 | 2,500 |
| 1977 | 3,000 | 800 | 8,000 | — | 600 | 2,000 |
| 1978 | 12,000 | 600 | 10,000 | — | 150,000 | 1,500 |
| 1979 | 9,500 | 400 | 7,500 | — | 1,000 | 1,000 |
| TIMING: | | | | | | |
| ARRIVE | L. Apr | E. May | M. Aug | — | Aug | — |
| START | Aug | Aug | E. Oct | — | L. Aug | — |
| PEAK | Sep | Sep | L. Oct | — | M. Sep | — |
| END | L. Sep | M. Oct | Dec | — | M. Sep | — |

[1]Summary from Brown, R.F. and M.M. Musgrave, 1979, p.66.

escapements were estimated between 100,000 to 1,000,000 spawners prior to 1947. Escapement records for the period 1947-79 (Table 4.5.4.1) indicate a range from a maximum population of 800,000 (1966) to a minimum of 35,000 (1960, 1962). The mean population for recorded years is 219,250.

The significantly smaller odd year escapements have ranged from a recorded maximum of 15,000 (1965) to a minimum of 500 (1975), with a mean of 4,510.

The continued dominance and success of the even year pink run has resulted in considerable management efforts to enhance the river by providing improved access to spawning grounds by logjam removal. The small returns estimated at 100,000-200,000 (escapement 35,000) in 1960 and 1962 resulted in studies initiated in 1964 to obtain accurate escapement counts for a more precise management of the commercial catch. Studies by F. Boyd (1964-66) were conducted to determine the relationship of logging practices and associated stream gravel removal on the pink stocks.

A detailed stock assessment study was initiated in 1964 by C.E. Walker (1965), which included construction of a counting fence and an observation tower for enumerating spawning adults. A juvenile sampling program on odd years was conducted to enumerate downstream migrants. As a result of the low escapements in 1960 and 1962, the commercial fishery in Masset Inlet was curtailed in 1960 and was not operational in 1962 and 1964. In 1964, a significant recovery occurred, with 325,000 spawners returning.

The commercial catch of pink salmon in Area 1, northern Queen Charlotte Islands, for the years 1952-1977 is presented in Table 4.5.4.2. It should be noted that the Yakoun River has historically produced approximately 50% of the returning even year pink populations for the Queen Charlotte Islands and, in 1964 and 1966, produced an estimated 70% of the escapement to all streams in Area 1. Thus, with an above average commercial catch of 1,317,000 in 1966, 992,000 originated from the Yakoun River. 1964 brood stock of 325,000 spawners and the total returning population was estimated at 1,317,000 + 992,000 = 1,695,000 pinks, which represents a fry to adult survival of 5.5% (Walker, 1965). Because of the importance of the Yakoun River even year pink run, a series of fisheries management measures were initiated in the early 1960's when stocks suddenly declined. A brief summary follows:

Table 4.5.4.2

Commercial Catch of Pinks for Area I

Northern Queen Charlotte Islands

| Year | Area I Catch |
|---|---|
| 1952 | 1,448,200 |
| 1953 | 9,300 |
| 1954 | 155,900 |
| 1955 | 16,700 |
| 1956 | 163,766 |
| 1957 | 25,268 |
| 1958 | 598,535 |
| 1959 | 23,912 |
| 1960 | 50,771 |
| 1961 | 26,812 |
| 1962 | 215,689 |
| 1963 | 71,037 |
| 1964 | 292,423 |
| 1965 | 76,975 |
| 1966 | 1,336,551 |
| 1967 | 87,203 |
| 1968 | 936,857 |
| 1969 | 48,799 |
| 1970 | 332,127 |
| 1971 | 99,689 |
| 1972 | 316,386 |
| 1973 | 52,730 |
| 1974 | 121,317 |
| 1975 | 63,784 |
| 1976 | 6,467 |
| 1977 | 109,706 |

| | | |
|---|---|---|
| 1960 | - | Poor escapement, commercial fishery curtailed |
| 1962 | - | Water gauging station installed |
| | - | Poor escapement - no commercial fishery |
| 1964 | - | Poor escapement - no commercial fishery |
| 1964-70 | - | Counting fence and tower operational (even years) |
| 1965-71 | - | Enumeration of downstream migrating fry (odd years) |
| 1972 | - | Poor escapement - no commercial fishery |
| 1974-80 | - | Commercial fishery curtailed |
| 1980 | - | Masset Inlet pre-fertilization study of odd year pink fry (Beak Consultants Limited) |

Limited commercial fishing effort and complete closures have been employed annually in an attempt to conserve both odd and even year stocks.

Pinks begin to enter the Yakoun River in early August, with spawning populations peaking in early September. High density spawning occurs as far as 26 mi upstream from the estuary. Spawning intensity is greatest in a 13 mi stretch commencing at and downstream from the mouth of Gold Creek. In this area, an estimated 325,000 square yards of pink spawning gravel occurs, which would provide optimum spawning capacity for 650,000 fish based on 1 female/square yard (Walker, 1965). Lowest frequency spawning occurs in the lower 13.5 mi where the Yakoun River is characterized by extensive pools. During years of extreme low flows, however, pinks are known to spawn in the lower reaches of the river, often within tidal influence.

Pinks spawners have been observed throughout the mainstem of the Yakoun River to Yakoun Lake and in several tributaries including Phantom, Ghost, King, Gold, and Florence Creeks.

Sockeye

Sockeye salmon escapement to the Yakoun River from 1947-79 has ranged from a maximum of 25,000 (1970) to a minimum of 750 (1957). The mean population for recorded years is 8,583.

Sockeye enter the Yakoun River in early May and ascend upstream to spawning grounds located at the Yakoun Lake outlet (Delta and Sandstone Creeks), and Phantom Creek. Emerging juveniles move into Yakoun Lake to rear an additional year prior to migration downstream as smolts. Sockeye also ascend Gold Creek to spawn, with rearing taking place in Marie Lake.

An annual Indian food fishery harvested between 731 (1976) and 13,000 (1970) sockeye salmon respectively for recorded years.

Native Fishery

| Year | # Permits Issued | % Used | Sockeye |
|---|---|---|---|
| 1978 | 28 | - | 1,122 |
| 1977 | 34 | 33 | 1,378 |
| 1976 | 24 | - | 731 |
| 1975 | 52 | 31 | 1950 |
| 1974 | 50 | - | 1,830 |
| 1973 | - | - | 5,400 |
| 1972 | 61 (IA) | - | 6,198 |
| 1971 | 38 (IA) | - | 4,700 |
| 1970 | 36 | - | 13,000 |

Due to the relatively low annual return to the Yakoun River, commercial fishing in Naden Harbor, Masset Inlet, and Masset Sound are regulated to conserve sockeye salmon.

Coho

Coho salmon escapement to the Yakoun River has ranged from a maximum of 35,000 (1951) to a minimum of 1,500 (1969). The mean population for recorded years is 8,712. Annual escapements have remained relatively stable since 1970.

Coho poulations arrive at the Yakoun River in mid-August, ascend the river in September, and spawn in October-November. Suitable spawning habitats occur throughout the Yakoun River and its tributaries. Important tributaries for spawning include Canoe, Log, Blackbear, Canyon, Brent, and the Yakoun Lake inlet creeks. Fry emerge from the gravel in late April-May and often move to suitable rearing sites throughout the watershed.

During IEC's May 1980 survey, coho fry were observed in abundance at sampling sites in Florence, Canoe, Gold, and Barbie Creeks, and in several unnamed creeks draining the Consolidated Cinola Mines Ltd. site.

Coho juveniles migrate downstream as fry or remain an additional year prior to migration as smolts.

No commercial fishery restrictions have been implemented to conserve returning adult populations. Angling pressure within the river during the fall migration period is generally increasing annually.

Spring

Spring salmon escapement figures for 1947-79 have ranged from a maximum of 15,000 (1965) to a minimum of 400 (1979). The mean population for recorded years is 2,318. Spring populations have been declining in recent years, resulting in angling closures within the river (1971 closed in October). In 1980, the Yakoun River will be closed 14 June-31 October to all sportfishing for spring salmon.

The spring migration begins in August in the Yakoun River, with peak spawning occurring in September. Spring salmon prefer to spawn in the mainstem of the river between Mile 18 and 23. Rearing has been observed in the main river (outlet of Yakoun Lake) and Phantom Creek.

In an attempt to improve declining spring salmon populations, a salmonid enhancement facility was constructed at King Creek in 1979. Brood stock was captured from the Yakoun River by the Masset tribe, with 80,000 fertilized eggs placed in incubation boxes (Colin Masson, pers. comm.). This facility will be expanded in 1980 to incubate 200,000 eggs. Fry began emerging in late April. Pen rearing of juveniles in Marie Lake is currently being considered, with final release in the spring of 1981.

## Chum

Chum salmon spawners have not been observed in the Yakoun River since 1965, when 25 were recorded. The last reported chum salmon in the Yakoun River were 7,707 downstream migrating fry that were collected during the 1967 pink enumeration study. Although many other rivers in Masset Inlet are good chum producers, the Yakoun River has historically provided low returns. The Masset Indian band are currently considering the suitability of small streams draining into Masset Inlet for chum enhancement, using gravity fed incubation boxes.

## Steelhead Trout

The Yakoun River is the premier steelhead producing river on the Queen Charlotte Islands. Annual spawning escapement estimates presented in Table 4.5.4.1 have been documented since 1966. Steelhead populations have ranged from a maximum of 15,000 (1965, 1966) to a minimum of 1,000 (1979). The mean population for recorded years is 5,400.

Relatively stable populations of 5,000-10,000 during the period 1969-73 have shown a steady decline in recent years. Due to this trend, Chudyk (1975), from the British Columbia Fish and Wildlife Branch, Victoria, summarized angler-catch data (Table 4.5.4.3) for the years 1966-74 and conducted an angling survey of the upper Yakoun River. Increased fishing effort to 1972-73 by anglers generally increased total steelhead captured; however, the angler success ratio declined to its lowest point in 1973-74.

A fishing closure between 1 August and 30 April was introduced in 1973-74 from the Charlotte bridge to Yakoun Lake in an attempt to conserve the dwindling stocks. This regulated closure has been in effect annually through 1980-81 (Ministry of Environment Sportfishing Regulations).

The Yakoun River creel census data presented in Table 4.5.4.4 was collected by Eccles (1978). In 22 censused days, 88 anglers caught eleven steelhead. The average steelhead catch/angler day was 0.125, as compared to 0.337 from the 1976/77 steelhead harvest analysis statistics.

## Table 4.5.4.3

## Angler Catch Statistics[1]

### YAKOUN RIVER

| YEAR | ANGLER DISTRIBUTION | | | | STEELHEAD DISTRIBUTION | | | |
|---|---|---|---|---|---|---|---|---|
| 66-67 | Resident Canadian | Non-Resident Canadian | Non-Resident | TOTAL | Resident Canadian | Non-Resident Canadian | Non-Resident | TOTAL |
| 66-67 | 72 | | 3 | 75 | 353 | | | 353 |
| 67-68 | 121 | | | 121 | 383 | | | 383 |
| 68-69 | 83 | | | 83 | 290 | | | 290 |
| 69-70 | 169 | | 7 | 176 | 790 | | 3 | 793 |
| 70-71 | 237 | | 1 | 238 | 520 | | 3 | 528 |
| 71-72 | 286 | | 7 | 293 | 869 | | 19 | 888 |
| 72-73 | 316 | 3 | 5 | 324 | 884 | | | 884 |
| 73-74 | 301 | | 6 | 307 | 633 | | | 633 |

| YEAR | ANGLER SUCCESS RATIO |
|---|---|
| 66-67 | 4.71 |
| 67-68 | 3.17 |
| 68-69 | 3.49 |
| 69-70 | 4.51 |
| 70-71 | 2.22 |
| 71-72 | 3.03 |
| 72-73 | 3.73 |
| 73-74 | 2.06 |

[1]Data obtained from K. Moore, Ministry of Environment, Queen Charlotte City.

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Table 4.5.4.4

Yakoun River Creel Census
(15 October 1977 - 23 February 1978)[1]

STEELHEAD CATCH FROM YAKOUN RIVER DURING CREEL CENSUS

| Fish No. | Date | Angler Origin | Locality | Sex | Weight |
|---|---|---|---|---|---|
| 1 | 27 Nov | Juskatla | Condemned Bridge | F | 11 |
| 2 | 28 Nov | Juskatla | Coffee Hole | - | — |
| 3 | 28 Nov | QCC | Condemned Bridge | M | — |
| 4 | 2 Dec | Juskatla | Alder Patch | F | — |
| 5 | 3 Dec | Juskatla | Alder Patch | - | — |
| 6 | 3 Dec | Wash. | Mouth of Gold | M | 12 |
| 7 | 4 Dec | Juskatla | Alder Patch | F | 14 |
| 8 | 4 Dec | Juskatla | Alder Patch | F | 14 |
| 9 | 29 Jan | Port Clements | Bridge 47 | - | — |
| 10 | 5 Feb | Juskatla | Bar Run | F | 10 |
| 11 | 5 Feb | Juskatla | Bar Run | F | 11 |

ANGLER ORIGIN AND STEELHEAD CATCH/ANGLER DAY
FROM YAKOUN RIVER CREEL CENSUS

| Angler Origin | No. of Angler Days | No. of Fish Caught | Catch Per Angler Day |
|---|---|---|---|
| Juskatla | 24 | 8 | 0.333 |
| Port Clements | 8 | 1 | 0.125 |
| Masset | 17 | — | — |
| QCC | 24 | 1 | 0.042 |
| Sandspit | 4 | — | — |
| Prince Rupert | 2 | — | — |
| Vancouver | 4 | — | — |
| Vancouver Island | 3 | — | — |
| USA - Washington | 2 | 1 | 0.500 |
| | 88 | 11 | 0.125 |

1 Data obtained from K. Moore, Ministry of Environment, QCC.
Census conducted by Brian Eccles

Steelhead ascend the Yakoun River in late November to spawn from the Branch 40 area upstream to Yakoun Lake. Spawning takes place intermittently throughout the system, with heavier spawning occurring above the Charlotte bridge. Some spawning has been observed in Ghost, Gold, Phantom and the Yakoun Lake feeder creeks. Ghost, Phantom, and Brent Creeks have been described as excellent steelhead rearing habitats (Chudyk, 1975; Bustard, 1974; Pollard, 1979).

Cutthroat Trout

Resident and anadromous cutthroat trout are common throughout the Yakoun River system. Several cutthroat trout were captured during an IEC trapping survey in May 1980 in Gold and Florence Creeks. Cutthroat were also captured near the plateau and in the swamp located on the Consolidated Cinola Mines Ltd. property.

The larger sea run cutthroat move short distances to sea or remain near the estuary, moving into the river in the spring during fry migration. Sea run cutthroat are abundant in the lower Yakoun River in May and June. Adults return to small gravelly streams in late autumn or early winter and may spawn from February to May.

Rainbow Trout and Dolly Varden Char

Rainbow trout and Dolly Varden char are resident species that are widely distributed throughout the Yakoun River system. Dolly Varden char appear to be more abundant, often found in tributaries draining through previously logged areas.

IEC captured Dolly Varden char during a trapping survey in May 1980 in Florence, Canoe, Gold, and Barbie Creeks as well as in several unnamed creeks in the vicinity of the Consolidated Cinola Mines Ltd. property.

## 4.6 Groundwater

There are no known accounts of groundwater hydrology that are relevant to the Cinola study area. The following discussion is derived from information collected by IEC during a site visit of the property in April 1980, including a review of available data on surficial and bedrock geology, a review of driller's records (D.W. Coates Enterprises Ltd., Richmond, B.C.), and discussions with mine exploration and development geologists and engineers.

### 4.6.1 Quantity

There is no evidence of groundwater seepage from rock outcrops on the property. A high percentage (greater than 80%)of the precipitation is intercepted by the vegetation, while the remainder moves downslope very quickly, either over the ground or through the duff soil layer. There is apparently little infiltration into fracture systems in the bedrock. Bedrock in the potential mine area above the valley floor has very low permeability. In lower areas, swamps hold large quantities of surface runoff before draining through tributaries to the Yakoun River. Again in these areas, the surface water does not drain into the subsurface, due to either cohesion silts and/or impermeable bedrock. In summary, groundwater flow is fast, shallow, and with little opportunity for mineralization to take place.

Due to low bedrock permeability and the absence of seepage in the mine area, groundwater quantity should be low and should not cause any disposal problems.

### 4.6.2 Quality

Surface water geochemistry indicates possible high values of arsenic and mercury, which will also be present in the groundwater. Fractures in core at depth are stained with limonite, indicating a high iron content. Pyrite mineralization associated with argillaceous host rock is an indicatation of high $NaSO_4$ content.

Due to the composition of host rock and soils in the study area, groundwater quality may present some problems. Further studies will be required.

## 4.7 Soils and Surficial Geology

No published information on landforms, surficial geology, or soils for the Cinola study area was located. IEC initiated a survey in April 1980 with the following terms of reference, to complete the data base:

- to identify distribution of surficial materials and landforms, and to classify them according to the Environmental Land Use Commision (ELUC) Secretariat's System of Classification (1976);
- to identify special areas such as muskeg, swamps, bedrock outcrops, and suitable granular areas, and to identify unstable areas such as land slide and avalanche areas, soft soils, and areas of seepage;
- to determine in a preliminary fashion suitable locations for the tailings disposal area and to relate the seepage characteristics of the probable tailings disposal effluent to the underlying material.

### 4.7.1 Landforms

The surficial deposits surrounding the Cinola study area were mapped by IEC according to the ELUC Secretariat's System of Classification . This data is summarized in Figure 4.7.1.1 using the classification outlined in Table 4.7.1.1. Initial air photo identification was verified through a ground inspection via helicopter and truck. Two samples were collected and general field characteristics of the materials were identified.

The dominant surficial deposits were glacial till (M) and fluvial material (F), with minor amounts of colluvium (C) and organic materials (O). Organic materials were generally less than 1 - 2 m in thickness and tended to cover most surficial deposits where local relief is less than 2 m.

Glacial till (M) consists of a heterogeneous assortment of clay to boulders deposited directly from melting glacial ice. It occupies positions on flanks of mountains and lowlands, and varies from 1 to greater than 5 m in thickness. The glacial till in this area

## Table 4.7.[illegible]

## Terrain Analyses of Consolidated Cinola Mines Ltd., Q.C.I., British Columbia

| Texture | | Genetic Materials | | Topography Surface Expression | | Modifying Erosion | |
|---|---|---|---|---|---|---|---|
| | sCv-V | | sCb-V | | sCb-V | | sCb-V |
| b | bouldery | C | Colluvial | a | apron | A | avalanched |
| s | sandy | F | Fluvial | b | blanket (greater than 1 m) | F | failing |
| s | silty | M | Morainal | f | fan | V | gullied |
| c | clayey | O | Organic | h | hummocky | E | channeled |
| r | rubbly | R | Bedrock | l | level (slopes less than 5°) | | |
| | | | | m | subdued | | |
| | | | | r | ridged (slopes 10-35°) | | |
| | | | | t | terraced | | |
| | | | | v | veneer (less than 1 m) | | |

can use two texture classes: sMl

C//MC C is 66%, M = 34%

$F^A$ active failing slope, $F^I$ is inactive

$\frac{rCb}{Ml}$ one overlies the other

Scale 1:50,000

June 1980

3073.2

is ground moraine and is composed of comminuted fragments of volcanic rock, with minor amounts of granitic material, conglomerates, and sandstones. The matrix of the collected soil samples is fine grained and consists of up to 70% silt and sand size particles (Figure 4.7.1.2).

Fluvial materials (F) refer to materials transported and deposited by streams and rivers. It is synonymous with the term alluvial and generally consists of sand and gravel, with minor amounts of silt and boulder size material. These sediments are commonly moderate to well sorted, displaying stratification. Although some of the sand and gravel sediments show clear evidence of having been deposited by glacial melt waters along the Yakoun River and in apices of creeks, no attempt was made to subdivide these fluvial deposits from those deposited by modern rivers. The sediments of the Yakoun River and its tributaries range from sand to gravel, with minor silt size material. Most alluvial fans (Ff) consist of silt to rubble size material and can be used as subbase for road fill. South of the Masset Inlet between Florence Creek and the Yakoun River are gravelly sand deposits several metres in thickness.

Colluvium (C) consists of materials transported downslope by the force of gravity. As a result, colluvium can consist of materials derived from both the underlying bedrock and the surficial deposits. In the study area, colluvium varies from 1 m to several metres in thickness with an average thickness of less than 1 m. Several deposits of colluvium have geological processes that are modifying their surface expressions.

As one goes southward along the Yakoun River the gravelly sands grade to sand and gravel deposits of commercial quality. Most fluvial deposits within the area are covered by veneer of organic materials (O) which range from silt to organic peat. This veneer of organic materials ranges in thickness up to 2 m, but averages less than 1 m in thickness along the extended flood plain of the Yakoun River and its tributaries.

Failing slopes (-F) are characterized by the formation of tension cracks or by large consolidated or unconsolidated masses moving slowly downslope (ELUC, 1976). In the study area, failing slopes are located in several areas. Most of these failures are small and involve masses of soil and rock that are moving downslope at a slow pace. About 5 km north of Marie Lake on the

FILE ____________

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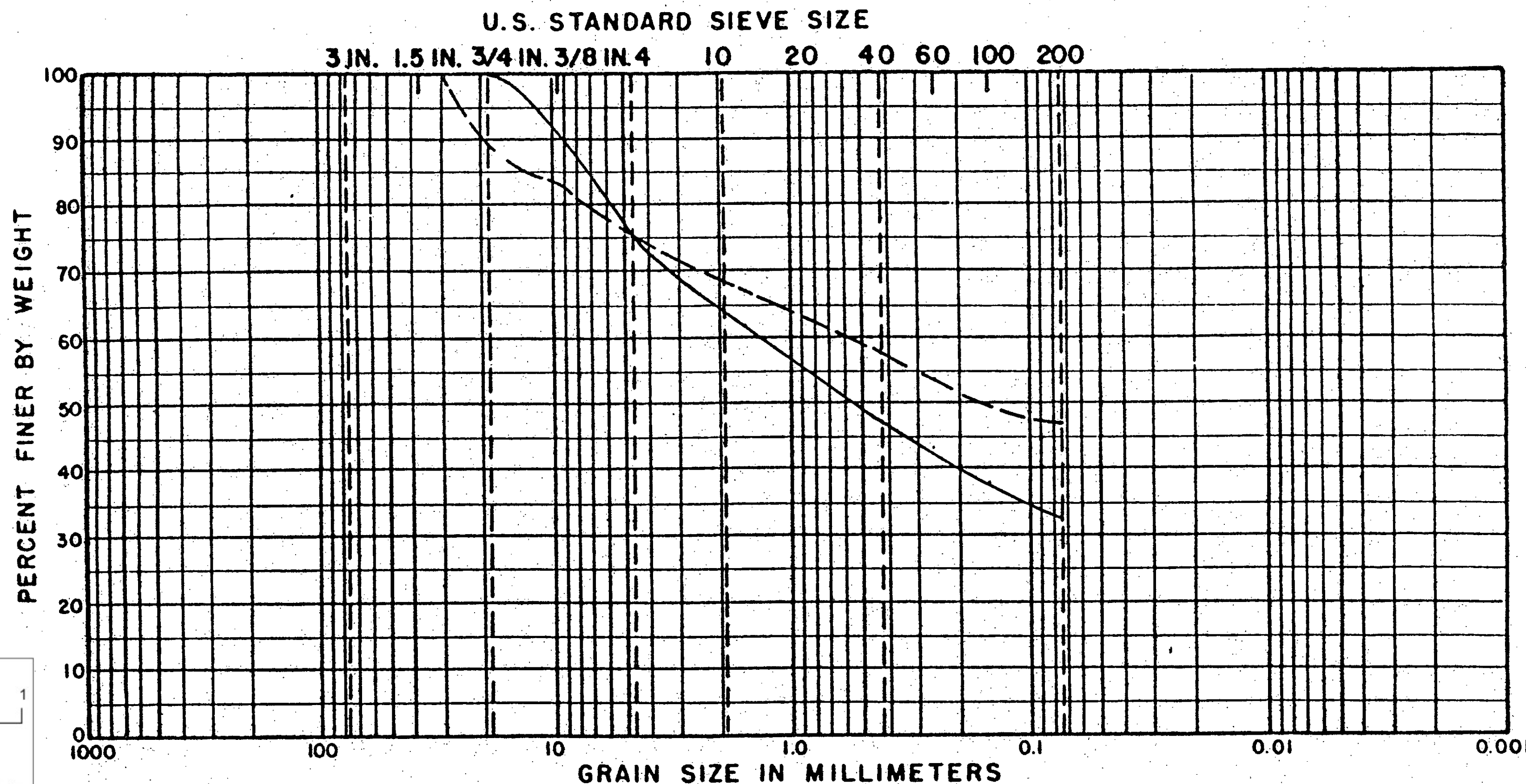



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| | DEPTH | CLASSIFICATION | | NAT. WC | LL | PL | PI | |
|---|---|---|---|---|---|---|---|---|
| ———— | MS-1 | GM | Gravelly sand & silt | | | | | Gray till |
| — — — | MS-2 | GM | Gravelly silt & sand | | | | | Brown till |



Figure 4.7.1.2

# GRADATION CURVE

east side of the road in an area that was logged several years ago, large masses of soil and rock are failing. Along the Branch 42 access road leading to the Consolidated Cinola Mines Ltd. core shack and office are four major slides. Three of the slides begin above the road and extend down to the muskeg materials below. The fourth slide begins at the road level and works down to the base of the hill. Most of the slides are extremely active and will continue to slide or unravel down the slope. Elsewhere, most of the movement on slopes is by soil creep.

Most steep rock slopes in the area are being modified by soil creep. Avalanched areas were not observed within the area.

Organic (O) sediments consist of inorganic silt to fibrous and peaty deposits. In the flood plain along the Yakoun River and its tributaries, organic sediments up to 2 m in thickness overlie flood plain deposits of sand and gravel. Elsewhere, on uplands and in low lying areas, organic sediments consisting of undecomposed organic matter rest on glacial till.

### 4.7.2 Depth to Bedrock

A depth of surficial deposits in the study area is incorporated into the terrain classification (ELUC 1976). In this classification, the lower case letter following the materials category describes whether the materials consist of a veneer or blanket (rCv) or (rCb). Generally, a veneer consists of materials less than 1 m in thickness and a blanket of greater than one metre in thickness. The glacial till ranges in thickness from 1 - 5 m in the lowlands but generally averages less than 2 m in thickness above the 200 m contour.

East of the Yakoun River and west of Tlell River, glacial till ranges from silt to gravel size material and is probably less than 5 m in thickness.

Fluvial materials range in thickness to over five metres. There are individual areas, such as near the proposed millsite on the edges of the plateau where the sand and gravel varies in thickness to over 10 m. Colluvium is generally not greater than 1 m in thickness on flanks of mountains but can reach thicknesses of at least 50 m near the base, especially in the area that is several kilometres north of Marie Lake.

### 4.7.3 Considerations for Site Selection of the Tailing Disposal Area

An estimated area about 1,500 $m^2$ is required to provide storage for tailing disposal for 25 years. Four preliminary sites were identified for tailing disposal: The Yakoun site situated west of the Yakoun River and east of the Tlell River; the Serpent site immediately east of the mine site and a possible extension to the north; and the Canoe and Florence Creek site a few km north of the proposed mill (superimposed on Figure 4.7.1.1).

The Yakoun Site

This site, located about 1/2 km east of the Yakoun River and north of Black Bear Creek, is situated on hummocky ground with small muskeg deposits. The underlying material consists of an organic blanket 1 - 2 m in thickness overlying glacial moraine, which ranges from silt to boulders. Although no ground truthing was conducted in this area, the centre of the muskeg appears to be raised above the surface of the surrounding countryside. This might be an optical illusion, but it is possible that the grasses are acting like semi-palsas. It is thought that the occasional ridge, which crosses this area consists of bedrock. It is suspected that bedrock fractures within this area may extend 5 - 10 m in depth. If a tailing pond were to be constructed in this area, the muskeg and underlying material would have to be partially stripped below the dyke in order to make certain that any leakage that does occur is controlled. Although stream patterns are difficult to decipher because of the dense foliage, the stream pattern in this area appears to be of a radial fashion.

The Serpent Site (and possible northern extension)

This possible tailing disposal site, located about 1 km northeast of the proposed plant site, is situated between major drainages that drain into the Yakoun River. The surface soils consist of a veneer of organic material less than 1 - 2 m in thickness overlying glacial moraine, which ranges from silt to boulders. Similar to the Yakoun site, the muskeg of the serpent shaped swamp appears to be raised approximately 1 m above the surrounding surface. Streams in this area are well channelled, with relatively wide valleys. Eastward from the Serpent site are a series of very small channels which drain into the Yakoun River. These channels arise about 2 km west of the Yakoun River near the edges of the proposed Serpent site tailing pond.

The extension site to the north is located between two major stream channels and is similar to the former sites in that a thin veneer of muskeg rests on glacial till.

The Canoe Creek Site

This site is located immediately east of Canoe Creek and 3 1/2 km north of the proposed millsite. Drainage in this area appears to be limited to Canoe and Barbie Creeks immediately east. Although muskeg is rare in this area, there is about 1/2 m of organic material overlying glacial till which ranges from silt to boulders in composition. The southern portion of the dyke could be founded on bedrock that occurs in this area.

The Florence Creek Site

This site lies about 1 km west of the Canoe Creek site and about 4 km north of the proposed millsite. It is located between Florence and Canoe Creeks. The Florence site is similar to the others in that organic material less than 2 m thick overlies glacial till, which ranges from silt to boulders. This site, unlike all others, appears to have drainage directed mainly towards the center. Interception ditches could be constructed to divert runoff from large rain storms into Florence Creek, which has a direct outlet into Yakoun Bay, bypassing the Yakoun River.

## 4.8 Vegetation

The Queen Charlotte Islands are within the Coastal Western Hemlock (CWH) Biogeoclimate Zone (Krajina, 1969). This is the wettest zone in British Columbia and is characterized by mild winters and cool summers. These conditions are conducive to the highest production of several coniferous trees. Western hemlock (Tsuga heterophylla), Sitka spruce (Picea sitchensis), western redcedar (Thuja plicata), lodgepole pine (Pinus contorta), and red alder (Alnus rubra) are major components of the lower elevation forests. At higher elevations and along the flanks of mountain ranges, the former species are complemented by yellow cedar (Chamaecyparis nootkatensis), mountain hemlock (Tsuga mertensiana), western yew (Taxis brevifolia), and Sitka alder (Alnus sinuata). Some common coastal species such as Pacific silver fir (Abies amabilis), alpine fir (A. lasiocarpa), and cottonwood (Populus balsamifera) are absent.

Twenty forest vegetation types and 15 nonforest types grouped in five land types were described by Orloci (1965) for the CWH zone in southwestern B.C. The major plant associations and land types that may be present in the Queen Charlotte Islands are listed in Table 4.8-1. Nomenclature is after Hitchcock and Cronquist (1973).

Plant communities of the Queen Charlotte Islands have been described in a broader classification system, although in greater detail than Orloci (1965), by Calder and Taylor (1968) in the work Flora of the Queen Charlotte Islands. The authors describe the bog, swamp, and forest communities that occur within the Cinola study area. These communities have been listed in Tables 4.8.2 and 4.8.3, and their general distribution in the study area mapped in Figure 4.8.1. This map has been derived from forest cover maps produced by MacMillan Bloedel Limited and from air photo interpretation based on recent (1979) aerial photography.

Bogs are distinguished from swamps primarily on the basis of the presence of scrub coniferous growth in the bogs. These are generally lowland communities, except blanket bogs, which may occur at any elevation.

Meadow forest communities are found on alluvial flats and terraces beside rivers and creeks. The largest conifers occur here. The understory is open with a semi-canopy.

## Table 4.8.1

## Plant Associations of the Coastal Western Hemlock Zone*
(adapted from Orloci, 1965)

A. Glacial Drift Land Type

1. Western Hemlock Association:

- occurs on mesic soils of middle slopes, or alluvial terraces with fine, deep, well-drained soil;
- is dominated by western hemlock, occasionally western redcedar; and
- Dull Oregon-grape (Mahonia nervosa) abundant in understory.

2. Sword-fern - Western Redcedar Association:

- occurs on moist to wet soils on concave lower slopes usually with permanent seepage;
- is dominated by western redcedar, often with western hemlock; and
- sword fern (Polystichum spp.) is abundant in understory.

3. Salal - Westen Hemlock Association:

- occurs on dry, shallow soils of convex upper slopes;
- is of low productivity;
- is dominated by western hemlock, often with western redcedar and occasionally yellow cedar;
- Salal (Gautheria shallon) and Alaskan blueberry (Vaccinium alaskaense) are predominant understory components.

4. Deer Fern - Western Hemlock Association:

- occurs on wet, concave lower slopes with much seepage and gleyed podzol soils with thick raw humus;
- is of high productivity;
- is dominated by western hemlock; and
- Alaskan blueberry and deer fern (Blechnum spicant) are abundant in understory.

* Associations not endemic to the Queen Charlotte Islands have been omitted.

## Table 4.8.1 (cont'd)

B. Spring Water Swamp, Ravine Land Type

1. Vaccinium - Skunk Cabbage Association:

- occurs on saturated black-muck soils on slope bases or depressions;
- is dominated by western redcedar and western hemlock; and
- is characterized by Vaccinium alsaskaense and American skunk cabbage (Lysichitum americanum) in understory.

2. Skunk Cabbage - Coptis Association:

- occurs on saturated woody peat soils at the margins of high moors;
- is dominated by western hemlock, occasionally with lodgepole pine; and
- is characterized by Vaccinium alsaskaense, stink currant (Ribes bracteosum), and Goldthread (Coptis spp.) in understory.

3. Devil's Club - Redcedar Association:

- occurs along permanent or semi-permanent creek banks in stream-worn ravines;
- is dominated by western redcedar and western hemlock; and
- is characterized by Vaccinium alaskaense and Devil's Club (Oplopanax horridus) in understory.

C. Alluvial Plain Land Type

1. Devil's Club - Sitka Spruce Association:

- occurs on high alluvial benches with deep, fine-textured soils;
- is dominated by Sitka spruce, occasionally red alder (Alnus rubra); and
- is characterized by stink currant (Ribes bracteosum) and braun sword fern (Polystichum braunii ssp. andersonii).

2. Snowberry - Sitka Spruce Association:

- occurs on high alluvial benches with fine-textured soils over gravel;
- is dominated by Sitka spruce, occasionally red alder; and
- is characterized by common snowberry (Symphoricarpos albus) in understory.

## Table 4.8.2

## List of Vascular Plant Species of Bog and Swamp Communities of the Queen Charlotte Islands

(after Calder and Taylor, 1968)

| Species* | Common Name* | Habitats** |
|---|---|---|
| PTERIDOPHYTA | | |
| Equisetaceae - Horsetail Family | | |
| Equisetum variegatum | Northern Scouring-rush | BB |
| Lycopodiaceae - Club Moss Family | | |
| Lycopodium annotinum | Stiff Club Moss | BR |
| Lycopodiella inundata | Bog Club Moss | SW |
| Selaginellaceae - Selaginella Family | | |
| Selaginella selaginoides | Mountain Moss | BR |
| Blechnaceae - Deer Fern Family | | |
| Blechnum spicant | Deer Fern | BB |
| PINOPHYTA | | |
| Taxaceae - Yew Family | | |
| Taxus brevifolia | Western Yew | BB |
| Pinaceae - Pine Family | | |
| Pinus contorta | Lodgepole Pine | BR,BB |
| Tsuga heterophylla | Western Hemlock | BB |
| Cupressaceae - Cypress Family | | |
| Chamaecyparis nootkatensis | Yellow Cedar | BB |
| Juniperis communis | Ground Juniper | BR,BB |
| Thuja plicata | Western Redcedar | BR,BB |
| MAGNOLIOPHYTA | | |
| Monocotyledoneae | | |
| Sparganiaceae - Bur Reed Family | | |
| Sparganium hyperboreum | Northern Bur Reed | BB |
| S. emersum var. angustifolium | Narrow-leaved Bur Reed | SW |
| Potamogeton aceae - Pondweed Family | | |
| Potamogeton natans | Floating-leaved Pondweed | SW,BB |
| P. spp. | Pondweed spp. | SW |
| Juncaginaceae - Arrow Grass Family | | |
| Triglochin palustrie | Marsh Arrow Grass | BB |

## Table 4.8.2 (cont'd)

| Species* | Common Name* | Habitats** |
|---|---|---|
| Poaceae - Grass Family | | |
| Agrostis aequivalvis | Alaska Bent Grass | BR,BB |
| Calamagrostis caespitosa | Reed Grass (?) | BR |
| C. crassiglumis | Thurber's Small Reed Grass | SD |
| C. nutkaensis | Pacific Small Reed Grass | SD |
| Torreyochloa pauciflora var. pauciflora | Weak False Manna | SW |
| Cyperaceae - Sedge Family | | |
| Carex canescens | Hoary Sedge | SW,M |
| C. leptalea | Bristle-stalked Sedge | BB |
| C. livida | Pale Sedge | BR,BB |
| C. obnupta | Slough Sedge | SDM,BR,BB |
| C. oederi | Green Sedge | BB |
| C. pauciflora | Few-flowered Sedge | BR |
| C. phyllamanica | Coastal Stellate Sedge | SW,BR |
| C. pluriflora | Many-flowered Sedge | M,BR |
| C. saxatilis | Russet Sedge | BB |
| C. sitchensis | Sitka Sedge | S,D,M |
| C. stylosa | Long-styled Sedge | M |
| C. vesicaria | Inflated Sedge | SW |
| Eriophorum angustifolium | Narrow-leaved Cotton Grass | BB |
| E. chamissonis | Chamisso's Cotton Grass | SW,BR |
| Rhynehospora alba | White-topped Beak-rush | BB |
| Scirpus lacustris ssp. glaucus | Great Viscid Bulrush | SW |
| Trichophorum cespitasum | Tufted Deer Grass | BB |
| Juncaceae - Rush Family | | |
| Juncus ensifolius | Sword-leaved Rush | BB |
| J. falcartus | Sickle-leaved Rush | SD,BB |
| J. oreganus | (?) Rush | SW,BB |
| Luzula multiflora | Many-flowered Wood Rush | BB |
| Liliceae - Lily Family | | |
| Tofieldia glutinosa | Sticky False Asphodel | BB |
| Veratrum viride ssp. eschscholtzii | Green False Hellebore | BB |
| Orchidaceae - Orchid Family | | |
| Plantanthera chorisiana | Chamisso's Rein Orchid | BB |
| P. dilatata | Fragrant White Rein Orchid | M |
| P. stricta | Slender Rein Orchid | BR |
| Spiranthes romanzoffiana | Hooded Ladie'-tresses | SW |
| Dicotyledoneae | | |
| Salisaceae - Willow Family | | |
| Salix spp. | Willow spp. | SD |
| S. scouleriana | Scouler's Willow | SW |

## Table 4.8.2 (cont'd)

| Species* | Common Name* | Habitats** |
|---|---|---|
| Myricaceae - Bayberry Family | | |
| Myrica gale | Sweet Gale | BB |
| Betulaceae - Birch Family | | |
| Alnus viridis ssp. sinuata | Sitka Mountain Alder | SD,BB |
| Nymphaeaceae - Water-lily Family | | |
| Nuphar lutea ssp. polysepala | Yellow Pond-lily | BR,BB |
| Ranunculaceae - Buttercup Family | | |
| Coptis asplenifolia | Spleenwort-leaved Goldthread | BR,BB |
| C. trifolia | Three-leaved Goldthread | BR |
| Ranunculus flammula | Lesser Spear-leaved Buttercup | SW,SD,BB |
| R. hyperboreus | Far-northern Buttercup | SW |
| Droseraceae - Sundew Family | | |
| Drosera rotundifolia | Round-leaved Sundew | SW,BR |
| Rosaceae - Rose Family | | |
| Geum calthifolium | Caltha-leaved Avens | BB |
| Luetkea pectinata | Luetkea | BB |
| Malus fusca | Pacific Crab Apple | SW,SM,M |
| Rubus chamaemorus | Cloudberry | BR |
| Sanguisorba officinalis | Great Burnet | BR |
| Callitrichaceae - Water Starwort Family | | |
| Callitriche heterophylla | Diverse-leaved Water Starwort | SW |
| Empetraceae - Crowberry Family | | |
| Empetrum nigrum | Black Crowberry | BR,BB |
| Apiaceae - Parsley Family | | |
| Oenanthe sarmentosa | Pacific Oenanthe | SD |
| Cornaceae - Dogwood Family | | |
| Cornus unalaschkensis | Western Cordilleran Bunchberry | BR,BB |
| Ericaceae - Heath Family | | |
| Andromeda polifolia | Bog Rosemary | BR,BB |
| Gaultheria shallon | Salal | BR |
| Kalmia microphylla | Western Swamp Kalmia | BR,BB |
| Ledum groenlandicum | Common Labrador Tea | SW,M,BR,BB |
| Loiseleuria procumbens | Alpine-azalea | BR,BB |
| Vaccinium caespitosum | Dwarf Blueberry | BR,BB |
| V. oxycoccus | Bog Cranberry | BR |
| V. uliginosum | Bog Blueberry | BR,BB |
| V. vitis-idaea | Mountain Cranberry | BR,BB |

## Table 4.8.2 (cont'd)

| Species* | Common Name* | Habitats** |
|---|---|---|
| Primulaceae - Primrose Family | | |
| Dodecatheon jeffreyi | Jeffrey's Shootingstar | SW,BR,BB,M |
| Trientalis europaea | Northern Starflower | BR,BB |
| Gentianaceae - Gentian Family | | |
| Gentiana douglasiana | Swamp Gentian | BR,BB |
| Menyanthaceae - Buckbean Family | | |
| Fauria crista-galli | Deer-cabbage | BR,BB |
| Menyanthes trifoliata | Buckbean | BB |
| Lentibulariaceae - Bladderwort Family | | |
| Pinguicula villosa | Hairy Butterwort | BR |
| P. vulgaris | Common Butterwort | BR |
| Utricularia intermedia | Flat-leaved Bladderwort | SW |
| U. minor | Lesser Bladderwort | SW |
| U. vulgaris | Greater Bladderwort | SW |
| Plantaginaceae - Plantain Family | | |
| Plantago macrocarpa | Alaska Plantain | SD |
| Rubiaceae - Madder Family | | |
| Galinum trifidum | Coastal Small Bedstraw | SW |
| Caprifoliaceae - Honeysuckle Family | | |
| Linnaea borealis | Northern Twinflower | BR |
| Compositae | | |
| Microseris borealis | Apargidium | BB |
| Erigeron perigrinus | Subalpine Fleabane | BB |

* According to Taylor and MacBryde (1977)

| | | | |
|---|---|---|---|
| ** | Swamps | - Wet | SW |
| | | - Dry | SD |
| | Mires | | M |
| | Bogs | - Raised | BR |
| | | - Blanket | BB |

## Table 4.8.3

## List of Vascular Plant Species of Forest Communities of the Queen Charlotte Islands

(after Calder and Taylor, 1968)

| Species* | Common Name* | Habitats** |
|---|---|---|
| PTERIDOPHYTA | | |
| Lycopodiaceae - Club Moss Family | | |
| Lycopodium annotinum | Stiff Club Moss | FC |
| Huperzia selago ssp. chinensis | Fir Club Moss | FC |
| Blechnaceae - Deer Fern Family | | |
| Blechnum spicant | Deer Fern | FC |
| Aspleniaceae - Spleenwort Family | | |
| Dryopteris assimilis | Spiny Shield Fern | FM,FC |
| Gymnocarpium dryopteris | Oak Fern | FM,FC,FL |
| Polystichum braunii | Braun's Holly Fern | FM |
| PINOPHYTA | | |
| Pinaceae - Pine Family | | |
| Picea sitchensis | Sitka Spruce | FM,(FC),FL |
| Tsuga heterophylla | Western Hemlock | (FM),FC,FL |
| Cupressaceae - Cypress Family | | |
| Thuja plicata | Western Redcedar | (FM),(FC),FL |
| MAGNOLIOPHYTA | | |
| Monocotyledoneae | | |
| Poaceae - Grass Family | | |
| Elymus hirsutus | Hairy Wild Rye Grass | FM |
| Festuca rubra | Red Fescue | FM |
| Holcus lanatus | Yorkshire Fog | FL |
| Melica subulata | Alaska Onion Grass | FM |
| Poa annua | Annual Blue Grass | FL |
| Trisetum cernuum | Nodding Trisetum | FM |
| Cyperaceae - Sedge Family | | |
| Carex deweyana ssp. leptopoda | Dewey's Sedge | FM |
| C. laeviculmis | Smooth-stemmed Sedge | FM,FC |
| C. mertensii | Merten's Sedge | FM |
| Araceae - Arum Family | | |
| Lysichiton americanum | American Skunk Cabbage | FC |

## Table 4.8.3 (cont'd)

| Species* | Common Name* | Habitats** |
|---|---|---|
| Juncaceae - Rush Family | | |
| Luzula multiflora | Many-flowered Wood Rush | FL |
| L. parviflora | Small-flowered Wood Rush | FM,FC |
| Liliaceae - Lily Family | | |
| Maianthemum dilatatum | Two-leaved False Solomon's Seal | FC |
| Streptopus amplexifolius | Cucumberroot Twistedstalk | FC |
| S. roseus | Simple-stemmed Twistedstalk | FC |
| S. streptopoides | Small Twistedstalk | FC |
| Veratrum viride | Green False Hellebore | FM |
| Orchidaceae - Orchid Family | | |
| Listera caurina | Northwestern Twayblade | FC |
| L. cordata | Heart-leaved Twayblade | FC |
| Dicotyledoneae | | |
| Betulaceae - Birch Family | | |
| Alnus rubra | Red Alder | (FM),(FC),FL |
| Polygonaceae - Buckwheat Family | | |
| Rumex acetosella | Sheep Sorrel | FL |
| Portulacaceae - Purslane Family | | |
| Claytonia sibirica | Siberian Spring Beauty | FM |
| Caryophyllaceae - Pink Family | | |
| Cerastium fontanum | Common Chickweed | FL |
| Stellaria crispa | Crisp Starwort | FL |
| Ranunculaceae - Buttercup Family | | |
| Coptis asplenifolia | Spleenwort-leaved Goldthread | FC |
| Ranunculus unicinatus | Little-flowered Buttercup | FM |
| Brassicaceae - Mustard Family | | |
| Cardamine angulata | Angled Bitter Cress | FM |
| Saxifragaceae - Saxifrage Family | | |
| Tiarella trifoliata | Trifoliate-leaved Foamflower | FM,FC |
| Grossulariaceae - Currant or Gooseberry Family | | |
| Ribes bracteosum | Stink Currant | FM |
| Rosaceae - Rose Family | | |
| Rubus pedatus | Five-leaved Creeping Raspberry | FC,FL |
| R. spectabilis | Salmonberry | FC |

## Table 4.8.3.(cont'd)

| Species* | Common Name* | Habitats** |
|---|---|---|
| Violaceae - Violet Family | | |
| Viola glabella | Yellow Wood Violet | FM |
| Onagraceae - Evening-primrose Family | | |
| Ciraea alpina | Alpine Enchanter's Nightshade | FM,FC |
| Epilobium glandulosum | Sticky Willowherb | FL |
| Araliaceae - Ginseng Family | | |
| Oplopanax horridus | Devil's Club | FM |
| Apiaceae - Parsley Family | | |
| Osmorhiza purpurea | Purple Sweet Cicely | FM |
| Cornaceae - Dogwood Family | | |
| Cornus sericea | Common Red-osier Dogwood | FM |
| C. unalaschkensis | Western Cordilleran Bunchberry | FC,FL |
| Pyrolaceae - Wintergreen Family | | |
| Moneses uniflora | One-flowered Wintergreen | FC |
| Ericaceae - Heath Family | | |
| Gautheria shallon | Salal | FM,FL |
| Menziesia ferruginea ssp. ferruginea | Rusty Pacific Menziesia | FM,FC |
| Vaccinium alaskaense | Alaskan Blueberry | FC |
| V. ovalifolium | Oval-leaved Blueberry | FM,FC |
| V. parvifolium | Red Huckleberry | FC |
| Scrophulariaceae - Figwort Family | | |
| Digitalis purpurea | Common Foxglove | FL |
| Rubiaceae - Madder Family | | |
| Galium kamtschaticum | Northern Wild Licorice | FC |
| G. triflorum | Sweet-scented Bedstraw | FM,FL |
| Caprifoliaceae - Honeysuckle Family | | |
| Sambucus racemosa ssp. pubens | Coastal American Red Elder | FL |

* According to Taylor and MacBryde (1977)

** Forest - Meadow FM
- Closed FC
- Logged-over FL

Sitka spruce predominates, but western hemlock, red alder, and western redcedar are scattered throughout the community. Herbs are particularly abundant in the understory, or meadow forest communities corresponding to plant associations C1 and C2 in Table 4.8-1.

Closed forest communities occupy the main portion of the lowland forested region on the Queen Charlotte Islands. The canopy is normally dense, with the result that understory shrubs and herbs are sparse. Western hemlock predominates, with minor amounts of western redcedar and Sitka spruce. Red alder occurs along creeks, closed forest communities corresponding to plant communities A1-4 and B1-3 in Table 4.8.1.

Logged-over forest communities occur in varying stages of regeneration and contain a large variety of both native and introduced species. Western hemlock, western redcedar, Sitka spruce, and red alder are dominant trees. The development of redcedar is seriously suppressed by deer browsing. Spruce seedlings are often planted following logging, giving them an artificial advantage.

## 4.9 Wildlife

The terrestrial mammalian fauna of the Queen Charlotte Islands is restricted to about 15 species (Table 4.9.1), of which only 7 are known to be indigenous (Cowan and Guiguet, 1965). Reptiles are absent, and only one species of amphibian (northwestern toad) occurs. Despite the paucity of terrestrial species, many species of bats and of birds have been recorded from the Queen Charlottes.

Species that occur in the study area include Sitka blacktail deer, black bear, blue grouse, and various waterfowl. Elk have been recorded on the upper Yakoun River.

Beaver, muskrat, raccoon, marten, ermine, mink, and river otter may be commercially trapped on the Islands. A trapline in the study area harvests primarily beaver and muskrat.

Deer habitat in the lower Yakoun River watershed has been studied by the B.C. Fish and Wildlife Branch (Hatter and Ingram, 1974). Their report concludes the following:

1. Aspect and elevation are not important, due to the low flat topography of the study area.
2. Deer spend both summer and winter on the same range, due to the mild winters.
3. Transitional forest communities between cedar swamp and closed hemlock-redcedar forest provide the best winter range.
4. Cedar blowdown within the closed forest community provides good winter feeding areas.
5. Cedar swamp provides the best summer range.
6. Redcedar-hemlock forested areas appear to be important only if they are on a slope, possess Vaccinium spp. in the understory, and are adjacent to cedar swamp with salal in the understory.
7. Major browse species are Vaccinium spp., salal, and Sitka spruce.

## Table 4.9.1

## Animals of Consolidated Cinola Mines Study Area

A. Mammals (after Banfield, 1974)

| | |
|---|---|
| INSECTIVORA | |
| *Dusky Shrew | Sorex monticolus |
| Masked Shrew | Sorex cinereus |
| CHIROPTERA | |
| *Silvery-haired Bat | Lasionycteris noctivagans |
| *California Myotis | Myotis californicus |
| *Keen Myotis | Myotis keenii |
| *Little Brown Myotis | Myotis lucifugus |
| *Long-legged Myotis | Myotis volans |
| *Hoary Bat | Lasiurus cinereus |
| RODENTIA | |
| Beaver | Castor canadensis |
| *Deer Mouse | Peromyscus maniculatus |
| Muskrat | Ondatra zibethica |
| Black Rat | Rattus rattus |
| CARNIVORA | |
| *Black Bear | Ursus americanus |
| Raccoon | Procyon lotor |
| *Marten | Martes americana |
| *Ermine/Short-tailed Weasel | Mustela erminea |
| Mink | M. vison |
| *River Otter | Lutra canadensis |
| ARTIODACTYLA | |
| Elk | Cervus canadensis |
| Sitka Blacktail Deer | Odocoileus hemionus sitkensis |
| *Dawson Caribou | Rangifer dawsoni |

*Indigenous species (after Cowan, 1965)
- now extinct from Q.C. Islands

B. Birds (after Godfrey, 1966)

| | |
|---|---|
| GAVIIFORMES | |
| Common Loon | Gavia immer B |
| Yellow-billed Loon | Gavia adamsii |
| Arctic Loon | Gavia arctica |
| Red-throated Loon | Gavia stellata B |

## Table 4.9.1.(cont'd)

| | |
|---|---|
| PODICIPEDIFORMES | |
| Pied-billed Grebe | *Podilymbus podiceps* • |
| Red-necked Grebe | *Podiceps grisegena* |
| Horned Grebe | *Podiceps auritus* |
| Western Grebe | *Aechmophorus occidentalis* |
| PROCELLARIIFORMES | |
| Black-footed Albatross | *Diomedea nigripes* |
| Northern Fulmar | *Fulmaris glacialis* |
| Sooty Shearwater | *Puffinus griseus* |
| Fork-tailed Petrel | *Oceanodroma furcata* B |
| Leach's Petrel | *Oceanodroma leucorhoa* B |
| Pink-footed Shearwater | *Puffinus creatopus* • |
| Flesh-footed Shearwater | *Puffinus carneipes* • |
| PELECANIFORMES | |
| Double-crested Cormorant | *Phalacrocorax auritus* |
| Pelagic Cormorant | *Phalacrocorax pelagicus* B |
| Brandt's Cormorant | *Phalacrocorax penicillatus* • |
| CICONIIFORMES | |
| Great Blue Heron | *Ardea herodias* B |
| Snowy Egret | *Egretta thula* • |
| American Bittern | *Botaurus lentiginosus* • |
| ANSERIFORMES | |
| Whistling Swan | *Olor columbianus* |
| Trumpeter Swan | *Olor buccinator* |
| Canada Goose | *Branta canadensis* B |
| Brant | *Brant bernicia* |
| Emperor Goose | *Philacte canagica* |
| White-fronted Goose | *Anser albifrons* |
| Snow Goose | *Chen caerulescens* |
| Ross's Goose | *Chen rossii* • |
| Mallard | *Anas platyrhynchos* B |
| Gadwall | *Anas strepera* |
| Pintail | *Anas acuta* |
| Green-winged Teal | *Anas crecca* |
| Blue-winged Teal | *Anas discors* |
| Cinnamon Teal | *Anas cyanoptera* • |
| European Wigeon | *Anas penelope* |
| American Wigeon | *Anas americana* |
| Northern Shoveler | *Anas clypeata* |
| Wood Duck | *Aix* sponsa • B |
| Redhead | *Aythya americana* |
| Ring-necked Duck | *Aythya collaris* |

## Table 4.9.1 (cont'd)

| | | |
|---|---|---|
| Canvasback | *Aythya valisineria* | |
| Greater Scaup | *Aythya marila* | |
| Lesser Scaup | *Aythya affinis* | |
| Common Goldeneye | *Bucephala clangula* | |
| Barrow's Goldeneye | *Bucephala islandica* | |
| Bullfehead | *Bucephala albeola* | |
| Oldsquaw | *Clangula hyemalis* | |
| Harlequin Duck | *Histrionicus histrionicus* | B |
| Steller's Eider | *Polysticta stelleri* | |
| Common Eider | *Somateria mollissima* | |
| King Eider | *Somateria spectabilis* | |
| Spectacled Eider | *Somateria fischeri* | |
| White-winged Scoter | *Melanitta deglandi* | |
| Surf Scoter | *Melanitta perspicillata* | |
| Common Scoter | *Melanitta nigra* | |
| Hooded Merganser | *Lophodytes cucullatus* | B |
| Common Merganser | *Mergus merganser* | B |
| Red-breasted Merganser | *Mergus serrator* | |
| Ruddy Duck | *Oxyura jamaicensis* | • |
| **FALCONIFORMES** | | |
| Goshawk | *Accipiter gentilis* | B |
| Sharp-shinned Hawk | *Accipiter striatus* | B |
| Red-tailed Hawk | *Buteo jamaicensis* | B |
| Swainson's Hawk | *Buteo swainsoni* | • |
| Rough-legged Hawk | *Buteo lagopus* | |
| Golden Eagle | *Aquila chrysaetos* | • |
| Bald Eagle | *Haliaeetus leucocephalus* | B |
| Osprey | *Pandion haliaetus* | B |
| Marsh Hawk | *Circus cyaneus* | |
| Gyrfalcon | *Falco rusticolus* | |
| Peregrine Falcon | *Falco peregrinus* | |
| Merlin | *Falco columbarius* | |
| American Kestrel | *Falco sparverius* | |
| **GALLIFORMES** | | |
| Blue Grouse | *Dendragapus obscurus* | B |
| Ring-necked Pheasant | *Phasianus colchicus* | B |
| **GRUIFORMES** | | |
| Sora | *Porzana carolina* | • |
| American Coot | *Fulica americana* | • |
| Sandhill Crane | *Grus canadensis* | B |
| **CHARADRIIFORMES** | | |
| Black Oystercatcher | *Haematopus bachmani* | B |
| Semipalmated Plover | *Charadrius semipalmatus* | B |

## Table 4.9.1 (cont'd)

| | |
|---|---|
| Killdeer | Charadrius vociferus |
| American Golden Plover | Pluvialis dominica |
| Black-bellied Plover | Pluvialis squatarola |
| Surfbird | Aphriza virgata |
| Ruddy Turnstone | Arenaria interpres |
| Black Turnstone | Arenaria melanocephala |
| Common Snipe | Capella gallinago B |
| Whimbrel | Numenius phaeopus |
| Spotted Sandpiper | Actitis macularia B |
| Solitary Sandpiper | Tringa solitaria |
| Greater Yellowlegs | Tringa melanoleuca |
| Lesser Yellowlegs | Tringa flavipes |
| Wandering Tattler | Heteroscelus incanus |
| Red Knot | Calidris canutus |
| Rock Sandpiper | Calidris ptilocnemis |
| Rufous-necked Sandpiper | Calidris ruficollis • |
| Sharp-tailed Sandpiper | Calidris acuminata |
| Pectoral Sandpiper | Calidris melanotos |
| Baird's Sandpiper | Calidris bairdii |
| Least Sandpiper | Calidris minutilla |
| Dunlin | Calidris alpina |
| Semipalmated Sandpiper | Calidris pusilla |
| Western Sandpiper | Calidris mauri |
| Sanderling | Calidris alba |
| Short-billed Dowitcher | Limnodromus griseus |
| Long-billed Dowitcher | Limnodromus scolopaceus |
| Stilt Sandpiper | Micropalama himantopus • |
| Buff-breasted Sandpiper | Tryngites subruficollis • |
| Hudsonian Godwit | Limosa haemastica |
| Marbled Godwit | Limosa fedoa • |
| Red Phalarope | Phalaropus fulicarius |
| Wilson's Phalarope | Steganopus tricolor • |
| Northern Phalarope | Lobipes lobatus |
| Skua | Catharacta skua |
| Pomarine Jaeger | Stercorarius pomarinus |
| Parasitic Jaeger | Stercorarius parasiticus |
| Long-tailed Jaeger | Stercorarius longicaudus |
| Glaucous Gull | Larus hyperboreus |
| Glaucous-winged Gull | Larus glaucescens B |
| Herring Gull | Larus argentatus |
| Thayer's Gull | Larus thayeri |
| California Gull | Larus californicus • |
| Ring-billed Gull | Larus delawarensis • |
| Mew Gull | Larus canus |
| Bonaparte's Gull | Larus philadelphia |
| Black-legged Kittiwake | Rissa tridactyla |
| Sabine's Gull | Xema sabini |
| Arctic Tern | Sterna paradisaea |
| Black Tern | Chlidonias niger • |
| Common Murre | Uria aalge |

## Table 4.9.1 (cont'd)

| | |
|---|---|
| Thick-billed Murre | Uria lomvia |
| Pigeon Guillemot | Cepphus columba |
| Marbled Murrelet | Brachyramphus marmoratus B |
| Ancient Murrelet | Synthliboramphus antiquus B |
| Cassin's Auklet | Ptychoramphus aleuticus B |
| Rhinoceros Auklet | Cerorhinca monocerata B |
| Horned Puffin | Fratercula corniculata |
| Tufted Puffin | Lunda cirrhata B |
| COLUMBIFORMES | |
| Band-tailed Pigeon | Columba fasciata • |
| Mourning Dove | Zenaida macroura • |
| STRIGIFORMES | |
| Great Horned Owl | Bubo Virginianus |
| Snowy Owl | Nyctea scandiaca |
| Hawk Owl | Surnia ulula |
| Great Gray Owl | Strix nebulosa |
| Short-eared Owl | Asio flammeus |
| Boreal Owl | Aegolius gunereus |
| Screech Owl | Otus asio • |
| Pygmy Owl | Glaucidium gnoma • |
| Long-eared Owl | Asio otus • |
| Saw-whet Owl | Aegolius acadicus B |
| CAPRIMULGIFORMES | |
| Common Nighthawk | Chordeiles minor • |
| APODIFORMES | |
| Black Swift | Cypseloides niger |
| Vaux's Swift | Chaetura vauxi |
| Rufous Hummingbird | Selasphorus rufus B |
| CORACIFORMES | |
| Belted Kingfisher | Megaceryle alcyon B |
| PICIFORMES | |
| Common Flicker | Colaptes auratus B |
| Yellow-bellied Sapsucker | Sohyrapicus varius B |
| Hairy Woodpecker | Picoides villosus B |
| PASSERIFORMES | |
| Traill's Flycatcher | Empidonax traillii B |
| Western Flycatcher | Empidonax difficilis B |

## Table 4.9.1 (cont'd)

| | |
|---|---|
| Horned Lark | Eremophila alpestris B (?) |
| Tree Swallow | Iridoprocne bicolor B |
| Barn Swallow | Hirundo rustica B |
| Steller's Jay | Cyanocitta stelleri B |
| Common Raven | Corvus corax B |
| Northwestern Crow | Corvus caurinus B |
| Chestnut-backed Chickadee | Parus rufescens B |
| Red-breasted Nuthatch | Sitta canadensis B |
| Brown Creeper | Certhia familiaris B |
| Dipper | Cinclus mexicanus B |
| Winter Wren | Troglodytes troglodytes B |
| American Robin | Turdus migratorius B |
| Varied Thrush | Ixoreus naevius B |
| Hermit Thrush | Catharus guttatus B |
| Swainson's Thrush | Catharus ustulatus B |
| Golden-crowned Kinglet | Regulus satrapa B |
| Ruby-crowned Kinglet | Regulus calendula B |
| Orange-crowned Warbler | Vermivora celata B |
| Yellow Warbler | Dendroica petechia B (?) |
| Townsend's Warbler | Dendroica townsendi B |
| Wilson's Warbler | Wilsonia pusilla B |
| Pine Grosbeak | Pinicola enucleator B |
| Evening Grosbeak | Hesperiphona vespertina B |
| Pine Siskin | Carduelis pinus B |
| Red Crossbill | Loxia curvirostra B |
| White-winged Crossbill | Loxia leucoptera B (?) |
| Savannah Sparrow | Passerculus sandwichensis B (?) |
| Dark-eyed Junco | Junco hyemalis B |
| Fox Sparrow | Passerella iliaca B |
| Lincoln's Sparrow | Melospiza lincolnii B |
| Song Sparrow | Melospiza melodia B |

• casual, accidental, uncommon, or rare species
B breed on Queen Charlotte Islands
(?) probable breeders

C. Amphibians and Reptiles (after Carl, 1966 and 1968)

ANURA

| | |
|---|---|
| Northwestern Toad | Bufo boreas |

A wildlife observation report from MacMillan Bloedel Limited files gives the following observations of the Yakoun River and estuary:

1. Large flocks of Canada, Lesser Canada and White-fronted geese, pintails, American wigeon, and mallards were seen on Yakoun tidal flats 8 October 1967.

2. Mallards, pintails, American wigeon, and teal, appear to be residents.

3. Geese nests on lower stretches of the Yakoun River.

4. Beaver, muskrat, marten, otter, deer, and bear are present, and elk have been sighted on the upper Yakoun River.

5. The study area is heavily used by deer all year, and by black bear during the salmon run.

A conversation held 23 April 1980 with Mr. Alvin Breitkreutz, Conservation Officer for the B.C. Fish and Wildlife Branch in Queen Charlotte City, revealed that, in general, wildlife populations in the Queen Charlotte Islands are considered to be adequate to meet consumptive and nonconsumptive demands. Little effort, therefore, has been spent to date to inventory populations or to apply intensive management techniques. The study area itself is not noted for above-average hunter utilization.

## 4.10 Land Capability and Use

### 4.10.1 Agriculture

No agricultural use of land presently occurs within the study area. The Consolidated Cinola Mines Ltd. property does, however, overlap with British Columbia Agricultural Land Reserve (ALR) pursuant to the Agricultural Land Commission Act. The boundaries of the ALR are shown on mapsheet 103 F/9 (1:50,000) of the ALR Plan - Skeena-Queen Charlotte Regional District.

Although not presently farmland, lands within the ALR have been deemed to be possibly suitable for the cultivation of some agricultural crops. Agricultural capability of the Cinola area is shown on Agriculture Capability manuscript map 103 F/9 (1:50,000). The present camp, core shack, geology office, and potential test adit and open pit sites are located on C.L.I. Class 7 lands (no agricultural productivity). The limiting factors are slope and adverse climate. The relatively flat lowland areas being considered for a tailings pond, pilot plant, and millsite have a somewhat higher capability of C.L.I. Classes 3 and 4 (reduced range of crops, restricted by a number of limiting subclasses including topography, stoniness, and undesirable soil structure). Organic wetlands, which comprise about 30% of these units, have an unimproved C.L.I. capability rating of Class 5.

### 4.10.2 Forestry

The project area is wholly within Tree Farm Licence (TFL) 39, Block 6, which is owned and managed by MacMillan Bloedel Limited, Queen Charlotte Division. Much of the timber in the vicinity of Cinola lease area has been logged since 1950. MacMillan Bloedel Limited has agreed to log mature timber on the lease area in 1980. Road and harvesting plans are currently being finalized (Keith Hunter, Development Engineer, Queen Charlotte Division, pers. comm.).

### 4.10.3 Recreation

The Canada Land Inventory has not rated the recreational capability of the Queen Charlotte Islands. MacMillan Bloedel Limited has published a Recreation Guide to Queen Charlotte Division - Map 17, which shows the logging roads of TFL 39 and decribes their status (e.g. "open to traffic 24 hours a day" or "escort vehicle required"). The pamphlet invites the public to use the road system for recreational purposes, and emphasizes public safety to avoid conflict with active logging operations and to protect the forest.

Recreational opportunities in the immediate study area are limited primarily to hunting and fishing. Yakoun River deer, bear, grouse, ducks and geese are hunted locally, although this area is not notable in terms of the intensity of hunter use. Boating and canoeing potential exists on the Yakoun River.

The Yakoun River is popular with local sportfishermen for steelhead and cutthroat trout, coho, and spring salmon, as well as nonresident sportfishermen, many of whom utilize fishing guides. The Yakoun River is the primary producer of steelhead on the Queen Charlotte Islands.

#### 4.10.4 Trapping

The study area contains only one registered trapline extending from Branch 40Q bridge downstream along the Yakoun River for 6 km, and west to Florence Creek. The current owner lives in Sardis, B.C. and traps for 3-4 weeks a year. Beaver and muskrat are the principal species trapped in the Yakoun River lowlands, below the Cinola lease area.

#### 4.10.5 Guiding

The study area lies entirely within one big game guiding territory, but the study area is apparently seldom or never used by guided hunting parties (Alvin Breitkreutz, British Columbioa Fish and Wildlife Branch, pers. comm.). Several individuals, including the owner of the big game guiding territory, do, however, take clients fishing on the Yakoun River. It is the "sole source of income" for two or three individuals. The remainder supplement their primary income by guiding. Their clients are generally nonresidents of the Queen Charlotte Islands, and many are foreign sportfishermen.

### 4.11 Historical and Archaeological Sites

No historic sites have been identified in the immediate study area. British Columbia Departmental reference maps R-103 F.NE (W½ and E½) and R-103 F/SE contain no reference to early mineral claims, townsites, district lots, or historic trails. Historic land use tended to be restricted to tidal water shoreline and stream estuaries.

The study area has not been inventoried for heritage resources (Ray Kenny, British Columbia Heritage Conservation Branch, pers. comm). Archaeological site potential occurs along the Masset Inlet shoreline, including the Yakoun River estuary, and along the creek drainages, including the Yakoun River, and Canoe, Barbie, Log, and Blackbear Creeks. The following seven archaeological sites are recorded on Masset Inlet in the vicinity of the Yakoun estuary (from British Columbia Archaeological Sites Maps, Heritage Conservation Branch):

| Site No. | Location | Historic Use |
|---|---|---|
| FkUb 1 | Martin Pt. | Shell midden |
| FkUa 2 | Kumdis Bay | Shell midden |
| FkUb 2 | Port Clements | Scattered artifacts on beach |
| FkUb 3 | Yakoun Bay | Village |
| FkUb 4 | Fraser Island | ? |
| FkUb 5 | Echinus Pt. | ? |
| FjUc 1 | Juskatla Narrows | ? |

The absence of recorded historic and archaeological sites may reflect a lack of inventory effort in the area or a lack of historic land use.

## 4.12 Existing Social Environment

As part of the environmental impact analysis for the Consolidated Cinola Mines Ltd. Stage I Submission, the social and economic impacts of the proposed mine are outlined. To assess the social and economic impacts of the Cinola project, the existing socio-economic situation and expected changes in these circumstances without the project are described, followed by a discussion of the changes that will be induced by establishment of the mine.

The main region of impact discussed in this report is Graham Island, the northernmost of the major Queen Charlotte Islands. In particular, the communities of Port Clements, Masset, Queen Charlotte City, Tlell and Juskatla are discussed, as well as the Native communities of Skidegate Mission and Haida.

### 4.12.1 Regional Economy

The economy of Graham Island is based primarily on resource extraction. Much of the Island is covered with merchantable timber, which is retained for the forest industry within a Provincial forest reserve. Harvesting timber dominates the economy of Graham Island by providing both direct employment and indirect employment in the service sector of the economy.

Commercial fishing is also important to the economy of Graham Island. Salmon, herring, and crab make up the major commercial species.

In addition, gold, silver, coal, and gravel deposits are found on the Island. Much of the gravel is reserved for use by the Ministry of Highways. Most of the known mineral deposits have been mined in the past, however; there is currently no mining activity being carried on. At present, therefore, mineral and gravel deposits do not contribute substantially to the local economy.

Some agricultural activity also takes place on Graham Island, but it is not of great significance to the economy. What agriculture there is consists primarily of small livestock operations. Agricultural potential is limited by the small local market, distance to major markets, climate, drainage, and clearing difficulties. Small quantities of food are grown, which supplement imported food supplies and supplement incomes.

Most of the resources harvested or extracted from the Island are processed elsewhere. The only secondary industries established on Graham Island are a fish processing and canning plant located at Masset and two small sawmills, one located in Queen Charlotte City and the other in Tlell.

The regional economic picture is completed by a service sector that caters to the needs of the residents and industries of the island. Most of the commercial sector is located in Masset and Queen Charlotte City, with limited services available in Port Clements and Juskatla.

Tourism currently does not play a significant role in the service sector of Graham Island, mainly due to poor access to the Island from the mainland. This could change, however, as a result of the proposed tri-weekly ferry service from Prince Rupert to Queen Charlotte City.

### 4.12.2 Population

The population of the Queen Charlotte Islands was 5,510 in 1976, a 26.6% increase over the 1971 population of 4,350. An estimated 80% of the population lives on Graham Island, with the Native communities of Haida and Skidegate Mission accounting for approximately 25% of the total population.

In 1976, the Islands' population was comprised of 2,475 females and 3,040 males. Seventy-four percent of the people were under 35 years of age. The population of the Queen Charlotte Islands therefore, is young relative to the rest of the Province, where an average 59% of the people are under 35 years of age.

The population of Masset, the largest community on Graham Island, grew from 541 in 1966, to 975 in 1971, and to 1,563 in 1976 which was a 189% increase over the ten year period. The 1976 population was made up of 840 males and 723 females with 535 under the age of 15 and 35 over 65 years of age.

Much of Masset's growth since 1966 is attributed to the establishment of a Canadian Armed Forces Base in the area. It is estimated that the Armed Forces Base accounts for approximately 43% of the 1979 Masset population.

The population of Port Clements was 410 in 1976, which was twice the 1966 population of 205. In 1976, the population consisted of 210 males and 200 females. Of these, 135 were under 15 years of age and 10 were over 65 years of age.

In 1971, Queen Charlotte City had a population of 665; Skidegate Mission, 308; Juskatla, 142; and Haida, 675.

The most current population statistics indicate that the population of Graham Island has been increasing up to 1976. It is estimated that the population has continued in this growth pattern to the present. Improved access to Graham Island from the mainland, the short supply of building lots, and the lifestyle offered on the Islands will affect population growth in the future. While the relaxed lifestyle found on Graham Island will continue to attract people, the high cost of living found on the Island and, in particular, the high cost of housing, may deter people from settling on Graham Island. In addition, improved access to Graham Island from the mainland will perhaps drastically change the way of life found there, as well as the character of the population.

### 4.12.3 Employment

The major sources of employment on Graham Island are in timber harvesting, commercial fishing, and military service. In 1975, an estimated 940 men were employed in logging. MacMillan Bloedel, Crown Zellerbach, and Rayonier are the major employers. There are also a number of small independent logging operations on the Island.

In 1976, approximately 155 commercial fishing vessels were based in the area. An estimated 269 people were employed on these vessels. In addition, people are employed at the B.C. Packer's Cannery in Masset, processing the fish that are harvested.

The military is also a major employer on Graham Island, in that much of the labor force is in the armed services. Although the military is not a large employer of civilian staff, it sustains a large portion of the service sector of Masset.

Current information on the labor force of the Queen Charlotte Islands is not available. People with forestry experience, however, constituted the largest component of the labor force (Table 4.12.3.1) in 1971 and continue to do so. The experienced labor force in forestry and the other primary industries (agriculture, mining, fishing) accounts for 35% of the total experienced labor force. The 1971 labor force breakdown also indicates that people with military, community, business, and personal service experience make up a large portion of the experienced labor force.

Table 4.12.3.1

Experienced Labor Force by Industry - 1971

| | | | |
|---|---|---|---|
| Agriculture | 20 | Finance, Insurance, and Real Estate | 30 |
| Forestry | 360 | Community, Business, and Personal Service | 275 |
| Fishing and Trapping | 65 | Public Administration and Defence | 215 |
| Mines, Quarries, and Oil Wells | 155 | Unspecified or Undefined | 280 |
| Manufacturing | 140 | | |
| Construction | 105 | | |
| Transportation, Communication, and Other Utilities | 120 | Total Experienced Labor Force | 1,735 |
| Trade | 110 | | |

### 4.12.4 Housing

The current housing situation on Graham Island varies from community to community, but, for the most part, it is tight. There is a supply shortage of houses and building lots, with the greatest shortages occurring around Queen Charlotte City. The tight housing situation is largely the result of there being both a lack of physically suitable land and a lack of available land, since large tracts of land are reserved for forestry purposes. Furthermore, the supply shortages and high transportation costs for building materials support high market values for homes throughout the Island.

Port Clements is no exception to this general rule. Here, housing is in short supply, and there are currently no building lots on the market.

The housing stock in Port Clements consists of approximately 120 units, five of which are rental units. The average selling price of a home in Port Clements is reported to be $65,000. With the present supply and demand situation in Port Clements, it is estimated that the housing prices have increased $20,000-$25,000 over the 8-month period ending in March 1980.

Some relief in the housing market is forthcoming because a 24-lot subdivision is in the final planning stages. As of March 1980, however, there were 68 people on a waiting list for these lots, and it is rumored that the asking price for these lots may be $18,000-$20,000. The community plan that is currently being prepared for Port Clements will extend the village boundaries to include possible new subdivisions.

In Masset, the current housing stock consists of 430 units, mainly single family dwellings. Available houses are reportedly selling for an average of $55,000. A 101-unit subdivision has been on the market for some time now, and 40 lots are still available at $4,000-$5,000 each. A 74-lot subdivision east of Masset is to be on the market by the summer of 1980. The asking price for cleared, serviced lots in this subdivision is apparently $15,000. Armed forces personnel are housed in 212 units, mostly duplexes on the armed forces base.

Juskatla is a company mobile-home community owned by MacMillan Bloedel. According to MacMillan Bloedel representatives, Juskatla is gradually being phased out by the company, and the MacMillan Bloedel employees will be relocating in Port Clements.

#### 4.12.5 Education

Educational services on the Island are administered from Queen Charlotte City. At present, there are elementary schools in Masset, Port Clements, and Queen Charlotte City. Students from Juskatla and Tlell attend the elementary school in Port Clements. Skidegate elementary students attend the Queen Charlotte City school.

Secondary schools are located in Masset and Queen Charlotte City. Students from Juskatla, Tlell, and Port Clements attend the secondary school at Masset.

The total student capacity of the schools on Graham Island is 1,275 and the total enrollment for 1979/80 is 1,030. The relationship between individual school capacity and current enrollment is shown in Table 4.12.5.1.

**Table 4.12.5.1**

**School Capacity and Current Enrollment - Graham Island**

| Name of School | School Capacity | Enrollment 1979/80 |
|---|---|---|
| Port Clements Elementary | 150 | 110 |
| Masset | | |
| Elementary | 450 | 380 |
| Secondary | 325 | 240 |
| Queen Charlotte City | | |
| Elementary and Secondary | 350 | 300 |
| TOTAL | 1,275 | 1,030 |

Enrollment has been increasing gradually over the past years, and this gradual growth is expected to continue. There is some discussion therefore, of building a secondary school in Port Clements. If funds are allocated for such a project, it would take three years to complete the new school. In the interim, some portables could be made available to help alleviate classroom shortages resulting from delays in getting approval and building a new school, and from an influx of new students.

### 4.12.6 Commercial Services

The commercial sector in Port Clements is limited. It consists of two service stations with tire repairs, a grocery store, neighborhood pub, credit union, 7-unit motel, and bottled gas outlet. Additional services are available in both Masset and Queen Charlotte City. Masset has a full complement of commercial services, which include: hotel/motels and restaurants; dry goods stores; finance, insurance, and real estate agents; supermarkets; cleaners; auto dealerships and repairs; and various construction contractors, associated trades, and supply outlets. The commercial services available in Queen Charlotte City, although more limited than Masset, include a clothing store, tire shop, welder, taxi, jeweller, electric sales and service, cafe, hotel, Sears catalogue sales, car rental agency, and realtor.

### 4.12.7 Public Facilities and Services

Health and Welfare

Physical and mental health of Graham Island residents is attended to mainly through the British Columbia Health and Human Resources Ministry. In Port Clements, a resident aide provides first aid care at the Health and Human Resources Clinic. In addition, doctors visit the clinic on a regular basis. Ambulance service provided by six trained people is available in Port Clements for transportation to either the hospital located in Masset or in Queen Charlotte City.

A Canadian Forces Station Hospital, with eight beds and five bassinets, is located in Masset. It is open for use by civilians, but is mainly for the care of armed forces personnel. The facilities at the hospital include an emergency ward, X-ray facilities, maternity ward, and one intensive care bed. No operating facilities are available. A staff of four doctors, two civilian and two military, look after the patients.

Queen Charlotte Islands General Hospital, located in Queen Charlotte City, has 26 beds and five bassinets. To care for the patients, there are the equivalent of 24 full-time staff, which includes 14 nurses and three resident doctors. Specialists visit the hospital on a regular basis, providing additional care.

Currently, the desired ratio of 3.5 beds per 100 population is being met in the Island's hospitals. Most of the surgery required by Island residents however, is performed in Prince Rupert or Vancouver. Any significant increase in population would mean that the hospital facilities should be expanded, and perhaps doctors would need refresher courses to enable them to do more of the required surgery. Queen Charlotte Islands General Hospital is seen as the most likely choice for such expansion and upgrading.

Other services provided for the residents of Graham Island include: one public health nurse located in Masset; two social workers, one located in Masset and one in Queen Charlotte City; a family support worker, located in Masset; a child care worker, in Queen Charlotte City; the Tlell Support Centre for alcohol and drug abuse; and two dentists, one located in Masset and one in Queen Charlotte City.

## Police and Fire Protection

Police protection on Graham Island is provided by the R.C.M.P. detachment in Masset and Queen Charlotte City. Six officers plus one assistant are stationed in Masset and provide policing services for Masset, Haida, Port Clements, Tlell, and Juskatla. There are three officers in the Queen Charlotte City detachment. Their area of coverage includes: Queen Charlotte City; Sandspit, on Moresby Island; and Skidegate Mission.

Fire protection is provided in each community by a volunteer fire department. In Port Clements, there is a fire hall that houses two trucks and a new pumper. Eighteen men make up the volunteer department.

In Masset, two trucks, one pumper, and one auxiliary truck are housed at the fire hall. There are 25 volunteers in the department.

## Utilities

Electricity is provided by B.C. Hydro and Power Authority from diesel-electric generating stations at Masset and Sandspit. Port Clements is serviced by the generator located in Masset.

For home heating, fuel oil is the primary source of heat in Port Clements and costs an average of $35-$40 per month. Currently, the trend in Port Clements is for more people to shift from heating with fuel oil to electric heat. In addition, more new homes are being constructed with electric heating. It is rumored that a small generator may be built in Port Clements.

## Water and Sanitation

Masset and Port Clements are the only villages with fully serviced water and sewer systems. In Port Clements, sewage is treated in an aerated system that has a capacity for 1,500 people.

Two 150-ft wells provide the town's water. At present, only one well is used to meet the demands of the residents.

Garbage is disposed of at the town landfill site located northeast of Port Clements.

Transportation Networks

Two roads connect the communities on Graham Island. A paved highway running north-south connects Queen Charlotte City with Masset. It follows the eastern coastline from Queen Charlotte City to Tlell, then inland to Port Clements, and north to Masset. A gravel road connects Port Clements with Juskatla to the west, then south to Queen Charlotte City.

Air service is also available for travel within the Queen Charlotte Islands. Trans-Provincial Airlines Ltd. has twice daily seaplane service from Sandspit to Masset, with stops in Queen Charlotte City and Juskatla.

Transportation between Graham Island and the mainland is currently available by air for people and freight, and by water for freight. Trans-Provincial Airlines has five return trips scheduled daily throughout the week and four return trips on weekends between Prince Rupert and Masset, Queen Charlotte City, and Sandspit. In addition, Pacific Western provides one return trip per day between Vancouver and Sandspit, on Moresby Island. Passengers arriving on the Pacific Western flight are transported to Queen Charlotte City, on Graham Island, by ferry.

Currently, freight is transported to the Island by RivTow Straits Ltd. and by a recently added freighter operated by Pacific Rim out of the Vancouver area. RivTow provides freight service to Masset once a week from both Vancouver and Prince Rupert. The Pacific Rim freighter "Church" began servicing the Island from the Vancouver area in the spring of 1980. On the "Church", the basic freight costs are $60/ton, with an additional tariff on small shipments.

Ferry service between Prince Rupert and Skidegate Landing is due to begin in the summer or fall of 1980. The ferry will make three trips per week and can carry a maximum of 20 freight trucks and 60 passenger vehicles per trip. Local opposition to the new ferry service into Skidegate Landing has been voiced. Traffic congestion at Skidegate Landing, lack of facilities on the Island for accommodating increased tourist traffic, and the fact that freight and residents of Graham Island will not be given boarding priority over recreational vehicles and tourists are cited as the objections.

Communications

Graham Island is fully serviced by B.C. Telephone. From Port Clements, a long distance charge is levied to call any other exchange on the Island.

Postal service is available in Port Clements, Masset, and Queen Charlotte City.

A weekly newspaper, Queen Charlotte Islands Observer, provides news coverage for Island residents.

CBC television and radio signals from Prince Rupert can also be recieved at some locations on Graham Island.

Recreation

Specifically constructed recreation facilities on the Island are limited. A recreation centre is located at the armed forces base in Masset, but its use is restricted to military personnel and their families. Entertainment is provided for civilians on an irregular basis by showing movies at the armed forces base.

In Port Clements, there are currently no recreation facilities other than the baseball diamonds and soccer field at the school. Leisure time is spent at the local tavern, and movies are shown weekly. Plans for a recreation centre, complete with skating ice and four ice sheets for curling, are underway. MacMillan Bloedel has offered to pay for the construction and operation of the facility until it pays for itself or until the community takes it over.

In Queen Charlotte City, the only recreation facility is the school yard. A hotel and tavern, plus weekly movies at the Legion, provide additional entertainment.

For outdoor recreation, campsites are located in Naikoon Provincial Park. Deer hunting is a popular sport as well as sportfishing in the Island's many creeks, rivers, and marine sites. Various forms of unorganized outdoor leisure activities seem to prevail.

## Social Environment

The people on Graham Island present two distinct philosophies with respect to the future of the Island. Queen Charlotte City is comprised of many people who want their village to remain small and secluded. On the other hand, residents of Port Clements and Masset tend to be more anxious for growth and expansion. They look forward to increased industrial development on the Island and to further stimulation of the local economy.

Although most people are not averse to increased industrialization on the Island, and the services this would bring, they are concerned that adequate environmental protection measures are taken. There have previously been confrontations between the forest industry and local environmental groups over such issues.

# 5.0 PROJECT DESCRIPTION

## 5.1 Exploration

The following is a summary of the exploration work completed on the property to the present time.

1970 - Discovered in 1970 by Efrem Specogna and John Trico

1971 - Optioned to Kennco Explorations (Kennecott) - Surface trenching, surface sampling, geochemical survey, 60 m of X-Ray core drilling in two holes.

1972 - Optioned to Cominco - Surface trenching and sampling plus nine BQ diamond drill holes totalling 600 m.

1973 - Optioned to Silver Standard Mines - Little or no field work.

1974 - Sub-optioned from Silver Standard to Quintana Minerals - 281 surface samples, four packsack drill holes from which 58 m of samples were taken, and 602 m of percussion drilling in 18 holes, plus an initiation of metallurgical test work.

1975 - Quintana Minerals. Five BQ diamond drill holes totalling 718 m plus further metallurgical testing. 34 additional claims staked - (now Mutual Resources - Silver Standard). Specogna himself mined and shipped approximately 6 tons to two smelters for treatment.

1976 - Quintana - Little or no field work. Minor metallurgical testing.

1977 - Consolidated Cinola Mines Ltd. - 708 m of BQ diamond drilling in thirteen holes.

1978 - Consolidated Cinola Mines Ltd. 1,254 m of BQ diamond drilling in eight holes.

1979 - Consolidated Cinola Mines Ltd. - Energy Reserves Canada Ltd. 7,500 m of BQ and NQ diamond driling in 35 holes, plus the start of extensive metallurgical testing.

1980 to date

- Consolidated Cinola Mines Ltd. - Energy Reserves Canada Ltd. - 9,000 m of BQ and NQ diamond drilling in 75 holes, plus extensive metallurgical testing.

## 5.2 Description of Deposits

The reports by G.G. Richards (1974) and M.R. Wolfhard (1975) of Quintana Minerals, summarized by R.C. Hart (1980), have been referred to in the history of exploration activities, Section 3.2. Two recent reports bring the studies of the accumulating geological data up to date. The first is by N. Champigny and A. J. Sinclair of the U.B.C. Department of Geological Sciences dated 11 October 1979 entitled, "Progress Report on the Geology of the Specogna Gold Deposit" and the second dated January 1980 by Fred W. Limbach and Michael G. Cruson of Cruson and Pansze, Geologists of Golden, Colorado entitled, "Progress Report, Queen Charlotte Gold Prospect". Finally, there is a report by Claudia Gasparrini, of the University of Toronto, entitled, "Determination of the Gold and Silver Distribution in Eight Samples of Drill Cores from the Queen Charlotte Gold Deposit". All of these studies are on file and the results are summarized below.

Briefly, the reports make it clear that:

- The deposit is comprised of a pile of young, clastic rocks of largely volcanic origin that was injected into a shallow sea environment where sorting took place prior to burial. Despite the sorting, it is apparent that the material in the pile was largely fine to coarse ash and agglomerate. It now dips gently to the south and east.

- Burial was aided and abetted by a fault zone striking N 25°W and dipping 55°, which developed on the west side of the volcanic pile to the east within a structurally weak mudstone shale.

- It appears that the volcanic material has been cemented and mineralized by silica, with breccias developed locally where settling of the material was incomplete. Later invasion(s) of silica formed vein quartz in fractured areas already solidified. Although only the footwall fault zone has been recognized, lesser slump movements taking place during the settling process may now be healed with quartz or quartz breccias. Geologists who have worked on the deposit have mapped a unit occurring in both footwall and hanging wall of the fault as an intrusive rhyolite porphyry. Mr. Hart believes it is possible that some of the rhyolites are volcanics completely replaced by silica.

In the area covered by Hart's report, gold occurs chiefly in microscopic to submicroscopic grains erratically distributed throughout the hanging wall rocks, although coarse gold occurs 200 m to the north at the Marino pit. Small specks of free gold have been seen occasionally where it has collected near concentrations of carbonaceous material[(1)] or in quartz veinlets. However, its occurrence is not confined to individual stratigraphic units, carbonaceous material, or sulphides. Miss Gasparrini states that silver occurs with the gold to the extent of about 10%. Other minerals detected include pyrite, pyrrhotite, sphalerite, chalcopyrite, native copper, and cinnabar.

The footwall fault zone is largely in mudstone and shale, and, as noted, dips about 55$^{o}$ to the east.

Aside from the footwall fault, two striking features show up on geological cross sections: (a) A tongue of waste appearing on the east side of section 14+88 NW at a depth of 50 m gradually extends westerly until, on section 12+42 NW, it may completely sever the ore grade material into two or more segments. The tongue reaches a thickness of 70 m at a cut-off of 0.025 ounces gold per ton. (b) On three sections 13+20 NW, 12+78 NW, and 12+42 NW unusual concentrations of gold occur at or near sea level, raising the possibility of a chemical interface affecting its precipitation.

Since Mr. Hart's report, additional information has been developed. Although final ore reserves figures are premature, a preliminary estimate of drill-indicated tonnage is 40 million tons grading 0.059 ounces of gold per ton. Overall gold recovery is projected at 87% and several silver studies indicate a 1:1 ratio of silver to gold. Based on these estimates and a milling capacity of 10,000 short tons per day, the present life expectancy of the mine is approximately 12 years.

(1) Carbonaceous material in the form of wood fragments or lignite occurs throughout the clastic beds in variable amounts. Miss Gasparrini noted the occurrence of fossil shells and reports that "graphite was occasionally observed".

## 5.3 Mine Development

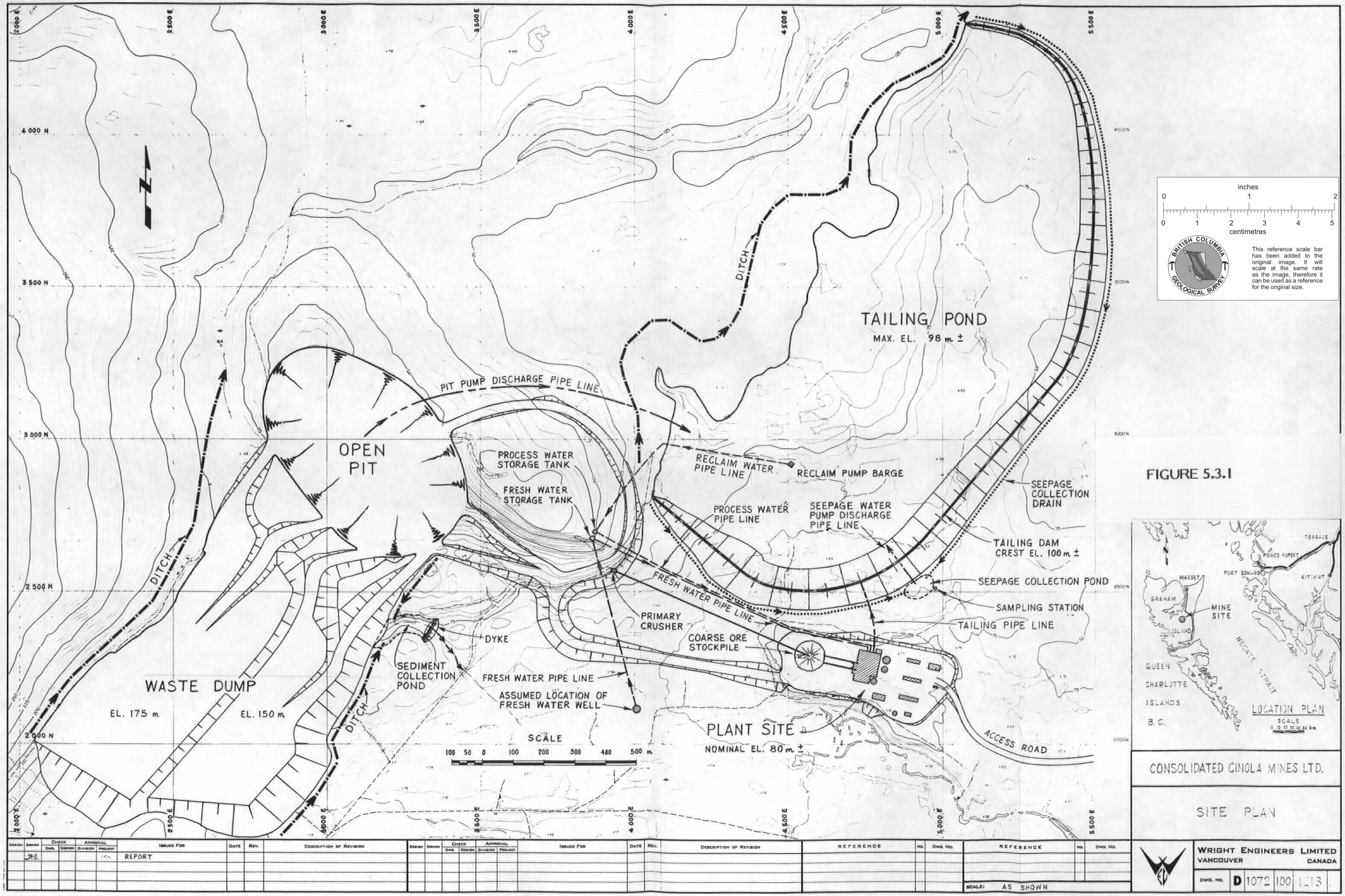
The project at this time is in the preliminary planning stage and very few alternate proposals have been studied or suggested. However there will, no doubt, be several options to be studied as the project progresses. Some examples, in general terms, might be: (a) a method to mine the deposit from underground rather than open pit; (b) alternate locations for the plantsite; (c) alternate locations for the millsite; (d) an improved mill flow sheet for more efficient recovery of gold; (e) an alternative metallurgical technique to eliminate the roasting process altogether; or (f) an alternate road access route; etc.

A preliminary mine plan to be considered for the Stage I environmental and socioeconomic assessment that includes the plant, pit, tailing pond, and waste dump sites is presented in Figure 5.3.1.

The configuration and mineral distribution of the deposit is suitable for conventional open pit mining. It is proposed to use three 9-7/8 in. diameter rotary drills, two 12-cu yd electric shovels, one 10-cu yd front end loader, nine 100-ton mechanical drive haulage trucks and a variety of auxiliary support equipment.

The explosives used would be a combination of metallized slurries, ammonium nitrate, and fuel oil mixtures. An explosives supplier will establish a mix plant at the site and deliver the explosives to the holes in a mix tank. A dewatering truck will be provided to pump out the blast holes prior to loading.

Ore will be hauled directly to the crusher or stockpiled during the early years, if high grading becomes practical. Waste rock will be used initially for haul road construction and for structural fill around the plant areas, as required. A waste disposal area west of the pit has been selected for all surplus waste material from the pit. This area will be cleared beforehand and suitably drained. At the conclusion of mining, the waste dumps will be recontoured to a slope suitable for revegetation.



TAILING POND
MAX. EL. 98 m ±
OPEN PIT
PIT PUMP DISCHARGE PIPE LINE
DITCH
PROCESS WATER STORAGE TANK
FRESH WATER STORAGE TANK
RECLAIM WATER PIPE LINE
RECLAIM PUMP BARGE
PROCESS WATER PIPE LINE
SEEPAGE WATER PUMP DISCHARGE PIPE LINE
SEEPAGE COLLECTION DRAIN
TAILING DAM CREST EL. 100 m ±
SEEPAGE COLLECTION POND
SAMPLING STATION
TAILING PIPE LINE
FRESH WATER PIPE LINE
PRIMARY CRUSHER
COARSE ORE STOCKPILE
DYKE
SEDIMENT COLLECTION POND
ASSUMED LOCATION OF FRESH WATER WELL
WASTE DUMP
EL. 175 m
EL. 150 m
PLANT SITE
NOMINAL EL. 80 m ±
ACCESS ROAD
SCALE
100 50 0 100 200 300 400 500 m
inches
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BRITISH COLUMBIA GEOLOGICAL SURVEY
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
LOCATION PLAN
QUEEN CHARLOTTE ISLANDS B.C.
GRAHAM ISLAND
MASSET
MINE SITE
HECATE STRAIT
PRINCE RUPERT
PORT EDWARD
TERRACE
KITIMAT
CONSOLIDATED CINOLA MINES LTD.
SITE PLAN
ISSUED FOR REPORT
SCALE: AS SHOWN
WRIGHT ENGINEERS LIMITED
VANCOUVER CANADA
DWG. NO. D 1072 100 1213


FIGURE 5.3.1

The production schedule will be based on a daily mill throughput of 10,000 tons of ore, operating seven days per week, 350 days per year, for an annual production of 3,500,000 tons. Daily mine production is 14,000 tons per day, operating five days per week.

Preproduction work will be carried out in the year prior to production startup and would include site clearing, some preliminary road building and the excavation of 1,000,000 tons of material to establish working sites for the two shovels and at least one alternate mining face. The front-end loaders and trucks will be used for this pre-production work prior to delivery and erection of the shovel in the pit area.

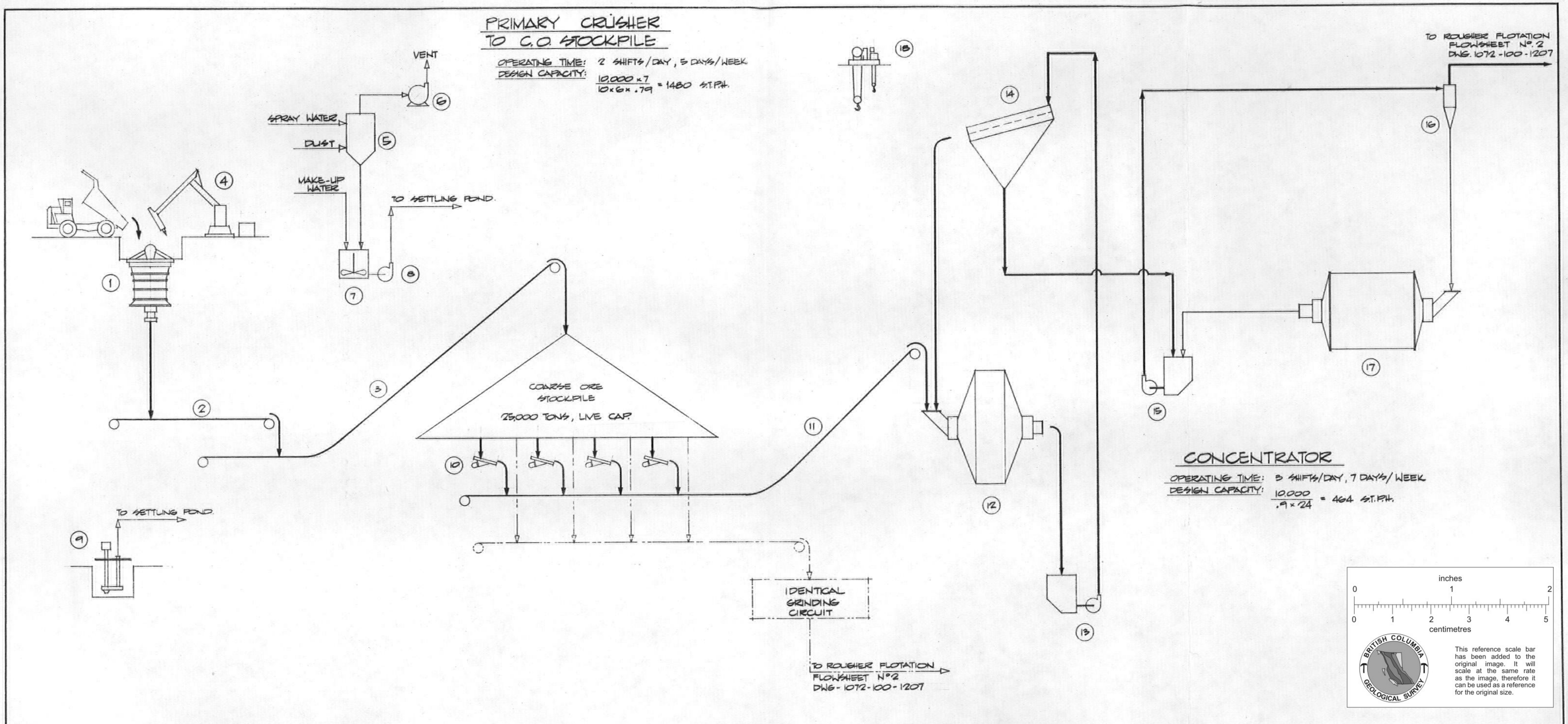
The overall average stripping ratio is 1.20:1. The initial stripping ratio is projected to be 1.56:1, which is 1.3 times the average, and considered reasonable for the initial year of an open pit operation such as Cinola. After the fourth year, the ratio will drop to the average and then decrease to 0.55:1 in the final year.

## 5.4 Mineral Process Plant

### 5.4.1 Process Description

The mineral process plant will operates seven days per week, with three shifts per day. At 90% availability, equipment will be sized to process 464 short tons per hour. The process will consist of five major operations: semi-autogenous grinding; flotation, concentrate roasting; calcine leaching; and precious metal precipitation and recovery. A flowsheet describing the crushing and grinding process is presented in Figure 5.4.1.1.

Coarse ore will be reclaimed onto two conveyors, each feeding an identical semi-autogenous primary grinding circuit. In each circuit, the coarse ore will be fed into a 28-ft by 10-ft semi-autogenous grinding (S.A.G.) mill powered through a gear reducer by a 3,600 horsepower synchronous motor. Each mill will contain a seven volumetric percent charge of 4-in. steel grinding balls. The grinding balls and the unground ore are retained in the mill by 3/4-in. grates. The mill will discharge into a pump box and be pumped to an 8-ft by 14-ft vibrating single deck screen (1/4-in. opening) by an 8-in. by 10-in. hard metal slurry pump. (Spare pumps will be provided for all major pumping functions in the process plant.) Screen oversize will join the semi-autogenous mill feed




| ITEM N° | N° REQ'D | EQUIP. N° | DESCRIPTION | MOTOR H.P./UNIT |
|---|---|---|---|---|
| 1 | 1 | | 42" × 65" GYRATORY CRUSHER C/W LUBE UNIT | 400 |
| 2 | 1 | | 72" × 18'-0" APRON FEEDER | 40 |
| 3 | 1 | | 48" CONVEYOR | 300 |
| 4 | 1 | | ROCK BREAKER | 40 |
| 5 | 1 | | DUST COLLECTOR | |
| 6 | 1 | | FAN | 50 |
| 7 | 1 | | 3' ⌀ MIX TANK C/W AGITATOR | 1 |
| 8 | 1 | | PUMP | 10 |
| 9 | 1 | | 2" VERTICAL SUMP PUMP | 5 |
| 10 | 8 | | 36" × 84" VIBRATING PAN FEEDER | |
| 11 | 2 | | 36" CONVEYOR | 50 |
| 12 | 2 | | 28' ⌀ × 10' S.A.G. MILL | 3600 |
| 13 | 4 | | 8 × 10 G.I.W PUMP (2 SPARES) | 100 |
| 14 | 2 | | 8' × 14' S.D. SCREEN | |
| 15 | 8 | | 10 × 8 SRL PUMP (4 SPARES) | 150 |
| 16 | 4 | | CYCLOPACS 11-10' ⌀ PER UNIT | |
| 17 | 4 | | 15' ⌀ × 20' BALL MILL | 2500 |
| 18 | 1 | | 40/10 TON CRANE | 50 |

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**CONSOLIDATED CINOLA MINES LTD.**
Queen Charlotte Islands B.C.

FLOWSHEET N° 1
CRUSHING & GRINDING PROCESS

**WRIGHT ENGINEERS LIMITED**
VANCOUVER — CANADA
DWG. No. E 1072 100 1206

FIGURE 5.4.1.1

as circulating load; screen undersize will be split and flow by gravity to the secondary ball mill discharge pump boxes.

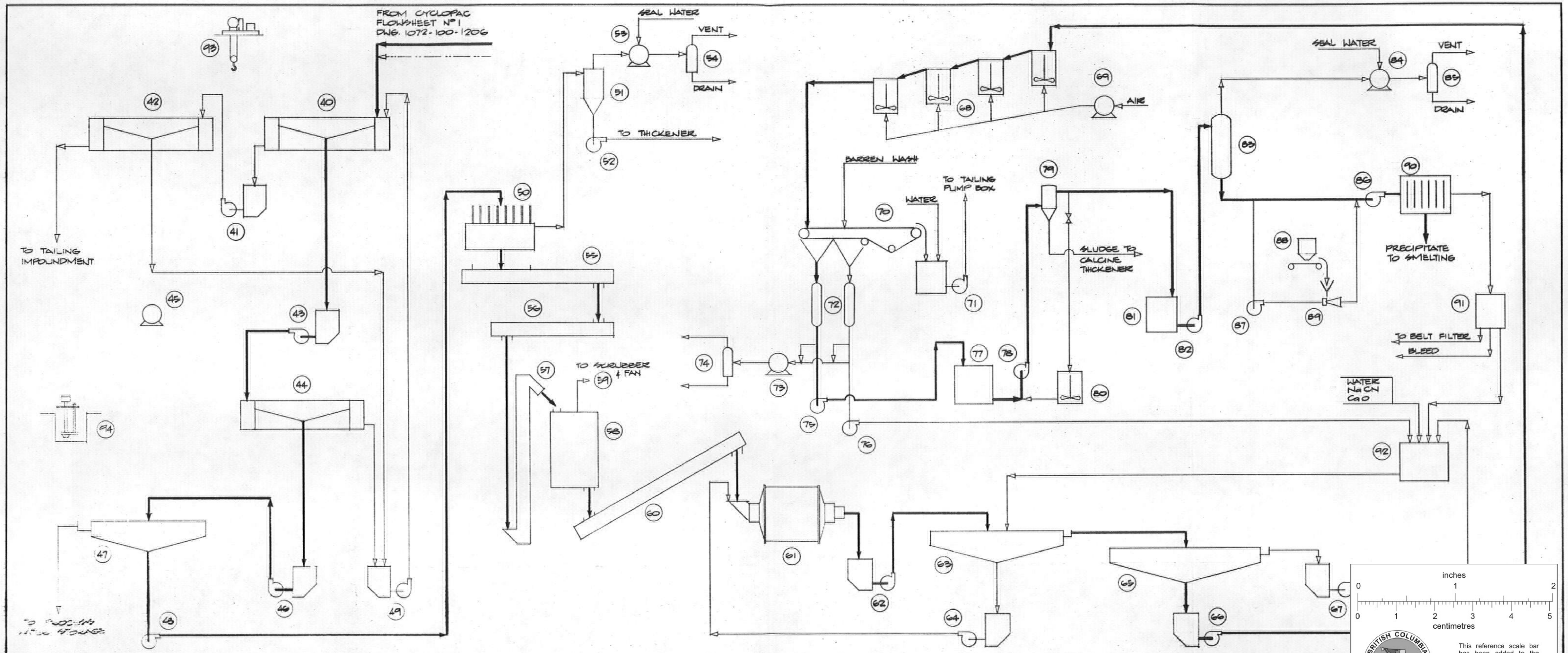
The secondary ball mill discharge, together with the primary screen undersize, will be pumped by a 10-in. by 8-in. rubber lined pump (one for each of the four secondary ball mills) to eleven 10-in. cyclones. The cyclones produce an overflow 80%, of which is finer than 57 microns, and this will become rougher flotation feed. A flowsheet describing the flotation and leaching process is presented in Figure 5.4.1.2. The cyclone underflow will feed the secondary grinding mills. Each of the four secondary mills will be 15-ft in diameter by 20-ft long and powered by a 2,500 hp synchronous motor. The mills will contain a 40 volumetric percent charge of 2-in. steel balls, and discharge product by overflow. The discharge will joint the screen underflow as feed to the cyclones.

Sodium silicate (3.0 lb/ton), Barrett's No. 4 oil (0.03 lb/ton) and Aerofloat 25 (0.02 lb/ton) will be added to the primary mill and copper sulfate (0.030 lb/ton) will be added to the secondary mill. These quantities are based on Mountain States test number QC-50.

Cyclone overflow at 35% solids will flow by gravity to twelve mechanical rougher flotation cells each of 1,350 cu ft nominal capacity. The cells are arranged in four banks of three cells, with a junction box placed between each bank. Total rougher flotation time will be 20 minutes. Reagent dosages to the rougher cells will be Aerofloat -25 (0.02 lb/ton) and potassium amyl xanthate (0.25 lb/ton).

Rougher tails will be pumped to scavenger flotation by a 16-in. by 14-in. rubber-lined pump. The scavenger cells are identical to the rougher cells. Reagent addition to the scavenger cells will be Aerofloat 25, 0.03 lb/ton. Tailing from the scavenger cells will be final plant tails which will be pumped to an impoundment area behind a tailing dam.

Rougher flotation concentrate at a rate of 1,300 tons per day will be pumped by a 10-in. rubber-lined pump to a single stage of cleaning in twelve 200-cu ft cells arranged in four banks of three. Cleaning time will be fifteen minutes, with no reagent addition. Cleaner tails at 845 tons per day will be pumped to the rougher cells together with the




| ITEM Nº | Nº REQ'D | EQUIP. Nº | DESCRIPTION | MOTOR H.P./UNIT |
|---|---|---|---|---|
| 40 | 2 | | BANK OF 350 CU FT RGHR FLOT CELLS (3+3+3+3) | 75/CELL |
| 41 | 2 | | 6×4 SRL PUMP (1 SPARE) | 75 |
| 42 | 2 | | BANK OF 350 CU FT SCAV. FLOT CELLS (3+3+3+3) | 75/CELL |
| 43 | 2 | | 10×8 SRL PUMP (1 SPARE) | 50 |
| 44 | 2 | | BANK OF 100 CU FT CLNR FLOT CELLS (3+3+3+3) | [illegible]/CELL |
| 45 | 4 | | FLOTATION AIR BLOWER | 200 |
| 46 | 2 | | 5×5 SRL PUMP (1 SPARE) | 15 |
| 47 | 1 | | 75' φ THICKENER | |
| 48 | 4 | | 3' ODS PUMP (1 SPARE) | |
| 49 | 2 | | 10×8 SRL PUMP (1 SPARE) | 50 |
| 50 | 1 | | 10-6' × 8' DISC FILTER | |
| 51 | | | FILTRATE RECEIVER | |
| 52 | | | 1½ × 1¼ FILTRATE PUMP | 1 |
| 53 | 1 | | VACUUM PUMP | 100 |
| 54 | 1 | | SILENCER | |
| 55 | 1 | | SCREW CONVEYOR | |
| 56 | 1 | | SCREW CONVEYOR | |
| 57 | 1 | | BUCKET ELEVATOR | |
| 58 | 1 | | ROASTER C/W CYCLONE | |
| 59 | 1 | | SCRUBBER & I.D. FAN | 500 |
| 60 | 2 | | COOLING SCREW CONVEYOR | |
| 61 | 1 | | 8'φ × 8' BALL MILL | 250 |
| 62 | 2 | | 6×6 SRL PUMP (1 SPARE) | 15 |
| 63 | 1 | | 80'φ HYDROSEPARATOR | |
| 64 | 2 | | 6×6 SRL PUMP (1 SPARE) | 20 |
| 65 | 1 | | 90'φ THICKENER | |
| 66 | 4 | | 3' ODS PUMP (1 SPARE) | |
| 67 | 2 | | 12×10 SRL PUMP (1 SPARE) | 50 |
| 68 | 3 | | 22'φ × 22' LEACH TANK C/W AGITATOR | 30 |
| 69 | 1 | | COMPRESSOR 3000 CFM. @ 20 PSIG | 200 |
| 70 | 3 | | 520 SQ. FT. BELT FILTER | |
| 71 | 2 | | 4×3 SRL PUMP (1 SPARE) | 10 |
| 72 | 2 | | FILTRATE RECEIVER | |
| 73 | 1 | | VACUUM PUMP | 200 |
| 74 | 1 | | SILENCER | |
| 75 | 1 | | PREGNANT FILTRATE PUMP | |
| 76 | 1 | | WASH FILTRATE PUMP | |
| 77 | 1 | | 14'φ × 14' PREG. SOLUTION TANK | |
| 78 | 2 | | 3×2 PUMP - 8" IMP (1 SPARE) | 15 |
| 79 | 1 | | 650 SQ FT STELLAR FILTER | |
| 80 | 1 | | 7'φ × 7' PRECOAT TANK | |
| 81 | 1 | | 14'φ × 14' CLARIFIED SOLUTION TANK | |
| 82 | 2 | | 2½ × 2½ PUMP - 4" IMP (1 SPARE) | 5 |
| 83 | 1 | | 4'φ × 12' DEAERATION TOWER PACKED WITH TELLURETTES | |
| 84 | 1 | | VACUUM PUMP - 200 CFM | 15 |
| 85 | 1 | | SILENCER | |
| 86 | 2 | | 3×2 PUMP - 8" IMP (1 SPARE) | [illegible] |
| 87 | 2 | | 1¼ × 1 PUMP - 5" IMP (1 SPARE) | |
| 88 | 1 | | Zn FEEDER - 3 LBS/HR | |
| 89 | 1 | | FLOCCULANT EDUCTOR | |
| 90 | 1 | | PLATE & FRAME FILTER PRESS 40"×25 CHAMBERS | |
| 91 | 1 | | 10'φ × 10' BARREN TANK | |
| 92 | 1 | | 20'φ × 20' MILL SOLUTION TANK | |
| 93 | 2 | | 7½ TON CRANE | |
| 94 | 4 | | VERTICAL SUMP PUMP | |

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BRITISH COLUMBIA GEOLOGICAL SURVEY

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**CONSOLIDATED CINOLA MINES LTD.**
Queen Charlotte Islands B.C.

FLOWSHEET Nº2
FLOTATION + LEACHING PROCESS

WRIGHT ENGINEERS LIMITED
VANCOUVER CANADA

DWG. No. E 1072 100 1207

G.C. - 2062

FIGURE 5.4.1.2

scavenger concentrate (500 tons per day) by a 10-in. by 8-in. rubber-lined pump to a 75-ft diameter thickener for dewatering.

Thickener underflow will be transferred by means of diaphragm pumps to a 10-1/2 ft by 8-ft disc filter to produce a filter cake at 15% moisture for feed to the roaster.

Disc filter cake will be transferred by means of a screw conveyor and a bucket elevator to the top of a 23-1/2 ft inside diameter by 12-ft hearth roaster for calcining to remove carbon in the concentrate. Preliminary engineering by Mine and Smelter suggests that this roaster can run autogenously, i.e., with negligible fuel consumption. This is based on an assumption that the concentrate will contain 10% lignite having a calorific value of 6,000 BTU/lb.

Roaster off-gas will be taken through a cyclone for dust removal, then to a venturi scrubber using a 1% caustic soda solution to remove sulfur dioxide and mercury.

Calcine from the roaster will be transported by means of a water-cooled screw conveyor to an 8-ft by 8-ft regrind ball mill with a 250 hp motor. Regrinding will be carried out in mill solution containing 0.15% sodium cyanide with a pH adjusted to 11 with slaked lime. Discharge from the mill will be pumped by a 6-in. rubber lined pump to an 80-ft hydroseparator. Underflow will be returned to the mill as circulating load. The overflow (80% passing 31 microns) will flow by gravity as a dilute slurry to a 90-ft thickener for dewatering prior to completion of the leaching reactions in eight 22-ft by 22-ft aerated agitators.

Pregnant solution assaying approximately 1.33 oz/ton or 0.046 g/l gold, with a lesser amount of silver, will be recovered from the leached slurry on three 520-sq ft belt filters. The solids will be washed sequentially with barren solution and water, then repulped in a launder and pumped to tails.

The pregnant solution recovered from the first section of the belt filters will be pumped by the filtrate pumps to a 14-ft by 14-ft pregnant solution storage tank. This tank will provide surge capacity to isolate the batch clarification process from the continuous belt filtration process.

The pregnant solution will be clarified by pumping it through a 650-sq ft stellar precoat pressure filter. The batch cycle will consist of forming a slurry of diatomaceous earth in clarified solution in the precoat tank and pumping this through the filter to achieve a layer of diatomaceous earth on the filter elements forming the filtration medium. With the filter precoated, pregnant solution will be pumped through the filter to the 14-ft by 14-ft clarified solution tank until achievement of a predetermined pressure drop across the filter indicates that discharge of the filter cake is necessary. The filter will then be valved off in a manner that retains pressure in the unit, and a drain valve will then open to relieve the pressure. Expansion of entrapped air in the filter will cause a backflow of solution through the filter elements, which will break off the precoat filter cake and all material collected during clarification. The resulting slurry will be drained from the filter and pumped into the leach circuit at a convenient location, thereby completing the clarification cycle.

Clarified solution will be pumped from the clarified solution storage tank to a 4-ft diameter by 12-ft deaeration tank. This tank will be maintained under vaccum, and the clarified solution will be sprayed into the top, over plastic tellurette packing. As the solution runs down over the packing, dissolved air will come out of solution and be removed by the vacuum pump. The removal of dissolved oxygen achieved in this step will reduce zinc consumption during the subsequent precipitation reaction.

The bulk of the deaerated pregnant solution will be pumped to a plate and frame filter press, using filter paper as the medium where precipitation of the gold by zinc dust will be completed. A slip stream will be taken off prior to the suction of the filter press pump and pumped through an eductor, where zinc dust and lead nitrate will be dispersed in the stream. The zinc dust slurry will go to the filter press pump, where precipitation will commence; precipitation will be completed as the solution passes through the zinc dust - gold precipitate filter cake in the press. Solution leaving the press will be barren of gold and silver and will be collected in a 10-ft by 10 ft barren solution tank. Some barren solution will be used in cake washing on the filter; some will be bled to tails to control impurities in the leach circuit, and the remainder will flow to the 20-ft by 20-ft mill solution tank, where it will be fortified with milk of lime and sodium cyanide and returned to the regrind-leach circuit.

The gold precipitate will be periodically discharged from the filter press, dried, smelted in a tilting reverberatory furnace, and cast as dore metal bricks for transport to a custom gold refinery-smelter.

If cyanide build-up in the reclaimed process water or tailing seepage proves to be a problem, the bleed stream may be treated by alkaline chlorination to destroy the cyanide prior to its discharge to tailing.

### 5.4.2 Water Supply

A preliminary plant water balance is shown in Figure 5.3.1. It has been assumed that water will be available from local wells at rates in the order of 1,500 U. S. Gallons Per Minute (USGPM). The estimated average demand for fresh water (as distinct from process water) will be 200-300 USGPM, and the design conservatively allows for an average of 600 USGPM. The fresh water will be required for potable water, washdown, seal water on pumps, etc.

The fresh water storage tank is sized at 200,000 U. S. Gallons (USG), of which 100,000 USG are considered necessary for a fire-fighting reservoir. A water treatment plant incorporating chlorination will be provided to ensure potable water meeting World Health Organization standards.

Fire protection will be by means of ring mains with hydrants, and sprinklers installed in buildings.

All water piping is welded steel, buried with at least 3-ft cover.

### 5.4.3 Tailing Disposal

The proposed tailing disposal area will be located as close as is practical to the plant site to minimize pumping costs. The tailing dam is assumed to consist of a massive section of waste rock and/or gravel, blanketted on the upstream side with a relatively impervious material. The tailing is considered unsuitable for use in dam construction, but will be deposited against the upstream face in order to decrease the permeability and to keep the water away from the dam face.

The pond will be sized on the basis of 10,000 tons per day milled for ten years, and a settled density of 80 lb/cu ft - about 32 million cu yd will be contained.

The tailing line will be constructed of high density polyethylene pipe. Pit drainage will also form part of the feed to the pond.

The seepage through the dam will be collected by a toe drainage ditch, held in a seepage collection pond, and pumped over the dam back into the pond. The quality of the seepage will be continually monitored.

#### 5.4.4 Water Reclaim

Water will be reclaimed from the tailing pond for reuse in the process by means of a pump barge on the pond. The barge will contain three vertical turbines, two operating and one stand-by. These will pump to a 200,000 USG process water storage tank. The process water will be fed to the mill via welded steel pipes.

### 5.5 Transportation

It is assumed that all incoming commodities will be available somewhere in the Greater Vancouver area. Rivtow Straits Ltd. will pick up these commodities and deliver them to the minesite on highway trailers. An average trailer will be 20 tons.

Mining supplies and freight are included in the mining cost. Mineral process plant supplies are priced F.O.B. Vancouver, and total 13,569 tons per year. Townsite supplies are estimated to total 2,500 tons per year. The total freight will thus be 16,069 tons per year.

It is assumed that a new paved two-lane highway will be constructed to join the Skidegate highway between Port Clements and Tlell, a distance of approximately twelve miles. A bridge over the Yakoun River will be required. An alternate route would be a new road on the east side of the Yakoun River from the minesite to Port Clements.

### 5.6 Sewage and Garbage Disposal

Sewage disposal at the construction camp, plant, and minesite will be by septic tank and field system. The collection system will be fabricated of polyvinyl chlorate pipe. Garbage will be collected by garbage disposal truck and disposed at the nearest municipal garbage dump, probably Port Clements.

### 5.7 Utilities

Power will be generated on site using five 5.7 megawatt diesel generating units burning No. 2 fuel oil. Four units will be operational at any time. To minimize environmental impact due to discharge of warm cooling water, cooling will be achieved through use of a closed circuit cooling tower system.

### 5.8 Employment

It is anticipated that approximately 267 employees will be required for the project. The mine will employ 144, the mill 73, the power house 11, with the remainder of 39 for general and administrative purposes.

### 5.9 Employee Housing

It is recognized that there are many options available with regard to degree of company involvement in employee accommodation, and it is recognized that Cinola has expressed a desire to avoid establishing a company town. Nevertheless, it is felt that in order to have a successful operation, Cinola must have some stability in its workforce and to achieve this, some form of assistance will probably be necessary for personnel to locate permanently in the area. There will undoubtedly be some integration of the mine employees and the 400 residents of Port Clements. It is the company's intention to encourage and subsidize, if necessary, the locating of employees and families in the Port Clements area or an alternate site.

In establishing the types of accommodation to be provided, it was assumed that the status of the employees would be divided as follows:

| | | |
|---|---|---|
| Single | 50% | 133 |
| Married (no children) | 25% | 67 |
| Married (children) | 25% | 67 |
| Total | 100% | 267 |

On this basis, the housing mix and land requirements have been established as:

| | | | |
|---|---|---|---|
| Single Detached | 50% | 134 Units | 26.8 Acres |
| Row Housing | 18% | 48 | 6.0 |
| Apartments | 15% | 40 | 2.7 |
| Permanent Bunkhouse | 17% | 45 | 2.0 |
| Total | 100% | 267 Units | 37.5 Acres |

### 5.11 Reclamation Objectives

Surface disturbances on the Consolidated Cinola property have resulted from previous exploration activities and will result from future mining operations.

Reclamation procedures have been initiated on surface disturbances resulting from the exploration activities. Areas of disturbance in the vicinity of the proposed minesite will be recontoured, using appropriate erosion control measures, and revegetated. Exploration activities that are located in the vicinity of the proposed pit and minesite will be assimilated into the mine reclamation program during mine operations.

The reclamation program on the Cinola mine site will include physical preparation of surface disturbances, fetilization of the soil where necessary, and revegetation measures to be implemented to produce a physically and biologicially stable area. Surface erosion is expected to be controllable, as the entire area is confined to one location, that is generally situated on medium-low slopes. Surface drainages will be re-established on disturbed areas.

While the mine is in operation, ongoing reclamation procedures will be carried out on the waste dump, tailing dam, road banks, and plant site to stabilize the large areas of disturbance as they are developing. Fertilizers, soil binders, soil treatments and surface dressing may be incorporated onto the slopes of the waste dump and tailing dam as required to produce stable slopes capable of supporting vegetation.

Preliminary studies will be undertaken to investigate the methods and feasibility of stripping and stockpiling overburden from the area of the waste dump, pit, plant site and tailing pond. Using the stockpiled soil as a surface dressing on the slopes of the waste dump, tailing dam, and areas of exposed rock will enhance rapid regeneration of plant communities.

Investigations will be made into the methods and availability of collecting and using local species of trees, shrubs, and forbes in the revegetation of the minesite. Planting local species will lead to the re-establishment of plant communities endemic to the area, recreating natural wildlife forage and habitat. The overall reclamation objective will be to return the area to commercial timber production upon mine completion.

# 6.0 ENVIRONMENTAL AND SOCIAL IMPACTS

## Introduction

In this section of the report the proposed preliminary mine plan activities are compared with the available socioeconomic and environmental data base to determine the potential and probable impacts of development. Many of the potential impacts have been anticipated in the conceptual design of the project. However, due to the incomplete nature of the data base, no attempt has been made to determine the magnitude of impacts nor their importance on either a local or regional value rating system. With the incorporation of more site-specific information in the subsequent stages of planning; such an evaluation can be undertaken with greater accuracy.

The following Sections 6.1 - 6.9 comprise, by topic, those interactions that are considered most significant at this preliminary stage of planning and development.

### 6.1 Air Qualilty

Fugitive dust from the construction and mining activities could on occasion cause local air quality problems. Potential sources of fugitive dust are the waste dump, mine pit, ore stockpile, tailing pond, and internal network of roads.

The gaseous emissions from the operation of the mine could also cause some changes in the air qualilty. The main sources of these potential emissions will be from the mill (crushing and roasting process), power generators, mining equipment, and explosives used in mining operations.

### 6.2 Water Quality

Ditches above the waste dump and tailing pond should adequately control and direct surface water runoff from the hillside into Barbie Creek and the two unnamed tributaries to the Yakoun River. No change in water quality of the Yakoun River is anticipated.

Seepage and runoff from the waste dump and pit area may contain elevated metal and suspended solid concentrations which will require containment and treatment. The sediment collection pond will be continuously monitored to determine water quality prior to release.

Tailing pond seepage collection drains are designed to direct possible flows into a collection pond where it will be pumped back into the tailing pond. Since seepage water may contain higher than background dissolved mercury, arsenic, and other naturally occurring heavy metals, continued monitoring and containment will be required.

The potential for contamination of groundwater reserves by surface water seepage from the pit, waste dump, and tailing pond will require further documentation before any impact can be implied.

### 6.3 Hydrology

The proposed ditch above the waste dump area may increase the flow in Barbie Creek by diverting surface runoff from the upper catchment of "Swamp" Creek. This will reduce the flow in "Swamp" Creek at the sediment collection pond by a comparable amount.

"Swamp" Creek will also have some of its flow reduced by the tailing pond diversion ditch and containment dam. A small tributary to Barbie Creek will also be reduced by the tailing pond, ditch, and dam.

A small portion of the upper end of two small unnamed tributaries of the Yakoun River will be covered by a section of the tailing pond. This containment should slightly reduce the flow in these unnamed creeks. The proposed access road to the townsite and Yakoun bridge crossing could also affect the drainage pattern of the stream along the proposed route.

### 6.4 Fisheries

The Yakoun River tributaries, "Swamp, "Plateau", "Outcrop", Barbie, and several unnamed tributaries draining the Cinola minesite provide spawning and rearing areas for both resident and anadromous fish species. The results of preliminary fish surveys in 1980 indicate that populations of coho, steelhead, cutthroad, Dolly Varden and three-spine stickleback are found in the study area.

The preliminary mine plan indicates that some watercourses will be altered during mine development. Runoff from the hillside above the waste dump and tailing pond will be rerouted into Barbie Creek, thus increasing flow. Barbie Creek fish populations are not expected to be adversely affected by the slight change in the flow regime.

The waste dump and pit collection ditch will remove a portion of the "Outcrop" Creek drainage. This will remove a minor spawning and rearing habitat for coho and Dolly Varden.

The tailing pond site will remove a portion of "Plateau" Creek, a branch of Barbie Creek, and two unnamed intermittent creeks from the watershed. These small creeks provide limited spawning but good rearing habitats for juvenile fish.

"Swamp" Creek will not be directly affected by the proposed development, however, due to the redirection of "Outcrop" and containment of "Plateau" Creeks, a net loss will result. This area, which is an artificial impoundment created by early logging roads and contains logging slash and stumps, provides an excellent rearing habitat for juvenile fish.

The mining and milling operations are expected to have no direct effect on the Yakoun River fish populations provided that waste dump, pit, and tailing pond seepages are properly contained and treated prior to discharge.

### 6.5 Groundwater

Groundwater reserves in the pit site and the waste dump site are expected to be minimal. Proper containment facilities to avoid escape of potentially contaminated water are planned.

Riverbank storage along the Yakoun River floodplain seems to be significant and probably sustains the river during low flow periods. Because of its importance, and its proximity to the study area, the Yakoun River groundwater will be protected from contamination.

The possibility of seepage through the tailing dike and through the aquifers in the floor of the tailing pond could be minimized by lining the impoundment with low permeability clays from the soft mud zones overlying the orebody, or other impervious materials where necessary.

### 6.6 Soils

The major impact on soils will result from the breaking up of the existing soil profile by stripping and removal from areas such as the mine pit, plantsite, tailing pond, and roads. Surface materials will be stockpiled and used as a surface growth medium during reclamation. The soils will be spread over the recontoured landscape to promote rapid and productive revegetation and effective drainage.

### 6.7 Vegetation

The major negative impact on vegetation will result from clearing prior to soil removal in areas that will be utilized in the mining operation (pit, tailing pond, plant site, waste dump, roads, etc.). These areas will be revegetated with plants adapted to the area and ultimately returned to commercial timber production.

Existing commercial timber will be harvested from the pit area and all mine facility sites by MacMillan Bloedel Limited. The pit and most of the tailing pond site are forested with old growth (mature) western hemlock and western redcedar, which will be harvested. The remainder of the facilities are located on areas covered with noncommercial, second growth Sitka spruce-western hemlock stands. The plantsite is proposed for a plateau that was more recently logged (1973-74).

### 6.8 Wildlife

Many of the adverse impacts to wildlife that would result from the mining project are unavoidable. These are the impacts expected to result from temporary habitat alteration necessary for mining to proceed. The removal of existing vegetative cover and stripping of soils and surface material will result in the temporary displacement of local wildlife populations to surrounding similar habitats. Because the habitats to be disturbed are small in relation to the large surrounding area of similar habitats, these impacts are not considered to be of major importance.

Bear and, in particular, Sitka blacktailed deer, using the area in the vicinity of the access road will encounter an increased risk of collision with vehicles. The noise of mine and plant construction and operation, as well as vehicular noise and harrassment, may contribute somewhat to displacement of animals from the immediate site. These impacts are not considered to be of major importance, but they will persist during the mine operation, with varying degrees of intensity.

The increase in hunting pressure contributed by the Cinola labor force should easily be absorbed by the wildlife populations, without modification to current hunting regulations.

### 6.9 Socio-economic Impact

Direct Work Force

Approximately 300 - 500 people will be employed during the construction phase of the project which will last for a period of one to two years. Room and board will be provided by Cinola at the minesite.

When the plant becomes operational, a total of 267 people will be employed at the site: 144 at the mine; 73 at the mill; 11 at the power house; and 39 general and administration. It is assumed that 50% (134) of these employees will be single, 25% (67) will be married with no children and 25% (67) will be married with children. Accommodation for these people will most likely be located in Port Clements, the nearest community. The workforce will commute to their jobs by private automobiles.

Source of Labour

To fill their demand for employees, Consolidated Cinola will have to recruit outside the Queen Charlotte Islands because the existing labor force, on the islands, is essentially fully employed. Skilled laborers are required. Recruitment will, most likely, take place in the Vancouver area and other mining areas in British Columbia.

British Columbia and Alberta are currently experiencing buoyant economies, and, as a result, shortages may be encountered in skilled trades as these trades are often common to the forestry and construction industries as well as mining. There is no guaranteed approach to overcoming this problem. However, the proponent plans to attract and keep an experienced work force by providing accommodation assistance and on-the-job training.

Indirect Work Force

In addition to the direct employment, new indirect employment in the service and manufacturing industries will be created by Cinola's project . To assess this impact of the direct employment, one must develop a multiplier which is used to predict the amount of indirect employment created by establishing new jobs in an area.

One method for developing a multiplier for use in predicting the indirect employment created by the Cinola project is to look at the existing relationship between employment in the primary and secondary sectors, and employment in the service sector for the area of concern. However, available data is not current or specific enough to do this. Assumptions as to the size of the multiplier are therefore based on professional experience as well as multipliers developed for similar projects in British Columbia. Rather than trying to pinpoint the project-related indirect employment, a range is presented. This range is based on a conservative multiplier of 1 to 0.3 and a more liberal multiplier of 1 to 0.5. This means that for each direct job created at the mine/mill, 0.3 to 0.5 indirect jobs will also be created.

During the construction phase, the laborers will be housed at the minesite and their main needs such as food will be provided by Cinola. Cinola plans to purchase the required supplies the Queen Charlottes and in Vancouver and ship them to the site. The indirect employment created to service the needs of the construction labor force will, however, be located in the greater Vancouver area. Given the unemployed found in any large city, it is assumed that Vancouver can absorb the increased demand for services. The construction labor force will have a minimal impact on the services and infrastructure of Graham Island with the possible exception of transportation facilities. The increased pressure put on the transportation services to and from the island by a transient construction workforce will have to be monitored and dealt with, if indeed this becomes a problem.

Once the mine and mill become operational, it is expected that the 267 direct employees will be mainly located in the Port Clements area simply because it is the closest community. This, in turn, will create employment for an additional 80 to 133 people. The total employment created by the Cinola project is therefore estimated to be between 347 and 400, most of which will be located on Graham Island.

Employment

| | Low | High |
|---|---|---|
| Direct Operation Employment | 267 | 267 |
| Multiplier | 1:0.3 | 1:0.5 |
| Indirect Employment | 80 | 133 |
| Total Employment | 347 | 400 |

Population

The population increase created by the project includes the direct employment,indirect employment, and increases brought about by those employees with families.

During construction, it is assumed that the only population increase will be that of the direct employees and this will be temporary. Given that the employment period is, at most, for two years, it is assumed that most of those people moving to Graham Island as construction workers will not bring their families. Some may, however, work during the construction phase of Cinola's project with the expectation of staying on to work in the mine/mill. Such people will increase the population of Port Clements at an earlier date than generally expected.

Once the mine and mill become operational, it is estimated that 50% of the people moving to Graham Island to take the newly created jobs will be single, 25% married with no children and 25% married with children. Therefore the total population increase will be between 660 and 760 people, consisting of 347 - 400 men, 174 - 200 women, and 139 to 160 children.

Given that the majority of these people will probably locate in Port Clements which currently has a population of 400, Port Clements will grow to be over twice its current size in a relatively short period of time. Every effort must be made to allow the town enough lead time to absorb this kind of population increase.

Population

| | Low | High |
|---|---|---|
| Direct Employment | 267 | 267 |
| Indirect Employment | 80 | 133 |
| Total Employment | 347 | 400 |
| Single Status (50%) | 174 | 200 |
| Married - no children (25%) | 174 | 200 |
| Married with children (25%) (at 3.6 per family) | 312 | 360 |
| Total Population Increase | 660 | 760 |

Population Age/Sex Breakdown

| | Low | High |
|---|---|---|
| Total Population Increase | 660 | 760 |
| Men | 347 | 400 |
| Women | 174 | 200 |
| Children | 139 | 160 |
| Pre-school aged* | 13 | 14 |
| School aged | 126 | 146 |

*Using B.C. Research population breakdowns.

Housing

Laborers working at the site during construction will be housed in single status accommodation (probably trailers). During the operating phase of the project, the Port Clements area is expected to be the location for accomodations of the majority of Cinola's staff, while some single status housing will probably continue to be available at the plant site.

In estimating the types of accommodation to be provided, it is assumed that 50% of the units will be single detached, 18% row housing, 15% apartments; and 17% permanent bunkhouses. Therefore, provisions are necessary for 134 single detached units, 48 row houses, 40 apartments, and 45 permanent bunks to accommodate the expected 267 employees and their families. An additional 80 housing units must be planned for on Graham Island, to house those new employees expected in the service sector as a result of the Cinola project. Certainly some of these will be in Port Clements, but other communities will also be affected.

In terms of cost and supply, housing is currently a problem in Port Clements and on Graham Island as a whole. At present the only available building lots in Port Clements are in a 24-lot subdivision and there is a waiting list for these lots.

The current demand/supply situation for housing, the limited availability of building lots, and transportation costs for building materials also create a situation where housing is costly.

Cinola expects to finalize housing assistance at an early date so that proper planning by appropriate governments can be initiated to accommodate the required housing.

Cinola has recognized the problems of a company town and therefore has chosen to integrate its workforce into the existing community. The shortage of building lots withstanding, efforts to integrate Cinola employees into the existing community is seen as a good choice.

A problem which must be addressed is the possible negative impact on Port Clements once the Cinola mine and mill are closed down. The possibility of negative impacts can be minimized by providing good quality housing which would be attactive to buyers 10 - 15 years in the future and by ensuring that capital costs of improved services in Port Clements are paid within the 10 - 15 years by the users.

Other Services

As stated above, an estimated 126 to 146 school aged children will enter the Graham Island school system. At present, the capacity of the schools on Graham Island is 1,275 and the 1979/80 enrollment is 1,030. This means that the existing schools can accommodate 245 more students. This overall excess capacity is more than enough to accommodate the children brought into the area by the Cinola project. However, only an elementary school is located in the Port Clements area and it is near full capacity with only room for 40 more students.

At present, there is some discussion of building a secondary school in Port Clements. With the current schooling needs in Port Clements, the expected natural growth of the community, and the additional needs created by the Cinola project, building the secondary school would seem appropriate. This would eliminate transporting high school students to Masset. Given that three years are required to complete a new school, a decision on this matter must soon be made. Any increase in demand for public school facilities beyond the existing capacity could perhaps be met by using portable classrooms.

The commercial sector in Port Clements is limited. It is expected that an increase in the population of the town from 400 to approximately 1,000 will create enough demand to support a better range of services. Through upgrading existing services and establishment of new businesses, it is expected that private entrepreneurs will fill this need.

At present in Port Clements, a resident aide provides first aid care for people living in Port Clements with doctors visiting the town on a regular basis and hospitals available outside the town. A doubling of the population may be a large enough increase in the population to require a resident doctor in Port Clements. The existing Health and Human Resources Clinic would be sufficient to house a doctor on a full time basis.

In addition, an increase of 600 - 700 people on the island may necessitate providing some surgical facilities at the Queen Charlotte Islands General Hospital. Such upgrading of services would benefit the entire population of Graham Island.

Currently the RCMP from the Masset detachment provide policing services. With the expected population increase in Port Clements, one more officer may be required. Consideration should be given to locating an officer in Port Clements.

At present, a volunteer fire department provides fire protection in Port Clements. Continuation of this system should be adequate to service the increase in population. Fire hydrants, sprinklers in buildings and emergency procedures will provide the necessary fire protection at the minesite.

Electricity is currently provided in Port Clements by a diesel electric generator located in Masset. It has been rumored that a generator may be installed in Port Clements. With the expected increase in the population of Port Clements such an installation may be desirable.

Currently, recreation facilities in Port Clements are limited to a baseball diamond and soccer field at the school. Plans are underway for a recreation center which is being funded by MacMillan Bloedel. To forestall any problems which may arise from Cinola employees using this recreation center, Cinola should, at an appropriate time, give consideration to playing an active role in the development of such facilities.

## Community Land

It has been estimated that approximately 35 acres of land will be required in the Port Clements area to provide housing for the Cinola workforce. An additional ten to fifteen acres will be required to house those people brought into the area to work in the service sector and land will be required for additional retail stores, recreation facilities, services (roads, water mains, etc.) and so forth. At present, a town plan is being prepared for Port Clements. This plan should provide the necessary direction for acquiring the needed land.

## Community Infrastructure

The increased population of Port Clements will put additional pressure on the existing road, water, and sewage system. Port Clements is fully serviced with water and sewer systems, both of which will have to be extended into the new residential areas. The present sewage treatment system has a capacity for 1,500 people which is more than adequate to meet the needs of the expected new residents.

## Regional Infrastructure

The expected 600 to 700 increase in the population of Graham Island will mean increased usage of the existing transportation systems.

In terms of the road network, construction of a new road on the west side of the Yakoun River would provide the best access between the mine and Port Clements.

Existing roads between Masset and Port Clements should be adequate for handling additional freight being transported from Masset to the mine site. Other major roads on the island should also be adequate for the general population increase.

## Social Impact

Port Clements is expected to at least double in size when the Cinola mine and mill become operational. In addition to the population growth brought about by Cinola, Port

Clements will also become the home for MacMillan Bloedel employees who are scheduled to be relocated there from Juskatla. Port Clements will therefore undergo a rapid period of growth in the next few years. The community plan which is currently being prepared should help to alleviate many of the problems associated with rapid growth.

# 7.0 PROPOSED FURTHER STUDIES

Listed below is a brief description and schedule of proposed Stage II studies that are either presently underway or that are dependent upon permit approval for the pilot plant or upon review of Stage I by the appropriate government agencies.

## 7.1 Scope

Climate

Site specific climatological and meteorological data required for the detailed mine design and reclamation planning is currently underway. Continuous recording instruments to monitor temperature, wind, and precipitation have been installed on site.

Air Quality

An air quality monitoring program to determine ambient conditions during construction and the level of emissions from the pilot plant will be required for Stage II. The number of sampling sites and frequency of sampling will be dependent upon the final location of the millsite. The specific parameters to be monitored will be discussed with the British Columbia Ministry of the Environment, Waste Management Branch.

Surface Water Quality

A surface water quality sampling program is currently underway to determine baseline conditions during the exploration phase. The water quality samples are being collected on a quarterly basis. The list of parameters and stations are presented in Section 4.5.2. The detection limit of certain laboratory analytical methods utilized in December 1979 was improved in the March survey. Dissolved metal rather than total metal concentrations will continue to be monitored in the water sampling program.

### Hydrology

A hydrological monitoring program is currently underway to meter and gauge watercourses draining the Cinola property during the phases of exploration, construction, and operation. The nine water quality stations described in Section 4.5.2 have been selected for a direct comparison of data. This data will provide important information required for the surface water handling system of the detailed mine plan. Flood and low flows are necessary to control drainage and to satisfy plant consumption requirements.

### Fisheries

A detailed habitat assessment and fisheries inventory of all tributary creeks in the vicinity of the present camp, proposed millsite, and tailing pond sites is currently underway. The watercourses presently considered (Section 4.5.2) are being studied to determine the species composition, abundance, distribution, and seasonal utilization of the study area by resident and anadromous fish. Important spawning, rearing, and overwintering areas that occur in the vicinity of the site will be identified and mapped. Fish bioassays will be conducted to determine the toxicity of pilot mill effluents. Metal analysis of resident fish tissues will also be conducted to determine background concentrations in resident species.

### Benthic Invertebrates

Due to the varying sensitivity of invertebrates to changes in water quality, they provide an excellent indication of long term trends. A study has been initiated at the water quality sites described in Section 4.5.2 to determine seasonal variability in species composition and relative abundance of the benthic invertebrate communities.

### Groundwater

The quantity and quality of groundwater existing in the study area and the potential for contamination of aquifers by mining-related activities will be investigated in Stage II. The first phase of the mining program, adit excavation, will provide an opportunity for collecting and testing the quantity and quality of available groundwater. Wells may have to be drilled and pump tests run to determine aquifer characteristics.

Surficial Geology

The level of effort required for the Stage II submission will be dependent on the detailed mine plan. The location of the final millsite and tailing pond site may necessitate further studies of terrain stability, and seepage characteristics.

Vegetation

A vegetation study is currently underway that involves a sampling of vegetation (areas of homogeneous soil and forest type), which will be classified into major vegetation types. This data will be used to augment the wildlife utilization studies, and reclamation/revegetation planning.

Wildlife

A wildlife inventory that involves a raptor nesting survey, small mammal line-trapping program, fur-bearer track inventory, and deer habitat utilization study is underway.

Reclamation

A small reclamation program has been implemented to date; to control erosion during exploration, however, in Stage II, a plan for erosion control and stabilization of disturbed areas will be prepared. Reclamation will be required for the millsite, tailing pond, and the waste dump sites. The detailed reclamation plan will be implemented during the construction phase of the mine and will continue throughout its operational life.

The Social Environment

The level of effort required for Stage II will be dependent upon a review of the Stage I submission by the appropriate government agencies and from details from the mining plan. Although no studies are currently underway, community consultation with various interest groups will form an essential part of the Stage II program, as will close cooperation with local and Provincial authorities responsible for community planning and development.

## 7.2 Schedule

Several of the Stage II studies, initiated in December 1979, will be completed for inclusion in the Stage II report, which is scheduled for submission in December 1980. Some of these studies that require a longer time frame for completion will be referred to in the Stage II report and will continue in 1981 during the construction phase.

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