Fisheries and Oceans Canada
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FULTON RIVER PROJECT

FULTON LAKE DAM AND OUTLET WORKS

OPERATION, MAINTENANCE AND EMERGENCY PROCEDURES MANUAL

REVISION AUGUST 2010

FISHERIES AND OCEANS CANADA
PACIFIC REGION

FULTON RIVER PROJECT

FULTON LAKE DAM
AND OUTLET WORKS

OPERATION, MAINTENANCE AND EMERGENCY PROCEDURES MANUAL

REVISION JANUARY 2010

(Original manual prepared by Patrick Fawkes and Associates, March 1988)

FULTON RIVER PROJECT

FULTON LAKE DAM AND FLOW CONTROL WORKS OPERATION MAINTENANCE AND SURVEILLANCE MANUAL

LIST OF REVISIONS

The original Operation & Maintenance (O&M) manual by Patrick Fawkes and Associates has been left unrevised and is retained in the Engineering Technical Library at the Department of Fisheries and Oceans, Regional Headquarters, in Vancouver. In addition a set of computer discs of the unrevised 1988 version is also kept at the library.

This manual has not received a revision since its preparation in March 1988. A Dam Safety Review was conducted by UMA Engineering in August of 1997 but they did not do a complete job and did not update the manual.

REVISION DATES

1. No revisions to the original March 1988 O&M report.
2. **November 2005** - The manual received a partial update in preparation for the Comprehensive Dam Safety Review due in 2007, by Gregg Morris, DFO Senior Project Engineer.
3. **August 2008** – Manual reviewed and updated by Engineering coop student Simon Kras.
4. **January 2010** – Manual revision and distributed by Jackie Hicks, DFO Senior Project Engineer.
5. **August 2010** – Manual revision completed by Shaun Loader, Engineering Technician and Jackie Hicks, DFO Senior Project Engineer

LIST OF OMS MANUAL HOLDERS

COPY NO.	STATUS	COPY HOLDER	LOCATION
COPY NO. 0	Original and unrevised (1988)	RPTS, DFO 401 Burrard St. Vancouver, BC, V6C 3S4 PH: 604-775-8902 FAX: 604-666-4725	Engineering Technical Library 10th floor
COPY NO.1	Original and unrevised (1988)	RPTS, DFO 401 Burrard St. Vancouver, BC, V6C 3S4 PH: 604-775-8902 FAX: 604-666-4725	Engineering Technical Library 10th floor
Hard Copy & Soft Copy	August 2010	RPTS, DFO 401 Burrard St. Vancouver, BC, V6C 3S4 PH: 604-775-8902 FAX: 604-666-4725	Engineering Technical Library 10th floor
Hard Copy & Soft Copy	August 2010	Fulton River Project Manager, DFO Fulton River Project, P.O. Box 9 Granisle, BC V0J 1W0 PH: 250-697-2314 FAX: 250-697-6253	Hatchery Managers copy located in the Fulton Maintenance office and Managers office.
Hard Copy & Soft Copy	August 2010	Will Jolley , Head Dam Safety Management & Stands Branch Water Stewardship Division PO Box 9340 Stn Prov Govt Victoria, BC V8W 9M1 ph 250-387-3263	Dam Safety Library, Victoria

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5.0 MAINTENANCE AND SURVEILLANCE

6.0 EMERGENCY PREPAREDNESS PLAN

7.0 EMERGENCY PREPAREDNESS PLAN FLOWCHARTS

APPENDIX

- Detailed contents of the Appendices are listed in the Appendix section of this manual.
- The Appendices represent a large volume of documentation and two complete sets are stored separately from this manual. (One is in the Engineering Library at DFO Regional Headquarters, and the second is in the Maintenance Managers office at the Fulton River Project).

Note: A detailed table of contents prefaces each section of the manual.

SECTION 1.0
GENERAL INFORMATION

CONTENTS
SECTION 1.0 – GENERAL INFORMATION

FIGURES

SECTION 1.1 - PURPOSE OF PROJECT

1.1.1 GENERAL

The purpose of the Fulton River Project is to alter the natural distribution of stream flows in the Fulton River to provide optimum conditions for spawning and egg incubation, and some control over fry migration. The altered environment ensures that the survival rate of the sockeye in the formative stages from egg to fry is increased from four to five times that found in nature. Augmenting natural low winter flows and constructing artificial spawning channels increases the capacity of the natural river to rear this fish population.

The altered environment was achieved by increasing the storage capacity of Fulton Lake by constructing a dam across the exit to the Fulton River. This increased storage provides a regulated flow to the downstream river channel and spawning channels of 250 cfs which is 50% greater than the average natural low winter flow between December and April. The reservoir drawdown to supply this augmented flow provides flood storage in the reservoir to truncate the peaks of flood inflows with high probabilities of occurrence.

Rule curves have been developed to ensure that the project will provide these regulated flows and flood relief.

An Operating and Maintenance manual for the Fulton River Project was prepared by the design Engineers, G. E. Crippen and Associates, in December 1969. This and the 1988 Manual supersede the 1969 Manual.

1.1.2 DAM AND OTHER FACILITIES

The dam across the natural outlet of the river comprises a free overflow spillway with a crest elevation of 2,547 feet and a low level outlet to provide release capacity when the reservoir elevation is below 2,547 feet. This will read a value of 47.00 on the dam staff gauge. To the left of the dam an intake tower was constructed to provide the regulated flow of 200 cfs via a 2 mile long tunnel and pipeline system. At the end of this system the pressure energy is converted to kinetic energy through a hollow jet valve. The energy in the jet is dissipated in a stilling basin before the water is discharged into the upstream end of Spawning Channel No. 2.

The supply tunnel to the spawning channel takes off from a larger regulating tunnel which connects the intake to a valve house located on the left bank of the river just downstream from the dam. Three hollow cone valves in the valve house control the releases back into the river to provide additional control of flows, including flood discharge capability. Details of the various components are given in **Section 2.0**.

SECTION 1.2 - DAM ACCESS INFORMATION

1.2.1 ACCESS BY ROAD

Access to the dam is shown in Fig. 1-1. From Highway 16 at Topley, take Topley Landing Rd (Hwy 118) North. Drive approximately 39 km, and cross the bridge over Fulton River. Take the second gravel road left after the bridge. Keep right on the access road and continue through to the dam.

In the event that the trestle bridge is flooded, there is another crossing over the Fulton River owned by the BC Forest Service. This bridge has a larger discharge capability than the trestle bridge and would therefore be more likely to survive a large flood. To access from Topley Landing Rd (Hwy 118), turn right on Michell Bay Forest Service Road just before the trestle bridge. Take the first left, then turn left again on Highway 118 and immediately right at the dam access road and continue on to the dam.

1.2.2 ACCESS BY AIR

(a) Helicopter and Float Plane Access

There is a designated helicopter landing area in the Fulton field office parking lot (see Figure 1-1). Float planes can land on both Fulton and Babine Lakes during daylight hours and in suitable weather conditions.

(b) Nearby airports

1. **Smithers Regional Aiport**: There are flights from Vancouver through Air Canada, and Hawkair. Central Mountain Air provides service to Prince George, Terrace, Kelowna and Kamloops. Northern Thunderbird Air provides service to Dease Lake. The Airport Manager can be contacted at **250-847-3664**.
2. **Houston Municipal Airport**: No commercial service. Contact Town District Office for more information at: **250-845-2238.**
3. **Burns Lake Municipal Airport**: No commercial service. Contact the Airport Manager (Glenn Tobin) for more information at: **250-692-3390**.

SECTION 1.3 - ASSIGNMENT OF RESPONSIBILITY

1.3.1 GENERAL

A simplified organization chart of the chain of responsibilities within the Salmon Enhancement Program is shown in **Figure 1-2.** The actual operation of the plant is the responsibility of Enhancement Operations but the maintenance and maintenance inspections are the responsibility of the Engineering Division. The small number of staff permanently at site come under Enhancement Operations and are organized as shown in **Figure 1-2.** The inspection and maintenance duties of these personnel are as follows:

1.3.2 ASSISTANT MAINTENANCE SUPERINTENDENT (Bill Watson)

The Assistant Maintenance Superintendent is permanently at site and provides support to the Maintenance Superintendent in operating and maintaining the Fulton River Facility. They should be trained and qualified to act as Maintenance Superintendent, should it be necessary.

1.3.3 MAINTENANCE SUPERINTENDENT (Dennis Merkley)

The Maintenance Superintendent is permanently at site and is responsible for the day-to-day operation of the plant under the Fulton River Project Manager, as well as carrying out the Scheduled Routine Inspections. They should also assist personnel engaged in performing the less frequent Scheduled Inspections and all Unscheduled Inspections. They should be familiar with the Emergency Preparedness Plan and know what action they are required to take in the emergency situations listed in **Section 6.3.**

1.3.4 FULTON RIVER PROJECT MANAGER (Brad Thompson)

The Fulton River Project Manager is also permanently at site and is responsible for the overall management of the plant. They are responsible to the SEP North Coast Team Leader. They should be familiar with the Emergency Preparedness Plan and know what action they are required to take in the emergency situations listed in **Section 6.3.**

1.3.5 SEP NORTH COAST TEAM LEADER (Don MacKinlay)

The SEP North Coast Team Leader is responsible to for the operation of the Babine Lake and other North Coast projects. They are based in Vancouver but visit the fisheries under their management on a regular basis. They should be familiar with the Emergency Preparedness Plan and know what course of action the staff are to follow in the emergency situations listed in **Section 6.3.**

They should co-operate with the Project Engineer for Fulton Dam and provide any assistance required in maintaining the preventative maintenance system detailed in **Section 5.2.**

1.3.6 PROJECT ENGINEER (Jackie Hicks)

The Project Engineer is based in Vancouver and provides technical support to the operation of the project. They should visit the project annually, so that they are familiar with the design and operation of the project. They are responsible for providing technical guidance and engineering support to the physical infrastructure.

SECTION 1.4 - COMMUNICATIONS

1.4.1 TELECOMMUNICATIONS

The site telephone number is 250 697-2314. Satellite internet access is available as well as a VHF radio, linked to the Smithers district office.

There is no telephone link from the staff house to any of the gate or valve houses at or near the dam. The vehicles are provided with mobile VHF radio sets and there is an additional VHF set at the residence.

See Section 6.0 for communications directory and dam breach notification procedures.

SECTION 1.5 - RECORDS AND REPORTING

1.5.1 OPERATING LOG

Information on the operation of the dam is maintained in the form of a weekly log by the Maintenance Superintendent, **Fig. 1-3.** The log sheet records for each day:

1. Fulton and Babine Lake elevations.

2. All valve and gate positions.

3. A record of flow in the river determined at the gauging station.

4. A record of flow through the two spawning channels.

5. Temperature measurements at the entrance and exit of each channel.

6. Temperature measurements of the flow entering the Fulton River at the valve house and at the counting fence.

An estimate of the average daily inflow is made from the record of outflows and change in storage.

1.5.2 METEOROLOGICAL AND HYDROLOGICAL RECORDS

A weather station is located near the staff house at which the following data is recorded.

1. Precipitation, snowfall and snowpack.

2. Daily maximum and minimum temperatures and relative humidity.

Snow course data from five courses operated by the Ministry of the Environment is used in the analysis of spring snowmelt runoff. Measurements at one of these snow courses, Tachet Creek, are made by DFO personnel.

SECTION 1.6 - PUBLIC SAFETY

1.6.1 GENERAL

Safety of both life and property of the public and DFO personnel is of primary concern in the operation of the Fulton River Project. The continuing protection of the project facilities from loss, damage, and vandalism is an important feature of maintaining the structures and equipment in a safe and reliable condition.

Public access is encouraged to a degree by the provision of a car park and an information display near the north end of the bridge crossing the Fulton River.

1.6.2 SECURITY

(a) Facilities

There are no barriers to public access on the road approaches to any of the facilities beyond warning signs. Log booms limit water access to the structures from upstream of the booms. Large warning signs on the structures facing out into the reservoir warn of the danger from water intakes.The doors to all gate houses and valve houses are locked.

(b) Inspections

The dam and facilities shall be given a security check at least once a week, as specified by the Preventative Maintenance software see **Section 5.2**.

1.6.3 TRAINING

All personnel concerned with operating, inspecting, maintaining or testing dam equipment such as gates, valves and hoists shall be properly trained in formal training courses, or by on-the-job training under qualified personnel. The Fulton River Project Manager and the Maintenance Superintendent shall ensure that other personnel operating, inspecting, maintaining, and testing equipment remain competent to carry out all assigned tasks. The Project Manager should be aware of the limitations of his staff and when it is necessary should seek outside assistance.

SECTION 1.7 - DISTRIBUTION AND REVISION

1.7.1 DISTRIBUTION

Copies of the manual and all subsequent revisions shall be held by the following personnel:

1. RPTS Project Engineer: Hard copy located in the Engineering bookshelves, 10th floor, RHQ, 1010 – 401 Burrard St., Vancouver BC. Soft copy located on the RPTS drive (rpts on 'svbcvanfp01'/TECHNICAL SUPPORT/FULTON RIVER PROJECT/2010 Dam OMS Manual)

2. Fulton River Project Manager: Hard copy

3. Dam Safety Management and Standards Branch, Victoria BC: Hard copy & soft copy

1.7.2 REVISIONS

To ensure that this manual is kept up to date the Project Engineer shall:

1. Ensure that the manual is reviewed and revised as necessary.

2. Review and incorporate revisions suggested by others as appropriate.

3. Maintain an accurate register of all manual holders and ensure that each receives a copy of all revisions promptly.

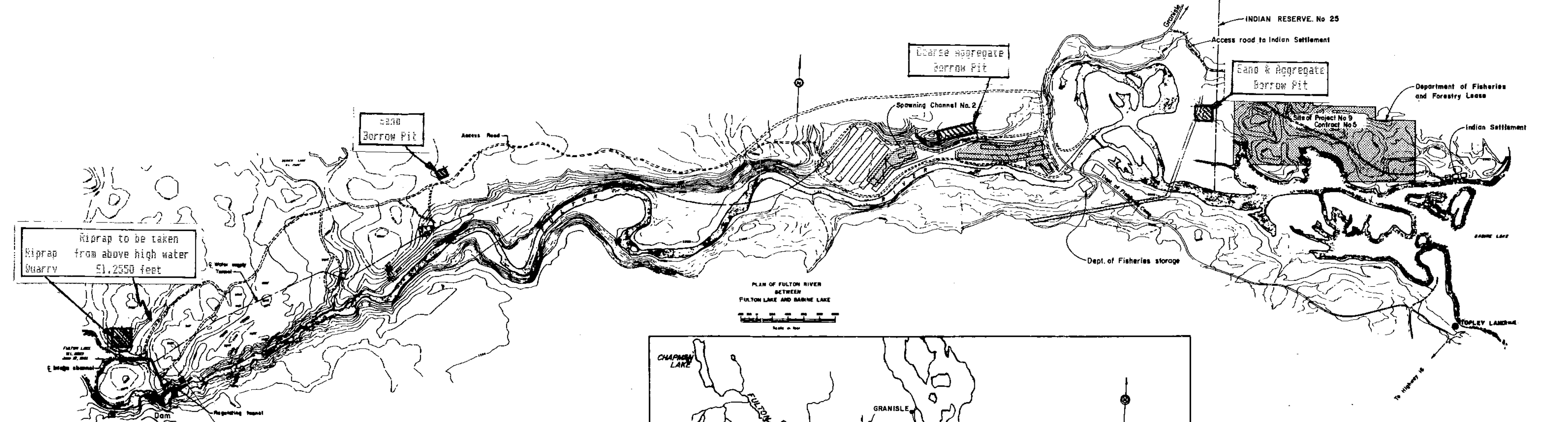
SECTION 1.8 - OPERATION AND MAINTENANCE MANUAL VERSION HISTORY

An Operating and Maintenance Manual for the Fulton River Project was prepared by the Engineers, G. C. Crippen and Associates, in December 1969. The 1988 Operation and Maintenance Manual supersedes the 1969 Manual; however, Appendices A to N of the 1969 Manual are still relevant. These Appendices are Instruction Manuals for the major components of the project such as gates, hoists, valves, etc.

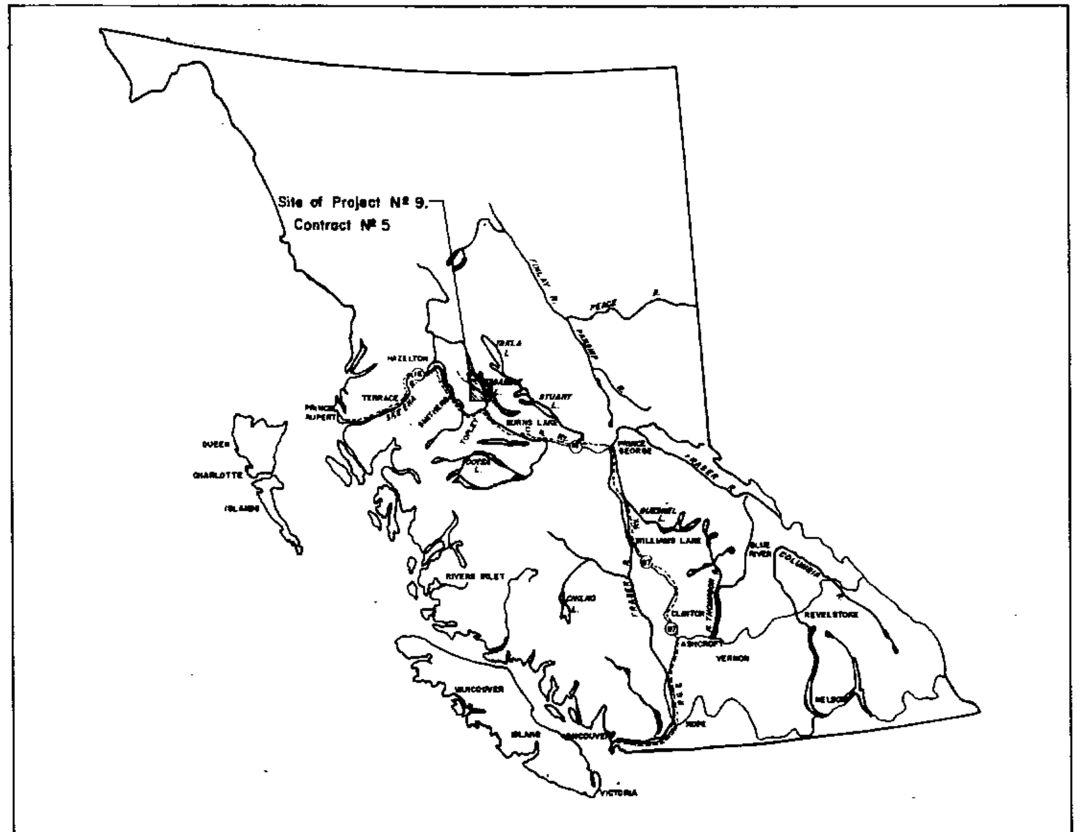
Instruction manuals have been added, forming **Appendices O & R**.

Appendices A to R form part of the 1988 and this Operation and Maintenance Manual and are bound separately. One copy of **Appendices A to R** should be kept with this Manual at the Fulton River Project Office and by the Project Engineer in Vancouver.

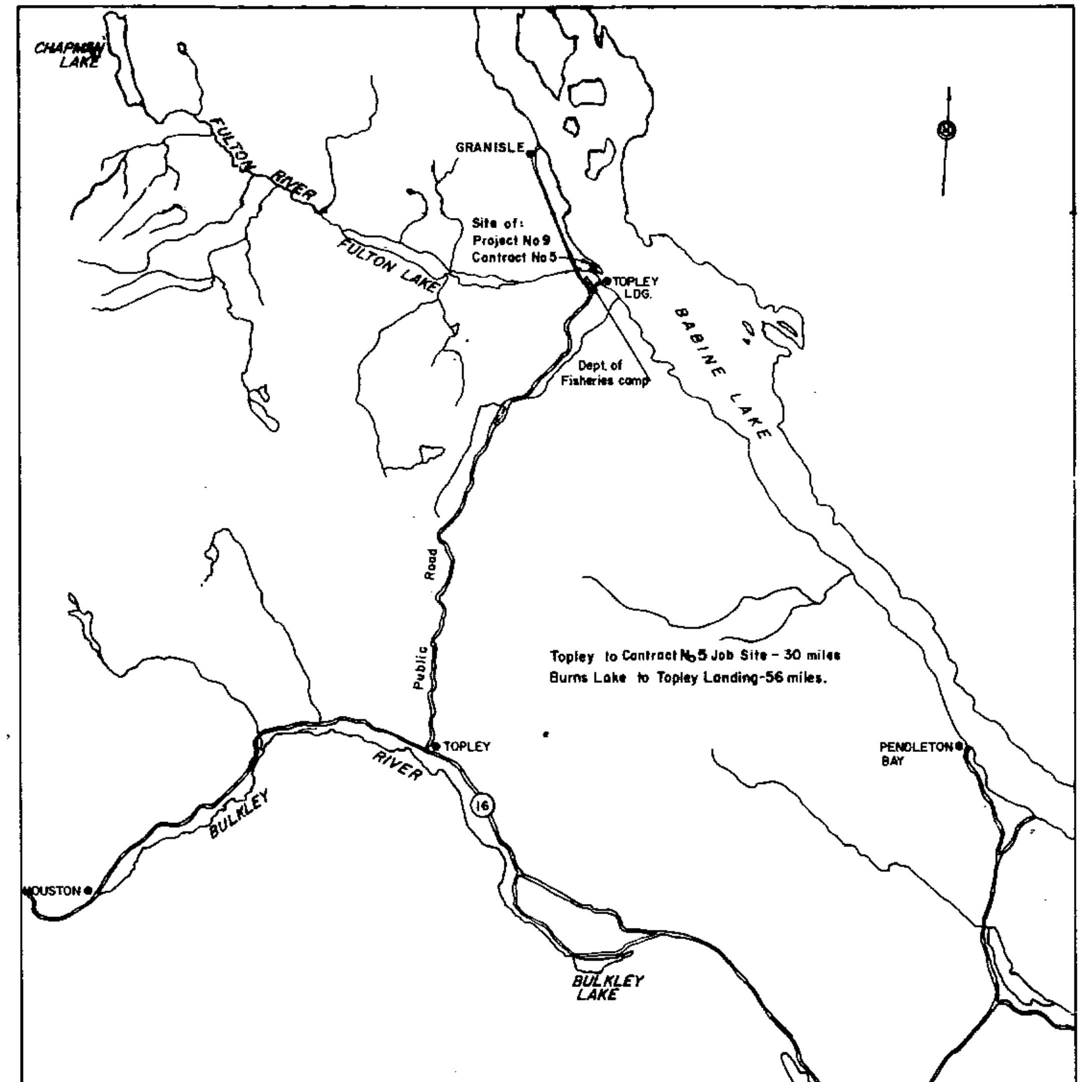
The 2008 version of the Manual preserves **Appendices A to R**, and is a revision of the 1988 Operations and Maintenance Manual.



PLAN OF FULTON RIVER BETWEEN FULTON LAKE AND BABINE LAKE



LOCATION MAP



LOCATION MAP

DATE	NO.	REVISION	BY

DEPARTMENT OF FISHERIES, CANADA

FULTON RIVER PROJECT OPERATION AND MAINTENANCE MANUAL

LOCATION MAP AND PLAN OF FULTON RIVER

DATE	RECOMMENDED:	SCALE: As Noted
DESIGN	APPROVED:	
DRAWN	APPROVED:	FIG. 1-1
CHECK		

FIGURE 1-2
FACILITY OPERATIONS
SIMPLIFIED ORGANIZATIONAL CHART
January 2010

Area Director
North Coast
Mel Kotyk

SEP North Coast Team Leader
Don MacKinlay

Fulton River Project Manager
Brad Thompson

Pinkut Creek Operations Manager
George Chandler

Fulton Maintenance Superintendent
Dennis Merkley

Pinkut Maintenance Superintendent
Ron Tuttle

Assistant Maintenance Superintendent
Bill Watson

FULTON RIVER PROJECT
HYDROMETERLOGICAL - WEEKLY REPORT

ATTENTION: BRAD THOMPSON **PERIOD: ____________TO ____________**

TOPLEY LANDING WEATHER STATION	SUN	MON	TUE	WED	THUR	FRI	SAT
Date							
Air temp max/min							
Precipitation (mm)							
Snow Fall (cm)							
Snow Pack (cm)							
Dam							
Fulton Lake Elev. @ Dam							
Fulton Lake Inflow (Ave.)							
Control Works Valve #1							
(% open) #2							
# 3							
Gauges/Flows							
Fulton River Level Tape							
CFS							
River + Channel 2 CFS							
Spawning Channel # 1							
Top End Gauge							
Discharge CFS							
Spawning Channel # 2							
Top End Gauge							
Discharge CFS							
Babine Lake Gauge							
Thermographs/Water temperature (daily max/min)							
Channel # 1							
Top End							
Bottom End							
Channel # 2							
Top End							
Bottom End							
Fulton River (above Ch 2 exit)							

Comments:

Signature: ________________________________

FIG. 1-3

SECTION 2.0
DESCRIPTION OF WORKS

CONTENTS
SECTION 2.O – DESCRIPTION OF DAM WORKS

TABLES

FIGURES

SECTION 2.1 – FULTON RIVER PROJECT

The Fulton River drains an area of about 140,000 hectares and connects the eastern end of Fulton Lake through a short steep river channel with the much larger Babine Lake. The original difference in elevation between these two lakes was increased by approximately 10 meters with the construction of the Fulton River Project in 1968 creating a live storage volume of 9,400 hectare-meters. This storage realized a regulated water supply to the downstream spawning channels.

The Project comprises a dam with a free overflow spillway and a bottom outlet to increase the discharge capability of the outlet structures during floods seen in **Figure. 2-1**. A flow regulating system includes an intake which provides regulated flow to the downstream Spawning Channel No. 2 via a supply tunnel and pipeline. The intake is protected from floating debris by a log boom. Flow control to Spawning Channel No. 2 is provided by a hollow jet valve located at the end of the pipeline which jets into a stilling basin.

The supply tunnel takes off from a larger tunnel just downstream from the intake; this larger tunnel leads to a valve house on the left bank downstream from the dam **Figure. 2-2**. The valve house contains three hollow cone valves which provide flow to the river when the reservoir level is below the crest of the spillway. The river is the source of flow for Spawning Channel No. 1. At times of high runoff, the valves also return excess flow not required for Spawning Channel No. 2 back to the river.

SECTION 2.2 – FULTON RIVER DAM

2.2.1 DESCRIPTION

The Fulton River Dam is a mass concrete structure with a 17-metre-long non-overflow section at the north end (left bank), a 6-meter-long outlet section and a 32-metre-long free overflow spillway seen in **Figure 2-3**. The spillway is curved in plan. Training walls, 600 millimeters thick and 3 meters high measured normal to the spillway surface, are provided on each side of the free spillway. A short bucket at the downstream end of the spillway section projects the spilling flows downstream and away from the base of the dam. The maximum spacing between vertical contraction joints is about 8 meters. The bucket, training walls and thinner parts of the dam outlet structure are reinforced.

The top of the non-overflow section is approximately 17 meters above the deepest part of the excavated rock foundation.

The dam outlet measures 2.2 meters square at the gates and the invert is at elevation 765.8 meters. The crest of the spillway is at elevation 776.3 meters and the top of the non-overflow section is at elevation 781.5 meters.

The structures have been designed by the Engineers, G. E. Crippen and Associates, for full hydrostatic pressure with the reservoir at elevation 780 meters, earthquake forces, an ice pressure of 15 kips per foot acting horizontally, and for uplift. Uplift was considered to be 100 per cent of maximum water pressure upstream of the grout curtain and varying linearly downstream from 75 per cent of maximum at the grout curtain to zero at the downstream face of the dam.

The stability of the dam has been checked at several sections, using the shear-friction factor method of analysis. With the reservoir water surface at elevation 2564 feet the shear-friction factor was shown to be greater than the minimum required for usual loading combinations.

2.2.2 FOUNDATION GEOLOGY

The geology of the site was investigated by Dolmage, Mason and Stewart Ltd., in 1965. The dam is founded on excavated bedrock comprising several rock types, mainly limestone, chert and porphyry, and appears to provide a strong and solid foundation for the concrete structures. The cherts in the vicinity of the dam tend to deteriorate and decompose when exposed to the weather, but this is limited to the surface layers only.

SECTION 2.3 – DAM OUTLET WORKS (DAM-GATEHOUSE)

2.3.1 GENERAL DESCRIPTION

The dam outlet comprises upper and lower gates both discharging into a common spillway channel seen in **Figure 2-3**. The upper gate is intended for supply releases to the river while the lower gate is intended for flood passage during the spring flood.

An electric monorail hoist mounted in the roof of the hoist house is used to raise and lower the gates during normal operation. The hoist is also capable of lifting the gates out of the gate slots for inspection and maintenance.

Trashracks are mounted on the upstream face of the dam to prevent logs, branches and other debris entering the outlets.

A substantial steel framed and steel-clad structure with lockable steel doors houses the low level outlet hoisting equipment.

2.3.2 TRASHRACKS

Separate trashracks are provided for the upper and lower intake entrances. These are fabricated from 1/2 inch by 3-1/2 inch bars at 8 inch spacing and welded to metal frames which are bolted in place. They are designed for a differential head of 2O feet. Structural steel is specified to conform to CSA G4O-12, except as otherwise noted on the drawings.

The trashracks are mounted on the upstream face of the dam and cannot be reached by the monorail hoist. A mobile crane is required to remove them. Debris removal is carried out periodically by divers, with or without the assistance of a mobile crane.

2.3.3 GATES

The gates are vertical lift fixed-wheel design fabricated in welded steel. The gates have J-type rubber seals at the top and sides and a flat bar type rubber seal at the bottom. The gates are designed for operation under specific unbalanced head conditions (see **Section 3.3** for details) and are operated by a monorail hoist. Additional gate data is given in **Table 2-1**.

The gate designers allowed 1/16-inch for corrosion on the skinplate thickness. The gate wheels are mounted on self-aligning bearings to accommodate the gate deflection caused by hydrostatic loading.

The upper gate is of welded steel construction with down- stream skinplate and seals. It is built in two sections with a bolted horizontal splice in the centre. The gate has four wheels per side: each wheel is 8-inch diameter with a 4-inch tread, and runs on grease-lubricated SKF223O8 C spherical roller bearings. The wheel shafts have 1/4-inch eccentricity to permit adjustment of seal contact.

The lower gate is also of welded steel construction but has an upstream skinplate and seals. It has two wheels per side, 11-inch diameter with 4-inch tread, and runs on grease-lubricated SKF 23218C spherical roller bearings. A 1/4-inch eccentricity is also provided to the wheel shafts for seal contact adjustment.

Note: SKF Bearing numbers have not been confirmed by visual inspection of the gate wheels.

2.3.4 GATE HOIST

The hoist is a DEMAG 10-ton capacity electrically powered wire rope hoist with manual chain operated travel, suspended from a monorail beam in the roof of the hoist house. It is pendant pushbutton controlled from the floor of the hoist house. See **Table 2-1**. For further details consult the Demag manual, **Appendix L.**

SECTION 2.4 – REGULATING WORKS INTAKE (INTAKE HOUSE)

2.4.1 GENERAL DESCRIPTION

The intake works are located in a concrete intake tower connected to Fulton Lake by an unlined intake channel about 150 meters long in **Figure 2-2**. The invert elevation of this channel is 2498.5 feet at the intake and slopes down towards the lake. The invert elevation of the intake entrance is at 25O1 feet which then slopes downstream at 3 horizontal to 1 vertical maintaining a constant width of 12 feet but with a warped soffit. This intake transition terminates at a 12-feet square section which is the upstream end of the transition from square to horseshoe tunnel seen in **Figure 2-4**.

Immediately behind the trashracks, which extend up to a height of 46 feet to cover the large intake surface provided, are three control gates. These gates are no longer used because they were found ineffective. They were installed with separate gate guides to enable water to be drawn off from selected elevations in the reservoir to give some temperature control to the spawning channel water supply.

Downstream from the control gates, there is a bulkhead gate, split into an upper and lower section., allowing the service gate to be inspected in position. The service gate is located at the 12-feet square section at the downstream end of the entrance transition.

To facilitate filling of the tunnel after a tunnel dewatering , a bypass pipe with a 60-inch diameter slide gate is located to the right of the main intake. This gate reduces the net pressure on the service gate allowing it to be opened more easily. The bypass pipe leads back into the main regulating tunnel downstream of the service gate.

The hoisting equipment in the intake house includes a fixed hoist for the service gate and a monorail hoist in the roof for the bulkhead and control gates. The original operating equipment for the 60-inch diameter slide gate has been replaced with a fully automated hydraulic power unit. A 24 KVA diesel unit providing emergency power is also located in the intake house. All this equipment is housed in a steel framed structure with a steel-clad enclosure.

2.4.2 SERVICE GATE AND HOIST

The service gate is a fixed-wheel vertical lift gate of welded steel construction with downstream skinplate and seals. It has five wheels per side, 12-inch diameter with 4-inch tread, running on grease-lubricated self- aligning FAG 23218HL spherical roller bearings. The gates have J-type rubber seals at the top and sides and a flat bar type rubber seal at the bottom. The designer added 1/16-inch to the skinplate thickness for corrosion and permitted 25 per cent overstress at a reservoir elevation of 2559 feet. See **Table 2-1** for additional gate data.

The service gate was designed to close in an emergency under any condition of flow or head. In normal operation the gate will be raised or lowered under balanced or nearly balanced pressure conditions. The service gate should normally hang on the ropes of the fixed hoist in readiness for emergency closure; however, it is normally dogged in the open position.

An air vent supplies air to the downstream side of the service gate. The intake is located behind the diesel fuel storage tank. The vent is 12 inches in diameter and performs the following functions:

1. Exhausts air from the tunnel when the tunnel and pipeline are being filled.

2. Admits air when the gate is closed and the pipeline is being drained.

3. Admits air when the service gate is closed suddenly during an emergency.

The service gate is operated by a 3 HP electric motor powered hoist with four part reeving utilizing an equalizer sheave. The electric motor is connected to a 5-inch drum brake which is coupled to a 10:1 reduction right angle gearbox. A fan brake is attached to the opposite end of this gearbox input shaft to permit emergency closing of the gate without electrical power by manually releasing the drum brake. The output of the first gearbox then goes to a second 36:1 parallel shaft reducer which is connected by a shaft to a spur gear which drives the main drum gear. A rotary limit switch is connected to the drum shaft and shuts off power to the hoist at preset upper and lower limits. A lever type limit switch also acts to stop the hoist at the upper limit. Additional hoist data is given in Table 2-1.

A pushbutton station with "UP", "DOWN" and "STOP" buttons is mounted near the motor on the hoist. The gate is operated locally with this pushbutton control. Emergency gate lowering is achieved by manual release of the drum brake so that the gate closes under its own weight resisted by the fan brake.

2.4.3 CONTROL GATES

The three control gates are designed to operate under a differential pressure head not exceeding 11 feet. Flaps in the lower and middle gates are held closed with shear pins which will break when the head exceeds 12.5 feet + 10%.

The gates are no longer used to control water temperature and are permanently dogged in their highest position.

2.4.4 BULKHEAD GATES

The bulkhead gate is a two-section assembly with an upper and lower part, lowered or raised individually. The two parts are vertical lift slide gates used primarily to permit inspection and maintenance of the service gate, service gate guides, downstream intake and tunnel. The gate is fabricated from welded steel with downstream skinplate and seals. The gate seals are J-type rubber seals at the sides and top and flat bar type rubber seals at the middle and bottom. The designer added 1/16-inch to the skinplate thickness for corrosion and permitted 25 per cent overstress at a reservoir elevation of 2559 feet.

The bulkhead gate is operated under balanced head conditions, using a lifting beam and the overhead monorail hoist. Additional gate data is given in **Table 2-1.**

2.4.5 MONORAIL HOIST

The hoist is a MUNCK 8-ton capacity electrically powered wire rope hoist, with manual chain operated travel, suspended from a monorail beam in the roof of the hoist house. It is pendant pushbutton controlled by an operator from the floor of the hoist house.

The hoist is used to raise and lower the bulkhead gate sections and the control gates during normal operation. It is also used to lift these gates as well as the fixed hoist, service gate, and trashracks for maintenance. A lifting beam and lengths of chain coupled with pear shaped link plates are used for lifting the gates and trashracks. See **Table 2-1** and Munck manual in **Appendix C** for additional data.

Note: Monorail beam was replaced and upgraded in 2009.

2.4.6 BYPASS, SLIDE GATE AND HOIST

A 6O-inch diameter slide gate and bypass intake pipe is located to the right of the main intake. This bypass allows the regulating tunnel to be filled independently of the main intake gate. The slide gate is a 60-inch diameter, 280 series sluice gate with a square flange and round opening wall thimble. It is cast iron, bronze mounted with side wedge, designed for an 80 feet seating head and manufactured by Rodney Hunt Company, Orange, Massachusetts, USA. The type 304 stainless steel operating stem is designed to operate the gate under 80 feet of head. The distance from centre line of the gate to the base of the hydraulic cylinder is 58.5 feet. See **Table 2-1** for additional data.

The gate is operated by hydraulic cylinder powered from an ENERPAC electric powered hydraulic pump unit.

2.4.7 TRASHRACKS

Trashracks are located on the upstream side of the intake structure to prevent logs, branches and other debris entering the intake and tunnels. The trashracks are constructed from 1/2-inch by 3-1/2 inch bars spaced 4 inches apart and welded to metal frames which slide into a slot upstream of the gates. Structural steel was specified to conform to CSA G4O-12 except as otherwise noted on the drawings.

The trashracks are raised and lowered by the monorail hoist using the lifting beam and hoisting chains. The racks are designed for a differential head across them of 20 feet.

The 60-inch diameter slide gate intake has a 65-1/2 inch diameter trashrack constructed from 2-inch by 3/8-inch flat bars at 4-inch centres.

2.4.8 POWER SUPPLY AND DISTRIBUTION

Power supply to the intake area from the main 138 kV power line from Topley is via a 25 kV wooden pole line feeder. This is stepped down at the intake through a 30 KVA transformer bank to the main 480V bus through a 50-amp air circuit breaker. Each auxiliary distribution circuit is protected by a separate circuit breaker and their loading requirements are as follows:

1. Monorail hoist in intake or low- level outlet	6.4 HP (4.8 KW)
2. Two control gate heaters	4 KW, 10.0 KVA
3. Service gate hoist	3.0 HP (2.3 KW)
4. Intake house lighting and instruments	2.0 KVA
5. Slide gate operator in intake house (Enerpac hydraulic power unit)	
6. Three hollow cone valve operators at O.5 HP each in valve house.	1.5 HP (1.2 KW)
7. Three hollow cone valve jacket heaters	22.0 KW
8. Valve house/low level outlet gatehouse lighting and controls	2.0 KVA

Circuit breakers for the monorail hoists and control gate heaters are interlocked so that only one circuit can be energized at one time.

2.4.9 DIESEL STANDBY POWER

Standby or emergency power is available from a 24 KVA, 0.8 PF, 480V AC 3 phase 60 cycle diesel driven generator set with automatic voltage regulation. The diesel is a "Lister" Type HA3 air-cooled engine, provided with an electric starter and a 12V

DC battery. A 115V AC/12V DC battery charger is also available. For further data see Engine Instruction Book 582/566, **Appendix H**.

The standby diesel power is connected to the main 48OV AC distribution through a separate 5OA air circuit breaker which is interlocked mechanically with the normal power supply breaker. The interlock feature is to allow only one breaker to be closed at any one time. There is no provision for automatic starting of the diesel engine, and no automatic transfer of circuit breakers on failure of normal power supply.

SECTION 2.5 – REGULATING TUNNEL AND OUTLET

2.5.1 GENERAL DESCRIPTION

The regulating tunnel connects the intake structure at the lake with the outlet works on the left bank of the river just downstream from the dam, as shown in **Figure 2-2**. The regulating tunnel has a modified horseshoe shaped section 12 feet high. The walls are vertical with a crown radius of 6 feet; the floor is level and 12 feet wide.

At the downstream end the tunnel changes to circular with a diameter of 10 feet 6 inches and is steel lined for approximately 65 feet, **Figure 2-5**. This steel lined section terminates at a wye piece at the outlet end leading to three hollow cone valves. The steel liner is 1/4-inch thick, painted with Hi-Build tank epoxy 78 Series, manufactured by Mobil Chemical Corporation.

The operating mechanisms for the three hollow cone valves are housed in a concrete structure founded on the mass concrete surround to the hollow cone valves. Access to the downstream end of the valves is by a steel ladder, attached to the side of the concrete block, or through an access hatch in the floor of the valve house.

2.5.2 DISCHARGE REGULATING VALVES (CONE VALVES)

The three regulating valves below the valve house are twin 84-inch diameter hollow cone valves and a 30inch diameter hollow cone valve located below, **Figure 2-5**. The hollow cone valves are opened and closed by rotating screws on each side of the valve. These screws are connected by intermediate shafts and gearboxes to a common vertical shaft which connects to the rotary actuator in the valve house.

The rotary actuators are normally operated by an induction electric motor connected to a three-push button control switch at the control cabinet. These valves can also be operated manually with an external hand wheel on the actuator. Rotary position indicators are provided on the actuators but are small and not calibrated, thus give only an approximate measure of valve opening. For further details of the valves and actuators, see **Table 2-1**, and **Appendix E**.

The valves have heaters to prevent ice build-up in winter. The heaters are turned on in the switch compartments of the valve house. Insulating blankets stored in the valve house are used to insulate the valve heaters in winter.

SECTION 2.6 - WATER SUPPLY TUNNEL, PIPELINE AND VALVES

2.6.1 GENERAL DESCRIPTION

The water supply tunnel and pipeline has a combined length of about 9,35O feet from the intake to the hollow jet valve at the entrance to Spawning Channel No. 2. The first 3,9OO feet is in tunnel except for the pipeline crossing of Beaver Creek.

For the remaining length, from the East Portal to the terminal structure, the water is conveyed in a 4 feet diameter pipeline. In this stretch the pipeline is sometimes exposed and sometimes buried; the latter in particular at the two river crossings at which the pipe passes under the river bed. At the terminal structure the potential energy is converted into kinetic energy, with a 36-inch hollow jet valve, and this energy is then dissipated in a concrete stilling basin before the water is admitted to the spawning channels.

2.6.2 TUNNEL AND PIPELINE

The tunnel is a modified horseshoe shape with a height and width of 7 feet 6 inches. The tunnel has vertical walls and is bored through competent chert rock. It branches off the larger regulating tunnel and continues for about 2,600 feet before daylighting in a pipeline at Beaver Creek. A 4-feet diameter pipe, 50-feet long, carries water across Beaver Creek. Following the crossing of Beaver Creek, a downstream tunnel continues to the East Portal for about 1,160 feet with the same cross- section as the upstream part of the tunnel, see **Figure 2-6**.

The upstream section of the tunnel is lined with pneumatically applied concrete, except for two stretches of about 200 feet each which are unlined. At locations where the rock cover is insufficient to counteract the water pressure, the supply water is carried in a 4 feet diameter steel pipe supported on concrete haunches. At the transitions between water conveying tunnel sections and steel pipe sections, mass concrete plugs carry the water pressure to the surrounding rock. There are no flared transitions at these junctions as the flow velocities are small.

2.6.3 VALVES

A 48-inch inch diameter butterfly control valve is located in the tunnel at Beaver Creek valve house, see **Figure 2-7**. This valve is a manually operated Glenfield valve which is double flanged with a horizontal shaft. The valve is not intended for flow regulation but only for fully open or shut service. The butterfly valve actuator is a Limitorque gear operated Type NH5B con- sisting of a worm and quadrant gearbox with an additional spur gear. It is enclosed in cast iron housing, complete with valve position indicator and direct-mounted handwheel turning on a vertical shaft.

An 8-inch pipe by-pass permits filling of the pipeline downstream from the butterfly valve so that the valve can be opened under balanced head conditions. An 8-inch drain line runs from this by-pass to permit draining of the upstream or downstream parts of the pipeline independently. Three 8-inch gate valves are provided for this purpose, one on the drain line and two on the by-pass each side of the drain. See **Table 2-1** and **Appendix I** for additional details of the butterfly and gate valves.

A 6-inch air inlet valve, Simplex Type VAC with standard drilling and a 6-inch diameter 125-lb gate valve, bronze mounted, with non-rising spindle and rubber gaskets is installed in the East Portal structure. This valve releases air during filling of the tunnel and pipeline and admits air during emptying.

Two 1O-inch air release valves, APCO Model 155/2OOA, are installed in a concrete chamber in the exposed section of the pipeline at chainage 67+06 feet to release or admit air during filling or emptying of the pipeline. On each 10" valve is a second smaller air release valve to release air accumulated during operation.

The supply pipe jets into a concrete terminal structure through a 36-inch diameter hollow jet valve. The valve was designed for a maximum head of 213 feet and a maximum discharge of 200 cfs. The valve is manually operated by a Limitorque hand cranked operator mounted above the valve. Additional details of this valve are given in **Table 2-1**, **Appendix K**, and in **Figure 2-8**.

2.6.4 CATHODIC PROTECTION FOR PIPELINE

A cathodic protection system connected to the pipeline at the downstream terminal has been installed to prevent corrosion of the pipe. The system consists of five anodes buried 6 to 8 feet deep at 15 feet centers and connected to a control panel containing a rectifier, rated at 25 volts/5 amps, to supply current. The anodes were installed in 1984 to replace the original anodes which had not allowed sufficient current for the system to work. The cathodic protection is annually inspected by an off site contractor, this ensures proper operation.

TABLE 2-1

FULTON RIVER PROJECT - PROJECT DATA

1 GENERAL

Project Name	Fulton River
Owner and Operator	Fisheries and Oceans Canada Fisheries - Pacific Region
Location	On Fulton River near Topley Landing
Purpose	Provide regulated flow to spawning channels and to Fulton River
Water Licenses	Conservation License CL31323 Storage License CL31324
Operational Dates:	
Dam	1969
Spawning Channel No. 1	1965
Spawning Channel No. 2	1969

2 DAM

Name of Dam	Fulton River Dam
Use	Head, seasonal storage
Foundation	Rock
Construction materials	Concrete
Non-overflow section:	
Crest length	56 feet
Crest elevation	2,564 feet
Overflow section:	
Crest length	1O4 feet
Crest elevation	2,547 feet
Height	55 feet maximum
Freeboard:	
Maximum normal level	5 feet
PMF	Zero

3 DAM OUTLET

Location	In main dam
Type	Bulkhead section with discharge channel and low terminal bucket
Upper Gate:	
Maximum design head	26.3 ft at reservoir, elevation 2,559 ft
Sill elevation	2,532.75 ft
Width	7 ft 4 in
Height	12 ft 9 in
Weight	4.8 kips + 4.O kips concrete
Lower Gate:	
Maximum design head	46.5 ft at reservoir, elevation 2,559 feet
Sill elevation	2,512.5 ft
Width	7 ft 4 in
Height	7 ft 6 in
Weight	4.2 kips + 2.4 kips concrete
Hoist Details:	
Demag Model - P625	Monorail hoist electric powered, complete with hand- geared trolley
Control	Pushbutton on pendant
Capacity	2O kips
Capacity of hoist motor	13HP
Line voltage	44OV, 3 phase at 6O hz
Control voltage	11OV, 1 phase at 6O hz

4 RESERVOIR

Name	Fulton Lake
Area at maximum normal elevation	5,OOO acres
Natural drainage area	54O square miles
Live storage	76,OOO acre-ft between elevation 2,515 ft and 2,547 ft
Maximum operating elevation	2,559 ft
Minimum operating elevation	2,515 ft
Maximum elevation with PMF	2,564 ft

5 REGULATING WORKS INTAKE

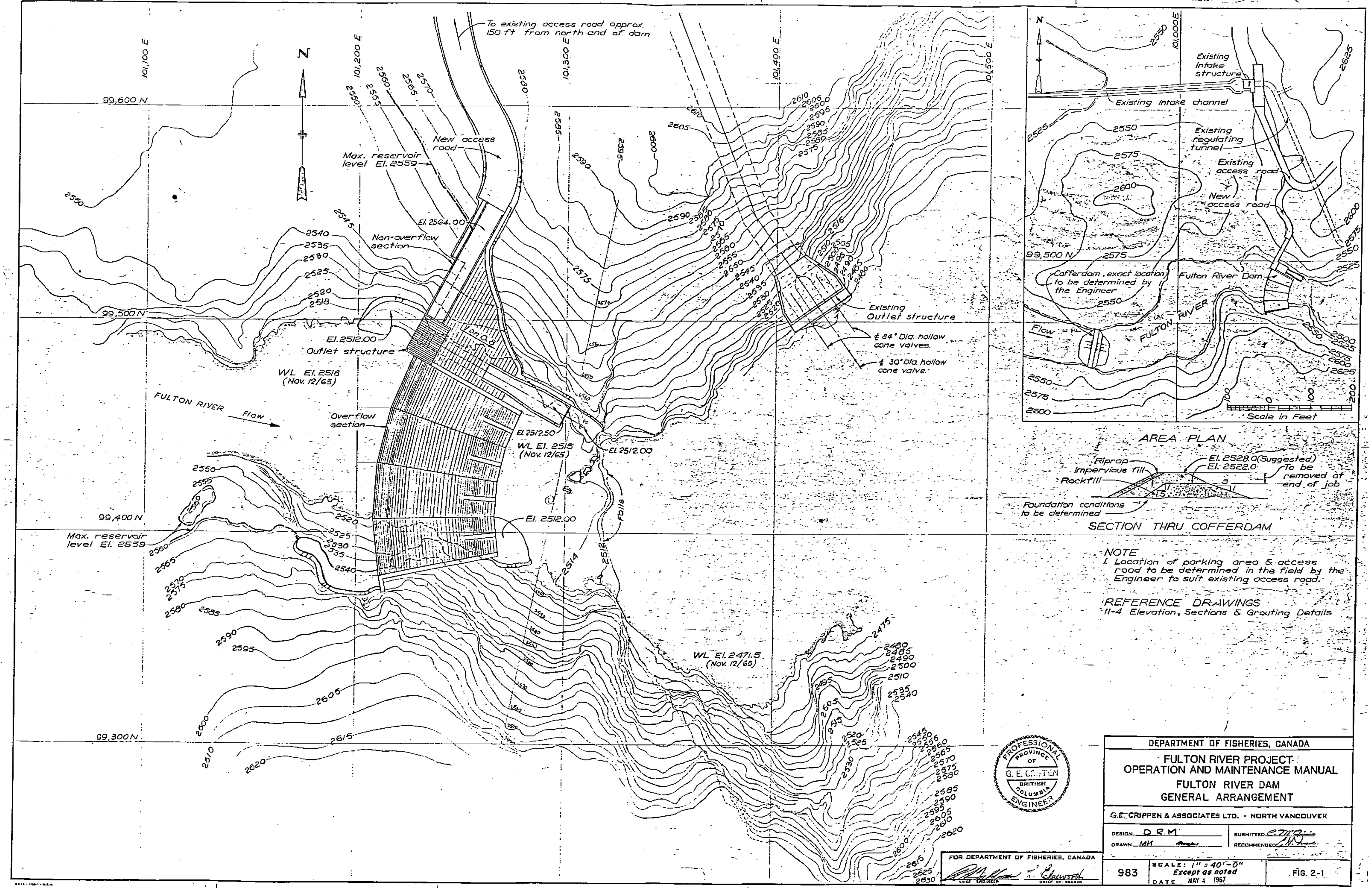
Location	5OO ft north of dam
Type	Independent concrete tower
Elevation of operating floor	2,56O ft
Invert elevation at entrance	2,5O1 ft
Service Gate:	
Maximum design head	55 ft at reservoir, elevation 2,55O ft
Sill elevation	2,495.39 ft
Width	13 ft 2 inches
Height	13 ft 3 inches
Weight	13.2 kips
Bulkhead Gates:	
Maximum design head	52 ft at reservoir, elevation 2,55O ft
Sill elevation	2,498 ft
Upper gate width	12 ft 11 in
height	1O ft 1O in
weight	8.5 kips
Lower gate width	12 feet 11 inches
height	8 feet 11 inches
weight	7.5 kips
Chain Bulkhead gate	3/4 inch
Dam gate	1 inch standard chain
Control gates:	
No.	3
Width (between wheels)	12 ft 5 in
Height	15 ft
Weight	5.4 kips
Fixed hoist:	
General Electric, Model 5KR213AK3O1	Induction motor
Control	Pushbutton station on motor side of hoist
Capacity of hoist motor	3 HP
Line voltage	46OV, 3 phase at 6O hz
Travelling Hoist:	
Munck Type 224-1419	Monorail hoist electric powered, complete with hand- geared trolley
Control	Pushbutton on pendant
Capacity	22 kips derated to 16 kips
Lift	22 ft
Lifting speed	6 ft per minute
Capacity of hoist motor	6.4 HP
Line voltage	44OV, 3 phase at 6O hz
Control voltage	11OV, 1 phase at 6O hz

6 REGULATING WORKS OUTLET

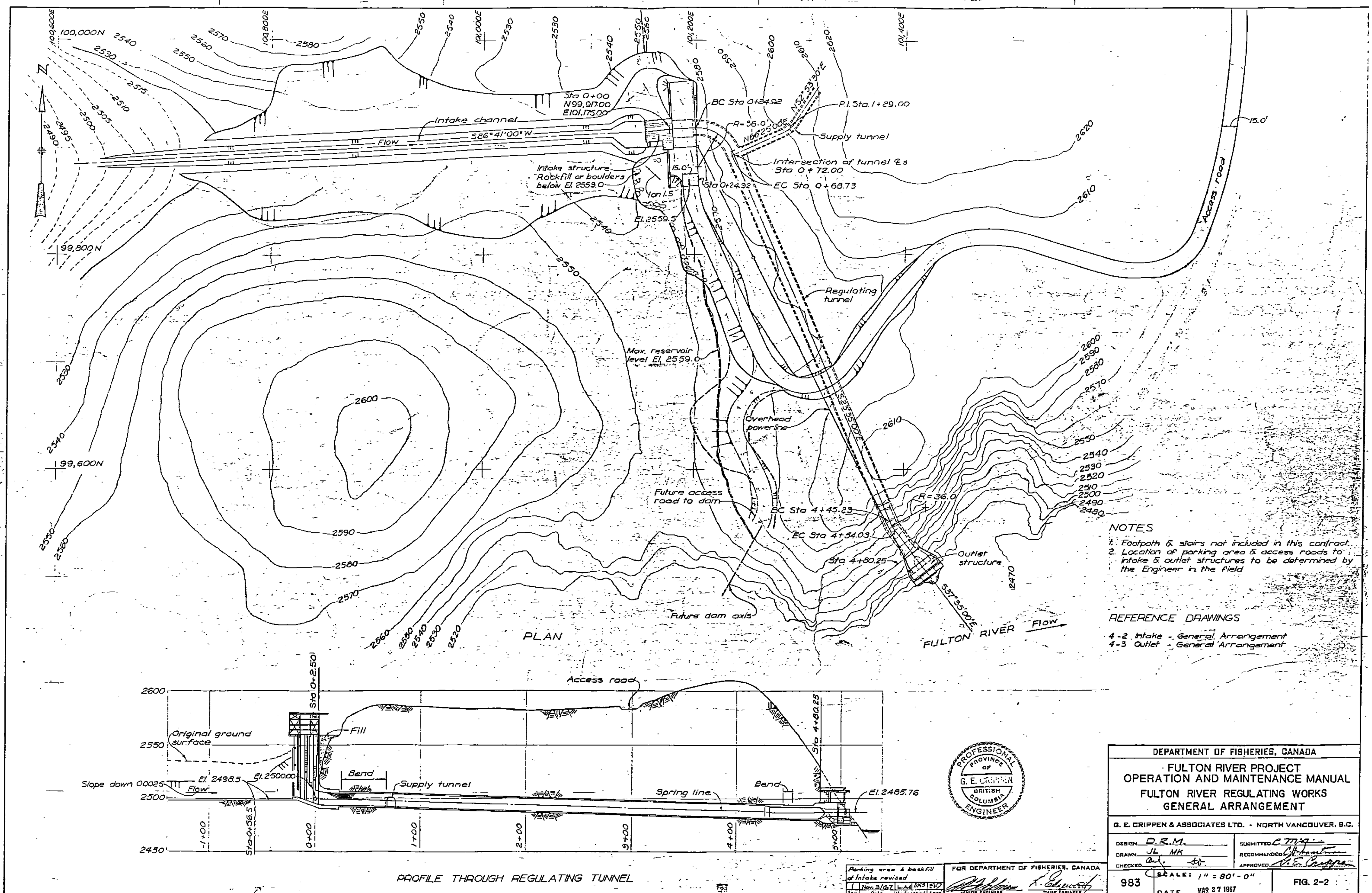
Hollow cone valves:	2 No. 84-inch diameter, 1 No. 3O-inch diameter	
	Manufacturer: English Electric Company Limited	
	84" Valves	3O" Valve
Bore (inches)	84	3O
Maximum static head (ft)	1O5	1O5
Maximum operating head (ft)	79	62
Test pressure (psi)	7O	7O
Maximum stroke (inches)	38.5	13.375
Operating time from fully open to closed (minutes)	21.5	5.5
Rotary Actuators:	2 No. 84-inch diameter, 1 No. 3O-inch diameter	
	Manufacturer: English Electric Company Limited	
	84" Valves	3O" Valve
Type	4592/1	4592/1
Output torque (ft-lbs)	7O	2O
Output speed (RPM)	28.8	57.6
Mains supply	48OV - 3 ph - 6O hz	
Control supply	11OV - 1 ph - 6O hz	
Wire diagram number	AE4652D339	
Serial number	LBW4998/22	LBW4998/31
Lubrication	Grade A	
Insulating class	BS.2613	
Rating	3O minutes	

7 PIPELINE VALVES

Butterfly valve:	
Location	Beaver Creek
Manufacturer	Glenfield and Kennedy Limited
Type	Glenfield
Diameter	48 inches
Description	Manually operated, double flanged and rubber seated with horizontal shaft
Hollow Jet Valve:	
Location	End of pipeline
Manufacturer	Kubota Limited, Osaka, Japan
Inlet diameter	36 inches
Maximum design head	213 feet
Number of revolutions to fully open or close - 2,3OO	
Gate Valves:	
Location	Beaver Creek
Quantity	3
Size	8"
Manufacturer	TOYO
Function	Flood tunnel downstream of 48" butterfly valve and drain.
Air Release Valves	
Location	Air release station No.1, pipeline station 39+65
Quantity	1
Manufacturer	Simplex V&M Co., Lang, PA, USA
Size	6"
Location	Air release Station No. 2, pipeline station 67+06
Quantity	4
Size	2 @ 10", Simplex type VAC
	2 @ 1" tiny, Simplex type AGFD
	Air release APCO 200A type ARV



FORMERLY 983-11-1



DEPARTMENT OF FISHERIES, CANADA

FULTON RIVER PROJECT
OPERATION AND MAINTENANCE MANUAL

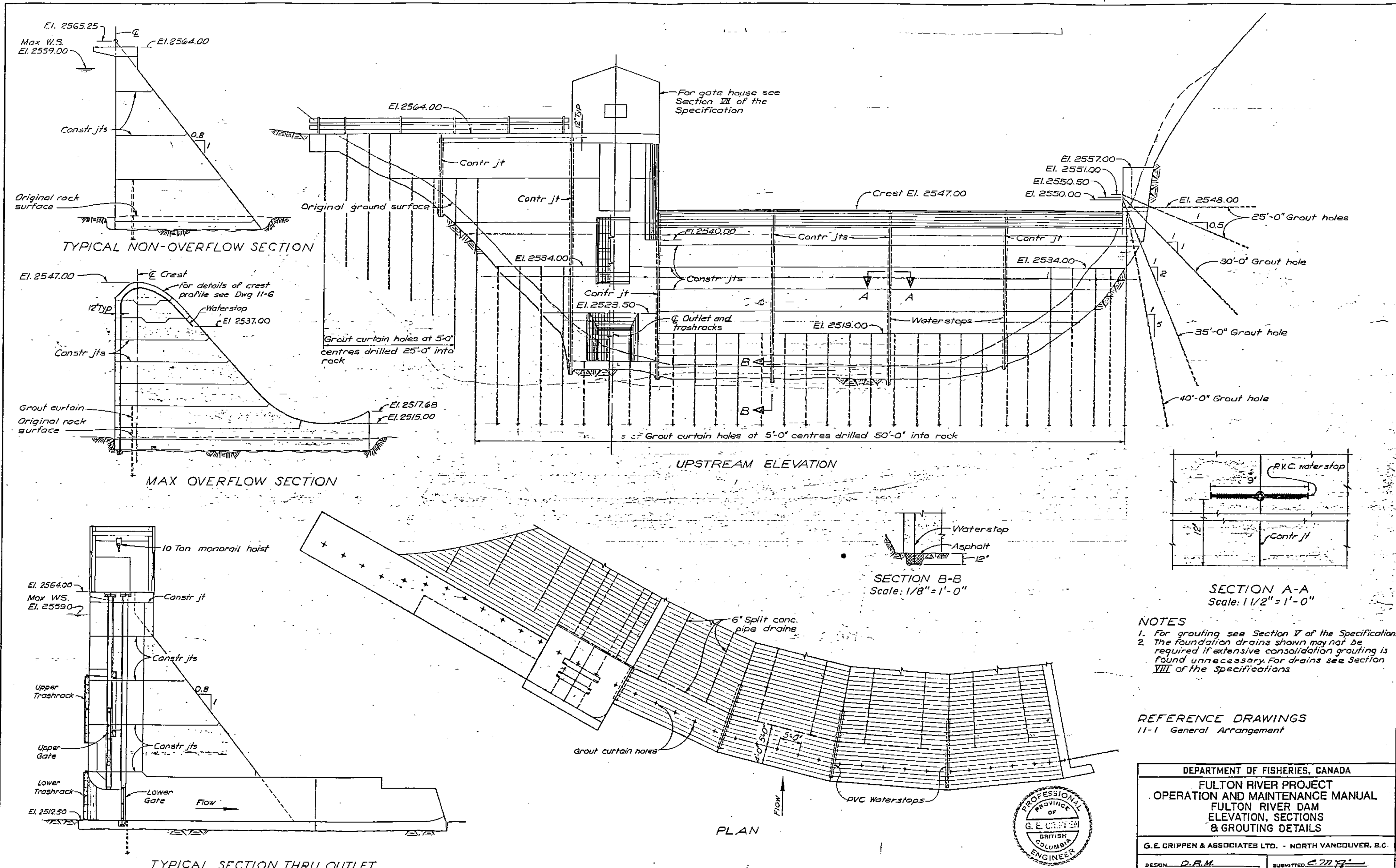
FULTON RIVER REGULATING WORKS
GENERAL ARRANGEMENT

G. E. CRIPPEN & ASSOCIATES LTD. - NORTH VANCOUVER, B.C.

DESIGN D.R.M.
DRAWN JL MK
SUBMITTED
RECOMMENDED
APPROVED

983 SCALE: 1" = 80'-0"
DATE MAR 27 1967
FIG. 2-2

FORMERLY 983-4-1R1



NOTES

1. For grouting see Section V of the Specification.
2. The foundation drains shown may not be required if extensive consolidation grouting is found unnecessary. For drains see Section VIII of the Specifications.

REFERENCE DRAWINGS

11-1 General Arrangement

DEPARTMENT OF FISHERIES, CANADA

FULTON RIVER PROJECT
OPERATION AND MAINTENANCE MANUAL
FULTON RIVER DAM
ELEVATION, SECTIONS
& GROUTING DETAILS

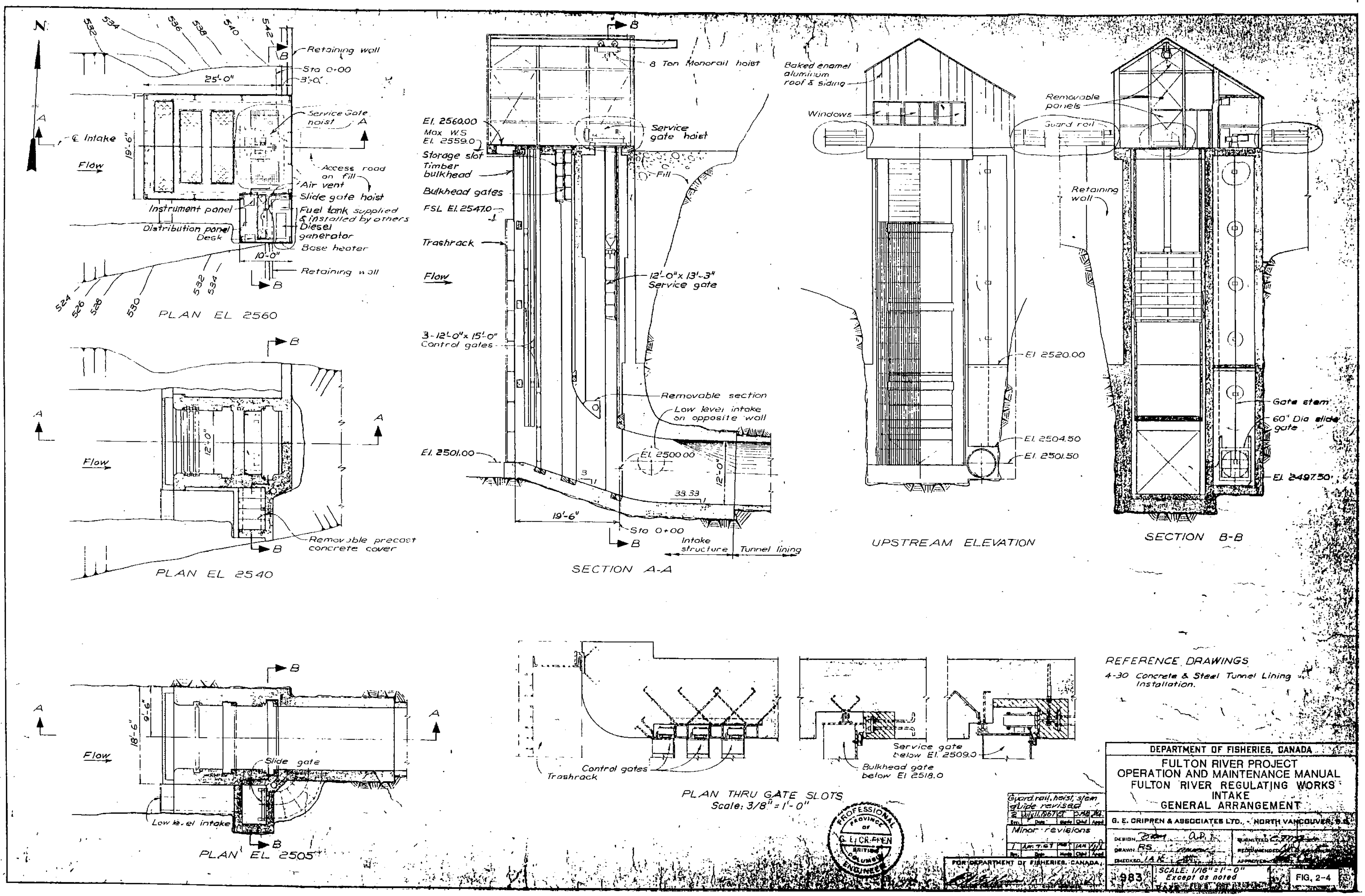
G.E. CRIPPEN & ASSOCIATES LTD. - NORTH VANCOUVER, B.C.

DESIGN D.R.M.
DRAWN RS
SUBMITTED
RECOMMENDED

FOR DEPARTMENT OF FISHERIES, CANADA
CHIEF ENGINEER — CHIEF OF BRANCH

983 — SCALE 1" = 20'-0" Except as noted — DATE MAY 8 1967 — FIG. 2-3

FORMERLY 983-11-4



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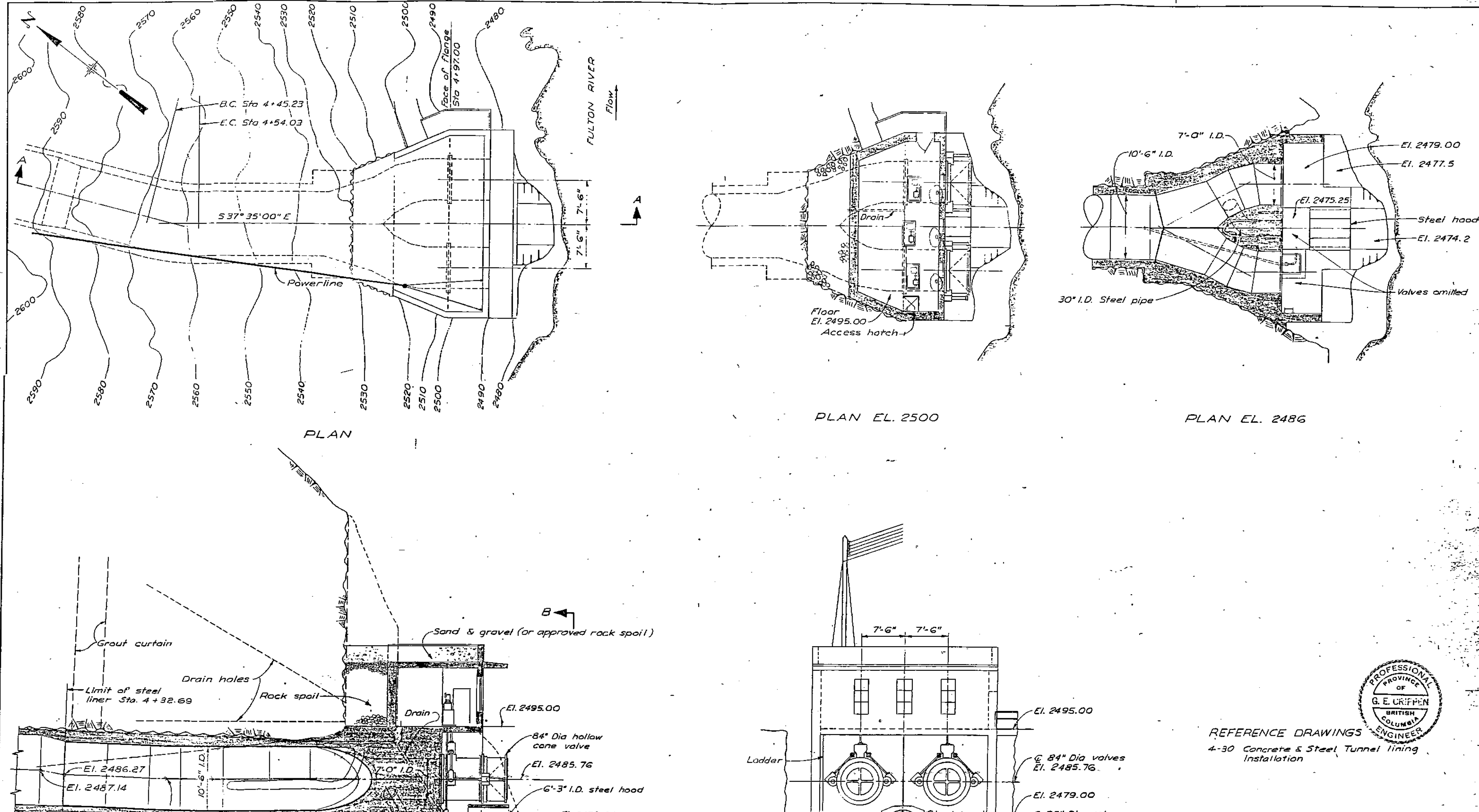


DEPARTMENT OF FISHERIES, CANADA.

FULTON RIVER PROJECT
OPERATION AND MAINTENANCE MANUAL
FULTON RIVER REGULATING WORKS
OUTLET
GENERAL ARRANGEMENT

G. E. CRIPPEN & ASSOCIATES LTD. - NORTH VANCOUVER, B.C.

3 July 11, 1967	Junction floor boxes added. Thermograph pipe removed
2 Apr 3, 67	Minor revisions
1 Jan 3, 67	Minor revision

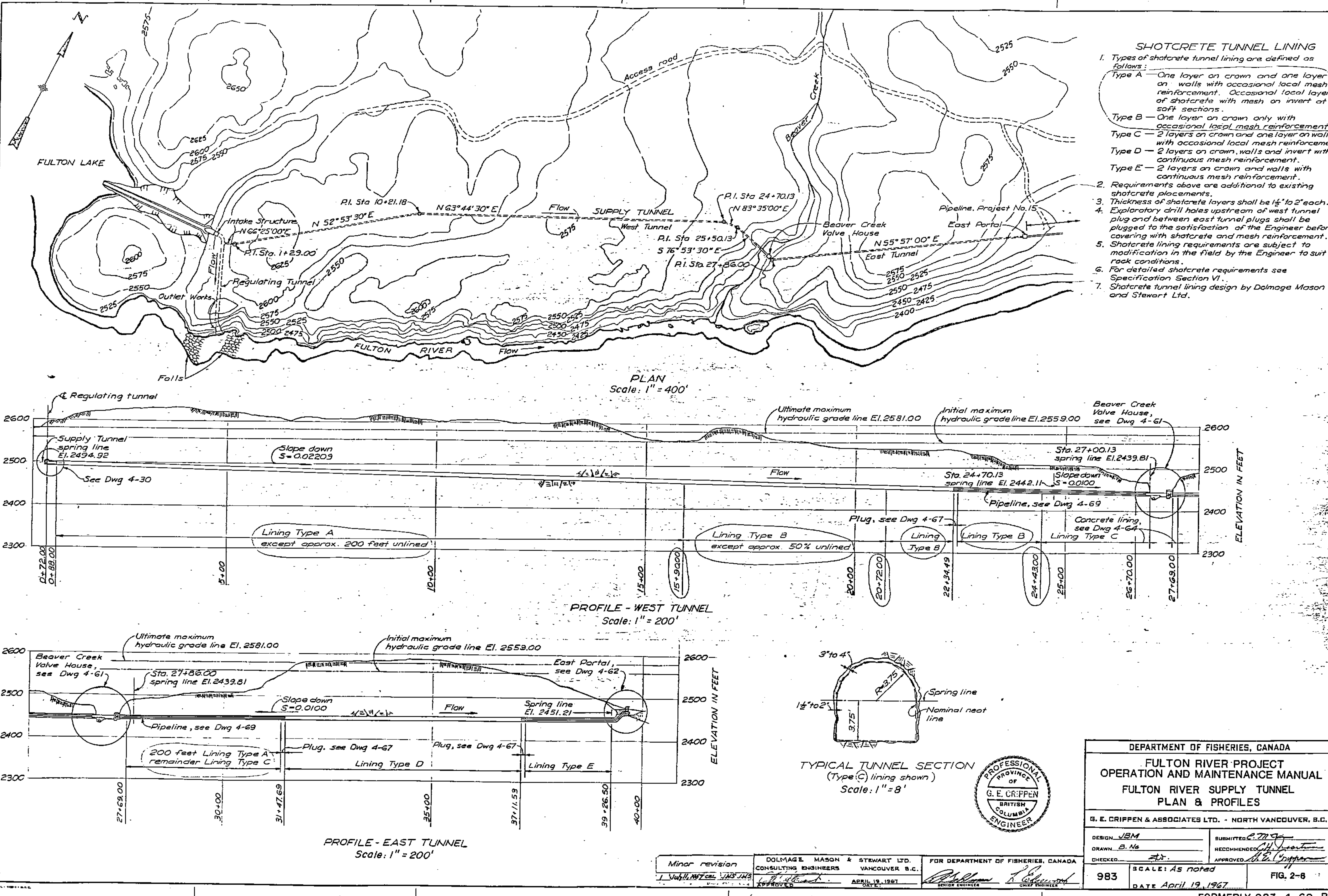
DESIGN SRB · DRAWN JBM · CHECKED

SUBMITTED · RECOMMENDED · APPROVED

FOR DEPARTMENT OF FISHERIES, CANADA — SENIOR ENGINEER · CHIEF ENGINEER

983 · SCALE: 1/16" = 1'-0" · DATE Oct 3, 1966 · FIG. 2-5

FORMERLY 983-4-3R3



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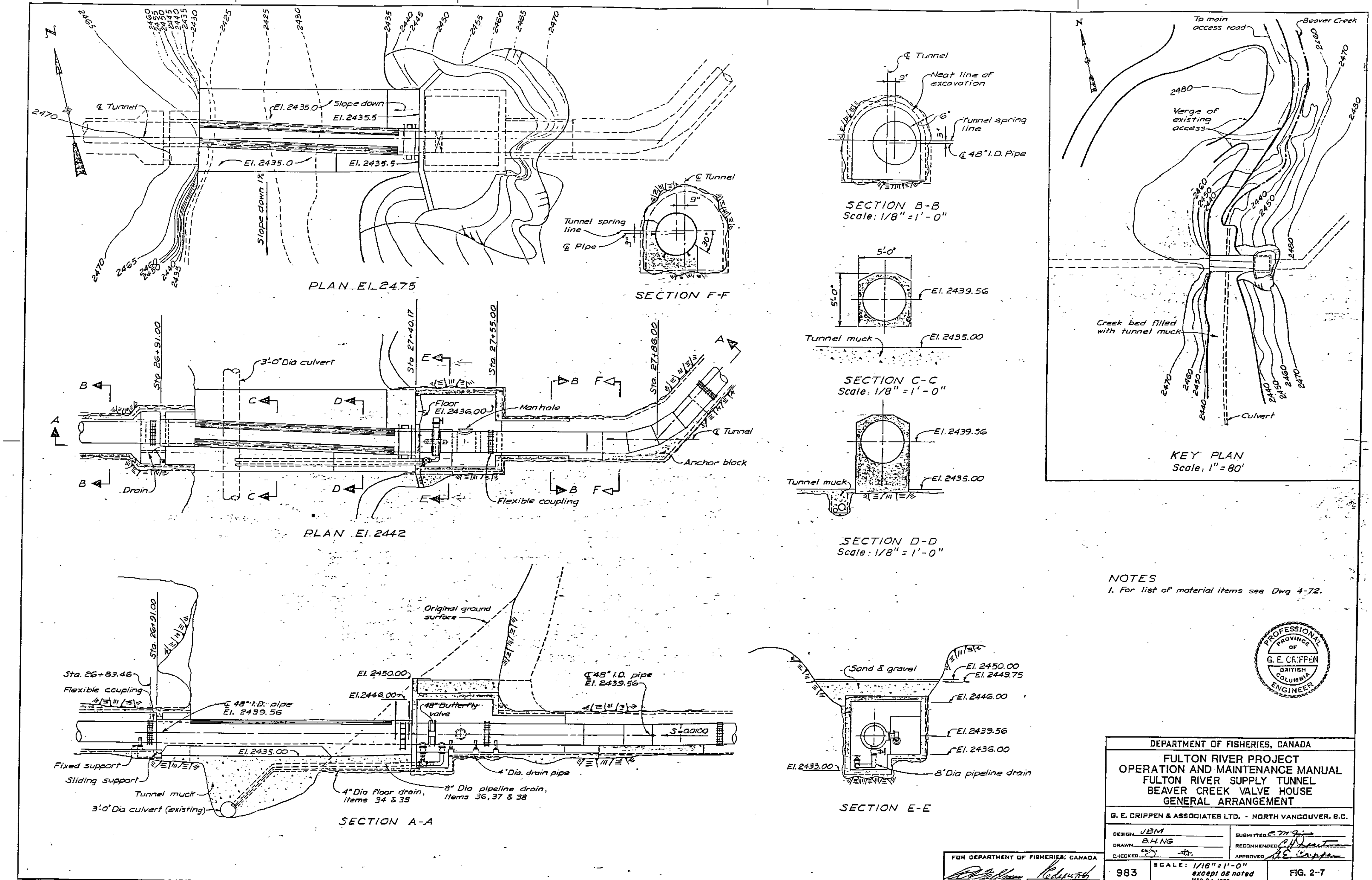

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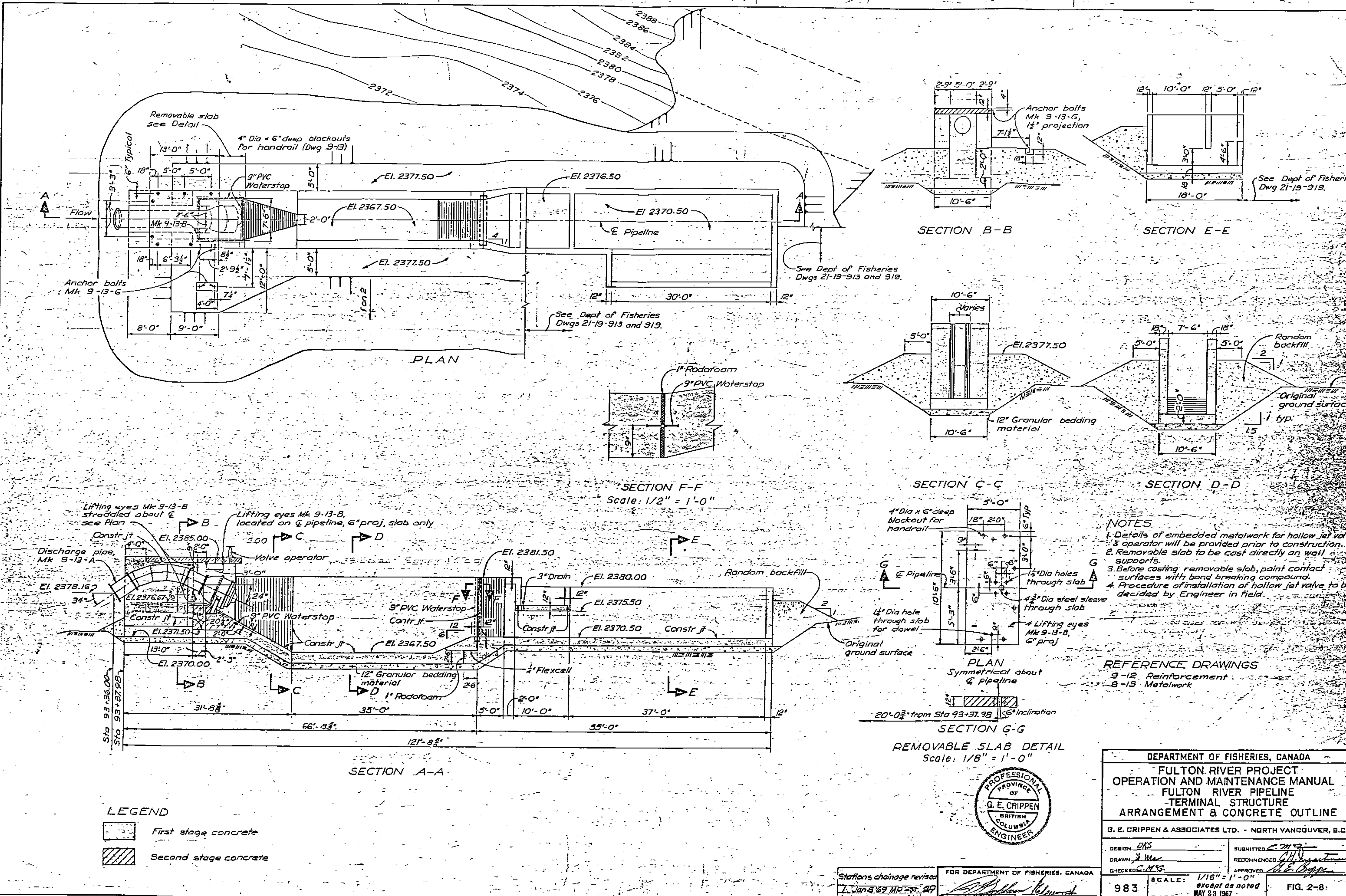

DEPARTMENT OF FISHERIES, CANADA

FULTON RIVER PROJECT
OPERATION AND MAINTENANCE MANUAL
FULTON RIVER PIPELINE
TERMINAL STRUCTURE
ARRANGEMENT & CONCRETE OUTLINE

G. E. CRIPPEN & ASSOCIATES LTD. - NORTH VANCOUVER, B.C.

DESIGN DKS
DRAWN
CHECKED C.M.G.
SUBMITTED
RECOMMENDED
APPROVED

Stations chainage revised

FOR DEPARTMENT OF FISHERIES, CANADA

983 | SCALE: 1/16" = 1'-0" except as noted | DATE MAY 23 1967 | FIG. 2-8

FORMERLY 21-19-911 R1

SECTION 3.0
DAM OPERATING INSTRUCTIONS

CONTENTS
SECTION 3.O – DAM OPERATING INSTRUCTIONS

SECTION 3.1 - GENERAL INTRODUCTION

The Fulton River Project was built to regulate the flow of the Fulton River to supply flows more suitable for spawning in the downstream artificial salmon spawning channels. Flows are maintained above a specified minimum limit, and flood flows are prevented from exceeding specified maximum limits. The storage necessary to provide the required regulated flows was created by raising the level of Fulton Lake with a dam across the natural outlet of the lake to the Fulton River.

Rule curves have been developed to ensure that the project will provide these regulated flows and flood relief.

A detailed discussion of the reservoir operation and rule curves is given in **Section 4.0**, Reservoir Operating Instructions.

Section 3.0 covers the operation of the flow control equipment such as spillway, gates and valves.

SECTION 3.2 – SPILLWAY (WATER OVER THE DAM)

The free overflow spillway is the main flood discharge outlet for the project. Reservoir rule curves have also been designed to limit the maximum release downstream to 3,000 cfs for 96 per cent of the years. However, the spillway does not operate every year, because the maximum release of 3,000 cfs can be passed through the regulating works when the reservoir is below elevation 2,547 feet, which is the crest elevation of the spillway.

The reservoir elevation-discharge relationship for the free overflow spillway is shown in **Figure 4.1**. The capacity of this spillway at a reservoir elevation of 2,560 feet, corresponding to the floor elevation of the intake to the regulating works, is 20,000 cfs.

For a more detailed discussion of reservoir operation refer to **Section 4.0**, Reservoir Operating Instructions.

Note: Historically this spillway has always 'leaked' a small amount of water, monitoring has shown that the amount of water leaking is stable from year to year.

Due to the fact this spillway has not been operated on a regular basis, it is believed it should not be used unless in an emergency situation where water from the reservoir must be released faster then the supply and regulating tunnels can accommodate.

SECTION 3.3 - DAM OUTLET WORKS (DAM GATE HOUSE)

3.3.1 INTRODUCTION

The main purpose of the dam outlet works is to provide flow to the river during inspection and repair of the regulating tunnel when the reservoir level is below the spillway crest El.2547 feet. It can also augment the spilling capacity of the free overflow spillway.

The elevation-discharge relationship for the lower gate in the dam outlet tower is shown in **Figure 4.1**. At a reservoir elevation of 2,560 feet, corresponding to the floor elevation of the regulating works intake, the low level outlet is capable of discharging about 2,300 cfs.

This lower gate should not be used when the reservoir elevation is at or below 2,525 feet. The upstream construction cofferdam with a crest elevation of 2,522 feet has been left in place to enable the upstream portions of the outlet and the dam to be inspected at low reservoir elevations. Use of the dam outlet at reservoir elevations below 2,525 feet could erode the crest of this cofferdam.

3.3.2 GATE OPERATION

Normal operation involves opening and closing the gates to permit water discharge back into the natural river channel to augment the spillway flows of all the outlet structures. The lower gate should always be operated in a fully open position to avoid excessive vibration and cavitation damage. The lower gate is designed to withstand a maximum head of 46.5 feet and the upper gate a maximum head of 26.3 feet.

Normally, the upper and lower gates are not opened at the same time. The upper gate is opened when the lower gate is closed. If the lower gate is already open then care must be taken to ensure that the lower gate does not block the discharge path of the upper gate. Hoisting chains should be pulled taut when the gates are closed to prevent chain wear caused by chain movement.

In practice the upper gate is almost never opened.

The lower control gate can be raised under any head conditions so far encountered; but it cannot be lowered to the sill if the lake elevation is above 2545 feet because of high uplift pressures. The use of the lower gate and timing of gate inspections must be carefully considered to avoid excessive drawdown of the reservoir.

Safety should always be a priority when operating the gates. The hatches should be covered at all times except when a gate is being hoisted above the deck; this will minimize possible injury to personnel.

The gate operation, starting with a closed gate, follows:

1. Position monorail hoist directly above the gate, hang pear-shaped link on hoist hook, connect the pear-shaped link and the link plate with shackle. Raise hoist till weight is off the dogging pin. Remove dogging pin.

2. Raise gate one chain length until the next link plate is just above the dogging beams, install the dogging pin in the centre hole.

3. Lower the gate until dogging pin rests on dogging beams and full load of gate is assumed by the beam.

4. Disconnect first chain from the hoist and from second link plate and store chain in a safe place.

5. Attach pear-shaped link to second link plate with shackle. Raise hoist till weight is off the dogging pin. Remove dogging pin. Continue as in No. 2.

3.3.3 GATE REMOVAL

To remove lower gate from the slot:

6. Raise gate by above procedures until all chains have been disconnected and gate is just below dogging beam, held by dogging beams and pin.

7. Attach pear-shaped link with anchor shackle to link plate.

8. Take up weight of gate with hoist and remove dogging pin.

9. Pivot dogging beams upwards until they are standing vertically.

10. Raise gate till it clears slot and move gate with monorail.

11. Reverse procedure to install gate.

To remove upper gate from slot:

12. Raise gate by procedures 1 to 9.

13. Raise gate until bolted connection joining the two gate sections appears above the floor.

14. Place an adequate support across each end of the slot, and lower the gate until wheel spindles of lower section of gate rest on these supports.

15. Remove bolts joining the two gate sections.

16. Remove top section of gate and transfer to storage area.

17. Install lifting bolt in two centre drain holes of top of lower gate section.

18. Insert pin of anchor shackle through lifting bolt, take weight of gate on hoist and remove the two supports.

19. Remove gate from slot.

20. Reverse procedure to install gate.

3.3.4 TRASHRACK HANDLING

To remove the trashracks the upper and lower bulkhead gates must be closed and leakage reduced low enough to enable divers to work safely on the trashracks. A mobile crane must be used and brought to a position to enable it to reach the centre of the trashrack panels. Divers are required to clear the debris from the trashracks, attach wire rope slings to the lifting eyes and also to unbolt the trashracks. The crane can then lift the trashracks.

SECTION 3.4 - REGULATING WORKS INTAKE (INTAKE HOUSE)

3.4.1 INTRODUCTION

This intake supplies a regulated flow of 200 cfs to Spawning Channel No. 2 through the upstream section of the regulating tunnel which leads to the supply tunnel and pipeline. Flow releases to the Fulton River are also made through the intake, regulating tunnel and discharge regulators just downstream from the dam. In addition the system is used to release flows in excess of that needed to comply with the rule curves. At time of flood the regulating works assist the spillway and dam outlet in passing the flood through the outlet structures.

3.4.2 NORMAL OPERATION

Normal operation of the regulating works intake is with all gates fully open, except the bypass slide gate; control of flow is maintained downstream. For the regulated supply of 200 cfs to Spawning Channel No. 2 the control of this flow is through the 36-inch hollow jet valve or Kubota valve at the end of the supply tunnel and pipeline. This valve discharges into the terminal structure at the upstream end of the spawning channel. For flow and spill releases, the control of flow is at the hollow cone valves at the end of the regulating tunnel. These valves discharge into the Fulton River just downstream from the dam.

3.4.3 TUNNEL AND PIPELINE DRAINING AND FILLING

Carry out the following steps to drain the tunnel and pipeline system:

1. Close the hollow cone valves and hollow jet valve to stop all flow through the system.

2. Close the service gate and slide gate under the no-flow conditions established by Step 1.

3. Drain the regulating tunnel first, by slightly opening one of the hollow cone valves.

4. If the supply tunnel is to be drained, check function of vacuum relief devices at air release stations at East Portal, and at chainage 67+00 feet. Next, slightly open the hollow jet valve or Kabota valve. When the flow has ceased, open the 8-inch drain valve at Beaver Creek and one of the two bypass valves.

Carry out the following steps to fill the tunnel and pipeline after dewatering:

1. Close the hollow cone discharge valves.

2. Close the butterfly valve at Beaver Creek and ensure that the two 8-inch by-pass valves are closed.

3. Close the hollow jet valve or Kubota valve at the terminal structure.

4. Open the slide gate to an opening of 3 inches to allow slow filling of the system.

5. Fill tunnel and pipeline to the butterfly valve first. Fill the downstream part of pipeline by opening the 8-inch gate valves in the bypass pipe (ensure that the 8-inch drain valve is closed). With bypass in operation, ensure that air release valves at the East Portal and at chainage 67+OO feet in the exposed pipeline are operating.

6. When the system has been filled, open service gate under balanced head conditions. The gate should be opened so that it is suspended above the tunnel soffit. Close the slide gate at the intake.

7. Open the butterfly valve at Beaver Creek, close the two 8-inch bypass valves, and open the 8-inch drain valve before opening the hollow jet valve or Kubota at the terminal structure.

8. Check that air release valves have closed.

9. Check concrete tunnel plugs for leaks.

SECTION 3.5 - INTAKE EQUIPMENT (INTAKE HOUSE)

3.5.1 INTRODUCTION

Under normal operation the bypass slide gate is closed and the service and bulkhead gates are open to ensure that flow control is maintained downstream at either the hollow jet or hollow cone valves or Kubota valve. The bulkhead gates are used when the service gate is inspected or removed for maintenance. For maximum safety, the bulkhead, service and slide gates must be closed before any internal inspection and maintenance of the tunnel and pipeline are made.

3.5.2 SERVICE GATE OPERATION

The service gate is normally suspended by the hoist ropes in the open position, with the bottom of the gate just above the soffit of the tunnel, in readiness for emergency closure. It is held in this position by the hoist drum brake.

For normal operation of the hoist, use the pushbutton station on the motor side of the hoist:

- **To lower the gate** press the "DOWN" pushbutton. The gate will close and the hoist will shut down with the rotary limit switch or by the operator. The limit switch should not be relied on to stop the hoist travel.

- **To open the gate** press the "UP" pushbutton. The gate will continue to open until the "STOP" push- button is pressed. The gate opens at about 2 feet per minute and should require about 7 minutes to clear the tunnel opening.

Repeated start-stop operations should be avoided as heat will accumulate quickly in the motor overload elements which may cut off the power supply to the hoist motor.

Emergency closure is achieved by manually releasing the solenoid drum brake which allows the gate to descend under its own weight controlled by the fan brake.

In the event of loss of electrical power at the intake, the diesel powered generator should be started to provide the necessary power to operate the gate.

The monorail hoist is used to remove the service gate hoist and the service gate when required. The gate is first dogged to permit dismantling of the gate hoist and its removal by the monorail hoist. The monorail hoist can then be used to remove the gate from the slot. Reverse this procedure to re-install the gate and hoist.

3.5.3 BULKHEAD GATE OPERATION

The monorail hoist is used to operate the bulkhead gate. The bulkhead gate is designed to operate under balanced head conditions only. The gate should not, therefore, be used until the flow of water through the intake is stopped by the service gate, or by the valves at the downstream ends of the regulating tunnel and supply tunnel and pipeline. Similarly, the gate should not be opened until the downstream tunnel has been completely filled.

Safety should always be a priority when operating the gates. The hatches should be covered at all times to minimize possible injury to personnel, except when engaging dogs on the lifting beam, and when the gate is being hoisted above the deck.

When not in service the top section of the bulkhead gate is stored in the storage slot and the bottom section, suspended from the lifting beam and hoisting chain, is dogged directly below the gatehouse floor.

The bulkhead gate is used to close the tunnel intake to inspect and repair the service gate, or do other major maintenance work in the downstream tunnel or pipeline. To provide better access for equipment into the tunnel, the service gate, service gate hoist and the removable concrete section in the service gate slot can be removed using the service gate hoist and the monorail hoist.

The monorail hoist, hoisting chains, lifting beam and dogging device are required to operate the bulkhead gates. Before operating the lifting beam, make sure the lifting beam hooks are free to swivel, and when raised, will return to the normal lifting position. The two bulkhead sections are operated by the monorail hoist. The hoisting chains are provided with link plates to permit dogging of the gate sections while the hoist hook is being transferred to a new position on the chain. The loose end of the chain should be suspended from a chain bracket on the dogging device and the dogging pin attached to the dogging device by a chain provided for that purpose.

With the gate sections initially in their stored positions, detailed operating procedures to lower the sections are as follows:

1. Attach hoist to two leg bridle chain of the lifting beam via pear shaped link and 7/8-inch anchor shackle.

2. Hoist gate with lifting beam until weight is taken off dogging pin, then remove pin from hole in link plate welded to the lifting beam.

3. Move dogging beams to allow two leg bridle chain to pass.

4. Lower gate and return dogging beams to their original position after the bridle chains of the lifting beam have cleared the opening.

5. Lower the gate section until the link plate at the top of the bridle is just above the dogging beams and install the dogging pin in the centre hole.

6. Lower the gate until the dogging beam carries the full weight.

7. Remove pin of anchor shackle and install the shortest length (10-feet) of hoisting chain to hoist and connecting plate of two leg bridle.

8. Raise hoist until weight is taken off dogging pin.

9. Remove pin and lower the gate section until top link plate is just above the dogging beams and install dogging pin in centre hole.

10. Lower gate until dogging pin carries the full weight.

11. Remove pin of anchor shackle and install next length (12-feet) of hoisting chain.

12. Repeat this procedure until the gate is at the bottom of the slot.

13. Release lifting beam from gate by pulling on the two release ropes. Ensure both hooks are free, and maintain tension on ropes as beam is raised.

14. Withdraw the lifting beam using a reverse procedure to that outlined in Steps 8 to 11 above.

15. Connect lifting beam to top section of gate in storage slot and transfer to gate slot.

16. Repeat complete procedure for the second gate section.

To raise the gates, lower the lifting beam down the guides until the chains are slack. Raise the hoist until the chains are in tension, pull on the hook release cables (they should not move) to ensure that the beam is properly latched to the gate. Raise hoist and follow the reverse of the lowering procedures. Maintain slight tension on hook release cables and coil excess as gate rises.

3.5.4 SLIDE GATE OPERATION

The 60-inch slide gate has been provided for the following reasons:

1. To enable the tunnel and pipeline to be filled to permit the service gate to be opened under balanced head conditions.

2. To permit the bulkhead gate to be opened under balanced head conditions.

3. To supply the minimum water requirements in emergency conditions, i.e. service or bulkhead gate is jammed in a closed position.

4. To assist with future temperature control of the supply water. If operations reveal the need for lower temperatures, the bypass intake pipe may be extended to deeper, cooler water in the reservoir.

To operate the slide gate, plug the hydraulic power unit into the adjacent 120V wall outlet, and turn unit on. When operating pressure is reached the gate can be raised using the flow control valve on the power unit. This valve has three positions: raise, stop and lower. The gate should be raised by about 3 inches and left in this position until the pipeline fills outlined in **Section 3.4.3**. When the pipeline is full the gate can be opened further, or closed, as needed. Normally, it should be closed so that the service gate is the only gate that needs to be closed in an emergency.

During initial operation the gate should be raised and lowered slowly to reduce the possibility of debris jamming the gate. If the gate has been partially open for any length of time it should be opened a few inches more prior to closing, in order to clear any debris which might jam the opening.

The pressure relief valve on the hydraulic unit should not be relied on to stop the hoist at the upper and lower limits of travel. The operator should maintain control at all times. Excessive force when closing the gate could cause the operating stem to buckle.

The slide gate is very difficult to remove as no upstream stoplogs or bulkhead gate is provided.

3.5.5 CONTROL GATE OPERATION

The control gates are not used and are dogged permanently in their slots. Should it be found necessary to use these gates in future new instructions should be written at that time.

3.5.6 TRASHRACK HANDLING

The trashracks should be cleaned of any debris before they are removed; otherwise debris might enter the intake. Divers should be used to clear the racks if debris cannot be removed by a mobile crane fitted with a clam or orange peel bucket.

The trashrack sections are lifted and lowered by the monorail hoist using a lifting beam and the same hoisting chain used for the bulkhead gates. Since the trashracks are removed infrequently, only during major overhauls, no special dogging device is provided. When removal is required, heavy timber beams placed across the trashrack slot together with the bulkhead or control gate dogging pin can be used. Alternatively, bulkhead gate or control gate dogging beams can be transferred temporarily to the trashrack slot. Before operating the lifting beam make sure the lifting beam hooks are free to swivel and when raised will return to the normal lifting position by their own weight. Attach the trigger rope to the hooks.

Close the service gate or bulkhead gate prior to raising the trashracks to prevent any debris entering the tunnel. Each time the trashracks are lowered, clear the space between the trashracks and the gates of debris prior to raising the gates.

SECTION 3.6 - REGULATING TUNNEL AND OUTLET (CONE VALVES)

3.6.1 INTRODUCTION

There are no operational restraints on flow through the regulating tunnel because the service gate is always used in the fully open position to ensure that control of flow remains at the hollow cone valves. Warning: if the control gates are brought back into service it is possible that flow through the regulating tunnel may be controlled at these gates. Undesirable flow conditions could occur with the tunnel alternately flowing full and with a free surface. This possibility should be examined if the control gates are brought back into use.

3.6.2 DISCHARGE REGULATING VALVES

The hollow cone valves are equipped with rotary actuators which are operated from the valve house directly above the valves.

The hollow cone valves are operated from a control cab- inet with a three pushbutton unit labeled "OPEN", "CLOSE" and "STOP". The "OPEN" pushbutton starts the actuator motor and the piston moves to the fully open position; a limit switch stops the motor in the fully open position. The "CLOSE" pushbutton starts the motor to close the cylinder; a limit switch stops the motor when the piston is fully closed. The "STOP" pushbutton allows the valve piston to be stopped in any intermediate position during the opening or closing stroke. The valve may be restarted in either direction by means of the "OPEN" or "CLOSE" pushbuttons. The limit switches should not be relied on to stop the motor. To assist clearing the valves of debris which may damage the seals, the valves should be opened slightly before commencing closure.

If the normal electrical power supply from the intake gate house fails the diesel powered generator in the intake building may be started to provide power to the discharge regulating valve house. If the power line from the intake building fails the valves can be opened or closed manually.

The actuators are provided with handwheels to operate the hollow cone valves during an electrical power supply failure, and also to adjust the stroke limit switches. The handwheels do not rotate during powered operation so that the operator is protected if the motor is started during hand operation.

During winter it is necessary to heat the valves to prevent build-up of ice. The heating elements are arranged around the outside barrel of the valves and insulating blankets are used to prevent heat loss. These blankets are stored in the valve house. The heaters are operated also from the valve house. The heating equipment should be kept in operation at all times once the air temperature drops to the freezing point.

Before attempting to open the valves in winter, it is necessary to remove the insulation from the valve barrels. All gearboxes should be gently heated with a propane torch to loosen grease and melt any ice that may have formed. With heated gears the gate actuators may still be overloaded and the torque switches cut in. Manual operation is suggested if this occurs. If continued problems occur with winter operation, further electrical heaters may need to be added to all gearboxes.

SECTION 3.7 - WATER SUPPLY TUNNEL, PIPELINE AND VALVES

3.7.1 INTRODUCTION

Flow control must always be maintained at the hollow jet valve or Kubota valve at the end of the pipeline. This is necessary to prevent any undesirable transient flow conditions occurring with control alternating between the intake and the valve.

3.7.1 BUTTERFLY VALVE (BEAVER CREEK)

The butterfly valve at Beaver Creek is used when filling the tunnel upstream of the valve, as described in **Section 3.4.3**. The valve is maintained only in the fully open or fully closed position when there is water in the tunnel. The valve position indicator is on the side of the gearbox and provides a good indication of the valve position.

3.7.1 HOLLOW JET VALVE (KUBOTA)

The hollow jet valve is opened manually after the pipeline has been filled and the service gate, bulkhead gate and control gates, and Beaver Creek butterfly valve have been fully opened. The valve takes approximately 2300 revolutions of the hand-crank to fully open or close, with an operating force of 8-lbs at no-load and 24-lbs at maximum water load. A dedicated electric drill attachment is available on site for operation of this valve.

SECTION 3.8 - ANCILLARY FACILITIES AND EQUIPMENT

3.8.1 LIGHTING AND POWER OUTLETS

Lighting and power outlets are provided in the intake gate house, the outlet works valve house and the dam gate house. The diesel powered generator in the intake gate house is the only alternative source of power.

3.8.2 AUXILIARY POWER SUPPLY

The following instructions for operating the diesel powered generator are taken from the Lister manual:

1. **Engine started electrically**: Decompressor levers must be left down (towards flywheel), so that engine is on full compression. Check items a. to c. of manual starting instructions before starting.

2. **Engine started manually**:
   a. Check fuel, lubricating oil levels, oil bath air cleaner oil level, and battery connections.
   b. Ensure fuel and oil lubricating systems are primed.
   c. Move decompressor levers away from flywheel.
   d. In cold weather lift overload stop to allow pumps to deliver excess fuel.
   e. Lightly oil end of crankshaft extension and fit starting handle.
   f. Turn engine slowly from three to ten turns, according to temperature and period of standing unused, in order to prime combustion chambers and lubricating system.
   g. Turn handle smartly, move decompression levers towards the flywheel and continue turning fast. Slip off starting handle when engine fires.

To stop the engine, move the control lever towards the fly-wheel and hold in this position until engine stops. Do not use decompressors for stopping.

SECTION 4.0
RESERVOIR MANAGEMENT INSTRUCTIONS

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SECTION 4.0 - RESERVOIR MANAGEMENT INSTRUCTIONS

FORM

TABLES

FIGURES

REFERENCES

1 Fulton River Project, Operating and Maintenance Manual - G.E. Crippen and Associates, 1969.
2 Field Investigations and Flow Regulation Schemes for Fulton River - G.E. Crippen and Associates, July 1965.

SECTION 4.1 - GENERAL INFORMATION

4.1.1 RESPONSIBILITY

The Maintenance Superintendent is responsible for managing the Fulton reservoir and outlets. This includes making snowmelt- runoff forecasts, planning releases from all valves and outlets, and operating all gates, valves and outlets. The Maintenance Superintendent should keep the Fulton River Project Manager informed as to all aspects of the operation. The Fulton River Project Manager should understand all aspects of reservoir operation to the extent that he can operate the reservoir when the Fulton River Maintenance Superintendent is unable to do so.

When changes from normal operation are anticipated, such as before or during a snowmelt flood with a volume greater than **160,000 cfs-days** or less than **95,000 cfs-days**, or during a summer drought, the Fulton River Project Manager shall inform the SEP North Coast Team Leader. Together they shall make a plan on the operation during these abnormal or critical conditions.

4.1.2 FISH FLOW REQUIREMENTS

Flows required in the Fulton River during fish migration and spawning are shown in the table below:

Fish Activity	**Date**	**Flows Required in Fulton River**
Upstream migration	Aug 10 to Oct 31	Opt. 120 – 150 CFS
Adults Spawn	Some Coho to Oct 30	Max. during rain flood: 1000 cfs while it can be controlled
End Spawning	After Oct 31	As above
Incubation and Hatching	Aug 10 to June 1	Opt. 120 – 180 cfs, No max. restriction
Downstream migration	After June 10	Max. 3000 cfs
End migration	After June 10	No max. restriction

Optimum flows required in Spawning Channel No.1 and No. 2 from September 1st to June 15th are, 40-70 cfs and 100 cfs respectively.

During the winter, when anchor ice forms on the channel bed (air temperatures about -19 degrees C), flows in Channel No. 2 are increased by 25-40 cfs until the air temperature rises to -15 to -12 degrees C. These increased flows can last for a few days to two weeks.

4.1.3 RESERVOIR MANAGEMENT OBJECTIVES

The Fulton reservoir and regulating works are used to control the flows to meet the requirements listed in **Section 4.1.2.**

For reservoir operation, the annual cycle of inflows, outflows and reservoir levels has been separated into three seasons:

1. **Spring snowmelt flood season** (April-July): inflows, outflows and reservoir levels rise rapidly.

2. **Summer and fall** (August-October): inflows and outflows generally decreasing, but can fluctuate in response to heavy rain; reservoir levels stay high.

3. **Winter drawdown period** (November-March): inflows and reservoir levels decrease gradually; outflows are maintained at fairly constant levels.

Outflow rule curves are to be used as guidelines in regulating the outflows from the reservoir to meet the fish flow requirements. These rule curves were derived using the computed inflows to the Fulton reservoir for 1968-85, and were designed to satisfy the following conditions:

1. A maximum release to the Fulton River during spring snowmelt floods limited to 3000 cfs in 90% of the years.

2. A reservoir filled to about El. 2546 feet by August 1 of each year.

3. Sufficient water stored in the reservoir at the beginning of winter to ensure 250 cfs continuous supply to the spawning channels and Fulton River until May 1 of each year.

Reservoir operating procedures for the snowmelt flood season - May to July, are described in **Section 4.2**. Operating procedures for the remainder of the year, including the fall rainfall flood season and the winter low flow season, are described in **Section 4.4**.

4.1.4 FLOOD CONDITIONS

There are no structures close to the shores of the Fulton reservoir, and there are no restrictions to operating the reservoir up to El. 2559.00 feet.

Downstream of Fulton dam the following structures could be affected by high flows in the Fulton River:

1. Spawning channels No. 1 and No. 2.

2. Wooden-Trestle Bridge on the Topley-Granisle road.

3. DFO residences and staff house.

4. The fish counting fence.

5. Lab and rearing facilities.

6. Steel girder Forest Service Bridge downstream of the counting fence.

7. Houses on the Babine Indian Reserve at the mouth of the Fulton River.

Flows in excess of about 6000 cfs, continuing for several days, would probably cause a large amount of debris to float down the river, which would significantly reduce water passages under the bridges and counting fence.

SECTION 4.2 - FLOOD OPERATING PROCEDURES (RUNOFF/HIGH WATER)

4.2.1 GENERAL

These procedures are to be followed during the snowmelt runoff season which generally starts between April 10 and May 10, and ends between June 20 and August 31, when the reservoir level reaches the full supply level El. 2546 or when the level returns to El. 2546 after spilling.

There are no special requirements that the reservoir be held below El. 2547 during the snowmelt flood season to safely pass the inflow design flood (see **Section 4.3** for a definition of the inflow design flood). However, if the reservoir is as high as El. 2547 at the start of the inflow design flood (this is very unlikely), all valves and the dam outlet would be required to pass the inflow design flood without exceeding El. 2559. The valves and outlet, therefore, must be operable during the snowmelt flood season from April to July: this includes maintaining access to the valve operating controls and the dam outlet controls.

4.2.2 OUTLET FACILITIES

Flood discharges can be released through the regulating tunnel with the two 84-inch diameter and one 30-inch diameter hollow cone valves; through the outlet in the dam; over the free-overflow spillway; or through a combination of these facilities. Stage-discharge curves for these facilities are shown in **Figure 4.1** and **Figure 4.3**.

The two 84-inch diameter hollow cone valves will normally be used to adjust the flood releases to the required level.

The dam outlet will normally be used only to assist in passing snowmelt floods that are greater than average. There are three restrictions on the use of the dam outlet:

1. The low-level gate should not be used when the reservoir level is below El. 2525, to prevent erosion of the cofferdam upstream.

2. The gate should be fully opened, when in use, to prevent the gate vibrating.

3. The gate cannot be closed when the reservoir level is above El. 2545 feet.

4.2.3 RULE CURVES

Rule curves for determining the outflows required to route the snowmelt floods are shown in **Figure 4.3**. These rule curves indicate the outflow which should be released at any reservoir level during the snowmelt period when the reservoir is rising. The curves were derived using 18 years of flow data, 1968-85, obtained from the Fulton Dam daily operating records.

The rule curves in Figure 4.3 supersede the curves presented in the 1969 operating manual, Reference 1, which were derived using 6 years of Fulton River flow data, 1960-67, plus flows derived from correlation with inflows to Babine Lake.

The objectives of the rule curves are to control the releases from the reservoir to a maximum of 3000 cfs (for an April-June runoff volume less than 190,000 cfs-days), and to ensure that the reservoir will fill to El. 2546 feet by the end of the flood period.

Two rates of runoff, or hydrograph shapes, were considered in the derivation of the rule curves:

1. An early or rapid runoff similar to the recorded 1976 hydrograph.

2. A late or slow runoff similar to the recorded 1972 hydrograph.

If the snowmelt runoff is early, the primary concern is to reduce the peak outflow; if the runoff is late the primary concern is to ensure that the reservoir will fill to El. 2546 feet. The rule curves have been designed to account for these rates of runoff.

The procedure for using these rule curves follows.

4.2.4 OPERATING PROCEDURE DURING SNOWMELT FLOODS

To operate the reservoir and regulating works during the spring snowmelt flood season - April through July - follow these procedures:

1. On about April 1, make a forecast of snowmelt inflow volume for the period April 15 to June 30.

2. With the forecasted volume, select the appropriate rule curve to use in **Figure 4.3.**

3. Operate the hollow cone valves and outlet in the dam to allow the outflow from the reservoir to follow the selected rule curve.

The procedure for making the snowmelt volume forecast is described in **Section 4.2.5.**

Figure 4.4 and **Table 4.1**. show the probabilities of exceedence of various inflow volumes, allow the operator to assess the size and the return period of the forecasted inflow volume. From 1968 to 1985 the inflow volumes (April 15 to June 30) ranged between 91,040 cfs- days (1980) and 195,100 cfs-days (1976).

For volumes less than 90,000 cfs-days outflows should be less than shown by the 90,000 line on **Figure 4.3**. For intermediate volumes of 100,000 to 150,000 cfs-days, the rule curves are designed to prevent the maximum outflow exceeding 2600 cfs - a flow which is acceptable for operating the counting fence. For large volumes, between 170,000 and 190,000 cfs-days, the maximum outflow would not exceed 3000 cfs. Volumes greater than 190,000 cfs-days would require outflows greater than 3000 cfs.

The reservoir level at the start of the snowmelt runoff, which is normally around April 15, should be equal to or less than the maxima shown below:

Forecast Volume	Maximum Reservoir Level at Start of Snowmelt Runoff
170,000 cfs-days or less	El. 2530 ft.
Greater than 170,000 cfs-days	El. 2525 ft.

Outflows should be controlled by operating the valves in the regulating tunnel and the dam outlet as follows:

1. When the inflow starts to increase, normally in April, start increasing the outflow so that it is **approximately equal to the inflow**. The outflow should be increased gradually to prevent fry from being flushed down the river.

2. Plot the reservoir level and outflow on **Figure 4.3** each day. If the current reservoir level vs. outflow plot is to the left of the appropriate rule curve keep the outflow equal to the inflow - this will maintain a constant reservoir level. When the reservoir level vs. outflow plot intersects the rule curve, increase the outflow to follow the rule curve as the reservoir rises.

3. When the inflow has peaked and has receded to less than the current outflow shown by the rule curve, reduce the outflow to maintain the reservoir at a constant level. If 80% of the forecasted volume has run off, and the inflow has peaked and receded to the current outflow, reduce the outflow to allow the reservoir to rise to El. 2546 feet.

4. After all fry have migrated (June 10-15) reduce the outflow to allow the reservoir to rise to the spillway crest El. 2547. Hold the reservoir at this level until August 1. See **Section 4.4** for operating procedures for the period August to November.\

Note: The Fulton River annual Fry Migration occurs approximately around April 1st to June 15th. The Reservoir Management and Flow Release Strategies are closely linked to this migration. The goal is to achieve the desired release flows ensuring the fry are not prematurely flushed out of the river. This also ensures that fry trapping can continue.

4.2.5 SNOWMELT VOLUME FORECAST

Forecasts of the snowmelt runoff-volume are made on March 1, April 1, May 1 and sometimes on June 1 each year. The forecasted volumes are used to select the appropriate reservoir rule curve to be used during the snowmelt runoff period - normally April 15 to the end of June or July. The method of making the forecasts is described below, with reference to the form Snowmelt Runoff-Volume Forecast Work Sheet – A blank form which is provided at the end of **Section 4.0.**

1. Obtain snow water-equivalent values (w-e) from the Snow Survey Bulletin for the following snow courses:

Snow Course	**Old Number**	**New Number (December 1980)**
Hudson Bay Mountain	(150) 235*	4B03A
Chapman Lake	151	4B04
Tachek Creek	189	4B06
McKendrick Creek	190	4B07
Mount Cronin	204	4B08

* Hudson Bay Mountain No. 1 (150) is inactive and has been replaced by Hudson Bay Mountain (235) at a lower elevation.

2. Divide the snow w-e values in mm by 25.4 to convert to inches, and enter on Work Sheet.

3. Compute the Snow Index from the following equation - the calculation is shown on the Work Sheet:

   Snow Index = 40(4B03A + 4B08) + 30(4B04) + 60(4B07) + 203(4B06 + 4B07)

   substituting the w-e values for the snow course numbers shown in the parentheses.

4. Using **Figure 4.5**, enter with the computed Snow Index on the x-axis and read off the predicted runoff- volume. Enter this volume on the Work Sheet.

4.2.6 DAM BREAK FLOODING

If the Fulton River Dam failed there would be major flooding and damage downstream. Refer to **Section 6.0** of this manual for procedures to be followed in the case of a dam break or potential dam break.

SECTION 4.3 - INFLOW DESIGN FLOOD (HIGH/HIGH WATER)

4.3.1 DESIGN FLOOD - 1965 STUDY

The inflow design flood is the flood for which the project was designed. It is the flood which, when routed over the spillway and through all controlled outlets, will cause the reservoir to rise no higher than the maximum design level, El. 2559 feet.

The inflow design flood derived in 1965 had an estimated annual probability of exceedence of 1/10,000 and an average return period of 10,000 years.

The derivation of this flood is described in Reference 2; a summary is given below:

1. Precipitation for the snow accumulation and runoff period from November to June, measured at Fort St. James and MacLure Lake, was correlated with the snowmelt runnoff, from April to June into Babine Lake. Twenty years of records between 1930 and 1964 were used.

2. The ratio of the April-June runoff volumes for the Fulton River and inflow to Babine Lake for 1961 and 1964 were computed; the average ratio was 0.36.

3. For each of the 39 years of precipitation data at Fort St. James and MacLure Lake, the April-June inflow volume to Babine Lake was derived from the correlation in (1) above; these inflow volumes were multiplied by 0.36 to give 37 years of April-June runoff volumes for Fulton River.

4. A frequency analysis of the Fulton River April-June volumes was made.

5. A best-fit line was drawn and arbitrarily extended to a probability of exceedence of 1/10,000.

6. The inflow design flood hydrograph of daily flows for Fulton Reservoir was derived by distributing the April-June volume over 60 days using a hydrograph shape similar to the 1964 May-June Fulton river hydrograph.

The peak and volume of the 10,000 year flood were:

Peak daily flow	25,000 cfs
60-day flow volume	370,000 cfs-days

This inflow design flood hydrograph was routed through the Fulton reservoir with all outlets open; the results were:

Maximum reservoir level	El. 2559 feet
Maximum total discharge	24000 cfs

4.3.2. REVIEW OF DESIGN FLOOD - 1986 STUDY

A review of the design flood for the Fulton Project was made in 1986.

In this review, the appropriate magnitude of the design flood was selected in accordance with guidelines prepared by B.C. Hydro. The minimum design flood should have an annual probability of exceedence of less than 1/1000 (or an average return period equal to or greater than 1000 years), and it should not be less than 0.5 times the Probable Maximum Flood (PMF).

The 1000-year flood peak was estimated from a regional flood frequency analysis of streams within 180 km of Fulton River. A second estimate of the flood peak was made from a frequency analysis of 17 years of computed inflows to the Fulton Reservoir.

An estimate of the PMF was made using approximate empirical methods. These methods were considered suitable for checking the order-of-magnitude of the original design flood derived in 1965. The peaks and volumes of the 1000-year flood and a flood equal to 0.5 x PMF are shown in the table below.

	1000-yr flood[1]	**1000-yr flood[2]**	**0.5 x PMF**
Peak daily flow: cfs	15,400	14,200	19,800
60-day volume: cfs-days	269,000 to 324,000	-	343,500

According to the guidelines the largest of these floods--0.5 x PMF--should be used as the design flood. This flood was routed through the reservoir with an initial reservoir level of El. 2547 feet and all discharge facilities open.

The results were as follows:

Maximum Reservoir Level	El. 2555 feet
Maximum Total Discharge	5,300 cfs

[1] From Regional Analysis using a log-normal distribution.

[2] From Fulton Inflows using a log-Pearson III distribution.

This maximum reservoir level is 4.0 feet lower than the maximum reservoir level that would be caused by the original design flood derived in 1965. The original design flood is considered to provide a conservative design for the project.

The approximate full PMF was also routed through the reservoir, with an initial reservoir level of El. 2547 feet and all discharge facilities open. The results were as follows:

Maximum Reservoir Level	El. 2564 feet
Maximum Total Discharge	36,400 cfs

With a maximum reservoir level of El. 2564 feet the dam will be stable according to the shear-friction factor method of analysis.

4.3.3 LARGE HISTORICAL INFLOWS

The four largest computed peak inflows that have occurred since the project was built in 1968 are shown in **Table 4.2.** The expected peak inflows are also shown for the mean annual flood and for floods with return periods of 10, 20, 50 and 100 years. These values indicate the magnitude of flood peaks that can be expected to occur, on average, once in 2, 10, 20, 50 and 100 years.

SECTION 4.4 OPERATING PROCEDURES EXCEPT DURING SNOWMELT FLOOD

4.4.1 OPERATING PROCEDURES FOR SUMMER AND FALL

This period normally starts around August 1 and lasts until around November 10-30. It starts at the end of the snowmelt flood when the inflow has receded and the reservoir has filled to about El. 2545 feet, and ends when the streams flowing into Fulton Lake have frozen over. The objectives for operation during this period are:

1. To keep the reservoir level near El. 2546 to ensure maximum storage of water at freeze-up.

2. To occasionally provide storage space to reduce outflow peaks, caused by heavy rain, to a maximum of 1000 cfs.

It is of primary importance to ensure that there is maximum water stored at the beginning of winter, to provide adequate flows for fish in the river and spawning channels until the spring snowmelt period. This is particularly true if extra water is used to flush ice from the river and spawning channels.

Rain-flood outflow peaks are reduced to prevent fish from spawning high up on the river banks. However, there is only one area near Channel No. 1 where this spawning might occur.

The amount of reservoir storage space needed to reduce the rain-flood peaks will depend on the magnitude of the recorded rainfall and the level of risk that is taken to allow flows to exceed 1000 cfs.

Two figures have been prepared to assist in making the decision as to the magnitude of the regulated outflow. Rainfall frequency curves for the months of August to October are shown on **Figure 4.6**, and the correlation between maximum 24-hour rainfall and resulting peak runoff is shown on **Figure 4.7**. **Figure 4.6** indicates the severity of a 24-hour rainfall, and **Figure 4.7** enables an approximate estimate of the expected peak runoff from a heavy rainfall to be made.

Note that there is normally a lag of 4-7 days between a heavy rainfall recorded at the Fulton project staff quarters (Topley Landing climatological station), and the peak inflow into Fulton Lake. This lag is likely to shorten if the total clearcut area in the basin increases significantly. If there has been heavy rain during the previous few days the lag can be as short as 2 days.

To regulate rainfall floods, first select the target peak outflow. Use **Figure 4.7** to estimate this target outflow as follows: Using the previous 24-hour rainfall, read off the expected peak inflow from the "best fit regression line". Use the peak inflow as an estimate of the target outflow. *Note that the peak inflow could be as high as the "envelope" line*.

When the inflow starts to increase, increase the outflow through the hollow cone valves or the dam outlet, keeping the reservoir level constant at about El. 2545 feet, until the selected target peak outflow is reached. Then allow the reservoir to rise to El. 2546 feet or higher by reducing the outflow through the valves or dam outlet. The reservoir will rise to El. 2549 feet before the spillway discharge reaches 1000 cfs.

4.4.2 OPERATING PROCEDURES DURING WINTER

Figure 4.8 shows the minimum reservoir levels required to ensure a continuous outflow of 200-300 cfs during the driest winter recorded to date (1988). If outflows are to be increased above normal for short periods to flush out ice in Channel No. 2, the total volume of additional outflow should be computed before flushing to ensure that the reservoir remains above the minimum level given in **Figure 4.8**. The minimum winter levels were derived based on a minimum target level of El. 2520 feet on May 1. If another minimum target level is used, the minimum winter levels should be recomputed.

TABLE 4.1

FULTON RIVER PROJECT

SNOWMELT INFLOW VOLUME PROBABILITIES

Probability of Exceedence	Average Return Period	Inflow Volume	Rule Curves	
%	years	cfs-days	Cfs-days	
90	1.11	92,000	90,000	Small
			100,000	intermediate
50	2	125,000	125,000	intermediate
20	5	154,000	150,000	intermediate
10	10	171,000	170,000	Large
5	20	187,000	190,000	Large
			2000,000	Extremely large
1	100	220,000	220,000	Extremely large

TABLE 4.2

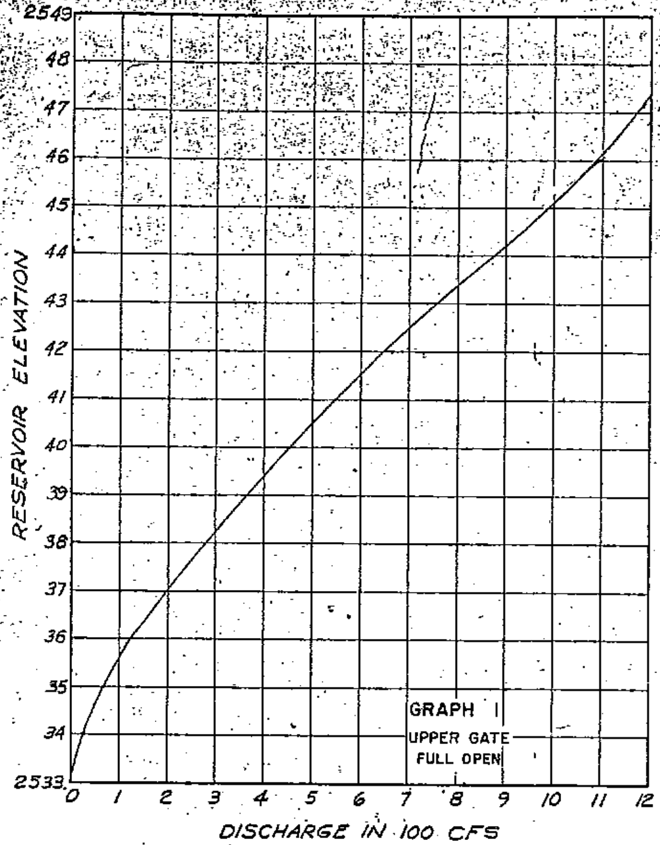
FULTON RIVER PROJECT

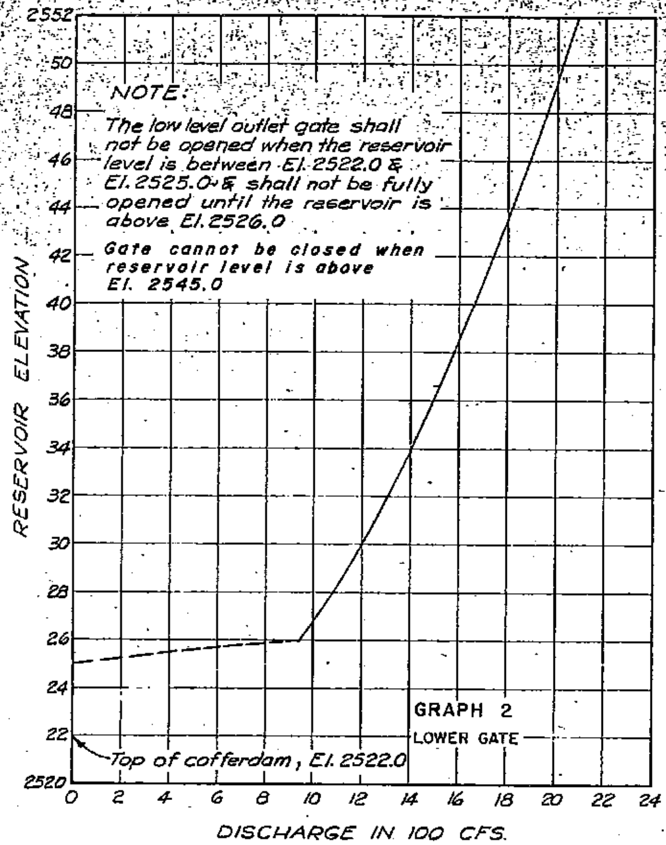
HISTORICAL AND EXPECTED PEAK DAILY INFLOWS TO FULTON RESERVOIR

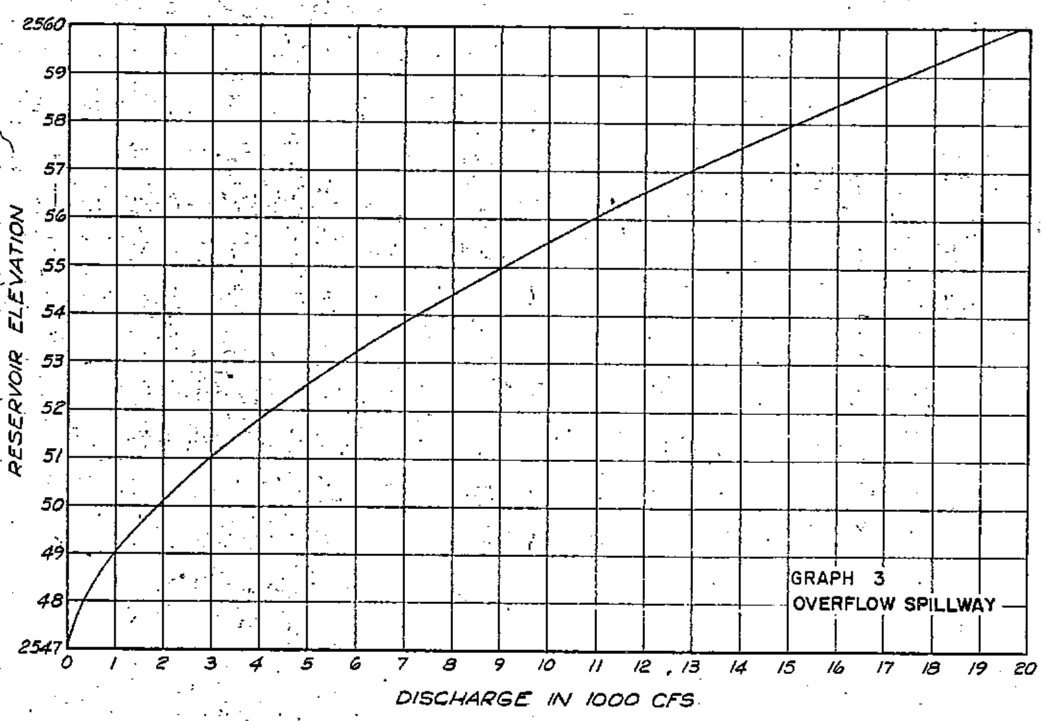
Historical Floods	Peak Daily Inflow	
	Cfs	Date
1972	6735	May 30
1973	6850	May 17
1976	6010	May 8
1982	5968	June 3

Expected Floods - Log Pearson Type III Distribution

Once in 2 years	3830
Once in 10 years	5920
Once in 20 years	6870
Once in 50 years	8250
Once in 100 years	9420







FULTON RIVER PROJECT
OPERATION & MAINTENANCE MANUAL

DISCHARGE RATING CURVES FOR DAM OUTLET AND OVERFLOW SPILLWAY

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FIG. 3.1

G. E. CRIPPEN & ASSOCIATES LTD. - NORTH VANCOUVER, B.C.

DATE	REVISION	No.	BY
FEB.18/70	GRAPHS 1&2	1	[illegible]

FOR DEPARTMENT OF FISHERIES, CANADA

SENIOR ENGINEER · CHIEF ENGINEER

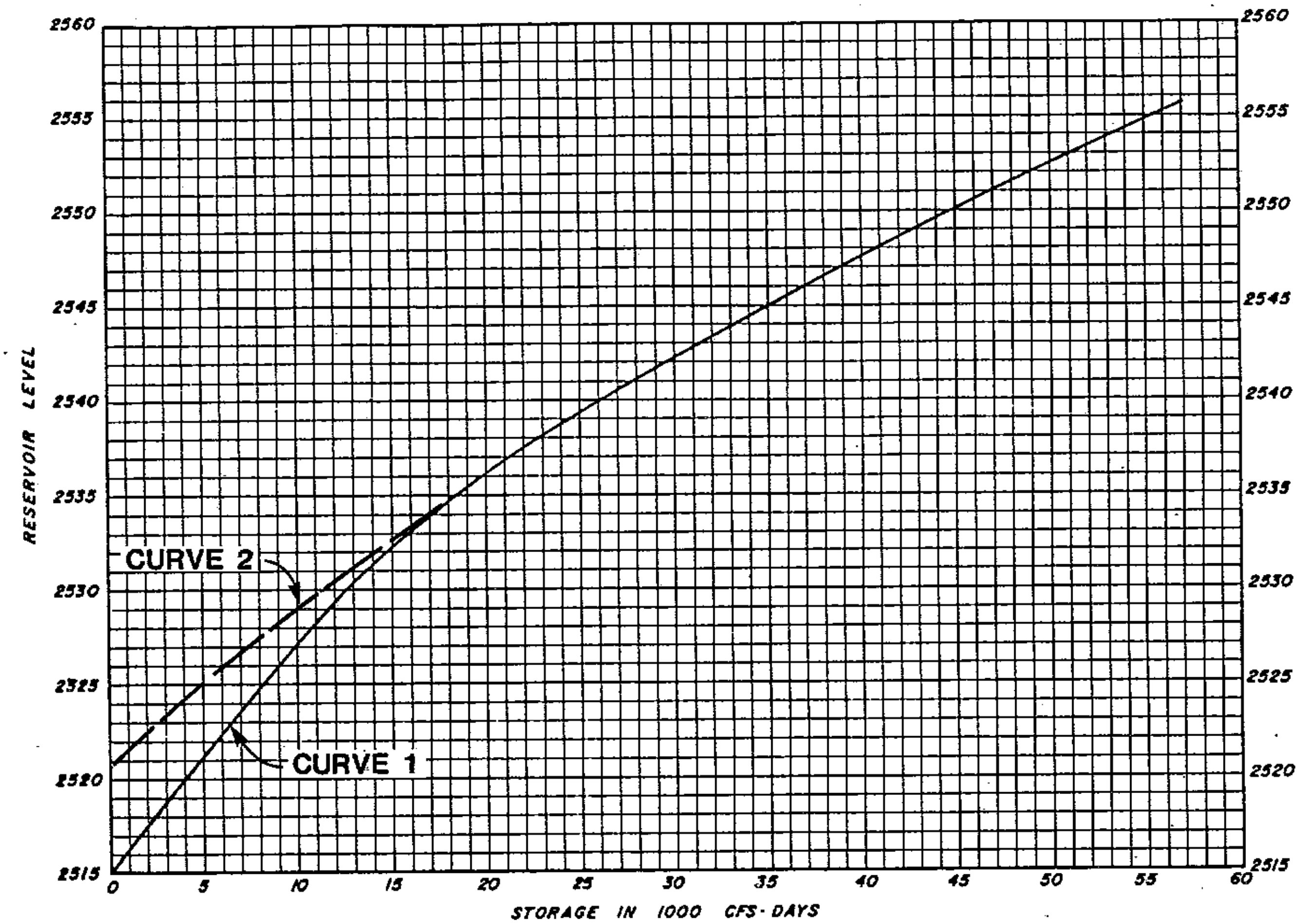
DESIGN
DRAWN M.P.
CHECKED [illegible]

SUBMITTED [signature]
RECOMMENDED [signature]
APPROVED [signature]

983-4-82

SCALE:

DATE

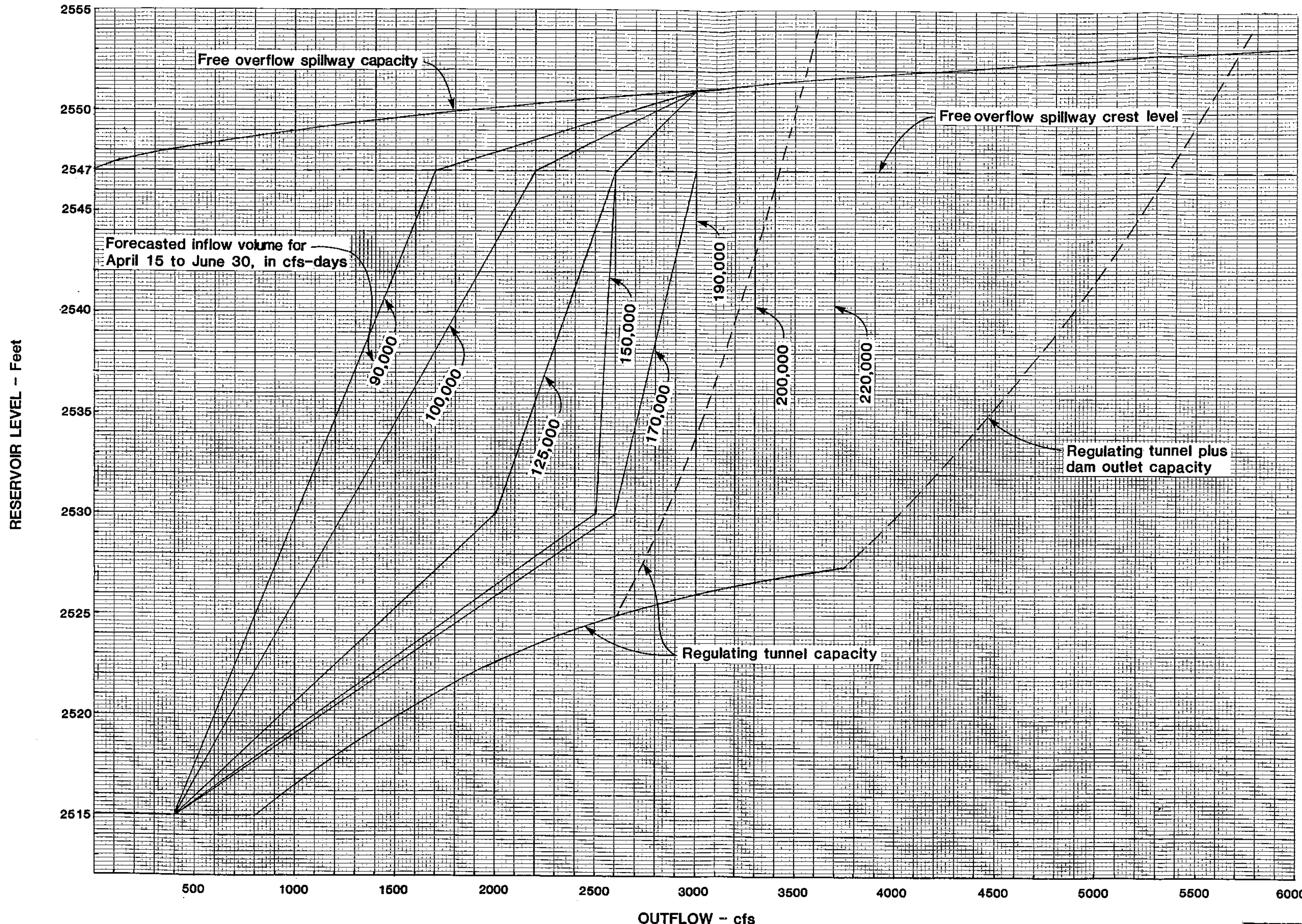


Notes

1. Curve 1 from Figure 5, Babine Lake Development, Fulton River Dam, Regulating Works and Pipeline, Operating and Maintenance Manual, G.E. Crippen & Associates Ltd, 1969

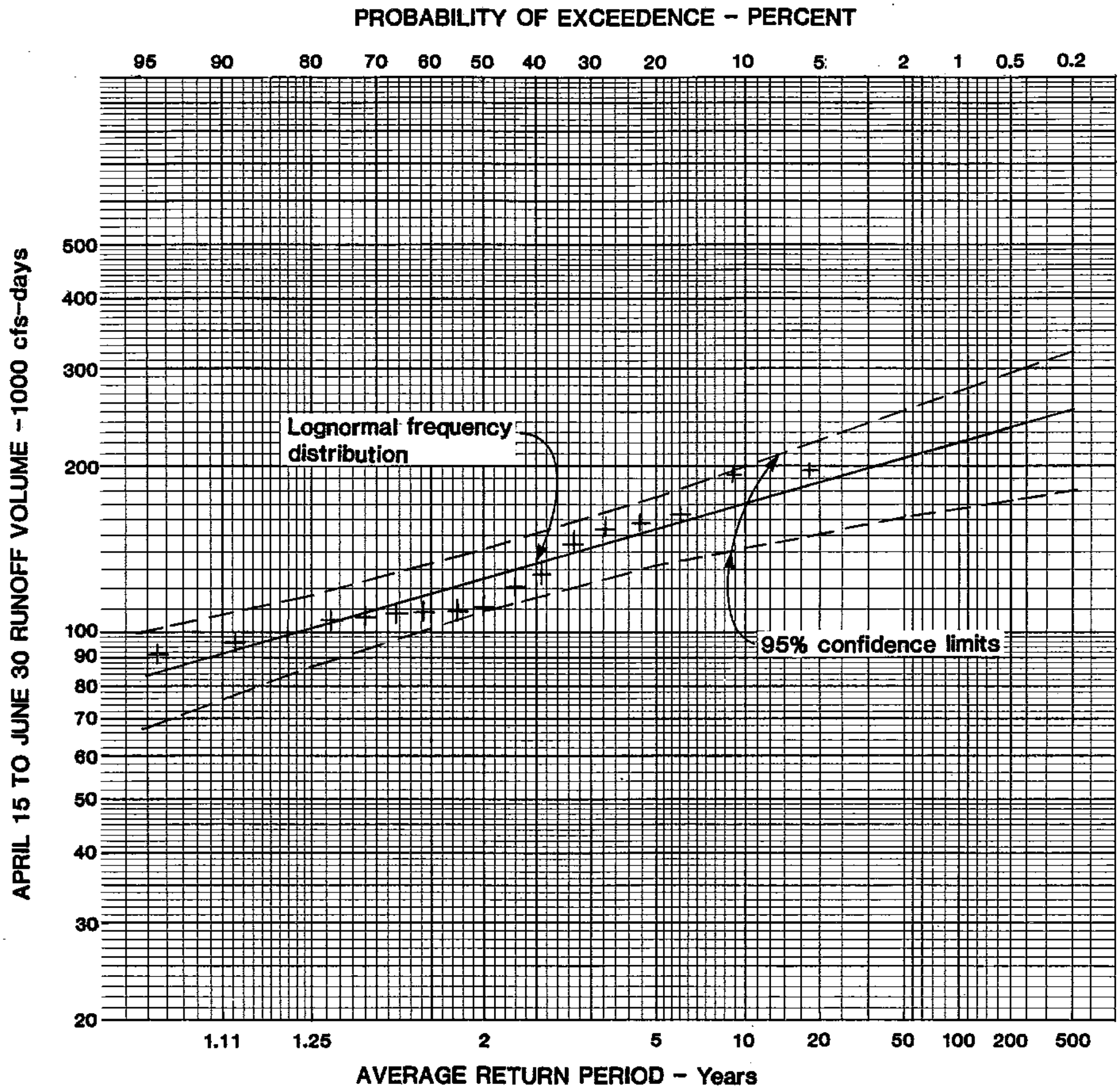
2. Curve 2 from hand written table titled Fulton Lake Reservoir Storage Curve, April 1 1974, Provided by Fulton River Project, Maintenance Superintendent in August 1986. Source of data unknown.

FULTON RIVER PROJECT OPERATION & MAINTENANCE MANUAL	
RESERVOIR STORAGE CAPACITY	
DEC 1986	**FIG. 3-2**

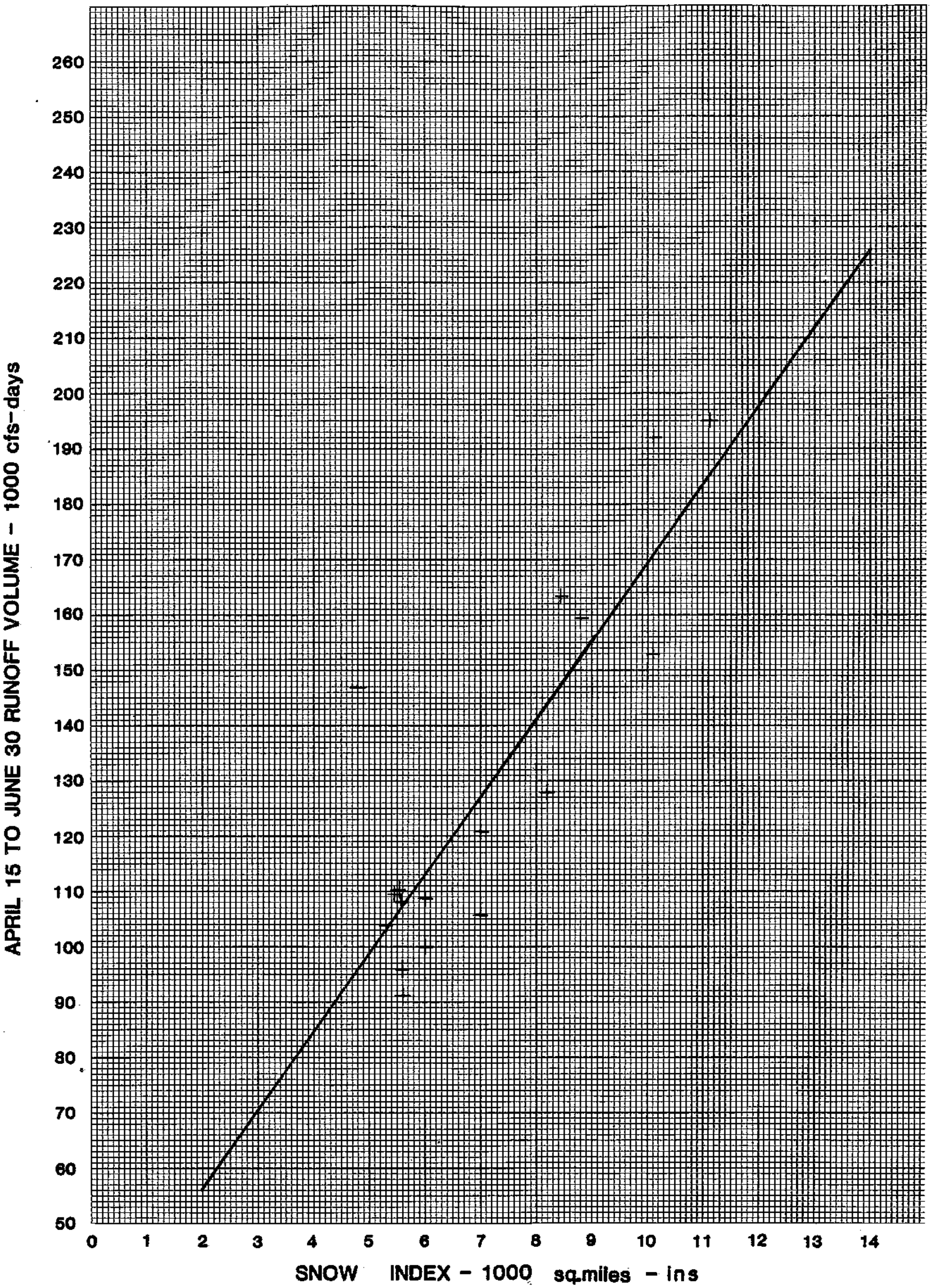


Note: Regulating tunnel and dam outlet capacities taken from drawing titled Babine Lake Development, Fulton River Reservoir Operation, Rule Curve for Snowmelt Runoff, Figure 4 (Drawing no. 983-4-82) Revised Feb 18/70. G.E. Crippen & Associates Ltd.

FULTON RIVER PROJECT OPERATION & MAINTENANCE MANUAL	
RULE CURVES FOR SNOWMELT RUNOFF	
DEC 1986	FIG. 3-3



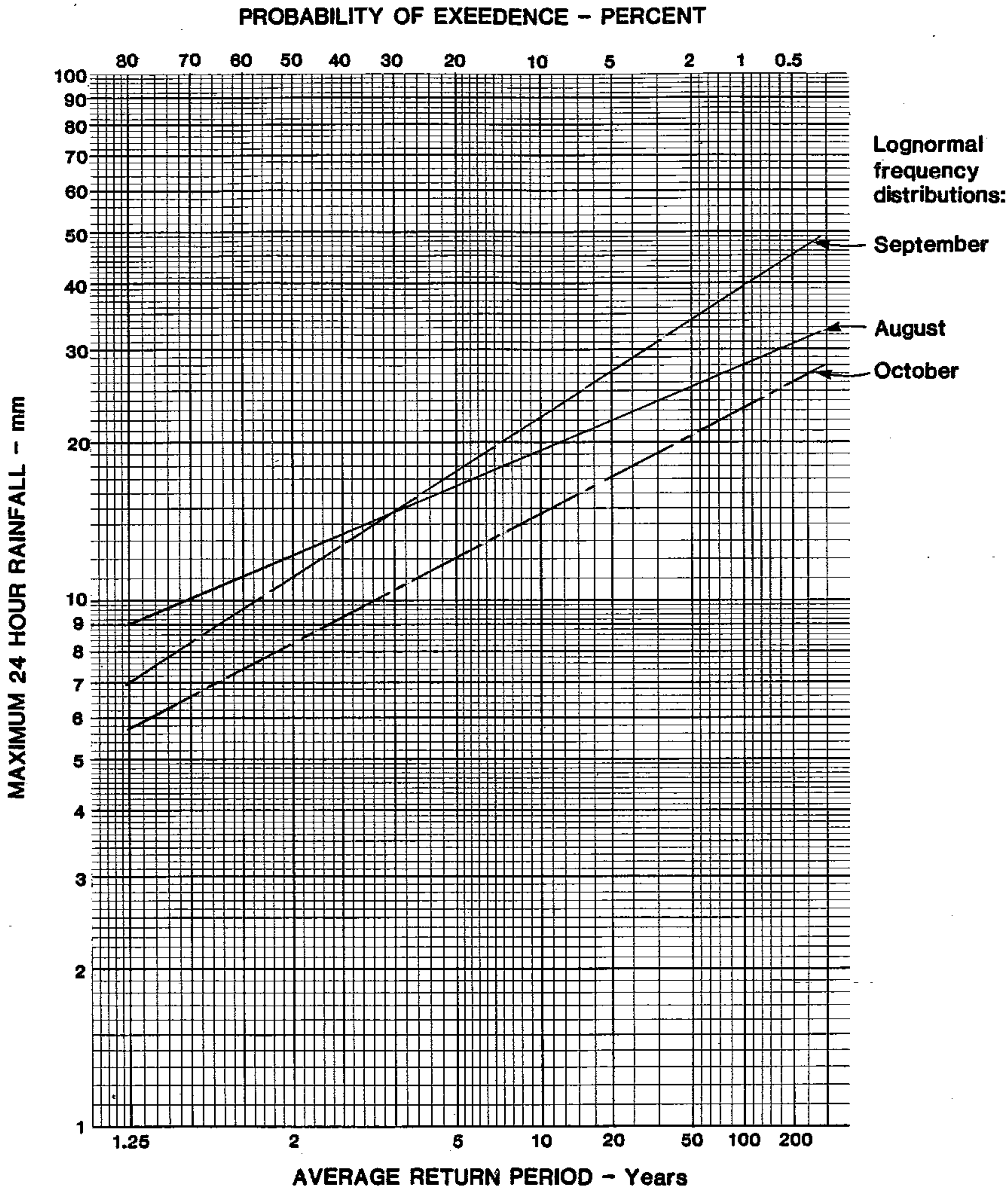
FULTON RIVER PROJECT OPERATION & MAINTENANCE MANUAL	
SNOWMELT RUNOFF VOLUME FREQUENCY	
DEC 1986	FIG. 3-4



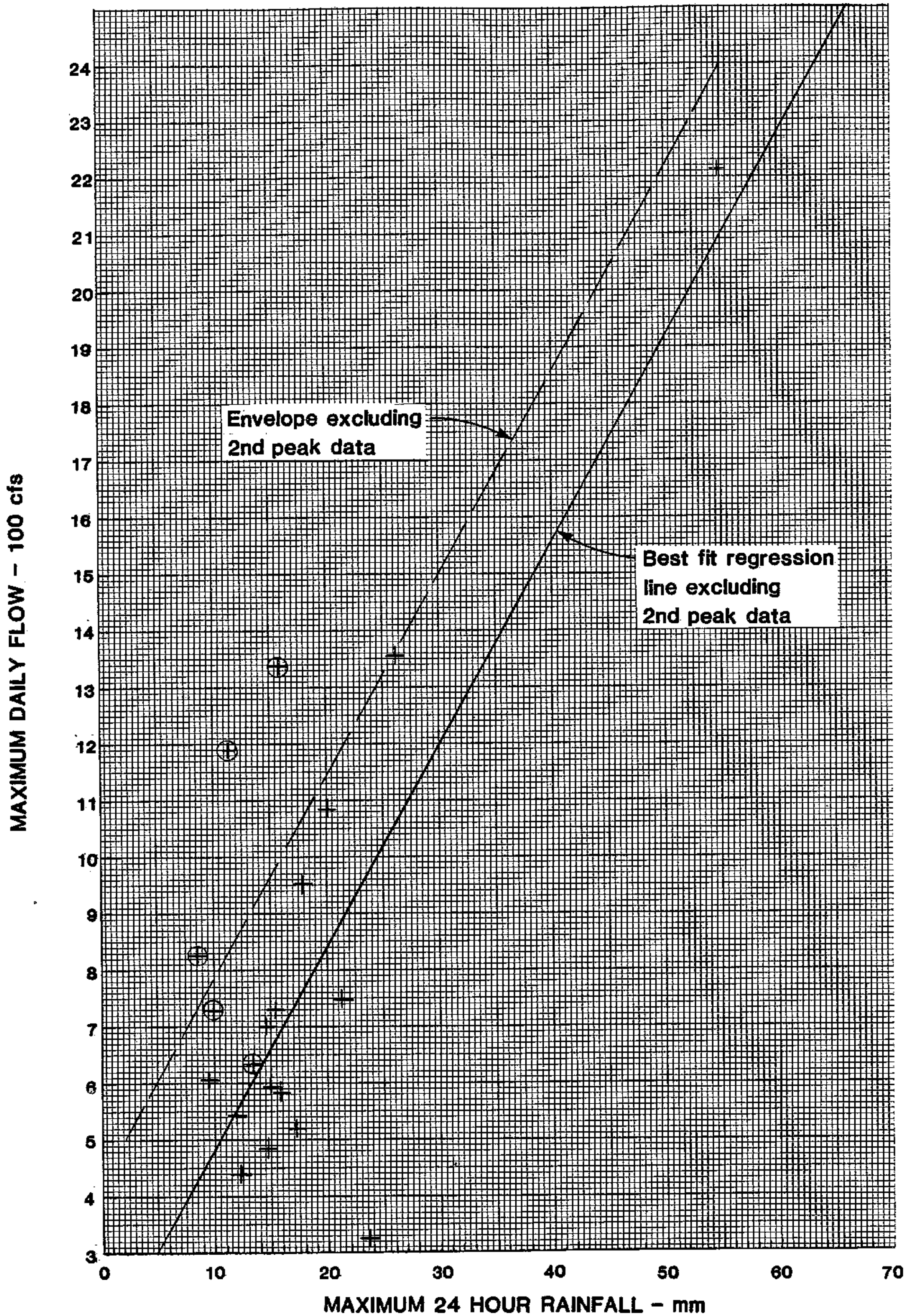
FULTON RIVER PROJECT
OPERATION & MAINTENANCE MANUAL

SNOWMELT RUNOFF VOLUME vs
APRIL 1st SNOW INDEX

DEC 1986 | FIG. 3-5



FULTON RIVER PROJECT OPERATION & MAINTENANCE MANUAL	
MAXIMUM 24 HOUR RAINFALL FREQUENCY - AUGUST TO OCTOBER	
DEC 1986	FIG. 3-6



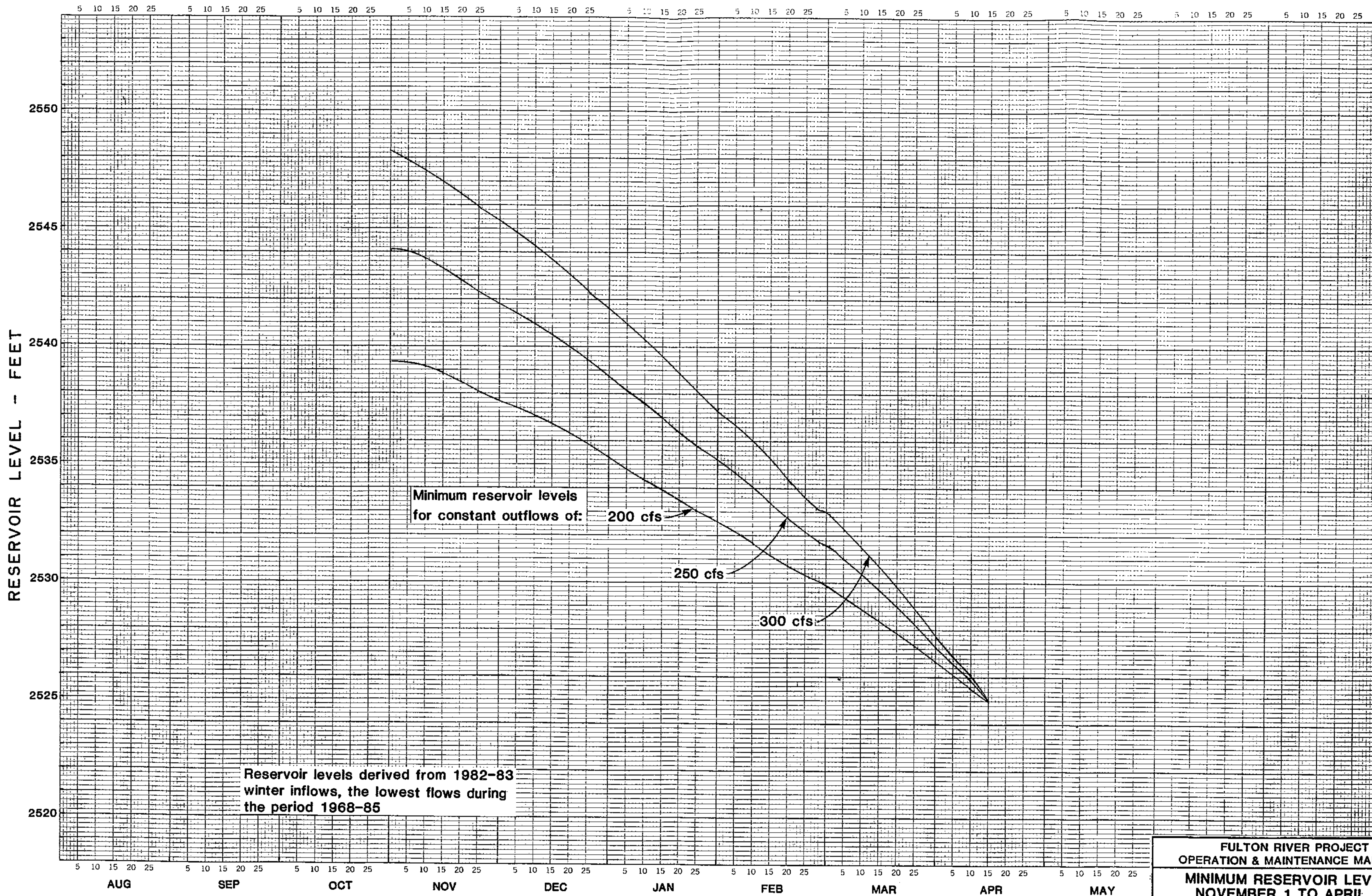
Legend:

+	Single peak flow
⊕	2nd peak flow within about 10 days of 1st peak

FULTON RIVER PROJECT
OPERATION & MAINTENANCE MANUAL

MAXIMUM 24 HOUR RAINFALL vs MAXIMUM DAILY FLOW

DEC 1986 — FIG. 3-7



FULTON RIVER PROJECT
OPERATION & MAINTENANCE MANUAL

MINIMUM RESERVOIR LEVELS
NOVEMBER 1 TO APRIL 15

DEC 1986

FIG. 3-8

FULTON RIVER PROJECT
SNOWMELT RUNOFF VOLUME FORECAST - WORK SHEET
Predicted Runoff Volume for 15 April to 30 June in cfs-days

		Snow Water Equivalent - inches						
	Year							
Snowcourse	Date							
Hudson Bay Mt. 4B03A	Mar 1							
	Apr 1							
	May 1							
Chapman Lake 4B04	Mar 1							
	Apr 1							
	May 1							
Tachek Creek 4B06	Mar 1							
	Apr 1							
	May 1							
McKendrick Creek 4B07	Mar 1							
	Apr 1							
	May 1							
Mount Cronin 4B08	Mar 1							
	Apr 1							
	May 1							
Mar 1 Prediction	40(4B03A+4B08)							
	+30(4B04)							
	+60(4B07)							
	+200(4B06+4B07)							
	Snow Index-mi^2 in							
	Predicted Vol (1000 cfs-days)							
April 1 Prediction	40(4B03A+4B08)							
	+30(4B04)							
	+60(4B07)							
	+200(4B06+4B07)							
	Snow Index-mi^2 in							
	Predicted Vol (1000 cfs-days)							
May 1 Prediction	40(4B03A+4B08)							
	+30(4B04)							
	+60(4B07)							
	+200(4B06+4B07)							
	Snow Index-mi^2 in							
	Predicted Vol (1000 cfs-days)							
Jun 1 Prediction	40(4B03A+4B08)							
	+30(4B04)							
	+60(4B07)							
	+200(4B06+4B07)							
	Snow Index-mi^2 in							
	Predicted Vol (1000 cfs-days)							

SECTION 5.0
MAINTENANCE AND SURVEILLANCE

CONTENTS
SECTION 5.O – MAINTENANCE AND SURVEILLANCE

5.11 Pipeline and Outlet Equipment

5.11.1 Inspection

5.11.2 Maintenance

5.12 Beaver Creek

SECTION 5.1 - GENERAL REQUIREMENTS

5.1.1 INTRODUCTION

To ensure the serviceability and integrity of the Fulton River Project, all components relevant to the proper operation of the dam, reservoir and appurtenant structures shall be regularly inspected and maintained in reliable condition.

Information obtained during inspections shall be retained and used to assess the current condition of the facilities, to detect any deterioration, and to determine any program of regular maintenance or special maintenance and repair. When any inspection reveals that structures or equipment are inoperative or in a condition which could jeopardize the safety or continued normal operation of the facilities, then prompt repair or replacement shall be carried out.

All facilities shall be operated and tested regularly to demonstrate their serviceability.

5.1.2 ROUTINE INSPECTIONS

All routine inspections and maintenance are described and logged in the Preventative Maintenance System software (see **Section 5.2** below).

5.1.3 SPECIAL INSPECTIONS

Unscheduled inspections may be carried out in response to abnormal operation or severe weather or weather forecasts. In some cases, assistance from a specialist and/or the Project Engineer may be required. For instance a significant problem with the intake tunnels or a very severe rainfall may require the Project Engineer and other specialists to perform a site visit. The results of these inspections are to be reported and included in the Preventative Maintenance System (PMD).

Other special inspections include a site inspection by a Provincial Dam Inspector and their subsequent reports are filed in the PMD.

5.1.4 DAM SAFETY REVIEW (Every 7 Years)

A Dam Safety Review (the “Review”) for the Fulton Dam shall be carried out be a qualified engineer (“The Engineer”) every seven years. The Review shall include an assessment of the condition of the dam and all appurtenant structures as well as design, operation, maintenance, surveillance and emergency plans, to determine if they are adequate and, if they are not, to determine required safety improvements.

The fundamental objective of the dam safety review is to provide a is a multidisciplinary review of all aspects of dam design, performance, and condition with respect to current standards, in order to detect any existing or potential deficiencies or weakness in the dam and associated structures that could affect the safety of the dam.

The Review may also include updates to the routine inspection schedule carried out by operators. These updates should be entered into the PMS (see **Section 5.2** below) as soon as the Review is completed.

Details of the reviews and inspections required are provided in the Canadian Dam Association's 2007 DAM SAFETY GUIDELINES.

SECTION 5.2 - PREVENTATIVE MAINTENANCE SYSTEM (PMD) 97

5.2.1 GENERAL DESCRIPTION

A computerized preventive maintenance database (PMD) is in operation at the Fulton River Project. The flow control structures and equipment are described in detail in the PMD. The PMD provides a description of scheduled inspections, maintenance, testing and record keeping.

The PMD is retained in the office of the Maintenance Supervisor. All appendices of this manual are also in the office of the Maintenance Superintendent.

The PMD consists of three components:

1. Item descriptions: Specification sheets have been prepared for all structures, systems and significant equipment comprising the dam and flow control works. The specification sheets also reference specific manuals, repair tools, companies and materials required to operate and maintain the flow control components.

2. Scheduled Work Orders: Detailed checklists have been prepared listing the inspections, testing and maintenance required for each structure, system and significant piece of equipment. Problems identified at the inspections are reported and scheduled for repair. Any continuing deterioration of structures, equipment, tunnel lining, bank armoring etc. is monitored. Work orders are issued automatically based on an established routine.

3. Maintenance Records: Detailed records of all scheduled and unscheduled maintenance are input to the PMD Repair invoices, past inspection checklists and any other reports on a specific component are kept in individual files per component.

5.2.2 ACCESS TO SOFTWARE

The PMD 97 software is a MS Access Database with a user interface. It can run on any workstation equipped with MS Access 97 or later.

The database consists of 2 files: pmpgm.mdb and pmdat.mdb

The primary copy of the database is kept on-site at the Fulton Dam field office. A secondary copy is kept by the Project Engineer, but does not contain up-to-date maintenance records.

The backup copy of the database is stored on a USB “thumb drive” located in the maintenance office.

SECTION 5.3 – FULTON RIVER DAM

5.3.1 INSPECTION

Scheduled inspections of the dam including the spillway and non-overflow sections should be carried out according to the PMD

Routine weekly inspections are primarily security checks. The purpose of monthly inspections is to have continuous surveillance of the dam, particularly in areas where some defect or deterioration has previously been detected. This continuing surveillance will enable any change in these conditions to be quickly detected.

There are no drainage galleries in the dam. Although there are longitudinal and lateral drains under the dam, the downstream outlets of these drains are not accessible. Inspection of these drains however, is not necessary as the design of the dam is based on the assumption that the drains are not operating.

The surface of the spillway crest and the downstream surfaces of the rollway and bucket should be inspected annually to assess the degree of scaling and the condition of concrete at the edges of vertical contraction joints. When the reservoir is at its lowest elevation in the spring, the upstream face of the dam should be inspected.

During "Dam Safety Review" year the contractors or the DFO employee responsible for the inspection should report any leakage at the vertical contraction joints on the downstream surface of the non-overflow part of the dam. If this leakage is observed it must recorded and photographed during these inspections. The photographs should be taken from the same point each time for comparisons over a period.

Offsets between individual blocks at vertical contraction joints and horizontal construction joints, or other evidence of differential movement, should be recorded. This evidence may be found especially where scaling or cracking of the concrete has occurred.

The contact between the concrete dam and rock at the abutments should be checked for evidence of leakage, preferably when the reservoir level is at the crest of the spillway.

Leakage along the bottom edge of the training walls should be inspected for evidence of rust. As it may indicate rust damage to the vertical reinforcement, the presence of rust should be included as a separate item in the inspection report.

5.3.2 MAINTENANCE

No regular maintenance of the concrete structures is scheduled. However, structural repairs shall be carried out as determined necessary by inspections.

If concrete has spalled at the edges of vertical contraction or horizontal construction joints, all loose particles should be removed and the surface cleaned to solid concrete. When the depth of damage exceeds 3 inches the concrete should be replaced; when the depth is less than 3 inches the concrete need not be replaced. Thin surface patches achieve no useful purpose and prevent proper inspection and assessment of damage.

SECTION 5.4 – DAM OUTLET WORKS (DAM-GATE HOUSE)

5.4.1 INSPECTION

Inspections of the dam outlet should be carried out in accordance with the PMD. In addition to the inspection of the exposed surfaces upstream in the reservoir, the inspection shall include all concrete surfaces downstream of the gate as well as the exposed surfaces of the training walls downstream of the dam.

The purpose of routine monthly inspections is to have continuous surveillance of the outlet works particularly in areas where some defect or deterioration has previously been detected. This continuing surveillance will enable any change in these conditions to be detected quickly.

Annual inspections are more thorough. During the annual inspections check for any damage to exposed concrete surfaces caused by cavitations, erosion or weathering. Cavitations damage, if present, should be measured, recorded and photographed. Erosion damage by debris carried in the flow should be recorded separately from cavitations damage.

The training walls should be examined for movement and scaling. The corner joints between the floor slab and the training walls should be checked for evidence of rust indicating loss of reinforcement area.

5.4.2 MAINTENANCE

Where cavitation damage exceeds 3 inches in depth, or results in exposure of reinforcement, it should be repaired with ordinary concrete. The cause of the cavitations should be investigated and eliminated if possible. All other areas of damaged concrete, where the depth of erosion exceeds 3 inches or results in exposure of reinforcement, should be repaired with specially formulated concrete with added latex or epoxy compounds. All areas to be repaired should be marked out with saw cuts around the perimeter and chipped out to a depth of one inch to prevent feather edges occurring between the old and new concrete.

To protect horizontal surfaces of the training walls from weathering, the top surfaces only of the walls may be painted with epoxy paint. This retards the penetration of moisture into the top layer of the concrete and reduces subsequent damage from freeze-thaw cycles.

The floor surfaces inside the gate house should be painted with a non-slip concrete paint to prevent damage from spilled oil or cleaning fluids.

SECTION 5.5 – DAM OUTLET EQUIPMENT (DAM-GATE HOUSE)

5.5.1 INSPECTION

Inspections should be carried out in accordance with the PMD. The routine weekly inspections of trash build-up in the forebay will ensure that a suitable time for removal is scheduled before the dam outlet is required to operate in the early summer. The monthly inspections will check the operation of the electrical hoist equipment, controls and limit devices.

Annual operational tests and inspection of the outlet gates should be made as indicated below, and if possible combined with the necessary maintenance outlined in the following Section.

<u>Hoisting Equipment:</u>

1. Initial Check
   a) Check monorail hoist operation.
   b) Check operation of limit switches, motor brakes, controls.
   c) Inspect wire rope for excessive wear, broken wires, etc.
   d) Inspect hook for cracks and throat opening distortion.
   e) Check gear reduction equipment, lubrication, oil level and bearings for wear.
   f) Note any abnormalities.

2. Inspect hoisting chains for worn links or shackles.

3. Inspect the dogging device, check pin, pivots and general condition.

4. Inspect general condition, check paint film, bumpers, welds and bolted connections, and overall service- ability of hoist.

5. Check monorail beam for secure mounting and check paint film.

Refer to the Demag. manual in **Appendix L** for further details of the hoist.

<u>Trashracks:</u>

1. Inspect for debris accumulation to determine if cleaning is necessary. (Clean trashracks before opening gates)

2. Check welds for damage. Check for corrosion damage and damage to metal protective coatings.

<u>Gates:</u>

Note - Gates only operable at specific reservoir levels

1. Operate gates through the full length of their travel and hoist them above the floor to inspect the gates. Record any observed damage or malfunction.

2. Check seals for damage.

3. Check that wheels turn freely and are in operating condition.

4. Check for corrosion damage and damage to metal protective coatings.

5. Inspect gate guides for alignment and corrosion damage.

5.5.2 MAINTENANCE

Regular maintenance should include draining and refilling the hoist gearboxes, greasing wire ropes, rope drum and sheave blocks. Gate wheels and any other moving parts should be properly lubricated.

Corrosion damage should be repaired. Corroded surfaces should be cleaned and painted according to the manufacturer's instructions.

SECTION 5.6 – REGULATING WORKS INTAKE (INTAKE HOUSE)

5.6.1 INSPECTION

The exposed concrete surfaces that are always above water should be inspected annually, as outlined in the PMD. The condition of the concrete should be recorded and photographed for comparative purposes. The submerged concrete and steel surfaces should be inspected during the Comprehensive Inspection Review at low reservoir elevations.

The metal-clad superstructure should be inspected during routine visits and inspected more thoroughly every year for damage due to the effects of weather or vandalism.

The steel lined surfaces of the bypass slide gate should be inspected for rust damage when the tunnel is dewatered. The depth, location and extent of rust damage should be recorded and photographed.

5.6.2 MAINTENANCE

No specific maintenance measures are scheduled for the regulating works intake. However protective painting and structural repairs should be carried out as determined by inspections.

The floor surface inside the gatehouse should be painted with a non-slip concrete paint to control dust and prevent damage due to oil or cleaning fluid spills.

Any rust nodules on steel surfaces that are normally submerged, such as gate guides and the liner behind the bypass slide gate, should be removed and a protective paint coat applied.

Accumulated trash at the trashracks should be removed following scheduled inspections. Any large floating logs and debris which have escaped under the log boom should be removed from the trashrack area on routine visits to the intake.

Clean gate house and check services.

SECTION 5.7 – REGULATING WORKS INTAKE EQUIPMENT (INTAKE HOUSE)

5.7.1 INSPECTION

Inspections should be carried out in accordance with the PMD. The routine weekly inspections shall record evidence of trash build-up on the trashracks by observing the head difference between the forebay and water level in the bulkhead gate shaft. If there is evidence of a trash build-up, an inspection should be made at a low reservoir elevation or by diver. The scheduled monthly inspections shall check the operation of the electrical hoist equipment, controls and limit devices.

Annual operational tests and inspection of hoists and operating gates shall be made as indicated below. The regular maintenance measures included in the following Section may also be carried out at this time.

<u>Hoisting Equipment:</u>

1. Initial Check
    a) Check operation of fixed hoist and monorail hoist.
    b) Check operation of limit switches, motor brakes, controls.
    c) Inspect wire rope for excessive wear, broken wires, etc.
    d) Inspect hook for cracks and throat distortion.
    e) Check gear reduction equipment, lubrication, oil level, and bearings for wear.
    f) Note any abnormalities.

2. Inspect hoisting chains and shackles for wear.

3. Inspect the dogging devices, check pins, pivots, and general condition.

4. Inspect hydraulic cylinder and power unit to the bypass slide gate and note any leaks or other problems.

5. Inspect general condition, check paint film, bumpers, welds and bolted connections, and overall serviceability.

Refer to Appendix B for further details of the service hoist and **Appendix C** for details of the Munck hoist.

Gates:

1. Operate the bulkhead gate through the full length of its travel and hoist above the floor to inspect. Record any damage or malfunction.

2. Due to difficulty in removal of the service gate, inspect it in place when the tunnel is dewatered.

3. Inspect the bypass slide gate in place when tunnel is dewatered.

4. Check seals for damage.

5. Check that wheels turn freely and are in operating condition.

6. Check for corrosion damage and damage to metal protective coatings.

7. Inspect gate guides for alignment and corrosion damage.

8. Check slide gate stem for buckling or deterioration.

5.7.2 MAINTENANCE

Regular maintenance shall include draining and refilling the hoist gearboxes, greasing wire ropes, rope drum and sheave blocks. Gate wheels and any other moving parts shall be properly lubricated.

Any rusted surfaces should be cleaned and painted according to the manufacturer's instructions. Any deep-seated corrosion damage in equipment should be repaired or the equipment replaced.

The trashracks should not be removed to clear debris. Divers should be used to clear the racks if debris cannot be removed by mobile crane fitted with clam or orange peel bucket.

SECTION 5.8 – REGULATING TUNNEL AND OUTLET (TUNNEL TO CONE VALVES)

5.8.1 INSPECTION

The tunnel and outlet works should be inspected annually. Check the condition of the concrete lining and ascertain that the pressure relief pipes are free draining for their entire depth.

The junction between concrete and steel at the steel liner near the downstream end of the regulating tunnel should be checked for damage from water-born debris. Check for damage to the protective paint on the steel liner and for any development of buckling or other distortions.

Inspect the concrete surround to the hollow cone valves for surface scaling. Record and photograph for comparative purposes.

5.8.2 MAINTENANCE

The pressure relief pipes in the tunnel lining should be kept clean for their designed depth. Soft deposits should be rodded and flushed out. Drilling may be required to free the pipes of hard calcinated deposits.

When damage to the concrete lining exceeds a depth of 3 inches the damaged area should be marked out with saw cuts to a depth of one inch and the enclosed area chipped out to sound concrete. The whole area should then be filled with a compatible concrete mix and the edges formed flush with the existing surfaces to avoid feather edges.

Rust damage to the steel liner should be monitored at each visit. When the damage to the protective paint reaches about 50 per cent of a particular area the affected area should be cleaned to bare metal and recoated with a compatible protective paint. Scratches and areas of other minor damage should be similarly painted.

Check condition of the cathodic protection system's sacrificial anode (27cm x 15cm zinc block) bolted to liner near the u/s end of the liner.

SECTION 5.9 – OUTLET EQUIPMENT (CONE VALVES)

5.9.1 INSPECTION

Routine monthly inspections of the valves, the valve actuators, gearboxes, and jacks should be carried out as per the PMD. Check for leaks and inspect the gliding strip for sand and grit deposits. Refer also to the manufacturer's Instruction Manuals in **Appendix E** and **Appendix F**.

At the annual inspection of the valves, check for damage to the anti-corrosion coatings. Inspect the interior and exterior surfaces of the valves for cracks in welds and damage to the surfaces as well as corrosion.

5.9.2 MAINTENANCE

The hollow cone valves should be operated once a month if standing dry, and every three months if standing filled with water. This regular exercise is recommended by the manufacturer to ensure that the sealing rubbers between piston and cylinder do not bind, and that all moving parts operate satisfactorily. The gliding strips should be cleaned before retracting the piston.

Note: DO NOT exercise in freezing conditions.

No periodic overhauls of the valve body and piston assembly are recommended by the manufacturer.

The manufacturer recommends lubrication of the actuators at six month intervals, and gearboxes and jacks every month.

The gearboxes should be drained and refilled with the correct lubricant at the time the valves are insulated for winter. The operation of the heaters should be checked at this time, and the insulating blankets inspected. Lubricate interface between rubber seals and moving steel body of hollow cone valve with Cosmolube 615.

Yearly inspection of the valve body includes cleaning prior to inspection for corrosion. Any rust tubercles that have developed should be ground out and filled with epoxy and coated with epoxy tank liner.

SECTION 5.10 – WATER SUPPLY TUNNEL AND PIPELINE (WATER SUPPLY TO CH #2)

5.10.1 INSPECTION

The normal frequency of inspections is outlined in the PMS. At the Dam Safety Review, the concrete lining in the upstream section of the tunnel should be examined for cracks, spalls and other evidence of stress in the surrounding rock. In the supply tunnel proper, whether as water conduit or housing for the pipeline, sections which are fully or partially shotcreted should be examined for cracks or spalls in the lining. The location of new cracks, especially those where leakage is evident, should be recorded and photographed for comparison with earlier inspections. Unlined sections should be inspected for rock falls.

The pressure relief pipe sleeves in the tunnel should be examined to see that they are open and free draining.

During routine monthly inspections of the pipeline the condition of the paint should be examined and its condition recorded. Check for leakage at the expansion joints and for the fit of the pipe shell on the saddle supports. The saddle supports should also be inspected for settlement, misalignment and other indications of distress.

5.10.2 MAINTENANCE

The tunnel and pipeline should be maintained free of loose debris and it is important to remove any debris during the Dam Safety Review. The pressure relief pipe sleeves in the tunnel should be kept freely draining by rodding and flushing out. In case of complete blockage with calcium deposits, they should be drilled out to a depth indicated in the original drawings.

It is important to schedule sufficient time to carry out all the above tasks while the tunnels are dewatered.

Rust spots or larger areas of rust on the steel pipeline should be treated regularly following routine monthly inspections. Rust should be removed and the areas cleaned to bare metal, then painted.

SECTION 5.11 – PIPELINE AND OUTLET EQUIPMENT

5.11.1 INSPECTION

Inspections should be carried out in accordance with the PMD. During the inspections of the various valves the following items should be examined.

Butterfly Valve: (Beaver Creek Station)

1. Examine the stuffing box for leakage at packing.

2. Inspect condition of thrust bearing located at the end of the non-driving steel shaft.

3. Inspect interior of pipe and examine condition of the rubber seat ring (access through manhole on pipeline).

8-inch Gate Valves: (Beaver Creek Station)

1. Examine the stuffing box for leakage at packing.

2. Check lubrication of external threads.

3. Check for leakage or other defects.

4. Check coal tar epoxy coating of piping and valves.

Air Valves: (Downstream Side of Tressel)

1. Check for leakage. A malfunction of the valve can be identified by leakage of water through the exhaust port.

2. Inspect seals annually.

Hollow Jet Valve: (Kubota Valve)

1. Inspect exterior of valve monthly.

2. During annual inspections, examine carefully for cavitation damage particularly upstream of the sealing ring.

Refer also to manufacturer's Instruction manuals in Appendices L, M and N.

Pipeline:

1. Do survey check of pipeline to identify movement of pipe down slope. See Pipeline Stability Survey, **Appendix M.**

2. Check insulation of exposed pipeline from sta. 61+10 to sta. 67+50.

3. Check extent of vegetation around pipeline and note if it is damaging insulation.

4. Check surface drainage culverts along pipeline route.

Cathodic Protection:

Monthly checks of the rectifier should be made to record amps, volts and tap setting.

Following every repair or change in rectifier or wiring, one or more potential readings should be taken.

A detailed survey should be performed by a qualified corrosion technologist every year. Refer to **Appendix O** of this manual for recommended checks to be made.

5.11.2 MAINTENANCE

The following maintenance steps should be carried out at the frequency recommended by the manufacturer.

Butterfly Valve: (Beaver Creek Station)

1. Lubricate grease-packed gear operators.

2. The horizontal valve shaft runs in bronze bearings, with self-lubricating graphite inserts, and does not require periodic lubrication.

8-inch Gate Valves: (Beaver Creek Station)

1. Re-pack stuffing box as determined necessary from inspection.

2. Grease screw stem as determined necessary from inspection.

Air Valves: (Downstream of Tressel)

1. No maintenance work should be carried out while valve is under pressure.

2. Grease air valve pivots and stem of gate valve when necessary.

Hollow Jet Valve: (Kubota Valve)

1. At three month intervals fill valve and operator grease nipples with a good grade cup-grease, and grease universal joints with a good grade, first or second, "O" type chassis lubricant. These two maintenance items should be carried out with a low pressure hand-operated grease gun as a high pressure gun could damage the seals. The lubricant should be a fine fibre grease with a high melting point. Lubrication can only be done when Kubota valve is closed.

2. At six month intervals grease the gear teeth of the head stock with a good quality gear compound.

Cathodic Protection:

The following maintenance should be carried out at monthly intervals.

1. Adjust rectifier to maintain current to the anodes between 1.5 and 3.0 amps; the current should not be allowed to drop below 1.5 amps.

2. If the maximum current setting drops below 1.5 amps, water the anode ground bed.

SECTION 5.12 – BEAVER CREEK (PROPER)

Inspect Beaver Creek for beaver dams and remove them to avoid impounding water in the creek course. Note that a breach of a past impoundment almost washed out the pipeline crossing at Beaver Creek.

SECTION 6.0
EMERGENCY PREPAREDNESS PLAN

CONTENTS
SECTION 6.O - EMERGENCY PREPAREDNESS PLAN

Quick Reference

Emergency Contacts

Name	Contact Information
Granisle RCMP	250 697-2333
Houston RCMP	250 845-2204
Granisle Ambulance	1 800 461-9911
Houston Ambulance	250 845-2900
Granisle Fire Department	250 697-2345
Houston Fire Department	250 845-2250
British Columbia Provincial Emergency Program	1 800 663-3456
Lake Babine Nation	250 692-4700
DFO Communications Branch	613 993-0999
Environment Canada – Pacific and Yukon Region	604 666-6496
Dam Safety Officer, Scott Morgan	250 387-3265
CFLD Radio, Burns Lake	250 692-3414

Facility / Site Information

Facility / Site Name: Fulton River Spawning Channel	**Phone** 250 697-2314
Location: Granisle, B.C.	**Postal** V0J 1W0

SECTION 6.1 - EMERGENCY IDENTIFICATION AND EVALUATION

6.1.1 DAM BREACH

(a) Definition

Dam breach is defined as an opening in the dam or abutments which results in large uncontrolled releases of water downstream from the reservoir.

(b) Downstream Hazard

This situation would present a high level hazard to all those living near the river downstream from the dam and a lower hazard to those living around the perimeter of Lake Babine, near the outlet of the Fulton River into the lake.

(c) Response

The downstream effects of a dam breach will be apparent before any warning can be given to those living within the affected area. **Table 6.1** outlines the effect of a breach in the surrounding area. It is probable that a dam breach would occur during a major flood event, which takes time to develop in the Fulton River system. Therefore, some advance warning could be given to those immediately affected by calling the local commercial radio station, and requesting a break in normal transmission to alert the public about the situation. The local radio station is CFLD radio in Burns Lake and can be reached by phone at 250 692-3414.

(d) Verification

It is important to verify that a breach has in fact occurred and, if a breach has occurred, that the situation is either stabilized or checked momentarily prior to the possible formation of a larger breach. As soon as possible a visit must be made to the dam to determine the:

1. Location of the breach.
2. Magnitude, width, and depth.
3. Rate of possible further development of the breach.
4. Uncontrolled flow.
5. Rate of change of flow.
6. Time of commencement of breach.
7. Photographs of the breach to show some of these features should be taken.

(e) Notification

If a breach has in occurred, immediately refer to the **Emergency Notification Flowchart: Dam Breach** in **Section 7.1.1**.

TABLE 6-1
FULTON RIVER PROJECT
DAM BREACH INUNDATION STUDY

Hypothetical Flood Data

	Distance from Dam (km)	Peak Water Elevation (m)	Time to Peak Elevation* (mins)
Dam Tailrace	0	755	0
Section 2	1.37	725.4	2.4
Section 3	2.86	719.2	8.4
Section 4	3.88	717.1	12.6
Bridge 5	4.14	716.8	15.6
Section 6	4.81	715.4	19.8
Section 7	5.49	712.4	21.6
Babine Lake	5.84	711.2	21.6

* Time to peak measured from completion of dam breach.

6.1.2 POTENTIAL DAM BREACH

(a) Definition

A potential dam breach is defined as any condition that presents an immediate threat to the safety of the dam or abutments, and which could result in large or rapidly increasing uncontrolled releases of water from the reservoir.

This situation requires an immediate response to prevent or alleviate the effects of a dam breach.

(b) Downstream Hazard

A potential dam breach may require the controlled release of large flows to minimize the effects of a breach by drawing the reservoir down to a lower elevation. These releases may cause downstream flooding but will be limited to a maximum discharge of about 5,400 cfs at a reservoir elevation of 2,547 feet, measured at the crest elevation of the spillway. These releases would be in excess of any uncontrolled flow over the spillway.

(c) Causes

A potential dam breach may be due to but not limited to any of the following:

- Seismic activity
- Landslides

- Floods
- Severe Storms
- Slumping or cracking of the dam
- Failure of dam outlet gate equipment
- Sabotage
- Springs, seeps or increased drainage.

If any of the above has occurred or if there is a suspected potential breach, follow the response procedures below.

(d) Response

Observation of a potential dam breach shall be thoroughly investigated. Site personnel shall:

1. Ascertain and verify details of potential dam breach.

    a. Description of slides, sloughs, subsidence in the abutments or movement, cracking, seeps, drainage, etc., in the dam.
    b. Location and extent.
    c. Effects on adjacent structures.
    d. Likelihood of deterioration.
    e. Reservoir and tailwater elevations.
    f. Prevailing weather conditions.
    g. Other pertinent facts.

2. Initiate notification procedures as detailed below in subsection **(e)**.

3. Evaluate the potential threat in collaboration with DFO Engineering and any other engineering consultants involved with the dam.

4. Determine and implement the immediate actions which can reduce or eliminate threat of a breach.

5. If the controlled release of large flows is required, take action to minimize the impact of any downstream flooding.

6. If the situation deteriorates and a breach develops or becomes imminent, implement dam breach procedures set out in **Section 6.1.2.**

(e) Notification

Immediately refer to the **Emergency Notification Flowchart: Potential Dam Breach** located in **Section 7.1.2.**

6.1.3 OTHER EMERGENCIES

(a) Definition

An emergency is defined as any condition that presents an immediate threat to the safety of the general public or Fisheries and Oceans personnel or property.

Emergencies may be caused by but are not limited to any of the following:

- Fires
- Oil and hazardous substance spills
- Bomb threats
- Riots
- Pipeline breakage

(b) Response

If an emergency situation occurs please refer to the appropriate response flow chart located in **Section 7.2**.

SECTION 6.2 - PREVENTATIVE ACTIONS

Refer to **Section 5.2** for a description of the preventative maintenance system currently in place for the dam.

Section 6.3 - NOTIFICATION PROCEDURE

An Emergency Operations Center (EOC) is a central command and control facility responsible for carrying out emergency management, or disaster management functions in an emergency situation.

The EOC for an emergency resulting from the Fulton Dam will be located at the Fulton Spawning Channel grounds main building.

In case of emergency hatchery staff will congrugate at the EOC and carry out the procedures listed in **Section 6.1** and **Secction 6.4** of this maual.

SECTION 6.4 - COMMUNICATION AND WARNING SYSTEMS

Phone
System(s) if phone service is interrupted:

- Radio (Burns Lake CFLD)
- Door to door (Fan out system)

SECTION 6.5 - ACCESS TO SITE

Refer to **Section 1.2** and **Figure 1-1** for detailed information on primary and secondary access routes to sites.

SECTION 6.6 - INUNDATION MAPS

6.6.1 PURPOSE

The purpose of the inundation studies is to simulate the effects of a dam breach so that the extent of downstream inundation may be estimated.

6.6.2 INUNDATION STUDIES

In these studies a hypothetical dam breach was assumed to occur during the probable maximum flood (PMF) inflow into the reservoir. The breach was timed to occur when the outflow from this flood was at its maximum, corresponding to the maximum elevation reached in the reservoir. The simulation was carried out with the computer program SMPDBK developed by the National Weather Service.

Experience with the geometrical form and temporal development of a breach is limited. The study, therefore, has been based on assumptions that are considered conservative. In the unlikely event of a dam breach, the actual conditions, and the final results, will differ from those assumed. However, the results obtained are considered appropriate for emergency planning purposes because they assume a worst case scenario.

The hypothetical breach assumed in the studies was the downstream displacement of two blocks in the dam section. This left a gap of 12.8m (42ft) width down to the elevation of the foundations at 764.74m (2509 ft). This simulated gap produced a maximum breach outflow of 1327m^3/s (46 900cfs) Along with a flow of 530 m^3/s (18,700cfs) over the spillway and through the valves and bottom outlet, this gave a total discharge of 1857m^3/s (65,600cfs)just downstream of the dam.

The 2007 Dam Breach and Inundation Study is in **Appendix T** and in the 2007 Dam Safety Review found in **Appendix P.**

6.6.3 INUNDATION MAP

The extent of peak inundation downstream from the dam from this combination of PMF and dam breach is shown in blue on **Figure. 6.1.** This drawing is reduced from a drawing to a scale of 1 cm to 80m (1:8000) with a contour interval of 2 m.

A record of peak water elevations at each river section is shown in **Table 6.1** and repeated for some sections on the Inundation Map in **Figure. 6.1.**

SECTION 6.7 - COMMUNICATIONS DIRECTORY

This directory lists telephone numbers that may be required in an emergency situation.

DFO:

Fulton River Project	250 697-2314
Technical Support Manager (Vancouver) Greg Brooke	Ph: 604 775-8902 Cell: 604 209-6286
Project Engineer (Vancouver) Jackie Hicks	Ph: 604 666-4697

RCMP:
Granisle: 250 697-2333
Houston: 250 845-2204

FIRE:
Granisle: 250 697-2345
Houston: 250 845-2250
Smithers: 250 847-2345

AMBULANCE:
Granisle: 1 800 461-9911
Houston: 250-845-2900
Smithers: 250 847-8808

Provincial Emergency Program:
To Report an emergency 1 800 663-3456
Northwest region 250 615-4800

Local Municipalities:
Granisle:
Municipal Offices 250 697-2248
Public Works 250 697-2489

Smithers:
Municipal Offices 250 847-1600
Works Yard 250 847-1647

Burns Lake:
Municipal Offices 250 692-7587
Works Yard 250 692-4882

Lake Babine Nation: 250 692-4700
Topley Landing: Babine Lake Lodge 250 697-2310

SECTION 6.8 - SOURCES OF EQUIPMENT

Contact:	Fulton Spawning Channel
Phone:	250 697-2314
List of Equipment:	1-3 ton flatdeck with Hiab and snowplow 1-5 ton dumptruck and snowplow 1-941B Caterpillar tracked loader

Contact:	Pinkut Creek Hatchery
Phone:	250 692-9385
List of Equipment:	1-977 track loader 1 dump truck

Contact:	Babine Barge
Phone:	250 845-1141
List of Equipment:	1-Excavator 1-Grader 1-Loader 2-Dump Trucks

Contact:	Village of Granisle
Phone:	250 697-2489 or 250 697-2248
List of Equipment:	1-Grader 1-Backhoe 1-Dumptruck

Contact:	B & A Equipment Rentals
Phone:	250 847-2037
Location:	Smithers, BC

Contact:	Lakes District Maintenance
Phone:	250 692-7766
Fax:	250 692-3930
Location:	

Contact:	Highland Helicopters Ltd
Phone:	250 847-3859
Location:	Smithers Airport, BC

Contact:	Canadian Helicopters Ltd
Phone:	250 847-9444
Location:	2880 Highway 16, Smithers, BC

Contact:	Westland Helicopters
Phone:	250 845-2334
Location:	Houston, BC

SECTION 6.9 - SOURCES OF SUPPLIES & MATERIALS

Hardware	
Contact:	Reitsma Home Hardware.
Phone:	250 845-2419
Location:	3443 - 9th St., Houston, BC

Hardware	
Contact:	Home Hardware Stores
Phone:	250 847-2052
Location:	1115 Main St., Smithers, BC

Hardware	
Contact:	Co-op
Phone:	250 845-2303
Location:	W. Yellowhead, Highway 16, Houston, BC

Plumbing	
Contact:	Smithers Lumber Yard Ltd.
Phone:	250 847-2246
Location:	3528 Yellowhead Highway 16, Smithers, BC

Plumbing and Heating	
Contact:	Alpine Wiring, Plumbing and Heating Supplies Ltd.
Phone:	250 847-2820
Location:	3843 4th Ave., Smithers, BC

Electrical	
Contact:	Alpine Wiring, Plumbing and Heating Supplies Ltd.
Phone:	250 847-4561
Location:	3843 4th Ave., Smithers, BC

Electrical	
Contact:	EEcol Electrical
Phone:	250 847-8880
Location:	Smithers, BC

Lumber	
Contact:	Smithers Lumber Yard Ltd.
Phone:	250 847-2246
Location:	3528 Yellowhead Highway 16, Smithers, BC

Lumber	
Contact:	Windsor Plywood
Phone:	250 847-4261
Location:	4156 Railway, Smithers, BC

Riprap and Aggregate	
Contact:	Fulton Spawning Channel
Phone:	250 697-2314
Description:	- rock rip rap - coarse and fine aggregate
Location:	See **Figure 6-1**.

SECTION 6.10 - EMERGENCY POWER SOURCES

6.10.1 ON SITE GENERATOR

In the event that power is lost the emergency backup generator will supply minimal power to some buildings on site. The buildings the generator will supply include:

- Maintenance SB House
- Laboratory
- Intake House
- 50% of the Cookhouse/Residence

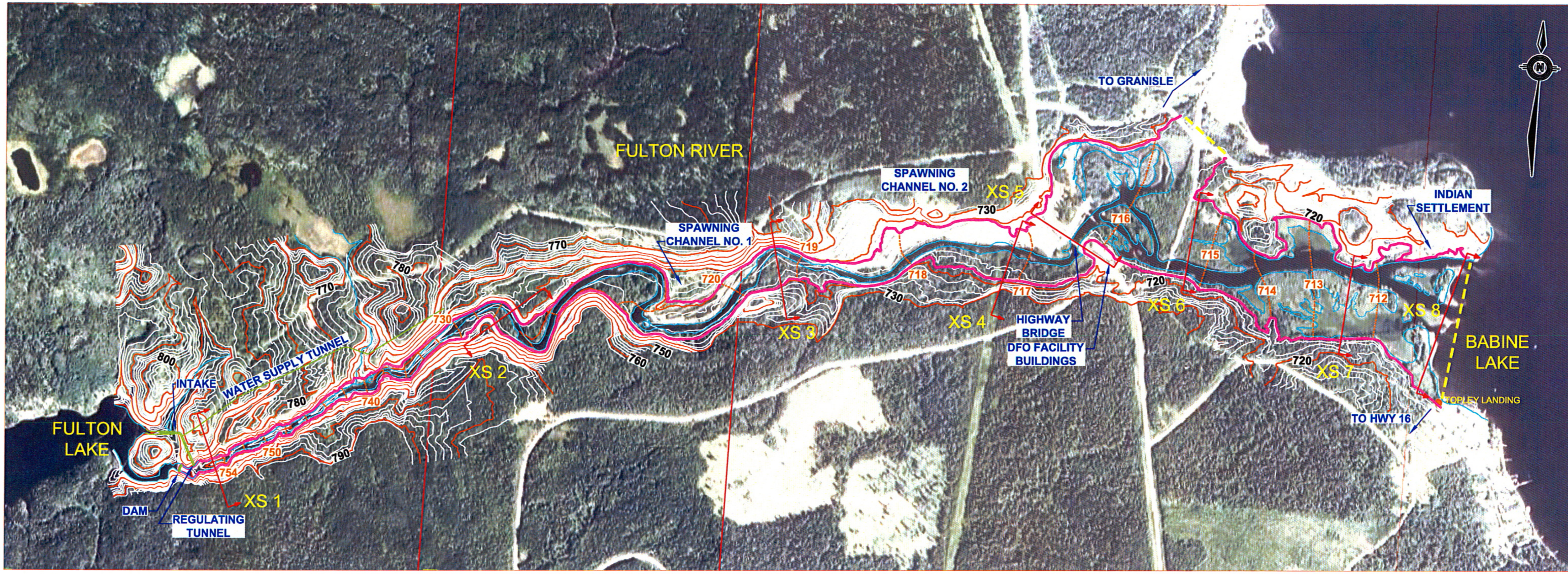
Buildings that are not on the Generator grid include:

- Manages SB House
- Shop
- All other site buildings

6.10.2 RENTAL GENERATOR

In the event that the main emergency generator fails or needs to be supplemented an additional generator can be shipped in from Prince George. This is 4-5 hours away. The contact information is:

Simpson Maxwell - 1846 Quinn Street Prince George, BC 1 800 374-6766



DAM BREAK ANALYSIS - SUMMARY OF RESULTS

CROSS SECTION	XS 1	XS 2	XS 3	XS 4	XS 5	XS 6	XS 7	XS 8
DISTANCE FROM DAM (km)	0.00	1.37	2.86	3.88	4.14	4.81	5.49	5.84
TIME TO PEAK ELEVATION (min)	0.0	2.4	8.4	12.6	15.6	19.8	21.6	21.6
PEAK WATER ELEVATION (m)	755.0	725.4	719.2	717.1	716.8	715.4	712.4	711.2

ISSUED FOR REVIEW

LEGEND/NOTES
- Base information taken from DFO Dwg No. 21-19-401
- Airphoto obtained from Google Earth
- Contours are 2m intervals

CONTOURS
WATERCOURSES
PROJECT STRUCTURES
SECTION LINES
FLOOD EXTENTS
FLOOD LEVEL ISOGRAMS
LIMIT OF STUDY

SCALE 1:8000
80 0 80 200 320m

CLIENT
Department of Fisheries and Oceans

HAYCO HAY & COMPANY CONSULTANTS A DIVISION OF EBA

FULTON DAM SAFETY REVIEW
2008 HYDROTECHNICAL ASSESSMENT

INUNDATION MAP

PROJECT NO.	DWN	CKD	REV
V13201140	ML	RJW	0

OFFICE	DATE
VANC	February 25, 2009

Figure 18

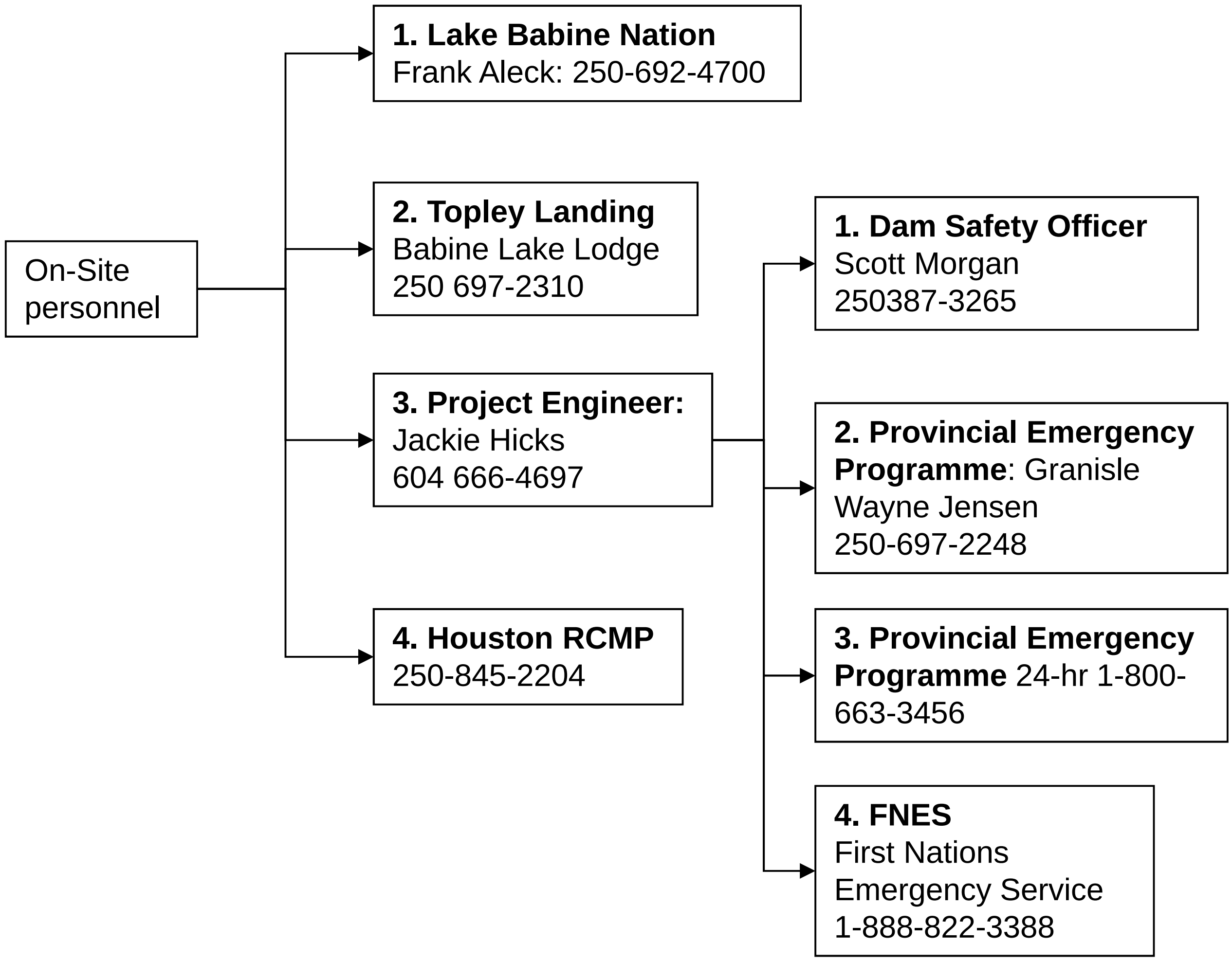
Q:\Vancouver\Engineering\V132\Projects\V13201140 Fulton Dam Safety Review\CADD\Inundation Map Rev03.dwg [FIGURE 18] February 25, 2009 - 3:38:36 pm (BY: MARIA LAU)

SECTION 7.0
EMERGENCY PREPAREDNESS PLAN FLOWCHARTS

CONTENTS
SECTION 7.O - EMERGENCY PREPAREDNESS PLAN FLOWCHARTS

FLOWCHARTS

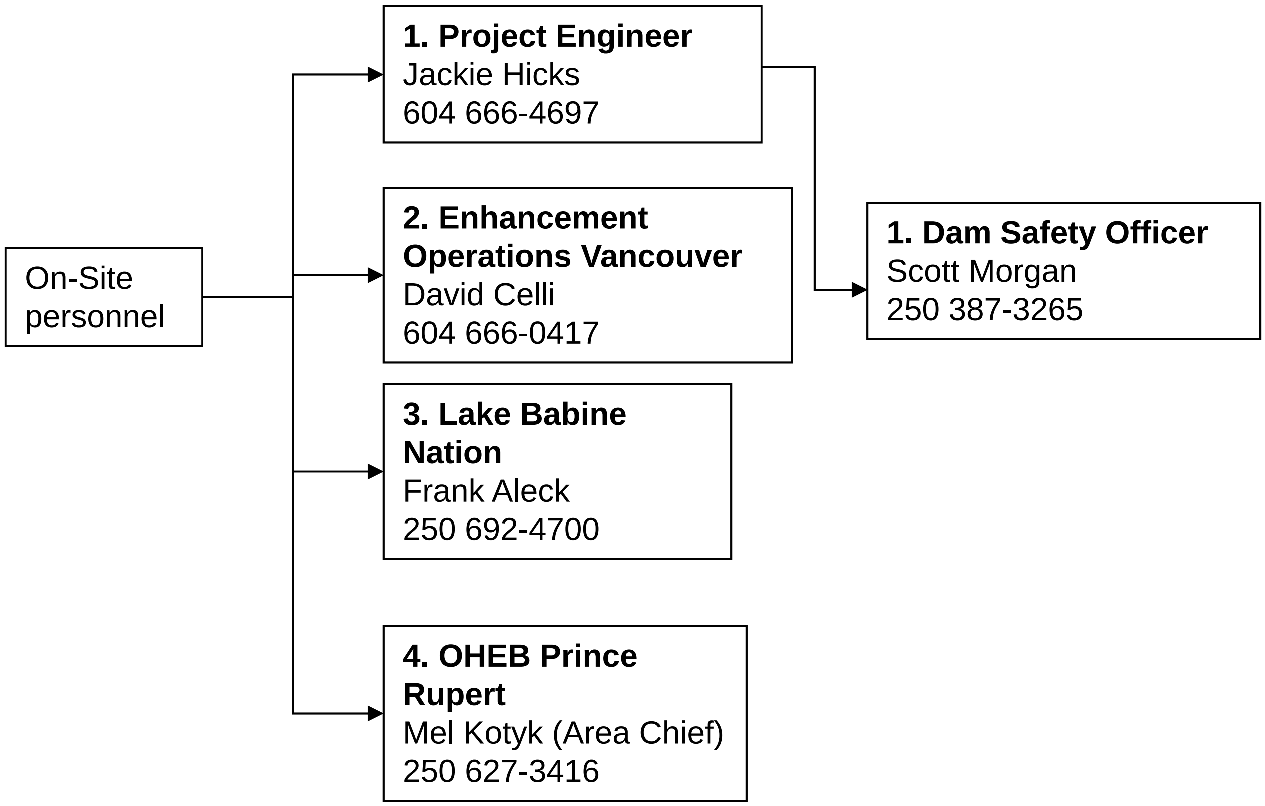
7.1.1 EMERGENCY NOTIFICATION FLOWCHART: DAM BREACH



Information to record
(whenever possible)

1. Location of breach.
2. Magnitude, width and depth.
3. Rate of possible further development of breach.
4. Uncontrolled flow.
5. Rate of change of flow.
6. Time of commencement of breach.
7. Photographs of the breach to show some of these features should be taken.

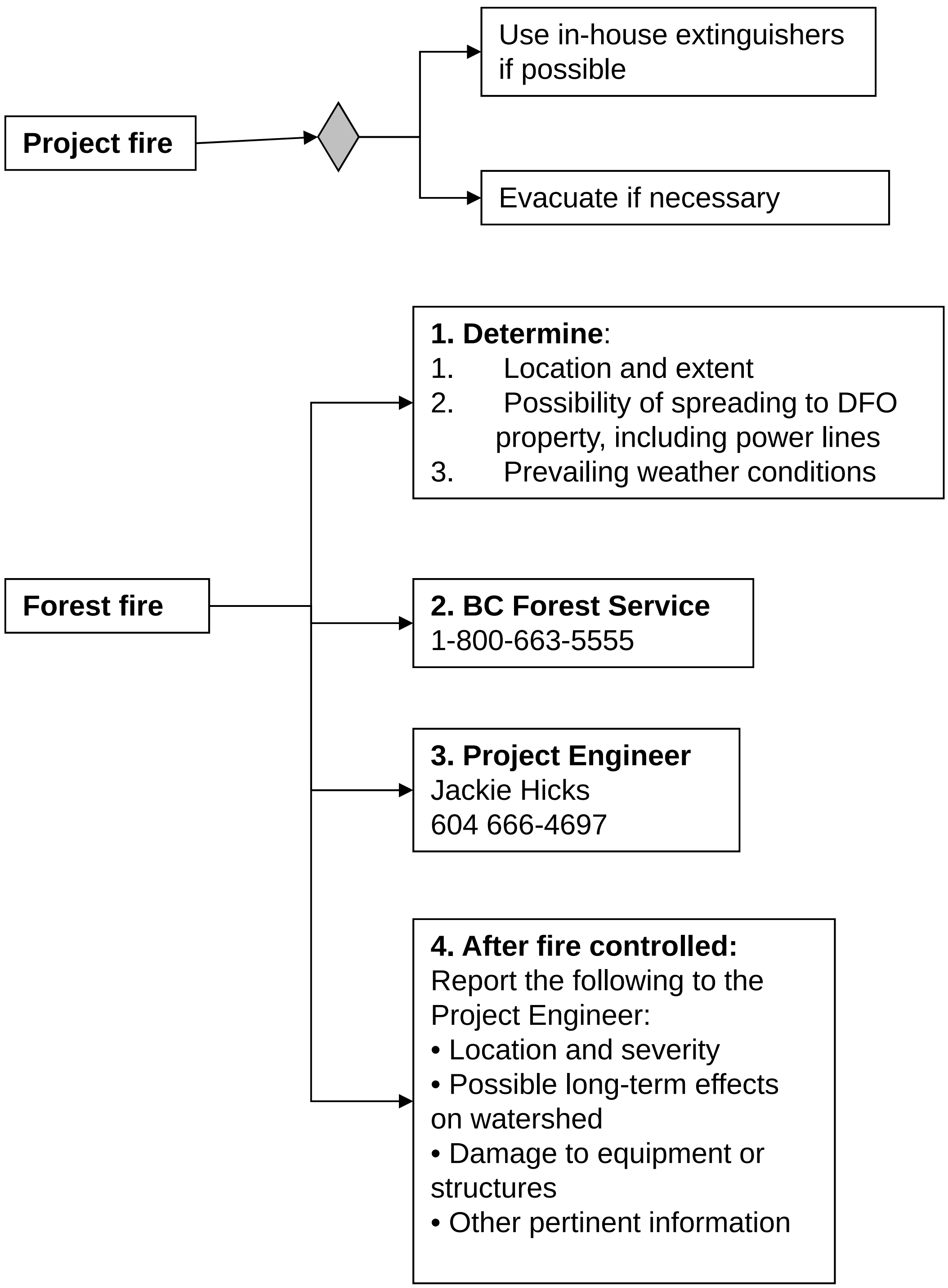
7.1.2 EMERGENCY NOTIFICATION FLOWCHART: POTENTIAL DAM BREACH



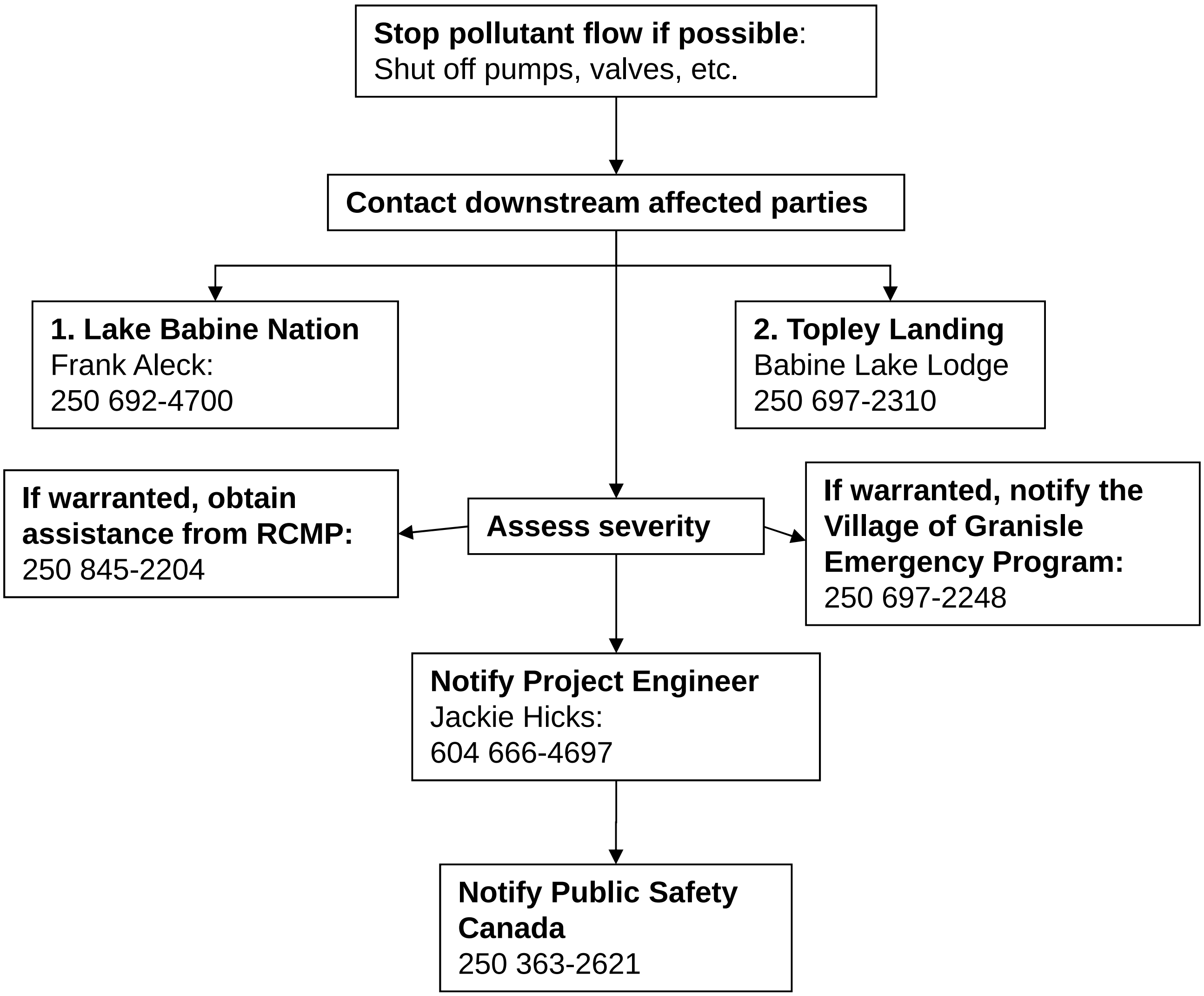
Information to record
(whenever possible)

1. Location of potential breach.
2. Reason for potential breach (landslide, dam failure, etc)
3. Rate of possible further development of breach.
4. Time/date that potential for breach first noted
5. Pertinent photographs (location of potential breach, cause of potential breach, etc)

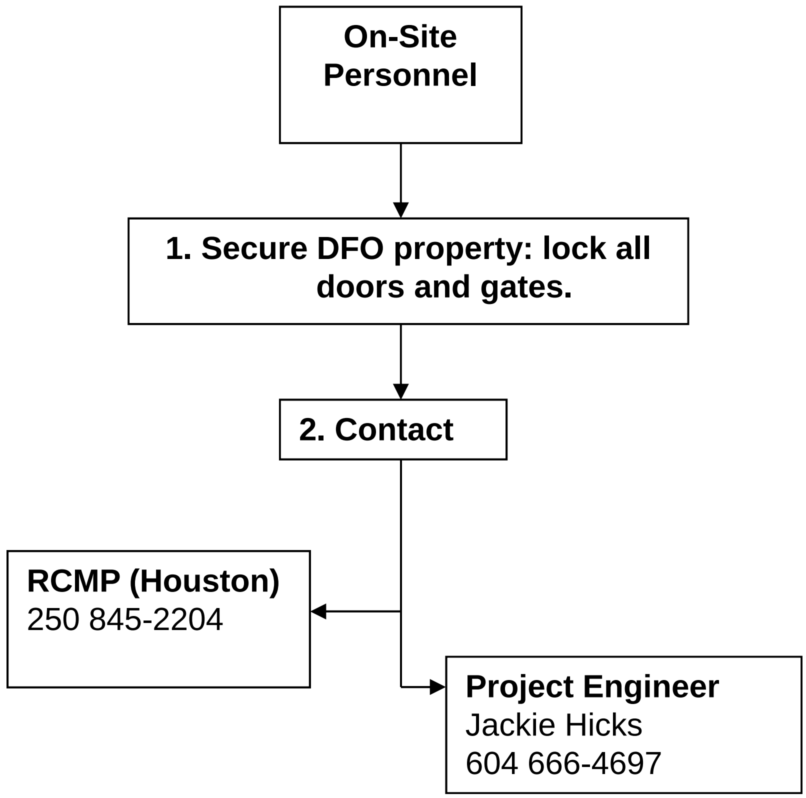
7.2.1 EMERGENCY RESPONSE FLOWCHART: FIRE



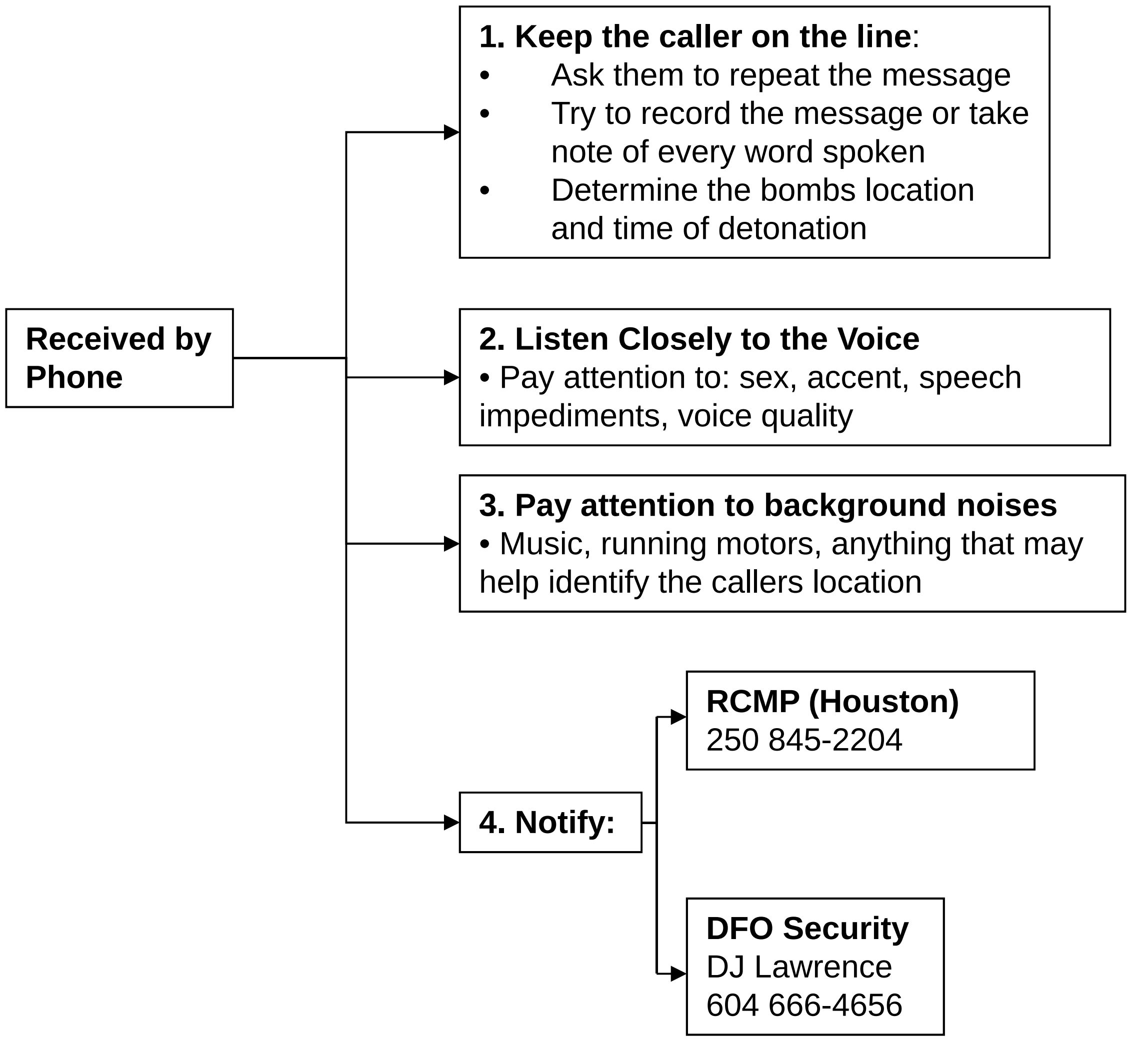
7.2.2 EMERGENCY RESPONSE FLOWCHART: SPILLS

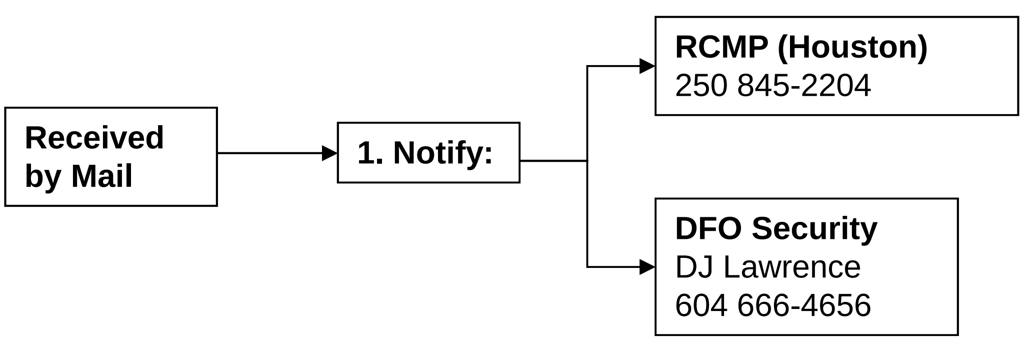


7.2.3 EMERGENCY RESPONSE FLOWCHART: RIOT



7.2.4 EMERGENCY RESPOSE FLOWCHART: BOMB THREAT





7.2.5 EMERGENCY RESPONSE FLOWCHART: PIPELINE BREAKAGE (Below Beaver Creek Station)

For The Purpose of Maintaining a River Flow while Isolating the Pipeline for Inspection and Service.