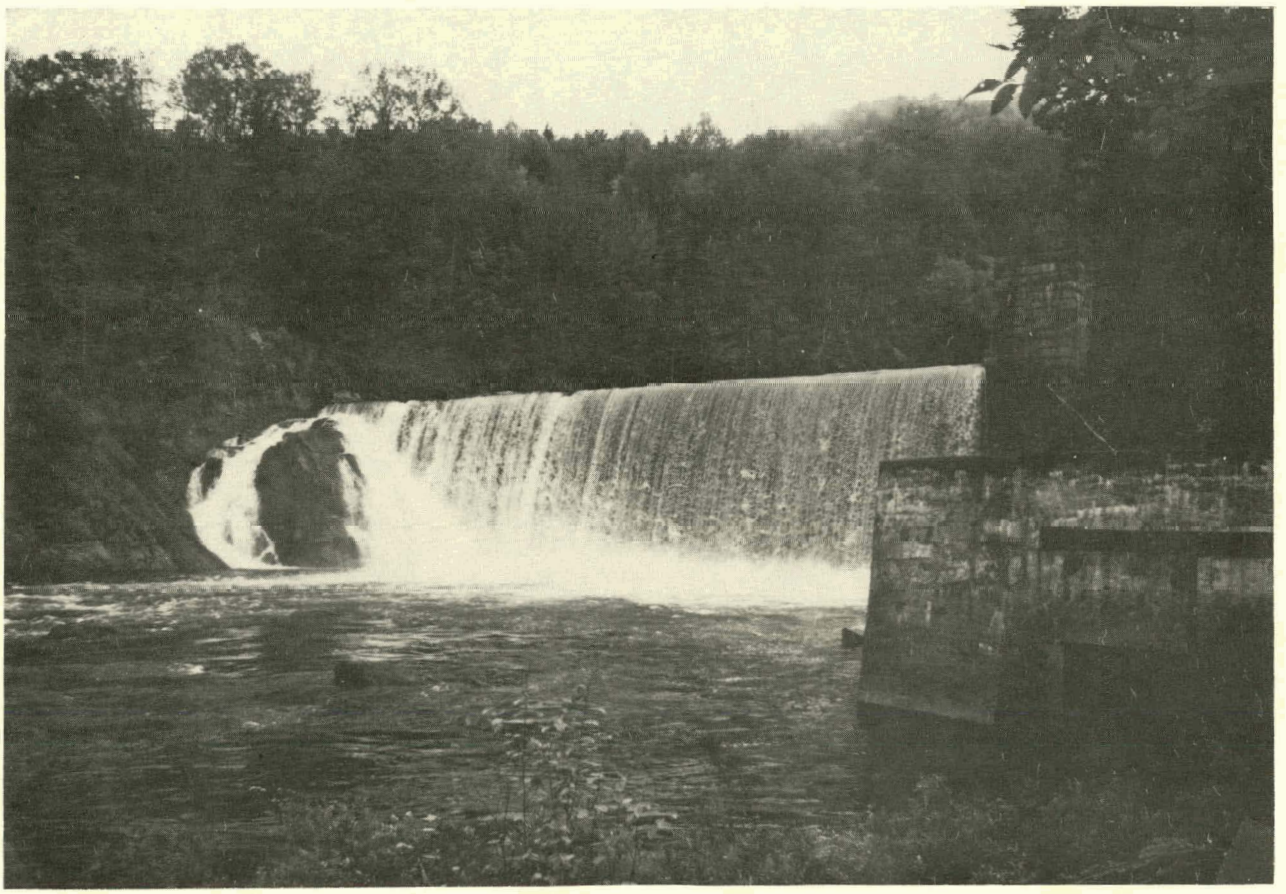
Small-Scale Hydroelectric Power
Demonstration Project

GREEN MOUNTAIN POWER CORPORATION

BOLTON FALLS
HYDROELECTRIC REDEVELOPMENT



FIRST ANNUAL REPORT

Department of Energy, Idaho Operations Office

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Printed in the United States of America

Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
NTIS Price Codes: Printed Copy A03
Microfiche A01

DOE/RA/23212--T1
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GREEN MOUNTAIN POWER CORPORATION
BOLTON FALLS HYDROELECTRIC REDEVELOPMENT
FIRST ANNUAL REPORT

BY

GREEN MOUNTAIN POWER CORPORATION
BURLINGTON, VERMONT

MARCH 1981

PREPARED FOR THE
U. S. DEPARTMENT OF ENERGY
UNDER CONTRACT DE-FC07-79RA23212

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I. Introduction

1. The following Annual Report is written in compliance with Cooperative Agreement No. DE-FC07-79RA23212, between the Green Mountain Power Corporation and the United States Department of Energy. The report will summarize the Bolton Falls Hydroelectric Redevelopment Project in terms of what was planned, what has happened, and what may be expected in the future. Since this is the first annual report, we will be including results of work carried out in the latter part of 1979, namely, the preliminary engineering and environmental work involved in the preparation of the FERC License Application.

2. Summary of Project Plan - The Bolton Falls Project, hereinafter referred to as "The Project", consists of a very straightforward effort to rehabilitate and re-use a former hydroelectric generating site on the Winooski River, west of the Village of Waterbury, in the Central part of the State of Vermont. The former station operated between 1898 and 1938, when the machinery and plant building were dismantled. The original dam, consisting of a wooden crib and rock structure, with granite block facing, remains intact, and will be strengthened and renovated along with the rebuilding of the intake works. A new power plant, machinery, penstocks, and tailrace will be constructed, and new recreational facilities will be provided. The Project will be operated by the Company as part of its existing hydroelectric system,

which, with respect to the Winooski River, consists of two plants upstream of Bolton, two plants downstream of Bolton, one plant on a main tributary, just upstream of Bolton, and a planned project in the lower portion of the river, near Burlington, (Chace Mill). The planned capacity will be 6500 KW, or greater, with annual production estimated at 28 million KWH.

3. Summary of Major Events - Following are the principal activities and events that have occurred since the inception of the Project in 1978.

a) October 1978 - Feasibility study and Application to DOE under PON E T - 78 - N - 07-1711
- Preliminary Permit Application to FERC.

b) June 1979 - Cooperative Agreement executed with DOE.
- FERC issued Preliminary Permit, Project No. 2879.

c) August 1979 - Contract with Gilbert Associates, Inc. to perform preliminary engineering, environmental studies, and preparation of FERC License Application.

d) April 1, 1980 - FERC License Application Submitted.
- Application for Water Quality Certification (401) submitted to Vermont Agency of Environmental Conservation.
- Corps of Engineers Application submitted.

e) April 29, 1980 - Phase II contract executed with Gilbert Associates, Inc. for detailed engineering plans and specifications for total Project.

f) July 25, 1980 - Received copy of new U.S. Fish & Wildlife Service policy on minimum river flows, which basically requires more than 3.5 times the minimum flow Green Mountain agreed to provide in the FERC Application. The policy also requires substantially higher flows in the Fall and Spring periods.

g) August 4, 1980 - Issued turbine-generator specification package to prospective bidders. The following firms were invited to submit proposals:

Allis-Chalmers, James Leffel Co., General Electric Co., Voest-Alpine, Combustion Engineering/Avery Division, Hitachi America, Ltd., and Dominion Bridge-Sulzer Co.

The first four firms subsequently submitted proposals, which are currently being studied and evaluated.

h) August 15, 1980 - United States Environmental Protection Agency wrote FERC, approving issuance of license, on the basis that we agreed to provide the "7 Q 10" minimum flow, which EPA had recommended in January 1979.

i) August 19, 1980 - U.S. Department of the Interior wrote to FERC, requesting that Green Mountain do additional cultural and

Historic resource work. They also asked FERC to require minimum flow releases in accordance with the new policy issued by the Northeast Regional Office (See Item f). Additionally, they requested that fish-passage facilities be constructed "upon request of the Secretary of the Interior."

j) August 22, 1980 - The Company wrote FERC, responding to comments previously made by the Vermont Agency of Environmental Conservation, concerning stream flow studies, fish passage at Bolton vs. fish trapping at Chace Mill, flood analysis, and recreation. At this time, the State had not developed any minimum flow standard for the project. In fact, they were just conducting river surveys at the site during the summer.

k) September 1980 - Streamflow studies were undertaken to respond to the USFWS policy. Addenda for the turbine-generator specifications were issued.

l) October 1980 - Additional archeological and historic assessment work was carried out. A Gilbert report on variable crest gates vs. flashboards was reviewed. The

USFWS policy assessment continued. An updated construction schedule was prepared, indicating a seven month slippage from that shown in the FERC application, due to the delay in getting a license. Turbine-generator proposals were received, and three obvious conclusions resulted:

1. The single machine concept, proposed by Gilbert, is more costly, with longer delivery time, than two "standardized units."
2. In either case (single or double), the vendor costs are about twice the Gilbert estimate, as shown in the FERC application.
3. All proposals had short acceptance periods, and delay in awarding a purchase order will cost about $40,000 per month, on this item, alone, due to inflation.

m) November 1980 - The Gilbert Associates' analysis of the USFWS minimum flow policy was completed and sent to FERC. It showed that in an average water year, the USFWS flow requirements could not be met 283 days.

- The Vermont Agency of Environmental Conservation finally issued its comments to FERC, regarding minimum flow require-

ments at Bolton Falls. In summary, they are as follows:

1. 325 cfs, when available from inflow and/or reservoir storage.
2. Proposal from licensee for operation of upstream stations to make available the minimum flow quantities during critical low flow periods.
3. Licensee investigate and report on feasibility of suppressing wide fluctuations in stream flow. Altered generating schedules at existing upstream stations was suggested as a possible mitigating measure.
4. By-pass valve operating conditions.
5. Applicant provide assurances that the design allows continuous flow through the pool directly below the dam.

n) December 1980 - Responses to the Vermont AEC recommendations were sent to FERC, in early December, wherein we pointed out the unavailability of the desired 325 cfs to be 20, 58, and 31 percent, in representative wet, dry, and average years, We also discussed the problems of changing upstream operations, due to

limited availability and adverse effects on existing recreation uses.

- Discussions with FERC staff continued on the various issues raised by the agencies, particularly the Vermont Agency of Environmental Conservation. We had previously requested FERC comments on such things as fish ladders, abnormal flow augmentation, re-scheduling of existing operations, pond depletion, etc. No written responses were obtained, but we were verbally advised to attempt to find "solutions" with the State.
- In a final effort to try to get the project moving, since FERC was obviously not going to arbitrate the issues, and render any decisions, we agreed to try to negotiate some middle ground with the State.

4. Project Status

Green Mountain proposed a compromise minimum flow plan for the project, which would provide twice the "7Q10" release, when available from inflow. Flow duration curves indicate that this quantity would be available about 80% of the time in an average water year. Under this plan, the company would generate the higher flow quantity, rather than wasting it through a by-pass valve, as contemplated in the license application. Based on the Vermont AEC curves of stream bed coverage vs. fish propagation, food production etc., the 240 cfs release

showed more favorable conditions for most of the criteria. The plan contemplates the use of two units, rather than one, which will suppress the "wide fluctuations "mentioned by the State, and allow efficient operation at low flows.

Under this scheme, the water would not be discharged at the base of the dam, but would enter the pool about 150 ft. downstream. The concern for adequate water coverage in the downstream fishing reach would be more than adequately met, under these conditions, in our opinion. The pool immediately below the dam would remain at present level, and would be "freshened" by anticipated crest and other leakage and occasional spillage.

To date, the Vermont AEC has not responded to the Company on this compromise mode of operation, therefore the status of the project, in terms of licensing, scheduling, ultimate costs, and economic viability, remains uncertain.

5. Expenditures - Project charges through December 1980 are as follows:

	FERC Licensing	Engineering	Total
Direct Charges	$202,076.	$422,162.	$624,238.
Interest	24,226.	19,769.	43,995.
Total	$226,302.	$441,931.	$668,233.
Less DOE Payment	-	(75,000.)	(75,000.)
Net	$226,302.	$366,931.	$593,233.

An additional $250,000. is expected to be charged by May 1981, for completion of engineering design, drawings, and specifications. This will raise the pre-construction expenditures to approximately $920,000, including about $80,000. in interest.

II. Comparison of Project Schedules and Costs with Previous Plans

1. Schedules - Following this page is a composite project schedule, which graphically compares each of the tasks/milestones, as originally contemplated, with later milestone charts. The most significant and obvious conclusion is that the construction and completion dates have slipped by about 15 months, based on a comparison of the original chart submitted to DOE in the PON Application and the latest schedule, prepared in November 1980.

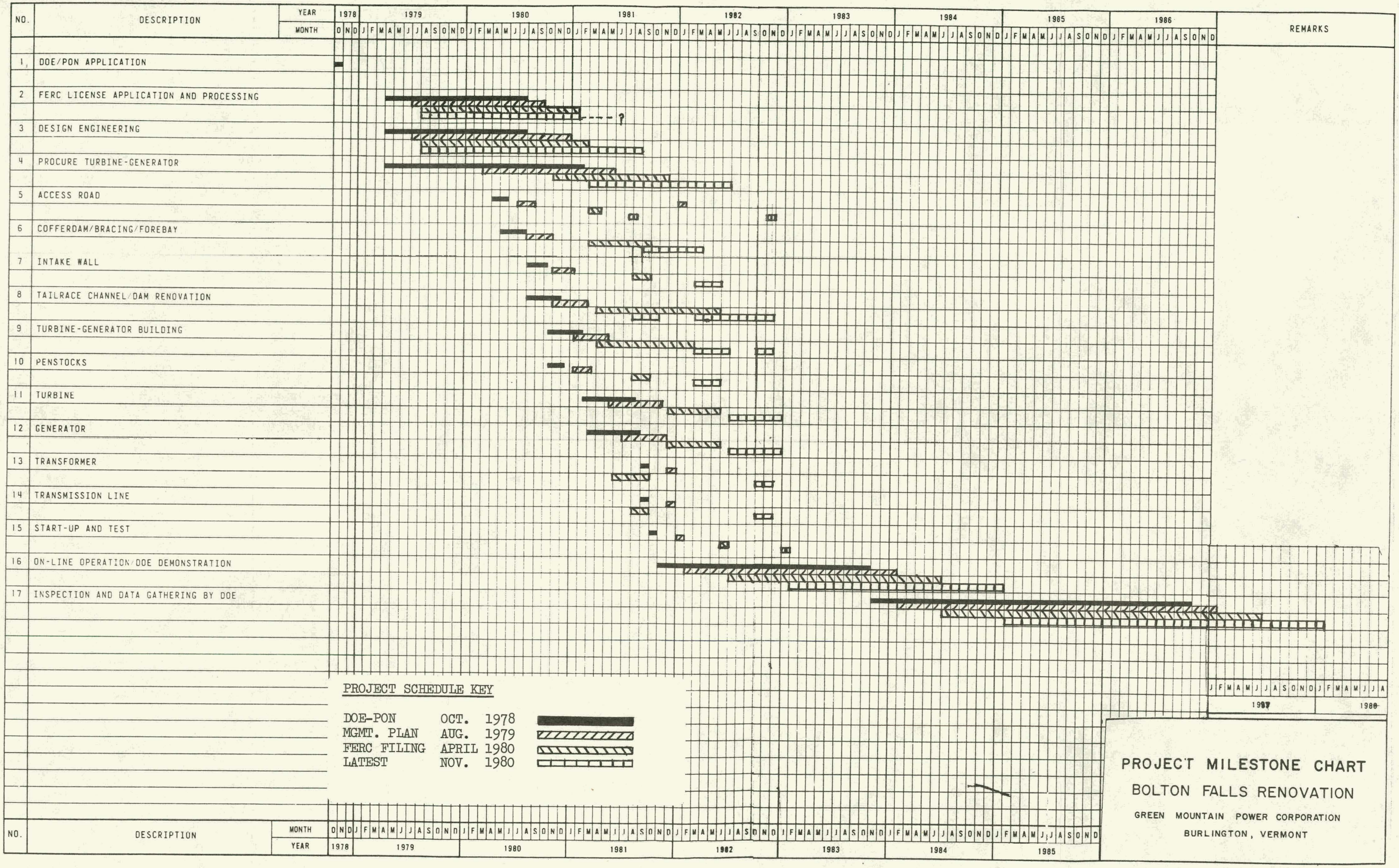
The lastest chart recognized what was then thought to be a more realistic date for issuance of the FERC license, and also recognized seasonal construction constraints at the site, due to the severe winters. It also provides for procurement of the turbine-generator, following issuance of the license, rather than concurrently with FERC application processing. This causes a significant shift, and is an appropriate correction.

What is not yet apparent, is the overall effect of further licensing delays. The two are not directly related. That is, a 3 month delay in licensing can mean more than a 3 month delay in the project, due to contractor committments, and the seasonal construction constraints.

Furthermore, the present non-resolution of the minimum flow issue impacts within and beyond the FERC licensing process in the following ways:

1. Decisions on machine selection to meet the requirements cannot be made until the requirements are finalized and accepted.

2. Final engineering cannot be performed until the machine selection is made.
3. Time to revise information and drawings for FERC, and the Corps of Engineers will extend the approval process.
4. Construction specifications, drawings, etc. cannot be completed for issuance to prospective bidders.
5. By the time these items are completed, it may be too late to start this year.


NO.
DESCRIPTION
YEAR
MONTH
1978
1979
1980
1981
1982
1983
1984
1985
1986
REMARKS
1 DOE/PON APPLICATION
2 FERC LICENSE APPLICATION AND PROCESSING
3 DESIGN ENGINEERING
4 PROCURE TURBINE-GENERATOR
5 ACCESS ROAD
6 COFFERDAM/BRACING/FOREBAY
7 INTAKE WALL
8 TAILRACE CHANNEL/DAM RENOVATION
9 TURBINE-GENERATOR BUILDING
10 PENSTOCKS
11 TURBINE
12 GENERATOR
13 TRANSFORMER
14 TRANSMISSION LINE
15 START-UP AND TEST
16 ON-LINE OPERATION/DOE DEMONSTRATION
17 INSPECTION AND DATA GATHERING BY DOE
?
1987
1988
PROJECT SCHEDULE KEY
DOE-PON OCT. 1978
MGMT. PLAN AUG. 1979
FERC FILING APRIL 1980
LATEST NOV. 1980
PROJECT MILESTONE CHART
BOLTON FALLS RENOVATION
GREEN MOUNTAIN POWER CORPORATION
BURLINGTON, VERMONT

2. Costs - The summary of project cost estimates, on the following page, must be viewed with certain criteria in mind, to avoid the erroneous conclusion that the most recent Net Capital Cost estimate, which is nearly triple the original, actually reflects a tripling of the project cost. While certain items were clearly underestimated in 1978, and later, and will be discussed individually, other items are now included in the revisions that were either not allowed to be part of the original estimates for DOE, or were curtailed in their use. These constraints were:

   1. Expressing costs in 1978 dollars. This resulted in unrealistic cost figures for a project that stretched over three years. (1st column)
   2. The use of 8% inflation (2nd column), in accordance with the PON instructions, did not adequately cover realized inflation.
   3. Neither of the original estimates for the PON contained anything for interest during construction. Although not allowed by the DOE, we have to include AFUDC for the capital expenditures.
   4. No contingency dollars carried in original estimates.

It is noted that the estimate used in the FERC application (column 3) is very close to the PON estimate, in regard to Direct Construction Cost plus Engineering and Owner's Cost. The bottom line (Net Capital Cost) difference results from the inclusion of contingency, escalation (beyond 1980), and AFUDC in the FERC estimate.

BOLTON FALLS PROJECT - COST ESTIMATE COMPARISONS

FERC Account	Item	Original: DOE - PON 1978 $	Original: DOE - PON 1978 $ plus 8% Infla.	Revisions: FERC Lic. Application April 1980	Revisions: Latest (Unofficial) Dec. 1980
331	Structures & Improvements	449,970.	531,839.	881,800.	810,000.
332	Reservoirs, Dams, & Waterways	2,493,270.	2,908,151.	2,687,100.	2,925,000.
333	Turbines & Generators	1,563,600.	1,969,667.	1,639,600.	3,555,000.
334	Accessory Elec. Equipment	-	-	211,000.	270,000.
335	Misc. Power Plant Equipment	-	-	80,000.	100,000.
336	Roads, Railroads & Bridges	17,300.	20,178.	41,400.	41,400.
353	Electrical Substation	185,000.	233,047.	139,000.	166,000.
355/356	Transmission	126,000.	158,724.	-	20,000.
	Sub-Total - Direct Const. Cost	4,835,140.	5,821,606.	5,679,900.	7,887,400.
	DOE Application & Feasibility	20,000.	20,000	38,000.	38,000.
	Prelim. Eng. & FERC Application	55,905.	61,320.	237,000.	280,000.
	Design Engineering	423,840.	483,950.	407,000.	480,000.
	Construction Supervision	294,204.	356,070.	250,000.	310,000.
	Start-up Engineering	12,711.	16,012.	14,700.	20,000.
	Owners Cost (Legal, A & G)	38,250.	46,796.	99,400.	300,000.
	Sub-Total - Eng. & Owners Cost	844,910.	984,148.	1,046,100.	1,428,000.
	Contingency	-	-	645,000.	900.000.
	Escalation	-	Incl.	1,134,000.	1,635,000.
	AFUDC	-	-	676,900.	930,000.
	Total-Direct & Indirect	5,680,050.	6,805,754.	9,181,900.	12,780,400.
	Less-DOE Funding (Cr. to Cap.)	(1,427,500)	(1,427,500)	(1,427,500)	(1,427,500)
	Net Capital Cost	4,252,550.	5,378,254.	7,754,400.	11,352,900.
	Two-Year Demo./Oper. Cost	210,000.	297,130.	240,000.	240,000.
	Less-DOE Funding (Cr. to O & M)	(40,000)	(40,000)	(40,000)	(40,000)
	Net O & M Cost (2 yrs.)	170,000.	257,130.	200,000.	200,000.

Of principal concern is the difference between the FERC estimate and the latest estimate, both of which were prepared on the same bases. The latest estimate is termed "Unofficial" because it has not been issued as a formal estimate, but is merely indicative of the perceived costs, based primarily on the vendor quotations received for the turbine-generator package. Since those quotations contain unspecified dollars for items in other accounts, namely A/C 334, and 353, some overall reduction is possible. Nevertheless, the dramatic price difference in the turbine-generator account is viewed as a most significant item. With this figure more than double the estimate in the FERC application, along with a 9% increase in A/C 332, the estimate of Direct Construction Cost has increased over $2 million.

Additionally, significant increases occurred in preliminary engineering and FERC application costs. An anticipated offset in Design Engineering did not materialize, so the overall consulting engineering effort is 20% higher than perceived for the FERC estimate.

A more realistic owner's cost is now included. Rather than being limited to direct charges to the project, owner's cost includes administrative and general expenses, which are charged to capital projects on a percentage basis.

Finally, the increase in Direct Construction Costs, Engineering, and Owner's Costs results in the last three items (Contingency, Escalation, & AFUDC) being increased proportionately, and the approximate 40% increase in these items, adds over $1. million in a "coat-tail effect".

The FERC filing indicated a bus bar cost per kilowatt-hour of between 6.5 and 6.7 cents. The latest figures would indicate an increase to 9.2 - 9.5 cents. Given the DOE contribution at a fixed amount, the participation is now estimated at only 12% of the cost, excluding AFUDC, rather than the 25% originally contemplated. All additional costs, for whatever reasons, are borne solely by the Company and ultimately, its customers. Still, the costs appear competitive in comparison to oil-gas-coal alternatives, and barring further inordinate delays and price increases, the project should be carried out. On the positive side, it appears that better efficiency operation, utilizing two units, could increase the annual production from 28 to 32 million kilowatt-hours. If so, costs would be about 8 cents per KWH.

III. Conclusion

The Bolton Falls Redevelopment Project is intended as a demonstration of the feasibility of restoring old hydroelectric sites to useful production. The experience to date has surely demonstrated things that we and potential developers can benefit from:

1. Experience in the hydroelectric field, in engineering, hydrology, machinery costs and procurement, and construction is a vital ingredient in producing complete and reliable data for projects.

2. Regulatory delays and extended response time from agencies can decimate a construction schedule, and add tremendous costs to the project. Without a real commitment to low-head hydroelectric development, at all levels of government, consistent progress cannot be made.

3. Enhancement of fisheries and waterways, as a pre-requisite to hydroelectric re-development, can severely limit economic feasibility of projects.

Report Prepared By:

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Assistant Vice President
Operations & Engineering
Green Mountain Power Corporation

March 12, 1981

APPENDIX

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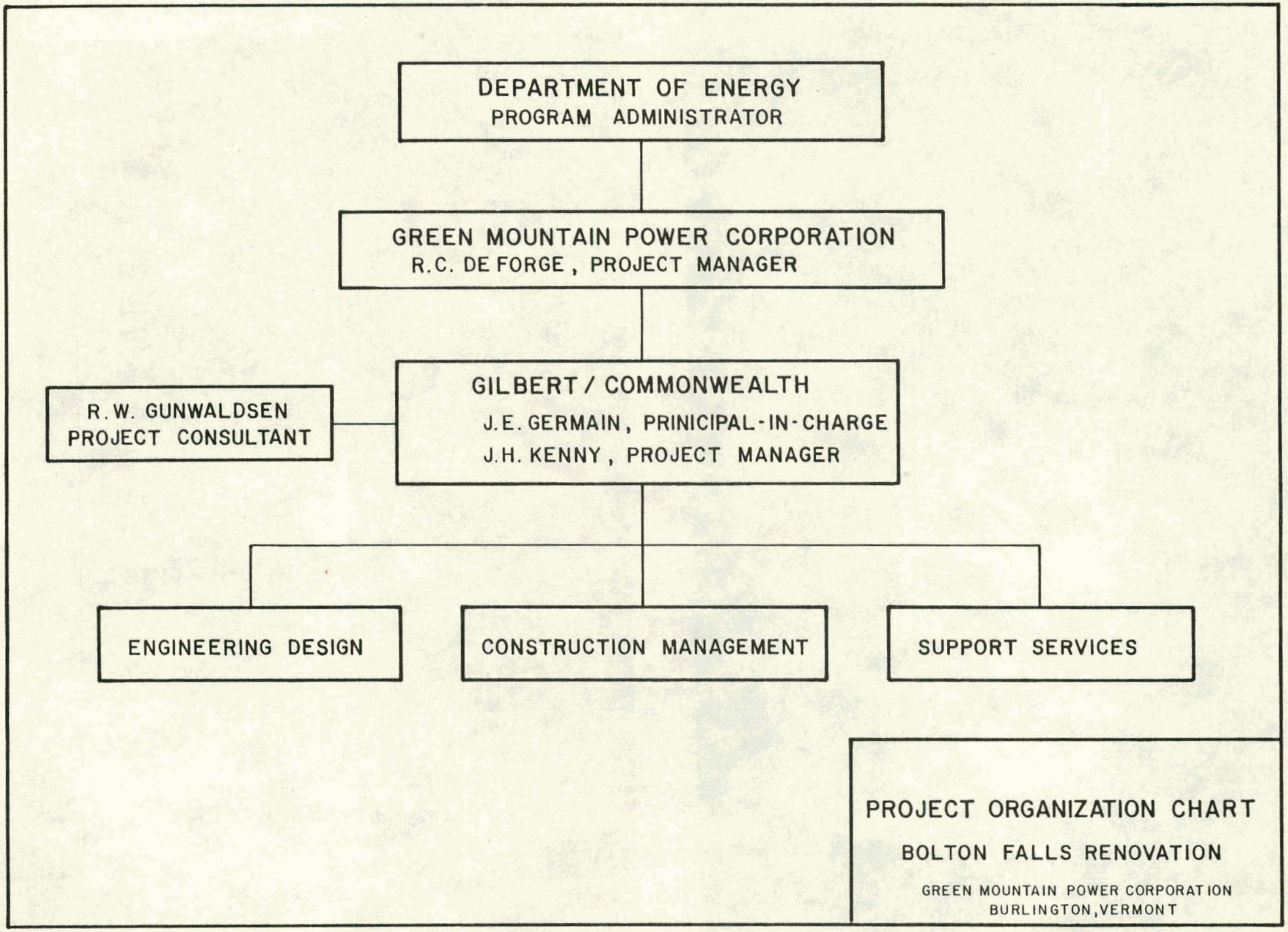
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J.H. KENNY, PROJECT MANAGER
R.W. GUNWALDSEN
PROJECT CONSULTANT
ENGINEERING DESIGN
CONSTRUCTION MANAGEMENT
SUPPORT SERVICES
PROJECT ORGANIZATION CHART
BOLTON FALLS RENOVATION
GREEN MOUNTAIN POWER CORPORATION
BURLINGTON, VERMONT


Green Mt. Pr. Corp.
Bolton Falls Dam
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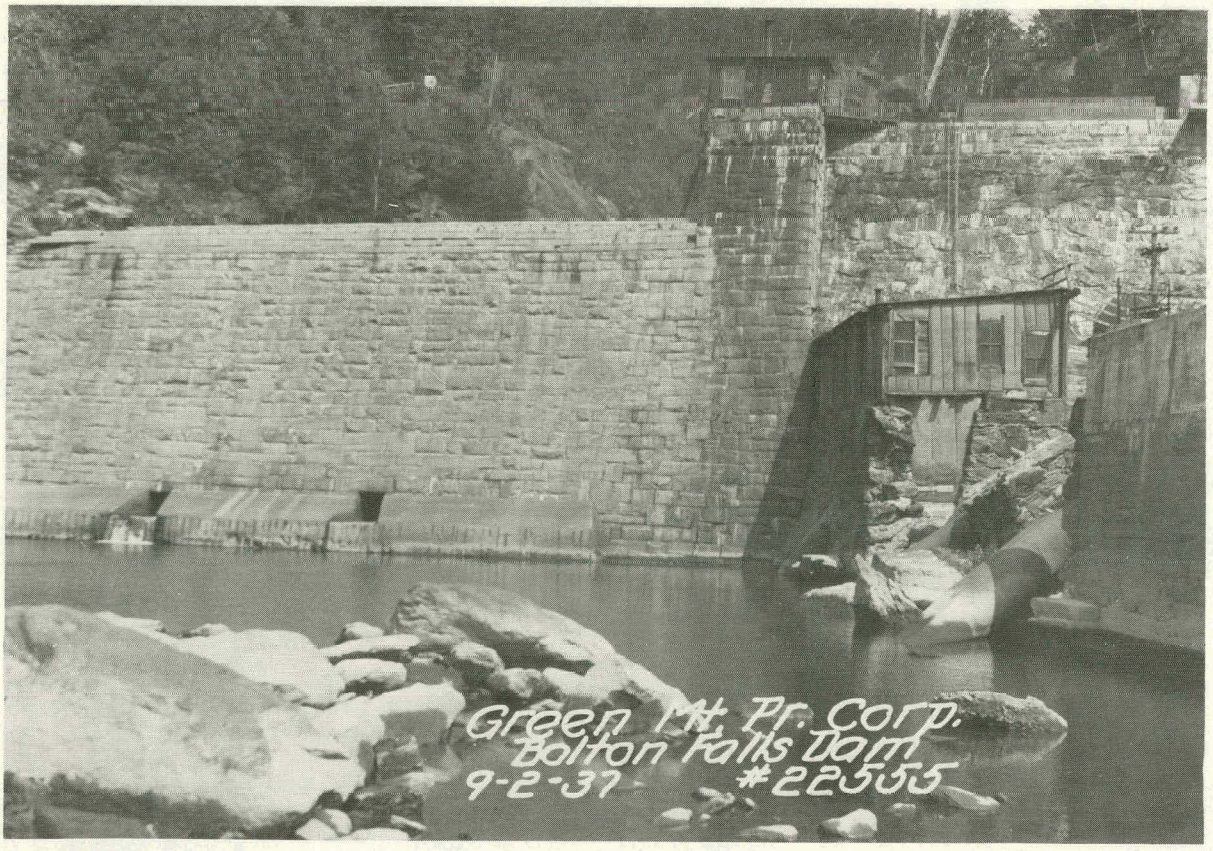
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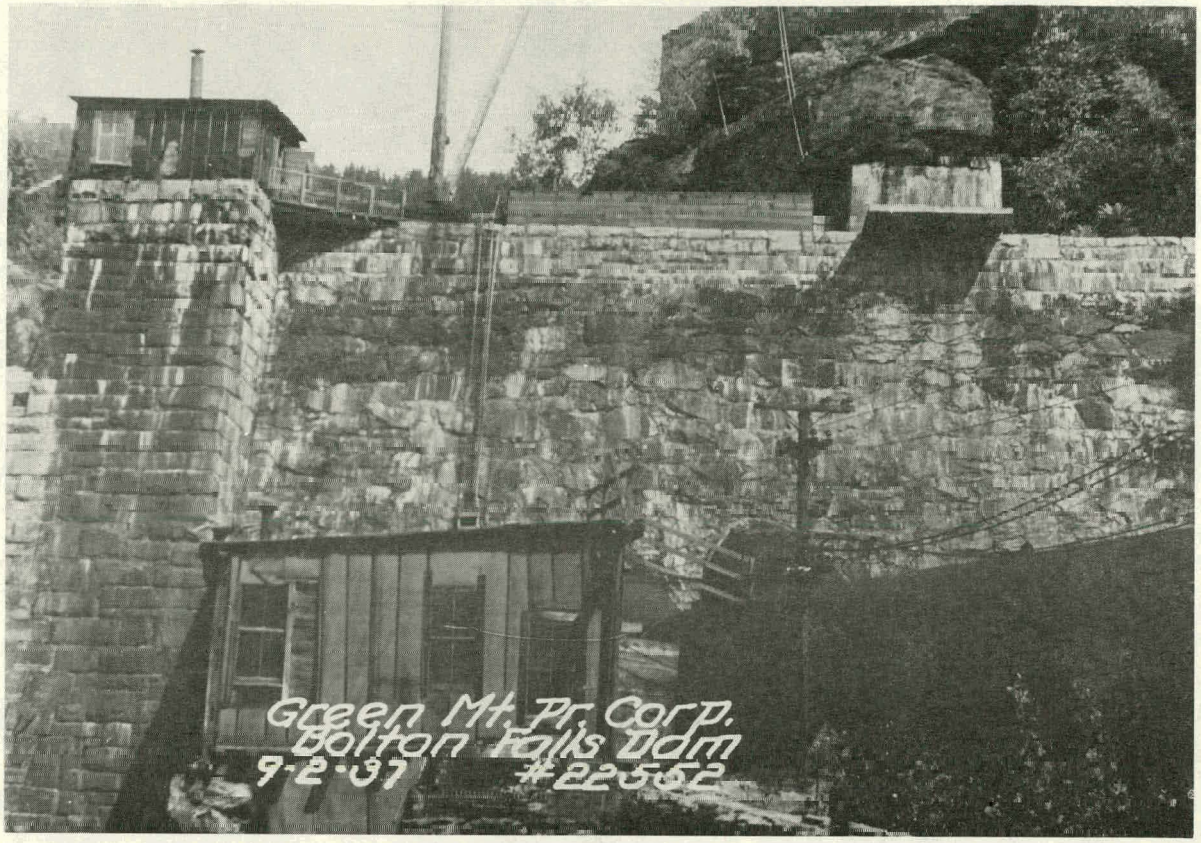
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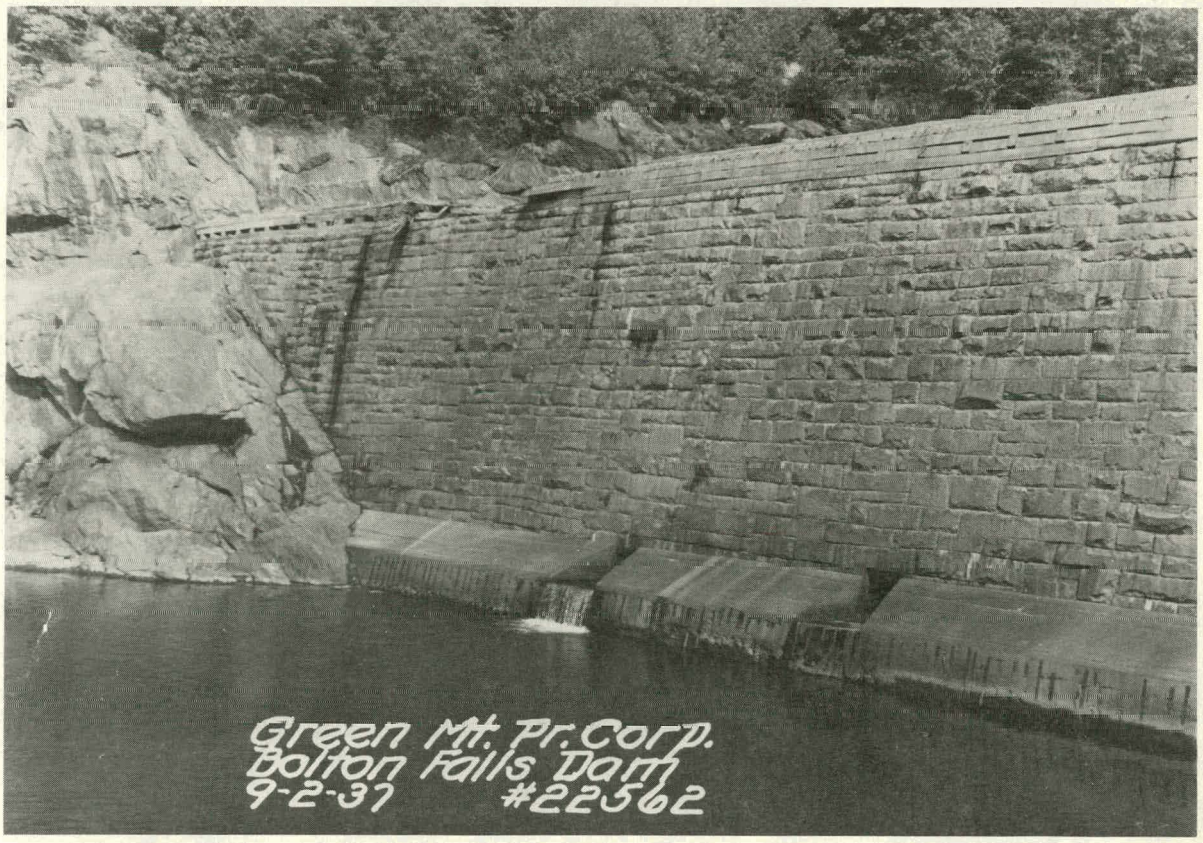
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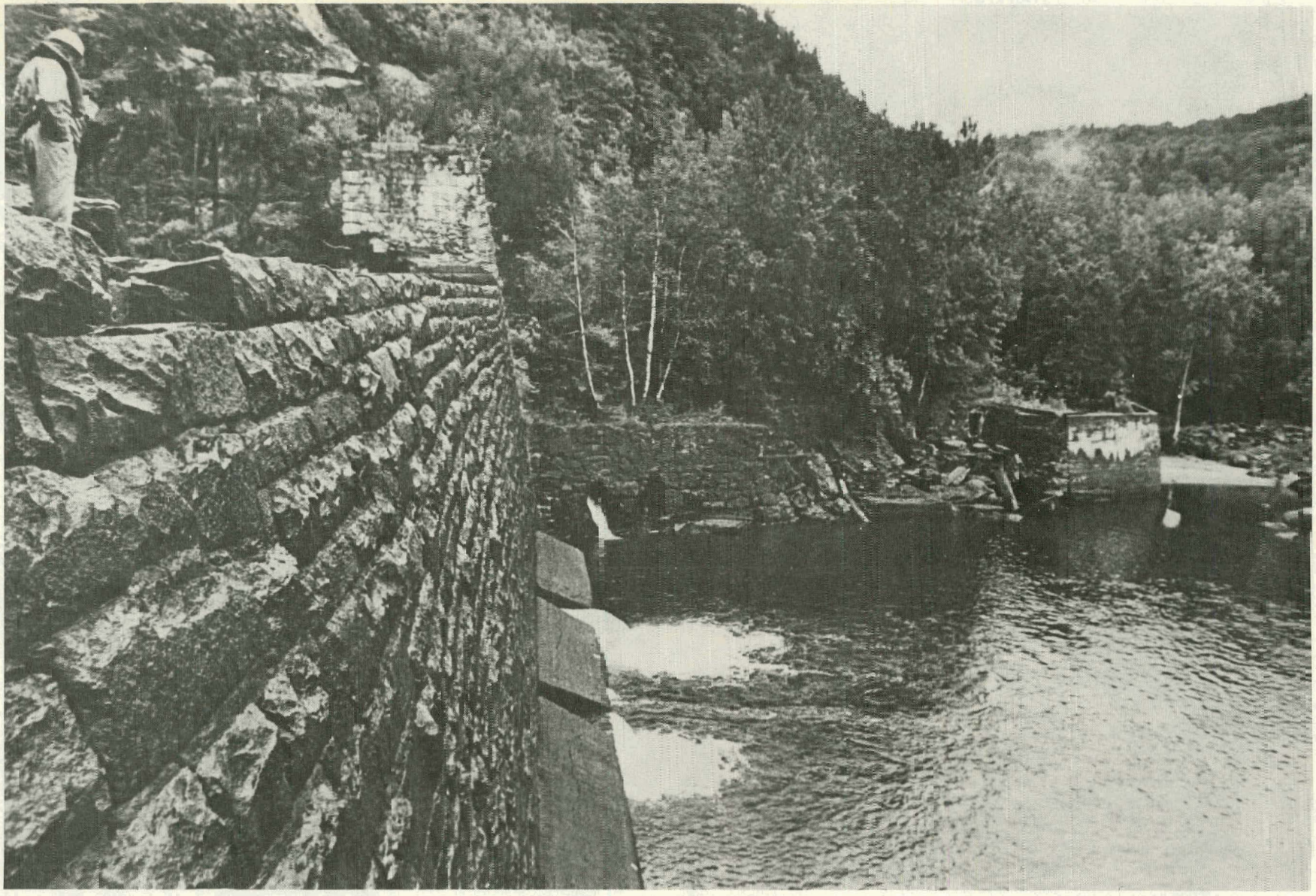

BOLTON FALLS DAM August 1978