

RECONNAISSANCE STUDY

TURNERS RESERVOIR DAM

and

HUNTS MILL POND DAM

TEN-MILE RIVER

CITY OF EAST PROVIDENCE

RHODE ISLAND

PROPOSED SMALL-SCALE HYDRO DEVELOPMENT

DATED AUGUST , 1980

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I. SITE DESCRIPTION

a. Location

The proposed additions and/or modifications to the presently non-functional and retired hydro-generation power plant are located in the City of East Providence, Rhode Island on Ten-Mile River in the County of Providence. (See Plate 1 and Photos 1-6). Additional details pertaining to the proposed location are in Appendix A. Coordinates of, the dams and power plant are approximately 41°-50'N Latitude and 71°-20'W Longitude. The area is suburban and populated. Plant site and dams are easily accessible. There are two dam 2,200 feet apart. The existing powerhouse building which houses the retired hydro-facility will be modified and rehabilitated for new and/or additional power generation units. This building is located at the foot of second dam (see Plate 1). Both the dams and power plant sites are easily accessible. Approach roads are in good condition and poses no problems during or after construction. Physical arrangements and construction needs of the proposed plant are normal and transmission of the generated power to existing distribution grid facilities are ideal.

b. Watershed Characteristics

The first of the series of two dams in this proposed project is called Turners Reservoir Dam and is located on the Ten-Mile River in the City of East Providence. The drainage basin of

the dam is almost oval in shape with a length of 15.0 miles and average width of 4.0 miles and a total area of 52.2 square miles. The second dam located 2,200 feet downstream of Turners Reservoir Dam is called Hunts Mill Pond Dam and has a drainage area of 54.4 square miles. There are natural and man-made storages in the watershed as to modify the natural river flows significantly. The basin is largely suburban and populated. The topography is comparably flat with average slopes of 10.0 feet-per mile. The stream channels are generally clean of vegetation; however the overbanks are highly vegetated with trees and brush. The climate of this watershed is characterised by typical New England climate with moderately warm summers with temperatures averaging around 75°F and winters are cool with temperatures averaging 30°F. Annual precipitation over the basin averages 43 inches. There is some variation in the monthly averages, however, rainfall is distributed fairly uniform throughout the year. The drainage basin is traversed by several main and secondary roads. There is no stream gaging station located on Ten-Mile River.

c. River and/or Stream Hydrology

The Ten-Mile River will provide the water for the proposed hydroelectric project. A part of Seekonk River Basin, Ten-Mile River drains an area of 56.4 square miles. Due to

the lack of any gaging station on Ten-Mile River, the amount of available water was indirectly based on gages located in hydrologically identical watersheds in this area. An actual and synthetically developed flow duration curve will be used in the feasibility study phase of this project. Average annual flow discharges were used to complete installed and generating hydroelectric capacity of the project. Turners Reservoir Dam has a surface area of 248 acres at the dam site. Average annual flow = 115 CFS = 2.2 CSM. It is anticipated that 200 CFS will be available 25% of the time in an average year.

d. Dams

There are two existing dams on the Ten-Mile River with the following pertinent data. (See Plate 1), elevations are in feet above MHW.

i) Turners Reservoir Dam	<u>Dam No. 1</u>
Top of Dam	54.0
Spillway Crest	49.0
Toe of Dam	34.6
Surface area at spillway crest	238 acres
ii) Hunts Mill Pond Dam	<u>Dam No. 2</u>
Top of Dam	30.10
Spillway Crest	14.00
Toe of Dam	12.00
Tailwater elevation	9.12
Surface area at spillway crest	0.40 acres

Distance between two dams	2,200 feet
Gross available head at two dams (cumulative)	40 feet
Net available head	34 feet

The entire length of both dams consists of an overflow spillway. The proposed powerhouse is located downstream of Dam No. 2. The proposed (66 inch diameter) penstock of will be located along the alignment of the existing penstock. It is anticipated to utilize the existing 66 inch diameter penstock both in size and alignment in the proposed new plant layout. But detailed analysis and subsequent decision will be made in the feasibility report. Dam No. 1 is in excellent condition and does not need any repairs. Dam No. 2 does require minor repairs for its stability and safety.

e. Reservoir

The reservoir upstream of Dam No. 1 (Turners Reservoir) has a large surface area of 248 acres. Due to silted-in process, the impact of increased power generation of the dam's storage capacity is doubtful; nevertheless this aspect of utilization of storage to increase the low flows to shave off the peaking power demand and other such issues will be further explored in the feasibility study within the framework of adverse impacts of desiltation process.

f. Geology

From visual observations, outcrops of bedrocks, both the dams are keyed to bedrock and also the existing and proposed foundations of powerhouse will be on solid rock and/or concrete mat. Geological conditons look excellent and the successful function for a long period of more than 20 years of existing power-generation facility is proof and testimony to the geological conditions at the site of the facilities and appurtenant components of this project. Nevertheless, soil borings will be undertaken for siting the additional sized power plant during the design stage of the project.

g. Appurtenant Structures

i) Spillway

The entire length of both the dams are spillways. Dam No. 1 and Dam No. 2 have a length of approximately 120 feet and 75 feet respectively. Dam No. 1 spillway requires no repairs, Dam No. 2 does require minor repairs. Monies are being provided for such and other unforeseen repairs to dams and spillways. These repairs of spillways and/or tops of dams will restore the original integrity of the dams.

ii) Outlet (Intake Structure)

The intake structures and outlet mechanism at Dam No. 1 need rehabilitation for its approaches, trashracks,

gates and gearing and the covered shed to make it safe against vandalism. From visual inspection, the intake flow capacity for existing 66 inches of penstock is sufficient for the optimum design discharge of 115 CFS to 250 CFS for hydrogeneration. The intake structure can discharge into the penstock upto 300 CFS with the gates fully open and upstream water surface elevation at spillway crest elevation. Consequently, no major modifications are proposed to be undertaken to this Dam No. 1 intake structure. At Dam No. 2, it is proposed not to have any intake structure to the penstock. By abandoning the existing one and by-passing Dam No. 2 in the alignment of proposed new penstock. In fact, Dam No. 2 will not be a part of this proposed hydro-generation facility.

iii) Penstock

The existing (66 inch diameter) penstock is a steel plated circular pipe and is 2,200 feet long starting from Dam No. 1 and terminating inside the existing but retired powerhouse. For most of its length, this penstock runs underground. Some portion of the penstock, approximately 200 feet are either missing or its steel plate rusted and hence leaking. It is the intention to carefully examine and replace the penstock where needed to suite new requirements in this proposed plant. Size and alignment of the penstock is at this time proposed to be kept the same. Sufficient monies

in the estimated costs are being provided to replace and/or repair 2,200 feet of 66 inch diameter penstock.

iv) Powerhouse

The existing powerhouse is in excellent condition and can easily accommodate another turbine-generator unit if need be. This existing powerhouse has already one unit with the following data:

Make:	Leffel Co. (1924 year make)
Type:	Vertical Francis Unit
Size:	144 KW
Speed:	225 RPM
KVA:	180
Powerfactor:	0.8 (A.C. Generator)

The proposed unit/units will have at least double the existing capacity (280 KW). Decision to replace the existing unit with one bigger unit or add another unit and also repair the existing one will be finalized in the feasibility study. Monies in the estimated costs for this project are being provided as higher of the two alternatives.

v) Tailrace

The existing tailrace is in good shape and needs very minimal repairs to keep it clean of debris, brush, etc. This tailrace channel has capacity much more than proposed discharge of 115 CFS. Actually it can carry 250 CFS without undue rise in tailwater surface elevation. Length of tailrace is approximately 100 feet.

vi) Transmission Lines

Main transmission lines of Narragansett Electric Company are nearby and the length of transmission lines to wheel in the power in this grid will be approximately 250 feet.

vii) Miscellaneous Structures

It is proposed to build an additional 20' x 20' one story structure to serve as a maintenance shop, storage room, and an office for controls and record keeping adjacent to the existing powerhouse if it is decided that two turbine units are to be operational simultaneously in the facility. For one unit, there is already ample space for these uses.

h. Water Rights, Downstream Requirements

This is a run of the river power plant. Consequently, no changes in the flow patterns of natural river flows are contemplated. Nevertheless, there are no water rights and/or downstream requirements of water established at this site. However, it is proposed to ensure a minimum flow if demanded and required by fish and wildlife for flow augmentation purposes by the provision of a bypass at the intake structure upstream of Dam No. 1.

*Review
classmate
differently*

i. Photographs

Following photographs of the site are attached.

- Photograph No. 1: Overall view of Dam No. 1
- Photograph No. 2: Overall view of Dam No. 2
- Photograph No. 3: Intake structure at Dam No. 1
- Photograph No. 4: Inside view of existing Powerhouse
- Photograph No. 5: Outside view of existing Powerhouse
- Photograph No. 6: Existing turbine unit

j. Maps

Following maps are attached for reference and use in this
Reconnaissance Study.

- i) Site Location Map (U.S.G.S. 1 inch = 2,000 feet scale)
- ii) Schematic Diagram of project layout (Plate 1 and 2)

II. BUSINESS DATA

a. Applicant's Description

City of East Providence is interested in developing, managing and operating small-scale hydro-generating facilities. The city has a full-time Director of Public Works, City Engineer, Superintendent of Water Supply, and other required engineering staff are capable of managing this type of project. The city intends to hire an Architectural/Engineering firm to design and supervise the construction of this facility.

b. Applicant's Financial Resources

City of Providence has the authority and resources to obtain funding if, and when they decide to proceed with the implementation of this project. Decision to implement will be dependent upon the outcome of feasibility study for which a loan application is being submitted to D.O.E.

c. Method of Transmitting the Power

Power generated at this proposed hydro-plant will be wheeled into the nearby existing grid system owned and operated by Narragansett Electric Company. Negotiations regarding the methodology, mode and cost of wheeling in this power will be undertaken during the preparation of Feasibility Study in accordance with State and Federal requirements.

d. Estimated Power Value Details

Average annual inflow	= 115 CFS
Adopted flow for installed capacity in permit. .	= 115 CFS
25% time flow is equalled or exceeded.	= 200 CFS
	(estimated)
Gross available head	= 40.0 feet
Net available head	= 34.0 feet
Adopted installed capacity (efficiency = 0.86) .	= 285 KW
Maximum potential installed capacity, based on 200 CFS available more than 25% of the time (estimated).	= 400 KW

Consequently two units will be the optimum installed capacity from the off-the-shelf availability point of view. There are two alternatives available to utilize the maximum potential of this river within the framework of economic justification:

- i) Repair and rehabilitate the old unit and add a new unit as well.
- ii) Abandon the existing unit and install one new large size unit. Feasibility Study will determine the best alternative.

Average yearly energy generated

at 50% plant factor = 1248300 KWH

and 285 KW installed capacity = 1248 MWH

Net Head = 34.0 feet

Discharge = 115 CFS

Dependable capacity = Negligible

III. ENVIRONMENTAL, INSTITUTIONAL AND SAFETY

A. ENVIRONMENTAL

1. Is river or stream classified or under consideration for wild and/or scenic status? NO

If yes, give status _____

2. Is the proposed site located in a wildlife preserve, recreational area, national or state park, historical site, or in any other restricted-activity area (including those restricted under federal, state or local law for future developments)? NO

If yes, give status _____

3. Is the proposed site located nearby or adjacent to designated wilderness areas or at areas otherwise restricted from development under federal, state or local law? NO

If yes, give status _____

*4. Are any rare endangered species located in the vicinity of the proposed development? NO

If yes, species name _____

*5. Are any migratory fish present in the river or stream during any part of the year? NO

If yes, is there a functional fishway located at the proposed site and list species? _____

* Data is available for most sites from the State Fish and Game and/or the U.S. Fish and Wildlife Services.

B. INSTITUTIONAL

1. Will the proposed hydropower installation alter the current dam usage and flows? NO
If yes, describe impact _____
2. Identify the Owner of the dam and support facilities
City of East Providence, Rhode Island
3. Does the proposer have right of access and the right to develop the project site and acquired right-of-way for transmission by easement, ownership, long-term (firm) lease agreement or condemnation? YES
If yes, give status Dams water rights easement access to site are by City of East Providence

C. SAFETY

1. Does the proposed hydropower installation require modification to the existing dam structure? YES
If yes, describe modifications _____

2. Last date the dam was inspected and by what agency?
Unknown
3. Has a dam safety report been issued, and what was the conclusion? NO

NOTE: Dam No. 1 (Turners Reservoir Dam) is in excellent condition and does not require any repairs. Dam No. 2 does require some minor repairs to restore it

to its original integrity. However, it may be pointed out that powerhouse is located downstream of Dam No. 2 and a continuous penstock starting from Dam No. 1 bypasses Dam No. 2 consequently the repairs to Dam No. 2 in no way affect the power-generation capacity and/or facility.

IV. PLANT CHARACTERISTICS AND POWER POTENTIAL

<u>ITEM</u>	<u>VALUE</u>
Average head (H)	34 Feet
Average annual flow, unless periods of 0 flow, then use average during flow periods or 25% exceedance level on flow duration curve - whichever is greater (Q)	115 CFS (Estimated average annual flow)
Capacity (Based on 86% efficiency)	285 KW

$$KW = \frac{HQ}{13.7}$$

Average yearly energy generated (assume 50% plant factor) [1] 1248300 KWh

$$KWh = \frac{05. HQ (365) (24)}{13.7}$$

Tailrace Length 100 Feet

Penstock Length 2,200 Feet

Transmission Line Length 250 Feet

Economic Life (assume 30 years unless other information is available) 30 Years

[1] If an irrigation system, the average yearly generated should be calculated as follows:

(Select plant factor (P.F.) based on specific site flow characteristics or assume 50% to 80%)

$$KWh = \frac{P.F. HQ (365) (24) (Months of Operations)}{13.7}$$

* It is anticipated that 25% exceedance level on flow duration curve to be developed in Feasibility Study will be approximately 200 CFS.

V. INVESTMENT COST

<u>ITEM</u>	<u>UNIT COST</u> (\$000)	<u>TOTAL COST</u> (\$000)
Turbine, Generator & Civil	\$	\$ 300
Additional Station Equipment (Multi Units)		20
Penstock		200
Tailrace		20
Switchyard Equipment		30
Transmission Line		10
Dam Rehabilitation		30
Other (Access, Fish Passage, Misc. Site Construction)		10
SUBTOTAL		620
Escalated Subtotal (July, '78 - Current, Ratio = 1:2		744
Contingencies (10% - 20%) (Used 20%) .		150
SUBTOTAL CONSTRUCTION COSTS		894
Indirects @ 25%		223
TOTAL INVESTMENT COSTS		1,117

VI. OPERATING & MAINTENANCE (O&M) Cost

O&M Cost (\$20,000 Minimum or 1.5% - 4% of Investment Costs) (Used 2%) .	30
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* This cost includes the cost of a new unit and rehabilitation of existing unit for a total discharge of 200 CFS or only one unit for 200 CFS.

VII. BENEFIT ESTIMATE

(\$000)

Average Annual Energy Generated From Part IV
(124800 KWh) x Value of Energy From Part II
or Appendix I (0.06 \$/KWh) \$ 75

Note: 1 Mill = \$0.001

VIII. ECONOMICS

Investment Cost (INV)
(From Part V) \$ 1,117

First Year Annual Revenue (Ar)
(From Part VIII) \$ 75

Escalation Rate - Revenue (Er) 8%

First Year Operating and Maintenance
(O&M) Cost (Ae) \$ 30
(From Part VI)

Escalation Rate - Expense (Ee) 6%

Number of Years (n)
(From Part IV) 30

Discount Rate (k) 8% Case 1

Use 8% for Public Sector

Use 15% for Individual or Corporation

Note: Use both 8% and 15% for k in the
calculation even if a specific
developer is defined

WITH ESCALATION

Determine the Following:

Present Value of Net Revenue (PNR)

Benefit/Cost Ratio (B/C)

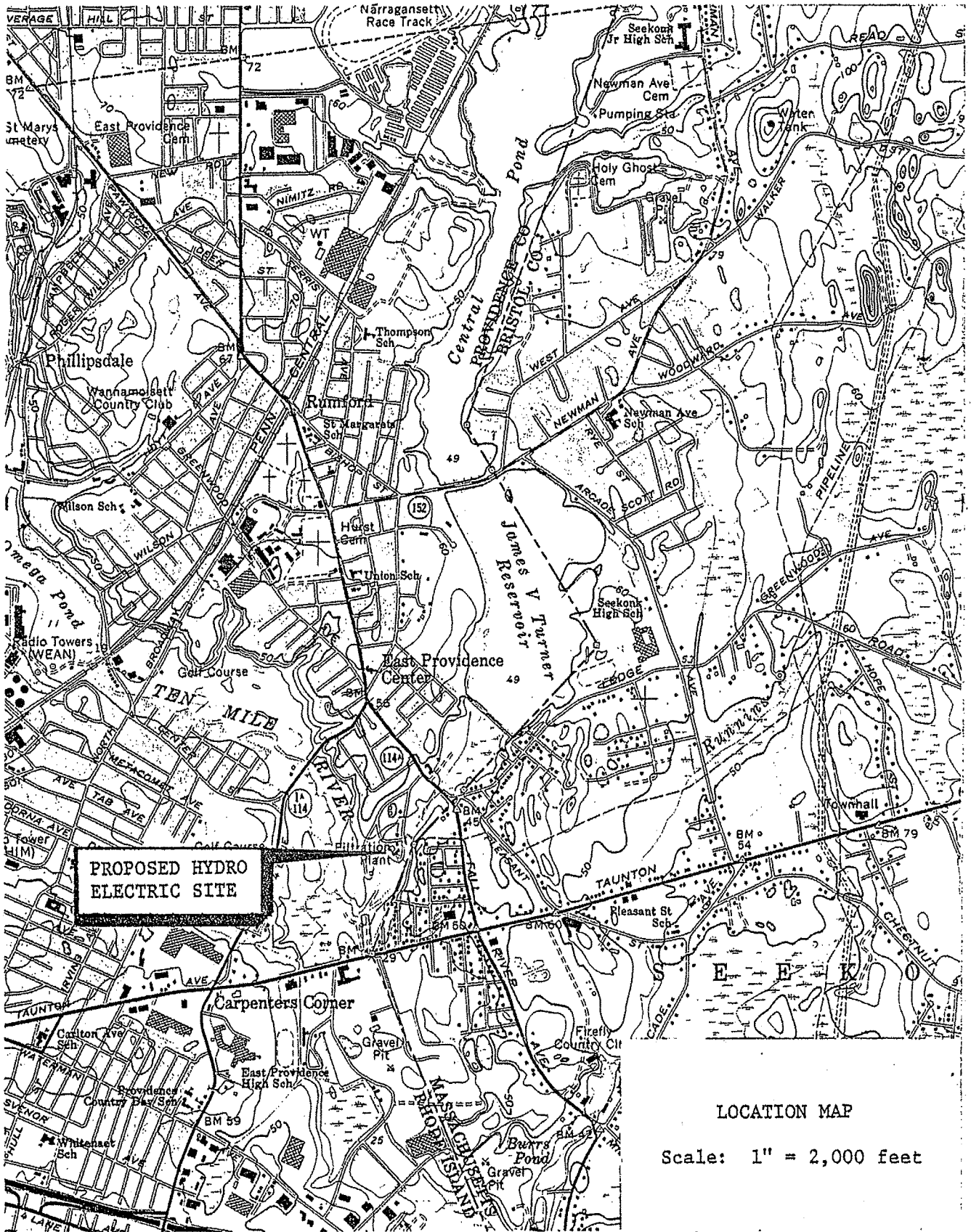
$$\begin{aligned}
 & \text{PNR} = \sum_{i=1}^n \frac{Ar(1 + .08)^i - Ae(1 + .06)^i}{(1 + k)^i} = 1,585 \\
 & \text{B/C @ k of 8\%} = \frac{\text{PNR}}{\text{INV}} = \frac{1,587}{1,117} = 1,418 = 1.42 \\
 & \text{B/C @ k of 15\%} = \frac{\text{PNR}}{\text{INV}} = \frac{648}{1,117} = 0.58 = 0.60
 \end{aligned}$$

- NOTE:
1. At \$0.07/KWh Value of Energy B/C @ k of 8% = 1.74
 2. At \$0.07/KWh Value of Energy B/C @ k of 15% = 0.72
 3. At \$0.05/KWh Value of Energy B/C @ k of 8% = 1.07
 4. At \$0.05/KWh Value of Energy B/C @ k of 15% = 0.12

APPENDICES

- A. Location of Site Map
- B. Photographs
- C. Miscellaneous Documents including deed for ownership of dams

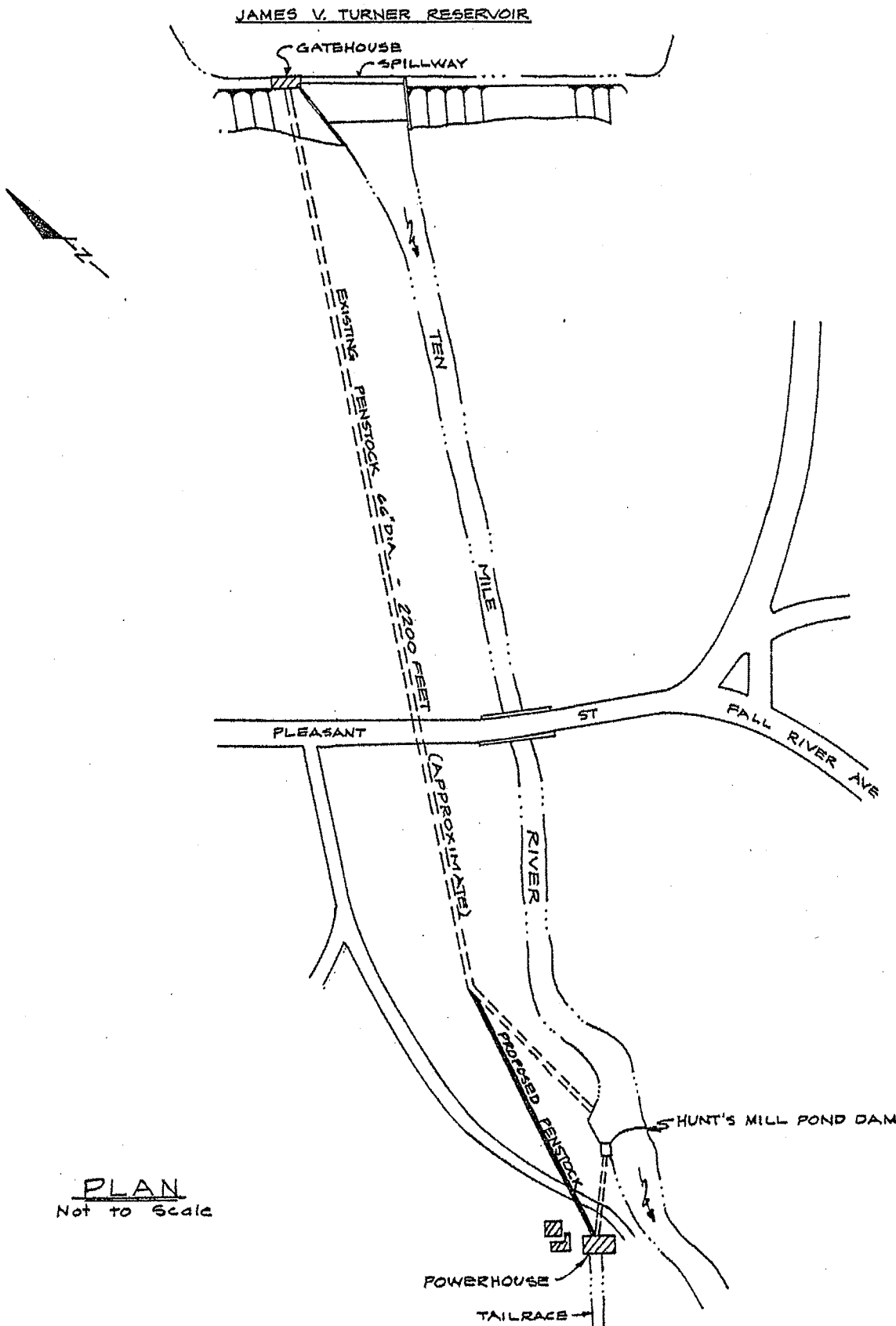
APPENDIX A



**PROPOSED HYDRO
ELECTRIC SITE**

LOCATION MAP

Scale: 1" = 2,000 feet



PLAN
Not to Scale

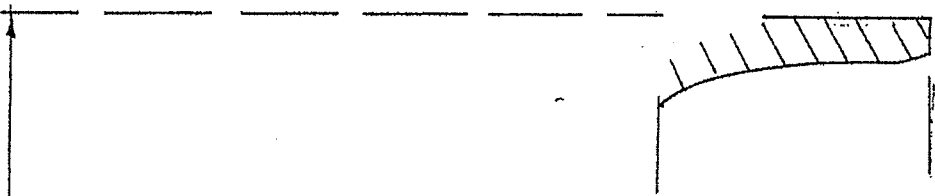
PROPOSED AND EXISTING
HYDRO-GENERATION
LAYOUT

11



TURNER RESERVOIR DAM

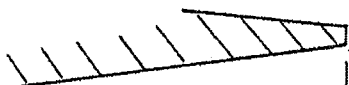
DRAINAGE AREA = 52.2 SQ.MI.
 SURFACE AREA = 248 ACRES
 TOP OF DAM = 54.0
 SPILLWAY CREST = 49.0



2200 FEET

HUNT'S MILL POND DAM

DRAINAGE AREA = 52.4 SQ.MI.
 SURFACE AREA = 0.4 ACRES
 TOP OF DAM = 30.1
 SPILLWAY CREST = 28.1



POWERHOUSE

T.W.E. = 9.12

SKETCH OF PROPOSED
 PLANT DEVELOPMENT