Research Technical Completion Report
Project A-057-IDA

UNDEVELOPED HYDROPOWER AS A POTENTIAL ENERGY SOURCE IN IDAHO

By

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ABSTRACT

Energy demands and rising costs of fuels for steam power plants has made small scale hydro a viable energy source in much of the United States. Because streams had not been studied for small scale hydro development a survey was needed to determine the potential energy available in the streams of the State.

Through this study a new technique was developed for finding flow duration information along reaches of natural streams that did not have streamflow records. In addition a method of estimating flow duration curves for regulated streams was developed. With these techniques a survey was made of the theoretical energy potential in the streams of the State of Idaho. This was first done on a reach by reach basis and then the hydrologic data generated for the reach analysis was used to estimate power potential at existing dams, all proposed power sites and certain power possiblities in irrigation systems. A summary of the results of the hydro survey for Idaho is included in this report.

Subsequently the study was expanded with the help of neighboring state water centers to cover the entire Pacific Northwest region of the United States. A preliminary social, political and environmental feasibility analysis was also made to identify the reaches wherein favorable action toward implementation could be expected. Results of feasibility analysis and a ranking of most promising reaches is included in this report.

INTRODUCTION

The rising costs and demands for energy has made it important for planners and engineers to look at all types of energy production to help meet the problem of supplying electrical energy. In the State of Idaho, with the favorable conditions of topographic relief and rather abundant water supply it was important to determine the ultimate theoretical energy from hydro power development in the streams of the state. Thus the objective of this research was to arrive at methods of assessing the potential energy in the streams of the state and to also make energy load appraisals of a preliminary nature to provide information for making site by site project feasibility studies.

Earlier studies by Federal and State agencies considered only selected dam sites with high heads and extensive impoundments on the rivers. The rising costs for producing electrical energy has now made the economics of building small scale, low-head developments an attractive alternative. Thus it is important to plan for smaller sized power installations. Recent advances in the production of smaller sized hydro units, and the development of standardized production units has also contributed to making small hydro development a viable means of helping meet a portion of the future energy needs. Following the initiation of this study the scope of the project was broadened to cover the entire Pacific Northwest and this effort then became supportive to a much larger study funded by the U.S. Department of Energy under Contract No. EG-77-S-07-1691 (Gladwell, Heitz, Warnick and others, 1979). This larger project was carried on cooperatively with the State of Washington Water Research Center, the Oregon Water Resources Research Institute and the Montana University Joint Water Resources Research Center.

TECHNICAL APPROACH

Basic Hydrologic Analysis

In many areas of Idaho and other sections of the Pacific Northwest there is not adequate stream gaging to have records of flow available at all the reaches of the river for which potential hydro energy needs to be determined. It was decided that a good way of expressing power and energy potential is to estimate the theoretical potential in all reaches of the streams of the State. Head for power computations was determined as the difference in elevation at the inflow and the outflow points on the stream. Preliminary consideration indicated most plants would be run-of-river type installations so a flow duration curve approach was used in computing theoretical energy potential. A procedure was developed and tested for constructing synthetic flow duration curves for reaches of all the streams. Techniques for constructing these curves were developed for both unregulated rivers and for regulated rivers. For the unregulated or natural stream situations, the technique was based on regression equation between flow in the stream at a given exceedance interval and the average annual flow. Area-precipitation products for areas up to a given location on the stream were used to arrive at values of average annual runoff at the given ungaged locations.

The unregulated stream flow duration curves resulted in parametric curves similar to Figure 1. Details on the techniques developed are reported in the following published reports and articles.

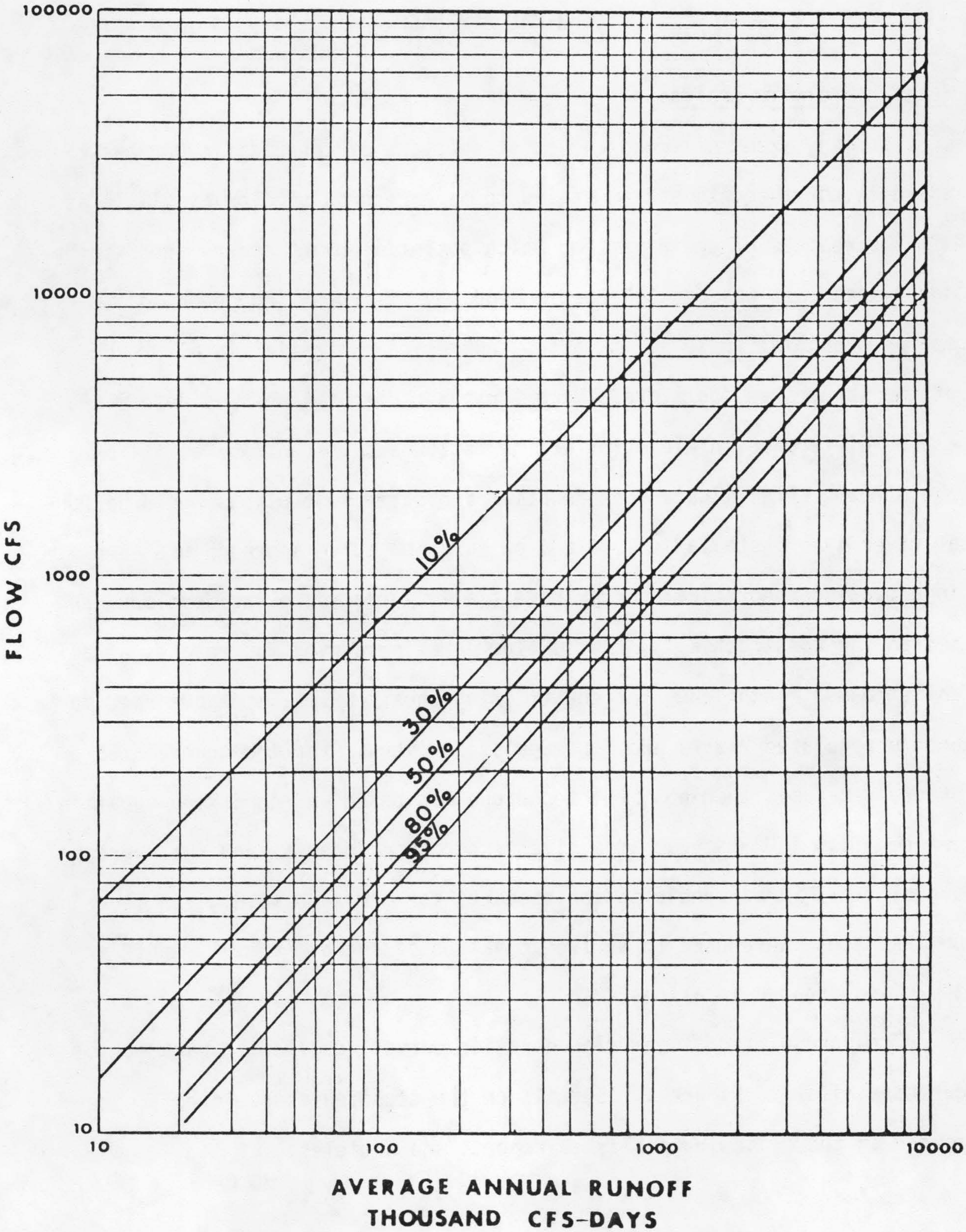


FIGURE 1 Parametric Flow Duration Curves Developed for Estimating Hydro Potential

Heitz, L.F., 1978, "Some Hydrologic Analysis Techniques." Low-Head Hydro. An Examination of An Alternative Energy Source, Compiled by John S. Gladwell and C.C. Warnick, Idaho Water Resources Research Institute, University of Idaho, Moscow, Idaho, pp. 159-167.

Gladwell, J.S., Heitz, L.F., Warnick, C.C., et al, 1979. "A Resource Survey of Low-Head Hydroelectric Potential Pacific Northwest Region, Completion Report Phase I, U.S. Department of Energy, Contract No. EG-77-S-07-1691, Volume A, Idaho Water Resources Research Institute, University of Idaho, Moscow, Idaho. pp. 4-26.

Emmert, R.L., 1979, "Methodologies for the Determination of Flow Duration Curves at Specific Sites and Ungaged Reaches of Streams", M.S. Degree Thesis, Department of Civil Engineering, University of Idaho, Moscow, Idaho, 126 pp.

For the determination of flow duration curves on regulated streams a slightly different procedure was developed. This entailed using flow records from the regulating reservoirs, the use of area-precipitation products, estimates of the runoff coefficient and evaluation of monthly distribution of the runoff. The procedure consisted of starting with the known reservoir outflow values and adding increments of flow from the tributary streams downstream, using as parameters for estimation the normal-annual area-precipitation values, the runoff coefficients for the inflow drainages and the estimated monthly distribution of the flow. The details for the techniques are reported in the thesis by Emmert listed above. This method was tested on the Payette River system in Idaho where it could be checked for accuracy at downstream gaged locations of the river. Results of the survey are reported in a later section of this report.

Screening for Feasibiltiy of Energy Development

In an attempt to make the information on the theoretical potential energy more useful a preliminary social, political and environmental feasibility evaluation was made of each reach for which a theoretical energy potential was determined. This was done by identifying the restraints to development. To make it a manageable undertaking certain index parameters of restraint to development were used. These parameters are either social, political or environmental considerations that will enter into whether small scale hydro should proceed with final stages of design and implementation. The index parameters are as follows:

A. Land use restraint
B. Utility displacement
C. Building displacement
D. Special fish problems
E. Energy Transmission
F. Energy load

This evaluation for more than 550 reaches of rivers in Idaho was done by using the best maps available, usually U.S. Geological Survey Topographic Maps, and a minimum of site visitations. Two days of aerial reconnaissance helped make the appropriate identification of restraints and special problems. If a reach appeared to have problems in any of the above parametric categories a note was made. Guidelines for making the above evaluation were prepared in advance for making the assessment of restraints uniform and consistent. For example, under the land use restraint parameter, a restraint problem was recorded as existing if the reach is part of a wild and scenic river designation, in a wilderness area, in a National or State Park, in a National Recreation Area, contained a known reserved natural area, or contains an identified archaeological site. Table 1 is an example of how these data were recorded. The numbers in the left hand column of Table 1 refer to given reaches of rivers. More details on the guidelines and methodology for making restraint evaluation are contained in the report by Gladwell, Heitz, Warnick, et. al. previously mentioned.

When the restraint tabulation had been completed a screening of a reaches was made to indicate which reaches had most promise for future development. This involved a rather subjective ranking procedure based on what the investigators considered significant at this time for the entire Pacific Northwest region. The approach and method used are in no way all inclusive or superior to any other schemes. This initial ranking merely represents a first effort to choose the best reaches of rivers for more intensive study.

The first step in the ranking and screening process was to screen out the less likely reaches. Using the information on feasibility restraints, transmission and load considerations given in the tabular information like that reported as an example in Table 1. The basic criteria used in the screening were as listed below:

1. A check in the column titled land use restriction.
2. More than one check in the columns titled Utility Displacement, Building Displacement, and Special Fish Problems.
3. The distance to the nearest transmission line was greater than 10 miles.
4. No local market exists.

If any of these four criteria were met the reach was eliminated from further consideration. After the preliminary screening of the over 550 reaches was accomplished, the remaining reaches were ranked according to the highest available flow in the river reach for that flow available 30 percent of the time. Results of this part of the

Table 1. Feasibility Evaluation Data Form with Transmission and Load Consideration Information

REACH IDENTIFICATION NUMBER	FEASIBILITY RESTRAINT				TRANSMISSION AND LOAD CONSIDERATIONS			
	LAND USE RESTRICTIONS	UTILITY DISPLACEMENT	BUILDING DISPLACEMENT	SPECIAL FISH PROBLEMS	DISTANCE TO NEAREST LINE Miles	LINE CAPACITY KV	LOCAL MARKET	DISTANCE TO CITY > 1000 Miles
03-500-500-000	KOOTENAI	RIVER	BASIN					
Kootenai River								
000R0002		X			<1	115 (B)	1,2,3	10
03-500-500-010	KOOTENAI	RIVER	TRIBUTARIES					
Boundary Creek								
000R0001	X				22	25 (BF)	1,3	24
03-500-500-020								
Smith Creek								
000R0001					21	25 (BF)	1,3	20
03-500-500-090								
Deep Creek								
000R0002	X	X			4	115 (B)	1,3	4
000R0004		X			2	115 (B)	1,3	4
000R0006		X			1	115 (B)	1	5
03-500-500-100								
Moyie River								
000R0001	X				1	25 (BF)	1,2	7
000R0005	X				5	25 (BF)	1,2	10
000R0007	X	X			10	25 (BF)	None	14
000R0009	X	X			16	25 (BF)	1,2	19

B = Bonneville Power Administration

BF = City of Bonners Ferry

evaluation are reported in later sections of this report.

Site Specific Evaluation of Hydro Potential

A more definitive assessment of the potential of specific sites was made using hydrologic information from the reach analysis. With support from this OWRT project and with primary support from a grant from the U.S. Department of Energy an evaluation was made of potential for hydro development at existing dams that have no generating facilities at present, at all proposed sites that have previously been identified for possible development, and at various irrigation systems operating in the State. The primary source of data for this evaluation came from the inventories and planning studies made by the U.S. Corps of Engineers, U.S. Bureau of Reclamation, U.S. Geological Survey, U.S. Soil Conservation Service, the Federal Power Commission (now Federal Energy Regulation Commission), and the Idaho Department of Water Resources. This has just been completed as a part of supported project of the U.S. Department of Energy, and the details on how it was accomplished are contained in the report listed below:

Gladwell, J.S., Heitz, L.F., Warnick, C.C., et.al., 1979, "A Resource Survey of Low-Head Hydroelectric Potential at Existing Dams and Proposed Sites in the Pacific Northwest, Completion Report Phase II", U.S. Department of Energy Contract No. EG-77-S-07-1691, Idaho Water Resources Research Institute, University of Idaho, Moscow, Idaho, September, 1979.

Figure 2. Typical Data Information Sheet of
Reach Hydro-Potential Charactersitics

REACH NUMBER 03250000CCC000R0011

I LOCATION
- A. STATE — IDAHO
- B. COUNTY — CARIBOU
- C. TOWNSHIP, RANGE — T 9S R41E
- D. LATITUDE, LONGITUDE — 42 38 111 42
- E. STREAM NAME — BEAR RIVER
- F. MAJOR BASIN NAME — BEAR RIVER
- G. RIVER MILE — 164.4 TO 167.8

LOCATION MAPS

U.S. TOPO SERIES
1:250000
SCALE

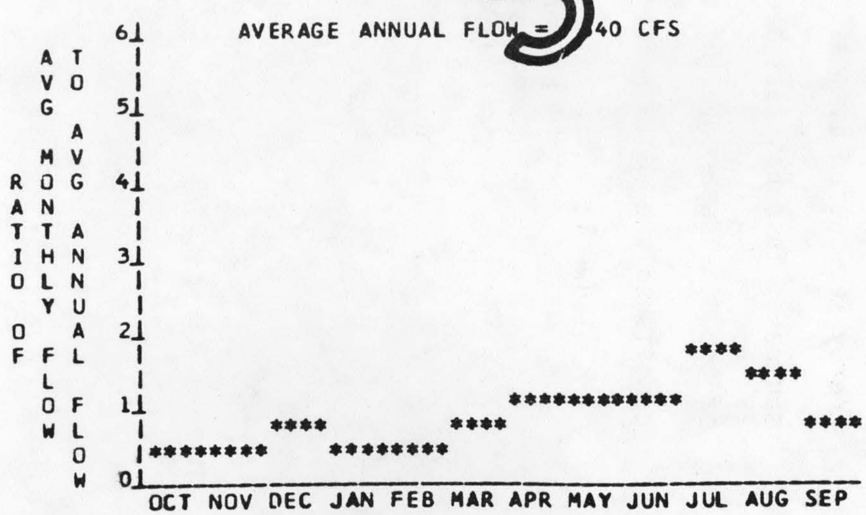
MAP NAME
PRESTON

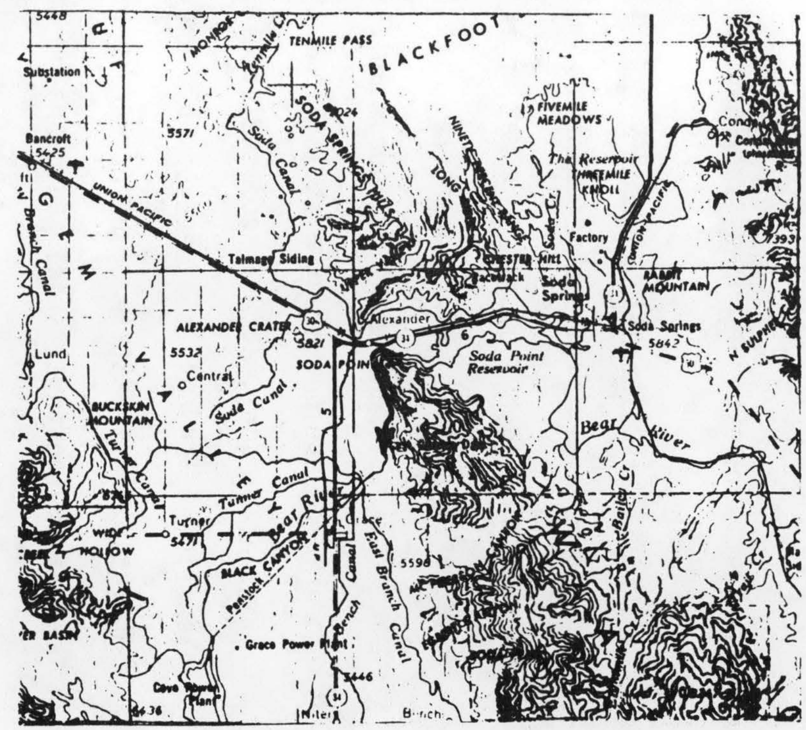
II HYDROLOGIC AND HYDRAULIC CHARACTERISTICS
- A. UPSTREAM ELEVATION OF REACH — 5630 FT. MSL
- B. DOWNSTREAM ELEVATION OF REACH — 5600 FT. MSL
- C. TOTAL AVAILABLE HEAD IN REACH — 30 FT.
- D. AVERAGE SLOPE IN REACH — 8.8 FT./MI.
- E. DRAINAGE AREA ABCVE REACH MOUTH — 4105 SQ.MI.
- F. INFLOW CLASSIFICATION — REGULATED

III REACH FLOW DURATION AND THEORETICAL POTENTIAL
ENERGY CHARACTERISTICS

EXCEEDANCE PERCENTAGE	DISCHARGE CFS	THEORETICAL PLANT SIZE MW	ANNUAL ENERGY AVAILABLE GWH	[illegible]
95	134	0.34	[illegible].95	[illegible]99
80	227	0.58	[illegible]	0[illegible]94
50	557	1.42	9.[illegible]	0.77
30	843	2.1[illegible]	1[illegible]	0.64
10	1225	[illegible]	1[illegible].79	0.51

IV TYPICAL ANNUAL HYDROGRAPH





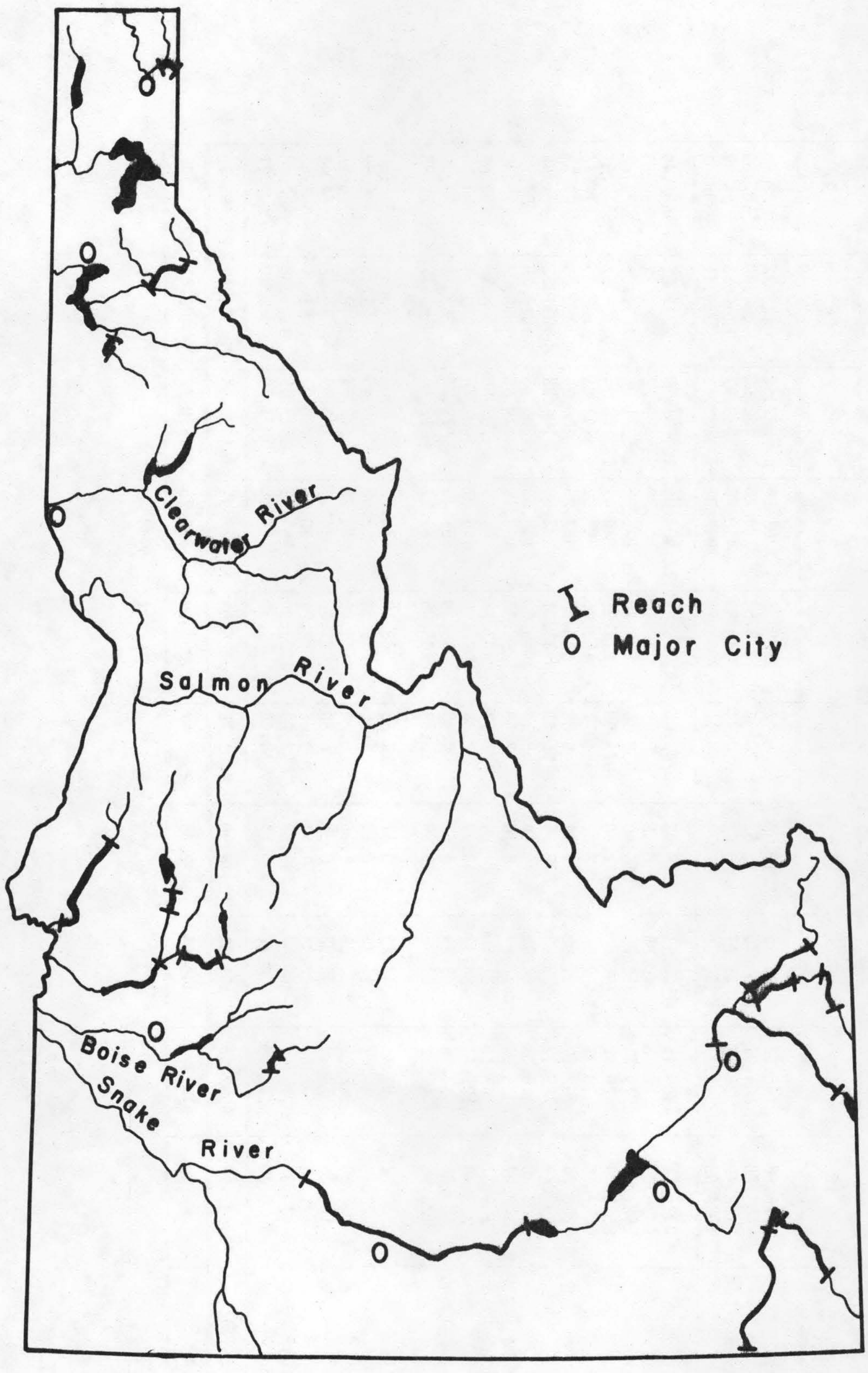


Figure 3. Map Showing Highest Ranked Hydro Potential for Reaches of Streams in Idaho

Table 2. Summary of Theoretical Developable Power and Energy Potential in Streams of Idaho

AREA OF INTEREST	POWER (MW)					ENERGY (GWh)				
	P_{10}	P_{30}	P_{50}	P_{80}	P_{95}	E_{10}	E_{30}	E_{50}	E_{80}	E_{95}
Bear River	75.66	48.57	33.22	15.38	8.42	328.75	281.28	227.52	125.92	72.50
Kootenai River	454.78	141.07	66.40	31.52	20.94	1273.84	724.20	462.56	264.00	182.84
Pend Oreille River	262.49	78.63	41.67	20.71	10.94	740.59	418.45	288.97	169.63	94.67
Spokane River	1034.93	376.34	150.66	62.74	38.41	2966.77	1812.91	1022.13	521.51	335.01
Snake River-Main Stem	3326.61	1984.41	1307.11	919.03	745.05	14,756.49	12,404.95	10,031.70	7822.02	6688.46
Palouse River	8.61	2.73	0.85	0.15	0.06	22.10	11.78	5.22	1.22	0.53
Clearwater River	7527.60	2079.81	1059.35	554.40	352.34	20,620.70	11,076.22	5271.78	4631.06	3074.63
Salmon River	8530.03	2620.97	1705.90	1261.99	973.90	16,717.26	16,274.47	13,248.24	10,720.57	8512.31
Wildhorse River	57.16	18.37	7.08	2.86	1.77	155.35	87.39	47.81	23.79	15.44
Weiser River	208.24	92.09	31.88	9.74	5.58	620.75	417.26	206.29	80.20	48.35
Payette River	1499.24	729.32	435.83	233.35	156.41	5481.51	4132.59	3104.23	1951.32	971.42
Boise River	1053.30	315.23	181.93	99.44	56.14	3049.53	1756.43	1289.38	819.86	487.76
Owyhee River-Idaho	102.07	25.64	11.67	4.70	2.58	261.37	127.46	78.83	38.63	22.35
Bruneau River-Idaho	189.17	47.40	21.50	11.86	7.92	492.78	244.39	153.65	98.77	68.56
Wood River	272.98	109.61	64.42	43.83	32.68	932.00	645.77	487.44	370.16	284.73
Salmon Falls River-Idaho	20.48	11.96	9.19	7.67	4.36	96.39	81.45	71.75	63.12	37.69
Lost River	123.96	41.82	27.83	19.69	13.89	405.05	261.13	212.11	165.77	121.35
Small Streams Near Twin Falls	62.72	52.40	44.31	30.57	24.63	388.10	370.03	341.67	263.43	215.20
Portneuf River	22.10	14.71	11.25	6.13	4.22	105.52	92.58	80.45	51.26	36.62
Mud Lake Basin	2.59	2.02	1.69	1.15	0.70	14.80	13.79	12.64	9.59	6.12
Blackfoot River	124.26	74.30	22.92	6.87	6.30	421.66	334.13	154.09	74.08	54.41
Willow Creek	21.03	5.87	2.91	1.43	0.86	57.21	30.64	20.27	11.86	7.46
Henry's Fork River-Idaho	479.37	273.61	203.47	133.88	92.23	2123.94	1763.48	1517.69	1121.36	802.25
Salt River-Idaho	0.60	0.29	0.22	0.16	0.14	2.52	1.98	1.70	1.40	1.21
Snake River Subtotal	23,632.12	8502.56	5151.31	3348.90	2481.76	76,725.03	50,127.92	36,336.94	28,319.47	21,456.85
Idaho Total	25,459.98	9147.17	5443.26	3479.25	2560.47	82,034.98	53,364.76	38,338.12	29,400.53	22,141.87

Table 3 SUMMARY OF THEORETICAL MAXIMUM DEVELOPABLE POWER AND ENERGY POTENTIAL FOR THE STREAMS OF THE PACIFIC NORTHWEST

State	Power (MW)		Energy (GWh)	
	P_{30}	P_{50}	E_{30}	E_{50}
Washington[1]	13,928	8,862	80,124	61,314
Oregon[1]	12,105	6,787	64,951	46,324
Idaho[1]	9,147	5,443	53,365	38,338
Montana in Columbia Basin	3,576	2,044	19,848	14,689
Wyoming in Columbia Basin	620	295	3,345	2,205
Nevada in Columbia Basin	15	8	76	53
Total	39,391	23,439	221,709	162,923
Portion of Regional Potential in Idaho	0.23	0.23	0.24	0.24

[1] State totals adjusted to equally share power and energy totals for common boundary reaches of Columbia and Snake Rivers.

Table 4. Summary of the Most Promising Reaches of Rivers in Idaho Having Potential for Small Scale Hydro Development.

Reach Number	Stream Name	Q_{30} CFS	Head Available in Reach, Ft.	Theoretical P_{30} mw
03-500-500-000-000-R0002	Kootenai River	17.517	40	59.38
03-500-240-000-000-R0026	Snake River	9.983	71	60.07
03-500-240-000-000-R0056	Snake River	9954	191	161.12
03-500-240-000-000-R0058	Snake River	9398	170	135.39
03-500-240-000-000-R0027	Snake River	8274	20	14.02
03-500-240-000-000-R0048	Snake River	7212	13	7.95
03-500-240-000-000-R0046	Snake River	7048	32	19.11
03-500-240-000-000-R0028	Snake River	6185	77	40.36
03-500-240-000-000-R0045	Snake River	6029	20	10.22
03-500-240-000-000-R0054	Snake River	6005	44	22.39
03-500-240-160-000-R0011	Payette River	3750	95	30.19
03-500-240-160-000-R0013	Payette River	3750	40	12.71
03-500-240-160-000-R0015	Payette River	3750	165	52.44
03-500-240-000-000-R0030	Snake River	3317	415	116.66
03-500-240-160-000-R0005	Payette River	2400	47	9.56
03-500-240-000-000-R0032	Snake River	2369	561	112.63
03-500-240-300-000-R0008	Henrys Fork River	1842	62	9.68
03-500-240-160-000-R0017	Payette River	1800	200	30.51
03-500-240-300-000-R0012	Henrys Fork River	1699	106	15.26
03-500-240-300-000-R0006	Henrys Fork River	1677	91	12.93
03-500-240-160-180-R0003	S. F. Payette River	1650	150	20.97
03-500-240-160-100-R0005	N. F. Payette River	1600	30	4.07
03-500-240-160-180-R0005	S. F. Payette River	1575	560	74.75
03-500-240-420-000-R0014	Coeur d'Alene River	1534	53	6.89
03-500-240-140-000-R0003	Weiser River	1403	85	10.11
03-500-240-140-000-R0005	Weiser River	1366	300	34.73
03-500-240-420-000-R0018	Coeur d'Alene River	1338	160	18.15

Table 4. (cont.) Summary of the Most Promising Reaches of Rivers in Idaho Having Potential for Small Scale Hydro Development.

Reach Number	Stream Name	Q_{30} CFS	Head Available in Reach, Ft.	Theoretical P_{30} mw
03-500-240-140-000-R0007	Weiser River	1310	90	9.99
03-250-000-000-000-R0013	Bear River	1040	43	3.79
03-500-420-504-000-R0024	Coeur d'Alene River	902	80	6.12
03-250-000-000-000-R0004	Bear River	899	205	15.62
03-250-000-000-000-R0009	Bear River	860	53	3.86
03-500-240-300-010-R0002	Teton River	852	150	10.83
03-250-000-000-000-R0011	Bear River	843	30	2.14
03-250-000-000-000-R0014	Bear River	842	145	10.35
03-250-000-000-000-R0002	Bear River	816	91	6.29
06-500-240-307-000-R0002	Salt River	730	55	3.40
03-250-000-000-000-R0010	Bear River	699	50	2.96
06-500-240-307-000-R0004	Salt River	603	305	15.59
03-500-240-140-000-R0011	Weiser River	600	180	9.15
03-500-240-220-150-R0007	S. F. Boise River	576	310	15.14
06-500-240-311-000-R0002	Hoback River	516	130	5.69
03-500-420-502-010-R0004	St. Maries River	495	430	18.05
06-500-240-309-000-R0002	Greys River	483	350	14.33
03-500-240-300-010-R0006	Teton River	471	660	26.34
03-500-240-140-000-R0013	Weiser River	440	60	2.24
03-500-480-275-000-R0002	Pack River	412	17	0.59

Many detailed feasibility and design studies by consultants and government agencies are already well along even before final completion of the site specific phases of the research.

The site specific studies on the project funded from the U.S. Department of Energy is now essentially complete. A summary of the results of that work is presented in Table 5. Complete detailed results of the site specific phase of the studies are contained in Phase II part of the U.S. Department of Energy study (Gladwell, Heitz, Warnick, et. al., September 1979).

A rather unexpected result of early adaption and use of the research was the interest of various groups in the procedures developed. This has resulted in several seminars, workshops, shortcourse and presentation at conferences within the state and even nationally. This is exemplified by the list of publications and presentation that are documented in the References sections of this report.

RESULTS

The basic hydrologic analysis for both unregulated and regulated streams in Idaho resulted in engineering data for each reach of river studied. This information was all catalogued and put in computer format for easy retrieval and processing in later studies that are anticipated. The results were formated on a single computer printout sheet and this has become known as a "reach sheet". Figure 2 shows one of these typical sheets of reach hydro potential characteristics. Over 550 of these reach sheets were developed to completely cover the state streams where there is no present hydro production. Table 2 gives a summary of the theoretical power capacity and avarage annual energy potential in various river basins in Idaho. Table 3 gives comparative data of theoretical energy potential for the Pacific Northwest States. It should be emphasized that these values or the theoretical potential considering 100 percent efficiency and the development of the entire head in a given reach. Complete results of the reach analysis is contained in three volumes of the Phase I part of the U.S. Department of Energy study (Gladwell, Heitz, Warnick, et.al., March 1979).

The feasibility screening for social, political and environmental acceptability of all the river reaches resulted in a listing of reaches having the most promise for more detailed study. Table 4 gives information on the most promising river reaches. Figure 3 is a map showing the sections of the rivers in the State wherein the reaches are located that have most promise for development. This information has been presented to the U.S. Department of Energy and various other governmental entities and utilities to encourage detailed feasibility studies.

Table 5. Summary of Site Specific Hydropower Potential for Idaho at Existing Dams and Proposed Power Sites.

IDAHO

SITE TYPE	POWER (MW) P(10)	P(30)	P(50)	P(80)	P(95)	ENERGY (GWH) E(10)	E(30)	E(50)	E(80)	E(95)
I. EXISTING DAMS										
1. WITHOUT GENERATION (EXISTING NG) 200 KW<P(50)<25 MW	160.	87.	30.	13.	5.	530.	403.	201.	106.	43.
2. WITHOUT GENERATION P(50)>25 MW	104.	72.	43.	3.	2.	410.	355.	253.	25.	14.
3. WITH GENERATION		1830. *					9678. **			
II. PROPOSED SITES										
1. 200 KW<P(50)<25 MW	8176.	2648.	1426.	851.	593.	24389.	14703.	10422.	7147.	5171.
2. P(50)>25 MW	15331.	5700.	3561.	2347.	1781.	51167.	34295.	26800.	19886.	15546.
3. IRRIGATION SITES 200 KW<P(50)<25 MW	54.	47.	41.	21.	6.	188.	179.	165.	93.	31.
4. IRRIGATION SITES P(50)>25 MW	191.	145.	82.	24.	11.	826.	746.	527.	194.	96.
5. ALL PROPOSED P(50)>200 KW	23752.	8541.	5111.	3243.	2392.	76570.	49923.	37913.	27319.	20845.
III. TOTAL HYDRO POTENTIAL AT EXISTING NG AND ALL PROPOSED SITES 200 KW<P(50)<25 MW	8391.	2783.	1497.	885.	605.	25106.	15285.	10787.	7346.	5245.
IV. TOTAL HYDRO POTENTIAL AT ALL EXISTING NG AND ALL PROPOSED SITES	24016.	8700.	5184.	3259.	2398.	77510.	50680.	38367.	27450.	20901.

NOTES
* THIS IS THE SUM OF THE INSTALLED CAPACITY FOR PLANTS LISTED IN THE FPC REPORT "HYDROELECTRIC POWER RESOURCES OF THE U.S.",1976
** THIS IS THE SUM OF THE AVERAGE ANNUAL GENERATION FOR ALL PLANTS SHOWN IN THE ABOVE LISTED FPC REPORT

CONCLUSIONS AND RECOMMENDATIONS

This research has resulted in a very useful and practical methodology for determining the theoretical energy potential of streams in a region of our country wherein there is great variability in the hydrologic characteristics of streams. The research has gone beyond the initial intent of making a state survey and through the extended financing of a U.S. Department of Energy grant has developed for the Pacific Northwest a detailed survey of the theoretical hydroelectric energy potential for all streams having capacities greater than 200 KW. This does show considerable theoretical potential for small scale hydro in the State of Idaho.

An initial attempt to quantify and prioritize the most likely reaches of the rivers of Idaho has been done in a subjective manner. This screening and ranking shows the gross potential is greatly reduced due to land use restrictions, displacement restraints and environmental restraints.

The initial studies by reaches has generated hydrologic data that helps make site specific analyses possible. This further site specific evaluation has included existing dams without developed power, proposed sites, and sites in operating irrigation systems having flow and head sufficient to produce 200 KW of power 50 percent of the time.

Recommendation for further action include three distinct areas of need.

(1) The first need is broad dissemination of the data and a program encouraging detailed feasibility and design studies which can result in early implementation of the construction of the hydro

developments that are economically, socially, environmentally and politically feasible. This should not overlook the possibility that integrated multiple site development is likely to be the most cost effective approach to developing small scale hydro.

(2) The second need is additional research to determine what the effect a paucity of hydrologic data will have on the economic feasibility of sites in given regions of river systems that might have hydroelectric development projects or programs. This type of research may have particular application in developing countries or in remote areas like Alaska where flow data are scarce and sometimes not very accurate.

(3) There is need for more research on the impact of small scale hydro on the environment and the public acceptance of the adverse effects that are likely to result from small scale hydro development. This research needs an interdisciplinary base that will thoroughly treat the problem.

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The following publications have resulted in part from the support of this allotment project.

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