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Exeter Hydropower

and

DHC Study

Office of State Planning.

EXETER HYDROPOWER AND DHC STUDY

JULY, 1981

SUBMITTED BY

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AUTHOR
TITLE
BORROWER
VOLUME NO.
DATE BORROWED
ROOM NO.
EXTENSION

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BORROWER CARD

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Introduction:

Exeter's Lower Water Street's direct access to the Exeter River I Dam and the municipal sewage pumping station may be or may become an energy asset for the town. The Federal Government recognizes potential savings through the development of these community based renewable energy alternatives and has established grant and loan programs to pursue this development. This report summarizes the assessment of the economic viability of retrofitting renewable alternate energy sources for use by the Town of Exeter. The work was sponsored by the Town of Exeter, under a Coastal Energy Planning Grant Program, conducted by the Exeter Planning Office, and assisted by the University of New Hampshire.

Data pertinent to the study were supplied by the following sources; New Hampshire Water Resources Board, Exeter Water Department, Lower Water Street Merchants, U.S.G.S. Lamprey River gauging station data, Corp of Engineers, equipment vendors, and computer programs developed at the University of New Hampshire.

Initial interest with application for this Coastal Energy planning grant was sponsored in part by the Downtown Process Committee, a group of business, private and government officials which serve on the committee to encourage appropriate development of the waterfront/downtown in accordance with the "Exeter Waterfront" master plan.

Upon nearing completion of this study Clemson-Milliken Fabrics, owners of the dams (Exeter River I Dam and Pickpocket Road dam) offered to deed to the Town of Exeter the dams, water rights, and certain parcels of land fronting along the Exeter River. The acceptance of these gifts will be the subject of a Special Town Meeting to be held in September 1981.

It should be noted that this study assessed the economic feasibility of retrofitting the Exeter River I Dam. The decision to concentrate the study to this dam was based on the town's direct access to the I Dam and its potential energy supply for a district heating and cooling system. The study results, however, can be interpolated, base on respective drainage areas, for estimating the economic viability of retrofitting the Pichpocket Dam for hydroelectric power.

REPORT SUMMARY

The results of our analysis provided two findings:

(1) The economic analysis illustrated the viability of a hydropower retrofit of the Exeter River I Dam based on no escalation in energy costs and providing to the Town approximately $13,000 income for operating, maintainance and profit. As the Town now has the option of acquiring two dams and all water rights it may become responsible for the operation and maintainance of the dam facility, which can be considered either an asset or a liability.

It is recommended that the town take the following steps on the hydro-power retrofit project:

- Develop and submit to Federal Energy Regulatory Commission an exemption package for the Exeter River I Dam (and now possibly the Pickpocket Dam).
- Select an engineering company to complete a final design for a 100 KW turbine/generator for a siphon installation on the spillway crest dam.
- Secure bids from manufacturers for the proposed mechanical and electrical equipment.

- Develop a municipal bond financing package.
- Make decision as to how to proceed.

(2) The results of the district heating/cooling study showed the proposed Exeter site to be not economical at this time. Further investigation is not recommended until the price of oil is approximately 60 times more costly than electricity.

PART I

PRELIMINARY SITE EVALUATION - HYDRO RETROFIT

The Exeter River originates in the Town of Brentwood and drains 102.7 sq. miles of basin land. It flows generally northeasterly to its confluence with the tidal Squamscott River in Exeter. Two dams regulate discharge, one above the tidal river intown Exeter; the other approximately 5 miles upstream, known as Pickpocket Dam. The Clemson Mill owns these structures and has had a long history of controlling flows and water rights to the river.

The following site data summarizes the information on file at the New Hampshire Water Resources Board for the Exeter River I Dam. This information has been validated by the Clemson Mill engineer.

Name of Dam:	Exeter River I Dam
COE Number:	304
State Number:	82.01

The concrete gravity dam is 15 feet high, 140 feet long, and has a 111 foot spillway. It was built in 1914, and rehabilitated in 1938 and 1968. Just below the dam is a 3 foot auxiliary dam, constructed for scour protection, and to the left of the spillway dam is a 3' x 3' fish ladder aquaduct. The dam gates consist of a spill gate and two control gates leading to a 14 ft wide by 7 ft high concrete penstock. The wooden control gates are operated on a wheel and gear mechanism located 5' above the spillway crest. The gates are protected by an iron trash rack; a single tank is located directly behind the gates to the penstock.

The penstock is approximately 200 yards long, terminating on mill property. Expansion of the mill complex has destroyed the tail race constructed for the original turbines.

WATERSHED CHARACTERISTICS

The available information for the Exeter River Watershed is as follows:

a. Drainage Area

Watershed - 102.7 sq. mi.

Ponding - 36 acres

b. Discharge

Maximum flood flow - unknown

Maximum spillway (design) - 4830 cfs

c. Elevation (ft. above MSL)

Dam - 40.5 (maximum pt.)

36.5 (minimum pt.)

Spillway Crest	-	36.5 ft
Head gate low level	-	31.5 ft
Stream bed at crest of dam	-	21.5 ft
Maximum tail water (est.)	-	26 ft
Power House floor (mill floor)	-	13.5 ft

d. Reservoir

Length of pool	-	26,400 ft
Average width (est.)	-	60 ft

e. Storage

Top of spillway	-	545 acre-ft
Design surcharge	-	unknown

f. Regulating Outlets

Spillgate	-	4.6' x 5' (wood)
wheel and gear control		
Head gates	-	2 4.6' x 5' (wood)
wheel and gear control		
Fish ladder	-	80' long
no control		

WATER SUPPLY

The Town of Exeter draws a portion of its water supply from the Exeter River. The pumping station records show an average draw of approximately a million gallons a day (see Table 1).

The water supply pumping station is approximately 1/2 mile upstream from the dam thus it will be unaffected by construction activities during hydropower retrofit or during operation.

Once the retrofit has been accomplished, the need to withdraw-on an average - one million gallons daily for water supply would have little, if any, effect on the hydropwer installation. During periods of extremely low flow, operational procedures that ensure the pumping station has first use of the river water can be part of the turbine control flow management program. The approximately one million gallons per day drawn for water supply would have little if any effect on a hydropower installation.

The town of Exeter depends most heavily on the river as a water supply during the dry summer months. During this time of year, minimum pond elevation is fixed at spillway crest, any lower elevation may adversely affect water quality. During medium (greater than 20 cfs) to heavy flow periods the

TABLE 1:- WATER CONSUMPTION DATA FOR ANNUAL WATER USAGE BY THE TREATMENT PLANT

PERIOD: JAN. - DEC. 1980

MONTH	GALLONS (MILLION OF GALLONS)
Jan.	37.46
Feb.	32.67
March	32.72
April	24.61
May	32.79
June	24.62
July	8.00*
Aug.	7.36*
Sept.	31.47
Oct.	11.29
Nov.	38.61
Dec.	42.89
TOTAL	324.49

*Water Treatment Plant, Pumping Schedule for Intake at Exeter River atypical because hazardous waste scare thought to occur in tributary stream.

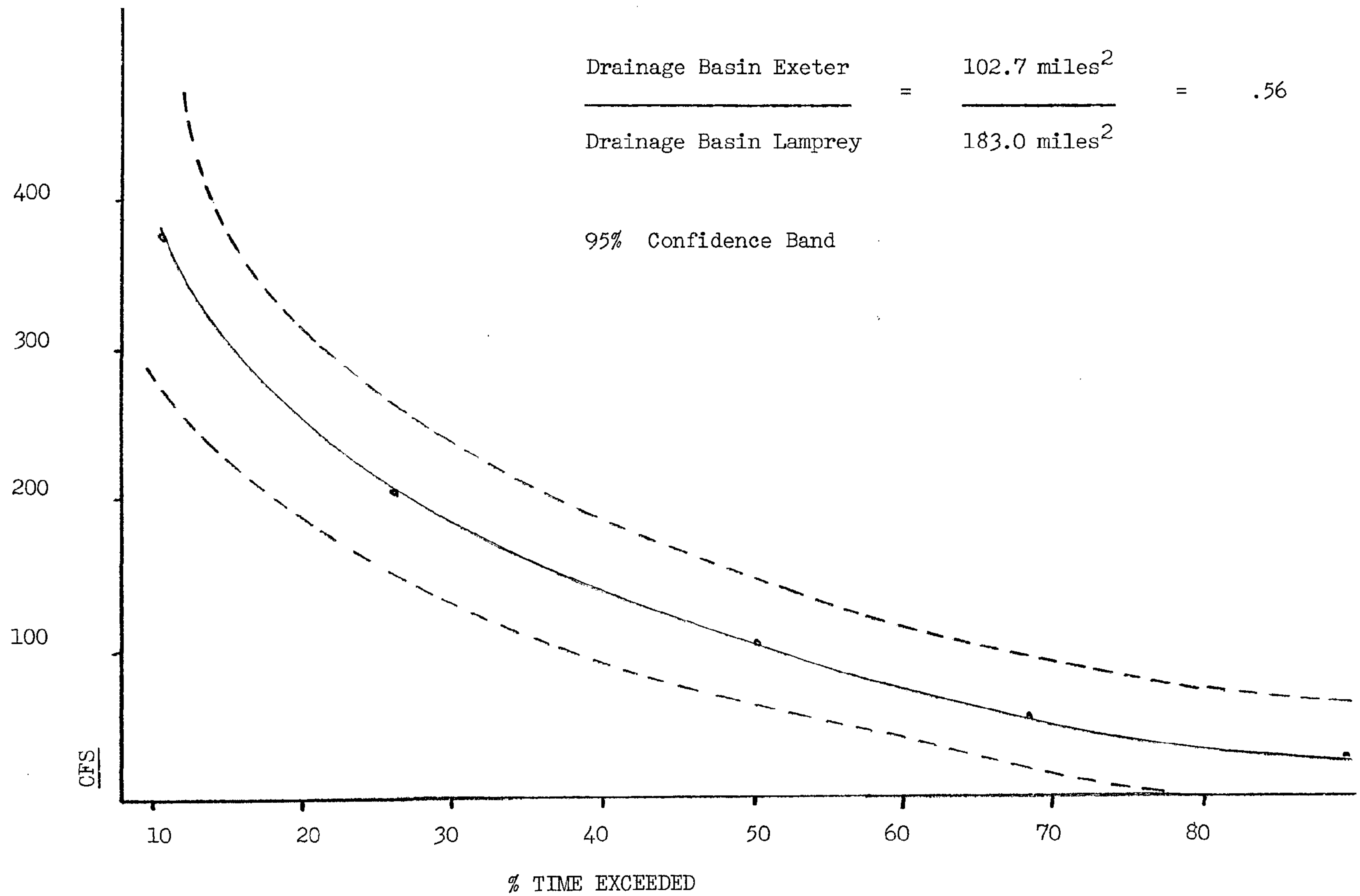
pond elevation could oscillate through as much as 3 to 4 feet with no effect on water quality and still remain usable for hydropower. The 3 to 4 foot range consists of 3 plus feet above spillway crest to 1 plus feet below crest (i.e. during a peaking operation). Maximum draw down is approximately 3 feet below spillway crest, the lower limit is established by the gate inverts. Exeter's short term plans are to continue drawing the approximately 1 million gpd, however, alternatives to the river water are being studied. Due to the increasing treatment costs associated with the river water, the potential of using deep rock wells is being investigated. Should sufficient quantities of well water be available, the usage of the river water will be reduced or stopped.

SYNTHESIS OF FLOW DURATION CURVE

There are no official daily flow data for the Exeter River. To establish a flow duration curve for the study, two procedures were followed using comparable U.S.G.S. data. The Lamprey River was selected because it is adjacent to the Exeter River, has similar basin characteristics, and has been monitored by the U.S.G.S. for 43 years. The Ratio of Drainage Areas method was the first method used to simulate a flow duration for the Exeter River (see Figure 1). Using a series of U.S.G.S. contour maps and a planimeter, the Exeter River drainage area was validated at 102.7 square miles and the Lamprey drainage area above the Packer Falls gauge station was determined to be 183 square miles. By taking the ratio of the area of the Exeter watershed to that of the Lamprey, a factor of .5683 was calculated. Using this factor and the Lamprey flow data, a flow duration curve for the Exeter River was developed.

Since this method is only an approximation, a second method by S.L. Dingman was used to estimate the potential error of the first method. Dingman's method is outlined in the Water Resources Bulletin, American Water Resources

Figure 1 Flow Duration Curve For Exeter River



Association, Vol. 14, No. 6. This method uses the area of the basin above the point of interest and either the measured mean elevation or the elevation of the highest and lowest points in the basin.

The measured or estimated mean elevation is used in a set of regression equations to estimate mean average flow. Similar equations were used to estimate the range in which the flow will vary 95% of the time (i.e. the actual flow will fall within the estimate range 95% of the time. In the remaining 5% of the time the flow will be either higher or lower than the estimated range.

SIZING OF TURBINES

Using the synthesized flow duration curve, an 85% turbine/generator efficiency, a 50 cfs to 350 cfs flow range and a head of 19.6 ft, preliminary sizing of turbines was investigated including a dual installation.

As can be seen by yearly output in KW/hr from Table 2 a double turbine installation will have the largest output approaching 1,091,700 KW/hr. The flow duration curve is only an estimate, thus these sizes are only a guide for an economic study.

The relatively small differences among the yearly capacities of the various turbine combinations allows a developer freedom in selecting the best combination solely on unit costs. The projected yearly income from a set of turbines using the full available head is in the $80,000 to $90,000 range figured on the PUC ruling of 7.7¢/kwh for a run-of-river plant (the expense of using the full head will be shown to be too expensive.) Further studies might show that by coordinating the control of the two dams along the river further output may be possible.

TABLE 2 Turbine Installations

Turbine Size (CFS)	Capacity (KW)	Plant Factor* (%)	Yearly Output (KW/hr)
50	70.8	65	409,400
100	141.6	48	595,400
150	212.4	36	669,900
200	283.2	26	645,000
250	354.0	19	589,200
300	424.8	14	521,000
350	495.7	11	477,600

50 cfs PRIMARY TURBINE & SECONDARY

Secondary Turbine (cfs)	Capacity (KW)	Plant Factor (%)	Yearly Output (KW/hr)
50	70.8	48	707,100
100	141.6	48	930,400
150	212.4	36	1,016,600
200	283.2	26	1,011,000
250	354.0	19	967,980
300	424.8	14	911,566

100 cfs PRIMARY TURBINE & SECONDARY

Secondary Turbine (cfs)	Capacity (KW)	Plant Factor (%)	Yearly Output (KW/hr)
100	141.6	26	918,000
150	212.4	19	1,059,100
200	283.2	14	1,091,700
250	354.0	11	1,085,500

150 cfs PRIMARY TURBINE & SECONDARY

Secondary Turbine (cfs)	Capacity (KW)	Plant Factor (%)	Yearly Output (KW/hr)
150	212.4	14	930,400
200	283.2	11	1,035,600

* Plant Factor is the percentage of time that the turbine is generating power. The turbine/generator efficiency pertains to the operating efficiency of the unit when it is operating.

SITE SUMMARY

- The dam has been adequately maintained by the owner per Corps of Engineers inspection reports. The dam is classified as a low hazard dam as there is a very small chance of loss of human life and property if the dam should breach.
- Using the simulated flow duration curve a range of turbines was established for the economic study.
- The projected income for a hydropower retrofit of the dam is estimated in the range of $80,000 in an average precipitation year, based on forty years of data, using the total available head.

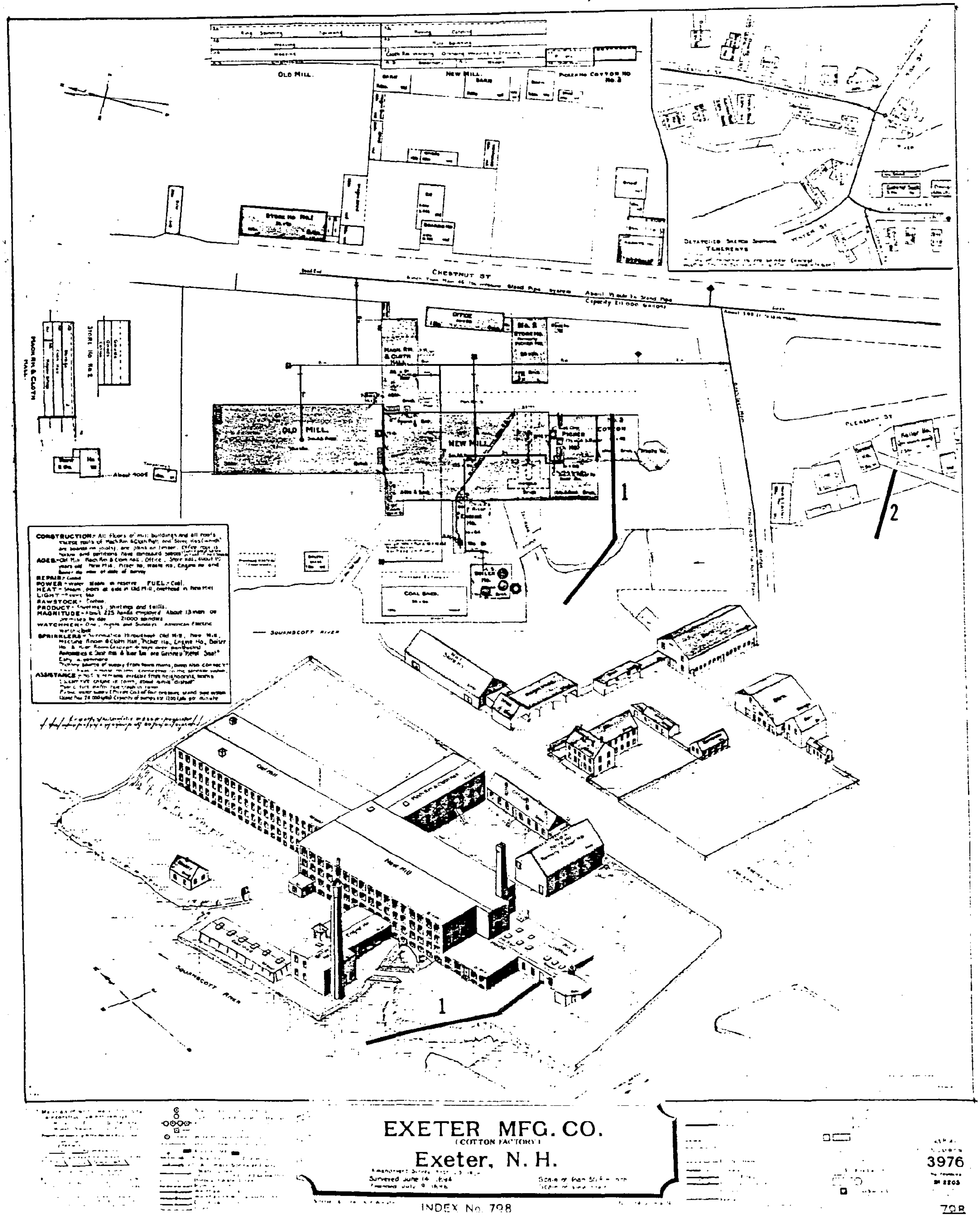
HYDROPOWER SITE SELECTION

The results of the initial turbine sizing illustrated the range of feasible turbine sizes for the Exeter River. Two unequal sized turbines were shown to develop the maximum KWH output for the synthesized flow duration curve.

A field study, a set of aerial photographs and a set of old drawings* were used to assess the economics of retrofitting the existing civil works for a turbine/generator installation. The field study revealed three potential locations for installing a turbine/generator and tailrace. (See illustration #1). The first designated location uses the full head potential. Access to the penstock would be through the storage (cotton) room wall of the mill. Space within the mill room would have to be taken for the turbine/generator installation and a segment of the floor cut out to enable installation of the tailrace. The tailrace would exit the building at a mill driveway, then to the river. Public underground utilities run along the driveway which is perpendicular to the direction of the tailrace thus may interfere with the tail-

*Source: Clemson Automotive Fabrics Corporation

Illustration No. 1 Exeter MFG, CO. 1886



race. The mill engineer, however, believes the tailrace could be installed below the existing utility line. Discharge from the tailrace at this location would be in tidal water. To maintain submergence of the discharge at low tide and to ensure a suction within the tailrace, a pool or dam structure must be constructed. This structure would require a relatively large civil works job to meet all environmental problems. An approximate tailrace length of 120 ft is, access to approximately 250 sq. ft of mill building space and 100 sq. ft of mill yard is required for this location.

The second potential location reviewed is at the penstock adjacent to the town fire tap. At this point the penstock is within 20 feet of the river with no interfering buildings. From field observation this location appeared to lose four feet of available head, relative to the first designated point. This location would not require extensive construction to install a tailrace; however, it would require constructing a dam structure to maintain submergence of the tailrace discharge point. The river divides at this discharge point and develops its greatest width along the short river segment running from the dam to the tidewater. To achieve the required submerged discharge point most efficiently with as little environmental impact as possible, the 6 foot of pond depth can be achieved by excavating a pond in the river bed. Silting may become a problem with this approach, however, the velocity of water during various seasons is such that a natural dredging should occur. An approximate tailrace length of 40 ft is required at this location, and approximately 500 sq. ft of river bed. must be excavated.

The third location was selected at the dam structure itself. (Not shown in illustration). This location has the least head, approximately 10 feet, fixed by the impoundment dam and the erosion dam crests. These existing structures, however, would directly support a siphon style turbine. Installation of the siphon turbine at this location would only require the construction of an anchor/foundation to hold the turbine and pipes to the existing impoundment dam structure.

Preliminary cost estimates on the three alternative locations illustrated that the third choice was the only economical alternative. As this site does not require extensive civil works construction (i.e., the discharge ponds required by the first two alternatives) the FERC licensing or FERC exemption process, whichever selected, will be simplified. A significant part of the simplification is in the environmental section. If no new structures are proposed the section requires only a report versus a complete environmental impact statement.

Turbine manufacturers were investigated for hardware directly adaptable to a siphon application. Two Essex Turbines and two Allis-Chalmers Turbines were investigated for a siphon installation with a head of 10.5 ft. Comparing the Essex 40 and 95 KW turbines used singularly and as a pair revealed that the 95 KW alone is the best choice. The 95 KW unit produces approximately 470,000 Kwh per year, giving a yearly gross income of $36,290. The Allis-Chalmers 88 KW and 120 KW turbines are competitive with the Essex turbines (see Appendix 1), however, the unit cost of the Allis-Chalmers units are slightly higher per KW than the Essex models. (See Appendix 2). Competitive bidding for a single 100 KW unit will probably yield the best price for the site.

The relatively low head, seasonal flow and existing civil works constrained the turbine site selection to a retrofit of the existing dam facilities. To maximize the electrical output for the third alternative, the installation should be operated on a peaking schedule. By peaking, it would be possible to run the turbine at design head and flow, thus all the flow below the maximum design flow as shown on the flow duration curve (see figure 1) would be used. This operational procedure would run the turbine within the optimum performance range. As an example: the flow valve to the turbine is opened when the water elevation reaches dam crest height and remains open until the elevation drops 6 inches, at which time the flow through the turbine is stopped until the pond refills to crest elevation. At zero flow coming into the river, not a physical occurence, the 95 KW turbine would draw the 6 inches of elevation in approximately 1/2 hour. During periods when the flow exceeds the turbine design flow, which occurs less than 20% of the time, water would spill over the dam.

SUMMARY OF INSTALLATION SITES

- Selection of a siphon type turbine installation is the recommended approach for retrofitting the Exeter River 1 Dam. The recommendation is based on cost, site access, licensing considerations and civil work requirements.
- The retrofit cost is estimated at a maximum of $225,000 and is projected to produce an approximate gross income of $35,000.
- A continous peaking operation procedure during low flow periods is recommended to optimize the output from a single turbine installation.

FINANCING

Two alternative financing packages have been developed (Private Developer & Public) for the town's consideration in deciding whether to retrofit the Dam for hydropower.

The cost estimate is as follows:

1.)	Civil Constr./Install.	-	$ 51,000
2.)	Mec. & Elec. Equip.	-	$ 93,000
3.)	Contingencies	-	$ 29,000
4.)	Eng./Admin./Mgm't.	-	$ 35,000
5.)	Interest During Constr.	-	$ 18,000
	Total	-	$226,000

To be consistent in comparing the alternatives, the same construction and annual costs were assumed for both analysis. The annual costs* assumed were:

Operation and Maintenance	- 2% of Constr. cost w/6.5% escalation w/a minimum cost of $10,000
Management	- 1% of Constr. Cost w/6.5% escalation w/a minimum cost of $5,000
Insurance	- 1% of Constr. Cost w/2% escalation

The annual income was assumed fixed at 7.7¢/KWH for 470,000 KWH's giving a $36,190.00 Gross Operating Income (G.O.I.). The 7.7¢/KWH was assumed constant for the duration of the study to be consistent with the present Public Utility Commission ruling which has no escalation clause. Future rulings may, however, increase the value of hydroelectric power. No sales contract is required with Public Service of New Hampshire for selling power, thus a hydro site maintains the option of selling or consuming the power if the fixed selling rate of 7.7¢/KWH falls below the Public Service consumer rate. Present utility rate projections show a steady climb in the consumer rate.

*Percentages recommended by Army Corp of Engineers.

The 21% federal tax credit is taken for the private developer and a tax shelter is established using the following depreciation schedule:

Item	Yrs.	Description
Civil Constr./Install.	20	150% Decl. Bal. & then S.L.
Mec. & Elec. Equip.	18	"
Contingencies	19	"
Eng./Admin./Mgm't.	8	Straight Line
Interest During Constr.	8	"

The tax shelter only benefits the private developer as the town does not pay an income tax.

Private Developer - Using the above data as input a computer analysis was done to assess the feasibility of soliciting private developers to retrofit the #1 dam for hydropower (see computer printout - Private Dev., Appendix, 3). The analysis optimized the Debt to Equity ratio at .45/.55 using a loan at 16% for 30 yrs. (long term financing may be limited to 20 years). The first year cash flow in the Facility Cash Flow table will be explained to assist the reader in assessing the financial analysis.

Col's	Item
2	Rate paid by a Utility as mandated by PUC. (No contract required).
3	G.O.I. .077$/KWH x 470000 KWH/yr.
4	Operation & Maintenance - The value of $10,000 assumes the developer has no infrastructure to handle the O & M thus must establish a contract to handle the O & M. This would be the payment to a Town Maintenance Department if the responsibility was so assigned. In this case only a portion of the $10,000 would actually be an expense. (To be comparative the same cost was used for both studies).
5	Insurance - Cost of an individual insurance policy to cover the hydro-equipment, if the hydro could be included in an umbrella policy, this may be reduced.

	hydro could be included in an umbrella policy, this may be reduced.
6	Management - This basically covers accounting costs.
7	Other - The Army Corp of Engineers recommendation is 1.5% of Construction Costs.
9	G.O.I. minus expenses.
10	Debt service on the loan.
11	The $421 shows a before tax loss in the first year.
12	Present worth of the annual cash flow before taxes.
13	To breakeven the generated power would have to be sold at 7.79¢/KWH. At the end of 34 years the power would have to be sold at 12.12¢/KWH, an increase of 55%.
14	The principle payment for the debt service.
15	Remaining debt.

To assess the potential market to raise the 55% equity for the project an Annual Investor Cash Flow table was developed (see computer printout).

Col's	Item
16	Interest paid on the loan.
17	Using the depreciation table as developed column 17 lists the amount of income tax deductible for the project.
19	Federal Taxable Income - the negative gives the project tax shelter status.
20	The tax savings is figured for a 50% income tax bracket.
21	The first year 21% tax credit - investment tax credit 10% - energy investment tax credit 11%
22	Cash flow after taxes for a 50% income tax bracket.

26A % return on investment.

26B Present Worth of % return. Only 74.72% return in 18 yrs. is available for the private developer.

Good hydro-retrofit projects are presently returning 200% on investment in less than 5 years. Comparing this with only 59.27% in five years for the Exeter project, it would be unlikely there would be much interest from private developers at this time.

Public Developer - The second alternative is for public development using bond financing. To be consistent for comparing the two alternatives, the public finance alternative was based on the same total construction cost of $226,000. This includes construction interest of $18,000 which is higher than required when using bond financing. The assumed Debt/Equity is .01/.99 using a bond value of $223,740 and a 30 year loan of $2,260 at 9%. The Computer printout (See Appendix 3) evaluates the cash flow based on the debt of $2,260. Adding columns 4,5,6, 7,9, which is equivalent to taking column 3 and subtracting col. 10 yields $35,972 to cover operating expenses bond financing and debt service. To determine the cost of bonds the following two assumptions were made:

- bonds to cover construction interest
- sell $220,000 worth of bonds for $210,000

The yearly payment at 9% for $220,000 worth of bonds is

$$.09 \times [220,000] = \$19,800$$

to be paid at the end of each year for 30 years at which time a principle payment of $220,000 will be made. The required annual revenues to cover the bond financing assuming a uniform payment to a sinking fund (assume discount rates of 9% & 15% for sinking fund) is calculated as:

if	i = 9%	i = 15%
SFF, i, 30	.00734	.00230
(Sinking Fund Factor)		

Annual = 220,000 x SFF	$ 1,614	$ 506
Annual interest	19,300	$19,300
Annual revenues	$21,414	$20,306

The true cost of money by floating the bonds is figured as

$210,000 = $19,800 (PWF, i, 30) + 220,000 (PWF, i, 30)

(Present Worth Factor)

@i = 10% PW = 199,261 < 210,000
@i = 9% PW = 220,013 > 210,000

$$\text{true } i = [.09 + .01 \frac{(210{,}000 - 220{,}013)}{(199{,}261 - 220{,}013)}] = 0.948$$

Comparing the bond debt service of approximately $21,000 and the adjusted operating income Col. 9 of $19,089 reveals the project is not feasible. However, a closer look at the operating expenses shows the town has received $15,000 in operating, maintenance and management costs. As previously stated this cost is a recommended figure based on an independent group operating the dam not an existing municipality infrastructure.

Finance Summary

- It is unlikely that a private entrepreneur would find the hydro development project attractive at present interest rates. However, at an interest rate less than 10%, the project would have a negative income which would qualify it as a tax shelter.

- The analysis figures the tax credits on the total construction cost. A new legislative proposal is being considered to limit the tax credit to only the equity financing. If passed, the large percent return in the first year will be reduced thus making it less attractive for private investors.

- If reliable escalation pricing for electricity was established, the entire analysis changes. A ten percent annual escalation factor, (we have experienced a little more than 18%

per year for the past four years) in the sale of hydropower to the public utility would make private development much more attractive.

- When one or more of the above mentioned parameters change the private development alternative should be reconsidered.

- If a public developer can break even in the first year it is highly recommended that the project be undertaken. Rising energy costs will continue to increase the financial feasibility of the project.

PART II

DISTRICT HEATING/COOLING (DHC) STUDY

The downtown area of Exeter, especially the waterfront buildings, support a fairly intensive level of activity and use and contains approximately 243, 255 sq. ft. of building floor space. This site also has nearby resources adaptable to a heat pump installation, namely, the two sewerage pumping stations and the tidal Squamscott River which could serve as heatsinks. For these reasons the concept of utilizing hydro-electricity to power heat pumps and distributing the heating/cooling products to the downtown area is being considered.

HEAT NEEDS SURVEY

To assess the economic viability of the District Heating/Cooling concept, the Exeter Planning Office conducted a survey to determine the floor space and heating needs of the buildings along the southern side of Lower Water Street. The collected information as to the type of heating systems, floor areas and heating costs/BTU's for each building is tabulated in Table 3.

Currently, an estimated 8770 million BTUs of heat energy are used for the 174,286 square feet of occupied floor space. A potential demand of 3500 million additional BTUs exist, should vacant floor space and subbasement become occupied as envisioned by Exeter's "Waterfront Revitalization Plan." The Town's sewer pumping station, located on Water Street, consumes approximately 169,000 KWH for operation of its pumps.

TABLE 3 - HEAT NEEDS STUDY

BLDG.	ADDRESS	OWNER	SQUARE FOOTAGE HEATED	SQUARE FOOTAGE UNHEATED	FUEL	SYSTEM	ANNUAL HEAT COST	BTU'S MILLIONS
27-31	Water Street	Exeter Investment Co.	4,368	1,000	Oil		$ 2,500 Est.	291
37	" "	Exeter Investment Co.	6,304	3,737	Oil		3,000	350
39-43	" "	Curtis Field	3,500	1,012	Oil		2,300	268
45	" "	Hartmann Construction	3,600	1,755	Oil/Elec.	FHW	1,400 Elec. 1,100 Oil	69.9 61.6
55	" "	Fred Schaake (IOKA)	5,129	3,900	Oil		3,000	350
59-65	" "	Exeter Masonic Assoc.	12,300	-0-	Oil (3800 gal.	FHW	4,000	466
69	" "	Jay Jenkins	2,750	-0-	Oil/Wood	FHW	1,500	175
81-83	" "	Selma Shaw	7,497	676	Oil	FHW	3,500	408
85	" "	Charles Haley	4,420	2,000	Oil/Elec.	FHW & Elec.	1,200 Elec. 1,300 Oil	60 145
93-97	" "	Indian Head Bnk	6,002	6,003	Oil		3,000	350
99-101	" "	John Kimball	3,878	3,878	Gas	Steam	1,890	270
105-107	" "	Frank Styles	3,328	2,764	Oil	Steam	2,220	258
109-113	" "	Odd Fellows Assoc.	4,680	4,680	Oil	FHW	2,600	303
23-25	" "	A. Catsoulis	1,816	908	Gas	FHA	600	85.7
19-21	" "	Illa Stacy	2,832	1,416	Oil	FHW	1,450	169
1-9	" "	J. Harlow	11,972	4,486	Oil	FHW	4,000	466
9-11	" "	Kenyon & McCaffrey	3,400	650	Oil	FHA	2,300	268
203	" "	PEA (McReel Block)	15,608	-0-	Oil		4,800	560
183	" "	Louise's Sport Shop	3,490	1,150	Gas	FHA	1,800	257
173-179	" "	George Freedman	20,000	8,500	Oil	FHW	5,400	629
163	" "	Gussie Wexler	16,000	3,196	Oil	FHW	4,900	571
149-153	" "	E. Holland	4,000	464	Gas/Elec.		500 Gas 4,000 Elec.	71.4 300
141-147	" "	Abbott Tennebaum	6,500	1,250	Oil	FHW & HA	3,000	350
135	" "	F. Seavey	6,000	5,820	Oil	LP Steam	3,700	431
129	" "	Roberge Photo	704	1,004	Gas	FHA	400	57
127	" "	Water St. Corp.	4,208	-0-	Gas	FHA	1,200	171.4
119-123	" "	Lumb Inc.	6,000	5,440	Oil	FHW	3,100	361
115	" "	Chester Rowe	4,000	3,280	Oil	FH Steam	2,600	303
Water St.		Ex. Pumping Station			Elec.	Pumps	11,895*	N/A
TOTALS			174,286	68,969			$90,155	8,770

*169,000 KWH

DHC SYSTEM

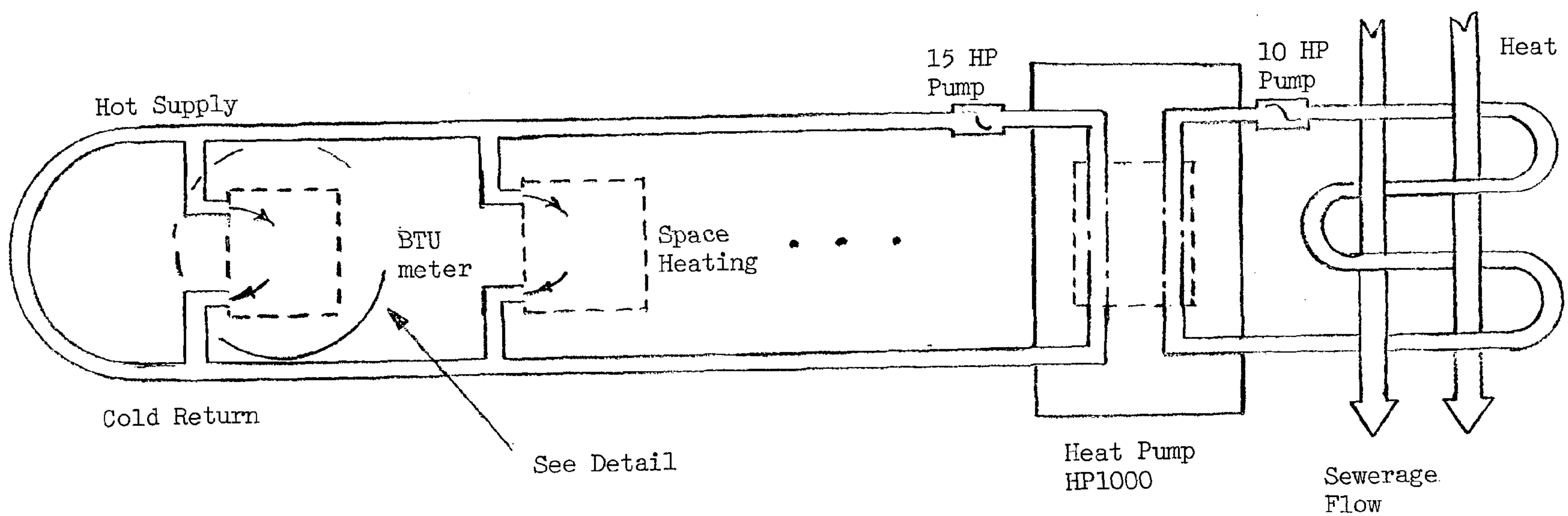
The heat pump district heating and cooling system consists of three components; Heat Exchanger, Heat Pump Unit and Distribution Network. In using this type of system for heating, over 3 times as much heat per KWH as resistance heating can be generated. The system could use electrical energy (supplied from a utility, the proposed hydro-retrofit, or a combination thereof) to drive the required pumps and use the heat energy in the Exeter sewerage pumping station as the heat sink. To supply the required BTU's (see Table 3) for the section of downtown being considered, during the 5-6 month heating season, would require around 3000 KWH/day of electricity and a flow of 200,000 gals/day in the sewerage pumping station. The proposed turbine/ generator system would produce approximately 2400 KWH/day which would supply up to 80% of the heat pump electrical power needs. The pumping station handles in excess of one million gallons per day which is more than adequate to meet the heat sink requirements. These design constraints for the system are based on the present heating load within the designated downtown area. The proposed system would use the existing hot water heating distribution systems in the buildings, the heat pump simply serves the purpose of the individual boilers. The existing building space heating units are baseboard, radiators or liquid to air heat exchangers. The radiant space heating units are limited to only the heating mode, contrary to the heat pump system dual mode capacity. The liquid to air exchangers can be easily adapted to run in both modes (i.e. heating and cooling).

Heat exchanger - The heat pump system extracts heat from one medium and dissipates it into another. The heat in the sewerage at the pumping station is used as the heat sink by placing the DHC system evaporator coils in the pumping station agitating tanks. The coils will lower the temperature of the sewerage by 10° to 20°F, to just above freezing during the winter season. The civil works requirements for the coil are a support structure within the agitation tank, inlet/outlet piping to the pump and a cleaning capability for the coil. The support structure which holds the coil submerged in the tank must be corrosive resistant to chemicals and to abrasive materials.

Heat Pump Unit - Turbo Refrigerating Company of Denton, Texas, (See Appendix 4) manufactures a heat pump unit directly adaptable to the Town of Exeter's needs. There are other companies with similar products; however, Turbo's seemed best suited from the product descriptions and discussions with other vendors. As stated in their letter, the heat pump unit consists of a compression, condenser, and evaporator. The heat pump unit, plus the evaporator coil pumps, would be placed behind the Lower Water Street buildings. The 1/6 ton/hr unit design recommended by Turbo, will receive the cold water return from the buildings and feed the hot water supply lines back to the buildings. The heat pump system control will monitor the hot water supply line to maintain sufficient heat to meet the building space heating needs. There are system control devices now available to optimally manage this type of heat pump operation. To optimize its performance this option should be investigated during the system design phase.

Distribution Network - The distribution network consists of the supply and return lines, BTU meters and controls (see figure 3). The supply and return lines distribute hot water for heating or chilled water for cooling to the buildings. The pipe depends on the present and anticipated building space heating loads. Connections to the individual building heating/cooling systems are made to both the supply and return lines, and BTU meters are installed at these connections for billing purposes. Servocontrolled valves in the connection lines and the existing boiler lines control the operation of the individual

FIGURE 3 DISTRICT HEATING/COOLING SYSTEM



installations, (see Figure 4 and Table 3). These valves as shown allow the most flexibility for the individual building space heating systems. New space heating installation or existing heating units may be connected with no individual boilers in the system. This would eliminate half of the control requirements.

The heat pump capacity, as designed to meet peak loading, was determined to be a 116 Ton/Hr. unit. The total cost to install the system was estimated to be approximately $200,000. The cost breakdown for the system is as follows:

HEAT PUMP COMPONENTS

	Costs
Heat Pump Hp 1000	$ 63,262
Heat Exchanger 15.5 40 022	3,000
Pump 4" 15 HP	3,400
Pump 4" 10 HP 15.2 45 210	2,300
Steel Pipe 4" installed 15.1 55 065 5527 ft @ $6.85/ft	37,860
Pipe Insulation 2" Fiberglass 15.5 65 472 1686 ft. @ $5.00/ft	8,430
Excavation: Backfill $2.82 yd^3	2,500
BTU meters 15 @ $500/each	7,500
Installation	$ 64,820
TOTAL	$193,072

TABLE 2. HEAT PUMP SYSTEM COSTS

<u>Debt Service</u>

for PW @ $200,000 — i @ 8% = 16,105 $/yr.
i @ 10% = 20,165 $/yr.
i @ 15% = 36,538 $/yr.

<u>Electrical Costs</u>

Heat Pump $\frac{1 \text{ KW}}{3413 \text{ BTU}} \times (\frac{1}{33}) \text{ C.O.P.} \times \frac{.064}{1\text{KWH}} = 5.68 \times 10^6$ \$/BTU

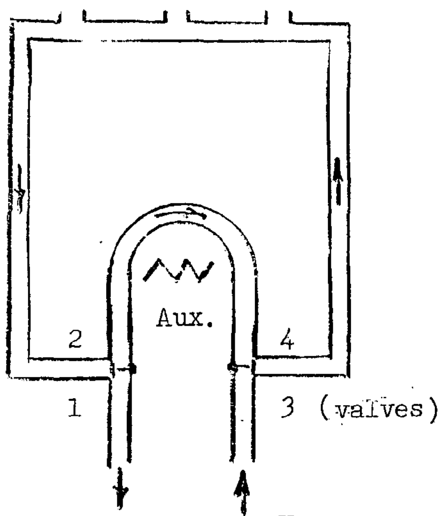


Figure 3 Control Device

Descision Table : Valve Settings

Modes \ Options	1	2	3
Boiler	Yes	No	No
Heat Pump	No	Yes	Yes
Thermostat On	Y/N	No	Yes
Valve Settings			
1	closed	closed	open
2	open	closed	closed
3	closed	closed	open
4	open	closed	closed

Table 3 Valve Settings

Supplemental Pumps

$$25 \text{ X } 254 \frac{\text{BTU}}{\text{HP HR}} \text{ X } \frac{83.33 \text{ tons}}{1\text{x}10^6 \text{ BTU}} \text{ X } \frac{1}{116 \text{ tons}} \text{ X } \frac{\text{KWH}}{3413 \text{ BTU}} \text{ X }$$

$$\frac{.065\$}{\text{KWH}} = \underline{8.56 \text{ X } 10^{-7} \text{ \$/BTU}}$$

Total Electrical Costs $= 6.54 \text{ X } 10^{-6}$ \$/BTU

Operating and Maintenance = 6000 \$/yr.

Last year's cost for oil fired hot air systems for the Lower Water Street area averaged 8.7 $\$/10^6$ BTU's for a total of 5,000 X 10^6 BTU's. An investment by the user is required to make the connection to a district heating/cooling system assuming a second party installs the DHC systems. To make the DHC system financially attractive to a user, the cost for heat is taken at 80% of their present cost to offset their connection costs. Using this data a revenue breakdown for the DHC system is as follows:

Existing Demand

$$5{,}000 \text{ X } 10^6 \text{ BTU X } \frac{8.7 \text{ \$ } (.8)}{10^6 \text{ BTU}} = 34{,}800 \text{ \$/yr}$$

Cost for Power

$$5{,}000 \text{ X } 10^6 \text{ BTU X } \frac{6.5 \text{ \$}}{10^6 \text{ BTU}} = 32{,}500 \text{ \$/yr.}$$

Power Cost Difference = 2,300 \$/yr.

DHC Potential Profit (assume full operation)

$$\frac{116 \text{ tons}}{\text{Hr}} \text{ X } \frac{1 \text{ X } 10^6 \text{ BTU}}{83.33 \text{ tons}} \text{ X } \frac{24 \text{ hrs}}{\text{day}} \text{ X } \frac{365 \text{ days}}{\text{yr}} \text{ X } \frac{(6.96 - 6.5)}{1} = 10{,}787 \text{ \$/yr.}$$

The present seasonal demand of 5,000 X 10^6 BTU's uses only 21% of the available yearly heat pump capacity. This small usage will not generate enough profit (\$2,300) to cover the debt service and O & M costs per year. At 100% usage, not physically possible, the DHC generates a savings of 10,787 \$/yr. in power which will still not cover the debt service and O & M. The more than \$80,000 in cost to run piping to and from the sewage treatment plant pushes the cost of the debt service above the fuel cost savings. For the DHC system to be economically feasible a higher density of heating and cooling space than exists on lower Water Street is required. For the lower Water Street system to be feasible as designed oil costs must be approximately 60 times more costly than electricity, for example:

Oil	3.90	$/gal.
Electricity	6.4	¢/KWH
	.064	¢/KWH

APPENDIX 1

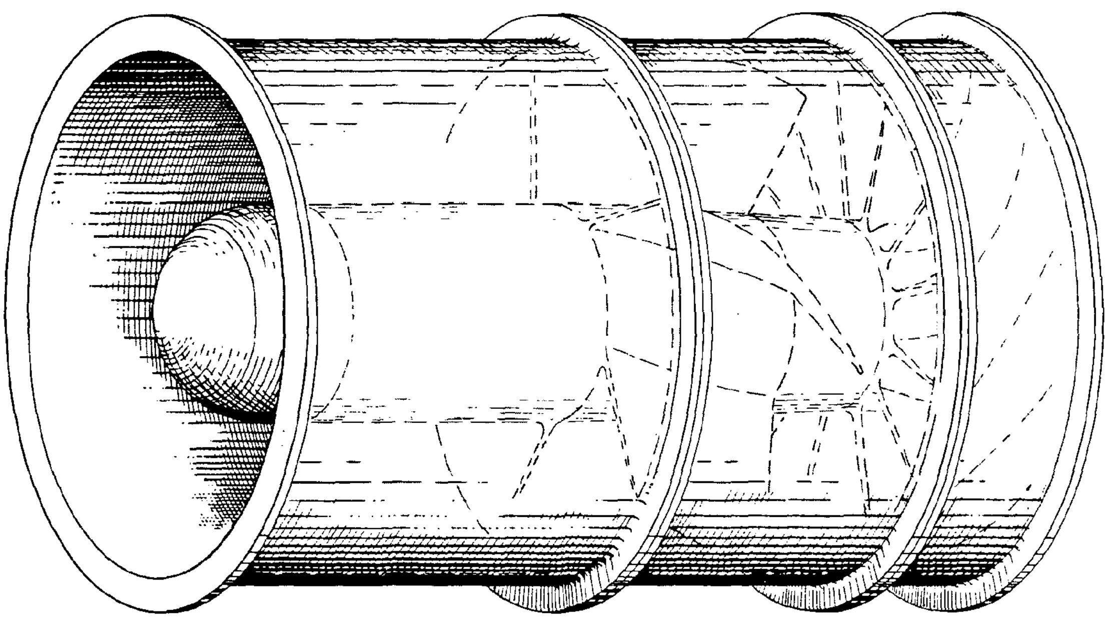
ESSEX TURBINE

JOHN F. KOOPMAN
Chief Engineer

Essex Turbine Compai

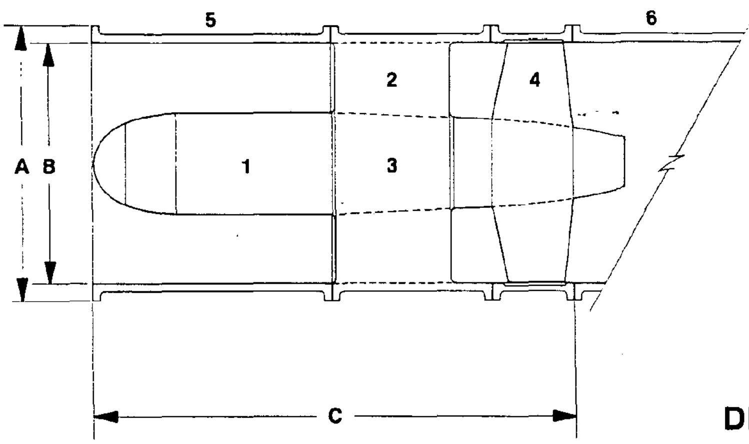
Essex Turbine Company
Kettle Cove Industrial Park
Magnolia, Massachusetts 01930
(617) 525-3523 TWX 710-347-0280

THE ESSEX TURBINE SERIES



Standardized Bulb Turbines for Hydroelectric Sites with 75-1000 KW Potential

Mechanical Data



CONFIGURATION

1. Induction or Synchronous Generator
2. Fixed Guide Vanes
3. Planetary Gearbox
4. Reaction Turbine Blades
5. Inlet Adapter Cone — Project Specific
6. Custom Designed Draft Tube — Project Specific

DIMENSIONS	**Feet (Meters)**	
	ET-1352	ET-1000
A.	5.086 (1.550)	3.938 (1.200)
B.	4.436 (1.352)	3.281 (1.000)
C.	6.644 (2.025)	6.644 (2.025)

MATERIALS

Essex Turbines are conservatively manufactured from a combination of ductile iron castings, corrosion resistant steel fabrications, and austenitic stainless steel castings and fittings. Anti-friction roller bearings are used throughout with minimum ISO B-10 life of 87,000 hours at maximum KW rating. The gears are precision ground alloy steel designed for AGMA 99 percent life of 87,000 hours at maximum KW rating. The main shaft is sealed from the outside by multiple high quality mechanical seals.

FLOW/POWER CHARACTERISTICS

Net Head* (Feet)	ET-1352 Flow (cfs)	ET-1352 Net KW	ET-1000 Flow (CFS)	ET-1000 Net KW
7	115	53	-	-
9	128	79	-	-
11	138	105	72	54
13	150	133	75	70
15	160	168	81	84
17	-	-	86	102
19	-	-	91	120
21	-	-	95	136
23	-	-	100	158
25	-	-	106	179

*Net head is defined as head between turbine inlet and tailwater.

General Data

The Essex Turbine Company offers prepackaged water turbine systems for low head applications. A system consists of any number of Essex bulb turbines and all the ancillary hydraulic and electrical equipment necessary to produce a fully automatic electrical generating facility. An Essex Turbine is a standardized power module consisting of an axial flow turbine, a speed increasing gear set, and a generator combined in a short pipe section. There are currently two available models, the ET-1352 and the ET-1000, which are complementary in their flow sizing.

The required hydraulic equipment is site dependent but could include a trash rack, inlet gate, piping to the turbine and draft tube. In general, development with Essex Turbines will require less civil investment than most conventional turbines. An automated control system provides electrical and mechanical failure detection, shutdown protection, and power measurement. There also can be provision for automatic startup and shutdown.

What Are The Advantages Of Essex Turbines Over Competing Equipment?

- They have greater flexibility, since they can be installed in series or parallel to cover a broad range of head and flow rates.
- Equipment costs are less, since standardization allows spreading of design and manufacturing costs.
- Civil costs are less, since a powerhouse or major excavation is not required.
- They are adaptable to horizontal thru vertical installations.
- Use of the latest turbomachinery theory and computer design methods has led to retained high efficiency at off design operating conditions.
- Simple design and standard equipment make for quick and easy installation.
- Conservative design assures minimum maintenance.

What Are Site Characteristics Appropriate To An Essex Turbine Installation?

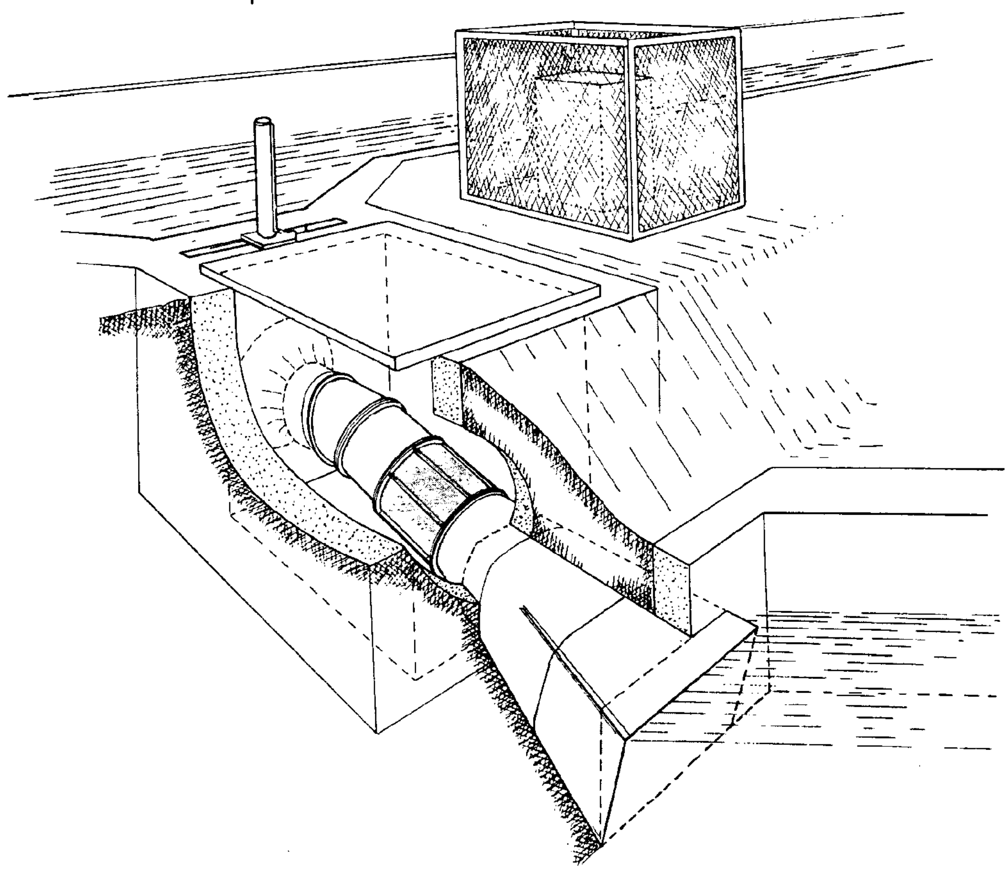
- Net head of 7-50 feet (2.1-15.2 meters) with operating variation less than ± 20%
- Mean flow rate of 50-500 cfs (1.4-14.2 cms).

What Are possible Uses Of Installed Essex Turbines?

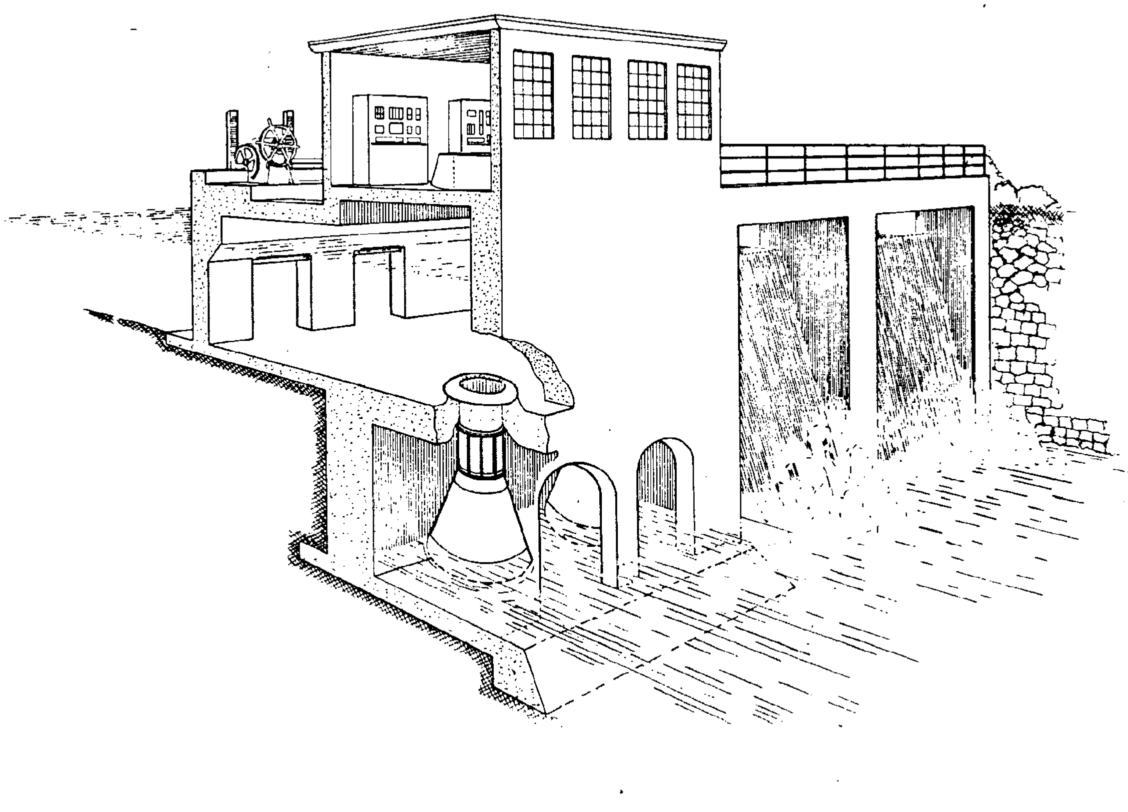
- To develop existing small damsites for 75-1000 KW of power.
- To develop irrigation and canal systems.
- To provide incremental peaking capacity at larger damsites.
- To maintain minimum flow requirements at larger damsites.
- To replace old existing equipment.

Installation

Closed Pit Canal Drop Installation

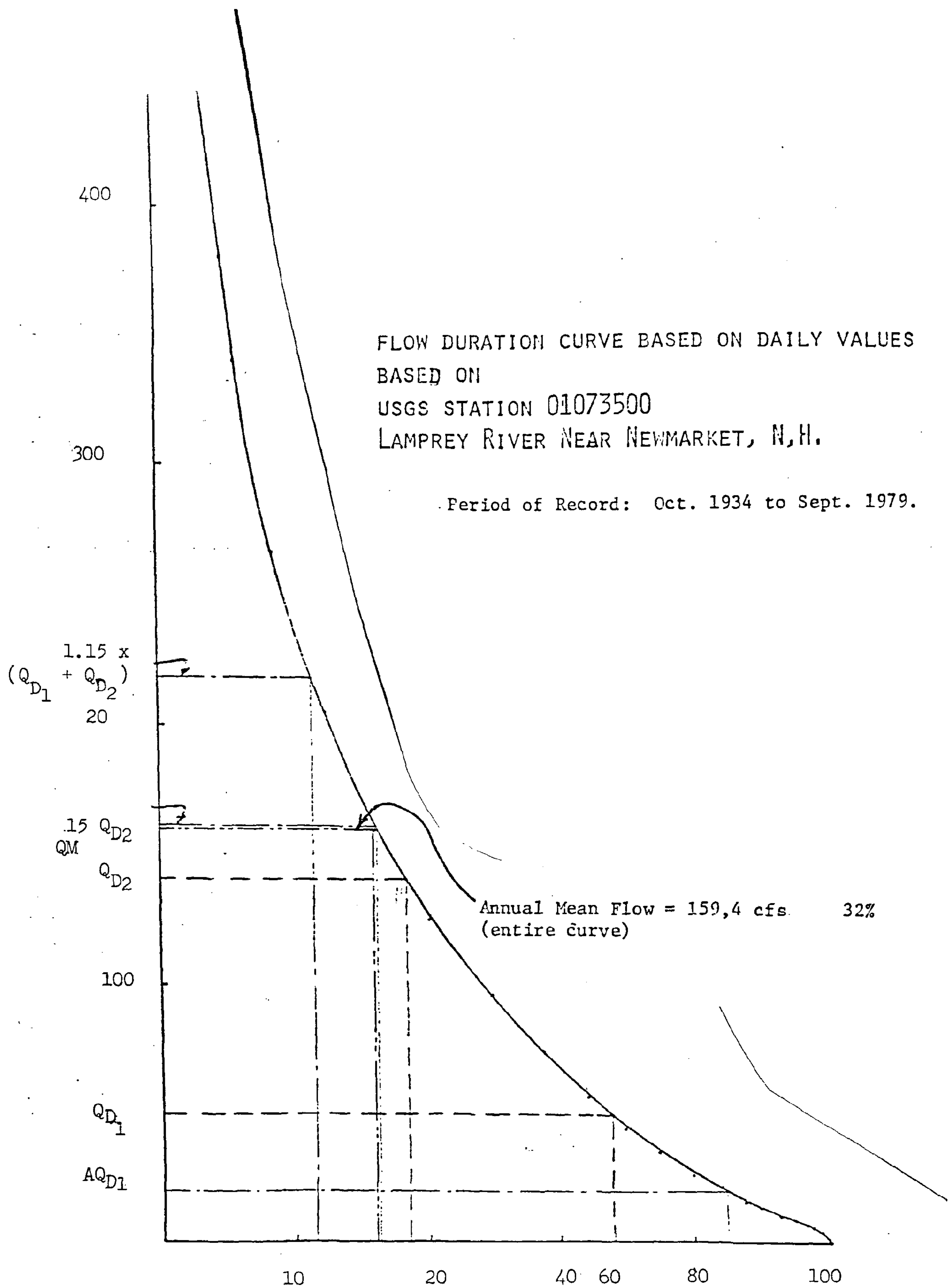


Two Units (2x1) Retrofitted to an Open Flume



APPENDIX 2

TURBINE SELECTION STUDY



FLOW DURATION CURVE BASED ON DAILY VALUES
BASED ON
USGS STATION 01073500
LAMPREY RIVER NEAR NEWMARKET, N.H.
Period of Record: Oct. 1934 to Sept. 1979.
400
300
1.15 x
(QD1 + QD2)
20
.15 QD2
QM
QD2
Annual Mean Flow = 159,4 cfs 32%
(entire curve)
100
QD1
AQD1
10
20
40
60
80
100

EXETER RIVER

FLOW DURATION CURVE BASED ON DAILY VALUES

BASED ON USGS STATION 01073500

LAMPREY RIVER NEAR NEWMARKET, N.H.

Period of Record: October 1934 to September 1979.

Proposed Turbine Sizes: $h = 10.5'$ $e = 0.80$

		%Time
I)	w/Turbine #1: ($e = 0.80$)	
	$P_R = 35$ KW: $Q_{D1} = 49.2$ cfs	68%
	$.4\ Q_{D1} = 19.7$ cfs	85%
	$1.15\ Q_{D1} = 56.6$ cfs	64.5%
II)	w/Turbine #2 ($e = 0.80$)	
	$P_R = 100$ KW: $Q_{D2} = 140.6$ cfs	37%
	$.4\ Q_{D2} = 56.2$ cfs	64.5%
	$1.15\ Q_{D2} = 161.7$ cfs	32.5%
III)	w/Turbines #1 and #2	
	$1.15\ (Q_{D1} + Q_{D2}) = 218.3$ cfs	23%

$E = 674,6000$ Kw-Hrs.

Overall Plant Factor = 57%

Annual Mean Flow = 159,4 cfs (entire curve) 32%

POWER/ENERGY:

w/Essex Turbines: $h = 10.5'$ $e = 0.83$

I) w/ET1000: $Q_D \cong 55$cfs $P = 40$ KW; 66% time

$E = .66\,(8760)(40) = 231{,}264$ kwh

@ $Q_D = 55$cfs, ponding would provide for 7.92 hrs w/o inflow.

Q from 66% to 100% of time:

$1/2\,(.34)(40)(8760) = 59{,}568$ kwh

avg. is 27.5cfs

$E = 231{,}264 + 59{,}568 = 290{,}832$

w/5% water loss & shut down: $E = 276{,}300$ kwh.

II) w/ET1352: QD $\cong$ 130cfs $P = 95$ KW; 39.5% time

$E = .395\,(8760)(95) = 328{,}719$ wkh

@ $Q_D = 130$cfs, ponding would provide for 3.35 hrs w/o inflow

Q from 395% to 100% of time:

$\Delta E = A \cong 1/3\,ab = 1/3\,(95)(.605)(8760)$

$\Delta E = 167{,}827$ kwh

$E = 496{,}547$ kwh

w/5% water loss & shut down: $E = 471{,}719$ kwh

III) w/1 ET1000 & 1 ET1352:

$Q_{D1} = 55$cfs $P_R = 40$ KW @66%

$Q_{D2} = 130$cfs $P_R = 95$ KW @39.5%

$Q_D = 185$cfs $P_R = 135$ KW @28%

$E = .28\,(8760)(135) + (.395 - .28)(8760)(95) + (.66 - .395)(8760)(40)$
$= 331{,}128 + 95{,}703 + 92{,}856 = 519{,}687$ kwh

ΔE for Q_{D1}: $1/2\,(40)(.34)(8760) = 59{,}568$ kwh

ΔE for Q_{D2}: 1/2 (95 - 40)(.66 -.395)(8760) = 63,839 kwh

ΔE for Q : 1/2 (40)(.395 -.38)(8760) = 20,148 kwh

E = 663,242 kwh

w/ 10% water loss & shut down, E = 596,900 kwh

@ Q_D = 185cfs t = 2.35 hrs w/o inflow

Q_{D2} = 130cfs t = 3.35 hrs w/o inflow

Q_{D1} = 55cfs t = 7.92 hrs w/o inflow

w/Allis-Chalmers fixed blade units:

I) w/A-C 120 $QD_1 \cong$ 165 cfs P = 120 kw: 32% time

E = .82 (8760)(120) = 336,384 kwh

@ QD_1 = 165 cfs, ponding would provide for 2.64 hrs w/o inflow

Q from 32% to 100% of time:

y_2 (.68)(120)(8760) = 357,408 kwh

Avg. is 82.5 cfs

E = 336,384 + 357,408 = 693,792 kwh

w/5% water loss and shutdown

E = 659,102 kwh

II) w/A-C 88 QD_2 = 121 cfs P = 88 kw; 40% time

E = .40 (8760)(88) = 308,352 kwh

@ QD_2 = 121 cfs, ponding would provide for 3.6 hrs w/o inflow

Q from 40% to 100% of time:

y_2 (.60)(88)(8760) = 231,264 kwh

Avg. is 60.5 cfs

E = 308,352 + 231,264 = 539,616 kwh

w/5% water loss and shutdown

E = 512,635 kwh

Try 1 ET1352 @ 470,000 kwh.

Turbine-Generator	$ 73,000
Switch gear	15,000
Microprocessor	3,000
Fence, Shed	6,000
Recorder	2,000
Construction & Installation	45,000
	$ 144,000
Contingencies (20%)	29,000
	$ 173,000
Eng., Admin., Mgm't (20%)	35,000
	$ 208,000
Interest During Construction	
1.4 x .12 1/2 $\cong$ 8.5% =	18,000
	$ 226,000

*Construction & Installation:

Siphon Type installation - place diagonally across face of dam.

NOTATION

E = Power output (kwh)

P_R = Turbine power rating (kw)

Q = Flow (cfs)

Q_D = Turbine design flow [subscripts designate the options]

APPENDIX 3

COMPUTER PRINTOUTS

FACILITY CASH FLOW

(1) YR.	(2) ASSUMED FUTURE RATE ($/KWH)	(3) GROSS OPERATING INCOME ($)	(4) EXPENSES: O&M ($)	(5) EXPENSES: INSUR. ($)	(6) EXPENSES: MGMT. ($)	(7) EXPENSES: OTHER COSTS ($)	(8) EXPENSES: OTHER COSTS ($)	(9) ADJUSTED OPERATING INCOME ($)	(10) DEBT SERVICE ($)	(11) CASH FLOW BEFORE TAXES: ANNUAL ($)	(12) CASH FLOW BEFORE TAXES: P.W. ($)	(13) REQD. OR EFF. RATE ($/KWH)	(14) PAID ON DEBT ($)	(15) REMAIN DEBT ($)
1	0.0770	36190.	10000.	2080.	5000.	3120.	0.	15990.	16411.	-421.	-383.	0.0779	150.	101550
2	0.0770	36190.	10000.	2122.	5000.	3120.	0.	15948.	16411.	-463.	-383.	0.0780	176.	101374
3	0.0770	36190.	10000.	2164.	5000.	3120.	0.	15906.	16411.	-505.	-380.	0.0781	206.	101168
4	0.0770	36190.	10000.	2207.	5000.	3120.	0.	15863.	16411.	-549.	-375.	0.0782	242.	100926
5	0.0770	36190.	10000.	2251.	5000.	3120.	0.	15819.	16411.	-593.	-368.	0.0783	283.	100643
6	0.0770	36190.	10000.	2296.	5000.	3120.	0.	15774.	16411.	-638.	-360.	0.0784	332.	100310
7	0.0770	36190.	10000.	2342.	5000.	3120.	0.	15728.	16411.	-684.	-351.	0.0785	390.	99921
8	0.0770	36190.	10000.	2389.	5000.	3120.	0.	15681.	16411.	-731.	-341.	0.0786	457.	99464
9	0.0770	36190.	10000.	2437.	5000.	3120.	0.	15633.	16411.	-778.	-330.	0.0787	535.	98929
10	0.0770	36190.	10000.	2486.	5000.	3120.	0.	15584.	16411.	-827.	-319.	0.0788	628.	98301
11	0.0770	36190.	10000.	2536.	5000.	3120.	0.	15534.	16411.	-877.	-307.	0.0789	736.	97565
12	0.0770	36190.	10000.	2586.	5000.	3120.	0.	15484.	16411.	-928.	-296.	0.0790	862.	96703
13	0.0770	36190.	10000.	2638.	5000.	3120.	0.	15432.	16411.	-979.	-284.	0.0791	1011.	95692
14	0.0770	36190.	10000.	2691.	5000.	3120.	0.	15379.	16411.	-1032.	-272.	0.0792	1185.	94507
15	0.0770	36190.	10046.	2745.	5023.	3120.	0.	15257.	16411.	-1155.	-276.	0.0795	1389.	93118
16	0.0770	36190.	10694.	2799.	5349.	3120.	0.	14222.	16411.	-2189.	-476.	0.0817	1629.	91489
17	0.0770	36190.	11394.	2855.	5697.	3120.	0.	13123.	16411.	-3288.	-651.	0.0840	1909.	89580
18	0.0770	36190.	12135.	2913.	6067.	3120.	0.	11955.	16411.	-4456.	-802.	0.0865	2238.	87342
19	0.0770	36190.	12924.	2971.	6462.	3120.	0.	10714.	16411.	-5698.	-932.	0.0891	2624.	84718
20	0.0770	36190.	13764.	3030.	6882.	3120.	0.	9394.	16411.	-7017.	-1043.	0.0919	3076.	81643
21	0.0770	36190.	14658.	3091.	7329.	3120.	0.	7992.	16411.	-8420.	-1138.	0.0949	3605.	78037
22	0.0770	36190.	15611.	3153.	7806.	3120.	0.	6501.	16411.	-9911.	-1217.	0.0981	4227.	73811
23	0.0770	36190.	16626.	3216.	8313.	3120.	0.	4916.	16411.	-11496.	-1284.	0.1015	4955.	68856
24	0.0770	36190.	17707.	3280.	8853.	3120.	0.	3230.	16411.	-13181.	-1338.	0.1050	5808.	63048
25	0.0770	36190.	18857.	3346.	9429.	3120.	0.	1438.	16411.	-14973.	-1382.	0.1089	6809.	56239
26	0.0770	36190.	20083.	3412.	10047.	3120.	0.	-467.	16411.	-16879.	-1416.	0.1129	7982.	48257
27	0.0770	36190.	21389.	3481.	10694.	3120.	0.	-2494.	16411.	-18905.	-1442.	0.1172	9357.	38900
28	0.0770	36190.	22779.	3550.	11389.	3120.	0.	-4649.	16411.	-21060.	-1460.	0.1218	10969.	27932
29	0.0770	36190.	24260.	3621.	12130.	3120.	0.	-6941.	16411.	-23352.	-1472.	0.1267	12858.	1507[illegible]
30	0.0770	36190.	25836.	3694.	12918.	3120.	0.	-9378.	16411.	-25790.	-1478.	0.1319	15073.	
31	0.0770	36190.	27516.	3768.	13758.	3120.	0.	-11971.	0.	-11971.	-624.	0.1025	0.	
32	0.0770	36190.	29304.	3843.	14652.	3120.	0.	-14729.	0.	-14729.	-698.	0.1083	0.	
33	0.0770	36190.	31209.	3920.	15605.	3120.	0.	-17663.	0.	-17663.	-761.	0.1146	0.	
34	0.0770	36190.	33238.	3998.	16619.	3120.	0.	-20785.	0.	-20785.	-814.	0.1212	0.	
		1230460.	530034.	99910.	265017.	106080.	0.	229418.	492342.	-262924.	-25451.		101700.	

STATE TAX : 0.00 % OF (COL. (9)-COL. (16)-COL. (17))

FEDERAL TAXABLE INCOME = COL.(9) - (COL.(16)+COL.(17)+COL.(18))

FEDERAL TAX EFFECT AT OWNER/INVESTOR TAX BRACKET OF 50.00 % ON FEDERAL TAXABLE INCOME OF COL. (19)

TAX CREDITS : INVESTMENT TAX CREDIT : $ 20800. BASED ON 10.00 % OF $ 208000.FOR FIRST YEAR

ENERGY INVESTMENT TAX CREDIT : $ 22880. BASED ON 11.00 % OF $ 208000.FOR FIRST YEAR

EQUITY INVESTMENT BY OWNERS/INVESTORS : $ 124300.

ANNUAL INVESTOR CASH FLOW

(1)	(9)	(16)	(17)	(18)	(19)	(20)	(11)	(21)	(22)	(23)	(24)	(25)	(26A)
									CASH FLOW AFTER TAXES				
YR.	ADJUSTED OPERATING INCOME ($)	DEBT INTEREST ($)	DEPRE-CIATION ($)	STATE TAX ($)	FEDERAL TAXABLE INCOME ($)	FEDERAL TAX EFFECT ($)	CASH FLOW BEFORE TAXES ($)	TAX CREDITS ($)	ANNUAL ($)	ANNUAL PRESENT WORTH ($)	SUM OF ANNUAL ($)	SUM OF ANNUAL P.W. ($)	ANNUAL % RETURN
1	15990.	16261.	20489.	0.	-20761.	10380.	-421.	43680.	53639.	48763.	53639.	48763.	43.15
2	15948.	16235.	19376.	0.	-19663.	9832.	-463.	0.	9369.	7743.	63007.	56505.	7.54
3	15906.	16205.	18352.	0.	-18651.	9326.	-505.	0.	8820.	6627.	71828.	63132.	7.10
4	15863.	16170.	17411.	0.	-17718.	8859.	-549.	0.	8310.	5676.	80138.	68808.	6.69
5	15819.	16128.	16545.	0.	-16854.	8427.	-593.	0.	7834.	4864.	87972.	73672.	6.30
6	15774.	16079.	15749.	0.	-16054.	8027.	-638.	0.	7389.	4171.	95361.	77844.	5.94
7	15728.	16022.	15017.	0.	-15311.	7656.	-684.	0.	6972.	3578.	102333.	81421.	5.61
8	15681.	15955.	14855.	0.	-15129.	7565.	-731.	0.	6834.	3188.	109167.	84609.	5.50
9	15633.	15876.	8230.	0.	-8473.	4237.	-778.	0.	3458.	1467.	112625.	86076.	2.78
10	15584.	15784.	8230.	0.	-8430.	4215.	-827.	0.	3388.	1306.	116013.	87382.	2.73
11	15534.	15675.	8230.	0.	-8371.	4186.	-877.	0.	3309.	1160.	119322.	88542.	2.66
12	15484.	15549.	8230.	0.	-8295.	4148.	-928.	0.	3220.	1026.	122542.	89568.	2.59
13	15432.	15400.	8230.	0.	-8198.	4099.	-979.	0.	3120.	904.	125661.	90471.	2.51
14	15379.	15226.	8230.	0.	-8077.	4039.	-1032.	0.	3006.	792.	128668.	91263.	2.42
15	15257.	15022.	8230.	0.	-7996.	3998.	-1155.	0.	2843.	681.	131511.	91944.	2.29
16	14272.	14783.	8230.	0.	-8741.	4395.	-2189.	0.	2206.	480.	133717.	92424.	1.77
17	13123.	14502.	8230.	0.	-9609.	4805.	-3788.	0.	1516.	300.	135233.	92724.	1.22
18	11955.	14173.	8230.	0.	-10448.	5274.	-4456.	0.	768.	138.	136001.	92862.	0.62
19	10714.	13788.	3632.	0.	-6706.	3353.	-5698.	0.	-2345.	-383.	133657.	92478.	-1.89
20	9394.	13336.	2273.	0.	-6215.	3107.	-7017.	0.	-3910.	-581.	129747.	91897.	-3.15
21	7992.	12806.	0.	0.	-4814.	2407.	-8420.	0.	-6013.	-812.	123734.	91085.	-4.84
22	6501.	12185.	0.	0.	-5684.	2842.	-9911.	0.	-7069.	-868.	116666.	90216.	-5.69
23	4916.	11457.	0.	0.	-6541.	3271.	-11496.	0.	-8225.	-919.	108440.	89298.	-6.62
24	3230.	10603.	0.	0.	-7373.	3687.	-13181.	0.	-9495.	-964.	98946.	88334.	-7.64
25	1438.	9603.	0.	0.	-8164.	4082.	-14973.	0.	-10891.	-1005.	88055.	87329.	-8.76
26	-467.	8430.	0.	0.	-8897.	4448.	-16879.	0.	-12430.	-1043.	75625.	86286.	-10.00
27	-2494.	7055.	0.	0.	-9548.	4774.	-18905.	0.	-14131.	-1078.	61494.	85208.	-11.37
28	-4649.	5443.	0.	0.	-10091.	5046.	-21060.	0.	-16014.	-1110.	45479.	84097.	-12.88
29	-6941.	3553.	0.	0.	-10494.	5247.	-23357.	0.	-18105.	-1141.	27374.	82956.	-14.57
30	-9378.	1338.	0.	0.	-10716.	5358.	-25790.	0.	-20432.	-1171.	6943.	81785.	-16.44
31	-11971.	0.	0.	0.	-11971.	5986.	-11971.	0.	-5986.	-312.	957.	81473.	-4.82
32	-14729.	0.	0.	0.	-14729.	7365.	-14729.	0.	-7365.	-349.	-6408.	81124.	-5.92
33	-17663.	0.	0.	0.	-17663.	8832.	-17663.	0.	-8832.	-380.	-15239.	80744.	-7.11
34	-20785.	0.	0.	0.	-20785.	10392.	-20785.	0.	-10392.	-407.	-25632.	80337.	-8.36
SUM	229418.	390643.	226000.	0.	-387224.	193612.	-262924.	43680.	-25632.	80337.			

DEBT SERVICE :

$ 101700. LOAN 16.00 % FOR 30 YEARS WITH MONTHLY PAYMENTS

$ 0. MID-TERM LOAN 0.00 % FOR 0 YEARS WITH QUARTERLY PAYMENTS

DISCOUNT RATE= 10.00%

FEDERAL TAX BRACKET= 50.00

EQUITY: 124300.

ECONOMIC ANALYSIS & SUMMARY

(1)	(3)	(27)	(28)	(15)	(29)	(30A)	(30B)	(30C)	(31)	(32)	(33)	(34)	(35)
	GROSS OPERATING INCOME			REMAINING DEBT		TOTAL ANNUAL EXPENSES			TOTAL ANNUAL COSTS			SALVAGE VALUE	
YR.	ANNUAL ($)	P.W. OF ANNUAL ($)	SUM OF P.W. ($)	ANNUAL ($)	P.W. OF ANNUAL ($)	ANNUAL ($)	P.W. OF ANNUAL ($)	SUM OF P.W. ($)	ANNUAL ($)	P.W. OF ANNUAL ($)	SUM OF P.W. ($)	ANNUAL ($)	P.W. OF ANNUAL ($)
1	36190.	32900.	32900.	101550.	92318.	20200.	18364.	18364.	-17449.	-15863.	-15863.	205511.	186828.
2	36190.	29909.	62809.	101374.	83780.	20242.	16729.	35092.	26821.	22167.	6304.	186135.	153830.
3	36190.	27190.	89999.	101168.	76009.	20284.	15240.	50332.	27370.	20563.	26867.	167782.	126057.
4	36190.	24718.	114717.	100926.	68934.	20327.	13884.	64216.	27880.	19042.	45909.	150372.	102706.
5	36190.	22471.	137189.	100642.	62491.	20371.	12649.	76865.	28356.	17607.	63516.	133827.	83096.
6	36190.	20428.	157617.	100310.	56672.	20416.	11525.	88389.	28801.	16257.	79773.	118078.	66652.
7	36190.	18571.	176188.	99921.	51275.	20462.	10500.	98890.	29218.	14994.	94767.	103061.	52887.
8	36190.	16883.	193071.	99464.	46401.	20509.	9568.	108458.	29356.	13695.	108462.	88206.	41149.
9	36190.	15348.	208419.	98929.	41955.	20557.	8718.	117176.	32732.	13882.	122343.	79976.	33918.
10	36190.	13953.	222372.	98301.	37899.	20606.	7944.	125120.	32802.	12647.	134990.	71746.	27661.
11	36190.	12684.	235056.	97565.	34196.	20656.	7240.	132360.	32881.	11525.	146515.	63516.	22262.
12	36190.	11531.	246588.	96703.	30813.	20706.	6598.	138957.	32970.	10505.	157020.	55286.	17616.
13	36190.	10483.	257070.	95692.	27719.	20758.	6013.	144970.	33070.	9579.	166599.	47056.	13630.
14	36190.	9530.	266600.	94507.	24887.	20811.	5480.	150450.	33184.	8738.	175338.	38825.	10224.
15	36190.	8664.	275264.	93118.	22292.	20933.	5011.	155462.	33447.	7983.	183321.	30595.	7324.
16	36190.	7876.	283140.	91489.	19911.	21968.	4781.	160243.	33984.	7396.	190716.	22365.	4867.
17	36190.	7160.	290300.	89580.	17723.	23067.	4564.	164806.	34674.	6860.	197576.	14135.	2797.
18	36190.	6509.	296809.	87342.	15709.	24235.	4359.	169165.	35422.	6371.	203947.	5905.	1062.
19	36190.	5917.	302726.	84718.	13852.	25470.	4166.	173331.	38535.	6301.	210248.	2273.	372.
20	36190.	5379.	308106.	81643.	12136.	26796.	3983.	177314.	40100.	5961.	216209.	-0.	-0.
21	36190.	4840.	312946.	78037.	10545.	28198.	3810.	181124.	42203.	5703.	221912.	-0.	-0.
22	36190.	4446.	317442.	73811.	9067.	29689.	3647.	184771.	43259.	5314.	227226.	-0.	-0.
23	36190.	4042.	321484.	68856.	7690.	31274.	3493.	188264.	44415.	4960.	232186.	-0.	-0.
24	36190.	3674.	325158.	63048.	6401.	32960.	3346.	191610.	45685.	4638.	236824.	-0.	-0.
25	36190.	3340.	328498.	56239.	5191.	34752.	3207.	194818.	47081.	4345.	241169.	-0.	-0.
26	36190.	3037.	331535.	48257.	4049.	36657.	3076.	197893.	48620.	4080.	245249.	-0.	-0.
27	36190.	2760.	334295.	38900.	2967.	38684.	2951.	200844.	50321.	3838.	249087.	-0.	-0.
28	36190.	2510.	336805.	27932.	1937.	40839.	2832.	203676.	52204.	3620.	252707.	-0.	-0.
29	36190.	2281.	339086.	15074.	950.	43131.	2719.	206395.	54295.	3423.	256130.	-0.	-0.
30	36190.	2074.	341160.	0.	0.	45568.	2611.	209006.	56622.	3245.	259375.	-0.	-0.
31	36190.	1885.	343046.	0.	0.	48161.	2509.	211516.	42176.	2197.	261572.	-0.	-0.
32	36190.	1714.	344760.	0.	0.	50919.	2412.	213927.	43555.	2063.	263635.	-0.	-0.
33	36190.	1558.	346318.	0.	0.	53853.	2319.	216246.	45022.	1938.	265574.	-0.	-0.
34	36190.	1417.	347734.	0.	0.	56975.	2230.	218476.	46582.	1823.	267397.	-0.	-0.

(1)	(11)	(12)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)
	CASH FLOW BEFORE TAXES			STATE & FEDERAL TAXES				FACTOR OF		B/C RATIO AT	INTERNAL RATE OF RETURN	
YR.	ANNUAL ($)	P.W. OF ANNUAL ($)	SUM OF P.W. ($)	ANNUAL ($)	P.W. OF ANNUAL ($)	SUM OF P.W. ($)	PRESENT WORTH FACTOR	SAFETY ON DEPT SERVICE	NET PRESENT VALUE ($)	GIVEN DISCOUNT RATE	PERCENT (%)	B/C RATIO
1	-421.	-383.	-383.	-54060.	-49146.	-49146.	0.9091	0.974	24510.	1.13	21.933	1.00
2	-463.	-383.	-766.	-9832.	-8125.	-57271.	0.8264	0.972	12818.	1.06	13.557	1.00
3	-505.	-380.	-1146.	-9326.	-7007.	-64278.	0.7513	0.969	4002.	1.02	10.820	1.00
4	-549.	-375.	-1520.	-8859.	-6051.	-70328.	0.6830	0.967	-2464.	0.99	9.581	1.00
5	-593.	-368.	-1888.	-8427.	-5233.	-75561.	0.6209	0.964	-7020.	0.97	8.957	1.00
6	-638.	-360.	-2249.	-8027.	-4531.	-80092.	0.5645	0.961	-10029.	0.96	8.649	1.00
7	-684.	-351.	-2599.	-7656.	-3928.	-84021.	0.5132	0.958	-11795.	0.95	8.525	1.00
8	-731.	-341.	-2940.	-7565.	-3529.	-87549.	0.4665	0.955	-12688.	0.95	8.502	1.00
9	-778.	-330.	-3270.	-4237.	-1797.	-89346.	0.4241	0.953	-11493.	0.95	8.713	1.00
10	-827.	-319.	-3589.	-4215.	-1625.	-90971.	0.3855	0.950	-10116.	0.96	8.917	1.00
11	-877.	-307.	-3897.	-4186.	-1467.	-92438.	0.3505	0.947	-8603.	0.97	9.113	1.00
12	-928.	-296.	-4192.	-4148.	-1322.	-93760.	0.3186	0.943	-6994.	0.97	9.303	1.00
13	-979.	-284.	-4476.	-4094.	-1187.	-94947.	0.2897	0.940	-5322.	0.98	9.485	1.00
14	-1032.	-272.	-4748.	-4039.	-1063.	-96011.	0.2633	0.937	-3615.	0.99	9.744	1.00
15	-1155.	-276.	-5024.	-3998.	-957.	-96968.	0.2394	0.930	-1906.	0.99	9.866	1.00
16	-2189.	-476.	-5501.	-4395.	-957.	-97924.	0.2176	0.867	-311.	1.00	10.000	1.00
17	-3288.	-651.	-6151.	-4805.	-951.	-98875.	0.1978	0.800	1165.	1.00	10.000	1.00
18	-4456.	-802.	-6953.	-5224.	-940.	-99814.	0.1799	0.728	2521.	1.01	10.215	1.00
19	-5698.	-932.	-7884.	-3353.	-548.	-100363.	0.1635	0.653	4130.	1.01	10.346	1.00
20	-7017.	-1043.	-8927.	-3107.	-462.	-100825.	0.1486	0.572	5617.	1.02	10.463	1.00
21	-8420.	-1138.	-10065.	-2407.	-325.	-101150.	0.1351	0.487	7022.	1.02	10.569	1.00
22	-9911.	-1217.	-11283.	-2842.	-349.	-101499.	0.1228	0.396	8170.	1.03	10.653	1.00
23	-11496.	-1284.	-12566.	-3271.	-365.	-101864.	0.1117	0.300	9084.	1.03	10.717	1.00
24	-13181.	-1338.	-13905.	-3687.	-374.	-102239.	0.1015	0.197	9786.	1.03	10.765	1.00
25	-14973.	-1382.	-15287.	-4082.	-377.	-102615.	0.0923	0.088	10296.	1.03	10.800	1.00
26	-16879.	-1416.	-16703.	-4448.	-373.	-102989.	0.0839	-0.028	10630.	1.03	10.821	1.00
27	-18905.	-1442.	-18145.	-4774.	-364.	-103353.	0.0763	-0.152	10804.	1.03	10.832	1.00
28	-21060.	-1460.	-19605.	-5046.	-350.	-103703.	0.0693	-0.283	10831.	1.03	10.833	1.00
29	-23352.	-1472.	-21077.	-5247.	-331.	-104033.	0.0630	-0.423	10724.	1.03	10.826	1.00
30	-25790.	-1478.	-22555.	-5358.	-307.	-104340.	0.0573	-0.571	10494.	1.03	10.810	1.00
31	-11971.	-624.	-23179.	-5986.	-312.	-104652.	0.0521		10182.	1.03	10.789	1.00
32	-14729.	-698.	-23877.	-7365.	-349.	-105001.	0.0474		9833.	1.03	10.766	1.00
33	-17663.	-761.	-24637.	-8832.	-380.	-105381.	0.0431		9453.	1.03	10.741	1.00
34	-20785.	-814.	-25451.	-10392.	-407.	-105788.	0.0391		9046.	1.03	10.713	1.00

NOTES:
COL.(30)= SUM OF COLS.(4) THRU (8)
COL.(31)= COLS.[(30)+(10)+(18)-(20)-(21)]= COLS.[(30)+(10)+(37)]
COL.(34)= DEPRECIATION RESERVED: TAKEN AS BOOK VALUE OF ASSETS
COL.(40)= 1/[(1+K)**T] WHERE K EQUALS DISCOUNT RATE
COL.(41)= COL.(9)/COL.(10)
COL.(42)= COLS.[(36)+(35)-(29)-(39)]-EQUITY
COL.(43)= COLS.[(28)+(35)]/[COLS.[(30C)+(39)]+CAPITOL COST]
COL.(44)= DISCOUNT WHEREBY B/C RATIO OF COL.(43) EQUALS 1.
COL.(45)= B/C RATIO AT COMPUTED IRR VALUE FOR CHECK PURPOSES.
PROGRAM'S COMPUTATIONAL ROUTINE MAY NOT PROVIDE EXACT IRR VALUE THAT WILL RESULT IN A B/C RATIO VALUE OF 1.000

FACILITY CASH FLOW

(1) YR.	(2) ASSUMED FUTURE RATE ($/KWH)	(3) GROSS OPERATING INCOME ($)	(4) EXPENSES: O&M ($)	(5) EXPENSES: INSUR. ($)	(6) EXPENSES: MGMT. ($)	(7) OTHER COSTS ($)	(8) OTHER COSTS ($)	(9) ADJUSTED OPERATING INCOME ($)	(10) DEBT SERVICE ($)	(11) CASH FLOW BEFORE TAXES: ANNUAL ($)	(12) CASH FLOW BEFORE TAXES: P.W. ($)	(13) REQD. OR EFF. RATE ($/KWH)	(14) PAID ON DEBT ($)	(15) REMAINING DEBT ($)
1	0.0770	36190.	10000.	2080.	5000.	21.	0.	19089.	218.	18871.	17155.	0.0368	15.	2245.
2	0.0770	36190.	10000.	2122.	5000.	21.	0.	19048.	218.	18829.	15561.	0.0369	17.	2228.
3	0.0770	36190.	10000.	2164.	5000.	21.	0.	19005.	218.	18787.	14115.	0.0370	18.	2209.
4	0.0770	36190.	10000.	2207.	5000.	21.	0.	18962.	218.	18744.	12802.	0.0371	20.	2189.
5	0.0770	36190.	10000.	2251.	5000.	21.	0.	18918.	218.	18700.	11611.	0.0372	22.	2167.
6	0.0770	36190.	10000.	2296.	5000.	21.	0.	18873.	218.	18654.	10530.	0.0373	24.	2143.
7	0.0770	36190.	10000.	2342.	5000.	21.	0.	18827.	218.	18609.	9549.	0.0374	26.	2116.
8	0.0770	36190.	10000.	2389.	5000.	21.	0.	18780.	218.	18562.	8659.	0.0375	29.	2087.
9	0.0770	36190.	10000.	2437.	5000.	21.	0.	18732.	218.	18514.	7852.	0.0376	32.	2056.
10	0.0770	36190.	10000.	2486.	5000.	21.	0.	18683.	218.	18465.	7119.	0.0377	35.	2021.
11	0.0770	36190.	10000.	2536.	5000.	21.	0.	18634.	218.	18415.	6455.	0.0378	38.	1983.
12	0.0770	36190.	10000.	2586.	5000.	21.	0.	18583.	218.	18365.	5852.	0.0379	41.	1942.
13	0.0770	36190.	10000.	2638.	5000.	21.	0.	18531.	218.	18313.	5305.	0.0380	45.	1897.
14	0.0770	36190.	10000.	2691.	5000.	21.	0.	18478.	218.	18260.	4809.	0.0381	50.	1847.
15	0.0770	36190.	10046.	2745.	5023.	21.	0.	18356.	218.	18138.	4342.	0.0384	54.	1793.
16	0.0770	36190.	10699.	2799.	5349.	21.	0.	17322.	218.	17103.	3722.	0.0406	59.	1734.
17	0.0770	36190.	11394.	2855.	5697.	21.	0.	16222.	218.	16004.	3166.	0.0429	65.	1669.
18	0.0770	36190.	12135.	2913.	6067.	21.	0.	15054.	218.	14836.	2668.	0.0454	71.	1598.
19	0.0770	36190.	12924.	2971.	6462.	21.	0.	13813.	218.	13595.	2223.	0.0481	78.	1520.
20	0.0770	36190.	13764.	3030.	6882.	21.	0.	12493.	218.	12275.	1825.	0.0509	85.	1436.
21	0.0770	36190.	14658.	3091.	7329.	21.	0.	11091.	218.	10873.	1469.	0.0539	93.	1343.
22	0.0770	36190.	15611.	3153.	7806.	21.	0.	9600.	218.	9382.	1153.	0.0570	101.	1241.
23	0.0770	36190.	16626.	3216.	8313.	21.	0.	8015.	218.	7797.	871.	0.0604	111.	1130.
24	0.0770	36190.	17707.	3280.	8853.	21.	0.	6329.	218.	6111.	620.	0.0640	121.	1009.
25	0.0770	36190.	18857.	3346.	9429.	21.	0.	4537.	218.	4319.	399.	0.0678	133.	876.
26	0.0770	36190.	20083.	3412.	10042.	21.	0.	2632.	218.	2414.	203.	0.0719	145.	731.
27	0.0770	36190.	21389.	3481.	10694.	21.	0.	606.	218.	387.	30.	0.0762	159.	572.
28	0.0770	36190.	22779.	3550.	11389.	21.	0.	-1549.	218.	-1768.	-123.	0.0808	174.	398.
29	0.0770	36190.	24260.	3621.	12130.	21.	0.	-3841.	218.	-4060.	-256.	0.0856	190.	208.
30	0.0770	36190.	25836.	3694.	12918.	21.	0.	-6279.	218.	-6497.	-372.	0.0908	208.	0.
31	0.0770	36190.	27516.	3768.	13758.	21.	0.	-8872.	0.	-8872.	-462.	0.0959	0.	0.
32	0.0770	36190.	29304.	3843.	14652.	21.	0.	-11630.	0.	-11630.	-551.	0.1017	0.	0.
33	0.0770	36190.	31209.	3920.	15605.	21.	0.	-14564.	0.	-14564.	-627.	0.1080	0.	0.
34	0.0770	36190.	33238.	3998.	16619.	21.	0.	-17686.	0.	-17686.	-692.	0.1146	0.	0.
		1230460.	530034.	94910.	265017.	707.	0.	334791.	6546.	328245.	156980.		2260.	0.

Public Developer

STATE TAX : 0.00 % OF [COL. (9)-COL. (16)-COL. (17)]

FEDERAL TAXABLE INCOME = COL.(9) - [COL.(16)+COL.(17)+COL.(18)]

FEDERAL TAX EFFECT AT OWNER/INVESTOR TAX BRACKET OF 0.00 % ON FEDERAL TAXABLE INCOME OF COL. (19)

TAX CREDITS : INVESTMENT TAX CREDIT : $ 0. BASED ON 0.00 % OF $ 208000.FOR FIRST YEAR

ENERGY INVESTMENT TAX CREDIT : $ 0. BASED ON 0.00 % OF $ 208000.FOR FIRST YEAR

EQUITY INVESTMENT BY OWNERS/INVESTORS : $ 223740.

ANNUAL INVESTOR CASH FLOW

(1)	(9)	(16)	(17)	(18)	(19)	(20)	(11)	(21)	(22) CASH FLOW AFTER TAXES	(23) CASH FLOW AFTER TAXES	(24) CASH FLOW AFTER TAXES	(25) CASH FLOW AFTER TAXES	(26A)	(26B)
YR.	ADJUSTED OPERATING INCOME ($)	DEBT INTEREST ($)	DEPRE-CIATION ($)	STATE TAX ($)	FEDERAL TAXABLE INCOME ($)	FEDERAL TAX EFFECT ($)	CASH FLOW BEFORE TAXES ($)	TAX CREDITS ($)	ANNUAL ($)	ANNUAL PRESENT WORTH ($)	SUM OF ANNUAL ($)	SUM OF ANNUAL P.W. ($)	ANNUAL % RETURN	P.W. % RETURN
1	19089.	703.	20489.	0.	-1603.	0.	18871.	0.	18871.	17155.	18871.	17155.	8.43	7.67
2	19048.	201.	19376.	0.	-530.	0.	18829.	0.	18829.	15561.	37700.	32717.	8.42	6.96
3	19005.	200.	18352.	0.	453.	0.	18787.	0.	18787.	14115.	56487.	46832.	8.40	6.31
4	18962.	198.	17411.	0.	1353.	0.	18744.	0.	18744.	12802.	75231.	59634.	8.38	5.72
5	18918.	196.	16545.	0.	2177.	0.	18700.	0.	18700.	11611.	93931.	71245.	8.36	5.19
6	18873.	194.	15749.	0.	2930.	0.	18654.	0.	18654.	10530.	112585.	81775.	8.34	4.71
7	18827.	192.	15017.	0.	3618.	0.	18609.	0.	18609.	9549.	131194.	91324.	8.32	4.27
8	18780.	189.	14855.	0.	3736.	0.	18562.	0.	18562.	8659.	149755.	99983.	8.30	3.87
9	18732.	187.	8230.	0.	10315.	0.	18514.	0.	18514.	7852.	168269.	107835.	8.27	3.51
10	18683.	184.	8230.	0.	10270.	0.	18465.	0.	18465.	7119.	186734.	114954.	8.25	3.18
11	18634.	180.	8230.	0.	10223.	0.	18415.	0.	18415.	6455.	205150.	121409.	8.23	2.88
12	18583.	177.	8230.	0.	10176.	0.	18365.	0.	18365.	5852.	223515.	127260.	8.21	2.62
13	18531.	173.	8230.	0.	10128.	0.	18313.	0.	18313.	5305.	241828.	132565.	8.18	2.37
14	18478.	169.	8230.	0.	10080.	0.	18260.	0.	18260.	4809.	260088.	137373.	8.16	2.15
15	18356.	164.	8230.	0.	9962.	0.	18138.	0.	18138.	4342.	278226.	141715.	8.11	1.94
16	17372.	159.	8230.	0.	8932.	0.	17103.	0.	17103.	3722.	295329.	145438.	7.69	1.66
17	16222.	153.	8230.	0.	7839.	0.	16004.	0.	16004.	3166.	311333.	148604.	7.15	1.42
18	15054.	147.	8230.	0.	6677.	0.	14836.	0.	14836.	2668.	326169.	151272.	6.63	1.19
19	13813.	141.	3632.	0.	10040.	0.	13595.	0.	13595.	2223.	339764.	153495.	6.08	0.99
20	12493.	133.	2273.	0.	10087.	0.	12275.	0.	12275.	1825.	352039.	155320.	5.49	0.82
21	11091.	125.	0.	0.	10965.	0.	10873.	0.	10873.	1469.	362912.	156789.	4.86	0.66
22	9600.	117.	0.	0.	9483.	0.	9382.	0.	9382.	1153.	372294.	157941.	4.19	0.52
23	8015.	107.	0.	0.	7908.	0.	7797.	0.	7797.	871.	380090.	158812.	3.48	0.39
24	6329.	97.	0.	0.	6233.	0.	6111.	0.	6111.	620.	386201.	159433.	2.73	0.28
25	4537.	85.	0.	0.	4452.	0.	4319.	0.	4319.	399.	390521.	159831.	1.93	0.18
26	2632.	73.	0.	0.	2559.	0.	2414.	0.	2414.	203.	392934.	160034.	1.08	0.09
27	606.	59.	0.	0.	546.	0.	387.	0.	387.	30.	393322.	160063.	0.17	0.01
28	-1549.	44.	0.	0.	-1594.	0.	-1768.	0.	-1768.	-123.	391554.	159941.	-0.79	-0.05
29	-3841.	28.	0.	0.	-3870.	0.	-4060.	0.	-4060.	-256.	387494.	159685.	-1.81	-0.11
30	-6279.	10.	0.	0.	-6289.	0.	-6497.	0.	-6497.	-372.	380997.	159312.	-2.90	-0.17
31	-8872.	0.	0.	0.	-8872.	0.	-8872.	0.	-8872.	-462.	372125.	158850.	-3.97	-0.21
32	-11630.	0.	0.	0.	-11630.	0.	-11630.	0.	-11630.	-551.	360495.	158299.	-5.20	-0.25
33	-14564.	0.	0.	0.	-14564.	0.	-14564.	0.	-14564.	-627.	345930.	157672.	-6.[illegible]	-0.28
34	-17686.	0.	0.	0.	-17686.	0.	-17686.	0.	-17686.	-692.	328245.	156980.	-7.[illegible]	-0.31
UM	334791.	4286.	226000.	0.	104505.	0.	328245.	0.	328245.	156980.				

DEBT SERVICE :

$ 2260. LOAN 9.00 % FOR 30 YEARS WITH MONTHLY PAYMENTS

$ 0. MID-TERM LOAN 0.00 % FOR 0 YEARS WITH QUARTERLY PAYMENTS

DISCOUNT RATE= 10.00%

FEDERAL TAX BRACKET= 0.00

EQUITY: 223740.

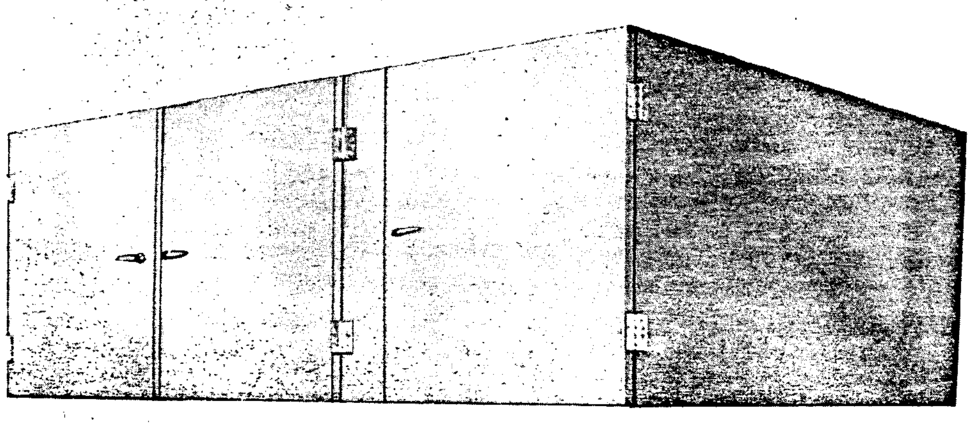
ECONOMIC ANALYSIS & SUMMARY

(1)	(4)	(27)	(28)	(15)	(29)	(30A)	(30B)	(30C)	(31)	(32)	(33)	(34)	(35)
	GROSS OPERATING INCOME			REMAINING DEBT		TOTAL ANNUAL EXPENSES			TOTAL ANNUAL COSTS			SALVAGE VALUE	
YR.	ANNUAL ($)	P.W. OF ANNUAL ($)	SUM OF P.W. ($)	ANNUAL ($)	P.W. OF ANNUAL ($)	ANNUAL ($)	P.W. OF ANNUAL ($)	SUM OF P.W. ($)	ANNUAL ($)	P.W. OF ANNUAL ($)	SUM OF P.W. ($)	ANNUAL ($)	P.W. OF ANNUAL ($)
1	36190.	32900.	32900.	2245.	2041.	17101.	15546.	15546.	17319.	15745.	15745.	205511.	186828.
2	36190.	29909.	62809.	2228.	1841.	17142.	14167.	29713.	17361.	14348.	30092.	186135.	153830.
3	36190.	27190.	89999.	2209.	1660.	17185.	12911.	42625.	17403.	13075.	43167.	167782.	126057.
4	36190.	24718.	114717.	2189.	1495.	17228.	11767.	54392.	17446.	11916.	55083.	150372.	102706.
5	36190.	22471.	137189.	2167.	1345.	17272.	10725.	65116.	17490.	10860.	65944.	133827.	83096.
6	36190.	20428.	157617.	2143.	1210.	17317.	9775.	74892.	17536.	9898.	75842.	118078.	66652.
7	36190.	18571.	176188.	2116.	1086.	17363.	8910.	83802.	17581.	9022.	84864.	103061.	52887.
8	36190.	16883.	193071.	2087.	974.	17410.	8122.	91924.	17628.	8224.	93088.	88206.	41149.
9	36190.	15348.	208419.	2056.	872.	17458.	7404.	99327.	17676.	7496.	100584.	79976.	33918.
10	36190.	13953.	222372.	2021.	779.	17507.	6750.	106077.	17725.	6834.	107418.	71746.	27661.
11	36190.	12684.	235056.	1983.	695.	17556.	6153.	112230.	17775.	6230.	113648.	63516.	22262.
12	36190.	11531.	246588.	1942.	619.	17607.	5610.	117840.	17825.	5680.	119327.	55286.	17616.
13	36190.	10483.	257070.	1897.	549.	17659.	5115.	122956.	17877.	5178.	124506.	47056.	13630.
14	36190.	9530.	266600.	1847.	486.	17712.	4664.	127620.	17930.	4721.	129227.	38825.	10224.
15	36190.	8664.	275264.	1793.	429.	17834.	4269.	131889.	18052.	4322.	133549.	30595.	7324.
16	36190.	7876.	283140.	1734.	377.	18868.	4106.	135995.	19087.	4154.	137703.	22365.	4867.
17	36190.	7160.	290300.	1669.	330.	19968.	3950.	139946.	20186.	3994.	141696.	14135.	2797.
18	36190.	6509.	296809.	1598.	287.	21136.	3801.	143747.	21354.	3841.	145537.	5905.	1062.
19	36190.	5917.	302726.	1520.	249.	22377.	3659.	147406.	22595.	3695.	149231.	2273.	372.
20	36190.	5379.	308106.	1436.	213.	23697.	3522.	150928.	23915.	3555.	152786.	-0.	-0.
21	36190.	4890.	312996.	1343.	181.	25099.	3397.	154320.	25417.	3421.	156207.	-0.	-0.
22	36190.	4446.	317442.	1241.	152.	26590.	3266.	157587.	26808.	3293.	159501.	-0.	-0.
23	36190.	4042.	321484.	1130.	126.	28175.	3147.	160733.	28393.	3171.	162672.	-0.	-0.
24	36190.	3674.	325158.	1009.	102.	29861.	3032.	163765.	30079.	3054.	165725.	-0.	-0.
25	36190.	3340.	328498.	876.	81.	31653.	2921.	166686.	31871.	2942.	168667.	-0.	-0.
26	36190.	3037.	331535.	731.	61.	33558.	2816.	169502.	33776.	2834.	171501.	-0.	-0.
27	36190.	2760.	334295.	572.	44.	35584.	2714.	172216.	35803.	2731.	174232.	-0.	-0.
28	36190.	2510.	336805.	398.	28.	37739.	2617.	174833.	37958.	2632.	176864.	-0.	-0.
29	36190.	2281.	339086.	208.	13.	40031.	2524.	177357.	40250.	2537.	179401.	-0.	-0.
30	36190.	2074.	341160.	0.	0.	42469.	2434.	179790.	42687.	2446.	181848.	-0.	-0.
31	36190.	1885.	343046.	0.	0.	45062.	2348.	182138.	45062.	2348.	184195.	-0.	-0.
32	36190.	1714.	344760.	0.	0.	47820.	2265.	184403.	47820.	2265.	186460.	-0.	-0.
33	36190.	1558.	346318.	0.	0.	50754.	2185.	186588.	50754.	2185.	188645.	-0.	-0.
34	36190.	1417.	347734.	0.	0.	53876.	2109.	188697.	53876.	2109.	190754.	-0.	-0.

APPENDIX 4

TURBO HEAT PUMP

TURBO ICE MAKING HEAT PUMPS



Post Office Box 396
Denton, Texas 76201
Cable Address "TURBO TEX"
TWX 510 - 877 - 0571
Area Code 817 — 387-4301

Shady Oaks Drive, Expressway Industrial Park

May 12, 1981

Mr. Charles Goodspeed
Kingsbury Hall
University of New Hampshire
Durham, New Hampshire 03824

Dear Mr. Goodspeed:

We appreciate your calling Turbo expressing an interest in our heat pump. I believe we have the equipment needed for your city heating project.

The yearly heat of 5,000 million BTU when averaged for five (5) months converts to 116 tons per hour. Our model HP1000 matches very well to your load requirements.

For budgetary purposes the expected cost for one (1) model HP1000 is $63,262.00. This price includes compressor, condenser, and evaporator all in one (1) factory assembled package. It does not include pumps or heat exchanger for extracting the heat from the sewage.

Enclosed is some information about our equipment. If you have any questions, please let us know.

Yours truly,

TURBO REFRIGERATING COMPANY

Buster Smith

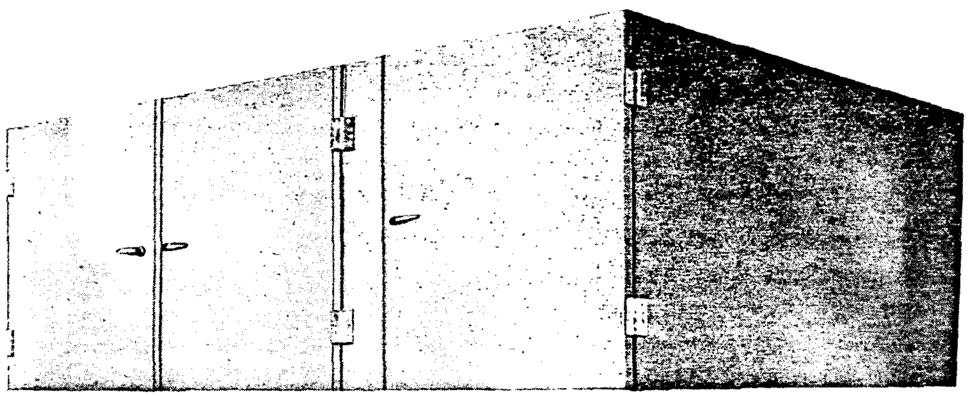
Buster Smith
Vice President/Director
Marketing

RBS:jam

THE TURBO HEAT PUMP

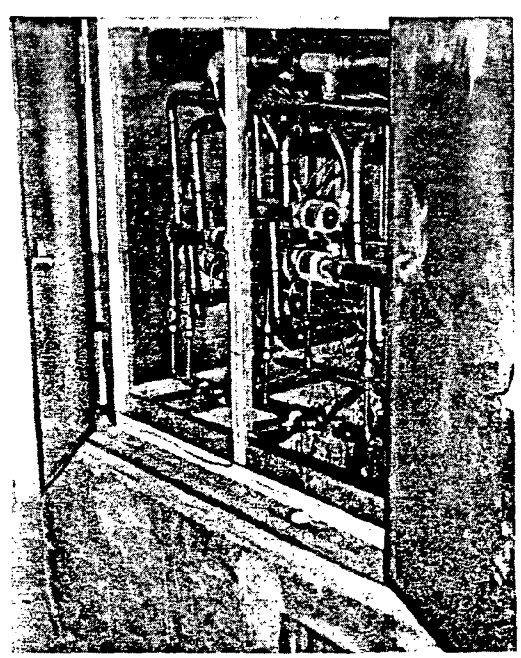
The TURBO HEAT PUMP is a well-built, factory tested unit mechanically efficient and energy saving.

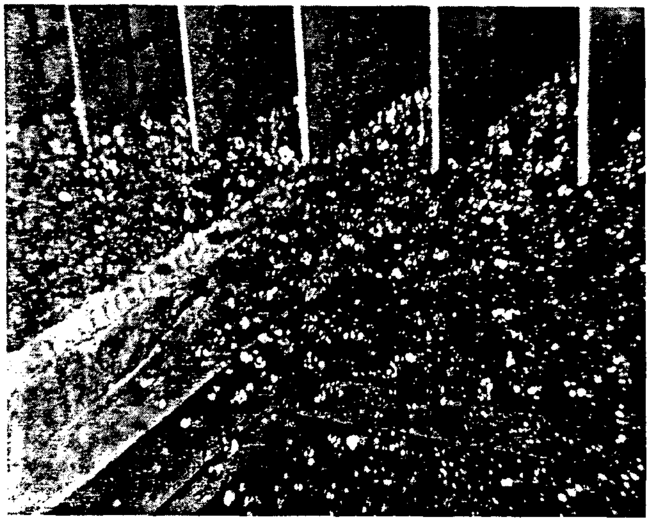
This HEAT PUMP was designed to save energy during both winter and summer seasons.

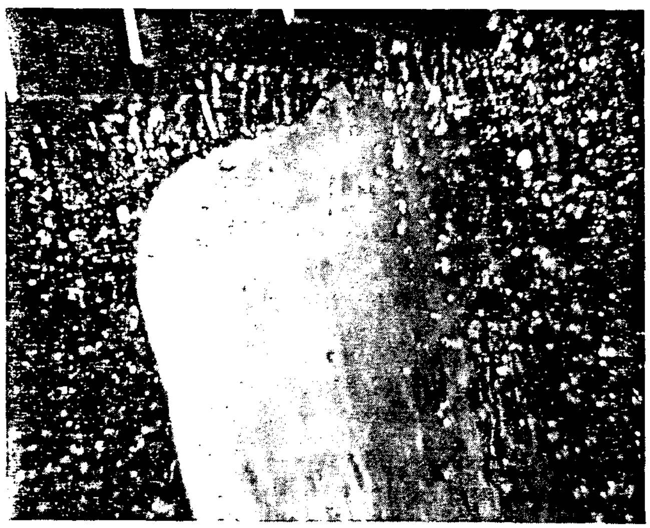


GENERAL OPERATION

The TURBO HEAT PUMP presents a multi-seasonal means of operation: that is, in the summer months, the ice from the evaporator plates can be used to *cool* a building, while, during the winter the heat from the condensers can be used to *heat* this same structure.




HEAT PUMP IN OPERATION


HEAT PUMP IN DEFROST

BASIC OPERATION

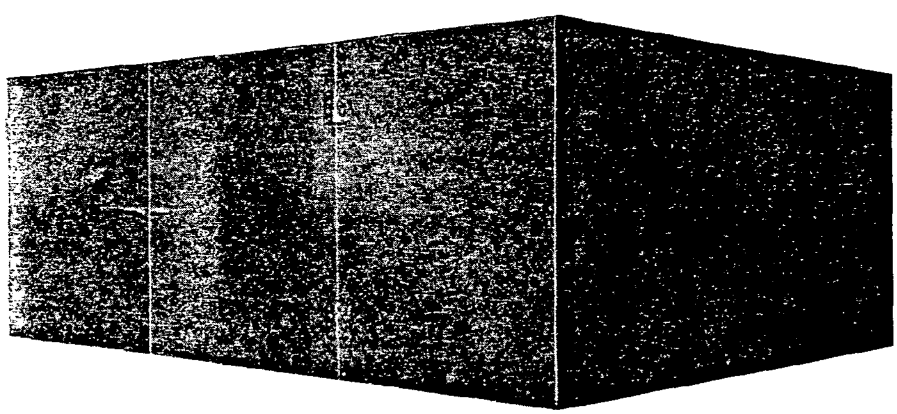
The TURBO HEAT PUMP simply removes heat from water that circulates over the evaporator plates. The water forms ice which is discharged through an ice opening into an ice storage tank. The heat is removed from the refrigerant system by condensers in the form of hot water. The auxiliary water condenser can have a temperature of 130° F or higher.

The condenser water can be used for space heating and/or for domestic hot water.

The ice in this operation can be used for air conditioning during the summer months, while the heat pump can also function as a water chiller.

EFFICIENCY

The coefficient of performance for this TURBO HEAT PUMP is 3.3.



TURBO HEAT PUMP

CONDITIONS: Heating & cooling in tons.
Heating tons represent the total heat-of-rejection.
Condensing at 105° F.
All data based on R-22.

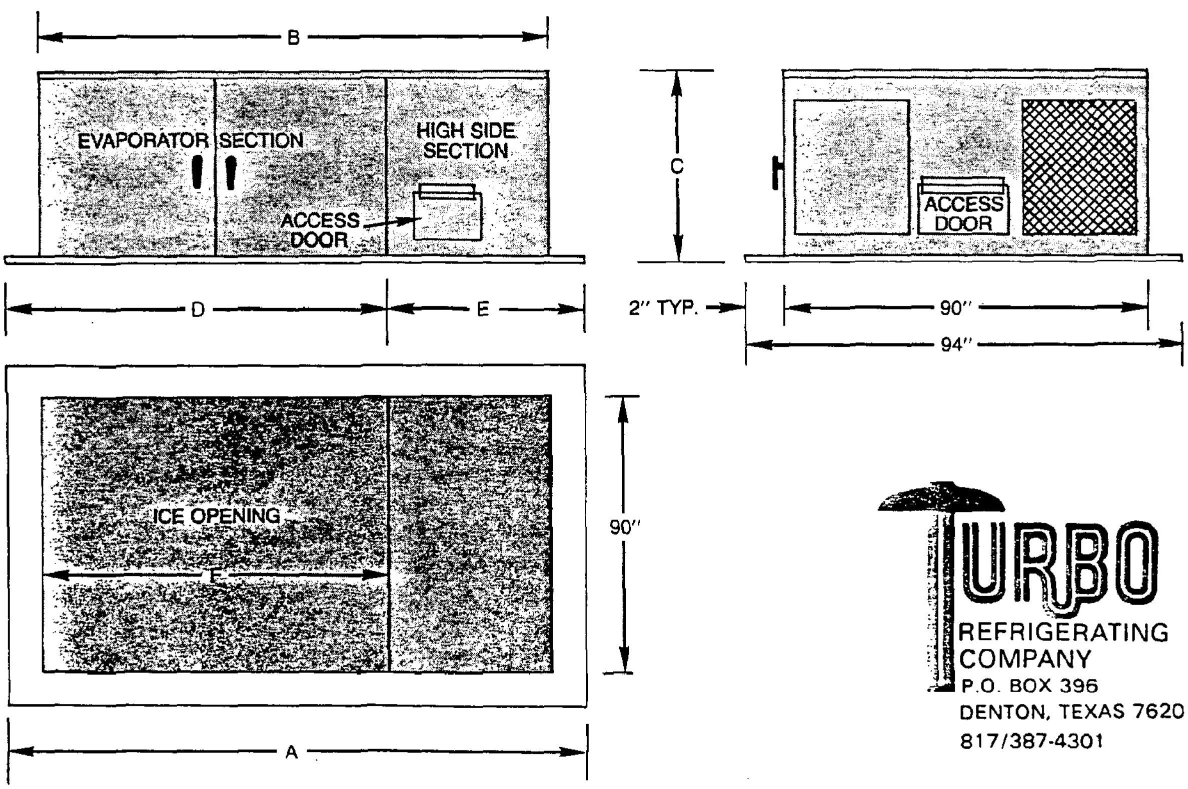
PHYSICAL DATA

		HP 100	HP 150	HP 200	HP 300	HP 400	HP 600	HP 800	HP 1000
HEATING	AT 20° SUCTION	10.11	12.55	18.73	28.75	34.60	51.85	69.07	103.72
COOLING		7.40	9.17	13.67	21.25	27.20	40.80	54.40	81.80
HEATING	AT 35° SUCTION	13.44	16.75	24.82	37.59	46.66	69.94	93.20	139.79
COOLING		10.42	12.91	19.16	29.17	38.50	57.75	77.00	115.60
HEATING	AT 45° SUCTION	16.03	20.04	30.28	44.66	55.75	83.47	111.25	166.82
COOLING		12.84	16.00	24.17	35.84	47.20	70.70	94.30	141.50

DIMENSIONAL DATA

A	98.5	98.5	113	153	183	253	313	373
B	94.5	94.5	109	149	179	249	309	369
C	50.5	50.5	50.5	50.5	50.5	60.5	60.5	60.5
D	56.5	56.5	71.0	101	131	191	251	311
E	40	40	40	50	50	60	60	60
F	54.5	54.5	69.0	99	129	189	249	309
HORSEPOWER (NOM.)	7.5*	15*	25*	35*	40	60	75/100	100/125
WEIGHT IN LBS.	3080	3840	5720	8780	11620	19860	21120	26240
NUMBER OF PLATES	12	18	27	36	48	72	96	120
G.P.M.	144	216	324	432	576	864	1152	1440

**SEMI-HERMETIC MOTOR RATINGS*



TURBO
REFRIGERATING COMPANY
P.O. BOX 396
DENTON, TEXAS 76201
817/387-4301