Reference Materials on Sedimentation and Morphology of the Lower Fraser River

compiled by

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SECOND EDITION

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Reference materials on sedimentation and morphology of the lower Fraser River.

GB
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1985-1

Reference materials on sedimentation and morphology of the lower Fraser River.

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Introduction

This report presents a compilation of reference materials on the subjects of physical hydrology, sedimentation, morphology, and related engineering problems on the lower course of Fraser River, British Columbia. The "lower course" of the river is taken to mean the river between Yale and the sea, a distance of some 190 km (114 miles). This includes the entire length of the alluvial channel of the river below Fraser canyon (cf. figure 1).

Between Yale and Hope (165 km; 99 mi. above the mouth), the river flows in a straight, single channel that is more or less constricted between Pleistocene terraces and, sometimes, bedrock. Below Hope, the river flows through its own floodplain and delta to the sea. Between Wahleach Creek (Laidlaw) and the mouth of Sumas River the channel is wandering or braided, and below that follows a single channel to the head of its "modern delta" at Port Mann, near the city of New Westminster. The lowermost 98 km (59 mi.) of the river's course may be subject to tidal influences during at least part of the year but, during the annual spring freshet tidal influence is much more restricted. Salt water is restricted to the lowermost few kilometres of the river. The so-called "estuary" of the river includes the reaches below Douglas Island and corresponds to that part of the river that is substantially affected by tides.

There are several major channels connecting the river with major lakes on the north side of the floodplain, and several more or less insignificant tributaries flowing to the main river on the south side. These channels and their alluvial deposits are included within the purview of the bibliography, though there is relatively little published work to report.

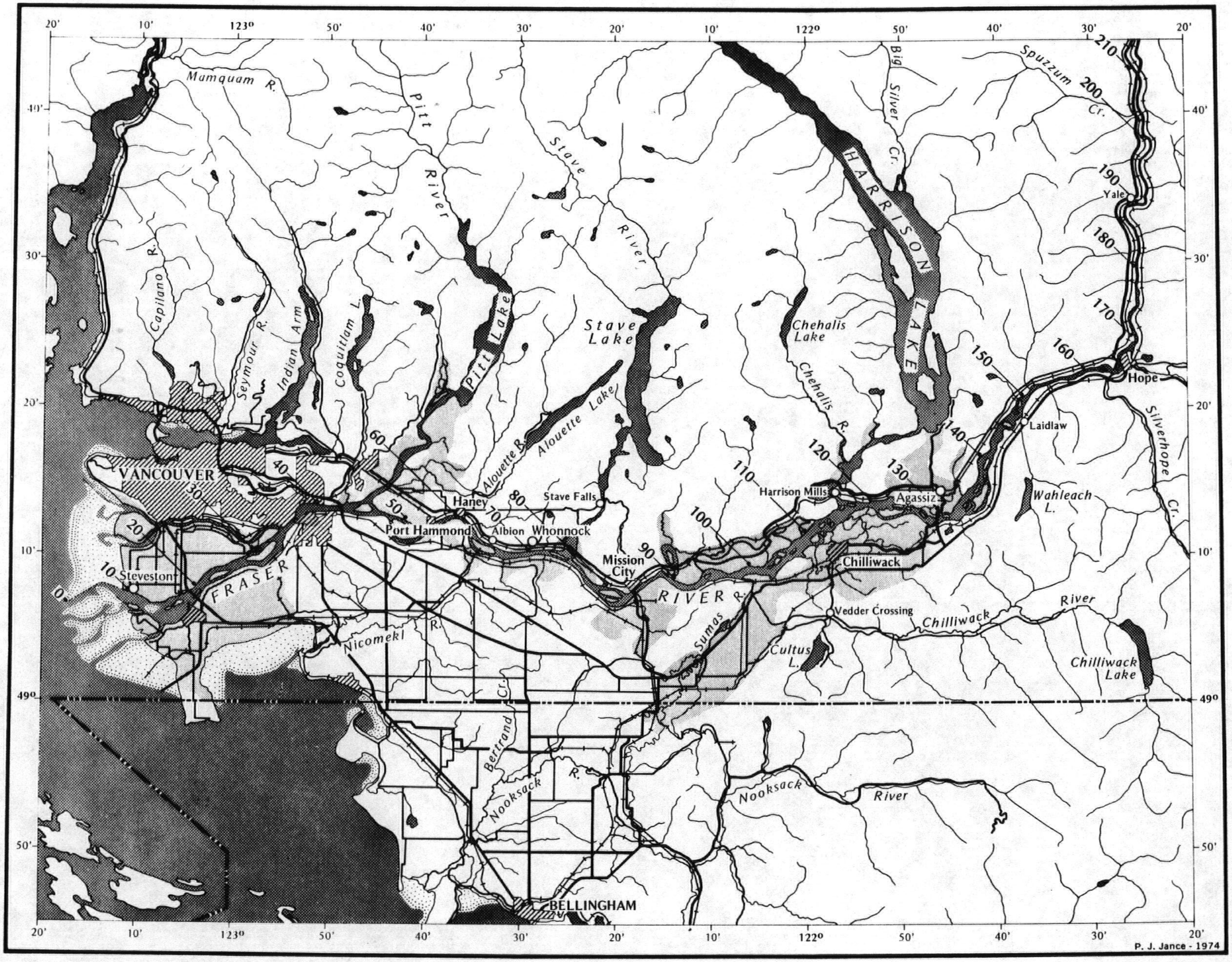
In making decisions about what material to include, several criteria were adopted:

1. The report attempts to be exhaustive in the central areas of clastic sedimentation and alluvial morphology. In relevant areas, such as physical hydrology and hydraulics, surficial geology, engineering works, more or less complete referencing is maintained. Some engineering and hydrological material was excluded--particularly relatively obscure reports that only incidentally contain information that is more explicitly or more readily available elsewhere. The particular subject of transport of dissolved materials has been included by listing major reports and sources of data. The general subjects of water quality and pollution of lower Fraser River waters have not been included, though.

2. The report is restricted to material making specific reference to the Fraser River. General reference works are excluded.

3. The report is restricted to material that is publicly accessible. A great deal of valuable information has been gathered in the course of commissioned engineering investigations. In many cases, however, the results remain restricted either by confidentiality or by the simple fact that the reports remain in one or two copies in private hands. Such

FIGURE 1. LOWER FRASER RIVER
(OPPOSITE)



LOWER FRASER RIVER REGION

Floodplain areas

Distances along Fraser River in Kilometres

Kilometres 10 0 20 30 40 50

Statute Miles 5 0 10 20 30

reports are not listed. Engineering and planning reports prepared for government agencies commonly become accessible for general or specific purposes and these are listed. The appearance of a reference in this report should not, however, be construed to mean that it is casually available.

4. The report does not list projects in progress.

5. References have generally been examined and confirmed by the writers, except as explicitly noted. In cases where the material has not been seen, it is included only if it has been reliably referenced in more than one source.

The bibliography is assuredly not complete. In several places, the existence of unexamined data resources is noted. Beyond that there are two particular areas of weakness:

(a) Historical materials related to the river, particularly photographic materials and local surveys: this material can only be uncovered by extensive search and fortuitous discovery. The work is beyond our resources.

(b) Engineering reports and other privately or irregularly published data. Companies, public agencies and individuals may often be willing to provide access for good purpose to materials that are nevertheless not noted or referenced elsewhere. In such cases, we have no means for systematically tracing materials.

The writers will appreciate reference to any relevant materials not included here.

Materials listed in this report are generally available in one or more of the following places:

The Library System
The University of British Columbia
Vancouver, British Columbia
V6T 1W5

National Air Photo Library
Surveys and Mapping Branch
Canada Department of Energy, Mines
and Resources
615 Booth Street
Ottawa, Ontario K1A 0E9

Air Photo Library
Surveys and Resource Mapping Branch
553 Superior Street
Victoria, B.C.
Mailing Address:
Parliament Buildings
Victoria, B.C. V8V 1X5

British Columbia Department of Environment
Victoria, British Columbia V8V 1X4

Report Library
Water Resources Service
British Columbia Department of Environment
737 Courtney Street
Victoria, British Columbia
Mailing Address:
Parliament Buildings
Victoria, B.C. V8V 1X5

Report Library
Environment Canada
Inland Waters Directorate
1001 West Pender Street
Vancouver, B.C.,

BIBLIOGRAPHIC REFERENCES

Bibliographic References

CLAGUE, J.J., GARDNER, R.H., RICKER, K.E., DONLEY, M.W., 1977, "Bibliography of Marine Geoscience Information, Pacific Regions of Canada 1900-1976" Geologial Survey of Canada, Paper 77-22, 43 p.

A selective bibliography of marine geoscience information for Pacific regions of Canada has been compiled. The inventory area is bounded by Dixon Entrance on the north; the Gulf-San Juan Islands, Juan de Fuca Strait, and the continental margin southwest of Vancouver Island on the south; and by the inlets of mainland B.C. and the Fraser Delta on the east. The bibliography comprises published papers, maps and readily available manuscript reports on geology, geochemistry and geophysics.

FOLSOM, M.M., 1970, The Glacial Geomorphology of the Puget Lowland, Washington and British Columbia: Comments and selected references. Northwest Science, 44; 143-146.

HOOS, L.M., and PACKMAN, G.A., 1974, The Fraser River Estuary: Status of Environmental Knowledge to 1974. Canada Department of the Environment, Regional Board: Pacific Region, Special Estuary Series No. 1. Vancouver, (Report to the Estuary Working Group) 238 pp. & Appendices.

The purpose of this report is to integrate the most pertinent available literature relating to the Fraser estuary and delta, so that rational informed decisions may be made in future planning.

LANDS DIRECTORATE, 1974 (February), Bibliography of Land Resource Information for 17 Estuaries in British Columbia, Canada Department of the Environment -Vancouver, Section A: 22 pp.

The objective of this report is to provide a list of selected references on land resource information for 17 estuaries in British Columbia, including Fraser River estuary. The emphasis of this bibliography is on published and unpublished surveys, reports and maps that deal with the soils, geology, and land capability of or near the estuary.

MARK, D.M., and OJAMAA, P.M., 1972, The Glacial Geomorphology of the Puget Lowland, Washington and British Columbia: Further comments and references. Northwest Science: 46; 336-338.

PRETIOUS, E.S., 1961, All publications prepared or issued by the Fraser River Model Office from commencement of the project up to and including August, 1961. University of British Columbia, Department of Civil Engineering, 10 pp. (mimeo).

Lists all publications, reports, memos, etc. relating to Fraser River Model. Includes many reports on aspects of river training which may contain comments on scour and fill. Reports primarily concerned with sediment transport are separately listed.

RICKER, K.E., 1974, Inventory of Marine Surficial Geology, Sedimentology, Geomorphology, Quaternary Paleontology and Palaeocology, Geochemistry and Related Studies of the Pacific Shelf of Canada. Part I. Coastal Areas of British Columbia, Washington and Alaska. Geological Survey of Canada, Department of Energy, Mines and Resources. Open File No. 197. 46 pp & map.

This bibliography of marine Quaternary investigations of the Pacific Shelf and Inside Waterways of Canada and adjacent areas of the United States includes about 200 major geologic reports. There are approximately another 400 reports of either supporting importance or other indirect relationship to the study of marine surficial sediments. The areal extent of each listed investigation is shown on an Inventory Map. Main sources of information include many governmental agencies and academic research projects. A large number of consultant geotechnical references have yet to be added. Efforts have been made to acquire information on the 17-18 critical estuaries currently under review by several agencies of the Department of Environment, including their Estuary Working Group. As the bibliography is updated, consultant geotechnical studies of inshore areas and investigations of the Pacific offshelf deep areas will be referenced as a second phase to this project.

PRIMARY DATA AND STATION LISTS

Primary Data and Station Lists

BRITISH COLUMBIA DEPARTMENT OF HIGHWAYS, Microfilm file of borehole information on British Columbia Highways and related installations. Victoria, British Columbia.

Much of the pertinent information for the estuarine region is in the Vancouver urban geology file (loc. cit.).

CANADA DEPARTMENT OF PUBLIC WORKS, 1972, Dredging summary: Fraser River and North Arm, 1959-1971. Vancouver, British Columbia. Internal memorandum mimeo: 2 pp.

Summary of total material removed by year, by dredging area. Lacks interpretive notes.

CANADIAN HYDROGRAPHIC SERVICE, Canadian Tide and Current Tables. 5. Juan da Fuca and Georgia Strait. Marine Sciences Branch, Canada Department of the Environment. (Formerly Department of Energy, Mines and Resources). Before 1967, titled Pacific Coast Tide and Current Tables (Canada Department of Mines and Technical Surveys). Before 1963, produced by Tidal Survey, Canadian Hydrographic Service, Surveys and Mapping Branch. Tidal Publication No. 10. Before 1951, agency name changes variously.

Gives tide time and height differences referred to Point Atkinson for secondary ports at the following stations: Sand Heads, Steveston, New Westminter*, Port Coquitlam*, Port Haney*, Sumas*.
River stations (*) show corrections for "ordinary months" and for "freshet months".

GEOLOGICAL SURVEY OF CANADA, Vancouver Office, n.d., Vancouver Urban Geology File. Canada Department of Energy, Mines and Resources. Map + card files.

Records borehole and other geological information - mainly engineering geological soil data - for sites in the Greater Vancouver region. File is organized according to UTM Military Grid reference coordinates and positions are plotted on NTS 25,000 series maps. Records relevant to Fraser River Sedimentary deposits are included on the following maps.

- 92 G/2e: New Westminster
- 92 G/2f: Port Mann
- 92 G/3g: Sea Island
- 92 G/3h: Mitchell Island

MCLEAN, A., n.d., MS compilation of drill hole data for the Vancouver International Airport and adjacent Sea Island areas. Canada. Ministry of Transport. Unpublished data compilation.

Includes data for the channel areas adjacent to Sea Island. Data mainly in Vancouver Urban Geology File.

WATER RESOURCES BRANCH, 1956-1966, Surface Water Supply of Canada, Pacific Drainage: British Columbia and Yukon Territory. Canada Department of Northern Affairs and National Resources. Water Resources Papers. No. 124: 1956-58 (n.d.); No. 128: 1958-59 (n.d.); No. 131: 1959-60 (n.d.); Titled: Surface Water Data for Pacific Drainage. No. 136: 1960-61 (Pub. 1969), No. 139: 1961-62 (1965); No. 142: 1962-63 (1966). Canada Department of Energy, Mines and Resources. No. 146: 1963-64 (Pub. 1966). Prior to 1956 data were released in Water Resource Papers, under the same title, by the Water Resources Division, Engineering and Water Resources Branch, Canada Department of Northern Affairs and National Resources. Prior to 1951 this office came under Canada, Department of Resources and Development. Prior to 1944 papers were issued by the Dominion Water and Power Bureau, Canada Department of Mines and Resources. Prior to 1930 papers were issued by various offices of Canada, Department of the Interior.

WATER SURVEY OF CANADA, 1968- Surface Water Data British Columbia, 1965- Canada, Department of Energy, Mines and Resources, Inland Waters Branch, 1968. Canada, Department of the Environment, Inland Waters Branch, 1969-71 (Pub. 1971-1972), Canada, Department of the Environment, Inland Waters Directorate, 1972 (Pub. 1973 - 1 volume per year).

WATER SURVEY OF CANADA, 1972, Surface Water Data Reference Index Canada 1972. Canada, Department of the Environment, Inland Waters Directorate; 411 pp. For Fraser River Mainstem and Tributary Stations refer to p. 111-157. Station list for Lower Fraser River is given as Table 1.

WATER SURVEY OF CANADA, 1980, Historical Streamflow Summary British Columbia to 1979. Canada, Department of the Environment, Inland Waters Directorate, 861 pp.

Contains alphabetical index of stations (by name), with monthly and annual mean discharges for period of record.

WATER SURVEY OF CANADA, 1968-. Sediment Data for Selected Canadian Rivers, 1965-. Canada Department of Energy, Mines and Resources, Inland Waters Branch. 1965-1968 (Published 1968-1970). Canada Department of Environment, Inland Waters Directorate, from 1969 (Pub. 1973)-. 1 volume per year.

Contains data of sediment transport observations.

WATER SURVEY OF CANADA, 1980, Historical Sediment Data Summary, Canadian Rivers to 1978. Environment Canada, Inland Waters Directorate, 121 pp.

Summarizes maximum and minimum daily sediment loads and concentrations and monthly and annual sediment loads at Hope, Agassiz, Mission and Port Mann.

WATER QUALITY BRANCH, 1973, Index of Water Quality Stations. Canada, Department of the Environment. Inland Waters Directorate, 100 pp.

Contains information on station sampling frequency, period of record, and parameters measured. Fraser River basin station list is given as Table 3.

Table 1

Lower Fraser River: Stage and Streamflow Data (includes major tributaries).

Stations maintained by the Water Survey of Canada, Inland Waters Directorate, Canada Department of the Environment. (Stage only*) (Miscellaneous Measurement #).

Station Number	Station Name	Gauge Location	Drainage area (km^2)	Period of record (years)
08MF044	Fraser River near Yale	49°31'04" 121°24'49"		55* (not published)
08MF005	Fraser River at Hope	49°22'05" 121°27'05"	217 000	12-
08MF047	Fraser River at Wahleach Power House	49°14'15" 121°41'00"		60-64*
08MF035	Fraser River near Agassiz (formerly near Rosedale)	49°12'16" 121°46'35"	218 000	12# 49-65* 66-
08MF060	Fraser River at Magellan (formerly near Harrison Mills)	49°13'33" 121°53'40"		64*
08MF064	Fraser River near Chilliwack	49°11'56" 121°57'05"		33-45* 46-50*
08MF058	Fraser River at Shefford Slough	49°11'13" 121°59'27"		62-64*
08MF057	Fraser River at Chilliwack Sewer Outfall	49°10'07" 122°00'16"		62-63*
08MF056	Fraser River at Chilliwack Mountain	49°09'48" 122°01'25"		62-68*

Table 1 (continued)

Station Number	Station Name	Gauge Location	Drainage area (km^2)	Period of record (years)
08MF038	Fraser River at Cannor	48°08'35" 122°03'51"		51-63*
08MH124	Fraser River at Cox	49°07'40" 122°11'41"	228 000	67-*
08MH071	Fraser River at Hatzic Lake Pumphouse (formerly near Hatzic)	49°08'46" 122°14'47"		60-64*
08MH024	Fraser River at Mission (formerly at Mission City)	49°07'39" 122°18'08"	228 000	1876*, 82* 1894-1964* 65-
08MH044	Fraser River at Whonock	49°10'21" 122°28'26"		54-*
08MH043	Fraser River at Port Hammond	49°12'09" 122°39'16"		54-*
08MH126	Fraser River at Port Mann Pumping Station	49°13'04" 122°49'37"	232 000	67-69* 70-
08MH054	Fraser River at Port Mann	49°13'03" 122°50'20"	232 000	35#, 48#, 54* 56-64
08MH025	Fraser River at New Westminster	49°12'13" 122°54'11"	232 000	19-20# 35-36* 42-

Table 1 (continued)

Station Number	Station Name	Gauge Location	Drainage area (km^2)	Period of record (years)
08MH042	Fraser River at Burr Landing (formerly near Ladner)	49°07'45" 123°02'57"		54-61*
08MH053	Fraser River at Deas Island Tunnel	49°07'30" 123°04'25"		49-51* 56-60*,62-*
08MH032	North Arm Fraser River at Vancouver	49°12'18" 123°05'17"		34# 45-
08MH028	Fraser River at Steveston	49°07'27" 123°11'06"		19# 33-
08MF009	Silverhope Creek near Hope	49°21'47" 121°28'09"	350	11-13 48# 65-71
08MG013	Harrison River near Harrison Hot Springs	49°18'40" 121°48'08"	7870	23-24# 51-
08MG014	Harrison River at Harrison Mills	49°14'01" 121°57'30"		38-
08MH001	Chilliwack River at Vedder Crossing	49°05'50" 121°57'45"	1230	11-31 43-51* 52-
08MH040 (08MH011)	Stave Lake Inflow (Stave River at Stave Falls)	49°13'46" 122°21'18"	935	01, 05-09 10-13

Table 1 (continued)

Station Number	Station Name	Gauge Location	Drainage area (km^2)	Period of record (years)
08MH017	Pitt River near Alvin	49°39'50" 122°41'10"	515	52-65
08MH062	Pitt Lake near outlet	49°21'15" 122°34'38"		62-*
08MH063	Pitt River opposite Widgeon Creek	49°20'41" 122°37'32"		62-63* (not published)
08MH064	Pitt River below Sturgeon Slough	49°17'16" 122°40'19"		62-63* (not published)
08MH035	Pitt River near Port Coquitlam	49°14'40" 122°44'00"	1640	48-* (not published)
08MH002	Coquitlam River at Port Coquitlam	49°15'56" 122°46'51"	237	15-16 60-61 62#, 63#, 64# 68-78 80-
08MF003	Coquihalla River near Hope	49°22'31" 121°25'10"	741	11-22 26* 55* 57-

Table 2

Fraser River: Clastic Sediment Transport Data.

Stations maintained by the Sediment Survey Section, Water Survey of Canada, Inland Waters Directorate, Canada Department of the Environment.

Station Name	Suspended Sediment Load	Bed Load	Bed Material Size	Suspended Particle Size	W.S.C. Ref. Gauging Station
Chilliwack River at Vedder Crossing	65-76	71	73-	68 72-73	08MH001
Fraser River near Agassiz	66-	68-	-	66-	08MF035
Fraser River at Hope	65-79	-	-	65-79	08MF005
Fraser River at Mission	65-	73-	65-	65-	08MH024
Fraser River at Port Mann	65-78	73-78	65-78	65-78	08MH054
Harrison River near Harrison Hot Springs	65-71	-	-	-	08MG013
Pitt River near Port Coquitlam	65-74	-	-	-	08MH035
Silverhope Creek near Hope	65-71	-	-	-	08MF009
Stave River at Stave Falls	65-71*	-	-	-	08MH040

*Measurements very sporadic at this station.

See also Kidd (1953) for additional measurements.

Table 3

Fraser River: Water Quality Stations.

Stations maintained by the Water Quality Branch, Inland Waters Directorate, Canada Department of the Environment (See notes following table).

Station Number (00BC08-)	Station Name	Station Location	Sample Freq.	Period of Record (years)	WSC Ref. Gauging Station
KA0001	Fraser River at Hwy. 16 bridge, Hansard	54°04'35" 121°50'52"	Q	62-63	08KA004
KB0001	Fraser River at Shelley	54°00'40" 122°37'00"	M	67-	08KB001
KE0001	Fraser River at Hwy. 97 bridge, Quesnel	52°58'32" 122°29'50"	M	62-	
MC0001	Fraser River at ferry crossing, 2 miles north of Marguerite	52°31'48" 121°26'32"	M	71-	08MC018
ME0001	Fraser River at Hwy. bridge, north of Lillooet	50°42'41" 121°54'39"	Q	61-62	
LB0001	North Thompson River at Hwy. 5 bridge, Mclure	51°02'31" 120°14'28"	M	62-	08LB064
LE0001	South Thompson River at Kamloops, intake at City Treatment Plant	50°40'50" 120°19'29"	Q	61-	
LF0001	Thompson River at Hwy. 1 bridge, Spences Bridge	50°21'17" 121°23'35"	M	61-	08LF051
MF0001	Fraser River at Hwy. 1 bridge, Hope	49°23'12" 121°26'59"	M	-	08MF005
MH0004	Fraser River at Mission City	49°07'39" 122°18'08"	M	60-	08MH024
JC0001	Nechako River at Dept. of Highways ferry crossing, 0.5 miles north of Isle Pierre	53°57'37" 123°14'01"	M	67-	08JC002
JE0001	Stuart River at Hwy. 27 bridge, 2 miles south of Fort St. James	54°25'00" 124°15'55"	M	67-	08JE001

Sampling Frequency:

M - Monthly

Q- Quarterly

Parameters Measured:

All samples are routinely analysed for major ions, (calcium, magnesium, potassium, sodium, bicarbonate, carbonate, chloride, and sulphate), pH, specific conductance, colour, turbidity, and total alkalinity. In addition, about every third sample is analysed for extractable and dissolved iron, extractable and dissolved manganese, fluoride, phosphate, ammonia, and residue on evaporation at 105°C. Occasional samples are also analysed for heavy metals (copper, zinc, and lead).

AIR PHOTOGRAPHY

Air Photography

The index of air photography is divided as follows:

- federal photography (all scales)
- provincial photography special projects
- provincial photography: 20 chain (1:15840)
- provincial photography: 40 chain (1:31680)

The record of federal photography may be incomplete. Provincial 80 chain photography was not recorded as the quality of information to be gained from it was thought to be redundant by comparison with the larger scale material. Provincial special projects are also incomplete since some very localized coverage of the river was not included. It is probable that some photography exists for every year since 1948.

The trimetrogon photography of ca. 1947-1952 has not been recorded. The cataloguing of this material is very complex. The material is of use chiefly for oblique views of the river. An index to the trimetrogon photography is held in the Map Library, Department of Geography, University of British Columbia, in addition to provincial and federal photographic archives.

Historical airphotography of the Fraser River delta tidal flats has been catalogued by the Geological Survey of Canada. Detailed maps have been prepared showing flight lines over the estuary for Provincial and Federal photography between 1922 and 1978. The reference to this work is:

Leroux, J. and Luternauer, J.L., 1979
"Comprehensive Compilation of Airphoto Indices
for the Fraser Delta Foreshore (Point Grey to
Tsawwassen), 1922-1978".
Cordilleran and Pacific Margin Division
Geological Survey of Canada
Dept. of Energy, Mines and Resources
Vancouver, B.C.

Remote sensing data has not been catalogued in this report. Documentation of remote sensing data up to 1975, covering the Fraser delta from the U.S. Border to Point Atkinson is available at the Federal and B.C. Provincial airphoto libraries. Reference to this documentation is:

"Remote Sensing Data Summary: Fraser River Delta"
Environmental Protection Service, Environment Canada, 1976.

More recent Landsat imagery listing can be obtained by writing to:

Canada Centre for Remote Sensing
User Assistance and Marketing Unit
717 Belfast Road
Ottawa, Ontario
K1A 0Y7
Ph. (613) 995-1210

FEDERAL AIR PHOTOGRAPHY

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1928 (15 July)   SCALE: 1:10,000 approx.

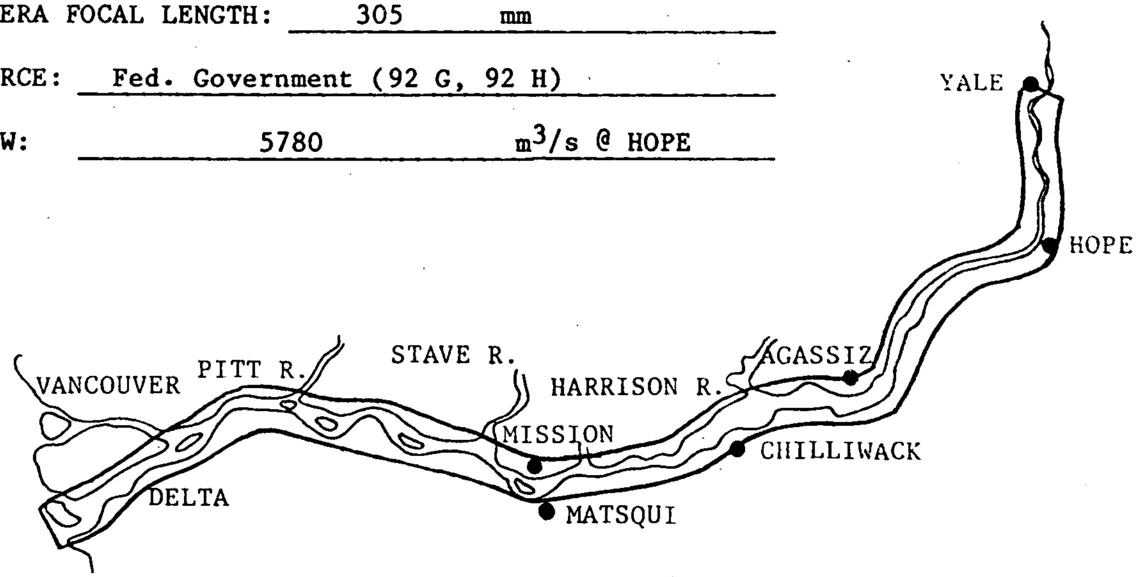
FLIGHT LINE ORIENTATION: Follow River

FLYING HEIGHT: 3110 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: Fed. Government (92 G, 92 H)

FLOW: 5780 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 289	1-40	RUBY CK. - YALE
A 297	1-21	HOPE
"	22-53	HOPE - YALE
A 288	5-104	WHONOCK CK. - RUBY CK.
A 296	1-90	MT. LEHMAN - WAHLEACH CK.
A 295	1-101	CANOE PASS - STAVE R.
A 287	1-100	SANDHEADS - ALBION

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1932 SCALE: 1:15,000

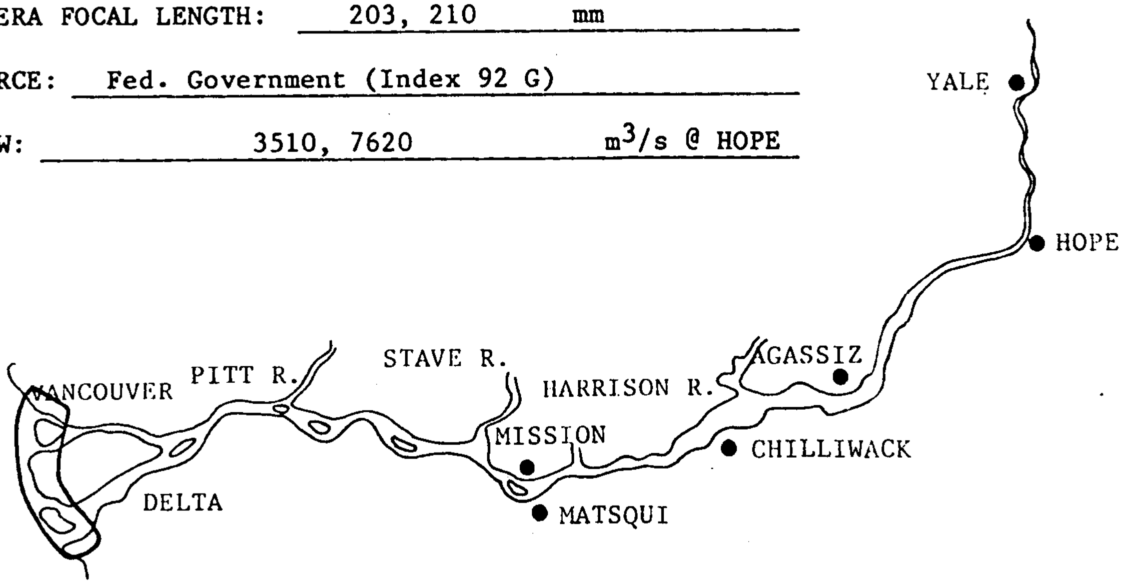
FLIGHT LINE ORIENTATION: north-south

FLYING HEIGHT: 3050 mASL

CAMERA FOCAL LENGTH: 203, 210 mm

SOURCE: Fed. Government (Index 92 G)

FLOW: 3510, 7620 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 4427	2-9	WESTHAM IS.
"	12-19	NORTH ARM
"	29-34	" "
"	37-48	WESTHAM IS.
"	55-80	DELTA FRONT
A 4445	50-65	STURGEON BANK
"	66-78	" "

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1938 SCALE: 1:22,500 approx.

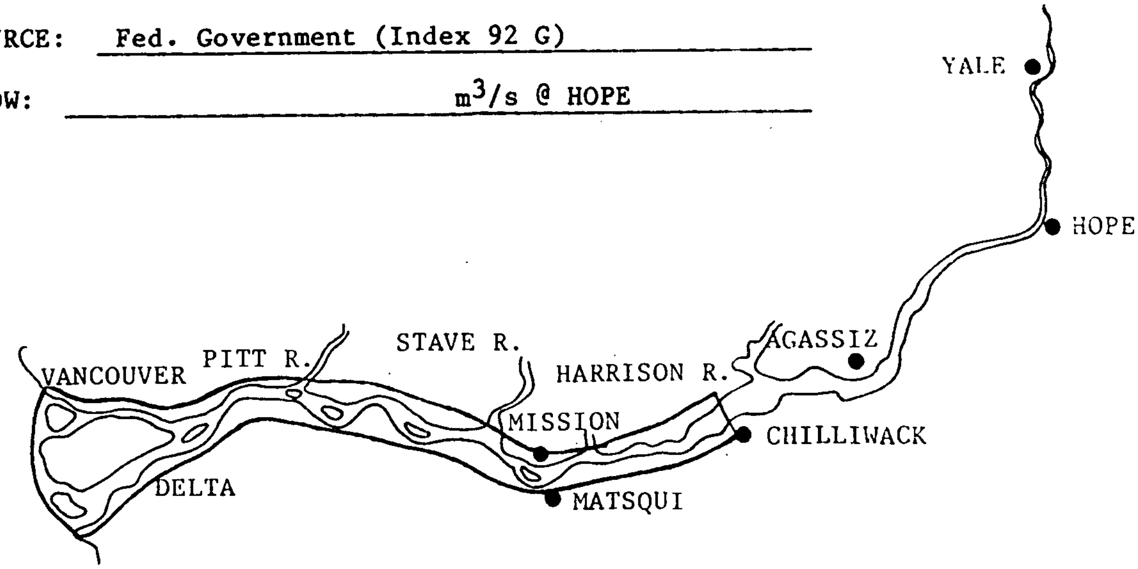
FLIGHT LINE ORIENTATION: Follow River

FLYING HEIGHT: 3050 mASL

CAMERA FOCAL LENGTH: 254, 305 mm

SOURCE: Fed. Government (Index 92 G)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.		REMARKS
A 5869	7 Apr	11-56	HARRISON R. - MATSQUI IS.
A 5870	"	7-48	"
A 5869	"	60-76	MATSQUI IS. - WILSON CK.
A 5871	"	55-57	MISSION
"	"	69-75	STAVE R.
"	"	88-90	HANEY
A 5937	18 May	1-51	MISSION - CHATHAM REACH
A 5871	7 Apr	1-54	PORT MANN - MATSQUI
A 5870	"	54-62	MATSQUI IS.
"	"	75-82	FT. LANGLEY
"	"	88-104	BARNSTON IS. - PORT MANN
A 5872	9 Apr	19-31	N. ARM JETTY
"	"	39-66	NORTH ARM
A 5985	6 June	1-30	WESTHAM IS. - NEW WEST.
A 5938	18 May	1-45	" "
A 5984	6 June	20-52	CANOE PASS - ANNACIS IS.
A 5936	18 May	44-63	CRESCENT SLOUGH - SANDHEADS
"	"	1-21	GRAVESEND REACH - GARRY PT.
A 5984	6 June	70-77	E. END LULU IS.
"	"	89-103	DELTA FRONT - GRAVESEND REACH
A 5872	9 Apr	55-67	" "
A 5939	"	1-9	" "
A 5984	6 June	58-66	PORT MANN
A 5939	9 Apr	11-54	CHILLIWACK - MATSQUI

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1943 (5 Dec) SCALE: 1:15,000 approx.

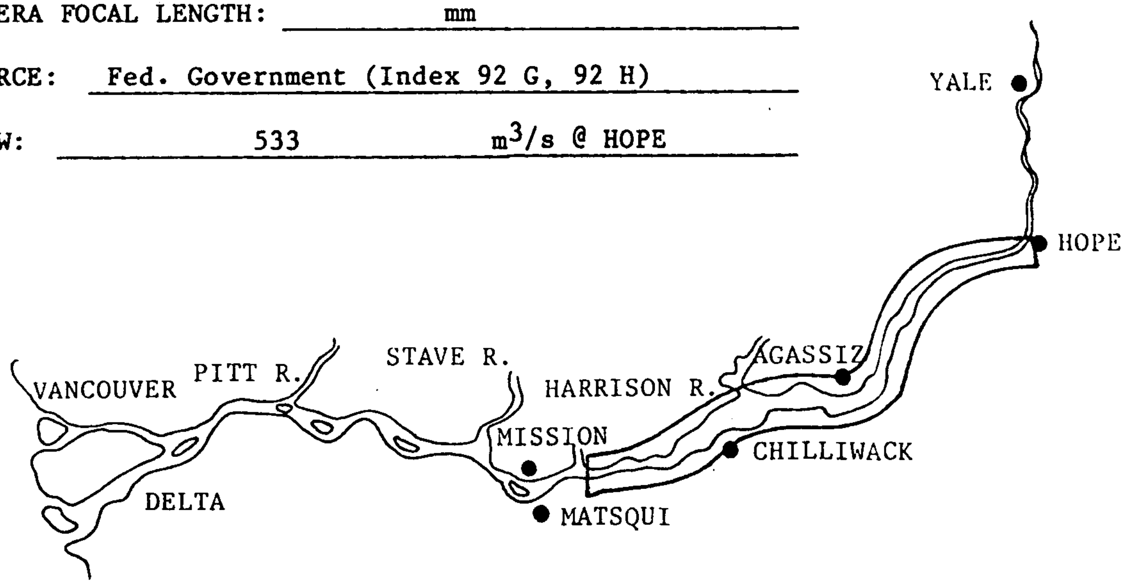
FLIGHT LINE ORIENTATION: Follow River unless noted

FLYING HEIGHT: mASL

CAMERA FOCAL LENGTH: mm

SOURCE: Fed. Government (Index 92 G, 92 H)

FLOW: 533 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 7077	5 Dec 36-59	WAHLEACH CK. - HOPE
A 7076	" 9-14	WAHLEACH CR. (EW)
"	" 27-34	"
A 7078	" 11-20	SEABIRD IS. "
"	34-40	"
"	57-59	"
"	73-78	"
"	79-96	CHILLIWACK - CHEAM VIEW (EW)
A 7077	5 Dec 1-34	CHILLIWACK - CHEAM VIEW "
A 7075	" 1-39	HATZIC - HARRISON R.
A 7074	" 29-53	SUMAS MTN. - CHILLIWACK
"	" 54-76	NICOMEN SLOUGH - CHILLIWACK

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1946 (8 Aug) SCALE: 1:24 000 (Approx)

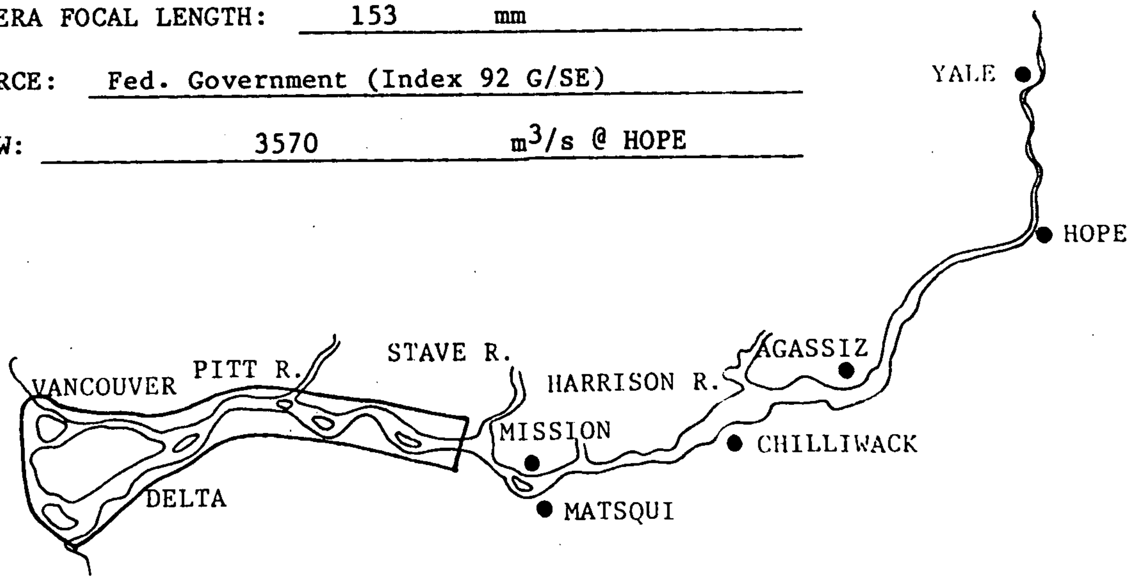
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 3660 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 92 G/SE)

FLOW: 3570 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 10399	1-25	SEA IS. - KANAKA CK.
A 10397	114-140	WHONOCK - SEA IS.
"	87-100	DELTA FRONT - ANNACIS IS.
"	105-113	BARNSTON IS. - WHONOCK
"	78-86	TILBURY IS. - GARRY PT.
"	29-36	WESTHAM IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1948 (23 May) SCALE: 1:21 000 Approx

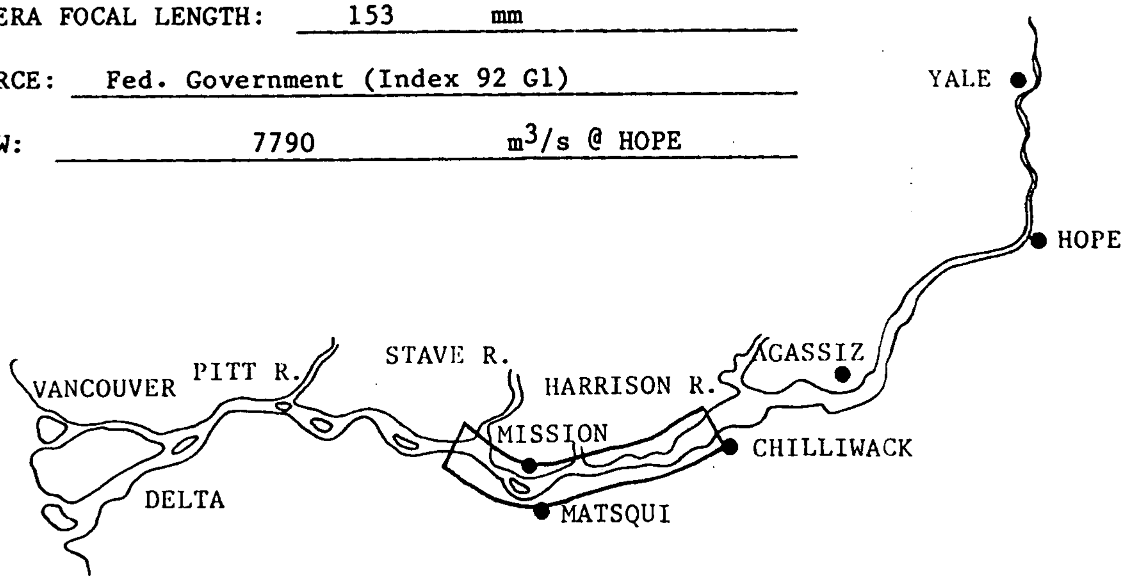
FLIGHT LINE ORIENTATION: Follow River

FLYING HEIGHT: 3190 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 92 G1)

FLOW: 7790 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 11343	10-13	MATSQUI IS.
"	135-150	MATSQUI IS. - CHILLIWACK
A 11344	4-8	HOPE
"	40-43	SEABIRD IS. (EW)
"	19-24	LAIDLAW
"	9-14	RUBY CK.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1951 (28 Jul, 6 Aug) SCALE: 1:70,000 approx.

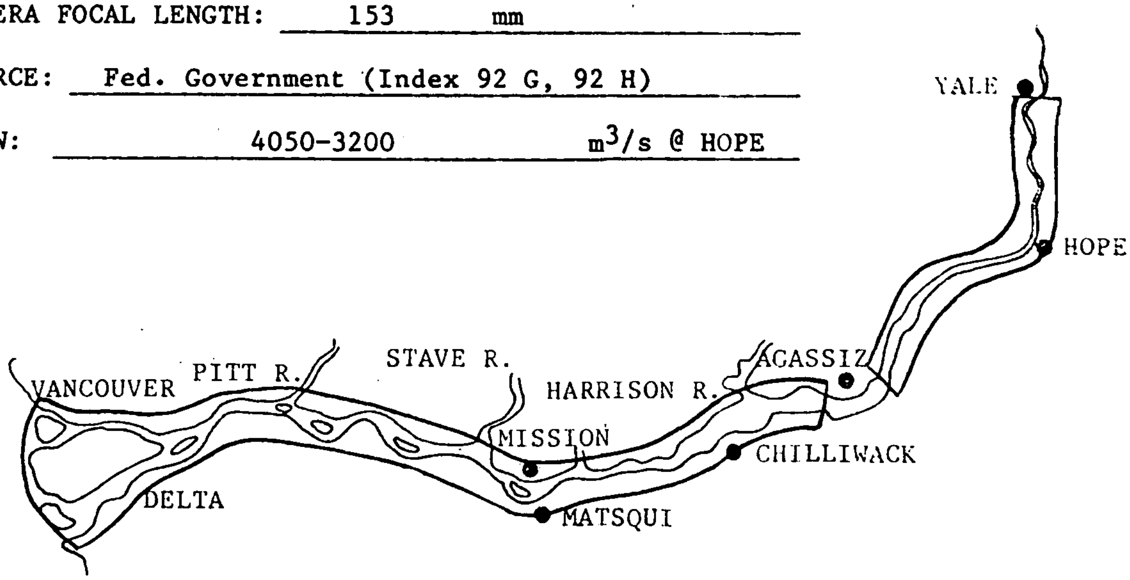
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 10,670 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 92 G, 92 H)

FLOW: 4050-3200 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 13245	1-20	PT. GREY - LAIDLAW
A 13247	18-32	SANDHEADS - CHILLIWACK
"	46-47	WESTHAM IS.
A 13245	36-38	HOPE - LAIDLAW
"	84-86	
"	98-100	EMORY CK.
A 13250	207-209	YALE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1959 SCALE: 1:64,000 approx.

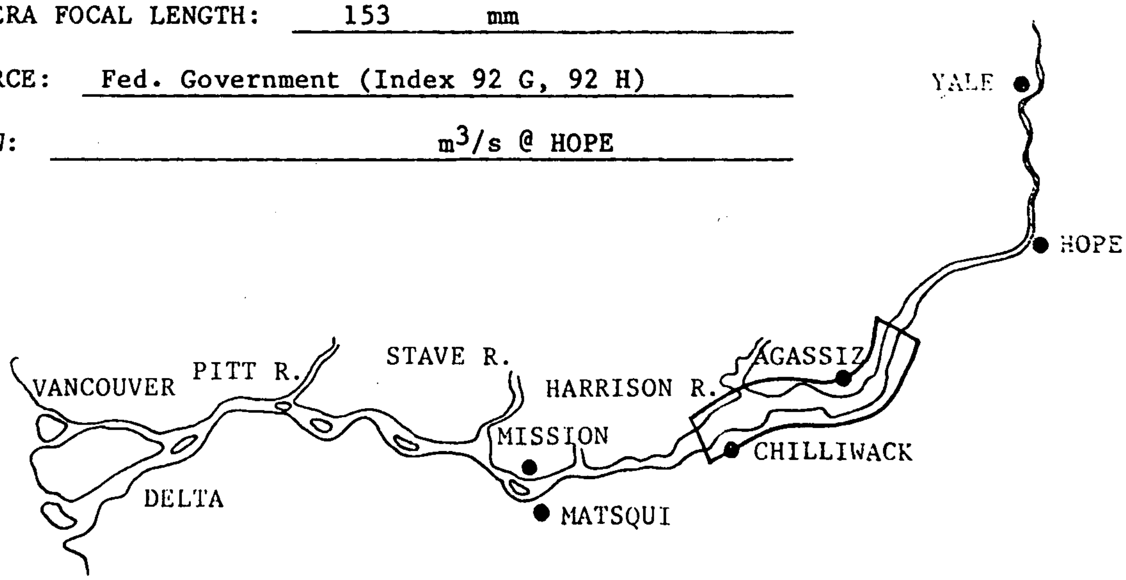
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 9750 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 92 G, 92 H)

FLOW: m³/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 16664	110-116	CHEAM VIEW - HARRISON HILLS
"	117-123	

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1960 SCALE: 1:12,000, 1:18,000, 1:22,000

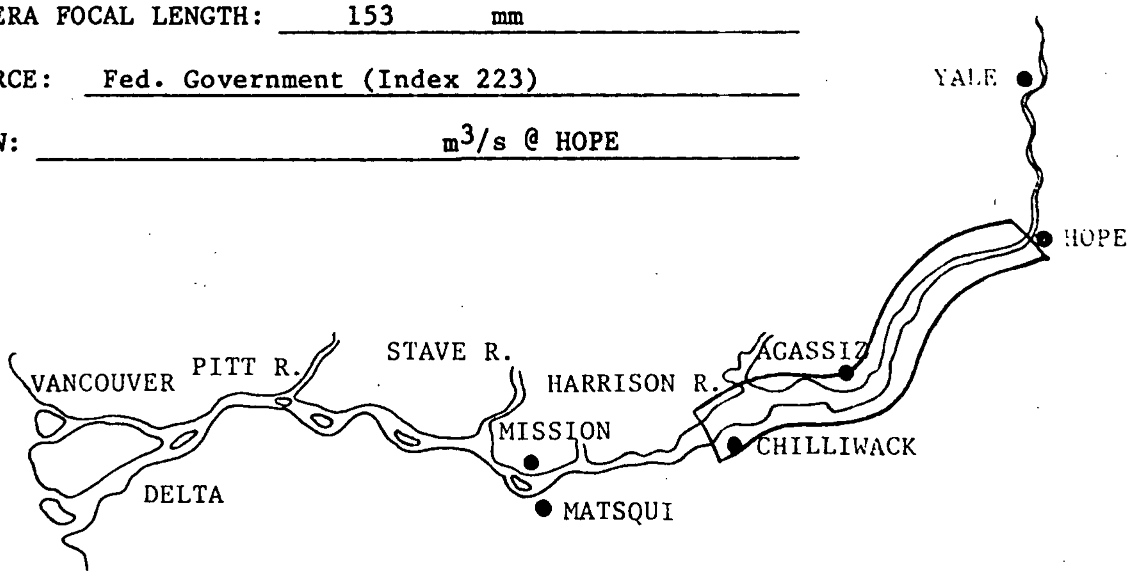
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1830, 2740, 3350 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 223)

FLOW: ______ m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS	
A 17247	75-85	HOPE - RUBY CK.	2740 m
"	56-70	RUBY CK. - POPKUM	
"	43-55	CHILLIWACK	
"	10-15	"	
A 17084	32-40	RUBY CK.	1830 m
"	21-30	LAIDLAW	
"	7-14	SEABIRD IS.	
"	17-20	CHEAM VIEW	3350 m

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1961 SCALE: 1:25,200

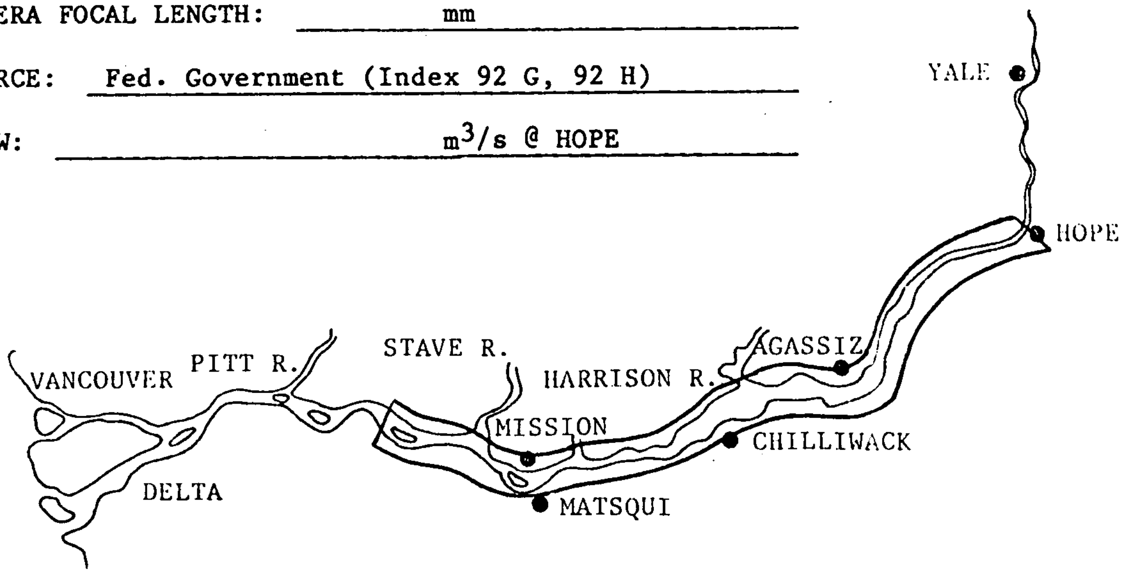
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: mASL

CAMERA FOCAL LENGTH: mm

SOURCE: Fed. Government (Index 92 G, 92 H)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 17282	5-31	CHILLIWACK - FT. LANGLEY
"	38-51	MT. LEHMAN - CHILLIWACK
A 17249	42-56	NICOMEN SLOUGH - POPKUM
"	1-10	AGASSIZ - HARRISON MILLS
A 17566	76-85	
"	63-73	RUBY CK. - HOPE
A 17244	28	

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1963 SCALE: 1:18,000

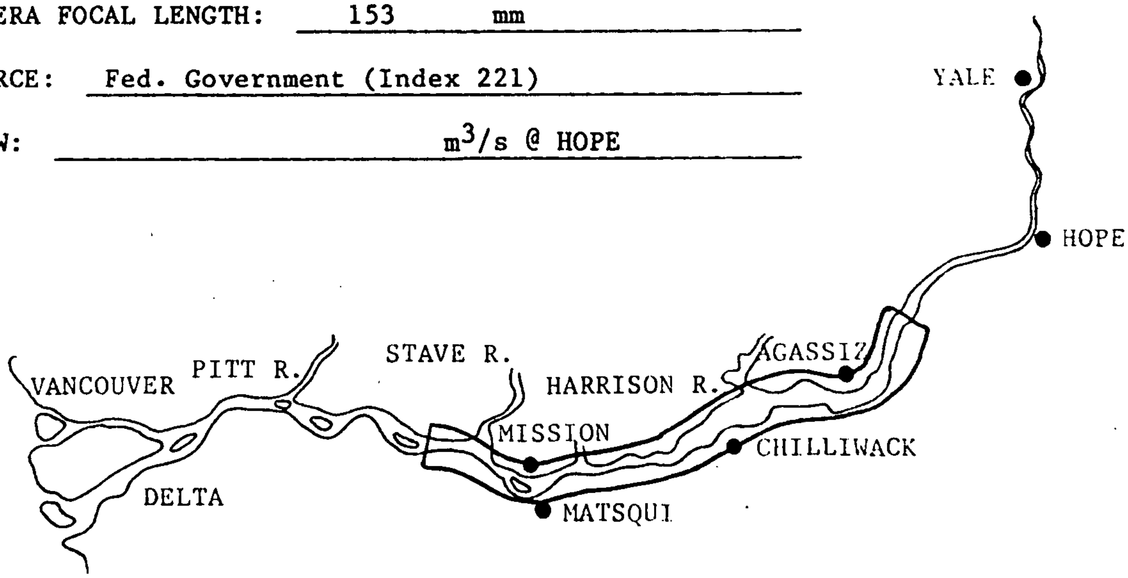
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2740 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 221)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 17962	165-177	NICOMEN IS.
"	190-197	"
A 17964	26-30	"
A 17962	150-158	"
"	38-49	"
"	1-20	FRASER MILLS
A 17960	4-15	MATSQUI
"	20-23	HANEY

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1964 SCALE: 1:18,000

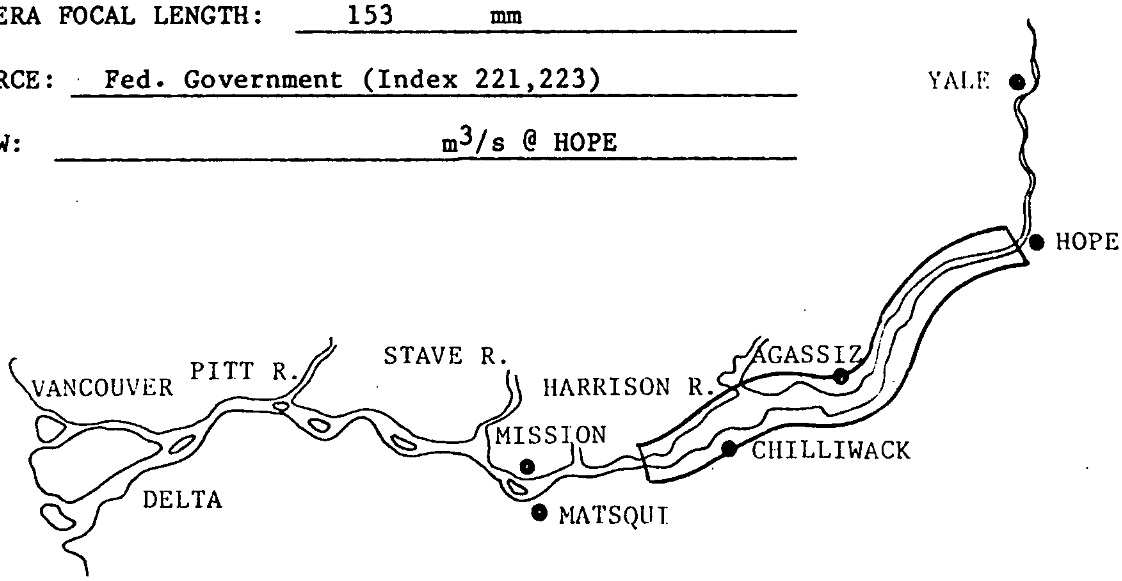
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2740 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 221,223)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 18340	1-12	RUBY CK. - HOPE
"	19-25	SEABIRD IS.
"	13-28	RUBY CK. - ROSEDALE
"	30-36	CHEAM VIEW
"	37-44	CHILLIWACK
"	47-57	"
"	68-74	"
"	75-82	"
"	89-101	NICOMEN IS.
"	60-67	"
"	83-88	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1964 (7 Apr) SCALE: 1:25,200

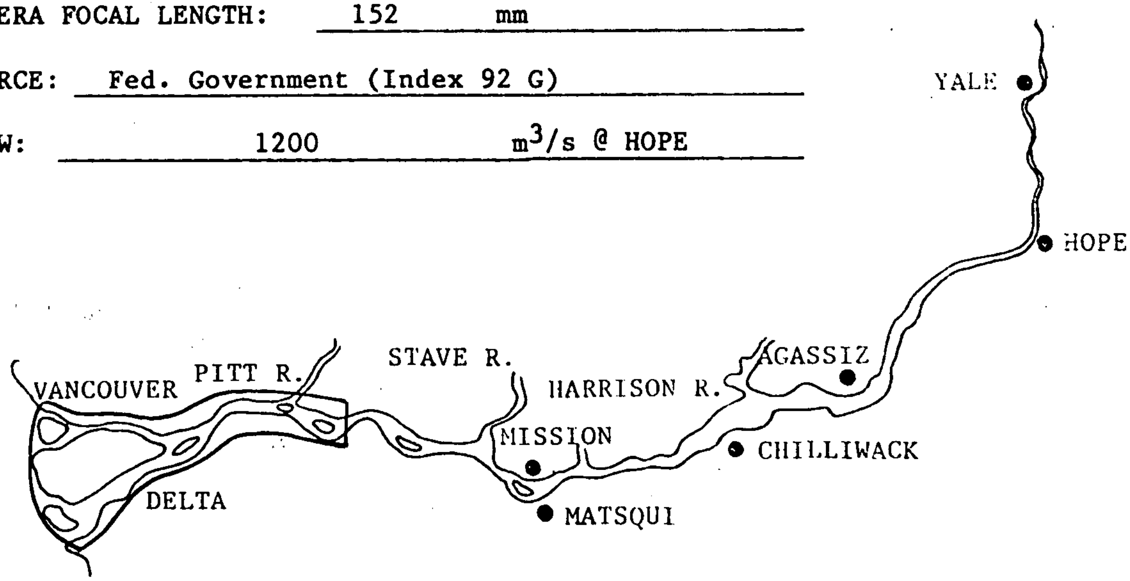
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 3810 mASL

CAMERA FOCAL LENGTH: 152 mm

SOURCE: Fed. Government (Index 92 G)

FLOW: 1200 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 18342	28-48	N. ARM JETTY - CHATHAM REACH
"	58-85	KANAKA CK. - STURGEON BANK
"	86-88	W. EDGE LULU IS.
"	92-96	ANNACIS IS.
"	162-181	SANDHEADS - GRAVESEND REACH
"	108-111	FT. LANGLEY

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1965-66 SCALE: 1:6,000, 1:18,000

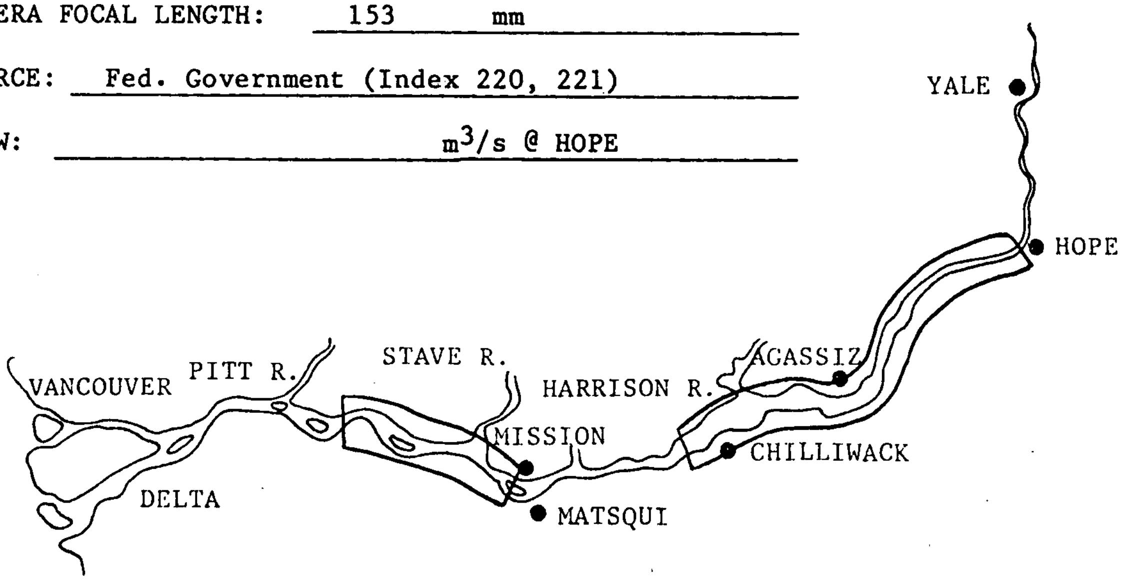
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 940, 2740 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 220, 221)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 18937	240-250	HOPE - RUBY CK.
"	224-239	RUBY CK. - POPKUM
"	195-200	CHEAM VIEW
"	210-223	POPKUM - HARRISON R.
"	180-185	HARRISON R.
"	165-171	"
"	176-179	NICOMEN IS.
"	172-175	"
"	137-144	"
"	126-136	"
"	251-260	PORT HAMMOND
A 18936	1-4	PITT R.
"	11-14	PORT HAMMOND
"	20-29	"
A 20261	1-10	MATSQUI

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1965 SCALE: 1:18,220

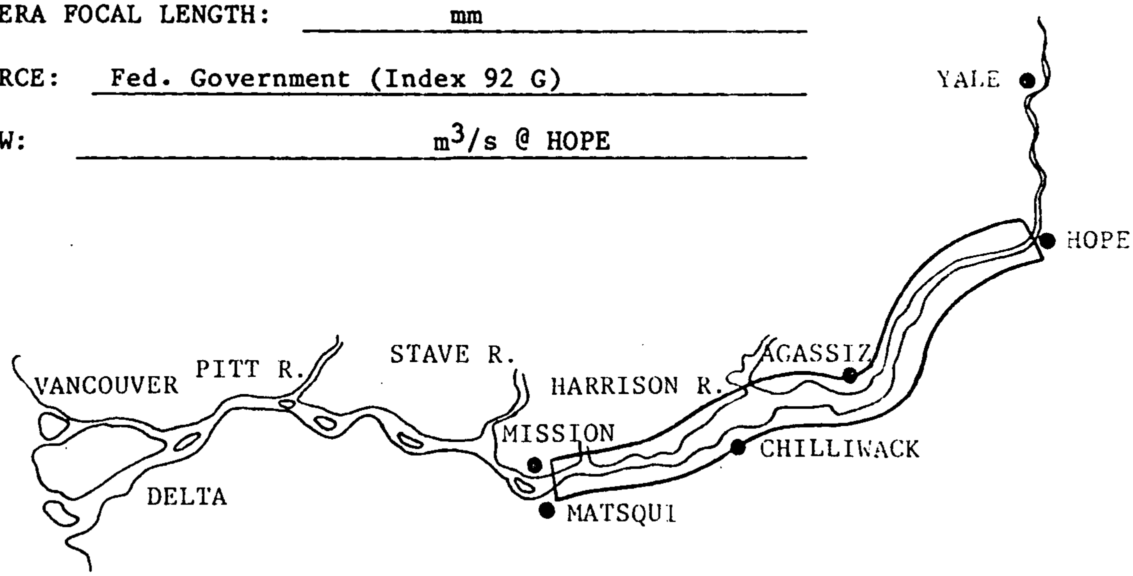
FLIGHT LINE ORIENTATION: Follow River

FLYING HEIGHT: mASL

CAMERA FOCAL LENGTH: mm

SOURCE: Fed. Government (Index 92 G)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 18731	1-13	MATSQUI - CHILLIWACK
"	14-20	NICOMEN IS. - L. ERROCK
	36-46	
	90-100	
	108-120	
	124-131	HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1967 (1-24 June) SCALE: 1:21,000 approx.

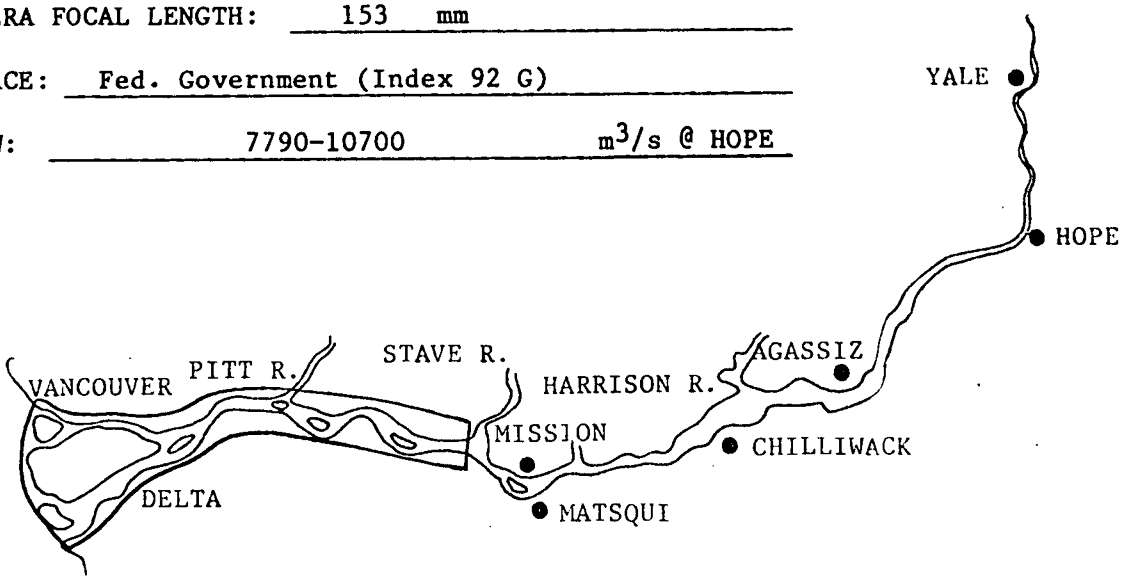
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 3200 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 92 G)

FLOW: 7790-10700 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 19953	165-172	N. ARM
A 19900	1-23	MITCHELL IS. - DERBY REACH
"	28-59	WHONOCK - SEA IS.
"	60-62	W. EDGE LULU IS.
"	67-72	GRAVESEND REACH
"	114-132	CRESCENT SLOUGH - GARRY PT.
	134-135	
"	184-189	CANOE PASS, ROBERTS BANK
	207-212	

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1968 SCALE: 1:18,000

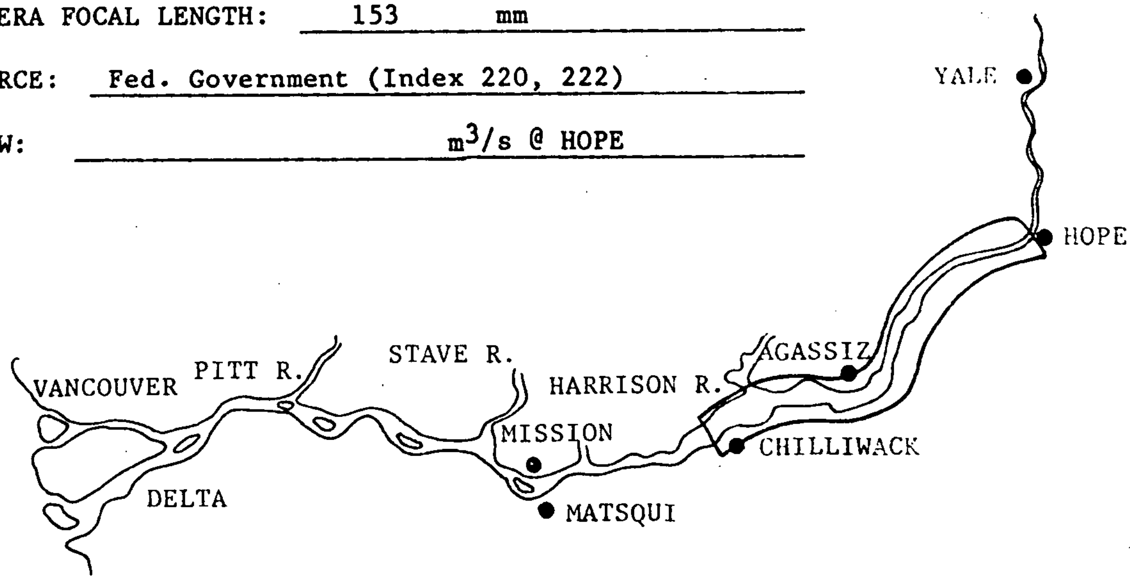
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2740 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 220, 222)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 20335	76-87	HOPE - RUBY CK.
"	88-102	RUBY CK. - POPKUM
"	103-110	CHEAM VIEW
"	115-130	CHILLIWACK
"	45-50	"
"	17-25	"
"	1-16	NICOMEN IS.
"	51-65	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: Mar 69 SCALE: 1:12,000, 1:18,000

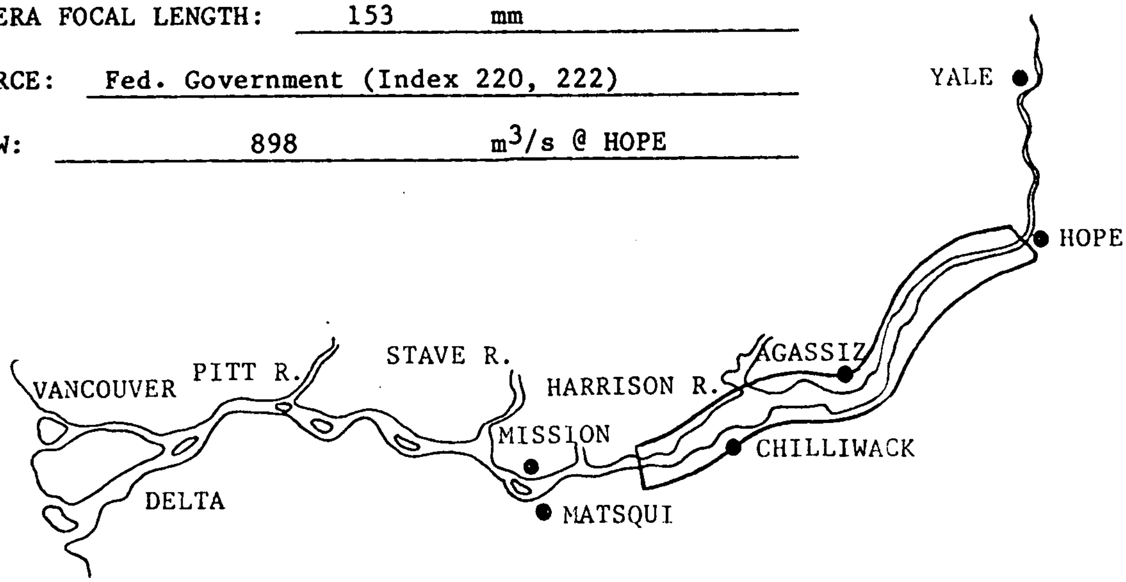
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2740, 1830 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 220, 222)

FLOW: 898 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 19477	119-130	HOPE - RUBY CK.
"	105-113	RUBY CK. - POPKUM
"	35-45	AGASSIZ
"	22-34	CHILLIWACK
"	90-99	"
"	68-72	"
"	63-67	NICOMEN IS.
"	56-62	"
"	5-17	"
A 20675	1-14	SEABIRD IS. } 1830 m

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1970 SCALE: 1:12,000, 1:18,000

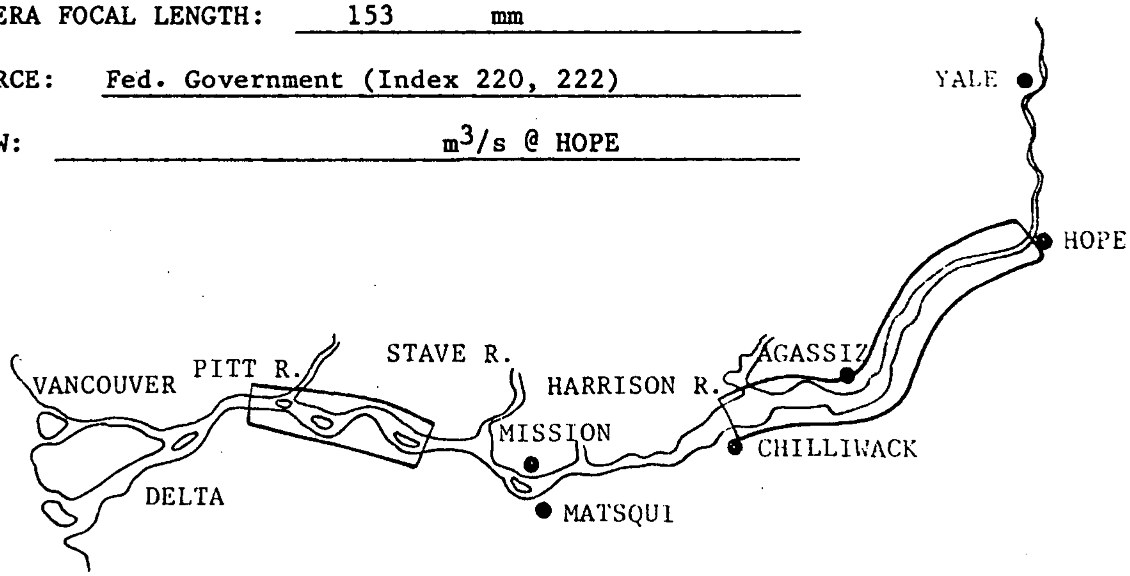
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1860, 2740 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 220, 222)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS	
A 21406	181-188	HOPE	1860 m
"	173-180	HOPE - RUBY CK.	
"	168-172	RUBY CK.	
"	159-167	"	
"	207-218	HOPE - YALE	
"	199-206	" "	
"	194-197	HOPE	
"	95-109	HOPE - RUBY CK.	2740 m
"	110-126	RUBY CK. - POPKUM	
"	147-158	CHILLIWACK	
"	130-144	"	
"	63-68	"	
"	33-45	"	
"	17-30	NICOMEN IS.	
"	75-83	"	
"	69-74	"	
A 21407	169-175	CHILLIWACK	
"	162-168	"	
A 21408	157-168	WHONOCK	1860 m
"	174-177	CRESCENT IS.	
"	153-156	DOUGLAS IS.	

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1971 SCALE: 1:12,000, 1:28,000

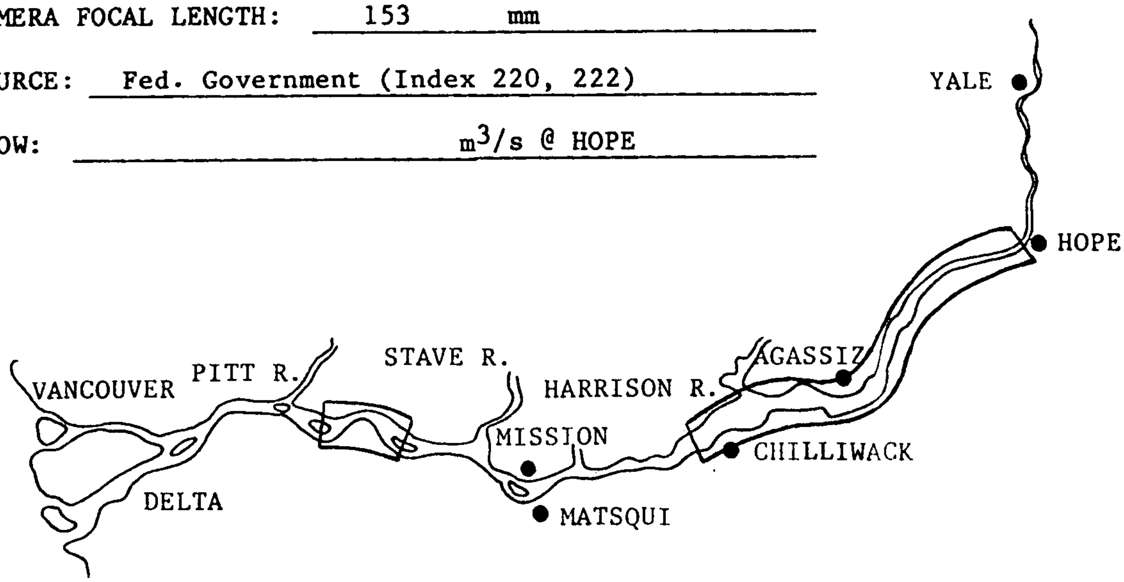
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1830, 4210 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 220, 222)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 22241	72-75	NICOMEN IS.
"	57-62	WHONOCK 4210 m
"	96-113	NICOMEN IS. - FORT LANGLEY
"	119-129	MATSQUI
"	76-84	CHILLIWACK
"	27-37	KENT 1830 m
"	10-15	PORT HAMMOND
"	1-9	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1972 SCALE: 1:6,000

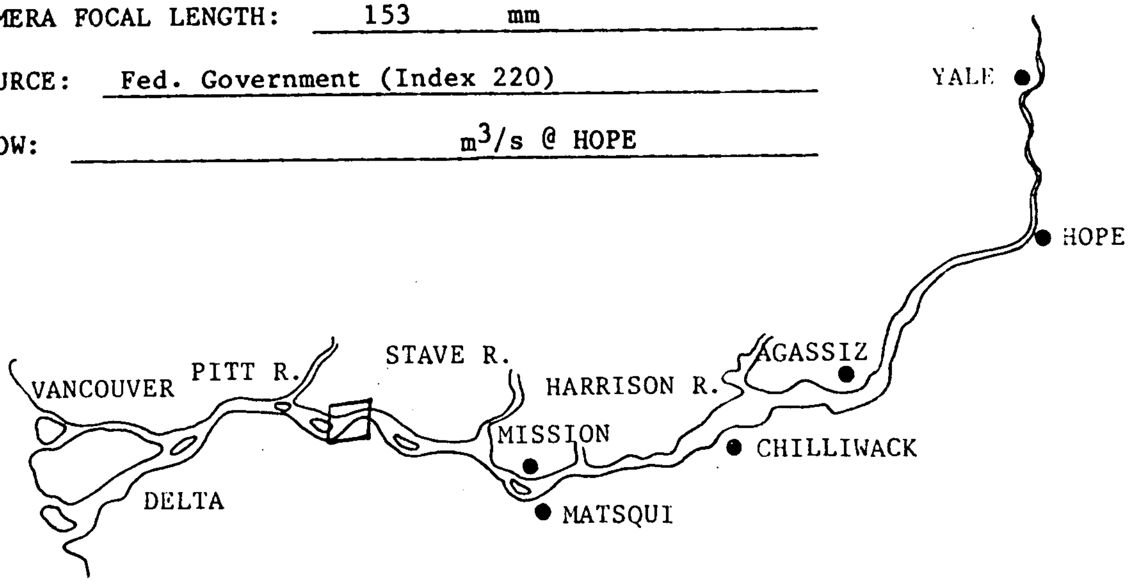
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 914 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 220)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 22462	200-207	PORT HAMMOND
"	167-183	"
"	143-166	"
"	112-120	"
"	96-109	"
"	72-95	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1972 (Apr) SCALE: 1:18,000

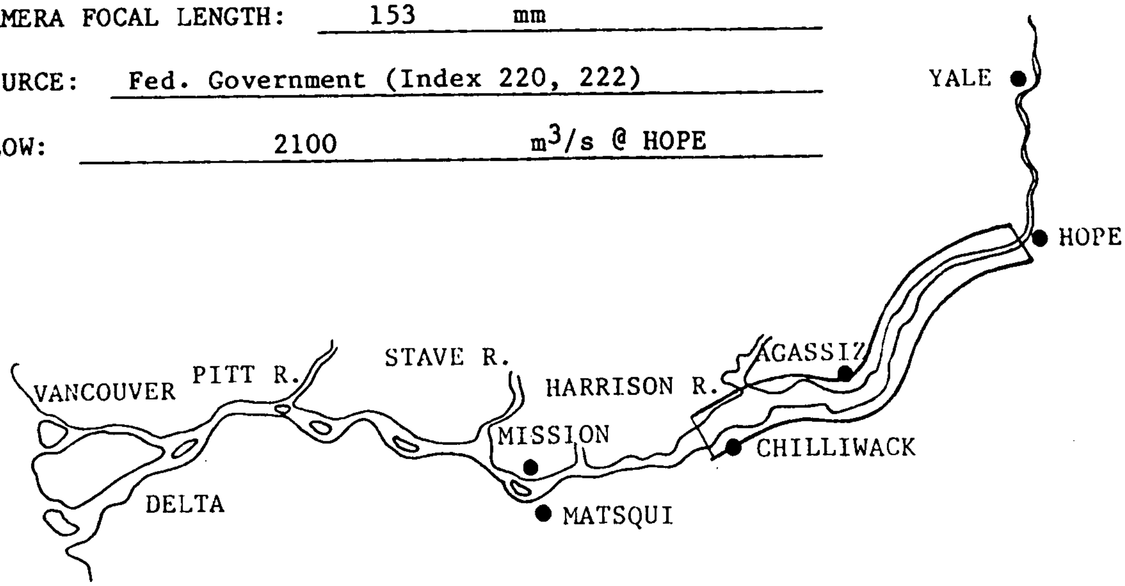
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2740 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 220, 222)

FLOW: 2100 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 22634	1-14	HOPE - RUBY CK.
"	37-46	CHEAM VIEW
"	16-36	RUBY CK. - ROSEDALE
"	62-72	CHILLIWACK
"	48-61	"
"	73-82	"
"	83-88	NICOMEN IS.
"	90-97	"
"	128-135	"
"	136-149	"
"	150-165	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1972 (Sept) SCALE: 1:50,000

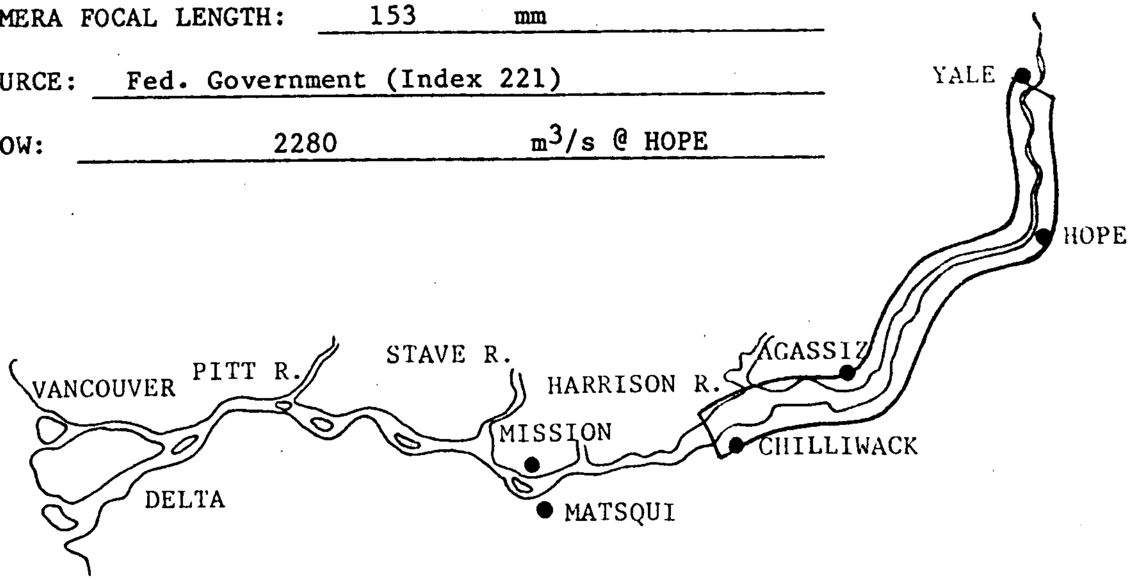
FLIGHT LINE ORIENTATION: North-South

FLYING HEIGHT: 7470 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 221)

FLOW: 2280 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 23080	77-82	YALE-HOPE
"	114-116	ODLUM
A 23081	19-22	RUBY CK.
A 23084	152-154	CHEAM VIEW
"	87-89	CHILLIWACK
"	135-137	"
"	199-201	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1973 (Apr) SCALE: 1:18,000

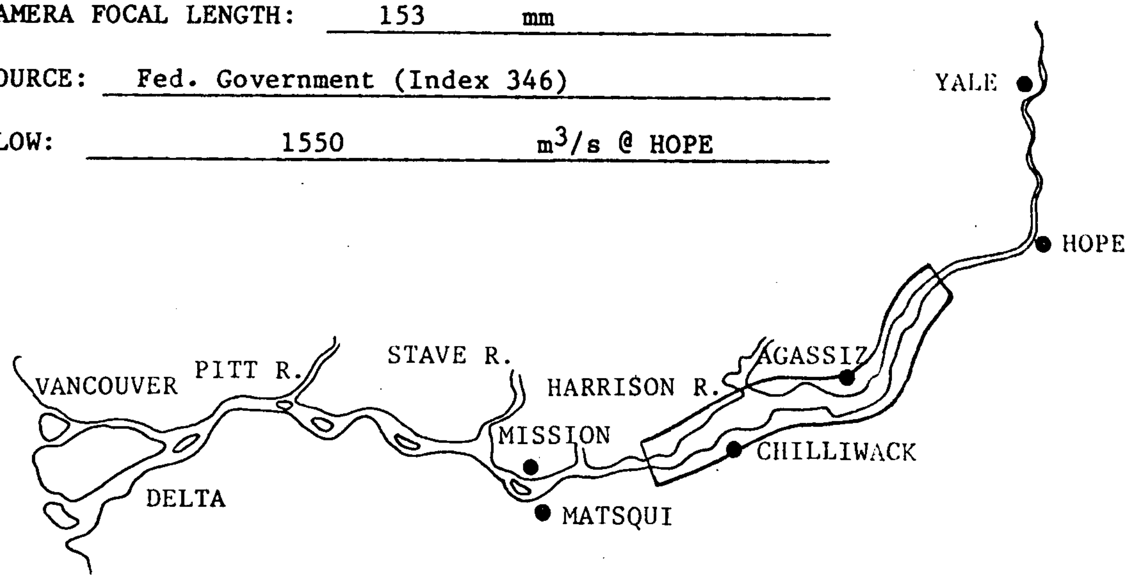
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2800 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 346)

FLOW: 1550 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 23133	94-106	RUBY CK. - SEABIRD IS.
"	85-93	HOPE - RUBY CK.
"	59-65	HARRISON R.
"	115-125	WINDERMERE IS.
"	37-53	MATSQUI - CHILLIWACK MTN.
"	54-58	NICOMEN IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1974 (Apr, Sept) SCALE: 1:18,000

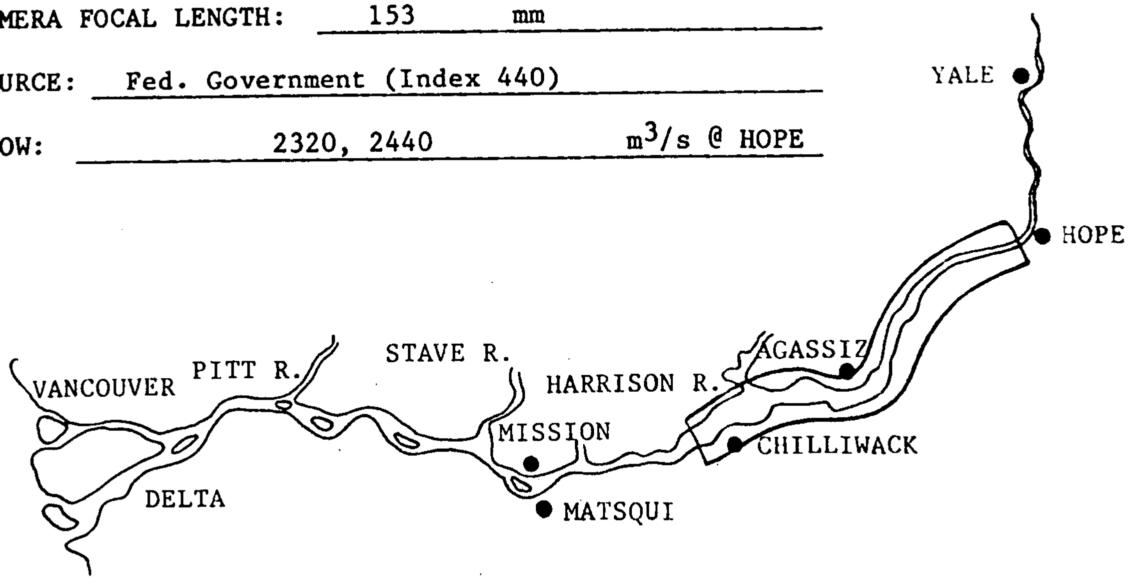
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2770 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 440)

FLOW: 2320, 2440 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 23658	77-88	HOPE - RUBY CK.
"	89-105	RUBY CK. - POPKUM
"	106-113	CHEAM VIEW
A 23661	37-54	CHILLIWACK - NICOMEN IS.
"	7-26	"
"	58-63	"
A 23913	6-12	" } sep.
"	55-57	NICOMEN IS. } sep.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1975 (27 Mar) SCALE: 1:18,000

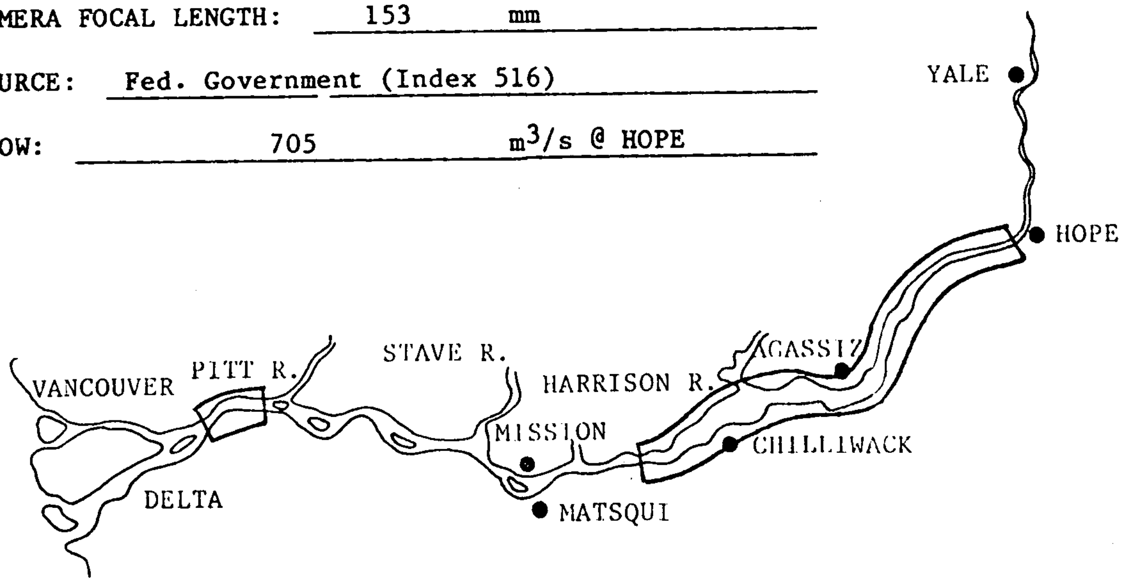
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2770 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 516)

FLOW: 705 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 23946	47-58	HOPE - RUBY CK.
"	74-82	RUBY CK. - CHEAM VIEW
"	59-73	" "
"	83-96	CHILLIWACK
"	21-27	"
"	28-29	NICOMEN IS. } 1:12,000
"	1-12	" }
A 23947	1-13	DOUGLAS IS.
"	60-70	NEW WESTMINSTER
"	14-27	"
A 24001	1-2	SUMAS MTN. } 1:12,000
"	5-8	" } May

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1976 (27 June) SCALE: 1:50,000

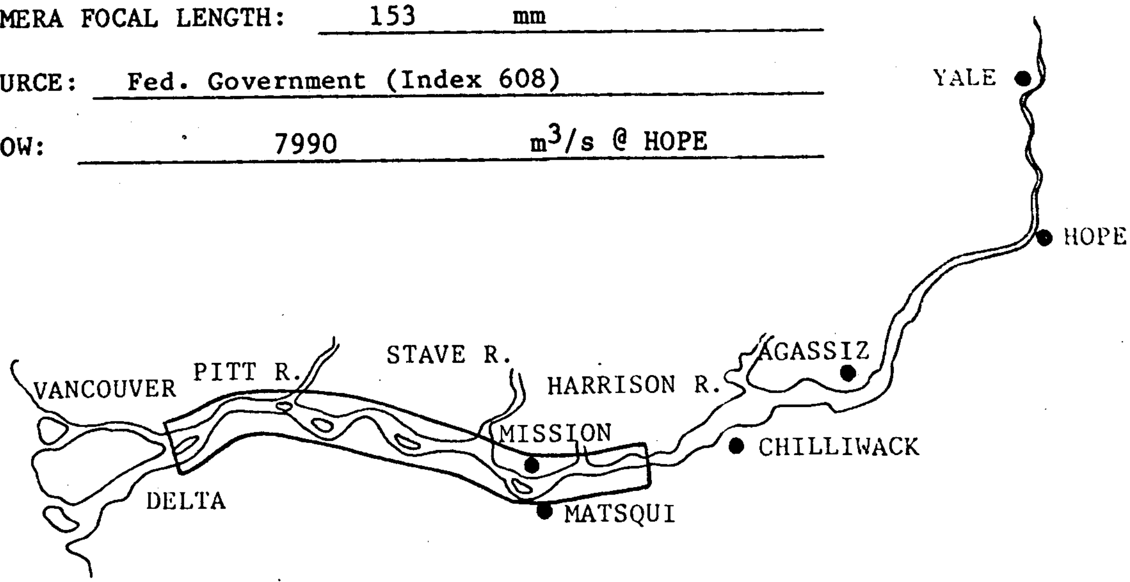
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 9140 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 608)

FLOW: 7990 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 24500	94-101	NICOMEN IS.
"	134-138	NEW WESTMINSTER
"	105-107	ANNACIS IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1977 (Mar) SCALE: 1:18,000

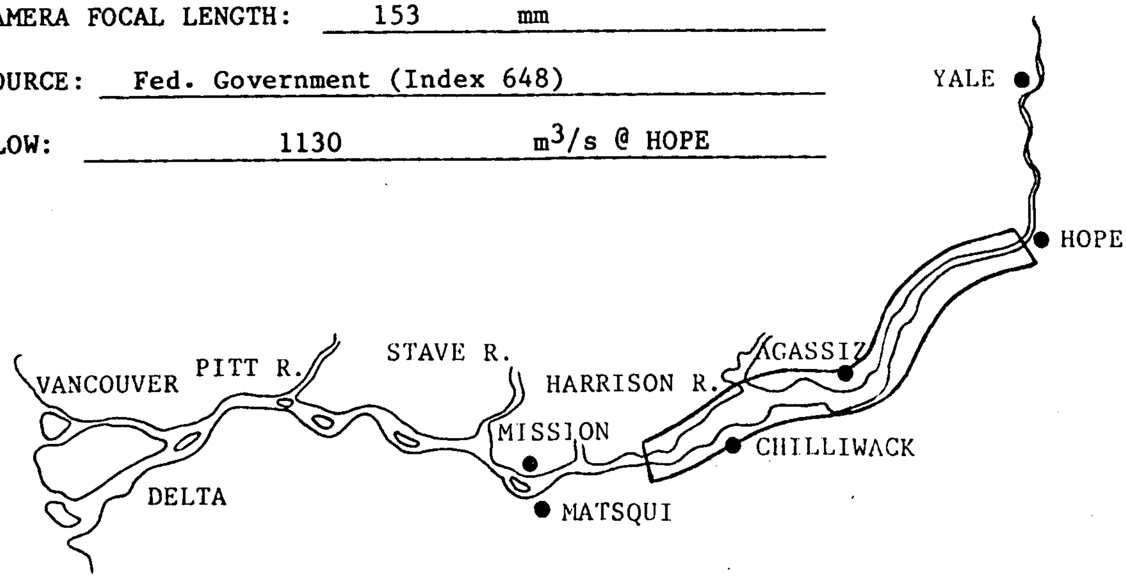
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 2770 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 648)

FLOW: 1130 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 24611	91-101	HOPE - RUBY CK.
"	65-70	CHEAM VIEW
"	74-90	RUBY CK. - CHILLIWACK
"	50-62	CHILLIWACK
"	37-49	NICOMEN IS.
"	1-20	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1978 (13 Jul, 13 Oct) SCALE: 1:25,000

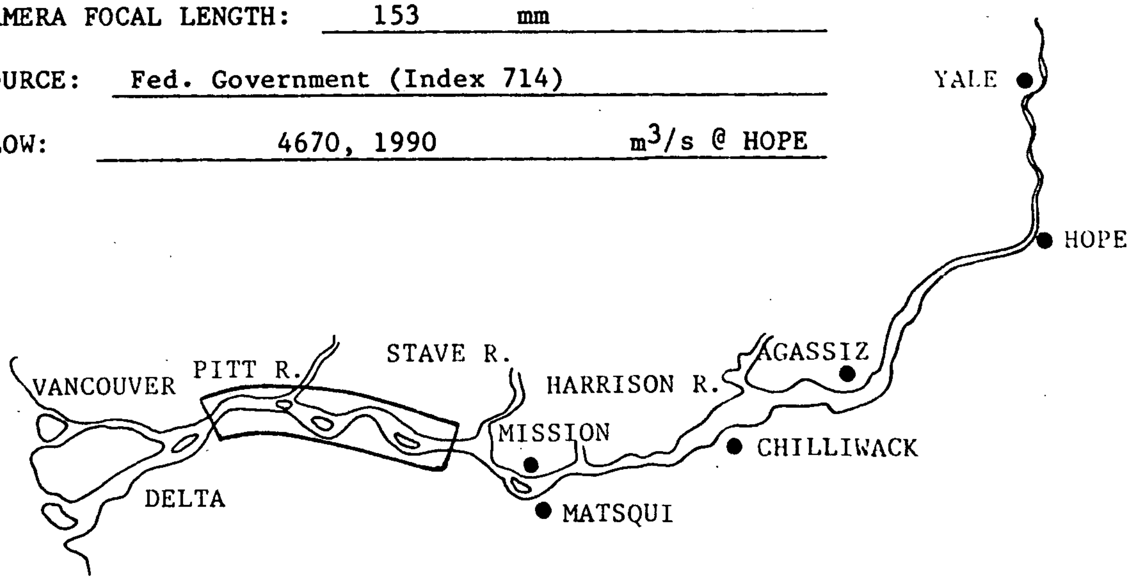
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 4420 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 714)

FLOW: 4670, 1990 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 24934	105-110	GLEN VALLEY } July
"	140-145	NEW WESTMINSTER } July
A 25069	75-86	SILVERDALE - BARNSTON IS. } Oct
"	50-60	PORT HAMMOND } Oct

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (Mar) SCALE: 1:20,000

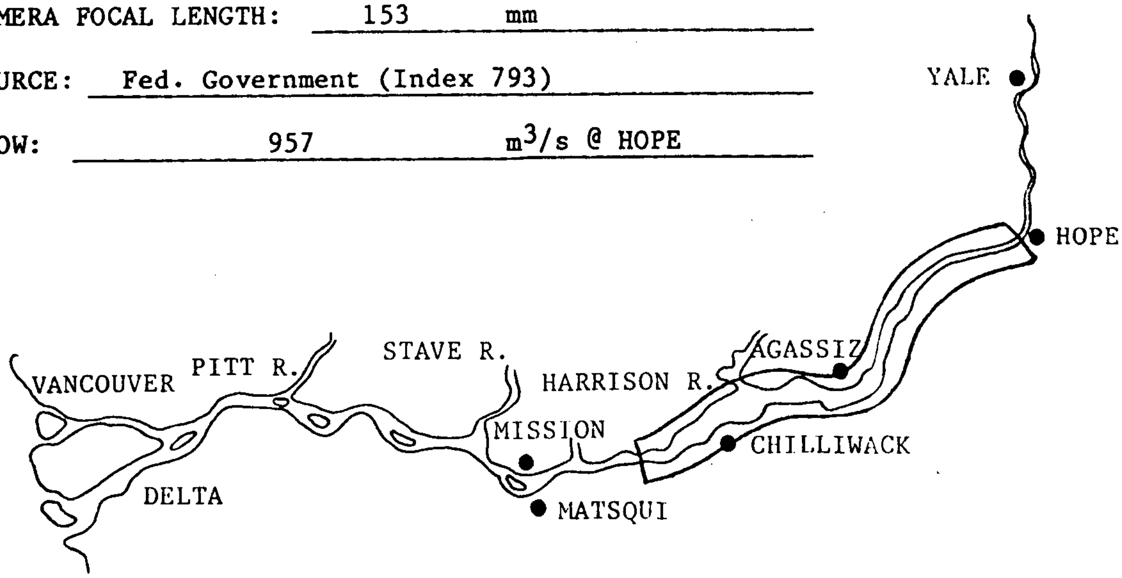
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 3080 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 793)

FLOW: 957 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 25106	1-12	HOPE - RUBY CK.
"	13-30	RUBY CK. - CHILLIWACK
"	31-40	CHILLIWACK
"	41-52	"
"	72-75	NICOMEN IS.
"	53-63	"
"	64-71	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1981 (Feb) SCALE: 1:20,000

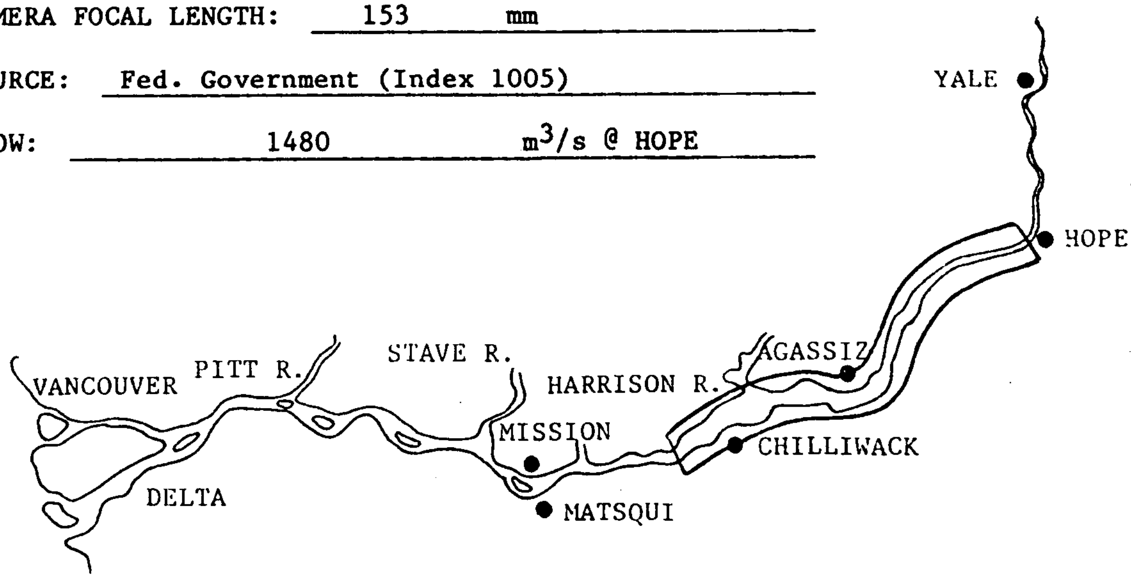
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 3200 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 1005)

FLOW: 1480 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 25638	1-10	HOPE - RUBY CK.
"	11-24	RUBY CK. - POPKUM
"	25-34	CHEAM VIEW
"	35-43	CHILLIWACK
"	44-54	NICOMEN IS.
"	55-62	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1980 (Mar) SCALE: 1:20,000

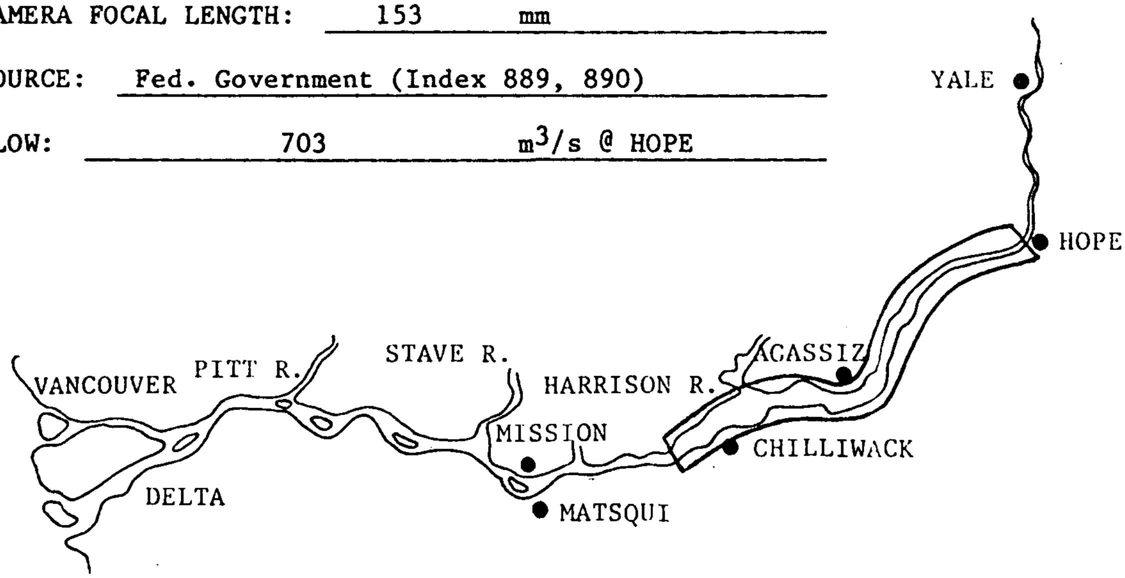
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 3170 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 889, 890)

FLOW: 703 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 25378	89-98	HOPE - RUBY CK.
"	1-11	" "
"	75-88	RUBY CK. - CHILLIWACK
"	66-73	CHILLIWACK
"	55-65	"
"	23-39	NICOMEN IS.
"	40-54	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1982 (Apr) SCALE: 1:25,000

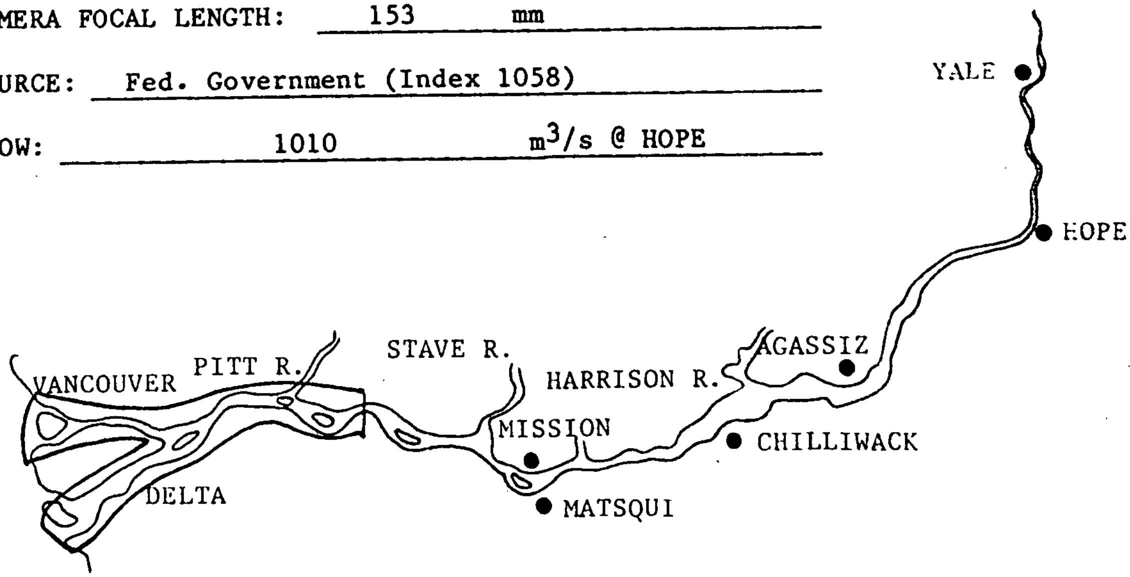
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 4110 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 1058)

FLOW: 1010 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 25941	176-181	FORT LANGLEY
"	110-117	PORT HAMMOND
"	131-138	FRASER MILLS
"	93-107	NEW WESTMINSTER
"	92-96	ANNACIS IS.
"	253-259	LADNER
"	153-158	LULU IS.
"	191-196	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1981 (Apr) SCALE: 1:25,000

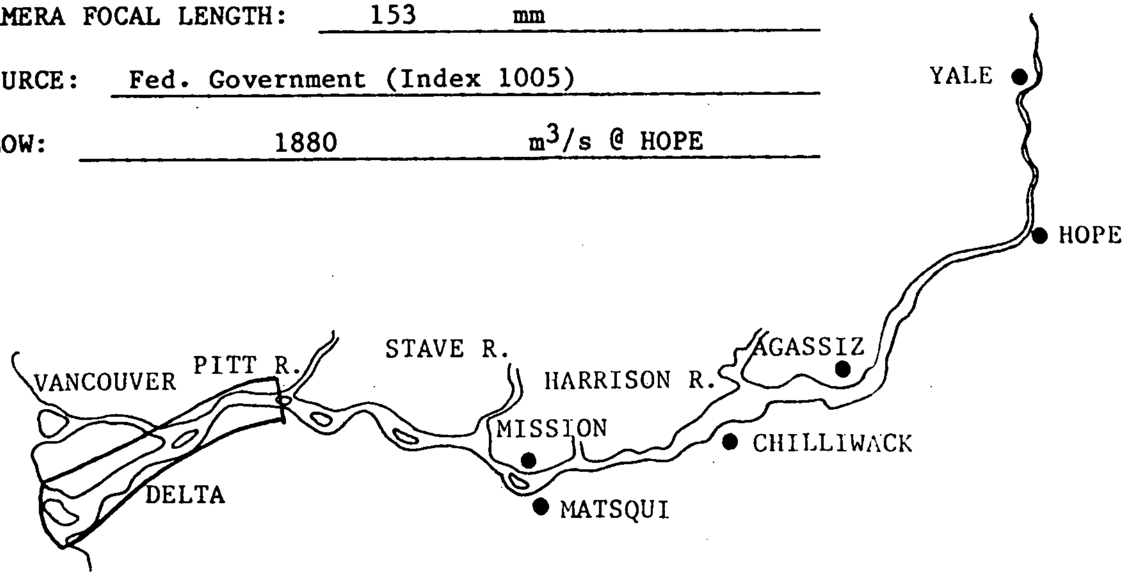
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 3870 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 1005)

FLOW: 1880 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 25666	41-50	PORT HAMMOND - NEW WESTMINSTER
"	56-84	CRESCENT IS. - LULU IS.
"	95-97	ANNACIS IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1982 (Mar)   SCALE: 1:20,000

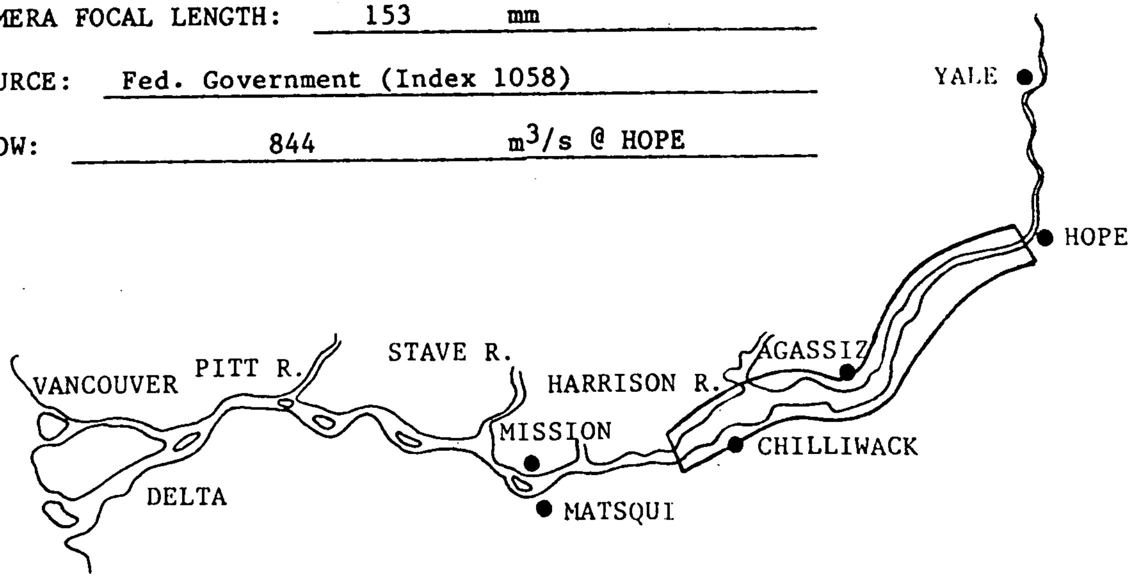
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 3170 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: Fed. Government (Index 1058)

FLOW: 844 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
A 25938	61-71	HOPE - RUBY CK.
"	72-86	RUBY CK. - POPKUM
"	87-94	POPKUM
"	1-13	CHILLIWACK
"	37-60	CHILLIWACK - NICOMEN IS.

B.C. GOVERNMENT
SPECIAL PROJECTS

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1953 (20-21 Oct) SCALE: 1:5,600

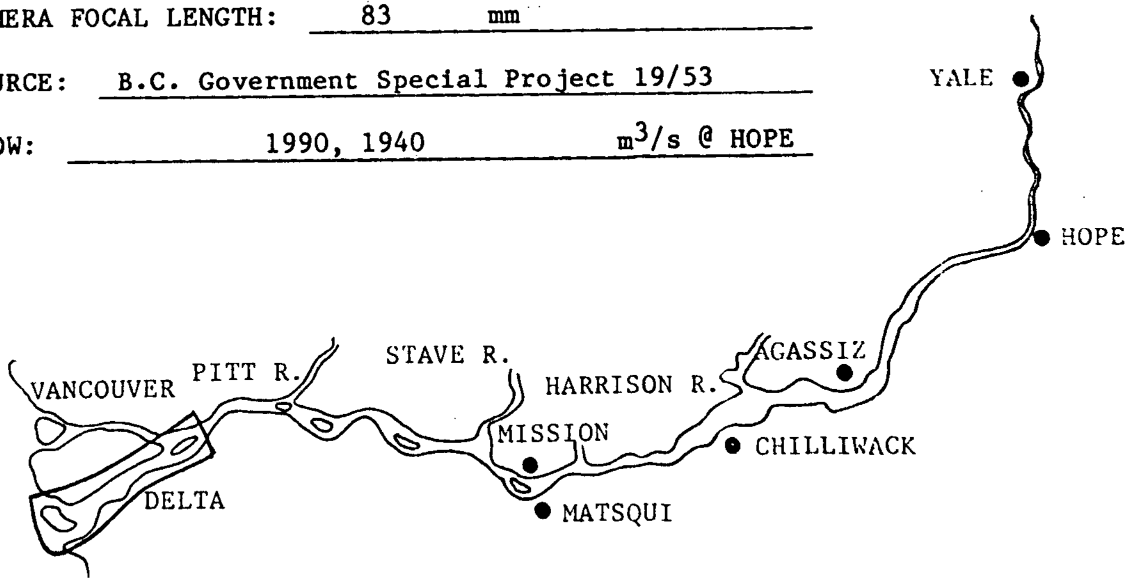
FLIGHT LINE ORIENTATION: North-South

FLYING HEIGHT: 880 mASL

CAMERA FOCAL LENGTH: 83 mm

SOURCE: B.C. Government Special Project 19/53

FLOW: 1990, 1940 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1817	42-53	REIFEL IS.
"	76-86	
"	28-41	WESTHAM IS.
"	17-27	"
"	6-16	"
BC 1816	95-103	
"	85-94	
"	51-59	LADNER
BC 1815	48-54	
"	61-67	
"	102-106	GRAVESEND BEACH
BC 1817	102-107	
BC 1816	44-48	
BC 1656	83-88	DEAS IS.
"	73-76	
BC 1655	2-12	
"	40-46	
"	88-92	
BC 1656	93-97	ANNACIS IS.
"	20-25	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1954 SCALE: 1:4,000

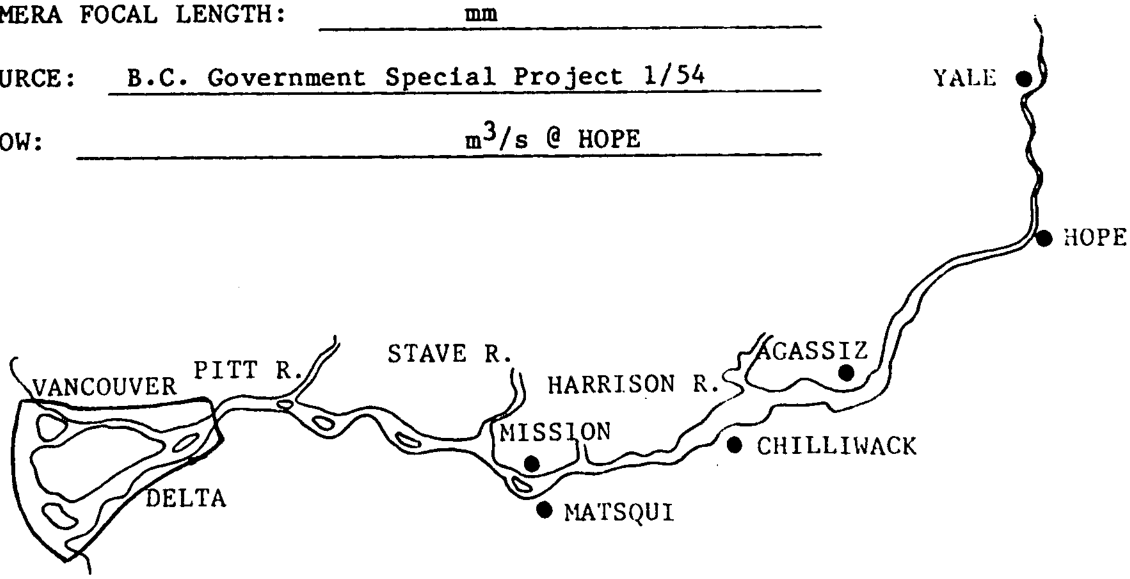
FLIGHT LINE ORIENTATION: North-South

FLYING HEIGHT: mASL

CAMERA FOCAL LENGTH: mm

SOURCE: B.C. Government Special Project 1/54

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1865	1-6	NR. MOUTH OF MIDDLE ARM
BC 1659	1-12	W. EDGE OF SEA IS.
"	13-15	
"	21-23	MIDDLE ARM
"	35-38	STEVESTON
"	66-67	
"	88-91	
BC 1660	1-4	
"	18-20	MIDDLE ARM
"	25-27	N. ARM
"	30-38	E. EDGE SEA IS.
"	61-62	
"	80-84	
BC 1661	23-27	MITCHELL IS.
"	1-3	ROSE IS.
"	23-26	MITCHELL IS.
"	57-62	
BC 1662	11-14	
"	30-33	
"	1-7	
BC 1665	1-9	
"	22-27	
BC 1662	36-38	(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ____________ SCALE: ____________

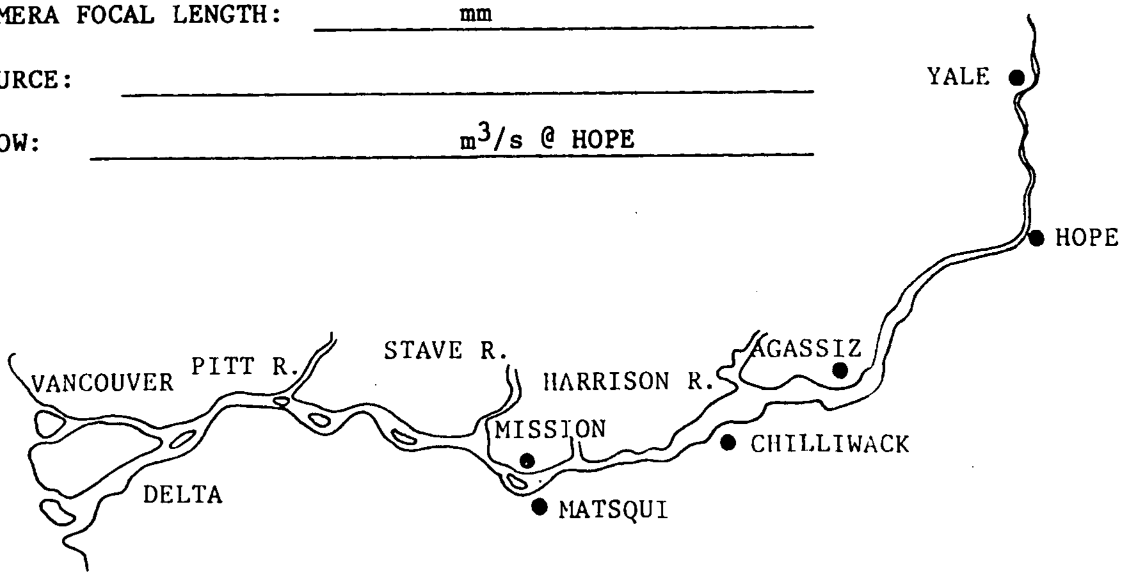
FLIGHT LINE ORIENTATION: ____________

FLYING HEIGHT: ____________ mASL

CAMERA FOCAL LENGTH: ____________ mm

SOURCE: ____________

FLOW: ____________ m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1665	22-28	
"	46-52	DEAS IS.
BC 1662	93-95	N. ARM
"	108-112	GRAVESEND REACH
BC 1665	77-79	N. ARM
"	93-98	GRAVESEND REACH
BC 1663	1-5	"
"	15-17	N. ARM
"	20-23	"
"	32-36	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1954 SCALE: 1:4,000

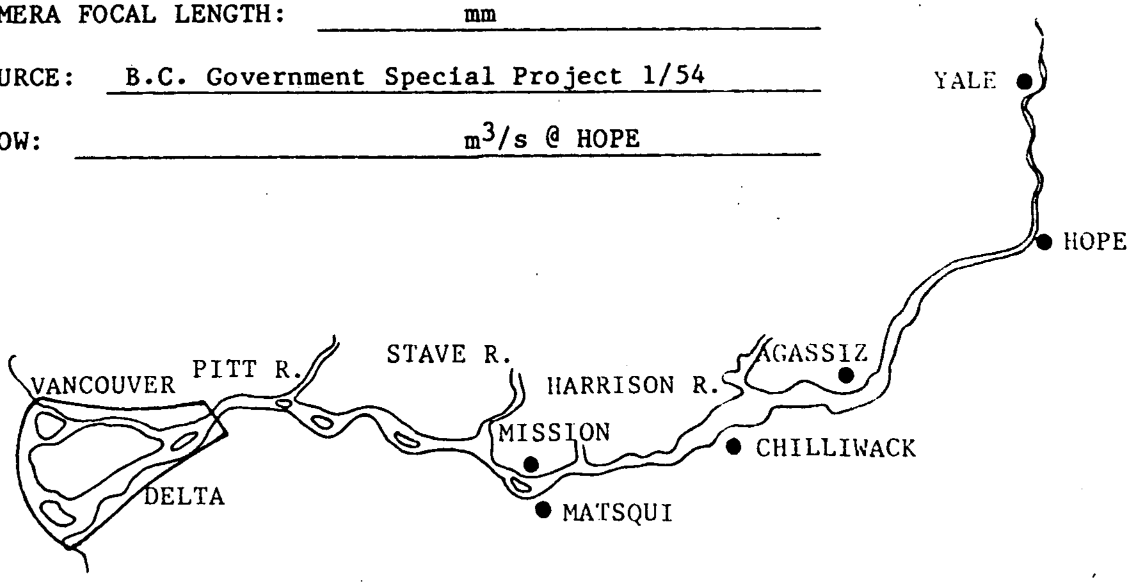
FLIGHT LINE ORIENTATION: North-South

FLYING HEIGHT: mASL

CAMERA FOCAL LENGTH: mm

SOURCE: B.C. Government Special Project 1/54

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1663	37-41	
"	48-51	
BC 1661	60-62	
"	66-70	
BC 1663	54-58	
"	63-68	
BC 1661	80-86	
BC 1663	69-78	
BC 1665	36-41	
BC 1661	87-90	
BC 1663	86-91	
BC 1661	92-102	
"	103-110	
BC 1659	96-109	ANNACIS IS.
BC 1664	1-12	
"	14-25	
BC 1666	4-14	
BC 1664	26-36	
"	37-48	
"	49-53	
BC 1665	99-105	
BC 1664	58-65	
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ____________ SCALE: ____________

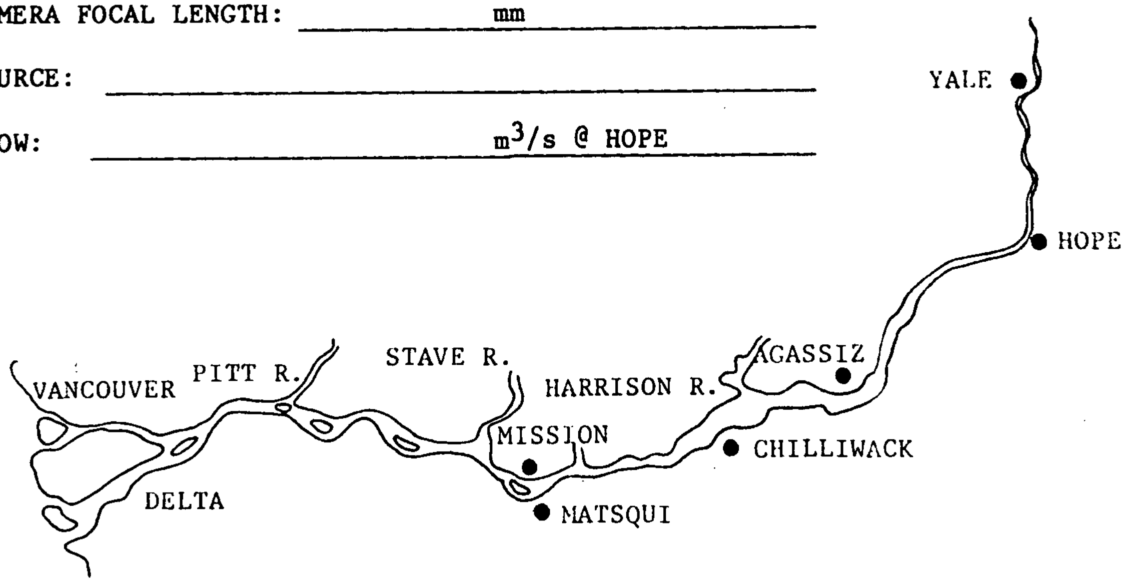
FLIGHT LINE ORIENTATION: ____________

FLYING HEIGHT: ____________ mASL

CAMERA FOCAL LENGTH: ____________ mm

SOURCE: ____________

FLOW: ____________ m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1664	68-76	NEW WESTMINSTER
"	81-86	
"	93-100	W. OF PORT MANN

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 11 Apr 1954-1 May 1955 SCALE: 20 CH

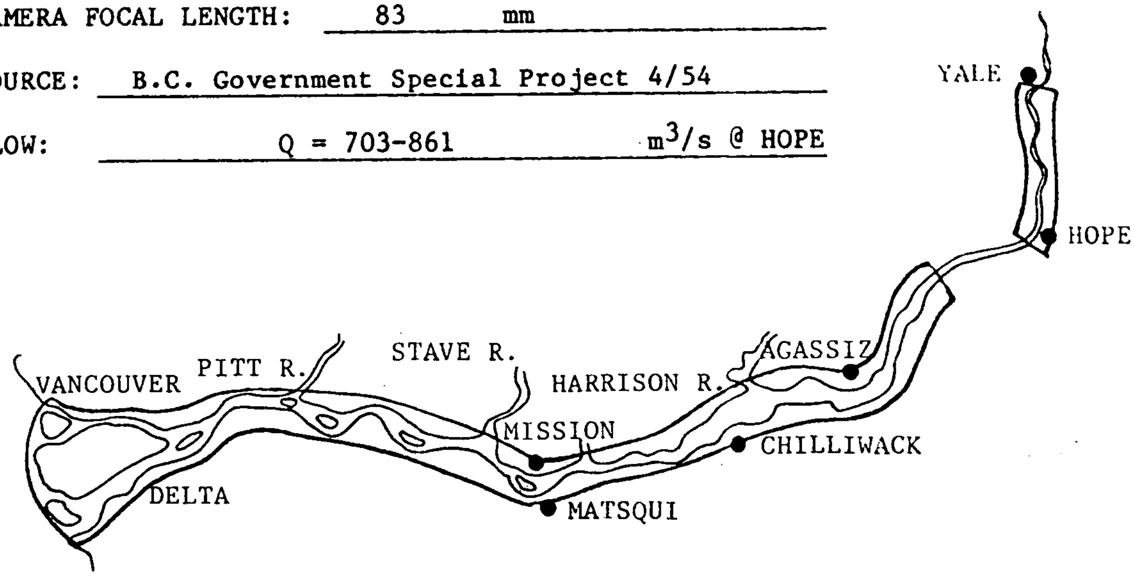
FLIGHT LINE ORIENTATION: north-south

FLYING HEIGHT: 1680 mASL

CAMERA FOCAL LENGTH: 83 mm

SOURCE: B.C. Government Special Project 4/54

FLOW: Q = 703-861 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1674	57-68	W. EDGE OF DELTA
"	41-56	
"	1-18	
BC 1673	80-94	
"	37-49	
"	9-22	
BC 1672	99-108	
"	67-54	
BC 1870	15-25	E. EDGE OF LULU IS. (1955)
BC 1672	42-47	123° 00'W
"	18-21	
BC 1689	16-20	
BC 1675	12-17	ANNACIS IS., POPLAR IS.
"	42-44	
"	75-78	
BC 1676	10-12	
"	52-54	
"	71-73	PORT MANN
BC 1677	23-25	
"	46-49	
"	93-97	
BC 1678	10-12	
"	54-59	BARNSTON IS. (continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ________________ SCALE: ____________________

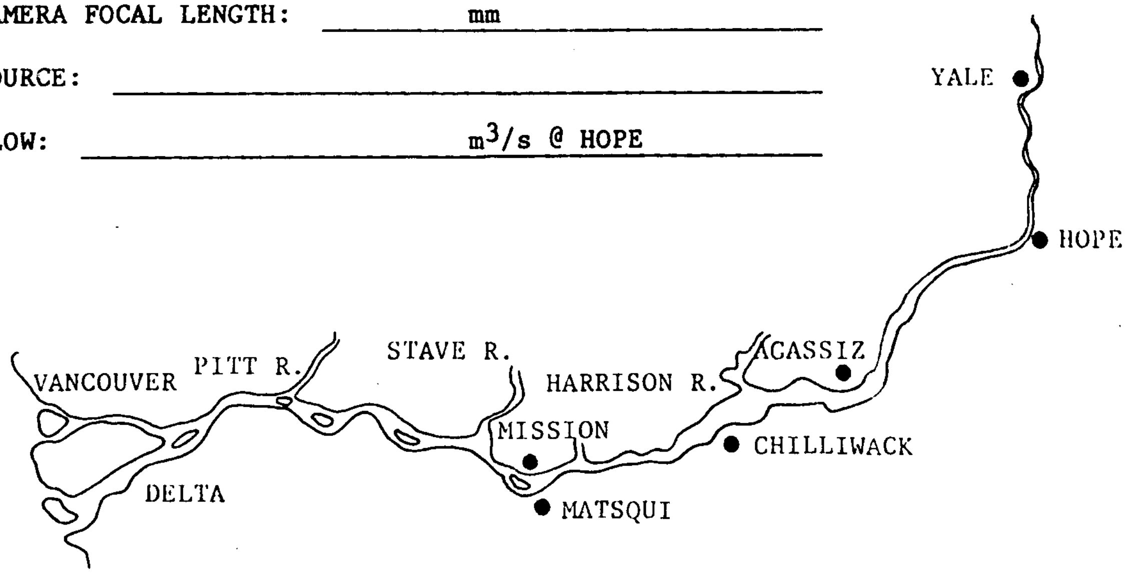
FLIGHT LINE ORIENTATION: ____________________

FLYING HEIGHT: ____________ mASL

CAMERA FOCAL LENGTH: ____________ mm

SOURCE: ____________________

FLOW: ____________ m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1678	79-82	
BC 1679	21-23	
"	53-55	
"	98-100	
BC 1680	10-12	
"	52-55	
"	72-74	
BC 1681	20-22	
"	37-39	

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1954 (1-7 May) SCALE: 20 CH

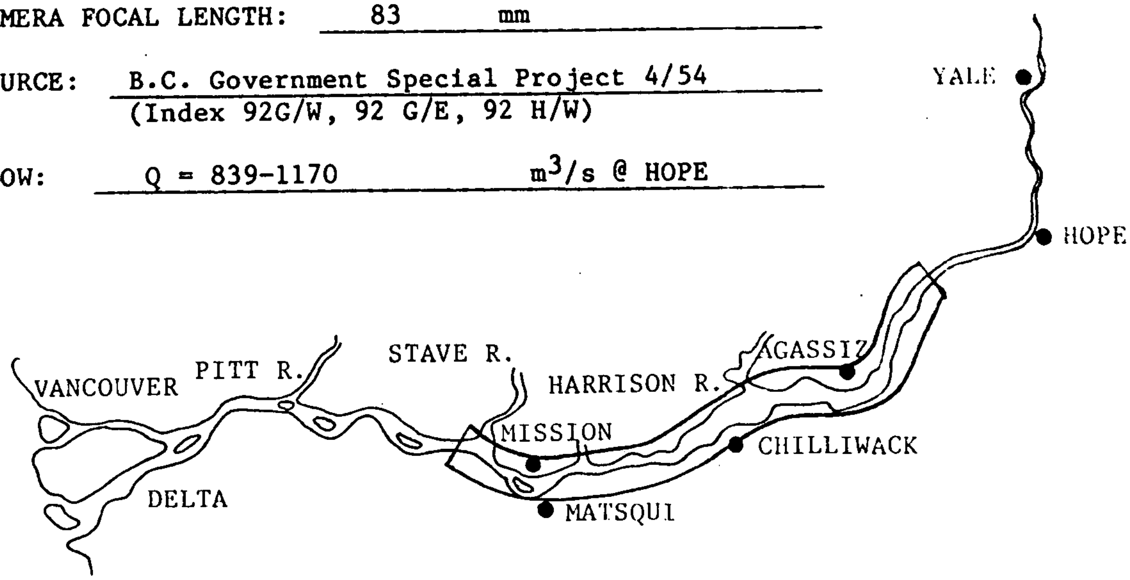
FLIGHT LINE ORIENTATION: north-south

FLYING HEIGHT: 1680 mASL

CAMERA FOCAL LENGTH: 83 mm

SOURCE: B.C. Government Special Project 4/54
(Index 92G/W, 92 G/E, 92 H/W)

FLOW: Q = 839-1170 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1681	76-78	
"	93-95	
BC 1682	19-21	CRESCENT IS.
BC 1782	22-24	
"	41-43	
"	82-84	
BC 1783	16-19	MATSQUI IS.
"	58-61	
"	81-85	MISSION
BC 1784	17-20	
"	42-44	
"	84-86	
BC 1785	11-14	
"	42-45	
"	57-65	NICOMEN IS.
"	93-98	
BC 1786	2-6	
BC 1789	1-7	
"	29-34	
"	35-41	
"	61-68	
"	70-75	
"	100-106	(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ______________________ SCALE: ______________________

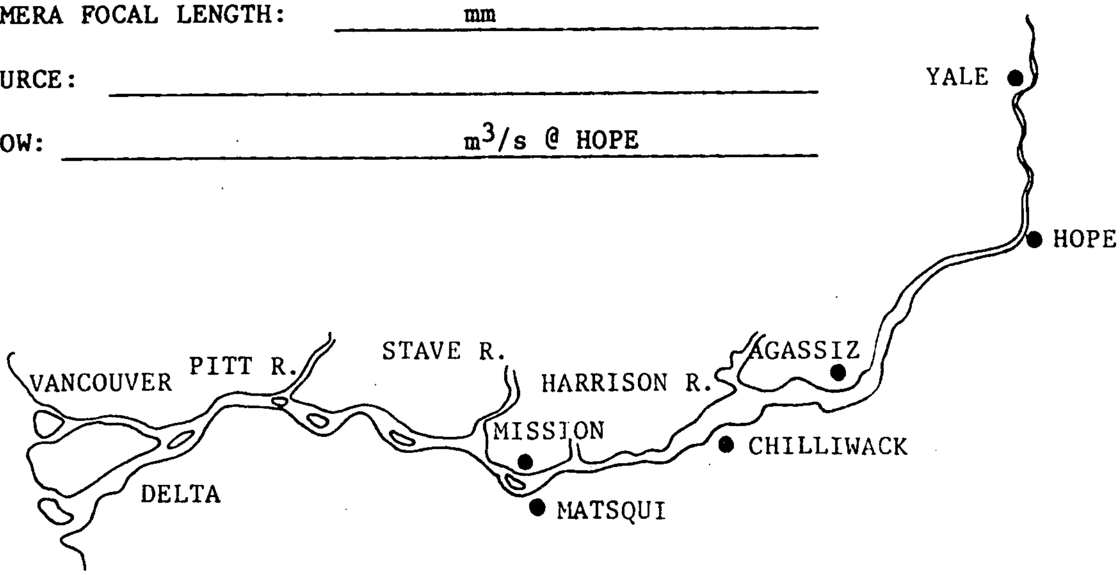
FLIGHT LINE ORIENTATION: ______________________

FLYING HEIGHT: ______________ mASL ______________

CAMERA FOCAL LENGTH: ______________ mm ______________

SOURCE: ______________________

FLOW: ______________ m^3/s @ HOPE ______________



FILM ROLL	PHOTO NOS.	REMARKS
BC 1683	12-22	
"	38-49	CHILLIWACK
"	73-79	
"	100-106	
BC 1684	15-21	
"	50-56	
"	89-95	
BC 1685	11-18	
"	40-45	

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1954 SCALE: 20 CH

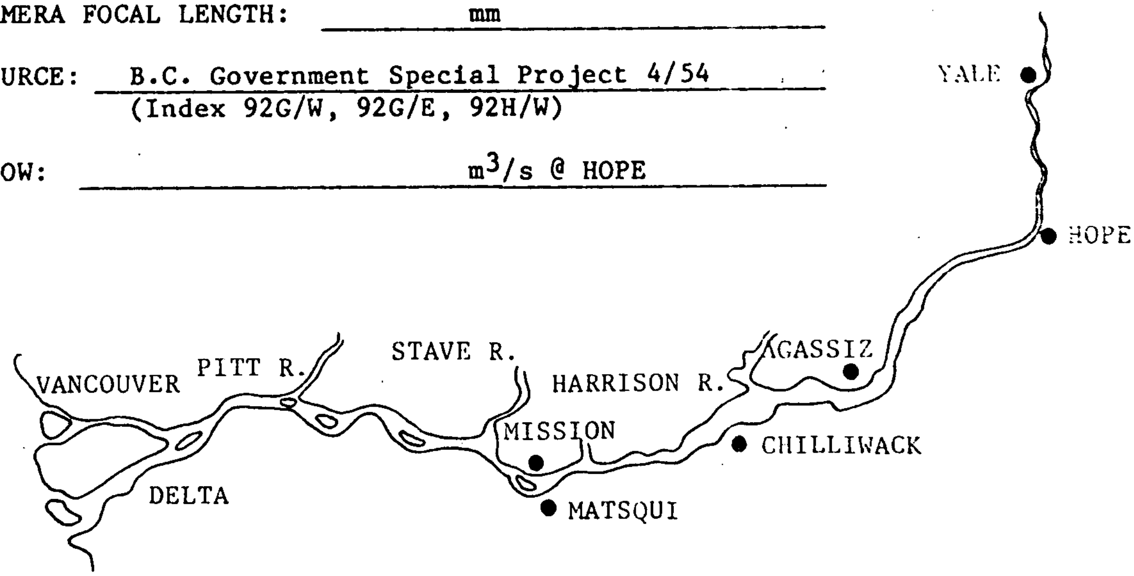
FLIGHT LINE ORIENTATION: north-south

FLYING HEIGHT: mASL

CAMERA FOCAL LENGTH: mm

SOURCE: B.C. Government Special Project 4/54
(Index 92G/W, 92G/E, 92H/W)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1685	73-75	
"	86-87	
"	106-115	
BC 1686	1-14	
"	34-44	
"	53-57	CHEAM VIEW
"	61-74	SW - NE (SINGLE LINE)
"	93-110	HOPE TO YALE (SINGLE LINE)
"	81-92	HOPE (SINGLE LINE)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1954 (May-June) SCALE: 1:25,000

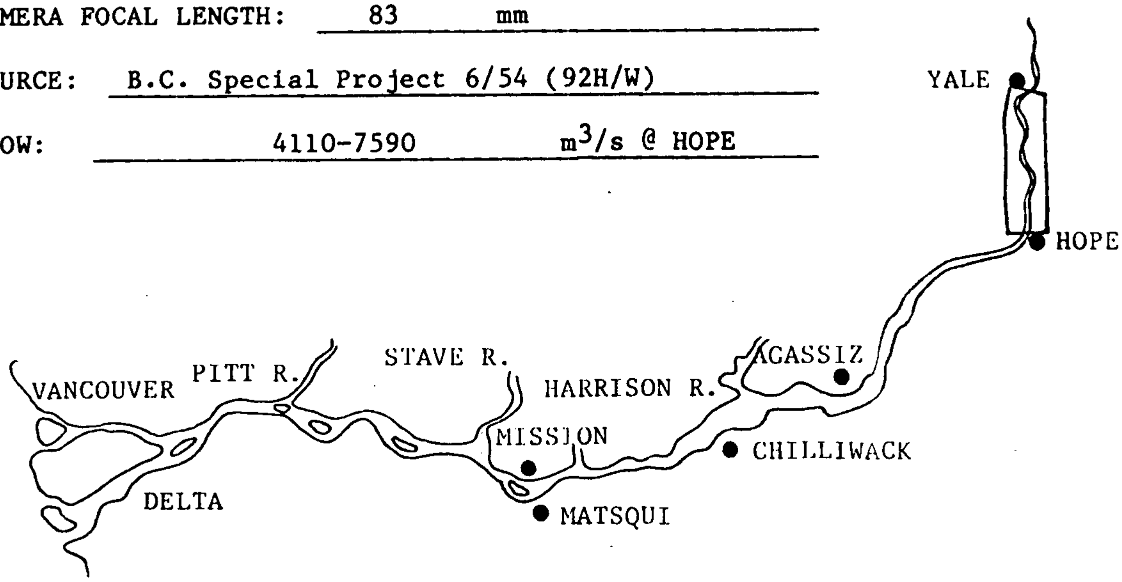
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2130 mASL

CAMERA FOCAL LENGTH: 83 mm

SOURCE: B.C. Special Project 6/54 (92H/W)

FLOW: 4110-7590 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1686	93-110	YALE - HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1955 (28 Apr) SCALE: 1:55,000

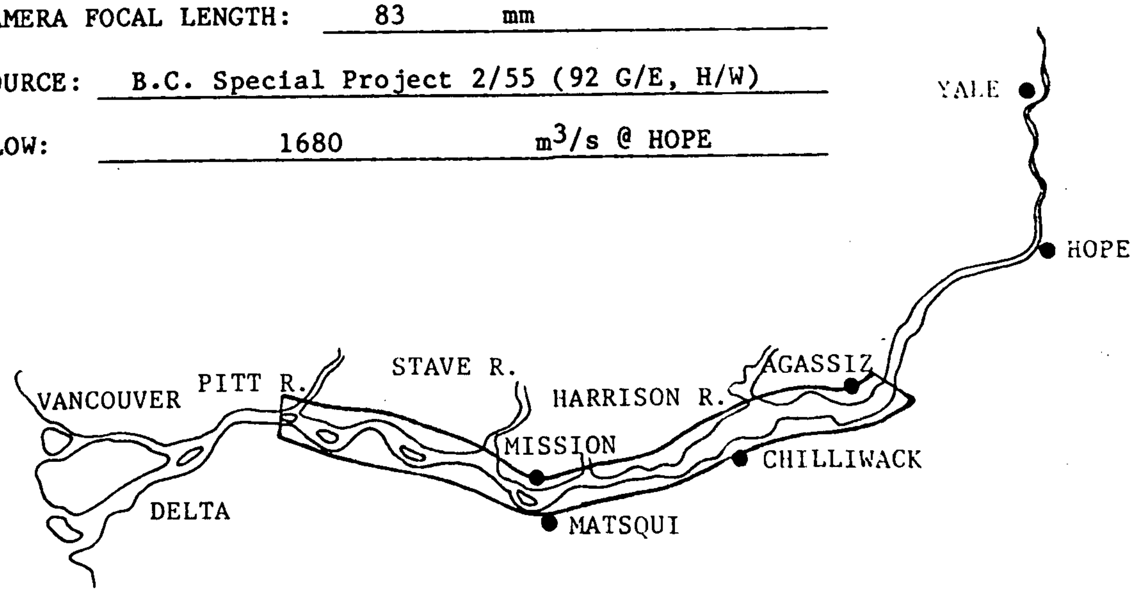
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4570 mASL

CAMERA FOCAL LENGTH: 83 mm

SOURCE: B.C. Special Project 2/55 (92 G/E, H/W)

FLOW: 1680 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1870	38-75	CHEAM VIEW - DOUGLAS IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1960 (8 June) SCALE: 1:18,000

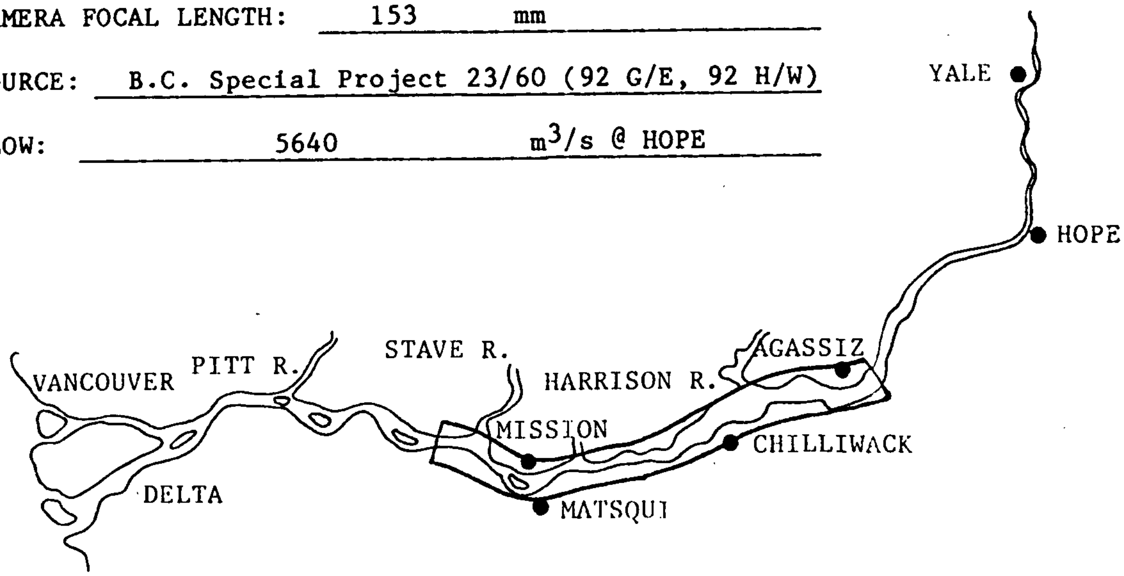
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2770 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 23/60 (92 G/E, 92 H/W)

FLOW: 5640 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5013	70-72	POPKUM
"	118-124	AGASSIZ
"	51-63	CHILLIWACK
"	10-23	NICOMEN IS.
"	25-32	"
"	141-146	MATSQUI IS.
"	150-159	GLEN VALLEY

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1961 (1, 2 June) SCALE: 1:18,000

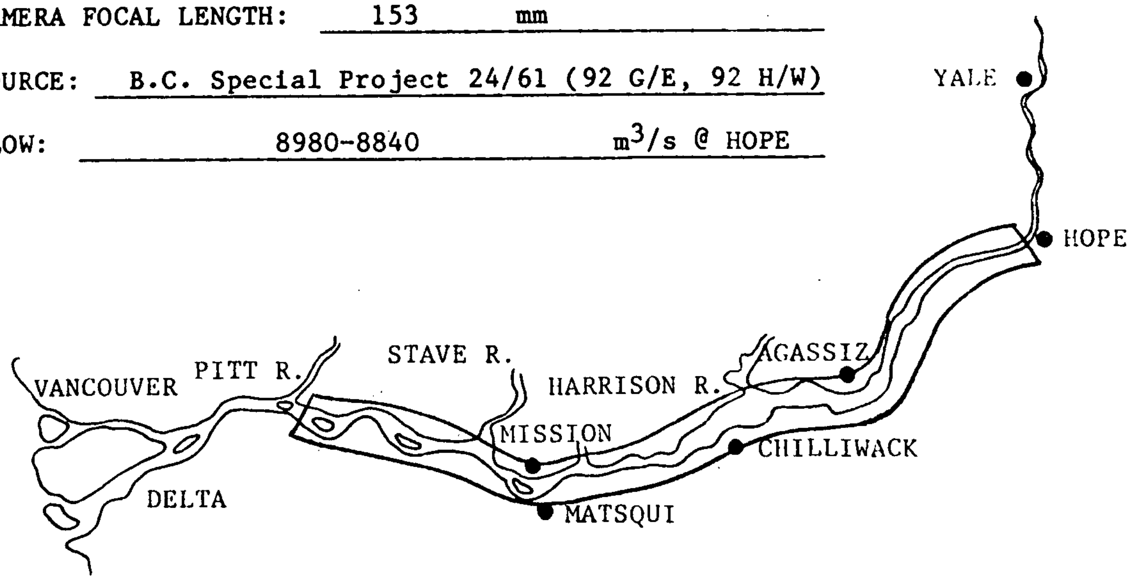
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2740 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 24/61 (92 G/E, 92 H/W)

FLOW: 8980-8840 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5028	145-155	HOPE
"	158-165	LAIDLAW
"	175-182	CHEAM VIEW
"	166-173	"
BC 5029	89-97	AGASSIZ
"	14-28	CHILLIWACK
BC 5028	196-210	"
"	115-125	NICOMEN IS.
"	68-80	"
"	65-67	DEWDNEY
"	40-46	MATSQUI IS.
"	29-36	"
"	19-28	GLEN VALLEY
"	4-15	MCMILLAN IS.
BC 5029	130-134	DOUGLAS IS.
"	102-115	BARNSTON IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1962 (7 May) SCALE: 1:32,000

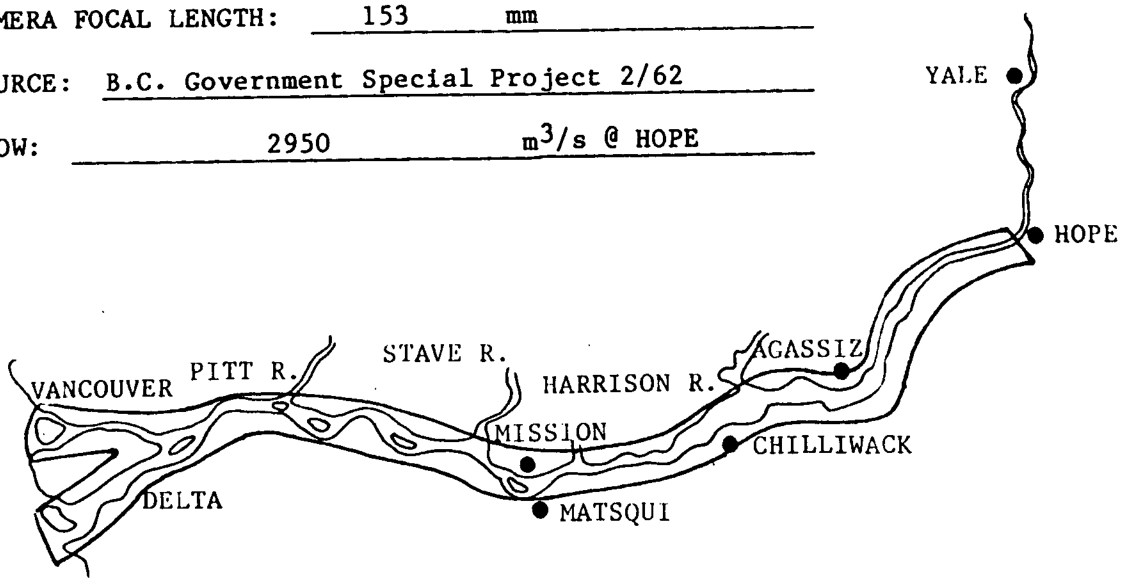
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4880 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project 2/62

FLOW: 2950 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5042	48-116	SEA IS. } HOPE WESTHAM IS. }

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1963 (16 June) SCALE: 1:30,000

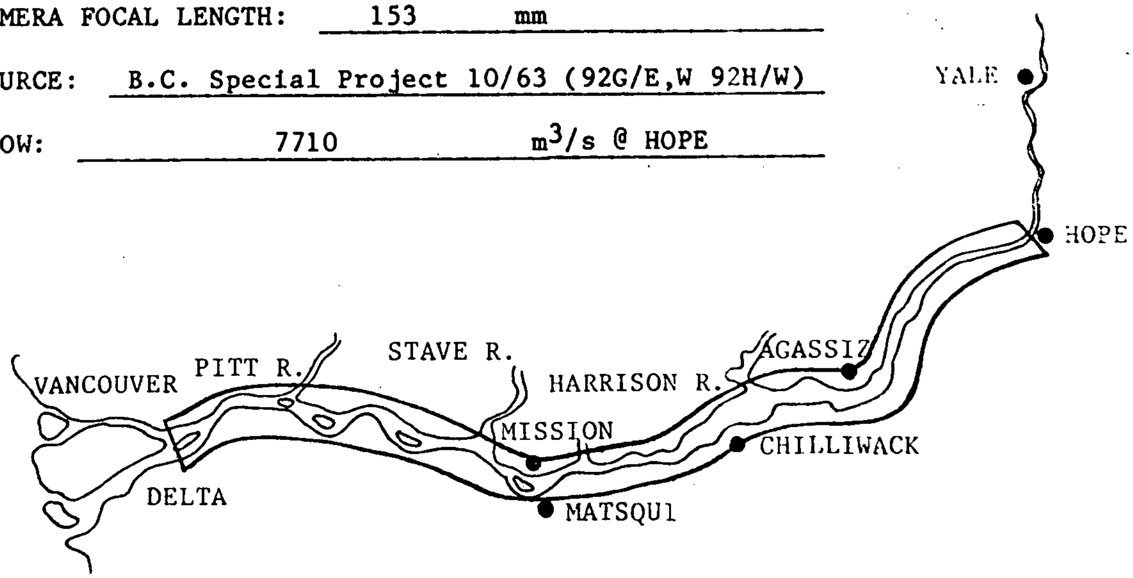
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4880 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 10/63 (92G/E,W 92H/W)

FLOW: 7710 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5077	45-57	HOPE - SEABIRD IS.
"	58-78	MT. LUDWIG
"	79-92	MATSQUI IS. - DOUGLAS IS.
"	112-117	PORT MANN
"	93-96	ANNACIS IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1964 (6 Apr) SCALE: 1:32,000

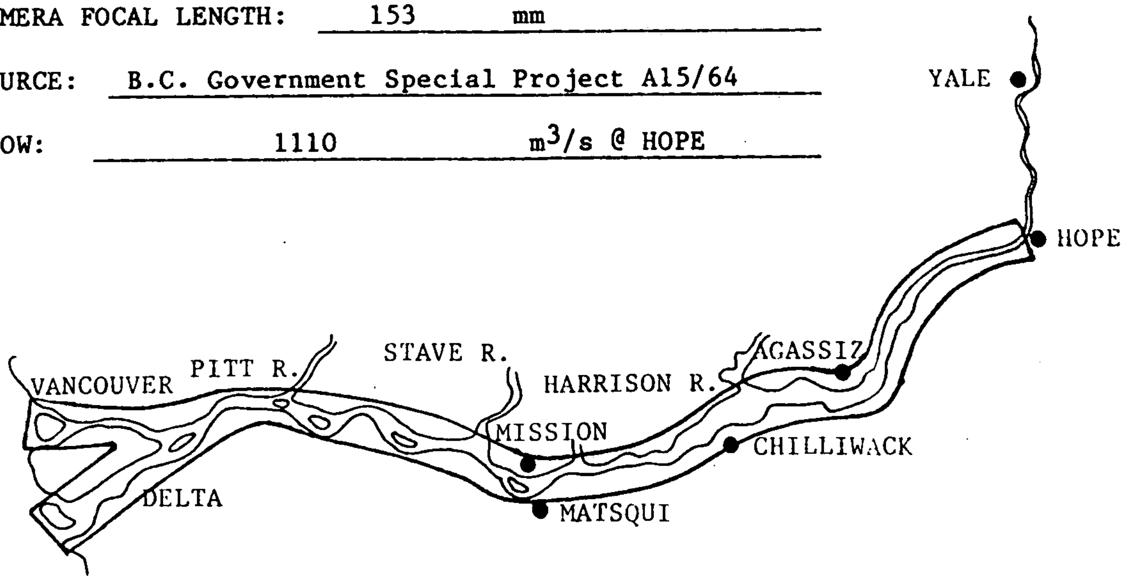
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4880 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project A15/64

FLOW: 1110 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5088	1-73	SEA IS. WESTHAM } HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1964 (22-25 June) SCALE: 1:32,000

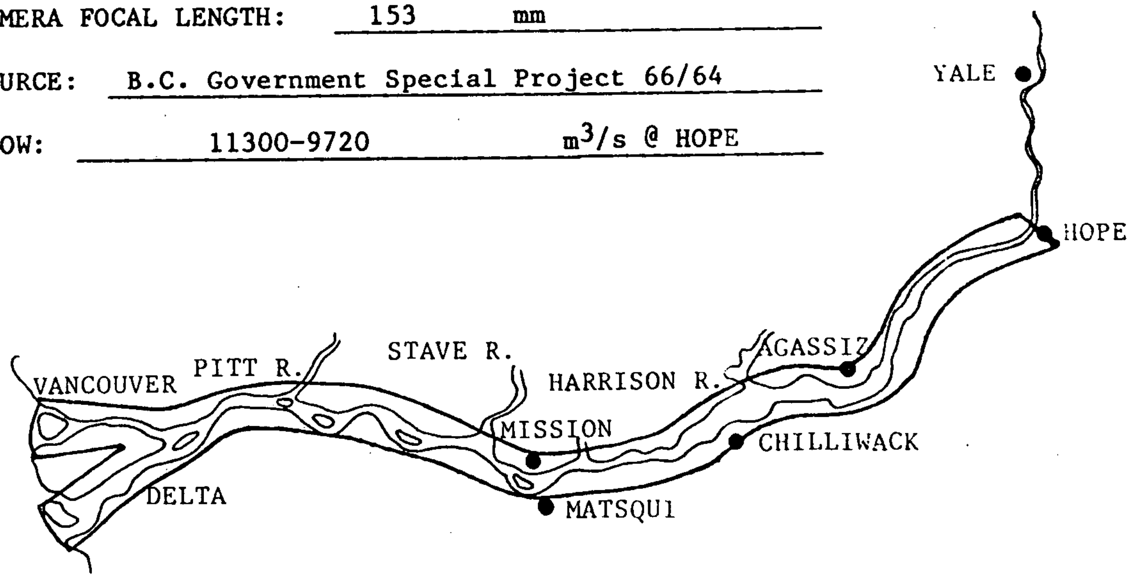
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1830 & 4880 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project 66/64

FLOW: 11300-9720 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5099	7-38	DOWNSTREAM OF KANAKA CK.
BC 5097	155-195	UPSTREAM OF " "

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1965 (2 Mar) SCALE: 1:32,000

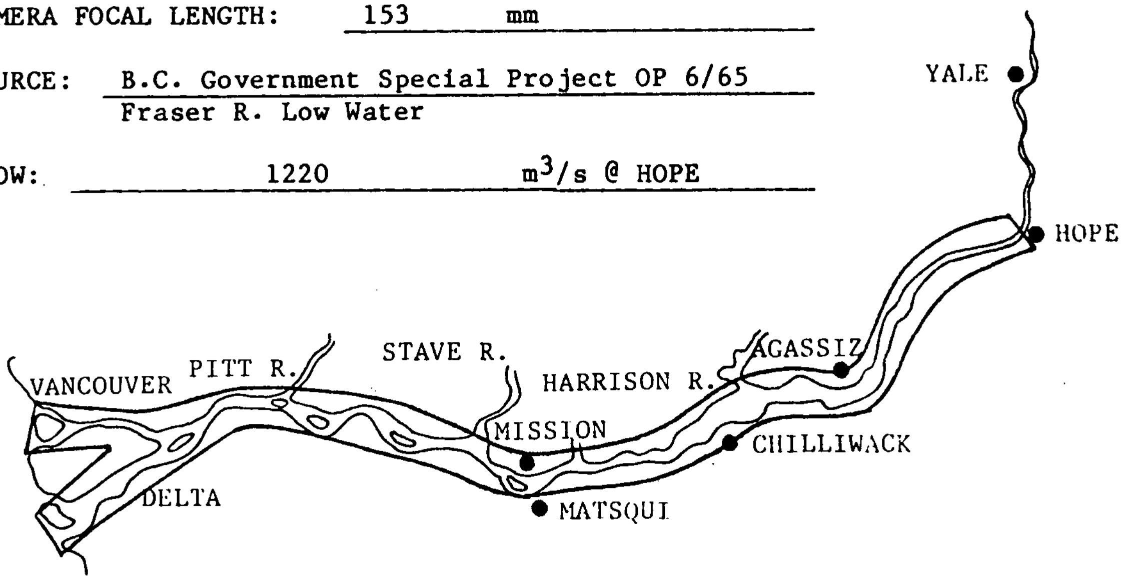
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4880 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project OP 6/65
Fraser R. Low Water

FLOW: 1220 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5124	251-324	SEA IS. } HOPE WESTHAM IS. }

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1966 (7 Apr) SCALE: 1:32,000

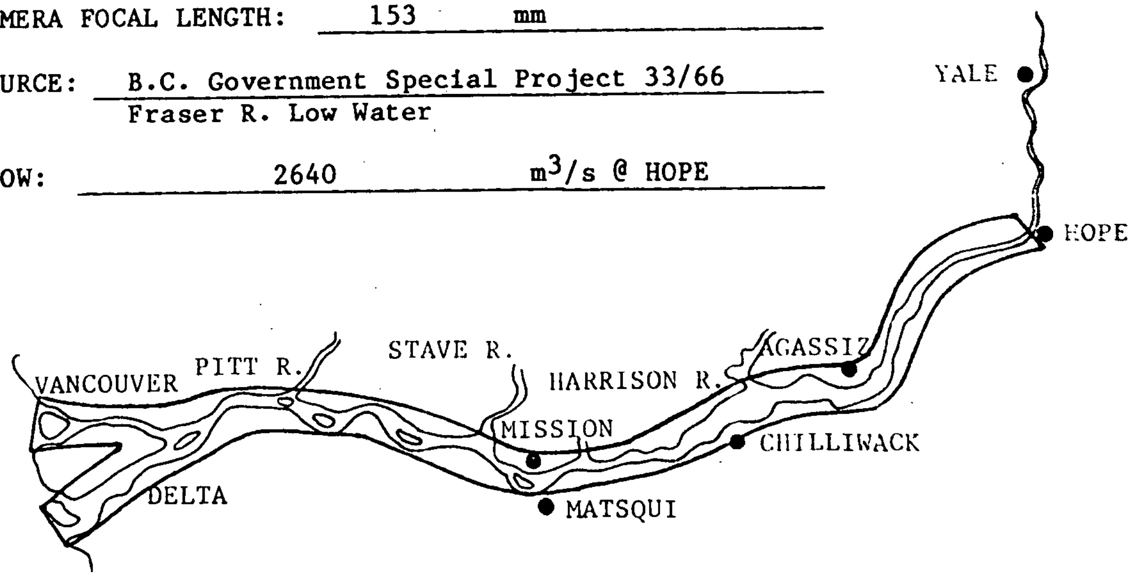
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4880 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project 33/66
Fraser R. Low Water

FLOW: 2640 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5172	1-75	SEA IS. } HOPE WESTHAM IS. }

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1966 (22 Dec) SCALE: 1:15,00

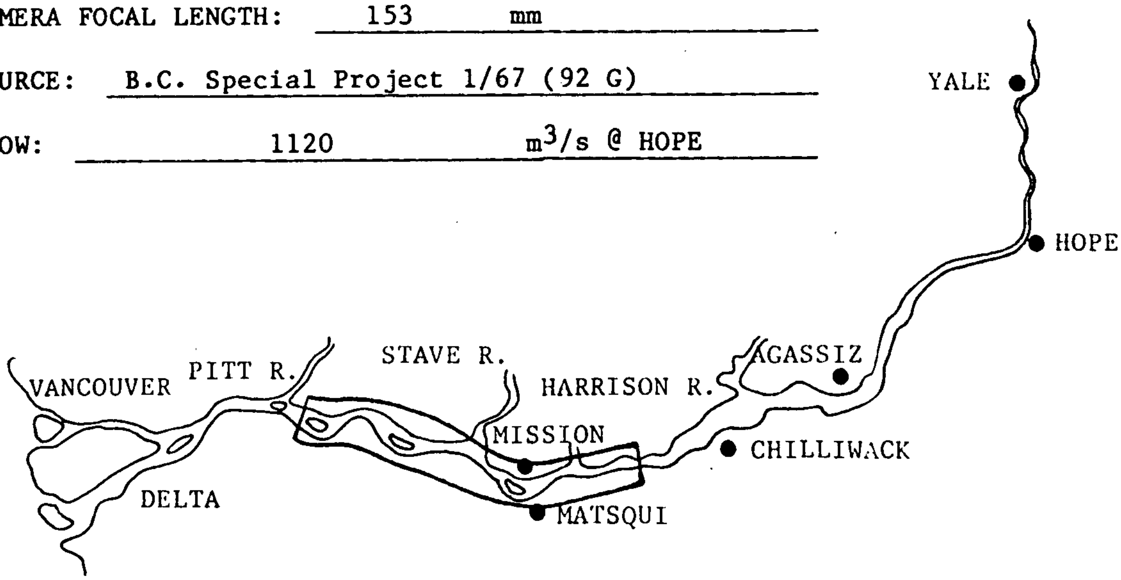
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2420 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 1/67 (92 G)

FLOW: 1120 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5223	108-112	NICOMEN IS.
"	97-104	MATSQUI IS.
"	25-34	McMILLAN IS. - SILVERDALE
"	11-15	BARNSTON IS.
"	1-8	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1967 (11 Apr) SCALE: 1:32,000

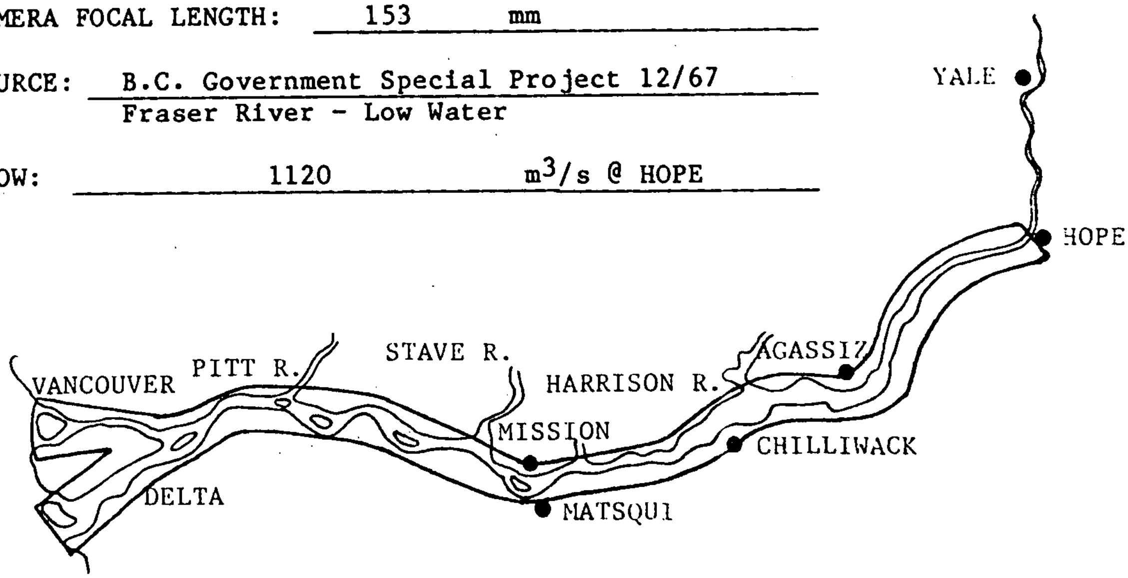
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4880 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project 12/67
Fraser River - Low Water

FLOW: 1120 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5226	1-77	SEA IS. } HOPE WESTHAM }

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1969 (11-13 Mar)   SCALE: 1:12,000

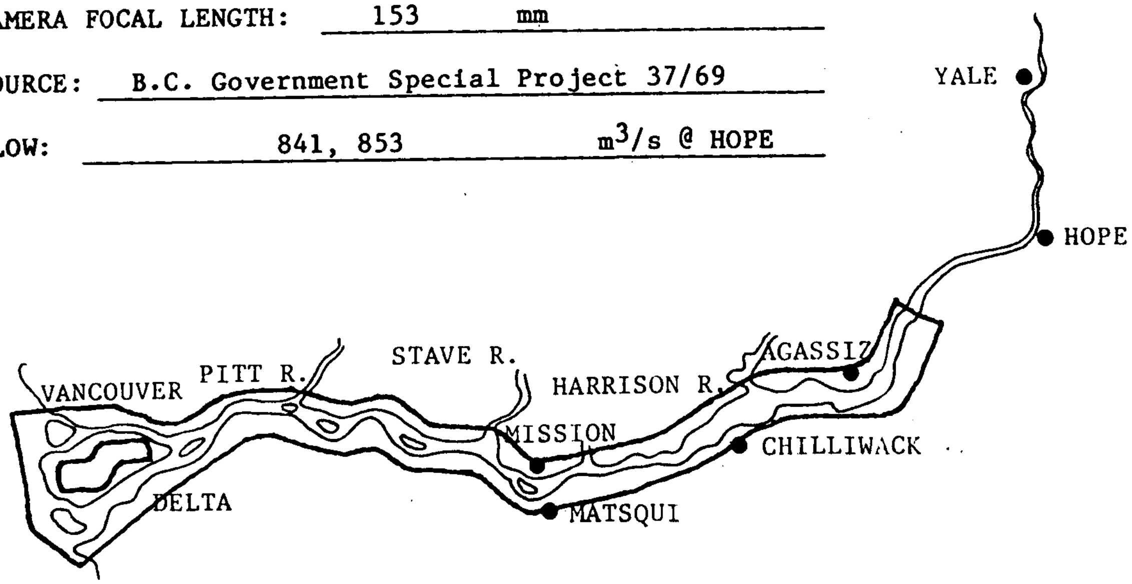
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 1830 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project 37/69

FLOW: 841, 853 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5322	15-20	LAIDLAW
"	45-50	
"	60-66	
"	102-108	
BC 5321	242-248	
BC 5322	130-152	HERRLING IS. - HARRISON R.
BC 5321	91-98	N. ARM JETTY
"	115-137	NEW WESTMINSTER - HANEY
"	185-211	HARRISON HILL - FOUR BROS. MT.
"	84-90	STURGEON BANK
"	72-81	N. ARM
"	63-65	NEW WESTMINSTER
"	39-52	
BC 5320	233-243	
"	216-224	POPKUM
"	92-97	MIDDLE ARM
"	106-113	
"	126-131	BARNSTON IS.
"	136-139	MCMILLAN IS.
"	174-185	
"	80-83	STURGEON BANK
"	61-67	ANNACIS IS.

(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ____________________ SCALE: ____________________

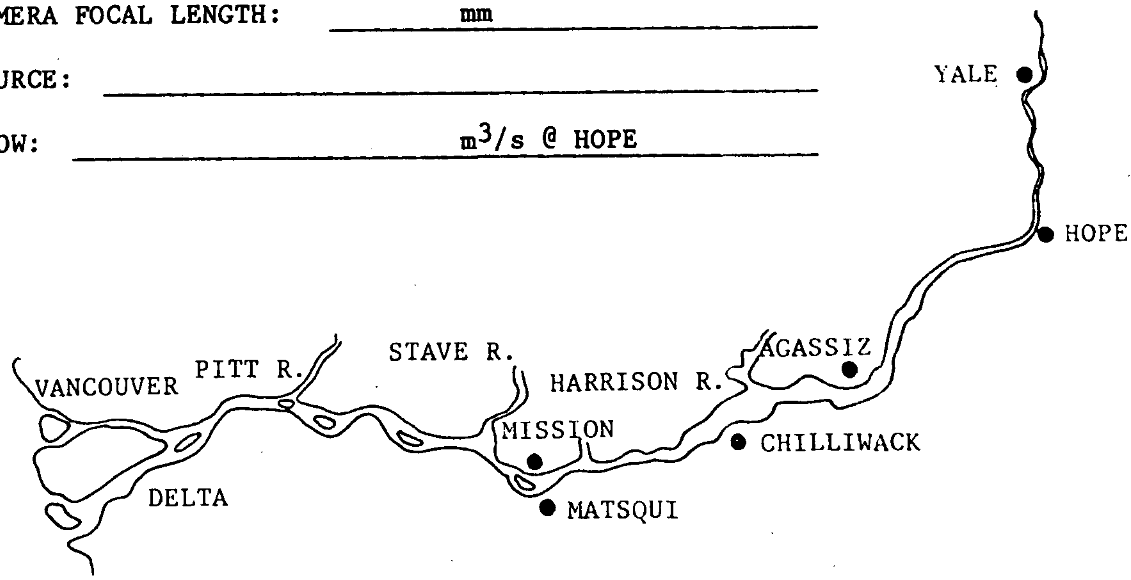
FLIGHT LINE ORIENTATION: ____________________

FLYING HEIGHT: __________ mASL __________

CAMERA FOCAL LENGTH: __________ mm __________

SOURCE: ____________________

FLOW: __________ m^3/s @ HOPE __________



FILM ROLL	PHOTO NOS.	REMARKS
BC 5320	25-36	CRESCENT IS. - MCMILLAN IS.
"	1-10	NICOMEN IS.
BC 5319	276-284	"
"	154-156	STURGEON BANK
"	168-173	
"	211-215	MISSION
"	221-238	MISSION - CHILLIWACK MTN.
"	148-153	GARRY PT.
"	136-140	
"	75-92	MATSQUI AREA

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1969 (11 Mar) SCALE: 1:12,000

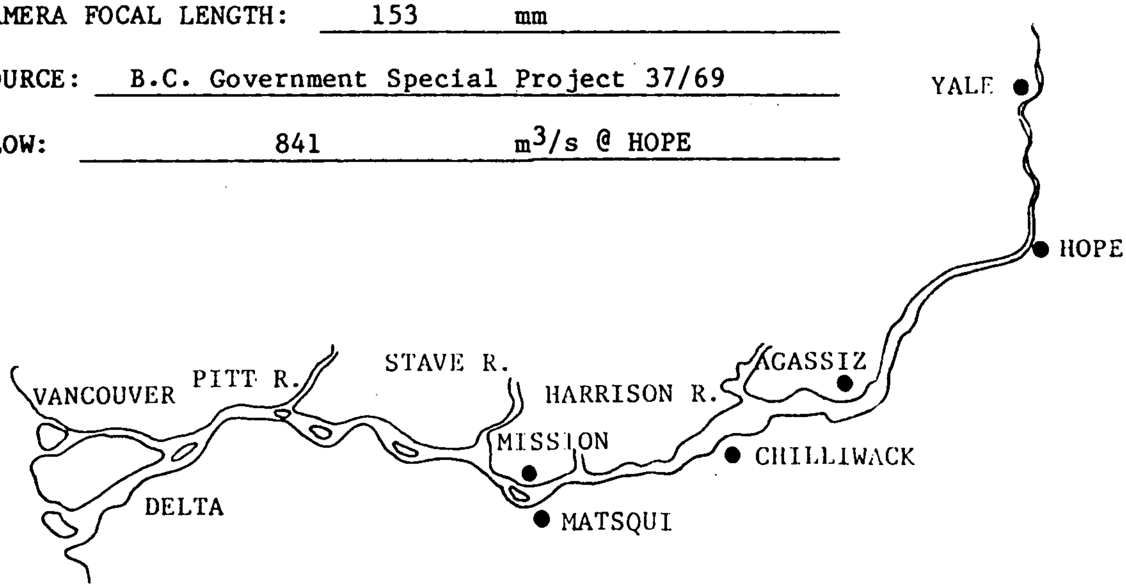
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 1830 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project 37/69

FLOW: 841 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5319	10-13	MATSQUI IS.
BC 5318	224-234	'S'. ARM
"	212-223	
"	42-47	CANOE PASS

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1969 (6 May) SCALE: 20 Chs

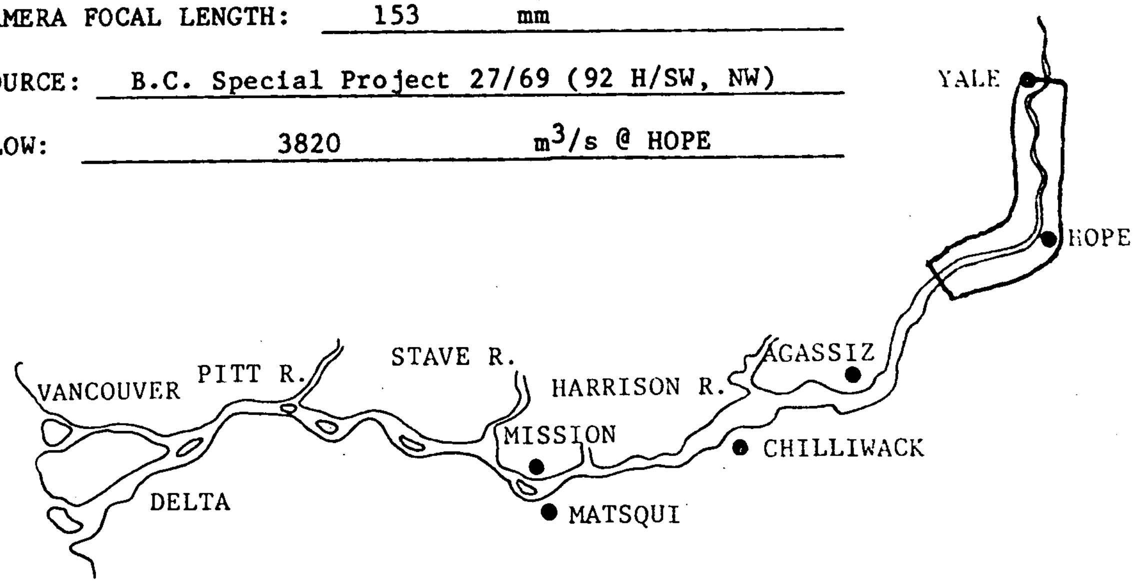
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 2590 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 27/69 (92 H/SW, NW)

FLOW: 3820 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5327	50-56	YALE-TEXAS BAR
"	42-49	TEXAS BAR-HOPE
"	37-41	HOPE
"	16-26	ODLUM-RUBY CK
"	10-15	RUBY CK

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1970 (29 Oct) SCALE: 1:32,000

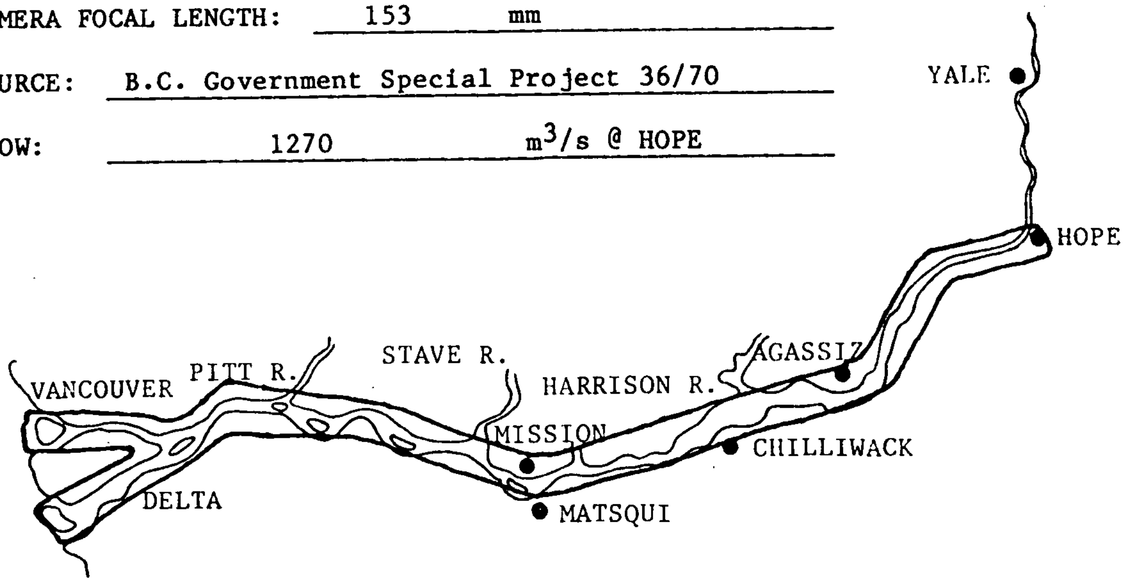
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4880 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project 36/70

FLOW: 1270 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5402	1-69	SEA IS. WESTHAM IS. } HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1971 (19 Mar & May) SCALE: 1:32,000 (40 Ch)

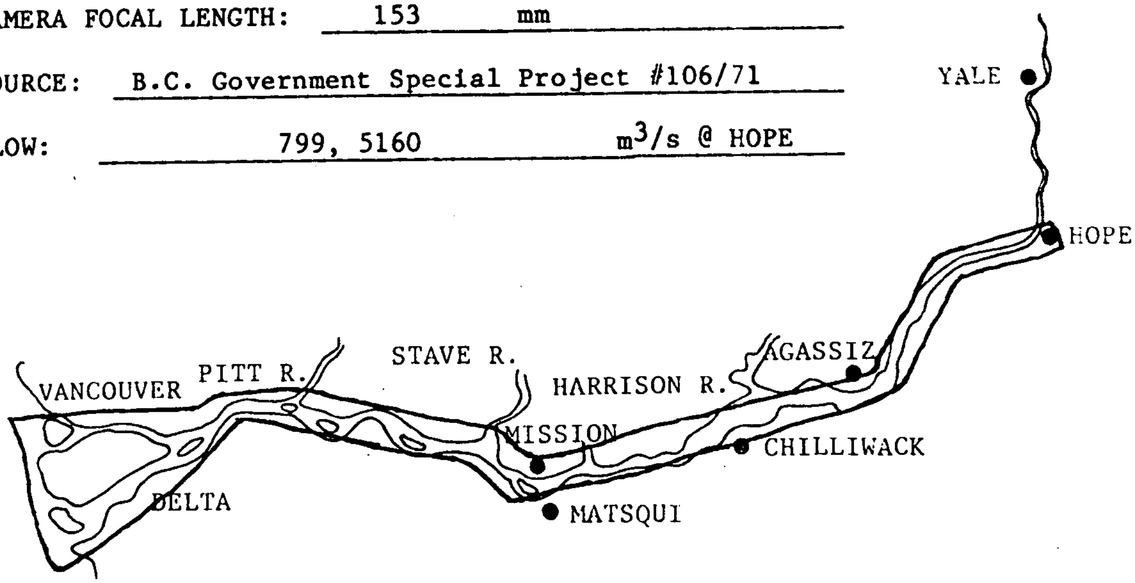
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 5180 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project #106/71

FLOW: 799, 5160 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5406	167-190	STAVE R. - STURGEON BANK
"	147-161	AGASSIZ - NICOMEN SLOUGH
"	103-105	W. END LULU IS.
"	108-111	ANNACIS IS.
"	114-142	BARNSTON IS. - CHILLIWACK
"	96-102	SAND HEADS - DEAS IS.
"	32-35	CANOE PASS
"	70-79	CHILLIWACK - MATSQUI IS.
BC 5407	44-47	AGASSIZ
"	54-56	SEABIRD IS.
"	72-74	SAIDLAW
BC 5410	77-86	LAIDLAW - HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1971 (18, 19 Mar) SCALE: 1:12,000

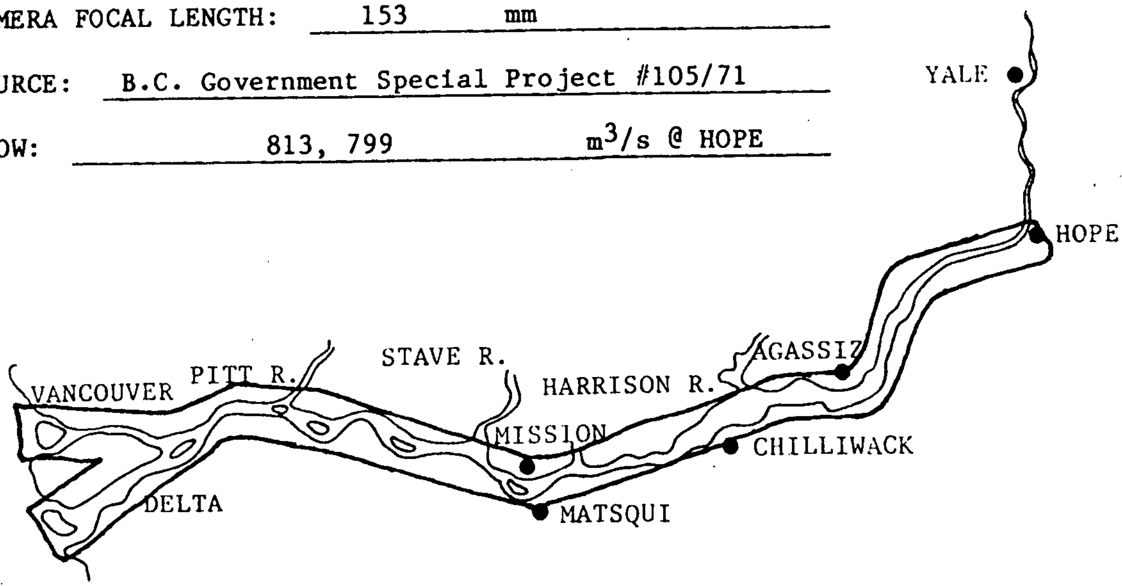
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1830 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project #105/71

FLOW: 813, 799 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5403	32-42	WESTHAM I.
"	63-93	DOUGLAS IS. - WESTHAM IS.
"	94-126	WESTHAM IS. - ESSONDALE
"	136-141	NORTH ARM AT E. LULU IS.
"	152-157	PELLY PT.
"	158-163	STURGEON BANK
"	185-194	SEA IS.
"	195-210	"
"	240-243	N. ARM JETTY
BC 5405	1-139	CHATHAM REACH - NICOMEN IS.
"	161-165	BARNSTON IS.
"	173-291	MATSQUI - CHEAM
BC 5404	1-14	SUMAS MTN. - CHIILLIWACK
"	26-34	
"	65-77	HOPE - RUBY CK.
"	95-104	CHEAM VIEW - RUBY CK.
"	105-119	" "

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1971 (16 July) SCALE: 1:137,000 (approx.) 9 x 9
1:160,000 - 70 mm format

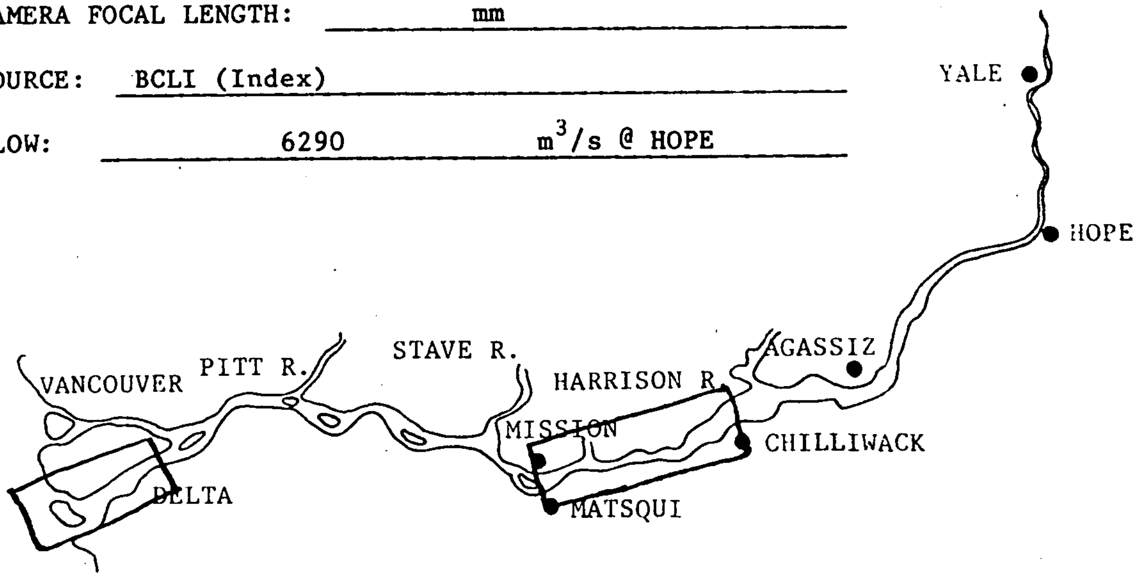
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: mASL

CAMERA FOCAL LENGTH: mm

SOURCE: BCLI (Index)

FLOW: 6290 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
9 x 9 format		
A 30339	113-115	True color, WESTHAM IS.
"	107-110	MISSION - CHILLIWACK
70 mm format		WESTHAM IS. MISSION - CHILLIWACK
BN 1180	IR 383-394	Infra Red B & W Film 2424 Filter 89-B
BN 1181	IR 411-414	B & W Film 5063 Filter 25-A
BN 1182	IR " "	B & W Green Filter Film 5063 Filter W-12+44
CP 1183	IR " "	Infra Red Colour Film 2443 Filter W-12
In ordering photos:		
e.g.		
9 x 9 format		
A 30339	107-110, 113-115	
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ____________________ SCALE: ____________________

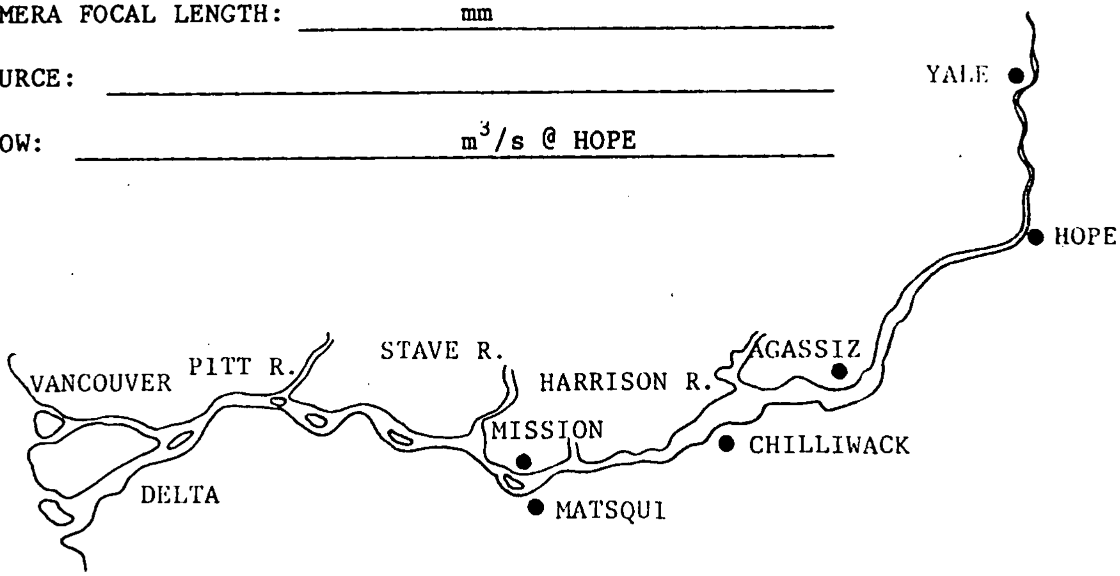
FLIGHT LINE ORIENTATION: ____________________

FLYING HEIGHT: __________ mASL __________

CAMERA FOCAL LENGTH: __________ mm __________

SOURCE: ____________________

FLOW: __________ m^3/s @ HOPE __________



FILM ROLL	PHOTO NOS.	REMARKS
70 mm format		
BN 1180	IR 383-394 411-414	
BN 1181	IR " "	
BN 1182	IR " "	
BN 1183	IR " "	

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1971 (5 Oct) SCALE: 1:6000

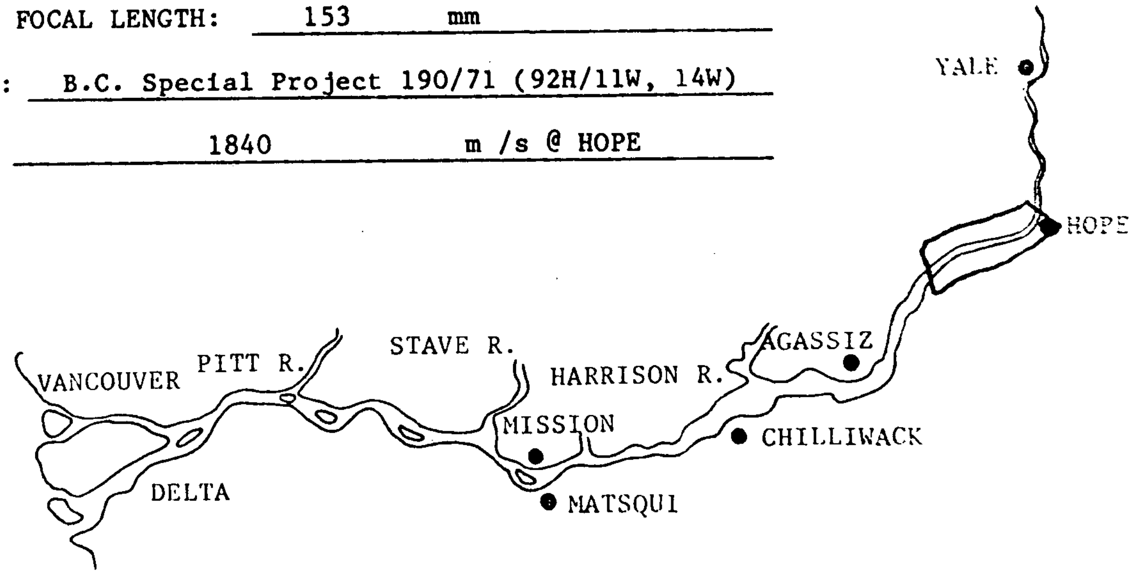
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 910 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 190/71 (92H/11W, 14W)

FLOW: 1840 m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5448	115-123	HOPE
"	124-129	VASASUS IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1971 (6 Dec) SCALE: 1:6000

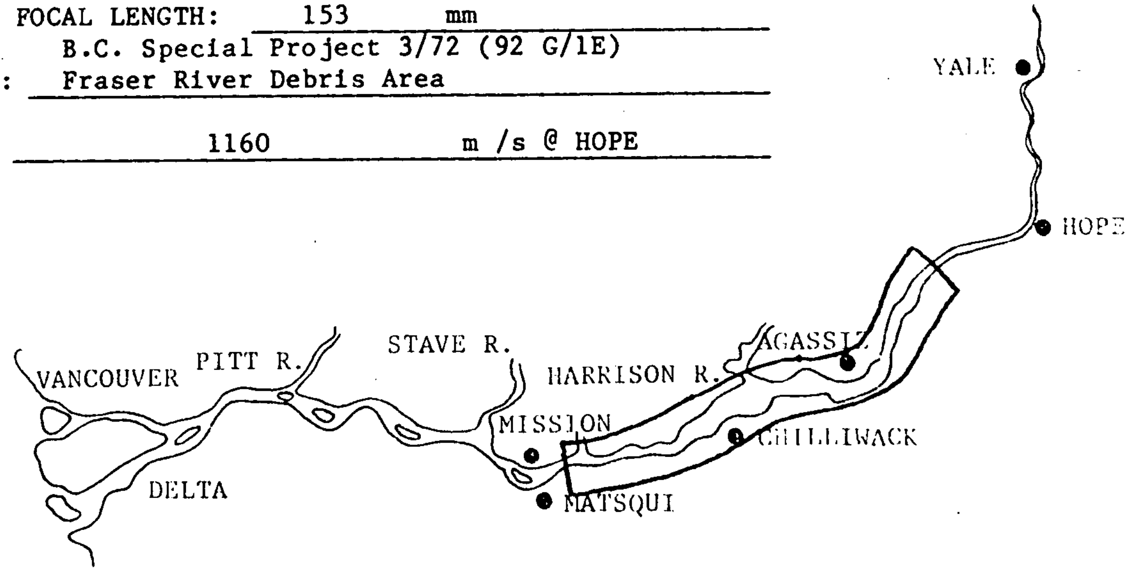
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 910 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 3/72 (92 G/1E) Fraser River Debris Area

FLOW: 1160 m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5449	47-53	LAIDLAW
"	54-59	WINDERMERE IS.
"	60-64	CHILLIWACK MTN.
"	65-71	NICOMEN IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1971 (7 Dec) SCALE: 1:4800

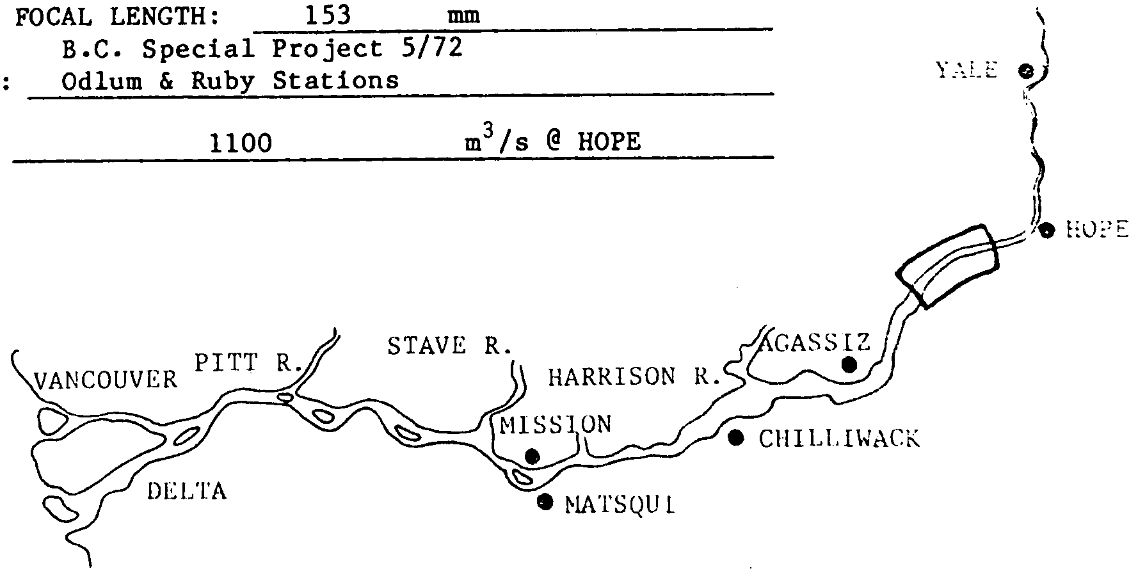
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 760 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 5/72 Odlum & Ruby Stations

FLOW: 1100 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5449	80-87	ODLUM
"	72-79	"
"	38-46	RUBY CK.
"	31-37	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1972 (20 Mar) SCALE: 1:16 000, 1:7200

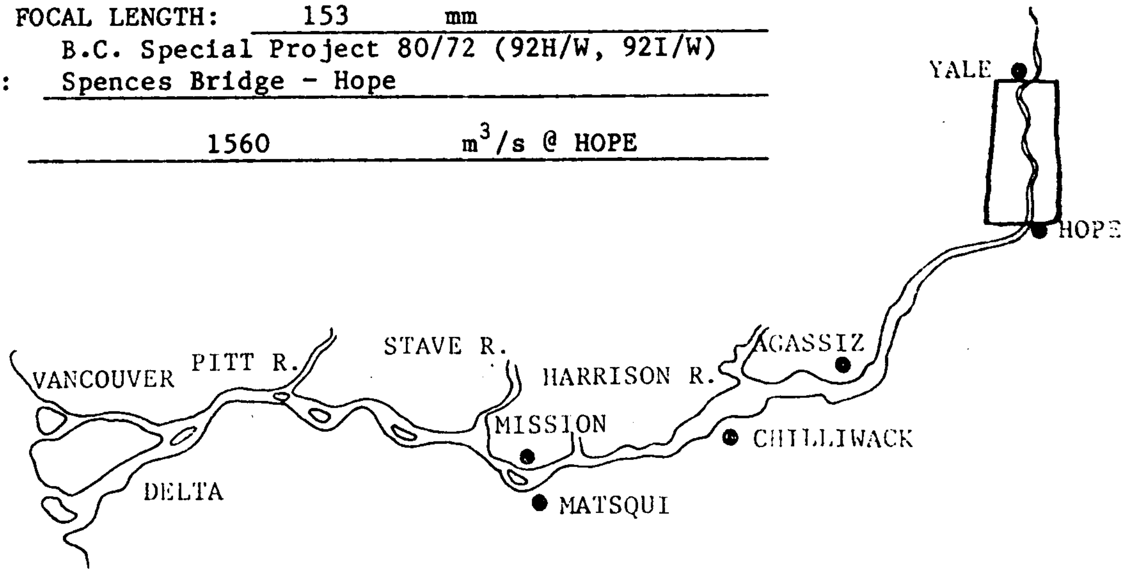
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1370 & 3200 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 80/72 (92H/W, 92I/W) Spences Bridge - Hope

FLOW: 1560 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5452	1-17	YALE - HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1972 (May) SCALE: 1:15,000

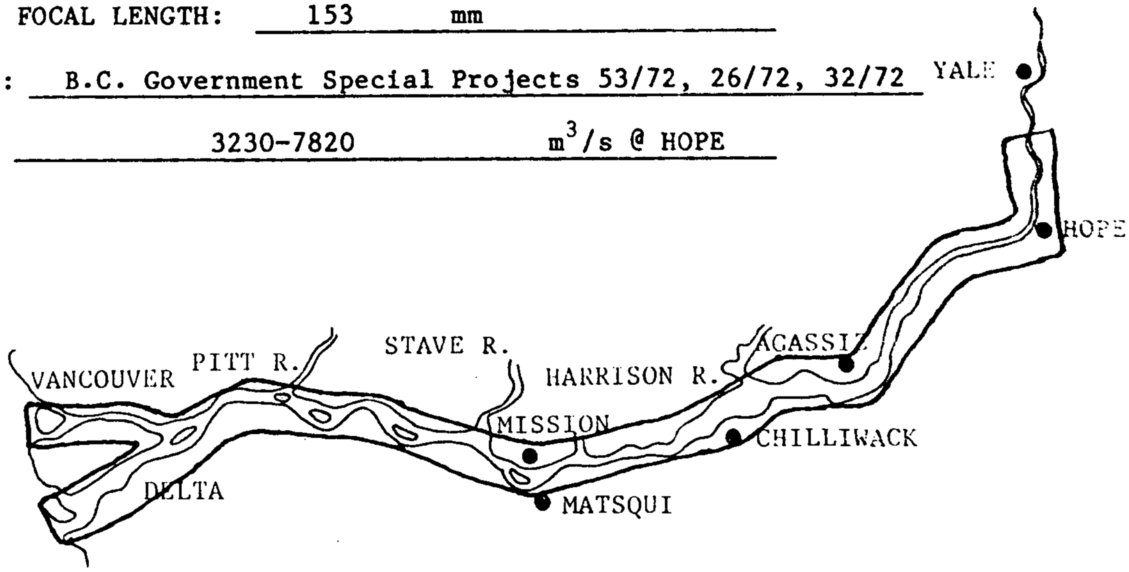
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1830 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Projects 53/72, 26/72, 32/72

FLOW: 3230-7820 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5455	146-152	N. ARM JETTY
"	106-126	SEA I. - NEW WESTMINSTER
"	98-105	S. EDGE OF SEA IS.
"	86-88	N. ARM
"	68-69	S. OF MIDDLE ARM MOUTH
"	1-30	WESTHAM IS. - QUEENS REACH
BC 5454	242-271	PT. MANN - WESTHAM IS.
"	199-209	CANOE PASS
"	218-220	CITY REACH
"	230-234	DOUGLAS IS.
BC 5455	193-195	MATSQUI IS.
"	204-211	"
"	219-226	MCMILLAN IS.
"	231-243	BARNSTON IS. - QUEENS REACH
"	247-292	PORT MANN - COX
BC 5456	35-37	
"	20-26	RUSKIN
"	1-9	
"	90-138	
"	139-173	COX - AGASSIZ
"	259-283	AGASSIZ - VEDDER CANAL
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ____________ SCALE: ____________

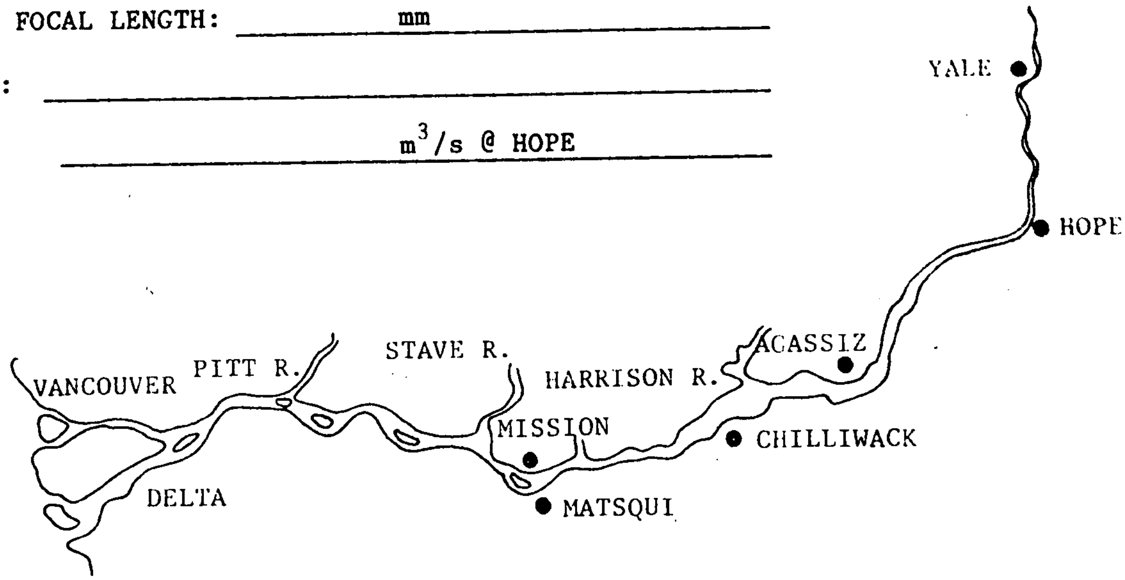
FLIGHT LINE ORIENTATION: ____________

FLYING HEIGHT: ____________ mASL

CAMERA FOCAL LENGTH: ____________ mm

SOURCE: ____________

FLOW: ____________ m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS	
BC 5456	186-204	HOPE SLOUGH - MT. HICKS	
"	210-229	" "	
"	230-249	POPKUM - LAIDLAW	
"	252-256	HERRLING IS.	
BC 5458	20-32	HOPE - RUBY CK. }	26/72
"	1-11	HOPE SQUEAH }	
BC 5453	23-31	CANOE PASS - DEAS IS.:	32/72

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1972 (18 June) SCALE: 1:12,000

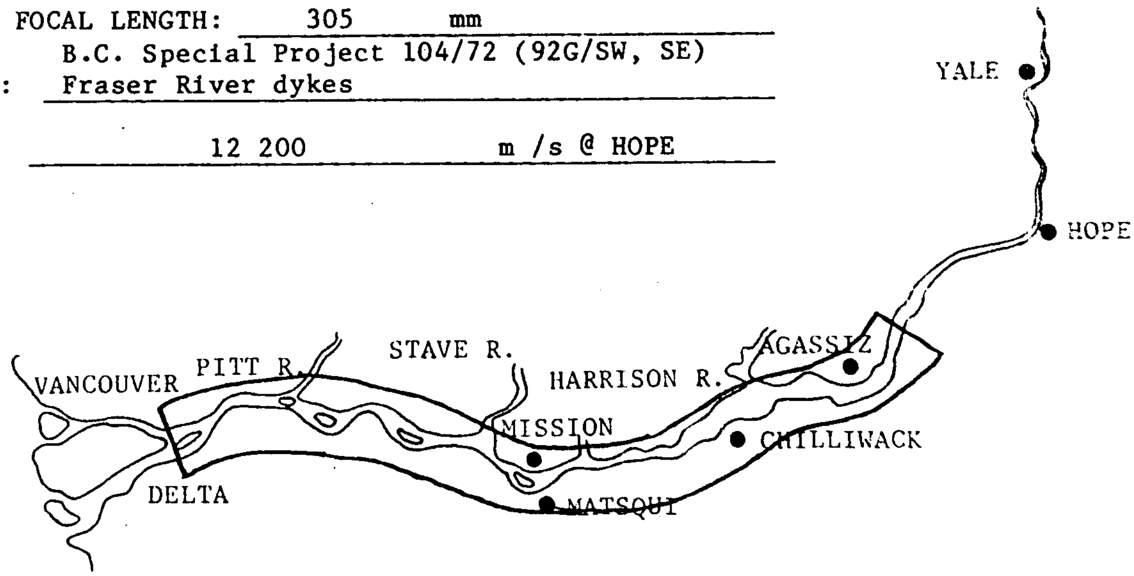
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 3650 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 104/72 (92G/SW, SE) Fraser River dykes

FLOW: 12 200 m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BCC 59	25-39	WINDERMERE IS.
"	59-69	AGASSIZ
"	41-57	"
BCC 58	99-119	HARRISON HILL - MATSQUI
"	69-98	" "
"	62-67	CRESCENT IS.
"	50-55	MCMILLAN IS.
"	31-35	BARNSTON IS.
"	37-47	BARNSTON IS.
BCC 57	90-100	ANNACIS IS.
"	31-61	NEW WESTMINSTER

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1972 (Aug. 7) SCALE: 1:108,000 approx 9 x 9 format
1:126,720 70 mm format

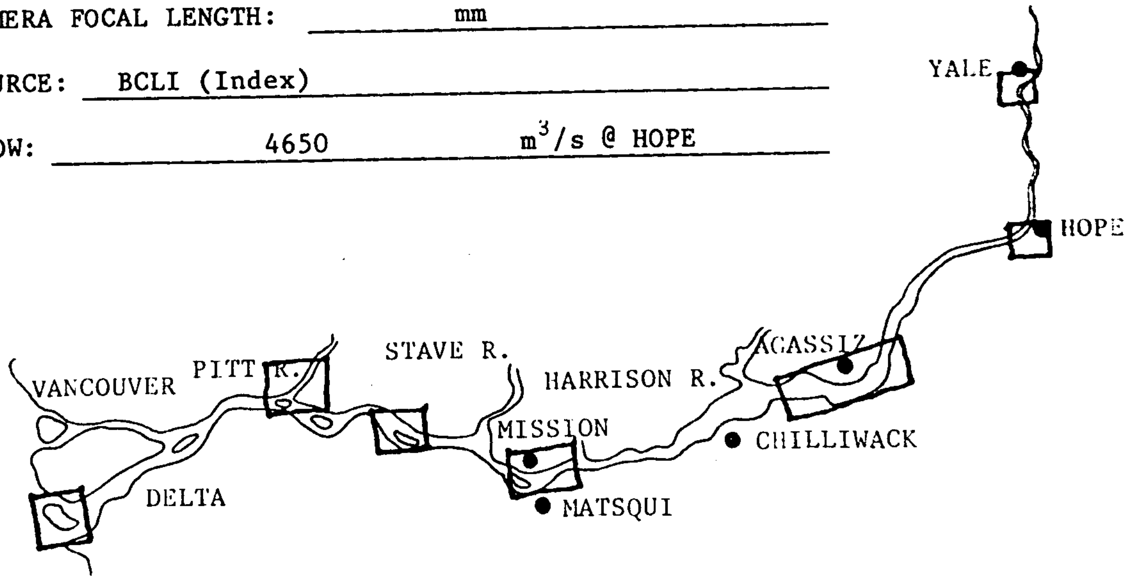
FLIGHT LINE ORIENTATION: north-south

FLYING HEIGHT: mASL

CAMERA FOCAL LENGTH: mm

SOURCE: BCLI (Index)

FLOW: 4650 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
9 x 9 format		
RSA 30518	59-61	True colour, DELTA FRONT
"	50-51	" " CHATHAM REACH
"	46-47	" " FORT LANGLEY
"	39-40	" " MISSION
"	34-37	" " ROSEDALE-LAIDLAW
"	31-32	" " YALE
RSA 30583	8	" " 1:120,000, Oct. 4, 1972: HOPE
70 mm format		
1717-9[1,2]	186-197	DELTA FRONT
"	153-155	CHATHAM REACH
"	143-145	FORT LANGLEY
"	122-124	MISSION
"	108-117	ROSEDALE LAIDLAW
"	98	YALE
1995-6 2068	24-26	1:140,000 Oct. 4, 1972 HOPE

(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ______________________ SCALE: ______________________

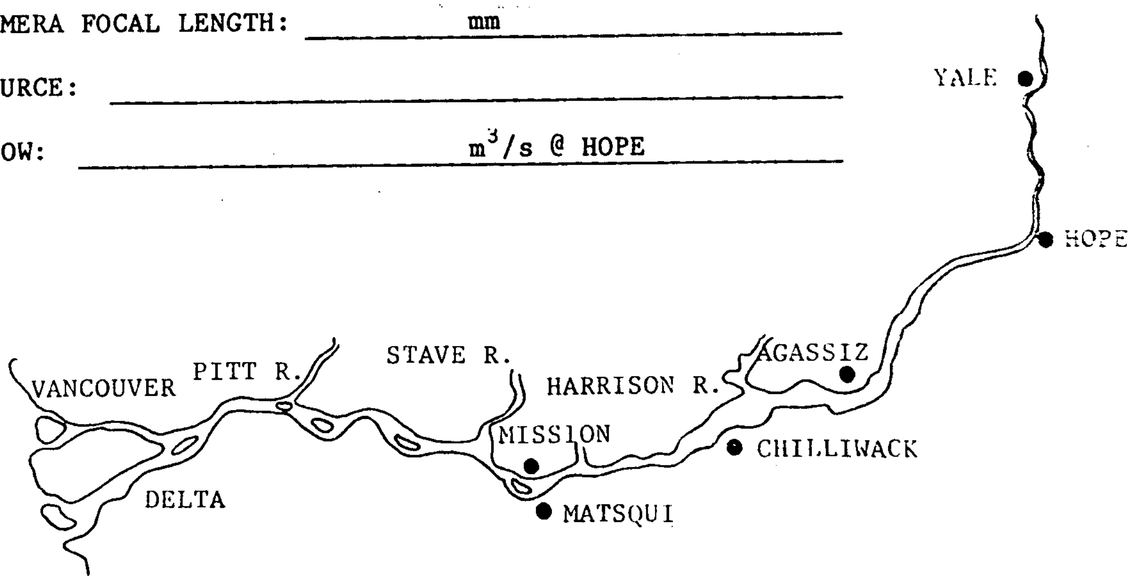
FLIGHT LINE ORIENTATION: ______________________

FLYING HEIGHT: ______________ mASL ______________

CAMERA FOCAL LENGTH: ______________ mm ______________

SOURCE: ______________________

FLOW: ______________ m^3/s @ HOPE ______________



FILM ROLL	PHOTO NOS.	REMARKS
See example for ordering photo on		
1 BN1717	IR	Film 2424 Filter 89B
BN1718	IR	Film 2405 Filter 58
CP1719	IR	Film 2443 Filter 12 (substandard)
CP1720	IR	Film 2443 Filter 12
2 BN1985	IR	Film 2424 Filter 89B
BN1986	IR	Film 2405 Filter 25A
BN1987	IR	Film 2405 Filter 12+58
CP1988	IR	Film 2443 Filter W 12 (substandard)
BN2069	Sc	Film 2498

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1973 (23 Mar) SCALE: 1:12000

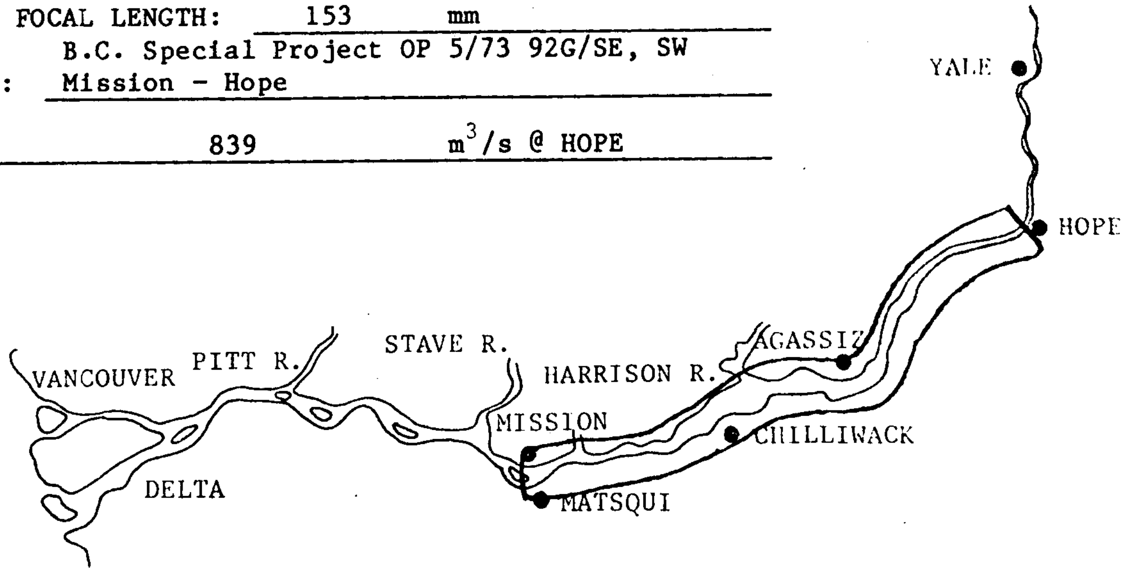
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1840 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project OP 5/73 92G/SE, SW Mission - Hope

FLOW: 839 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5524	167-173	CHEAM VIEW
"	150-166	HOPE - VASASUS
"	127-149	POPKUM - VASASUS
"	116-126	AGASSIZ
"	103-115	WINDERMERE
"	85-102	CHILLIWACK
"	61-84	CHILLIWACK - MATSQUI

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1973 (30 Apr)   SCALE: 1:12,000

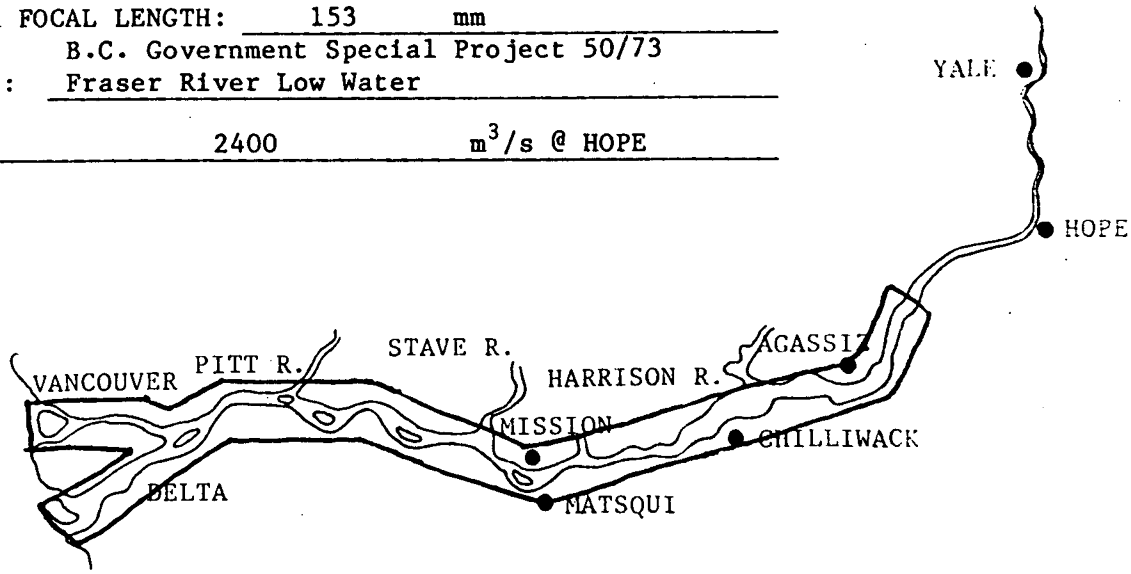
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1830 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Special Project 50/73 Fraser River Low Water

FLOW: 2400 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5525	1-156 }	DOWNSTREAM OF PORT MANN
"	167-169 }	
"	168-280	
BC 5526	78-193	
"	209-271	
BC 5527	1-31	MT. HICKS - POPKUM AREA

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1974 (19 Mar) SCALE: 1:12,000

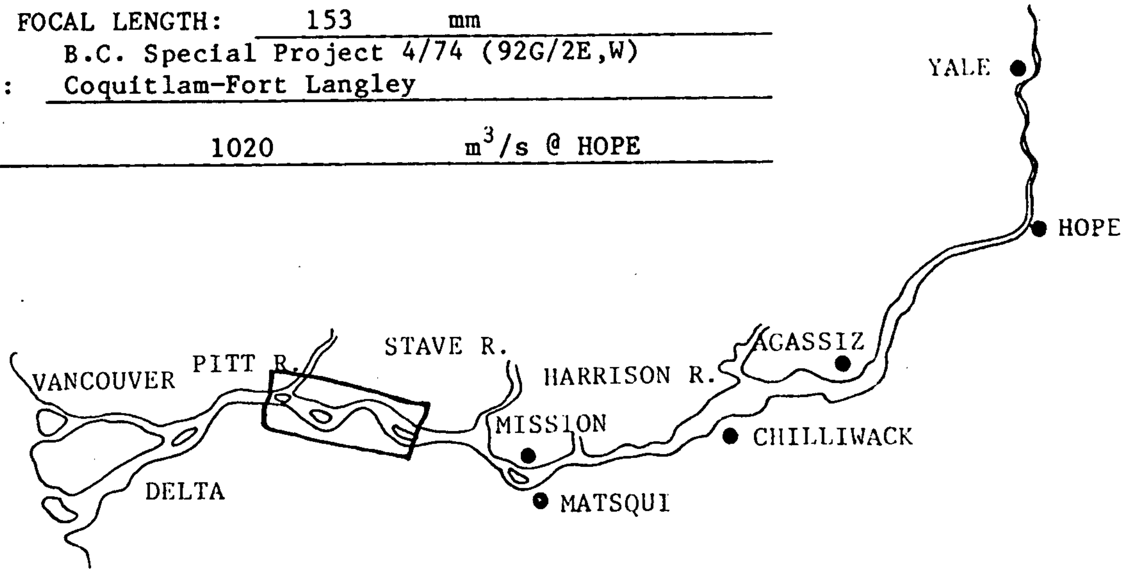
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 1850 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 4/74 (92G/2E,W) Coquitlam-Fort Langley

FLOW: 1020 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5572	15-21	MCMILLAN IS.
"	37-24	BARNSTON IS.
"	44-60	HANEY
"	72-75	"
"	80-87	DOUGLAS IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1974 (20-21 Mar) SCALE: 1:12,000

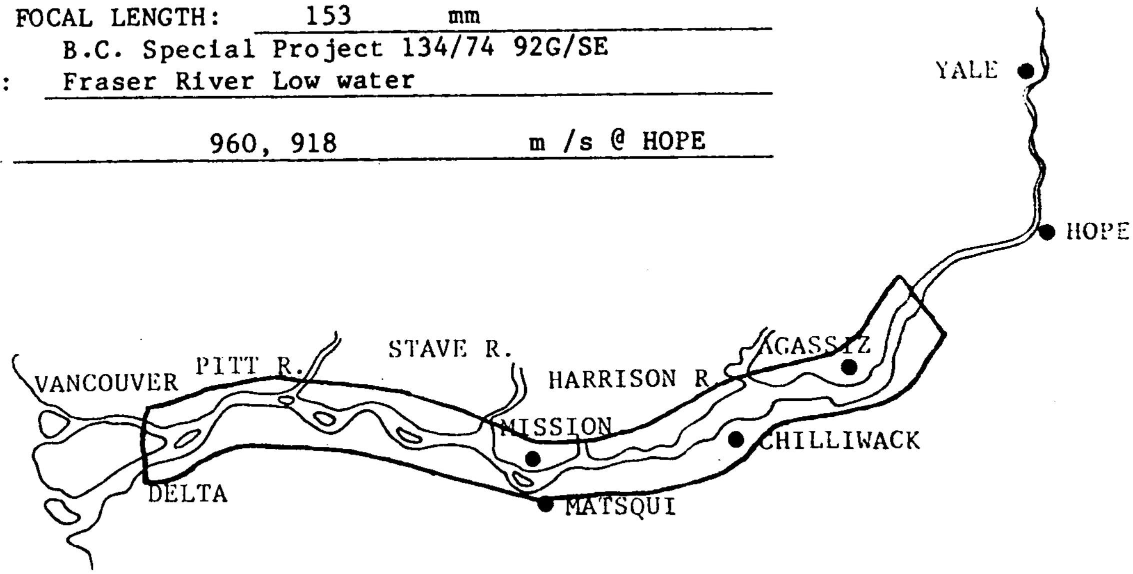
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1860 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 134/74 92G/SE Fraser River Low water

FLOW: 960, 918 m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5573	-62?	SEABIRD IS.
"	26-40	"
"	8-28	"
"	1-4	HERRLING IS.
BC 5574	161-171	CHILLIWACK
BC 5571	220-260	HARRISON R. - MISSION
BC 5573	68-110	" "
BC 5571	70-76	MISSION
"	152-160	MATSQUI
"	139-144	MCMILLAN IS.
"	120-133	BARNSTON IS.
"	60-61	CRESCENT IS.
"	50-51	DERBY REACH
"	82-115	DOUGLAS IS. - MISSION
"	30-35	PORT MANN
"	15-20	LULU IS.
"	260-280	"
BC 5572	- ?	"
BC 5572	200-?	

NOTE: Index illegible, photo nos. may be in error.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1974 (21 Mar, 31 May) SCALE: 1:12,000

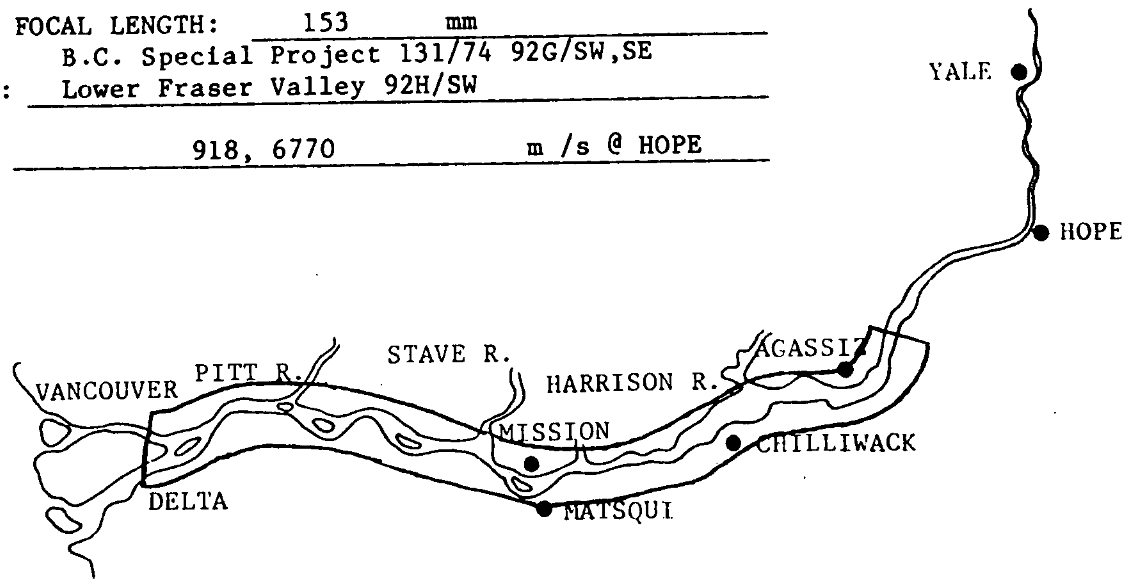
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 1920 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 131/74 92G/SW,SE
Lower Fraser Valley 92H/SW

FLOW: 918, 6770 m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5574	183-190	AGASSIZ
"	130-135?	CHEAM VIEW
"	142-146	"
"	176-180	"
"	201-206	CHILLIWACK
BC 5580	115-117	"
"	203-207	"
"	20-28	"
BC 5575	256-260?	"
"	28-39	NICOMEN IS.
"	75-87	"
"	168-170	SUMAS MTN.
"	114-130	CHILLIWACK - MISSION
BC 5580	176-191	MISSION
"	126-128	"
BC 5575	108-111	"
"	100-103	CRESCENT IS.
"	1-9	"
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ______________ SCALE: ______________

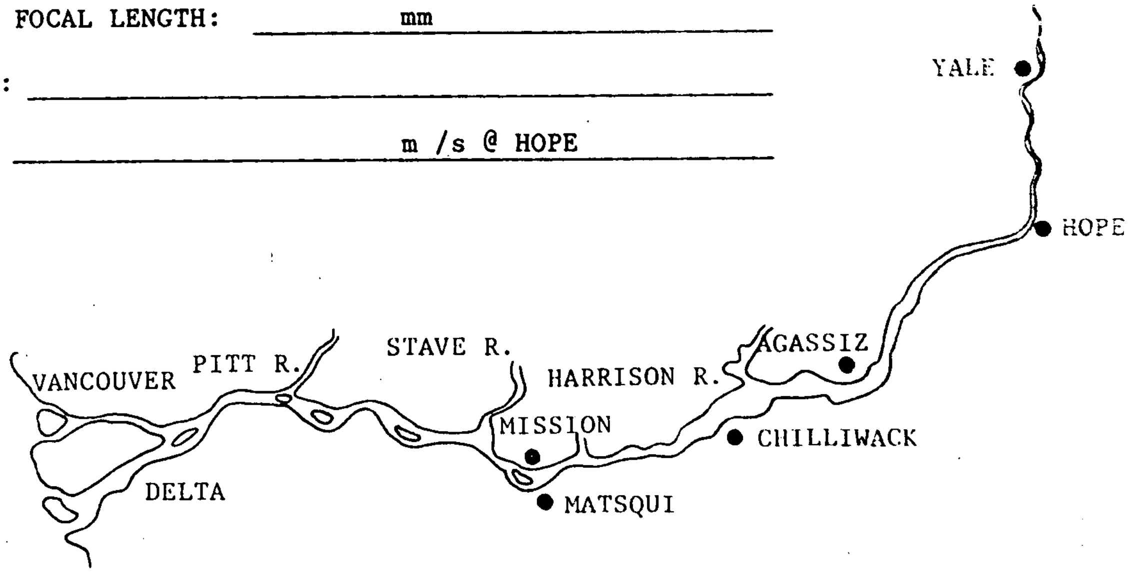
FLIGHT LINE ORIENTATION: ______________

FLYING HEIGHT: ______________ mASL

CAMERA FOCAL LENGTH: ______________ mm

SOURCE: ______________

FLOW: ______________ m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5581	260-273	CRESCENT IS.
"	172-176	MCMILLAN IS.
"	148-150	"
"	180-183	BARNSTON IS.
"	137-145	"
"	33-36	PITT R.
"	25-30	NEW WESTMINSTER
"	64-85	" - PORT HAMMOND
"	125-128	"
"	196-200	LULU IS.
"	234-240	"
"	223-233	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1974 (28 May) SCALE: 1:4000

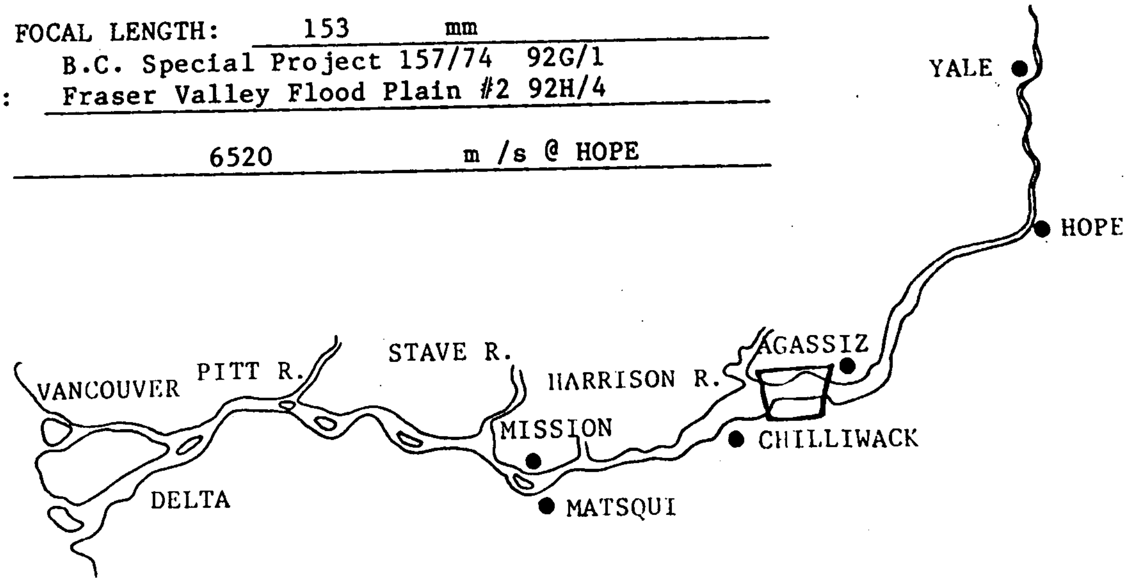
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 620 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 157/74 92G/1
Fraser Valley Flood Plain #2 92H/4

FLOW: 6520 m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5576	30-34	CHILLIWACK
"	69-72	"
BC 5579	235-240	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1974 (31 May) SCALE: 1:8000

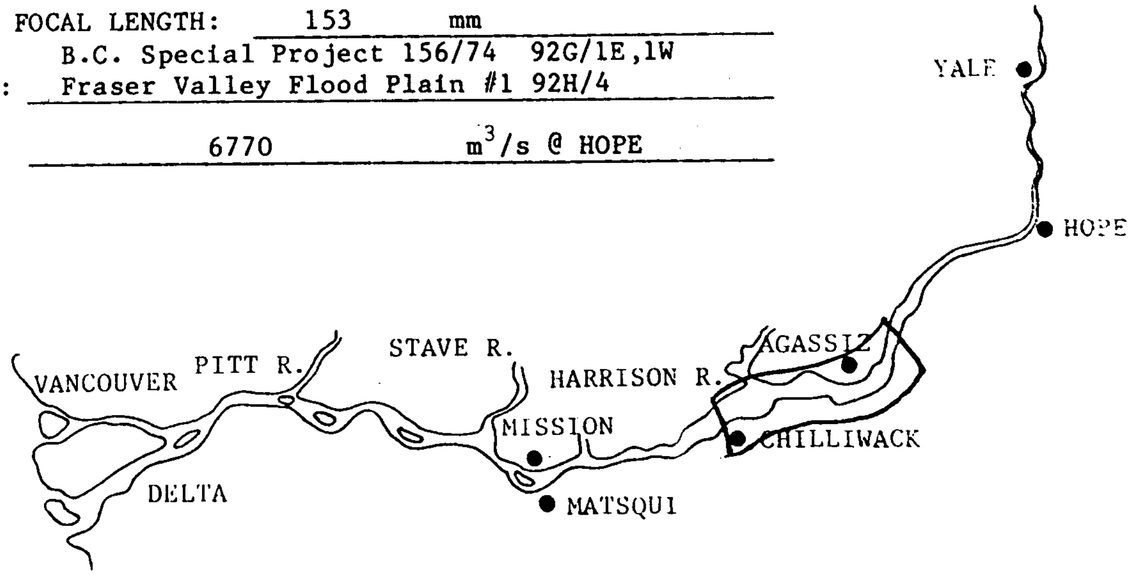
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1220 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 156/74 92G/1E,1W
Fraser Valley Flood Plain #1 92H/4

FLOW: 6770 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5582	140-147	AGASSIZ
"	148-152	"
"	272-280	WINDERMERE IS.
BC 5583	94-104	CHILLIWACK
"	146-174	"
"	175-182	NICOMEN IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1974 (11 June) SCALE: 1:32,000

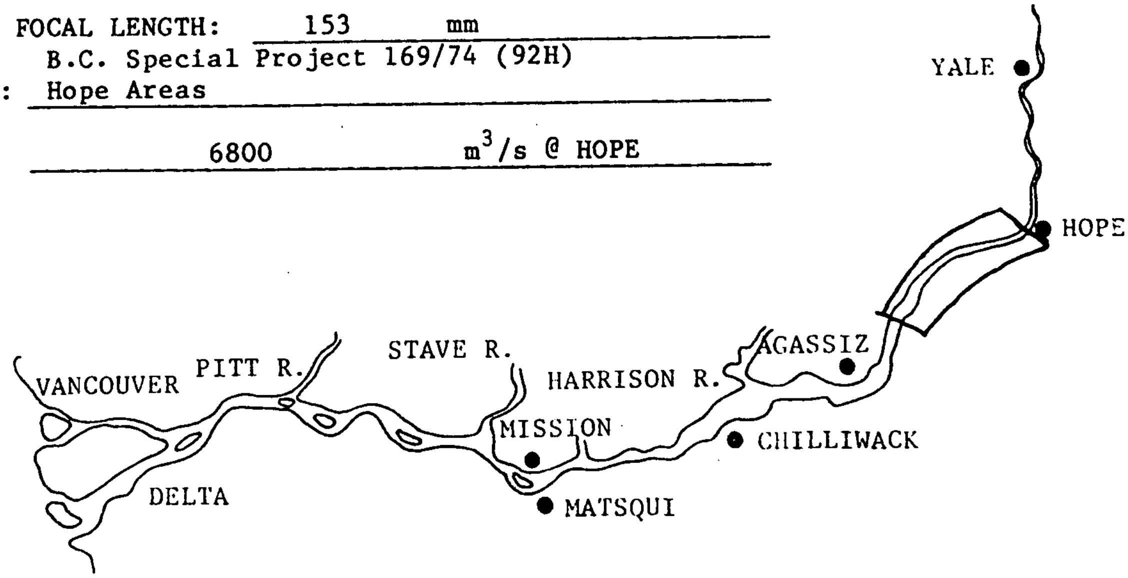
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 6090 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 169/74 (92H) Hope Areas

FLOW: 6800 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5589	65-68	HOPE
"	9-12	"
"	1-7	CHEAM VIEW

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1974 (5 Oct) SCALE: 1:12,000

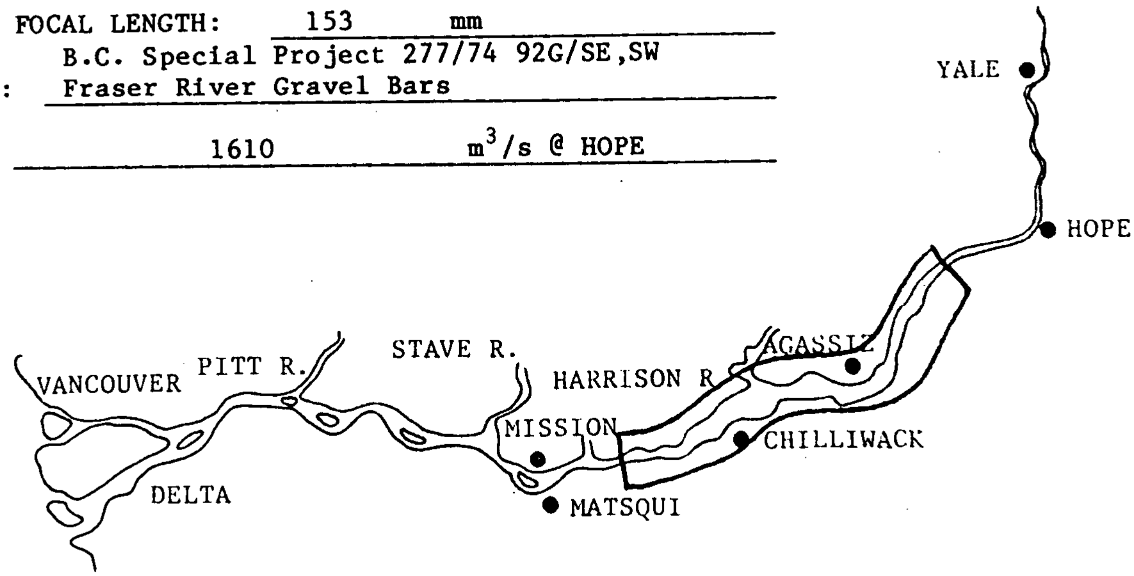
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1830 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 277/74 92G/SE,SW Fraser River Gravel Bars

FLOW: 1610 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5636	65-81	RUBY CK. - BRIDAL FALLS
"	22-64	KATZ - HARRISON MILLS
"	1-21	AGASSIZ - VEDDER CANAL

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1975 (10 Apr) SCALE: 1:4000, 1:8000

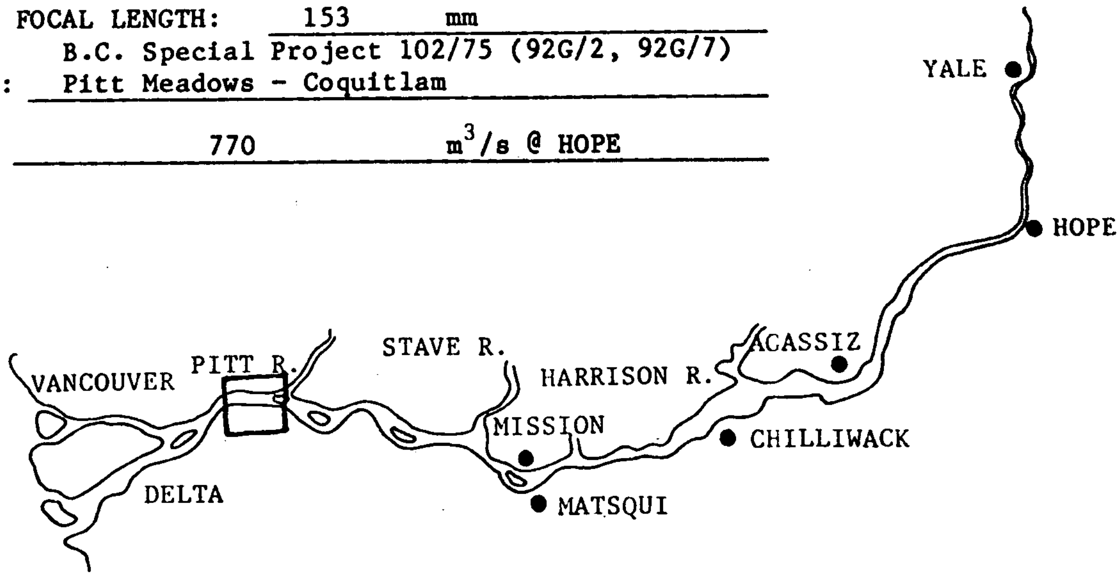
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 640 & 1250 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 102/75 (92G/2, 92G/7) Pitt Meadows - Coquitlam

FLOW: 770 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS	
BC 5642	213-216	PORT MANN	1:4000
"	217-242	"	
BC 5643	246-258	"	1:8000

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1975 (11 June) SCALE: 1:12,000

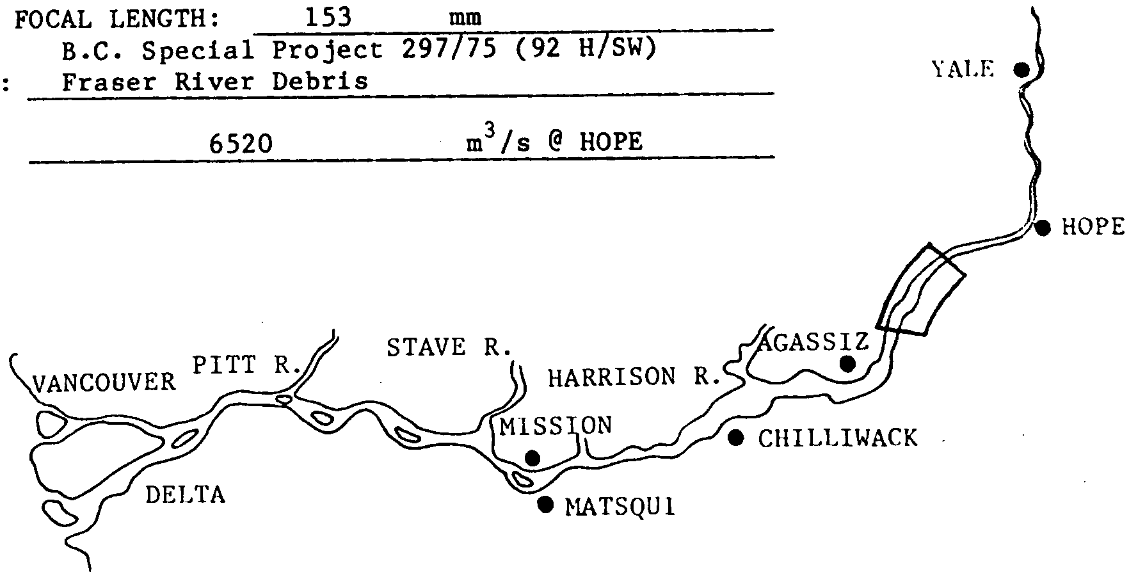
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1860 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 297/75 (92 H/SW) Fraser River Debris

FLOW: 6520 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5658	219-229	LAIDLAW

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1975 (22 Sept) SCALE: 1:50,000

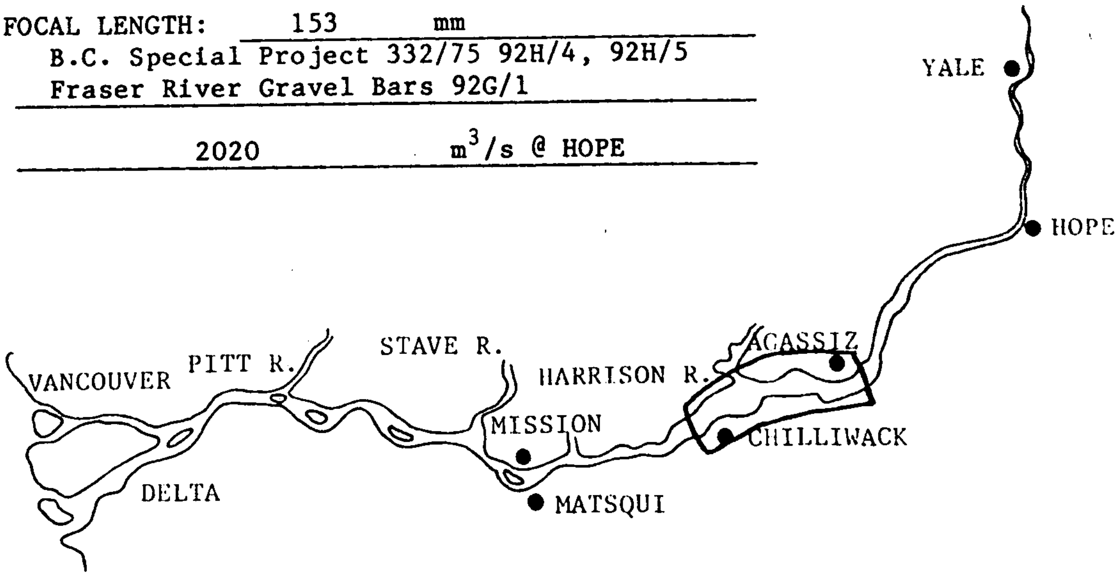
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 580 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 332/75 92H/4, 92H/5
Fraser River Gravel Bars 92G/1

FLOW: 2020 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5691	64-70	POPKUM IND. RES.
"	56-63	CHEAM " "
"	32-40	WINDERMERE
"	41-46	"
"	47-55	"
"	24-31	CHILLIWACK - FAIRFIELD IS.
"	17-23	" "
"	1-16	"
"	71-81	SEABIRD IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1975 (12 Dec.) SCALE: 1:6000

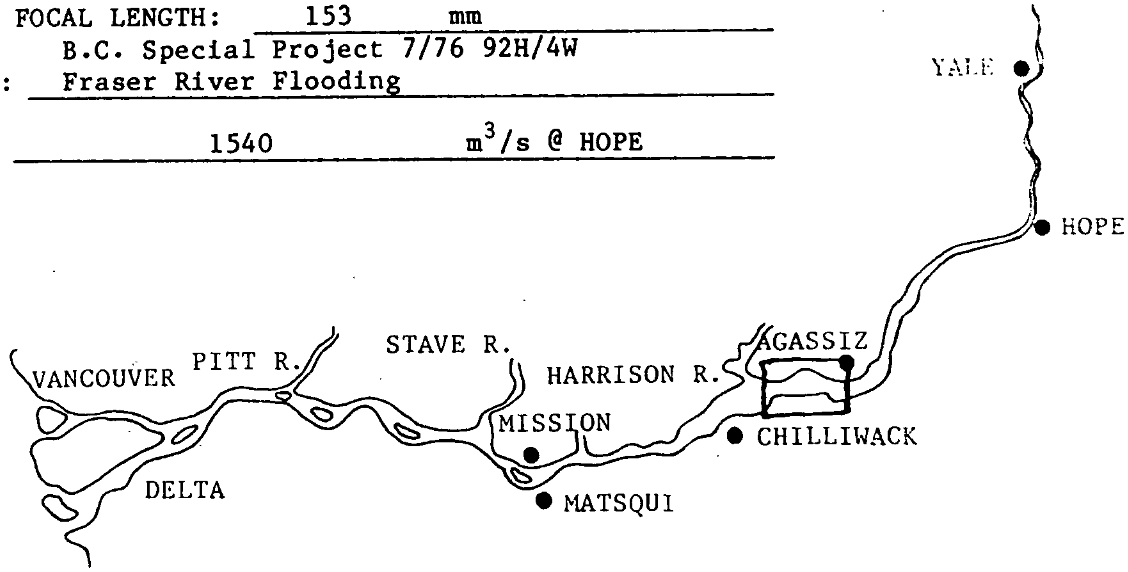
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 910 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 7/76 92H/4W Fraser River Flooding

FLOW: 1540 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5700	1-2	ROSEBANK IS.
"	64-65	"
"	115-117	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1975 (11, 15 Dec) SCALE: 1:12,000

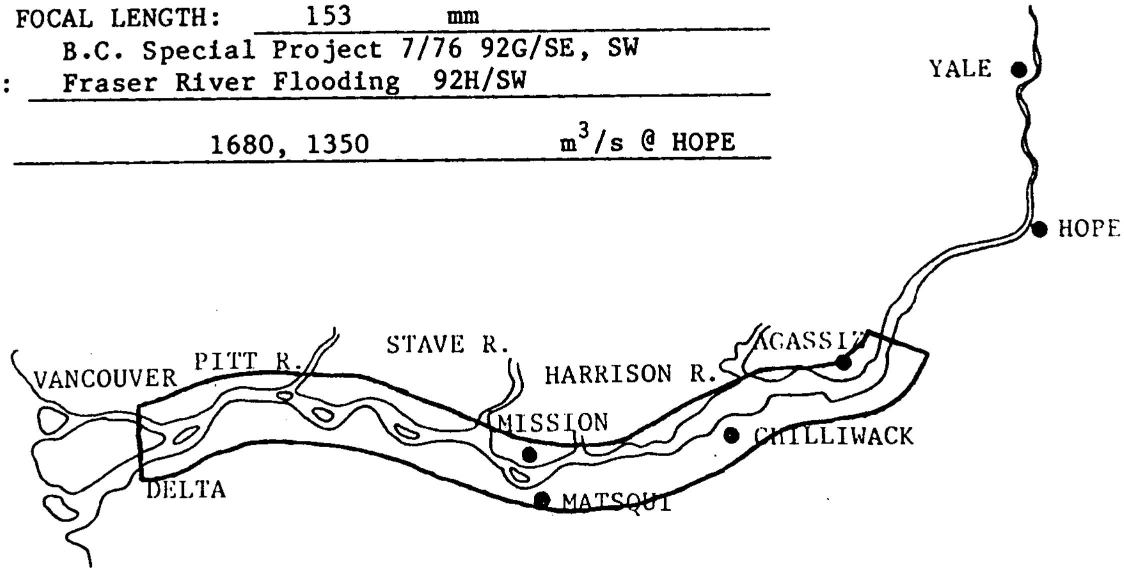
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1870 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 7/76 92G/SE, SW
Fraser River Flooding 92H/SW

FLOW: 1680, 1350 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5703	165-172	CHEAM VIEW
"	152-164	ROSEDALE
"	140-151	"
"	129-138	"
"	116-126	CHILLIWACK
"	103-110	"
"	64-80	"
"	180-187	"
"	42-60	"
"	20-39	NICOMEN IS.
BC 5701	30-34	"
"	35-42	"
"	162-164	DEWDNEY
"	165-174	MATSQUI IS.
"	286-290	"
"	175-180	MISSION
"	148-150	SILVERDALE
"	55-68	SILVERDALE - FORT LANGLEY
"	1-10	WHONOCK
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ______________ SCALE: ______________

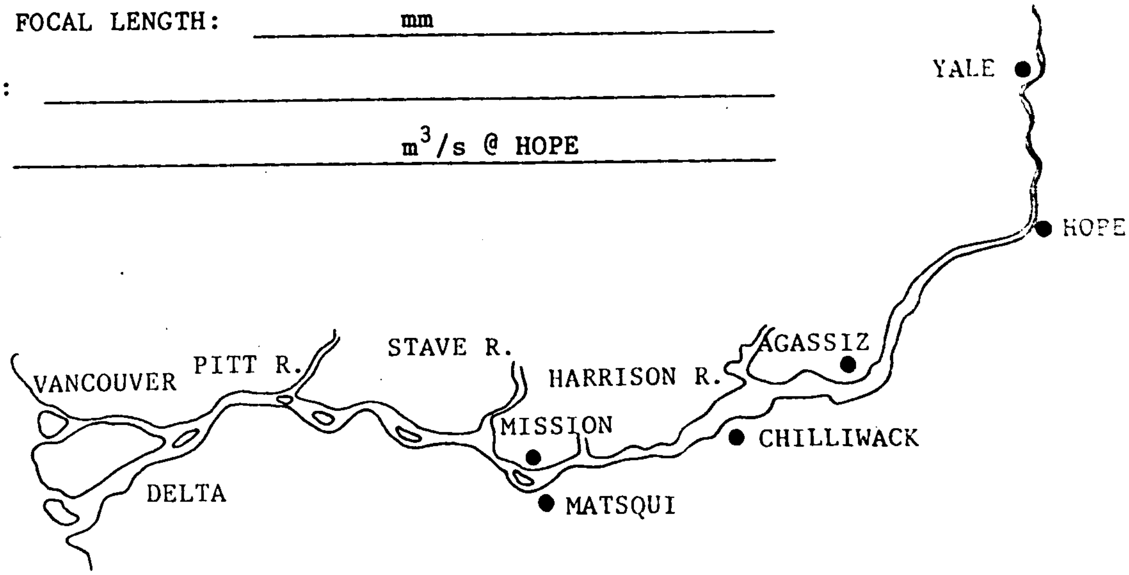
FLIGHT LINE ORIENTATION: ______________

FLYING HEIGHT: ______ mASL

CAMERA FOCAL LENGTH: ______ mm

SOURCE: ______________

FLOW: ______ m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5699	250-254	MCMILLAN IS.
"	240-244	BARNSTON IS.
"	165-177	"
"	60-62	PITT R.
"	90-101	DOUGLAS IS.
"	185-190	NEW WESTMINSTER
"	221-229	LULU IS.
BC 5701	90-95	"
"	105-110	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1976 (11 Mar, 2, 5 Apr) SCALE: 1:12,000

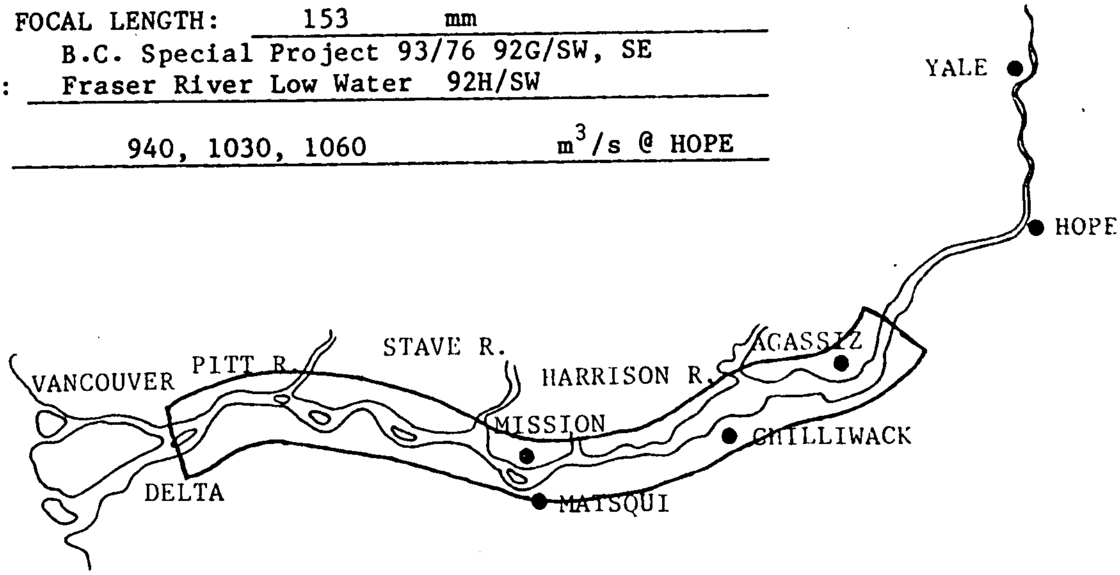
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1860 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 93/76 92G/SW, SE
Fraser River Low Water 92H/SW

FLOW: 940, 1030, 1060 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5706	1-41	AGASSIZ - MISSION
"	47-92	" "
BC 5704	26-34	HERRLING IS.
"	35-54	"
"	57-75	POPKUM - HERRLING IS.
"	78-96	AGASSIZ
"	176-178	POPKUM
"	195-202	CHILLIWACK MTN.
"	135-174	AGASSIZ - MATSQUI
"	94-134	" "
"	215-258	SEABIRD IS. - MISSION
BC 5705	77-81	GIFFORD
"	49-55	PORT KELLS
"	1-39	MATSQUI - PORT MANN
BC 5704	259-300	MATSQUI - DOUGLAS IS.
BC 5705	100-105	CRESCENT IS.
"	112-120	HANEY
BC 5707	1-7	DOUGLAS IS.
BC 5706	189-201	NORTH ARM
"	207-220	NEW WESTMINSTER
BC 5707	45-60	ANNACIS IS.
"	15-18	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1976 (7 June)　　SCALE: 1:20,000

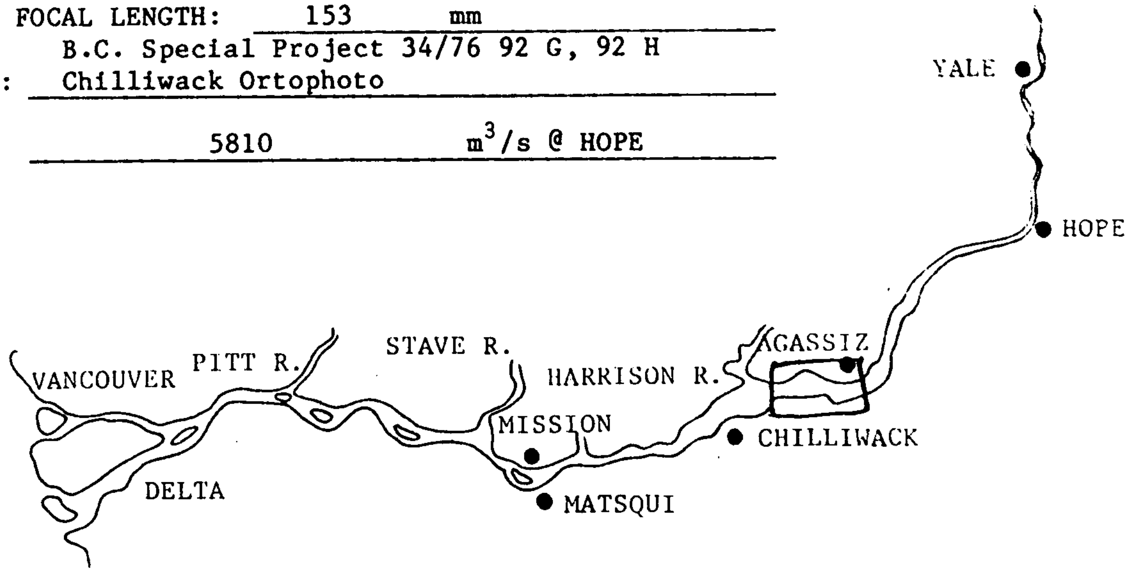
FLIGHT LINE ORIENTATION: NE - SW

FLYING HEIGHT: 3060 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 34/76 92 G, 92 H
Chilliwack Ortophoto

FLOW: 5810 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5714	59-63	ROSEDALE
"	28-32	CHILLIWACK
"	84-97	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1976 (14, 15 July) SCALE: 1:12,000

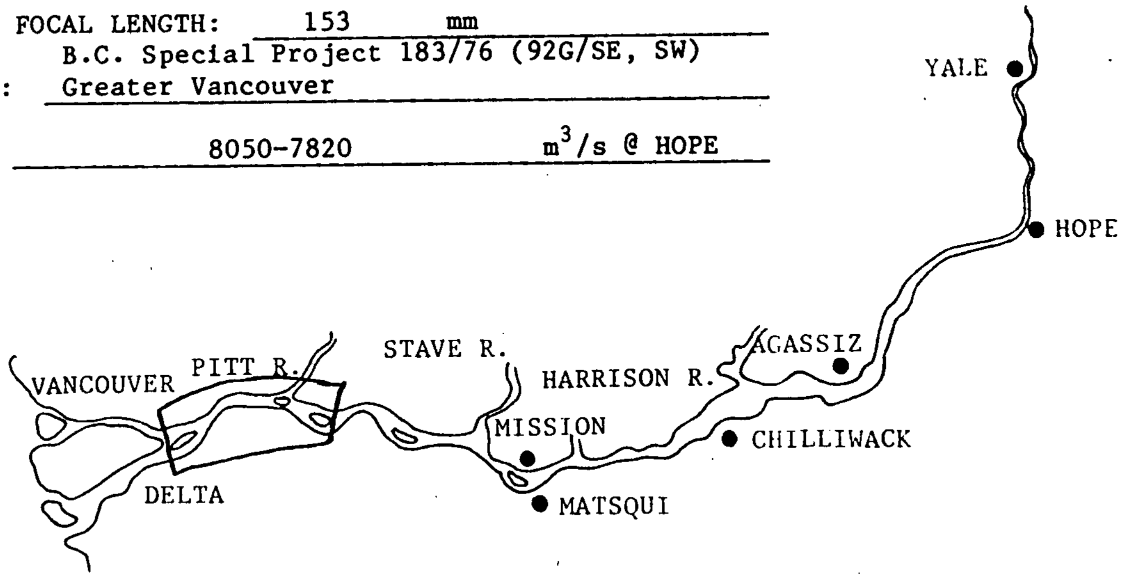
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 2090 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 183/76 (92G/SE, SW) Greater Vancouver

FLOW: 8050-7820 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5724	251-256	BARNSTON IS.
"	257-262	"
BC 5720	62-72	PITT MEADOWS - NEW WESTMINSTER
"	50-61	BARNSTON IS. - "
BC 5724	272-274	NEW WESTMINSTER
BC 5720	3-8	ANNACIS IS.
BC 5724	235-240	"
BC 5719	190-195	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1976 (30 Sep) SCALE: 1:20,000

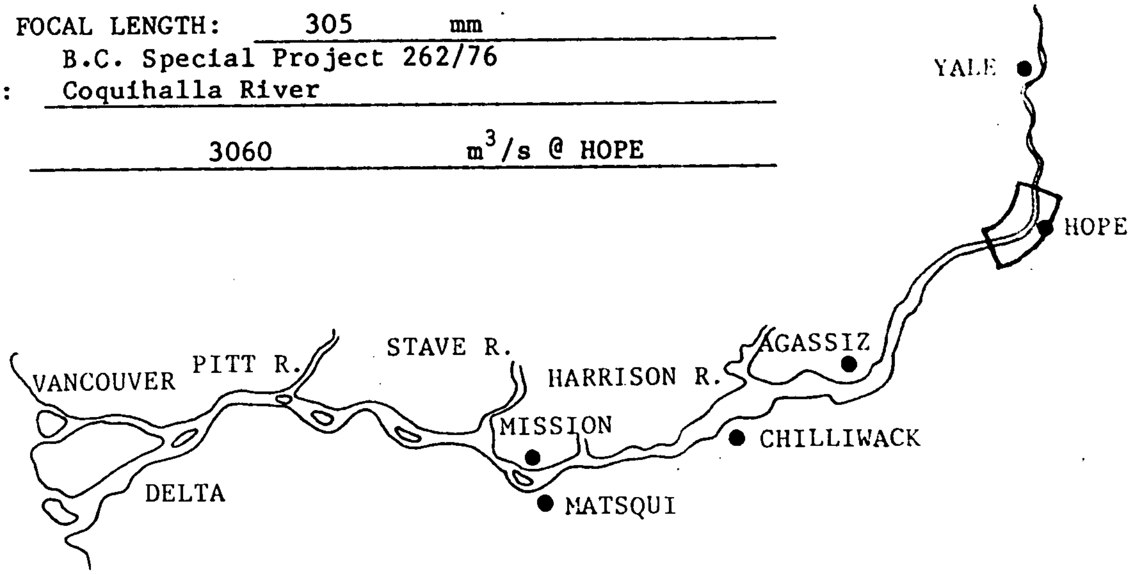
FLIGHT LINE ORIENTATION: variable

FLYING HEIGHT: 6250 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 262/76 Coquihalla River

FLOW: 3060 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 7836	78-90	HOPE
"	91-102	"
"	120-125	"
"	103-109	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1976 (6 Oct) SCALE: 1:3,800

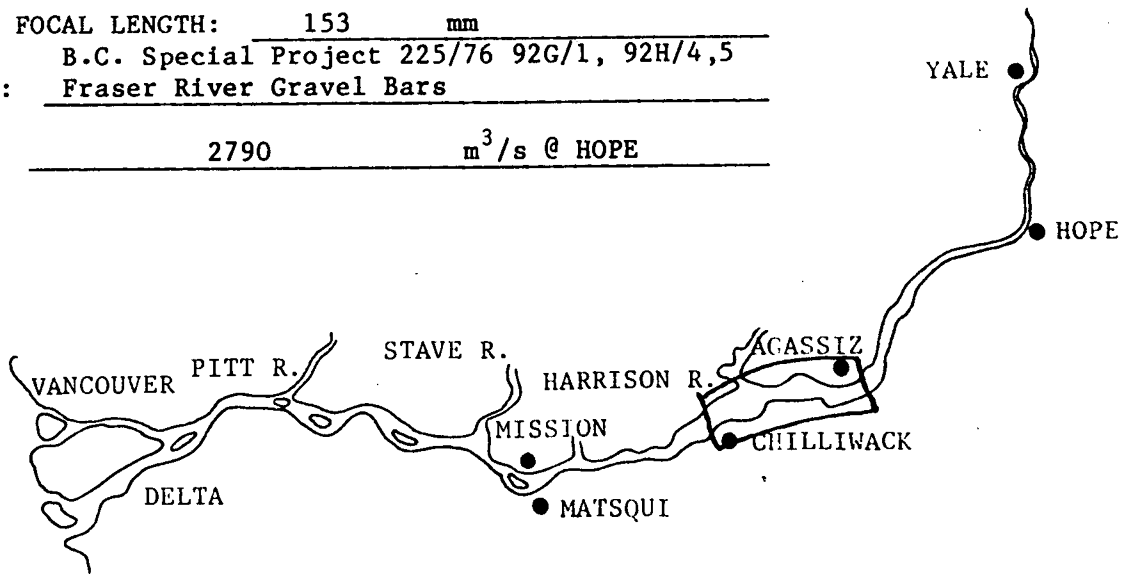
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 580 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 225/76 92G/1, 92H/4,5 Fraser River Gravel Bars

FLOW: 2790 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5757	112-122	POPKUM
"	141-148	AGASSIZ
"	254-265	"
"	99-111	"
"	266-278	"
"	149-157	"
"	89-98	FAIRFIELD IS.
"	158-167	"
"	65-88	CHILLIWACK MTN.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1976 (15 Oct) SCALE: 1:12,000

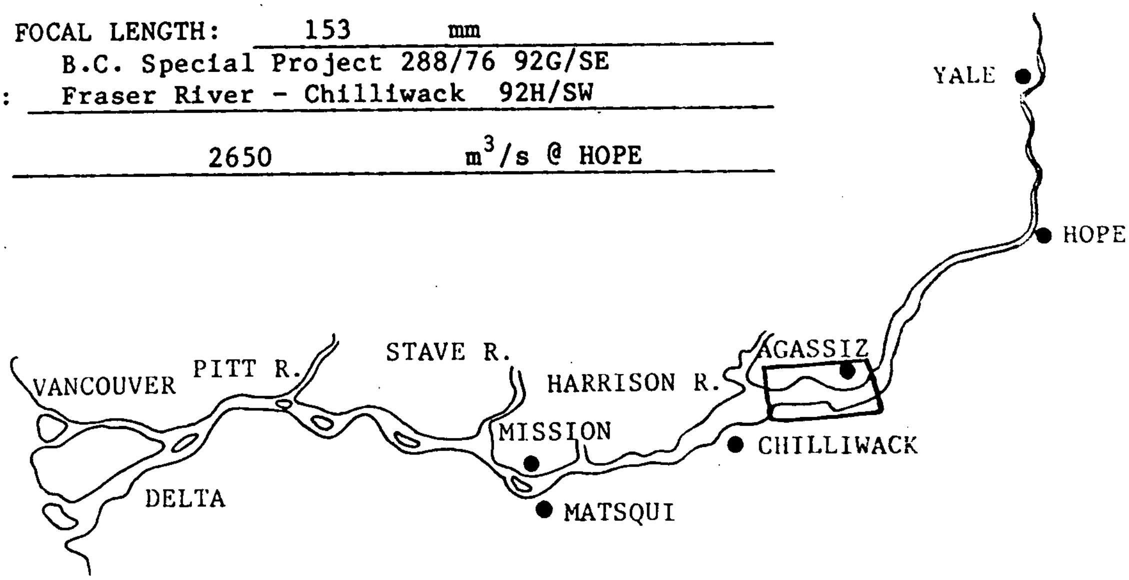
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1860 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 288/76 92G/SE
Fraser River - Chilliwack 92H/SW

FLOW: 2650 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5757	170-186	WINDERMERE IS.
"	187-201	"
"	222-242	CHILLIWACK
"	202-221	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1977 (25 May) SCALE: 1:12,000

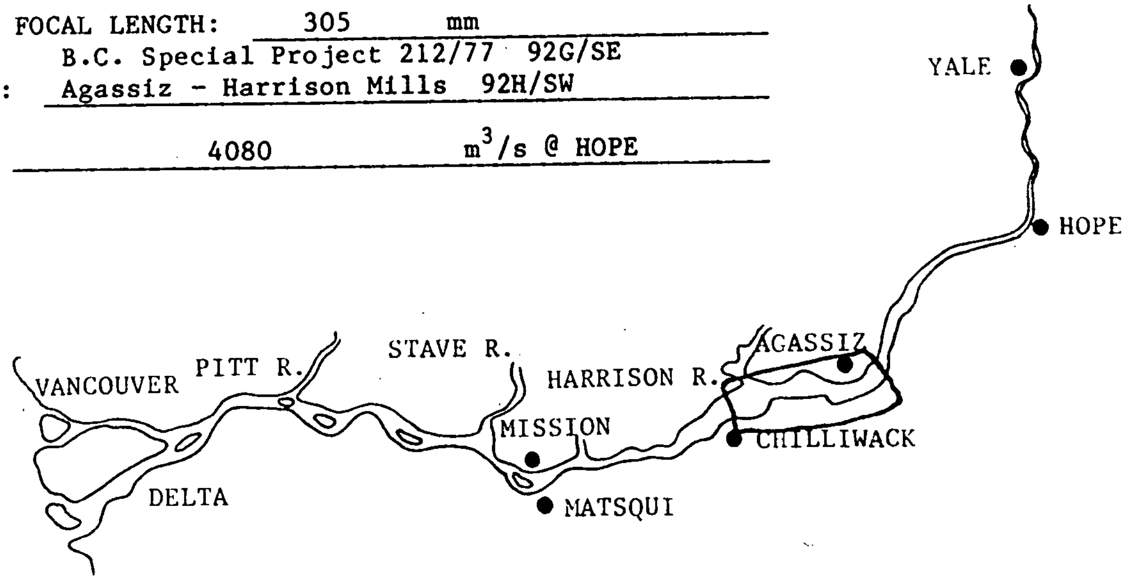
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 3700 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 212/77 92G/SE
Agassiz - Harrison Mills 92H/SW

FLOW: 4080 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 77019	86-100	AGASSIZ
	72-85	"
	51-71	"
	30-47	CHILLIWACK
	1-14?	"
	16-29?	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1978 (6 May) SCALE: 1:12,000

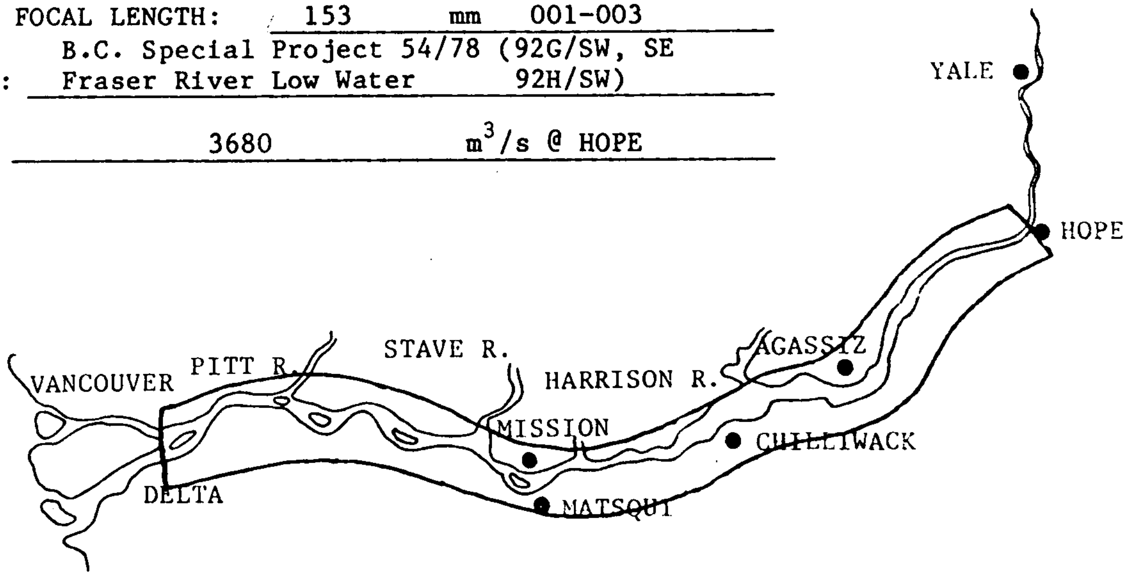
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: mASL

CAMERA FOCAL LENGTH: 305 / 153 mm 013-014 / 001-003

SOURCE: B.C. Special Project 54/78 (92G/SW, SE / Fraser River Low Water 92H/SW)

FLOW: 3680 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 78013	1-16	HOPE
"	102-106	CHEAM VIEW
"	75-98	"
"	43-71	RUBY CK - AGASSIZ
"	17-41	AGASSIZ
"	155-168	HARRISON MILLS
"	173-217	SEABIRD IS. - DEWDNEY
"	218-263	AGASSIZ - MATSQUI
"	264-303	AGASSIZ - SUMAS MTN.
BC 78014	30-35	CHILLIWACK
"	1-10	POPKUM
"	125-134	MISSION
BC 78001	160-165	BARNSTON IS.
"	140-145	NEW WESTMINSTER
"	192-200	MATSQUI
"	202-257	MISSION - NEW WESTMINSTER
BC 78014	45-90	MISSION - PORT MANN
BC 78001	1-10	NEW WESTMINSTER
BC 78003	55-72	"
"	88-92	ANNACIS IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1978 (6 May) SCALE: 1:10,000

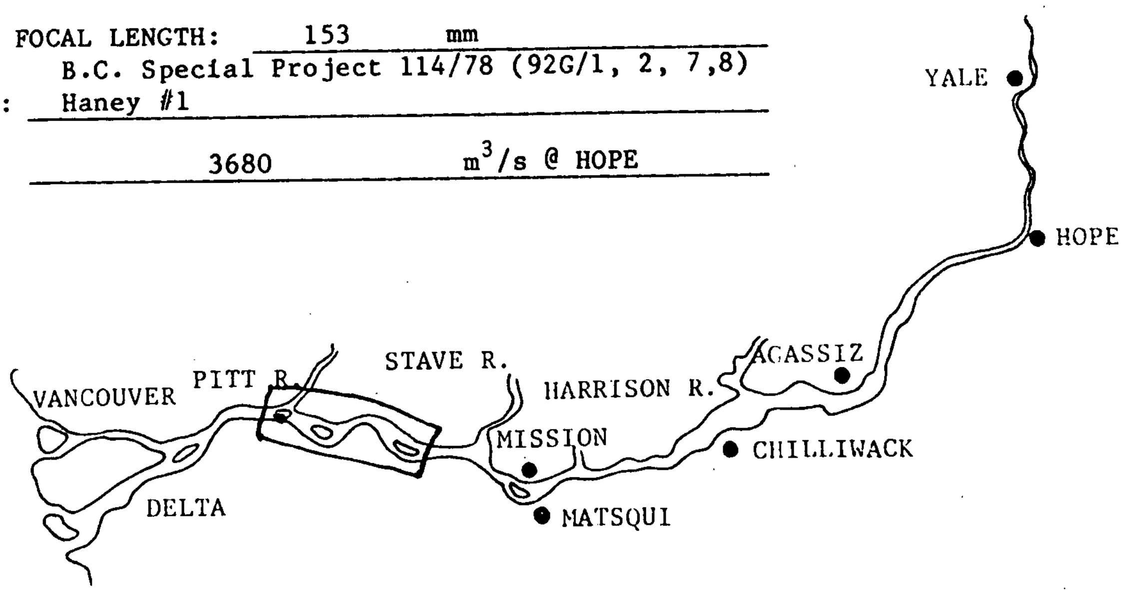
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 1660 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 114/78 (92G/1, 2, 7,8) Haney #1

FLOW: 3680 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 78010	171-185	CRESCENT IS. - MCMILLAN IS.
BC 78017	115-117	MCMILLAN IS.
BC 78010	154-168	HANEY
"	105-112	DOUGLAS IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1978 (6 May) SCALE: 1:20,000

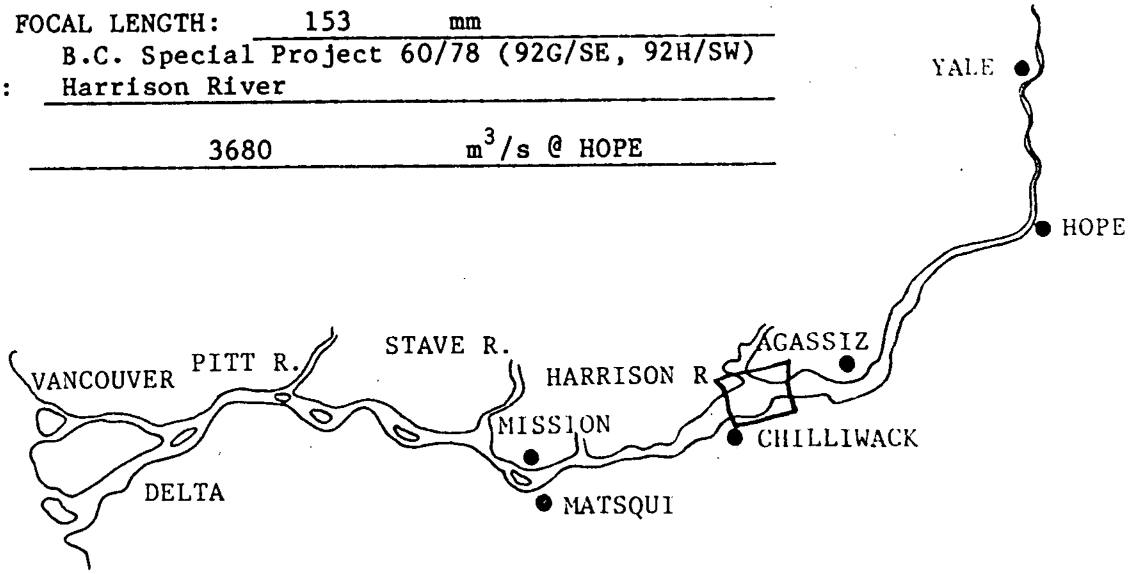
FLIGHT LINE ORIENTATION: variable

FLYING HEIGHT: 3200 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 60/78 (92G/SE, 92H/SW) Harrison River

FLOW: 3680 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 78016	230-234	HARRISON R.
	243-246	"
	235-242	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1978 (1 June) SCALE: 1:20,000

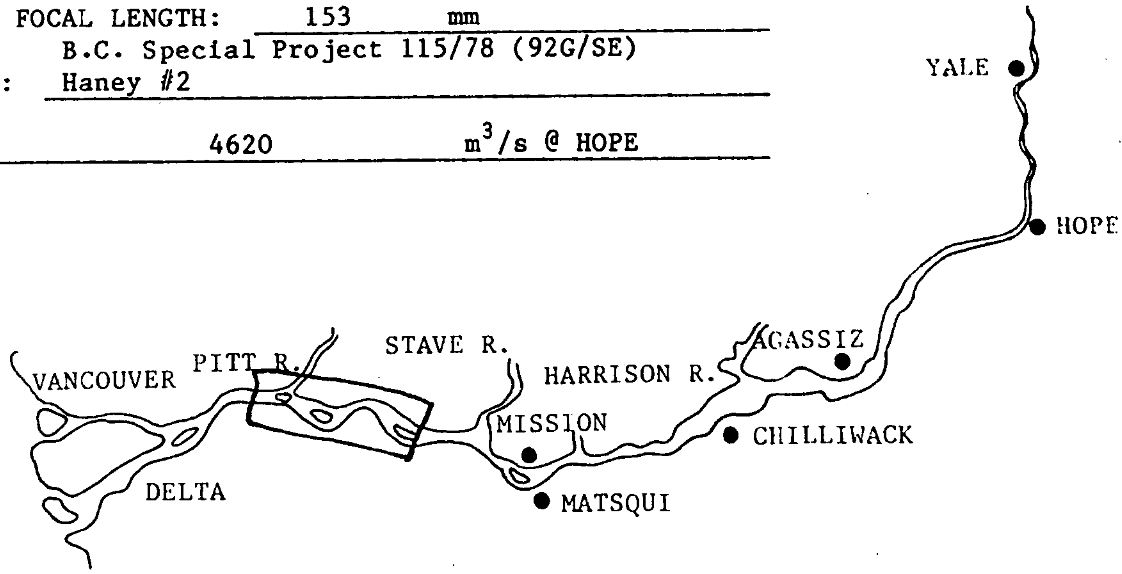
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 3120 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 115/78 (92G/SE) Haney #2

FLOW: 4620 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 78039	74-82	MCMILLAN IS. - CRESCENT IS.
"	61-69	BARNSTON IS.
"	33-36	DOUGLAS IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1978 (17 June)   SCALE: 1:25,000

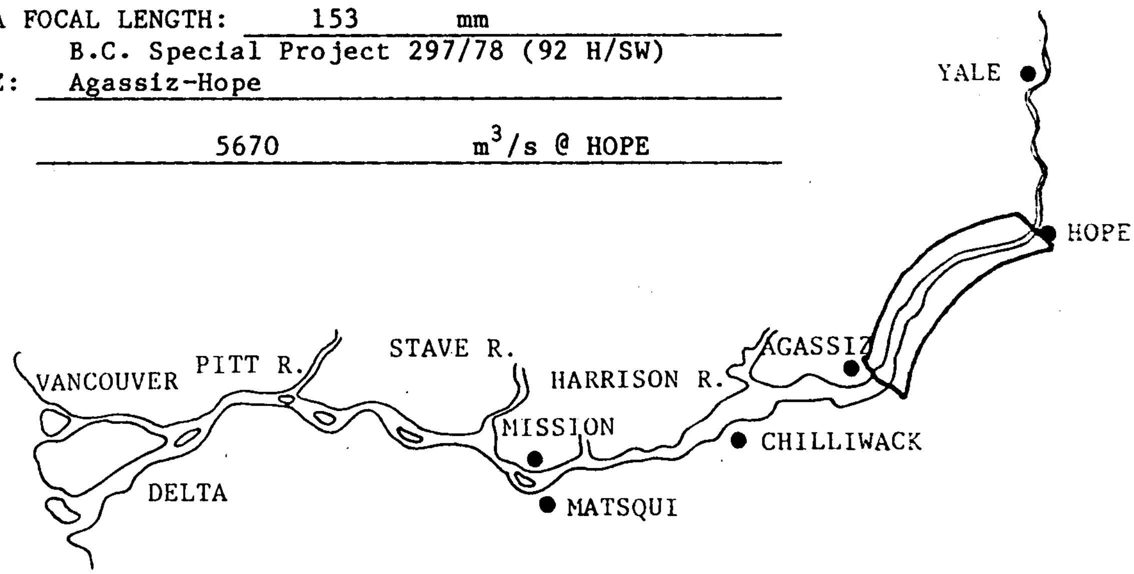
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4570 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 297/78 (92 H/SW) Agassiz-Hope

FLOW: 5670 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 78072	87-90	HOPE
"	64-70	HOPE - VASASUS
"	43-58	HOPE - ROSEDALE
"	23-35	RUBY CK. - ROSEDALE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (26 Apr) SCALE: 1:5000

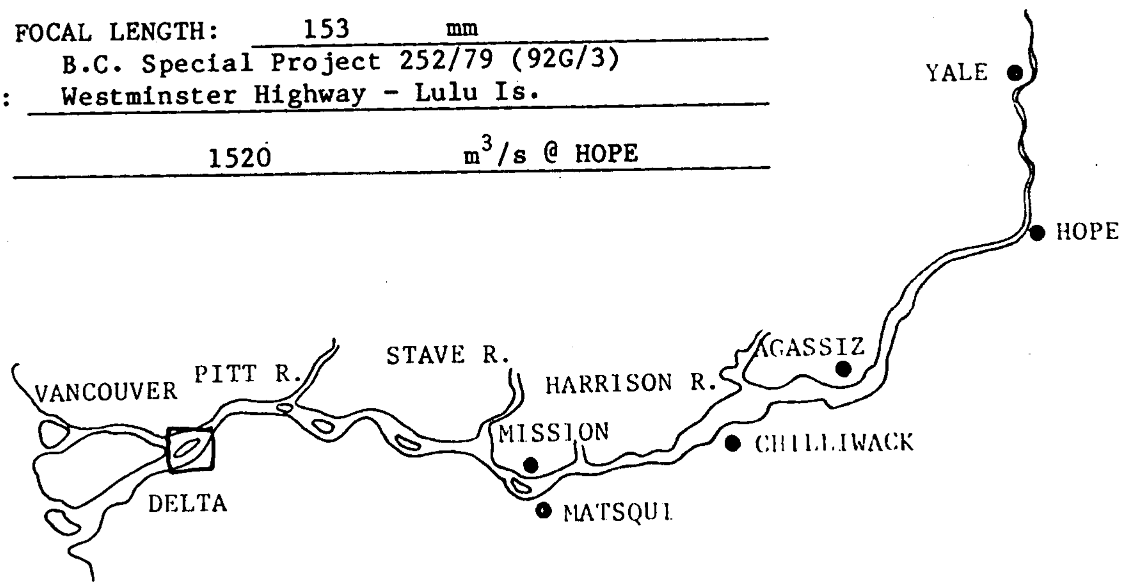
FLIGHT LINE ORIENTATION: variable

FLYING HEIGHT: 680 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 252/79 (92G/3)
Westminster Highway - Lulu Is.

FLOW: 1520 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79016	64-80	ANNACIS IS.
"	50-63	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (8, 10 Aug) SCALE: 1:10,000

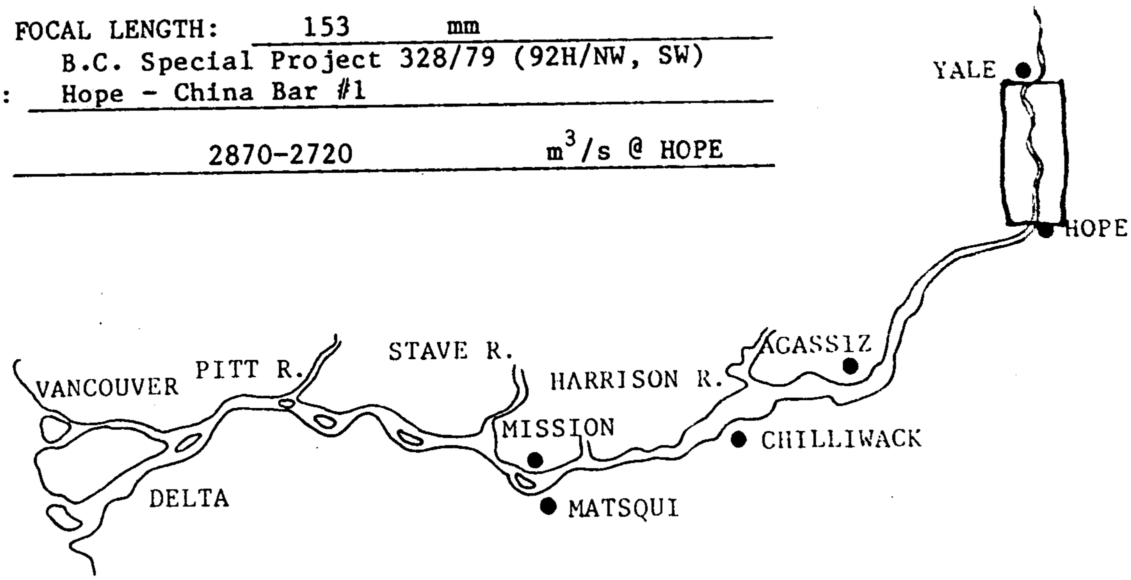
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1830 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 328/79 (92H/NW, SW)
Hope - China Bar #1

FLOW: 2870-2720 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79140	50-77	YALE - HOPE
"	78-82	HOPE
"	89-95	YALE
BC 79128	230-257	YALE - HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (11 Sep) SCALE: 1:10,000

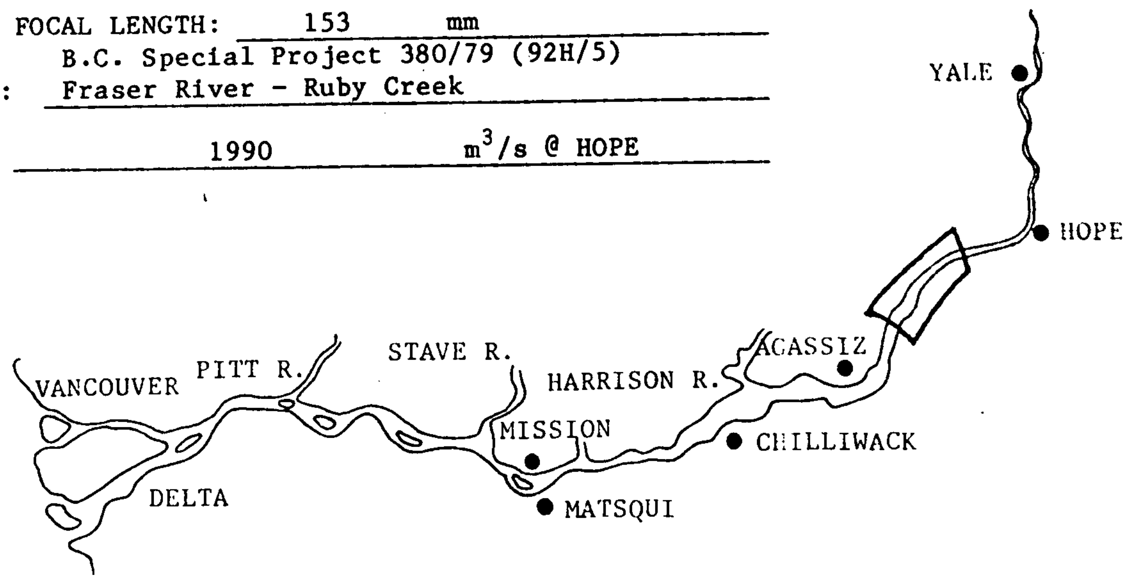
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 1520 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 380/79 (92H/5) Fraser River - Ruby Creek

FLOW: 1990 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79206	71-88	VASASUS - CHEAM VIEW

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (22, 23 Mar) SCALE: 1:12,000

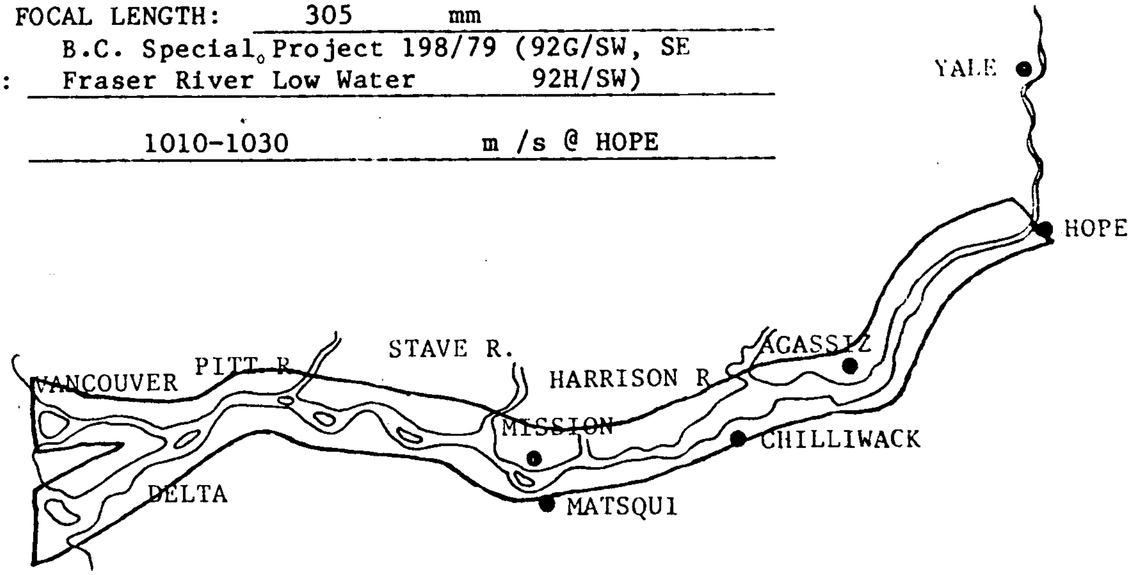
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 3670 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 198/79 (92G/SW, SE Fraser River Low Water 92H/SW)

FLOW: 1010-1030 m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BCC 201	54-68	HOPE
"	1-21	CHEAM VIEW
"	36-53	SEABIRD IS.
"	22-35	"
BCC 199	146-154	CHILLIWACK
"	155-188	"
"	97-226	"
BCC 200	1-33	NICOMEN IS.
"	34-63	"
BCC 199	46-53	MATSQUI
"	59-68	MCMILLAN
BCC 200	97-102	MISSION
"	108-115	WHONOCK
BCC 199	10-13	BARNSTON IS.
"	71-82	"
"	83-127	MISSION - DOUGLAS IS.
BCC 200	120-128	HANEY
BCC 198	16-20	ANNACIS IS.
"	40-56	"
"	88-90	LULU IS.
"	113-115	"
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ____________ SCALE: ____________

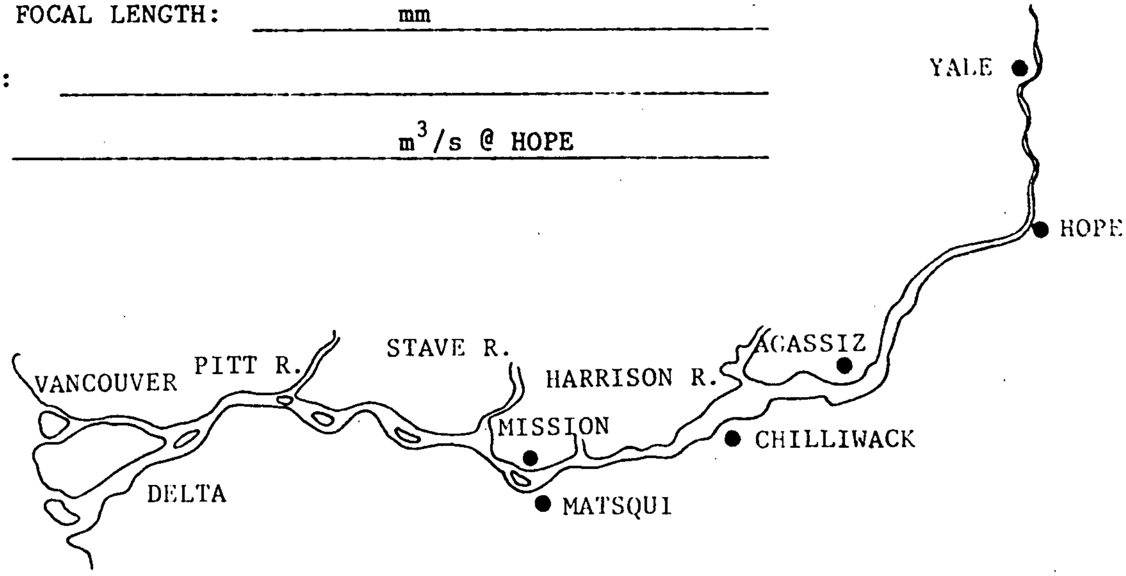
FLIGHT LINE ORIENTATION: ____________

FLYING HEIGHT: ____________ mASL

CAMERA FOCAL LENGTH: ____________ mm

SOURCE: ____________

FLOW: ____________ m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79004	19-33	HOPE
BC 79003	242-262	CHEAM VIEW
BC 79004	1-18	SEABIRD IS.
BC 79003	263-278	"
"	25-32	AGASSIZ
"	33-66	AGASSIZ - ROSEDALE
"	67-104	" "
BC 79003	105-137	AGASSIZ - MISSION
"	138-167	NICOMEN IS.
BC 79002	260-268	MATSQUI
"	251-255	"
BC 79003	201-231	MISSION - HANEY
BC 79002	276-283	MCMILLAN IS.
"	224-226	BARNSTON IS.
"	298-335	MATSQUI - DOUGLAS IS.
"	288-297	BARNSTON IS.
"	87-103	NEW WESTMINSTER
"	39-56	"
"	15-20	ANNACIS IS.
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ____________ SCALE: ____________

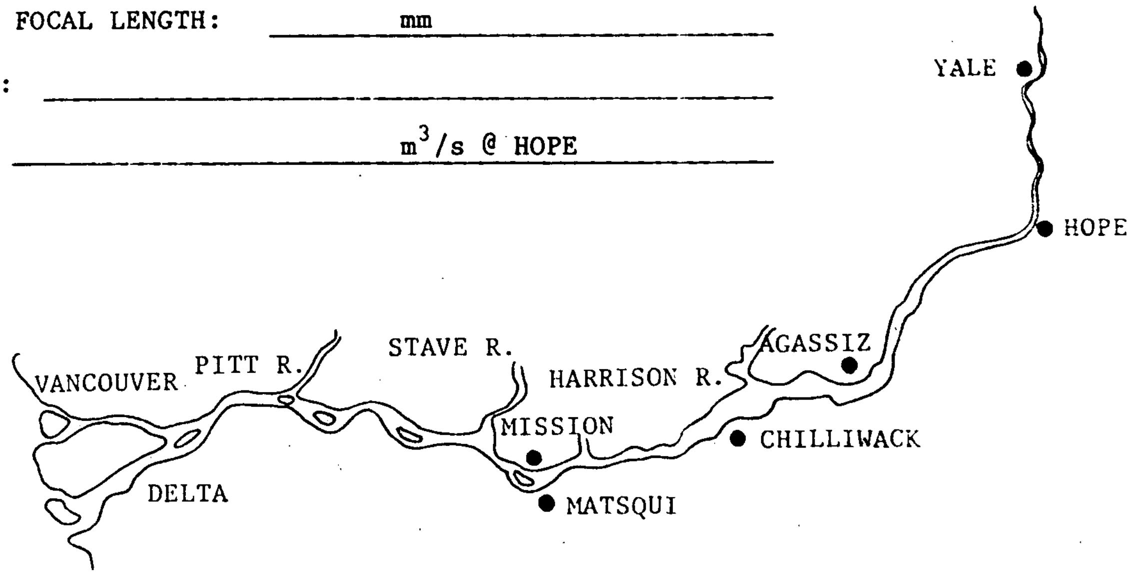
FLIGHT LINE ORIENTATION: ____________

FLYING HEIGHT: ____________ mASL

CAMERA FOCAL LENGTH: ____________ mm

SOURCE: ____________

FLOW: ____________ m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79002	1-15	DELTA
"	56-71	"
"	72-87	"
"	132-150	LULU IS.
"	151-170	"
"	171-193	"
BCC 227	25-41	WESTHAM
"	15-24	"
"	5-10	LULU IS.
BCC 198	1-13	DELTA
"	52-71	"
"	72-89	LULU IS.
"	128-131	"
"	132-135	NORTH ARM
"	150-170	"
"	171-194	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (Mar-June) SCALE: 1:10,000

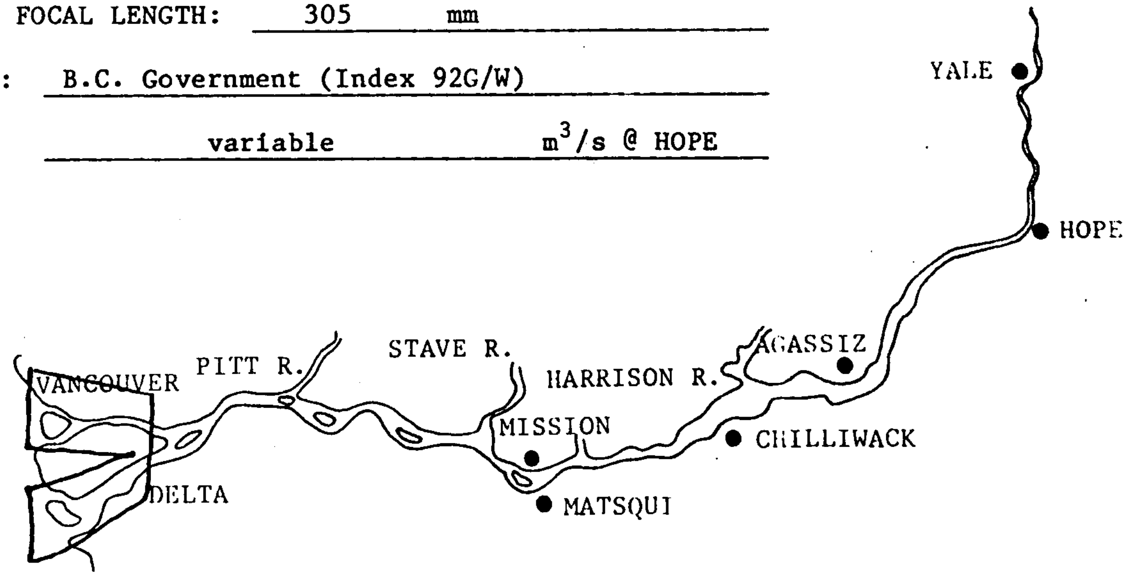
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 3330 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Government (Index 92G/W)

FLOW: variable m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79036	139-161	SEA IS., NORTH ARM
BC 79011	188-202	" "
BC 79011	209-210	"
BC 79055	19-20	"
BC 79055	1-10	"
BC 79066	250-257	"
BC 79009	123-125	LULU IS.
BC 79006	15-18	TILBURY IS.
BC 79008	164-171	"
BC 79008	147-155	STEVESTON
BC 79005	283-303	"
BC 79008	125-146	WESTHAM
BC 79005	48-60	"
BC 79010	222-230	"
BC 79005	45-47	CANOE PASS

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (27 Mar-25 Jun) SCALE: 1:10,000

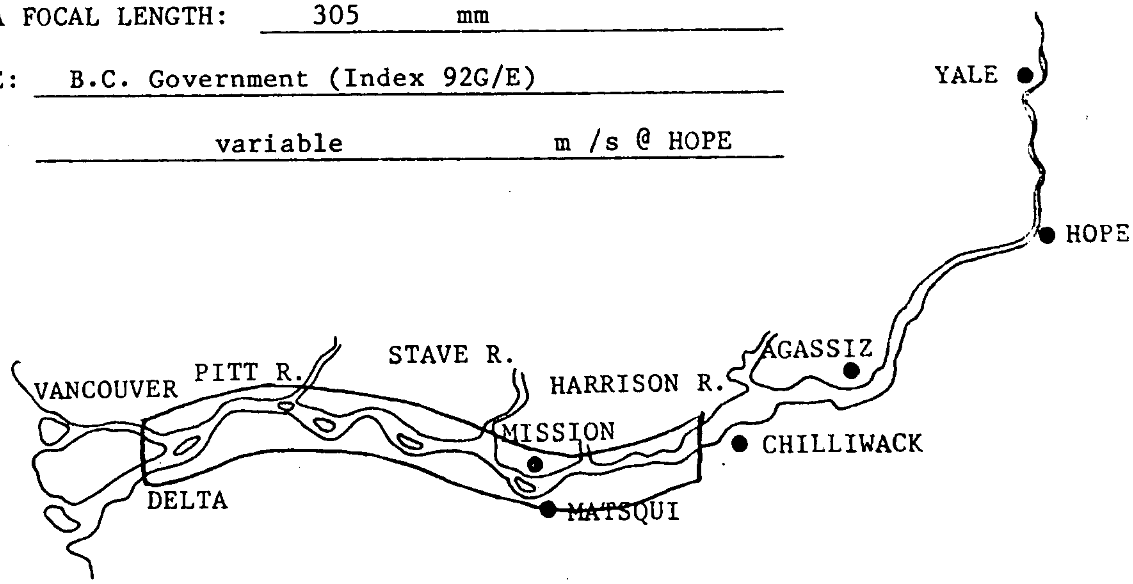
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 3270 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Government (Index 92G/E)

FLOW: variable m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79036	244-251	NICOMEN IS.
BC 79055	98-105	"
BC 79006	151-162	"
BC 79009	35-53	"
BC 79006	82-98	"
BC 79008	238-246	"
BC 79006	76-79	MISSION
BC 79008	233-237	"
BC 79008	59-60	MATSQUI
BC 79005	223-229	"
BC 79008	225-230	"
BC 79006	65-67	SILVERDALE
BC 79009	69-83	PLUMPER REACH
BC 79006	185-201	MCMILLAN IS - PLUMPER REACH
BC 79055	53-57	RUSSET REACH
BC 79011	246-249	"
BC 79036	187-195	DERB REACH
BC 79006	209-214	BARNSTON IS.
BC 79055	42-49	"
BC 79011	234-242	"
BC 79036	181-186	"
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ______________ SCALE: ______________

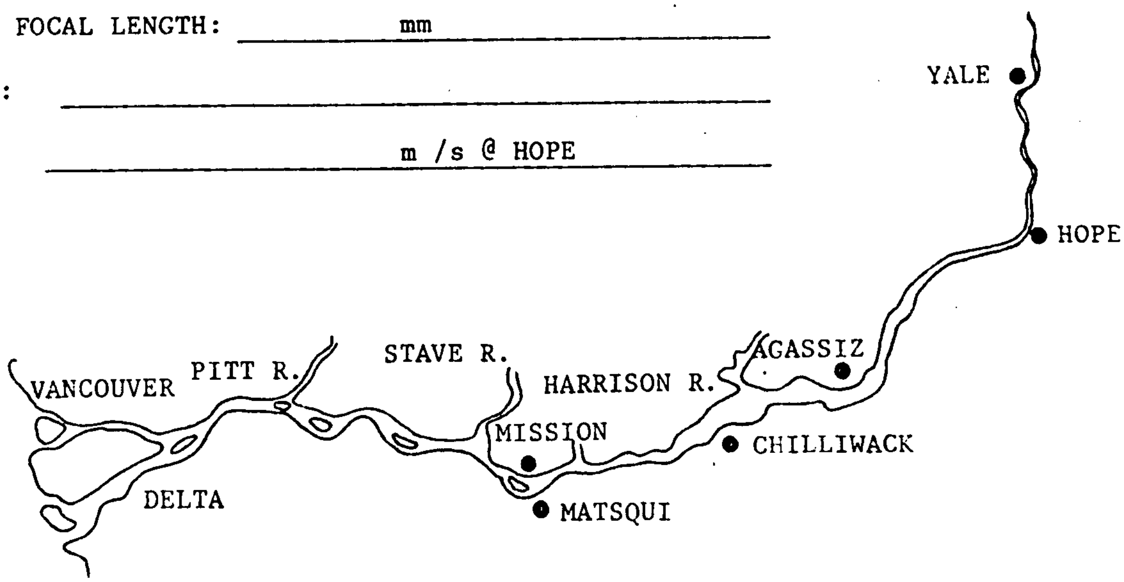
FLIGHT LINE ORIENTATION: ______________

FLYING HEIGHT: ______ mASL

CAMERA FOCAL LENGTH: ______ mm

SOURCE: ______________

FLOW: ______ m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79038	106-109	DOUGLAS IS.
BC 79055	191-204	DOUGLAS IS. - NEW WESTMINSTER
BC 79036	168-170	NEW WESTMINSTER
BC 79011	217-220	"
BC 79055	21-29	ANNACIS IS.
BC 79006	230-238	"
BC 79009	116-122	"
BC 79006	19-24	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (Mar-Jul) SCALE: 1:10,000

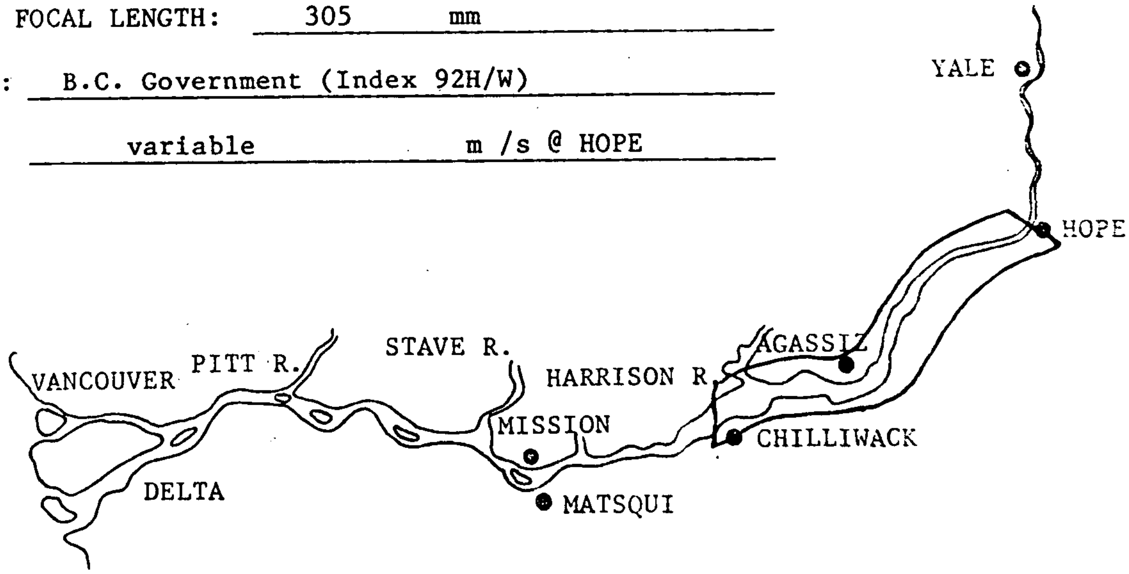
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 3230 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Government (Index 92H/W)

FLOW: variable m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79069	140-142	HOPE
BC 79069	165-174	"
BC 79069	101-106	VASASUS IS.
BC 79103	35-37	RUBY CK.
BC 79069	31-34	LAIDLAW
BC 79013	24-29	"
BC 79069	43-48	SEABIRD IS.
BC 79045	142-148	"
BC 79045	77-85	"
BC 79045	126-134	"
BC 79045	59-66	CHEAM VIEW
BC 79045	3-31	HARRISON KNOB - HERRLING IS.
BC 79038	2-30	" "
BC 79044	213-239	" "
BC 79036	252-258	CHILLIWACK
BC 79055	106-110	"
BC 79006	150-151	" (23 Mar)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (Apr-Jun) SCALE: 1:20,000

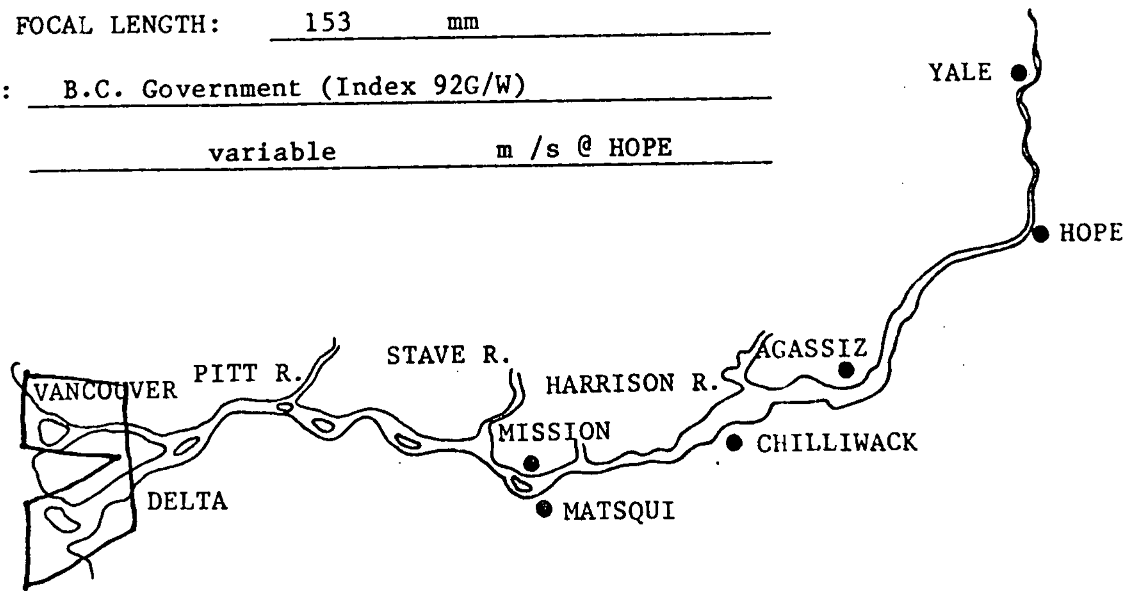
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 3230 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government (Index 92G/W)

FLOW: variable m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79056	3-14	SEA IS., NORTH ARM
BC 79071	74-85	" "
BC 79056	169-179	" "
BC 79071	67-70	" "
BC 79015	193-194	TILBURY IS.
BC 79015	170-174	"
BC 79015	105-111	WOODWARD IS.
BC 79015	91-92	PORT GUICHON

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (Apr-Jun) SCALE: 1:20,000

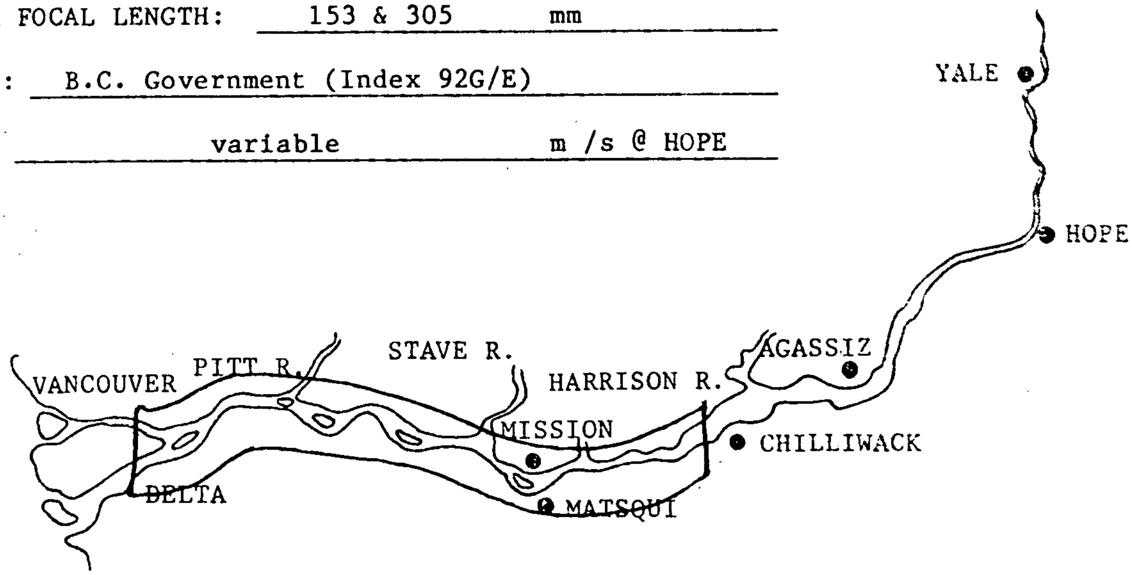
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 3250 & 6900 mASL

CAMERA FOCAL LENGTH: 153 & 305 mm

SOURCE: B.C. Government (Index 92G/E)

FLOW: variable m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79062	250-251	NICOMEN IS.
BC 80054	133-134	" (1980/153mm/3350mASL)
BC 79056	216-222	"
BC 79071	19-29	"
BC 79007	167-176	"
BC 79007	177-178	MISSION
BC 79007	104-108	MATSQUI
BC 79015	140-142	"
BC 79007	115-133	MISSION
BC 79015	143-145	MATSQUI
BC 79007	183-192	GLEN VALLEY
BC 79015	213-221	"
BC 79071	43-45	MCMILLAN IS.
BC 79056	196-198	"
BC 79071	47-51	BARNSTON IS.
BC 79056	190-193	"
BC 79056	258-272	DOUGLAS IS.
BC 79071	89-102	"
BC 79056	180-183	ANNACIS IS.
BC 79071	57-61	"
BC 79015	195-197	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (23 Apr-11 Sep)   SCALE: 1:20,000

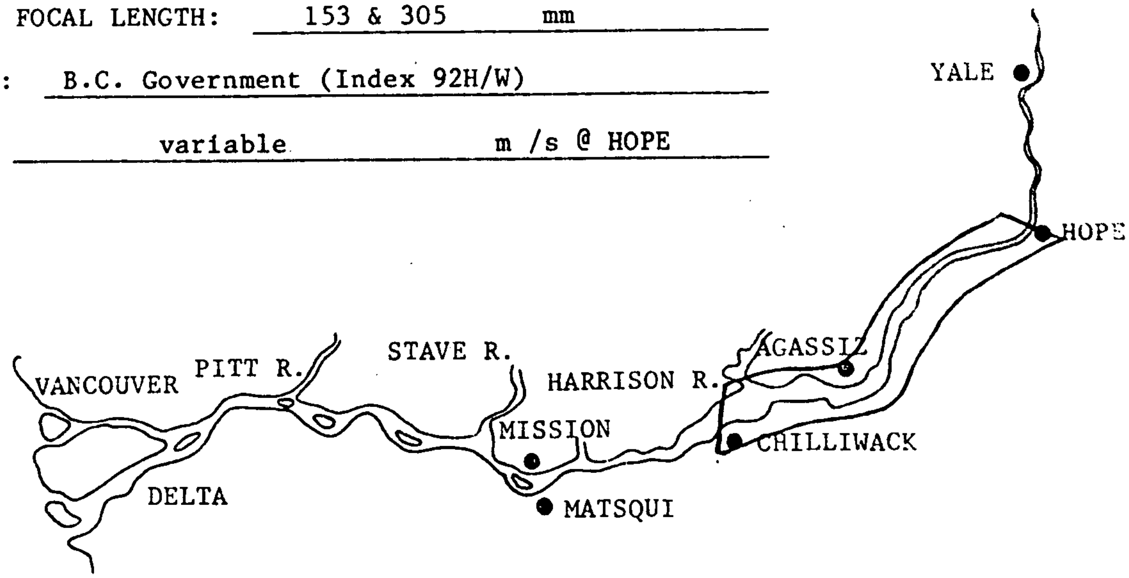
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 3290 & 7240 mASL

CAMERA FOCAL LENGTH: 153 & 305 mm

SOURCE: B.C. Government (Index 92H/W)

FLOW: variable m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79013	248-249	HOPE
BC 79013	225-229	RUBY CK.
BC 79071	247-250	LAIDLAW
BC 79116	2-6	SEABIRD IS.
BC 79063	21-25	"
BC 79063	13-15	AGASSIZ
BC 79193	12-15	HARRISON BAY
BC 79062	252-265	AGASSIZ - CHILLIWACK
BC 79056	223-224	CHILLIWACK
BC 79071	17-18	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (8 Aug) SCALE: 1:20,000

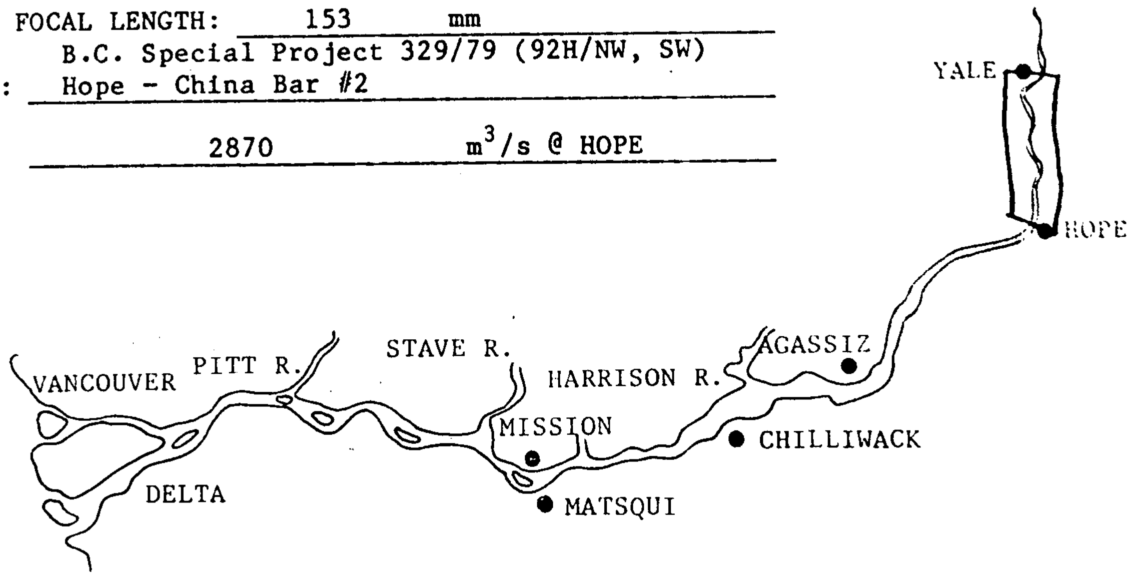
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 3200 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 329/79 (92H/NW, SW) Hope - China Bar #2

FLOW: 2870 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79128	200-203	YALE
"	209-222	EMORY BAR - HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (1 June) SCALE: 1:25,000

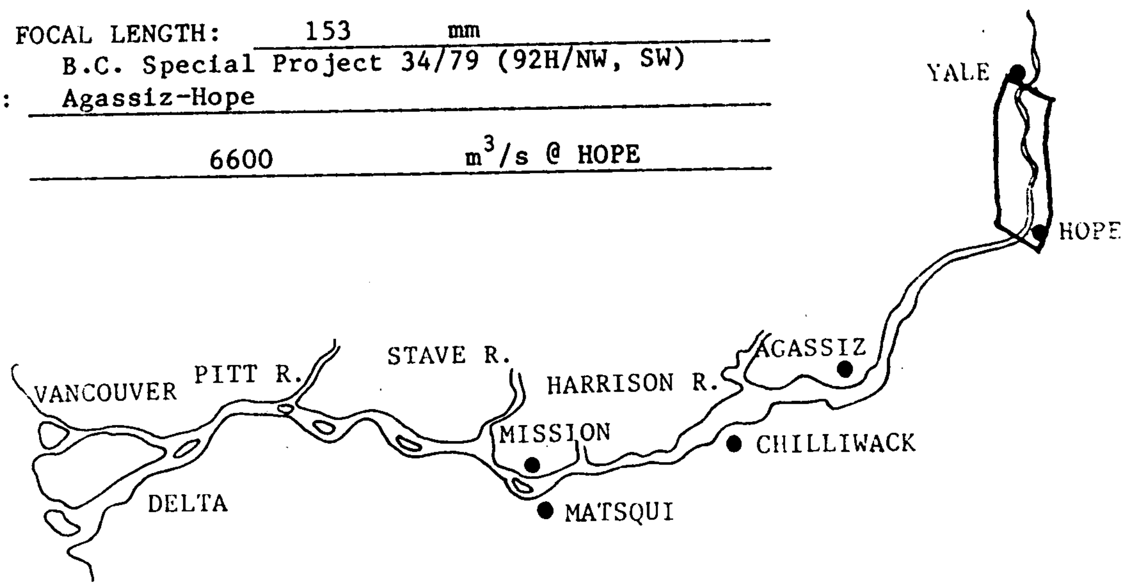
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 4720 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 34/79 (92H/NW, SW) Agassiz-Hope

FLOW: 6600 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79034	35-45	YALE - HOPE
"	17-18	HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1980 (19 Jan) SCALE: 1:6000

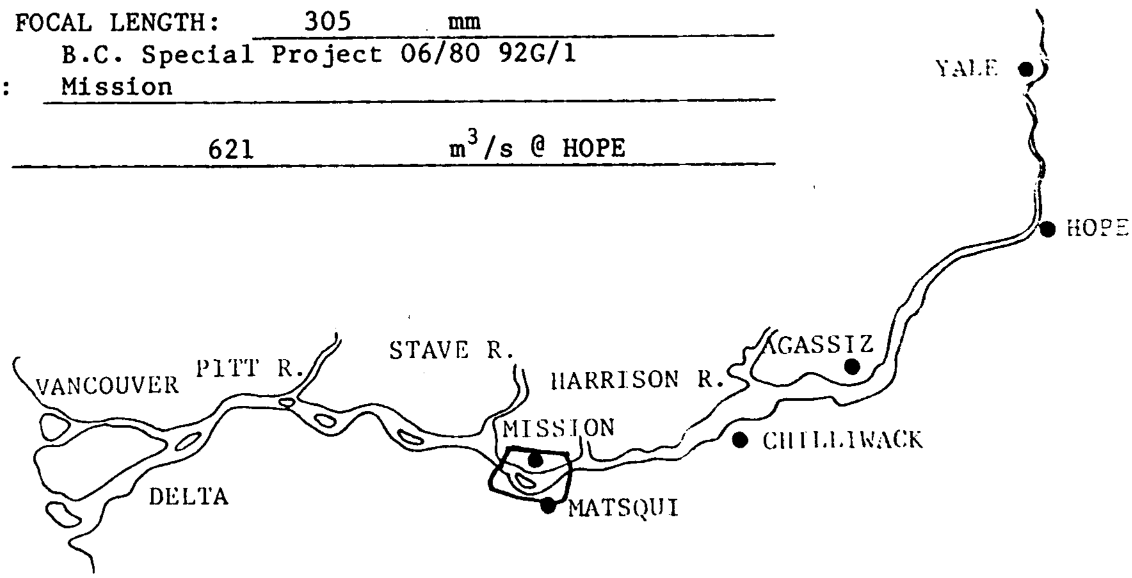
FLIGHT LINE ORIENTATION: variable

FLYING HEIGHT: 1890 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 06/80 92G/1 Mission

FLOW: 621 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BCC 235	1-11	MISSION
"	22-36	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1980 (Mar-Sep) SCALE: 1:6000

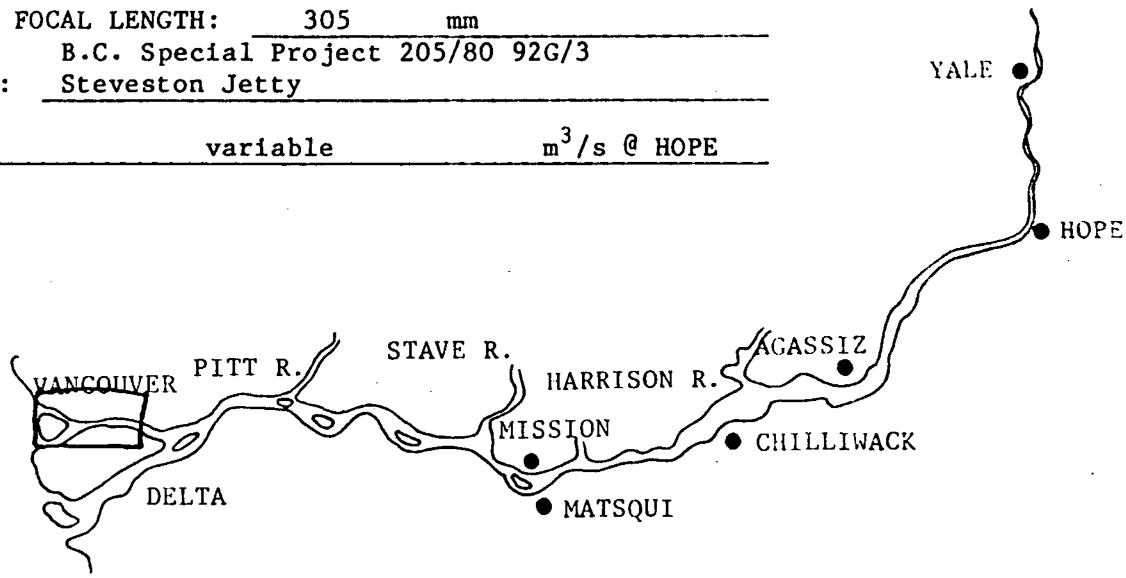
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 1830 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 205/80 92G/3
Steveston Jetty

FLOW: variable m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BCC 240	197-208	STEVESTON
"	183-196	"
BCC 243	121-134	"
"	109-120	"
BCC 279	1-12	"
"	13-27	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1980 (21 Apr)   SCALE: 1:6000

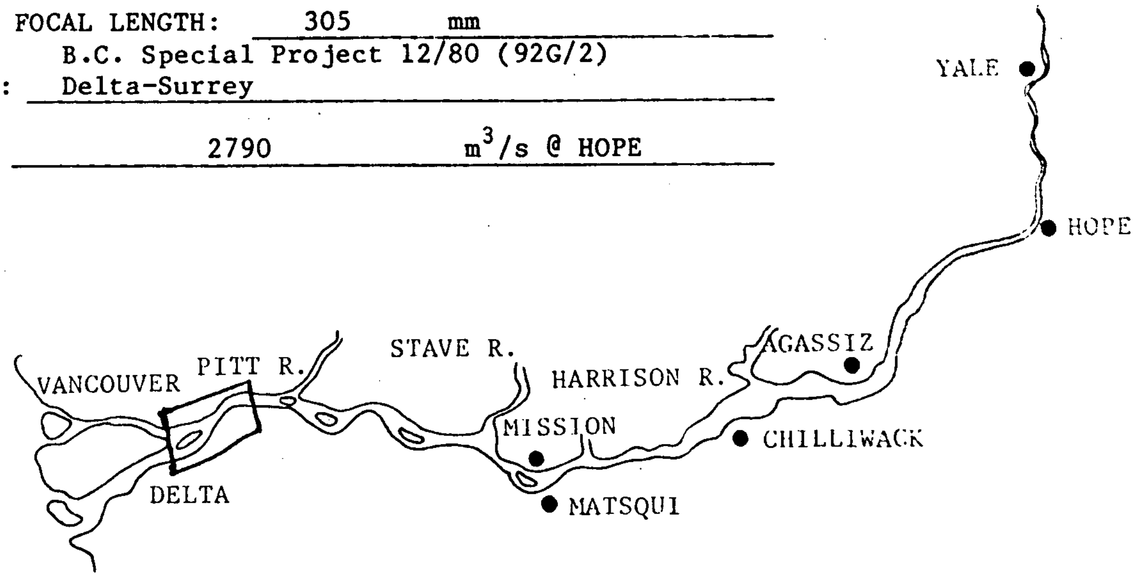
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 1890 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 12/80 (92G/2) Delta-Surrey

FLOW: 2790 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BCC 241	147-148	NEW WESTMINSTER
"	181-183	"
"	190-193	"
BCC 242	6-10	ANNACIS IS.
"	19-25	"
"	70-78	"
"	80-83	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1980 (9 Sept) SCALE: 1:12,000

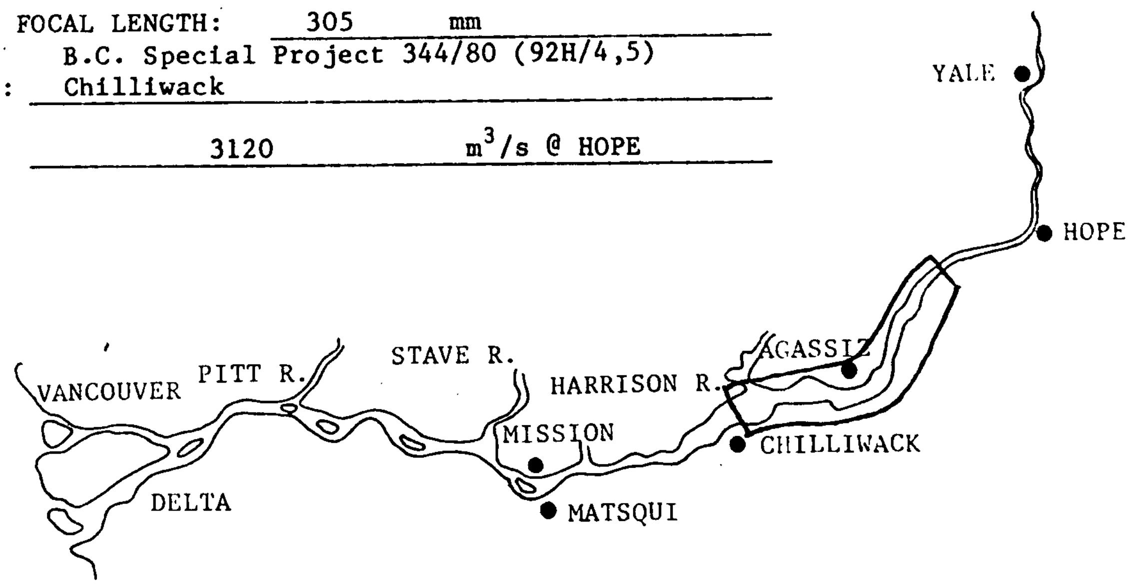
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 3650 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 344/80 (92H/4,5) Chilliwack

FLOW: 3120 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BCC 278	95-112	RUBY CK. - POPKUM
"	73-90	CHEAM VIEW
"	61-72	SEABIRD IS.
"	25-34	HARRISON R.
"	37-58	HARRISON HILL - HERRLING IS.
"	1-18	ROSEBANK IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1980 (28 July)   SCALE: 1:12000

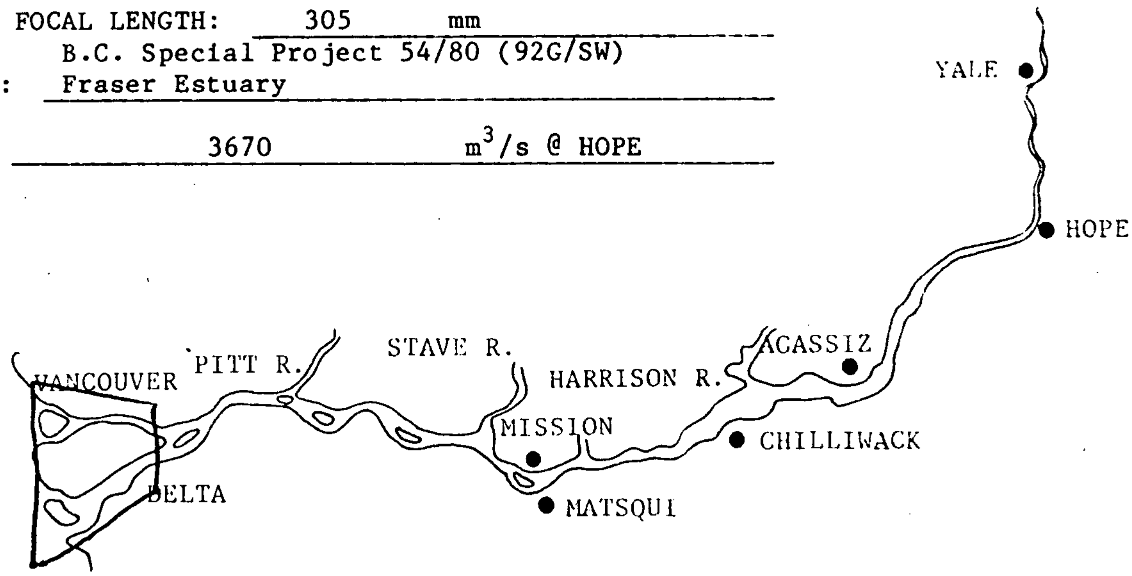
FLIGHT LINE ORIENTATION: variable

FLYING HEIGHT: 3650 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 54/80 (92G/SW) Fraser Estuary

FLOW: 3670 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BCIR 37	42-48	DELTA
"	49-58	"
"	32-41	WESTHAM
"	20-31	"
BCIR 38	59-63	SEA IS.
"	44-47	"
"	30-34	"
"	4-8	"
BCC 261	166-172	DELTA
"	173-182	"
"	156-165	WESTHAM
"	144-155	"
"	59-62	SEA IS.
"	44-46	"
"	30-33	"
"	6-8	"

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1981 (24 June) SCALE: 1:5000

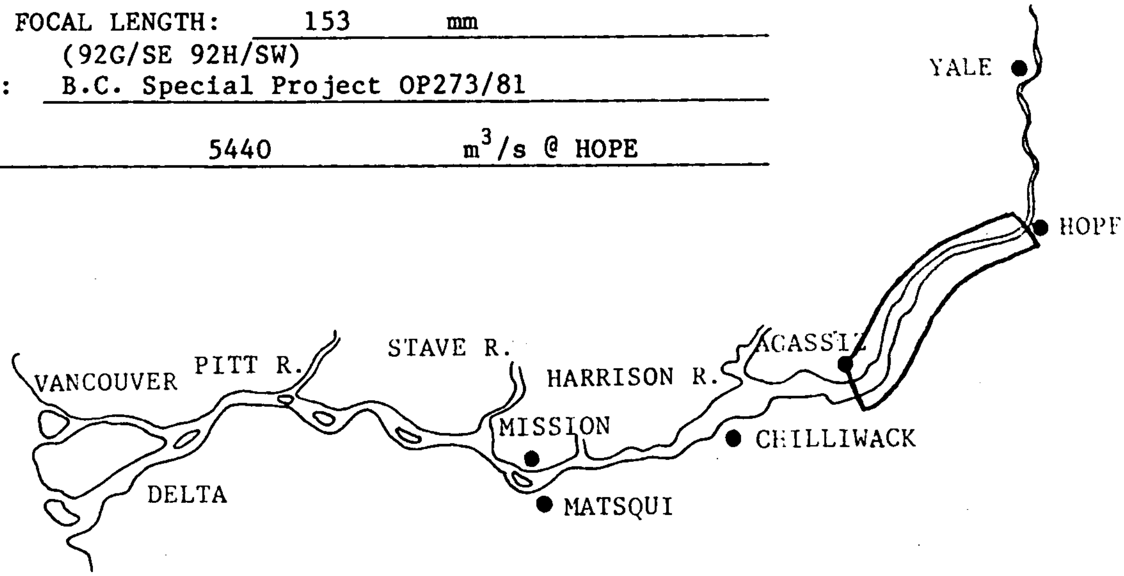
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 850 mASL

CAMERA FOCAL LENGTH: 153 mm

(92G/SE 92H/SW)
SOURCE: B.C. Special Project OP273/81

FLOW: 5440 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 81023	1-100	HOPE - POPKUM
"	125-131	POPKUM

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1982 (Sept-Oct) SCALE: 1:12000

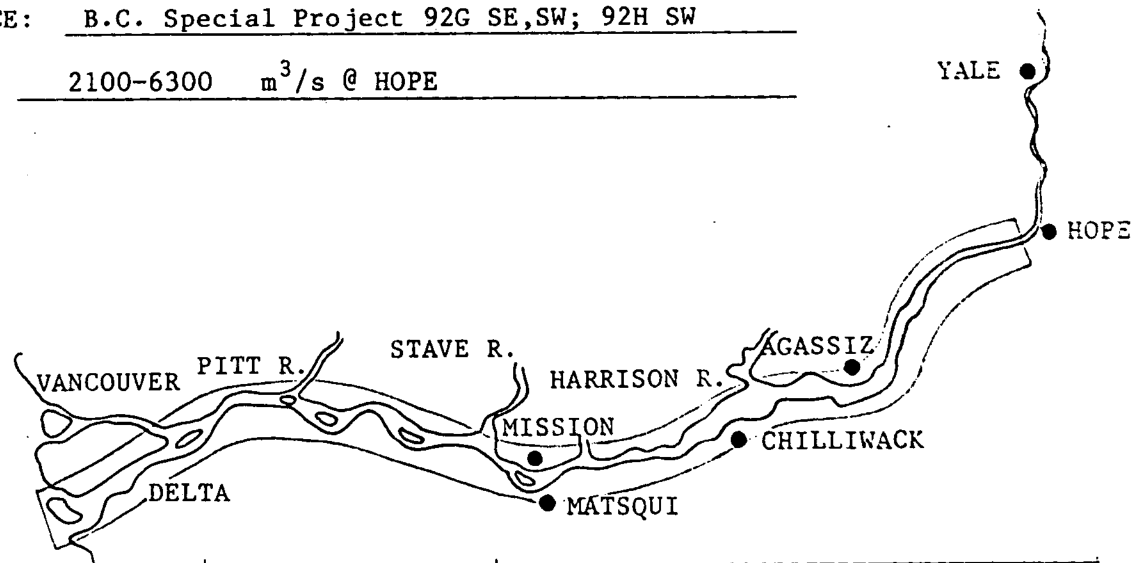
FLIGHT LINE ORIENTATION: follows river

FLYING HEIGHT: 12 050 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Special Project 92G SE,SW; 92H SW

FLOW: 2100-6300 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BCC 319	59-65	ODLUM
"	32-39	HERRLING IS.
"	2-25	VASASUS-SEA BIRD IS.
"	72-85	RUBY CK.
"	185-197	POPKUM
"	200-220	HARRISON CONFLUENCE
"	160-164	CHILLIWACK
BCC 320	30-45	CHEAM VIEW - WINDERMERE
"	96-150	CHEAM VIEW - RIDGEDALE
"	1-22	CHILLIWACK-SUMAS MOUNTAIN
"	160-168	MATSQUI IS.
"	180-189	GLEN VALLEY
BCC 323	20-26	CRESCENT IS.
"	85-93	MATSQUI IS.
"	70-78	MCMILLAN IS.
"	53-68	BARNSTON IS.-FRASER MILLS
"	102-138	MATSQUI-FRASER MILLS
BCC 324	65-70	DOUGLAS IS.
"	80-145	FRASER MILLS-ROBERTS BANK

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1982 (Aug-Oct)   SCALE: 1:24000

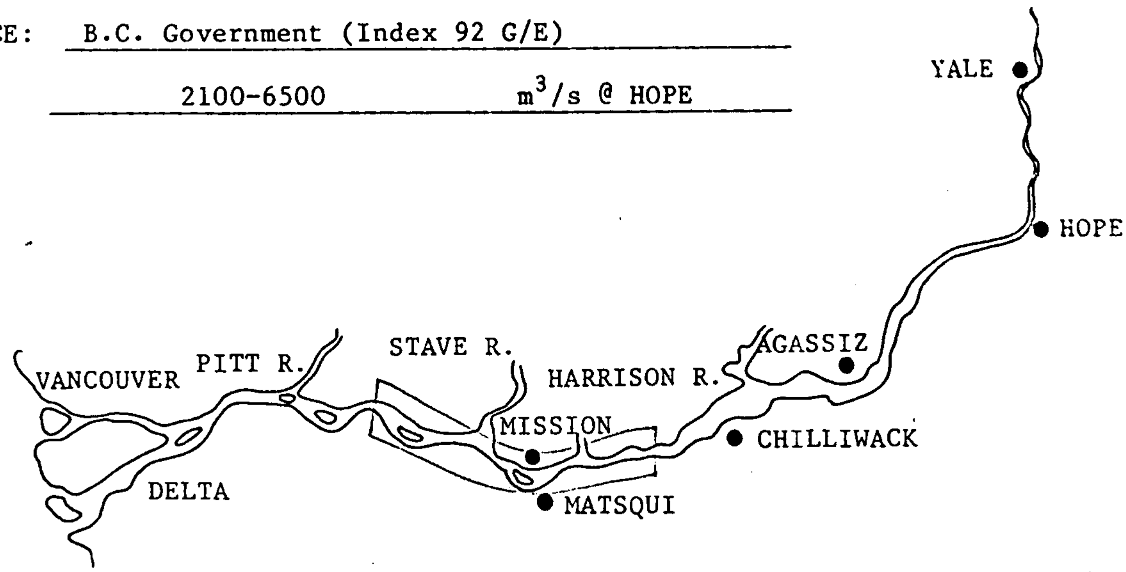
FLIGHT LINE ORIENTATION: North-South

FLYING HEIGHT: 7315 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Government (Index 92 G/E)

FLOW: 2100-6500 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 82058	167-170	NICOMEN IS.
BC 82058	174-175	"
BC 82058	84-86	"
BC 82059	90-102	"
BC 80259	85-87	GLEN VALLEY
BC 82063	147-150	NICOMEN IS.
BC 82063	273-275	HATZIC
BC 82-63	268-269	"
BC 82063	4-6	MISSION
BC 82063	143-144	SILVERDALE
BC 82062	169-171	GLEN VALLEY
BC 82062	70-74	MCMILLAN IS.
BC 82062	172-175	FORT LANGLEY
BC 82061	148-149	GLEN VALLEY
BC 82061	152-154	MATSQUI
BC 82061	35-37	PORT HAMMOND

B.C. GOVERNMENT 20 CHAIN
AIR PHOTOGRAPHY

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1961 SCALE: 20 Ch

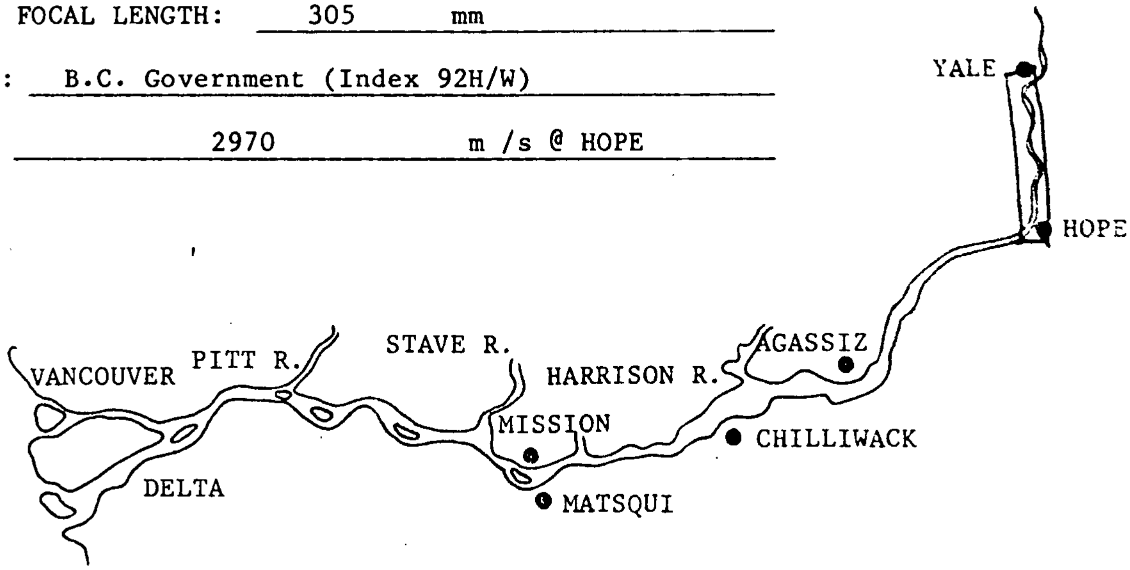
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 5790 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Government (Index 92H/W)

FLOW: 2970 m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 4014	53-54	HOPE
BC 4020	21-23	
BC 4014	67-68	
BC 4017	8-9	
"	52-53	
"	73-74	TEXAS BAR
BC 4020	42	SQUEAH
BC 4017	116-118	
"	139-140	EMORY CK.
"	185-186	
BC 4018	9-12	YALE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1962 SCALE: 20 Ch.

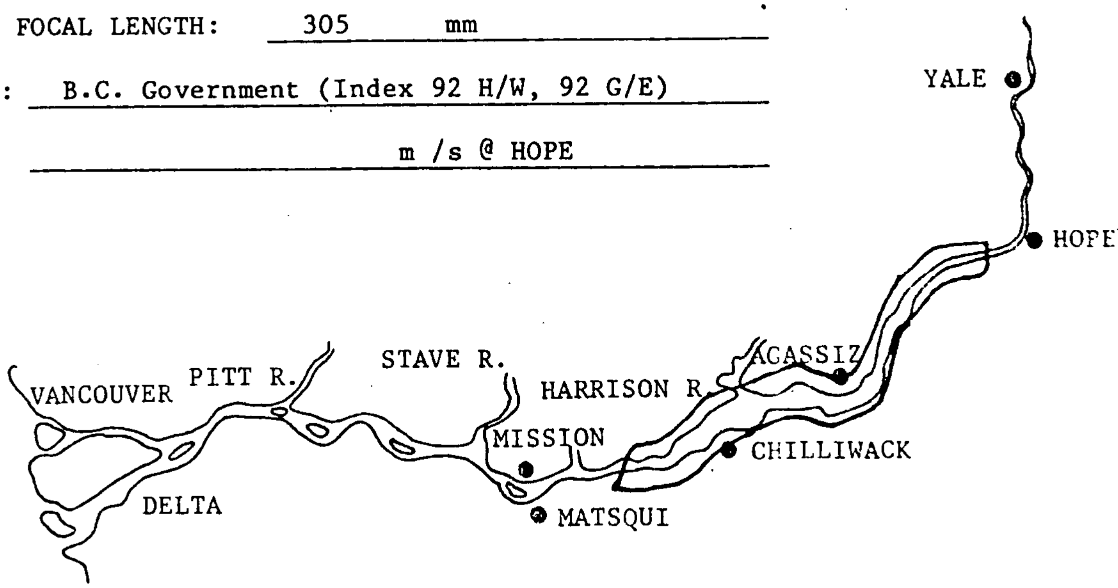
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 5790 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Government (Index 92 H/W, 92 G/E)

FLOW: m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 4055	5-6	
BC 4066	58-65	
"	37-55	NICOMEN IS. - HOPE SLOUGH
"	7-21	
BC 4067	189-205	AGASSIZ - PYE CK.
"	172-185	HARRISON MILLS - AGASSIZ
"	157-160	SEABIRD IS.
"	108-113	
BC 4058	40-44	WAHLEACH CK.
BC 4055	104-106	
"	30-32	RUBY CK.
"	101-102	W. OF HOPE

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1963 (28 Apr) SCALE: (20 Ch) (1 in = 1000 ft) (1:12,000)

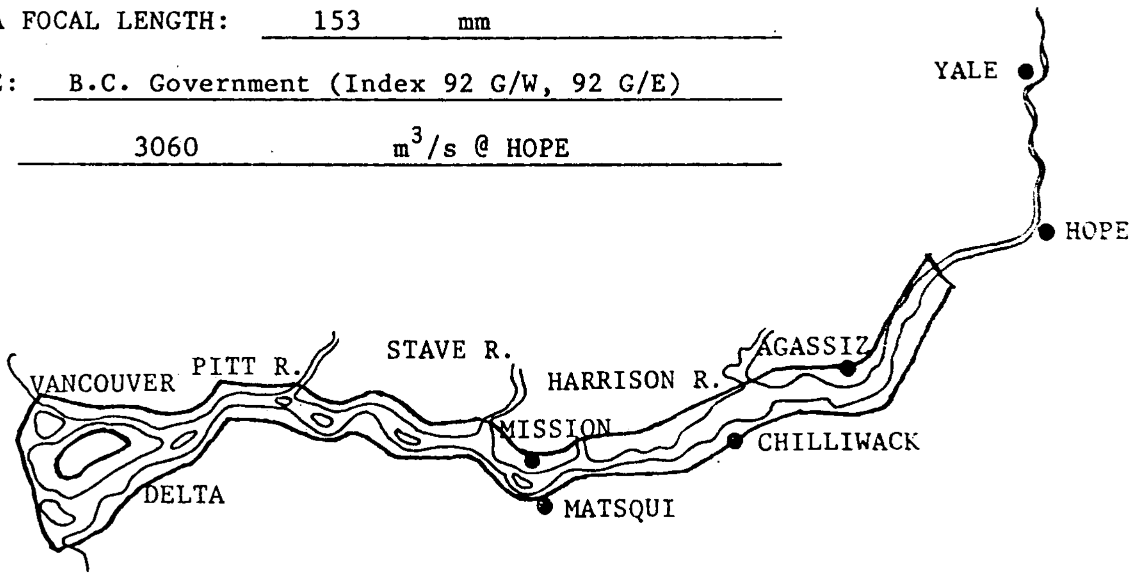
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 1930-2010 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government (Index 92 G/W, 92 G/E)

FLOW: 3060 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5059	77-80	RUBY CREEK
BC 5064	248-251	
BC 5059	119-123	LAIDLAW
"	319-325	
BC 5061	1-6	
"	192-197	
"	199-204	
BC 5062	138-146	AGASSIZ
"	148-171	AGASSIZ TO NICOMEN SLOUGH
"	71-81	NEW WEST. TO CHATHAM REACH
"	259-262	IONA IS.
BC 5063	90-110	PYE CK. TO AGASSIZ
"	36-47	BISHOPS REACH - KANAKA CK.
"	22-25	POPLAR IS.
"	8-18	
"	3-5	W. EDGE SEA IS.
"	117-141	ROSEDALE - NICOMEN SLOUGH
"	173-175	RUSSEL REACH
"	181-184	BARNSTON IS.
"	198-204	
"	213-217	S. SEA IS.
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ____________ SCALE: ____________

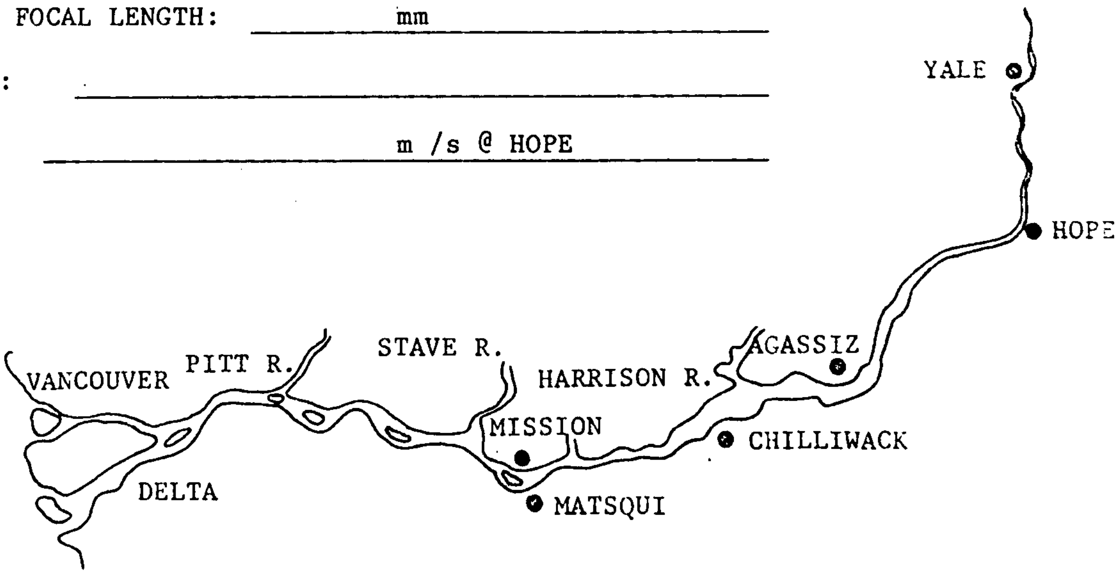
FLIGHT LINE ORIENTATION: ____________

FLYING HEIGHT: ____________ mASL

CAMERA FOCAL LENGTH: ____________ mm

SOURCE: ____________

FLOW: ____________ m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5064	37-38	HOPE SLOUGH
"	11-25	NICOMEN IS.
BC 5063	262-277	FT. LANGLEY - PLUMPER REACH
"	237-242	ANNACIS IS.
"	222-224	W. EDGE LULU IS.
BC 5064	59-75	
"	81-83	
"	119-127	
"	137-139	W. EDGE LULU IS.
"	200-215	
"	153-157	
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1963 (May) SCALE: ____________

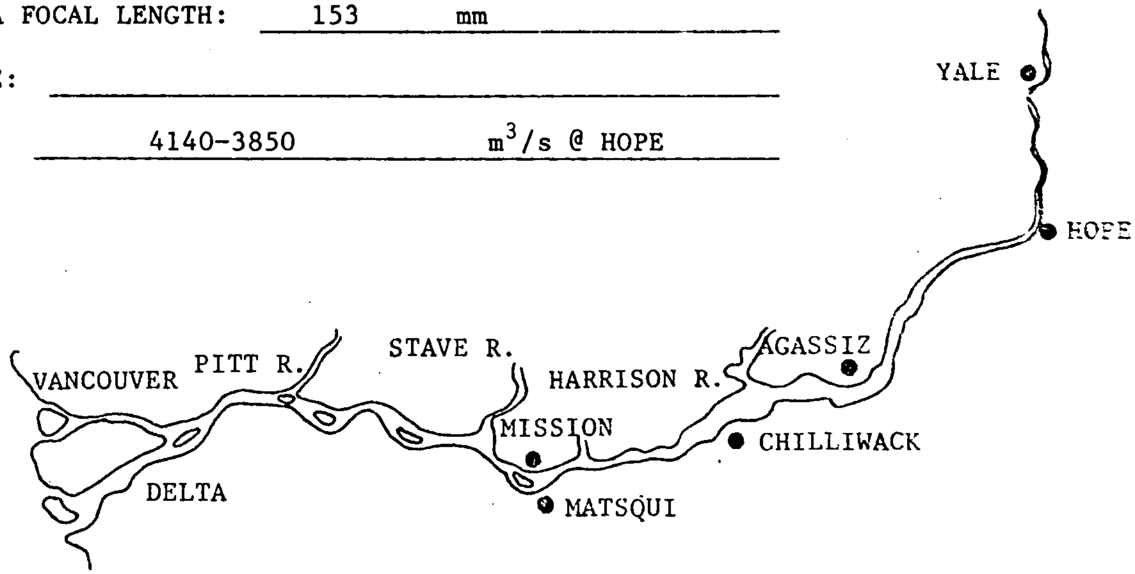
FLIGHT LINE ORIENTATION: ____________

FLYING HEIGHT: 1950 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: ____________

FLOW: 4140-3850 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5064	143-145	STEVESTON
BC 5065	42-47	MATSQUI IS.
"	92-106	
"	113-125	
BC 5066	45-54	
BC 5072	1-5	CANOE PASS

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1968 SCALE: 20 Ch.

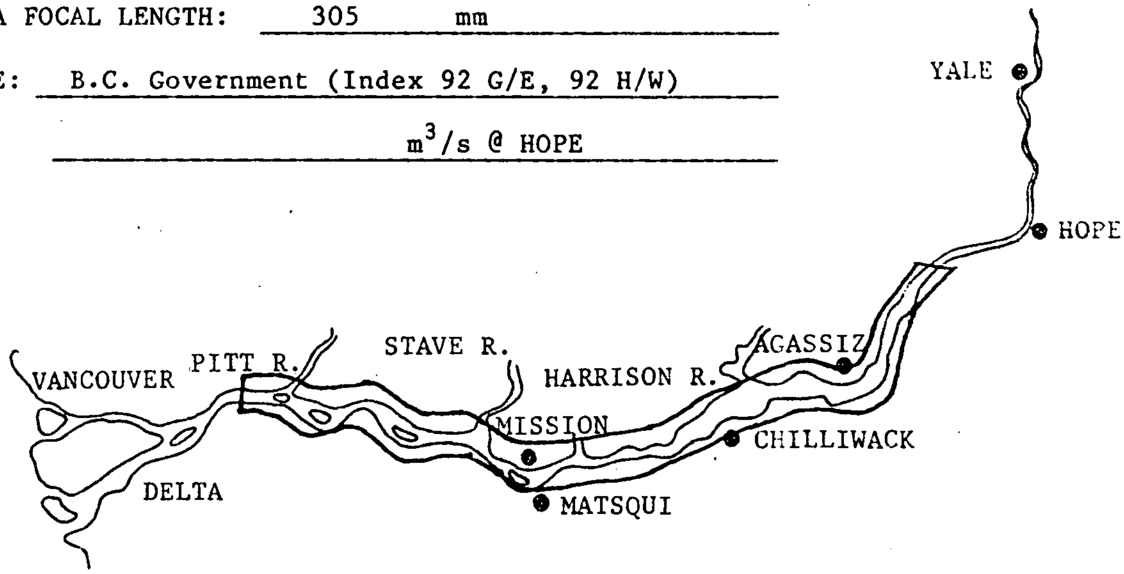
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 5560-5610 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Government (Index 92 G/E, 92 H/W)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 7104	209-212	WAHLEACH IS.
"	201-205	
"	15-21	SEABIRD IS.
BC 7058	1-7	AGASSIZ
"	12-21	
"	62-64	CHATHAM REACH
BC 7056	103-117	PORT MANN - KANAKA CK.
"	150-169	SQUAKUM L. - AGASSIZ
"	174-198	BRIDAL CK. - NICOMEN SLOUGH
"	223-232	
BC 7057	1-5	
"	7-17	FT. LANGLEY - PLUMPER REACH
"	30-51	DEWDNEY - HOPE SLOUGH
"	80-101	
"	104-116	MT. LEHMAN - COX

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1973 (13-15 July) SCALE: 20 Ch.

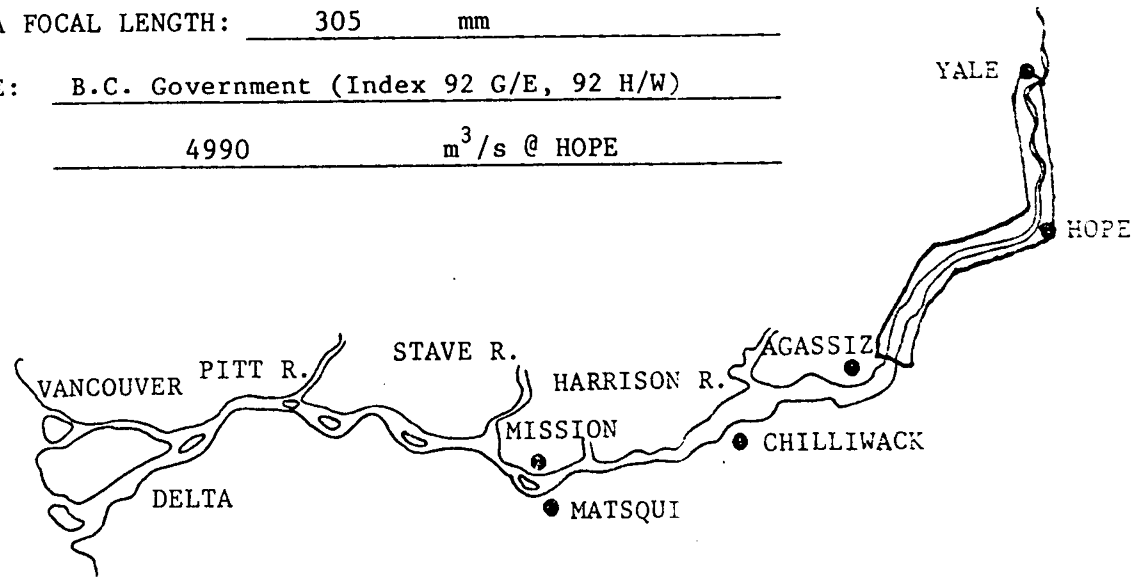
FLIGHT LINE ORIENTATION: east-west

FLYING HEIGHT: 6090 mASL

CAMERA FOCAL LENGTH: 305 mm

SOURCE: B.C. Government (Index 92 G/E, 92 H/W)

FLOW: 4990 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 7468	25-37	YALE
"	88-89	
"	149-151	QUALARK CK.
"	93-95	SUKA CK.
"	253-255	
BC 7469	23-24	STRAWBERRY IS.
"	83-84	AMERICAN CK.
"	126-128	
BC 7471	187-190	HOPE
"	238-245	
BC 7476	227-230	RUBY CK.
"	156-158	LAIDLAW
"	125-128	
"	39-43	CHEAM VIEW AND SEABIRD IS.
"	28	SEABIRD IS.

B.C. GOVERNMENT SMALL SCALE
AIR PHOTOGRAPHY

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1939 SCALE: 40 Ch.

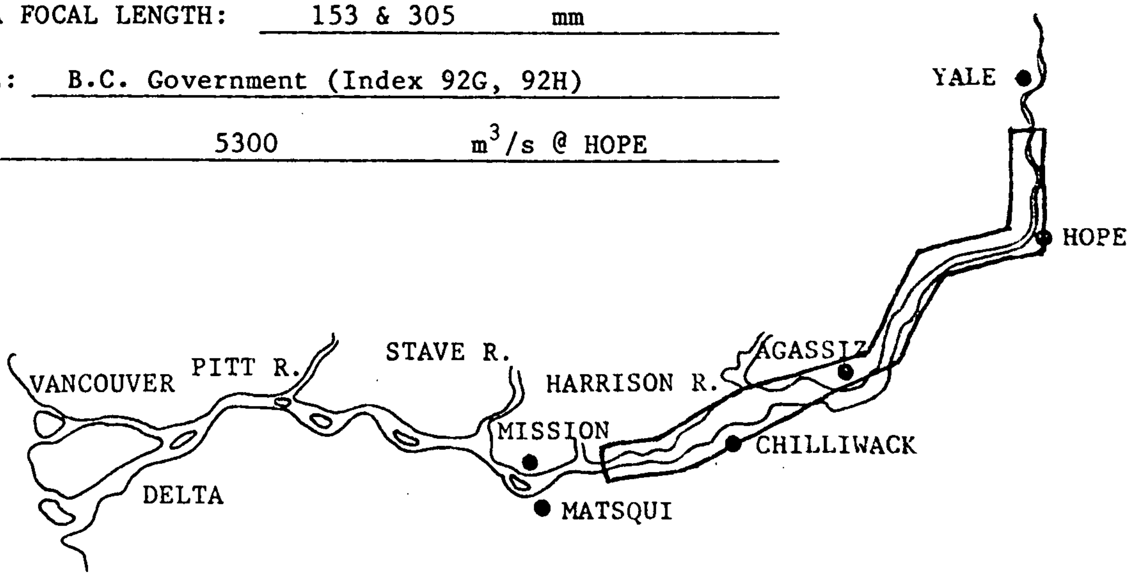
FLIGHT LINE ORIENTATION: NE-SW (approx.)

FLYING HEIGHT: 1460-4720 mASL

CAMERA FOCAL LENGTH: 153 & 305 mm

SOURCE: B.C. Government (Index 92G, 92H)

FLOW: 5300 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 140	13-15	SUKA CK.
"	16-17	TEXAS BAR
"	96-97	AMERICAN CK.
"	61-75	HATZIC - HARRISON R.
"	98-106	HOPE - RUBY CK.
"	85-91	HICKS L. AND EASTWARD
BC 136	1-22	WAHLEACH CK. - SUMAS MT.
"	23-28	SEABIRD IS.
BC 139	20-22	QUALARK CK.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1940 (May-June) SCALE: 40 Ch.

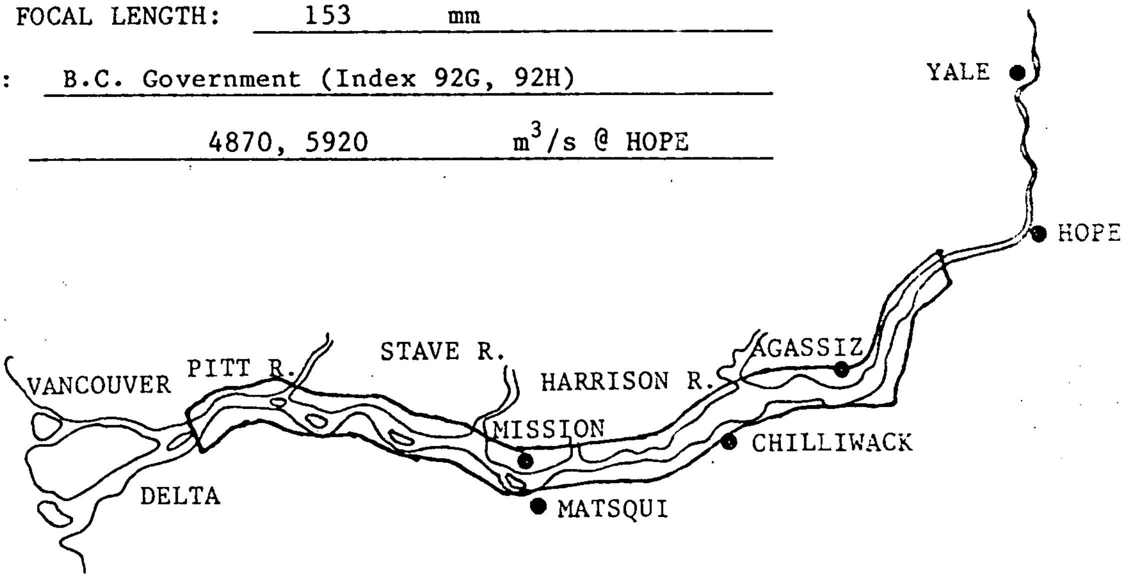
FLIGHT LINE ORIENTATION: varies

FLYING HEIGHT: 3100-6200 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government (Index 92G, 92H)

FLOW: 4870, 5920 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 204	94-109 (SW-NE)	RUBY CK. - POPKUM
"	60-85 "	60-76 EW
BC 206	53-65 "	
BC 204	42-54 EW	BARNSTON IS. - STAVE R.
"	22-30	
"	35-37	ANNACIS IS.
BC 205	10-42	CHILLIWACK - FT. LANGLEY
"	59	CITY REACH
"	79-95	
BC 206	24-26	JUST E. OF MT. LEHMAN
BC 203	88-90	CHATHAM REACH

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1952-1953 SCALE: 40 Ch.

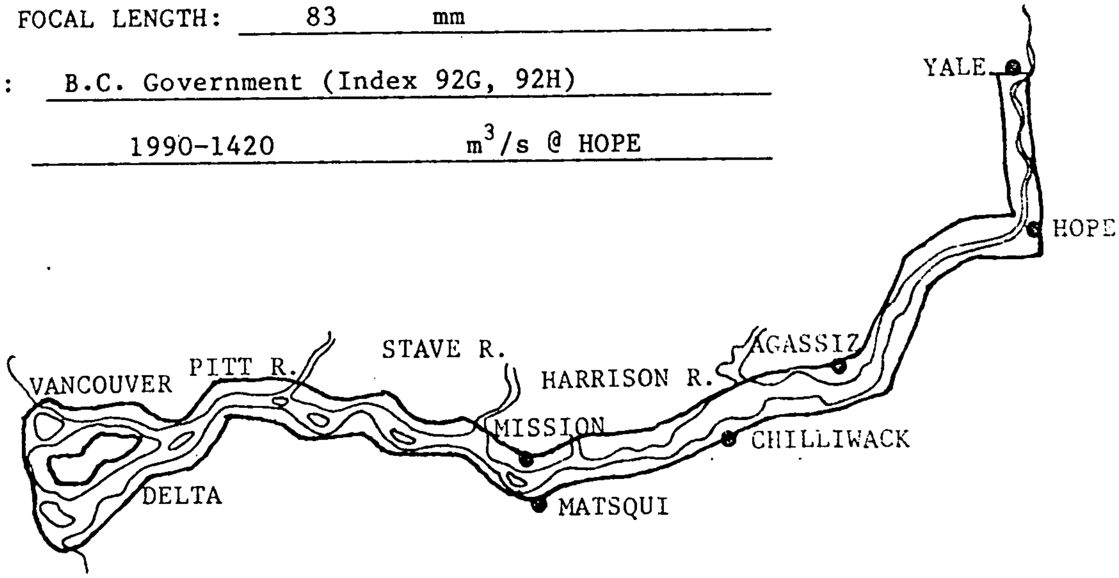
FLIGHT LINE ORIENTATION: north-south

FLYING HEIGHT: 6100 mASL

CAMERA FOCAL LENGTH: 83 mm

SOURCE: B.C. Government (Index 92G, 92H)

FLOW: 1990-1420 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1634	70-76	DELTA FRONT
"	10-15	"S" ARM
"	18-20	N. ARM
BC 1633	83-84	"S" ARM (GRAVESEND REACH)
"	81-90	N. ARM (MITCHELL IS.)
BC 1634	1-3	
BC 1633	111-112	
"	14-16	E. END LULU IS.
"	1-2	
BC 1632	20-21	
"	66-67	PORT MANN
"	90-91	DOUGLAS IS.
BC 1806	83-85	BARNSTON IS. (1953)
"	101-103	PORT HAMMOND "
"	31-33	MCMILLAN IS. "
BC 1805	100-101	WHONOCK "
BC 1620	37-39	
"	52-54	MATSQUI IS.
BC 1621	10-11	MISSION
"	47-49	
"	63-66	NICOMEN IS.
		(continued)

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: ____________ SCALE: ____________

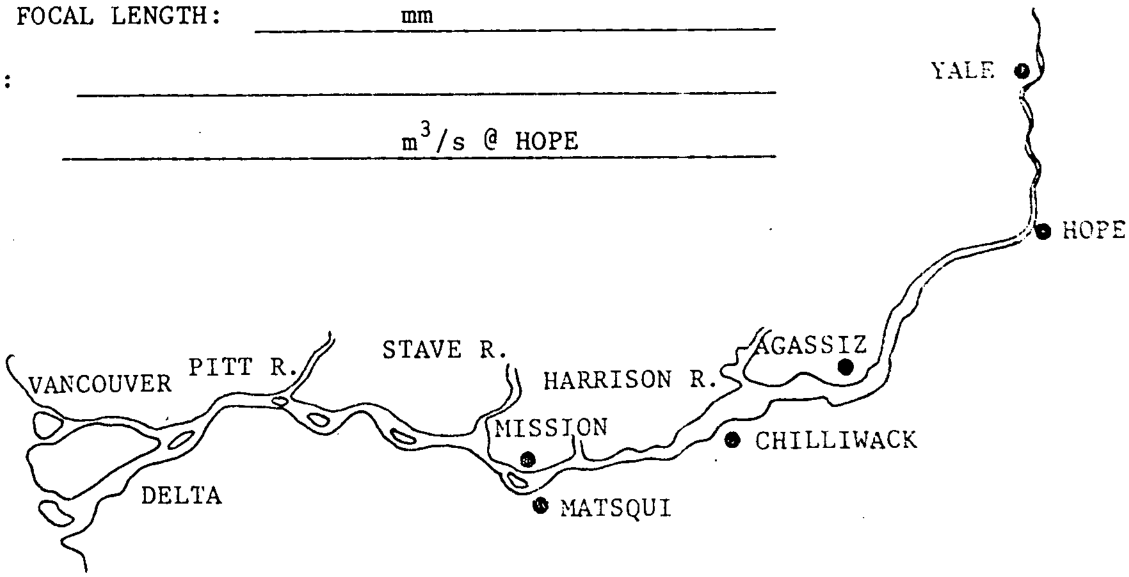
FLIGHT LINE ORIENTATION: ____________

FLYING HEIGHT: ______ mASL ______

CAMERA FOCAL LENGTH: ______ mm ______

SOURCE: ____________

FLOW: ______ m^3/s @ HOPE ______



FILM ROLL	PHOTO NOS.	REMARKS
BC 1622	6-9	
"	24-26	
"	67-70	
"	89-92	
BC 1623	5-7	
"	31-34	AGASSIZ
BC 1805	73-76	(1953)
"	48-50	"
"	11-12	"
BC 1804	97-98	"
"	48-57	YALE - HOPE "

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1955-1956 SCALE: 40 CH.

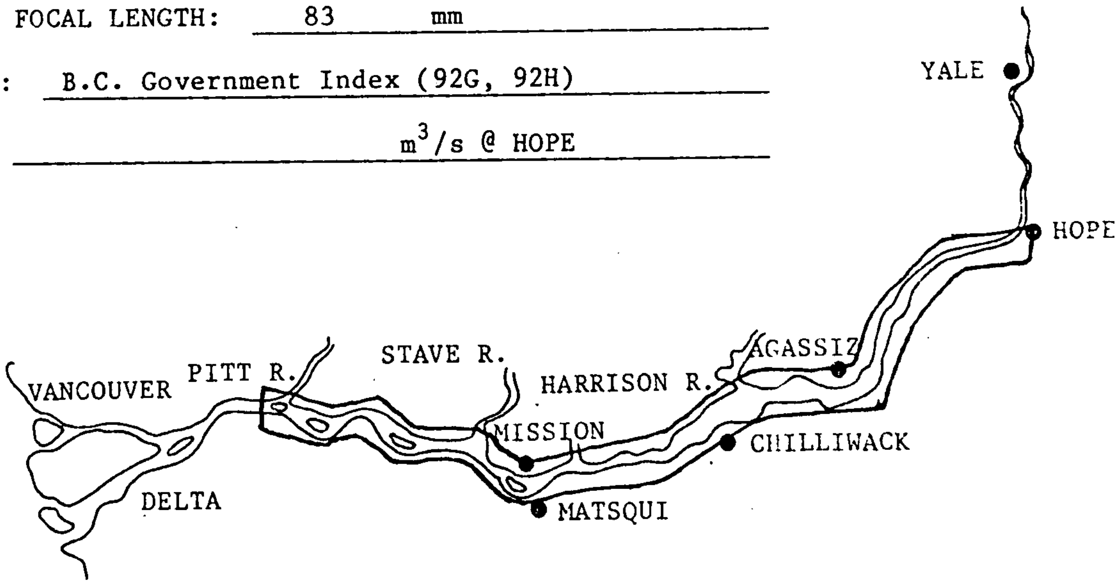
FLIGHT LINE ORIENTATION: follow river

FLYING HEIGHT: 1580 mASL

CAMERA FOCAL LENGTH: 83 mm

SOURCE: B.C. Government Index (92G, 92H)

FLOW: m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 1870	38-54	CHATHAM REACH - MATSQUI
"	55-75	MATSQUI - POPKUM
"	89-102	HOPE - AGASSIZ
BC 2041	45-80	CHATHAM REACH - AGASSIZ (1956)
"	81-85	AGASSIZ - CHEAM VIEW "
"	90-94	HOPE AREA "
BC 2045	4-30	PT. MANN - NICOMEN IS. "

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1958 (28 Apr) SCALE: 40 CH.

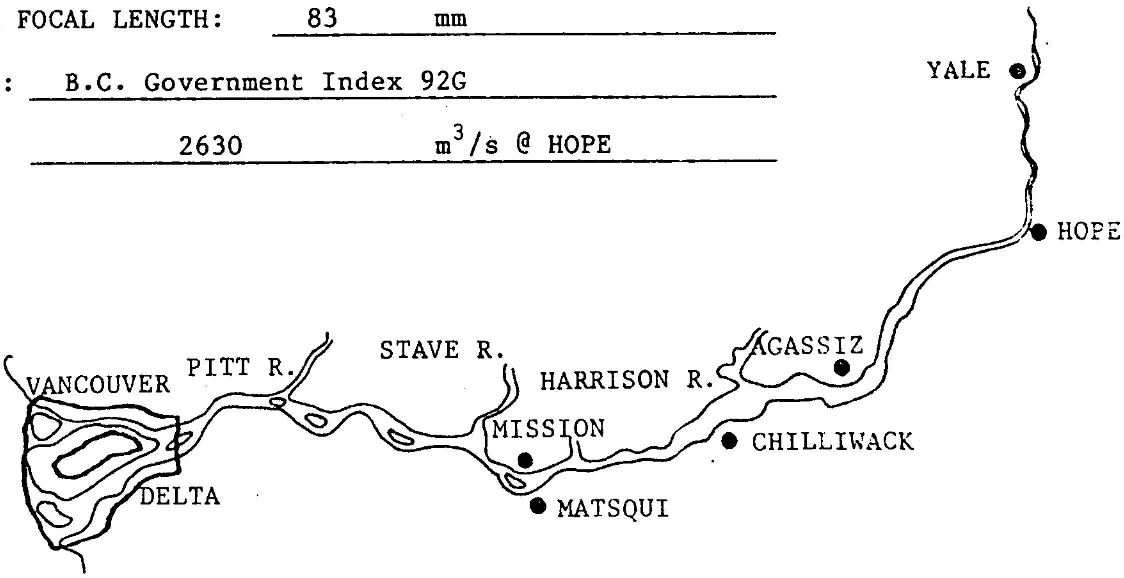
FLIGHT LINE ORIENTATION: north-south

FLYING HEIGHT: 1520 mASL

CAMERA FOCAL LENGTH: 83 mm

SOURCE: B.C. Government Index 92G

FLOW: 2630 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 2249	43-49	DELTA FRONT
"	50-52	
"	54-56	
"	63-64	
"	67-68	
"	79-82	E. END OF LULU IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1966 (Jun-Sep) SCALE: 40 Ch.

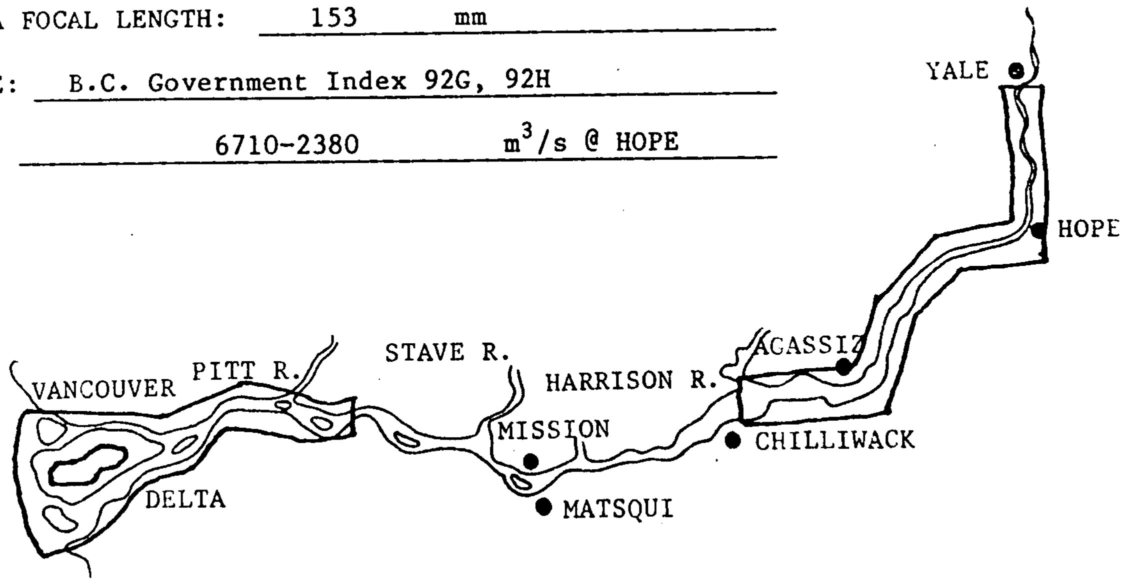
FLIGHT LINE ORIENTATION: north-south unless noted

FLYING HEIGHT: 5180-5940 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Index 92G, 92H

FLOW: 6710-2380 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5169	194-201	YALE - HOPE (1965)
BC 5212	179-181	(1966)
"	207-208	"
BC 5213	77-78	LAIDLAW
"	106-111	
BC 5215	129-132	SEABIRD IS.
BC 5217	17-19	AGASSIZ
"	35-37	
"	192-194	
"	197-199	CHILLIWACK
BC 5194	4-7 EW	CHATHAM REACH
"	21-37 "	STURGEON BANK - PORT HAMMOND
"	53-54 "	DELTA FOOT
"	46-47, 90 EW	GRAVESEND REACH
BC 5205	205-213	SANDHEADS - CRESCENT SLOUGH
BC 5194	55-57	CANOE PASS

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1967 (4, 5 Jun) SCALE: 40 CH.

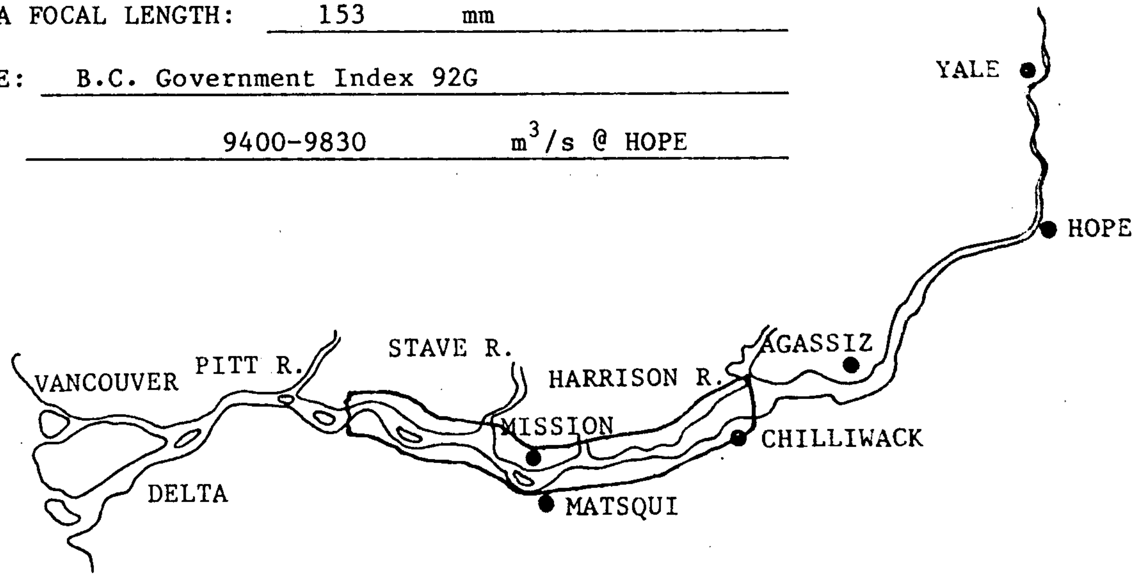
FLIGHT LINE ORIENTATION: north-south

FLYING HEIGHT: 5630 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government Index 92G

FLOW: 9400-9830 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5236	188-190	NICOMEN IS.
BC 5237	119-121	
"	107-109	
BC 5236	201-202	
"	235-236	MISSION
"	242-246	MT. LEHMAN
BC 5237	16-17	CRESCENT IS. (PLUMPER REACH)
"	31-32	
"	60-62	FT. LANGLEY
"	76-78	PORT HAMMOND

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1972 (30 July)   SCALE: 1:63,000

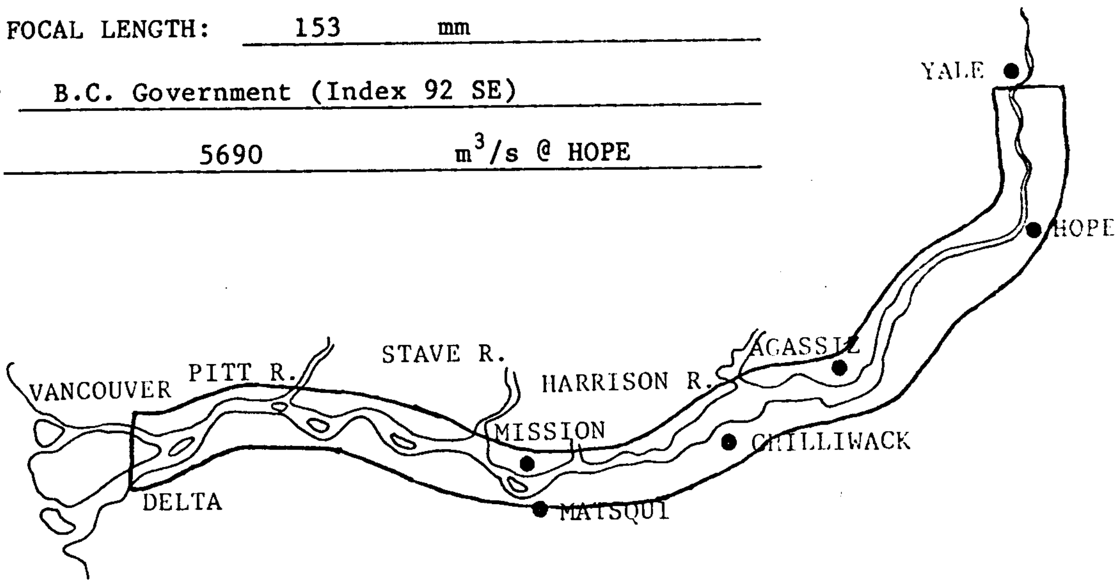
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 11,150 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government (Index 92 SE)

FLOW: 5690 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5492	263-265	YALE
"	191-192	SKAWAHLUM
"	176-178	HOPE
"	128-130	LAIDLAW
"	90-110	AGASSIZ - SEA IS.
"	85-89	LULU IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1976 (14 July) SCALE: 1:50,000

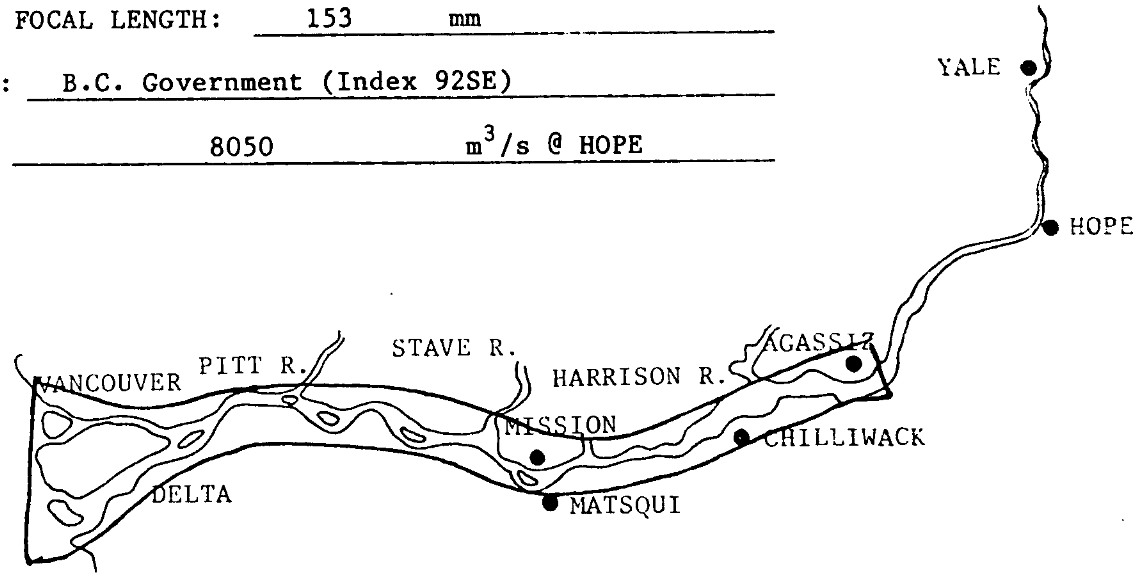
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 8340 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government (Index 92SE)

FLOW: 8050 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 5725	98-105	AGASSIZ
"	42-49	MISSION
"	117-120	NEW WESTMINSTER
"	69-92	CHILLIWACK - LULU IS.
"	57-64	WESTHAM IS.

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1978 (7 Jul) SCALE: 1:40,000

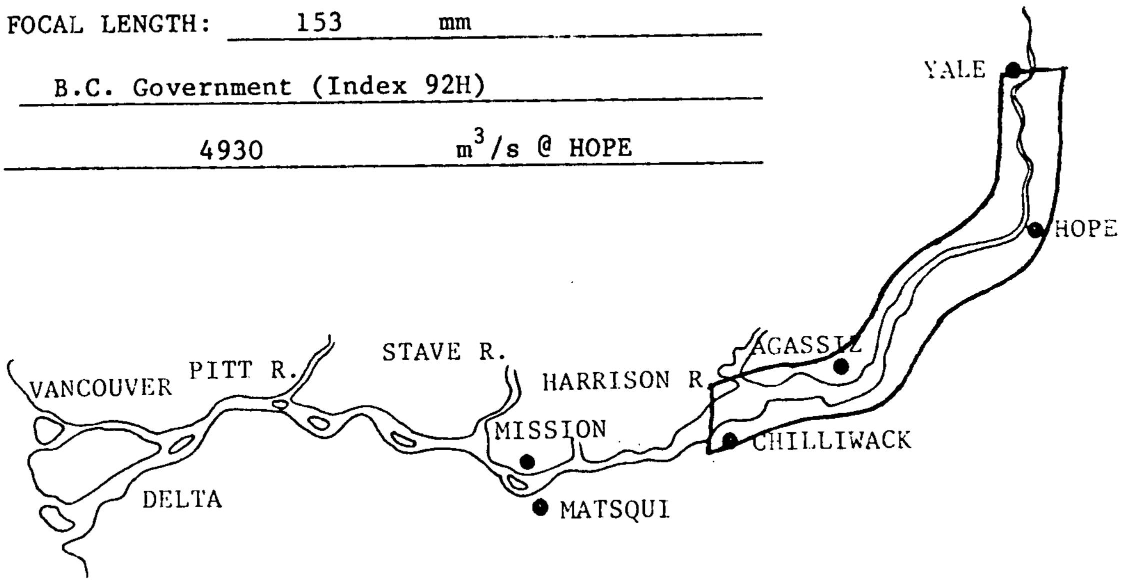
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 7920 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government (Index 92H)

FLOW: 4930 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 78100	193-195	YALE
BC 78100	211-213	SKAWAHLUM
BC 78100	234-235	HOPE
BC 78101	10-14	"
BC 78101	26-28	SEABIRD IS.
BC 78101	57-59	AGASSIZ
BC 78101	66-71	CHILLIWACK

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1979 (9 June) SCALE: 1:50,000

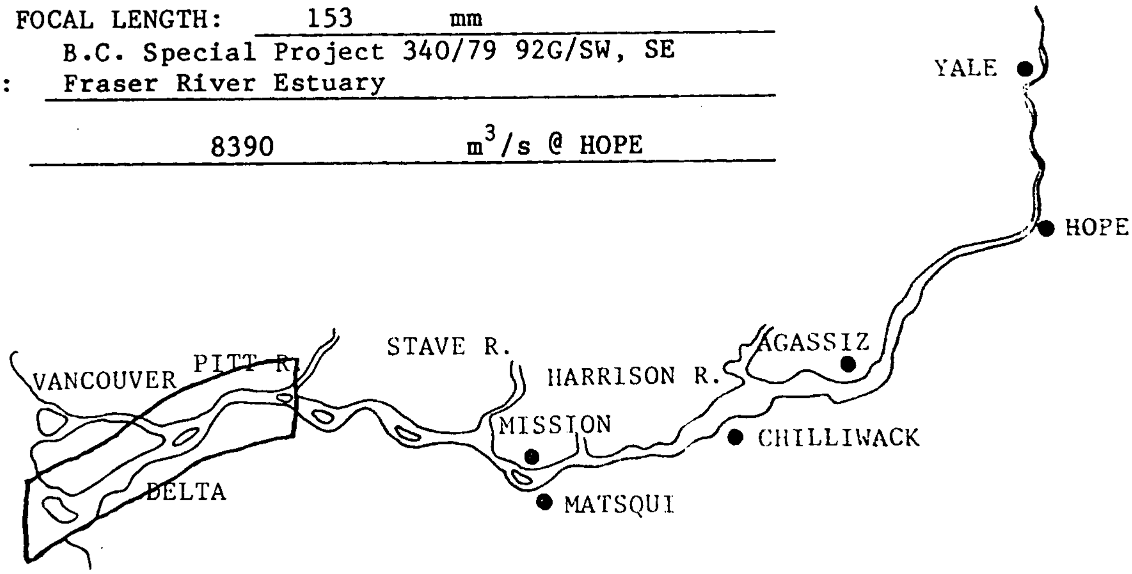
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 7650 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Special Project 340/79 92G/SW, SE Fraser River Estuary

FLOW: 8390 m^3/s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS
BC 79037	111-117	DOUGLAS IS.
"	127-142	LULU IS.
"	150-156	WESTHAM

AIRPHOTO COVERAGE OF LOWER FRASER RIVER (YALE TO OCEAN)

DATE: 1980 (Jul-Oct) SCALE: 1:50,000

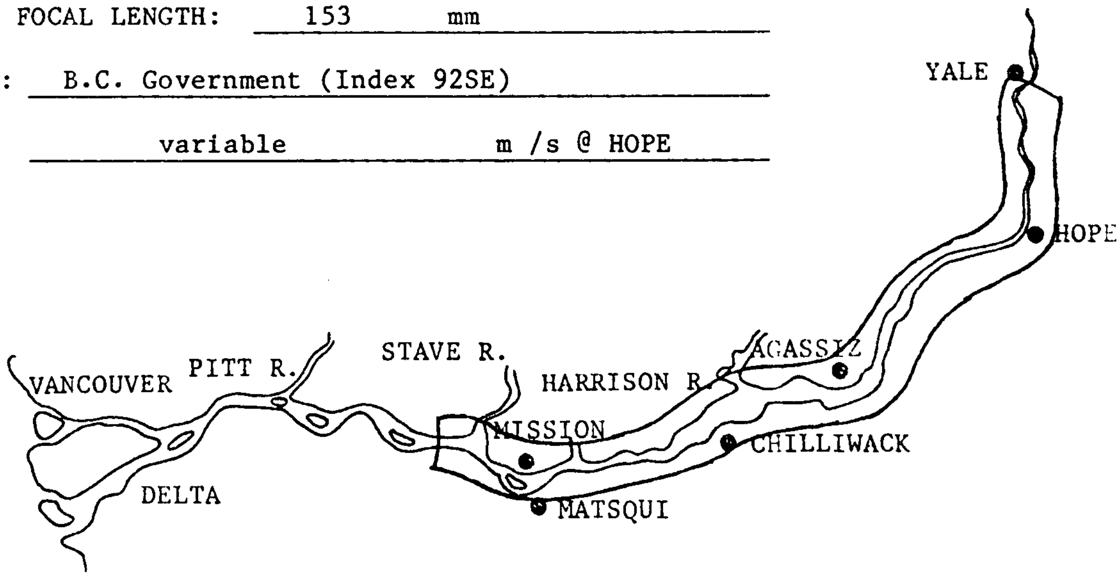
FLIGHT LINE ORIENTATION: East-West

FLYING HEIGHT: 8900 mASL

CAMERA FOCAL LENGTH: 153 mm

SOURCE: B.C. Government (Index 92SE)

FLOW: variable m /s @ HOPE



FILM ROLL	PHOTO NOS.	REMARKS	
BC 80143	270-271	YALE	(25 Sep)
BC 80142	26-27	SKAWAHLUM	"
BC 80144	173-174	HOPE	(2 Oct)
BC 80065	1-2	"	(21 Jul)
"	85-90	RUBY CK.	"
"	105-110	AGASSIZ	"
"	160-176	CHILLIWACK	"
"	147-150	HANEY	"
"	225-230	MATSQUI	"

MAPS AND CHARTS

Maps and Charts

In addition to the primary maps and charts listed here, many reports include additional charts and maps of various parts of the river. Some of these are derivative but many record the results of additional, special surveys. These are notated with the report entries, and are not repeated here.

Some maps and charts that have not been seen are listed in the section "Reference not seen".

Federal Topographic Maps[1]

Surveys and Mapping Branch Various Dates
National Topographic Series. Scale: 1:25,000
Department of Energy, Mines and Resources

No.	Name	Date
92 G/3g	Sea Island	1970
92 G/3h	Mitchell I	1970
92 G/3b	Westham I	1970
92 G/3a	Ladner	1973
92 G/2e	New Westminster	1970
92 G/2f	Port Mann	1970
92 G/2g	Port Hammond	1970
92 G/2h	Fort Langley	1970
92 G/1e	Whonock	1975
92 G/1d	Aldergrove	1975
92 G/1f	Mission	1976
92 G/1c	Abbotsford	1975
92 G/1g	Dewdney	1975
92 G/1b	Kilgard	1976
92 G/1h	Deroche	1976
92 G/1a	Yarrow	1976
92 G/4e	Chilliwack	1975
92 G/4f	Rosedale	1976

Surveys and Mapping Branch, Various Dates.
National Topographic Series. Scale: 1:50,000. Canada
Department of Energy, Mines and Resources

No.	Name	Date
92 G/3E	Vancouver South	1978
92 G/2W	New Westminster	1977
92 G/2E	" "	1962
92 G/1	Mission	1977
92 H/4	Chilliwack	1980
92 H/5E	Harrison Lake	1980
92 H/6W	Hope	1976
92 H/11W	Spuzzum	1979

Provincial Base Maps
Obtainable from:

MAPS - BC
Surveys and Resource Mapping Branch
Ministry of Environment
Parliament Buildings
Victoria, B.C.
V8V 1X4

1:5000 scale Base Maps

B.C. Geographic System Number	Sheets	Area
92G.005.1	4	Tsawwassen
92G.005.3	1,3,4	Westham Island
92G.015.1	1,2	Steveston
92G.015.2	1,3,4	Deas Island-Tilbury
92G.016.3	2	Annacis Island
92G.016.4	3	Patullo Bridge
92G.026.2	1,2	New Westminster
92G.027.1	1,2	Douglas Island
92G.017.3	4	Barnston Island
92G.017.4	3,4	Barnston Island
92G.027.2	1,2	Derby Reach
92G.028.1	1	Haney
92G.018.3	1,2,3	McMillan Island
92G.018.4	1,2	Crescent Island
92G.019.1	2,3,4	Matsqui Island
92G.019.2	1,3,4	Matsqui-Hatzic
92G.019.4	1,2	Hatzic-Dewdney
92G.020.1	3,4	Sumas Mountain
92G.020.2	3,4	Sumas River
92G.020.3	1,2	Nicomen Island
92G.020.4	1,2,4	Nicomen Island
92H.011.3	3,4	Chilliwack
92H.012.3	3,4	Rosedale
92H.021.1	1,2	Harrison River Confluence
92H.021.2	1,2	Windemere Island
92H.022.1	1,2	Herring Island
92H.022.2	1,3	Cheam View
92H.022.4	1,3,4	Cheam View
92H.032.2	1,2,4	Laidlaw
92H.032.4	2	Ruby Creek
92H.033.3	1,2,4	Ruby Creek
92H.033.4	1,2,3,4	Hope

1:2500 scale Base Mapping is available for some localized areas near communities such as Mission, Deroche, and Hope. Details for ordering these maps as well as the 1:5000 maps listed above can be found in:

Base Mapping Catalogue
Province of British Columbia
Ministry of Environment
Surveys and Resource Mapping
October, 1982

Hydrographic Charts

Canadian Hydrographic Service, 1930 Fraser River: Sheet 1, Entrance to Steveston. Canada Department of Mines and Resources. Scale 1:12,208, Frequent Soundings

Canadian Hydrographic Service, 1930. Fraser River Sheet 2, Steveston to Deas Island. Canada Department of Mines and Resources. Scale: 1:12,183. Frequent Soundings.

Canadian Hydrographic Service, 1930. Fraser River: Sheet 3, Deas Island to Annacis Island. Canada Department of Mines and Resources. Scale: 1:12,195.Frequent Soundings.

Canadian Hydrographic and Map Service, 1940, Fraser River: Sheet 2, Steveston to Tilbury Island. Canada Department of Mines and Resources. Scale: 1:12,803, Soundings.

Canadian Hydrographic and Map Service, 1944, Fraser River: Sheet 3, Tilbury Island to Douglas Island. Canada Department of Mines and Resources. Scale: 1:12,000 Soundings.

Canadian Hydrographic and Map Service, 1947, Fraser River: Sheet 1, Sand Heads to Tilbury Island. Canada Department of Mines and Resources. Scale: 1:12,000 Soundings.

Canadian Hydrographic Service, 1964 (Corrected subsequently). Fraser River, North Arm. Marine Sciences Branch, Canada Department of Mines and Technical Surveys. Chart No. 3489 (1st Edition). Scale: 1:18,000.

Canadian Hydrographic Service, 1965 (Corrected subsequently). Fraser River, Sand Heads to Douglas Island. Marine Sciences Branch, Canada Department of Energy, Mines and Resources. Chart No.3488 (1st Edition). Scale: 1:25,000.

Canadian Hydrographic Service, 1971, Active Pass to Burrard Inlet. Canada, Department of Energy, Mines and Resources, Marine Sciences Branch. Chart No. 3480. Scale: 1:50,000. (also 1:30,000 field sheet (1968) manuscript). Shows the edge of the Fraser River delta.

Great Britain, Admiralty, 1860. Fraser River and Burrard Inlet. Hydrographic Office, London. Chart 145. Revised to 1922. (in Ricker and Maximuk, 1974).

Great Britain, Admiralty, 1872. Fraser R. to N.E. Pt. of Texada I. Hydrographic Office. Chart 579. London. Scale: 1:143,000. Scattered soundings up to E. ends of Western and Sea I. Some along Sturgeon Bank.

Great Britain, Admiralty, 1874. Fraser River and Burrard Inlet, Hydrographic Office. Chart 1922, London. Scale: 1:72,960. This is probably the 1860 charts referred to by Johnston (1921), p.40. Shows frequent soundings up to Laidlaw area.

Great Britain, Admiralty, 1900. Fraser R. to N.E. Pt. of Texada I. Hydrographic Office, Chart 579, London. Scale: 1:143,000. Shows soundings on Sturgeon Bank up to Westham I. (E. side). Large corrections to 1900.

Great Britain, Admiralty, 1913. Fraser River and Burrard Inlet. Hydrographic Office. Chart 1922, London. Scale: 1:72,960. Shows large corrections to 1906 edition. Frequent soundings to Laidlaw.

Great Britain, Admiralty, 1944. Juan de Fuca Strait to Strait of Georgia. Hydrographic Office. Chart No.2689, London. Scale: 1:145,800.
Note (1) First Edition Published in 1882.
(2) Soundings in Fraser Shown (in Fathoms)

Hydrographic Office, 1931, Fraser River and Burrard Inlet. U.S. Navy. United States Hydrographic Office, 1931, Fraser River and Burrard Inlet. U.S. Navy. Washington, D.C. Scale: 1:97,283.

Fraser R. soundings shown. Authorities cited:
a. British Admiralty. charts nos. 1922, 922.
b. U.S. Hydrographic Office charts nos. 1408, 1455, 1389.

Canada Department of Public Works Charts

CANADA, DEPARTMENT OF PUBLIC WORKS, 1952
Plans of the Fraser River, Barnston Island to Yale.
Scale 1 in. = 400ft., 20 sheets.
Contains very detailed soundings of the river.

CANADA, DEPARTMENT OF PUBLIC WORKS
Douglas Island to Mission, 1962
Scale 1:12,000. 4 sheets.
Contains detailed river soundings.

CANADA, DEPARTMENT OF PUBLIC WORKS
Douglas Island to Mission, 1964
Scale 1:12,000. 4 sheets.
Contains detailed river soundings.

CANADA, DEPARTMENT OF PUBLIC WORKS
Carey's Point Rosedale, 1964
Scale 1:6,000. 2 sheets.
Contains detailed river soundings.

CANADA, DEPARTMENT OF PUBLIC WORKS
Fraser River Soundings, Sandheads to Douglas Island. Vancouver, B.C.
Scale 1:12,000. 4 sheets.

Frequent soundings. Sheets as follows:

1. Sandheads to Steveston.
2. Steveston to Deas Island.
3. Deas Island to Annacis Island.
4. Annacis Island to Douglas Island.

Published annually since circa 1965. Charts since 1977 in metric at a scale of 1:12,500.

CANADA, DEPARTMENT OF PUBLIC WORKS, n.d.
North Arm of Fraser River showing established channel and ranges.
Scale: 1:12,000.

No soundings shown on this map.

Other Maps and Charts

Armstrong, J.E., 1980. Surficial Geology; New Westminster, Mission, Vancouver and Chilliwack. Geological Survey of Canada M2ps 1484A, 1485A, 1486A, and 1487A. Shows Fraser River floodplain deposits and other Pleistocene sediments. These maps supercede Maps 53-1959, 55-40 and 16-1957 which are now out of print.

ARROWSMITH, J., 1859, Plan of part of Fraser's River shewing the character of the ground from the entrance to the site of Old Fort Langley. in Papers Relative to the Affairs of British Columbia. Part II. London, Queen's Printer, p.94. Scale: 1 inch = 2 miles.

Shows 4 soundings at Robert's Bank. Shoals and delta front indicated.

ARROWSMITH, J., 1860, Map of a portion of British Columbia compiled from the surveys and explorations of The Royal Navy and Royal Engineers. in Further Papers Relative to the Affairs of British Columbia. Part II. London, Queen's Printer, p.78. Scale: 1 inch = 16 miles.

No soundings.

GEOLOGICAL SURVEY OF CANADA, 1923, Fraser River Delta, B.C. Geological Survey of Canada. Department of the Interior. Publ. No. 1933. Scale: 1:63,360.

Topographic Map.

GREAT BRITAIN ADMIRALTY, HYDROGRAPHIC OFFICE, 1858, Fraser River from a drawing by Mr. Emilius Simpson in H.B.C. Schooner Cadboro, 1827. Scale: unknown.

Shows numerous soundings up to Barnston Island. This must be chart referred to by Johnston (1921), p.40. (Available in U.B.C. Library Special Collections Map File in form of 5" x 7" negative)

Jones, R.K., 1977 (March) Surficial Materials of Southwestern Fraser Lowland Land Directorate, Fisheries and Environment Canada, Vancouver, B.C.

North, M.E., Dunn, M., Teversham, J., 1979. Vegetation of the Southwestern Fraser Lowland 1858-1880. Lands Directorate, Environment Canada, Vancouver, B.C.

Historical vegetation patterns were established primarily from Land surveyors notebook records. Marginal notes describe vegetation patterns, influences on vegetation prior to 1858 and soil characteristics.

ROYAL ENGINEERS, 1860, British Columbia: New Westminster to Lillooet. Scale: 1 inch = 10 miles.

No soundings.

Swan Wooster Ltd., 1967 (April). Roberts Bank and Sturgeon Bank Harbour Study: Topographic Maps. Scale 1:18,000. 2 foot contours. Prepared by Lockwood Survey Corporation, Vancouver. (Lockwood Survey Project 67-100. Sturgeon Bank and Roberts Bank Lines 1-5; 1:24,000, and Lines 6-32; 1:12,000). Prepared for the National Harbours Board of Canada, Vancouver.

THOMPSON, D., 1812, Columbia River. Scale: unknown.

Small scale map (U.B.C. Special Collections).

REPORTS
(annotated bibliography)

Reports (annotated bibliography)

ALLEN, J.R.L., 1973.
Phase Differences Between Bed Configuration and Flow in Natural Environments, and Their Geological Relevance. Sedimentology. 20; 323-329.

In nature where unsteady flows prevail, the characters of bed configurations lag, or differ in phase from, the flow conditions. This is demonstrated from quantitative data for dune beds in the Fraser River (Canada) and the Gironde Estuary (France), where the flow conditions change ahead of the bed form by as much as 1/4 period. The existence of lag appears to confuse attempts to establish from field data the relationships between bed-form properties and flow conditions and, at the same time, makes difficult the confident application to field situations of formulae based on steady-state experiments or theories.

AGES, A., 1979.
"The Salinity Intrusion in the Fraser River: Salinity, Temperature and Current Observations, 1976, 1977". Pacific Marine Science Report 79-14 Institute of Ocean Sciences, Patricia Bay 193p.

The salinity intrusion in the Main Arm of the Fraser River is examined by salinity and temperature measurements for a variety of discharges and tidal phases.

A detailed field study of the effect of the saltwedge upon the vertical distribution of flow is made by time series of salinities, temperatures and currents at selected points in the river.

The results are presented in tabular form and illustrated by contour charts and profile sketches.

AGES, A., WOOLLARD, A., 1978.
"The Tides in the Fraser Estuary", Pacific Marine Science Report 76-5, Institute of Ocean Sciences, Patricia Bay, Sidney, B.C., 100pp. (Unpublished Manuscript).

Results from a one-dimensional numerical model of the Fraser River estuary are presented. The model computes water surface elevations between the head of the tide water at Chilliwack and the mouth of the Fraser, including all four delta arms and Pitt Lake.

The report covers a description of the computation methods, the schematization of the river, field work to provide calibration data and an analysis of model errors.

ARMSTRONG, J.E., 1953.
Geology of Sand and Gravel Deposits in the Lower Fraser Valley. Canadian Mining and Metallurgical Bull., 46; 234-241.

The general geology and glacial history of the Lower Fraser Valley are reviewed. Locations and origins of sand and gravel deposits are discussed in some detail.

ARMSTRONG, J.E., 1956.
Mankato Drift in the Lower Fraser Valley of B.C. Geological Society of America, Bull., 67; 1666-1667.

From Abstracts of Papers submitted for the meeting in Minneapolis, Minn., Oct. 31-Nov. 2, 1956. Recent C-14 datings on wood obtained from the base of a till found in the upper part of the Lower Fraser Valley of British Columbia indicate an age of 11,300 ± 300 years suggesting that the last ice advance was during the Mankato subage. This ice sheet was not nearly so extensive as pre-Mankato ice sheets, and the author believes that Mankato glaciation in southwestern British Columbia consisted of valley glaciation only. The Mankato ice sheet advanced southwestward from the Coast and Cascade Mountains and approximately half this distance terminating a few miles south of the Canada-United States boundary. Evidence suggests that the Mankato valley glacier in its early advance stage was very similar to some of the present-day coastal glaciers in Alaska--that is, it terminated in the sea and deposited glaciomarine drift in front of and beneath the ice. During the initial advance of the ice the sea stood 600 feet or more higher than at present. As the land rose the glacier advanced and retreated across the glaciomarine drift depositing normal glacial deposits. In the final stage of retreat the Fraser River apparently was diverted from its channel 20 miles south of the boundary to its present channel.

ARMSTRONG, J.E., 1956.
Surficial Geology of Vancouver Area, B.C. Geological Survey of Canada, Paper 55-40; 16 pp. + map, scale 1:63,360.

This report deals with the geology of the surficial deposits, and to a much lesser extent the bedrock geology, of the Vancouver area, British Columbia. The general stratigraphic succession and geological history of the Pleistocene and Recent epochs are discussed briefly.

The geological boundaries on the map are mostly gradational and are accurate only within 1/4 mile. Furthermore, map units are to some extent generalized so that a pattern representing a certain type of deposit may contain small areas of another related type of deposit shown elsewhere by a different pattern. Not attempt has been made to study the detailed physical and chemical properties of the various materials discussed.

ARMSTRONG, J.E., 1957.
Surficial Geology of New Westminster Map-Area, B.C. Geological Survey of Canada, Paper 57-5; 25 pp. + map; scale 1:63,360.

This report deals with the geology of the surficial deposits of the New Westminster area, British Columbia. The general stratigraphic succession and geological history of the Pleistocene and Recent epoch are discussed briefly.

ARMSTRONG, J.E., 1960.
Surficial Geology of Sumas Map-Area, B.C. Geological Survey of Canada, Paper 59-9; 27 pp., + map; scale 1:63,360.

As previous reports.

ARMSTRONG, J.E., 1975.
"Quaternary Geology, Stratrigraphic Studies and Revaluation of Terrain Inventory Maps, Fraser Lowland, British Columbia", in Report of Activities Part A Geological Survey of Canada Paper 75-1A, pp. 377-380.

Investigations of the Quaternary geology of the Fraser Lowland were undertaken between 1948 and 1956 by Armstrong and four preliminary maps and three reports were published by the Geological Survey. Three of the preliminary map-sheets, namely Vancouver, New Westminster, and Sumas have been reprinted, however, all are now out of print. The fourth map-area, Chilliwack is still available. The aim of the project is to revaluate and update the previous work culminating in publication of final maps and reports.

ARMSTRONG, J.E., 1981.
Post-Vashon Wisconsin Glaciation, Fraser Lowland, British Columbia. Geological Survey of Canada, Bulletin 322, 34 p.

The late Wisconsin Fraser Glaciation commenced between 23,000 - 26,000 yr. B.P., reached its climax 15,000 - 15,500 yr. B.P. and terminated 11,000 yr. B.P. At its climax the ice thickness in the Fraser Lowland reached 1800m causing the area to be isostatically depressed at least 350m. From about 13,000 to 11,000 yr. B.P. most of the Fraser Lowland was invaded by the sea while the eastern part of the valley was occupied by a piedmont glacier. Throughout this period glaciomarine sediments comprising the Fort Langley and Capilano Formations were laid down. The final withdrawl of the sea coincided with a final surge of piedmont ice termed the Sumas stade. The ice apparently began to advance about 11,400 yr. B.P. and probably had disappeared 11,000 yr. ago.

Meltwater from the decaying Sumas Ice formed the ancestral valley now occupied by the Fraser River from Chilliwack to the Fraser Delta. From about 10,800 to 5,000 yr. B.P. sea level was up to 12m lower than at present, permitting Fraser River to establish itself in the old meltwater channel.

ARMSTRONG, J.E. and BROWN, W.L., 1953.
Ground Water Resources of Surrey Municipality, B.C. Geological Survey of Canada, Water Supply Paper 322.

This report deals with the ground-water conditions of Surrey Municipality in the province of British Columbia.

This survey has shown that large ground-water supplies are available in gravel and sand aquifers within 375 feet of the land surface. Although gravel and sand deposits at greater depth undoubtedly contain other ground-water reservoirs the information on them is so meagre that the are not dealt with.

ARMSTRONG, J.E. and BROWN, W.L., 1954.
Late Wisconsin Marine Drift and Associated Sediments of the Lower Fraser Valley, British Columbia, Canada. Geological Society of America, Bull., 65; 349-364.

During late Wisconsin time an assemblage of fossiliferous till-like stony clays and associated clays, silts sands, and gravels with an aggregate thickness of 500 feet was deposited in the Lower Fraser Valley of British Columbia. The authors believe these sediments were deposited in the sea during and following the wasting and retreat of a major Cordilleran ice sheet, and during subsequent uplift of the land above sea level. The agents of transportation probably were ice, including shelf-, berg-, and sea ice; glacial meltwater; and sea water. The writers believe the till-like stony clays called glacial till by previous workers, had more than one origin, as follows: (1) The stony clays are in part marine drift; that is, the stones and some of the finer materials were transported. These are (a) shelf-ice theory, (b) berg-ice theory, and (c) sea-ice theory. (2) The stony clays were in part deposited as a result of submarine erosion in the littoral and sub-littoral zones from the action of submarine slides or slopewash, sea currents, and turbidity currents on pre-existing sediments, mainly till and till-like mixtures, during uplift following maximum advance of the ice sheet. The authors have termed this the submarine slopewash theory. The marine drift and slopewash theories are combined in a composite theory which also explains the origin of the associated sediments.

ARMSTRONG, J.E., CRANDELL, D.R., EASTERBROOK, D.J., and NOBLE, J.B., 1965.
Late Pleistocene Stratigraphy and Chronology in Southwestern British Columbia and Northwestern Washington. Geological Society of America, Bull., 76; 321-330.

Six geologic-climate units are proposed for the late Pleistocene sequence in southwestern British Columbia and northern Washington. They include two major units, the Olympia Interglaciation and the Fraser Glaciation, and four subdivisions of the latter--the Evans Creek, Vashon, and Sumas Stades, and the Everson Interstade. The Olympia Interglaciation is a nonglacial episode that started at least 36,000 years B.P. and continued until the advance of Cordilleran glacier ice during the Fraser Glaciation. During the Evans Creek Stade, alpine glaciers formed in the mountains of western Washington and British Columbia while nonglacial sediments were still being deposited in the southern Puget Lowland. Further growth of glaciers in British Columbia resulted in the formation of the Cordilleran ice sheet. This ice entered the northern end of the area after 25,000 years B.P. but did not reach the southern end until after 15,000 years B.P. The Vashon Stade of the Fraser Glaciation began with this advance of Cordilleran ice into the lowlands. It ended with the beginning of marine and glaciomarine conditions there, which commenced in the southern Puget Lowland about 13,500 years B.P. and in the Strait of Georgia about 13,000 years B.P. The episode represented by the marine conditions is called the Everson Interstade and lasted about 2,000 years, during which the sea contained much floating ice. The Interstade ended when the land rose with respect to the sea level forcing withdrawal of the sea and the disappearance of floating ice in most of northwestern Washington and southwestern British Columbia; in the eastern part of the Fraser Lowland this event coincided with the advance of a valley glacier during the Sumas Stade.

ARMSTRONG, J.E. and HICOCK, S.R., 1975.
"Quaternary Landscapes: Present and Past - at Mary Hill, Coquitlam, British Columbia", in Report of Activities Geological Survey of Canada Paper 75-1B, pp.99-103.

The hills in the western half of the Fraser Lowland consist of unconsolidated deposits laid down during several major advances and retreats of continental glaciers and during several interglacial intervals. Five major Pleistocene formational units are exposed in the Fraser Lowland. No one stratigraphic section is found illustrating all these older units, since the hills in the western part of the Fraser Lowland are composite hills. Mary Hill is used as an example to illustrate the difficult task of interpreting the complex stratigraphic succession.

ARMSTRONG, J.E. and HICOCK, S.R., 1976.
"Quaternary Multiple Valley Development of the Lower Coquitlam Valley, Coquitlam, British Columbia." Geological Survey of Canada Paper 76-1B, pp.297-200.

The main purpose of this paper is to illustrate the complex geological makeup of the Quaternary sediment fills in glaciated bedrock valleys bordering the Fraser lowland. These sediments were deposited during several major glacial advances and retreats and during several nonglacial intervals. Each major ice advance and retreat was accompanied by eustatic and isostatic sea level changes. Thus, buried landscapes are common. Consequently, the unravelling of the stratographic succession becomes complex, especially as lithologic units of different chronologic ages may closely resemble one another and may be impossible to separate without absolute chronologic ages.

ASHLEY, G.M., 1977.
Sedimentology of a Freshwater Tidal System, Pitt River - Pitt Lake, British Columbia. Ph.d. Thesis, Department of Geology, University of British Columbia, Vancouver, B.C., 404 p.

In early post-glacial times the Pitt valley was occupied by a fiord. By 8,300 yr. B.P. the prograding Fraser River had sealed off Pitt Fiord from the sea. Tidal currents carried sediments from the Fraser River up Pitt River and built a tidal delta at the southern end of the Lake. By 4650 yr. B.P. the leading edge of the Pitt delta stood at least 20km north of the Fraser River. Since this time the delta has advanced a further 6km. Present day rates of advance are very low, probably a few centimetres per year.

Under present conditions stage levels can fluctuate as much as 1.2m in Pitt Lake over a tidal cycle. The effective discharge of the river is considered to be produced by winter flood tides. Calculations indicate that during flood tides the basal shear stress peaks earlier in the cycle and reaches high values than during the ebb. Therefore the net sediment transport is in an upstream direction. The upstream migration of sediment is indicated by the identical mineralogy of the Pitt and Fraser River sediments and the predominance of flood oriented bedforms. Three distinct scales of bedforms were identified in the channel and delta by means of repeat echo sounding and observations with side scan sonar.

ASHLEY, G.M., 1978.
"Bedforms in the Pitt River, British Columbia" in Fluvial Sedimentology, A.D. Miall (ed.), Canadian Society of Petroleum Geologists Memoir 5, pp.89-104.

The large-scale bedforms of the Pitt River are divided into different groups based on their three-dimensional geometry. These groups fall on a straight line on a log height-log spacing plot implying a common hydraulic control. Repeated depth soundings revealed reorganization of bedforms from one scale range to another, by halving or doubling. The size and morphology of bedforms appear to be independent of depth. Bedforms are flood-oriented, reflecting dominant flow conditions and direction of net sediment transport, and appear to be in quasi-equilibrium with tidal and seasonal flow variations.

ASHLEY, G.M., 1980.
"Channel Morphology and Sediment Movement in a Tidal River, Pitt River, B.C." Earth Surface Processes V.5, pp. 347-368.

Pitt Lake acts as a temporary reservoir for tidally diverted Fraser River flow. Stage level can fluctuate 2m in Pitt River and as much as 1.2m in Pitt Lake on a tidal cycle. Large tidal and seasonal variations in discharge occur. Calculations indicate that during the flood, basal shear stress peaks earlier in the cycle and reaches higher values than during the ebb. Thus, sediment moves farther forward on a flood flow than it moves back on the succeeding ebb. An upstream movement of sediment in Pitt River from the Fraser River is indicated by: (1) the identical mineralogy of the two rivers, (2) a decrease in median grain size from the Fraser to Pitt Lake, and (3) a predominance of flood-oriented bedforms in the river channel. A delta, 12km^2 area, has accumulated at the lower (draining) end of the lake.

Studies of the Pitt River channel reveal regular meanders and evenly spaced riffles and pools. Meander point bars are accreating on the "upstream" side indicating deposition by the flood-oriented flow. Large-scale bedforms were determined by echo soundings and side-scan sonar. Their occurrence by size appeared to be related to their position in the channel rather than the depth of flow.

ASHLEY, G.M., MORITZ, L.E., 1979.
"Determination of Lacustrine Sedimentation Rates by Radioactive Fallout (^{137}Cs), Pitt Lake, B.C. Canadian Journal of Earth Sciences, V.16, pp.965-970.

The stratigraphic record of ^{137}Cs activity levels found in Pitt Lake, B.C., mimics the radioactive fallout values for ^{137}Cs and ^{90}Sr recorded in milk from adjacent Fraser Valley. The Pitt Lake record closely parallels the fallout values obtained in England, Alabama and Lake Michigan. The presence of ^{137}Cs in Pitt Lake sediments is unequivocable evidence for modern (since 1952) clastic deposition. Calculated sedimentation rates as great as 1.8 cm year^{-1} were made using the ^{137}Cs technique. The rates have been steady for the last 25 years and the lake delta appears to be building out rather than up. Rythmic laminae are found on both delta and lake bottom and the laminae decrease in thickness away from the distributary channel. There is good agreement between the sedimentation rate estimated from the rythmic laminae and these values calculated by the cesium method.

BAINES, W.D., 1952 (January 22).
A Discussion of "Distribution of Sizes in River-Bed Sand Samples". Canada National Research Council. Fraser River Model Project. Rpt. HY-102.

BAINES, W.D., 1952.
Water Surface Elevations and Tidal Discharges in the Fraser River Estuary, January 23-24, 1952. Canada National Research Council. Fraser River Model Project. Report MH-32.

BAINES, W.D., 1952.
Survey of Tidal Effects on Flow in the Fraser River Estuary, June 10 and 11, 1952. Canada National Research Council. Fraser River Model Project. Report MH-40.

B.C. RESEARCH, 1976.
Analyses of Dredge Spoils, Fraser River, B.C. Project No.1739-2 (unpublished report to Public Works Canada).

Reports textural properties, organic content and heavy metal content of dredge spoil from the main channel between Steveston and Sandheads and the North Arm channel near the North Jetty.

BEAK CONSULTANTS LTD., 1981.
"Environmental Impact Study for Proposed Improvements to the Fraser River Shipping Channel - Overview Summary."

An environmental impact statement on the proposed improvements to the Fraser River Shipping Channel was prepared. Specific objectives were: description of the chief bio-physical systems of the lower Fraser River, description of the chief economic and social characteristics and recommendations on mitigation.

BENEDICT, A.H., HALL, K.J., and KOCH, F.A., 1973.
A Preliminary Water Quality Survey of the Lower Fraser River System. University of British Columbia, Westwater Research Centre, Tech. Rept. No.2; 49pp.

The data assembled and reviewed in this report provide an overview of existing water quality in the Lower Fraser River and its tributaries, based on available historical data and on the results of the preliminary sampling program which was conducted during the months of July and August, 1972. Comparison of this summer data with that from the historical review shows no significant difference for those parameters and reaches where comparative data were available. Results indicate that water quality in several of the tributaries is significantly lower than in the Lower Fraser itself.

BLENCH, T., 1952.
Hydraulic Solutions for Dredging Problems of the Lower Fraser River. Canada National Research Council. Fraser River Model Project Special Report No.6.

BLUNDEN, R.H., 1968.
Fraser Street Replacement Bridge: Note on Geology of the Site Area. CBA Engineering, Ltd. For British Columbia Department of Highways. 6pp. + Sections.

Interpretation based on 13 boreholes and published data. A section on the centerline of the bridge includes an estimated maximum depth of bed load movement on the river bed.

BLUNDEN, R.H., 1973.
Urban Geology of Richmond, British Columbia. University of British Columbia. Dept. of Geological Sciences. Rpt. No.15; 13pp. + map.

The Township of Richmond, British Columbia, has grown up on a series of islands in the Fraser River Delta. The area has been mapped and the sub-surface geology deduced from bore-hole records.

The surficial geology includes fluviatile, interdistributary swamp, salt marsh and tidal flat facies. Sub-surface geology includes river channel facies, tidal flat facies, shallow water deltaic and deep water pro-delta facies, over-lying Pleistocene deposits. Late Pleistocene deposits, correlated with the Gumboot Group of Vancouver, of believed Sumas age, are locally inset into Vashon tills and earlier materials.

The bed-rock basement appears to be of Oligocene and Miocene age at depths ranging from 700 to 900 feet below present sea-level.

The history of the delta development has been traced together with an assessment of the isostatic, eustatic and tectonic forces working upon the area. It is concluded that the Fraser River Delta became emergent about 8,000 years ago.

BOYLE, H.D., 1973.
The recent geology of Queensborough District, City of New Westminster, British Columbia. University of British Columbia. Department of Geology. B.A. Sc. Thesis. 36pp.

Subsurface conditions of the Queensborough district of New Westminster, at the east end of Lulu Island, are examined, using borehole logs. Isopach maps and cross-sections of the Holocene deposits are presented and interpreted in light of deltaic concepts.

BRADLEY, O.E., 1960.
Gravel Correlation of Foundation Material at the Proposed Port Mann Bridge Site, New Westminster, British Columbia. University of British Columbia, Dept. Geology, B.A. Sc. Thesis. 22pp.

Contains a cross section of Port Mann Bridge site showing sub-surface geology obtained from boring logs.

BRITISH COLUMBIA, DEPARTMENT OF LANDS AND FORESTS, 1953.
Report of the Lands Service, 1953, "Fraser River Basin Studies".

Review of Fraser River Basin damsites and suspended sediment transport surveys (cf. plate 9).

BRITISH COLUMBIA, DEPARTMENT OF LANDS AND FORESTS, 1954.
Report of the Lands Service, 1954.

Maps of diking (1949) and of recent erosion and bank stabilization works on the river. Text implies that measurements of bank erosion rates have been made (cf. plates 16-17).

BRITISH COLUMBIA ENERGY BOARD, 1972.

Report on Electric Energy Resources and Future Power Supply, British Columbia (1972-1990); pp.40-45.

A summary of detailed studies presented in 10 vols. Includes discussion of Fraser River Hydrology, Hydroelectric Power potential, and incidental consequences of dam construction on the river.

BRITISH COLUMBIA RESEARCH COUNCIL, 1951 (June 6).
Study of Tidal Effects in the North Arm of the Fraser River, April 23-24, 1951. Vancouver. 17pp. + maps, figs.

Short-term study of surface float and florescein dye movements in North Arm of Fraser River, as influenced by river and tidal currents. River discharge at Hope was 69,000 cfs. Contain maps, and estimated florescein dispersion formula. It appears from these data that North Arm is not completely flushed out in one tidal cycle.

BRITISH COLUMBIA RESEARCH COUNCIL, 1952 (April).
Water Quality in the Fraser-Thompson System of British Columbia. For the Dominion-Provincial Board, Fraser River Basin. Vancouver. 40pp. + tables.

Baseline data report covering the system upstream to Prince George and Kamloops. Discusses methods of analysis and presents data for inorganic and organic substances.

BRITISH COLUMBIA RESEARCH COUNCIL, 1971 (November 2).
Water Quality Survey of the Lower Fraser River. For British Columbia Energy Board. Vancouver, 17pp. + tables. Also in British Columbia Energy Board (1972) op.cit., vol.3, Appendix 1-A.

Data report on water quality of the Lower Fraser River (estuarine zone).

BRUCE, J.P., 1964.
Large Scale Atmospheric Circulations Affecting Floods on the Fraser River. Western Snow Conference, Nelson, B.C., April 1964. Proc., 44-51.

The study is concerned with atmospheric circulations leading to floods on the Fraser watershed. It is hoped that the results will point the way towards further research to make longer-range predictions possible.

BYRNE, P.M., 1978.
"An Evaluation of the Liquefaction Potential of the Fraser Delta Canadian Geotechnical Journal V.15, No.1, pp.32-46.

The Fraser Delta lies within the highest earth-quake risk zone in Canada. It is underlain by deep deposits of loose to medium dense sands and soft silts. Similar alluvial and deltaic sand deposits have liquefied when subjected to strong ground shaking and caused severe damage to structures founded upon them.

Empirical methods for evaluating liquefaction potential predict that liquefaction of the Fraser Delta Sands could occur in the depth range of 9.1 - 21.3m. Analytical methods predict that liquefaction could occur in the depth range 6 - 15m for an earthquake having a maximum ground surface acceleration of 0.12g. These conclusions are based on an average blow count value of 20 for the sands and the assumption that the silts are at least as earthquake resistant as the sands.

CAMSELL, C., 1913.
Coast Range (Lytton to Vancouver) Geological Survey of Canada, International Geological Congress, Toronto, Guidebook No.8, Part 2, 256-274.

Comments on the tertiary history of Fraser River, with special reference to Fraser Canyon and the Delta. Nothing on modern deposits.

CANADA DEPARTMENT OF ENERGY, MINES AND RESOURCES, INLAND WATERS BRANCH, 1969 (June).
Flood frequencies of the Lower Fraser River. For Fraser River Joint Program Committee. Engineering Division, Pacific Region.

Derives flood-frequency curves using maximum likelihood method and recommends use of this technique over conventional plotting techniques - in part because of the possibility to get confidence limits on estimates.

CANADA DEPARTMENT OF ENERGY, MINES AND RESOURCES, INLAND WATERS BRANCH, 1969 (December).
Supplementary Report on Flood Frequencies of the Lower Fraser River. For Fraser River Joint Program Committee. Engineering Divison, Pacific Region. 5pp. + figs.

Compares flood frequencies for several stations on the lower Fraser River by log-Pearson Type III and Maximum-Likelihood methods.

CANADIAN HYDROGRAPHIC SERVICE.
British Columbia Pilot. volume 1. Southern portion of the coast of British Columbia. Marine Sciences Branch, Canada Department of Mines and Technical Surveys, Ottawa. Various Editions. (7th; 1965; Supplement No.5, 1971).

CANADIAN HYDROGRAPHIC SERVICE, 1973.
Sailing Directions: British Columbia Coast (south portion). Volume 1. Marine Sciences Directorate, Canada Department of the Environment, Victoria, British Columbia. (8th Edition: Supercedes British Columbia Pilot; 7th Ed.).

Contains section on Fraser River to Mission City. Gives channel directions and clearances, dock allowances and general information. Latest edition gives detailed information only to Douglas Island.

CBA ENGINEERING LTD., 1958 (October).
An Introductory Study for the Development of the Tidal Sections of the Fraser River. For the New Westminster Harbour Commissioners. Vancouver. 144 pp. + Appendices + figs.

Appendix I: River Sediment (7 pp. + calculation sheets). Detailed consideration of sediment transport in the deltaic zone on the basis of data to that time. Includes calculations of sediment transport based on the Einstein formula. Contains several foldout maps showing soundings from the river mouth to Port Mann (including an 1827 Admiralty chart, poorly reproduced.

CBA ENGINEERING LTD., 1973.
"Project No. 7, District of Mission, Soil Investigation - Dyke Project" Report 7313.

The investigation ascertains the extent and composition of the existing buried dyke section located from Home Avenue east to Canadian Pacific Railway in Mission. While this work was in progress, opportunity was also taken to obtain additional soil information at several locations of interest along the existing dyke alignment.

CBA ENGINEERING LTD., 1980. Annacis Island Crossing, Report on Preliminary Soil Investigations.

Contains borehole data from the Annacis Channel and Annieville Channel near St. Mungo bend.

CBA ENGINEERING LTD., 1980
"Flood and Erosion Protection Study of Lower Fraser Valley Indian Lands" Report No. 7912, for Dept. of Indian & Northern Affairs.

This study is primarily an inventory of the existing protective works, rates of bank erosion, frequency of flooding, present land use and agricultural capability of the Indian Lands.

CHANG, P., POND, S., TABATA, S., 1976.
"Subsurface Currents in the Strait of Georgia, West of Sturgeon Bank". Fisheries Research Board of Canada Journal. V. 33. No. 10, pp. 2218-2241.

Spectral characteristics of subsurface currents and temperature records spanning 310-533 days from the Strait of Georgia near Sturgeon Bank are examined. Of particular interest are low-frequency fluctuations having a characteristic period of 30 days. Typically, the energy of the low-frequency and tidal currents are equal at 50 m (each about 40% of the total) and 10 and 70%, respectively at 200 m.

Low-frequency currents are observed to be baroclinic and possess a lateral length scale < 10 km. Their generation mechanisms are not identified. Low-frequency fluctuations in sea level and current have poor-to-fair coherence, while those in air pressure and current have poor coherence.

Fluctuations in water temperature have a characteristic period of 300 days. Water temperature and current have poor coherence.

Tidal currents are found to be ellipses, with their magnitude, shape and orientation time-dependent. Internal tides are suggested as an explanation.

CLAGUE, J.J., 1975.
"Late Quaternary Sea Level Fluctuations, Pacific Coast of Canada and Adjacent Areas." Report of Activities part C. Geological Survey of Canada. Paper 75-1C, pp. 17-21.

This report is a summary of published accounts of former land-sea relationships in British Columbia and adjacent parts of the state of Washington.

CLAGUE, J.J., ARMSTRONG, J., MATHEWS, W.H., 1980.
Advance of the Late Wisconsin Cordilleran Ice Sheet in Southern British Columbia Since 22000 yr B.P. Quaternary Research, 13, p. 322-326.

Documents the chronology of the growth and climax of the Fraser Glaciation in the greater Vancouver area.

CLAGUE, J. and BORNHOLD, B., 1980.
Morphology and Littoral Processes of the Pacific Coast of Canada. in The Coastline of Canada, S.B. McCann (ed.), Geological Survey of Canada, Paper 80-10, p. 339-380.

Provides a brief summary of past studies on the delta of the Fraser River (p. 360-362).

CLAGUE, J., HARPER, J., HEBDA, R., HOWES, D., 1982.
Late Quaternary Sea Level and Crustal Movements, Coastal British Columbia. Canadian Journal of Earth Science, 19, 597-618.

During the initial deglaciation of the Fraser Lowland 13000 years B.P. sea level was about 200 km higher than at present. Subsequent isostatic rebound caused rapid emergence until by 8000 years ago B.P. sea level was about 12 km lower than at present. The main evidence for a lower sea level at this time is the widespread occurrence of terrestrial organic sediments beneath the floodplain of the Fraser River. Five radiocarbon dates on peat at el. -10 m to -11 m range from 7300 ± 120 to 8360 ± 170 years B.P. A rise in sea level beginning about 7000-7500 years ago triggered aggradation on the Fraser River and probably caused a marine incursion up to the vicinity of Pitt Meadows. The relatively rapid rise in sea level continued until about 5000-5500 years ago. At that time the floodplain level became stable again which allowed organic sediments to accumulate in bogs bordering the river. It was suggested that sea level had risen to within 2 m of its present position before about 5000 years ago.

CLAGUE, J.J., LUTERNAUER, J.L., 1982.
"Late Quaternary Sedimentary Environments, Southwestern British Columbia." Excursion 30A: Field Excursion Guide Book, International Association of Sedimentologists. Eleventh International Congress on Sedimentology, McMaster University, Hamilton, Ontario, 167 pp.

Provides a general history of the Lower Fraser Valley and Fraser Delta. Includes summary descriptions of field trips to Burns Bog, Iona Island Causeway, and Roberts Bank.

CLAGUE, J.J., LUTERNAUER, J.L., HEBDA, R.J., 1983.
Sedimentary Environments and Post-Glacial History of the Fraser Delta and Lower Fraser Valley, British Columbia. Canadian Journal of Earth Sciences, 20, p. 1314-1326.

This report summarizes the early history of the Lower Fraser River and its delta in Holocene times. Following deglaciation the Fraser River extended westwards down a glacially scoured trough east of New Westminster. About 10,000 years ago the mouth of the river terminated at New Westminster. A delta was constructed south and west of this site as the sea dropped below its present level relative to the land. Delta progradation continued after sea level stabilized at about -12 m after 8000 years B.P. A marine transgression between 7500 and 5000 years ago temporarily inhibited its seawards advance. This transgression ended with the sea 1-2 m below its present position whereupon large areas became emergent and large bogs began to form.

CLARK, E.M., 1963.
"Lower Fraser Valley Dyke Studies - Drilling Program September 1962 to April 1963". Water Resources Branch, Dept. of Northern Affairs and National Resources.

The Fraser River Board authorized a subsurface exploration program to determine the ability of dykes in the Lower Fraser Valley to withstand high water levels. An outline of the equipment and methods used, of the work completed and of the costs which were incurred is provided.

CLARK, E.M., 1965 (March).
1964, 1948 and 1894 High-Water Profiles for the Lower Fraser Valley. Canada Department of Northern Affairs and National Resources. Water Resources Branch. Vancouver. 15 pp. + maps.

High water profiles from Sandheads to Mile 89.1 (Cheam View). 1964 data are based on 14 regular continuous-stage recorders and 43 staff gauges. Includes computed rating curves for main stations along the river.

COOK, P.M., 1967.
Preliminary Soil Report: Sturgeon and Roberts Banks. Prepared for Swan Wooster Engineering Ltd., in Association with Engineering Drillers, Ltd., Vancouver, British Columbia. 10 pp. + data appendices.

Reports results of preliminary soil mechanical investigations of Roberts and Sturgeon Banks. Thirty-five holes were drilled to ca. 70 feet, with four of them continued to ca. 450 feet. Samples were taken at 5 foot intervals. Sand/silt break and mechanical properties are given, with some complete size analyses. Results are keyed to Swan Wooster (1967).

COOK, P.M., 1968.
Soil and Foundation Report. Roberts Bank Development. Prepared for Swan Wooster Engineering, Ltd., in Association with Engineering Drillers, Ltd., Vancouver, British Columbia. 7 pp. + data appendices.

Reports results of nine holes at Roberts Bank port site, two of them drilled to 200 feet ±, the remainder to 100 feet ±. Sand/silt break was logged at 5 foot intervals for the first 80 feet and 14 samples were completely analysed. Additional soil mechanical data is given. Results are keyed to Swan Wooster (1968).

COOK, PICKERING and DOYLE LTD., 1970.
"Report on Soil Conditions, East Chilliwack Dykes."

The results of embankment and foundation testing are given. This work is more detailed than a previous study by Ripley, Klohn & Leonoff. Includes floodplain borehole data.

DAWSON, G.M., 1879.
Report on Exploration in the Southern Portion of British Columbia. Geological Survey of Canada, Rept. of Progress, 1877-78, Part B; 1-173.

pp. 8 and 9. contain comments of historical interest.

DEMLOW, T.C., TAMBURI, A.J., 1979.
"An Analysis of the Impact of the McGregor River Diversion on the Deep Draft Navigation Channel of the Lower Fraser River." Fourth National Hydrotechnical Conference. The Canadian Society for Civil Engineering, Vancouver, B.C., V. 1, pp. 295-305.

The effect of a diversion of the McGregor River on a proposed 40 ft draft navigation channel in the Fraser River from Sandheads to New Westminster was studied using regime relations. Bivariate and multivariate regime equations for mean and maximum depth were developed using simple and step-wise regression analysis. The regime equations were then used to determine the effect of the diversion on mean and maximum depths.

DUTFIELD, D.O., 1969.
Report of Survey of Canoe Passage Channel, Canada Ministry of Transport, Marine Service, Coast Guard Hovercraft Base. File No. 9151-5: 2 pp. + chart overlay (for chart 3450).

Reports soundings for May 5, 1969 in Canoe Passage. Siltation at the mouth of the passage has reduced depths to ca. 1 ft. in this year. It is concluded that there are considerable channel changes from year to year.

EASTERBROOK, D.J., 1963.
Late Pleistocene Glacial Events and Relative Sea Level Changes in the Northern Puget Lowlands, Washington. Geological Society of America, Bull. 74; 1465-1484.

During the late Pleistocene the Vashon glacier, a lobe of Cordilleran ice which at its maximum was 5300-7000 feet thick in northern Washington, occupied most of the Puget Lowland. During a late stage in the recession of the glacier when the ice was no more than a few hundred feet thick marine waters entered the area, floating the ice. Organisms living on the sea floor were incorporated in glaciomarine drift deposited beneath the floating ice. Radiocarbon dates from shells in the drift indicate an age of 11,660 ± 350 years (W-996).

Several hundred feet of emergence followed, during which fluvial and lacustrine sediments were deposited. A radiocarbon date from wood at the base of these sediments indicates deposition had begun by 11,640 ± 275 years ago (W-940).

A readvance of ice into northern Washington from British Columbia coincided with submergence of the lowland. Marine water and floating ice again covered the area depositing a second glaciomarine drift in places now at least 400 feet, and perhaps as high as 600 feet above sea level. Radiocarbon dates of 11,800 ± 400 (I-1037) and 10,370 ± 300 (I-1035) were obtained from wood in the deposits of two localities.

Emergence and deposition of till and outwash occurred near the Canadian border about 11,000 years ago.

Radiocarbon dates and stratigraphic relationships suggest that 350 feet of emergence, 500-700 feet of submergence, and emergence of 500-700 feet occurred in a period of only 1000-2000 years. These changes in relative sea level during such a short period may have resulted from a combination of two opposed tendencies, isostatic uplift of the land due to glacial unloading, and eustatic rise of sea level, superimposed on tectonic movement.

EASTERBROOK, D.J, 1966.
Radiocarbon Chronology of Late Pleistocene Deposits in Northwest Washington. Science, 152; 764-767.

Fourteen radiocarbon dates of shells and wood from late Pleistocene sediments in northwest Washington provide evidence for correlation of the Everson interstadial with the Two Creeks interval of the midcontinent and suggest possible correlations between the Sumas and Valders stadials and between the Vashon stadial and part of the Tazewell-Cary advances.

EASTERBROOK, D.J., 1969.
Pleistocene Chronology of the Puget Lowland and San Juan Islands, Washington. Geological Society of America, Bull., 80; 2273-2286.

The Puget Lowland and San Juan Islands, lying in the Puget Trough between the Cascade Range and the Olympic Mountains, were in the path of Pleistocene ice sheets which flowed southward from Canada.

Floodplain, silt, sand, and peat of the Whidbey Formation were deposited prior to 40,000 years ago during an interglaciation believed to be equivalent to the Puyallup and Sangamon Interglaciations. Possession Drift, which overlies sediments of the Whidbey Formation, is radiocarbon dated at 34,000 + 3000, - 2000 years B.P. in its upper part and is limited by a radiocarbon age of 39,900 in its lower part.

Peat lying on Possession Drift yielded radiocarbon dates between 27,200 + 1000, - 900 and 22,700 ± 550, representing the Olympia Interglaciation.

Esperance Sand, deposited by meltwater streams in front of advancing ice during the Fraser Glaciation and subsequently overridden during the Vashon Stade, was radiocarbon dated at 18,000 ± 400 years. During deglaciation, the ice sheet thinned until it floated in marine water and poorly sorted, fossiliferous glaciomarine drift was deposited in the Everson Interstade. Shell-bearing sediment at altitudes up to 400 feet above present sea level and unfossiliferous glaciomarine drift up to 600 feet indicate that relative sea level at that time was 500 to 700 feet higher. Eighteen radiocarbon dates from marine shells in Everson glaciomarine drift vary from 10,370 ± 300 to 13,010 ± 170 years. The Everson Interstade ended with lowering of relative sea level to approximately its present position and the disappearance of floating ice. The following Sumas Stade ended shortly before 9,920 ± 760 years ago.

ELLIOT, T.C. (ed.), 1912.
Journal of John Wonk, November and December 1824, Washington Historical Quarterly , Vol. 3, No. 3, pp. 198-228.

The objective of this journey was to obtain all possible information as to an outlet to the Coast by way of Fraser river or any other stream of New Caledonia; and to explore the interior.

A narrative account of the journey is given, including descriptions of the prevailing weather and to a limited extent the local hydrology.

ENGEL, P., WIEBE, K., 1979.
A Hydrographic Method for Bedload Measurement. Fourth National Hydrotechnical Conference. The Canadian Society for Civil Engineering, Vancouver, B.C., pp. 98-112.

This report describes a method of measuring bedload by tracking the progression of bedforms in sand-bed rivers. The method has been demonstrated in laboratory flumes. Attempts to use the method on the Fraser River at Mission proved less successful partly because of the relatively low flows that were experienced during the measurement period. However the approach appears to be very promising under higher flow conditions when the bed is active and large dunes have developed.

ENVIROCON LTD., 1976.
"Environmental Overview: Assessment and Guidelines, Lower Fraser River Channel Training Program."

This overview develops guidelines for a detailed study to assess the environmental effects of a proposed channel-training program.

ENVIROCON LTD., 1980.
"Fraser River Estuary Habitat Development Program - Criteria Summary Report" for Public Works Canada.

The objective of this Habitat Development Program was to develop and use, criteria for the selection and construction of fish and wildlife (wetland) habitat in the Fraser River estuary using dredge spoil as a substate. Ten potential sites and three species of tidal macrophytes were selected for investigation.

ESLER, J.A., 1949.
The Character of the Fraser Valley Flood Sediments. University of British Columbia, Department of Agronomy Soils Division, B.S.A. Thesis.

Reports grain size and some chemical analyses of six samples of overbank sand deposits of the 1948 Fraser River flood.

E.V.S. Consultants Ltd., 1982.
"Environmental Evaluation of the Tsawwassen Salt Marsh in Relation to Flood Control Dyking."

The study attempts to delineate whether discernible successional changes had occurred in the floral community of the Tsawwassen salt marsh since 1975 and to provide preliminary data related to fish utilization.

FEDERAL-PROVINCIAL COMMITTEE ON LOWER FRASER VALLEY DYKE RECONSTRUCTION, 1966 (October).
Report on Lower Fraser Valley Dyke Reconstruction, Drainage Improvement and River Bank Stabilization. Published by British Columbia, Department of Lands, Forests and Water Resources. Water Resources Service, Water Investigations Branch, 11 pp.

Map shows areas requiring new or improved bank protection (1966).

FEELY, R.A., LAMB, M.F., 1979.
A Study of the Dispersal of Suspended Sediment from the Fraser and Skagit River into Northern Puget Sound Using Landsat Imagery. Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration, Seattle, Washington, 42 p.

Landsat images obtained between 1972 and 1978 were utilized to study the surface trajectories of sediments plumes from the Fraser River. A multiple regression analysis was used to evaluate the relation between image radiance and suspended sediment concentration in the plumes.

FISHERIES SERVICE, PACIFIC REGION 1973-1975.
"Fraser River Dredging Guide (Mouth of Fraser River to Ruby Ck.)"

The Fraser River Dredging Guide has been prepared as a guideline for the scheduling of dredge operations in a manner which will minimize conflict with the fisheries resource. Included in the guide are outlines of fisheries problems associated with dredge operations, background data and dates of adult and juvenile anadromous fish migrations, general dredging restrictions and specific sections of the Fisheries Act and Regulations.

FRASER RIVER MODEL PROJECT.
This project consisted of a scale model of the estuarine zone of Fraser River, and operated at the University of British Columbia from 1949 to 1961, under the direction of Professor E.S. Pretious, Department of Civil Engineering. The project was initiated under the auspices of the National Research Council of Canada, and was supported by Canada Department of Public Works after 1953. In addition to basic studies of stream flow and sediment transport in the estuarine zone, which are listed in this report, many special studies of flow and siltation problems at specific sites and of proposed engineering works were carried out. A list of all reports and memoranda issued by the project office is given by Pretious (1961) (Bibliographic references).

References in this list are given under the present heading and also under the following individual authors: Baines, W.D., Blench, T., Jalan, G.E., Parkinson, W. and Pretious, E.S.

FRASER RIVER MODEL PROJECT OFFICE, 1949 (July 11).
Preliminary Laboratory Experiments on Sediment Movement in University of British Columbia, Fraser River Model Progress Reports. U.B.C. - 2 (3).

FRASER RIVER MODEL PROJECT OFFICE, 1950 (September).
Supplementary Report No. 1 to Memorandum Re Special Observations 1950 Freshnet. Canada. National Research Council. Fraser River Model Project. Tech. Note No. 7. (see Pretious and Blench, 1950).

FRASER RIVER MODEL PROJECT OFFICE, 1950-51.
Memorandum Report on Flume Studies and Bed Movement of Fraser River Sand (November, 1950) with Supplement (To February, 1951). Canada. National Research Council. Fraser River Model Project. Tech. Note No. 9.

FRASER RIVER MODEL PROJECT OFFICE, 1951 (February).
Memorandum to Supplementary Report No. 1, Special Observations 1950 Freshnet. Canada. National Research Council. Fraser River Model Project. Tech. Note No. 17.

FRASER RIVER MODEL PROJECT OFFICE, 1951.
Note on Bed Load for Fraser River Model. Canada. National Research Council. Fraser River Model Project. Tech. Note No. 23.

FRASER RIVER MODEL PROJECT OFFICE, 1953 (May).
A Detailed Report on the Controls and Indicators of the Fraser River Model. National Research Council of Canada. Report MH-41.

FRASER RIVER MODEL PROJECT OFFICE, 1959 (January 20).
Results of Preliminary Bed-Movement and Discharge-Distribution Tests (in the New Westminster Trifurcation area). Canada. Dept. Public Works. Fraser River Model Project. Memorandum.

FRASER RIVER BOARD, 1958.
Preliminary Report on Flood Control and Hydro-Electric Power in the Fraser River Basin. Victoria, B.C., 171 pp. + Appendices (in separate volumes), 77 pp. + maps, figures.

Contains hydro meteorological data and profiles of sections of Fraser River. Note that this Board and its predecessor (The Dominion-Provincial Board, Fraser River Basin) published Reports of Progress and Interim Reports back to 1949. These are not separately listed.

FRASER RIVER BOARD, 1963.
Final Report on Flood Control and Hydro-Electric Power in the Fraser River Basin. Victoria, B.C., Queen's Printer, 106 pp.

FULTON, R.J., 1971.
Radiocarbon Geochronology of Southern B.C., Geological Survey of Canada, Paper 71-37; 28 pp.

The radiocarbon-dated Quaternary history of southern British Columbia extends over the past 52,000 years. This interval has been subdivided into 3 major geologic-climate units: Olympia Interglaciation, Fraser Glaciation, and Postglacial.

In southern British Columbia the Olympia Interglaciation began more than 52,000 years ago and ended about 19,000 years B.P. Meagre information available from the west coast suggests that the climate during this period was cool and damp but probably not too different from present. Bison and Equus bones collected from deposits of this age in the interior of British Columbia indicate that the climate was such that it could support large herbivorous animals. The Olympia Interglaciation sedimentary framework, the processes active and the deposits formed, were similar to those of the same area at present. Three major depositional cycles have been recognized: (1) an early period of deposition at base levels higher than present, (2) a period of low base levels, and (3) a late episode of deposition at base levels above those of present day.

Fraser Glaciation ice did not occupy the lowlands of southern British Columbia until later than 19,000 years ago, but probably began to build up in the mountainous areas before that time. Parts of the west coast were ice free about 13,000 years ago and all of southern British Columbia was probably as free of ice as at present by 10,000 years B.P.

From the time of deglaciation to about 8,000 years ago, isostatic movements tended to control local sea level and to mask eustatic changes. The apparent sea levels were high, due to isostatic depression at the time of Fraser deglaciation. Isostatic adjustments caused local sea levels to fall during deglaciation, rise again about 11,000 years ago and fall below the present level about 8,000 years B.P. At that time, it appears that approximate isostatic equilibrium was achieved and the later sea level history is largely one of changes in response to worldwide eustatic fluctuations.

The Postglacial record of southern British Columbia includes four dated ash falls: (1) Mazama, about 6,600 years B.P., (2) St. Helens Y, about 3,300 years B.P., (3) Bridge River, about 2,400 years B.P., and (4) St. Helens W (?), later than 1,200 years B.P. The climate was cold 12,000 years ago, but it warmed sufficiently to be similar to the present when most of southern British Columbia was deglaciated. A thermal maximum about 6,000 years ago was followed by a cooler period which persisted until present. Glacial advances took place 3,000 to 2,500 years ago and in the past few centuries. During this most recent advance, the alpine glaciers of southern British Columbia were more extensive than at any time since the end of Fraser Glaciation about 10,000 years ago.

GARRISON, R.E, and LUTERNAUER, J.L., 1969.
Texture of calcitic cements formed during early diagenesis Fraser River delta, British Columbia. Bermuda Biological Station for Research, St. George's West, Bermuda. Special Publication No. 3; 106-109 (also in Bricker, O.P. (editor), 1970, Carbonate Cements. Johns Hopkins University, Studies in Geology. No. 19. Johns Hopkins University Press, Baltimore, 151-154.

Platy to irregular bodies of cemented sediment are frequently encountered during dredging on shallow marine bottoms flanking the Fraser River delta and in estuarine distributary channels. Discussion is given of a possible sequence of cementation.

GARRISON, R.E, LUTERNAUER, J.L., GRILL, E.V., MACDONALD, R.D. AND MURRAY, J.W., 1969.

Early Diagenetic Cementation of Recent Sands, Fraser River Delta, British Columbia. Sedimentology, 12, 27-46.

Modern terrigenous sediments cemented by low-magnesium calcite are found in distributary channels and adjacent shallow-water marine localities at the front of the Fraser River delta. These permanently submerged areas are usually covered by sea water, including sea water intruded upstream along bottoms of river channels. The cemented sediments occur as irregular to platy nodular masses at or near to sediment-water interface, where they are frequently encountered during dredging. The cement consists of small crystals arranged in fibrous rims and other aggregates around and between sand grains. Processes leading to cementation are not yet known, but may include dissolution of calcareous shells by pore waters in buried sediments, followed by precipitation of calcite at higher levels from these fluids as they are expelled upward during compaction.

GASPARD, J.F., 1979.
"Beach Erosion Immediately South of the Tsawwassen Causeway, Vancouver, British Columbia." B.A. Sc. Thesis, Geological Engineering, University of British Columbia, 116 pp.

Recession of the Tsawwassen foreshore has been observed by residents over the past decade. This paper examines the mechanics of erosion and analyzes the prevailing littoral drift regime: It was proposed that the foreshore may be considered as a closed system with no sources of sediment replenishment. Methods of beach stabilizlation are evaluated.

GELLNER, J. (ed.), 1966.
Cheadle's Journal. The Account of the First Journey across Canada undertaken for pleasure only, by Dr. Cheadle and Lord Melton, 1862/1863. Baxter Publishing, Toronto. 228 Bloor St. West.

A brief description of the Lower Fraser River from Lytton to New Westminster.

GIBBARD, J.E., 1937.
Early History of the Fraser Valley 1808-1885. M.A.Thesis, University of British Columbia, 308 pp.

This thesis provides a map of the Fraser Valley prior to 1885. A general description of the land and its people is followed by a discussion of the initial exploration of the area, the fur trade, the gold rush, and an exhaustive account of the pioneer agricultural communities. An extensive reference section, showing early sources, is also included.

GLASS, D.J. (editor), 1972.
Quaternary Geology of the Southern Canadian Cordillera. 24th International Geological Congress, Montreal. Field Excursion A02, Guidebook. 49 pp.

Gives a quantitative description of the Fraser Delta. Gives several dates on the deposits (pp. 5-6). Information on radio-carbon dates along Fraser Valley below Yale, and descriptions of the deposits are given (pp. 14-19).

GOLDER, BRAWNER AND ASSOCIATES, LTD., 1967.
Soil Investigation. Proposed Marine Facilities, Boundary Bay, British Columbia. Prepared for Swan Wooster Engineering, Ltd., Vancouver, British Columbia.

Reports results of six test holes drilled in Boundary Bay, to depths between 70 feet and 350 feet. Soil mechanical results are reported, incorporating earlier data as well. Results are keyed to Swan Wooster (1967).

GOLDER, BRAWNER AND ASSOCIATES, 1970.
"Dyke Investigation - Mission and Silverdale Dyking Districts" for Fraser River Joint Program Committee.

The results of a study on dykes in the Mission and Silverdale Dyking Districts are reported. The purpose of the study was to review all available data, determine the soil conditions at the dykes and the stability of the dykes. Floodplain borehole data are included in the report.

GOLDER ASSOCIATES, 1979.
"Stability Study, Fraser River, North River Bank, Haney to Port Hammond, B.C." for Ministry of Environment.

The report contains a description and findings of site investigation work and engineering analysis of the Fraser River North Bank between Haney and Port Hammond. Sections on general soil conditions, groundwater conditions, historical landslide activity and river bank erosion are included.

GOLDER ASSOCIATES, March, 1982.
Geotechnical Investigation, Annacis Island Bridge.

Contains very extensive records from boreholes in the Annieville Channel between St. Mungo and Annacis Island.

GRIEVE, D.A., 1977.
"Behaviour of Some Trace Metals in Sediments of the Fraser River Delta Front, Southwestern British Columbia" M.Sc. Thesis, Dept. of Geological Sciences, University of British Columbia, 133 pp.

The overall purpose of this study was to determine factors governing content and distribution of Co, Cu, Fe, Mn, Ni, Pb, and Zn in the surficial sediments of the Fraser River's active delta front. Factors influencing metal profiles in subsurface sediments are discussed. Measurements of dissolved and suspended particulate trace metals in the estuarine portion of the Fraser River are also described.

GRIEVE, D. and FLETCHER, K., 1975.
"Trace Metals in Fraser Delta Sediments", in Report of Activities Part B, Geological Survey of Canada Paper 75-1B, pp. 161-163.

Distribution of Co, Cu, Fe, Mn, Ni, Pb, and Zn have been determined for surficial sediments of the Fraser River Delta tidal flats and upper foreslope. The study is intended to provide geochemical maps and baseline data on factors influencing metal dispersion in the delta.

GRIEVE, D.A. and FLETCHER, W.K., 1976.
"Heavy Metals in Deltaic Sediments of the Fraser River, British Columbia" Canadian Journal of Earth Sciences, V. 13, No. 12, pp. 1683-1693.

Co, Cu, Fe, Mn, Ni, Pb and Zn, together with sand content and loss of ignition, have been determined for surficial sediments from the Fraser River delta front and upper foreslope. Both geochemical maps and statistical analysis disclose close relationships between trace-metal concentrations, sediment texture, and Fe and Mn content. Detailed studies of the distribution of labile and non-labile trace metals within sediments indicate that these relationships reflect increased concentrations of trace metals associated with both the detrital minerals and hydrous Fe oxides coatings in the finer fractions of the sediment. Abnormally high concentrations of labile trace metals are found on the tidal flats at two stations influenced by discharge of metal-rich sewage.

GRIEVE, D.A. and FLETCHER, W.K., 1976.
Interactions Between Zinc and Suspended Sediments in the Fraser River Estuary, British Columbia. Estuarine and Coastal Marine Science, Vol. 5, No. 3, pp. 415-419.

Behaviour of Zn has been studied in the Fraser River estuary. Increases in dissolved and suspended Zn in the mixing zone between fresh and brackish waters demonstrate the importance of both absorption and description phenomena in estuarine waters. Together with estuarine circulation these processes provide a mechanism for retention of heavy metals in coastal zone sediments and waters.

HAGGEN, E.A., 1918.
Petroleum in the Fraser Valley: Mining and Engineering Record, Vol. 23, pp. 40-43, 1918.

An account of the exploration for oil and natural gas in the Fraser Lowland. Some account is given of the oil seepage and borehole data.

HAGGEN, E.A., 1921.
Oil development in the Fraser River Delta. Mining and Engineering Record, Vol. 26, pp. 170-1, 193, 235.

A review at the attempts to discover economically viable amounts of oil. At Pitt Meadows a fine showing of gas was struck and in Burnaby oil was discovered in peat bogs. Some geological descriptions are included.

HALSTEAD, E.C., 1957.
Ground-Water Resources of Langley Municipality, B.C. Geological Survey of Canada, Water Supply Paper 327, 47 pp.

This report deals with ground-water conditions of Langley municipality in the province of British Columbia.

This survey has shown that gravel and sand aquifers deposited as outwash plains at or near the surface will yield large supplies of free ground water. Confined artesian water is available in aquifers of sand and gravel within 300 feet of the land surface in the upland areas, whereas, flowing artesian water is available in the Langley Lowland where wells are drilled from 50 to more than 900 feet.

HALSTEAD, E.C., 1959.
Ground-Water Resources of Matsqui Municipality, B.C. Geological Survey of Canada, Water Supply Paper 328.

This report deals with the ground-water conditions of Matsqui Municipality in the province of British Columbia.

HALSTEAD, E.C., 1961.
Ground-Water Resources of Sumas, Chilliwack and Kent Municipalities, B.C. (92G/1 and 92H/4). Geological Survey of Canada Paper 60-29; 37 pp. + maps.

Sumas, Chilliwack and Kent Municipalities and adjoining unincorporated districts covered in this report are all in the eastern part of Fraser Lowland, British Columbia, between longitudes 121°45' and 122°15' and latitudes 49°00' and 49°15'. Although parts of the area obtain ample water from surface sources, most of it depends on ground water for industrial, municipal, domestic, and irrigation uses.

HALSTEAD, E.C., 1966.
Aldergrove Test Hole, Fraser Valley, B.C. Geological Survey of Canada. Paper 64-51; 17 pp.

A test hole was drilled at Aldergrove to a depth of 852 feet determine the depth and nature of the unconsolidated deposits and the hydrologic properties of the principal aquifers. The stratigraphic section is complex, indicating repeated glaciations as well as eustatic changes of sea-level of greater magnitude than formerly realized. Prospecting for groundwater is probably best within the upper 400 feet of material filling Fraser Valley.

HANSEN, B.S. and EASTERBROOK, D.J, 1974.
Stratigraphy and Palynology of Late Quaternary Sediments in the Puget Lowland, Washington. Geological Society of America. Bull., 85; 587-602.

Paleoclimatic fluctuations from 50,000 year B.P. to the present are recorded in pollen assemblages from buried Pleistocene peat and in postglacial bogs in the Puget Lowland of Washington.

Two peat beds in Possession Drift, radiocarbon-dated at 47,600 + 3,300/- 1,800 and 34,900 + 3,000/- 2000 year B.P., contain high percentages of pine with minor spruce, fir, and western red cedar. Significant representation of total NAP suggests an open landscape dominated by herbs, with intermittent patches of lodgepole pine, characteristic of a cool climate and unstable physiographic conditions.

The nonglacial interval immediately preceding the last glacial advance was originally defined as the Olympia Interglaciation, but new radiocarbon and palynological evidence now suggest that it should be considered to be a nonglacial interval of less than interglacial rank. Olympia peat beds yielded radiocarbon dates of 22,700 ± 550, 22,700 ± 600, 24,800 ± 600, 26,850 ± 1,700, 27,200 ± 1,000, and 27,600 ± 1,000 year B.P. Pine maintains a dominant role throughout the units, although spruce, mountain hemlock, and total NAP increase in the younger units, suggesting a trend towards a cooler climate.

HAWLEY, P.M., 1979.
"Erosional Stability of a Dredged Borrow Pit on Southern Roberts Bank, Fraser River Delta, B.C." Unpublished B.A.Sc. Thesis, Dept. of Geological Engineering, University of British Columbia, 65 pp.

The shoreward erosion of a dredged shipping channel and borrow pit on the south side of the Roberts Bank Superport, Fraser River Delta is examined. Proposed expansion of the terminal facilities has precipitated concern about the stability of a major eelgrass meadow into which the borrow pit intrudes.

Detailed bathymetric plans and aerial photography are used to document changes in the topographic expression of the borrow pit. Current meter records and bottom sediment sampling results are presented. Various possible mechanisms which have led to the development of intertidal dendritic channels at the head of the borrow pit are considered. The effect of morphological changes on the eelgrass meadow is considered under the present circumstances and in the light of additional dredging for port expansion.

HEBDA, R.J, 1977.
"The Paleoecology of a Raised Bog and Associated Deltaic Sediments of the Fraser River Delta." Ph.D. Thesis, Dept. of Botany, University of British Columbia, 202 pp.

In this study, three cores obtained from Burns Bog just south of the Fraser River in Delta, were analysed palynologically. The paleoecology of the bog was reconstructed from the results of these analyses, together with data from vegetation studies of the bog, pollen rain and surface pollen spectrum investigations of selected wetland environments, as well as pollen tetrad and pollen productivity studies of bog ericads.

The study shows that Burns Bog has developed on Fraser River deltaic deposits which appeared above sea level just after 5000 years B.P.

A model for raised bog development is proposed for the Fraser lowland.

HICOCK, S.R. and ARMSTRONG, J.E., 1981.
Coquitlam Drift: a pre-Vashon Fraser glacial formation in the Fraser Lowland, British Columbia. Canadian Journal of Earth Science, Vol. 18, pp. 1443-1451.

Coquitlam Drift is formally defined and stratotypes established for it in the Coquitlam-Port Moody area. It is a Pleistocene formation consisting of till, glaciofluvial, ice-contact, and glaciomarine sediments deposited between 21700 and 18700 years B.P., during the Fraser Glaciation and prior to the main Vashon glacial maximum at about 14500 years B.P. The drift was deposited in short pulses by valley and piedmont glaciers fluctuating into the Fraser Lowland from the Coast Mountains to the north and Cascade Mountains to the east.

HICOCK, S.R., HOBSON, K., ARMSTRONG, J., 1982.
Late Pleistocene Proboscideans and Early Fraser Glacial Sedimentation in Eastern Fraser Lowland, British Columbia. Canadian Journal of Earth Science, 19, pp. 899-906.

Describes the early Fraser glaciation in the eastern Fraser Valley.

HILLABY, F.B., BARRETT, D.T., 1976.
"Vegetation Communities of a Fraser River Salt Marsh". Fisheries and Oceans, Technical Report Series No. PAC/T-76-14.

This study describes the vegetation of the Tsawwassen salt marsh and analyzes the composition of its plant communities. The study was undertaken in response to the threatened alienation of the marsh by the construction of a new dyke along its seaward perimeter.

HODGINS, D.O., 1974.
Salinity Intrusion in the Fraser River, British Columbia, University of British Columbia, Dept. Civil Engineering, Ph.D. Thesis.

The dynamics of salt water intrusion in a tidal estuary (Fraser River) was studied by both a programme of field measurements and the use of numerical solutions of the equations of motion. Time series conductivity measurements spanning several tidal cycles indicated significant penetrations exceeding an estimated 15 kilometres above Steveston for tides of large diurnal inequality. On each large ebb tide salt water was washed out of the river despite low winter discharges averaging 100 m^3/sec. Mixing sufficient to disperse the salt water throughout the water column was not observed although surface currents typically ebb between 2 and 3 meters/second, and the salt wedge appeared to flood and ebb in a fairly well-defined layer. Longitudinal salinity gradients were detectable in each layer, indicating that two-way mixing took place during flood and ebb periods. Both conductivity and velocity data revealed that maximum intrusion lagged high water by 60 to 80 minutes near the river mouth.

A numerical two-layer model predicted the salt water thickness within 10 percent of the total depth and a phase agreement of $\pm$ 40 minutes at maximum intrusion. Velocities were comparable to measurements within 15 cm/sec. The model neglected mixing across the interface but included the Reynold's stress. The bottom stress was also included and both stresses were found to be significant in the dissipation of energy in the flows.

HODGINS, D. and QUICK, M.C., 1972.
"Computer Studies of Estuary Water Quality", 13th Conference on Coastal Engineering, Vancouver, British Columbia, July 10-14, 1972. Proceedings. Vol. 3, 2327-2338.

The convection and dispersion of pollutants in a deltaic estuary system are calculated using several interfaced computer programmes. The basic programme is a one dimension hydrodynamic model, which is interfaced with a model of salt water intrusion in the seaward reach.

The importance of Pitt Lake, a large fresh water but tidal lake, is discussed, inasmuch that it integrates water quality changes over long periods of time.

The salt wedge analysis reveals the nature of the internal stress which is not a function of velocity or velocity bred. It is shown that the interfacial stress is a function of entrainment, rather like a Reynolds stress, and plots are given of interfacial stress against local Richardson number multiplied by local upper layer velocity.

HODGINS, D.O., OSBORN, T.R., QUICK, M.C., 1977.
Numerical Model of Stratified Estuary Flows. Journal of the Waterways, Port, Coastal and Ocean Division, American Society of Civil Engineers, W.W.I., p. 25-41.

[see Hodgins, 1974.]

Pollen from sediments of the Everson Interstade of the Fraser Glaciation is dominated by lodgepole pine, suggesting that the environment was characterized by extreme edaphic disturbance and severe climatic conditions.

Postglacial bogs show a lower pine - Douglas fir zone and an upper western red cedar - western hemlock zone, separated by an ash younger than 7,140 ± 600 year B.P. The Hypsithermal is marked by high pollen values for Douglas fir about 7,000 years ago, followed by increased western red cedar and western hemlock, implying a moister, cooler climate.

HOLLAND, S.S., 1964.
Landforms of British Columbia, A Physiographic Outline. Department of Mines and Petroleum Resources, British Columbia. Bull. No. 48, 138 pp.

Fraser Lowland is described (quotes from Armstrong, 1957) (pp. 36-37).

HUGHES, G.C., AGES, A.B., 1975.
"Salinity and Temperature Measurements in the Lower Fraser River". Unpublished manuscript Pacific Marine Science Report 75-2 Institute of Ocean Sciences, Patricia Bay, 295 p.

A large number of salinity and temperature measurements were taken in the Lower Fraser River; in the North, Middle and Main Arms and in Canoe Pass, during the years 1966-68 and 1970-73.

The majority of the observations were made with a Beckman RS5-3 portable salinometer, which measures electrical conductivity and temperature and computes the salinity from these two values.

The data are presented in tabular form as well as in profile sketches.

INLAND WATERS DIRECTORATE, PACIFIC AND YUKON REGION, 1977.
"Dredging in the Lower Fraser River: A Study into Assessing Cumulative Effects".

The study examines available information to 1) determine whether a detailed study of potential cumulative effects of dredging is possible and worthwhile and 2) draw any preliminary conclusions about the nature of dredging referrals and activities.

ISFIELD, E.O., 1973.
"Fraser River Upstream Storage Review, Task No. 57 - Navigation Studies" Department of Public Works, Vancouver, B.C.

This report assesses the effects of upstream storage dams on navigation. Conclusions are based on departmental records, discussions with river administrators, operators and planners as well as a report by B.C. Research entitled "Impact of Fraser River Reservoir Systems on Downstream Shallow Draft Navigation."

ISFELD, E.O., HAY, D. and ROSSUOW, J., 1973.
Field and model studies on a siltation problem in the Fraser River. 1st Canadian Hydraulics Conference, University of Alberta, Edmonton, Alberta. May 10 and 11, 1973. Proceedings. Canadian Society for Civil Engineering.

This paper describes a siltation problem which developed behind a training wall in the Fraser River at New Westminster and outlines studies undertaken to examine remedial measures. Field studies included detailed measurements of suspended load and directional velocity profiles across various sections of the river in the area of the training wall. The model study consisted of two stages. In the first stage, the model bed was fixed and mainly suspended load was studied. In the second stage a movable bed was used and the bedload was studied. This report is concerned primarily with the objectives of the model study and the techniques employed during the first stage of testing.

JARLAN, G.E., 1955 (March 11).
I. An Aspect of the Sedimentation Problem. II. Flume Studies. Canada. Department of Public Works. Fraser River Model Project. Rpt. FRM-214.

JARLAN, G.E. and PRETIOUS, E.S., 1955.
Model Studies of Improvement Plans for the Navigable Channel in the Main Arm of the Fraser River at New Westminster, British Columbia. Canada. Department of Public Works, Fraser River Model Project. Rpt. FRM-222. 26 pp. (Mimeo).

This report describes the hydraulic model studies of improvement plans for the navigable channel of the Main Arm of the Fraser River at New Westminster, British Columbia. Contains large scale maps of the river, with soundings, including one from 1898.

JOHNSTON, W.A., 1921.
The Age of the Recent Delta of Fraser River, B.C., Canada. American Journal of Science. N.S. 1; 450-453.

The history of the Delta is discussed. A description is given of how a determination of rate of advance of the Delta was made.

JOHNSTON, W.A., 1921.
The Occurrence of Calcareous Sandstone in the Recent Delta of Fraser River, B.C., Canada. American Journal of Science. N.S. 1: 447-449.

This study indicates that calcareous sandstone forms not in the river channels but in the sandbanks below the level of low tide. An analysis of one sample is presented, and mode of formation and occurrence are briefly discussed.

JOHNSTON, W.A., 1921.
Pleistocene Oscillations of Sea Level in the Vancouver Region, British Columbia. Royal Society of Canada, Trans. Sect. IV, 15: 9-19.

Attention is directed to the character and extents of the oscillations of sea-level relative to the land, which took place during the Pleistocene in the Vancouver region.

JOHNSTON, W.A., 1921.
Sedimentation of the Fraser River Delta. Geological Survey of Canada, Memoir 125; 46 pp. + maps. (includes GSC Map No. 1854, Scale: 1:190,080).

The report is a geological investigation of the Fraser River Delta region in British Columbia. A study of the physical characteristics of the Fraser River and its delta formed part of the investigation and was made largely for the purpose of aiding the Department of Public Works to determine by what engineering methods the navigable parts of the river might be improved. The present report gives the results of the investigation of the river in 1919 and 1920 and deals chiefly with the characteristics of that part of it between New Westminster and the Strait of Georgia.

Considerable data obtained from the excellent records of the Department of Public Works, regarding freshet and low water stages, changes in the river channels, and tidal records have been included.

JOHNSTON, W.A., 1922.
The Character of Stratification of the Sediment in the Recent Delta of the Fraser River, British Columbia, Canada. Journal of Geology, 30, 115-129.

The tidal flood-plain deposits of the Fraser River are characterized by a very thin lamination which is tidal in origin. The seasonal character of the bedding is shown in places by layers of vegetable material and in other places by alternations of silty layers and sandy layers, both of which show tidal lamination.

The alluvial flood-plain deposits of the Fraser are characterized by seasonal layers of silt and vegetable material.

Neither the tidal nor the alluvial flood-plain deposits show to any marked extent gradational lamination.

The fore-set beds of the Fraser Delta, deposited in sea water, are characterized by a thin lamination which is the result of the combined action of flocculation in sea water, river and tidal currents, and slack water. The beds have in places marked cross-bedding as well as inclined bedding. The fine-grained bottom-set beds are thick and without lamination, because of the effect of flocculation in sea water.

The Pitt Lake Delta deposits formed at the south end of Pitt Lake (a tidal fresh-water lake) are characterized by a very thin lamination and by a banding, both of which are probably tidal in origin. The fine-grained bottom-set beds have a very thin and gradational lamination, which is due to tidal action and to the absence of flocculation in fresh water. They show no definite evidence of seasonal banding. The deposits now forming in the delta at the north end of Pitt Lake have a tidal lamination and probably also a seasonal banding.

A conclusion which may be drawn from the fact that the fine-grained sediments deposited in salt water are not laminated, because of the effects of flocculation, while those formed in fresh water are, is that fine-grained sediments which are evenly and gradationally laminated are fresh-water sediments in origin or, if marine in origin, are glacial; for it is probable that sea water would be sufficiently dilute to prevent flocculation and hence to permit of lamination of the sediments only at times when and in places where large volumes of water from melting ice sheets were being poured into the sea. A possible exception might occur in places where large volumes of river water are being poured into an estuary or into a nearly land-locked part of the sea; but flocculation takes place in the Strait of Georgia in spite of the large volume of fresh water brought down by the Fraser; and where the density of the surface sea water is only 1,010, as compared with the density of normal sea water which at 17.5°C is 1.027.

JOHNSTON, W.A., 1923.
Geology of Fraser River Delta Map-Area. Geological Survey of Canada, Memoir 135, 87 pp. (includes GSC map no. 1965, scale, 1:63,360).

A geological investigation of the Fraser River delta and vicinity and a study of the tertiary rocks which underlie a considerable part of the area. Drilling for oil and gas has been carried on for several years and has furnished considerable information regarding the character and structure of the rocks. This information is embodied in the present report, which deals also with sands, gravels, and clays.

The area geologically mapped extends from the International Boundary to the north shore of Burrard Inlet and from a north and south line through Fort Langley to the Strait of Georgia.

JONES, R.K., 1977.
Surficial Materials of the Southwestern Fraser Lowland. Lands Directorate, Fisheries and Environment Canada. Vancouver, B.C. March 1977.

The southwestern Fraser Lowland has had a complex geological history which has resulted in thick deposits of diverse origin and a series of landforms relatively uncommon in British Columbia. The purpose of this map is to present a synthesis and correlation of existing information on the distribution and extent of surficial materials in both terrestrial and nearshore marine environments of the area.

JONES, W.C., 1963 (June 18).
Stability of Lower Fraser Valley Dykes. British Columbia. Department of Mines and Petroleum Resources. Victoria. 15 pp.

Reports a series of 71, 40-foot test cores bored into and under Fraser River dykes. Analyses of sedimentary properties were prepared as well-logs and are recorded in atlas form in the files of the British Columbia Water Resources Service (not in this report).

JONYS, C.K., 1976.
"Acoustic Measurement of Sediment Transport", Scientific Series No. 66, Environment Canada, Inland Waters Directorate, 105 pp.

This report summarizes laboratory and field investigations to determine whether bedload movement in gravel-bed rivers can be detected by acoustic measurements. Field studies were conducted in 1973 and 1974 on the Fraser River at Agassiz and the Vedder River. Underwater noise measurements were recorded with two different hydrophone systems at a number of stations across the rivers and at different distances above the river beds. Measurements of bedload with conventional basket samplers were also reported.

It was concluded that bedload generated noise could not be identified from the underwater river sound spectra between 30 Hz - 50 Hz because of the masking by background noise sources.

KEANE, J.C.B., 1957 (February).
Report on the Hydrometric Surveys, and Discharge Computations for the Fraser River Estuary for May, June and August, 1954. Dominion-Provincial Board, Fraser River Basin. Victoria, British Columbia. 25 pp. + Appendices.

Reports results of an investigation into methods for estimating discharge and sediment transport below Hope on the basis of stage measurements only, using relationships projected from Hope. Trial observations run in May, June and August, 1954, are used to test the computational methods. (Marked "Confidential, not to be published without the authority of the Fraser River Board").

KELLERHALS, P. and MURRAY, J.W., 1969.
Tidal Flats at Boundary Bay, Fraser River Delta, British Columbia. Bulletin of Canadian Petroleum Geology, 17: 67-91.

In Boundary Bay, on the south side of the Fraser Delta, sandy tidal flats extend 2.5 mi seaward. Four main sedimentologic-hydrologic divisions exist - the salt marsh, and the high, intermediate and low tidal flats. Each division is characterized by distinct drainage and sedimentary structures plus a diagnostic floral and faunal assemblage.

The salt marsh, bounded landward by an artificial dike, is incised by meandering tidal creeks and contains fresh-water ponds. The seaward portion of the marsh is covered with a dense growth of halophytes whereas normal terrestrial plants dominate on the landward portion. Poorly stratified, silty and sandy peat is accumulating throughout the area. In the western part of the Bay the marsh is prograding over the high flats, whereas to the east it has receded at least 0.75 mi since 4350 years B.P. The high tidal flats, bounded landward by the salt marsh, have an irregular, incomplete drainage system. In the winter sand covers the high flats, but in summer blue-green algal mats spread over the surface, particularly on the upper landward side. Thus, a varve-like stratification is produced.

In contrast, the intermediate tidal flats have a well-developed dendritic drainage system, they are devoid of vegetation and are composed principally of fine to medium-grained sand which is continually being re-worked by shifting channels and fauna. The low tidal flats are incised by deeper, more stable channels, in which high flow velocities produce dunes. Eel-grass meadows flank the sides of the channels and the shell beds are interpreted as lag deposits.

The average rate of sedimentation for the last 4350 years is 0.42 mm/yr. The index of re-working on the high tidal flats is 12.

KELLERHALS ENGINEERING SERVICES, LTD., 1984.
Review of sediment survey program, lower Fraser River, British Columbia. Report for Sediment Survey Section, Water Survey of Canada, Water Resources Branch, Environment Canada, various pagination.

Reviews the program of the Water Survey of Canada, initiated in 1965, and makes recommendations for further work.

KIDD, G.J.A., 1952 (April 1).
Interim Report: Sedimentation Programme. For the Dominion-Provincial Board, Fraser River Basin. British Columbia. Department of Lands and Forests. Water Rights Branch. Water Investigations Division. Report 321. 5 pp. + tables.

Reports results of the second year's programme of suspended sediment transport observations on the Fraser River (1951).

KIDD, G.J.A., 1953 (April 15).
Fraser River Suspended Sediment Survey: Interim Report for Period 1949-1952. British Columbia Department of Lands and Forests. Water Rights Branch. Water Investigations Division. Report 322. 44 pp. + figs. + additional memoranda on Methods of Grain Size Analysis.

This report covers the development and progress of the Fraser River Suspended Sediment Survey for the period 1949 to 1952.

The procedures, methods and equipment used in obtaining and analysing samples are described in some detail. Data and calculated results are tabulated and are also shown in graphical form where applicable. Results are discussed and conclusions made wherever possible.

The Fraser River is not a heavy suspended sediment bearing river in comparison to famous suspended sediment laden streams such as the Colorado in the United States. However, the rate of erosion from certain unprotected areas is probably high. As yet the data obtained is of short duration and insufficient as the basis for firm conclusions.

KIVISILD, H.R., 1959.
"The Effect of Density Currents on Deas Island Tunnel Sinking Operations". 8th Congress International Association of Hydraulic Research, Paper 11-C, 23 pp.

Deas Island Tunnel has a 2100 ft. subaqeous section under the Fraser River in its tidal range. During low discharge periods, tidal waves of salt water reach the tunnel site. These density currents cause flow reversals, irregular velocity patterns and water density changes of considerable magnitude.

The subaqeous part of the tunnel consists of six precast elements, each weighing about 18500 tons. These elements were cast in a drydock and later towed to the site and sunk into a trench dredged in the river bottom. A high pumping capacity was required to control the water ballast inside the elements. The difference in buoyancy caused by varying water density had to be closely monitored during the sinking operation.

KLOHN LEONOFF CONSULTANTS LTD., 1974.
"Subsurface Investigation Report - Richmond Dykes".

Soils data from a series of test holes are recorded for analyzing the stability of the river bank. Piezometer results on groundwater levels and tidal fluctuations are included.

LANGLEY, H.I., 1971.
An Experiment in Bedload Sampling by Pumping. Canada. Department of Public Works, Vancouver, B.C. 19 pp. + Figures and Maps.

The range of velocities and particle sizes covered in this experiment is a very narrow one in relation to the spectrum covered by the Fraser River system. For example, this experiment did not extend into the range involving major bedwaves. However, it would appear to be fair to say that such an experiment could point the way toward more comprehensive observations on a larger scale. The study demonstrated:
1. Measurement of suspended load in the bottom 12" is of value at least equal to the study of bed load.
2. A relatively large amount of information can be secured in a short time and at moderate cost by using the pumping method for sediment investigations.
3. The supporting program of suspended load observations was valuable in completing the sediment transport picture and in establishing confidence in the accuracy of the test.

Deals with bed load sampling experiment on North Arm of Fraser. Figure 12 shows bedload variations for a period of 48 hours (June 16-18, 1971).

LANGLEY, H.I., 1973.
An Experiment in Bed Load Sampling by Pumping <u>in</u> Canada. National Research Council, Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, Fluvial Processes and Sedimentation. 9th Hydrology Symposium. University of Alberta, Edmonton, May 8 and 9, 1973. Proceedings, Canada Dept. of the Environment, Inland Waters Directorate, 320-324.

As previous reference.

LANGLEY, I., 1975.
Bedload Sampling By Pumping, Public Works Canada, Pacific Region, Marine Engineering, Vancouver, B.C., 72 pp.

Bedload sampling was carried out on the main channel of the Fraser River immediately downstream of New Westminster between June 27-30, 1972. During this time the tidally averaged daily discharge reached up to 10100 m^3/s at Port Mann and instantaneous discharges exceeded 14700 m^3/s. The highest current velocities reached 2.4 m/s and water depths reached up to 12 m. Although bedforms were not measured during the study previous studies suggest large dunes having heights up to 3-5 m would have been present during the sampling.

Approximately 48 hours of near continuous bedload and suspended load measurements were obtained during the period of study. The investigation appears to demonstrate that bedload sampling by pumping is feasible in the main sand-bed channel of the Fraser River during large freshets. The main advantages of the method is that very large samples can be collected at frequent intervals. It was suggested that the equipment could be used to field calibrate more conventional basket-type bedload samplers.

LASALLE HYDRAULIC LABORATORIES LTD., 1967.
Fraser River Improvements, Hydraulic Model Studies of the Carey's Point - Rosedale Reach, unpublished report to Department of Public Works, 40 p.

Channel instability and erosion are documented in the vicinity of Rosedale-Greyell Slough between 1952 and 1966. The instability in this reach was triggered by bank erosion along the North side of the river upstream of the Agassiz-Rosedale bridge. This erosion caused a change in flow alignment downstream of the bridge which induced further channel shifting and diversion of flow into Greyell Slough. Erosion control measures were designed with the aid of a movable bed hydraulic model. Channel shift maps, bed material data and channel cross-sections are included in the report.

LAVKULICH, L.M., 1971.
Alluvial soils of the Lower Fraser Valley, British Columbia, their properties and utilization. 12th Pacific Science Congress, Canberra, Australia, 18 August - 3 September Proceedings, Vol. 1 (abstract), p. 17.

LEACH, T.A.J., 1951.
Investigations on the Fraser River Basin carried out during 1951. British Columbia, Department of Lands and Forests, Water Rights Branch. Water Investigations Division. Report No. 282. 7 pp. + Drawings.

Mentions the establishment of the suspended sediment transport observation programme in 1950. Comments on gravel bar formation in Coquitlam River.

LEACH, T.A.J., 1952.
Investigations on the Fraser River Basin carried out during the year 1952 by the Water Rights Branch. British Columbia. Department of Lands and Forests. Water Rights Branch. Water Investigations Division. Report No. 283. 9 pp. + Drawings.

Reviews the schedule of suspended sediment transport observations. Indicates detailed mapping and groundwater levels monitored in the Harrison-Agassiz area.

LEAMING, S., 1968.
Sand and Gravel in the Strait of Georgia area. Geological Survey of Canada, Paper 66-60; 149 pp. Includes location and comments on in recent alluvium.

LEE, J.C.Y., LYONS, R.O., 1980.
"JSIM Users' Manual - Computer Program for Fraser River Flood Control Simulation". Water Planning and Management Branch, Environment Canada.

Techniques for studying the flood control effectiveness of a system of proposed reservoirs in the Fraser River basin are presented. By using a mathematical approach a critical flood hydrograph is estimated. With the best use of available upstream reservóir storage, regulated water levels at the flood damage center are derived.

LEE, J.C.Y., LYONS, R.O., 1982.
"Flood Forecasting for Fraser River at Hope using PREDICT", Water Planning & Management Branch, Environment Canada.

The PREDICT - computer program was written initially to predict the peak discharge that might occur under the most severe conditions during a freshet period on the Fraser River. It has been written in a general manner so that it can be applied to any other river that undergoes a large snowmelt freshet. Also it could be applied, with different input parameter values to predict the typical hydrograph that is likely to occur from such a basin.

LEVINGS, C.D., 1980.
Consequences of Training Walls and Jetties on Habitats at Two British Columbia Estuaries, Coastal Engineering, 4, pp. 111-136.

This report describes the impacts of river training structures and jetties on aquatic habitat at Sturgeon Banks, Fraser River and at the Squamish River estuary.

On Sturgeon Banks sedimentation patterns have been disturbed by the placement of dredge spoil in the intertidal zone between the Iona Causeway and the North Arm Jetty. Wave action and longshore currents have redistributed this material and created prominent sand waves with amplitudes of 0.2-0.5 m and wavelengths of 10-20 m. The sand waves have increased the relief on Sturgeon Banks and have allowed fine sediments to be trapped in the troughs of the bedforms.

On southern Sturgeon Bank a 1 m deep trench has developed along the north side of the Steveston North Jetty. Scour holes developed in the tidal flats within weeks of construction of four low sills in the jetty in 1978. Rapid expansion of marsh on parts of Sturgeon Bank was attributed to construction of the airport causeway on Sea Island in 1962.

Some general guidelines were presented for estimating the time scales for ecological impacts to develop after construction of jetties. It was concluded that many impacts associated with changes in salinity distribution and sedimentation patterns will develop over time spans of decades or more.

LUTERNAUER, J.L., 1975.
"Fraser Delta Sedimentation, Vancouver, British Columbia", in Report of Activities Part A. Geological Survey of Canada Paper 75-1A, pp. 467-468.

This project was initiated to provide a geological/sedimentological knowledge base of the Fraser River Delta which would help predict environmental consequences of sediment budget disruptions.

Efforts were made to monitor the response of the delta to seasonal fluctuations of the local wave-current-river climate. This was planned to be accomplished by sampling and bathymetrically surveying the delta slope both shortly after erosive winterstorms had subsided and after the summer freshet had deposited its load across the delta front.

LUTERNAUER, J.L., 1975.
"Fraser Delta Sedimentation, Vancouver, British Columbia", in Report of Activities Part B, Geological Survey of Canada Paper 75-18, pp. 171-172.

The first series of sediment sampling operations for this project, initiated in 1974, was completed with the October-November post-freshet sediment surveys of the western delta front slope and tidal flats.

The grain size analysis of the sediment sampling program are presented, short term morphological and sedimentary changes along the western delta front of the Fraser River are also documented.

LUTERNAUER, J.L., 1976.
"Fraser Delta Sedimentation, Vancouver, British Columbia", in Report of Activities Part A, Geological Survey of Canada Paper 76-1A, pp. 213-219.

This paper details the broad morphologic character of the delta front and presents a preliminary compilation of sedimentologic data acquired to date. In addition, echo-sounding records indicate that in general the slope of the delta is free of relief where it is not cut by major canyons.

LUTERNAUER, J., 1976.
"Fraser Delta Sedimentation, Vancouver, British Columbia," Report of activities Part B, Geological Survey of Canada Paper 76-1B, pp. 169-171.

A preliminary appraisal of the relief (exclusive of continuous canyons) on the Fraser Delta slope was carried out employing echo sounding records obtained by the Canadian Hydrologic Service.

Over much of the slope there is little or no relief. Significant relief (2 to 5 m) is apparent only on isolated segments of the northern central, and southernmost slope off Roberts Bank. The gently rolling morphology (on a 1 to 3 degree slope) in these areas may be maintained by the freshet-related dumping of coarser sediment which subsequently is transported downslope along finer scale tributary canyons or incipient larger scale canyons and/or by mass wasting.

LUTERNAUER, J.L., 1977.
"Fraser Delta Sedimentation, Vancouver, British Columbia". Report of Activities Part A, Geological Survey of Canada Paper 77-1A, pp. 65-72.

The author presents the detailed grain size analysis on 25 short cores obtained from the Fraser Delta tidal flats during the summer of 1975. From this data it is apparent that sedimentary processes on the Fraser Delta tidal flats can be exceedingly variable both in time and space.

Also included in the report are the results of a preliminary reconnaissance side-scan survey of one of the zones of high relief on the delta slope. It was found that the relief can be attributed to the presence of megaripples on the sandy sea floor.

LUTERNAUER, J.L., 1980.
"Genesis of Morphologic Features on the Western Front of the Fraser River, British Columbia - Status of Knowledge" In The Coastlines of Canada, S.B. McCann (Ed.) Geological Survey of Canada Paper 80-10, p. 381-396.

Major morphologic features on the western front of the Fraser River delta include: sand swells, mud pools and dendritic drainage networks on the tidal flats: gullies (sea valleys) and sandwaves on the slope. The character and extent of these features are described.

LUTERNAUER, J.L. and MURRAY, J.W., 1973.
Sedimentation on the Western Delta-Front of the Fraser River, British Columbia. Canadian Journal of Earth Sciences, 10; 1642-1663.

The broad patterns of sedimentation and erosion on the western delta-front of the Fraser River are described on the basis of a detailed sedimentological survey and three successive bathymetric surveys.

The surveyed portion of the delta-front can be sub-divided into three sedimentary environments: salt marsh, main platform, and upper fore-slope. The salt marsh lies near high tide level and is a flat to hummocky, vegetated zone about 0.5 mi (1 km) wide, having sediments with a mean grain size finer than 4 ^{u} (0.063 mm). The main platform (which includes the tidal flats below the salt marsh) is the zone that slopes gradually for about 4 mi (6 km) from the salt marsh to the break in slope at approximately 30 ft (9 m) below lowest normal tide level. It is mantled mainly with 1.5 ^{u} to 3 ^{u} (0.35 mm to

0.125 mm) rippled sand. The upper fore-slope has here been designated as that portion of the delta-front extending from the main platform to the limit of the bathymetric survey (-300 ft) (-90 m). The gradient of the upper fore-slope is variable and attains a maximum inclination of approximately 12°. Upper fore-slope sediments are muddy at, and north of the main river channel, but consist mostly of sand south of there. The sharp transition between platform sand and muddy fore-slope sediment north of the main channel suggests that the -30 ft (-9 m) contour there denotes the maximum depth of vigorous wave and current action.

Bathymetric surveys conducted in 1968 and April and August 1972 coupled with a calculation of the gross sediment budget of the western delta-front reveal that, as a consequence probably of local physical oceanography and confinement and dredging of the main channel, yearly freshet deposition is promoting the advance of the delta-front principally off the main channel and seems sufficient, at least, to maintain the stability of the upper fore-slope north of there. However, on the southernmost segment of the western delta-front, prevailing conditions have brought about the retreat of the upper fore-slope at least during the period 1968-1972.

LUTERNAUER, J.L., SWAN, D., LINDEN, R.H., 1976.
Sand Waves on the Southeastern Slope of Roberts Bank, Fraser River Delta, British Columbia, Current Research, Part A, Geological Survey of Canada, Paper 78-1A, p. 351-356.

Sand waves within a 4 Km^2 segment of Roberts Bank was surveyed with side scan sonar and conventional echo soundings. Local current velocities .3 m above the bottom were monitored for a period of 94 days. The overall wave crest orientation is normal to the dominant tidal current flow direction. Maximum wave heights increase from 2 to 3 m and wave lengths increase from 15 to 30 m west to east. On the basis of limited current observations it was speculated that tidal current velocities are high enough to permit general sediment motion at least 10% of the time and that there is a net westerly transport of sand.

LUTERNAUER, J.L., FINN, W.D., 1983.
Stability of the Fraser River Delta Front. Canadian Geotechnical Journal, 20, pp. 603-616.

The distributary front deposits of the delta consist mainly of interlayered sand and silt and lie in one of the most seismically active zones in Canada. Slope angles on the delta vary from 23° at the head to 1-2° within 2 km beyond the tidal flats. Formation of gullies which crease the delta slope probably are initiated by failure of oversteepened deposits at a channel mouth. Interpretation of penetration test data suggests that previous analyses have overestimated failure potential. It is estimated that the slopes may withstand an earthquake with a duration of 15 significant cycles of motion at a peak acceleration in the range of 11-13% G.

MACDONALD, J.L., 1957.
"History of Dykes and Drainage in B.C." Transactions of the 10th British Columbia Natural Resource Conference, Victoria, B.C. British Columbia Natural Resources Conference, pp. 75-85.

A history of dyking and drainage in the Fraser Valley from 1864 to 1948, with a discussion of design trends in the 1950s.

MACKINTOSH, E.E. and GARDNER, E.H., 1966.
A Mineralogical and Chemical Study of Lower Fraser Alluvial Sediments. Canadian Journal of Soil Science, 46; 37-46.

Mineralogical and chemical analyses were conducted on samples representing Fraser River sediments deposited under freshwater and seawater environments. The analyses indicated these sediments to be highly detrital in nature, dominantly reflecting their source area and being influenced to a lesser degree by marine diagenesis. Indications of diagenesis were most pronounced in sediments from the neritic environment. These were characterized by a reduction in the content of expanding-lattice minerals. The average non-exchangeable K, Mg, and Ca contents of the clay fractions were considerably higher in the neritic and littoral sediments than the corresponding contents of the floodplain sediments.

The type of alluvial deposit - lateral accretion, vertical accretion, or deltaic deposition - appeared to have little influence on their clay mineral contents.

MACLEAN, D.A. and KIDD, G.J.A., 1951 (March 1).
Interim Report: Sedimentation Programme. For the Dominion-Provincial Board, Fraser River Basin. British Columbia. Department of Lands and Forests. Water Rights Branch. Water Investigations Division. Report 320, 7 pp. + figs.

Results of the first year's suspended sediment transport observation programme on the Fraser River (at Hope, 1950).

MANNERSTROM, M.C. and MCLEAN, D.G., 1985.
Estimating bedload transport in the lower Fraser River. Canadian Society for Civil Engineering, 7th Canadian Hydrotechnical Conference, Saskatoon, May 28-31. Proceedings, Vol. 1B: 97-116.

This paper describes uncertainties involved in estimating bedload transport rates in the Fraser River near Agassiz. Measurements between 1968 and 1976 are analyzed. The errors were found to be very large due to uncertainties in sampler calibration and operation and large random variations in transport rates. Estimates of transport rates were also made using a number of bedload formulae. Even formulae developed specifically for gravel-bed channels gave a wide range of estimates.

MATHEWES, R.W., 1973.
Paleoecology of Postglacial Sediments in the Fraser Lowland Region of British Columbia. University of British Columbia, Department of Botany, Ph.D. Thesis, 77 pp.

The postglacial vegetation history of the University of British Columbia Research Forest and the Yale area in the Fraser Lowland region was investigated using percentage and absolute pollen analysis, macrofossil analysis, and radiocarbon dating.

Between approximately 10,000 B.P. and 8,000 B.P. in the Yale area pollen assemblages suggest that the climate was relatively warm and dry, although natural succession, topography, and fires might account for the increase of non-arboreal vegetation observed in the interval.

MATHEWES, R.W., 1973.
A Palynological Study of Postglacial Vegetation Changes in the University Research Forest, Southwestern British Columbia. Canadian Journal of Botany, 51, 2085-2103.

The postglacial vegetation history of the University of British Columbia Research Forest was investigated using percentage and absolute pollen analysis, macrofossil analysis, and radiocarbon dating. A marine silty clay deposit records the oldest (12,690 + 190 years before present (B.P.) assemblage of terrestrial plant remains so far recovered from the post-glacial of south coastal British Columbia. Lodgepole pine (Pinus contorta) dominated this early vegetation, although some Abies, Picea, Alnus, and herbs were also present. Sediment cores from two lakes were also studied. The older is Marion Lake, where five pollen assemblage zones are recognized, beginning with a previously undescribed assemblage of Pinus contorta, Salix, and Shepherdia in clay older than 12,350 ± 190 B.P. The pollen diagram from Surprise Lake (11,230 ± 230 B.P.) is divide into three pollen zones which show the same major trends of vegetation change as the Marion Lake diagram.

The first report of the postglacial vegetation history of cedar (Thuja and perhaps Chamaecyparis) in southwestern British Columbia is presented from pollen and macrofossil analyses.

At about 10,500 B.P. in both lakes, pollen of Douglas fir (Pseudotsuga menziesii) began a rapid increase, probably in response to climatic amelioration. The palynological evidence, supported by well-preserved bryophyte subfossils, suggests that humid coastal conditions have prevailed in the study area since about 10,500 B.P. with virtually no evidence for a classical Hysithermal interval between 8,500 B.P. and 3,000 B.P.

MATHEWES, R.W., BORDEN, C.E., and ROUSE, G.E., 1972.
New Radiocarbon Dates from the Yale Area of the Lower Fraser River Canyon, British Columbia. Canadian Journal of Earth Sciences, 9; 1055-1057.

Three new radiocarbon dates from two lakes near Yale, B.C. establish that ice-free conditions existed in parts of the Lower Fraser Canyon as early as 11,430 + 150 B.P. A volcanic ash layer found in both lakes is considered to have come from the Mount Mazama eruption, based on a radiocarbon date from Squeah Lake. Mention is made of the problematic relationship of the three new dates to post-Vashon chronology in this area.

MATHEWES, R.W., ROUSE, G.E. 1975.
Palynology and Paleoecology of Post-Glacial Sediments From the Lower Fraser Canyon of British Columbia. Canadian Journal of Earth Sciences, V. 12, p. 745-756.

The post-glacial history of vegetation in the Lower Fraser Canyon was described from analysis of Lake sediment cores. Three distinct pollen assemblage zones were distinguished. Inferred climatic variations are in general agreement with earlier studies near Haney.

MATHEWS, W.H. (editor), 1968.
Guidebook for Geological Field Trips in Southwestern British Columbia. University of British Columbia, Department of Geology, Rept. No. 6, 62 pp.

Contents include Introduction to Stratigraphy of southwestern B.C. and northwestern Washington; Geomorphology southwestern B.C. and field trip Vancouver-Kamloops and return.

Map illustrates geology of Fraser Valley to Yale.

MATHEWS, W.H., 1972.
Geology of Vancouver area of British Columbia. 24th International Geological Congress. (Montreal, Province of Quebec). Field Excursion No. A05-C05: 47 pp.

Includes summary contents on Fraser delta sedimentation, pp. 43-44.

MATHEWS, W.H. and SHEPARD, F.P., 1962.
Sedimentation of Fraser River Delta, British Columbia, American Association of Petroleum Geologists, Bull. 46; 1416-1443.

The delta of Fraser River, first investigated in detail by W.A. Johnston in 1919 has been resurveyed and sampled. The slope of the delta front was found to average 1 1/2° but the upper parts of the main channel have inclinations that range mostly from 1 3/4° to 3 1/2°. Gullies occur off the main channel and these are bordered downslope by hills, both features apparently the result of landsliding on the delta front. Near the river mouth the front has advanced an average of 840 feet in 30 years at moderate depth, but appreciably less than this in shallow water. Volume of sediment added annually to the delta front is estimated to be about 700 x 10^6 cubic feet; silt predominates but sand is an important constituent. Delta-front sediments are sandy off, and south, of the river mouth, silty on the north. Tidal movements of sediment-laden waters may account for this asymmetric distribution. Within the silty sediment the water content increases regularly with distance from the river mouth, regardless of the depth of the bottom, and the clay: silt ratio increases less markedly. Porosites and liquid and plastic limits of the freshly deposited sediments are high compared with uplifted glaciomarine and buried deltaic sediments of similar texture in the vicinity of the delta. Much exchangeable calcium and magnesium remain in the bottom sediment notwithstanding contact with sodium-rich sea water.

Recent data will agree with Johnston's estimate of 8,000 years for the age of the delta. Depth of deltaic sediment is estimated to average almost 400 feet and to range up to at least 700 feet. Environmental conditions and associated deposits on the delta top and front are summarized and the classical distinction of fore-set and bottom-set beds is not readily applicable in this example. Speculation regarding consolidation, based on laboratory and theoretical studies suggests that more than just gravitational pressure plays a part in quick compaction of the sediments of this delta.

MATHEWS, W.H., FYLES, J.G. and NASMITH, H.W., 1970.
Postglacial Crustal Movements in Southwestern British Columbia and Adjacent Washington State. Canadian Journal of Earth Sciences, 7; 690-702.

Records of former land-sea relationships in southwestern British Columbia and adjacent Washington State have been established in considerable detail by terrestrial and marine stratigraphy, by terrestrial and littoral landforms, and by archaeological remains, aided by radiocarbon dating of shells, wood, peat, and charcoal from critical sites. These records indicate submergent conditions at the time of retreat of the Vashon ice sheet, 13,000 years ago, followed by an unusually quick emergence of several hundred feetby about 12,000 years ago. In the northeast and north of the area studied, this emergence was followed by a submergence of some hundreds of feet during the next half millennium preceding the Sumas ice advance. During and following this ice advance, land again became emergent, and during the period 9,000 to 6,000 years ago sea level stood approximately 35 ft (10 m) below the present shore in some parts of the area. The shore has stood close to its present level for the last 5,500 years in all parts of the area.

Early movements were dominantly isostatic. The pre-Sumas submergence is of problematical origin. Sea level shifts since 8,000 years ago appear to be dominantly eustatic; isostatic movements were evidently essentially complete by this time. In historic time very small changes shown by tide gauges and precise levelling may be tectonic.

MATHEWS, W.H., MURRAY, J.W. and MCMILLAN, N.J., 1966 (May).
Recent Sediments and Their Environment of Deposition, Strait of Georgia and Fraser River Delta. (A Manual for Field Conferences). Prepared by Tenneco Oil and Minerals Ltd., Calgary, Alberta, Various pagination.

Contains summaries of the sedimentary geology of the area in the following sections:

I. Regional Setting of Strait of Georgia and Fraser River delta.
II. Composition of the sediments of the Strait of Georgia-Fraser River Delta area.
III. Fraser River.
IV. Tidal flats, Boundary Bay.

V. Tidal flats, Iona Island.
VI. Bottom sediments and topography in the central Strait of Georgia.
X. Pitt Lake
XI. Summary of sedimentary environments of Strait of Georgia.

MAYERS, I.R., 1968.
An Analysis of the Form and Origin of the Fraser River Delta's Subaqueous Slump Deposits. University of British Columbia, Department of Geophysics, B.Sc. Thesis, 49 pp.

The sample data of W.H. Mathews and F.P. Shepard (1962), and the bottom current information of G.L. Pickard (1956), has been utilized in an analysis of the effects of the sedimentary environment on the topography of the Fraser River delta's subaqueous slump deposits. The structure of the latter is illustrated in detail by available Continuous Seismic Profiling sections. An isochron map has been constructed to show the extent of the slumps and from this a crude estimate of the total volume of sediment involved and a possible mode of formation of the feature has been derived.

The topographic form of a deeper event representing an earlier erosion surface is shown by an isochron map and is illustrated on the C.S.P. sections.

A brief review has been sketched of previous geological and soil mechanical work on the problem of subaqueous slumping and an attempt has been made to apply the necessary criteria for failure to the conditions at the Fraser River Delta. From this analysis a region of insipient slumping at the mouth of the main distributary of the Fraser River and a possible mechanism by which slumping originates has been derived.

MCLAREN, W.A., BUCKINGHAM, W.R., 1983.
Sand Movement on Fraser River Foreshore, 1983 ACROSES Conference, Canadian Coastal Conference, pp. 217-233.

Sediment movement studies were conducted over Roberts Bank and Sturgeon Bank on the Fraser River foreshore using sand samples dyed with Rhodamine WT. The dyed sand was placed at 9 sites prior to and during the Fraser River freshet period. Attempts were made to correlate sand movement with wind and tidal current records.

Sand on the north part of Sturgeon Bank showed little movement while movement on the south part of Sturgeon Bank was primarily due to wave action at low tide on the outer foreshore and to tidal action near shore. Movement on Roberts Bank was due primarily to tidal and river discharges through distributary channels. Maximum rates of movement were observed in the vicinity of Canoe Pass.

MCLAREN, A., MCLEAN, D., 1983.
Hydraulic Model Studies for Fraser River Bridges. Workshop on Bridge Hydraulics and other aspects of stream crossing design, Canadian Society for Civil Engineering, Banff, Alberta.

Summarizes results of hydraulic model studies and field investigations that were carried out during the design of two bridges downstream of New Westminster. Information on channel sediments, and river hydraulics is provided.

MCLEOD, G.D., 1979.
"McGregor River Diversion: Fraser River Water Temperature Study" Fourth National Hydrotechnical Conference. The Canadian Society for Civil Engineering, Vancouver, B.C., V. 1, pp. 180-195.

A computer program for predicting stream temperature is introduced. By using this program, the effects of a complete diversion of the McGregor River on the water temperatures along the Fraser River are estimated. It is concluded that the greatest change in the summer water temperature regime would occur immediately above the confluence with the Quesnel River. From this point downstream the temperature increases due to diversion would be less due to the cooling effects of the remaining major tributaries.

MEDLEY, E., 1978.
Dendritic Drainage Channels and Tidalflat Erosion West of Steveston, Fraser River Delta, British Columbia. B.A.Sc. Thesis in Geological Engineering, University of British Columbia, 70 pp.

A study was made of a network of rapidly extending drainage channels located in the tidal flats 1 km west of Steveston. The channels are bounded to the east by marshlands, to the south by a newly developed distributary slough and to the west by a broad field of sinuous sand waves.

It was speculated that the network evolved following rapid deposition of muds from tidal flat runoff partially impounded by the sandwaves. Contemporary rates of network extension at the time of the study averaged 0.2 - 1.0 m per month.

MEDLEY, E., LUTERNAUER, J.L., 1976.
Use of Aerial Photographs to Map Sediment Distribution and to Identify Historical Changes on a Tidal Flat. Report of Activities Part C; Geological Survey of Canada, Paper 76-1C, p. 293-304.

Aerial photos were used to map the surficial sediment distribution on the tidal flats and to identify the most significant historical changes in intertidal morphology over the last 25 years. It was concluded that the marsh edge has been generally very stable. The report contains detailed descriptions of six sites where anomalous changes were observed.

MEYERHOF, G.C., and SEBASTIAN, G.Y., 1970.
Settlement Studies on Air Terminal Building and Apron, Vancouver International Airport, British Columbia. Canadian Geotechnical Journal 7: 433-456.

Includes data on the character of the sediments at the site of the Vancouver Air Terminal building on Sea Island.

MILLIMAN, J.D., 1980.
Sedimentation in the Fraser River and its estuary, Southwestern British Columbia. Estuarine and Coastal Marine Science, Vol. 10, p. 609-633.

This report reviews suspended sediment data collected along the Lower Fraser River downstream of Hope and presents results from field studies in 1975-1976 in the estuary below Port Mann.

Measurements during freshets in 1967-1972 showed up to 56% of the suspended load at Hope was composed of sand. The proportion of sand in the suspended load increased up to 65% at Mission and then decreased below Port Mann, presumably reflecting transfer from suspension to bedload. Early freshet flows were found to carry greater sediment concentrations than comparable flows in late summer due to supply Limitation effects. As many as six distinct sediment pulses were observed at Hope prior to the main freshet. Some of these pulses reached Mission while others were deposited between Hope and Mission and re-suspended during subsequent higher flows.

Except at the time of the spring freshet the estuary is partially mixed. During freshet flows the estuary is essentially composed of freshwater above Steveston. The daily suspended sediment loads decreased seaward from Port Mann to Steveston reflecting sediment deposition and/or transfer to bedload. Suspended sediment concentrations increased downtream of Steveston indicating resuspension occurs in the vicinity of the salt wedge.

MINISTRY OF THE ENVIRONMENT 1980-81.
"Soils of the Langley-Vancouver Map Area" RAB Bulletin 18.

The report is divided into six volumes: Volume 1 consists of soil map mosaics (1:25000) of the Lower Fraser Valley. Volume 2 contains soil maps (1:50000) of the Sunshine Coast and a portion of the Coast Mountains. Volume 3 describes the soils mapped and classified in (1) and (2). Volume 4 contains interpretations for specified uses of the soils in (3). Volume 5 is agriculturally oriented and Volume 6 consists of detailed, technical profile descriptions.

MOODY, A.I., 1978.
"Growth and Distribution of the Vegetation of a southern Fraser Delta Marsh", M.Sc. Thesis, University of British Columbia.

This study was initiated to obtain information on the factors controlling, and characteristics of, the primary productivity, decomposition and spatial and temporal distributions of the emergent vegetation of Brunswick Point Marsh.

The emergent marshes of the Fraser River estuary have experienced major modifications during the past century and these may continue. Extensive dyking of high marsh areas has reduced the areal extent of foreshore marshes. The remaining marsh areas are an important source of detrital material which forms the basis of extensive estuarine food webs.

MORTON, K.W., 1949 (July).
Fraser River System, Province of British Columbia: History of Improvements 1871 to 1948. Canada. Department of Public Works. Vancouver. 66 pp. + maps.

Includes discussion of natural sediment regime of the river, noting the dominantly depositional activity below Yale, and the disappearance of gravel from the river below the confluence of Sumas River. Comments on river bank erosion throughout the basin as a major source of sediment.

MUIR, J.F., 1969.
Fraser River Flood Flow Forecasting. University of British Columbia, Department of Civil Engineering Reports, 121 pp.

Methods are developed for forecasting the flood flows in the lower reaches of the major rivers of British Columbia. Formulas are derived and computer programs written for predicting the daily flows for various periods up to five days at four gauging stations of the Fraser River system. Predicted flows are compared with the recorded values from May 15 to June 30 for the 15 year period from 1953 to 1967 inclusive.

The most accurate forecasts of the Fraser River flows are given by the "Forecaster" formulas which are based mainly on flood routing techniques. Relationships between air temperatures, volumes of snow, and snow-melt rates in the mountainous regions of the river basin are incorporated in these formulas to give results slightly better than those based only on flood routing relationships.

MURRAY, J.W., and KELLERHALS, P., 1968.
Intertidal flat sediments at Boundary Bay, Southwestern British Columbia. Geological Society of America. Special Paper No. 101. Abstracts for 1966: 444.

Abstract only. See Kellerhals and Murray (1969).

MURRAY, J.W., LUTERNAUER, J.L., PHARO, C.H. and MCGEE, T.M., 1972 (August).
Preliminary Study of the Sediment Budget of the Fraser River Delta Front, University of British Columbia, Department of Geological Sciences, Report. 38 pp. + Appendices.

NEU, H.J.A., 1972.
"Proposals for Improving Flood and Navigable Conditions in the Lower Fraser River,"National Research Council of Canada, Unpublished report, 79 pp.

Describes methods of predicting water levels in the Fraser River and illustrate the effect of a diversion channel connecting Boundary Bay to the river near New Westminster.

NORTH, M.E.A. and TEVERSHAM, J., 1984 [1985].
The vegetation of the Fraser, Serpentine and Nicomekl Rivers, 1859 to 1880. Syesis 17: in press.

Characterizes early vegetation distribution on the Fraser floodplain between Hope and Sandheads.

NORTHCOTE, T.G., 1974.
"Biology of the Lower Fraser River: A Review". Westwater Research Centre, U.B.C. Technical Report No. 3.

A summary of literature on biological conditions, water quality and resource utilization in the lower portion of the Fraser River.

PARKINSON, V., 1955 (September 9).
1955 Prototype Studies of the Lower Fraser River, British Columbia. University of British Columbia. Fraser River Model Project Office. Report FRM-220.

PETERS, N., 1973.
The Pleistocene Geology and the Geotechnical Aspects of the Proposed Pitt River Bridge, Port Coquitlam, British Columbia. University of British Columbia, Department of Geology, B.A.Sc. Thesis: 46 pp.

Describes the geomorphology and geology of the Pitt River area and its relation to new information generated by bridge foundation excavations, and aspects of the proposed bridge and its foundation design. The logs of 8 test holes to a maximum depth of -250 ft. (ref. MSL) and one additional hole located 1 mi. NW of the site provide the main data basis. An attempt is made to interpret the depositional sequence of the bridge site and to relate the sediments to previously described geology of the area.

PHARO, C.H., 1972.
Sediments of the central and southern Strait of Georgia, British Columbia. University of British Columbia, Department of Geology. Ph.D. Thesis, 290 pp.

A study of the distribution, dispersal and composition of surficial sediments in the Strait of Georgia has resulted in the understanding of basic sedimentologic conditions within this area, a long, narrow, semi-enclosed basin with a restricted circulation. The Fraser River supplies practically all the sediment now being deposited in the strait, the bulk of it during the spring and summer freshet. This river is building a delta into the straitfrom the east side near the south end. Ridges of Pleistocene deposits within the Strait and Pleistocene material around the margins, like bedrock exposures, provide local sources of sediment of only minor importance. Rivers and streams other than the Fraser contribute insignificant quantities of sediment to the strait.

Sandy sediments are concentrated in the vicinity of the delta, and in the area to the south and southeast. Mean grain size decreases from the delta toward the northwest along the axis of the strait, and basinwards from the margins. Silts and clays are deposited in deep water west and north of the delta front, and in deep basins northwest of the delta. Poorly sorted sediments containing a gravel component are located near tidal passes, on the Vancouver Island shelf area, on ridge tops within the strait, and with sandy sediments at the southeastern end of the study area. The southeastern end of the area contains a thick wedge of sandy sediment which appears to be part of an earlier delta of the Fraser River. Evidence suggests that it is now a site of active submarine erosion.

Sediments throughout the strait are compositionally extremely similar, with Pleistocene deposits of the Fraser River drainage basin providing the principal, heterogeneous source. Gravels and coarse sands are composed primarily of lithic fragments, dominantly of dioritic to granodioritic composition. Sand fractions exhibit increasing simplicity of mineralogy with decreasing grain-size. Quartz, felspar, amphibole and fine-grained lithic fragments are the dominant constituents of the finer sand grades. Coarse and medium silt fractions have compositions similar to the fine sands. Fine silts show an increase in abundance of phyllosilicate material, a feature even more evident in the clay-size fractions. Montmorillonite, illite, chlorite, quartz and felspar are the main minerals in the coarse clay fraction, with minor mixed-layer clays and kaolinite. The fine clay fraction is dominated by montmorillonite, with lesser amounts of illite and chlorite.

The sediments have high base-exchange capacities, related to a considerable content of montmorillonite. Magnesium is present in exchange positions in greater quantity in Georgia Strait sediments than in sediments from the Fraser River, indicating a preferential uptake of this element in the marine environment. Manganese modules collected from two localities in the strait imply slow sediment accumulation rates at these sites. Sedimentation rates on and close to the delta, and in the deep basins to the northwest, are high.

PIPES, A., QUICK, M.C. and RUSSELL, S.O., 1970.
Simulating Snowmelt Hydrographs for the Fraser River System, in Western Snow Conference, Victoria, British Columbia April 21-23, 1970, Proceedings: 91-97.

A computer simulation model of the Fraser system is presently being constructed in the Civil Engineering Department at the University of British Columbia for purposes of flood forecasting, planning, system evaluation, teaching and research. The model has two main components, a streamflow routing component and a runoff simulation component, both of which are under active development. As yet the two components have not been combined.

PITEAU, D.R., 1979.
Regional Slope Stability Controls and Related Engineering Geology of the Fraser Canyon, British Columbia, in Rock Slope Engineering, Piteau Associates (unpublished report).

Discusses the factors governing rock slope instability along the Fraser Canyon between Hope and Lytton. Describes how river erosion and erosion induced by tributary alluvial fans have contributed to slope instabilities.

POOL, M.I., 1975.
Sand Sources, Volumes and Movement Patterns on Wreck Beach, Vancouver, B.C. M.A. Sc. Thesis, Dept. of Civil Engineering, University of British Columbia, 107 pp.

Along Wreck Beach the headland cliffs are eroding and receding under attack from terrestrial and marine agents. Remedial measures undertaken in the summer of 1974 to halt marine erosion along the cliff base were only partially successful. Calculations suggest the Fraser River North Arm could provide the beach's longshore transport supply requirements. However, some means must be available to bring this sand into a range where wind generated wind activity can incorporate it into the existing Wreck Beach system.

POTTER, R.E., 1950.
"Flood Control Analysis - 1948 Flood"

Recommendations on how to improve flood control of the Fraser based on the experience gained from the 1948 flood.

PRETIOUS, E.S, 1956 (March 28).
Bed-Load Movement in the Main Arm of the Fraser River Estuary. Canada. Department of Public Works, Fraser River Model Project. Report FRM-224. 21 pp. (Mimeo).

The flow in the Fraser River estuary is variable due to tidal action and varying river discharges. A question which is frequently asked is: when and under what conditions does the material of the bed of the estuary begin to move? The answer to this question must be based primarily on physical data.

An attempt has been made in this report to estimate when bed-load movement occurs in the Fraser River estuary, based partly on two tidal surveys and a bed-sand sampling program in the actual river. Unfortunately, we are unable to observe visually the bed of the river due to the depths and turbidity of the flow. Our final predictions therefore have to be based on theory, laboratory experiments, published data, general knowledge, the above field surveys, certain approximations and assumptions.

Report contains maps of bed-sediment distribution (ca-1951) at scale 1" = 1,000' from Sandheads to Port Mann.

PRETIOUS, E.S., 1958 (August 21).
Estimate of Quantity Rate of Bed-Load Transport in the Fraser River Estuary. Canada. Department of Public Works, Fraser River Model Project Report FRM-229; 14 pp. (Mimeo).

In a previous report an attempt was made to establish tentative criteria for determining incipient motion of bed material in the Main Arm of the Fraser River. These criteria were based on some limited laboratory flume studies, prototype tidal surveys and bed-sand sampling programs.

The present report is an attempt to extend the work of the previous report and to rationalize a practical, convenient method of estimating the quantity rate of bed-load transport by utilizing existing dredging records to check the validity of formulas devised to employ the results of the above laboratory studies and field surveys.

The object of this study was an attempt to ascribe definite values to the limits so that dredging predictions could be made once the freshet hydrography of the river is known. Striking variations in the dredging figures for different years are not explicable in terms of natural phenomena.

PRETIOUS, E.S., 1961.
The Fraser River, Model and Prototype. The B.C. Professional Engineer, 12, No. 11; 13-18.

This article reviews the design and operation of the Fraser River Model at U.B.C.

PRETIOUS, E.S., 1969 (February).
The Sediment Load of the Lower Fraser River, B.C. University of British Columbia. Department of Civil Engineering. 27 pp.

Review of sediment transport measurements and calculations made for lower Fraser River, with attention paid to introducing techniques and bases for judgement, for the non-specialist reader.

PRETIOUS, E.S., 1972.
Downstream Degradation and Delta Erosion in British Columbia Research Council, Study of the Impact of a Dam at Moran on Selected Aspects of the Economy. Report to British Columbia Energy Board. Published as Appendix XV-D of British Columbia Energy Board, 1972, op.cit., p. 3-25.

The purpose of this study was to make a preliminary appraisal of probable changes that could occur in the sedimentation pattern of the Fraser River downstream of the suggested site of the Moran Dam.

The study consisted of an extensive review of published literature dealing with similar problems, as well as published and unpublished data from government sources. Aerial photographs of the Fraser River at low flow, from Moran to Agassiz were also examined.

PRETIOUS, E.S., 1972 (January).
Downstream Sedimentation Effects of Dams on Fraser River, B.C. University of British Columbia, Department of Civil Engineering, Water Resources Series, No. 6; 91 pp.

This report deals in a semi-quantitative fashion with the possible effects that dams would have on the sedimentation behaviour of the Fraser River downstream of the dams. An effort has been made to bring to the forefront all of the available factual data on Fraser River flows and sediment loads. Theoretical evaluations have been deferred until adequate field data are available.

PRETIOUS, E.S. and BLENCH, T., 1950 (July).
Memorandum re Special Observations 1950 Freshet. Canada. National Research Council. Fraser River Model Project. Tech. Rpt. No. 2.

PRETIOUS, E.S. and BLENCH, T., 1951 (July 6).
Final Report on Special Observations of Bed Movement in Lower Fraser River at Ladner Beach during 1950 Freshet (and till June, 1951). Canada. National Research Council. Fraser River Model Project. 12 pp. + figs., tables.

To provide information for "proving" or verifying the Fraser River Model, daily sonic soundings and bed-sediment observations were made under freshet conditions on section lines associated with an important bifurcation. Principal items of information obtained, include:

i. Marked change of river cross-sectional form, at a section, starts and ends at approximately the same stage.
ii. Bed waves, or dunes, are always present.
iii. During changes of cross-sectional form, bed-waves increase enormously in length, height, and speed - up to 500 feet long, about 15 feet high and 250 feet per day.
iv. There is a distinct, direct relation between bed-wave length and stage.
v. Scour produces a coarsening of the bed material.
vi. There is a rough, but distinct, correlation between grain size of bed material and depth of flow.
vii. Grain size of bed sand in Ladner Reach is relatively fine, and consistent with calculations from regime theory in terms of relative discharge.
viii. The heavy deposit from the 1950 freshet in the head of Ladner Reach had reduced to about half by the end of April, 1951.

PRETIOUS, E.S. and VOLLMER, E., 1960.
Study and Proposal for the Elimination of Dredging at Ladner Slough and the Improvement of Ladner Channel for Navigation, Canada. Department of Public Works, Fraser River Model Project, Report FRM-234; 16 pp. (Mimeo).

This study was made to assess the magnitude and causes of the persistent shoaling problem in the Fraser River at Ladner and to propose a practical remedial solution.

In order to thoroughly assess the river problem at Ladner, a study of the Public Works of Canada sounding maps and dredging records, covering a period of years for the Ladner area, had to be made. This study revealed that an average of about 78,000 cubic yards of river-bed material was removed annually from the entrance to Ladner Slough and from the Slough itself (Fig. 1), over the past 10 years. Furthermore, it was found that the two "Cut-off Channels" north of "Ladner Island" (tentative naming for convenient reference to plans) had increased their depths considerably during the past 10 years, while the depths in Ladner Channel south-eastward of the Island, had decreased. The study also showed that there is a possibility that the two Cut-Off Channels north of Ladner Island could develop further, which would result in a complete shoaling of the bend in Ladner Channel immediately fronting the town of Ladner. This possibility, if it materialized, would eliminate this frontage and Ladner Slough as mooring grounds for fishing boats and other small vessels.

These findings showed that it was necessary to extend the improvement proposal beyond the limits stated above and to incorporate river-training structures which would ensure the development of the downstream end of Ladner Reach and Ladner Bend into a stabilized channel of adequate width, depth and alignment. By imposing a suitable curvature on the flow past the entrance to Ladner Slough, shoaling there, and in the Slough, would be eliminated.

Report contains 1" = 400' blueprint map of Ladner bifurcation area with frequent soundings.

PRETIOUS, E.S. and VOLLMER, E., 1960 (March 31).
Historical Review of River Training and its Effects in the New Westminster Area, Fraser River, B.C. Canada. Department of Public Works, Fraser River Model Project Rpt. FRM-223; 38 pp + tables and figures.

Contains several fold out maps showing soundings in trifurcation region (earliest is 1898). Also has river cross-sections.

PRETIOUS, E.S., VOLLMER, E. and BARLOW, J.E., 1961 (July 15).
Fraser River Model Studies and Prototype Confirmations. Canada. Department of Public Works. Fraser River Model Project. Rpt. FRM-235; 27 pp. (Mimeo).

Report contains several large scale maps with soundings and several photos.

PRETIOUS, E.S., VOLLMER, E. and MERCER, A.G., 1957.
Fraser River Model Tests, Deas Island Tunnel. Memorandum to Foundation of Canada Engineering Corporation Limited. 20 pp. (Mimeo).

Fig. 1 shows bed contours below local low water (post freshet - 1955) in Ladner bifurcation area.

PUBLIC WORKS CANADA, 1976.
Proposed improvements to the shipping channel on the Fraser River from New Westminster to the Strait of Georgia. Interim Report. Pacific Region Office, Vancouver, 88 pp.

A study to determine the feasibility of establishing a 40 ft. draft navigation channel in Fraser River from the mouth upstream to New Westminster.

PUBLIC WORKS CANADA, 1977.
"The Fraser - Waterway to the Pacific - Proposed Navigation Channel Improvements". Pacific Region Office, Vancouver. 23 pp.

A summary of studies carried out by Public Works to determine the feasibility of providing a channel in the Fraser River from its mouth to New Westminster to accommodate ships with up to a 40ft draft.

QUICK, M.C., 1965.
River Flows, Forecasts and Probabilities. American Society of Civil Engineers, Proceedings, J. Hydraulics Division, 91; No. HY3: 1-18.

A flow forecasting system is built up for calculating daily flows from meteorological and snow data for the Fraser River. The system is based on energy input to the snowpack together with the response of the river system that is considered to be analogous to a highly damped spring-mass system.

Using this forecasting system, various simple melt patterns are examined and it is shown that as the melt rate becomes high, the river becomes increasingly insensitive to any further increases in melt rate. Hence, useful conclusions can be drawn concerning maximum probable flows. Furthermore, the individual probabilities of the various meteorological and hydrological factors involved in producing high flows can be assessed and, therefore, their composite probability can be determined. It is considered that when only short records exist for a given river, this composite method of calculating flood probabilties is more reliable than extrapolation of the short term river flow data.

RAWN, A.M., HYDE, G.G., and OLIVER, J., 1953.
Sewerage and Drainage of the Greater Vancouver Area, British Columbia. Vancouver Sewerage and Drainage Board, 278 pp.

Contains information on water mass movements into Fraser River Estuary (pp. 102-109).

READ, P.B., 1960.
Geology of the Fraser Valley Between Hope and Emory Creek, B.C. University of British Columbia, Department of Geology, M.Sc. Thesis, 145 pp.

Contains some structural information on Fraser Valley in the area.

RILEY, J.P., 1963 (October 23).
Lower Fraser River: Dyke and Flood Profiles. British Columbia Department of Lands, Forests and Water Resources. Water Resources Service. Water Investigations Branch. Report 1171. 2 pp. + table, maps.

Profiles from Sandheads to mile 83 (2 1/2 mi. east of Rosedale Bridge) for floods of 1894, 1948 and 1950.

RIPLEY, KLOHN and LEONOFF INTERNATIONAL LIMITED, 1970.
"Richmond Dykes - Peat Studies".

This report presents recommendations concerning the rehabilitation of dykes resting on peat and weak organic silt foundation soils in Richmond. The report includes floodplain borehole data.

RYCKBORST, H., 1969.
"A parametric Streamflow Simulation of the Fraser River Basin" Engineering Institute of Canada Annual Meeting, Vancouver.

Daily runoff simulation from the Fraser River Basin based on the "no surface runoff" concept combined with the "100 percent ground-water runoff" assumption is presented. For a basin of this size, the system amplitude, used for matching the rainfall and stream flow volumes, is ten to twenty times more sensitive than the system dampening parameters.

RYCKBORST, H. and CHRISTIE, R.O., 1977.
"Feasibility of Electromagnetic, Streamflow Measurement Using the Earth's Field", Hydrological Studies Bulletin, Vol. 12, 1977, pp. 241-255.

Results are presented from experimental electromagnetic streamflow measurements on the Fraser River near Port Mann. The method was based on measuring the E.M.F. induced by the flow of river water moving through the earth's magnetic field. An electrical analog model was used to relate the measured potentials to streamflow velocities. Interpretation of the measurements was complicated by voltages induced from adjacent transmission lines, pipelines, underwater cables and electrochemical phenomena in groundwater. However the initial results demonstrated the feasibility of measuring large tidally varying flows.

RYDER, J.M., 1972.
Pleistocene Chronology and Glacial Geomorphology: Studies in Southwestern British Columbia in Slaymaker, O. and McPherson, H.J., editors, Mountain Geomorphology, B.C. Geographical Series, No. 14. Vancouver, Tantalus Research, 63-72.

First section deals with Pleistocene Chronology of the Lower Fraser Valley.

SCOTTON, S., 1978.
"The Outer Banks of the Fraser River Delta; Engineering Properties and Stability Considerations" M.A.Sc. Thesis, Dept. of Civil Engineering, U.B.C. 127 p.

Based on geological, geomorphological and engineering reports published on the Roberts Bank and Sturgeon Bank, the stability of the area is reviewed.

The upper 80 feet of sediments, which is the zone of concern for strength analysis, are primarily granular in nature. These sediments exist at a medium to loose density with a relative density as low as 40 percent. Some of the deeper sediments are moderately compressible in nature and are presently normally consolidated.

The nature of the surficial sediments is such that there is the possibility of earthquake induced liquefaction. Methods of assessing the probability of liquefaction are discussed.

The subaqueous slopes of Roberts Bank and Sturgeon Bank, which average 1.5 degrees but exceed 23 degrees in a few spots, are shown to be at least nominally stable with respect to mass wasting. There are some indications that these slopes could be subject to erosional instability.

SANDILANDS, R.W., 1971/72.
"Hydrographic Charting and Oceanography on the West Coast of Canada from the Eighteenth Century to the Present Day". Proceedings of the Royal Society of Edinburgh, Sec B73, pp. 75-83.

All major exploration voyages and hydrographic studies on the West Coast of Canada since 1749 are described. Describes some of the early surveys at the mouth of the Fraser in 1857 by Captain Richards, H.M.S. Plumper.

SEDIMENT SURVEY SECTION, WATER SURVEY OF CANADA, 1970.
Hydrometric and Sediment Survey, Lower Fraser River: Progress Report, 1965-1968. Canada. Department of Energy, Mines and Resources. Inland Waters Branch. Ottawa. 133 pp.

The progress of the hydrometric and sediment survey of the Lower Fraser River for the period 1965 to 1968 inclusive is described in this report.

Although hydrometric data for the Lower Fraser River have been collected since 1876, the sediment survey did not become fully operational until the spring of 1965. The sediment survey program was intended to provide streamflow, suspended sediment and bed load discharge and other related data for the Lower Fraser River region. These data are used in design, operation and maintenance of river channels and hydraulic works and facilities.

The operational aspects of the survey are outlined and described in detail. These include the equipment used, the field survey conditions and survey techniques, methods of analysis and interpretation of the data.

Preliminary results of the survey are illustrated by means of tables and graphs. Some of the pertinent data are similarly compiled in the appendices of the report.

Several conclusions with respect to the hydrometric and sediment surveys are presented. Finally, recommendations are made to continue with the present surveys for at least an additional ten years and to include in these surveys the delta region downstream from the Fraser River at Port Mann.

SERVIZI, J.A., and BURKHALTER, R.A., 1970.
Selected Measurements of Water Quality and Bottom Drilling. Organisms of the Fraser River System, 1963-1968. International Pacific Salmon Fisheries Commission. Manuscript Report, 70 pp.

SHEPPERD, J.E., 1979.
"Development of a Salt Marsh on the Fraser Delta at Boundary Bay, B.C., Canada". M.Sc. Thesis, U.B.C. 99 pp.

The development of a late Holocene salt marsh was studied on the inactive part of the Fraser Delta at Boundary Bay. Present-day vegetation zones in the western part of the Bay, were distinguished in the salt marsh and were related to zones found in cores obtained in a transect across the marsh. A sequence of development, related to elevation, was determind. A radiocarbon date on organic silts at a depth of 35 to 40 cm suggests that salt marsh development commenced 320 ± 70 years B.P.

A former salt marsh peat is now partially buried and being actively eroded where exposed, in eastern Boundary Bay. A palaeoenvironmental reconstruction suggests the peat started developing in fresh water and was later successively inundated by marine water and a salt marsh developed, as seen by an increase in the abundance of chenopod pollen. Subsequent emergence of the salt marsh was accompanied by the development of an increasingly diverse vegetation.

SHEPARD, F.P., MILLIMAN, J.D., 1978.
"Sea-floor currents on the Foreset Slope of the Fraser River Delta, B.C." Marine Geology, V. 28, No. 3/4, pp. 245-251.

At the shallow heads of canyons and seavalleys (shoaler than about 250 m), current meter records have shown high frequency of up-and down-valley alternation, but in the seavalley off the Fraser Delta at an axial depth as shallow as 85 m, the alternation is clearly in phase with the tides. The explanation is thought to be related to the large range of the tides. At 85 m in Fraser Seavalley, the currents run up the valley with the rising tide and down the valley with the ebbing tide. The fastest currents are found during the diurnal ebb tides of the spring tide period. The record at 220 m axial depth shows essentially an inverse relation to the tides so that the current is flowing upvalley during ebbs and down during floods. This contrast is interpreted as perhaps due to internal waves of tidal period moving down the valley axis.

SIMMONS, G.E. and BUCHANAN,J., 1955 (January).
A Preliminary Report on Bank Erosion on the Lower Fraser River. British Columbia. Department of Lands and Forests. Water Rights Branch. Water Resources Investigations. Report 278. 53 pp. + figs.

Along the Fraser River between Agassiz and the Pitt River, nearly 22 miles of bank is being subjected to severe erosion. A further seven miles of bank has been stabilized by the placement of rock or by the construction of timber walls or groins. From a field investigation of the problem of erosion in the valley, it is apparent that certain sections, notably in the Agassiz and Albion areas, are the cause of some considerable worry to local residents. In particular, the recession of the bank at Albion has so reduced the distance from the river to several homes, that at the present rate of erosion, these houses are likely to be untenable within two years.

In all, forty-one points along the banks of the Fraser between the above-mentioned limits showed erosion to be occurring at various rates. While some attempt has been made to indicate the erosion rate on the basis of a five-year period (1949-1954), changes in river bars with subsequent repositioning of the main channel can alter the rate of recession during one season.

A considerable number of sections of erosion are in the immediate vicinity of dykes and in one or two instances, the dyke forms part of the bank with no berm for protection.

Section-by-section data for 42 sites include bank material, height, slope, depth of water, underwater slope, bank condition, proximity of dyke, rate of erosion (from comparison of air photographs), and land evaluation.

SINCLAIR, F.N., 1961.
A History of the Sumas Drainage, Dyking and Development District, Chilliwack Historical Society (unpublished).

The history of the reclamation of Sumas Lake and the construction of the Vedder Canal are described by the former chief engineer of the project. Early ungauged floods on the Fraser River are described.

SLAYMAKER, H.O., 1972.
Physiography and Hydrology of Six River Basins in J.L. Robinson, editor, Studies in Canadian Geography: British Columbia. Toronto, University of Toronto Press, pp. 32-68.

Includes examination of Fraser River Basin.

SLAYMAKER, H.O., 1972.
Recent Fluctuations in the Mean Discharge of the Fraser River in R. Leigh, ed., Contemporary Geography: Research Trends, B.C. Geographical Series, Occasional Papers in Geography, Number 16. Vancouver, Tantalus Research, 3-13.

An unresolved problem is to explain an increase in the mean discharge of the upper Fraser basin of 19 percent between 1953-57 and 1963-67. The only possible source is that of precipitation above the 3,000 foot level where there are no precipitation gauges. The meteorological factors producing such a local increase in high level precipitation during 1958-67 probably relate to the mean position of the Arctic front. The evidence given here suggests that the Arctic front must have occupied a more northerly mean position during 1958-67 than in 1953-57.

SLAYMAKER, H.O., 1972.
Sediment Yield and Sediment Control in the Canadian Cordillera <u>in</u> Slaymaker, H.O., and McPherson, H.J., editors, Mountain Geomorphology, B.C. Geographical Series, No. 14, Vancouver, Tantalus Research Ltd., p. 235-245.

This article summarizes the sediment movement problem in British Columbia at 3 scales; namely river basins larger than 25,000 km^2 in area; those of 250 to 25,000 km^2, and those less than 250 km^2.

STANCIL, D.E., 1980.
"Fraser River Estuary Study Water Quality - Aquatic Biota and Sediments" Fraser River Estuary Study Steering Committee, Victoria, B.C. 187 pp.

This report deals with distributional data for algae and aquatic invertebrates and levels of metal contamination in a number of aquatic organisms and sediments. An extensive reference list of water quality reports on the Fraser River is included.

STICHLING, W. and SMITH, T.F., 1968.
Sediment Surveys in Canada. Canada. Department of Energy, Mines, and Resources, Inland Waters Branch, 17 pp.

This paper presents an outline of the Sediment Survey Program of the Water Survey of Canada, its current status including technical methods, instrumentation and data available, and a look at what is planned for the future of the program.

(Figure 12 shows a graph of stage, velocity, suspended sediment concentration and bed load of Fraser River at Port Mann for a 56 hour period in June).

STYAN, W.B., 1981.
The Sedimentology, Petrography and Geochemistry of Some Fraser Delta Peat Deposits. M.Sc. Thesis, Dept. of Geological Sciences, University of British Columbia, 188 pp.

On the recent lobe of the Fraser River Delta peat deposition is occurring in three distinct settings - the destal delta plain, the transitional upper delta to lower delta plain and the upper delta plain to alluvial plain.

The distal lower peats are dominated by sedge grass facies. They overlie thin fluvial sequences which in turn overlies coarsening upwards sequences of prodelta clays and silty clays. The lower delta plain - upppe delta plain peats developed from interdistributary brackish marshes. Sphagnum dominated sequences succeeded in areas where fluvial influences were minimal. Sedge grass peats intercalate with silty clay overbank and sandy splay deposits along active channel margins. Alluvial plain peats accumulated in freshwater brackish backswamps. Earliest sedge clay and gyttjae peats developed over thin fining upwards cycles of silty sand, silt and clay.

SWAN WOOSTER ENGINEERING, LTD., 1967.
Outer Port Development at Vancouver, British Columbia: A Planning Study. Prepared for the National Harbours Board of Canada, Vancouver. File 1835; various pagination.

Contains summary results of soil mechanical investigations on Sturgeon and Roberts Bank (cf. Cook, 1967) and in Boundary Bay (cf. Golder, Brawner, 1967).

SWAN WOOSTER ENGINEERING, LTD., 1968.
Roberts Bank Stage 1. Dredging and Reclamation. Prepared for the National Harbours Board of Canada, Vancouver. 10 sheets.

Design drawings: includes soil information sheet, synthesizing the results of Cook (1968).

SWINBANKS, D.D., 1979.
"Environmental Factors Controlling Floral Zonation and the Distribution of Burrowing and Tube-Dwelling Organisms on Fraser River Delta Tidal Flats, British Columbia". Ph.D. Thesis, Dept. of Geological Sciences and Institute of Oceanography, University of British Columbia, 274 pp.

The distribution of various burrowing and tube dwelling organisms, their biogenic sedimentary structures and the rates they turn over sediments were investigated on three different tidal flat environments of the Fraser Delta.

The intertidal region of Boundary Bay has five floral sedimentological zones delimited primarily by elevation and exposure. These are from the shoreline seawards, the saltmarsh, algal mat upper sand wave, eelgrass and lower sandwave zones.

An estimated 4.25 x 10^8 <u>Abarenicola</u> on Boundary Bay tidal flats annually rework about 10^6 m^3 of sand. This bioturbation may be a factor limiting the extent of the algal mat zone.

SWINBANKS, D.D., MURRAY, J.W., 1981.
"Biosedimentological zonation of Boundary Bay Tidal Flats, Fraser River Delta, B.C." Sedimentology, v. 28, p. 201-237.

Boundary Bay tidal flats have surface sediments consisting almost entirely of fine, well sorted sands which show a gradual fining-shorewards trend. Five floral/sedimentological zones form distinct bio-facies: the saltmarsh, algal mat, upper sand wave, eelgrass and lower sand wave zones.

In the algal mat and eelgrass zones micro-topography of biogenic origin, only a few centimetres high, creates lateral heterogeneity within the zonal biofacies. In the upper sand wave zone, very low amplitude (a ^{d} 0.1 m) symmetrical sand waves ($_{b}$ ^{d} 30 m) of probable storm-wave origin have a similar effect. In the lower sand wave zone, sand waves (a ^{d} 0.5 m, $_{b}$ ^{d} 60 m) are formed by tidal currents or wave action and physical sedimentary structures dominate over biogenic ones.

The densities of a number of macrofaunal organisms which produce distinctive biogenic sedimentary structures were determined.

TABATA, S., 1955.
Oceanographic Conditions in Steveston Harbour during normal discharge of the Fraser River. Fisheries Research Board of Canada, Pacific Station, Nanaimo. Progress Report No. 104: 26-29.

Describes oceanographic conditions in the artificial tidal basin at Steveston through a tidal cycle for flows less than 100,000 cfs. of the river. Salt water intrudes at high tide and is withdrawn after low tide.

TABATA, S., 1965.
Sea water intrusion in the Steveston Cannery Basin. Fisheries Research Board of Canada, Pacific Station, Nanaimo. Progress Report. No. 106: 3-6.

Describes persistence of sea water in Steveston Cannery Basin except during the freshet period (Q > 300,000 cfs.). Compares more efficient tidal flushing in the river channel with that in the basin.

TABATA, S.F., GIOVANDO, L.F., DEVLIN, D., 1971.
"Current Velocities in the Vicinity of the Greater Vancouver Sewerage and Drainage District's Iona Island Outfall - 1968". Fisheries Research Board of Canada, Technical Report 263. 110 pp.

The rapidly increasing population in the area served by the Iona Island treatment plant, led to the possibility of health and aesthetic problems arising. In response to these concerns a study of the surface and sub-surface circulation was carried out in 1968. Three methods were employed: current metering at fixed stations, release of free-floating surface current followers and visual/aerial photographic tracking of the movement of surface water containing tracers such as dykes or suspended silt.

TAMBURI, A.J., 1976.
Regime Studies of the Lower Fraser River. Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions, American Society of Civil Engineers, p. 1680-1699.

The influence of the post-glacial history of the Fraser Valley on present day channel processes below New Westminster is described. Sounding data and investigations using a clamshell dredge were used to identify the presence of non-alluvial sediments in the river channel. Glacial and outwash deposits near the Surrey Uplands were identified in the main channel opposite Annacis Island.

The main factors governing channel depth along the river were found to be discharge, top width and the geotechnical properties of the river bed. Empirical correlations were developed using the extensive sounding data that has been collected by Public Works Canada. The equations were used in conjunction with a mobile bed hydraulic model to design river training structures along the river.

TAMBURI, A.J., 1979.
"Sediment and Morphologic Studies of the Lower Fraser River", Fourth National Hydrotechnical Conference, The Canadian Society for Civil Engineering, 1979, pp. 566-581.

Sediment transport measurements from the Fraser River at Mission and Agassiz are summarized. (For complete results see "Analysis of Federal Sediment Survey Data Taken on the Lower Fraser River", W.C.H.L., 1978).

Channel geometry data from the sand-bed portion of the river downstream of Mission are also presented. Historical channel changes in the main channel near Ladner and Steveston, North Arm and Canoe Pass are also described.

TAMBURI, A., HAY, D., 1978.
An Introduction to River Mechanics and the Lower Fraser River. Canada Department of Public Works, Pacific Region, Marine Civil Engineering Section, Vancouver, 72 p.

Provides a general account of river processes on the Lower Fraser River for non-specialist readers.

TAMBURI, A.J., HAY, D., 1981.
Hydrodynamics and Sediment Patterns on the Fraser River Foreshore. 5th Canadian Hydrotechnical Conference, The Canadian Society for Civil Engineering, Fredericton, New Brunswick, p. 537-558.

This report presents some conclusions of tidal flow velocities and directions on Sturgeon and Roberts Bank from a very limited number of temporary current metering stations. Some analysis of sediment processes on the tidal flats is also presented.

TERZAGHI, K., 1962.
Discussion of Mathews, W.H., and Shepard, F.P., 1962, Sedimentation of the Fraser River Delta, British Columbia. American Association of Petroleum Geologists, Bull., 46: 1438-1443.

The author offers an explanation for the topographical configuration of the Fraser River delta front.

Two figures, showing boring records for drillholes 3 and 10 miles upstream from the mouth of Fraser River are included.

A discussion of the influence of the depth of water on properties of sediments and effect of time on physical properties of sediments conclude the paper.

THOMAS, D.J., 1975.
"The Distribution of Zinc and Copper in Georgia Strait, British Columbia: Effects of the Fraser River and Sediment Exchange Reactions." M.Sc. Thesis, Dept. of Chemistry and the Institute of Oceanography, University of British Columbia, 110 pp.

The distribution of dissolved and particulate copper and zinc was studied at a series of stations in Georgia Strait between May, 1973 and May, 1974. Large time-dependent fluctuations in concentrations were observed and related to the discharge of the Fraser River. Most of the large scale features were related to a release of copper and zinc from river-borne sediment as it passes from fresh to salt water.

THOMSON, R.E., 1974.
"Longshore Current Generation by Internal Waves in the Strait of Georgia", Canadian Journal of Earth Sciences, v. 12, No. 3, pp. 472-488.

Presented in this paper is a derivation of the longshore current generated by breaking lowest mode internal waves in a two layer fluid of slowly shallowing depth, with emphasis on the nearshore region of the Fraser River delta. It is proposed that such a current, having a maximum speed of order $10^4/{}^{e}v$ cm^3/s^2 (equal to 10^2 cm/s for reasonable vertical eddy viscosities, ${}^{e}v$ of 10^2 cm^2/s) and a width of order kilometers based on measured water properties and internal wave characteristics in the Strait, is responsible for the persistent northward flow observed to be associated with the delta in summer. Accordingly, it is suggested that the longshore current would have important implications to sedimentation rates and pollutant dispersal in the delta area, with greatest effects possibly occurring in summer and fall when the stratification in the Strait of Georgia is most pronounced.

THOMSON, R., 1981.
Oceanography of the British Columbia Coast. Canadian Special Publication of Fisheries and Aquatic Sciences 56, Department of Fisheries and Oceans, 291 pp.

Reviews tidal and oceanographic processes in the Strait of Georgia and Fraser River estuary (p. 139-169).

TIFFIN, D.L., MURRAY, J.W., MAYERS, I.R. and GARRISON, R.E., 1971.
Structure and Origin of Foreslope Hills, Fraser Delta, British Columbia. Bull. Canadian Petroleum Geology, 19; 589-600.

Several continuous seismic profiles across the Fraser River delta, British Columbia, provide insights into the internal structure and possible origin of foreslope hills similar to those found on other major deltas. The continuity and wave-like progression of the structures suggests that these hills are the result of downslope movement of a large mass of sediment. It is estimated that the Fraser delta slump deposits are at least 200 years old.

TUPPER, W.A., 1977.
A Photogrammetric Study of the Morphology of the Fraser River Delta, Intertidal Zone. Survey Department, British Columbia Institute of Technology, Unpublished report, 34 p.

Discusses some of the problems in using photogrammetric techniques for mapping shoreline changes in the intertidal zone of the delta. Rigorous photogrammetric mapping procedures were used to plot the water line from photographs taken in 1938, 1972, and 1975.

TYWONIUK, N., 1972.
Sediment Budget of the Lower Fraser River (Estuary). 12th Conference on Coastal Eng., Vancouver, British Columbia, July 10-14, 1972. 1105-1122.

The Lower Fraser River is an area of active sedimentation. The dynamic processes influenced by river discharge, tides and winds are probably the most important factors in the transport and deposition of sediments in the estuary. The main part of the Fraser Estuary is vertically homogeneous (non-stratified) and the sediments are transported progressively seaward and are accumulated near the limit of net landward flow. The lower estuary is stratified and coarse sediments are trapped near the toe of the salt wedge while the fine sediments are carried seaward with the outflowing river water.

The hydrometric and sediment survey of the lower Fraser River are described. Survey results are used in determining the sediment balance of the river reach. In the budget analysis the river and estuary are divided into four consecutive reaches the sediment discharges are subdivided to represent about 10 particle size ranges and the balance is then determined for each reach and particle size range.

Conclusions are drawn with respect to the sediment transport and depositional characteristics, annual variations, and the agreement between the sediment entering the estuary and the sediment dredged.

TYWONIUK, N., 1973.
Sediment Budget of the Lower Fraser River in Canada. National Research Council, Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, Fluvial Processes and Sedimentation. 9th Hydrology Symposium, University of Alberta, Edmonton May 8 and 9, 1973. Proceedings. Canada. Department of the Environment, Inland Waters Directorate, 624-638.

The Lower Fraser River is an area of active sedimentation. The dynamic processes influenced by river discharge, tides and winds are probably the most important factors in the transport and deposition of sediments in the estuary. The main part of the Fraser Estuary is vertically homogeneous (non-stratified) and the sediments are transported progressively seaward and are accumulated near the limit of net landward flow. The lower estuary is stratified and coarse sediments are trapped near the toe of the salt wedge while the fine sediments are carried seaward with the outflowing river water.

The sediment balance of the Lower Fraser River, as a result of both natural and man-induced dynamic processes, is represented factually by means of a sediment budget. In this analysis, the river and estuary are divided into four consecutive reaches, the sediment discharges are subdivided to be representative of several particle size ranges and the balance is then determined for each reach and particle size range. The budget is based on five years of continuous data (hydrometric, suspended sediment and bed load data) at four stations on the main channel of the Lower Fraser River and at five tributaries and on miscellaneous data in other parts of the estuary.

An attempt is made to interpret some of the results and to identify and describe the causative factors. Finally, conclusions are drawn with respect to the transport and depositional characteristics, annual variations, and the agreement between the sediment entering the estuary and the sediment dredged.

TYWONIUK, N., STICHLING, W., 1973.
"Sedimentation Phenomenon of the Fraser River", International Association of Hydraulic Research, International Symposium on River Mechanics, Bangkok, Thailand. V. 1, Paper A-69, pp. 805-818.

From a study of suspended sediment and bed load data at Hope, Agassiz, Mission and Port Mann the following observations and conclusions are made:

At Port Mann, the sediments transported are comprised largely of sands and silts. Upstream from Port Mann, gravels and boulders are transported by the river during very high flow and are deposited at about the tidal limit between Agassiz and Mission. A natural sorting of grain sizes occurs, the coarser particles being deposited in the upstream reaches. In the most active dredging reach, between Port Mann and Steveston, the sorting appears to terminate resulting in a river bed composed of relatively uniform grain sizes.

Clay and silt sizes constitute only a very small fraction of the bed material at the four main channel stations. The absence of this fraction indicates that silts and clays are deposited nearer to the foot of the delta.

A comparison of dredged and measured quantities indicates that more coarse material is dredged than is transported by the river to the dredging regions considered.

WALDICHUCK, M., MAKERT, J.R., and MEIKLE, J.H., 1968.
Fraser River Estuary, Burrard Inlet, Howe Sound, and Malaspina Strait Physical and Chemical Oceanographic Data, 1958-1966. Fisheries Res. Board of Canada, MS Rept. No. 929. Vol. 1: Sept. 1957-Feb. 1962, 244 pp., Vol. II: Sept. 1962-July 1966, 277 pp.

Contains oceanographic data for five stations in the main channel of Fraser River between Steveston and Port Mann, taken in late summer during the years 1957-1966 (and February 1962). Data include temperature, salinity, density DO, pH for several depths, BT trace, and bottom condition and Secchi transparency data at each station.

WALLIS, D.M., 1979.
Ground Surface Motions in the Fraser Delta Due to Earthquakes. M.A. Sc. Thesis, Dept. of Civil Engineering.

The dynamic properties of the Fraser Delta soils were calculated and a numerical model was developed based on wave propogation theory. It was estimated that under large earthquakes liquefaction is likely to occur in the upper few meters of the delta sand deposits but is unlikely below the 6 to 9 m depth. The report contains descriptions of the mechanical properties of the delta soils from unpublished geotechnical borehole data.

WALLACE, R., 1968.
River Training Works on the Fraser River in Seminar on Alluvial Problems in River Engineering, April 1968. Proceedings. Organized by the Vancouver Branch, Engineering Institute of Canada, in co-operation with the Extension Department, University of British Columbia. 64-79.

INTRODUCTION
PHYSICAL CHARACTERISTICS OF THE FRASER RIVER
SEDIMENT LOAD
CHANNEL MAINTENANCE
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(d) Deas Island Bankline Rock Protection
The New Westminster Trifurcation Project
Model Studies for the Trifurcation Project
Evolution of the Structures
Channel Improvements Resulting from The Project
CONCLUSION

WALLACE, R., 1970.
The Trifurcation Project, Fraser River, British Columbia, 4th Marine Engineering Seminar, October, 1970, Vancouver, British Columbia. Canada. Department of Public Works, Pacific Region, British Columbia District: 24 pp.

This paper deals with a system of river training works designed and constructed to reduce annual maintenance dredging and improve harbour conditions in the vicinity of New Westminster. Includes charts of the channel, details of shoaling problem and summary information on annual dredging.

WARD, P.R.B., 1976
Seasonal Salinity Changes in the Fraser Estuary, British Columbia. Canadian Journal of Civil Engineering, Vol. 3, p. 342-348.

A systematic set of measurements are presented documenting the change in the tip of the salt water wedge in the Fraser estuary as a function of fresh water discharge. All measurements were made under similar tidal conditions, just after lower high water. The tip of the salt wedge was found to be displaced a distance of 22 km seaward as the freshwater discharge increased from 850 m^3/s to 9000 m^3/s.

Vigorous surface to bottom mixing was observed during large ebb flows. This mixing was sufficiently strong to break up the wedge over a large part of the estuary.

WASLENCHUCK, D.G., 1973.
The Analyses of Sediments from the Fraser River, the Point Grey Cliffs, and Beaches, and Spanish Banks, at Vancouver, British Columbia. University of British Columbia. Department of Geological Sciences, B.Sc. Thesis, 80 pp.

Sieve analysis, heavy-mineral suite studies and light-mineral examination have each provided evidence for the presence of Fraser River sediments on Spanish Banks. Fraser River sand occurs on the seaward portion of Spanish Banks. The beaches around Point Grey, and the shoreward portion of Spanish Banks are supported by sand derived from the cliffs. A zone of mixed sand from both sources, the Fraser River and the cliffs, exists between the seaward and shoreward portions of Spanish Banks.

The Fraser River current which sweeps around Point Grey is not barren of sediments, and therefore its capacity to strip the beach of sediments is not great. Removal of material from the toe of the cliffs is probably due not to the Fraser River discharge, but rather to alongshore and littoral currents produced by wave action on the beach.

WATER PLANNING AND OPERATIONS BRANCH, OTTAWA, 1972.
"Streamflow Synthesis Studies for the Fraser R. Basin".

Monthly and daily streamflow generation models are described, as part of the Fraser River upstream storage study. The models satisfactorily reproduce most of the relevant characteristics of the historical records.

WESTERN CANADA HYDRAULIC LABORATORIES LTD.

The following is a partial list of engineering reports dealing with river training, navigation and sedimentation on the Lower Fraser River. Most reports were prepared for government agencies such as Water Survey of Canada and Public Works Canada and may not be accessible to the general public. However much of the results from these studies have been published in journals or conference proceedings, as noted below.

1973

- Hydraulic Model Studies, Fraser River: Phase 3 - Trifurcation, Siltation, and Fraser-Surrey Dock Extension. 46 pp. + figures. Prepared for Canada. Department of Public Works, Vancouver, B.C.

1976

- Interim Report, Analytical and Hydraulic Model Studies, Lower Fraser River. Prepared for Public Works Canada (see Tamburi, 1976).

- Borrow Pit Migration and Effects on Tidal Hydraulics in the Pitt River and Fraser River System. Prepared for Public Works Canada.

1977

- Feasibility Study, Development of a Forty Foot Draft Navigation Channel, New Westminster to Sandheads. Prepared for Public Works Canada (see Tamburi, 1976).

1978

- Final Report, Analysis of Federal Sediment Survey Data Taken on the Lower Fraser River. Prepared for Water Survey of Canada (unpublished).

This study was undertaken to analyze the available Water Survey of Canada sediment transport measurements at Hope, Agassiz, Mission and Port Mann. Data collection techniques were also examined and further improvements to the measurement program were suggested.

Bivariate and multivariate regression techniques were used to develop empirical correlations between sediment loads and flow parameters such as discharge, velocity, depth and slope. At Agassiz and Mission multivariate equations were developed to predict total bed material load. (See Tamburi, 1979).

- Roberts Bank Hydrologic Study, Proposed Vancouver Island Pipeline. (Prepared for B.C. Hydro).

- Final Report, Queensborough Bridge Scour Study. Prepared for the Ministry of Highways.

- Final Report, Hydraulic Model Study Wahleach Island Debris Storage.

- Preliminary Analysis of the Impact of the McGregor River Diversion on the Deep Draft Navigation Channel of the Fraser River. (see Demelow, Tamburi, 1979). Prepared for Public Works Canada.

1979
- A Pilot Sand Tracing Study on the Fraser River Foreshore. Prepared for the Department of Supply and Services, Canada.

1980
- Hydraulic and Related Studies on Roberts Bank and Review of Existing Oceanographic, Hydraulic and Geotechnical Information on Steveston Bank (see Tamburi, 1981).

- Physical Impact of the Proposed Improvements to the Fraser Navigation Channel. Prepared for Public Works Canada.

1981
- Hydraulic Model Studies of Ladner Fishing Harbour. Prepared for Public Works Canada.

- Report on Hydraulic Model Studies for Roberts Bank Port Development. Prepared for the B.C. Development Corporation.

- Conceptual Design of Erosion Control at Carey Point.

- Final Report on Dredge Spoil Disposal at Steveston South Jetty. Prepared for Public Works Canada.

1982
- Hydraulic Model Studies of Annacis Island Bridge Crossing over Annieville Channel. (see McLaren, 1983). Prepared for Ministry of Transportation and Highways.

- Report on Hydraulic Model Studies of Scour and Scour Protection at Annacis Channel Movable Bridge. Prepared for the Ministry of Transportation and Highways.

WHITE, R.J., 1962 (November).
Report on Flood Frequencies at Selected Points in the Fraser River Basin. Canada. Department of Northern Affairs and National Resources. Water Resources Branch. Vancouver, 19 pp. + Appendices.

Flood frequency data are presented for key points in the Fraser River basin (mainly Lower Mainland and main-stem stations). Rank-plotting methods are used.

WHITE, G.B., 1937.
A History of the Eastern Fraser Valley Since 1885. M.A. Thesis, University of British Columbia, 165 pp.

This thesis gives a concise summary of events to 1885. After this period an exhaustive description of the development of Transportation, Agriculture (including Dyking), Settlement, Social Institutions, Communications, and other further Economic Development is included.

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WHITE, W.H., and NORTHCOTE, K.E., 1962.
Distribution of Metals in a Modern Marine Environment. Economic Geology, 57: 405-409.

Gives distribution of fine sediments in Mud Bay (% - 200 mesh), and distribution of iron, sulphur, copper and zinc in the surface 2 feet of sediment (113 samples were taken at 1000 foot intervals). Discussion indicates that iron is controlled by deposition of detrital magnetite by normal processes; sulphur is associated with fine, organic-rich sediments. Copper and zinc also show affinities for finer sediments.

WHITFIELD, P.H., SCHREIER, H., 1981.
"Hysteresis in Relationships between Discharge and Water Chemistry in the Fraser River Basin, British Columbia" Limnology and Oceanography, 26, pp. 1179-1182.

River loading rates are frequently determined from discharge and water chemistry relationships using regression techniques. Such methods were inadequate in a study of the Fraser River where hysteresis was present in most sampling stations. Over a 4-year period the year-by-year fluctuations in hysteresis were relatively consistent but there were dramatic differences in its shape and direction between sampling stations in the same river basin. Events on two time scales were discerned: one forming minor loop relationships was related to individual storms, the other forming major loop relationships to seasonal changes. Conventional techniques are inadequate for dealing with this problem.

YUNG, K.Y.C., 1979.
"McGregor River Diversion: Lower Fraser River - Water Level Studies" Fourth National Hydrotechnical Conference. The Canadian Society for Civil Engineering, Vancouver, B.C. V. 1, pp. 196-210.

The studies described in this paper were carried out to assess the effects that a diversion of the McGregor River would have on salmon spawning areas of the Fraser River and tributaries between Hope and New Westminster. Field data in the form of water levels, channel bed topography, water velocities and streamflow records were analyzed to estimate water levels for various Fraser River discharges as determined at Hope.

References not seen

The following references have not been examined. However, their existence has been confirmed by cross-referencing. The primary source of each reference is given with each entry.

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Numerical Model in the Fraser Delta Area - Predicting Height and Velocities Including Circulation on Roberts Bank. Pacific Marine Sciences Report 74.

BORDEN, C.E., 1965.
Radiocarbon and Geological Dating of the Lower Fraser Canyon Archaeological Sequence; 6th International Conference of Radiocarbon and Tritium Dating. Pullman, Wash. June 7-11, 1965. Proc. United States Atomic Energy Commission. Div. Scientific and Technical Information, Springfield, Virginia. 165-178. in Fulton, 1971.

BRITISH COLUMBIA. DEPARTMENT OF LANDS, FORESTS AND WATER RESOURCES. WATER INVESTIGATIONS BRANCH, 1963.
Atlas of Borehole Investigations of Fraser Valley Dykes. File Report. in Jones, 1963.

BRITISH COLUMBIA RESEARCH COUNCIL, 1972.
Water Movement Studies in the South Arm of the Fraser River. Project 1462. For British Columbia Pollution Control Board. File F-26A. In Hoos and Packman, 1974.

BRITISH COLUMBIA RESEARCH COUNCIL, 1973.
Water Quality Studies in the Lower Fraser River. Prepared for the Greater Vancouver Sewerage and Drainage District. Annual Report. In Hoos and Packman, 1974.

Comments on the inverse correlation between sediment median particle size and chemical loading. This is thought to reflect absorption of organically-based materials rather than sediment mineralogy.

BRITISH COLUMBIA RESEARCH COUNCIL, 1973 (July).
Environmental Studies at Iona Island. Prepared for Greater Vancouver Sewerage and Drainage District. 160 pp. in Ricker, 1974.

A classified report of sediments, currents, geochemistry, benthos, climate, and water column properties. Some comments on particle size/chemical load correlations.

CANADA, DEPARTMENT OF ENERGY, MINES AND RESOURCES, INLAND WATERS DIRECTORATE, 1970.
Reverse Flow in the Fraser River for 1969. In Hoos and Packman, 1974.

CANADA, DEPARTMENT OF ENVIRONMENT, INLAND WATERS DIRECTORATE, 1973.
Hydrologic Data on Selected Estuarine Rivers. 56 pp. in Lands Directorate, 1974.

CANADA, DEPARTMENT OF FISHERIES, PACIFIC AREA, 1958.
The salmon spawning ground of the Fraser River below Hope and of the Harrison River in relation to the dredging of shipping channels. Prepared for International Pacific Salmon Fishery Commission, Vancouver, British Columbia. Report 1958-5; 9 pp. + maps. In Hoos and Packman, 1974.

CANADA DEPARTMENT OF NORTHERN AFFAIRS AND NATIONAL RESOURCES, WATER RESOURCES BRANCH, 1963 (April 18).
Key Map, Fraser River Mileages, Agassiz to the Mouth. WRB Plan No. 1750. Vancouver, B.C. in Clark, 1965.

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Fraser River Delta Charts. Prepared by Department of Naval Services. In Ricker, 1974.

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Flood Profile, 1948. Drawing No. 212, Vancouver, B.C. In Clark, 1965.

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GAMBLE, R., 1894 (30 June).
"Report on the Fraser River" Canada. Department of Public Works. Vancouver. In Morton, 1949, p. 1.

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Pitt Lake, Bathymetry. New Westminster, British Columbia. In Ricker and Maximuk, 1974.

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Fraser Valley Soil Survey Mosaics. Scale; 1:25,000. In Ricker and Maximuk, 1974.

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A vegetation study of the islands and associated marshes in the South Arm of the Fraser River, B.C., from the Deas Tunnel to Westham Island foreshore. British Columbia Dept. of Recreation and Conservation, Fish and Wildlife Branch. In Ricker, 1974.

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Preliminary Design Considerations for a Complete Model of the Fraser River Delta. National Research Council of Canada. Report MH-12. In CBA Engineering, 1958.

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Water Quality on the Fraser River for the period 1960-1972, Fraser River at Hope and Fraser River at Mission City. Canada Department of the Environment, Inland Waters Branch, Water Quality Division. In Benedict et al., 1973.

NEWCOMB, R.C., SCEVA, J.E., and STROMME, O., 1949.
Ground-water Resources of Western Whatcom County. United States Geological Survey. Open File Report. 135 pp.

PACIFIC OCEANOGRAPHIC GROUP, 1951.
Data Record - Fraser River Estuary Project 1950. Fisheries Research Board of Canada Joint Committee on Oceanography. 21 pp.

Same title also Manuscript Rpt. Oceanography and Limnology Series. No. 459: 489 pp. In Ricker, 1974.

PACIFIC OCEANOGRAPHIC GROUP, 1956.
Data Record, Fraser River Estuary, Steveston Cannery Basin, August 13, 1954 to October 6, 1955. Fisheries Research Board of Canada, Joint Committee on Oceanography, Nanaimo, British Columbia. Manuscript Report: 33 pp. In Ricker, 1974.

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"Report of a Survey of the Great Flood of 1894" Canada. Department of Public Works. Vancouver. In Morton 1949, p. 1.

SWAN WOOSTER ENGINEERING, LTD., 1967 (April).
Roberts Bank and Sturgeon Bank Harbour Study: Topographic Maps. Scale: 1:18,000, 2 foot contours. Prepared by Lockwood Survey Corporation, Vancouver, British Columbia (Special air photography: Lockwood Survey Project 67-100. Sturgeon Bank and Roberts Bank. Lines 1-5; 1:24,000 and Lines 6-32; 1:12,000). Prepared for the National Harbours Board of Canada, Vancouver.

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Studies in Steveston Harbour Basin. Part I. Sea water intrusion into Steveston Harbour basin (by R.J. LeBrasseur). Fisheries Br. Research Board of Canada. Joint Committee on Oceanography. Manuscript Report; 31 pp. In Ricker, 1974.

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Sea water intrusion into the Fraser River and its relation to the incidence of shipworms in Steveston Cannery Basin. Fisheries Research Board of Canada. Journal. 15; 91-133. (also published as Fisheries Research Board of Canada, Joint Committee on Oceanography, Manuscript Report (1956); 17 pp.) In Ricker, 1974.

THOMAS, J.F.J., 1954.
Industrial Water Resources of Canada: Fraser River Drainage Basin, 1950-51. Canada Department of Mines and Technical Surveys, Mines Branch. Industrial Minerals Division. Publication No. 842. Water Survey Report No. 6. In Inland Waters Directorate Publications List. 1973.

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Clague, Bornhold, 1980; Clague, Luternauer, 1982; Clague et al., 1983; Johnston, 1921, 1922, 1923; Mathews, Shepard, 1962; Terzaghi, 1962.

Delta Morphology
Dutfield, 1969; Johnston, 1921, 1922; Kellerhals, Murray, 1969; Luternauer, 1975, 1976, 1977, 1980; Luternauer et al., 1969; Luternauer, Murray, 1973; Mathews, Shepard, 1962; Medley, 1978; Medley, Luternauer, 1976; Milliman, 1980; Murray et al., 1972.

Dyking
British Columbia Dept. Lands, Forests, 1954; CBA, 1973; Clark, 1963; Federal-Provincial Committee, 1966; Golder, Brawner, 1970; Jones, 1963; Klohn Leonoff, 1974; MacDonald, 1957; Riley, 1963.

Dredging
Blench, 1952; Fisheries Service, 1973, 1975; Canada Dept. Fisheries, 1958; Hawley, 1979; Inland Waters Dir., 1977; Pretious Vollmer, 1960; Swan Wooster Engineering, 1968.

Flood Control
B.C. Dept. Lands and Forests, 1954; CBA, 1973; Clark, 1963, 1965; Federal-Provincial Committee, 1966; Fraser River Board, 1958, 1963; Muir, 1969; Nev, 1972; Potter, 1950; Riley, 1963; Sinclair, 1961.

History
Dawson, 1879; Elliot, 1912; Gellner, 1966; Gibbard, 1937; MacDonald, 1957; Pretious, Vollmer, 1960; Sandilands, 1971, 1972; Sinclair, 1961.

Hydrology

B.C. Energy Board, 1972; Bruce, 1964; Canada Dept. E.M.R., 1969; Clark, 1965; Fraser River Board, 1958, 1963; Keane, 1957; Lee, Lyons, 1980, 1982; Pipes et al., 1970; Quick, 1965; Ryckborst, 1969; Ryckborst, Christie, 1977; Slaymaker, 1972; Water Planning and Operations Branch, 1972; White, 1962; Whitfield, Schrier, 1981.

Littoral Processes

Clague, Bornhold, 1980; Gaspard, 1979; McLaren, Buckingham, 1983; Medley, 1978; Pool, 1975; Tamburi, Hay, 1978, 1981; Thomson, 1981; Waslenchuck, 1973; WCHL, 1979, 1980.

Marshes

Envirocon, 1980; EVS Consultants, 1982; Hebda, 1977; Hillaby, Barrett, 1976; Kellerhals, Murray, 1969; Levings, 1980; Moody, 1978; Shepperd, 1979; Styan, 1981.

Model Studies

Fraser River Model Projects, 1949-1959; Isfeld et al., 1973; Jarlan, 1955; Jarlan, Pretious, 1955; McLaren, McLean, 1983; N.R.C., 1948; Parkinson, 1955; Pretious, 1958, 1961; Pretious, Vollmer, Mercer, 1957; Pretious et al., 1961.

Navigation

Beak Consultants, 1981; Canadian Hydrographic Service, 1971, 1973; Demelow, Tamburi, 1979; Isfeld, 1973; Jarlan, Pretious, 1955; Nev, 1972; Public Works Canada, 1977.

River Training

Envirocon, 1976; Levings, 1980; McLeod, 1979; Pretious, Vollmer, 1960; Tamburi, 1976; Tamburi, Hay, 1978; Wallace, 1968, 1970; WCHL, 1973, 1976, 1977, 1979, 1980.

Salinity Intrusion

Ages, 1979; Hodgins, 1974; Hodgins, Quick, 1972; Hodgins et al., 1977; Hughes, Ages, 1975; Kivisild, 1959; Levings, 1980; Tabata, 1954, 1955, 1965; Tabata, LeBrasseur, 1955, 1958; Ward, 1977.

Sealevel Changes

Clague, 1975; Clague et al., 1982; Easterbrook, 1963; Johnston, 1921; Mathews et al., 1970.

Sedimation

Ashley, 1977, 1980; Ashley, Moritz, 1979; Dutfield, 1969; Garrison, Luternauer, 1969; Garrison et al., 1969; Johnston, 1922; Pharo, 1972; Swinbanks, 1979; Swinbanks, Murray, 1981.

Sediment Size Analysis

Baines, 1952; B.C. Research, 1976; Esler, 1949; Lavkulich, 1971; Mackintosh, Gardner, 1966; Tywoniuk, 1972, 1973; Tywoniuk, Stichling, 1973; WCHL, 1978.

Sediment Transport
British Columbia Dept. of Lands, Forests, 1953; CBA, 1958; Engel, Wiebe, 1979; Feely, Lamb, 1979; Fraser River Model Project, 1949, 1950, 1951, 1959; Jonys, 1976; Keane, 1957; Kidd, 1952, 1953; Langley, 1971, 1973, 1975; MacLean, Kidd, 1951; Pretious, 1956, 1958, 1969, 1972; Sediment Survey Section, Water Survey of Canada, 1970; Stichling, Smith, 1968; Tamburi, 1979; Tywoniuk, 1972, 1973; Tywoniuk, Stichling, 1973; WCHL, 1978.

Slope Stability
Byrne, 1978; Golder, 1979; Luternauer, Finn, 1983; Mayers, 1968; Piteau, 1979; Scotton, 1978; Tiffin et al., 1971; Wallis, 1979; WCHL, 1980.

Surficial Geology
Armstrong, 1953, 1956, 1957, 1960, 1975, 1981; Armstrong et al., 1965; Armstrong, Hickock, 1975, 1976; Blunden, 1973; Boyle, 1973; Clague et al., 1980; Easterbrook, 1966, 1969; Fulton, 1971; Glass, 1972; Hansen, Easterbrook, 1974; Hickock, Armstrong, 1981; Hickock et al., 1982; Holland, 1964; Jones, 1977; Leaming, 1968; Mathewes, 1973; Mathewes et al., 1972; Mathewes, Rouse, 1975; Mathews, 1968; Mathews, 1972; Mathews et al., 1966; Ministry of Environment, 1980, 1981; Peters, 1973; Read, 1960; Ryder, 1972.

Tidal Currents
Ages, 1974; British Columbia Research Council, 1972; 1973; Chang et al., 1976; Shepard, Milliman, 1978; Tabata, 1976; Tabata et al., 1971; Tamburi, Hay, 1981; Thomson, 1981; WCHL, 1980.

Tidal Hydraulics
Ages, Wollard, 1978; Baines, 1952; British Columbia Research Council, 1951; Canada, Dept. of E.M.R., Inland Waters, 1970; Hodgins, 1974; Hodgins, Quick, 1972; Hodgins et al., 1977; Ryckborst, Christie, 1977.

Trace Metals
Grieve, 1977; Grieve, Fletcher, 1975, 1976; Mackintosh, Gardiner, 1966.

Vegetation
Hebda, 1977; Hillaby, Barrett, 1976; McLaren, 1972; Moody, 1978; North et al., 1979 (Maps and Charts); North and Teversham, 1984; Styan, 1981.

Water Quality
Benedict et al., 1973; British Columbia Research Council, 1952, 1971, 1973; McLeod, 1979; Northcote, 1974; Rawn et al., 1953; Servizi, Burkhalter, 1970; Stancil, 1980; Thomas, 1975; Waldichuck et al., 1968; White, Northcote, 1962; Whitfield, Schrier, 1981; Yung, 1979.

Waves
Thomson, 1974, 1981; WCHL, 1979, 1980.