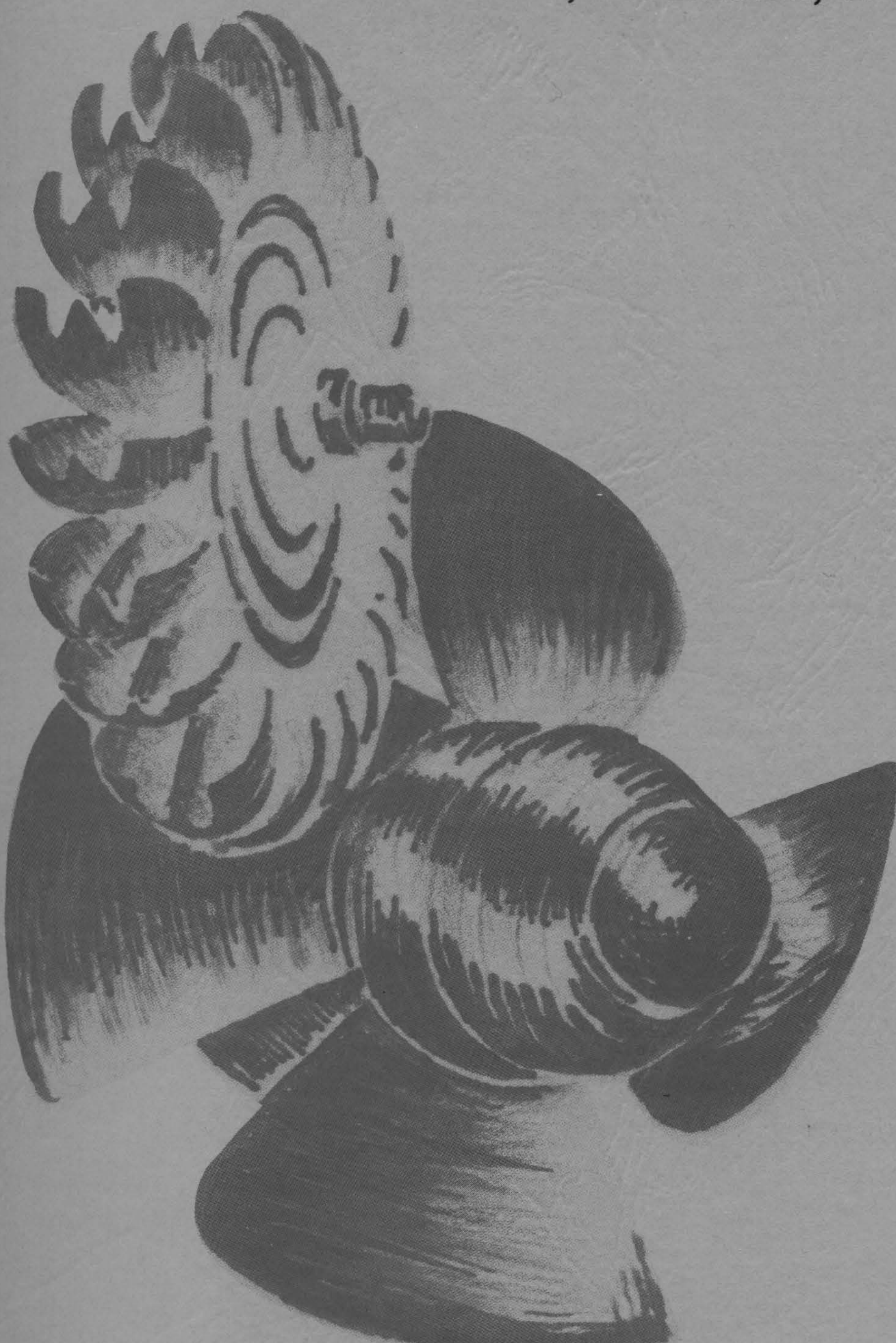
Research Technical Completion Report

Project A-079-IDA

A MANUAL FOR DEVELOPING SMALL-SCALE AND MICRO-HYDROPOWER PLANTS IN IDAHO

A GUIDE TO PERMITS, LICENSES, & INCENTIVES



by

C.C. Warnick

Idaho Water & Energy Resources Research Institute
University of Idaho
Moscow, Idaho

April 1983

The research on which this report is based was financed in part by the U.S. Department of the Interior, as authorized by the Water Research and Development Act of 1978 (P.L. 95-467).

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Submitted to
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Washington, D.C. 20242

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Idaho Water and Energy Resources Research Institute
University of Idaho
Moscow, ID 83843

March 1983

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FOREWARD

The Idaho Water and Energy Resources Research Institute has provided administrative coordination for this compilation and organized the team that did the writing and accumulating of information. It is the Institute policy to make available the results of significant research related to the water and energy resources within Idaho. The Institute neither endorses nor rejects the findings of the author. In this compilation, a strong effort has been made to bring together information that would be useful to those interested in developing hydropower in Idaho. Where information was already available, reference has been made to suitable publications where one may get more detailed help. Extensive reference and information has been given as to how to contact appropriate agencies to obtain necessary permits and to gain compliance with the many local, State and Federal regulations governing hydropower development. An extensive glossary of often-used technical terms has been included to help the person who is new to the subject of hydropower.

ACKNOWLEDGEMENTS

The manual has been sponsored through the Idaho Water and Energy Resources Research Institute under the direction of Dr. John R. Busch as Director of the Institute. Financial support was provided from the Office of Water Research and Technology of the U.S. Department of the Interior, the U.S. Department of Energy through contract No. DE-C07-761D01570 and from the Civil Engineering Department. Assistance in gathering of legal and institutional material was provided by six students from the College of Law: Michael K. Ashcroft, Gregory G. Clark, Michael McBride, Roy Moulton, Bryan K. Murray, and Jeffrey K. Ward. Larry G. Kirkland, a Research Associate in Civil Engineering, assembled much of the necessary supporting information. Don Schutt and Ned Warnick assisted in preparing the illustration and my wife, Kathleen Warnick, helped extensively with editing.

Considerable material has been extracted from similar manuals prepared by Al Cunningham of Montana State University, G.W. Boese and J.A. Kelly of the Washington State Energy Office and Greg Lindsey of Wapora, Inc. working with the State of Illinois, Institute of National Resources.

Assistance has been given by the staffs of the Idaho Public Utility Commission, the Environmental Division of the Idaho Department of Health and Welfare and the Idaho Department of Water Resources.

The typing and preparation of manuscripts for the publication was done by Gloria Hall and Marvette Benscoter of the Institute staff and secretarial assistance was provided by Cathy Merickel of the Department of Civil Engineering. The encouragement of Dr. J.H. Milligan as chairman of the Department of Civil Engineering is gratefully acknowledged.

ABSTRACT

This manual has been prepared to assist potential developers of hydropower and to help agency personnel concerned with hydropower, planning and development in Idaho. It is designed to guide the developer through the various steps in preparing a feasibility study and completing the necessary licensing. The manual gives brief information on the engineering requirements and the economic analysis and references as to how to obtain necessary professional assistance.

Necessary steps and actions that must be taken to obtain appropriate permits, licenses and compliance certification have been presented in sections involving local permitting, State law requirements, and Federal law requirements. This includes graphic flow charts, expected time requirements, and specific information on addresses and phone numbers to make necessary contacts.

A brief discussion is presented on incentives for developing small-scale hydropower in Idaho, with information on financing possibilitites and requirements for developing power sales contracts. A very specific set of references for use of those working in Idaho is included. The manual includes in the Appendix a glossary and a list of hydroelectric turbine manufacturers.

INTRODUCTION

This manual has been prepared for individuals who have an interest in developing small-scale hydropower and micro-hydropower plants in Idaho. It should also be useful to entities, agencies, and companies involved in assisting in hydro development or to those involved in the regulatory and management aspects of hydropower in Idaho. Small-scale hydropower normally refers to developments with generating capacity from 15 megawatts down to 100 kilowatts. Micro-hydropower involves plants having generating capacity less than 100 kilowatts.

The major purpose of this manual is to make available in one place relevant information on how to proceed with the complex task of developing the energy available at potential hydropower sites in Idaho with emphasis on the requirements for obtaining the necessary permits and licenses. Recommendations are also given for making necessary financial and sales agreements. Pertinent information is presented on engineering considerations. A glossary is included in the Appendix to help in understanding many special terms and units of measurement.

The information presented in this manual will be useful in helping to make the decision on whether or not to proceed with a particular development. It is recommended that competent professional help be obtained in the engineering phases, the legal and institutional phases, the economic and financial aspects, and the environmental assessment elements of planning and development.

Existing Plants

Developments of hydroelectric plants in Idaho in the early part of this century were small-scale plants, many of them with capacities less than 1 megawatt. Use was made of the electrical energy at mines and small community developments. Gradually the economics of developing high-capital cost facilities made it more attractive to develop large scale plants such as Palisades, Anderson Ranch, Brownlee, Hells Canyon, and Dworshak.

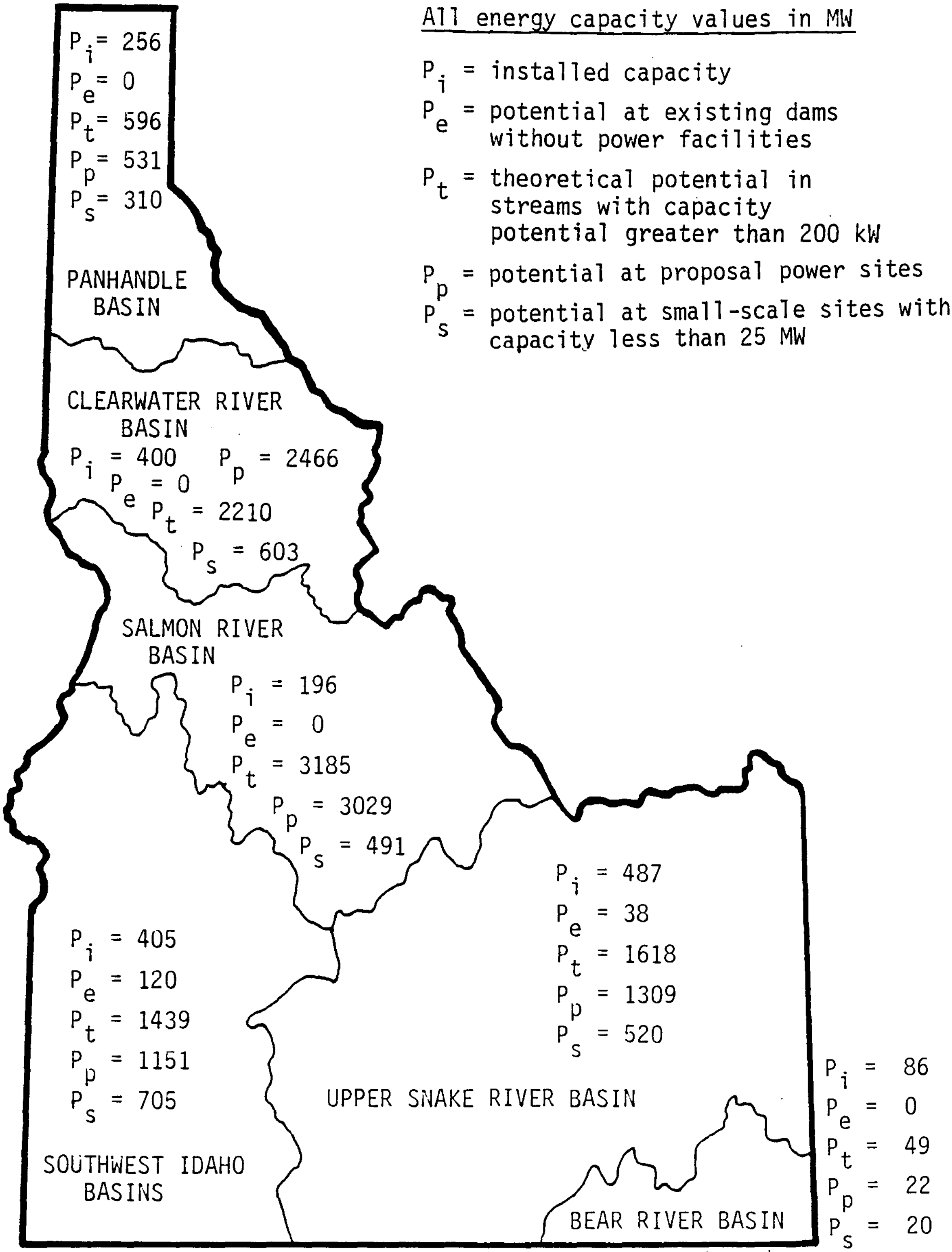
More recently, a few small scale plants have been developed at remote locations for special uses. In general these small plants were not connected with an electric grid. Representative of this type of development are several micro-hydro plants in the Salmon River drainage, some near Riggins, at Corn Creek near Shoup; a few unique installations in the Hagerman Valley; and a tiny micro-hydro site near Banks on a small stream flowing into the Payette River. Plants that have been developed since 1980 are Stevenson's micro-hydro plant near Bliss. Skeem's plant on Mud Creek near Buhl, and White's small plant near Clark Fork on Derr Creek that flows into Pend Oreille Lake. These latter plants have come into existence primarily because of the incentive offered through the Federal act known as PURPA P.L. 95-617, the Public Utilities Regulatory Policies Act of 1977. This Act encourages energy development efforts that utilize renewable energy sources. Prospective developers should visit one or more of these newer small developments to get acquainted with the general nature of small-scale hydro and to learn about the experiences and difficulties encountered by the developers who have pioneered some of the developments.

Potential for Development

A part of the Federal program to encourage development of renewable energy sources was an inventory of the potential hydroelectric energy in the Pacific Northwest, funded by the Idaho Operation office of the U.S. Department of Energy. This inventory was completed under a contractual study by the Idaho Water Resources Research Institute at the University of Idaho in cooperation with water research centers at Oregon State University, Washington State University and Montana State University. The study inventoried sites with low head characteristics and capacity of at least 200 kW. The results for Idaho are available in a seven-volume publication titled "Idaho Hydroelectric Potential - Theoretical Potential in Stream and Potential at Existing Dams and Projected Sites" by Heitz, Warnick, and Gladwell (1980). The inventory also indicated in a very general way the feasibility, transmission and environmental restraints to development of hydropower.

Figure 1 is a summary by river basins of installed capacity and potential power identified in the Idaho inventory. Streams were divided into "reaches" and hydrologic characteristics of each of these sections of the streams were estimated. Figure 2 is a typical reach characteristic sheet, showing the type of information available from the inventory.

The inventory by Heitz, Warnick, and Gladwell can be a useful publication in studies of possible power plant siting. The inventory can be of assistance in obtaining engineering information on flows, energy potential, crude estimates of available head, and very preliminary information on restraints to development such as land use restraints, special fish problems, problems with transmission and locations for possible market situations. This document is available from the Idaho Water and Energy Resources Research Institute, University of Idaho, Moscow.



Source: Heitz et al. (1980)

Figure 1. Summary of existing, theoretical potential, and proposed site's potential hydroelectric energy in Idaho by drainage basin regions.

REACH NUMBER 03500240040020R0065

I LOCATION

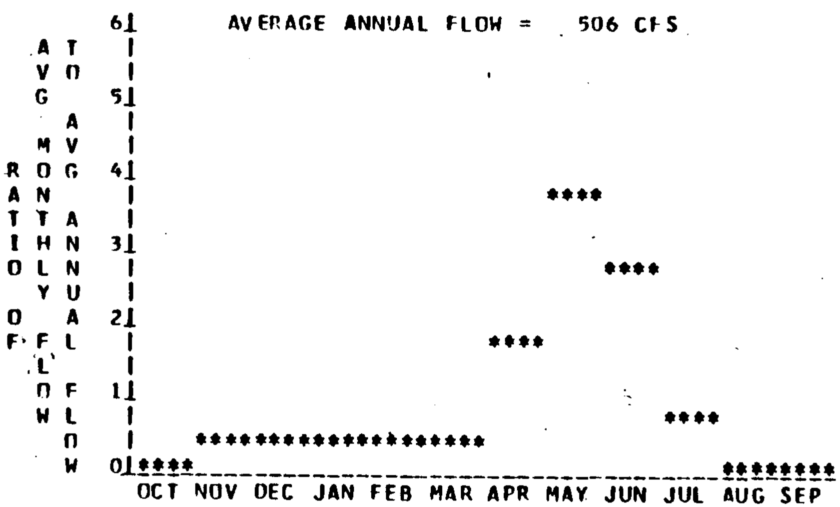
A.	STATE	IDAHO
B.	COUNTY	IDAHO
C.	TOWNSHIP, RANGE	T36N R15E
D.	LATITUDE, LONGITUDE	46 29 114 35
E.	STREAM NAME	WHITE SAND CREEK
F.	MAJOR BASIN NAME	CLEARWATER RIVER
G.	RIVER MILE	0.0 TO 13.0

II HYDROLOGIC AND HYDRAULIC CHARACTERISTICS

A.	UPSTREAM ELEVATION OF REACH	4440 FT. MSL
B.	DOWNSTREAM ELEVATION OF REACH	3430 FT. MSL
C.	TOTAL AVAILABLE HEAD IN REACH	1010 FT.
D.	AVERAGE SLOPE IN REACH	77.7 FT./MI.
E.	DRAINAGE AREA ABOVE REACH MOUTH	240 SQ.MI.
F.	INFLOW CLASSIFICATION	NATURAL
G.	AVERAGE FLOW DURATION AND POWER VALUES FOR THE REACH	

EXCEEDANCE PERCENTAGE	DISCHARGE CFS	PLANT SIZE MW	ANNUAL POWER OUTPUT GWH	LOAD FACTOR
95	63	5.40	47.13	1.00
80	101	8.69	72.33	0.95
50	193	16.49	116.74	0.81
30	397	34.00	178.12	0.60
10	1630	139.52	362.98	0.30

H. TYPICAL ANNUAL HYDROGRAPH



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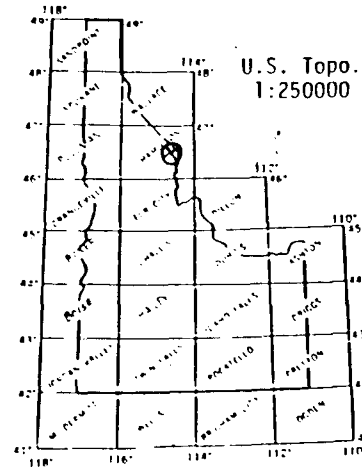


Location Map

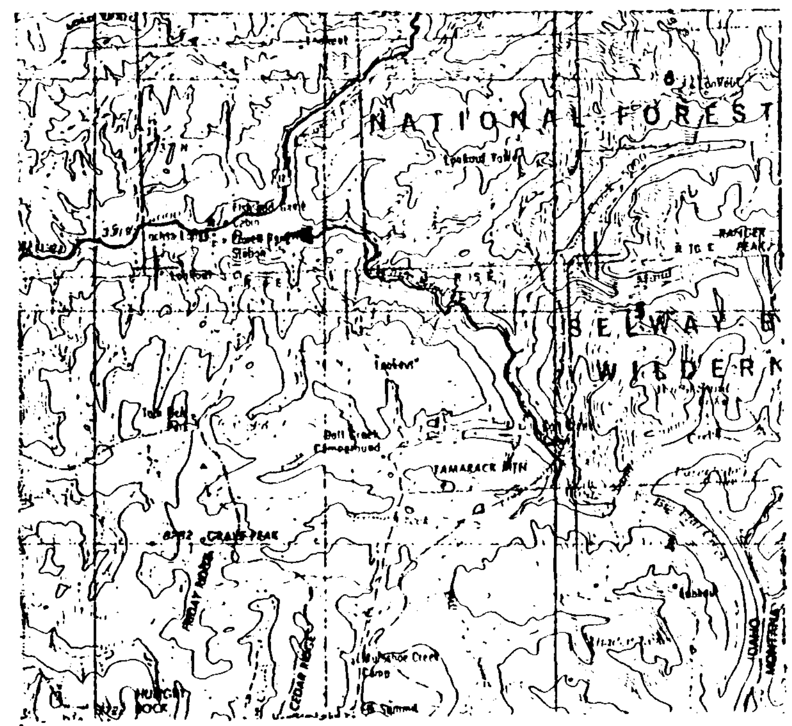


Figure 2. Representative reach characteristics sheet showing theoretical energy potential.

Another more site specific inventory for Idaho was prepared by Warnick, Filler, and Vance (1981) as a contract report to the Idaho Department of Water Resources. This includes information on all publicly disclosed reports on hydropower development up to 1981, including information on the U.S. Corps of Engineers (1979) National Hydropower Study; the U.S. Department of Interior (Water and Power Resource Service, now U.S. Bureau of Reclamation) (1980), and "Western States Inventory of Low-Hydroelectric Sites". Review of these various inventories can be very useful in determining what sites have already been looked at. The Warnick, Filler, and Vance inventory includes a complete list of references. It can be obtained from the Idaho Department of Water Resources.

A current listing of sites being investigated and for which preliminary permits, license applications or exemption requests have been filed with the Federal Energy Regulatory Commission can be obtained by contacting that agency or the Energy Resources Divison of the Idaho Department of Water Resources.

None of these inventories give information on very small power sites in the range below 200 kW. The general problem is that most of the sites are remote and will require considerable length of transmission line and access roads making economical development of sites. For remote locations at-site-use of the electrical energy from a micropower plant may offer attractive development opportunities.

GENERAL CONSIDERATIONS FOR PLANNING

Head and Flow

The most important consideration in planning hydropower developments is to determine whether there is sufficient head and flow to produce energy to make an economically viable project. The two factors of head and flow are used to determine the magnitude of the power produced. The power equation is:

$$P_{hp} = Q\gamma H\eta / 550 \qquad (1)$$

where P_{hp} = power capacity in hp

Q = discharge through turbine in ft^3/sec

γ = specific weight of water in lbs/ft^3 = 62.4 lbs/ft^3

H = effective head in ft

η = plant efficiency

550 = number ft-lbs of energy per hp

Usually power capacity is expressed in kW and 1 hp = 0.746 kW so that

$$P_{kw} = QH \quad /11.81 \qquad (2)$$

The head is expressed in two ways: gross head and net head. Gross head or operating head is the difference between headwater and tailwater elevation. Figure 3 illustrates operating head for three different types of small-scale hydropower situations. The gross head can be obtained by surveying, determining the elevations of the headwater and the tailwater. Care must be taken to determine what these elevations will be at various times throughout the year and the variations that will possibly occur by operation of the power plant. Net head also called (rated head, effective head and design head) is the

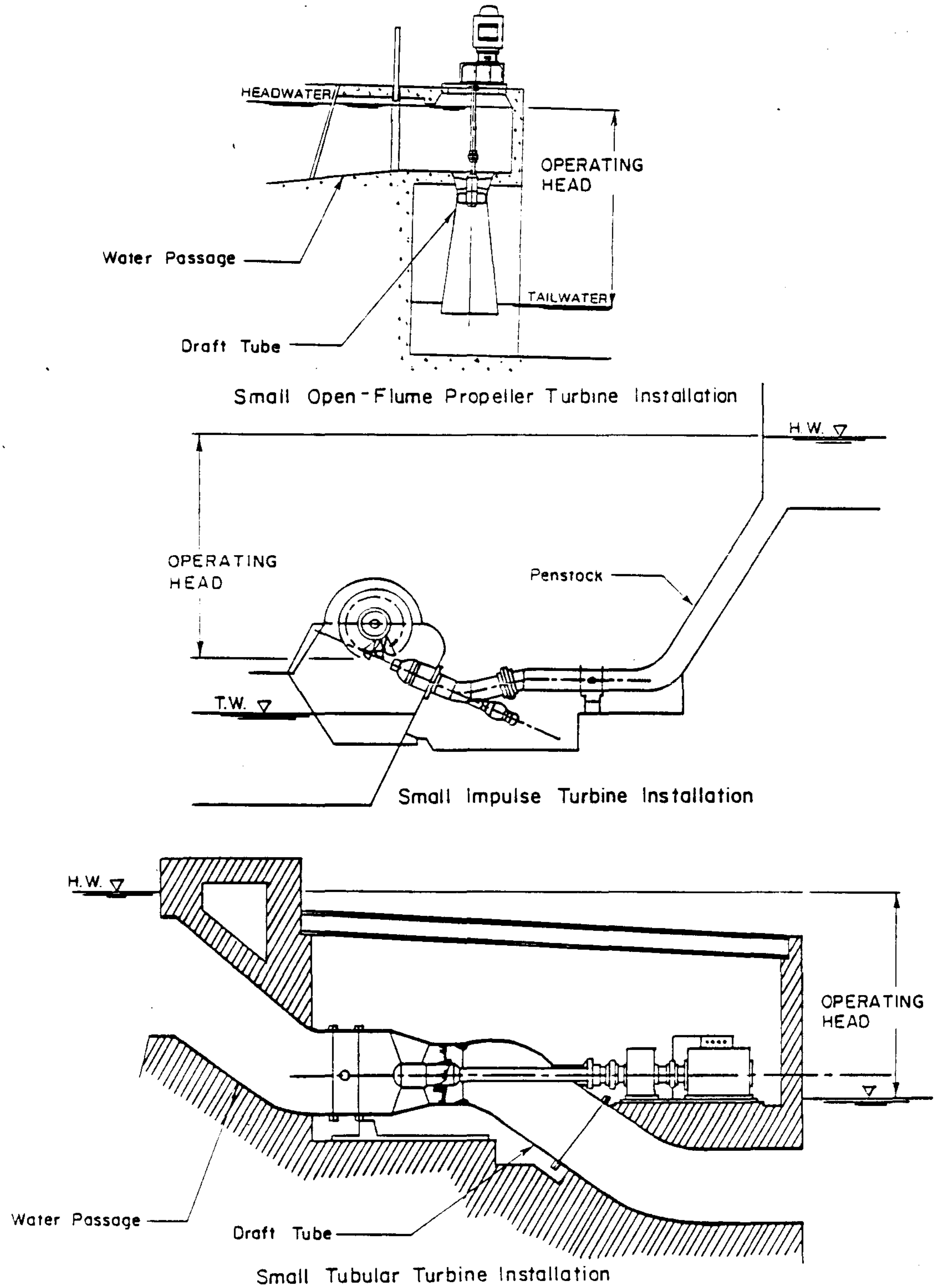


Figure 3. Different types of small-scale hydroelectric power developments.

gross head minus losses in the water passage entrances, the penstocks, and valves down to the turbine. The losses can be estimated when flow is known from hydraulic computation and tables of losses available in hydraulic engineering texts.

Hydropower developments are described as being low-head, medium head, or high head. Low-head plants are those with operating head less than 60 feet (20m). Medium head plants cover the range from 60 feet up to 200 to 300 feet. High head plants usually have heads greater than 200 feet and may be greater than 1000 feet. These ranges of head require different kinds of turbines to make effective use of the water energy.

The flow determination is more difficult. This involves a hydrologic study of the stream or source of water to be used in producing power. Needed is an estimate of how the flow will vary with time. There are two ways of expressing the flow for use in hydropower studies: a flow duration curve and a hydrograph of flow.

The flow duration curve is a representation of the magnitude of flow and percent of time that flow is expected to be equaled or exceeded. Figure 4 gives an example of such a curve. Details on how to make computations for this are presented in the work of Heitz (1981) and Warnick (1983). Information for plotting flow duration curves at gaged streams in Idaho can be obtained from the U.S. Geological Survey in Boise, Idaho. Methods and techniques for estimating flow duration curves at ungaged locations are discussed in Heitz (1979) and Warnick (1983). Most engineering offices have techniques for estimating hydrologic flow data. At ungaged sites it is a good practice to make actual streamflow measurements to check on the estimations that are made. A useful publication in Idaho for the flow

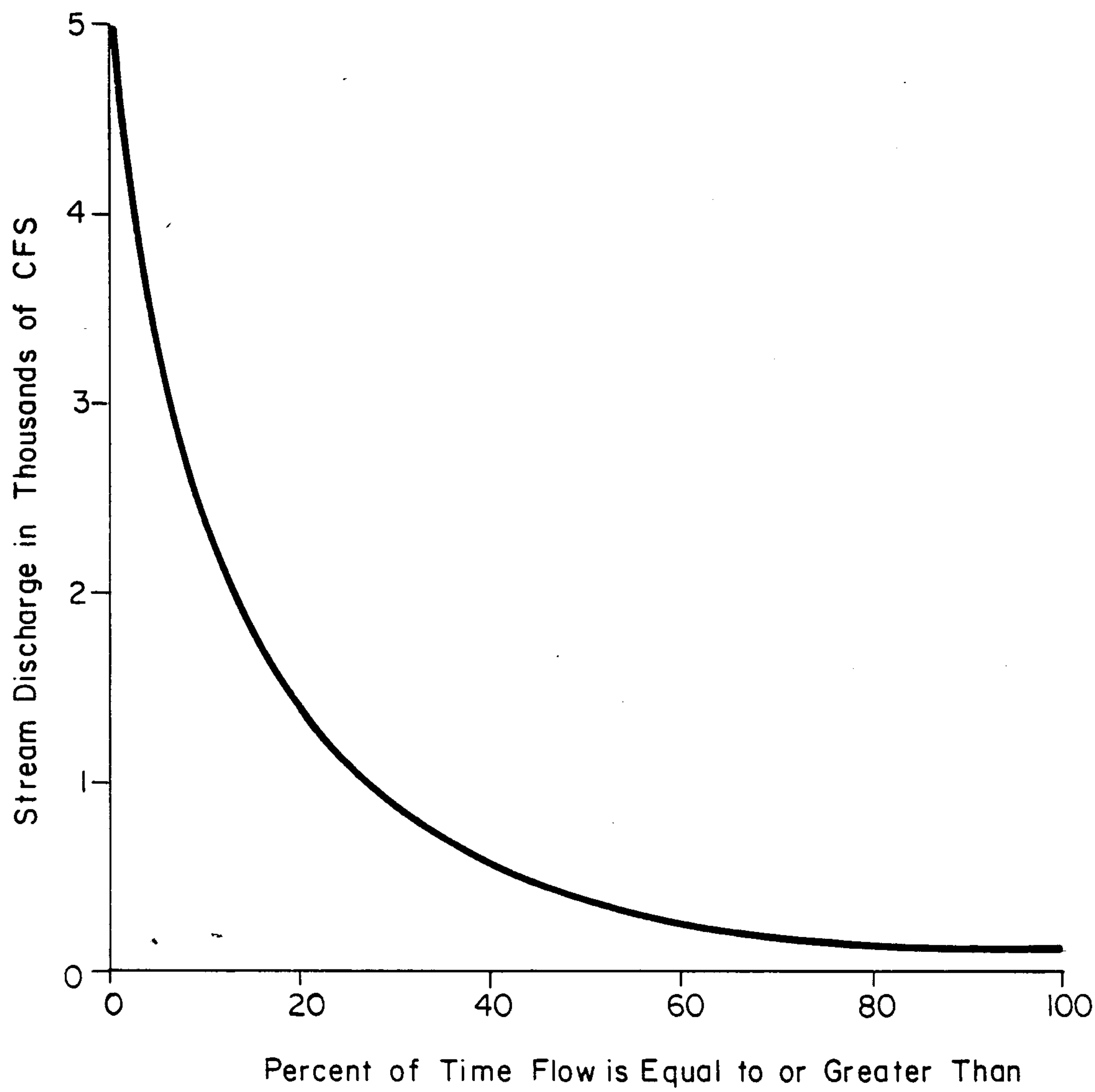


Figure 4. Representative flow duration curve.

determination at ungaged sites is the hydrologic map and guide publication by Warnick, Heitz, Kirkland, and Burke (1981).

A hydrograph expresses the flows sequentially with respect to time. The usual practice is to obtain values of mean monthly flow for each month of the year. Sometimes mean daily flows are needed. Figure 5 shows a representative hydrograph of monthly mean flows for the gaged site on the Little Salmon River at its mouth near Riggins. Information on mean-monthly discharges and mean-daily discharges of gaged streams in Idaho can be obtained from the U.S. Geological Survey in Boise, Idaho. These data are published annually in "Water Resources Data for Idaho (year)" by U.S. Geological Survey (year). This document is available in federal document libraries in several places in the state. A recommendation is made that professional engineering help be used in obtaining and processing the flow information.

Power Capacity Determination

With the flow data, either the flow duration curve or the flow hydrograph, it is possible to proceed with the determination of the power capacity of the water flowing at the site under consideration. Figure 6 illustrates the concept of how the flow duration curve is used to estimate power capacity at a site. The marked value on Figure 6 of Q_C (power flow capacity) represents the discharge for which the rated or maximum power output capacity is planned. It should be noted that in this case it is at the exceedance percentage of 20%. In run-of-river plants the most economical point for development of the water sources is usually between 20-30% excellance. The actual selection of plant capacity is an economic sizing problem. A later presentation in this section of the manual presents an approximating method to make a

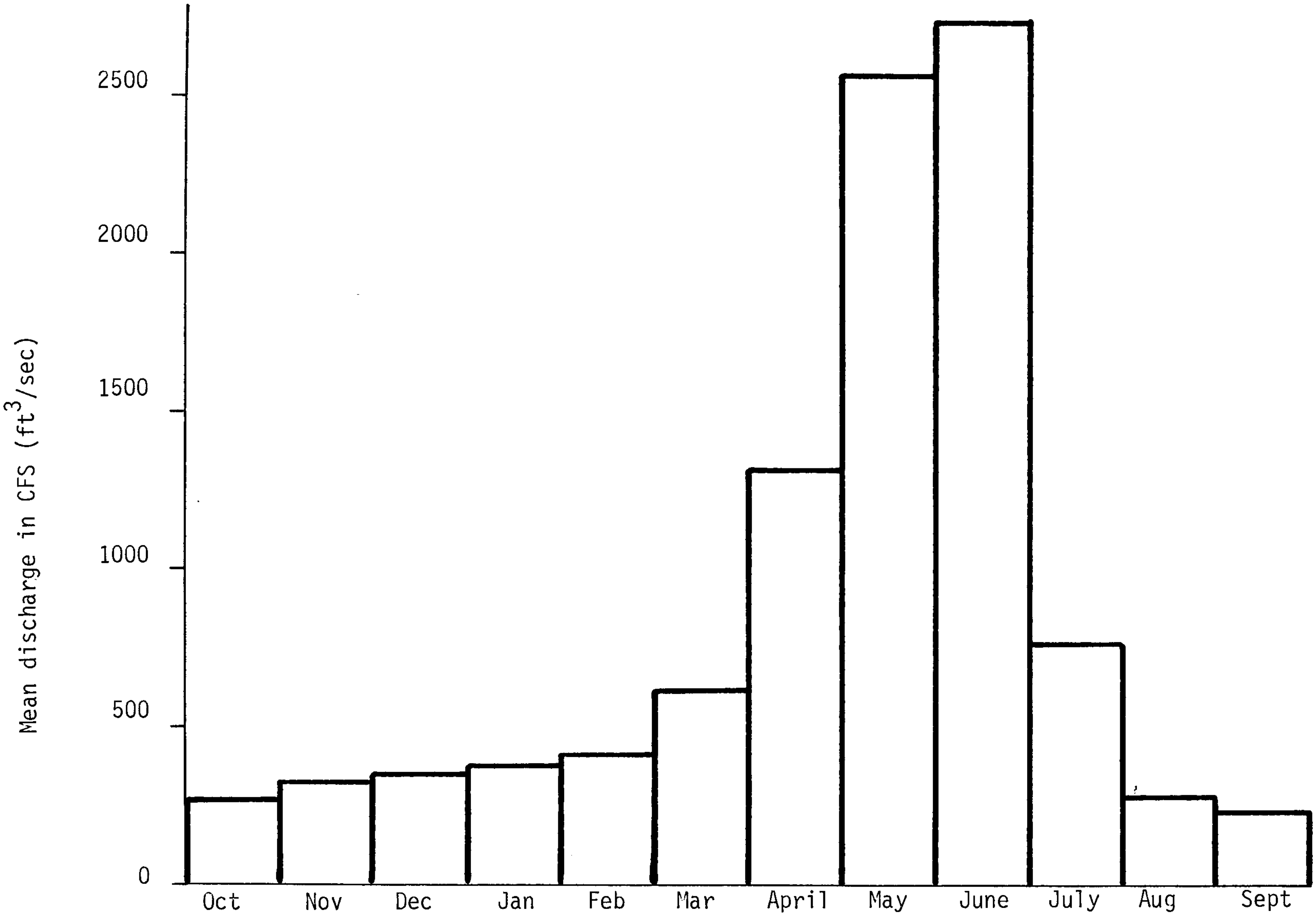


Figure 5. Representative hydrograph of monthly mean flow - Little Salmon River near Riggins.

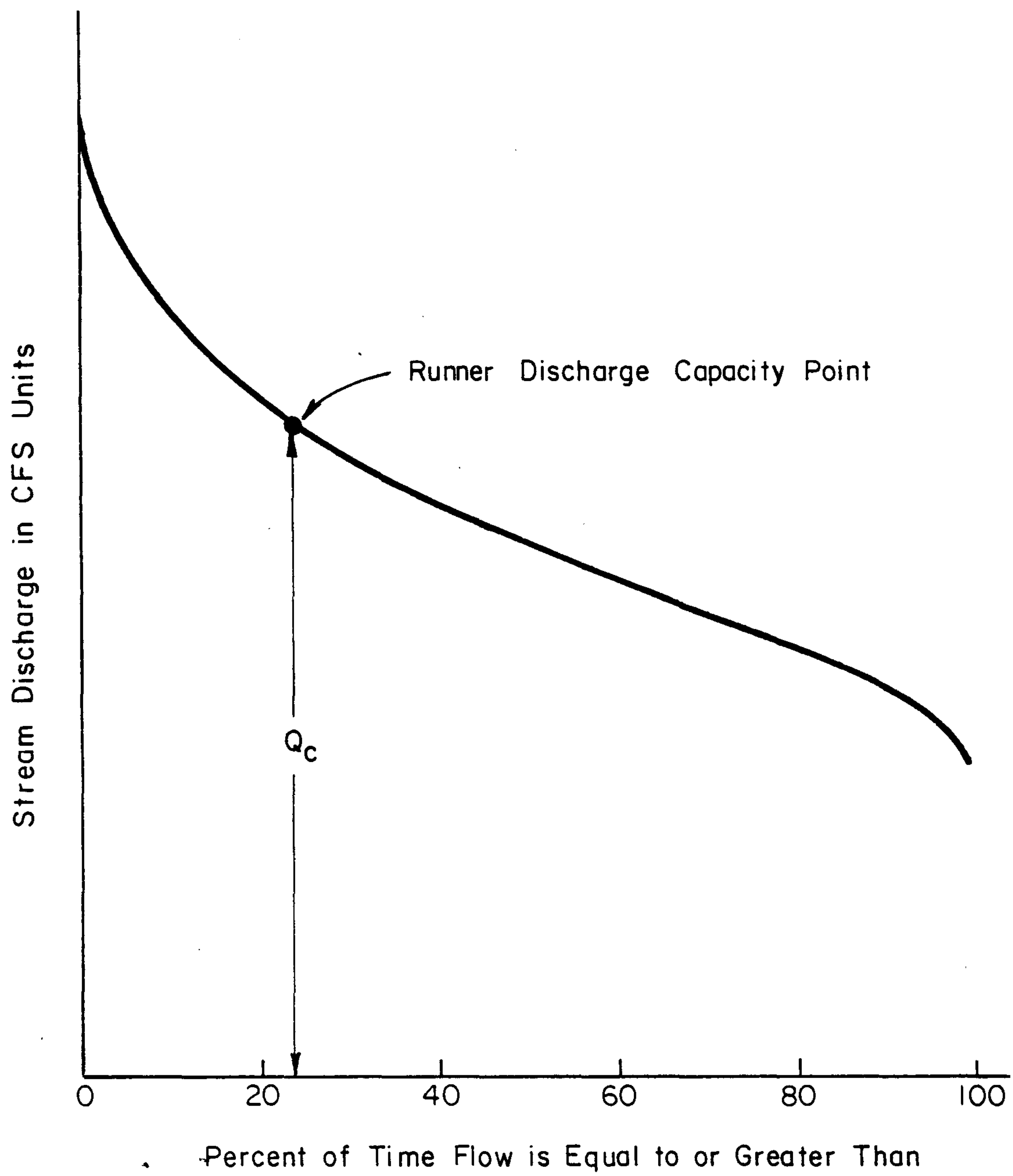


Figure 6. Flow duration curve showing power capacity flow.

quick appraisal of the economic practicability at a particular site. Detailed techniques for making the plant capacity selection are described in publications by Warnick (1983) and Broadus (1981).

Selection of Equipment

Different head and flow situations make it necessary to use different types of turbines for developing a power site. The basic types of turbines in use are impulse turbines (Pelton, Turgo, cross-flow, and Schneider power generator) and reaction turbines (Frances and Propeller turbines). Figure 7 shows a graphic classification of types of turbines. In the low-head range, newer forms of propeller turbines have become popular and meet certain situations to advantage. Figure 8 shows ways in which the low-head propeller would be utilized. Recently in Idaho some small centrifugal pumps have been used as turbines by running the pump in reverse. Figure 9 is a useful chart showing the applicable ranges for the different type of turbines and Figure 10 gives an indication of the range of head for different pump arrangements.

In the small-scale range, standard-sized turbines have been developed by manufacturers. Figure 11 gives a representative nomograph utilized in sizing such turbines. For selection of microhydro units, similar selection nomographs have been developed. A list of manufacturers is presented in the Appendix along with types of unit normally supplied by the manufacturer.

Detailed turbine selection procedures for feasibility level studies are presented in publications by Warnick (1983), the U.S. Department of the Interior (1976), and Doland (1954). Most consulting

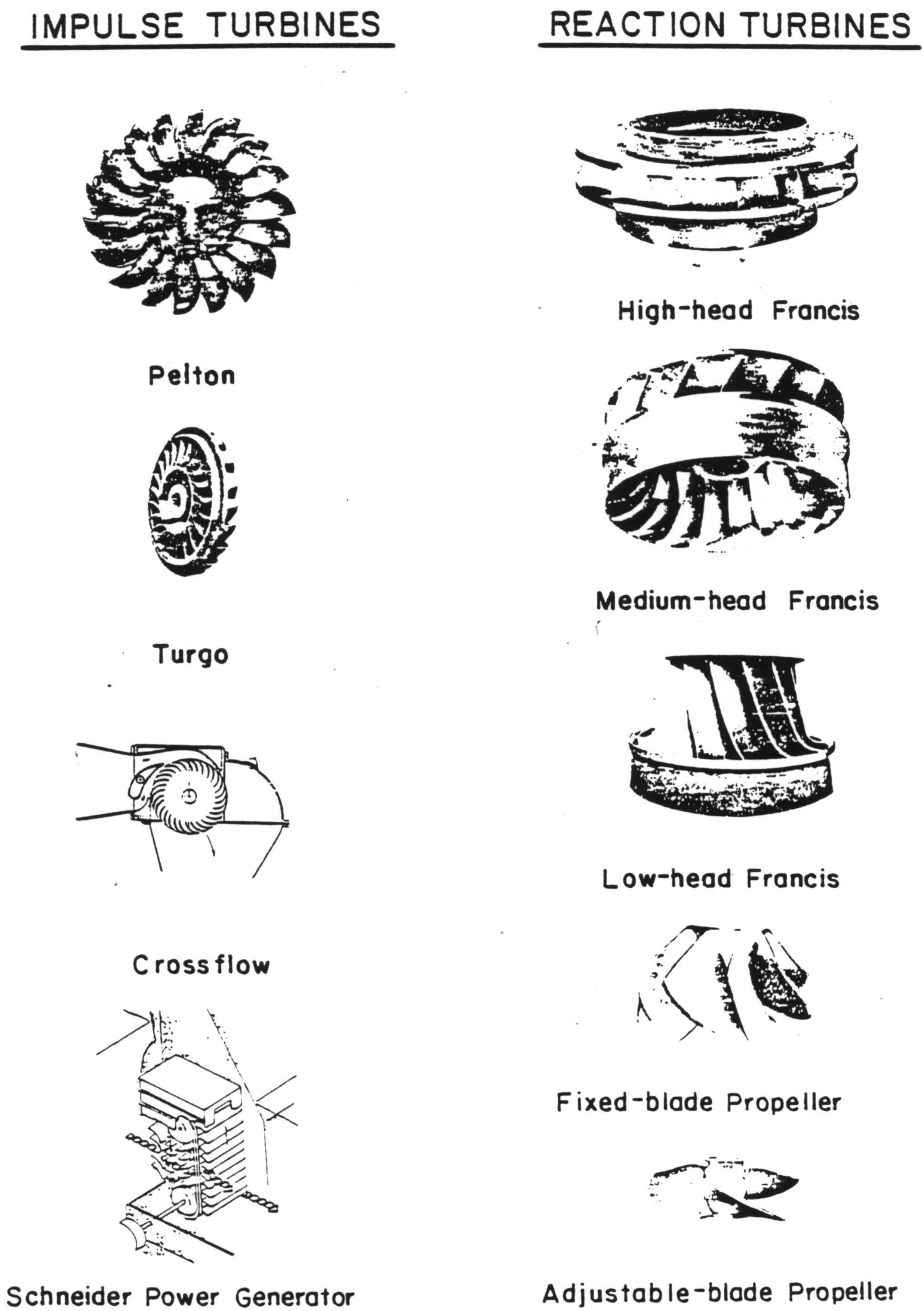
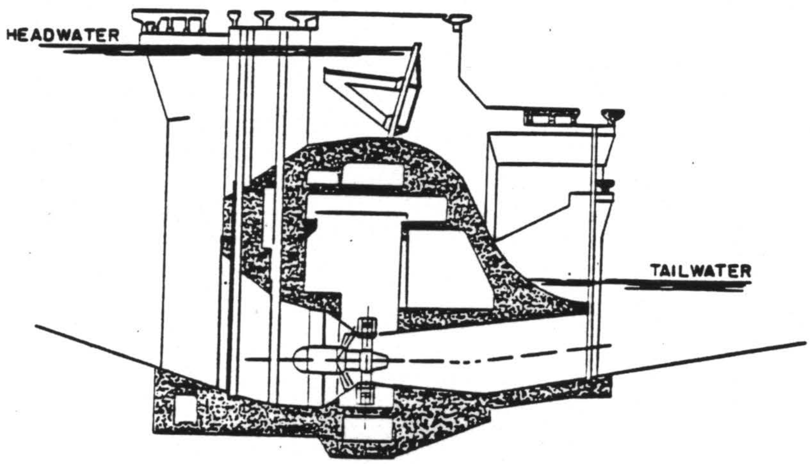
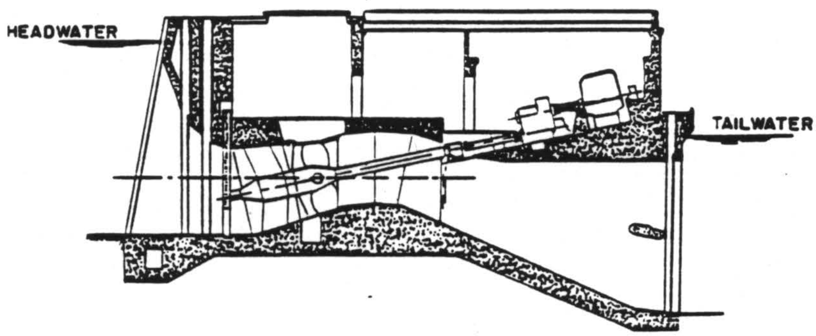


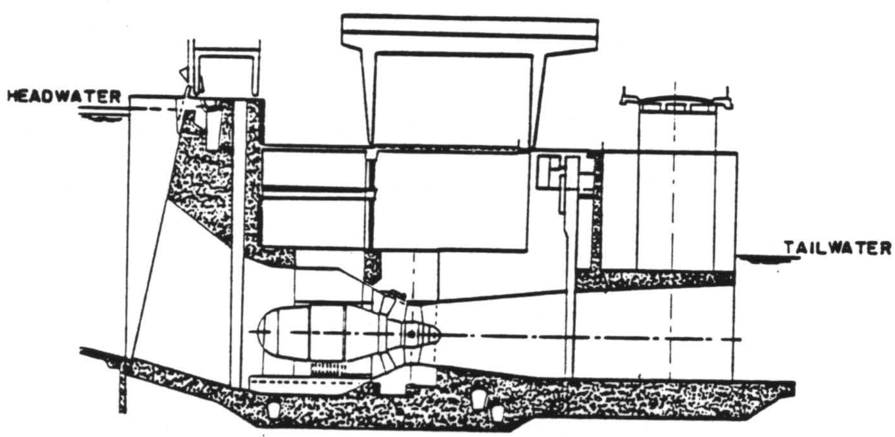
Figure 7. Classification of types of turbines.



Rim-generator turbine

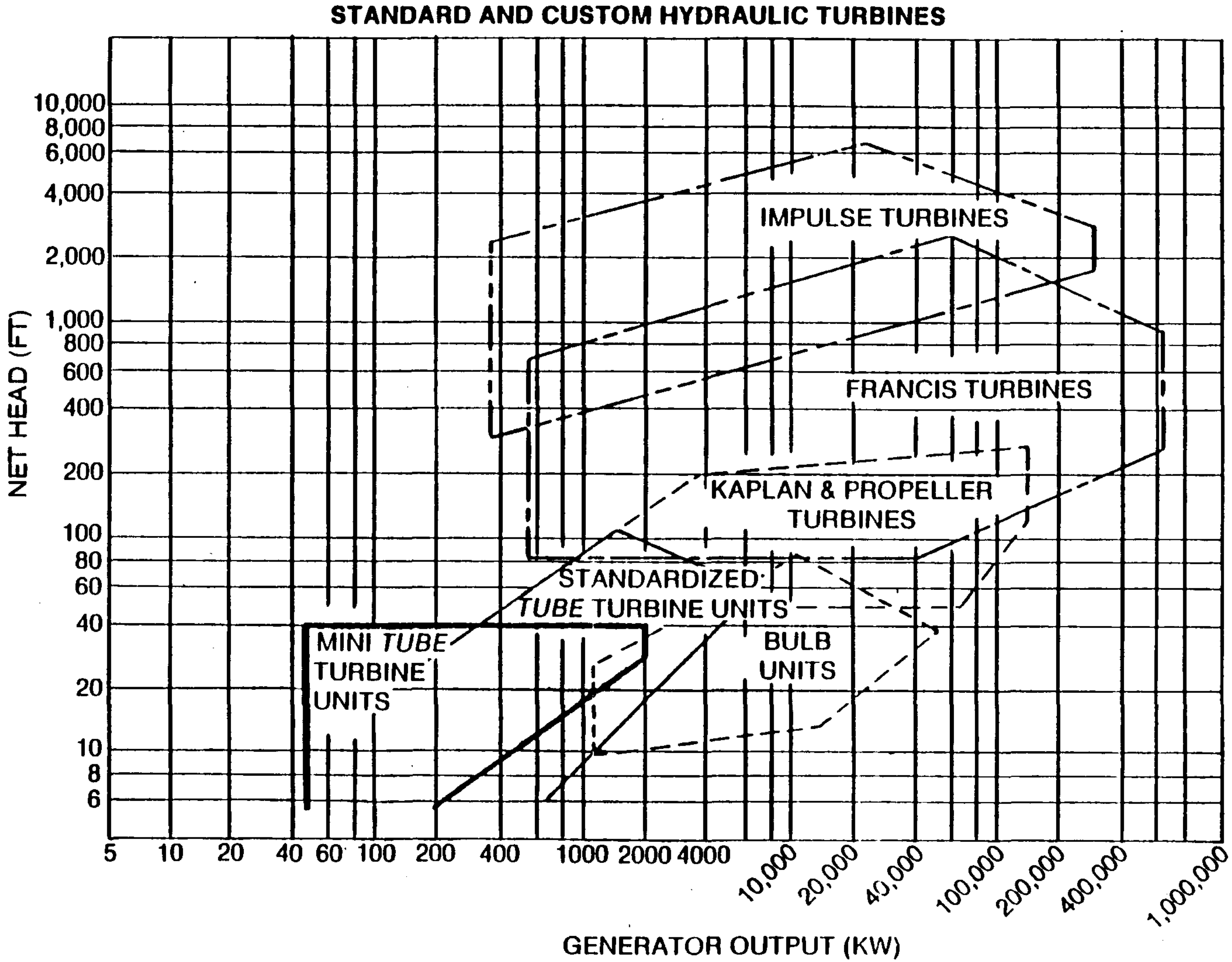


Tubular turbine



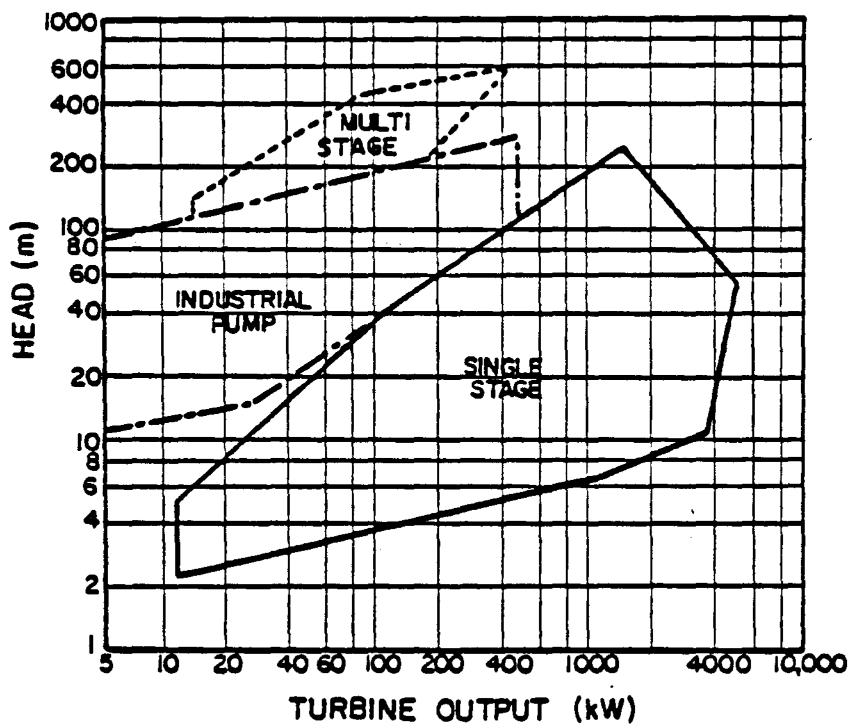
Bulb turbine

Figure 8. Types of low-head propeller type turbines.



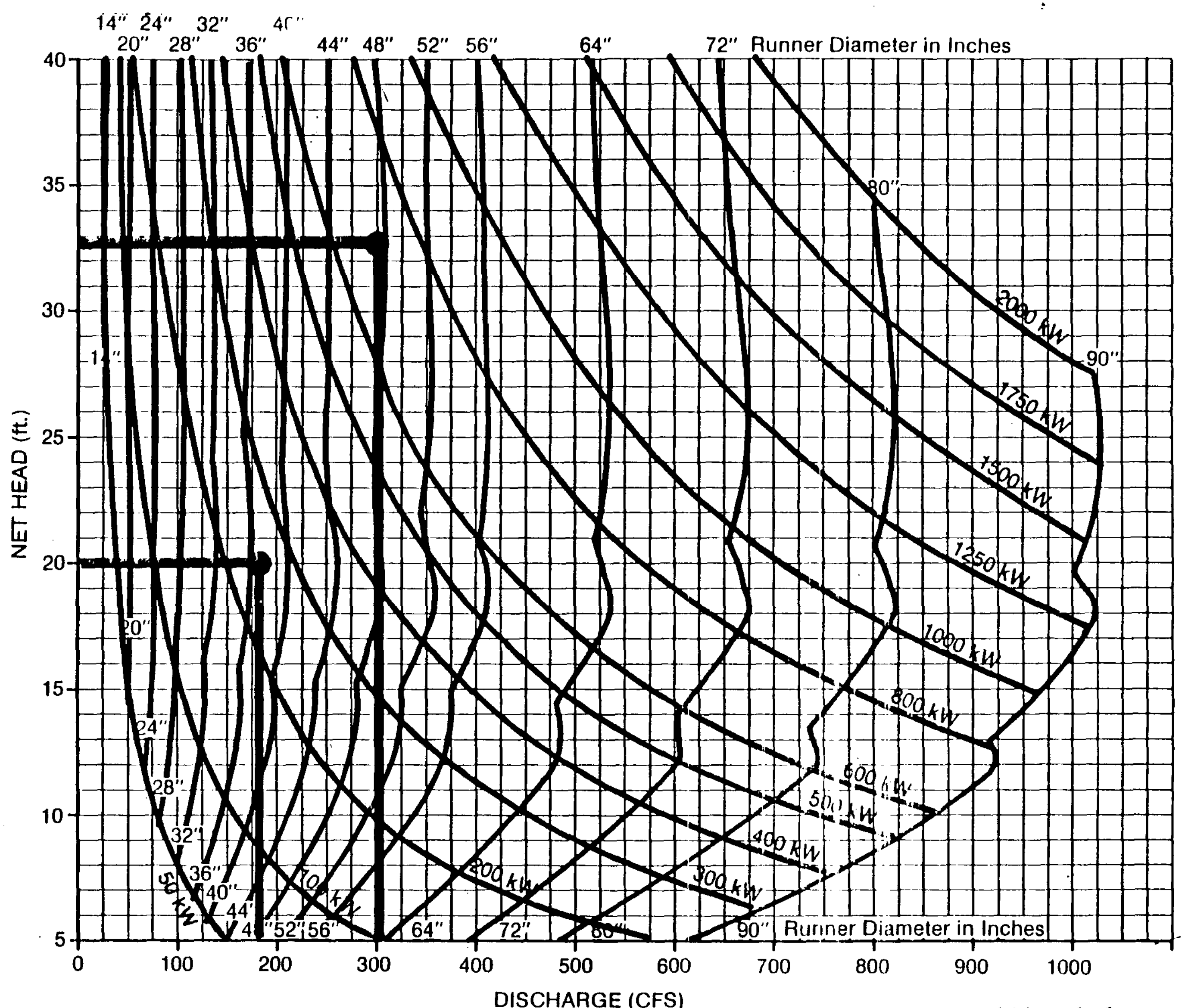
Source: Allis Chalmers

Figure 9. Application ranges for different types of turbines.



Source: Allis Chalmers

Figure 10. Application ranges for different types of pumps as turbines.



Source: Allis Chalmers

Figure 11. Nomograph for sizing small-scale hydroelectric turbines.

firms have proprietary procedures they use and turbine manufacturers prefer even at the feasibility level to make the selection with proprietary information known as "hill" curves. For final design the turbine manufacturer will specify the size along with controlling dimensions of the water passages.

Preliminary Economic Analysis

Early in the study an estimate must be made of the amount of energy that can be produced at a site with a given plant capacity. This means power duration calculation should be made and a power duration curve developed. Figure 12 is representative power duration curve. This represents the variation in power output of the plant with respect to time, expressed as a percent of time the water is available to produce a given amount of power. Thus, it is related to the flow duration curve. Determining this average annual energy production requires first determining the plant capacity. This determination can be a rather sophisticated engineering calculation. Detailed references for this procedure are presented by Broadus (1981) and Warnick (1983). For this manual a very brief presentation is made of the capacity determination and development of data for power duration; to illustrate a procedure for making a preliminary economic analysis.

To facilitate visualizing this procedure, a flow diagram (Figure 13), and a computational table, Table 1, have been developed. At the stage of preliminary analysis it may not be necessary to choose the number of units, just estimate total plant capacity.

The completed computational table, Table 1 has been developed for a hypothetical plant wherein the number of units has not been specified. The first row of the table gives exceedance percentage, the

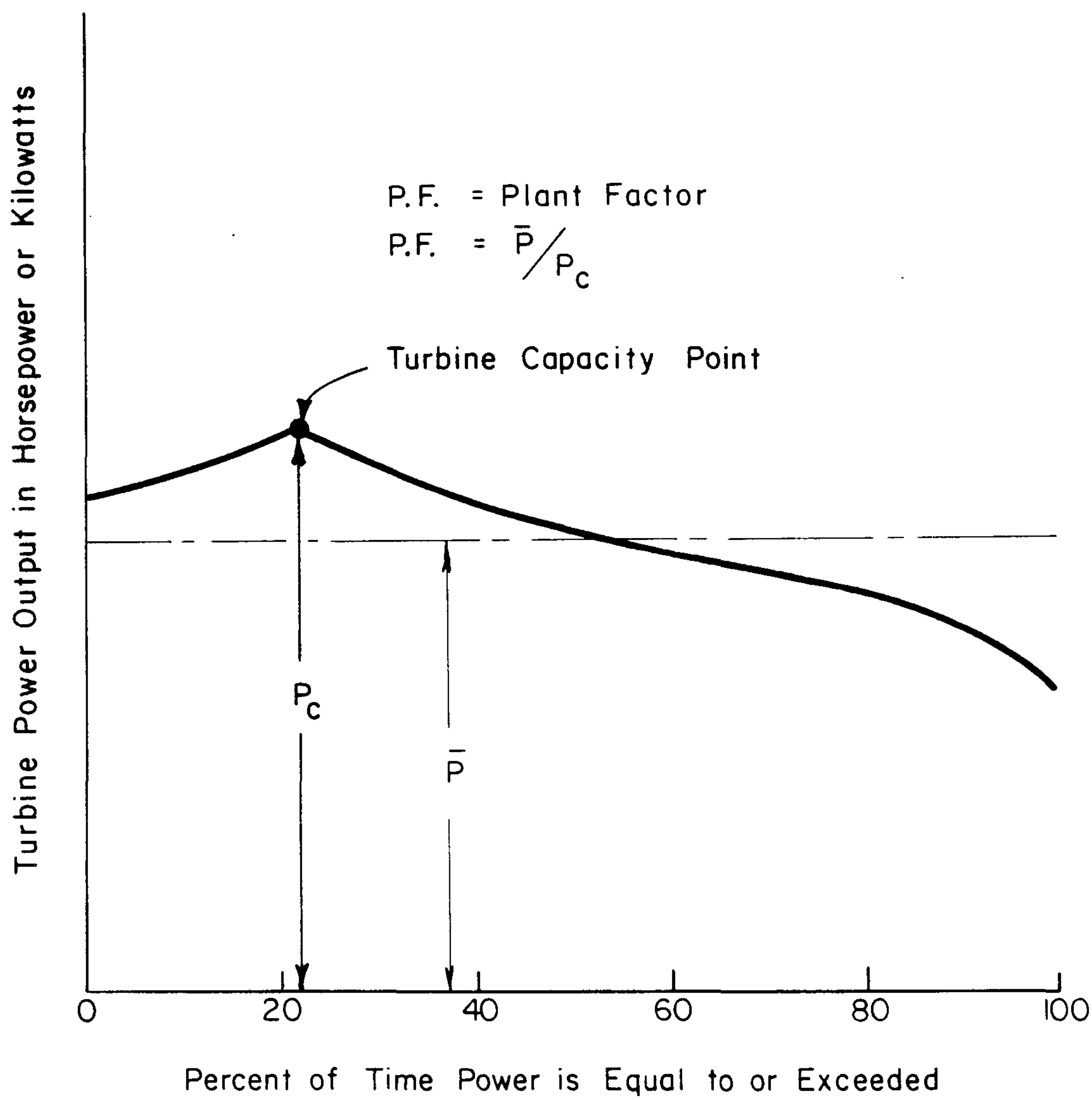


Figure 12. Representative power duration curve.

1. Obtain river flow data for each percent of time. 0% through 100% in at least 10% increments.
2. Determine headwater elevation at each flow characterized by flow duration curve. On run-of-river plants this is often constant.
3. Determine tailwater elevation at each flow characterized by the flow duration curve.
4. Estimate head loss through hydro system. This will vary with penstock and draft tube.
5. Compute a net head for each of the flows characterized. Note, that as river flows increase,tailwater rises and reduces net head.
6. Estimate a plant efficiency,either a constant one or a varying one to be expected as flow is reduced.
7. Choose a wheel or plant capacity flow. This full-gate flow will be limited by runner diameter and selected penstock size.
8. Compute plant discharge at all flow values for each exceedance percentage. Note; at river flows greater than plant capacity the plant discharge will be less than full capacity. See sample computational table.
9. Compute power output at each percent time under investigation.
10. Compute annual energy output for given plant capacity. Repeat this for four or five plant capacities.
11. Estimate the annual plant costs for each of the plant capacities investigated, using estimating curves.
12. With annual energy output calculate plant benefits based on average expected value of power in mills per KWH.
13. Plot a curve or develop table to show where maximum net benefit is obtained.

Figure 13. Flow diagram for plant capacity determination.

Table 1. Plant Capacity Determination and Average Annual Energy Calculations.

(Turbine Full Gate Discharge 470 CFS at 21.0 ft.)

Duration % of Time or Exceedance %	0	10	20	30	40	50	60	70	80	90	100
River Discharge (CFS)	100	635	470	390	340	210	280	265	255	225	101
Head (ft)	15.50	18.8	21.0	23.0	24.5	26.1	27.5	28.5	29.5	30.5	31.2
Plant Discharge Q (CFS)	403.8	444.7	470.0	390.0	340.0	310.0	280	265	255	225	101
Efficiency	89	89	89	89	89	89	89	89	89	89	89
Power (kW)#	469.4	627.0	740.3	672.8	624.8	606.8	577.5	566.4	564.2	514.7	234.0
Percent Time	10	10	10	10	10	10	10	10	10	10	
Energy 100 KWH##	480.2	598.9	618.9	568.3	539.4	518.7	501.0	495.2	472.5	327.9	

Total Energy KWH 5,121,272 ANSWER

$$\# \text{ Power} = \frac{QHe}{11.81} = 0.075\ QH$$

$$\#\# \text{ Energy} = \frac{\text{Percent Time}}{100} \times \frac{(P_1 + P_2)}{2} \times 8760\text{h/year} = (P_1 + P_2)\ 438$$

next row the corresponding river flows. This information is taken from a flow duration study. The next row of information is the net head available at the site. This is the headwater elevation minus tailwater elevation minus losses in the penstock and draft tube. To obtain this information, study must be made of how the headwater elevation is expected to vary and a tailwater curve should be developed based on the cross-sectional areas at the tailrace and the slope of the channel at the tailrace.

Care must be exercised in computing the plant discharge because once the choice for full gate discharge has been made the size of conduit and runner opening is set. The plant discharge cannot be greater than this full gate value. Hence, for exceedance percentages to the left in the computational table, Table 1, of the full-gate point, the discharge through the turbines will actually be less than the full gate discharge. As the net head decreases due to a rising tailwater, the water flow through the turbine decreases. To calculate the plant discharge, use the following formula:

$$Q_i = Q_c \frac{h_i}{h_c} \qquad (3)$$

where Q_i = The plant discharge at the percent exceedance being expressed in CFS

Q_c = The plant discharge at design full gate capacity expressed in CFS

h_i = The net head at the percent exceedance being studied expressed in feet

h_c = The net head at the percent exceedance at which the flow in the river is at design full gate magnitude expressed in feet

In Table 1 note that at 10% exceedance (10% of time) the discharge through the plant has been reduced to 444.7 CFS from the full gate discharge of 470.

In the next row, efficiency has been entered in the example. This has been chosen as a constant value. For preliminary analysis this use of constant efficiency may be justified, but estimates can be made of variation in efficiency based on the relative output and reduced efficiency expected due to reduced Q (discharge) and the reduced H (net head).

With the above information then it is possible to proceed to complete the table. The power output is calculated at each exceedance percentage and then the annual energy production in kilowatt hours is determined. Note that this table illustrates only one set of calculations for a given plant capacity flow. Several sets of calculations using different values for plant capacity discharge must be made to find which gives the most cost-effective size.

Another important concept is understanding the term plant factor. The plant facot, or sometimes called the capacity factor, is the ratio of the average power produced, P to the installed capacity, P^3, or full load capacity. Figure 12 shows graphically what plant factor is.

In the example presented, a total of 5,121,272 KWH is projected as the estimated average annual energy output. The plant actually has capacity to produce power at 672.8 kW throughout the year (8760 hours) but does not have sufficient water. The plant factor in this case then is

$$PF = \frac{\text{Average power produced}}{\text{Theoretical rated capacity to produce power}} = E_a/E_t \quad (4)$$

$$= \frac{5,121.272}{672.8 \times 8760} = 0.87$$

This factor will vary quite widely depending on the shape of the flow duration curve. The fluctuation of the available streamflow that can be diverted and discharged through the turbines is an important factor in the economic analysis. Figure 14 shows graphs of power duration curves that might be representative of different flow situations. In some cases the flow gets so low that the turbine cannot be operated, as is represented by the power duration curve of Figure 14(f). In a very rough and first approximation for a reconnaissance evaluation of a hydropower site, one might just estimate the plant factor at values of 0.3, 0.5, 0.7 and 0.8 and determine whether a site has reasonable likelihood of being capable of producing enough revenue to be economically feasible.

With the hydrologic information known, the net head determined, and the capacity selection made it is then possible to proceed to an economic analysis. The steps in a graphic representation of the analysis process for determining economic feasibility are shown in Figure 15.

The benefit-cost ratio for a projected development must be greater than one for the project to be economically justified. A simplified approach to test economic feasibility is given by the following equation:

$$B/C = \frac{E_a\, p\, (\frac{P}{A}, i\%, n)}{P_c\, I_\$ + E_a\, p_m\, (\frac{P}{A}, i\%, n)} \quad (5)$$

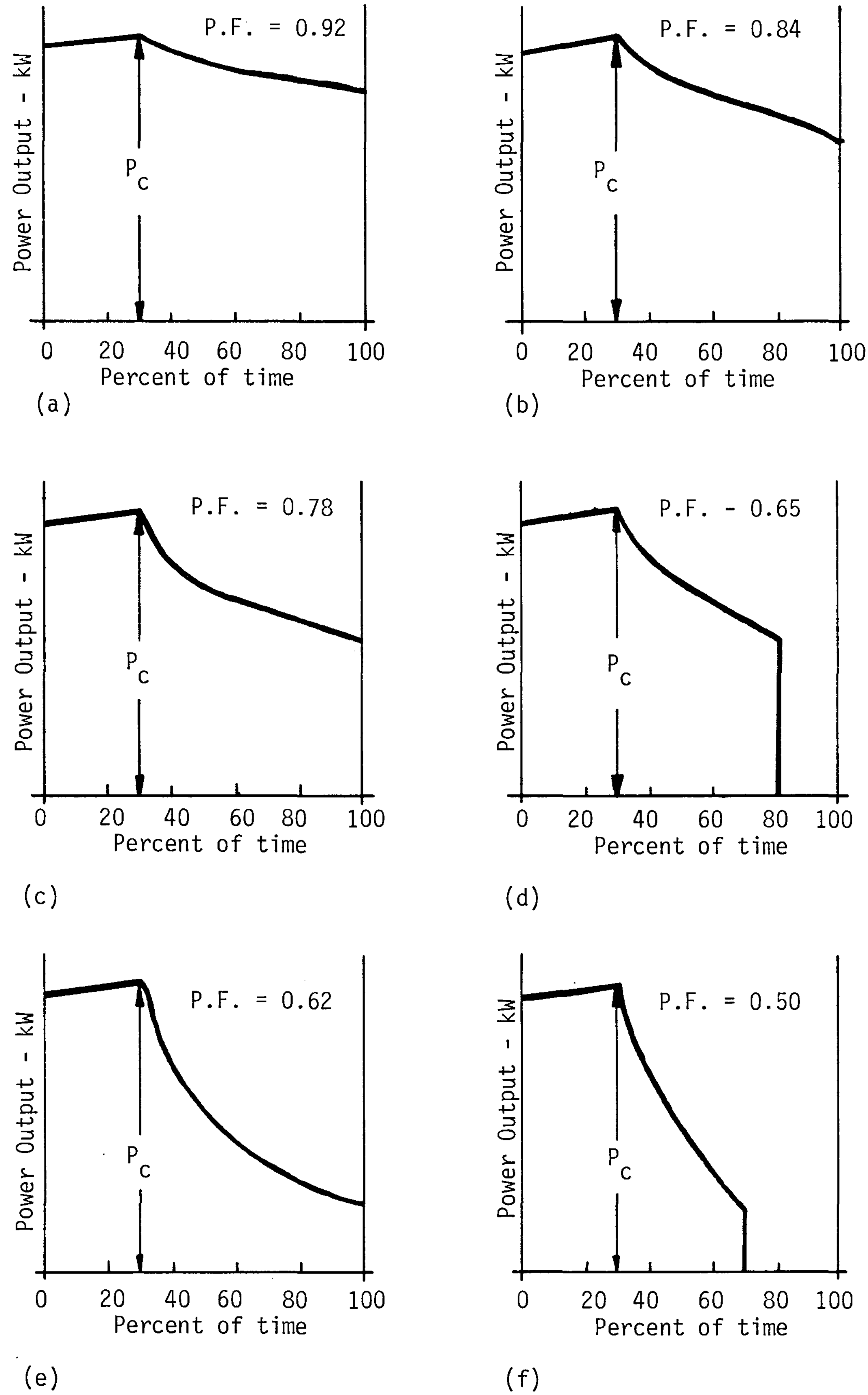


Figure 14. Representative power duration curves showing how plant factor, P.F., varies.

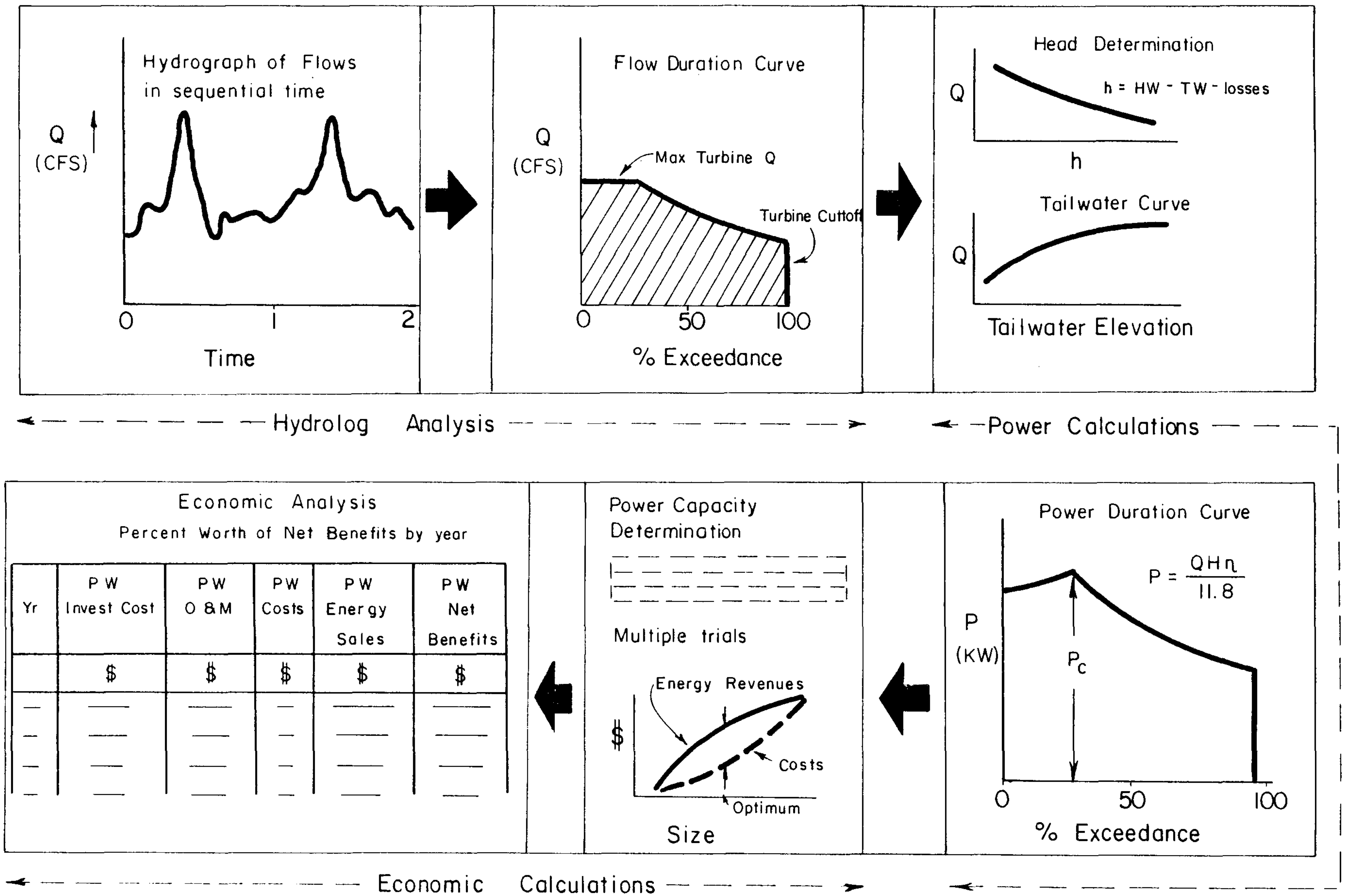


Figure 15. Graphic representation of analytical process for economic feasibility determination.

where B/C = the benefit-cost ratio

E_a = average annual electrical energy output in KWH, the area under a power deviation curve

p = average value or price of the electrical energy per KWH

$(P/A, i\%, n)$ = discounting factor for computing the present worth of the flow future revenues, a series present-worth factor

$$(P/A, i\%, n) = \frac{(1 + i)^n - 1}{i\,(1 + i)^n} \tag{6}$$

where i = the discount rate or interest rate on borrowed money

n = project life of the project usually at least 30 years but may be as great as 50 years

P_c = design power capacity of the plant in KW as determined from calculations like those illustrated in Table 1

$I_\$$ = the total investment cost in dollars per KW.

(more is presented on determining this parameter and sources of obtaining cost estimating information is presented in a later paragraph)

p_m = the annual operation and maintenance cost for operation of this development per KWH, a reasonable first approximation is \$0.003 per KWH. This will depend on whether the plant is manned continually or whether it is remote controlled.

As pointed out in Figure 13 and Table 1 and the accompanying discussion the value for E_a comes from an engineering calculation. The value for p, the sale price of the power, will vary from place to place and from utility to utility. It is frequently referred to as avoided cost. More precise calculation may break this down as to value of firm energy and value of electrical capacity. In 1983 the value in Idaho should be at least 30 cents per KWH but the developer should discuss with the purchasing utility or utilities this value of the energy produced.

The interest rate of borrowed money for financing the project will vary and for preliminary analysis one might try different rates. A later example shows how the interest rate influences the economic feasibility. Early in the project study the developer should contact banks and obtain the help of a competent financial consultant to get realistic estimates of costs of money.

The estimation of total investment costs, $I_{\$}$, is probably the most important challenge to the developer. Many shortcuts and cost savings can be achieved but cutting corners may lead to an unsound project. Figure 16 as taken from the work of Cunningham (1982) and as prepared by Ott illustrates the relative magnitude of different components od the investment cost. Several recent publications are available for giving cost data: "Feasibility Studies for Small Hydropower Additions - A Guide Manual", U.S. Army Corps of Engineers (1979), "Reconnaissance Evaluation of Small Low-Head Hydroelectric Installations", U.S. Department of the Interior (1980), "Simplified Methodology for Economic Screening of Potential Low-Head Small-Capacity Hydroelectric Sites, Electric Power Research Institute (1981) and "Hydropower Cost Estimating Manual", U.S. Army Corps of Engineers (1979). The total investment cost in 1983 dollars may range from $800 per kW to $3500 per kW depending on many factors. To illustrate how

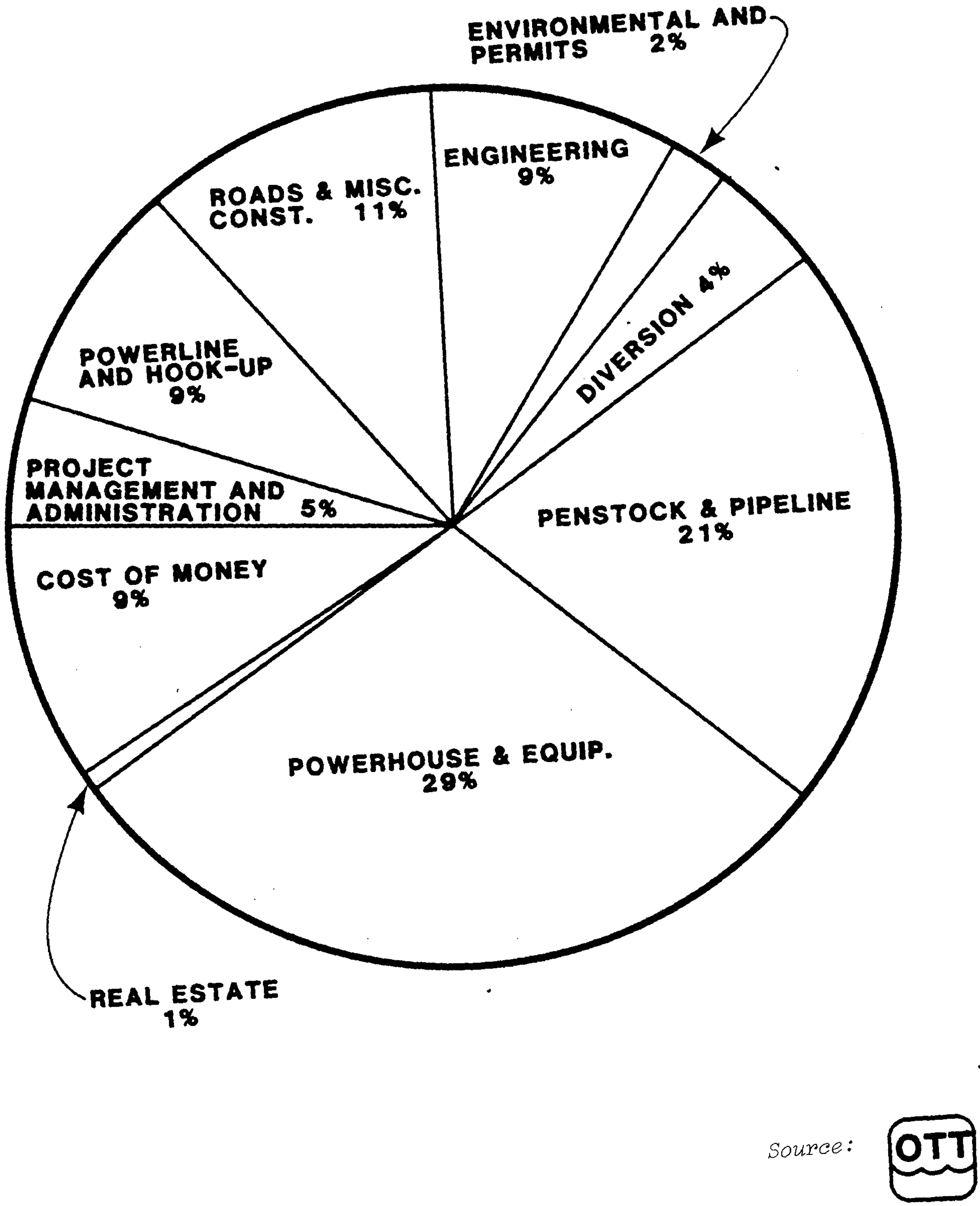


Figure 16. Different components of investment costs and their relative magnitude.

these various factor influence the component parts of Equation 5, Gladwell (1980) prepared a hypothetical example that is reproduced here to help in determining economic feasibility. In his example he has used a somewhat sophisticated form of Equation 5, in that he has allowed for inflation.

The example indicated an average annual energy output of 20,000,000 KWH/year, so the plant factor, P.F. would be 0.38.

HYDRO EXAMPLE

GIVEN:

a. Installed capacity is 6000 kW or 6 MW

b. Investment or capital costs are to be from $1000 to $3500 per installed kilowatt in $500 increments

c. Investment costs are funded by a 40-year loan (alternatively at 7%, 10%, and 15%)

d. Operation and maintenance costs assumed to be $50,000 the first year for all conditions

e. Energy output, E_a, is 20,000,000 KWH per year

f. Energy value during the first year is assumed to vary between 20 and 50 mills per KWH (increments of 5 mill per KWH). This may be assumed to be the cost of purchasing energy from an alternative source or an avoided cost.

g. Inflation rate of 5% per year assumed to apply to the O & M costs and to the energy value.

h. Present worth is calculated using the assumed interest rate for the 40-year loan (7%, 10%, and 15%).

ANALYSIS AND SOLUTION

Table 2 shows a typical computer output for the hypothetical Hydro Example. Results of energy cost calculations for the various combinations of assumptions is shown in Figure 17. It should be noted that the value of 5% inflation assumption has been very conservative for the last several years. The effect of increased interest is quite evident. This is further illustrated in Figure 18 in which the effect on the Benefit-Cost Ratio (present worth) is shown both as a function of interest rates, and cost of alternative energy. The three parts of Figure 18 are then summarized in Figure 19 which shows the break point for a Benefit-Cost Ratio of unity as a function of interest rate, cost of alternative energy, and the hydro capital cost.

And, finally, because proper financing must consider cash-flow, Figure 20 illustrates the periods of time before which a development's benefits can be expected to exceed the costs (for the 7% case).

It should be noted that the variability of interest rates is very much a function of borrowing situation. It is thus quite possible for a particular site to be "unfeasible" to one group while being a profitable investment to another. As a result, the "financing" arrangements can be very important in hydro development.

An additional example is presented to show a very abbreviated and simplified approach to give a first approximation of economic feasibility.

SIMPLIFIED EXAMPLE

GIVEN:

a. Plant capacity is 740 kW

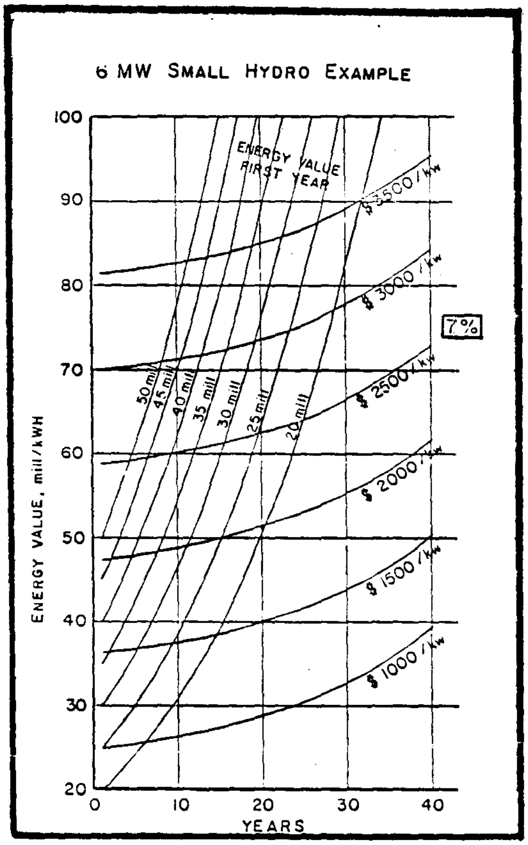
b. Estimated flow duration curve indicates power duration curve similar to Figure 14e so plant factor of 0.62 is assumed, p.

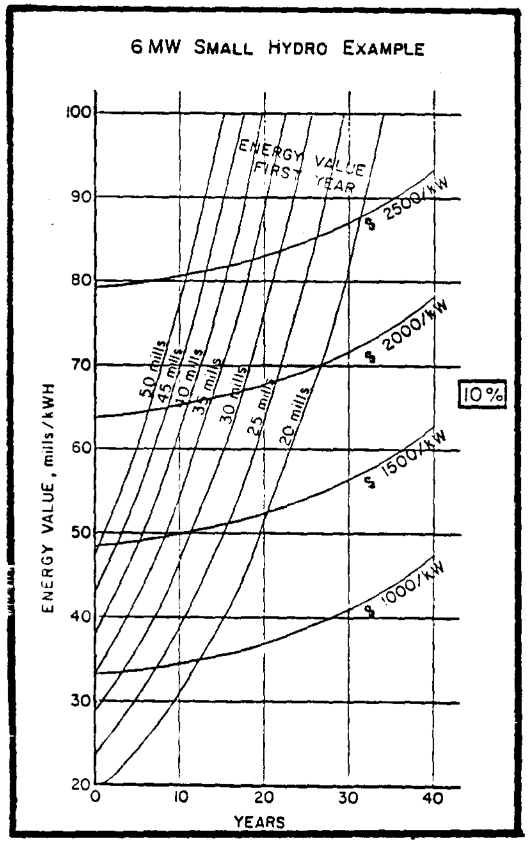
Table 2. Computer Output for Economic Analysis for Hypothetical Hydro Example.

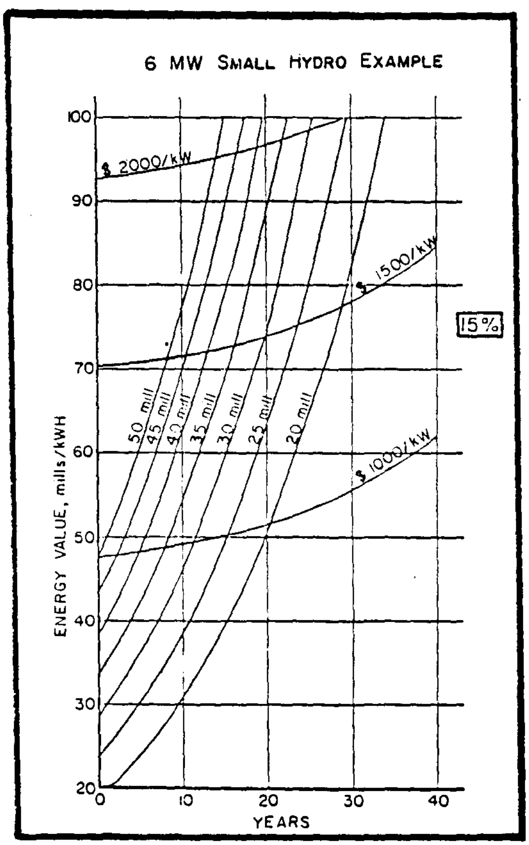
YEAR	REPAY ($) (40-year/10%)	O & M ($)	TOTAL ($)	HYDRO Mill rate (mills/kwh)	ENERGY PURCHASE ($)	PURCHASE Mill rate (mills/kwh)	PWF (10%)	PW COST ($)	PW BENEFIT ($)	PW SURPLUS ($)
1	920335.00	50000.00	970335.00	48.52	800000.00	40.00	0.9090914	882123.13	727273.06	-154850.06
2	920335.00	52500.00	972834.94	48.64	839999.94	42.00	0.8264475	803997.00	694215.88	-109781.13
3	920335.00	55124.99	975459.94	48.77	881999.88	44.10	0.7513167	732879.31	662661.25	-70218.06
4	920335.00	57881.24	978216.19	48.91	926099.81	46.30	0.6830157	668137.00	632540.69	-35596.31
5	920335.00	60775.30	981110.25	49.06	972404.75	48.62	0.6209239	609194.81	603789.38	-5405.44
6	920335.00	63814.06	984149.00	49.21	1021024.94	51.05	0.5644767	555529.19	576344.81	20815.63
7	920335.00	67004.75	987339.75	49.37	1072076.00	53.60	0.5131614	506664.56	550147.94	43483.38
8	920335.00	70354.94	990689.94	49.53	1125679.00	56.28	0.4665107	462167.38	525141.19	62973.81
9	920335.00	73872.63	994207.62	49.71	1181962.00	59.10	0.4241009	421644.38	501271.19	79626.81
10	920335.00	77566.25	997901.25	49.90	1241060.00	62.05	0.3855467	384737.50	478486.56	93749.06
11	920335.00	81444.50	1001779.50	50.09	1303112.00	65.16	0.3504974	351121.06	456737.31	105616.25
12	920335.00	85516.69	1005851.69	50.29	1368267.00	68.41	0.3186342	320498.69	435976.56	115477.88
13	920335.00	89792.50	1010127.50	50.51	1436680.00	71.83	0.2896676	292601.19	416159.63	123558.44
14	920335.00	94282.06	1014617.06	50.73	1508513.00	75.43	0.2633345	267183.63	397243.44	130059.81
15	920335.00	98996.13	1019331.13	50.97	1583938.00	79.20	0.2393953	244023.00	379187.25	135164.25
16	920335.00	103945.88	1024280.88	51.21	1663134.00	83.16	0.2176322	222916.44	361951.44	139035.00
17	920335.00	109143.13	1029478.13	51.47	1746290.00	87.31	0.1978475	203679.69	345499.19	141819.50
18	920335.00	114600.25	1034935.25	51.75	1833604.00	91.68	0.1798616	186145.06	329794.94	143649.88
19	920335.00	120330.25	1040665.25	52.03	1925284.00	96.26	0.1635107	170159.94	314804.56	144644.63
20	920335.00	126346.75	1046681.75	52.33	2021548.00	101.08	0.1486462	155585.25	300495.50	144910.25
21	920335.00	132664.06	1052999.00	52.65	2122625.00	106.13	0.1351330	142294.94	286836.69	144541.75
22	920335.00	139297.25	1059632.00	52.98	2228756.00	111.44	0.1228483	130174.00	273798.94	143624.94
23	920335.00	146262.06	1066597.00	53.33	2340193.00	117.01	0.1116804	119118.00	261353.75	142235.75
24	920335.00	153575.13	1073910.00	53.70	2457202.00	122.86	0.1015278	109031.63	249474.19	140442.56
25	920335.00	161253.88	1081588.00	54.08	2580062.00	129.00	0.0922980	99828.44	238134.63	138306.19
26	920335.00	169316.56	1089651.00	54.48	2709065.00	135.45	0.0839074	91429.69	227310.50	135880.81
27	920335.00	177782.38	1098117.00	54.91	2844518.00	142.23	0.0762795	83763.81	216978.44	133214.63
28	920335.00	186671.44	1107006.00	55.35	2986743.00	149.34	0.0693451	76765.38	207115.81	130350.44
29	920335.00	196005.00	1116340.00	55.82	3136080.00	156.80	0.0630410	70375.13	197701.50	127326.38
30	920335.00	205805.19	1126140.00	56.31	3292883.00	164.64	0.0573101	64539.20	188715.44	124176.19
31	920335.00	216095.44	1136430.00	56.82	3457527.00	172.88	0.0521002	59208.17	180137.63	120929.44
32	920335.00	226900.19	1147235.00	57.36	3630403.00	181.52	0.0473638	54337.40	171949.63	117612.19
33	920335.00	238245.19	1158580.00	57.93	3811923.00	190.60	0.0430580	49886.17	164133.88	114247.69
34	920335.00	250157.44	1170492.00	58.52	4002519.00	200.13	0.0391437	45817.39	156673.38	110855.94
35	920335.00	262665.25	1183000.00	59.15	4202644.00	210.13	0.0355852	42097.32	149552.00	107454.63
36	920335.00	275798.50	1196133.00	59.81	4412776.00	220.64	0.0323502	38695.17	142754.25	104059.06
37	920335.00	289588.38	1209923.00	60.50	4633414.00	231.67	0.0294093	35583.02	136265.56	100682.50
38	920335.00	304067.75	1224402.00	61.22	4865084.00	243.26	0.0267358	32735.32	130071.75	97336.38
39	920335.00	319271.13	1239606.00	61.98	5108338.00	255.42	0.0243053	30128.96	124159.50	94030.50
40	920335.00	335234.63	1255569.00	62.78	5363754.00	268.19	0.0220957	27742.69	118515.94	90773.19

BENEFIT/COST RATIO (PW) = 1.37

6 Mw/20,000,000 kwh Annual Energy
40 mill/kwh Thermal Energy Purchase Alternatives
Capital Cost: $1500/kw installed
Assumed interest rate: 10%
Assumed 5% annual inflationary rate on O & M and Purchase Energy

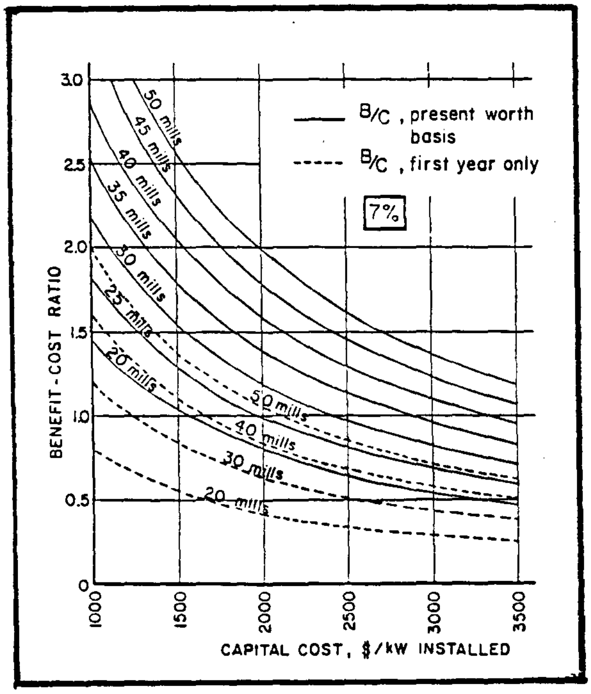


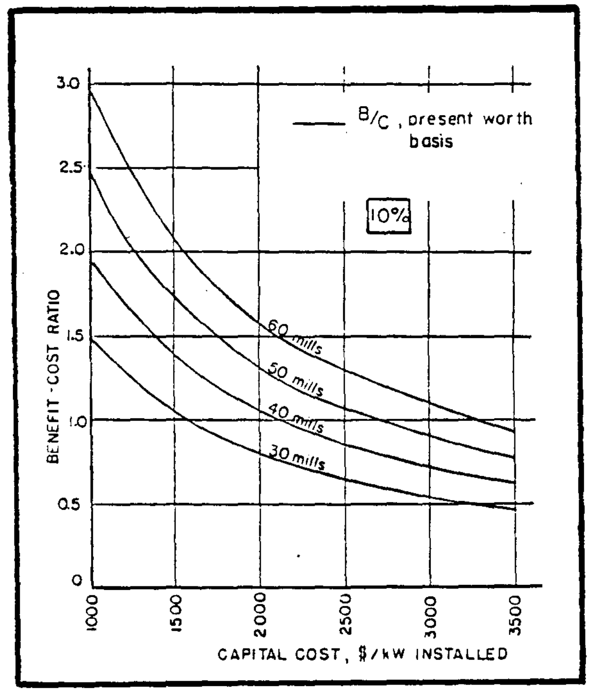




Source: Gladwell (1980)

Figure 17. Cost of hydro and value of energy with varying interest rates.





Source: *Gladwell (1980)*

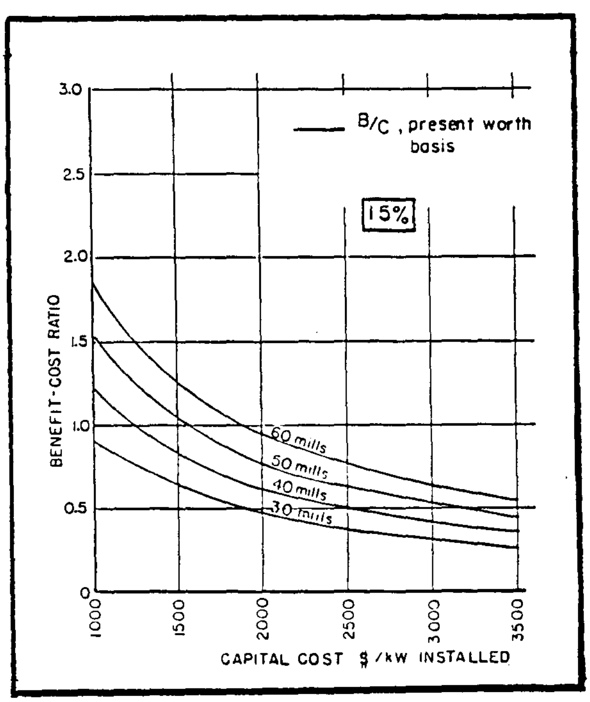
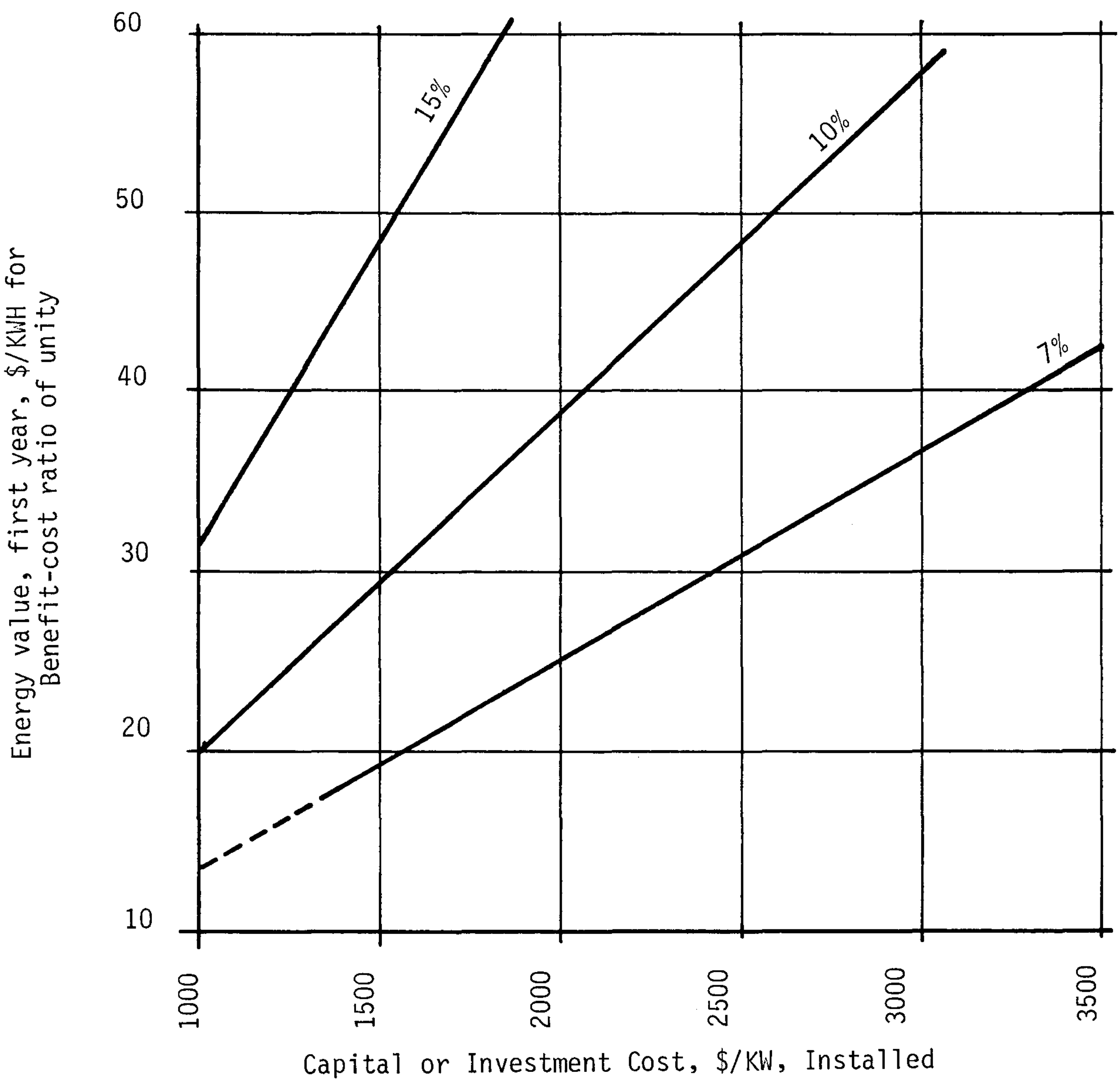


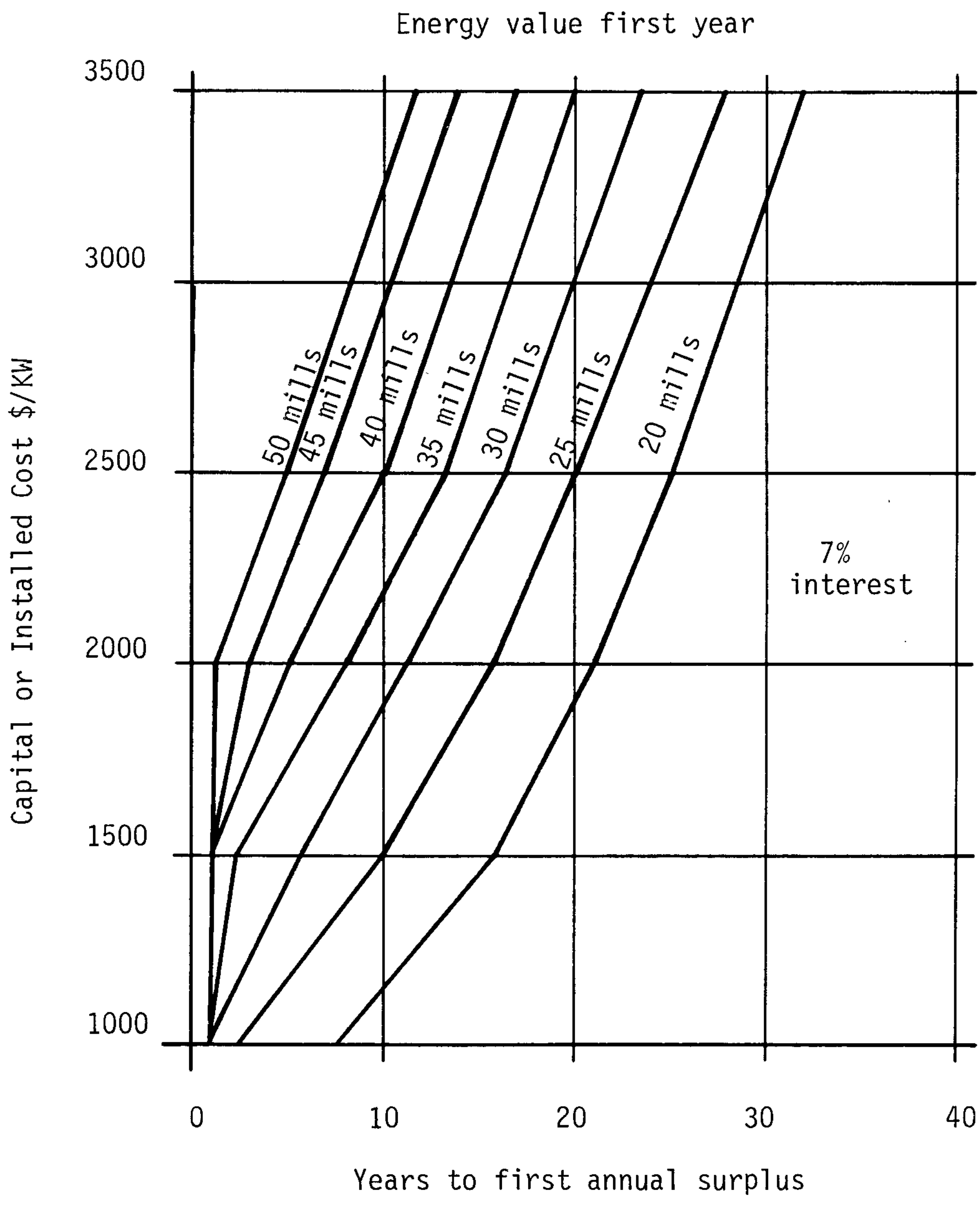
Figure 18. Variation of benefit-cost ratio for different capital costs and different interest rates.

6 MW plant



Source: Gladwell (1980)

Figure 19. Energy value variation for B/C ratio of one with various capital costs and different interest rates.



Source: Gladwell (1980)

Figure 20. Variation of year-to-first-annual surplus as influenced by capital cost and interest rate.

c. Estimated average sale price of power is 35 mills/KWH

d. Interest, i, on borrowed money is 12%.

e. Estimated total investment cost of power development equals $1500/KW.

f. Project life, n, 40-years.

g. Operation and maintenance cost for each year on the average life of project is $0.004/KWH.

REQUIRED:

To determine first approximation of economic feasibility of project.

ANALYSIS AND SOLUTION:

Using Equation 4, find E_a annual energy output

$$E_a = P_c \times P.F. \text{ (time)} = 740 \times 0.62 \times 8760 = 4{,}019{,}088 \text{ KWH}$$

Using Equation 6, find present worth factor

$$\left(\frac{P}{A}, i\%, n\right) = \frac{(1.12)^{40} \quad -1}{(0.12)(1.12)^{40}} = 8.2438$$

Now using Equation 5, find Benefit-cost ratio

$$B/C_{\text{for this example}} = \frac{(4{,}019{,}088)(0.035)(8.2438)}{(740)(1500) + 4{,}019{,}088(0.003)(8.2438)}$$

$$= \frac{1{,}159{,}640}{1{,}119{,}940} = 1.04 \qquad \text{ANSWER}$$

A benefit-cost ratio of 1.04 indicates the project is feasible. However, at a sale price of 30 mills/KWH the benefit-cost ratio would be 0.89 and the project would not be economically feasible. This shows how sensitive the economic feasibility can be. An alternative empirical equation for calculating the annual operating cost (as given by Cunningham (no date) and credited to Tudor) is:

$$A_{c_{O\,\&\,M}} = 17{,}200\left(\frac{P_c}{1000}\right)^{0.543} \qquad (7)$$

where $A_{c_{O\,\&\,M}}$ = annual operation and maintenance cost in dollars

P_c = power plant capacity in kW

More detail on approaches to analyzing economic feasibility are presented in the following publications, Abramowitz, D.E. (1977), Goodman and Brown (1979) and Warnick (1983). Points considering tax incentives have not been discussed in this treatment of economic analysis and the way in which taxes are treated can have a bearing on the economic viability of a project.

Other Engineering Considerations

In planning for a hydropower development, after the determination of the size of the installation and the magnitude of flow diversion an important consideration is determining how excess water will be bypassed at the place where the hydropower diversion is to be made. Flood studies must be made and adequate spillway capacity provided.

Road access, transmission lines and rights-of-way for the roads and transmission lines must be provided for in the planning. Frequently on higher head installations a penstock must be used to take the water from the headwater forebay to the turbine. Provision must be made for the route of the penstock and for design of the penstock as to diameter, thickness, type of material and anchors for the penstock. These necessary items require special design calculations. Good references for the penstock design are U.S. Bureau of Reclamation Monographs 3 (1967) and Monograph 7 (1977). An important part of the hydropower plant is the power house which for small turbines can be a relatively simple structure. This will require a design that meets building codes in the area in which you are building your plant. The recommendation here again is that a competent engineering firm be retained to complete this part of the planning and design.

A further engineering need is to have suitable electrical components such as generators, transformers, switch gear and interconnection equipment. These must be carefully planned and designed in cooperation with the purchasing utility. On small plants it may be cost- effective to use induction generators.

Normally it will be best to get the help of an experienced engineering firm that has done hydropower studies to make the aforementioned feasibility analyses. Engineering firms operating in Idaho and information on their availability can be obtained by contacting the Idaho Engineering Registration Board or the Idaho Society of Professional Engineers. The address for the two entities is the same and is:

842 LaCassia Drive
Boise, Idaho 83705

LICENSING, PERMITS AND INSTITUTIONAL CONSIDERATIONS

This section of the manual is intended to serve as a guide to developers in their efforts to satisfy the local, state, and Federal requirements for constructing and operating a hydroelectric plant in Idaho. Figure 21 is a diagram that shows how permitting and licensing fit into the engineering aspects of a hydropower investigation. These permitting and licensing requirements include a wide variety of issues such as legal compliance public safety, and environmental concerns.

Although numerous agencies and entities have potential permitting or review authority, small projects may not need all the permits and fit into the engineering aspects of a hydropower investigation. These permitting and licensing requirements include a wide variety of issues such as legal compliance public safety, and environmental concerns.

Although numerous agencies and entities have potential permitting or review authority, small projects may not need all the permits and reviews. Nevertheless, conducting necessary studies and filing for permits and licenses will require considerable time and extend over a substantial part of the total development and construction period.

In spite of the difficulty in obtaining the necessary permits and licenses, the process is beneficial because it forces attention early in the planning on many potential problems that are likely to arise. Care should be exercised to push efforts on several fronts at the same time. The following discussion centers on pointing out the many regulations and entities that are involved in the permitting and licensing process and is presented in the order noted in the flow diagram of Figure 21.

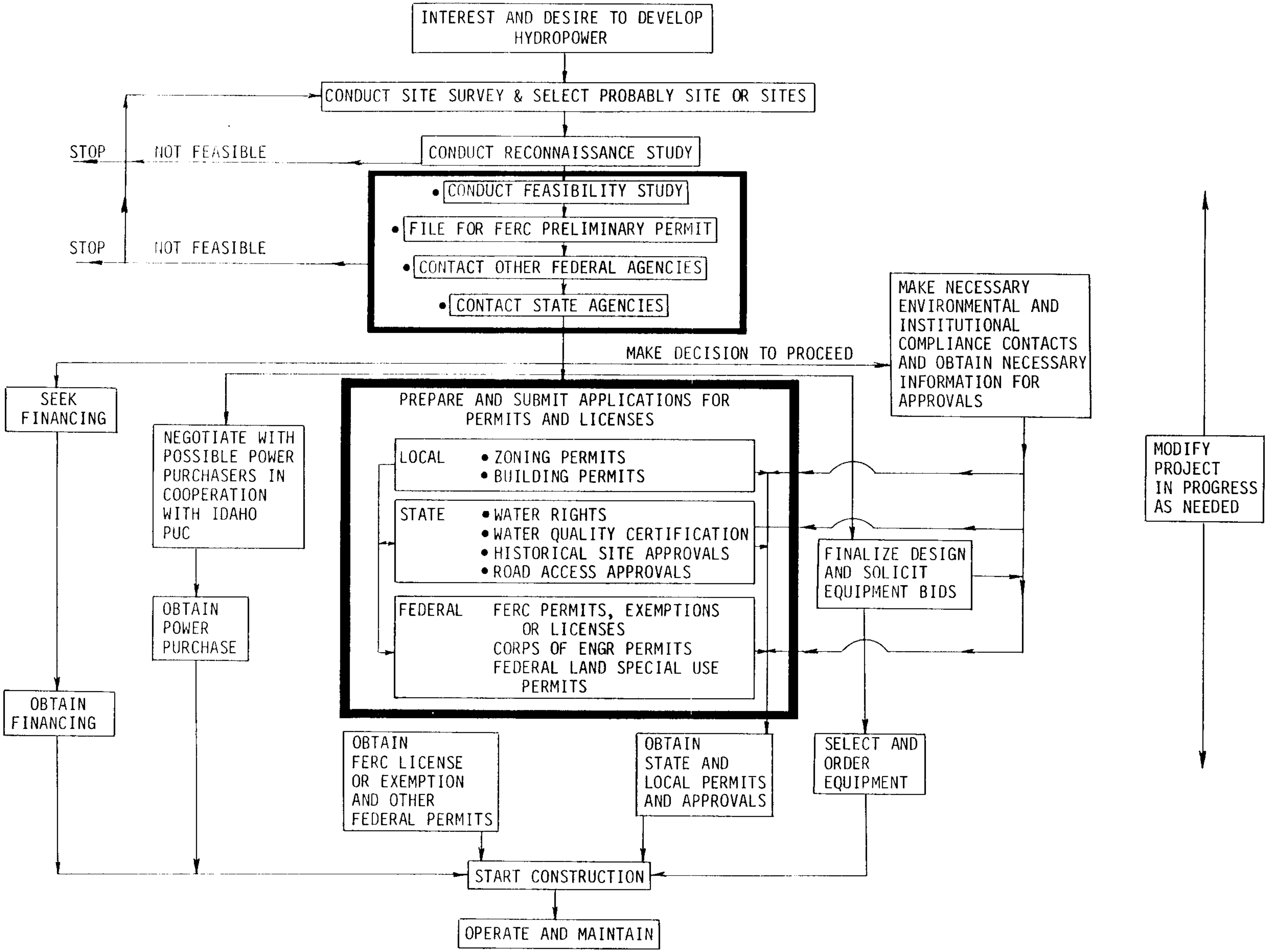


Figure 21. Diagram showing the various tasks involved in the planning, designing, constructing and operating a small-scale hydro development.

Local Permitting Process

Early in the project study, the developer should contact local governments such as cities, counties, flood control districts, road districts, and drainage districts that might be impacted by the hydro power development. Most county governments in Idaho require a construction permit for developments over a minimum investment value. This covers such items as building code compliance, electrical code compliance and plumbing code compliance. In most counties in Idaho a planning and zoning commission reviews plans for developments such as hydropower facility. Contacting the administrative officials in the county courthouse will give the developer the names of those who must be contacted and give information as to what kind of certificates of compliance will be necessary. If the development site is near a city, contact should also be made with city officials, because frequently the city has jurisdiction over regions that are defined as areas of urban impact around the city.

If a hydropower plant is located on a stream which is in a flood control district it will be necessary to get permission to construct and operate under restraints of the flood control district. If flood control districts are functioning in a county this can be learned from county administrative officials.

Permits which may be required by local governmental units include the following:

a. County zoning, compliance with comprehensive plan
b. Building permit
c. Road permits and temporary road closures
d. Flood plain permits

All local permit requirements must be met prior to or concurrently with applications for use and occupancy of federal land and for applications to the Federal Energy Regulatory Commission (FERC) for exemption and licenses.

In some cases there may be requirements for public hearings conducted by the local governments, like a county planning and zoning commission hearing. The time requirements for local permitting should not exceed 2 to 3 months.

State Permitting Requirements

In Idaho, the principal state requirements include: (1) water rights, (2) dam safety compliance, (3) state environmental considerations and compliance, (4) historical and archeological considerations, (5) state land use permits, and (6) transportation permits. The water rights permits and dam safety permits must be obtained from the Idaho Department of Water Resources.

Water Rights. The water right permit should be obtained as early as possible because the priority date of application may be a deciding point when there are competing applications for the same water or for the same development site. Figure 22 is a copy of the form for filing an application for a permit to appropriate water in Idaho. This utilizes Form 202 dated 3/78. Form I-202 of the State of Idaho Department of Water Resources gives detailed instruction for filing Form 202 an application for a water permit. A fee schedule for the filing is included in the instruction forms. The forms and fee schedule can be obtained from the following offices:

Form 202
3/78

Ident. No. ________

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
APPLICATION FOR PERMIT

To appropriate the public waters of the State of Idaho

1. Name of applicant ____________________ Phone ____________

 Post office address ______________________________

2. Source of water supply ____________ which is a tributary of ____________

3. Location of point of diversion is ______ ¼ of ______ ¼ of Section ______ Township ______

 Range ______ B.M. ____________ County, additional points of diversion if any: ____

 ____

4. Water will be used for the following purposes:

 Amount ______ (cfs or acre-feet per annum) for ____________ purposes from ______ to ______ (both dates inclusive)

 Amount ______ (cfs or acre-feet per annum) for ____________ purposes from ______ to ______ (both dates inclusive)

 Amount ______ (cfs or acre-feet per annum) for ____________ purposes from ______ to ______ (both dates inclusive)

 Amount ______ (cfs or acre-feet per annum) for ____________ purposes from ______ to ______ (both dates inclusive)

5. Total quantity to be appropriated:

 a. ____________ cubic feet per second and/or b. ____________ acre-feet per annum.

6. Proposed diverting works:

 a. Description of ditches, flumes, pumps, headgates, etc. ______________________________

 ____

 ____

 b. Height of storage dam ______ feet, active reservoir capacity ______ acre-feet; total reservoir capacity ______ acre-feet, materials used in storage dam: ____________

 Period of year when water will be diverted to storage ______ (Month/Day) to ______ (Month/Day) inclusive.

 c. Proposed well diameter is ______ inches; proposed depth of well is ______ feet.

7. Time required for the completion of the works and application of the water to the proposed beneficial use is ______ years *(minimum 1 year – maximum 5 years)*.

8. Description of proposed uses:

 a. If water is not for irrigation:

 (1) Give the place of use of water: ______ ¼ of ______ ¼ of Section ______ Township ______

 Range ______ B.M.

 (2) Amount of power to be generated: ______ horsepower under ______ feet of head.

 (3) List number of each kind of livestock to be watered ______________________________

 ____

 (4) Name of municipality to be served ____________, or number of families to be supplied with domestic water ______.

 (5) If water is to be used for other purposes describe: ______________________________

 ____

 ____

Figure 22. Copy of form for filing for water rights in Idaho.

b. If water is for irrigation, indicate acreage in each subdivision in the tabulation below:

TWP	RANGE	SEC.	NE¼				NW¼				SW¼				SE¼				TOTALS
			NE¼	NW¼	SW¼	SE¼	NE¼	NW¼	SW¼	SE¼	NE¼	NW¼	SW¼	SE¼	NE¼	NW¼	SW¼	SE¼	

Total number of acres to be irrigated ________

c. Describe any other water rights used for the same purposes as described above. ________

____

____

9. a. Who owns the property at the point of diversion ________

b. Who owns the land to be irrigated or place of use ________

c. If the property is owned by a person other than the applicant, describe the arrangement enabling the applicant to make this filing ________

____

____

10. Remarks ________

____

11. Map of proposed project: show clearly the proposed point of diversion, place of use, section number, township and range number.

Scale: 2 inches equal 1 mile.

BE IT KNOWN that the undersigned hereby makes application for permit to appropriate the public waters of the State of Idaho as herein set forth.

____
(Applicant)

Figure 22. Copy of form for filing for water rights in Idaho (continued).

Northern Region
Idaho Department of Water Resources
Route 5, Box 203 - Suite 1
Coeur d'Alene, Idaho 83814
Tel.- 667-6484

Southern Region
Idaho Department of Water Resources
1041 Blue Lakes Blvd. North
Twin Falls, Idaho 83301
Tel.- 734-3578

Eastern Region
Idaho Department of Water Resources
150 Shoup
Idaho Falls, Idaho 83401
Tel.- 525-7161

Western Region
Idaho Department of Water Resources
Broadbent Business Park
92 South Cole Road
Boise, Idaho 83709
Tel.- 334-2190

In addition to completing Form 202, 3/78, an affidavit of residence within the State of Idaho must be filed. Form 205/206 dated 7/81 is to be used for this purpose and Figure 23 is a copy of that form. Statutes covering the water rights in Idaho are contained in Idaho Code 42:606. In some cases the water right for power is considered to be subordinate to upstream irrigation water rights and even to future upstream irrigation water use. The developer should check this out when obtaining the water right.

Dam Safety Compliance. If the hydropower development requires a dam that has height greater than 10 feet and impounds storage of 50 acres-feet or more, a dam safety certification must be obtained. Two classes of dams are specified under the rules and regulation of the Idaho Department of Water Resources. "Small" dams are dams 20 feet or less in height and capable of storing less than 100 acre-feet of water. "Large" dams are dams more than 20 feet in height or capable

Form 205/206
7/81

Ident. No.________

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
AFFIDAVIT FOR WATER RIGHTS TO BE USED
FOR POWER PURPOSES

A. Establishment of Residency: (Complete either 1, or 2).

1. Individual Applicant or Individual Members of a Partnership:

I, ______________________ (name) of ______________ (city),

county of ______________________, State of Idaho, being duly sworn, do hereby certify that I am a bona fide resident of the State of Idaho.

2. Corporation:

I, ______________________ (name) of ______________ (city),

County of ______________________, State of Idaho, being duly sworn, depose and say: That I am the designated registered agent of the ______________________ (name of corporation): that as such I am in charge of the registered office of the said corporation as required by Section 30-1-12, Idaho Code, at ______________ (city) Idaho, wherein are kept the corporate records required by Section 30-1-52, Idaho Code: and that ______________________ (name of corporation) is a corporation qualified to do business in the State of Idaho under the laws of the State of Idaho.

B. Ownership of Facilities: (To be completed for hydropower projects only) 42-205

The hydropower facility to be developed pursuant to the attached Application for Permit:

(check one)

- ☐ Will not utilize existing man-made irrigation facilities such as a dam or a canal.
- ☐ Will utilize existing man-made irrigation facilities such as a dam or a canal, and permission of the owner is documented in an affidavit attached hereto.
- ☐ Will utilize existing man-made irrigation facilities such as a dam or a canal and the owner of the facilities is the signee of this affidavit.

____
Applicant

State of Idaho)
County of ______________) ss.

On this ________ day of ______________________, 19______, personally appeared before me the signer(s) of the above instrument, who duly acknowledged to me that he (she) (they) executed the same.

____
Notary Public residing at

____

seal

My commission expires:

____

Figure 23. Form for residency affidavit for filing for hydro power water rights in Idaho.

of storing 100 acre-feet or more of water. Development of small dams requires less stringent standards in meeting the certification. Filing for small dam certification requires Idaho Department of Water Resources Form 1710; construction of a large dam requires filing of Form 1712. The certification is a storage certificate and is renewed each two years following an inspection and evidence that the dam continues to function as to purpose and without undue risk. Rules and regulation are published for safety of dams by the Idaho Department of Water Resources. The latest issue is "Safety of Dam - Rules and Regulations," Idaho Water Resources Department (1981).

Another requirement specified by the Idaho Department of Water Resources with regard to hydropower development for plants planned for production greater than 500 horsepower is a certificate of financing plan. The Idaho Department of Water on projects greater 500 horsepower production will not issue permits until necessary applications for FERC licenses or exemption applications or FERC preliminary permits have been filed. For plants smaller than 500 horsepower capacity, the Idaho Department of Water Resources will issue permits before FERC action. Water rights processing procedures for Idaho are indicated in Figure 24.

State Environmental Considerations and Compliance. Environmental requirements center on three principal areas of concern (1) water quality and pollution, (2) fish and wildlife considerations, and (3) general environmental impact.

Water Quality and Pollution. The water quality and pollution certification of compliance, sometimes referred to as terms and conditions, is under the jurisdiction of the Environmental Division of the

IDAHO

STATUTORY WATER RIGHT PROCESS

APPLICATION

- Submitted by applicant with fee.
- Advertised twice in local newspaper.
- Any protests resolved by conference/hearing.
- Evaluated by 5 criteria.
- Approved/Denied.

PERMIT

- Development of project can begin.
- Excavation or construction of diversion works within 1 year.
- 1 to 5 years allowed.
- Extension of time can be granted in certain circumstances, if "Due Diligence" can be shown.
- "Statement of beneficial use card submitted when project is completed.
- Field examination conducted.

LICENSE.

- Final document until decree.
- Can be lost by 5 years consecutive non-use.

Figure 24. Water rights processing procedures for Idaho.

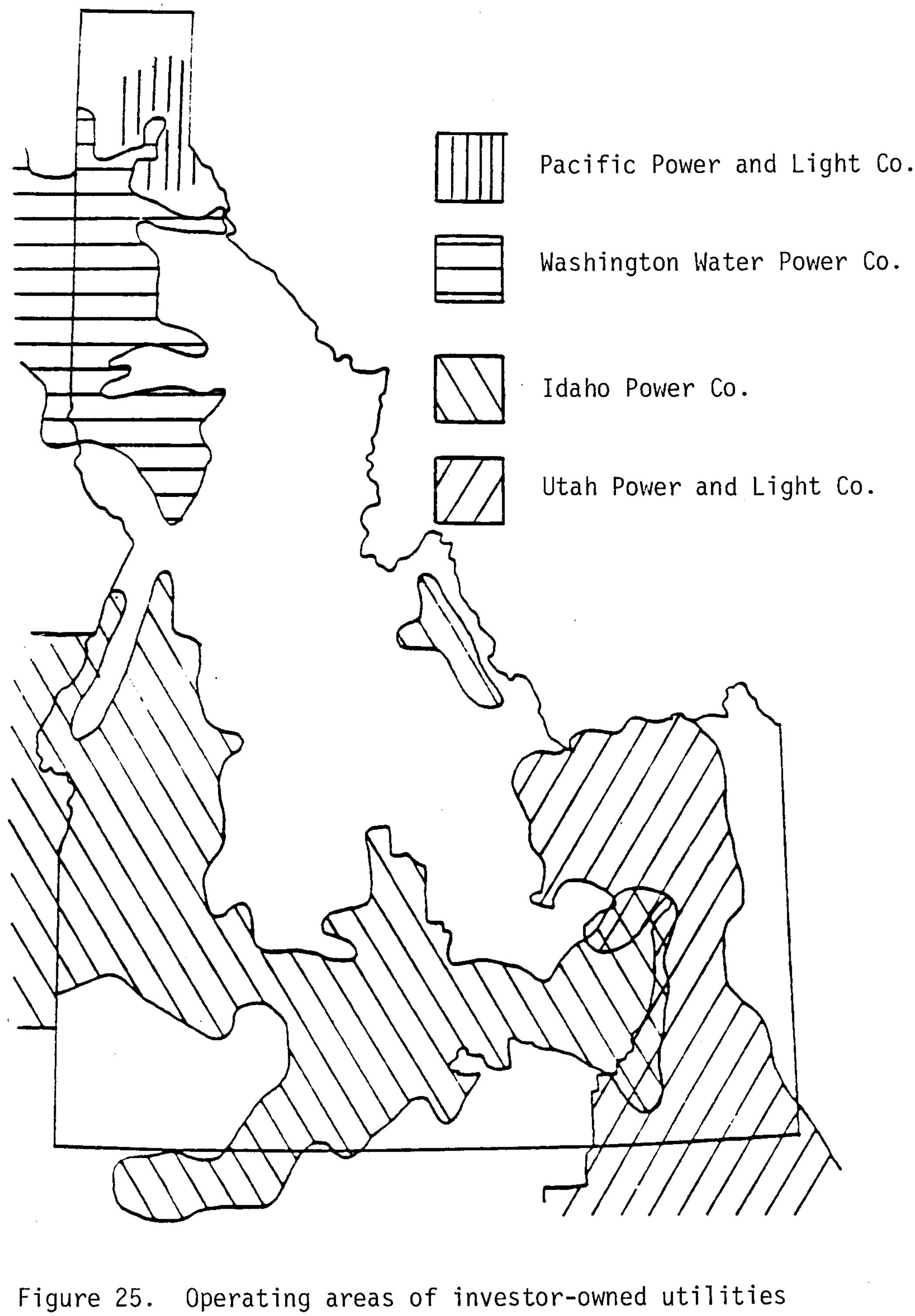


Figure 25. Operating areas of investor-owned utilities in Idaho.

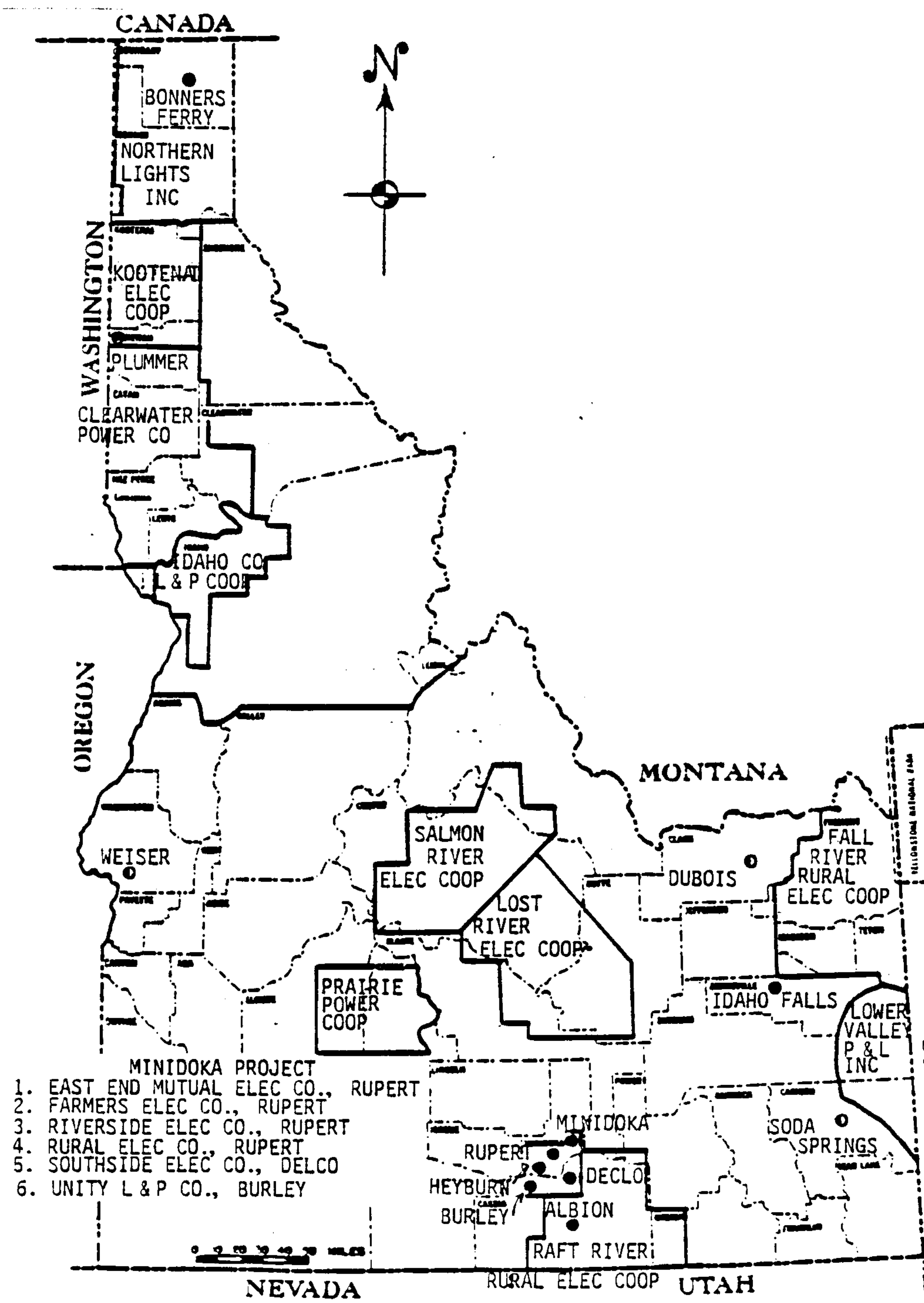


Figure 26. Operating areas of electric cooperatives in Idaho.

Idaho Department of Health and Welfare. This requires that the developer present information that will assure that the State of Idaho Water Quality Standards will be met. The water quality parameters that need to be considered are:

a.	significant ions	g.	total hardness
b.	nutrients	h.	dissolved oxygen
c.	specific conductance	i.	bacteria
d.	hydrogen ion concentration (pH)	j.	temperature
e.	total dissolved solids	k.	suspended sediments
f.	coliform concentration	l.	turbidity

The actual standards for particular streams in Idaho can be obtained from the Idaho Department of Health and Welfare (Water Quality Standards and Wastewater Treatment Requirements). In most cases of hydropower development, a temporary modification of the water quality criteria is permitted during construction, even though construction will temporarily violate some water quality standards. A permit will be necessary for even the temporary violation of the water quality standard. The address of the State agency involved is:

Bureau of Water Quality
Division of Environment
Idaho Department of Health and Welfare
Statehouse
Boise, Idaho 83720
Telephone (208) 334-4250

Fish and Wildlife. Fish and wildlife considerations require a certification of acceptability or evidence of acceptable mitigation of the impact of the hydropower development on fish and wildlife. Potential adverse effects of hydropower development vary by site, type of installation, and operating regime. The Idaho Department of Fish and Game exercises jurisdiction for certifying compliance. This Department has prepared a stream classification map of the streams in Idaho having greatest importance with respect to fish. The developer should consult the Idaho Department of Fish and Game to get exact recommendations for a particular site.

Environmental considerations which must be addressed in planning hydropower development include the following:

1) Migrating fish. Particular problems exist on streams that support anadromous fish which return from the ocean to spawn in Idaho streams. The Idaho State Water Plan sepcifies that certain streams which support anadromous fish runs shall be protected and enhanced. For development on these designated streams, obtaining the necessary permits and certification for compliance from the Idaho Department of Water Resources, which administers the State Water Plan, may be difficult.

Upstream migrating fish are generally blocked by obstructions in excess of 18 inches in height, but the extent of blockage varies with the flow and with the species and size of the migrating adults. By-pass system for adults can usually be engineered because the swimming ability of most migrating species are fairly well understood. Down-stream movement of juveniles may be a more serious problem, especially if the project is designed to take all or a significant portion of the flow of the stream during the migrating period. One possibility to minimize mortality of migrating juveniles and to minimize conflict with resource management agencies would be a "shut down" for the period of downstream migration to allow the juveniles to pass through the system unobstructed. Most migrating species leave smaller tributaries during a 2 to 4 week period of time. Such a shut down would, of course, have to be considered in calculating the economic feasibility of a project.

2) Minimum stream flow. A primary requirement of the Idaho Fish and Game Department will be to maintain a minimum flow to protect aquatic life in the stream. The minimum flow insures adequate spatial habitat for fish and benthic invertebrates, maintains stream temperature within an allowable range, and allows for transport dissolved nutrients and particulates. In general, flow sufficeint to maintain the biological components of a stream's aquatic ecosystem are assumed to be sufficient to maintain the recreational and aesthetic qualities of the stream. Minimum stream flows need to be considered as an instantaneous quantity, not just a yearly or monthly average flow.

The Idaho Water Resources Board has applied for and specified minimum flows on certain streams. Various state and federal agencies have requested the Idaho Water Resources Board to set minimum flow standards on certain streams. Studies to set these standards are in progress and a developer will need to contact the Idaho Department of Water Resources to determine what streams are involved, either with designated minimum flows held as a water right by the Idaho Water Board or as being in a study category.

3) Water level fluctuations. The major potential adverse environmental effect of fluctuating water levels in the headwater impoundment or in the stretch of the stream where diversion is made would be interference with the spawning and incubation of fish which spawn in shallow shoreline areas. Fluctuating levels adversely affect spawning success by exposing incubating embryos to desiccation and increasing the potential loss from preditation and sedimentation. Fluctuating

water levels also interfere with food chain relationships by decreasing production of aquatic macrophytes and fish food organisms. Water level fluctuations caused by small-scale run-of-river plants are not likely to cause problems downstream of a power plant.

4) Water quality. Impoundments in watersheds with high nutrient loads from domestic and agricultural sources could create undesirable water quality conditions such as algal blooms, reduced dissolved oxygen leaks and increased un-ionized ammonia levels. Impoundments may result in undesirable changes in water temperature. Turbidity in downstream water could increase as a result of construction and operation of hydro projects.

The water quality standards set by the Environmental Division of the Idaho Department of Health and Welfare (see page) speak to the needs of fish and wildlife as well as to human needs.

5) Wildlife. Adverse effects of hydropower development on wildlife could be habitat loss and interference with migration of large game animals. Fluctuating water levels could affect reproductive success of water birds.

The compliance (terms and conditions) requirements that are specified by the Idaho Department of Fish and Game must have been satisfied when a developer submits information to the Federal Energy Regulatory Commission. Therefore, it is important to make early contact with the Idaho Department of Fish and Game and work closely with them as a site study progresses. The agencies have environmental specialists that can assist in determining what information needs to be collected. Obtaining the services of an expert environmental consultant is recommended to help in gathering necessary information and in recommending mitigative measures that might be required by the regulatory agency.

The following are useful references that should help in preparing environmental compliance information: U.S. Forest Service, "Stream Habitat Inventory Form", available from Nezperce National Forest, Grangeville, Idaho, U.S. Department of Agriculture; U.S. Forest Service "Stream Reach Inventory and Channel Stability Evaluation: A Watershed Management Procedure", (1978); Boston College Environmental Affairs Law Review article by Burke (1981), "Small Scale Hydroelectric Development and Federal Environmental Law: A Guide for the Private Developer"; U.S. Fish and Wildlife Service, "A Users Guide to Instream Flow Incremental Methodology: Instream Flow Information Paper No. 12", (1981) and a publication by Stauffer (1979) entitled "Terrestrial Wildlife Habitat Inventory of BLM Lands in West Central Idaho".

General environmental impact considerations would treat other impacts that might disturb the natural surrounding. Among these impacts are the effect on the recreation potential of the stream and the adjoining land. Impact on recreation is the jurisdictional responsibility of the Idaho Department of Parks and Recreation. Since the beds of navigable streams in Idaho are owned by the State of Idaho, the Idaho Department of Lands has jurisdiction over protecting the stream channel for its scenic beauty or other environmental amenities. The addresses for these two state agencies are:

Idaho Department of Parks and Recreation
2177 Warm Springs Ave.
Boise, Idaho 83706
(208)334-2154

Idaho Department of Lands
State Capitol, Room 121
Boise, Idaho 83720
(208) 334-3284

Historical and Archeological Considerations. Historical and archeological sites are protected under both state and federal law. In proceeding through to FERC licensing, a clearance must be obtained from the appropriate agency that the hydropower development does not adversely impact a designated historical site or a known archeological site. The appropriate agency to contact in Idaho is the Idaho Historical Society. The address is:

Idaho Historical Society
610 N. Julia Davis Drive
Boise, Idaho 83702
(208) 334-2120

State Land Use Permits. If State land is involved in a proposed hydropower development (either for the power plant, road access, transmission line right-of-way or canals and penstocks for conveying the water, necessary use permits and leases will need to be negotiated through the Idaho Department of Lands. These may not need to be fully negotiated before proceeding with the FERC permitting process but must be finalized before licenses or exemptions are obtained. The address is:

Idaho Department of Lands
State Capitol, Room 121
Boise, Idaho, 83720
(208) 334-3284

Transportation Permits. If a developer has to construct a road into a potential site and the new road connects with an existing highway a permit must be obtained to make the connection. When a hydrodevelopment requires transporting oversize or overweight equipment over a highway a permit must be obtained. These permits can be obtained by contacting the Idaho Department of Transportation. In the case of secondary road connections the jurisdiction may be a local road district. However, the Idaho Department of Transportation can advise the devel- oper as to the jurisdiction that has the permitting authority. The address of the Idaho Department of Transportation is:

Idaho Department of Transportation
P.O. Box 7129
3311 West State St.
Boise, Idaho 83707
(208) 334-3664

Another useful and necessary contact with respect to State regulations is the Idaho Public Utilities Commission, (IPUC). This agency has responsibility for setting electricity rates that investor-owned utilities can charge. The agency is also responsible for setting the avoided cost (see page 78) that investor-owned utilities can claim which will influence the sale price at which a developer may contract sale of electricity produced at a new hydropower development. The IPUC can identify the utility companies that might be possible buyers of the new electrical energy. Figure 25 shows the approximate operating areas of the investor owned utilities in Idaho and Figure 26 shows the operating areas of electric cooperatives.

The address for the Idaho Public Utility Commission is:

Idaho Public Utility Commission
472 W. Washington St.
Boise, Idaho 83720
(208) 334-3143

Table 3 summarizes the various State permit, certification and "terms and conditions" requirements. The table also indicates an approximate time requirement for the processing. The time requirement does not include time for collecting necessary information for making the filing. Collecting certain required environmental information may take considerable time merely to be able to get data that is only seasonally available.

Table 3. State Permit and Compliance Requirements for Small-Scale Hydropower Development in Idaho

Required Action	Agency	Comments	Estimated Time to Process
Water Rights	Idaho Department of Water Resources	Water use permit application must be filed; application advertized; possible hearing; fee required.	6-12 months
Dam Safety	Idaho Department of Water Resources	Storage certificate required on dams higher than 10 ft., fee required.	3-6 months
Water Quality Certification	Idaho Department of Health & Welfare	Certification required before FERC or exemption is issued.	3-12 months
Temporary Modification of Water Quality Standard	Idaho Department of Health & Welfare	Required for activity that might result in temporary violation of Idaho Water Quality Standards.	2 months
Fish & Wildlife Compliance Certification	Idaho Department of Fish & Game	Certification required before FERC license or exemption is issued coordination necessary with Federal fish & wildlife agencies.	6-12 months
Historical and Archeological Approval	Idaho Historical Society	Certification required of acceptability before FERC license or exemption is issued.	2-3 months
State Land Use or Lease Provisions	Idaho Department of Lands	Permits and leases to be approved before final license action by FERC and granting of State water right permit.	6-18 months
Road Access Permits and Oversize Load Operation on Highways	Idaho Department of Transportation	Permits required before construction can proceed.	2-6 months

Federal Compliance Requirements

FERC Requirements. The Federal Energy Regulatory Commission, FERC, has major responsibility as the Federal agency for regulating hydropower developments. This responsibility extends to non-federal projects that involve navigable waters, occupy federal lands, use water behind federal government dams, or affect interstate commerce. This includes almost all developable power sites in Idaho. An exception might be a development of hydropower in a water conveyance system like a pipeline or canal that is privately owned and control is completely independent of a free flowing stream.

One of the permits issued by FERC is a preliminary permit. The preliminary permit does not authorize construction, it merely grants the permittee priority of application for a license or license exemption. The permit is not a prerequisite for a license but it prevents other possible developers from developing a site while the permittee conducts feasibility studies and collects data required for a final FERC license application. Municipalities and State power authorities receive preference over competing private applications in the award of preliminary permits as long as the application of the policitial subdivision is "best adapted to develop, utilize and conserve in the public interest of the region's water resources". Permit information requirements must include an introductory statement by the applicant, the location, a description of the proposed project including civil and mechanical structures, average power production, a description of studies to be conducted, projected costs, and expected sources of funding. Preliminary permits may be issued to cover a period up to 36 months.

Five possible ways of handling licensing and exemption are available through FERC. Figure 27 shows these five options along with reference to appropriate rules. Procedures for complying with FERC requirements are listed in a publication known as the "Blue Book", Publication FERC-0097, entitled "Application Procedures for Hydropower Licenses, License Amendments, Exemptions and Preliminary Permits, dated September 1982. Caution: FERC has been making rule changes especially with reference to microhydropower permitting and with regard to exemptions. To be sure the latest rules are being followed, contact FERC to confirm whether information in the "Blue Book" is the most recent regulation. The address for the Federal Energy Regulatory Commission is:

Federal Energy Regulatory Commission
Office of Electric Power Regulation
825 Capitol Street, N.E.
Washington, D.C.
(202) 376-9171

On the exemption application, the developer is required to make contact with other Federal agencies to obtain certification of necessary terms and conditions that will need to be considered. The process that applies is illustrated in Figure 28. Federal agencies that might need to be contacted in connection with exemption application are: U.S. Fish and Wildlife Service, U.S. Bureau of Indian Affairs, U.S. Bureau of Land Management, U.S. Park Service, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, U.S. Forest Service, the Environmental Protection Agency, and the National Marine Fisheries Service. Addresses for offices of these agencies in Idaho can be obtained from the Boise telephone directory.

Proposed Project

	OPTIONS	ACTION REQUIRED AND APPLICABLE RULES
1	FERC rules no jurisdictional responsibility.	Letter of confirmation of non FERC responsibility
2	Project is at an existing dam. Categorical exemption may be applied for if the site meets the qualifications.	Notice of exemption is filed with FERC. See Order No. 202; Docket No. RM81-7; 18 CFR Part 4.
3	Project is at an existing dam or "natural water feature." Applications for exemption are made on a case by case basis.	Application for exemption is required. See Order No. 106; Docket No. RM80-65; 18 CFR Part 4.
4	Project is on a "conduit." Applicant may apply for a "conduit" exemption.	Application for "conduit" exemption required. See FERC Order No. 76; Docket No. RM79-35.
5	Applicant may apply for a license.	Project does not qualify for exemption as specified above, yet it may still be possible to obtain a license. Example: Environmental Impact of the project is significant.

Figure 27. Regulatory options available through Federal Energy Regulatory Commission.

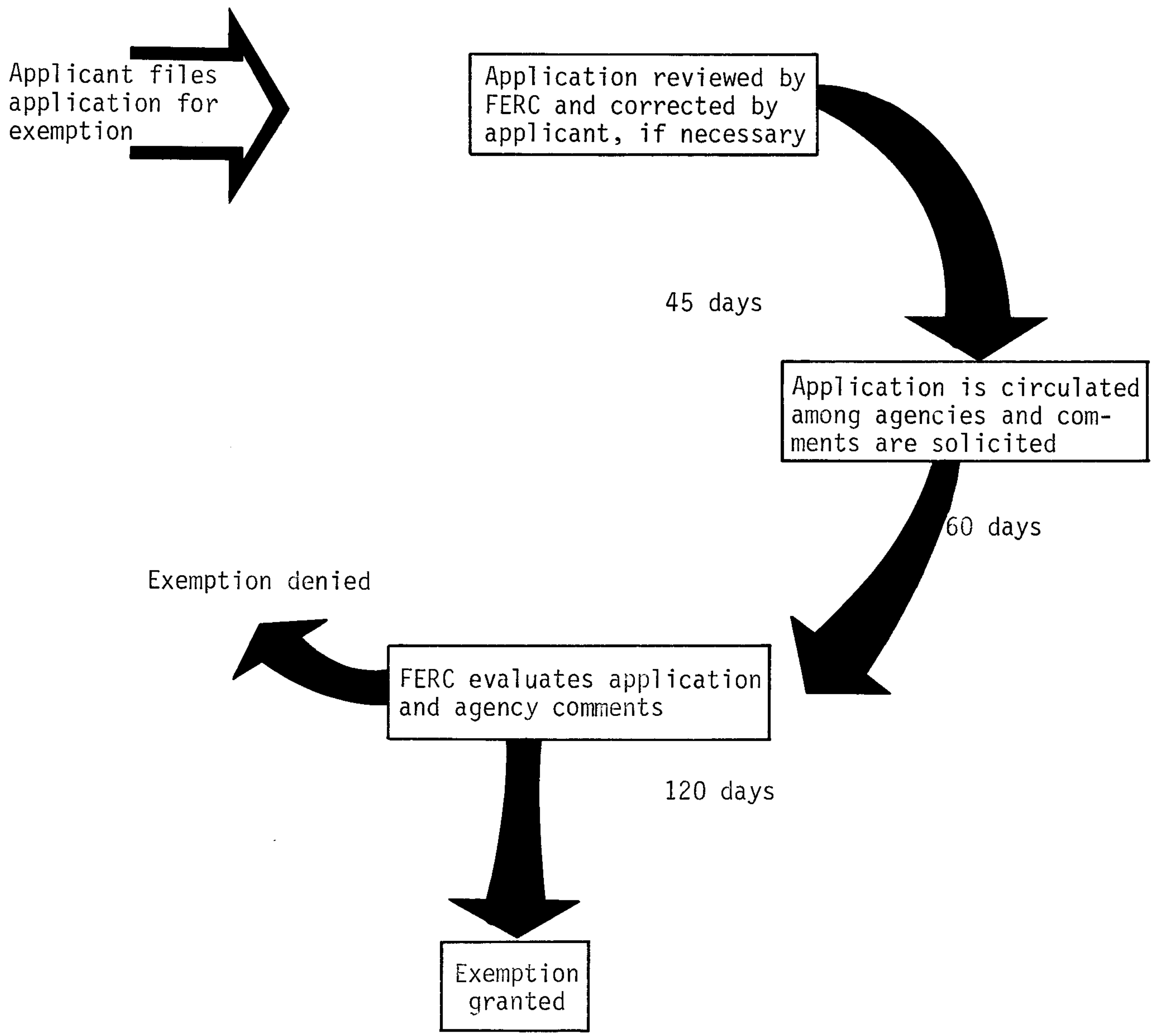


Figure 28. Process for processing and approval of Federal Energy Regulatory Commission requirements.

Army Corps of Engineers Requirements

In addition to the FERC permit and license requirements, the U.S. Army Corps of Engineers through three important Federal Acts, Section 10 of the Rivers and Harbor Act of 1899, Section 404 of P.L. 92-500 and Section 103 of P.L. 92-332, has responsibility for authorizing structures and materials movement in navigable streams in Idaho. This is often referred to as the navigation servitude requirements through which U.S. Army Corps of Engineers provides protection of navigability of the waters of the nation. This permitting, known as a "404" permit, covers placement of fill that is necessary for the construction of any structure; the building of any structure or impoundment requiring rock, sand, dirt, or other materials for its construction; the building of dams or dikes, fill for structures such as intake and outfall pipes associated with power plants; and any dredging. Figures 29 and 30 give a graphic outline of the procedures, the review process and a brief account of information required. The U.S. Army Corps of Engineers form required is Eng. Form 4345. For developers involved in streams upstream of Lewiston in the Snake River drainage contact should be:

Walla Walla District
Army Corps of Engineers
Bldg 602 City-County Airport
Walla Walla, Washington 99362
(509) 525-5500

Developers involved in streams in Northern Idaho not draining into the Snake River upstream of Lewiston should contact:

Seattle District
Army Corps of Engineers
P.O. Box 3-3755
Seattle, Washington 98134

what information is required in a permit application?

Applicants are expected to furnish the Corps of Engineers:

- A detailed description of the proposed activity, including the purpose, use, type of structures, types of vessels that will use the facility, facilities for handling wastes and the type, composition and quantity of dredged or fill material.

- Names and addresses of adjoining property owners and others, on the opposite side of streams or lakes or whose property fronts on a cove, who may have a direct interest because they could possibly be affected by your project.

- Complete information about the location, including street number, tax assessors description, political jurisdiction and name of waterway in enough detail so that the site can be easily located during a field visit.

- A list of the status of all approvals and certifications required by other federal, state, and local governmental agencies. This information is important because review time is often reduced by joint or simultaneous processing.

- Reasons that explain denial of any approvals or certifications required by other government agencies. When other approvals or authorizations are denied, application for a Corps permit may not be approved.

If ENG Form 4345 is not signed by the applicant, attach a statement designating the duly authorized agent who is acting on your behalf.

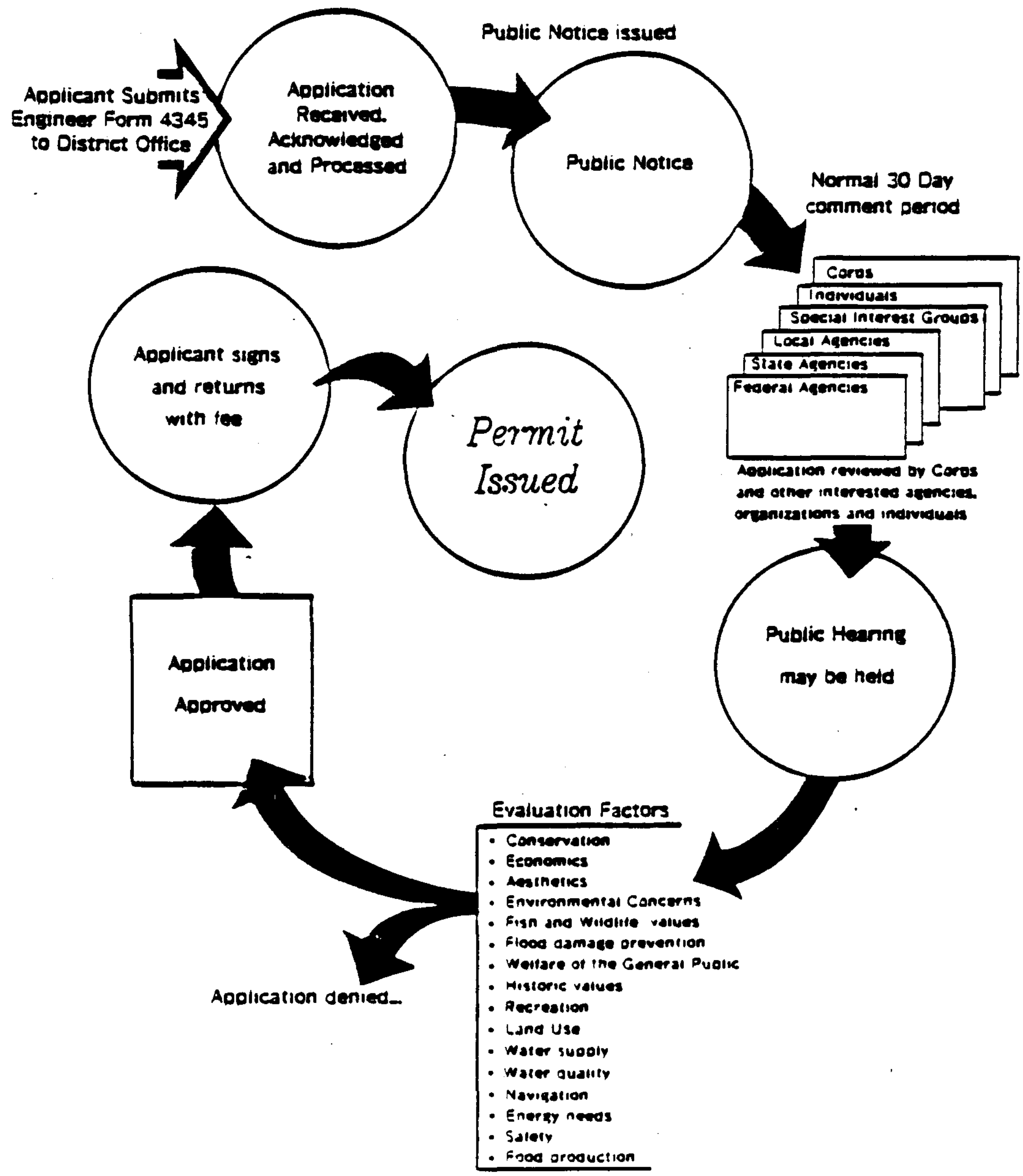
For most projects little or no additional information is required. What you provide on ENG Form 4345 and the drawings is usually all that is needed to review your application.

Yet, when wetlands, historic or archeological sites, dredging, filling, or ocean dumping are involved, you may be asked to furnish additional information or drawings that will assist in evaluating your application.

Source: U.S. Army Corps of Engineers

Figure 29. Information requirements for U.S. Army Corps of Engineers permit compliance.

typical corps permit review process



Source: U.S. Army Corps of Engineers

Figure 30. Permitting process for U.S. Army Corps of Engineers requirement related to hydro power development.

Developers in the Bear River drainage in Idaho should contact:

San Francisco District
Army Corps of Engineers
211 Main St.
San Francisco, California 94105

EPA Requirements. An additional Federal requirement may involve another permit known as a "402" permit, as specified under the Federal Water Pollutional Control Act (P.L. 92-500, Section 402). This covers discharge of any pollutant into a navigable stream. If the quality of the water is diminished in any way by addition of sediments, decreasing oxygen content or increasing temperature, this may be construed as discharging a pollutant into the stream. If a dam or impoundment is utilized in a small hydropower development, the law requires that the developer must obtain a "402" permit under regulations of the U.S. Environmental Protection Agency (EPA), but administrative and field checking may be handled through the Idaho Department of Health and Welfare. If the developer has complied with the State water quality requirement, the 402 requirement will have normally been fulfilled. The appropriate form for the "402" permit is EPA Form 7550-B.

Other Federal Agencies Requirements. Before construction can proceed and usually before issuance of a FERC license other federal requirements will include necessary special use permits, leases, and memoradum of understanding from Federal land supervising agencies for the use of the land the power plant is to be built on; the impoundment areas, if any; right-of-way for access roads, transmission lines, canals, and penstocks, or any other uses of Federal land.

If any part of a project is located on National Forest System lands, authorization from the U.S. Forest Service is required. On hydropower projects for which the potential developer seeks a preliminary permit or license from FERC, the U.S. Forest Service requires that Memorandum of Agreement or special use authorization be executed between the potential developer and the Forest Service before studies start on National Forest System lands. Approval of such a memorandum of understanding may take as much as three months time. This provides for project studies and investigation. The U.S. Forest Service prefers to authorize these studies under special use permits. Potential developers should contact the local U.S. Forest Service Ranger early in the study to gain an understanding of information and data required for officials of the U.S. Forest decision to make full authorization. The following kinds of information are usually needed:

> A general project plan and schedule, a description of roads and facilities which are to be inundated or impacted, a description of proposed construction scheduling, design, location, and drainage provisions, the proposed clearing plan and the clearing method of the reservoir, location of slash , disposal, borrow, and waste area, powerline locations, impact mitigation, and methods of fire protection. The U.S. Forest Service will inform the applicant of any additional information and the scope and depth of the information.

A preliminary or study permit from the U.S. Forest Service may be issued to permit on-site investigation to obtain necessary data for making a final decision. The study permit will require general project scope and site data to be developed, including hydrologic, wildlife and fisheries information. Before the special use permit authorizing construction and operation is issued, detailed plans and specifications, operational plans, and schedules will be required. Contact for this action should be through Forest Supervisor of the particular Forest involved.

If a project involves permanent use of U.S. Bureau of Land Management (BLM) lands the developer must obtain a "Right-of-Way Authorization" from the local U.S. Bureau of Land Management office. Developers must obtain permission to make studies on BLM land, and must negotiate an annual rental agreement for land use which will be based on current land values. "Temporary Use Permits" along with "Construction Materials Sales Permits" are also available from the BLM.

In Idaho there are several Indian reservations and their land and the treaty areas constitute Federal land compliance problems also. The U.S. Bureau of Indian Affairs office should be contacted if a potential developer is involved in areas that border Indian reservations or are involved in areas where streams impact Indian reservations.

Even though these aforementioned Federal Regulatory permits processes appear to cover all that is needed, there are numerous other Federal laws that may need to be considered in developing hydropower in Idaho depending on site-specific circumstances. Table 4 is a summary of the most important Federal laws. A brief discussion follows of the significance and manner in which these Federal laws might influence a hydropower feasibility study, the actual construction of a project, or the power plant operation.

Pertinent Federal Laws. The National Environment Policy Act (NEPA) [P.L. 91-190], requires the presentation of an environmental assessment or an environmental impact statements for all development or construction projects involving government lands or Federal funding. Section 102 of the Act mentions that all Federal agencies must report on major Federal actions significantly affecting the quality of the human environment. Most microhydro and small-hydropower developments will not create a major significant action and the principle concern will be any involvement the developer has with a Federal agency. However, this act requires that the responsible Federal agency evaluate the impact of its action on the environment. Thus FERC must consider the environmental impact of licensing or exempting a microhydro or small-scale development. Where the impact is negligible, which should be the case for most microhydro development, a negative declaration stating the lack of significant impact will be the most common result. If the impact on the environment of a microhydro project is significant, hearings and perhaps an environmental impact statement may be necessary. This part of NEPA may mean that environmental impact statements may need to be made on certain areas in Idaho where an accumulated effect of several small power plants located on Federal lands or involving Federal jurisdiction may cause a significant impact. This appears to be a problem in the vicinity of Riggins on Salmon River streams.

The Fish and Wildlife Coordination Act [P.L. 85-624] provides that "whenever the water of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened or the stream or other body of water otherwise controlled or modified for any purpose whatever", the U.S. Fish and Wildlife Service, Department of the Interior, must be consulted. For microhydro power development it

Table 4. List of Pertinent Federal Laws

1. National Environmental Policy Act [Jan. 1, 1980] 91st Congress
   (P.L. 91-190)
   42 U.S.C. 4321F.

2. Fish and Wildlife Coordination Act [Aug. 12, 1958] 85th Congress
   (P.L. 85-624)
   16 U.S.C. 661-64; 1008

3. Endangered Species Act [Dec. 28, 1973] 93rd Congress
   (P.L. 93-205)
   16 U.S.C. 1531-41F.

4. Historic Preservation Act [Oct. 15, 1966] 89th Congress
   (P.L. 89-665)
   16 U.S.C. 470a-t

5. Federal Water Pollution Control Act [Oct. 18, 1972] 92nd Congress
   (P.L. 92-500)
   33 U.S.C. 1251-1265F.

6. Water Quality Improvement Act [Apr. 3, 1970] 91st Congress
   (P.L. 91-224)
   33 U.S.C. 466 + more

7. Wild and Scenic River Act [Oct. 2, 1968] 90th Congress
   (P.L. 90-542)
   16 U.S.C. 1271-87

8. Clean Water Act Amendments of 1977 [Dec. 27, 1977] 95th Congress
   (P.L. 95-217)
   33 U.S.C. 1251

9. Federal Land Policy and Management Act of 1976 [Oct. 21, 1976]
   94th Congress (P.L. 94-579)
   43 U.S.C. 1701,02F

10. Public Utility Regulatory Policy Act of [Nov. 9, 1978] 95th
    Congress (P.L. 95-617)
    16 U.S.C. 2601-2633F

11. National Trails System Act [Oct. 2, 1968] 90th Congress

12. Wilderness Act [Sept. 3, 1964] 88th Congress
    (P.L. 88-577)

13. Federal Power Act [June 10, 1920; Aug. 26, 1935; May 28, 1948,
    etc.] see also Federal Water Power Act

14. Pacific Northwest Power Planning and Conservation Act [Dec. 5,
    1980] 96th Congress
    (P.L. 96-501)
    16 U.S.C. 837-839

may appear that this would be unnecessary, but early contact with a regional office of the U.S. Fish and Wildlife Service should be made to clarify what is necessary to meet requirements of this law. A letter of negative declaration will be necessary to get a FERC exemption or license in many cases. This can be coordinated in contacts with Idaho Department of Fish and Game but may mean separate actions. Likewise a requirement will be to coordinate with and obtain compliance certification from the National Marine Fisheries Services on streams supporting anadromous fish.

The provisions of the Endangered Species Act (P.L. 93-205) are most relevant for Federal government actions including FERC licensing. Through the Act the government has acquired and set aside protected areas of natural habitat for endangered and threatened species. These includes a variety of species of birds, aquatic life, and land animals and plant life. Normally these protected areas will closely restrict human activities and so development of microhydro power in such areas may not be possible. The agencies to contact in this regard are the U.S. Fish and Wildlife Service and the Idaho Department of Fish and Game. The U.S. Forest Service, the U.S. Bureau of Land Management, and the U.S. National Park Service should be consulted where their lands are involved. These agencies have lists of endangered species and the habitat areas involved. Normally local inquiry will quickly indicate if an endangered species is involved.

The provisions of the National Historic Preservation Act (P.L. 89-665) require the licensing agency, FERC in this case, to ascertain if a historical or archeological site would be affected by a micro hydro or a small-scale hydropower development. Either FERC or the developer must contact the National Council on Historic Preservation or the state equivalent to check on what specific action needs to be taken. The Council maintains a National Register of Historic and Archeological sites but is authorized to consider sites not on the list if the historic or archeological items are eligible for inclusion on the National Register. A developer should seek consultation or examine the National Register of Historic Places in the reconnaissance stage of the project. The best contact for this in Idaho will be the Idaho Historical Society and this need not duplicate the State requirements if coordinated properly.

Federal Water Pollution Control Act -- P.L. 92-500

The Federal Water Pollution Control Act (P.L. 92-500) provides for control of the water quality in the streams and as previously discussed includes possibilities of "402" permits and Idaho Department of Health and Welfare certification of compliance.

The provisions of the Wild and Scenic River Act (P.L. 90-542) have set aside portions of certain select rivers to maintain the streams free flowing state and water quality and to protect the environment in a corridor along the stream. Certain rivers in Idaho are also protected as "study" rivers. It is not possible to install hydropower developments on such streams. Table 5 lists rivers that have restraints with regard to classification as "wild and scenic" rivers, along with present (1983) status as interpreted by the Idaho Department of Water Resource. Regulations concerning wild and scenic rivers in general and the specific details of the river corridors involved can be obtained from the U.S. Forest Service, the U.S. Bureau of Land Management or the U.S. Park Service.

Table 5. List of Rivers in Idaho with Wild and Scenic River Restraints

1. Moyie River (Canadian border to Meadow Creek) - Study is completed. It probably will not be recommended.

2. Priest River (above Upper Lake) - Study completed. Recommended as a "Wild and Scenic River".

3. St. Joe River (headwater to near Avery) - Designated as a "Wild and Scenic River".

4. Middle Fork Clearwater River (Kooskia upstream, including Lochsa and Selway Rivers) - Designated as a "Wild and Scenic River".

5. Snake River (67 mile section through the Hells Canyon National Recreational Area) - Designated as a "Wild and Scenic River".

6. Snake River (north boundary of the Walloaw-Whitman National Forest to Asotin - 33 miles) - Study completed. The reach from north boundary to the Grande Ronde recommended as a "Scenic River" and the remaining reach to Asotin as a "Recreation River". The designation is still pending.

7. Rapid River - Designated as a "Wild and Scenic River".

8. Salmon River - 46 miles from North Fork to Corn Creek is designated as a "Recreation River" and 79 miles from Corn Creek to Long Tom Bar is designated as a "Wild and Scenic River".

9. Salmon River (237 miles from Long Tom Bar to confluence with the Snake River) - Study completed, not recommended.

10. Owyhee River (Duck Valley to Oregon border) - Studies completed, recommended and designation pending.

11. Bruneau River - Studies completed, recommended and designation pending.

Source: Idaho Department of Water Resources

The National Wilderness Preservation Act (P.L. 88-577) has provided for setting aside certain areas where limited activities are permitted by man, with the idea that the primative character of the area be protected. Normally no man-made facilities are permitted nor are any mechanical motorized activities or facilities allowed. An unusual provision of the act is the power given the President of the United States for the establishment and maintenance of reservoirs, water conservation works, power projects, transmission lines and other facilities needed in the public interest. It is not likely hydropower developments will be permitted in National Wilderness Areas in Idaho unless the development is necessary for maintaining the integrity of the area as a public interest consideration.

The Federal Land Policy and Management Act (P.L. 94-579) is a comprehensive act that calls for classification for all public lands. Through this act and previous action, the U.S. Congress has withdrawn certain lands and designated or dedicated these public lands for specific purposes. The two agencies that administer the public lands in general are the Forest Service in the U.S. Department of Agriculture and the Bureau of Land Management in the U.S. Department of the Interior. The National Park Service of the U.S. Department of the Interior likewise administers considerable Federal land but in general not even microhydro development would be permissible on National Park Lands. In Idaho certain Federal land has been withdrawn for hydropower purposes as part of the classification of Federal lands. This withdrawal may prevent private developers from making a valid application for development. The U.S. Bureau of Land Management in the Boise Office has information on these withdrawn lands.

Provisions of the Public Utility Regulatory Act (PURPA) (P.L. 95-617) were enacted to help preserve nonrenewable energy resources and to give incentives for development of renewable energy sources like hydropower. Including existing dams and remaining stream sites which are readily adaptable to power generation but are presently undeveloped. The act encourages municipalities, electric cooperatives, industrial development agencies, private developers, and non-profit organizations to undertake small-scale hydropower development of qualified sites. This encouragement was done through requiring electric utilities to purchase the power produced at small power plants at the utilitie's avoided cost. If the purchasing utility can reduce its costs or avoid purchasing energy from another utility by purchasing energy from a new small hydropower qualifying facility, the rate of purchase is to be based on those energy costs which the utility can avoid and this is termed the "avoided cost". This implies that the purchasing facility can defer or delay the constructon of a costly new generating plant, or decrease purchase of power from another utility because of power purchased from the developers new hydropower facility.

The act supposedly eliminated the developer's problems of: 1) reluctance of electric utilities to purchase the power produced because of lack of in-house control and the perceived unreliability of the production, 2) the charging of discriminatory rates for backup power by some electric utilities, and 3) being considered an electric utility and thus becoming subject to extensive state and Federal regulations.

Significant in the requirements of PURPA is the definition of a "qualifying facility". A facility can quality for avoided cost payments from electrical utilities under PURPA as specified above if, first, the power development and all other facilities at the same site which use the same energy source do not exceed a generating capacity of 80 megawatts (MW). Facilities are considered to be located at the same site as the facility if they are located within one mile of the facility and for hydropower facilities, if they use the water from the same impoundment for power generation. Second, the power development can qualify if the primary source of energy for the facility comes from the use of biomass, waste, renewable resources, or a combination of these and more than 50 percent of the facility's total energy input is from these sources. Third, as a last requirement, the small hydropower facility may not be owned by a person or company primarily engaged in the generation or sale of electric power. A cogeneration or small production facility will be considered to be owned by a person or company primarily engaged in the generation of electric power if more than 50 percent of the equity interest in the facility is held by an electric utility or utilities, or by a public utility holding company or companies or any combination thereof.

Court action has clouded the applicability of the PURPA act to some extent but in Idaho the Idaho Public Utility Commission (IPUC) is proceeding with action to require utilities within the state to purchase energy from new small scale hydropower plants. The IPUC is charged with setting the avoided cost for the utilities.

Provisions of Pacific Northwest Power Planning and Conservation Act (P.L. 96-501) were enacted to encourage development of renewable energy resources including hydropower. The act authorizes Bonneville Power Administration (BPA) to:

1. enter into long term contracts to purchase the output from hydropower projects
2. provide billing credits to utilities and others that develop hydropower
3. pay for feasibility studies and preliminary engineering for renewable resource projects (note that this is <u>not</u> limited to existing dams).

Bonneville Power Administration is authorized to reimburse the sponsor of a renewable energy resource project for certain investigation and pre-construction costs, but with significant limitations.

The Northwest Power Planning Council established under P.L. 96-501 is charged with developing a plan for energy conservation and energy production for the Pacific Northwest reigon. A draft plan has been issued recently, "Regional Conservation and Electric Power Plan," Northwest Power Planning Council (1983). This has designated certain of new hydropower development in the Pacific Northwest. These new planning designations are defined and the impact is not well understood at present (1983). Questions regarding the effect of the eletric power plan should be addressed to:

Bonneville Power Administration
Division of Resource Development and Acquisiton
1002 N.E. Holliday St.
P.O. Box 3621
Portland, Oregon 97208
(503) 230-5341

or

Northwest Power Planning Council
Suite 200 - 700 S.W. Taylor St.
Portland, Oregon
(503) 222-5161

Table 6. Summary of Federal Permitting and Compliance Requirements for Small-Scale Hydropower Developments in Idaho.

Required Action or Possible Consideration	Agency	Comments	Estimated Time to Process
FERC Preliminary Period	Federal Energy Regulatory Commission (FERC)	Not required but does protect developers priority	3-6 months
FERC License or Exemption	Federal Energy Regulatory Commission (FERC)	License or exemption required require approval on other Federal and State agency certification	1-2 years
"404" Permits	U.S. Army Corps of Engineers	Permit required on all structure, dredge and fill of materials on navigable streams, Eng. Form 4345 required.	3-6 months
"402" Permits	Environmental Protection Agency	Permit required on discharge of pollutant into navigable streams EPA Form 7550-B required to be coordination with water quality certification	3-6 months
Federal Land Use Permits	U.S. Forest Service U.S. Bureau of Land Management U.S. Bureau of Indian Affairs	Special use permits, memorandum of understanding, or lease required for use of land for any purpose of project.	6-18 months
NEPA Impact Statement	Environmental Protection Agency and FERC	Environmental impact statement may be required if EPA and FERC rule project would have significant Federal impact.	12-24 months
Fish & Wildlife Coordination	U.S. Fish and Wildlife	Compliance certification required and coordination to be made with State Department of Fish and Game.	3-6 months
Endangered Species Protection Compliance	U.S. Fish and Wildlife Service	Certification that endangered species will be required must be made, coordinate with Idaho Department of Fish & Game.	3-6 months
National Historic Preservation Compliance	National Council on Historic Preservation	Certification of compliance required, coordination with Idaho Historical Society.	2-4 months
Wild & Scenic Rivers Constraint	U.S. Forest Service U.S. Bureau of Land Management	Development prohibited on National Wild & Scenic River System, verification required.	1 month

Table 6. Summary of Federal Permitting and Compliance Requirements for Small-Scale Hydropower Developments in Idaho.

Required Action or Possible Consideration	Agency	Comments	Estimated Time to Process
Wilderness Preservation Compliance	U.S. Forest Service	Development prohibited in Wilderness area unless by Presidential approval. Verification required.	1 month
Federal Land Withdrawl	U.S. Bureau of Land Management	Federal land withdrawl would prohibit private or municipal hydropower development, check should be made.	1 week
PURPA Incentives and Restraints	Federal Energy Regulatory Commission and Idaho Public Utility Commission	Incentives provided for qualifying facility interpretation may need to be defined.	response 1 month
Northwest Energy Plan Impact	Bonneville Power Administration	Incentive provided and certain target goals being set may influence decision.	response 1 month

INCENTIVES, FINANCING, AND SALE OF POWER

Incentives.

As mentioned earlier, both Federal and State governments have indicated a desire to offer incentives through a variety of programs to encourage hydropower developments in Idaho. This part of the manual is an attempt to define these incentives and offer recommendations to hydro developers that will help in overcoming procedural roadblocks in financing projects, and expedite reaching suitable power sales contracts that will be useful and profitable. In recent years prospects for receiving financial assistance from the Federal government have diminished due to extensive budget cuts and resultant elimination of some programs, like the feasibility funding loan program. Assistance for financing development may still be available from Federal agencies like the Rural Electrification Administration, the Farmers Home Administration, the U.S. Small Business Administration, U.S. Department of Housing and Urban Development, and Bonneville Power Administration. These programs are changing but contact with these agencies may provide helpful references for financing. The addresses for these contacts are:

Rural Electrification Administration
Washington, D.C. 20250
(202) 447-5723

Farmers Home Administration
8th and Bannock
Boise, Idaho 83720
(208) 334-1730

U.S. Department of Housing and Urban Development
Energy Loan Program
1405 Curtis St.
Denver, Colorado 97206
(303) 837-2475

Assistance from these agencies is limited to municipalities, political subdivisions, and for REA non-profit organizations and rural electric cooperatives. Other possibilities to contact are:

Small Busines Administration
Small Business Loan Program
1005 Main St.
Boise, Idaho 83720
(208) 334-1696

Bonneville Power Administration
Resource Development & Acquisition
1002 N.E. Holliday St.
Box 3621
Portland, Oregon 97206
(503) 230-5341

One of the provisions originally intended as an incentive under PURPA (P.L. 95-617) was the designation of "qualifying facilities" by FERC to encourage development by other than investor-owned utilities. The developer was to file with FERC an application for certification of a "qualifying facility". The complexity, delays, and uncertainties created by case-by-case certification of "qualifying facilities" may have actually acted as a barrier to financing and implementation of worthwhile small hydropower projects. Then, FERC determined that notification from a potential qualifying facility developer to the utility with which the developer wishes to interconnect for purpose of selling power would substitute for the certification process. If unusual conditions exist and confusion exists the developer may request clarification from FERC.

Section 292.203 (A) of PURPA provides that a small power production facility is a qualifying facility if it:

(1) meets size criteria

(2) meets fuel use criteria, and

(3) satisfies the ownership criteria.

The State of Idaho has had limited success in legislating incentives for small scale hydropower development even though several attempts have been made. Sponsoring of resources inventories, sponsoring of energy extension service seminars on strategies for hydropower development in Idaho, negotiating for joint sponsorship of planning and construction at existing dams that have undeveloped potential, and limited engineering feasibility studies at a few sites in Idaho represent the extent of State incentives. Future opportunities in the form of financing help may exist under the Idaho Water Resource Board programs of the (1) Revolving Development Fund, (2) Water Management Account, (3) Cooperative Tax-Exempt Mortgage Program. The latter program was until recently limited to multipurpose water projects and must be in conformance with the Idaho State Water Plan. Recent Idaho Water Resource Board action allows for State participation in single purpose hydropower development. Developers are encouraged to seek out these possibilities as incentives with the Idaho Department of Water Resources.

There are, through provisions of PURPA (P.L. 95-617), the Energy Tax Act of 1978 (P.L. 95-618), Windfall Profit Tax Act of 1980, and the Economic Recovery Tax Act of 1981 (P.L. 97-34), certain financial incentives in the form of investment tax credits, income tax credits, and energy tax credits. Developers are advised to consult with the Internal Revenue Service or a tax consultant to determine financing advantages.

Deductions allowed under the Internal Revenue Code affect financing of hydropower developments and allow for: (1) current deductions from gross income for ordinary and necessary business expenses, (2) depreciation of certain capital expenditures, and (3) net operating loss carryover.

1. Internal Revenue Code (IRC) Section 162 should be consulted for determining allowance of deductions from gross income to those expenses incurred as a result of running a hydropower development as a business.
2. IRC Section 167 should be referred to for determining depreciation of certain capital expenditures. As a general rule, the amount invested may be deducted from gross income over the useful life of the project. Expenditures that are given this credit include legal and engineering fees associated with acquiring the property, land preparation costs in connection with construction, and flood plain easement costs.
3. IRC Section 172 indicates that non-municipal corporations involved in small hydropower development may be entitled to utilize the net operating loss carryover provisions of the code. This entitles a corporation to apply any deductions (with certain adjustments) in excess of gross income against its gross income in subsequent tax years. A net operating loss may be carried over for five years.

Investment tax credits under Title II of the Windfall Profits Tax Act of 1980 allow an 11 percent business energy credit for investment in qualifying hydroelectric projects. This credit is in addition to the long-standing 10 percent investment tax credit. This credit is available at both existing dams and developable sites. The credit is available to all licensed businesses, and applies to generating equipment such as turbines, generators, powerhouses, penstocks, and fish passage facilities. It also applies to reconstruction and rehabilitation of dams. The energy tax credit is not valid for large plants that have a capacity greater than 25 MW.

There are certain incentives that are only available to public utilities. A good discussion of the incentives, organizational and business considerations, as well as financing possibilities for public bodies is presented in a publication by the Energy Law Institute (1981) and is also discussed in a Washington State Energy Office publication by James and McCoy (1982).

The spring (1983) issue of Hydro Review, a quarterly magazine of the small-scale hydroelectric industry presents the latest on financial issues that need attention. Articles by Kissel (1983), Brown (1983), Ritter (1983) and Fritz (1983) are particularly valuable. The publication can be obtained from:

Hydro Consultants, Inc.
P.O. Box 344
Cambridge, Mass. 02238

Financing

Usually developers do not have enough financing of their own to study, construct and operate a small hydropower project. This means the developer must seek financing. Frequently the preliminary planning and licensing costs are financed by short-term loans for what are termed front-end costs. This is usually relatively high risk and may demand rather high rates of interest for financing. To enter into such indebtedness it is usually of advantage to incorporate or it may be necessary to enter into a partnership. This usually facilitates securing necessary capital.

Financing hydropower developments can be either through public financing or private sector financing. Under public financing bond financing is available to certain types of entities like municipalities, irrigation districts, and other quasi-public entities. The bonds may be general obligation bonds or revenue bonds. Revenue bonds are self liquidating debt arrangements in which the cost of capital improvements is paid for exclusively from revenues produced by the project. Another arrangement for financing is a lease arrangement wherein a developer, whether private or a municipality, may wish to lease the site to a development company. An example of this type of company is Hydropower Consultant of Sandpoint, Idaho. They will design, construct and operate the hydropower. The site owner contracts for a percentage of the gross revenues. This arrangement transfers risk to the developer from the development company.

Sections 4 (e)(1) and 4 (e)(2) of the Pacific Northwest Electric Power Planning and Conservation Act (P.L. 96-501) provides for Bonneville Power Administration to help in financing. BPA is charged with acquiring conservation measures and renewable energy resources and can provide billing credits to power customers with contracts for purchase of power, technical and financial assistance. BPA can likewise fund or secure debts for investigation and preconstruction costs. This has had limited application because the regional energy plan has to be developed and put into operation before BPA can implement some of the options of the plan.

Previous mention has been made that the Idaho Water Resource Board may implement certain of its lending authorities.

Private sector financing may include bank loans, some small business investment firms, and joint ventures sometimes with certain of the manufacturers. Additional oportunities exist in combining private sector financing in leaseback and leaseback leverage arrangements. More specific details on all these financing arrangements are presented in a manual by James and McCoy (1982), and a U.S. Department of Energy publication entitled "The Financing of Private Small-Scale Hydroelectric Projects (1981) and a new handbook on microhydropower sponsored by the Idaho Operations Office of the U.S. Department of Energy that is to be published in 1983. Obtaining expert advice from a financial consultant that has worked with financing cogeneration or small hydropower is recommended. Advice on this kind of help can be sought through the energy extension service of the Idaho Office of Energy.

Sales Contracts

The final and culminating requirement is to secure a power sales contract with a utility. In Idaho the possible entities are the four investor-owned utilities operating in Idaho, Bonneville Power Administration, or one of the rural electric cooperatives that is furnished power by BPA. Inquirires regarding power sales negotiations should be directed to:

Renewable Energy Department
Pacific Power and Light Co.
320 W. Sixth Ave.
Portland, Oregon 97204
(503) 243-1122

Washington Water Power Co.
P.O. Box 3727
Spokane, Washington 99220
(509) 489-0500

John Ferree, Planing Resource Department
Idaho Power Company
1220 Idaho St. Box 70
Boise, Idaho 83707
(208) 383-2427

Utah Power & Light Company
P.O. Box 899
Salt Lake City, Utah 84110
(801) 350-3535

Bonneville Power Administration
Resource Development & Acquisition
1002 N.E. Holliday St. Box 3621
Portland, Oregon 97206
(503) 230-5341

Many of the terms of the power sales contracts are site specific and utility company specific. The following discussion is presented to acquaint the developer with the general nature of requirements for power sales contracts.

Terms of Purchase. Availability of power must be defined and the term of the purchase must be stated. The seller agrees to deliver and sell to and the buyer agrees to accept and purchase power from seller. This requires a commencement date, a termination date and usually a default time if delivery is not made.

Sale and Purchase of Power. The rates of payment are to be defined. Various approaches are used to define this. The more common are:

a. "As Available Rate": The rate is for spot market rate and is is the current PURPA avoided cost. There is little security as to future prices for either seller or buyer.

b. Cost of Service Contract: This option defines the debt coverage, operating expenses and fixed profit for the developer. This may include a management fee.

c. Levelized Contract with Escalator: This option may be set for entire term of the contract and contain provisions for debt coverage, operating expense, overhead, and have an adjustment with reference to an escalator index like a consumer price index.

d. Flat Rate with a System Escalator: This option provides a minimum the developer will receive. This is based on a designated utility cost or rate. Usually there is an initial period designation with options for scheduled changes that are tracked by the parties as to increases the utility component costs and rates.

There are other methods that can be developed that define more specifically payments based on capacity value of the power and the as-available energy from the project. A penalty clause is usually defined for failure of the Seller to deliver as specified.

Billing and Payments. The dates of billing and payment and the manner in which these are documented must be defined.

Service to Seller. Usually some type of backup power is provided by the utility for station power at the project. This must be defined.

Metering. The Utility usually provides for the metering and arrangements for payment and purchase and maintaining of the equipment should be defined.

Facility and Equipment Designs and Standards. The seller is usually required to furnish to the utility information providing the design of equipment and verification that it meets product electrical standards of practice.

Operation, Protection and Control of Interconnection. The developer must provide for the interconnection to the utility purchaser including approval of protective devices and testing for adequacy.

Schedule of Service and Continuity of Service. Provision must be included for period of servicing and maintaining facilities and for shut down periods and definition of arrangements for interruption or service and costs of reduction in deliveries.

Land Rights. Provisions must be made for right-of-way, easements to install, inspect, maintain and remove equipment that is a part of the interconnection to the utility system.

Government Jurisdictions, Authorizations and Permits. Provisions must be given defining the government agencies control and permitting requirements and compliance to assure satisfactory operation of the system.

Indemnity and Insurance. The sales contract will require a definition of what protection the developer will have for indemnity from the utility and what the utility have have for indemnity from the developer. The developer will be required to carry acceptable insurance that will provide for coverage of accidents and liability of the claims against the developer.

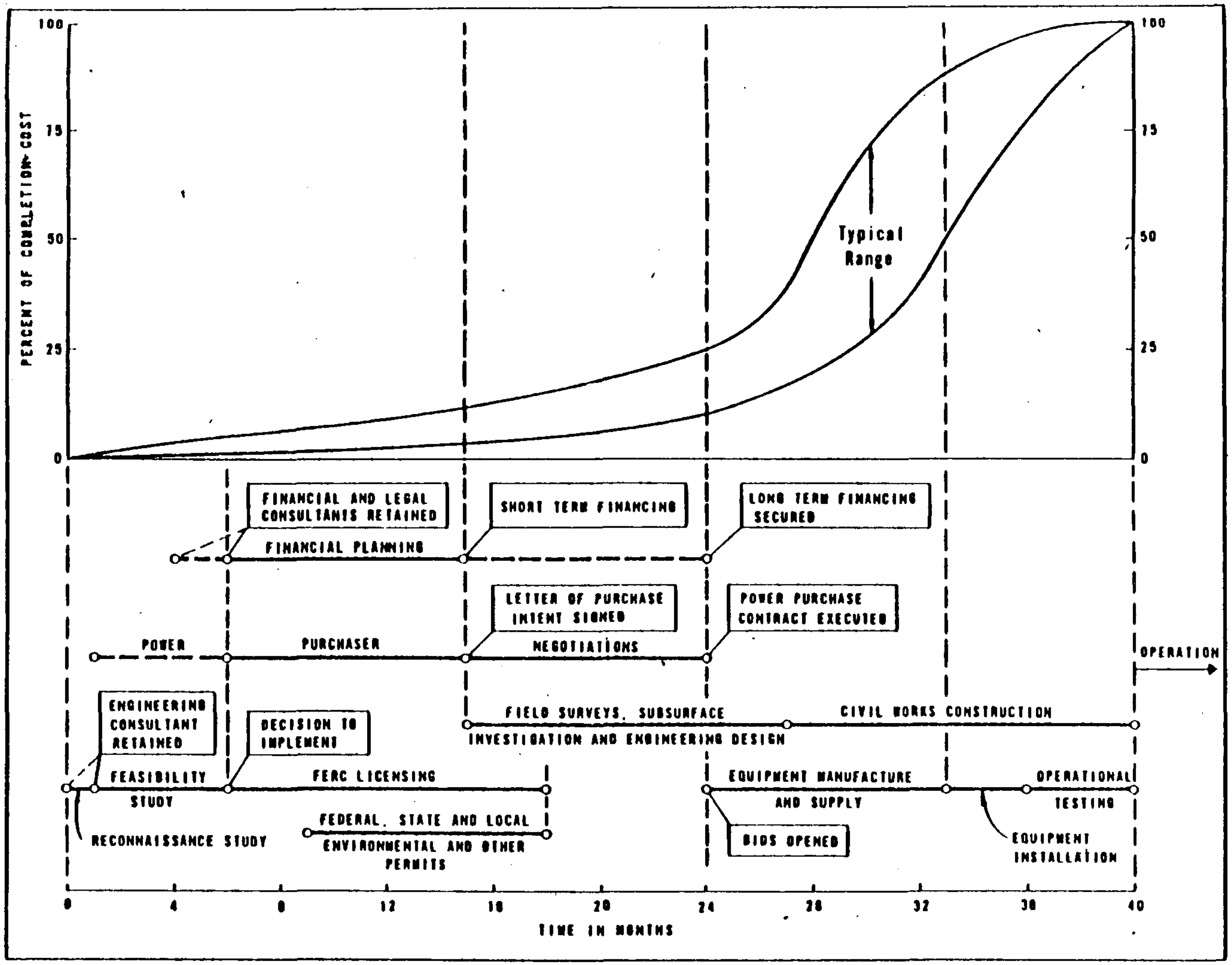
Other Consideration. Other provision that need to be defined and provide for in the agreement are contract termination, resolution of disputes, provisions for unforeseen events and catastrophes, and appropriate signature.

The utilities have in the past prepared sample sales contracts and these may be available by contacting the utilities previously listed. Publications that can be helpful in this respect are: The Washington State Energy Office Marketing Manual by James and McCoy (1982), and a publication entitled "Key Provisions of Sample Purchase Power Agreement", by Thaxter, Lipez, Stevens, and Micoleau (1982) available through:

The National Alliance for Hydroelectric Energy
1050 17th Street N.W.
Washington, D.C. 20036
(202) 775-8915

Other useful papers are one by McGrath (1981) entitled "Utility Rate Negotiations: A Solution to the Rubic's Cube of Hydro Financing", and one by Nelson (1981) entitled "Power Marketing in the Pacific Northwest". These also are available through the National Alliance for Hydroelectric Energy.

As a final item, Figure 31 is presented to give the developer an idea of the time requirements for various phases of a small-scale hydropower development project.



Source: U.S. Army Corps of Engineers

Figure 31. Representative time requirements for various phases of small-scale hydropower development program from reconnaissance to operational status.

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APPENDIX

GLOSSARY

Acre-foot (Ac Ft, A.F.) - A measure of water volume, that would be required to cover an acre to one foot depth. It is equivalent to 43,560 cubic feet or 325,851 gallons.

Alternating current - The type of electricity generated by conventional hydroelectric plants with synchronous generators.

Amortization - The paying off of borrowed money or capital in installment payments. Also writing off investment expenditures by prorating the payments over a period of time.

Anadromous Fish - Fish such as salmon and steelhead which ascend rivers from the ocean to spawn.

Avoided cost - The payment to be made for capacity and energy from small-scale hydroelectric plants; such payment equals the cost of the utility of obtaining and operating additional generating capacity and energy production or purchase of power from another source, if the power were not available from the utilities own production.

Base load - The amount of electrical power needed to be delivered at all times and all seasons, also termed firm load.

Benefit-cost Ratio (B/C) - The ratio of the present value of the benefits (e.g. revenues from power sales) to the present worth of project costs.

BIA - The Bureau of Indian Affairs, an agency in the U.S. Department of the Interior.

BLM - The Bureau of Land Management, an agency in the U.S. Department of the Interior.

BPA - A Federal power marketing agency operating in the Pacific Northwest region, an agency in the U.S. Department of Energy.

Bulb Unit - A type of hydroelectric machine that combines turbine and generator to operate within the water passage, the generator is enclosed in a water-type housing shaped like a bulb.

Capacity - The maximum power output or load for which the hydroelectric generating unit, generator station, or electrical apparatus is rated. Common units are KILOWATT (kW) and/or MEGAWATT (MW).

Capacity Factor - The ratio of the energy that a plant produces to the energy that would be produced if it were operated at full capacity throughout a given period, usually a year. Also called the PLANT FACTOR.

Capacity Value - The part of the market value of electric power that is assigned to having dependable capacity available.

Capital Expenditures - The construction costs of new power facilities and expenditures for purchase or acquisition of needed facilities, usually includes engineering and contingency costs. Also referred to as Investment costs.

Civil Works - All the construction works associated with powerhouse, impoundment, channeling and emergency release of water. Usually does not include the turbine, generator and electrical equipment.

Costs (economic) - The value of goods and services required to produce the electric power. In small scale hydropower this includes the management and construction expense, the operation and maintenance expense, replacement expense and any expense necessary to continue the power plant in operation.

Critical Streamflow - The record of streamflows during the most adverse drought period to be expected during the project life.

CFS - The unit of measure usually used for expressing stream, cubic feet per second, sometimes referred to as second feet or cusecs.

Debt Service - The principle and interest payments on the debt used to finance the project, sometimes referred to as annual capital cost.

Demand - The rate at which electricity is required to be delivered to the electric users, or system. Usually expressed in KILOWATTS (kW) at a given instant or average over a specified time period.

Dependable Capacity - The electric capacity, which for a specified time interval can be relied on to carry the system demand, provide assured energy reserve, and meet firm power demand, taking into account operational variables, hydrologic conditions, and seasonal variations.

Discharge - The rate of water flow supplied through the turbines. Usually expressed in CFS.

Discount Factor - A factor for computing the present worth of the revenues and costs based on an assigned interest rate.

Diversion Dam - A structure used in conjunction with tunnels, penstocks and canals to divert water from a stream through a hydroelectric plant.

Draft Tube - A part of the water passage of a hydroelectric plant used to carry water as it is released from the turbine back into a receiving stream or water body. The tube is used to reduce the velocity of the water as it discharges back into the stream.

Energy - The capacity for performing work, the rate of doing work. Usually expressed in units of KILOWATT-HOURS, KWH. It represents power (kW) operating for some period of time (hours).

Environmental Concerns - Those impacts on plant and animal life caused by a hydropower development, including impact on man and his culture.

Feasibility Study - An investigation performed to formulate and scope a project and definitely assess its desirability for implementation.

FERC - Federal Energy Regulatory Commission.

Firm Energy - The energy generation that is to have assured availability to the consumer to meet all or any agreed upon portion of the load requirement for a specified time period.

Flow - The water discharge or streamflow that is available in the stream. Usually expressed in CFS.

Flow Duration Curve - A curve developed using historic water flow records which shows what percent of the time a certain flow will be equalled or exceeded. The curve shows flow values plotted in descending order of magnitude against time interval, usually expressed in percentage exceedance.

Generator - The electrical machine that converts mechanical energy into electricity.

Generator Capacity - The maximum load which the generator can supply under specified conditions for a given time interval, without exceeding approved limits of temperature and stress on physical elements of the machine. Usually expressed KILOVOLT-AMPERES (KVA).

Grid - The transmission or electrical distribution interconnecting the electric power system including more than one hydropower plant and also thermal generating facilities.

Head - The difference between two water surfaces or the hydraulic pressure between two points expressed in vertical length of the column of water which represents the same pressure, feet of water.

Gross Head - The difference in elevation between the headwater and the tailwater below the hydropower plant.

Net Head - The gross head less hydraulic losses in the water passages up to entrance to the turbine, sometimes referred to as effective head, and design head.

Operating Head - The hydraulic head existing at particular time of operation. Usually expressed as a range.

Hill Curves - Curves developed by manufacturers from hydraulic model tests of hydraulic turbines relating efficiency to characteristics of speed, discharge, head and power output.

Horsepower (hp) - 550 foot-pounds of energy equivalent 0.746 KILOWATT.

Hydroelectric Plant - The complete unit or system for producing electrical energy, consisting of a powerhouse; all water conduits, all dams and appurtenant works and structures which are necessary for the production of energy; the turbines, generators and electrical switching and transmission equipment necessary to deliver power to the grid.

IPUC - Idaho Public Utility Commission

Impoundment - An artificial reservoir or pond created behind a dam used to regulate flow of water.

Interest - The time value of money. The fee one producer pays to use the capital of another.

Installed Capacity - The total of capacities shown on the nameplate of the generating units of a hydropower plant.

Investment Cost - The total cost of the facilities, it can be expressed as total present worth or as an annual equivalent cost.

Kilowatt (kW) - A unit of electrical power, one thousand watts, or 1.34 horsepower.

Kilowatt-Hour (KWH) - A unit of electrical energy, the amount of electric energy produced or consumed by a one-KILOWATT unit operating for one hour, one thousand watthours (wh).

Load - The amount of electrical power required at a point or points in a electrical system.

Load Factor - The ratio of the average load to the maximum load during a given time period.

Low-Head Hydropower - Hydropower that operates with a head of 20 meters (66 feet) or less.

Marginal Cost - The cost of an incremental unit of capacity or of producing an incremental unit of power.

Market Value - The value of energy or the price consumers are willing to pay on a free market situation.

Megawatt (MW) - One thousand KILOWATTS (kW) or one million watts (w).

Megawatt-Hour (MWH) - One thousand KILOWATTHOURS.

Micro-hydropower - Power capacity 100 kW or less.

Mill - A unit used in pricing energy, one-tenth of a cent.

Millogram per Liter (Mg/l) - A unit of measure used to report concentrations of most substances that commonly occur in natural waters. A concentration of 1/1000 gram of substance in one (1) liter of water. Because one (1) liter of water weighs 1,000 grams, the concentration also can be stated as 1 ppm (part per million, by weight).

Navigable Streams - Streams that in the natural and ordinary condition was useable for customary modes of travel on water. In state tests, this is commonly water sufficient to float a 6-inch log.

NEPA - National Environmental Policy Act (P.L. 91-190). A Federal Act, passed in 1969, requiring that environmental impact of most projects and programs be identified that have a significant impact on Federal lands and involving Federal programs.

Nomograph - A graph or graphs used to make selection or solution to size, capacities, or magnitudes of component parts of a hydropower system (e.g. sizes of turbines).

Off-Peak - Periods of relatively low demand for system capacity specified by the supplier or producer.

O & M Cost - Operation and maintenance cost usually expressed on an annual cost basis.

Outage - The period during which the hydropower facility is out of service.

Forced Outage - The shutdown of facilities for emergency reason.

Scheduled Outage - The shutdown of facilities for inspection or maintenance as scheduled.

Output - The amount of power or energy delivered for a given piece of equipment, a plant, or a system.

Peaking Capacity - That part of a system's capacity which operated during the hours of highest power demand.

Peak Load - The maximum load in a stated period of time.

Penstock - A conduit or pipe for conducting water to a hydropower unit.

Plant Factor - The ratio of the average power produced to the installed power capacity or full load capacity.

Pondage - The short-term storage of water to meet short-term variations in load, usually not more than a daily variation.

Power (Electric) - The rate of generation or use of electric energy, usually measured in KILOWATTS (kW).

Preliminary Permit - An initial permit to proceed with study of hydropower issued by FERC. The permit does not authorize construction, but during the permit's term of up to 36 months, the permittee is given a right of priority-of-application for a license while completing the necessary studies to determine engineering and economic feasibility, the marketability of the power, and other information needed to complete a license.

Preliminary Study - An initial investigation to determine advisability of proceeding with project development.

Pumped Storage Plant - A power plant utilizing an arrangement whereby electric energy is generated for peak load use by utilizing water pumped into a storage reservoir usually during off-peak periods. A pumped storage project may also be used to provide reserve generating capacity. Usually pump/turbines, reversible units are used as the machines.

PURPA - The Pacific Utility Regulation Policies Act of 1978 (P.L. 95-617). This Act requires utilities to purchase power from and an interconnect with privately developed facility and mandates the State utility agency to set a "just and reasonable price".

Reconnaissance Study - An initial "mini" feasibility study designed to identify the power site and to ascertain whether a feasibility study is warranted.

Runoff - The portion of rainfall, melted snow or irrigation return flow that flows over the land surface and reaches a stream.

Runner - The part of the power unit that is rotated and contacted by the water, consisting of blades, buckets, and hub.

Run-of-River-Plant - A hydropower plant that uses the flow of stream as it occurs with little or no storing of water.

Secondary Energy - All hydroelectric energy that is not firm energy.

Small-scale hydropower - Hydropower installations that are 15 MW or less in capacity. This is variable with different rules and agency interpretations.

Spillway - A passage for discharging excess water over or around a dam or hydroplant.

Storage - Water impounded in a reservoir to be released later to meet water demands for various uses including flood control.

Streamflow - The water flowing in a natural or designated channel.

Surplus Energy - Generated energy that is beyond the immediate needs of the producing system. This power is usually sold to another utility on an interuptible basis.

Tailwater - The water below a dam or where the discharge from a hydroplant is comingled with a natural stream or water body. The water downstream from the draft tube.

Thermal Plant - An electric generating plant which uses heat to produce electricity. Such plants may burn coal, gas, oil, biomass or use nuclear energy to produce thermal energy.

Transmission - The act or process of transporting electrical energy from a source to a user.

Turbine - The machine and appurtenant facilities that is utilized to drive an electric generator.

Tubular Turbine - A type of hydroelectric machine connected by a shaft to a generator that is outside the water passage. Sometimes provided with gears to drive the generator. Usually the shaft is horizontally mounted or slightly inclined.

USBR - The U.S. Bureau of Reclamation, a Federal agency in the U.S. Department of the Interior.

USCE - The U.S. Army Corps of Engineers, a Federal agency in the U.S. Department of Defense.

USGS - The U.S. Geological Survey, a Federal agency in the U.S. Department of the Interior.

Watt - A unit of electric power measurement, equal to a current of 1 ampere under 1 volt of pressure, or one joule per second equal to 1/746 of one horsepower.

Wheeling - The transporting of electricity by an electric utility over its own lines for another utility.

Yield - The amount of water that can be supplied from a reservoir or a watershed in a specified period of time.

LIST OF TURBINE MANUFACTURERS

	Manufacturer Name	Address	Phone Contact	Contact Person	Type of Units
1.	Ateliers Bouvier	53 rue Pierre-Semard 3800 Grenoble (France)	(76) 96.63.36		P, F, K, T
2.	Allis Chalmers	P.O. Box 712 York. PA 17405 (USA)	(717)792-3511	Helmut Wirshal Selim Chacour	P, F, K, B, T
3.	Barber Hydraulic Turbine, Ltd.	Barber Point Box 340 Port Colborne, Ontario, L3K 5W1 Canada	(416)834-9303	M. R. Wilson	P, F
4.	Canyon Industries	6342 Mosquito Lake Road	(206)592-5552	Don New	P
5.	Dependable Turbines. Ltd	#7-3005 Murray St. Port Moody, B.C. V3H1X3 (Canada)	(604)461-3121	Robert Prior	P, F, K, Tu
6.	Escher Wyss, Ltd	CH-8023 Zirich, Switzerland (Swiss)	(01) 44.44.51	Dimtri Foca	P, F, K, T
		Sulzer Bros. Inc. 200 Park Ave. New York, NY 10017 (USA)	(212)949-0999		
7.	General Electric	Installation & Service Engineering Division-Small Hydro Operation One River Road Schenectady, N.Y. 12345	(518)385-7097 (480)974-4729	D.W. Lyke P.O. Box 6440 Salt Lake City, UT 84106	P, F, T
8.	Gilbert Gilkes & Gordon, Ltd	Kendal Cumbria LA9 7BZ England	(0589)20028	O.S. Shears	P, F, T, Tu
		Gilkes Pumps Inc. P.O. Box 628 Seabrook, TX 77586 (USA)	(713)474-3016	Alan S. Fife	P, F, T
9.	Hitachi, Ltd.	6-2 Otemachi, Chiyoda-ku Tokyo 100 (Japan)	(03)270-2111	M. Suzuki	P, F, K, T
10.	Hydro-Watt Systems	146 Siglono Road Coos Bay, OR 97420 (USA)		Mert. J. Junking	P, C
11.	Independent Power Developers, Inc.	Route 3, Box 174H Sandpoint, ID 83864 (USA)	(208)263-2166	William Delp Charles Green	P, C
12.	AB Karlstads Mekaniska Werkstad KMW or KaMeWa	Fack S-681 01 Kristinehamn (Sweden)	0550/15200	Hans G. Hansson Lars-Erik Lindestrom	P, F, K, T
13.	Kraerner Brug A/S	Kvaernerveien 10 Oslo 1, (Norway)	(472)676970	James Victory	P, F, K, T
			(212)752-7310	Kvaerner Moss, Inc. 31st Floor, 800 Third Ave. New York, N.Y. 10022	
14.	James Leffel & Co.	426 East St. Springfield, Ohio 45501 (USA)	(513)323-6431	Kim Brockl Kenneth W. Berchak	P, F, T
15.	Leroy Somer	Boulevard Marcellin-Leroy B.P.119-16004 Angouleme (France)	003345.62.41.11		
		NEEDS New England Energy Development Systems, Inc. 109 Main St. Amherst, MA 010002 (USA)	(413)256-3466	Michael Pill	T
16.	Little Spokane Hydroelectric	P.O. Box 82 Chattaroy, WA 99003 (USA)	(509)238-6810	Mike Johnson	P, T

LIST OF TURBINE MANUFACTURERS (continued)

Manufacturer Name	Address	Phone Contact	Contact Person	Type of Units
17. Mitsubishi Heavy Industries, Ltd.	5-1 Marunouchi 2-chome Chiyoda-ku Tokyo (Japan)	Tokyo 212-3111 (415)981-1910	Kenji Fukumasu Billy M. Tanaka	F, D
18. Neyrpic	Groupe Creusot-Loire B.P. 75 Centre de Tri 38041 Grenoble Cedex (France)	(76)96.48.30	Lucien Megnint	
	GE/Neypic 969 High Ridge Road Box 3834 Stanford, CT 06905 (USA)	(203)322-3887	Michael Guer	P, F, K, B, T
19. Obermeyer Hydraulic Turbins, Ltd	10 Front Street Collinsville, CT 06022 (USA)	(203)693-4292		P, F, B, T, C
20. Ossberger-Turbinenfabrik	D-8832 Weissenburg/Bay Pastfach 425 Bayern (West Germany)	0 91 41/40 91		
	F.W.E. Stapenhorst, Inc. 285 LaBrosse Ave. Pointe Claire, Quebec H9R 1A3 (Canada)	(514) 695-2044	F.W.E. Stapenhorst	
21. Small Hydroelectric Systems	5141 Wickersham Acme, WA 98220 (USA)	(206)595-2312	William Kitching	P
22. Tampella	Engineering Division SF-33100 Tampere 10 (Finland)	(931)-32 400	Georg von Graeveniyz	P, F, K, B, T
23. Toshiba	Power Apparatus Export 1-6 Uchisaiwai-cho Chyoda-ku, Tokyo 100 (Japan)		Hideki Yamada	
24. Vevey Engineering Works, Ltd	1800 Vevy (Switzerland)	(021) 51 0000 51	J. P. Kaufmann	P, F, K, B, T
25. J.M. Voith GmbH	P.O. Box 1940 D7920 Heidenheim (West Germany)	(07321)32.25.61	Peter Ulith Franz Wolfram	P, F, K, B, T

B = Bulb turbine
C = Cross-flow turbine
F = Francis turbine
K = Kaplan turbine

P = Pelton turbine
T = Tubular turbine
Tu = Turgo turbine

Selected Water Resources Abstracts

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16. Abstract

This manual has been prepared to assist potential developers of hydropower and to help agency personnel concerned with hydropower, planning and development in Idaho. It is designed to guide the developer through the various steps in preparing a feasibility study and completing the necessary licensing. The manual gives brief information on the engineering requirements and the economic analysis and references as to how to obtain necessary professional assistance.

Necessary steps and actions that must be taken to obtain appropriate permits, licenses and compliance certification have been presented in sections involving local permitting, State law requirements, and Federal law requirements. This includes graphic flow charts, expected time requirements, and specific information on addresses and phone numbers to make necessary contacts.

A brief discussion is presented on incentives for developing small-scale hydropower in Idaho, with information on financing possibilities and requirements for developing power sales contracts. A very specific set of references for use of those working in Idaho is included. The manual includes in the Appendix a glossary and a list of hydroelectric turbine manufacturers.

17a. Descriptors

Hydroelectric Power, Hydraulic Turbines, Hydroelectric Project Licensing, Electric Power, Federal Power Act, Idaho Hydropower, Evaluation Assessment, Economic Evaluation.

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