PUB 3.2
Attachment E

NEWFOUNDLAND POWER

DAM SAFETY EVALUATION
LOCKSTON DEVELOPMENT

NEWLAB
ENGINEERING
LIMITED

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NEWFOUNDLAND POWER

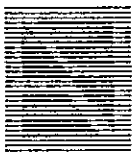
DAM SAFETY EVALUATION
LOCKSTON DEVELOPMENT

SUBMITTED TO:

Newfoundland Power
P.O. Box 8910
St. John's, NF
A1B 3P6

DATE: *DECEMBER 31, 2000*

SUBMITTED BY:



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1.0 INTRODUCTION

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In March 2000, Newlab Engineering Limited, in conjunction with Maurice Lewis, P.Eng, submitted a proposal to Newfoundland Power for Dam Safety Evaluations at Port Union, Lockston, Pierres Brook and Mobile/Morris Hydroelectric Developments.

As per the Newfoundland Power Terms of Reference, the following inspection and review of the Lockston Development includes:

- Field inspection of hydraulic structures complete with a report summarizing the findings of the inspections, deficiencies noted and a prioritized list of remedial work.
- Dam classification based upon Section 1.4 of the Canadian Dam Association, Dam Safety Guidelines.
- Review of operating procedures.
- Review of design and construction.
- Review of maintenance practices.
- Assessment of surveillance and monitoring of dam performances, if applicable.
- Review of Flood and Dam Break study.
- Compliance with previous reviews.

2.0 PROJECT DESCRIPTION

2.0 PROJECT DESCRIPTION

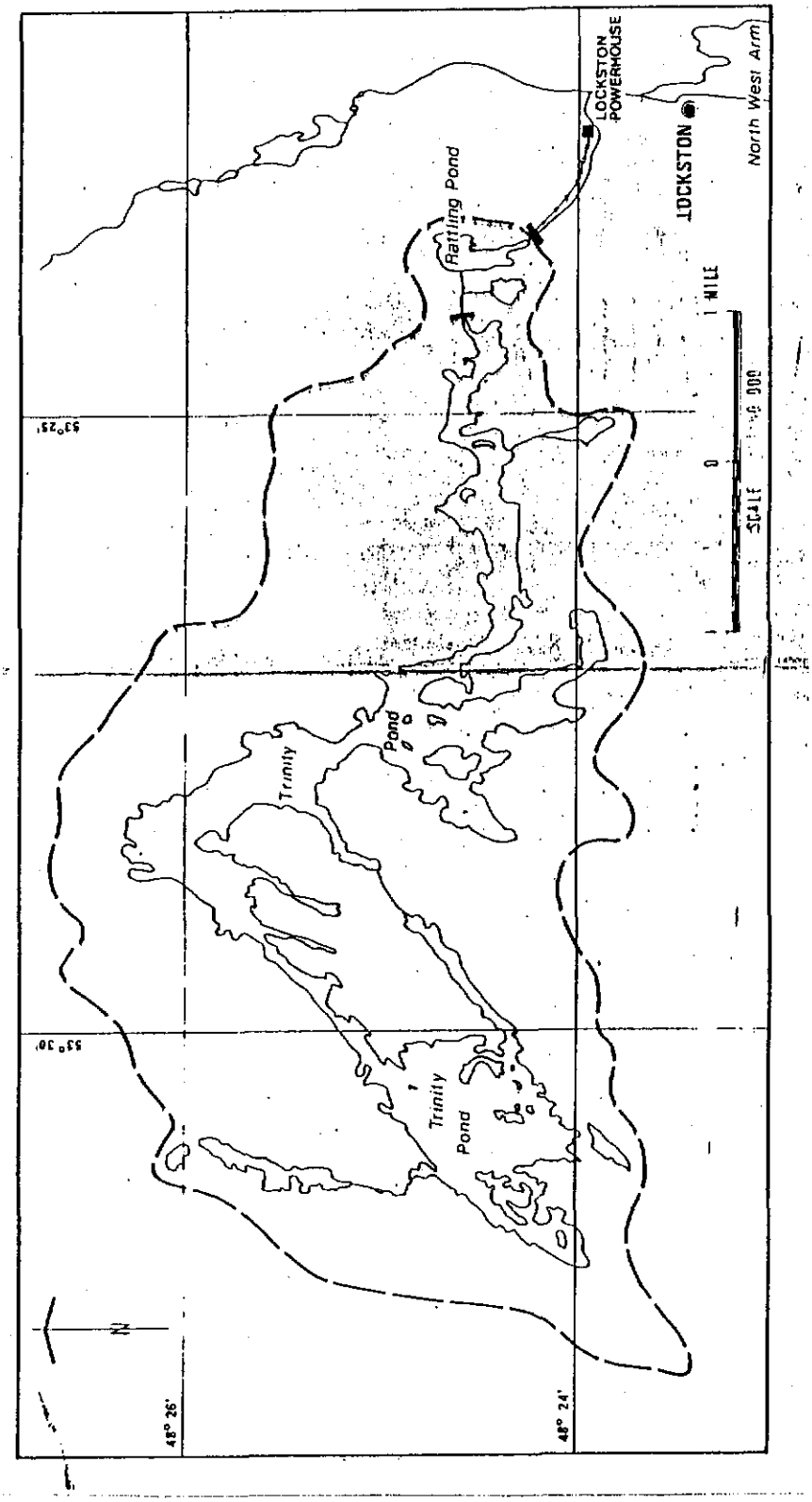
Lockston Development is located on the Bonavista Peninsula, near the Community of Port Rexton. The development, originally constructed in the mid 1950's, has been upgraded and changed several times and today consists of:

- Powerhouse - 2 horizontal Francis Turbines
- Wood stave penstock
- Concrete intake structure
- Rattling Pond forebay dam, spillway and canal inlet structure
- Power canal
- Trinity Pond Storage Dam
- Copeley's Pond Diversion Dam

Flow regulation to the intake is provided by the Rattling Pond Forebay Dam. Spill from Rattling Pond follows the natural riverbed and is lost to the system. The main storage structure in the development is located on Trinity Pond. The Copeley's Pond Diversion Dam was recently constructed and adds 6 sq. km. to the watershed.

The intake is a reinforced concrete structure with a wood gatehouse, stoplog gate structure, trash racks and controls. The intake is connected to the Rattling Pond Forebay Dam by an earth/rock canal.

Following is an outline map of the Lockston Watershed. The structure on Copeley's Pond is a very small structure not included in the original development and is not shown on the Watershed Map.



NEWFOUNDLAND POWER
LOCKSTON
WATERSHED AREA

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3.0 FIELD INSPECTIONS

3.0 FIELD INSPECTIONS:

3.1 General

The following section describes the results of field inspections conducted on Wednesday, May 10, 2000. Present during the inspections were:

- Tony Chislett - Newfoundland Power
- Ian Kerr - Newfoundland Power
- Bob Keough - Newfoundland Power
- Maurice Lewis - Newlab Engineering Limited
- Aubrey Greeley - Newlab Engineering Limited

Weather conditions: cloudy, Temperature: 6^0C

3.2 Inspection Observations:

3.2.1 Rattling Pond Forebay Dam, Spillway and Canal Inlet Structure

Rattling Pond Forebay Structures are reinforced concrete. The structure consists of the main overflow spillway section; a concrete dam section; and a concrete inlet structure to the power canal. The structures are founded on rock.

The structure, in general, is in need of concrete repairs. This is typical of concrete structures and an ongoing program is necessary. This may apply more to Lockston

where most of the concrete was likely mixed on-site.

The Spillway section is located remote from the dam and inlet section of the structure. The structure is an overflow spillway. Spill is lost to the system.

Bolts were noted in the top of the spillway. These bolts appear not to provide any useful service and may snag debris when the reservoir is spilling. The bolts should be removed.

There is a poor bond between the concrete and the supporting rock. The bond should be monitored. Repairs may be necessary.

There is ponded water immediately downstream of the spillway. The water does not appear to be from leakage under the structure but likely local drainage from the adjacent embankments. The water should be drained.

The dam/inlet structure is in fair to good condition with minor concrete repairs necessary, as noted above. Both the sluice gate and the outlet gate are working properly. Minor seepage was noted through the sluice gate. Minor seepage was also noted at the concrete/rock interface near the sluice gate.

There is a new wood walkway and deck along the dam structure to the sluice gate. There is no walkway to the canal outlet valve. Without such a walkway, the valve may not be accessible during high water levels. The need for a walkway and work deck should be investigated.

3.2.2 Power Canal and Intake

The power canal is cut into rock, utilizing low level concrete walls at low points in the rock. Little vegetation was noted along the route.

A sink hole was noted near the canal concrete walls where the wall is one (1) metre high. This hole should be monitored.

During the inspection, careful observation was made along the downstream face of the canal embankment for leakage. Audible leaks were noted in the 1999 Newfoundland Power Dam Safety Inspection Report. During this inspection the only leak noted was near the intake. This leakage, exiting the ground near the culverts, should be monitored.

The intake is a concrete structure with a wood gatehouse. The structure has a new gate and lift mechanism. Some deteriorated timbers were noted, which should be replaced.

3.2.3 Penstock

The penstock is a wood stave pipeline on wood cradles and sills. The penstock is in poor condition with significant leaks throughout the full length. The extent of flow from the leakage has caused the bedding to be washed away and cradle supports eroded.

In attempt to repair the leakage, steel bands have been continuously tightened resulting in crushing of the wood staves. Steel bands were noted missing in at least two locations.

Despite the excessive flow of water from leakage, drainage along the route is working well.

The penstock needs to be considered for total replacement. In the interim, direct leakage away from the penstock supports.

3.2.4 Trinity Pond - Dam and Outlet

Trinity Pond is a concrete buttress structure located in a narrow rock cut. The structure has a gate, lift mechanism and metal railing.

The structure is in good condition. Concrete repairs should continue as a maintenance

program. The metal railing appears low and should be raised. The bolts fastening the sign should be cut off flush at the sign.

It was noted that the gate stem is exposed to damage from ice and debris. Protection may be necessary.

3.2.5 Copeley's Pond Diversion Dam

Copeley's Pond Dam was the original railway track bed. The culvert through the track was plugged to form the diversion. Differential head is approximately 1 metre. There is no rip rap on the dam face.

The structure is very low with minimal impact anticipated from failure. The structure should be monitored for performance.

3.3 Recommended Actions

3.3.1 General

The following recommended actions were determined from the field inspections and are prioritized as per the following schedule:

Priority 1: Identifies work that should be carried out immediately.

Priority 2: Identifies work which should be carried out before the end of the present year to ensure safe operation.

Priority 3: Identifies work which should be carried out within the next year in order to ensure safe operation and/or mitigate continuing deterioration.

Priority 4: Identifies work which will improve the operation of facilities and should be carried out when funding is available.

Priority 5: Identifies general maintenance which is considered good practice and should be routinely attended to.

Priority 6: Identifies areas where design and operational reviews should be carried out to confirm safe operations and determine mitigation measures, if deemed necessary by such review.

RESERVOIR AND STRUCTURE	RECOMMENDED ACTION	PRIORITY
Trinity Pond Dam & Outlet	Investigate protection for gate stem	6
	Raise railing approximately 150 mm. Remove bolts fastening sign. Continue concrete repairs.	5
Rattling Pond Dam, Spillage & Outlet	Repair rock/concrete interface or spillway	5
	Drain ponded water downstream of spillway	5
	Remove bolts top of spillway	2
	Monitor leakage through sluice gate	5
	Investigate need for walkway and wood deck at canal inlet gate	4
	Continue concrete repair program	5
Power Canal & Intake	Continue concrete repair program.	5
	Monitor leakage near intake	5
	Monitor sink hole along canal	5
Penstock	Monitor leakage and support erosion	1
	Investigate penstock replacement	1

4.0 REVIEWS

4.0 REVIEWS

4.1 Dam Classification

Each structure/reservoir was classified according to the Dam Safety Guidelines prepared by the Canadian Dam Association.

In accordance with the guidelines, each dam should be classified in accordance with the reasonably foreseeable consequences of failure. The consequences of failure are evaluated in terms of:

- loss of life
- economic value of other losses and/or damage to property, facilities, other utilities and dam, as well as loss of power generation or water supply.
- other less quantifiable consequences related to social, cultural and environmental damages.

Table 4.1 outlines the consequence classification of dams.

TABLE 4.1
CLASSIFICATION OF DAMS
IN TERMS OF CONSEQUENCES OF FAILURE

CONSEQUENCE CATEGORY	POTENTIAL INCREMENTAL CONSEQUENCES OF FAILURE(a)	
	LIFE SAFETY	SOCIOECONOMIC FINANCIAL & ENVIRONMENTAL(b)(c)
VERY HIGH	Large number of fatalities	Extreme damages
HIGH	Some fatalities	Large damages
LOW	No fatalities	Moderate damages
VERY LOW	No fatalities	Minor damages beyond owner's property

(a) Incremental to the impacts which would occur under the same natural conditions (flood, earthquake or other event) but without failure of the dam. The consequence (i.e. loss of life or economic losses) with the higher rating determines which category is assigned to the structure. In the case of tailings dams, consequence categories should be assigned for each stage in the life cycle of the dam.

(b) The criteria which define the Consequence Categories should be established between the Owner and regulatory authorities, consistent with societal expectations. Where regulatory authorities do not exist, or do not provide guidance, the criteria should be set by the Owner to be consistent with societal expectations. The criteria may be based on levels of risk which are acceptable or tolerable to society.

(c) The Owner may wish to establish separate corporate financial criteria which reflect their ability to absorb or otherwise manage the direct financial loss to their business and their liability for damage to others.

The hydrology of each reservoir is taken from the Newfoundland Power Lockston Hydroelectric Development Flood and Dam Break Study, April 2000. Both Trinity Pond and Rattling Pond are classified as LOW. This corresponds well with CDA Consequence Classification of Dams, i.e. no incremental fatalities anticipated and moderate Socioeconomic,

Financial and Environmental losses. The May 10, 2000 inspection verified this classification and confirmed the sparse downstream development.

The Diversion Dam on Copeley's Pond is not classified. This structure is very small with minimal consequence from failure for either increased loss of life or socioeconomic/financial/ environmental damage. The structure would be rated VERY LOW.

4.2 Operation, Maintenance and Surveillance

4.2.1 General

The development is in accordance with Newfoundland Power Water Reservoir Operating Levels and Turbine Operating Procedures. Units are to be operated at optimum efficiency to maximize water use.

4.2.2 Operations Manual

Under Section 3.2 of the CDA, Dam Safety Guidelines, an Operations, Maintenance and Surveillance Manual is required for each applicable dam. The manual is to contain sufficient information to allow operators to operate the dam in a safe manner, maintain it in a safe condition and monitor its performance for early signs of distress.

The Operations and Maintenance Manual, developed by the design engineers and equipment manufacturers should include the following:

- Procedures for routine servicing
- Requirements for operation of special equipment
- Emergency Preparedness Plans and Inundation Mapping, if required
- Reservoir operations
- Provision for recording actions and observations

The Newfoundland Power Water Reservoir Operating Levels and Turbine Operating Procedures for Lockston address some of the items required in an Operations and Maintenance Manual. The Operating Procedures noted provide for safe operation of the development

4.2.3 Flood Operating Procedures

The April 2000 Flood and Dam Break Study selected an Inflow Design Flood with an AEP of 1/1000 for both Rattling Pond and Trinity Pond. No flood was selected for Copeley's Pond.

The analysis confirmed that Rattling Pond Spillway can safely pass the design flood of 17 cms.

Trinity Pond is a concrete structure designed to overtop. The analysis determined that maintaining a reservoir level of 0.71 m below the dam crest will limit overtopping to tolerable levels, i.e. 500 mm maximum allowable.

The flood control systems for all Lockston reservoirs are uncontrolled overflow spillways. The ability of the system to pass the design flood is based upon the spillway capacity only. No allowance is made for outlet gates.

To ensure spillway capacity is not compromised, the spillway and upstream and downstream channels are to be maintained free of debris and vegetation. The flood plain should be monitored for its full length to prevent uncontrolled development.

4.2.4 Maintenance

Newfoundland Power maintains a staff of experienced personnel who are responsible for ongoing maintenance and repair of hydraulic structures and components.

Maintenance procedures are adequate for the safe operation of the development. Particular attention should be paid to operation and maintenance of gate mechanisms. Gates and lifts should be operated annually, lubricated and serviced in accordance with

manufacturer's instructions.

4.2.5 Surveillance

Ongoing surveillance of all components is required for safe operations. At Lockston the following schedule is maintained:

- The dams, intake and penstock are formally inspected by maintenance personnel every two months. A written report is filed with the Civil Dam Safety Technician.
- Reservoir water levels are monitored by operations staff on a weekly or bi-weekly basis. Visual inspections of dam structures are carried out coincidental with water level checks.
- Powerhouse, penstock and forebay facilities are visited, by operating personnel, daily Monday to Friday and, if deemed necessary, on Saturday and Sunday. A telephone report of water levels and plant load is made to the System Control Centre.
- Engineering inspections are conducted as part of the Newfoundland Power Dam Safety Policy.

At Lockston, the following items are recommended for careful monitoring:

Trinity Pond:

- Ice damage to gate stem.

Canal:

- Leakage near intake.

Penstock:

- Damage to penstock bedding from leakage
- Penstock deterioration; wood, bands, leakage

No specific instrumentation requirements are noted at this time.

4.2.6 Design & Construction

As per CDA Dam Safety Guidelines, Section 2.2.3, a review of design and construction is required to demonstrate whether the dam meets all currently applicable safety requirements.

The review should include an assessment of the design calculations and a determination of how closely the constructed dam adheres to the design assumptions and requirements.

Stability Calculations for Trinity Pond Dam and Outlet Structure, dated 1996-03-08, were provided for review. The calculations adequately cover all aspects of stability and overturning for both ice and no-ice conditions.

The calculations for 300 mm ice cover resulted in an unstable structure. The

calculations were then re-done for 150 mm ice cover. The results were then satisfactory. At the time of rehabilitation, operation of the reservoir and gate was reviewed. It was concluded that since the gate was operated on a regular basis during the winter, ice cover does not form due to high velocities. An assumed ice cover of 300 mm is, therefore, too conservative and not required as design criteria.

The Flood and Dam Break Study has confirmed the ability of the system to safely pass the design flood. It is concluded, therefore, that planning and construction adequately reflect operating design parameters.

The structures at Lockston have remained essentially unchanged since constructed in the 1950's. Work since that date has been limited to rehabilitation, repair and upgrading while maintaining the original structures.

In general, design and construction of structures at Lockston are adequate and within accepted guidelines. As noted in the field inspection reports, an investigation should determine the need for a work deck at the canal inlet structure at Rattling Pond and gate stem protection at Trinity Pond.

4.3 Compliance with Previous Reports

The following recommendations were made in the 1993 BAE Group Report. The ratings are as described below and are as per the original report.

STRUCTURE	RECOMMENDED MAINTENANCE & REPAIR	PRIORITY	ACTION TAKEN
Trinity Pond Dam & Outlet	- Repair leaks/cracks in concrete	2	Re-built
	- Repair gates to operable condition	2	Complete
	- Clean and grease metal gate parts	2	Complete
Rattling Pond Dam/Spillway & Outlet Structure	- Clean and repair outlet gate	3	Complete
	- Clean and paint metal parts on canal inlet gate	3	Complete
	- Repair leaks/cracks in concrete	3	Ongoing
Spillway	- Seal leaks in right abutment	3	Not complete
	- Seal open joints in concrete	3	Not complete
	- Fill spillway undercutting	3	Not complete
Power Canal	- Seal leaks in concrete	3	Ongoing
	- Fill undercutting walls	3	Ongoing
	- Repair waterstops	3	Not complete
	- Reinstate portion of missing canal wall	2	Complete
Intake Structure	- Seal leaks/cracks in concrete	2	Complete
	- Repair deck support	2	Complete
	- Repair leakages at sluice gate	2	Not complete
	- Clean and paint metal parts on gate mechanisms	3	Complete
Woodstave Pipe	- Design check	1	Not complete
	- Re-treat woodstaves	3	Not complete
	- Re-lubricate band threads	3	Not complete
	- Repair leakages	3	Not complete
	- Repair cradle supports	3	Not complete
	- Repair deterioration in concrete anchor block at bifurcation	3	Not complete

Priority 1: Identifies work to be completed for development to operate safely and should be initiated as soon as possible

Priority 2: Identifies work to reinstate structure to acceptable standards. If unattended could possible hinder operation of development

Priority 3: Identifies work that is considered good maintenance practice which should be carried out on a regular basis.

4.4 Flood and Dam Break Study

As part of the Dam Safety Evaluation, a review was conducted of the Newfoundland Power Lockston Hydroelectric Development Flood and Dam Break Study.

The format of the Flood and Dam Break Study is excellent with good use of tables, figures and maps. The report objectives are achieved as dam classifications and inflow design floods have been established.

The review agrees with the conclusions of the Flood and Dam Break Study, classifying both Trinity Pond and Rattling Pond as LOW.

More detailed comments regarding the Flood and Dam Break Study will be addressed under separate cover.

4.5 Emergency Preparedness Plan (EPP)

An emergency preparedness plan is required, as per CDA Guidelines, Section 4.0, for any dam whose failure could be expected to result in loss of life as well as for any dam for which advance warning would reduce upstream or downstream damage. Based upon the above premise, an EPP is not required for Lockston Development.

REFERENCES:

.1 Dam Safety Guidelines, Canadian Dam Association, 1999.

.2 1993 Dam Safety Evaluation Report, Lockston Development, July 1993.

.3 1995 Dam Safety Inspection Reports, Lockston Development; Newfoundland Power, November 1995

.4 1999 Dam Safety Inspection Reports, Lockston Development; Newfoundland Power, November 1999

.5 Flood and Dam Break Study, Lockston Hydroelectric Development, Newfoundland Power, April 2000

.6 Design of Small Dams, United States Department of the Interior, Bureau of Reclamation, Third Edition, 1987

APPENDIX A

WATER RESERVOIR OPERATING LEVELS
TURBINE OPERATING PROCEDURES

LOCKSTON

Water Reservoir Operating Levels and Turbine Operating Procedures

Prepared By: K. D. Nicholson Approved By: M. Hunter

DEVELOPMENT: Lockston

UNIT LOADINGS

	Best Efficiency			Maximum Load			Rough Zone	
Unit	Load (Kw)	Flow (M^3/S)	$Kw/M^3/S$	Load (Kw)	Flow (M^3/S)	$Kw/M^3/S$	Min.	Max.
#1	1375			1675			None	None
#2	1395			1700			None	None

FOREBAY OPERATING ELEVATIONS (Ft.)

Upper	Lower	Trip Level
16.0	15.0	8.5

STORAGE ELEVATION LIMITS (Ft.)

	Upper	Lower	Summer
Trinity Pond	16.6	2.0	-

Summer elevation is a minimum that the reservoir will operate at between June 15 and September 15 under normal circumstances.

Water Reservoir Operating Levels and Turbine Operating Procedures

Prepared By: K. D. Nicholson Approved By: M. Hunter

Lockston Plant Operating Procedures

1.) Units should be cycled on and off at best efficiency to maximize water use.

2.) Full load should be used only in event of predicted spill. Main control should be via operating gates.

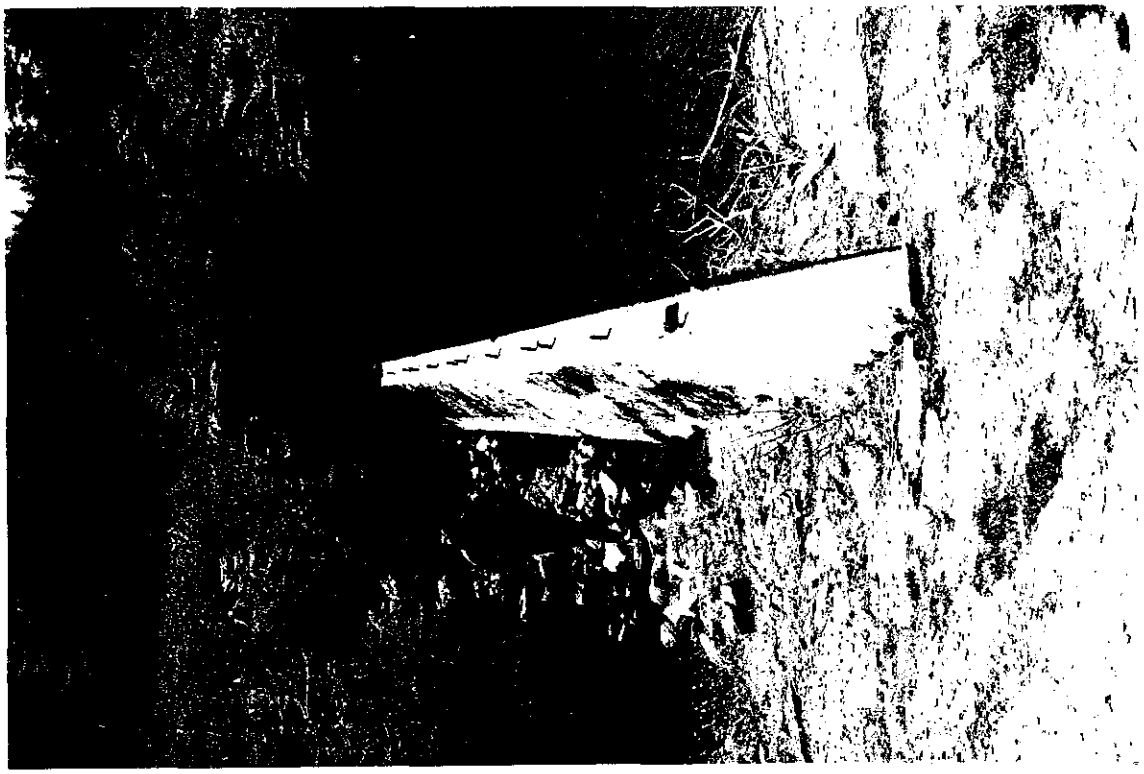
3.) Plant has a large storage reservoir and seldom spills. The control gate at Rattling Pond which feeds the canal is usually full open. The water flow to the plant is controlled using the outlet gate at Trinity Pond.

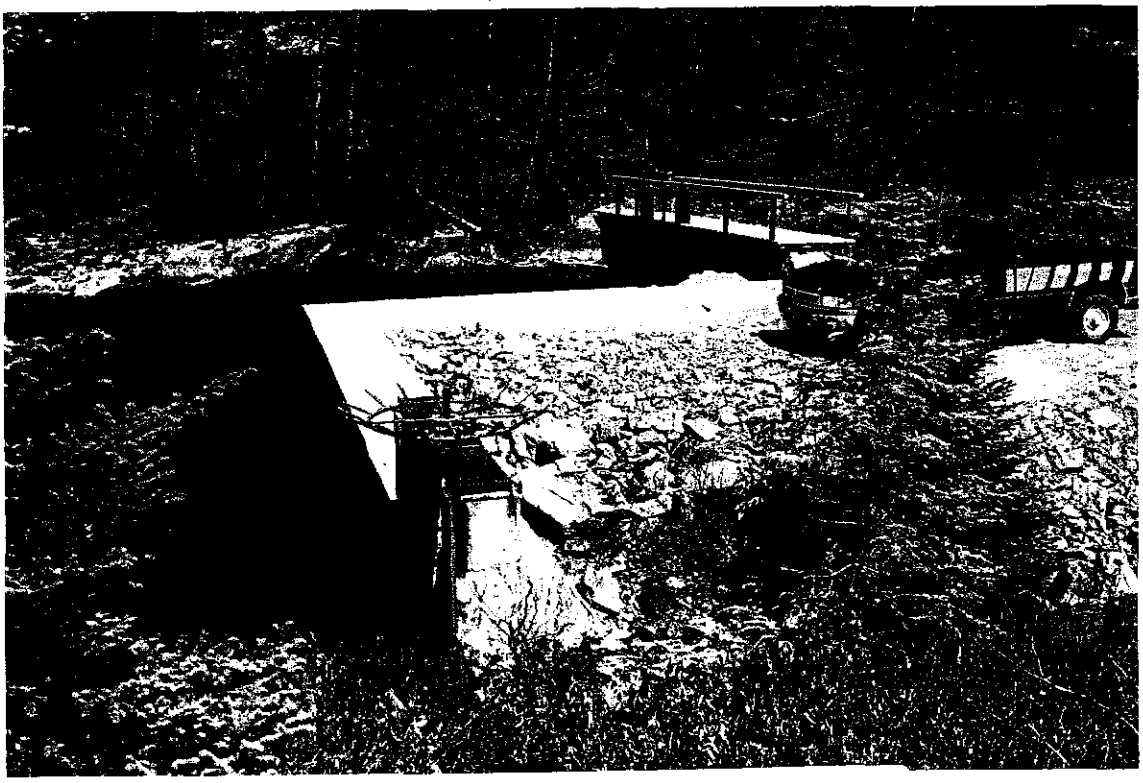
4.) The gate at Trinity Pond is typically kept open 8 - 10" in the winter.

5.) All gates to be left open a minimum of 1" to maintain flow for fisheries. If gate has to be closed, an alternate method of maintain flow must be established.

PHOTOGRAPHS

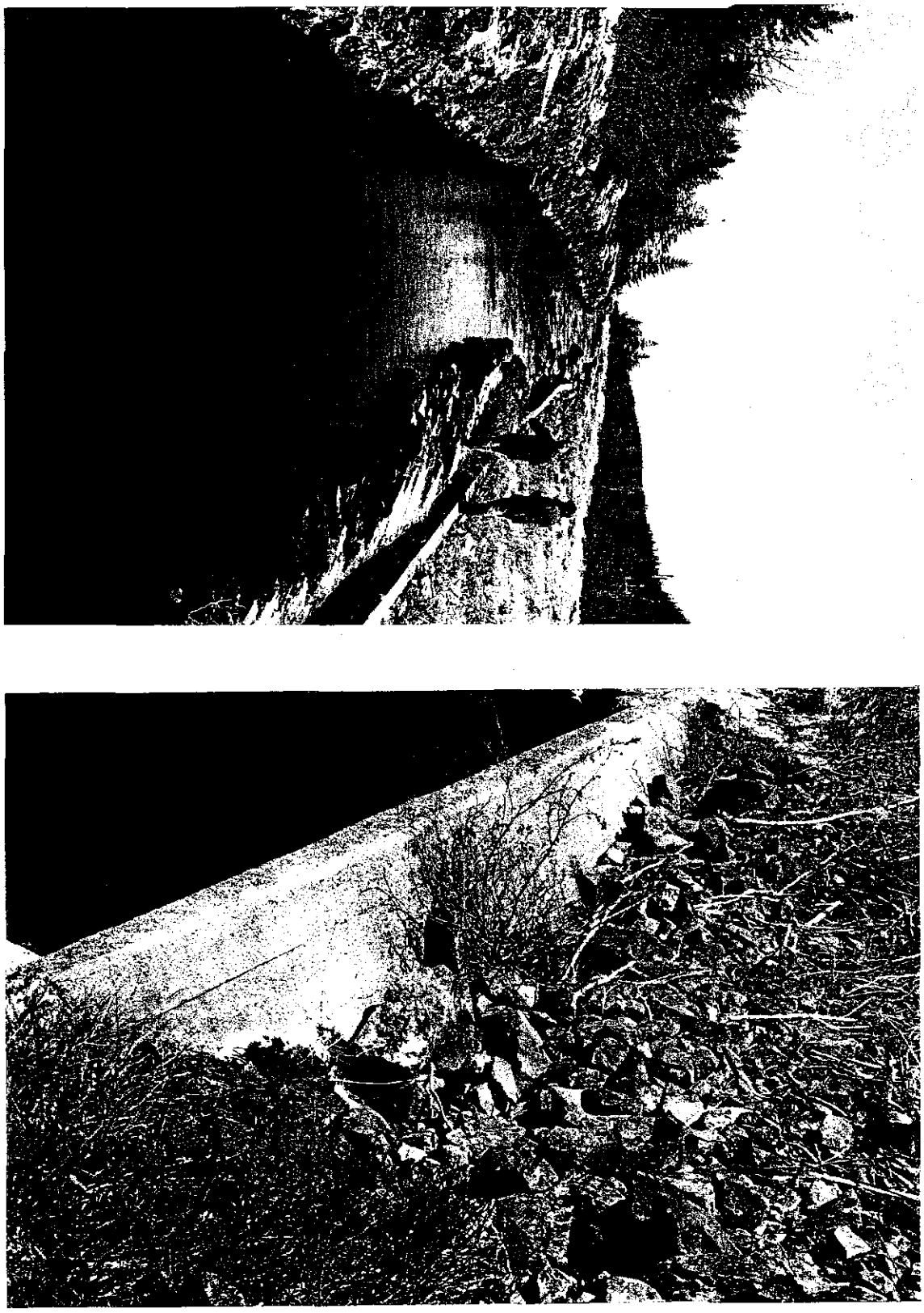
Rattling Pond Spillway - note Bolts in Flashboards



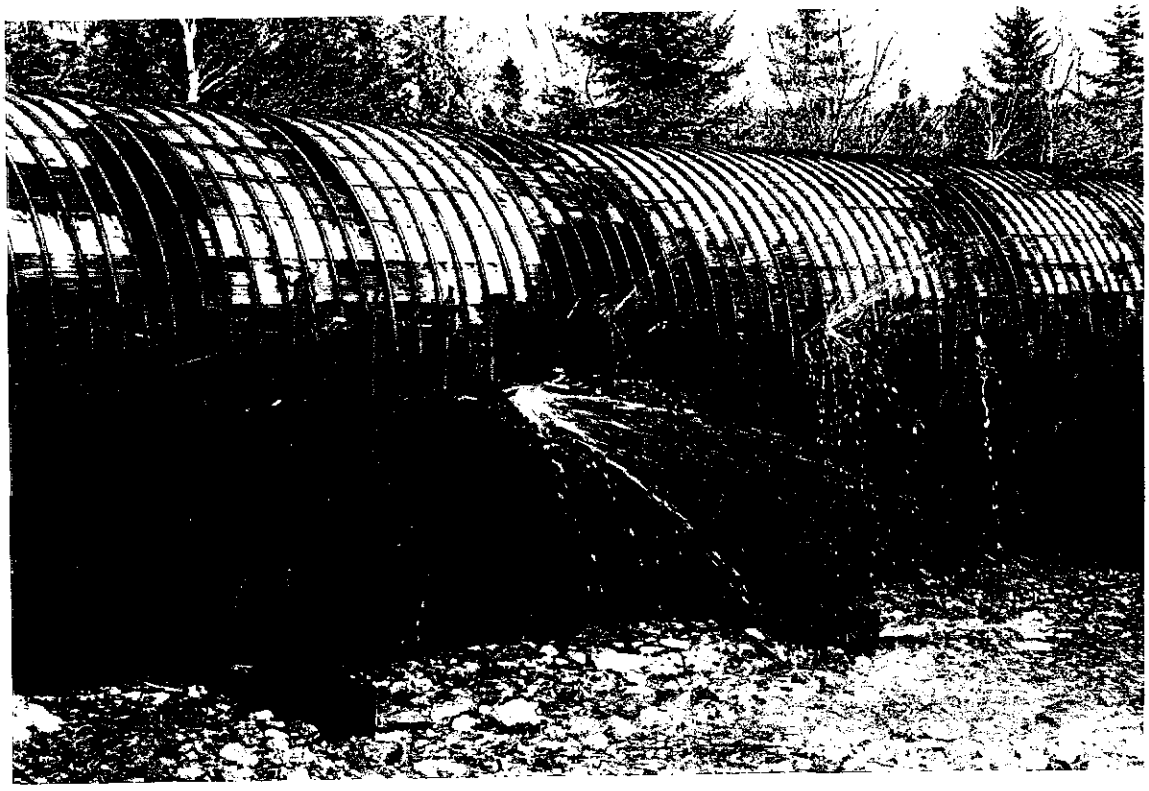


Rattling Pond Dam & Canal Outlet

Power Canal



Typical Canal Concrete Wall



Penstock Spring Line: Note Excessive Leakage

Intake Gate House

Trinity Pond Structure

Copeley's Pond Diversion Dam