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OREGON HYDROELECTRIC POWER POTENTIAL

A 2½-year resource analysis to determine the hydropower potential for the State of Oregon was recently completed. This issue of Oregon's Environment is devoted to a summary of that investigation. Involved was a 2-year regional project conducted by the Water Resources Research Institutes of Oregon, Washington, Idaho, and Montana with funding by the U.S. Department of Energy. In Oregon, this was complemented by the Institute's information dissemination program (supported by Oregon State University and the U.S. Department of Interior's Office of Water Research and Technology) and by participation on the Governor's Hydropower Task Force, Alternative Energy Development Commission.

The research was conducted in two phases -- the first to determine power and energy potentials for Oregon's undeveloped river reaches; the second to evaluate the power and energy potentials at existing and proposed dams in the state. The research follow-up consisted of translating the findings into various report formats, extending portions of the work for use by the Hydropower Task Force,

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presenting related talks to interested public groups, talking with numerous individuals interested in individual backyard hydropower systems or small commercial/industrial systems, and developing material for the OSU Energy Extension Service.

SCOPE OF INVESTIGATION

The Phase I Investigation

The Phase I study provided basic data gathering, preliminary hydrologic analyses, related evaluations of power and energy, and preliminary feasibility-of-development assessments for 7,626 miles of river reaches (segments) in Oregon where no dams or reservoirs now exist. These reaches had streamflows and river slopes adequate for hydropower development of 200 kW or more at least 50 percent of the time using run-of-river operation. For low-head plants with less than 20 meters (66 feet) of gross head, this required median streamflows of 36 cubic feet per second or more. Hence, smaller streams were not included in the study, even though they could meet the needs for residential size-hydropower.

The Phase II Investigation

In the Phase II study, over 5,000 existing and proposed dams were reviewed, resulting in identification of 48 existing projects with 200 kW or more of installed capacity, 59 existing non-power dams having a potential for developing 200 kW or more, 10 existing irrigation diversion dams and 9 irrigation canal drops where 200 kW or more might be developed, and 395 proposed dams where 200 kW or more might be developed. Data characterizing these dams came from federal and state agencies and from the Phase I analyses.

Particular interest was focused on the potential for developing small-scale hydropower projects. "Small hydro" was defined as a dam or site with the potential to produce between 200 kW and 25 MW of power based on streamflow available at least 50 percent of the time at run-of-river conditions and at 100 percent generating efficiency.

SUMMARY OF ANALYSIS TECHNIQUES

Analyses and evaluations were organized using the 18 major drainage basins identified by the Oregon Water Resources Department as analytical units for river basin planning. These natural subdivisions of the state only roughly correspond to the major political subdivisions of the state.

All evaluations were based upon available publications, maps and other documents. No field site investigations were conducted, other than for general orientation and work-planning purposes.

The physical characteristics of river reaches were determined from topographic maps and river profile maps. The physical features of each existing or proposed dam were obtained from available reports.

The streamflow regime for each river reach and at each existing or proposed dam was determined by means of a flow-duration curve (see Figure 1). This curve depicts the amount (or percent) of time during some total period that flow rates of a stream can be expected to equal or exceed any specified flow rate.

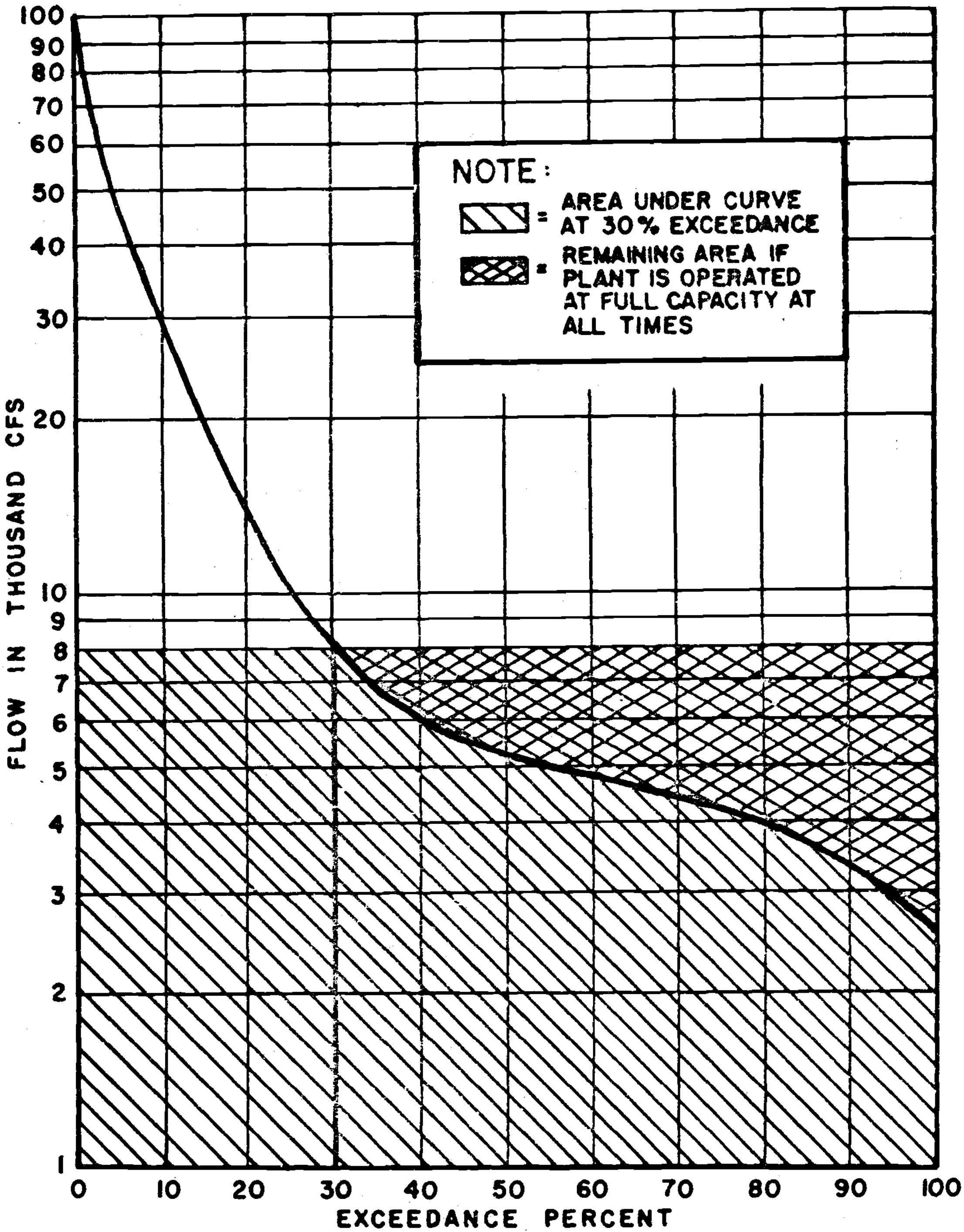

FIGURE 1. ILLUSTRATIVE FLOW-DURATION CURVE, SHOWING ENERGY RELATIONSHIPS FOR A FLOW EXCEEDED 30% OF THE TIME

The flow-duration curve for each reach was determined from precipitation and streamflow data and from topographic information. Corresponding curves for each dam or dam site were determined from the average annual flows and flow-duration curves developed for the corresponding reach of stream.

Power and energy potentials were computed for each river reach and at existing or proposed dams. The calculation assumed 100 percent efficiency of power development. The reach or plant capacity (power) and the theoretical annual energy available were computed for five different flow rates, corresponding to the 10, 30, 50, 80 and 95 percent exceedance levels.

Preliminary feasibility analyses and screening were used to identify relatively unconstrained reaches and dams with energy marketing potentials worth further examination. A few important factors were selected that could be documented from available information and which, if present, were likely to constrain the feasibility of low-head development. All feasibility parameters were evaluated on the basis of various published maps and reports, rather than by field inspection. Many other factors not included here would presumably be included in detailed reconnaissance investigations.

Feasibility restraints that were selected included land use restrictions (existing uses, federal special-use designations, identified archaeological sites), utility displacement (highways, railroads, power lines, telephone lines, fuel pipelines), building displacement (residential and commercial structures), and special fish problems (anadromous fish) beyond expected local aquatic ecosystem disruptions.

Transmission considerations included the distance from the dam or the center of the reach to the nearest power line and the capacity of that line. Some type of local load was also deemed necessary. Load considerations included the type of local load, if any, present in that area closer to the reach or dam than the nearest transmission line and the distance from the dam or center of the reach to the nearest town of 1000-or-more population.

Reach and dam screening to identify minimal constraints involved, first, the elimination of those reaches or dams that had a land use restriction. Of all those remaining, further elimination occurred if more than one feasibility restraint occurred among utility displacement, building displacement, and special fish problems. Finally, remaining reaches and dams were eliminated if there was no transmission line within 10 miles or no local market available. As a result, the reaches and dams least likely to involve restraints on development were identifiable.

POWER AND ENERGY POTENTIALS AT UNDEVELOPED REACHES

It is estimated that about 110,000 miles of streams exist in Oregon. Of these, 7,626 presently undeveloped river miles were found to possess adequate flows and elevation changes to provide 200 kW or more at least 50 percent of the time with heads no greater than 20 meters. These are shown in Figure 2 as heavy lines superimposed on a general map of streams in Oregon. For convenience, the streams were analyzed by subdividing them into 1,443 individual segments, each generally less than 10 miles in length and typically starting and ending at the mouths of tributary streams.

The theoretical developable power and energy potentials for Oregon streams, based on the low-head criteria, are shown in Table I for two exceedance conditions (30 percent and 50 percent of the time) that correspond roughly to the mean and median streamflow conditions. The minimally constrained potential for development of hydropower in these reaches is also shown in Table I.

It can be seen that the minimally constrained low-head hydropower potential is only about four percent of the total theoretical potential. The lack of availability of a local market, whether residential, industrial or agricultural, was a constraint for 87 percent of the reaches. Special fish problems constrained 71 percent of the reaches.

FIGURE 2. STREAM REACHES MEETING THE LOW-HEAD CRITERIA OF 200 KW OR MORE AT LEAST 50 PERCENT OF THE TIME

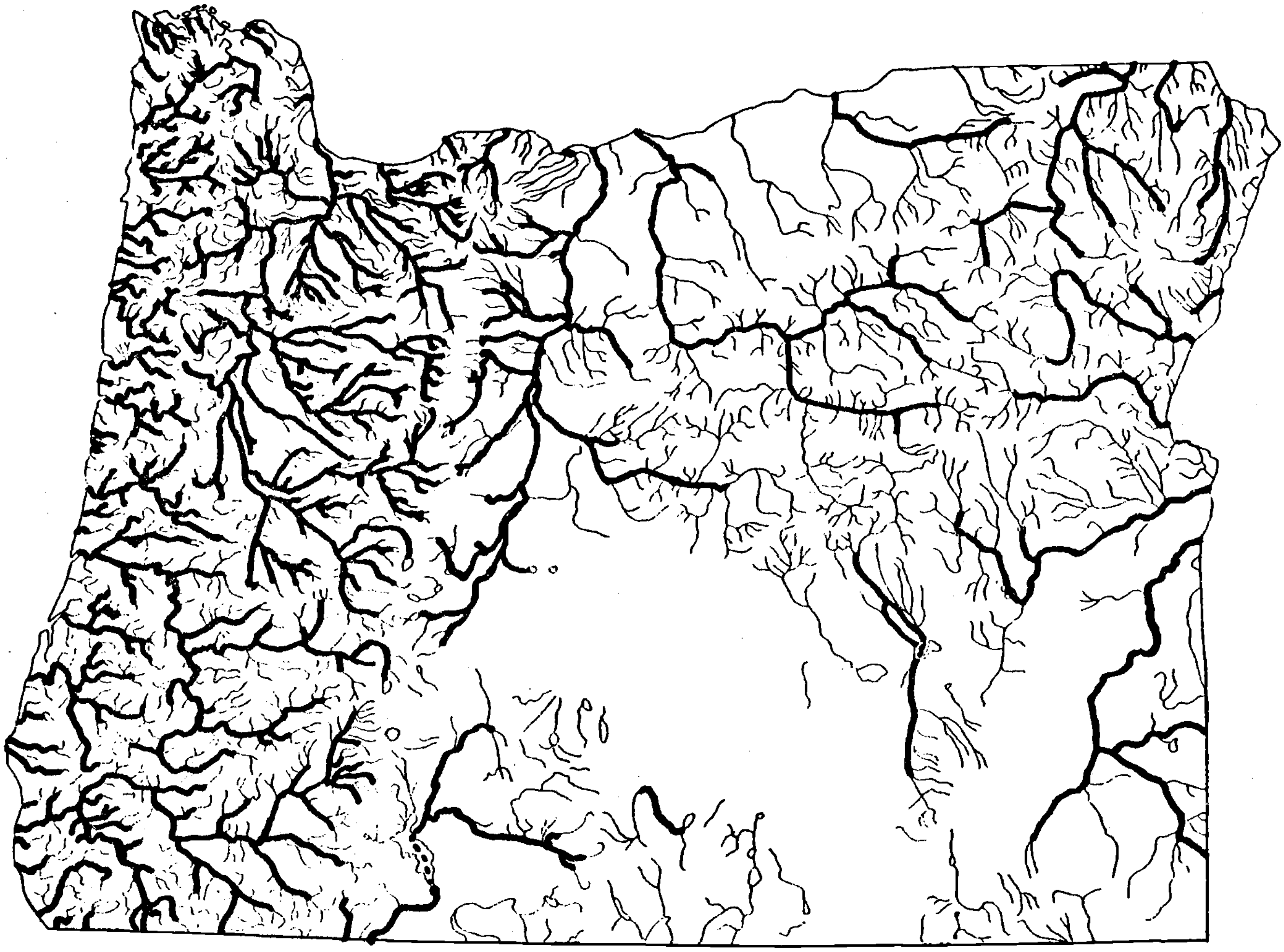

TABLE I. HYDROPOWER POTENTIALS AT PRESENTLY UNDEVELOPED REACHES

TYPE OF POTENTIAL	POWER (MW)		ANNUAL ENERGY (GWh)	
	P_{30}	P_{50}	E_{30}	E_{50}
Theoretical Potential	11,465	6,292	60,621	42,505
Minimally Constrained Potential	413	228	2,188	1,539

Power is summarized in megawatts (MW) and energy in gigawatt-hours (GWh)
1 GW = 1,000 MW = 1,000,000 kW

POWER AND ENERGY POTENTIALS AT EXISTING DAMS

Number of Dams Analyzed

About 2500 dams in Oregon have sufficient height or storage capacity to require registration with the State. Elimination of all dams incapable of producing 200 kW with streamflow available 50 percent of the time left 107 projects for analysis. Of these, 48 presently have installed facilities and generate hydroelectric power whereas 59 do not.

In addition to these 107 projects, there are 7 large power dams on interstate rivers bordering Oregon: four on the Columbia River -- Bonneville, The Dalles, John Day, and McNary -- and three on the Snake River -- Hells Canyon, Oxbow, and Brownlee.

Potentials at Existing Hydropower Projects

The 48 existing power projects in Oregon that presently have generating capabilities of 200 kW or more, plus two smaller generating projects listed by the Federal Power Commission, have a developed capacity of 1,465 MW and can generate 6,486 GWh annually (see Table II). Of these 50 plants, 18 can generate 25 MW or more. For comparison, the 7 large interstate projects on the Snake and Columbia Rivers have a developed capacity of 6,407 MW and generate 36,090 GWh annually. Figure 3 shows the locations of existing in-state and interstate power generation projects.

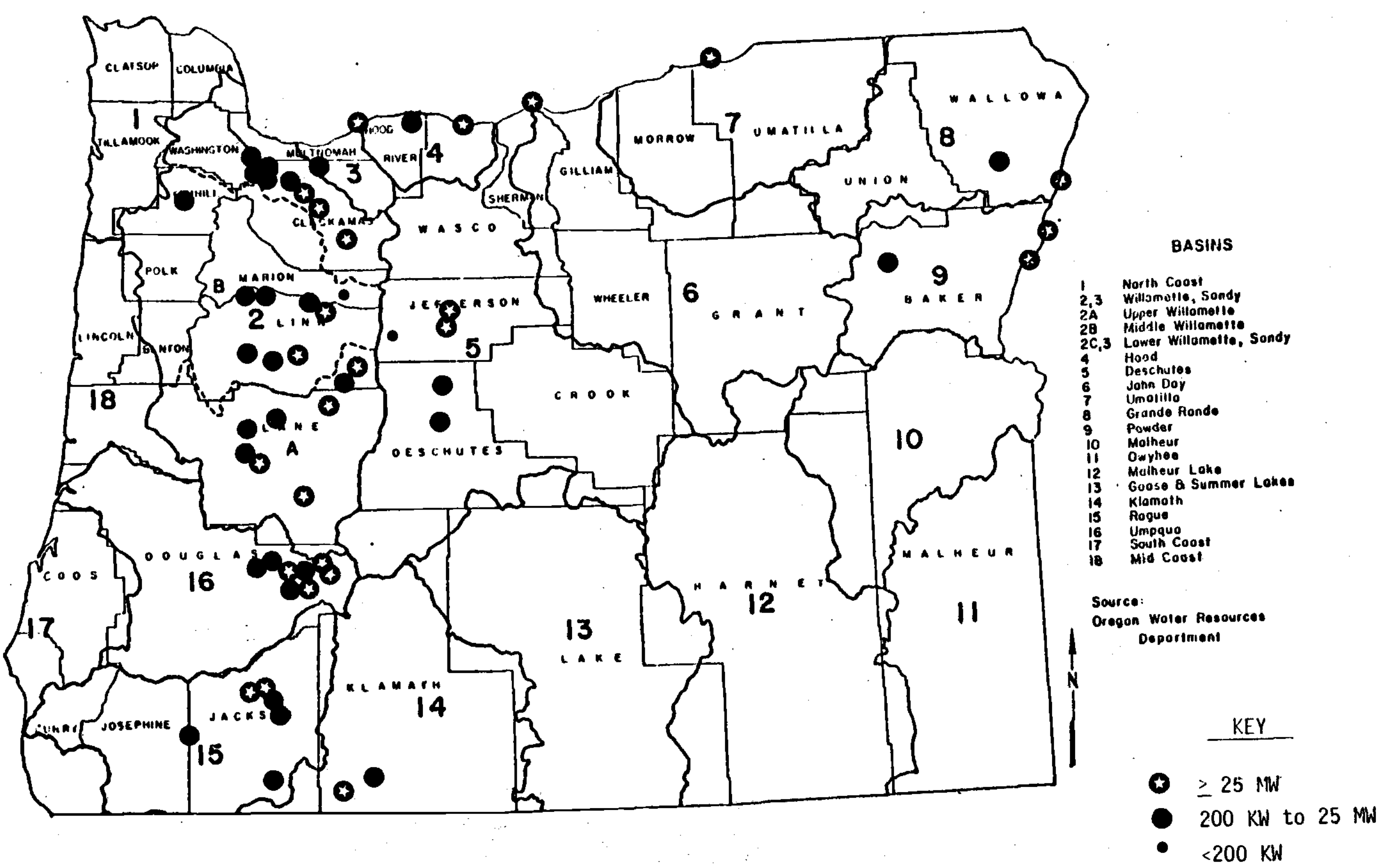

FIGURE 3. EXISTING HYDROELECTRIC PROJECTS

TABLE II. ESTIMATED INTRASTATE HYDROELECTRIC POWER POTENTIAL

Power Production Category	Theoretically Developable		Minimally Constrained	
	Power (MW)	Annual Energy (GWh)	Power (MW)	Annual Energy (GWh)
Now Generated at Existing Power Projects	1,465	6,486	--	--
Expansion at Existing Power Projects	860	2,206	860	2,206
Retrofitting at Existing Non-Power Dams[1]	117	784	44	295
Retrofitting at Existing Irrigation Facilities[1]	13	40	13	40
Development of Proposed Large Dams[1]	2,017	(no estimate)	311	(no estimate)
Development of Proposed Small-Hydro Dams[1]	1,839	12,102	628	4,155
Total New Power Potential[1]	4,846		1,856	

[1]Based on P_{50} and E_{50} and run-of-river operation.

From Table II, the undeveloped capacity that could be tapped is 860 MW. This would yield 2,206 GWh of energy output. For comparison, the 7 interstate dams have an expansion potential of 5,477 MW and 7,253 GWh.

The expansion potential at existing power projects, as estimated by others, apparently assumes that all untapped streamflow will be available for turbines without competition for other water uses. No estimate has been made on the practical limits to which this potential can be developed. The practical expansion at existing power projects will depend upon multiple-purpose plans for each basin as well as on the economics of retrofitting.

Potentials at Existing Non-Power Dams

Table II also shows the power and energy potentials for the 59 existing non-power dams in Oregon that have power potentials of 200 kW or more at the 50 percent exceedance level for run-of-river potential. None of the existing non-power dams has a hydroelectric potential greater than 25 MW with presently-regulated streamflow patterns. Therefore, the Table II values also may be considered as presenting the small-scale hydro potential at existing non-power dams. Retro-fitting would provide 117 MW and 784 GWh under the above assumptions. Figure 4 shows the locations for all non-power dams identified in Table II.

Detailed power and energy potentials were calculated for all 59 existing non-power dams using the five exceedance levels. The analyses show the influence of seasonal streamflow patterns. For example, the P_{95} power potential, available almost all year-round, is only 27 MW whereas the median power potential (P_{50}) is 117 MW and the near-maximum power potential (P_{10}) is 485 MW. Thus, streamflow variability causes almost a 20-fold range between the P_{95} and P_{10} values. The potential annual energy produced at these limits has only a 7-fold range, due to the short time that large flows are sustained when run-of-river operation occurs.

To indicate the "least constrained" dams, the screening process was applied to the 59 dams. It was assumed that future reservoir operation would not significantly modify the present streamflow release patterns. The minimally constrained power and energy potential were 44 MW and 295 GWh, respectively (See Table II), about 40 percent of the theoretical values.

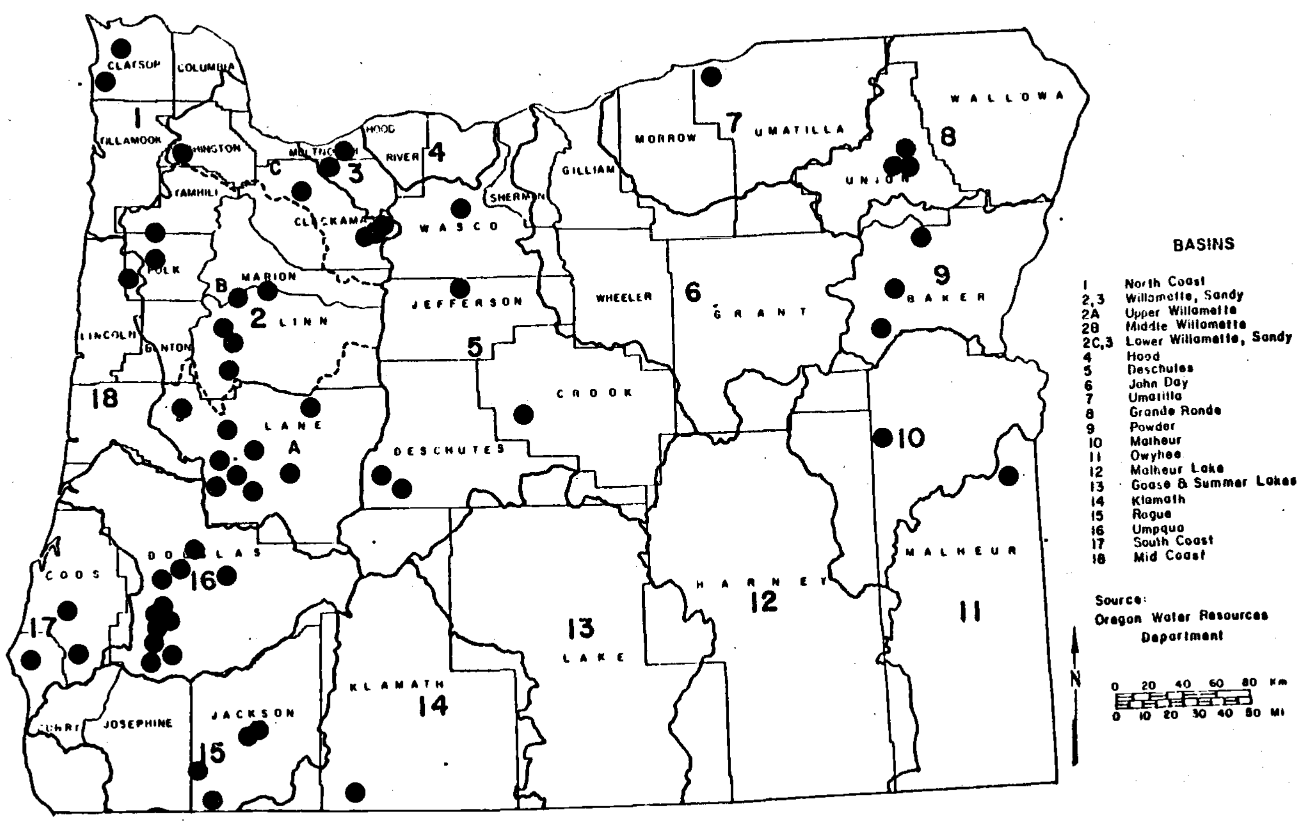

FIGURE 4. NON-POWER DAMS WITH HYDROELECTRIC GENERATION POTENTIALS (P_{50}) EXCEEDING 200 kW

POWER AND ENERGY POTENTIALS AT EXISTING IRRIGATION STRUCTURES

Nineteen existing irrigation facilities were found to have potential hydropower capabilities of 200 kW or more. This includes 10 irrigation dams on rivers where the Phase I study disclosed insufficient streamflow to meet the low-head criteria. The heights of these storage dams and the flows diverted by them to irrigation canals could partially provide small-scale hydropower in at least 8 cases and perhaps in all 10 cases. Therefore, they are included in the "irrigation structure" category. Also included are 9 irrigation drops, all in the Deschutes Basin, which have small-scale hydropower potentials. However, new structures would be required in order to develop this potential. Figure 5 shows the locations of the 19 structures.

The theoretical potential power (13 MW) and energy (40 GWh) are shown in Table II. Due to the seasonal nature of irrigation releases and the annual variability of water supply, estimates of the potential annual energy output are quite uncertain.

It is assumed that the irrigation systems would provide a local market for power produced and that no constraints, other than economic, would seriously limit the theoretical potentials.

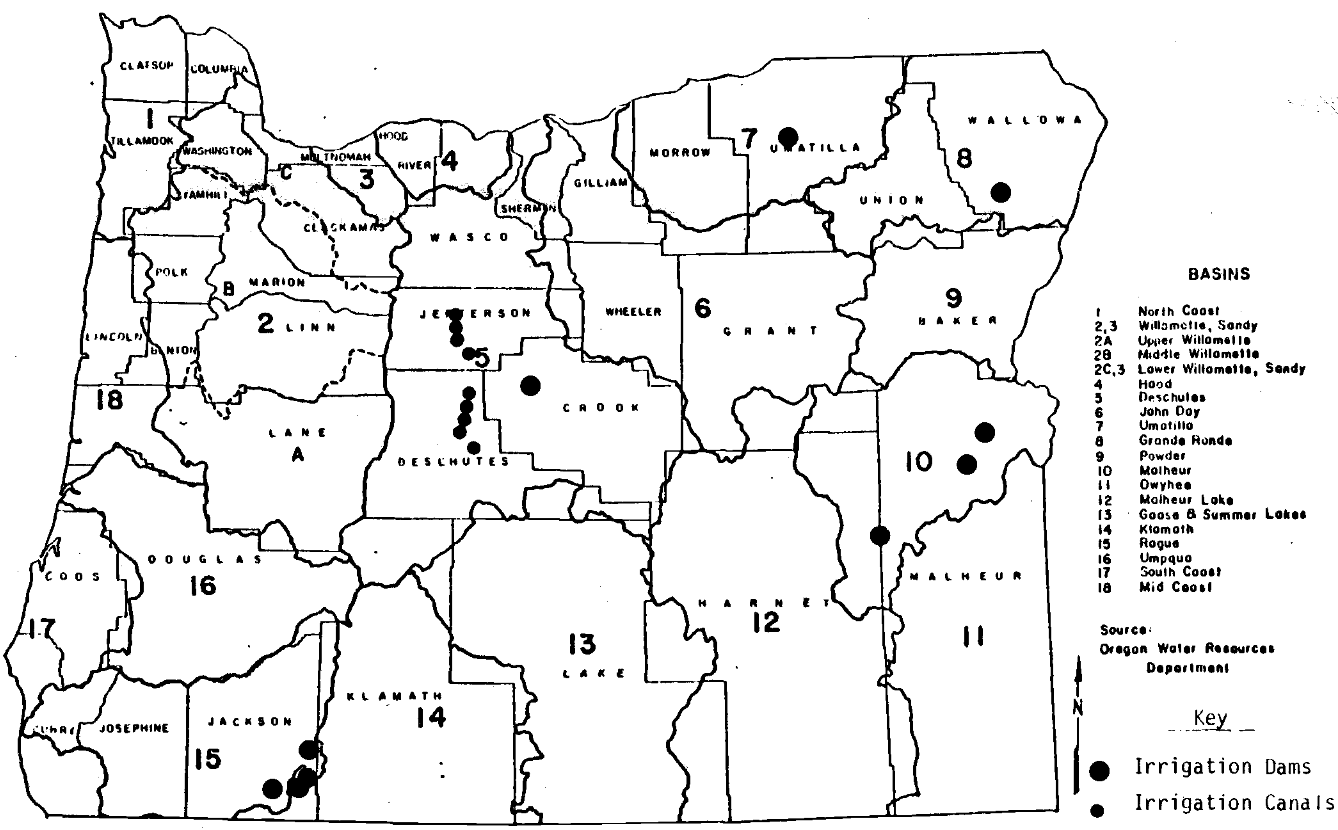

FIGURE 5. EXISTING IRRIGATION STRUCTURES WITH HYDROELECTRIC GENERATION POTENTIAL (P_{50}) EXCEEDING 200 kW

POWER AND ENERGY POTENTIALS AT PROPOSED DAMS

Number of Dams Analyzed

The initial compilation of proposed dams in Oregon totaled about 2500 sites. Eliminated were those proposed for river reaches where the streamflow was insufficient to allow power generation of 200 kW or more at least 50 percent of the time under the small-scale hydropower assumptions. Hence, 395 proposed dams remained for analysis. Of these, 53 were found to have potentials of 25 MW or more and 342 were found to fit the small-scale hydropower category.

Potentials at Proposed "Large" Dams

The potential capacity of the 53 proposed large dams, based on 50 percent exceedance conditions, is estimated to be 2,017 MW if all projects are developed (see Table II). This potential is based on run-of-river operation. No potential annual energy generation has been estimated for proposed dams exceeding 25 MW capacity. A primary reason for this is that the run-of-river operation assumption is questionable for such large projects. Figure 6 shows the locations for 49 of the 53 proposed large dams. Specific locations within the basins are unavailable for the remaining four proposed large dams. Nearly all of the proposed large dams would be located on the main stems of large rivers.

Only 10 of the 49 fully-documented proposed dams were found to be relatively unconstrained. The resulting potential capacity at 50 percent exceedance is 311 MW if all projects are developed (Table II).

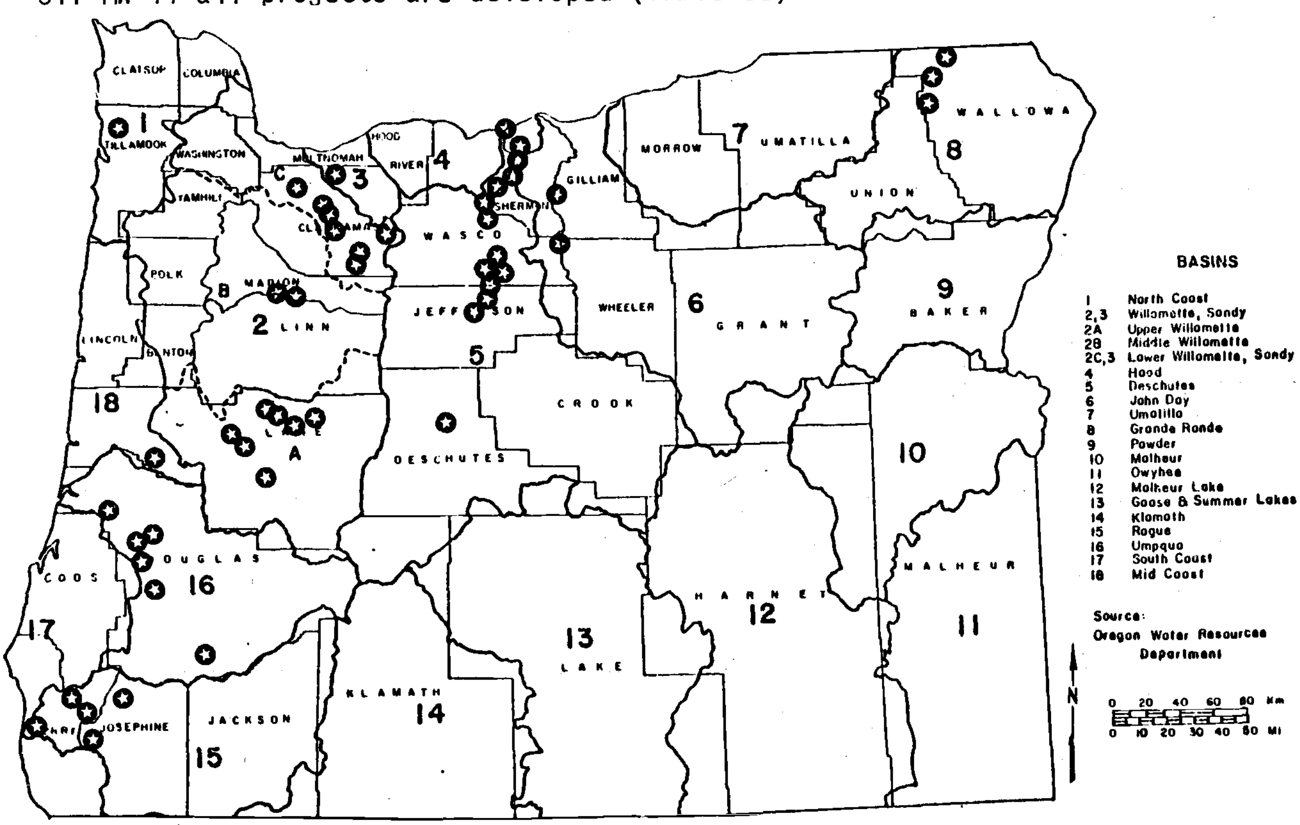

FIGURE 6. PROPOSED DAMS WITH HYDROELECTRIC GENERATION POTENTIALS (P_{50}) EXCEEDING 25 MW

Potentials at Proposed "Small-Scale Hydro" Dams

Figure 7 shows the locations of the 342 proposed dams having hydropower potentials between 200 kW and 25 MW. Those dams proposed for eastern Oregon are almost all "strung-out" along the largest streams. By contrast, those sites west of the Cascade crest are more widely scattered on streams of various sizes.

The small-scale hydropower and energy potentials available 50 percent of the time with run-of-river operation are 2,136 MW and 14,076 GWh, respectively, based on hydraulic head. These values must be reduced by about 14 percent to take into account the head interference caused by adjacent dams when developing the entire affected river system. This gives 1,839 MW and 12,102 GWh, respectively (Table II).

The influence of seasonal streamflow patterns is apparent from the analyses. For example, there is a 20-fold range between the P_{10} potential of 9,813 MW and the P_{95} potential of 462 MW, with P_{50} intermediate at 2,136 MW. The corresponding annual energy values at 10 and 95 percent exceedances have an 8-fold range.

Applying the screening process, 117 of the 341 fully-documented proposed dams were found to be relatively unconstrained. The resulting potential power and annual energy available 50 percent of the time are 628 MW and 4,155 GWh, respectively, for run-of-river operation.

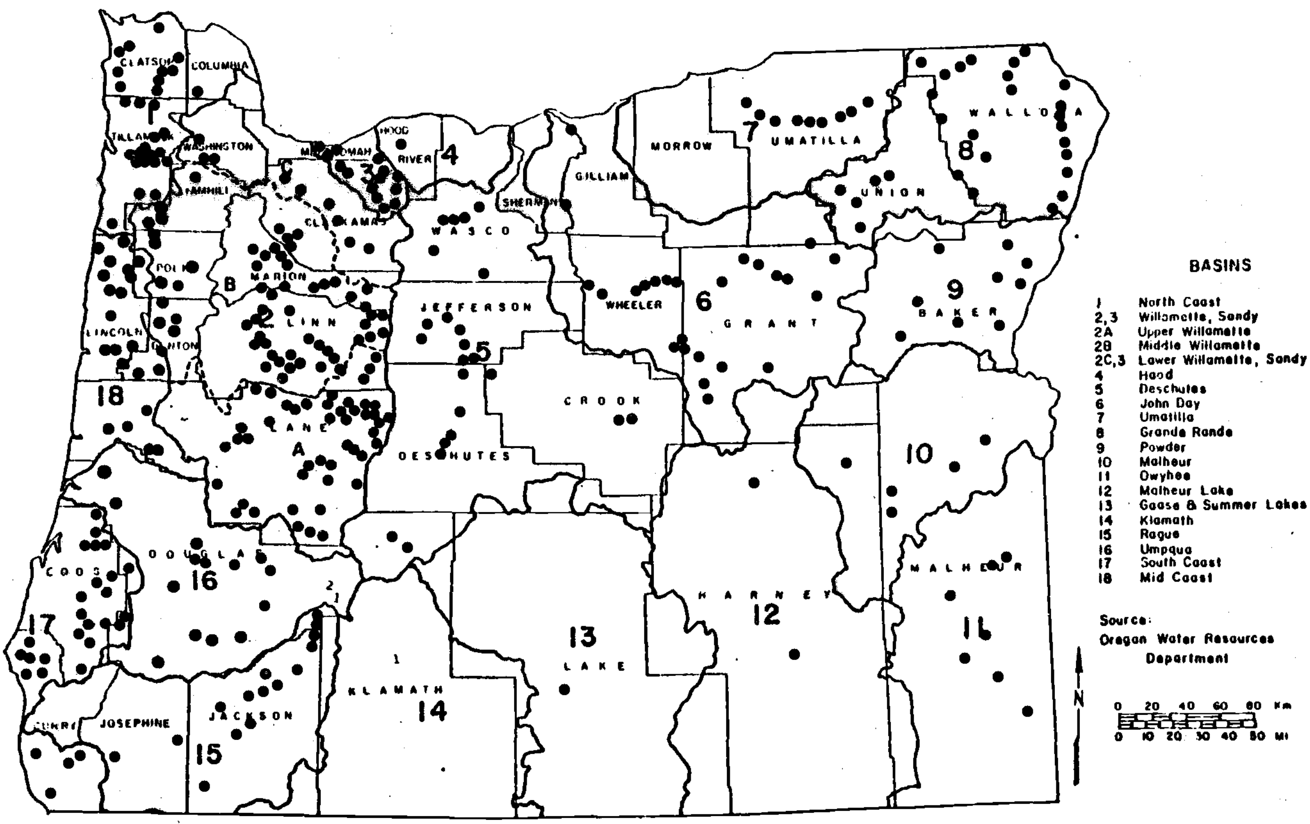

FIGURE 7. PROPOSED DAMS WITH HYDROELECTRIC GENERATION POTENTIALS (P_{50}) BETWEEN 200 kW AND 25 MW

CONCLUSIONS

The distribution of existing and proposed dams among the major drainage basins in Oregon is a revealing indicator of the importance of surface water development and use. Table III shows this distribution for dams capable of providing at least 200 kW for 50 percent of the time under run-of-river operation. The Willamette Basin has the greatest existing development, followed distantly by the Umpqua, Rogue and Deschutes Basins. The Willamette Basin also has the greatest proposed development. Important development has also been proposed for the coastal basins (North Coast, Mid-Coast, South Coast) and for the Deschutes, John Day and Grande Ronde Basins, followed by the Umpqua and Rogue Basins. In all, 117 existing dams and 395 proposed dams have P_{50} potentials of 200 kW or more.

TABLE III. DISTRIBUTION OF EXISTING AND PROPOSED DAMS IN OREGON[1]

Drainage Basin	Existing Power Projects		Existing Non-Power Dams			Total Existing Dams	Proposed Dams		Total Proposed Dams
	≥ 25 MW	200 kW to 25 MW	≥ 25 MW	200 kW to 25 MW	Irrigation Diversion Dams		≥ 25 MW	200 kW to 25 MW	
1. North Coast	-	-	-	2	-	2	1	28	29
2. Willamette	9	15	-	21	-	45	18	110	128
3. Sandy	-	1	-	2	-	3	1	14	15
4. Hood	-	1	-	-	-	1	-	1	1
5. Deschutes	2	2	-	5	1	10	14	23	37
6. John Day	-	-	-	-	-	-	2	25	27
7. Umatilla	-	-	-	1	1	2	-	9	9
8. Grande Ronde	-	1	-	3	1	5	3	28	31
9. Powder	-	1	-	3	-	4	-	9	9
10. Malheur	-	-	-	1	3	4	-	5	5
11. Owyhee	-	-	-	1	-	1	-	7	7
12. Malheur Lake	-	-	-	-	-	-	-	2	2
13. Goose and Summer Lakes	-	-	-	-	-	-	-	1	1
14. Klamath	1	1	-	1	-	3	1	1	2
15. Rogue	2	4	-	4	4	14	5	15	20
16. Umpqua	4	4	-	11	-	19	6	14	20
17. South Coast	-	-	-	3	-	3	-	28	28
18. Mid-Coast	-	-	-	1	-	1	2	22	24
State Totals	18	30	0	59	10	117	53	342	395

[1] Only dams with P_{50} potentials exceeding 200 kW under run-of-river operation are included.

The existing capacity at power projects in Oregon is 1,465 MW. This can be expanded by 860 MW (59 percent) at those same projects. Based upon streamflows exceeded 50 percent of the time, existing non-power dams could provide 117 MW (8 percent) more capacity than now exists through retrofitting. Also, a limited number of irrigation facilities might be retrofitted to provide 13 MW (1 percent) more capacity. Thus, existing facilities could be used to augment the present capacity by 990 MW (68 percent), based on P_{50} conditions.

Proposed dams might be developed to provide 3,856 MW (263 percent) more power than is presently produced, based on P_{50}. But environmental and transmission constraints make the potential more realistically on the order of 939 MW (64 percent).

If all existing facilities and proposed dams were developed, a P_{50} potential of 4,846 MW (331 percent) could be added to the existing capacity, for a total of 6,311 MW. However, constraints make practical a much lesser increment, amounting to 1,856 MW (127 percent), for a total of 3,321 MW.

Differences in the findings of this and other studies can be attributed in large part to different values obtained when reservoir storage use is considered, rather than ignored as in run-of-river operation. The underlying assumption made here of run-of-river operations is viewed as crucial to minimize the impacts of low-head hydropower development. Because of the strongly seasonal patterns for streamflow runoff in Oregon, the run-of-river assumption tends to favor the minimization of streamflow alteration impacts at the expense of power and energy development. Reported values are also highly sensitive to the choice made for streamflow exceedance condition in calculating power. The data are generally based on median streamflows, equalled or exceeded about 50 percent of the time. Larger or smaller exceedance values might have been used to indicate the power and energy potentials, giving significantly different numerical results, with a 20-fold range found between the P_{10} and P_{95} values.

Hydroelectric development cannot occur with 100 percent efficiency, as assumed here. For planning purposes, estimates made in this study might be realistically adjusted by an efficiency of about 80 percent.

The constraint evaluation and screening, while involving practical criteria, were somewhat arbitrary. (For example, the constraint imposed by transmission line distance might vary considerably with the type of terrain encountered.) Therefore, some projects identified here as "constrained" may be found to be feasible upon detailed examination whereas some projects found to be "minimally constrained" may have unreported problems that would eliminate them from further consideration.

The work reported here is a resource survey. Resource surveys are typically limited by the quality of the data available. In this study, much of the available information was out-of-date, sketchy, incomplete, contradictory, and subject to different interpretations. The impacts of hydroelectric power development were not specifically addressed, other than through preliminary environmental constraints and screening criteria. It is hoped that the findings of this study will add useful information for continued serious assessment of hydropower as an available technology for meeting Oregon's energy needs.

OTHER STUDIES

At present, the WRRI hydropower resource inventory is the only complete statewide inventory involving impact-minimizing assumptions of small-scale and run-of-river operation. The estimates of power available tend to be conservative. The U.S. Army Corps of Engineers is now conducting a refined national study that includes Oregon. Different assumptions (less conservative) allow use of reservoir storage for power peaking and for carryover use; recent cost data allow "economical" powerplant sizing. When completed several months hence, the Corps study can be used with the WRRI findings to help bracket the range for power potential in Oregon.

REPORTS AVAILABLE FROM WRRI

1. This newsletter -- to summarize the full WRRI study.

2. Synopsis Report: A Resource Survey of River Energy and Low-Head Hydroelectric Power Potential in Oregon, April 1979.

3. WRRI-61: A Resource Survey of River Energy and Low-Head Hydroelectric Power Potential in Oregon, April 1979.

   Main Report*
   20 Appendices, each for a different river basin*

4. WRRI-62: A Resource Survey of the Hydroelectric Potential at Existing and Proposed Dams in Oregon, January 1980.

   Main Report*
   Appendix*

5. Backyard Hydropower: 1. Guidelines For Getting Started

6. Potential Environmental Effects of Small-Scale Hydroelectric Development in Oregon, January 1980.

* A charge is made for copies of these reports to cover printing and mailing costs.

Pacific Northwest Hydroelectric Power Potential

The Oregon hydropower resource inventory described in the preceding pages was part of a larger study supported by the U.S. Department of Energy to evaluate the theoretical potential for small-scale hydroelectric development of the Pacific Northwest Region. The study area included all of the Columbia River system in the United States and all other river basins in Idaho, Oregon and Washington. The total area studied was approximately 292,000 square miles.

The first phase of the study was an evaluation of the theoretical power potential of the streams in the region. That portion of the study was completed in March, 1979. A ten volume regional report was completed describing the study methodologies and containing appendices showing the potential by stream segment for almost all of the streams in the region. The Phase I completion report was entitled "A Resource Survey of Low-Head Hydroelectric Potential, Pacific Northwest Region". A summary of the power potential is shown in Table IV.

TABLE IV. SUMMARY OF THEORETICAL MAXIMUM DEVELOPABLE POWER AND ENERGY POTENTIAL FOR PACIFIC NORTHWEST STREAMS

State	Power (MW)		Annual Energy (GWh)	
	P_{30}	P_{50}	E_{30}	E_{50}
Washington[1]	13,928	8,862	80,124	61,314
Oregon[1]	12,105	6,786	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	163,923

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

The second phase of the study was an evaluation of the hydropower potential for existing and proposed dams and existing irrigation systems. The existing dams studied were those that were identified in state dam registration lists, Federal Power Commission lists, and U.S. Army Corps of Engineers Dam Safety Studies. The primary sources of information for the proposed sites were siting studies done by various federal and state agencies. No searches were made for new sites that had not been previously identified.

The second phase of the study was completed in September, 1979. The Phase II completion report was entitled "A Resource Survey of Low-Head Hydroelectric Potential at Existing Dams and Proposed Sites in the Pacific Northwest Region". A summary of the power potential is shown in Table V; the Oregon data shown have been revised slightly subsequent to completion of the regional study.

TABLE V. SUMMARY OF HYDROPOWER POTENTIAL AT EXISTING AND PROPOSED DAMS IN THE PACIFIC NORTHWEST FOR RUN-OF-RIVER OPERATION

State and Power Production Category	Power (MW)		Annual Energy (GWh)	
	P_{30}	P_{50}	E_{30}	E_{50}
Washington				
Existing non-power dams	157	90	852	621
Proposed dams	7,968	5,009	46,114	35,746
Irrigation sites	240	195	927	833
Total	8,365	5,294	47,893	37,200
Oregon				
Existing non-power dams	218	117	1,151	784
Proposed dams	6,684*	3,856	36,686*	26,781*
Irrigation sites	18*	13	56*	40
Total	6,920*	3,986	37,893*	27,605*
Idaho				
Existing non-power dams	159	73	758	454
Proposed dams	8,348	4,987	48,998	37,222
Irrigation sites	192	123	925	692
Total	8,699	5,183	50,681	38,368
Montana in PNW Region				
Existing non-power dams	5	3	25	18
Proposed dams	2,971	1,649	16,459	11,827
Irrigation sites	0	0	0	0
Total	2,976	1,652	16,484	11,845
Wyoming in PNW Region				
Existing non-power dams	14	3	57	19
Proposed dams	323	147	1,714	1,097
Irrigation sites	0	0	0	0
Total	337	150	1,771	1,116
Nevada in PNW Region				
Existing non-power dams	0	0	0	0
Proposed dams	1	1	7	5
Irrigation sites	0	0	0	0
Total	1	1	7	5
Pacific Northwest Region Totals				
Existing non-power dams	553	286	2,843	1,896
Proposed dams	26,295	15,649	149,978	112,678
Irrigation sites	450	331	1,908	1,565
Total	27,298	16,266	154,730	116,139

* Estimated from revised data for inclusion in this table.