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GEOLOGICAL SURVEY
Conservation Division

REVIEW OF WATERPOWER CLASSIFICATIONS AND WITHDRAWALS

JOHN DAY RIVER BASIN

OREGON

By

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PORTLAND, OREGON

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REVIEW OF WATERPOWER CLASSIFICATIONS AND WITHDRAWALS
JOHN DAY RIVER BASIN, OREGON

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INTRODUCTION

This report has been prepared in fulfillment of a basic responsibility of the Geological Survey to identify and protect by classification federally owned lands which have value for water resource development. It reviews the existing waterpower classifications and withdrawals and examines other unclassified potential sites in the John Day River basin (see fig. 1). The orders include 7 power site reserves, 1 power site classification, and 4 Federal power projects. Of the total 39,497 acres reviewed, 1,467 acres in Geological Survey classifications and 879 acres in Federal Power Commission withdrawals are shown to have negligible value for water resource development sites (see table 10). The sites discussed have been given numbers which are based on the Geological Survey gaging station numbering system.

Only two hydroelectric powerplants have been built in the John Day basin, neither of which is presently operating. The Fremont plant began supplying power to gold mines in the vicinity in 1907 and ceased operation in 1967 when it became uneconomical. The Prairie City powerplant dates back to 1916, but it was destroyed by fire in 1952.

The potential hydroelectric power in the basin is estimated as 401,400 kw (kilowatts) at 100 percent efficiency using gross head and mean flow for 17 sites (see table 7). A few other sites in the lower basin are considered to be alternative and only those which offer maximum potential power have been added into the total. Full development of the sites listed in table 7 could produce an estimated 2,810,000 Mwh (megawatthours) per year.

Appraisals of the classifications and withdrawals were based upon investigations of the status of planning for future water resource development in the basin by all known interested parties and examinations of topographic maps, water supply records, and water rights. Decisions relating to Geological Survey classifications are based on tract-by-tract evaluation. Recommendations relating to Federal Power Commission withdrawals are based on an evaluation of the purpose of each filing action. A proposed disposition is given for all lands affected by Geological Survey classifications and Federal Power Commission project withdrawals within the basin. Those which appear to be no longer in the public interest will be considered for revocation by subsequent orders.

In this report "classification" refers to Geological Survey actions and "withdrawal" refers to actions by the Federal Power Commission.

Geological Survey classifications for water conservation or water-power purposes are designations of Federal lands possessing value for reservoirs or power sites. These classifications neither commit the Government to construction nor prohibit private use for water resource development; however, they do serve to identify, protect, and forestall encumbrances of potential sites. Classification as a potential water development site does not constitute a "withdrawal" or "reserve" in the usual sense of these terms--the lands remain under the supervision of the agency having control over them at the time of classification and when justified may continue to be entered for other purposes with the understanding that water development cannot be precluded by such entry.

Section 24 of the Federal Power Act of June 10, 1920, as amended, provides that any lands of the United States included in any project are reserved from entry, location, or other disposal until otherwise determined by the Federal Power Commission or by Congress. Withdrawals resulting from filing an application for a project under the Federal Power Act are automatic and are effective on the date of filing of the application. However, the revocation of such withdrawals is not automatic when the permit or license expires, is suspended or denied, but requires a special action by the Commission termed a "vacation" of the project withdrawal.

Classifications initiated by the Geological Survey as well as those withdrawals effected by the filing of an application under the Federal Power Act are subject to conditional restoration for noninjurious uses under another provision of Section 24 of the Federal Power Act whenever the Federal Power Commission determines that the nonpower use will not be injurious to the value of the lands for power purposes. An Act of August 11, 1955 (69 Stat. 679), opened the power site lands, whether so classified by the Geological Survey or withdrawn by an application under the Federal Power Act, to acquisition for mining purposes with a reservation of the power values automatically included in any entry for location or patent of mining claims, except lands which are included in any project operating or being constructed under a license or permit issued under the Federal Power Act or other act of Congress, or which are under active examination and survey by a prospective licensee. All power rights on the opened lands are retained by the United States.

It was found that 29,566 acre of public domain lands lie within water resource sites not previously classified as such (see table 12). Five sites affecting 16,300 acres of this total are in the reach designated in the Oregon Scenic Waterways Act which will prevent encumbrances until such time that land use needs might shift from scenic to power development. Classification of the remaining public lands may be required and this report provides the base for making that decision.

Both general and local floods occur in the basin. Usually, the basinwide floods are associated with the springtime snowmelt. However, severe basinwide floods have occurred in winter. There are no constructed flood control dams within the basin but the potential Hall Hill, Rail Creek, and Monument sites include a flood control value. These and numerous smaller flood control sites throughout the basin have been studied by Federal and State agencies. Channel improvements and revetments constitute the only flood control measures presently used in the basin.

A change now underway from predominantly hydroelectric power to thermal power in the Pacific Northwest will require special siting studies for thermal plants. Future thermal generation in the area will probably use nuclear fuel rather than fossil fuels due to the local lack of fossil fuels. Protection of the environment from thermal pollution by discharge of warmed water used for cooling thermal powerplants will be necessary. Siting studies should consider the use of cooling towers or cooling ponds. A reconnaissance study of possible cooling pond sites in the basin revealed several places where large shallow lakes could be constructed which would permit cooling of the condenser water. Portions of the sites are on public lands and classification as water resource development sites may be required in the future.

Peaking power required to supplement base loads may often be supplied best by pumped-storage developments. Upper reservoir sites have been selected within the John Day River basin where pumped storage appears to be feasible and economical. Criteria for selecting these sites are based on the following assumptions: a minimum installation would be 1,000 MW; reservoir sites being considered for multipurpose development on the main stream of the subbasins would serve as the lower reservoirs; and penstock lengths would be generally limited to two miles. It was found that some of the sites selected were partially on public land. Cost studies and geologic investigations are advisable to determine if these sites should be classified to protect their potential power value.

Conclusions reached by the Oregon State Water Resources Board and published in their 1962 John Day report include statements which point out that although irrigation is probably the main use for John Day River waters, recreation, enhancement of fish life, and pollution assimilation are also important. Development of potential storage sites to regulate the seasonal runoff variations will be necessary to provide flood control, and to utilize basin waters efficiently for irrigation, recreation, and hydroelectric power.

The Oregon Scenic Waterways legislation, effective December 3, 1970, establishes portions of various free-flowing rivers of the State as scenic waterways. This law declares that the highest and best uses of waters included in a scenic waterway classification are recreation, fish, and wildlife uses. The free-flowing character of these waters is to be maintained and no water impoundment may be constructed in the reach so designated. The main stem of the John Day River from Service Creek Bridge (river mile 157) to Tumwater Falls (river mile 10, the backwater of Lake Umatilla) is one portion so classified among other rivers of the State.

The Federal Wild and Scenic Rivers Act, Public Law 90-542, of October 2, 1968, provided for future identification of segments of rivers in a study category for possible later designation as wild, scenic, or recreational. Subsequently, a notice dated September 17, 1970, appeared in the Federal Register on October 28, 1970, listing among others: John Day River from mouth to confluence with North Fork, North Fork from John Day River at Kimberly to junction with Baldy Creek, and Granite Creek to its junction with Clear Creek. In accordance with section 5(d) of the Act, planning reports concerning the listed rivers shall evaluate the recreational potential as an alternative use of the river and the related land resources. Many of the sites discussed in this report are located within the reaches described. Water resource developments are not necessarily incompatible with recreation as reservoirs frequently have a high potential for fishing, camping, and other water-based recreational activities. Development of reservoirs expressly for recreation purposes has occurred in the past and may become more common in the future. Proper planning could coordinate such activities for mutual benefit. Specific plans for development for recreation are not discussed in this report for the reaches of the rivers concerned, but it is recognized that such possibilities exist.

GENERAL DISCUSSION

Description of the basin

The John Day River drains an area of 7,920 square miles of north central Oregon. The L-shaped basin is about 130 miles across the widest east-west dimension narrowing to 25 miles along the Columbia River, and is 90 miles across the longest north-south direction. The river is 284 miles long from its Blue Mountain headwaters to the confluence with the Columbia River in Lake Umatilla, the backwater from John Day Dam. The main tributaries are the North Fork, Middle Fork, and South Fork. Altitudes in the basin range from 9,038 feet (Strawberry Mountain) in the Upper John Day basin to 265 feet at the river mouth, the normal pool elevation of Lake Umatilla. The main river fall averages 19 feet per mile from about 5,600 feet at the headwaters of perennial flow to Lake Umatilla.

The basin is bounded on the extreme north by Lake Umatilla. The Blue Mountains form the northern, eastern, and a part of the southern boundaries of the basin. The adjacent basin to the north drains into the Columbia River via Willow Creek and Umatilla River; to the northeast and east drainage is into the Snake River via Grande Ronde, Powder, Burnt, and Malheur Rivers; southward drainage is into the Malheur Lake closed basin via Silvies River; and to the southwest and west drainage is into the Deschutes basin.

The boundary between John Day River basin and the Columbia River tributaries on the north is on a plateau gradually rising from the John Day River to an altitude of 5,470 feet on Texas Butte in the Umatilla National Forest. Highest altitudes along the divide between John Day and Snake River tributaries are 8,080-foot Lookout Mountain, 8,131-foot Vinegar Hill, and 8,338-foot Ireland Mountain. Strawberry Mountain, elevation 9,038 feet, is the highest peak within the basin. It is located a few miles north of the basin rim near its southeastern corner.

A part of the divide on the south lies along the backbone of the Aldrich and Ochoco Mountains. Midway along the southern boundary the basin of the South Fork John Day River extends 20 miles southward in a 15-mile-wide valley that is separated from the Silvies River basin by a ridge from 6,128-foot Sugar Loaf Mountain in the Malheur National Forest to 7,190-foot Snow Mountain in the Ochoco National Forest. The Deschutes River basin on the west is separated by the remnants of the Ochoco Mountains as they taper off to a high plateau-like ridge gradually falling away to the Columbia River.

The differences in physical characteristics, needs and uses of water, and levels of economic development of the parts of the basin, make it convenient to subdivide it into three subbasins for individual analysis (see fig. 1). Subbasin 1 (2,145 square miles) is all of the main basin above the mouth of the North Fork including the South Fork; subbasin 2 (2,625 square miles) is the North Fork John Day which includes the Middle Fork; subbasin 3 (3,150 square miles) is the remainder of the basin below the North Fork. Potential sites and developments within the John Day basin are discussed in downstream order.

There are about 9,500 miles of streams, large and small, throughout the basin. The stream gradients range from 100 to 300 feet per mile in the headwaters to 20 to 40 feet per mile in the valley sections.

The population of the basin at the time of the 1970 census was about 13,000, less than 2 persons per square mile. The average for the State was about 22 per square mile. John Day is the largest town in the basin with a 1970 population of 1,531. Populations of other towns are: Condon, 916; Prairie City, 856; Canyon City, 628; Fossil, 488; Mount Vernon, 418; and Arlington, 370. There are a number of smaller communities which have less than 50 inhabitants.

The climate of the basin is described as continental having cold winters, hot, dry summers, and low annual precipitation. Average annual temperatures range from 41 degrees Fahrenheit (^{o}F) to 54^{o} F. The extremes range from well below zero at Ukiah to as much as 114^{o} F at Arlington. Temperatures at Condon are typical of the seasonal pattern throughout the basin. Mean January temperature is 29^{o} F and mean July temperature is 67^{o} F. Average maximums range from 36 to 84^{o} F and average minimums from 21 to 49^{o} F (SWRB, 1962, p. 3-4).

Of the total basin area approximately two-thirds is privately owned. About 90 percent of the lower basin is in privately owned farms and ranches. A few large timber companies have holdings in the upper basins. Of the federally owned or administered land about 2,200 square miles or 84 percent is in Malheur or Umatilla National Forest and the remainder is public domain range land. The State, county, and municipal lands are less than one percent of the total basin area.

Agriculture is the major source of income with the main activities in production of beef and dry-land grain. Grain farms are largely in the Lower John Day basin (subbasin 3) with some livestock raised on the stubble and nontillable areas. Livestock production is the main agricultural activity in the southern part of the Lower John Day and the Upper (subbasin 1) and North Fork subbasins (subbasin 2). Croplands amount to 552,000 acres, 11 percent of the basin, most of which is used for hay or pasture (SWRB, 1962, p. 8). There has been a recent trend toward fewer but larger farms. Efficiency of operations with larger units is the main reason for this expansion in farm and ranch size.

The range land used for livestock production is being depleted and damaged by overgrazing by domestic livestock and big game. About

50 percent is classed as being in poor condition. Improvement of these grazing lands offers a major opportunity in the basin, and it has been estimated that an 87 percent increase in forage production is possible. Management improvement would require additional stock water developments such as wells, springs, and ponds (SWRB, 1962, p. 9).

Forestry and forest products provide income which ranks second in the economy of the basin. About 44 percent, 2,259,000 acres, of the total area is forest land. About two million acres of this is classified as commercial with the remainder in forest reserves or too unproductive to be marketable. The Ochoco, Malheur, and Umatilla National Forests contain 69 percent of the commercial forest lands. The annual sustained yield timber production of commercial forest land is between 170 and 200 million board feet with about 135 million board feet of this from the national forest lands (SWRB, 1962, p. 11-14).

Mineral production in the basin in 1960 amounted to $1,018,000. Sand, gravel, stone, gold, asbestos, copper, and silver are the main minerals. Oil and gas have not been found although there has been limited drilling in eight exploratory wells (SWRB, 1962, p. 15).

Federal highways, I-80N and US 26, cross the basin east and west, and US 395 runs north and south. State Highway 19 runs from Arlington to a junction with US 26 at Picture Gorge. Other State, county, and forest roads crisscross the basin linking population centers and the main highway systems. There is rail freight service with branch lines of the Union Pacific, which follows the Columbia River, running from Biggs to Moro, and from Arlington to Condon. There is no commercial airline service although there are a few private landing strips. River barge traffic on the Columbia serves for shipping wheat from Arlington (SWRB, 1962, p. 17).

Recreation in the basin is mostly in the form of hunting, fishing, and camping. Numerous geologic features such as the fossil beds near Condon and Painted Hills State Park near Mitchell are popular attractions. Lower summertime streamflow and the limited number of lakes and reservoirs restrict the water-based recreation potential. Recreational use of the forest lands and the five State parks is increasing, however, and a total of 532,000 visitor days is predicted for 1976 (SWRB, 1962, p. 16). Development of reservoirs in connection with potential power or irrigation systems would add considerably to recreational use.

Geology
(Baldwin, 1959, and Thayer, 1969)

The earliest known part of the geologic history of the John Day country began with lava flows and volcanic ash, sandstone, and shale deposits in a sea more than 250 million years ago. Later 200 to 250 million years ago, molten material intruded into these marine deposits and formed the core of Canyon Mountain. Erosion exposed the harder parts of this core and the area was submerged again about 180 million years ago. The Aldrich Mountain area south of the John Day River between the towns of John Day and Dayville was a part of a seaway into which the region's active volcanoes deposited layers of volcanic ash thousands of feet thick. Mudstone and shale were deposited between the eruptions. Eventually Canyon Mountain was buried in the accumulation and subsequently emerged 135 to 150 million years ago. Other molten intrusions formed granitic mountains in the Aldrich Mountains and northeast of Prairie City. Another sea encroached upon the Blue Mountains after the granites were exposed by erosion.

After the retreat of the sea and further erosion volcanic eruptions buried the area under thousands of feet of rocks known as the Clarno formation during a period of building and erosion which took place within the past 30 to 60 million years. The lava and mud flows that make up the Clarno formation were extensively folded, faulted, and eroded before another layer of volcanic ash and detritus was deposited from volcanoes in and east of the Cascades. This layer is called the John Day formation and appears to have been confined to the lowland area of the John Day basin. It may be recognized by the colorful layers ranging from buff to green to red in the lowest level. It is in the Clarno and John Day formations where the extensive and well-known fossil deposits are found. The ancient mammals, leaves, and petrified woods have been preserved in the volcanic ash of these formations much the same as in the burial of Pompeii by Mt. Vesuvius of 79 A.D.

The modern landscape of the basin began to form with the flow of lava which covered the John Day formation. This Picture Gorge basalt flowed out of fissures in the earth's crust and left great dikes which were exposed when softer materials were eroded away. Volcanoes in the Strawberry Mountains erupted during this time and built up cones several thousand feet above the Picture Gorge basalt. The deposited ash and erosional debris on the basalt is known as the Mascall formation. The eruptions ceased about 10 million years ago and processes of erosion and faulting continued to alter the landscape. The Strawberry-Aldrich Mountains were gradually raised, partly by bending and partly by breaking along the John Day fault through the length of the valley. Gravels eroded from the rising mountains filled the valley floor and formed a broad gently sloping surface in the valley. As the gravels accumulated yet another ash flow from volcanic eruption spread a 100-foot layer throughout the valley.

Erosion and landslides changed the valley and glacial action has shaped the principal valleys above 5,000 feet. Strawberry Lake lies in a glacial cirque and the Strawberry Creek valley shows the effects of ice scour. Glacial action occurred as an alpine type associated with the higher mountains rather than one massive sheet of ice covering the entire region.

The present day landscape in the valley is characterized by numerous landslides which develop through the erosion of softer layers. As the support of the softer rock fails the harder rocks slide downward and tilt backward. This is visible particularly downstream from Picture Gorge. Glacial effects are visible in the cirques and scars especially in the Strawberry Mountains. Broad alluvial valleys along the main stem of the upper John Day River are the best agricultural lands and are used for irrigated hay crops necessary to support the cattle industry.

Water supply and use

Precipitation

Precipitation has been measured in the John Day River basin at many sites, some of which have records as long as 71 years. Table 1 lists in order of descending altitude 13 of these stations which are scattered throughout the basin.

Table 1.--Precipitation at selected stations in John Day basin, Oregon.

Station	Approx. altitude (feet)	Years of record	Average annual precipitation (inches)
Austin 3S	4,213	42	19.04*
Long Creek	3,722	13	13.07
John Day	3,063	16	13.38
Condon	2,830	62	12.64*
Mitchell	2,744	8	12.84
Fossil	2,650	38	14.22
Dayville	2,364	71	11.72
Monument 2	1,995	9	13.03
Ione 18S	1,925	35	12.99
Spray	1,770	12	13.66
Mikkalo 6W	1,550	55	10.08*
Morgan 3NE	905	43	9.34*
Arlington	315	58	9.04*
		Average	12.70

* Averages are for a standard 1931-60 period as determined by the Weather Bureau.

The arithmetical average annual precipitation of these stations for varying periods is 12.7 inches. An isohyetal map of Oregon for the period 1930-57 prepared by the Soil Conservation Service and the U.S. Weather Bureau was used to determine the average annual precipitation for the entire basin. This map shows an average of 19 inches for the basin with about 30 percent of the area receiving 15 inches or less.

A small area, estimated as about 2 percent of the basin, receives more than 35 inches of precipitation annually. A comparison of these averages indicates that the stations listed in table 1 are not completely representative of the basin. Areas having higher precipitation are remote and thus are not measured while the lower and drier accessible areas have been measured.

Evapotranspiration

Evapotranspiration rates have not been measured in the John Day basin. Measurements of evaporation from U.S. Weather Bureau land pans have been made at Moro which is on the plateau in the adjoining Deschutes basin to the west. Table 2 shows evaporation rates at Moro as measured for April, May, June, July, August, September, and October for these seven-month periods from 1957 through 1970. The period average for the 12 years is 56.6 inches. This compares with an average evaporation from land pans at 5 stations in the Deschutes basin, including the Moro station, of 42.7 inches (Colbert, 1969). A general comparison of the physical characteristics of the Deschutes and John Day River basins indicates that the average evaporation rate in the John Day basin may be in the order of 50 inches.

Table 2.--Evaporation at Moro in inches.

(from U.S. Weather Bureau land pans)

Year	April	May	June	July	Aug.	Sept.	Oct.	Total season
1957	4.10	6.13	8.01	10.01	8.38	5.66	1.73	44.02
1958	3.80	7.74	9.25	13.36	12.35	6.12	3.65	56.27
1959	5.88	6.75	8.59	13.57	10.90	5.82	3.15	54.66
1960	4.50	5.41	10.12	13.79	9.71	6.91	3.25	53.69
1961	5.13	5.55	10.79	13.02	12.83	8.69	3.32	59.33
1962	5.87	5.68	9.67	12.78	8.64	6.72	2.99	52.35
1963	-	-	-	-	-	-	-	-
1964	5.53	8.00	8.88	11.62	10.06	7.35	3.79	55.23
1965	-	-	-	-	-	-	-	-
1966	6.31	9.87	9.68	11.38	12.17	7.74	3.74	60.89
1967	3.57	8.19	10.37	13.99	14.30	9.38	4.30	64.10
1968	6.20	8.43	10.56	13.62	8.73	6.88E	3.65	58.07
1969	4.92	8.74	9.64	12.47	11.50	6.85	3.51	57.63
1970	5.14	8.43	11.13	13.32	13.34	7.55	4.53	63.44
Avg.	5.08	7.41	9.72	12.74	11.08	7.14	3.47	56.64 Avg./Season

E - Estimated

The runoff at the gaging station farthest downstream, John Day River at McDonald Ferry, which represented 7,580 square miles (95 percent of the basin) averages 3.2 inches per year. With basin precipitation averaging 19 inches annually, according to the isohyetal map, the indicated average annual water loss, including evapotranspiration and ground water infiltration is 15 to 16 inches.

Runoff

Discharge measurements have been made at many places throughout the John Day basin and selected stations are shown in table 3. Most of these stations are still operated but other records of short term, discontinued, or miscellaneous measurements may be found in the appropriate USGS water-supply papers.

Table 3.--Selected gaging stations, John Day basin.

USGS No.	Name	Period (water yr)	Drainage area (sq.mi.)	Discharge (cfs) Q95	Q50	Qmean
14-0385	John Day R. at Prairie City	1954-68	231	24	82	113
-0395	S.F. John Day R. nr. Dayville	1952-56	590	28	77	189
-0405	John Day R. at Picture Gorge	1927-70	1,680	9	240	457
-0415	N.F. John Day R. nr. Dale	1930-58	520	40	133	404
-0425	Camas Cr. near Ukiah	1915-70	121	3	22	95
-0440	M.F. John Day R. at Ritter	1930-70	515	16	83	236
-0460	N.F. John Day at Monument	1926-70	2,520	68	365	1,194
-0465	John Day R. at Service Cr.	1931-70	5,090	75	670	1,785
-0480	John Day R. at McDonald Ferry	1906-70	7,580	86	740	1,988

The John Day River rises on the west slope of the Blue Mountains rimmed by high peaks such as Lookout Mountain (8,080 feet), Little Baldy Mountain (7,741 feet), and Deardorff Mountain (6,885 feet). Strawberry Mountain (9,038 feet) is also near the extreme eastern end of the basin. Average annual flow of Strawberry Creek is 1.8 cfsm (cubic feet per second per square mile). The river was gaged at Prairie City at mile 262 and there are several diversions for irrigation above the station. Average annual runoff from 231 square miles is 0.49 cfsm.

The South Fork John Day is about 60 miles long and joins the main river from the south at mile 212 near Dayville. The record of streamflow of the South Fork as measured near Dayville (discontinued in 1956) reflects the general dry character of the subbasin which contributes less water on a per-square-mile basis, an average of 0.32 cfsm, than that portion of the main basin above Prairie City. The gage on the John Day River at Picture Gorge, at mile 205.1, also shows that the runoff decreases in the valley in the 55 river miles downstream from

Prairie City. The average per-square-mile runoff is 0.27 cfsm, roughly half of that for the basin above Prairie City. At Picture Gorge the river turns northward from its generally westward course and continues north to the confluence with the North Fork at Kimberly near mile 184.5.

The North Fork also heads in the Blue Mountains and flows about 80 miles to the confluence with the Middle Fork. Desolation Creek enters from the south near mile 60 and Camas Creek, about 37 miles long, drains from the north and east and enters the North Fork at mile 57. This upper reach of the North Fork and Camas Creek have the highest unit runoff of the gaged streams within the subbasin being 0.78 and 0.79 cfsm, respectively.

The Middle Fork with headwaters on the west slope of the Blue Mountains drains the east-central portion of the basin. It flows about 76 miles and joins the North Fork at mile 32. The gage near Ritter measures runoff from 515 square miles and has a unit runoff of 0.46 cfsm which is a little more than half the unit runoff of the North Fork and about the same as on the main stem above Prairie City. Long Creek is the main tributary of the Middle Fork entering from the southeast at mile 5.

The North Fork is gaged at Monument about 16 miles above the confluence with the main stem at Kimberly where the drainage area is 2,520 square miles. At this point the average runoff is 0.48 cfsm showing the modifying influence of the much drier area in the central part of the North Fork basin.

The John Day River receives little additional inflow between Kimberly and the next gaging station at Service Creek. The drainage area increases about 20 percent but the inflow increases only about 7 percent. At the gaging station at Service Creek, mile 156.7, the drainage area is 5,090 square miles and average discharge is 0.35 cfsm.

Downstream from Service Creek the river is generally in a remote rocky canyon receiving little inflow from the area it traverses. Bridge Creek entering from the south at mile 135 and Butte Creek entering from the east at mile 97 add little to the flow. Rock Creek entering near mile 22 from the southeast has a brief record indicating a maximum discharge of 335 cfs during the one flood when it was gaged. However, the record also indicates there were periods during which there was no flow. The most downstream gaging station, located at McDonald Ferry (mile 20.9) measures the runoff from an area of 7,580 square miles (95 percent of the total basin). Unit discharge at this gage is 0.26 cfsm, which provides an average annual runoff of 1,440,000 acre-feet. This is more than enough to satisfy the consumptive demands on the river, but, because the occurrence of the discharge varies widely, serious shortages occur annually.

The streamflow pattern in the basin is typical of a climate with cold winters and a spring melt which produces flood flows in March or April. Floods have occurred in December and as late as June. Maximum flow at the McDonald Ferry Station came December 24, 1964, with a discharge of 42,800 cfs as the result of a warm rain on heavy snowpack. The high flows dwindle rapidly and reach the low point in August or September. The low flows are a result of normally dry summers and irrigation diversions. There is very little storage within the basin and as a result the natural flows are directly influenced by these diversions.

About 40 percent of the average annual yield occurs during the nonirrigation season but less than one percent of the yield is appropriated during this October through March period. About 56 percent of the average annual yield and the highest depletion occurs during the first three months of the irrigation season, April through June. Adjudication of water rights grants these higher diversion rates early in the irrigation season. Shortages occur during the July through September period at the end of the irrigation season when discharge is only 4 percent of the annual (SWRB, 1962, p. 26). Seasonal shortages relative to fish life occur for the months of August through October as well. It is obvious that storage of excess winter and spring runoff is necessary to relieve these shortages.

Water rights

As of September 1, 1971, there were about 2,600 water rights in the John Day basin. These rights total 2,550 cfs of which 2,068 cfs are consumptive and 482 cfs are nonconsumptive. Irrigation makes up the largest group of consumptive rights with 2,021 cfs for use on approximately 90,000 acres. Nearly 65 percent of all nonconsumptive diversion rights are in the North Fork subbasin (No. 2) with most of the rest in the Upper John Day subbasin (No. 1). About 60 percent of the consumptive rights are in the Upper John Day subbasin with the remainder divided equally between the North Fork and Lower John Day subbasins (No. 3). (See table 4.)

The State Water Resources Board (1962, p. 24) estimated that if all surface water rights were used to their maximum legal extent, about 340,000 acre-feet could be legally diverted for consumptive purposes and 380,000 acre-feet could be used nonconsumptively. However, the actual rate of use can't be determined because some rights are inactive, are used intermittently, or are not used because of insufficient water in low-flow years. Water used for nonconsumptive purposes reappears downstream as does irrigation return water. Actual annual diversion and consumption is probably much less than the legal amount. It is estimated that 100,000 acre-feet is actually consumed (SWRB, 1962, p. 25).

Table 4.--Water rights allotted by the State of Oregon in John Day River basin.
Source: State Water Resources Board, Salem, Oregon, 1971.

Stream	Consumptive rights (cfs)						Nonconsumptive rights (cfs)				Total
	Dom.	Mun.	Irrig.	Ind.	Rec.	Total	Power	Mining	Fish	Total	Rights (cfs)
Subbasin 1											
Beech Creek	.05	.33	20.06		.54	20.98	2.00			2.00	22.98
Birch Creek			8.88			8.88					8.88
Canyon Creek	.30	5.58	21.02		2.55	29.45		20.75	11.61	32.36	61.81
Dixie Creek		1.00	30.65	.60		32.25		1.92		1.92	34.17
Dry Creek	.14		9.36			9.50					9.50
Fields Creek	.05		6.01			6.06					6.06
Ingle Creek			10.51			10.51					10.51
John Day River	1.81	3.19	769.53	2.35	.02	776.90	78.97	19.25	.13	98.35	875.25
Laycock Creek			9.01			9.01		1.00		1.00	10.01
Riley Creek	.11		7.29			7.40					7.40
Rock Creek	.14		168.08			168.22		30.75		30.75	198.97
S.F. John Day R.	.13	5.05	91.51			96.69					96.69
Strawberry Creek	.11		93.86			93.97					93.97
Subbasin 1 totals	2.84	15.15	1,245.77	2.95	3.11	1,269.82	80.97	73.67	11.74	166.38	1,436.20
Subbasin 2											
Camas Creek	.15		52.19			52.34					52.34
Cottonwood & Fox Crks.	.54		138.96			139.50		5.00	.32	5.32	144.82
Cupper Canyon	.07		2.64			2.71					2.71
Deer Creek	.10		8.54			8.64					8.64
Desolation Creek	.01		.13			.14		2.00		2.00	2.14
Granite Creek	.24	3.53	53.98	2.03		59.78	30.00	155.87		185.87	245.65
Long Creek	.23	.98	21.65	.02	.55	23.43					23.43
M.F. John Day R.	1.35	1.22	77.86	2.26	.04	82.73	1.25	66.25		67.50	150.23
N.F. John Day R.	.44	.72	55.65		2.89	59.70		40.30	2.23	42.53	102.23
Rudio Creek	.03		10.40			10.43					10.43
Subbasin 2 totals	3.16	6.45	422.00	4.31	3.48	439.40	31.25	269.42	2.55	303.22	742.62

Table 4.--(continued).

Stream	Consumptive rights (cfs)						Nonconsumptive rights (cfs)				Total Rights (cfs)
	Dom.	Mun.	Irrig.	Ind.	Rec.	Total	Power	Mining	Fish	Total	
Subbasin 3											
Bridge Creek	.08	2.00	64.17			66.25			.51	.51	66.76
Butte Creek	.04	.20	39.24			39.48					39.48
Cherry Creek			6.57			6.57					6.57
Currant Creek			7.89			7.89					7.89
Grass Valley Canyon	.05		5.82			5.87					5.87
John Day River	.68	1.84	147.06	.37	.26	150.21	11.00		.20	11.20	161.41
Rock Creek	.02		74.16			74.18			.11	.11	74.29
Thirtymile Creek	.02	.14	7.46	.78	.02	8.42					8.42
Subbasin 3 totals	.89	4.18	353.31	1.15	.28	358.87	11.00		.82	11.82	370.69
John Day Basin totals	6.89	25.78	2,021.08	8.41	6.87	2,068.09	123.22	343.09	15.11	481.42	2,549.51

Ground water rights as of June 30, 1961, total 14 cfs of which 5 cfs are for municipal use and 9 cfs are for irrigation (SWRB, 1962, p. 28). The Lower John Day basin accounts for 80 percent of these rights. To date, ground water studies have not been made and the potential for development of this source is generally unknown. Ground water yield and distribution is mainly determined by precipitation, topography, character of the rocks, and infiltration characteristics of the various types of soil.

The average annual precipitation for the basin was estimated as 19 inches. Topography is characterized by deep canyons, narrow river valleys, high mountains in the south and east portions, and gently rolling plateaus in the northern and central parts. The rocks are generally of a type with low to very low ground water yield capability with the best source being the alluvium which occurs in a narrow band along the John Day River upstream from Picture Gorge. Most of the wells and some springs are found in this alluvium zone. Some water is obtained from the contact zones between the lavas and the impermeable tuffs. The Columbia River basalt is a good aquifer in parts of the basin, and some public-supply wells tap this formation.

Rights for ground water use are not always required. The Ground Water Act of 1955 requires no permit for developing ground water supplies for stock watering, irrigating lawns or noncommercial gardens less than one-half acre in area, for domestic purposes not exceeding 15,000 gpd (gallons per day), or any industrial or commercial purpose not exceeding 5,000 gpd (SWRB, 1962, p. 29). There are ground water users that do not have water rights so the full use of ground water cannot be shown by totalling such legal rights.

Classified uses of John Day River waters

The State Engineer withdrew and withheld from appropriation 2,000 cfs of the John Day River and tributaries in 1915 (SWRB, 1962, p. 29 and 30). These withdrawals in applications R-4707 and R-4708 were to be supplemented by storage of 250,000 acre-feet of water in the proposed Dayville reservoir and 150,000 acre-feet of water in the proposed Carty reservoir for irrigation, power, and domestic purposes. The withdrawal was to supply water for the proposed John Day project studied by the State and the Bureau of Reclamation. About 300,000 acres of the Umatilla plateau between Alkali Canyon and the Umatilla River were to be irrigated by the John Day River.

In 1930, in order to protect the municipal supply of the city of John Day, the State Engineer ordered that no subsequent applications for permits should be accepted to appropriate water of Long Gulch or its tributary springs. A similar order affecting Bly Creek and tributary springs was issued in 1934 to protect the water supply of the town of Long Creek.

On July 10, 1939, under Chapter 324 of Oregon Laws, the Morrow County Court consisting of the county judge and commissioners was given authority to store and divert the waters of Ditch Creek, a tributary of the North Fork John Day River within Morrow County, for irrigation purposes. According to ORS 538.010 the water diverted from Ditch Creek to Willow Creek becomes a part of Willow Creek and subject to the same rights of use and appropriation as Willow Creek. If the waters are not used for a five-year period the license shall expire.

Flooding and erosion

Three primary types of floods can be expected in the John Day basin: (1) floods caused by winter rainstorms on frozen ground; (2) spring floods resulting from snowmelt augmented by rainfall; and (3) local summer thunderstorm floods. The streams in the basin are quite flashy in discharge and are subject to flooding after the short intense rainstorms typical of the area. The largest known floods were the winter rain floods that occurred in December 1964 and January 1965 (USCE, Dec. 1969).

The December and January floods were caused by about the same sequence of weather with more extreme and widespread effects occurring in December. General rains in late November wet the ground and raised the streams slightly. Mild weather with snow and rain in the first half of December was followed by extreme cold weather during the December 16-18 period. Streams iced up and the ground froze hard. A warm, subtropical air mass with heavy rains moved over the area on December 21, and temperatures raised abruptly from near 30^{o} to 50 and 60^{o}. The sudden snowmelt and heavy rain on the frozen ground produced rapid and massive runoff in most of the streams in the Pacific Northwest. The rains lasted into December 23, and at Condon totalled 7.56 inches for the December 19-23 period.

In the Upper John Day River basin peak discharges were below record levels, but in the Lower basin they far exceeded previous record highs. The peak stage on December 24 at McDonald Ferry, the most downstream gaging station, exceeded the historic 1894 peak, and those of December 22 and 25 were within a foot of the 1894 peak. Normally, the canyons just downstream from McDonald Ferry contribute little to the peak flows, but during the 1964 flood they discharged very large flows and peaked on December 22. As a result the peak discharge at the mouth of the river probably occurred on the afternoon of December 22. This peak discharge was responsible for the washing out of the I-80N highway bridge under construction over the John Day River at the mouth.

In January 1965 floods resulted from a similar set of conditions; heavy precipitation on frozen ground and warm rains melting an accumulated snowpack on the higher elevations. Most streams reached their peaks on January 29 or 30 and receded below flood stages by February 2.

Beech Creek, entering the John Day at Mt. Vernon in the Upper basin, was especially high although most of the tributaries had high flows. Peaks were not as high as those of December 1964, and the flooding affected areas previously flooded. In some cases the earlier erosion of stream channels enlarged the capacities almost enough to contain the January floods. Flood peaks were not as high but the peaks were broader: at Service Creek the peak flow was 38,600 cfs and flow remained very high for 23 hours (USCE, Jan. 1966). Flows upstream from Picture Gorge were generally lower than in December but a new peak record, 33,400 cfs, was set for the North Fork at Monument. Damaged or weakened river banks resulting from the December floods were further eroded by the prolonged high flows in January.

The two storms cited were thoroughly documented and analyzed as to losses by studies of the Corps of Engineers (USCE, 1966). Their evaluation of damages throughout the basin amounts to about $7 million for losses to urban and rural residences, utilities, industries, roads, bridges, and emergency services. Damages resulting from other seasonal floods and thunderstorms are localized and are minor in comparison to these floods. The debris and silt deposited by the rapid runoff causes severe damage to pasture and hay lands.

Storage and regulation

Due to the seasonal and annual variability of streamflow in the John Day River basin, storage reservoirs to insure dependable flows would be necessary in any power development plan. For many years storage requirements have been obtained by analysis of mass curves of cumulated discharge plotted against time. The storage thus obtained includes both the seasonal and carryover storage that would have been required during the period of record. If the period of record included a noteworthy drought, the resulting draft has usually been considered to be dependable.

Recently, requirements for seasonal storage have been analyzed on a frequency basis by using low-flow frequency curves, while carryover storage has been defined by probability routing of mean annual flows. Combining these two requirements provides draft-storage-frequency relations for total storage.

Most texts on water supply and hydrology provide explanation of storage analysis based on the mass curve of streamflow method, but analysis involving separate methods for seasonal and carryover storage requirements is relatively new with little available information. The most detailed guides are by Riggs (1964) for seasonal storage and by Hardison (1968) for carryover storage. Patterson (1968) provides a concise procedure for combining seasonal and carryover storage, and then regionalizes the data to develop storage requirements throughout the State of Arkansas. No attempt will be made to describe these methods as the lengthy explanation required is beyond the scope of this report, and the references are clear. Rather, presentation of the results in the John Day River basin applying these methods is more appropriate.

Both the mass-curve and the draft-storage-frequency curve methods were used and compared. Results were derived from the use of all long-term records of gaging stations on the main stem and main tributaries of the John Day River. Comparison of the two methods indicates that the storage needs defined by the mass curve are comparable to results obtained from draft-storage-frequency curves with deficiency frequencies of from 1 to 5 percent. Percent chance of deficiency is defined as the percent of years in which a storage reservoir of indicated capacity would become empty with a certain uniform draft. Thus a 1-percent chance of deficiency indicates that storage will be deficient on the average of about once in 100 years and has a 1-percent chance of being deficient during any one year.

Figures 2 and 3 define draft-storage relations at four streamflow stations for deficiency recurrence intervals of 100 and 20 years (1- to 5-percent chance of deficiency). The storage results indicated from a mass curve of streamflow for each station are also plotted on the same graphs to show the comparability of the two methods.

Increasing draft rate, holding storage capacity constant, will increase the deficiency frequency of the reservoir. For example, a storage capacity of half the mean annual runoff (storage ratio 0.5) at the Picture Gorge site (fig. 2), would allow a draft rate of about 48 percent of the mean annual flow, with a 1-percent chance of deficiency (100-year frequency). However, increasing the draft rate to 58 percent of the mean annual flow using the same amount of storage, would mean a 5-percent chance of deficiency (20-year frequency). The mass curve analysis indicates that with this same amount of storage, a draft rate of 50 percent of the mean annual flow is possible and the mass curve chance of deficiency is about 2 percent. Between deficiency frequencies of 1 to 5 percent, the mass curve is reliable for all draft-storage relations except for extremely low or high draft rates. Similar results can be seen in the draft-storage frequency diagrams for the other three streamflow stations.

These graphs have been applied to several reservoir sites in the John Day River basin to determine regulated flows obtainable for suggested storage capacities. At damsites near the gaging stations, such as Monument and Picture Gorge, the draft-storage-frequency diagrams can be used directly. At damsites some distance away from any gaging station, such as Kimberly and Butte Creek, several diagrams may have to be observed and compared to determine the flows available.

For example, the estimated mean annual runoff for Kimberly is 1,260,000 acre-feet. A reservoir with a storage capacity of 500,000

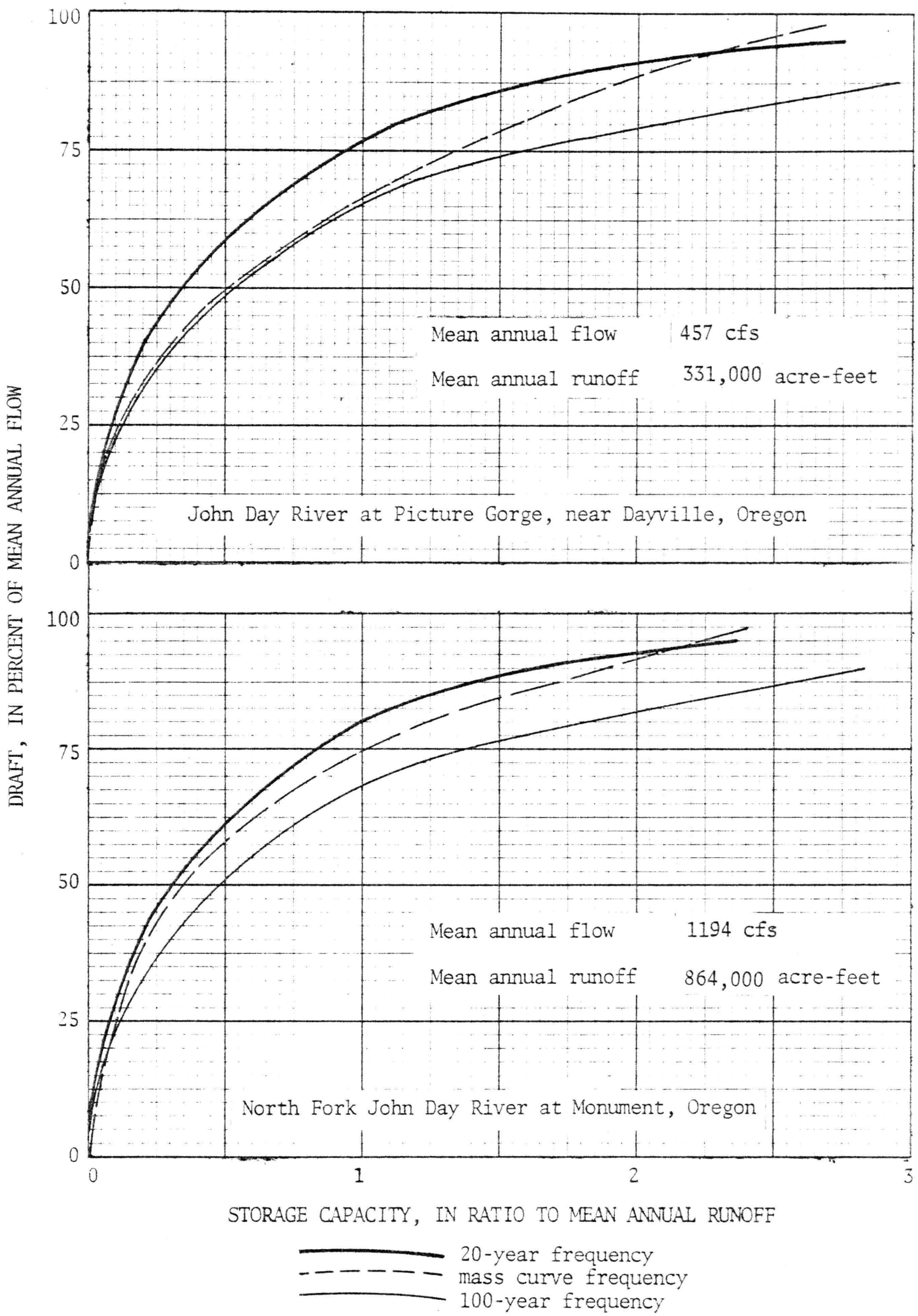

Figure 2.--Draft-storage-frequency diagrams for selected gaging stations.

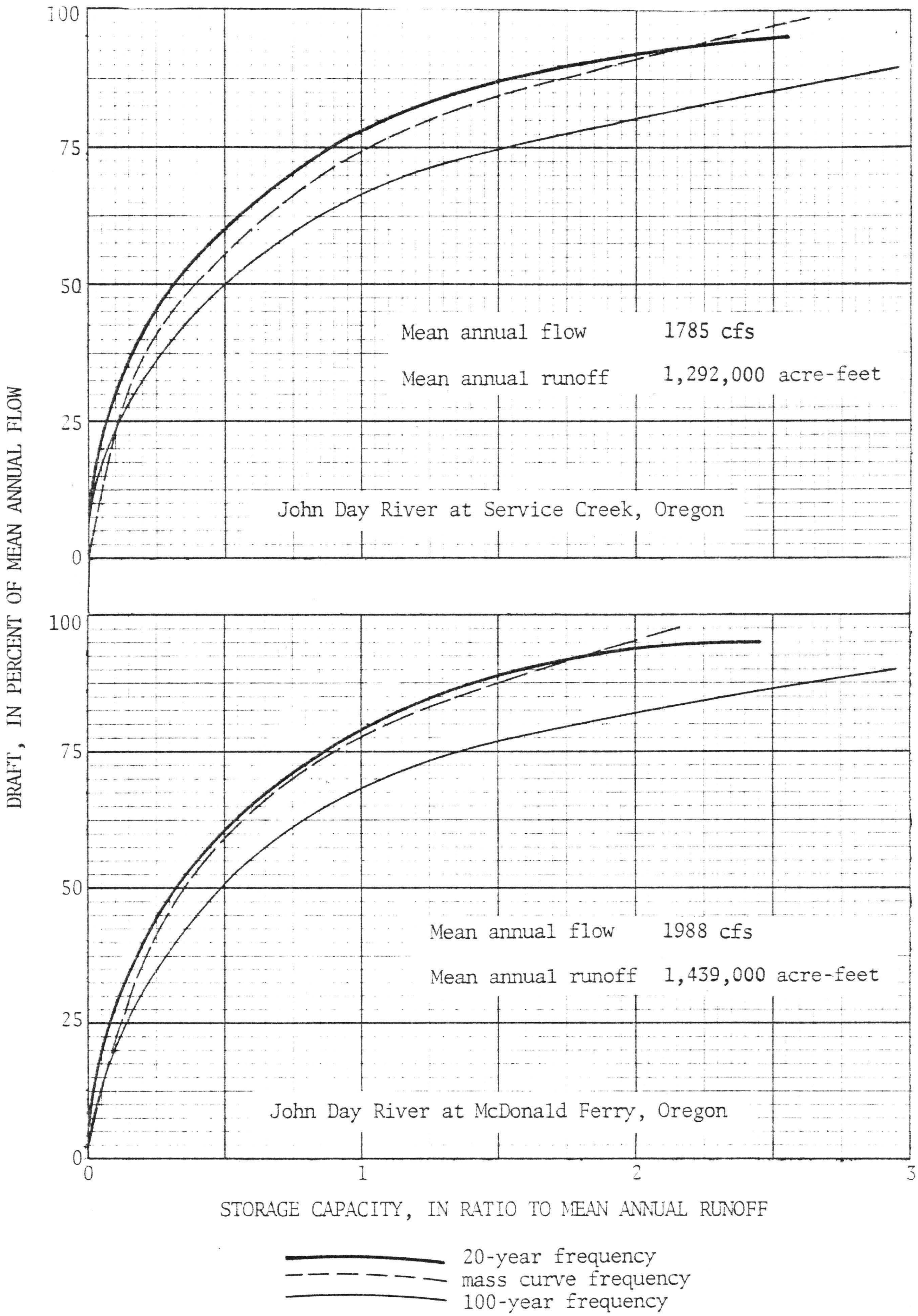

Figure 3.--Draft-storage-frequency diagrams for selected gaging stations.

acre-feet would have a storage ratio to mean annual runoff of 0.40. Three gaging stations are in the vicinity of the Kimberly site; John Day River at Picture Gorge and North Fork John Day River at Monument are upstream from the damsite, and John Day River at Service Creek is downstream. The draft-storage-frequency diagrams at these stations with a deficiency chance of between 1 and 5 percent, indicate an available draft rate ranging from 45 to 55 percent of the mean annual flow. Consequently, this is about the draft rate that can be expected at the Kimberly site for a storage ratio of 0.40.

Similarly the Butte Creek site can be analyzed using the draft-storage-frequency diagrams for streamflow stations at Service Creek and McDonald Ferry, Oregon (fig. 3). The estimated mean annual runoff at Butte Creek is 1,413,000 acre-feet. A storage capacity of only 435,000 acre-feet (storage ratio 0.31) should provide a regulated flow equal to about 45 percent of the mean annual flow with a 3-percent chance of deficiency.

It should be noted that these regulated flow estimates rely heavily upon having a correct estimated mean annual flow at the damsite. A few streamflow measurements at the site, when compared to measurements made at the gaging stations, may help to verify the estimate.

Although evaporation losses and reservoir seepage have to be considered part of the draft rate, neither the mass-curve method nor the draft-storage-frequency relations method evaluate them separately from the draft rate, and losses have not been considered in the computations for the John Day River basin. Evaporation loss is primarily related to reservoir surface area. As the allowable draft is increased, the amount of storage required also increases, and the evaporation loss resulting from the enlarged reservoir surface area tends to offset the increase in draft.

Additionally, it should be noted that probability-routing used for carryover storage computations assumes that annual flows are independent of each other. In reality, they are not independent. Serial correlation of annual flows indicates the dependence of successive flows upon each other. If serial correlation is a significant factor, then the draft rate for a given storage should be reduced by some percent of the mean annual flow, as suggested by Hardison (1968, p. 17).

Thermal-electric (nuclear) plant cooling

At the present time thermal-electric power development in the Pacific Northwest is limited and is entirely absent in the John Day River basin. Conventional steam plants requiring fossil fuels probably will not be a major factor in power production because of the lack of these fuels in the region. Some fuels could be brought in to take advantage of available water supplies. However, it may be anticipated that nuclear plants will be utilized to provide an increasing share of the power load. Nuclear plants require cooling facilities and one method of cooling is provided by cooling ponds. Environmental restrictions on dumping warmed water into natural bodies of water or rivers make it necessary to provide short time retention reservoirs which allow dissipation of the heat from the cooling water. Sites suitable for construction of cooling ponds are available in the John Day basin generally in the broad flatter portions of the valley.

Detailed examinations of such potential sites have not been made but a preliminary inventory of topographically suitable sites has been made from available maps. Geographic location and water supply were also used as a criteria in site selection. Some of the major main stream reservoirs discussed in following sections may have a value as cooling ponds provided the generation, irrigation, cooling, recreation and other uses of the multiple use concept could be integrated. Off-stream cooling storage would be a more acceptable method, however, because the environmental effects of adding heat to a potential main stream reservoir would be avoided.

Agricultural use of warmed water may offer a benefit to crops, and research is being done to determine the best means of application. The use of water from the cooling ponds for such irrigation might enhance the economic benefits of a project. If consideration is given to irrigation as a supplemental benefit the siting of ponds can be further localized to crop-raising areas. Agriculture in the John Day River basin is generally confined to wheat or alfalfa at the present time because of a short growing season and inadequate rainfall. Supplemental irrigation from warmed water storage would permit higher-value crops.

A rule-of-thumb for estimating the size of cooling ponds requires about one to two acres of surface area per megawatt of production (Eicher, 1969, p. 90). A 1,000-MW plant might require a 2,000-acre lake. Lakes need not be particularly deep for cooling purposes only, but multiple use of the lakes could establish other criteria for depth or content. Winter use would permit recirculation of cooling water when irrigation needs were minimal, and make-up water for normal operation and evaporation losses might be the only water required from the river.

A list of sites worthy of further investigation is shown in table 5.

Table 5.--Cooling pond sites, John Day River basin.

Site		Damsite location				
Name	Number	Sec.	T.	R.	Stream	Map reference
Upper John Day subbasin						
Hall Hill	385+10	17	13S	33E	John Day R.	John Day 15'
Picture Gorge	405+00	17	12S	26E	John Day R.	Picture Gorge 15'
Mountain Cr.	405+02	13	12S	22E	Mountain Cr.	Mitchell 15'
Willow Creek	405+05	30	11S	24E	Willow Creek	Richmond 15'
Frog Hollow	405+06	27	11S	23E	Fopiano Creek	Richmond 15'
North Fork John Day subbasin						
Wiley Creek	441+70	11-12	11S	29E	Wiley Creek	Long Creek 15'
Fox Creek	445+00	17	11S	29E	Fox Creek	Courtrock 15'
Lower John Day subbasin						
Bridge Creek	466+57	14	10S	20E	Bridge Creek	Painted Hills 7½'
Rock Creek	475+00	15	1N	20E	Rock Creek	Turner Butte 7½'
Alkali Canyon	360+50	27	2N	21E	Alkali Canyon	Shutler Flat 7½'

Transbasin diversion

Diversion of water from certain reaches of the John Day River to adjacent areas has been considered in the past. The short supply of excess water in the upper reaches near the dividing ridges would make interbasin transfers of water impractical or marginal. A brief discussion of possible developments is included in the 1962 State Water Resources Board report (p. 39).

The Teel irrigation project was planned to utilize a diversion from Camas Creek and tributaries into Butter Creek, a tributary of the Umatilla River, to irrigate 18,000 acres in an area between Butter Creek and the Umatilla River. A portion of a tunnel and a canal were built around 1920 but financial difficulties prevented completion of the project. The Teel project is still being considered but only 6,000 acres are proposed for irrigation, and this would be served by pumping from the Columbia River (Columbia-Blue Mountain Resource Conservation and Development Project, 1970, p. 56).

Recent planning by the Bureau of Reclamation includes the Butter Creek development involving transbasin diversions from the John Day River basin. The principal features of the plan are: Snipe Creek dam, reservoir, and tunnel; Hidaway diversion dam and canal; Owipe diversion headworks and canals; and Butter Creek channelization. Water from Snipe

Creek and Camas Creek would be stored at the Snipe Creek site and diverted by the Hidaway dam. The Owipe diversion dam on Snipe Creek would divert releases from the reservoir through about 12 miles of canals to irrigate 1,400 acres along Snipe Creek. A 4-mile tunnel from the reservoir would divert water out of the basin to East Fork Butter Creek to supplement natural flow of Butter Creek and irrigate up to 8,700 acres of lands along Butter Creek in the Umatilla basin north of John Day River basin.

One of the most ambitious of the transfers of water planned for the basin was to irrigate a vast area of 350,000 acres on the Umatilla Plateau between Alkali Canyon and the Umatilla River by diversion from the John Day River. Storage on the John Day River would have been accomplished at the Butte Creek site and supplemented by storage at the Dayville (Picture Gorge) site. A withdrawal of water for this proposal was filed by the State Engineer in 1915 for 2,000 cfs or a maximum annual diversion of 1,450,000 acre-feet. The proposed Carty reservoir on Six Mile Canyon out of the John Day basin in the irrigated area would store 150,000 acre-feet. A 340-foot high dam at the Butte Creek site and a canal 125 miles long including a 14-mile tunnel would have been required to deliver water eastward to Butter Creek near the eastern edge of the irrigable tract.

An article in the Portland Telegram of August 21, 1929, by the former State Engineer, John H. Lewis, discusses the project and outlined the procedure for development. It was proposed that pumping from the Columbia River be undertaken initially to irrigate on 50,000 to 100,000 acres of the project to reduce the size of the "colonization problem." As this area became successful and flourished the larger undertaking of the dam and diversions might be accomplished. The early-day discussion of the proposal mentions the dependence upon whether or not the Columbia River Umatilla Rapids dam (McNary) or Canoe Encampment Rapids dam (somewhat upstream from present John Day Dam) were built. A portion of the irrigable lands would be inundated by either of these then-proposed dams but pumping from the reservoir would be feasible to irrigate 100,000 acres prior to full development requiring the John Day diversion.

Now that the John Day and McNary Dams have been built irrigation by diversion from the John Day River appears to be less likely. Current planning affecting the irrigable area proposes pumping from the Columbia River with no mention of diversion from John Day River. Development of nuclear power utilizing Columbia River water for cooling purposes and irrigation with the warmed water is being investigated in north Morrow County. The Carty reservoir on Six Mile Canyon would be utilized as in the 1920 plan but would be available for nuclear cooling as its primary purpose with irrigation water distributed from the cooling pond.

Other transbasin diversion plans which would affect the John Day basin include schemes similar to the Sierra-Cascade Project or the

Western Water Project (Howe and Easter, 1971, p. 109). These major long-range plans for augmenting the Colorado River proposed diversion of 15 to 30 million acre-feet of Columbia River water through central Oregon by way of Warner Valley in Oregon to southern California or across western Nevada to Lake Mead. These plans propose a series of ascending reservoirs up the Deschutes and Crooked Rivers and a somewhat similar opportunity exists in the John Day basin.

One such plan using the John Day River as a waterway for an out-of-basin diversion was discussed by an engineer (Alspaugh, 1972) at a governor's water resources conference in 1964 in Salem, Oregon. The John Day River upstream as far as Dayville would require about 5 dams and reservoirs in a pumping-generating cycle to lift water to an altitude of 2,500 feet. The last 60 miles of the transbasin diversion would be by way of the South Fork John Day River where the water would be raised another 2,500 feet by 8 or 10 dams with pumping facilities only. The water would then be at an altitude of about 5,000 feet. From here it could flow virtually by gravity by way of Lake Abert, Goose Lake, and Pit River drainage into California. Generation through about 3,000 feet of head might be utilized in this downhill portion of the diversion. Irrigation of central and southeastern Oregon might be a part of such a diversion scheme as well. However, the political implications of such interstate diversions appear to be sufficient to forestall them for many years.

The 1970 Oregon Scenic Waterways law which restricts developments on the 147 miles of the main John Day River between Service Creek and Lake Umatilla would preclude lifting water by way of the river channel. The same legislation applies to the lower 100 miles of the Deschutes River in the adjacent valley west of the John Day.

Pumped storage

Although nuclear and fossil fuel plants may be utilized in the Pacific Northwest in the future to provide low-cost base load energy, they are expensive sources of peaking power. Presently, peaking requirements are being met by expansion of existing hydroelectric projects on the Columbia and Snake Rivers, but in less than 20 years new sources of peaking energy will be needed. Pumped storage appears to be a promising method of generating relatively low-cost peaking power to complement base sources.

An inventory of potential pumped-storage sites in the John Day basin was made using available topographic map coverage of the area. Because there are many variables in selecting a suitable site, certain criteria were chosen. Investigation was confined to upper reservoirs for those sites that could use as a lower reservoir one of the hydroelectric possibilities described in the section, Development possibilities and classification needs. Other limiting factors were: upper reservoir within about two miles of the lower reservoir; weekly storage capacity

Table 6.--Pumped storage sites, John Day River basin.

Number	Site	Embankment location Sec.	T.	R.	Upper Reservoir: Total storage (ac.-ft.)	Maximum pool altitude (ft.)	Drawdown (ft.)	Drawdown storage (ac.-ft)	Dam** height (ft.)	Crest length (ft.)	Horizontal penstock length (ft.)	Average head (ft.)	Lower reservoir	Pool altitude (ft.)
North Fork John Day subbasin														
0441+20P1	Thompson Flat	26	6S	29E	21,300	4,400	25	10,200	200	1,900	10,300	1,690	Two Mile Canyon	2,700
0441+20P2	Wickiup Spring	19	6S	29E	14,200	4,400	60	10,300	220	1,600	7,600	1,680	Two Mile Canyon	2,700
0460+50P1	Board Creek (alternative)	13	8S	27E	23,000	3,240	96	19,000	220	6,200	8,400	940	Upper Monument	2,263
0460+50P1	Board Creek (alternative)	13	8S	27E	23,000	3,240	75	16,200	220	6,200	8,700	1,070	Monument	2,140
Lower John Day subbasin														
0460+50P1	Board Creek	13	8S	27E	23,000	3,240	73	16,000	220	6,200	8,700	1,090	Kimberly	2,120
0460+60P1	Spray	19	8S	25E	24,400	2,750	140	20,500	250	3,000	10,600	878	Hoogie Doogie	1,820
0460+60P2	Harper Creek	20	8S	24E	24,900	2,770	125	19,900	250	3,100	11,400	904	Hoogie Doogie	1,820
0470+70P1	Sorefoot Creek	23	7S	18E	27,900	2,390	78	19,700	230	8,000	7,300	918	Butte Creek	1,440
0470+70P2	Big Lakes	12	7S	18E	31,700	2,225	130	25,200	225	8,700	7,500	734	Butte Creek	1,440
0473+55P1	Cottonwood Canyon West	14	1S	18E	44,000	1,850	75	26,000	250	7,000	7,900	713	Mikkalo	1,106
0480+82P1	Cottonwood Canyon East (alt.)	4	2S	19E	23,700	2,030	114	20,200	240	5,900	5,400	885	Mikkalo	1,106
0480+82P1	Cottonwood Canyon East	4	2S	19E	15,700	2,000	109	13,800	210	4,200	5,800	1,240	Tenmile Falls	725
0480+82P2	Hay Creek	19	1S	20E	27,000	1,600	98	21,600	225	5,300	8,400	837	Tenmile Falls	725
0480+82P3	Grass Valley Canyon	30	1N	19E	33,700	1,590	58	21,500	240	6,600	9,300	841	Tenmile Falls	725
0481+P1	Blalock Canyon	7	2N	20E	94,600	975	15	26,400	205	4,600	11,400	703	Lake Umatilla	265
0481+P2	*Myers Canyon	12	2N	19E	23,800	1,030	57	21,800	130	6,700	6,800	740	Lake Umatilla	265
0481+P3	*Indian Rapids	20	3N	18E	18,200	1,280	40	16,200	50	16,700	2,400	1,000	Lake Umatilla	265
0481+P4	*John Day Bluff	26	3N	17E	20,000	1,250	60	16,900	145	15,100	2,800	960	Lake Umatilla	265

* Sites studied by North Pacific Division Corps of Engineers (1972, p. 32)
** Does not include freeboard, excluding Corps sites (*)

equivalent to at least 14 hours of full plant generation; minimum head of 700 feet; and a minimum power capacity of 1,000 megawatts, since unit costs rise rapidly for plants of less than 1,000 MW. Similar restrictions were used in recently prepared reports by the North Pacific Division Corps of Engineers (1972, p. 13) and by the Federal Power Commission (1969, p. 2).

Though numerous bluffs adjacent to the John Day River are 700 feet or more above potential lower reservoirs, relatively few natural depressions exist which conform to the above mentioned site criteria for upper reservoirs. Several high flat areas might be suitable for upper reservoir construction; but natural depressions and canyons were chosen on the assumption that they are more economical to develop. Twelve different upper reservoir sites in the John Day basin were found to be topographically feasible. These 12 sites, a few alternatives and three Corps of Engineers' sites are listed in table 6, and all are potential 1,000 MW plants.

There are virtually no pumped-storage sites available in the Upper subbasin that will meet the selection criteria. Generally, the potential head existing in this area is rather low, the capacity of natural depressions for upper reservoirs is too small, or required penstocks would be too long. The sites in the North Fork and Lower subbasins are much more suitable.

Excluding the three sites studied by the Corps, (see table 6) embankment heights exceed 200 feet for all sites. Crest lengths vary between 1,600 and 8,700 feet, with penstock lengths ranging from about one to two miles. Drawdown storage would allow weekly operation equivalent to 14 hours of continuous operation at full output of 1,000 MW.

Multipurpose use should be considered in any reservoir development, particularly in areas having public access. With a growing demand for water-oriented recreation, selection of sites with minimal drawdown might be required. Furthermore, drawdowns of half the reservoir depth or more may require special design to prevent reservoir instability. Increasing storage capacity by higher dams to reduce drawdowns is costly and at some sites may be impractical.

An additional problem requiring further investigation is the amount of make-up water needed due to reservoir evaporation losses. Weather Bureau evaporation records at Moro indicate the loss might be substantial, possibly reducing the pumped-storage potential in this arid basin (see table 2).

Although all of these sites are topographically feasible and meet the selection criteria, many of them may not be economically justified. Thompson Flat and Wickiup Spring, which are probably the most promising sites found within the basin, are the only pumped-storage sites located on public land. Cost studies and geologic investigations are advisable before land classifications are considered. Appropriate action will be taken to protect those sites which the investigations find to be of value.

The inventory made for this report considered only possible pumped-storage sites located on the main stem and forks of the John Day River, but many other small sites may exist which could produce less than 14 hours generation at 1,000 MW. However, it is evident that pumped storage could be developed in the basin, assuming availability of low-cost base load energy, and some of the most favorable sites are included.

(p. 31 follows)

DEVELOPED HYDROELECTRIC POWERPLANTS

There are no operating hydroelectric powerplants in the John Day River basin. A plant at Prairie City was operated by the Prairie Power Company as early as 1916. The powerplant was acquired by Peoples West Coast Hydroelectric Corporation in 1928, and some time later the name was changed to West Coast Power Co. The powerplant had a maximum capacity of about 750 hp (horsepower) and was located in SE¼NE¼ sec. 10, T. 13 S., R. 33 E. Water was diverted about 2.5 miles by canal from the left (south) bank John Day River in SE¼ sec. 7, T. 13 S., R. 34 E., and from tributary streams crossed by the canal. Average discharge as measured in the canal (1925-51) was 47.7 cfs. After passing through the powerplant the water was returned to the river about 600 feet downstream from the present gaging station in sec. 10, T. 13 S., R. 33 E. The plant was destroyed by fire February 2, 1952, and has not been replaced.

The Fremont plant (0405+30) was the only other power site developed in the basin. The old powerhouse is shown in figure 4. It required a

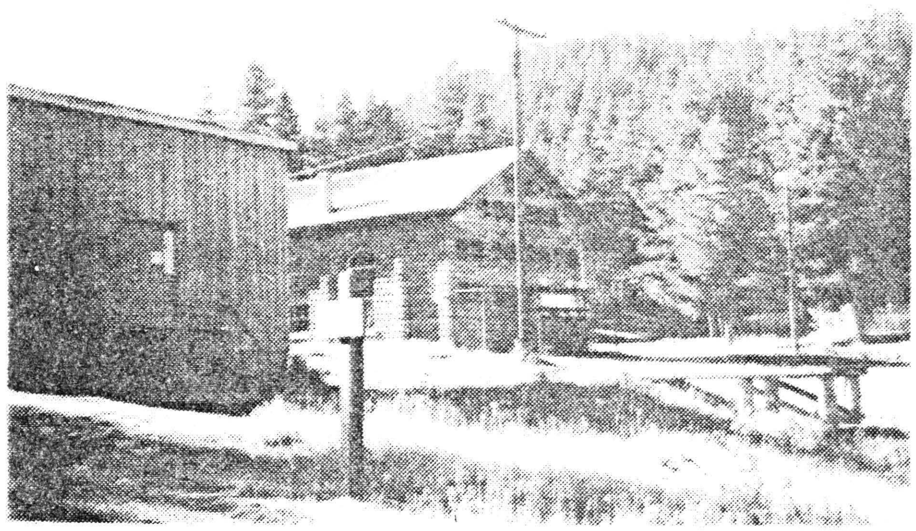

Figure 4.--Fremont powerhouse

dam on Lake Creek in sec. 15, T. 9 S., R. 34 E., forming Olive Lake (fig. 5), with a surface area of 172 acres and a storage capacity of about 5,590 acre-feet. A low dam on North Fork of Desolation Creek diverted water by a ditch about 7,060 feet to Olive Lake. A pipeline from Olive Lake to the powerhouse picked up additional water diverted from Lost Creek through a pipe 1,690 feet long. The powerhouse is in sec. 9, T. 9 S., R. 35 E., on the North Fork of Congo Creek and contains two 550-kw generators which produced an estimated 5,000 MWH annually. A transmission line 18.25 miles long extends to the town of Bourne.

Figure 5.--Olive Lake

The Fremont plant was built by the Fremont Power Company in 1907 to furnish power to local mines and the public. It was operated by the Eastern Oregon Light and Power Company from 1909 until 1946 when the California-Pacific Utilities Company acquired it. The plant was operated under a Department of Agriculture waterpower permit until January 14, 1948, when a license (No. 1987) was issued by the Federal Power Commission. The license was amended January 7, 1966, to exclude Upper Lake from the project as the diversion structures had been damaged by high water and were too costly to maintain. Amendment of the license also redescribed the location of a transmission line between the towns of Bourne and Fremont. No public lands were withdrawn by the filing for license, but the project operated on 250 acres under a special land use permit issued by the U.S. Forest Service.

On July 26, 1967, the company applied for a surrender of the license for the project in its entirety as it had become uneconomical to operate or restore to a state of efficient operation. Only the transmission line would continue to be used. The remainder of the project was to be taken over by the U.S. Forest Service with the lake to be converted to recreational use. In 1968 the California-Pacific Utilities Company donated the plant to the Forest Service and it is preserved as a museum (Oregonian, 1971). The surrender of the license was effective December 31, 1967.

Tubbs (1922) reported that a plant operated around 1920 on John Day River at Tenmile Falls near the backwater of present-day Lake Umatilla. The capacity was unknown and no other records of the development have been found. A later report by Helland (1931) makes no mention of a developed plant but discussed a potential site at mile 10.6 near Tenmile Falls.

(p. 37 follows)

DEVELOPMENT POSSIBILITIES AND CLASSIFICATION NEEDS

Upper John Day subbasin

As previously mentioned the John Day River basin has been subdivided for analysis in this report. Subbasin 1 (Upper John Day subbasin) has an area of 2,145 square miles and is that part of the main basin above the mouth of the North Fork at Kimberly including all of the South Fork (figs. 6 and 6a). There are six undeveloped sites; five of which have a total potential power capacity of 27.2 MW at 100 percent efficiency, mean flow, and gross head, and one which has storage value only. The formerly developed site at Prairie City is within this subbasin. Each site is considered in downstream order and potential project purposes and classification needs are discussed. Table 7 follows the discussion of the Lower John Day River subbasin and lists sites considered to be physically feasible for development for power or storage.

Sites have been given identifying numbers based on the established gaging station numbers of the Water Resources Division. All of the sites and gages numbered are in Part 14, Pacific Slope basin in Oregon and lower Columbia River basin, so the 14 has been omitted from the identifying number. A site may be located relative to a gage by noting the plus number appended to the gage number. This indicates that the site is downstream from the gage an arbitrary distance relative to the magnitude of the plus amount. Sites at or very near a gaging station will have the same number as the gage. A large plus number means the site is well downstream from the gage while a small plus number indicates that it is still downstream but closer to the gage. Pumped-storage sites are designaged by using the same number as the lower reservoir with an added letter "P" followed by figures in numerical downstream order.

Little Meadows (0360+20).--The most upstream site in subbasin 1 is called Little Meadows. It is on John Day River in sec. 6, T. 15 S., R. 35 E., at river mile 280, and was studied by the Corps of Engineers and the State of Oregon. An average annual estimated yield of 3,300 acre-feet from a drainage area of 10 square miles could provide about 1,000 acre-feet of water for irrigation. The reservoir with a maximum pool area estimated at 39 acres behind a dam approximately 80 feet high could furnish some flood control benefit. Current studies by the Corps of Engineers have not included this site. Power at the site is not practical and no classifications are outstanding or required.

Rail Creek (0360+40).--This site is on the John Day River in sec. 13, T. 14 S., R. 34 E., at river mile 275 (fig. 7). It was recently studied by the Corps of Engineers and shown to be economically infeasible by their standards. The suggested pool altitude was 4,475 feet and the capacity was 13,000 acre-feet. The Bureau of Reclamation in its studies determined that the site could not be justified for irrigation development because canals from the reservoir to arable lands on the Prairie City bench would have to cross a number of draws and drainages which

Figure 7.--Rail Creek damsite

Figure 8.--Deardorff damsite

would result in very high costs. The water which could be stored economically at the site was inadequate for irrigation demands. No power would be developed at this site because of physical limitations of the reservoir and lack of water, and no classifications or withdrawals are outstanding nor are any required.

Deardorff (0360+50).--The Bureau also considered a site on the John Day River in sec. 35, T. 13 S., R. 34 E., near river mile 271 (fig. 8). Storage at this site was evaluated for supplemental irrigation and recreation. Distribution canals from the reservoir would cross the same difficult terrain that affects the Rail Creek plan. The site has certain advantages over the Hall Hill site discussed below including more arable land lying downstream from the reservoir, more stream fishery benefit, a smaller amount of crop-producing land flooded by the reservoir, and lower right-of-way and relocation costs. However, drainage area and water supply is less at Deardorff site and a larger dam would be required. Possibilities of geologic weaknesses such as buried channels in either abutment also make the site less desirable. No classified lands would be affected.

Reynolds Creek (0360+60).--A site on Reynolds Creek, a tributary to the Upper John Day in sec. 30, T. 13 S., R. 35 E., would create about 2,500 acre-feet of flood control storage with a dam 108 feet high forming a pool with a surface area of about 62 acres. The drainage area at the site is 27 square miles yielding an estimated average annual runoff of about 9,000 acre-feet according to the studies by the Corps of Engineers. No classifications are outstanding or required for this small site.

Strawberry Lake (0360+90).--The next site in downstream order is on Strawberry Creek, in sec. 31, T. 14 S., R. 34 E. A plan to develop this

Figure 9.--Strawberry Lake outlet

site, studied by the State Engineer of Oregon, included a dam to raise the lake 25 feet to provide a total irrigation storage of about 800 acre-feet. The outlet of the lake appears to be dry during the summer but Strawberry Creek emerges somewhat downstream from the lake indicating the porous nature of the underlying rock formations (fig. 9).

An application filed December 12, 1925, designated as FPC Project No. 683, withdrew 729 acres of land around Strawberry Lake and along Strawberry Creek for a proposed power development for public utility use. No indication of how much power was anticipated is found in the file, but the Prairie Power Company of Prairie City plan included about 1.75 miles of diversion pipeline from earthfill dams on Strawberry and Onion Creeks to the powerhouse. A preliminary permit issued to the Company on September 14, 1926, expired two years later without any further work being done.

An application designated as FPC Project No. 942 was filed December 1, 1928, for a similar development on Strawberry Creek by the Peoples West Coast Hydro-Electric Corporation. A preliminary permit was issued March 13, 1930, to be effective for two years. However, the power company failed to provide for necessary stream gaging and the Federal Power Commission authorized the cancellation of the permit on November 25, 1930. An estimated 150 acres withdrawn by filing for FPC Project 942 duplicated lands withdrawn in FPC Project 683 except that the area withdrawn did not include Strawberry Lake and was limited to lands within a project boundary as shown on maps accompanying the filing.

Strawberry Lake, shown in figure 10, is a popular recreational site used by fishermen and campers with facilities provided by the U.S. Forest

Figure 10.--Strawberry Lake

Service. It is in a wild area as designated by the Forest Service in 1942, and with the passage of the Wilderness Act in 1964, it became a part of the National Wilderness Preservation System. The lake is unsuitable for power because of low discharge (6 cfs est.), and both of the expired project withdrawals should be vacated.

Hall Hill (0385+10).--The most promising development for multiple-purpose use in the Upper John Day subbasin is the Hall Hill site at mile 259 on John Day River, sec. 17, T. 13 S., R. 33 E. (fig. 11). It

Figure 11.--Hall Hill damsite

has been studied by the Corps of Engineers and the Bureau of Reclamation. Total storage proposed was about 40,000 acre-feet of which 35,000 would be active. A rolled earthfill dam 116 feet above the streambed to a maximum pool altitude of 3,495 feet with a crest length of 3,710 feet would create a reservoir with a surface area of 1,070 acres (Bureau of Reclamation, 1970). It would provide much-needed irrigation and flood control storage for this portion of the basin and would also provide considerable recreation potential in an area where such facilities are scarce. The Bureau of Reclamation determined that the Hall Hill site had a benefit cost ratio of 1.04 based on a 100-year period and a Federal interest rate of 4 7/8 percent.

Two basic plans of using storage at the Hall Hill site were evaluated by the Bureau of Reclamation. The most economically attractive one considered storage for supplemental irrigation, stream fishery enhancement, recreation, reservoir fishery, and joint use flood control. This plan assumed that supplemental irrigation water would be released from storage into the river and would utilize the existing distribution system. The second plan had inadequate project benefits to offset construction, operation, and maintenance costs of both storage and a new distribution system. Power generation was considered as impractical because low head and low dependable flow resulted in a very small plant capacity, and because outside power sources are ample to supply the area.

The project, if built, would be operated for flood control from October through May, for irrigation from April through September, and for stream fishery enhancement throughout the year. Supplemental irrigation of 6,580 acres would be provided by the reservoir through existing distribution works. Estimated project costs as of January 1969 were $10 million. The average annual runoff estimated at the site is 88,000 acre-feet from the 252.5 square miles of drainage area. The entire project would be constructed on private lands and no power or reservoir classifications are involved.

The proposed Hall Hill reservoir might also have value for thermal powerplant cooling purposes. It would be relatively shallow but the surface area would be sufficient to cool a 500-MW plant by a 2-acre-per-MW assumption. The use of water warmed by once-through cooling might have a beneficial effect on the irrigation value, but the warmed water would be detrimental to fish life.

Oliver Ranch (0385+31).--A site called Oliver Ranch was considered near mile 255 on the John Day River in secs. 19 and 30, T. 13 S., R. 32 E. (fig. 12). A dam 2,000 feet long raising the water from altitudes 3,125 to 3,300 feet, backing water nearly to the Hall Hill site, would store

Figure 12.--Oliver Ranch damsite

99,000 acre-feet and provide 175 feet of head. At the estimated average flow of 190 cfs the power available at 100 percent efficiency would be 2.80 MW. This is insufficient to warrant construction for power purposes considering the large amount of private and productive lowlands which would be inundated. There are no classified or Federal lands in this vicinity which would be affected.

Canyon Creek (0385+33).--A site on Canyon Creek called Canyon Creek, or Fawn, has been considered in sec. 13, T. 15 S., R. 31 E., at stream mile 12 where the drainage area is 68 square miles (fig. 13). This site, usable for irrigation and flood control, would have a reservoir of 22,000

Figure 13.--Canyon Creek damsite

acre-feet capacity, a maximum pool area of 365 acres, and a pool altitude of 4,095 feet. The dam would be 155 feet high and 660 feet long at the crest. The meager streamflow and 500 feet of head developed by the dam and a diversion to a downstream powerhouse site would produce only about 1.7 MW at mean flow and 100 percent efficiency. The site is approximately the same studied by the Corps of Engineers in 1940 and is called the Joaquin Miller site by the Bureau of Reclamation. A field inspection revealed a large landslide on the right abutment and because of the unknown stability and the possibility of a buried stream channel this site was excluded from further study by the Bureau of Reclamation. It is possible that the axis of the Joaquin Miller dam site might be moved about a mile upstream and a more detailed study of the site could be made in a feasibility level investigation. However, if storage on Canyon Creek is to be feasible it would probably have to be supplemented by storage elsewhere because of limited runoff. There are no lands presently classified in the site and no classifications are required.

Beech Creek (0385+35).--The next major tributary to the John Day River in subbasin 1 is Beech Creek entering the river at Mt. Vernon. The Beech Creek site considered suitable for irrigation and recreation by the Soil Conservation Service, would be located on Beech Creek in sec. 7, T. 13 S., R. 31 E., at stream mile 6. A dam 45 feet high and 650 feet long with a maximum pool altitude of 3,150 feet would form a pool 50 acres in area and store 600 acre-feet. Drainage area at the site is 87 square miles and average streamflow runoff is estimated at 30 cfs (21,700 acre-feet per year). Beech Creek has a known flood potential and some flood-control studies have been made by the Corps of Engineers. (See Flooding and erosion.) There are no public lands in the site.

From Mt. Vernon to Dayville the main stem of the John Day River flows through relatively flat open country completely developed by farming and ranching.

Bear Creek (0390+10).--The South Fork John Day enters the main stem at Dayville near river mile 212. The South Fork basin has been considered for development at various sites the most upstream of which is the Soil Conservation Service's Bear Creek site on tributary Bear Creek in sec. 34, T. 18 S., R. 29 E. Here a small storage reservoir of 250 acre-feet could be provided by a 40-foot high dam with a crest length of 550 feet and a pool altitude of 5,200 feet. Such a site might be used for irrigation, flood control, and recreation but it is too small for power. No lands in the site are presently classified and no classifications are required.

South Fork (0390+30).--A site called South Fork on the South Fork John Day River at river mile 53, sec. 24, T. 18 S., R. 28 E., could store 2,500 acre-feet in a pool at an altitude of 4,500 feet with a surface area of 125 acres. The dam would be 55 feet high and 1,600 feet long at the crest. Irrigation, flood control, and recreation could be provided, but this site selected by the Soil Conservation Service is not feasible for power. No lands in the site are classified and no classifications are needed.

Pine Creek (0390+50).--The Pine Creek site on South Fork John Day in sec. 19, T. 16 S., R. 27 E., at stream mile 30 was once considered as a possible power site. Estimated head of 150 feet and a mean flow of 80 cfs could produce only about 1 MW at 100 percent efficiency so the site is infeasible for power generation. There are no water resource classifications in the site and none are needed.

Upper Murderers Creek (0390+60) and Lower Murderers Creek (0390+70).--These sites on South Fork Murderers Creek in sec. 26, T. 15 S., R. 28 E., were considered by the Soil Conservation Service as recreational sites. They would be approximately 60 or 90 acres in area and have capacities from 800 to 1,150 acre-feet. Forty-five foot high dams 850 and 975 feet long, respectively, might develop these sites for recreation purposes only. There are no classifications in the sites and none are needed.

Black Canyon (0390+80).--A site near mile 16 on South Fork John Day River called Black Canyon in sec. 26, T. 14 S., R. 26 E., was studied for hydroelectric power generation by the Corps of Engineers by utilizing a dam 110 feet high and 300 feet long (fig. 14). The drainage area of

Figure 14.--Black Canyon damsite

569 square miles is estimated to yield an average flow of 180 cfs. This flow and the 110 feet of head available at the dam could produce 1.7 MW at 100 percent efficiency. Current studies by the Corps have not listed this site. A dam between altitudes 2,850 and 3,100 storing 50,000 acre-feet could increase potential head to 250 feet and produce 3.8 MW. The damsite and lands along the river for 1.25 miles upstream are classified in Power Site Reserve 64 of July 2, 1910. These lands should remain classified to add flexibility for future planning of water resource developments at the site and downstream from it.

Fourmile (0390+90).--This site, which has long been discussed, is located in sec. 24, T. 13 S., R. 26 E., at river mile 6 (fig. 15). The site was considered in the early 1940's by the Corps of Engineers, the Oregon State Engineer, and in early studies by the Geological Survey. According to the Corps of Engineers a dam 115 feet high with a pool altitude of 2,637 feet would store a total of 10,000 acre-feet with usable storage of 7,000 acre-feet for irrigation, flood control, and power. Drainage area at the site is 590 square miles. This site has not been considered seriously by the Bureau of Reclamation because the current John Day project study indicates that most of the presently irrigated lands that need supplemental water are upstream from the Fourmile site. Studies by the Corps of Engineers for the Fourmile site assumed a maximum pool of 2,660 feet above sea level and a total capacity

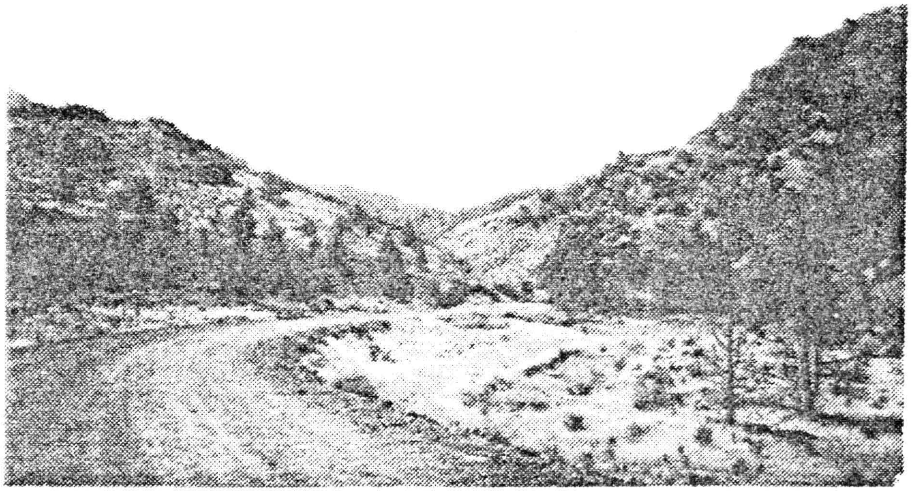

Figure 15.--Fourmile damsite

of 16,000 acre-feet, but the site was shown to be economically infeasible by present Corps standards.

A power development in this reach would have 350 feet of head if a 6- or 7-mile conduit between the Black Canyon tailrace and backwater from the potential Picture Gorge dam on the John Day were utilized to develop the steep slope of the stream. Studies by the Geological Survey indicate that power developed with 350 feet of gross head and an estimated average flow of 180 cfs would be 5.4 MW at 100 percent efficiency. In line with modern trends of larger plants and higher heads, a combination of the Black Canyon reservoir with the Fourmile diversion is suggested. Adding the head developed by the reservoir to the diversion head would increase the total head to 555 feet.

Lands in the vicinity of the Fourmile powerhouse site were withdrawn in Power Site Reserves 64 and 75 but the reserves were subsequently restored by Power Site Restoration 458 of January 27, 1931. No new classifications of Federal lands are needed.

Dayville (0405+00).--The Dayville site listed in the State Water Resources Board report (1962) was studied by the Corps of Engineers, the Department of the Interior in cooperation with the State of Oregon, and separately by the Geological Survey. This site is called Picture Gorge in current Geological Survey studies (fig. 16). The Corps of Engineers site would be in sec. 20, T. 12 S., R. 26 E., near river mile 206 and considered a reservoir with a capacity of 300,000 acre-feet behind a dam 193 feet high. The alternative site studied by the Geological Survey was slightly downstream in sec. 17 and near river mile 205 forming a pool at an altitude of 2,500 feet. Estimated power with the average streamflow of 450 cfs is about 10.3 MW at 100 percent efficiency.

Figure 16.--Picture Gorge damsite

At an altitude of 2,500 feet the reservoir would back water upstream about 16 miles and inundate much private land including a portion of the town of Dayville. Capacity of the reservoir if filled to 2,500 feet altitude would be 840,000 acre-feet which is more than 2.5 times the drainage area annual runoff of 331,000 acre-feet (457 cfs). The storage would be sufficient to regulate to a firm flow of about 400 cfs. The estimate assumes complete emptying of the reservoir to achieve the regulation. If only the upper 30 feet is used 210,000 acre-feet would be available at an average head of 255 feet. This head and a flow of 250 cfs which the 210,000 acre-feet of storage could provide would produce 5.4 MW of firm power at 100 percent efficiency.

The Picture Gorge site offers a reservoir for cooling purposes, but because it is on the main stem of the river addition of heat to the reservoir may have a detrimental effect on the environment.

The damsite area in sec. 20, T. 12 S., R. 26 E., was in Power Site Reserve 65, subsequently restored subject to Section 24 of the Federal Power Act, and should be retained in that status. The damsite in sec. 17 of the same township is within the John Day Fossil Beds State Park (fig. 17), and the lands in the John Day valley through the reservoir site are nearly all patented. About 1,270 acres of public land in T. 12 S., R. 26 E., and in T. 13 S., R. 27 E., would be affected but there are no current plans which consider development of this site. Lands in the reservoir area which were included in the orders for Power Site Reserve 65 were removed from the records by Power Site Restoration 588, July 31, 1963, because they were patented.

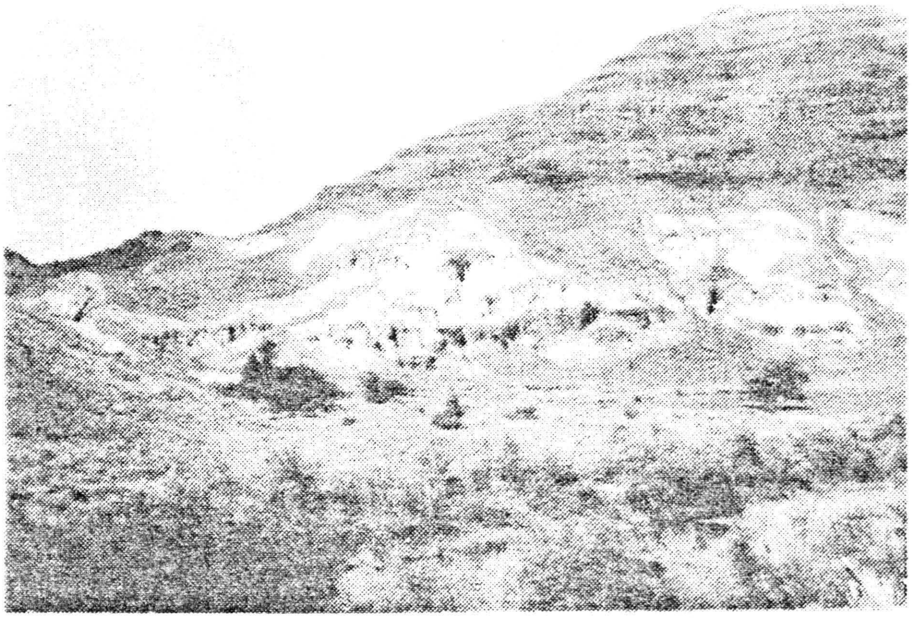

Figure 17.--Fossil beds downstream from Picture Gorge damsite.

Rock Creek (0405+01).--Rock Creek enters the John Day River from the west just downstream from the Picture Gorge site. The Rock Creek site, located on a tributary in the headwaters in sec. 21, T. 12 S., R. 25 E., was considered by the Soil Conservation Service. The drainage area of 83 square miles would contribute an estimated average annual yield of about 22,000 acre-feet. A 120-foot dam would be about 400 feet long and would raise water to a maximum pool altitude of 2,910 feet. The pool would have an area of about 70 acres and store about 2,400 acre-feet of water. The estimated 30 second feet of average annual flow and 120 feet of head would produce only around 300 kw at 100 percent efficiency. This site is considered to be too small to be practical for power. No classifications have been made in the site and none are needed.

Mountain Creek (0405+02).--The Mountain Creek site is on Mountain Creek, a tributary to Rock Creek. The damsite is in sec. 13, T. 12 S., R. 22 E., where the drainage area is only 29 square miles. The Soil Conservation Service estimated the average annual yield as about 6,000 acre-feet. A dam 55 feet high and 460 feet long would create a pool with a maximum altitude of 4,250 feet and surface area of 178 acres. The total storage estimated for this reservoir was 3,500 acre-feet. The site was also studied by the Corps of Engineers who estimated the capacity at 4,000 acre-feet and considered it suitable for multiple purpose use, mainly irrigation and recreation. The small streamflow and low head make it impractical for power development.

As a cooling pond it would require a 220-foot high dam to raise the water surface to an altitude of 4,400 feet, creating a 122,000 acre-foot reservoir with a surface area of 1,410 acres. An auxiliary dike 80 feet high in sec. 22 of the same township would be necessary. A reservoir having an area of 680 acres and a capacity of 39,000 acre-feet would be possible with only one dam to an altitude of 4,320 feet. Water would have to be pumped about 20 miles to the site from the John Day River to fill the reservoir but natural flow might provide make-up water. No classified lands are involved and no classification is needed.

Fort Creek (0405+03).--A site on Fort Creek, a tributary to Mountain Creek, in sec. 18, T. 12 S., R. 24 E., was studied by the Soil Conservation Service for irrigation and recreation potential. Drainage area is only 9 square miles and the estimated average annual yield is about 1,200 acre-feet. A dam 45 feet high and 700 feet long would be required to raise the water to a pool altitude of 3,865 feet covering 97 acres. The Soil Conservation Service in its studies considered the total storage to equal the average annual yield. The site has no power possibilities and no site lands need classification.

Sixshooter Creek (0405+04).--Another site studied by the Soil Conservation Service is on Sixshooter Creek in sec. 12, T. 11 S., R. 23 E. The total drainage area of 4 square miles would yield an estimated 900 acre-feet. This would require a dam 55 feet high and 700 feet long forming a pool with a maximum altitude of 4,140 feet. At this altitude the pond would have a surface area of 53 acres and store 800 acre-feet usable for irrigation. This site has no power possibilities and affects no classified lands.

Willow Creek (0405+05).--The Willow Creek site on Willow Creek in sec. 30, T. 11 S., R. 24 E., was studied by the Soil Conservation Service. Drainage area is 32 square miles which the Soil Conservation Service estimated would yield 4,200 acre-feet. A dam 45 feet high and 330 feet long backing water to a pool altitude of 3,870 feet would store an estimated 2,300 acre-feet for irrigation and recreation in a pool 149 acres in area. A dam 160 feet high could store 230,000 acre-feet in a pond of 3,980 acres at an altitude of 4,000 feet if the site were to be used as a cooling pond. Water would have to be lifted from the John Day River through conduits up to 15 miles long for the initial filling, but make-up water might be provided by natural flow at the site. This site has no power possibilities, and no classified lands are involved. About 120 acres of public lands would be affected, but classification is not warranted at this time.

Frog Hollow (0405+06).--The Frog Hollow site in sec. 27, T. 11 S., R. 23 E., (fig. 18) appears to be topographically feasible for a cooling pond site. About 29,000 acre-feet could be stored in a pond with a surface area of 750 acres at an altitude of 4,160 feet. This would require a dam about 80 feet higher than an existing irrigation storage dam at the site. There are about 120 acres of public lands within the reservoir area which would be affected by development of this reservoir.

Humphrey Ranch (0405+10).--This site is downstream from the confluence with Rock Creek on the John Day River at mile 200. A dam located

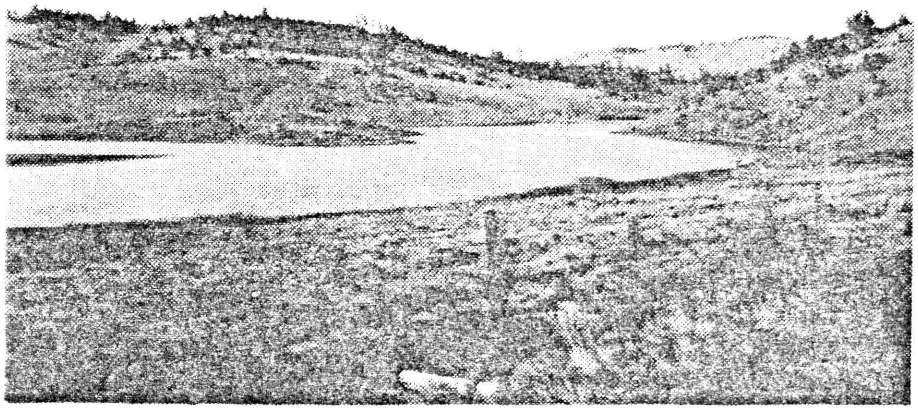

Figure 18.--Frog Hollow dam and reservoir

in sec. 30, T. 11 S., R. 26 E., would raise the river surface altitude from 2,120 to 2,230 feet, store about 20,000 acre-feet, and provide a head of 110 feet (fig. 19). The backwater would reach the Picture Gorge

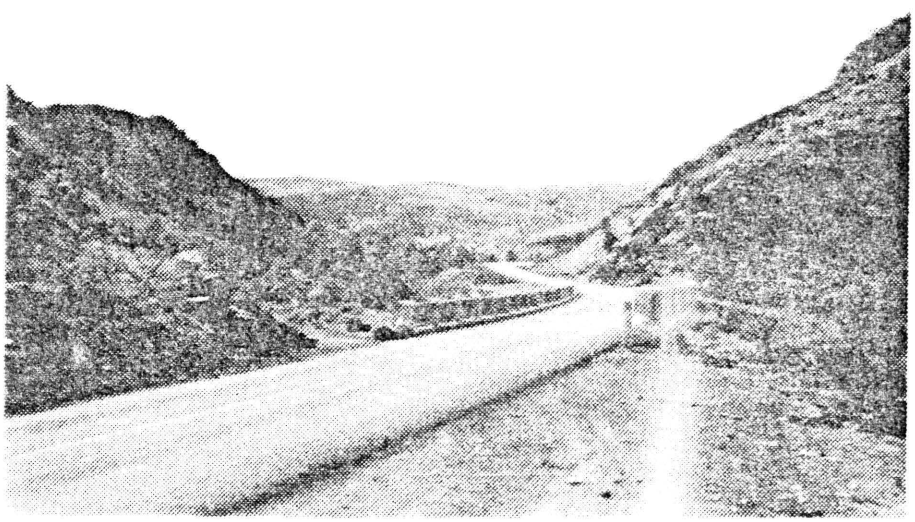

Figure 19.--Humphrey Ranch damsite

site discussed previously. The 500-acre pond would have a potential for cooling, but the main stem location could prohibit this use because of the heat added to the river. The 1,991 square-mile drainage area would provide an estimated average annual streamflow of 520 cfs (377,000 acre-feet). The gross head available at the dam and the average flow could produce an estimated 4.86 MW at 100 percent efficiency. Lands in the dam and reservoir site were classified in Power Site Reserve 65 of July 2, 1910, but the order was revoked on January 27, 1931, by Power Site Restoration 458. No new classifications are proposed.

The Kimberly site on the John Day River downstream from the mouth of the North Fork would back water to the Humphrey Ranch site in a pool at an estimated altitude of 2,120 feet. The site is discussed in the section on the Lower John Day subbasin.

(p. 57 follows)

North Fork John Day subbasin

Subbasin 2 (North Fork John Day subbasin) includes the Middle Fork John Day River and North Fork John Day River upstream from the confluence with the main stem (figs. 20 and 20a). The subbasin area is about 2,625 square miles, 788 square miles in Middle Fork and 1,837 in North Fork. There are six undeveloped powersites which appear technically feasible. The total potential power is 88.6 MW at 100 percent efficiency, using mean flow and gross head. These power sites, the abandoned Fremont project, and a number of sites which do not include power are discussed in downstream order and their potential for multiple-purpose development and possible classification needs are considered. Data for the principal sites are listed in table 7 following the discussion of sites in the Lower John Day subbasin.

Fremont (0405+30).--The most upstream site is the now-abandoned Fremont plant which is the only remaining previously developed site in the John Day basin. This small plant now belongs to the U.S. Forest Service. The powerhouse is in sec. 9, T. 9 S., R. 35 E. A detailed discussion of the project was made previously in the section, Developed hydroelectric powerplants.

Upper Olive Lake (0408+20).--This site is located in sec. 22, T. 9 S., R. 34 E., on Lake Creek, a tributary of Granite Creek, about one-half mile upstream from Olive Lake (see Developed hydroelectric powerplants). The Corps of Engineers considered the site for fish enhancement and recreation purposes and found it to be economically feasible. A 33-foot high dam would inundate an existing lake, and form a reservoir of 65 surface acres to store 600 acre-feet. According to studies made by the U.S. Fish and Wildlife Service, the impoundment could provide excellent habitat for cutthroat trout, a species not usually cultured in Oregon. The site is within the Umatilla National Forest and will not be classified at this time.

Camp Creek (0408+60).--Diversion of the North Fork in sec. 13 or 14, T. 8 S., R. 34 E., near river mile 87 just downstream from the confluence with Granite Creek could develop about 970 feet of head in a distance of 22 miles to the Camp Creek powerhouse site just upstream from Camp Creek in sec. 6, T. 7 S., R. 33 E. Estimated mean flow of 175 cfs from 249 square miles of drainage area and the available head between altitudes 3,930 and 2,960 feet could develop 14.4 MW of power at 100 percent efficiency. No classified lands are involved and no lands are proposed for classification at this time.

Numerous sites in the upper reaches of Camas Creek, a tributary to the North Fork John Day River, have been considered by the Soil Conservation Service, the Bureau of Reclamation, and the Oregon State Engineer.

Camas Creek (0415+70).--The most upstream Camas Creek site is in sec. 4, T. 5 S., R. 33 E., where a 95-foot high dam 630 feet long could store 23,000 acre-feet of water for irrigation purposes. Alternative sites in the same section have been studied ranging upward to 46,000 acre-feet of storage behind a dam 127 feet high. Another site slightly downstream could store 31,300 acre-feet behind a 105-foot high dam 750 feet long. Drainage areas are about 53 square miles for the Camas Creek sites.

Nelson Meadows (0420+00).--An alternative to these upper Camas Creek sites is Nelson Meadows located on Camas Creek in or near sec. 33, T. 4 S., R. 33 E. Storage of 18,000 acre-feet of irrigation water would be possible with a 93- to 96-foot high dam forming a pool with an altitude of 4,042 feet. Average annual yield at Nelson Meadows site is estimated by the Corps of Engineers as 19,000 acre-feet from 59 square miles of drainage area.

Hidaway Creek (0420+50).--This site on Camas Creek in sec. 1, T. 5 S., R. 32 E., was studied by the Bureau of Reclamation. A low dam only 5 feet high and 90 feet long was considered to impound the water from a 26 square-mile drainage area and to divert water to the potential Snipe Creek reservoir discussed below.

Cable Creek (0425+50).--At the Cable Creek site another low dam 5 feet high and 160 feet long in sec. 23, T. 5 S., R. 32 E., was studied by the Bureau of Reclamation.

Camas Creek (0435+00).--A site farther downstream on Camas Creek in sec. 4, T. 5 S., R. 32 E., was studied by the Soil Conservation Service. Its purpose was for irrigation, flood control, and recreation, and required a dam 85 feet high 1,760 feet long to store 12,390 acre-feet in a pool at an altitude of 3,600 feet. A drainage area of 105 square miles was estimated by the Soil Conservation Service to yield an annual flow of 66,800 acre-feet.

Snipe Creek (0435+10).--A site on Snipe Creek in secs. 21 and 28, T. 4 S., R. 31 E., was studied by the Bureau of Reclamation for irrigation as a part of the transbasin diversion to Butter Creek area. The potential reservoir, at a pool altitude of 3,633 feet, would store 70,000 acre-feet of water from Snipe Creek in addition to water diverted through a canal in sec. 1, T. 5 S., R. 32 E., from Camas Creek using the Hidaway Creek site discussed previously.

Owipe (0435+60).--The Owipe diversion dam in sec. 35, T. 4 S., R. 31 E., would divert the releases from Snipe reservoir discussed above through 12 miles of canals to irrigate 1,400 acres along Snipe Creek.

None of these sites in the Camas basin are considered valuable for power purposes due to lack of water and head. There are 1,118 acres of public domain lands which would be affected by the potential Nelson

Meadows reservoir site, all of which are within the Umatilla National Forest. No classification is warranted at this time.

Dale (0408+80).--The Dale site as discussed by the Oregon State Water Resources Board and studied by the Corps of Engineers would be located on the North Fork John Day River in sec. 32, T. 6 S., R. 32 E., near river mile 63. This proposed power site would include a dam 270 feet high and 450 feet long.

Dale (0435+61).--The Dale site considered by the Geological Survey (fig. 21) would be somewhat downstream from the Corps of Engineers site

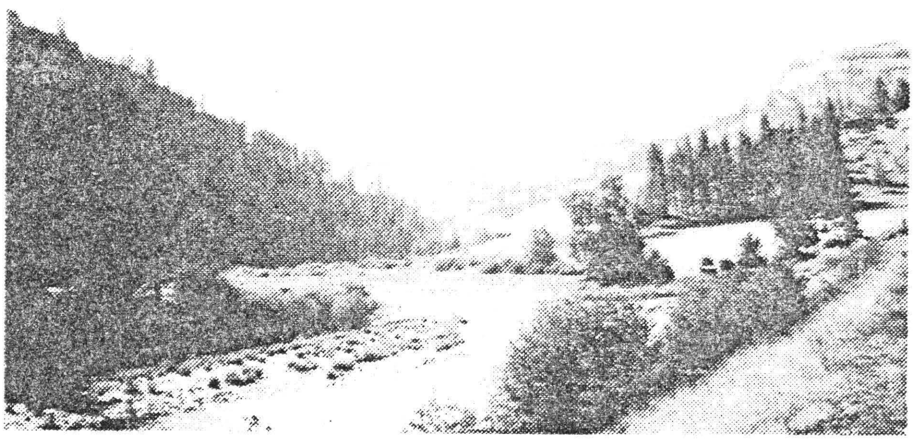

Figure 21.--Dale damsite

with the damsite downstream from the mouth of Camas Creek in sec. 33, T. 6 S., R. 31 E., near river mile 56. A dam to raise the water surface altitude from 2,700 to 2,960 feet, backing water 10 miles up the North Fork and 6 miles up Camas Creek, would store 188,000 acre-feet and would provide 260 feet of gross head. Estimated streamflow from the 990 square-mile drainage area averages 600 cfs annually. Using this gross head and estimated streamflow, 13.2 MW of power at 100 percent efficiency could be produced.

About 1,000 acres of public lands in T. 6 S., Rs. 31 and 32 E., would be affected by a reservoir at an altitude of 2,960 feet including bank protection up to 3,000 feet. A part of the damsite had been classified in Power Site Reserve 61 of July 2, 1910, but the action was partially revoked by Power Site Restoration 458 of January 29, 1931.

Sites in the headwaters of the Middle Fork have been studied by several agencies, but development for waterpower is unlikely. Nearly all of the basin upstream from the Galena vicinity is in Malheur National Forest. One or more of the sites might be constructed, however, to provide upstream regulation, conservation, or recreation.

Phipps Meadows (0435+62).--The Corps of Engineers studied an alternative economically feasible site located on the Middle Fork John Day River near Bates, Oregon. A 37-foot high earthfill dam in sec. 25, T. 11 S., R. 35 E., would impound 1,030 acre-feet with a surface area of 123 acres for recreation and fish purposes. The Fish and Wildlife Service in their studies of the site indicate that intensive management would be required to avoid proliferation of nongame species.

Middle Fork (0435+62).--The Middle Fork site was considered by the Soil Conservation Service. The dam would be in sec. 25, T. 11 S., R. 35 E., near mile 71, and would be 35 feet high and 650 feet long. The maximum pool at an altitude of 4,100 feet would contain 1,800 acre-feet of storage for irrigation, flood and erosion control, and recreation.

Bates (0435+63).--A site called Austin at one time and now called Bates in a more recent study by the Geological Survey has a capacity to store about 190,000 acre-feet of water between altitudes 4,040 and 4,200 feet. The dam would be in sec. 20, T. 11 S., R. 35 E., near river mile 66 where the 104 square-mile drainage area is estimated to produce an average of 50 cfs annually. With the 160 feet of gross head and average flow, an estimated 680 kw of power could be generated. The site studied by the Corps of Engineers considered a low power dam only 25 feet high and 150 feet long in sec. 22, T. 11 S., R. 35 E. A site in sec. 20 of the same township studied by the State Engineer is considered alternative to the previously mentioned sites. The low flows make power development infeasible. The lands are in the Malheur National Forest but there are no water resource site classifications and none are needed.

Hunt Gulch (0435+64).--Development of a site called Hunt Gulch near river mile 59 on the Middle Fork John Day River in sec. 4, T. 11 S., R. 34 E., would store 97,000 acre-feet and develop 240 feet of head between altitudes 4,040 and 3,800 feet. Drainage area is estimated as 156 square miles which would produce an annual average flow of about 70 cfs. Indicated power is 1.4 MW with gross head and average flow. There are no water resource site classifications and none are warranted because of insufficient water supply.

Sunshine (0435+65).--The Sunshine site at river mile 54 in sec. 26, T. 10 S., R. 33 E., might utilize a 73,000 acre-foot reservoir site between altitudes 3,800 and 3,610 feet (fig. 22). Drainage area at the damsite is 204 square miles and the estimated average annual flow is about 90 cfs. The 190 feet of head and this average flow would produce 1.4 MW at 100 percent efficiency. The same powerhouse site might be used to develop all of the 430 feet of head in the 12-mile reach from

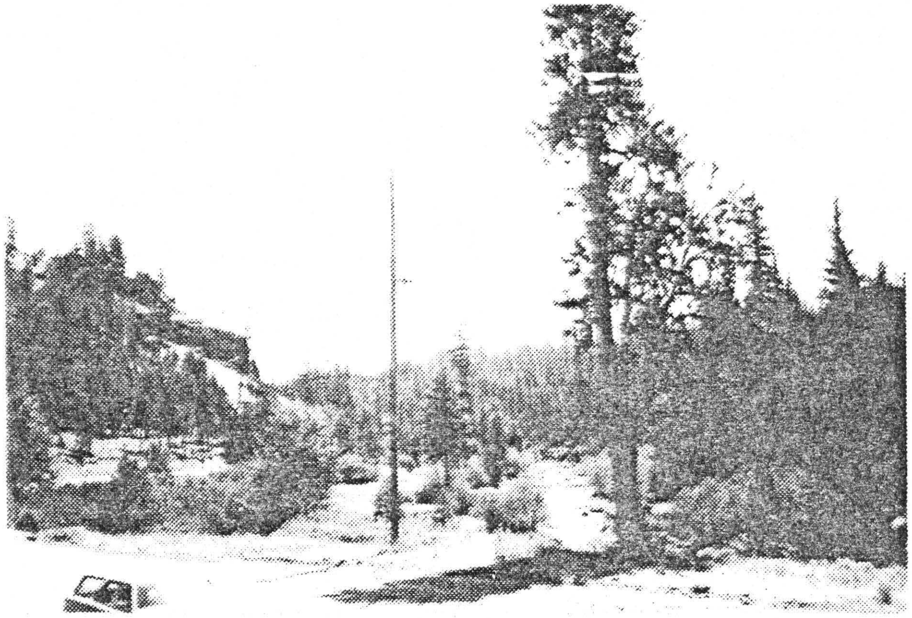

Figure 22.--Sunshine damsite

Bates if the 50 cfs at Bates and 5 cfs from Granite Boulder Creek basin were diverted between altitudes 4,040 and 3,610 feet to the Sunshine powerhouse to generate 2 MW of power. Under present circumstances these possibilities are economically infeasible. There are no water resource site classifications in the reach which is in the Malheur National Forest and none are needed.

Galena (0435+66).--The Galena site at river mile 45 on the Middle Fork John Day River could store 180,000 acre-feet of water between a streambed altitude of 3,390 feet and a maximum pool altitude of 3,610 feet with a dam in sec. 12, T. 10 S., R. 32 E. The drainage area is 312 square miles and the estimated average annual flow is 140 cfs. This gross head and flow would produce 2.6 MW at 100 percent efficiency. Power potential is minor but the site has value as a water resources development site for regulation of flow for a possible downstream power installation as well as providing a lake for recreation and conservation.

Big Creek (0435+67).--Big Creek site on Big Creek in sec. 19, T. 9 S., R. 33 E., as studied by the Soil Conservation Service would develop only 450 acre-feet of storage for irrigation and recreation. The dam would be 25 feet high and 480 feet long raising the pool to a maximum altitude of 5,500 feet. The site is within Malheur National Forest.

Indian Creek (0435+68).--The Indian Creek site near river mile 38 in sec. 20, T. 9 S., R. 32 E., has a storage capability of 52,000 acre-feet between altitudes 3,390 and 3,220 feet. Drainage area is estimated as 378 square miles and average annual flow as 170 cfs. The gross head and average flow could produce about 2.5 MW of power. The Indian Creek site was considered for power only by the Corps of Engineers. A dam only 35 feet high and 150 feet long was to be located in sec. 18, of the same township.

The lack of dependable streamflow makes development of the Galena, Big Creek, and Indian Creek sites infeasible for power development by present standards. Power Site Reserve 60 classified lands in several sections in this portion of the upper reaches of the Middle Fork John Day River, but most of the classification has been revoked because the lands have passed to patent. One parcel, the SW¼NE¼ sec. 18, T. 9 S., R. 32 E., in the Indian Creek damsite area considered by the Corps of Engineers remains classified. Because it is in a potential damsite it should be retained in classification to protect the water storage site.

Johnson (0435+69).--The Johnson site at river mile 31 in sec. 10, T. 9 S., R. 31 E., or an alternative in sec. 32, T. 8 S., R. 31 E., could be developed by a dam 220 feet high forming a reservoir with a capacity of 61,000 acre-feet between altitudes 3,220 and 3,000 feet (fig. 23). As studied by the Geological Survey, the 220 feet of gross

Figure 23.--Johnson damsite

head and estimated 200 cfs average flow from the 449 square-mile drainage area could produce 3.7 MW at 100 percent efficiency. The alternative dam as proposed by the Corps of Engineers would be 4 miles downstream in sec. 32. It would be 100 feet high and 450 feet long and was considered for power only. Land was classified along the river in the dam and reservoir area in Tps. 8 and 9 S., R. 31 E., by Power Site Reserve 60, but the reserve has been partially revoked by Restorations 74, 219, and 458. The outstanding classifications including those on land which has been restored subject to the provisions of Section 24 of the Federal Power Act should be retained in that status, but no new withdrawals are justified at this time.

Porter (0435+70).--The Porter site in secs. 24 and 25, T. 8 S., R. 30 E., was studied by the Corps of Engineers as a single purpose power dam (fig. 24). The dam was to be 90 feet high and 180 feet long and could be considered as an alternative to the proposed Sugar Loaf Mountain site discussed below.

Figure 24.--Porter damsite

Sugar Loaf Mountain (0435+75).--The Sugar Loaf Mountain site near river mile 20 in sec. 14, T. 8 S., R. 30 E., on the Middle Fork would have a storage capacity of 176,000 acre-feet and would develop a maximum 300 feet of head between altitudes 3,000 and 2,700 feet (fig. 25). The site has an estimated average annual flow of 220 cfs from a drainage area of 501 square miles and could produce 5.6 MW at 100 percent efficiency. Power Site Reserve 60 classified land in the vicinity of the Porter site in secs. 24 and 25, T. 8 S., R. 30 E., thereby protecting part of the Sugar Loaf Mountain reservoir site. The classification should be retained for protection of the water resource sites. The remaining land in the reservoir area is in private ownership.

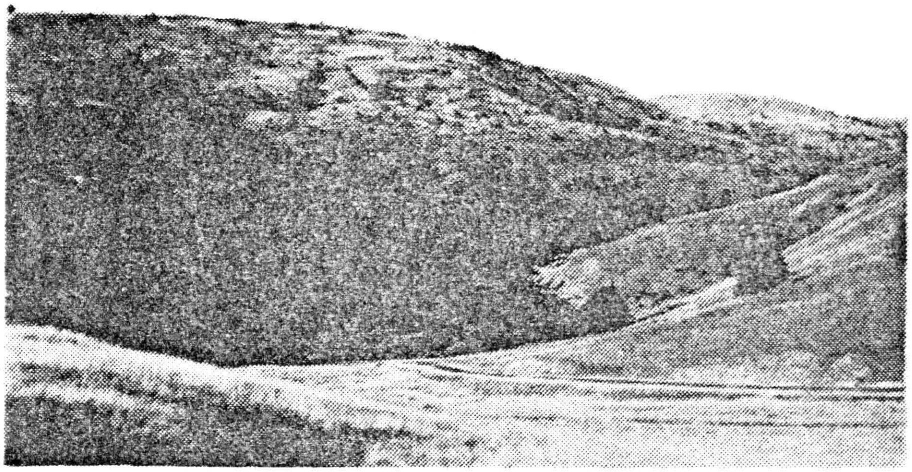

Figure 25.--Sugar Loaf Mountain damsite

The Corps of Engineers studied two sites on the Middle Fork that are included in the backwater of the undeveloped Twomile Canyon site located downstream from the junction of the North and Middle Forks. These are the Ritter site (0440+00) in sec. 8, T. 8 S., R. 30 E., and the Long Creek site (0440+10) in sec. 10, T. 8 S., R. 29 E. A dam 25 feet high and 150 feet long was considered at the Ritter site (fig. 26), and the Long Creek site would have a dam 60 feet high and 225 feet long.

Figure 26.--Ritter damsite

The Middle Fork enters the North Fork near river mile 32 in the backwater of the Twomile Canyon site. Figure 27 shows the North Fork valley in this vicinity about half a mile upstream from the confluence of the Middle Fork.

Figure 27.--North Fork valley

Twomile Canyon (0441+20).--Development of the Twomile Canyon site at river mile 30 in sec. 35, T. 7 S., R. 28 E. (fig. 28), on the North

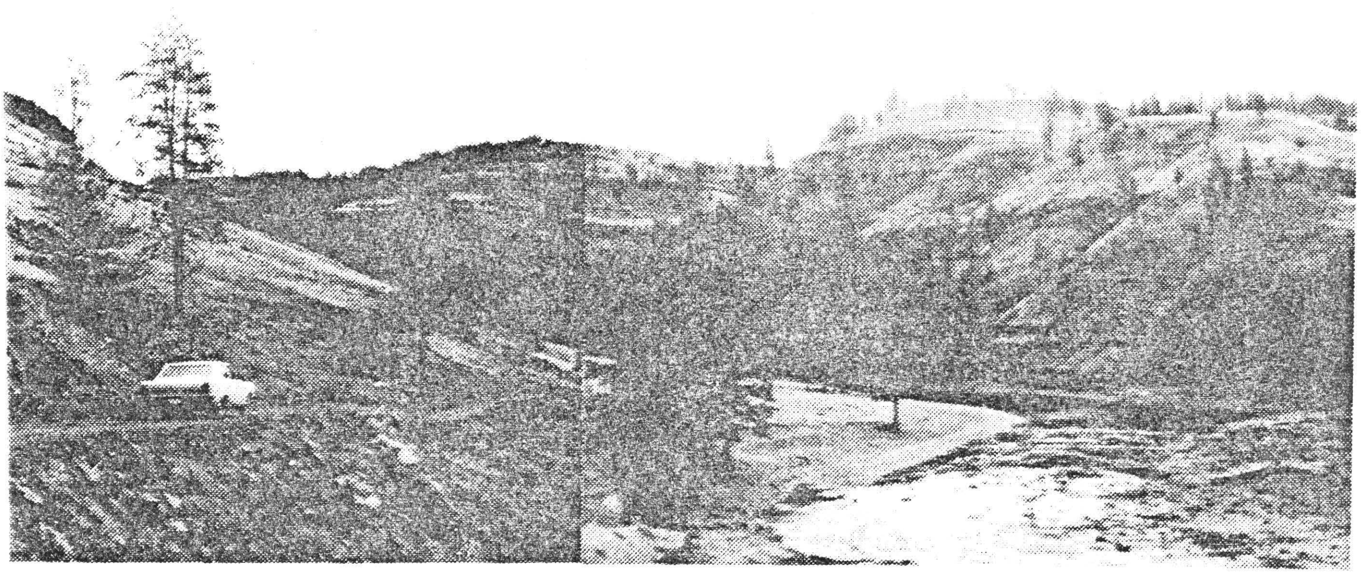

Figure 28.--Twomile Canyon damsite

Fork would develop an estimated maximum head of 580 feet between altitudes 2,700 and 2,120 feet storing 2,800,000 acre-feet and backing water up the North Fork to the Dale site and up the Middle Fork to the Sugar Loaf site. This gross head and estimated average annual flow of 700 cfs would produce 34.5 MW at 100 percent efficiency.

Either of the two most promising pumped-storage sites in the John Day River basin, Thompson Flat (0441+20P1) or Wickiup Spring (0441+20P2), could utilize the backwater of Twomile Canyon as a lower reservoir and develop nearly 1,700 feet of head (see table 6). Thompson Flat requires a slightly smaller embankment than Wickiup Spring, but a longer penstock. Both sites are entirely within Umatilla National Forest and are the only pumped storage upper reservoirs on public lands. There are about 1,200 acres and 640 acres of public lands that would be affected in Thompson Flat and Wickiup Spring sites, respectively.

One 40-acre tract located in the Ritter site in sec. 17, T. 8 S., R. 30 E., is classified in Power Site Reserve 60. Other lands classified in Power Site Reserve 60 in T. 8 S., R. 29 E., are in the Long Creek site. Lands classified in Power Site Reserve 61 in sec. 35, T. 7 S., R. 28 E., are in the Twomile Canyon damsite which would be flooded by the development of the Upper Monument site discussed below. Some of the classified lands have been restored subject to Section 24 of the Federal Power Act. They are all valuable for flowage or damsites and should remain in their present status.

In addition to the existing classifications there are about 3,900 acres of vacant public land in the Twomile Canyon site lying below an altitude of 2,720 feet, 20 feet above the maximum pool altitude. Some of this land might also be used for the downstream alternative Monument or Kimberly reservoir sites. The land is in T. 8 S., R. 28 E.; Tps. 7 and 8 S., R. 29 E.; Tps. 6 and 7 S., R. 30 E.; and T. 6 S., R. 31 E.

Monument (0460+00).--The Corps of Engineers (written communication, 1969) is making studies of two alternative sites on the North Fork in the vicinity of the community of Monument: the Upper Monument site (0441+50) in sec. 17, T. 8 S., R. 28 E.; and the Monument site (0460+00) in sec. 2, T. 9 S., R. 27 E. (fig. 29). Both sites have been considered for storage of 236,000 acre-feet with pools to altitudes of 2,263 and 2,140 feet, respectively. At the Upper site which is about half a mile downstream from Wall Creek, a dam to altitude 2,263 feet would be about 2,000 feet long and 235 feet high. It would back water through the Twomile Canyon dam site to a point in sec. 5, T. 8 S., R. 29 E., near river mile 4 on the Middle Fork and to a point near river mile 37 in sec. 7 or 18, T. 7 S., R. 29 E., on the North Fork.

An earlier plan by the Corps of Engineers (SWRB, 1962) anticipated a total storage of 177,000 acre-feet at a site in sec. 1, T. 9 S., R. 27 E., with a dam 160 feet high and 520 feet long to an altitude of

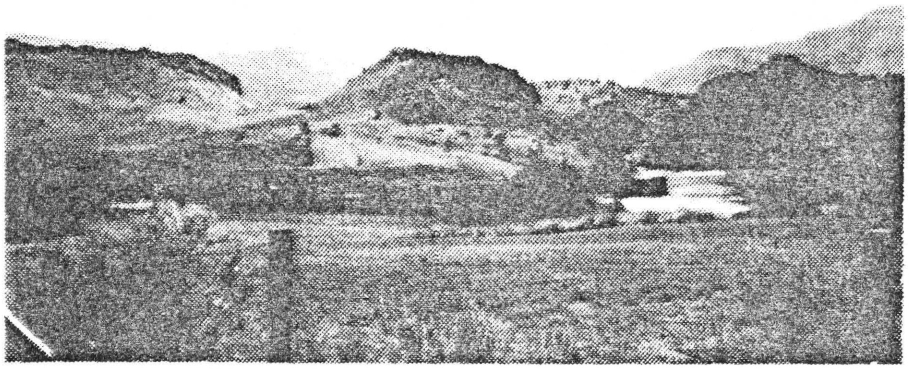

Figure 29.--Monument damsite looking upstream

2,120 feet. This would be just upstream from the community of Monument. Current Geological Survey studies also place the Monument site in sec. 2, T. 9 S., R. 27 E., in the narrow canyon section immediately downstream from the town of Monument near river mile 15. A dam here 170 feet high raising the water from 1,970 feet to an altitude of 2,140 feet would flood the town and require about 1,800 feet of dike 60 or 70 feet high across a saddle half a mile north of the damsite. A dam to this altitude would encroach only slightly on the Twomile Canyon site. Estimated potential power using a mean flow of 1,190 cfs from the 2,520 square-mile drainage area through 170 feet of head would be 17.2 MW at 100 percent efficiency. The reservoir would provide irrigation, flood control, and power storage.

A gaging station at the damsite, North Fork John Day at Monument, (14-0460), has a record of streamflow dating from 1926. For a period 1926-70 the average discharge was 1,194 cfs from 2,520 square miles of drainage area. The potential 236,000 acre-feet of storage afforded by the high dam studied by the Corps at the Monument site is sufficient to regulate the flow to a firm 490 cfs if the reservoir were allowed to empty completely. Storage in the top 20 feet would provide 56,000 acre-feet which is considered sufficient for regulation to a firm 230 cfs. An average head of 160 feet using a maximum of 20 feet of drawdown could produce an estimated potential firm power of 3.1 MW. The Corps of Engineers is continuing their studies but has determined by a preliminary analysis that the Monument site is economically infeasible.

Lands along the North Fork in Tps. 7, 8, and 9 S., R. 28 E., and in sec. 2 of T. 9 S., R. 27 E., are classified in Power Site Reserve 61 of July 2, 1910. Portions of the classification have been restored subject to the provisions of Section 24 of the Federal Power Act. The lands should remain in their present status to protect the Upper Monument and Monument dam and reservoir sites or the alternative reservoir for the Kimberly site in subbasin 3, which would back water into the Monument sites.

Cottonwood Creek is the most downstream tributary to the North Fork entering from the south near mile 16 just upstream from the Monument site. (The Monument site was discussed prior to the Cottonwood basin sites for convenience.) There are two sites in the Cottonwood basin which have been considered for cooling ponds: Wiley Creek and Fox Creek.

Wiley Creek (0441+70).--The Wiley Creek damsite in secs. 11 and 12, T. 11 S., R. 29 E., would store 97,000 acre-feet of water in a reservoir of 3,600 acres with a dam 60 feet high and 7,000 feet long at an altitude of 4,360 feet.

Fox Creek (0445+00).--The Fox Creek damsite in sec. 17, T. 11 S., R. 29 E., would store 31,500 acre-feet in a reservoir with a surface area of 1,560 acres with a 60-foot dam 500 feet long to an altitude of 4,280 feet.

These two sites lie on a high plateau area north of the John Day River about 15 miles from the community of Mt. Vernon. The water supply from natural flow is inadequate and pumping from the John Day River would be necessary. They offer a cooling potential for 750 to 1,800 MW thermal plants based on the rate of 2 acres of water surface per MW. There is no public land at either site.

The remainder of North Fork John Day River is in the backwater of the Kimberly damsite which is on the main stem of the John Day River. The site will be discussed in the section concerning subbasin 3.

(p. 73 follows)

Lower John Day subbasin

The 3,150 square-mile area in the John Day River basin downstream from the confluence of the North Fork at Kimberly to the mouth is considered as subbasin 3 (Lower John Day subbasin, figs. 30 and 30a). The river falls 1,555 feet from Kimberly to Lake Umatilla on the Columbia River through a distance of 175 miles, much of which is inaccessible in a deep rocky canyon. Six undeveloped sites which are topographically feasible would develop the entire head. The net total potential power is 302.5 MW at 100 percent efficiency using mean flow, and gross head. Two additional sites are discussed as alternatives. All sites which have been studied by various agencies are numbered and described in downstream order. The power potential of the classified lands is discussed and the need for retention, restoration, or classification of new lands is considered. Principal sites are listed in table 7 following the discussion of this subbasin.

Kimberly (0460+50).--The Kimberly site (fig. 31) is the first site in the lower subbasin. It is near mile 183 in sec. 25, T. 9 S., R. 25 E., about 1.5 miles downstream from the confluence of the North Fork John

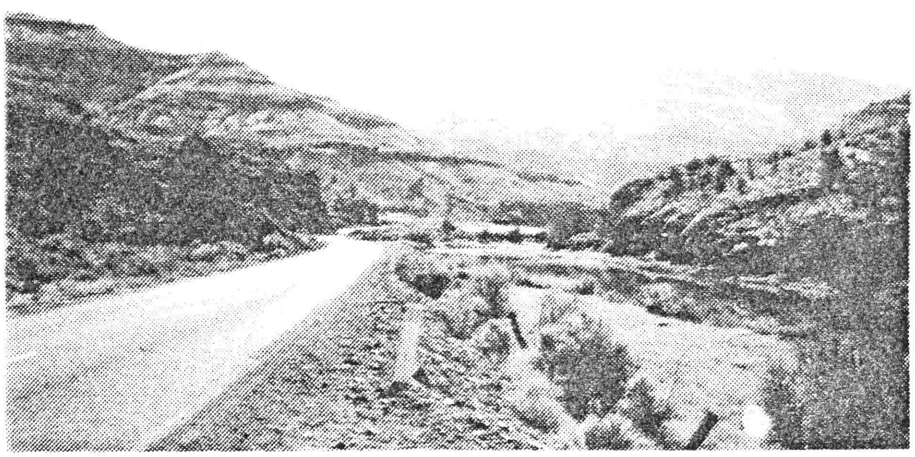

Figure 31.--Kimberly damsite

Day River. The drainage area is 4,765 square miles and water would back up the North Fork and the main stem of the John Day River. This site has been called the Spray site in some other investigations. A dam between altitudes 1,820 and 2,120 feet using the estimated mean flow of 1,740 cfs would produce 44.4 MW at 100 percent efficiency. The capacity of the Kimberly reservoir site is 1,620,000 acre-feet at an altitude of

2,120 feet which is sufficient to regulate the flow to 1,350 cfs. Regulation using the 500,000 acre-feet of storage capacity in the top 40 feet of the reservoir would provide a firm flow of 850 cfs. This would provide an average head of 280 feet and produce 20.2 MW at 100 percent efficiency. Limiting the height of the dam to an altitude of 1,980 feet would avoid flooding the town of Monument and would reduce the storage to 300,000 acre-feet regulating flow to a firm 680 cfs.

Power Site Reserve 61 classified a few parcels of land along the North Fork John Day River in T. 9 S., R. 26 E., between the damsite and the town of Monument and also upstream from Monument in Tps. 7, 8, and 9 S., R. 28 E. These lands would be used for the large Kimberly reservoir that would inundate the Monument sites. Lands in an alternative Kimberly damsite about three-fourths of a mile downstream in secs. 24 and 25, T. 9 S., R. 25 E., are classified in Power Site Reserve 24. Other lands in the potential reservoir area along the main stem in Tps. 9 and 10 S., R. 26 E., are classified in Power Site Reserve 65. These lands should be retained in classification for future water resource developments. About 2,235 acres of other public land in the Kimberly or Monument sites up to an altitude of 2,200 feet would be affected by alternative developments (see table 12).

As has been mentioned in the discussion of the other two subbasins the Kimberly site as described here encroaches upon or floods the Two-mile and the Monument sites on the North Fork, and extends up the main stem to the Humphrey Ranch site. The State Water Resources Board listed a dam only 112 feet high and 425 feet long at Kimberly site based on studies by the Corps of Engineers and a cooperative study between the Interior Department and the State of Oregon. These studies referred to the site as Spray.

The pool behind the Kimberly site could serve as the lower reservoir for the Board Creek pumped-storage site (0460+50P1) on Board Creek, just above the Upper Monument site (0441+50). Due to its location the Board Creek upper reservoir provides two alternative plans for pumped storage development (see table 6) by allowing filling from the backwaters of either the Upper Monument or Monument sites discussed previously in the North Fork subbasin. The Board Creek site is entirely on patented land. The Kimberly site would develop the head and flow to maximum advantage over either the Monument or Upper Monument sites, and it would also offer the best advantage for the Board Creek pumped-storage site.

Berry (0460+51).--The Berry site investigated by the Corps of Engineers included a power dam 50 feet high and 725 feet long on the John Day River in sec. 6, T. 9 S., R. 25 E., near river mile 174. This site would be flooded by Hoogie Doogie reservoir discussed below.

Kahler Creek sites (0460+52, 53, 54).--Three sites have been considered by the Soil Conservation Service in the tributary Kahler Creek basin which enters on the right bank near mile 171. The upper site (0460+52) in sec. 4, T. 8 S., R. 25 E., has been considered for irrigation and recreation. A dam 40 feet high and 280 feet long would store 153 acre-feet. A small site (0460+53) on Henry Creek within the Umatilla National Forest would have a dam 85 feet high and 520 feet long in sec. 20, T. 7 S., R. 25 E., and would store 582 acre-feet for irrigation purposes. The lower Kahler site in sec. 13, T. 8 S., R. 24 E., (0460+54) would have a dam 65 feet high, 400 feet long, and a maximum pool altitude of 2,150 feet. It would store 900 acre-feet for irrigation purposes. No lands have been classified for these sites and no classifications are needed.

Alder Creek (0460+55).--The Alder Creek site studied by the Corps of Engineers in sec. 6, T. 9 S., R. 24 E., would be developed for power generation by a dam 90 feet high and 260 feet long near mile 165 on the John Day River. This site as well as the Berry site will be flooded by development of the Hoogie Doogie reservoir.

Hoogie Doogie (0460+60).--The Hoogie Doogie site at mile 163, about a mile downstream from the Alder Creek site, is in sec. 12, T. 9 S., R. 23 E. (fig. 32). A dam raising the water from a streambed altitude of 1,700 to 1,820 feet would back water to the Kimberly site and would store 190,000 acre-feet. The average annual runoff from the 4,976 square miles of drainage area is estimated as 1,840 cfs. This average flow and 120 feet of gross head could produce an estimated 18.8 MW at 100 percent efficiency. The land in the Alder Creek damsite area is classified in Power Site Reserve 145 and the Hoogie Doogie damsite is

Figure 32.--Hoogie Doogie damsite

in Power Site Reserve 24. Retention of these reserved lands is recommended for future water resource development. An additional 1,130 acres of Federal land in T. 8 S., R. 25 E., and T. 9 S., Rs. 23, 24, and 25 E., would be affected by the dam and reservoir.

The Hoogie Doogie site would provide a lower reservoir for two potential pumped-storage sites; Spray (0460+60P1), a depression between two ridges about 2.5 miles northeast of the town of Spray, and Harper Creek site (0460+60P2) on Harper Creek, a right-bank tributary to the John Day River about one mile upstream from Hoogie Doogie damsite. Both sites are similar in embankment fill and penstock length requirements, total capacity available, and drawdown storage needed to generate 1,000 MW of peaking power. No public lands are available within the reservoir areas.

Horseshoe Creek (0460+65).--The Horseshoe Creek site is in secs. 23 and 24, T. 10 S., R. 23 E., in the headwaters of the left bank tributary Horseshoe Creek. This irrigation and recreation reservoir as studied by the Soil Conservation Service would have a dam 30 feet high, 750 feet long, and store 740 acre-feet. No lands are presently reserved and no classifications are needed for this small project.

Alder Creek (0460+70).--A right bank tributary, Alder Creek, has been considered for development by the Soil Conservation Service at a site in sec. 13, T. 8 S., R. 23 E. The site would be useful for irrigation and recreation with a dam 75 feet high and 330 feet long. No lands are classified and no classifications are needed for this small project.

Twickenham (0465+50).--The Twickenham site as planned by the Corps of Engineers would be on the John Day River in sec. 36, T. 9 S., R. 20 E., near river mile 137. This power site would have a dam 165 feet high and 550 feet long. The Geological Survey considered an alternative Twickenham site downstream from Bridge Creek which is discussed on the following page.

Bridge Creek sites (0465+60, 0466+55, 0466+56, and 0466+57).--Bridge Creek is a left bank tributary entering the John Day River near river mile 135. A small site located in sec. 24, T. 12 S., R. 21 E., on an unnamed tributary of Bridge Creek was considered for irrigation storage by the Soil Conservation Service. A 35-foot high dam 290 feet long could store 131 acre-feet of water. Further development of tributaries to Bridge Creek would include two sites on Bear Creek. Upper Bear Creek site is in sec. 4, T. 11 S., R. 20 E., where a dam 125 feet high and 530 feet long would store 7,180 acre-feet. The lower Bear Creek site in sec. 35, T. 10 S., R. 20 E., would require a dam 115 feet high and 900 feet long to store 6,570 acre-feet. These sites were considered for irrigation and recreation by the Soil Conservation Service.

A site on Bridge Creek considered as a cooling pond site offers a storage of 45,000 acre-feet. A dam raising water from a streambed altitude of 1,700 feet, the backwater of the potential Twickenham reservoir, to 1,880 feet in sec. 14, T. 10 S., R. 20 E., would back water 2.5 miles up Bridge Creek and the pool would have a surface area of 895 acres. The location would facilitate the filling of the cooling pond from the John Day River. A containment of thermal plant discharges in the pond with make-up by pumping or natural inflow of Bridge Creek would protect the main stem from heat. There are 160 acres of public domain land in the Bridge Creek site which would be within the reservoir area.

Twickenham (0466+58).--The Twickenham site as studied by the Geological Survey is at mile 132 on the main stem of the John Day River in sec. 32, T. 9 S., R. 20 E. (fig. 33). At this more downstream location, 260 feet of head could be developed between streambed altitude 1,440 to 1,700 feet by a dam which would store 871,000 acre-feet and back water to the Hoogie Doogie site. The estimated 1,900 second feet of average annual flow from a drainage area of about 5,600 square miles could produce 42 MW of power with 260 feet of head and 100 percent efficiency. Lands in the damsite vicinity have been classified in Power Site Reserves 24 and 145 and they should be retained for future water resource development. Lands in the reservoir site classified in Power Site Reserves 24, 145, and 566 and Power Site Classification 383

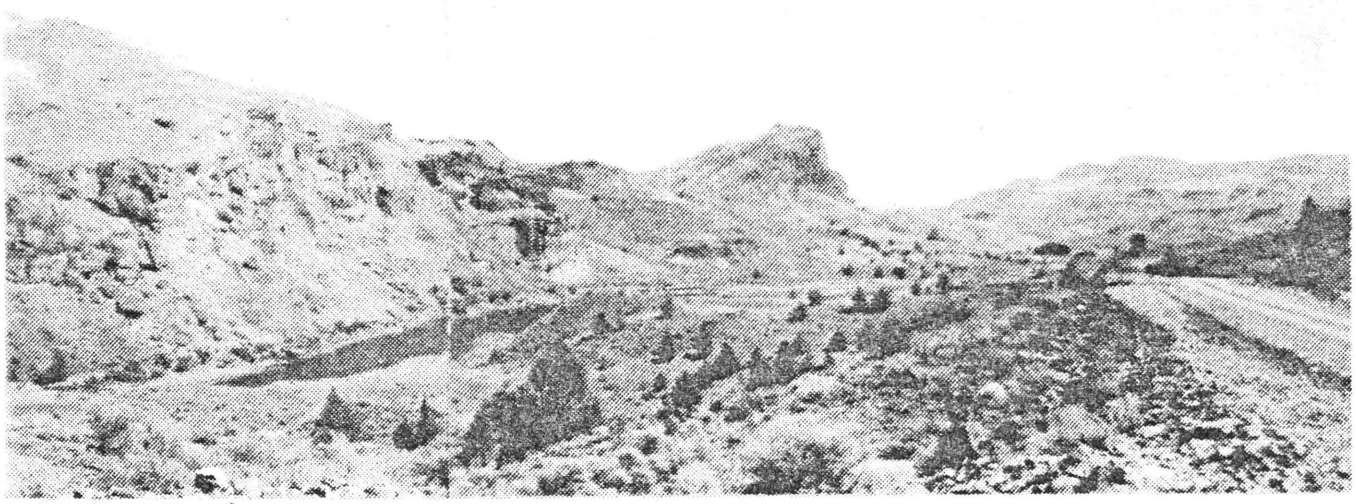

Figure 33.--Twickenham damsite

should be retained up to an altitude of 1,750 feet for future development. About 1,235 acres of public lands which lie below an altitude of 1,750 feet would be within the site. This reach of the river is within the State Scenic Waterways designation and as such, under Oregon laws, cannot be dammed.

Hicks (0466+59).--The Hicks power site near river mile 119 as studied by the Corps of Engineers would be located in sec. 26, T. 8 S., R. 19 E., and have a 225-foot high dam 640 feet long. It would be within the Butte Creek site discussed below.

Currant Creek (0466+60).--The Soil Conservation Service studied a small site on Currant Creek, a left bank tributary. The site located in sec. 35, T. 8 S., R. 18 E., would store 140 acre-feet with a dam 30 feet high and 430 feet long. It would be used for irrigation, and receive runoff from an estimated 30 square miles.

Sorefoot Creek (0470+10).--Another left bank tributary has been considered by the Soil Conservation Service for development at the Sorefoot Creek site in sec. 23, T. 7 S., R. 18 E.. A dam 35 feet high and 350 feet long could store 100 acre-feet for recreation purposes.

None of the above named tributary sites are protected by classifications and none are considered necessary as these are all small sites. Practically all of the lands involved are patented.

Clarno (0470+15).--The Clarno site as discussed by the Oregon State Water Board in cooperation with the Department of Interior is located on the main John Day River in sec. 18, T. 7 S., R. 19 E., at river mile 105. The irrigation reservoir would store a usable 115,000 acre-feet in a pool with a maximum altitude of 1,350 feet. Clarno is within the site discussed below as Butte Creek.

Butte Creek sites (0470+30, 40, 50, 60).--There are several smaller sites considered by the Soil Conservation Service in the Butte Creek basin, a right bank stream entering the John Day River a few miles upstream from the Butte Creek site. The most upstream site, Straw Fork, is in sec. 17, T. 7 S., R. 22 E., where a dam 30 feet high and 380 feet long could store 124 acre-feet for irrigation purposes. A site called Upper Butte Creek located in sec. 12, T. 7 S., R. 21 E., might store 1,450 acre-feet behind a dam 45 feet high and 860 feet long. The proposed use would be irrigation and flood control. The Kinzua 15-minute quadrangle map indicates that this site would be capable of developing 33,000 acre-feet of storage with a dam 180 feet high and 1,300 feet long. The Lower Butte Creek site in sec. 4, T. 7 S., R. 21 E., would store 332 acre-feet for irrigation and flood control behind a dam 50 feet high and 350 feet long. Development on Hoover Creek, another tributary of Butte Creek, by a dam 35 feet high and 530 feet long in sec. 15, T. 6 S., R. 21 E., would store 68 acre-feet for irrigation purposes.

There are no classified lands in the Butte Creek basin and lands in the Upper Butte Creek site were found to be patented.

Butte Creek (0470+70).--The Butte Creek site as studied by the Corps of Engineers is at river mile 93 on the John Day River practically on the township line between secs. 25 and 30, T. 5 S., Rs. 18 and 19 E. (fig. 34). It would store 1,490,000 acre-feet in a pool between the streambed altitude 1,100 feet and pool altitude, 1,440 feet, and back water to the Twickenham site thus flooding the Clarno and the Hicks sites. The average annual flow of 1,950 cfs and the 340 feet of gross

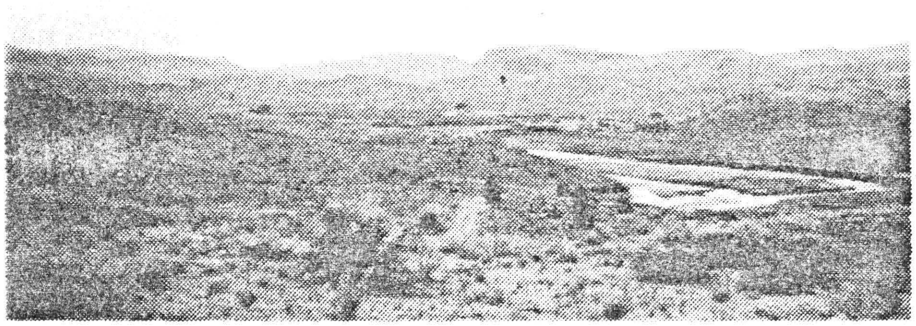

Figure 34.--Butte Creek reservoir site

head available could provide 56.3 MW at 100 percent efficiency. If all of the storage is used for regulation an estimated 1,440 cfs would be available for power. Using the top 40 feet of the reservoir down to an altitude of 1,400 feet would make 435,000 acre-feet available for regulation and provide a firm flow of 870 cfs.

As early as 1921 the Corps of Engineers investigated the site and conducted geologic drilling on the damsite. Capacities and altitudes are based on these early plans. Development would be at the backwater of the Mikkalo site discussed on page 81. The site was considered economically feasible by preliminary studies of the Corps of Engineers but planning was discontinued about midsummer of 1970 due to technical problems associated with anadromous fish migration, lack of regional support, and pending inclusion of that portion of the John Day River in the Oregon Scenic Rivers Act. The site was to be the most upstream of three sites used in a pumped-storage scheme utilizing Butte Creek, Mikkalo, and Emigrant sites. Water to fill the system initially would be pumped back up from the Columbia River (Lake Umatilla). Makeup and normal release water would come from natural flow with a recycling of the pumped water through the three power plants. Economic feasibility studies did not include the value of irrigation and recreation, costs connected with the effects on fish, and costs related to the loss of the flowing stream through the Scenic River area.

Lands in the Butte Creek damsite area are classified in Power Site Reserve 566. Lands in the reservoir area are classified in Power Site Reserves 24, 145, and 566, and in Power Site Classification 383. All of the land below an altitude of 1,500 feet will be retained in classification status for future water resource developments. Examination of the Clarno 15-minute quadrangle map indicates that about 700 acres of additional public land would be affected by the development of the potential reservoir site. Its location within a scenic waterway area precludes development under current Oregon laws.

Two areas in the vicinity of the Oregon State Water Board's Clarno site, discussed previously, could provide upper reservoir pumped-storage capacity using the Butte Creek pool as the lower reservoir. Sorefoot Creek pumped-storage site (0470+70P1) is on Sorefoot Creek in the same location as the recreation site (0470+10) mentioned on page 78. Big Lakes site (0470+70P2) would enclose a small bench containing several ponds draining into Big Dry Lake and Big Lake, about two to three miles north of Sorefoot Creek. Both pumped-storage sites would require lengthy embankments, and are on patented lands. Sorefoot Creek is probably the better of the two sites.

Thirtymile Creek (0473+10).--On Thirtymile Creek a small site for irrigation and recreation might be developed near river mile 9 in sec. 4, T. 5 S., R. 20 E., where the drainage area is 200 square miles. A 105-foot high dam 790 feet long would store 7,190 acre-feet for irrigation and recreation. The site would include about 120 acres of public domain lands which would be affected by the development of the reservoir.

Bull Basin (0473+20).--The Bull Basin diversion dam on the John Day River in sec. 27, T. 3 S., R. 18 E., would be 120 feet high and raise a pool to an altitude of 915 feet. Storage at the site would amount to 4,000 acre-feet as considered by the State of Oregon in cooperation with the Department of the Interior. The site would be within the backwater of the Jackknife site discussed below.

Jackknife (0473+40).--The Jackknife site as considered by the Geological Survey would be located at river mile 60 on the John Day River in sec. 11, T. 3 S., R. 18 E. A dam at a streambed altitude of 725 feet to a pool altitude of 1,100 feet would provide 999,000 acre-feet of storage and a gross head of 375 feet, inundating the Bull Basin site. Estimated mean annual streamflow from the 6,924 square miles of drainage area is 1,980 cfs. This streamflow and gross head could produce an estimated 63 MW of power at 100 percent efficiency. The Jackknife site has been used to estimate potential power for a portion of the reach of the river between the Tenmile and Butte Creek sites. A site considered usable for irrigation by the State of Oregon is located in sec. 15, T. 3 S., R. 18 E., which is within the potential Jackknife site backwater.

Lands throughout the reach between the Jackknife site and the Butte Creek site are presently classified in Power Site Reserves 24, 145 and 566. These lands will be retained in classification to protect the reservoir area and another 1,500 acres of public land would be affected by the reservoir. The status of this reach of the river as a scenic waterway precludes development under present Oregon laws.

Mikkalo (0473+55).--The Mikkalo site as studied by the Corps of Engineers is near river mile 29 on the John Day River in sec. 6, T. 1 S., R. 20 E. It is the largest site in the basin and as planned would have a rockfill dam 675 feet high and 4,900 feet long storing about 8,450,000 acre-feet in a pool with an altitude of 1,106 feet. Water surface altitude of the river at the site is about 460 feet. The capacity is about six times the annual runoff and is intended to provide a higher head for power as well as to provide a pumped-storage reservoir as a unit in the Corps plan described on page 79. Total installed power considered was 1,500 MW. The reservoir would cover 26,500 acres and would back water to the Butte Creek site nearly 64 miles upstream flooding the Jackknife site. The multiple purpose site appears to be economically feasible in preliminary analysis but has been dropped from active planning because it is within the scenic waterways reach.

There are lands in the damsite area classified by Power Site Reserves 24 and 145, and these lands should remain in their present status to protect their value for future water resource developments. Map coverage is not detailed enough to accurately identify lands which would be affected but approximately 11,000 acres of unclassified public lands would be involved in development of the Mikkalo reservoir site. The Mikkalo reservoir would be alternative to Jackknife reservoir mentioned above and would affect the same scenic waterways lands as those in the Jackknife site.

Cottonwood Canyon West pumped-storage site (0473+55P1) would use the Mikkalo pool as a lower reservoir. The low head available with a rather high dam makes it one of the less attractive pumped-storage sites in the basin.

Rock Creek (0475+00).--A site on Rock Creek in sec. 15, T. 1 N., R. 20 E., could store 51,000 acre-feet for cooling purposes with a 130-foot dam and would have a surface area of 1,000 acres at an altitude of 800 feet.

Alkali Canyon (0360+50).--A dry valley outside the John Day basin but adjacent to Rock Creek called Alkali Canyon offers a site in sec. 27, T. 2 N., R. 21 E. A dam here raising water 75 feet to an altitude of 800 feet would store 34,000 acre-feet in a reservoir with a surface area of 1,045 acres. This site and the Rock Creek site could be filled by pumping from the backwater of the potential Tenmile Falls site on the John Day. If the Tenmile Falls site discussed on the following page were built to an altitude of 725 feet as proposed by the Geological Survey it would encroach slightly on the Rock Creek site.

The Rock Creek site contains 80 acres of public land and the Alkali Canyon site 40 acres.

Rosebush Creek (0480+10).--One small site on a left bank tributary of Rosebush Creek is located in sec. 8, T. 3 S., R. 17 E. A dam 30 feet high 450 feet long would store 407 acre-feet for irrigation according to the Soil Conservation Service.

Emigrant (0480+81).--The Corps of Engineers studied the Emigrant site in sec. 13, T. 2 N., R. 18 E., to develop the head in the reach upstream from the backwater of the constructed John Day Dam to the vicinity of the potential Mikkalo site (altitudes 265 to 480 feet). If the Mikkalo site were built with the tailrace at 460 feet the pool altitude for Emigrant would be limited to 460 feet. Maximum storage at Emigrant was estimated as 223,000 acre-feet. The earth and rockfill dam, about 205 feet high, would provide head and serve as the most downstream unit of the pumped-storage plan previously mentioned on page 79. Total installed pump-generator capacity suggested was 412 MW. The plan has been dropped from current planning for the same reasons given in discussion of the Butte Creek site; fish passage problems, lack of local support and inclusion of the reach in the scenic waterway.

Tenmile Falls (0480+82).--A dam at Tenmile Falls at the backwater of Lake Umatilla in sec. 13, T. 2 N., R. 18 E., as studied by the Geological Survey would create a head of 460 feet between altitudes 265 and 725 feet and store 1,740,000 acre-feet. Total drainage area at the site is 7,807 square miles which produces an estimated 2,000 cfs of annual flow. The gross head and annual flow would produce an estimated 78 MW of power at 100 percent efficiency. The Tenmile Falls site as considered by the Soil Conservation Service would be located slightly upstream in sec. 18, T. 2 N., R. 19 E.

The Tenmile Falls site has been used to estimate power potential of this reach and includes the Emigrant site and a portion of the Mikkalo site (fig. 35). A 40-acre parcel in sec. 18 is classified in Power Site Reserve 566 which will be retained to protect the damsite. Other lands within the reservoir site in various classifications will also be retained up to an altitude of 750 feet. An additional 1,900 acres of public land would be affected by development of the reservoir site to an altitude of 750 feet, however. The Scenic Waterways Act precludes development.

Three pumped-storage sites, Cottonwood Canyon East (0480+82P1), Hay Creek (0480+82P2), and Grass Valley Canyon (0480+82P3) could use the backwater behind Tenmile Falls damsite as a lower reservoir.

Cottonwood Canyon East would enclose the southern end of Cottonwood Canyon. An average head of 1,240 feet would be available with a penstock about one mile long cutting through the western wall of the canyon.

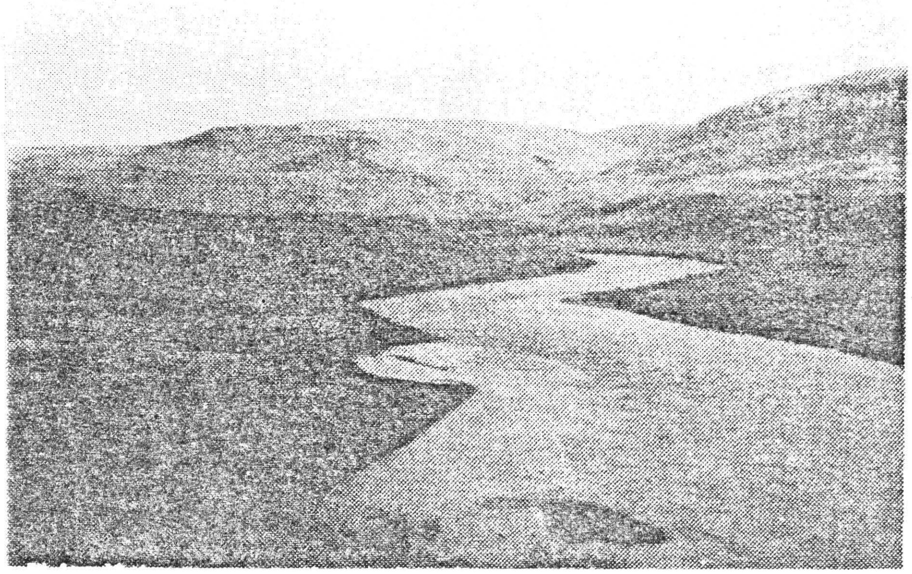

Figure 35.--View of Tenmile Falls reservoir site

Cottonwood Canyon East could operate in conjunction with the Mikkalo pool as an alternative if the storage capacity of the upper reservoir were increased (see table 6). The alternative plan would probably be more costly.

Both Hay Creek and Grass Valley Canyon pumped-storage sites require more embankment fill and considerably longer penstocks than Cottonwood Canyon East. They would use the Tenmile Falls reservoir for water supply. In addition, average head is only about 840 feet. Lands in all three upper reservoir areas are patented.

The John Day Dam on the Columbia River backs water about 10 miles up the John Day River to an altitude of 265 feet at the potential Tenmile Falls powersite. Lands in the vicinity of Lake Umatilla were reviewed during investigations for Power Site Cancellation 260 and Power Site Restoration 672 which were completed on November 13, 1970.

The Blalock Canyon pumped-storage site (0481+P1) is on a tributary to the Columbia River but is discussed here because of its proximity to the John Day River basin. Lake Umatilla would be used as the lower reservoir. Low head combined with a lengthy penstock requirement make the site less attractive than other sites studied in this area by the Corps of Engineers. Their report (1972, p. 32) mentions three other sites adjacent to the Lower subbasin also utilizing Lake Umatilla as the lower reservoir; Myers Canyon (0481+P2), Indian Rapids (0481+P3), and John Day Bluff (0481+P4). The last two sites are located on high bluffs adjacent to the Columbia River with little or no natural depressions. Myers Canyon is immediately downstream from and similar to the Blalock Canyon site, but requires a considerably smaller dam and shorter penstock. Lands within these four pumped-storage sites are patented.

Table 7.--Selected undeveloped reservoirs and powersites in John Day River basin.

Site and stream	Location: Mile	Location: Sec.	Location: T. (S.)	Location: R. (E.)	Drainage area (sq mi)	Reservoir storage (ac-ft)	Altitudes (ft-msl): Pool	Altitudes (ft-msl): Tail	Gross head (ft)	Computed existing discharge (cfs): Q95	Computed existing discharge (cfs): Q50	Computed existing discharge (cfs): Qm	Gross theoretical power, with gross head, 100 percent efficiency and flows at: MW Q95	MW Q50	MW Mean
UPPER JOHN DAY SUBBASIN															
Hall Hill	259	17	13	33		40,000	3495	3379	-	-	-	-	-	-	-
Oliver Ranch	255	19-30	13	32	392	99,000	3300	3125	175	35	140	190	.50	2.09	2.8
Black Canyon	16	26	14	26	569	50,000	3100	2850	250	10	75	180	.21	1.60	3.8
Fourmile	6	24	13	26	569	--	2850	2500	350	10	75	180	.30	2.23	5.4
Picture Gorge (Dayville)	205	17	12	26	1,680	841,000	2500	2230	270	9	240	450	.21	5.50	10.3
Humphrey Ranch	200	30	11	26	1,991	20,000	2230	2120	110	10	275	520	.10	2.57	4.9
										Subbasin totals			1.32	13.99	27.2
NORTH FORK JOHN DAY SUBBASIN															
Camp Creek	69	6	7	33	249	--	3930	2960	970	10	50	175	.82	4.12	14.4
Dale	56	33	6	31	990	188,000	2960	2700	260	50	190	600	1.10	4.20	13.2
Johnson	31	10	9	31	449	61,000	3220	3000	220	30	120	200	.56	2.24	3.7
Sugarloaf Mountain	20.5	14	8	30	501	176,000	3000	2700	300	30	130	220	.76	3.32	5.6
Twomile Canyon	30	35	7	28	1,983	2,800,000	2700	2120	580	40	400	700	1.97	19.7	34.5
Monument*	15.5	2	9	27	2,520	236,000	2140	1970	170	70	365	1190	1.0	5.3	17.2
										Subbasin totals			6.21	38.88	88.6
LOWER JOHN DAY SUBBASIN															
Kimberly (Spray)	183.5	25	9	25	4,765	1,620,000	2120	1820	300	70	650	1740	1.8	16.6	44.4
Hoogie Doogie	163	12	9	23	4,976	190,000	1820	1700	120	70	700	1840	.7	7.1	18.8
Twickenham	132	32	9	20	5,600	871,000	1700	1440	260	80	750	1900	1.8	16.6	42.0
Butte Creek	93	25	5	18	6,396	1,260,000	1440	1100	340	100	800	1950	2.9	23.1	56.3
Jackknife	60	11	3	18	6,924	999,000	1100	725	375	100	900	1980	3.2	28.7	65.1
Mikkalo**	29	6	1	20		8,450,000	1106	460	646	-	-	-	-	-	-
Emigrant***	10	13	2N	18	7,807	223,000	480	265	215	-	-	-	-	-	-
Tenmile Falls	10	13	2N	18	7,807	1,742,000	725	265	460	110	940	2000	4.3	36.7	78.2
										Subbasin totals			14.70	128.80	302.80
										Total John Day Basin			21.23	176.57	401.40

* Power for this reach included in Kimberly; do not add Monument to total John Day Basin power potential
** Alternative to Jackknife
*** Alternative to Tenmile Falls

Classifications, withdrawals, and subsequent actions

The earliest classifications in the John Day River basin were the temporary power site classifications made by the Geological Survey in 1909. These were confirmed and continued by the Act of June 25, 1910. The first of these was Power Site Reserve 24 of June 26, 1909, which was confirmed and continued by Executive Order of July 2, 1910. Table 8 lists the Power Site Reserves, Power Site Classifications, and Federal Power Commission Projects which affect lands in the John Day River basin.

Geological Survey classifications include:

Classification	Authority
Power site classifications	Act of March 3, 1879 (20 Stat. 394)
Reservoir sites	Act of October 2, 1888 (25 Stat. 527)
Power site reserves	Act of June 25, 1910 (36 Stat. 487)
Reservoir site reserves	Act of June 25, 1910 (36 Stat. 487)
Waterpower designations	Act of June 20, 1910 (36 Stat. 557, 564, 575) Act of June 9, 1916 (39 Stat. 218) Act of Feb. 26, 1919 (40 Stat. 1178, 1180)

The Federal Power Commission withdraws land for projects automatically as of the date of filing of application, under Section 24 of the Federal Power Act of June 10, 1920 (41 Stat. 1075; 16 U.S.C. 818), as amended. The first project withdrawal in the John Day basin was made pursuant to the filing of application on January 19, 1923, for Federal Power Commission Project 378, a transmission line withdrawal. All project withdrawals in the John Day River basin have been reviewed along with Geological Survey classifications; those lands with negligible value for waterpower purposes are so listed. Vacation of project withdrawals is a function of the Federal Power Commission.

Section 24 of the Federal Power Act further provides that power site lands may be used for other purposes if the Federal Power Commission determines that the proposed use will not injure or destroy the power value. If a "no-injury" determination results, the lands may be used subject to such stipulations as the Federal Power Commission may deem necessary to protect the power value. Applications for use of withdrawn lands in the John Day River basin began in 1921. There have been many since that time, and only one has been denied because of injury to power value (DA-7, June 6, 1921). Table 9 lists the Determination Actions (DA).

Early Geological Survey classifications often included land without power value because of insufficient information on availability of water and a lack of suitable topographic maps at the time of classification. The early classifications often included entered lands, the entered lands being exempt from the provisions of the classification if a patent was obtained later. As better maps and more complete water supply records became available and when patents were issued to entered lands, parcels having negligible power value and patented lands were often removed from classification. This was done by a restoration order which revoked a reserve and a cancellation order which revoked a classification. Modifications designate actions permitting noninjurious, nonpower uses. Interpretations conform classifications to new plats of survey. Vacations are made by the Federal Power Commission to revoke Federal Power Project withdrawals. Classifications, withdrawals, and subsequent orders of restoration, cancellation, modification, interpretation, and vacation, are listed in table 8 by action, number, date, and acreage.

Table 8.--USGS classifications, withdrawals, and subsequent actions in John Day River basin.

Action	Date	Original classification (acres)	Subsequent actions			Gross area[1/] outstanding (acres)
			Action	Date	Acres	
TPSR 24	6/26/09	14,402	Rest. 10	5/19/10	- 760	
PSR 24	7/2/10	14,402	Rest. 167	10/2/14	- 680	
			Rest. 187	7/19/15	- 840	
			Rest. 439	6/20/30	- 1,273	
			Rest. 458	1/27/31	- 640	
			Audit	12/16/40	+ 430	
			Rest. 619	1/22/65	- 40	
			Audit	10/10/69	- 443	
			Rest. 672	11/13/70	- 200	9,956
TPSR 60	11/16/09	6,441	Rest. 74	7/10/12	- 40	
PSR 60	7/2/10	6,441	Rest. 219	8/2/16	- 40	
			Rest. 458	1/27/31	- 4,786	1,575
TPSR 61	11/16/09	9,031	Rest. 458	1/27/31	- 5,496	
PSR 61	7/2/10	9,031	Audit	2/8/40	- 240	
			Audit	3/21/69	+ 280	3,575
TPSR 64	11/16/09	7,930	Rest. 458	1/27/31	- 7,449	
PSR 64	7/2/10	7,930	Audit	1/27/59	- 41	440
TPSR 65	11/17/09	2,403	Mod. 109	7/28/14	0	
PSR 65	7/2/10	2,403	Rest. 458	1/27/31	- 1,320	
			Rest. 588	7/31/63	- 200	
			Audit	3/21/69	+ 3	886
TPSR 145	5/19/10	3,440	Rest. 458	1/27/31	- 200	
PSR 145	7/2/10	3,440	Rest. 460	2/25/31	- 40	
			Rest. 619	1/22/65	- 10	
			Audit	4/4/69	- 3	
			Rest. 672	11/13/70	- 350	2,837
PSR 566	11/24/16	14,291	Rest. 460	2/25/31	- 593	
			Rest. 619	1/22/65	- 109	
			Audit	4/4/69	- 16	
			Rest. 672	11/13/70	- 124	13,449
	Total outstanding Power Site Reserves					32,718

Table 8.--(continued).

Action	Date	Original classif-ication (acres)	Subsequent actions Action	Date	Acres	Gross area[1/] outstanding (acres)
PSC 383	8/15/47	5,888	-	-	-	5,888
	Total outstanding Power Site Classifications					5,888
Federal Power Commission withdrawals						
FPP 378	T/L 1/19/23	29	Vacation	10/15/69	- 29	0
FPP 683	12/12/25	729	Permit exp.	9/14/28		729
FPP 810	T/L 6/1/27	13	Amendment No. 1	12/6/40		13[2/](Gen'l. Deter. applies)
FPP 942	12/1/28	[3/]	Canc. of permit authorized	11/25/30		Est. 150[3/]
FPP 1987	1/14/48	0[4/]	Lic. surr.	4/18/68		0[4/]

Footnotes:

TPSR - Temporary Power Site Reserve, made permanent by the Executive Order of July 2, 1910.
PSR - Power Site Reserve
Rest. - Restoration
Mod. - Modification

1/ - Includes overlapping area (if any) in other classifications or withdrawals in John Day River basin.

2/ - Federal Power Commission General Determination of April 17, 1922 is applicable.

3/ - Covered same lands as in FPC Project 683 but was confined to area within project boundary shown on Exhibits H and I: no acreage given.

4/ - No Federal Power Commission withdrawal by the project filing. Project operated under U.S. Forest Service special use permit issued to Eastern Oregon Light and Power Company in 1911.

Table 9.--Federal Power Commission Determination Actions (DA) affecting classified lands in John Day River basin.

T.	R.	DA No.	Date issued	No Injury	Injury	Section 24 Rest. No.	Date	Classification No.
1N	19E	199	6/30/31	x		605	8/12/31	PSR 24
1N	19E	468	2/18/59	x		PLO 2492	9/13/61	PSR 566
1N	20E	266	4/24/34	x		857	10/8/35	PSR 24 & 566
1S	19E	201	6/30/31	x		615	9/15/31	PSR 145 & 566
1S	19E	381	5/24/50	*		Not restored		PSR 566
7S	19E	402	9/25/51	x		Not restored		PSC 383
8S	19E	530	11/1/67	x		Not restored		PSC 383
1S	20E	201	6/30/31	x		615	9/15/31	PSR 24
9S	21E	102	10/3/25	x		275	11/24/25	PSR 24
9S	21E	274	7/24/34	x		840	9/6/35	PSR 24
9S	22E	8	6/23/22	x		48	7/20/22	PSR 24
9S	22E	24	6/23/22	x		48	7/20/22	PSR 24
9S	22E	192	2/19/30	x		543	8/29/30	PSR 24
9S	22E	195	5/19/30	x		537	8/29/30	PSR 24
10S	22E	24	6/23/22	x		48	7/20/22	PSR 24
10S	22E	192	2/19/30	x		543	8/29/30	PSR 24
10S	22E	8	6/23/22	x		48	7/20/22	PSR 24
9S	23E	94	10/3/25	x		275	11/24/25	PSR 24
9S	23E	106	10/3/25	x		275	11/24/25	PSR 24
9S	23E	192	2/19/30	x		543	8/29/30	PSR 24
9S	23E	325	9/17/40	x		Not restored		PSR 24
9S	24E	21	1/24/22	x		Not restored		PSR 145
9S	26E	17	8/16/23	x		157	10/2/23	PSR 61
9S	26E	101	5/14/26	x		303	6/3/26	PSR 61
9S	26E	114	5/14/26	x		313	9/11/26	PSR 61
9S	26E	330	7/1/41	x		Not restored		PSR 61
10S	26E	24	6/23/22	x		48	7/20/22	PSR 65
10S	26E	325	9/17/40	x		Not restored		PSR 65
12S	26E	502	4/30/63	x		Not restored		PSR 65
14S	26E	206	7/10/31	x		610	11/16/31	PSR 64
9S	27E	7	6/6/21		x	(Rest. 9 revoked	8/16/30)	PSR 61
8S	28E	53	2/5/23	x		99	2/27/23	PSR 61
8S	28E	153	3/26/28	x		404	5/2/28	PSR 61
8S	29E	145	1/18/28	x		399	2/25/28	PSR 60
8S	29E	172	6/14/29	x		487	7/31/29	PSR 60
8S	29E	177	6/14/29	x		487	7/31/29	PSR 60
8S	30E	91	10/3/25	x		275	11/24/25	PSR 60
8S	30E	432	6/23/54	x		Not restored		PSR 60
8S	31E	91	10/3/25	x		275	11/24/25	PSR 60
8S	31E	118	8/19/26	x		315	10/18/26	PSR 60
9S	31E	118	8/19/26	x		315	10/18/26	PSR 60

* With stipulations
PLO - Public Land Order
Rest. - Restoration

PSR - Power Site Reserve
PSC - Power Site Classification

(p. 91 follows)

SUMMARY

The sites which have value for potential development of the water resources of the John Day River basin should be protected from alienation. The existing classifications protect several sites, but with the use of present day maps and streamflow data it has been determined that some of the protected sites do not have power value. According to the results of this study 2,346 acres are judged to have a negligible value for water resource development or are patented and the classifications will be removed insofar as they affect this land. Those lands which have little or no value for water resource development sites are outside potential flow lines, are along minor tributaries where development might be by conduit, or are along streams having low streamflow as a result of diversions or low yield drainages. The lands which are valuable lie along major stream channels within potential dam, powerhouse, or reservoir sites. Of the 39,497 acres presently withdrawn, 37,152 acres are considered to have value for potential development and should be retained. Table 10 lists the acreages of classified and withdrawn lands and categorizes them as to whether or not they have value for water resource development. Table 11 lists the lands by subdivisions as "with power value" or "with negligible power value." The proposed revocation of Geological Survey classifications will in no way affect the withdrawals resulting from filings for preliminary permits or licenses under the Federal Power Act.

During the course of this review other areas within the John Day River basin were studied to seek potential sites which had water resources value but which were not heretofore classified. As a result of this study, it was determined that 29,566 acres of public land are within potential sites including freeboard and recreational access and are considered valuable for water resource developments. Included are potential power sites, reservoir sites investigated for their value as cooling ponds for thermal electric powerplants, and pumped-storage sites. Lands having these values are listed by site and subdivision in table 12. Future development of some of these sites may become necessary as demands for power or storage increase, and classification of these vacant lands may be required.

Table 10.--Audit of acreage review - John Day River basin.

Order No.	Gross area in the order	Lands with power value (acres)	Lands with negligible power value (acres)
PSR 24	9,955.61	9,235.61	720.00
PSR 60	1,575.66	1,575.66	---
PSR 61	3,575.01	3,415.01	160.00[1]
PSR 64	440.00	440.00	---
PSR 65	885.61	885.61	---
PSR 145	2,837.11	2,757.98	79.13[1]
PSR 566	13,448.82	13,448.82	---
PSC 383	5,887.53	5,379.85	507.68
FPP 683	729.13	---	729.13
FPP 810	13.0	13.0	---
FPP 942	150.0[2]	---	150.0[2]
FPP 1987	---[3]	---	---[3]
PSReserves	32,717.82	31,758.69	959.13
PSClassifications	5,887.53	5,379.85	507.68
FPProjects	892.13	13.0	879.13
Grand totals	39,497.48	37,151.54	2,345.94
Public lands affected by potential sites not presently classified or withdrawn -		29,565.76	

1/ Patented

2/ Estimated (overlaps acreage in FPC Project 683)

3/ No public lands withdrawn by the filing for Project No. 1987. Project operated under U.S. Forest Service special use permit issued to Eastern Oregon Light and Power Company in 1911 for 250.25 acres.

Table 11.--Disposition of classified and withdrawn lands - John Day River basin.

Power Site Reserve 24 - 7/2/10

Land with power value	Land with negligible power value
T. 1 N., R. 19 E. (116.20 acres) (Tenmile Falls) sec. 4, lots 1, 2, and SE¼NE¼.	
T. 1 N., R. 20 E. (187.90 acres) (Tenmile Falls) sec. 31, lots 1, 2, and E½NW¼.	
T. 3 S., R. 18 E. (1,401.43 acres) (Jackknife) sec. 2, lots 2, 3, 4, SW¼NE¼, SE¼NW¼, S½SW¼, and W½SE¼; sec. 11, W½NE¼, N½NW¼, SE¼NW¼, NE¼SW¼, S½SW¼, and W½SE¼; sec. 23, N½ and SW¼; sec. 24, NW¼NW¼; sec. 27, E½NE¼; sec. 35, SW¼SE¼.	
T. 4 S., R. 18 E. (1,522.31 acres) (Jackknife) sec. 2, lot 2, SW¼NE¼, and S½NW¼; sec. 3, lots 1, 2, S½NE¼, SE¼NW¼, E½SW¼, and W½SE¼; sec. 14, S½SW¼; sec. 15, E½E½; sec. 22, NE¼NE¼; sec. 23, NW¼NE¼, S½NE¼, NW¼, and SE¼; sec. 25, NE¼, N½NW¼, and SE¼NW¼.	
T. 4 S., R. 19 E. (200.00 acres) (Jackknife) sec. 29, SW¼NW¼ and SW¼.	
T. 5 S., R. 19 E. (840.00 acres) (Jackknife) sec. 9, SW¼ and SW¼SE¼; sec. 21, NW¼NW¼, S½NW¼, and SW¼; sec. 29, S½NE¼, S½NW¼, NW¼SW¼, and SE¼.	
T. 7 S., R. 19 E. (763.63 acres) (Butte Creek) sec. 5, lots 3, 4, S½NW¼, and S½SW¼; sec. 7, E½NE¼ and NE¼SE¼;	

Power Site Reserve 24 (continued)

Land with power value

T. 7 S., R. 19 E. (continued)
- sec. 8, SW¼NW¼ and W½SW¼;
- sec. 17, NW¼NW¼;
- sec. 18, W½SE¼ and SE¼SE¼;
- sec. 19, N½NE¼;
- sec. 20, NW¼NW¼.

T. 8 S., R. 19 E. (400.00 acres) (Butte Creek)
- sec. 3, NE¼SW¼;
- sec. 9, SE¼SW¼;
- sec. 21, N½NE¼;
- sec. 25, W½SW¼;
- sec. 26, N½SE¼ and SE¼SE¼;
- sec. 35, NE¼NE¼.

T. 9 S., R. 19 E. (120.00 acres) (Butte Creek)
- sec. 12, NE¼SE¼ and S½SE¼.

T. 1 S., R. 20 E. (197.95 acres) (Tenmile Falls)
- sec. 6, lot 3, SW¼NE¼, SE¼NW¼, and NW¼SE¼;
- sec. 7, lot 4.

T. 8 S., R. 20 E. (197.01 acres) (Butte Creek)
- sec. 31, lots 2, 3, E½SW¼, and SW¼SE¼.

T. 9 S., R. 20 E. (769.66 acres) (Butte Creek or Twickenham)
- sec. 6, lots 1, 2, 6, 7, S½NE¼, E½SW¼, and NW¼SE¼;
- sec. 30, lots 1, 2, and E½NW¼;
- sec. 32, S½NE¼, NW¼, and N½SE¼.

T. 9 S., R. 21 E. (560.00 acres) (Twickenham)
- sec. 28, SW¼SW¼;
- sec. 29, S½S½;
- sec. 30, SE¼SE¼;
- sec. 31, NE¼, E½NW¼, NE¼SW¼, and NW¼SE¼.

Land with negligible power value

T. 8 S., R. 19 E. (360.00 acres) (Patented)
- sec. 36, W½NE¼*, SE¼NE¼*, NW¼*, and N½SE¼*.

T. 8 S., R. 20 E. (40.00 acres) (Above Butte Creek flowline)
- sec. 31, SE¼NW¼.

T. 9 S., R. 20 E. (200.00 acres) (Above Butte Creek flowline or Patented)
- sec. 6, NE¼SE¼;
- sec. 36, S½S½*.

* Patented lands

Power Site Reserve 24 (continued)

<u>Land with power value</u>

T. 9 S., R. 22 E. (880.00 acres) (Twickenham)
sec. 13, NW¼SW¼;
sec. 14, NE¼SE¼ and S½SE¼;
sec. 22, SE¼NE¼, NE¼SW¼, N½SE¼, and SW¼SE¼;
sec. 23, W½NE¼ and SE¼NW¼;
sec. 27, NE¼NW¼;
sec. 28, SE¼NE¼, NE¼SW¼, S½SW¼, and NE¼SE¼;
sec. 32, SW¼NE¼, NE¼SW¼, and W½SE¼.

T. 10 S., R. 22 E. (119.80 acres) (Twickenham)
sec. 5, lot 4;
sec. 6, lot 3 and SE¼NW¼.

T. 9 S., R. 23 E. (760.00 acres) (Twickenham or Hoogie Doogie)
sec. 1, S½SE¼;
sec. 8, NE¼SE¼;
sec. 9, SW¼NE¼, S½NW¼, and N½SW¼;
sec. 10, S½NE¼ and SE¼NW¼;
sec. 11, N½NE¼ and SE¼NW¼;
sec. 12, NW¼NE¼ and N½NW¼;
sec. 18, E½SW¼.

T. 9 S., R. 24 E. (79.72 acres) (Hoogie Doogie)
sec. 6, lot 6 and SE¼SE¼.

T. 9 S., R. 25 E. (120.00 acres) (Kimberly
sec. 24, S½SW¼;
sec. 25, NW¼NW¼.

Total with power value - 9,235.61 acres

<u>Land with negligible power value</u>

T. 9 S., R. 22 E. (40.00 acres)
sec. 28, SW¼SE¼. (Above Twickenham flowline)

T. 9 S., R. 23 E. (80.00 acres) (Above Twickenham flowline)
sec. 11, NE¼NW¼;
sec. 17, NW¼NW¼.

Total with negligible power value - or patented 720.00 acres

Power Site Reserve 60 - 7/2/10

Land with power value

T. 8 S., R. 29 E. (720.00 acres) (Twomile Canyon)
sec. 10, N½SE¼ and SW¼SE¼;
sec. 11, N½;
sec. 12, NE¼, N½NW¼, and SW¼NW¼.

T. 8 S., R. 30 E. (280.00 acres) (Twomile Canyon or Sugar Loaf Mountain)
sec. 17, NE¼NW¼;
sec. 24, S½SW¼ and SW¼SE¼;
sec. 25, E½NE¼ and NE¼SE¼.

T. 8 S., R. 31 E. (255.94 acres) (Sugar Loaf Mountain)
sec. 30, lots 2, 3, and NE¼SW¼;
sec. 32, NE¼NW¼, NW¼SW¼, and S½SE¼.

T. 9 S., R. 31 E. (279.72 acres) (Sugar Loaf Mountain)
sec. 4, lot 4, SW¼NW¼, and N½SW¼;
sec. 5, lots 1, 2, and SE¼NE¼.

T. 9 S., R. 32 E. (40.00 acres) (Johnson)
sec. 18, SW¼NE¼.

Total with power value - 1,575.66 acres

Land with negligible power value

Power Site Reserve 61 - 7/2/10

Land with power value

T. 9 S., R. 26 E. (480.00 acres) (Kimberly)
sec. 14, NW¼NE¼, SE¼NE¼, and N½NW¼;
sec. 19, NE¼SE¼;
sec. 20, W½NE¼, NE¼NW¼, S½NW¼;
sec. 21, NW¼NW¼;
sec. 30, SE¼NW¼.

T. 9 S., R. 27 E. (160.00 acres) (Kimberly)
sec. 2, SE¼.

Land with negligible power value

T. 9 S., R. 26 E. (160.00 acres) (Patented)
sec. 17, S½SE¼*;
sec. 20, NE¼NE¼* and NW¼SW¼*.

* Patented lands

Power Site Reserve 61 (continued)

Land with power value | Land with negligible power value

T. 7 S., R. 28 E. (840.00 acres) (Kimberly or Twomile Canyon)
sec. 33, S½NE¼, E½SW¼, and N½SE¼;
sec. 34, S½N½, SW¼, and N½SE¼;
sec. 35, S½NE¼, SW¼NW¼, and N½SE¼.

T. 8 S., R. 28 E. (1,864.99 acres) (Kimberly)
sec. 4, lots 2, 3, SW¼NE¼, SE¼NW¼, SW¼, and W½SE¼;
sec. 5, SE¼SE¼;
sec. 7, SE¼SE¼;
sec. 8, N½NE¼, SW¼, N½SE¼, and SW¼SE¼;
sec. 9, N½NW¼;
sec. 17, SE¼NW¼ and SW¼;
sec. 18, NE¼NE¼;
sec. 19, SE¼;
sec. 20, NW¼, N½SW¼, and SW¼SW¼;
sec. 30, NE¼, N½SE¼, and SW¼SE¼.

T. 9 S., R. 28 E. (70.02 acres) (Kimberly)
sec. 6, lots 3 and 6.

Total with power value - 3,415.01 acres

Total patented lands - 160 acres

Power Site Reserve 64 - 7/2/10

T. 14 S., R. 26 E. (440.00 acres) (Black Canyon)
sec. 23, S½SE¼;
sec. 26, E½;
sec. 35, NE¼NE¼.

Total with power value - 440.00 acres

Power Site Reserve 65 - 7/2/10

Land with power value

T. 9 S., R. 26 E. (163.00 acres) (Kimberly)
sec. 31, lots 3, 4, and E½SW¼.

T. 10 S., R. 26 E. (562.61 acres) (Kimberly)
sec. 7, lots 1, 2, 3, 4, W½NE¼, and SW¼SE¼;
sec. 18, W½NE¼, E½W½, and NW¼SE¼.

T. 12 S., R. 26 E. (160.00 acres) (Picture Gorge)
sec. 20, SW¼NE¼, E½NW¼, and NE¼SW¼.

Total with power value - 885.61 acres

Land with negligible power value

Power Site Reserve 145 - 7/2/10

Land with power value

T. 2 S., R. 18 E. (200.00 acres) (Tenmile Falls)
sec. 13, SW¼SW¼;
sec. 24, SW¼NE¼, S½NW¼, and NW¼SW¼.

T. 3 S., R. 18 E. (440.00 acres) (Jackknife)
sec. 11, E½NE¼ and E½SE¼;
sec. 15, SE¼SE¼;
sec. 27, W½NE¼, SE¼NW¼, NE¼SW¼, and N½SE¼.

T. 4 S., R. 18 E. (80.00 acres) (Jackknife)
sec. 13, W½SW¼.

T. 1 S., R. 19 E. (240.00 acres) (Tenmile Falls)
sec. 10, S½NE¼, NE¼SW¼, and NW¼SE¼;
sec. 31, W½SE¼.

T. 5 S., R. 19 E. (120.00 acres) (Jackknife)
sec. 17, SE¼SE¼;
sec. 20, NE¼NE¼;
sec. 29, NE¼NW¼.

Land with negligible power value

T. 1 S., R. 19 E. (40.00 acres) (Patented)
sec. 11, SW¼NW¼*.

*Patented lands

Power Site Reserve 145 (continued)

<u>Land with power value</u> | <u>Land with negligible power value</u>

T. 6 S., R. 19 E. (560.00 acres) (Butte Creek)
sec. 7, NW¼NE¼ and SE¼NW¼;
sec. 8, SW¼SW¼;
sec. 17, NW¼NW¼ and SW¼SW¼;
sec. 18, SW¼NE¼ and NW¼SE¼;
sec. 19, E½NE¼ and SE¼SE¼;
sec. 20, W½NW¼;
sec. 29, SE¼NW¼ and NE¼SW¼.

T. 7 S., R. 19 E. (200.00 acres) (Butte Creek)
sec. 8, SE¼NW¼ and E½SW¼;
sec. 17, NE¼NW¼;
sec. 29, NW¼NW¼.

T. 8 S., R. 19 E. (40.00 acres) (Butte Creek)
sec. 22, SE¼SE¼.

T. 9 S., R. 19 E. (120.00 acres) (Butte Creek)
sec. 12, SW¼NE¼, SE¼NW¼, and NW¼SW¼.

T. 1 S., R. 20 E. (160.00 acres) (Tenmile Falls)
sec. 6, E½SE¼;
sec. 7, NW¼SE¼ and SE¼SW¼.

T. 9 S., R. 20 E. (200.00 acres) (Butte Creek or Twickenham)
sec. 30, W½NE¼ and S½SE¼;
sec. 32, NE¼SW¼.

T. 9 S., R. 22 E. (160.00 acres) (Twickenham)
sec. 23, NW¼SW¼ and NW¼SE¼;
sec. 28, E½NW¼.

Power Site Reserve 145 (continued)

Land with power value

T. 9 S., R. 24 E. (237.98 acres) (Hoogie Doogie)
sec. 6, lots 1, 3, 5, NE¼SW¼, and N½SE¼.

Total with power value - 2,757.98 acres

Land with negligible power value

T. 9 S., R. 24 E. (39.13 acres) (Patented)
sec. 6, lot 2*.

Total patented lands - 79.13 acres

Power Site Reserve 566 - 11/24/16

T. 1 N., R. 19 E. (320.00 acres) (Tenmile Falls)
sec. 2, SW¼NW¼ and NE¼SW¼;
sec. 14, S½NE¼ and SE¼.

T. 2 N., R. 19 E. (440.00 acres) (Tenmile Falls)
sec. 18, SW¼NE¼;
sec. 19, E½SW¼;
sec. 28, SW¼SW¼ and E½SE¼;
sec. 30, E½NE¼;
sec. 32, N½NE¼ and NE¼NW¼.

T. 1 N., R. 20 E. (307.55 acres) (Tenmile Falls)
sec. 30, lots 3, 4, E½SW¼, NW¼SE¼, and S½SE¼.

T. 2 S., R. 18 E. (2,796.81 acres) (Tenmile Falls)
sec. 1, lots 1, 2, SW¼NE¼, and NE¼SE¼;
sec. 11, SE¼;
sec. 12, W½NE¼, N½SW¼, SW¼SW¼, and SE¼SE¼;
sec. 13, NW¼, N½SW¼, and SE¼SW¼;
sec. 14, NE¼;
sec. 23, E½;
sec. 24, NW¼NE¼, NE¼NW¼, NE¼SW¼, S½SW¼, and W½SE¼;
sec. 25, N½NW¼ and SW¼NW¼;
sec. 26, E½ and E½W½;
sec. 34, E½SE¼;
sec. 35, NE¼, NE¼NW¼, S½NW¼, SW¼, and E½SE¼.

*Patented lands

Power Site Reserve 566 (continued)

Land with power value	Land with negligible power value

T. 3 S., R. 18 E. (2,080.29 acres) (Tenmile Falls or Jackknife)
sec. 2, lot 1, SE¼NE¼, and E½SE¼;
sec. 13, W½SW¼;
sec. 14, all;
sec. 22, NE¼, N½SE¼, and SE¼SE¼;
sec. 23, NW¼SE¼;
sec. 26, W½;
sec. 27, NE¼NW¼;
sec. 34, NE¼NE¼, S½NE¼, and SE¼.
sec. 35, N½NW¼, SW¼NW¼, N½SW¼, and NW¼SE¼.

T. 4 S., R. 18 E. (1,200.00 acres) (Jackknife)
sec. 3, E½SE¼;
sec. 10, NE¼, E½NW¼, N½SE¼, and SE¼SE¼;
sec. 13, SW¼NW¼;
sec. 14, N½NE¼, SE¼NE¼, NE¼NW¼, S½NW¼, NW¼SW¼, and S½SE¼;
sec. 23, N½SW¼ and SE¼SW¼;
sec. 24, SW¼ and SW¼SE¼;
sec. 25, SW¼NW¼.

T. 5 S., R. 18 E. (200.00 acres) (Butte Creek)
sec. 25, SE¼SW¼ and SE¼.

T. 1 S., R. 19 E. (2,684.80 acres) (Tenmile Falls)
sec. 10, SE¼NW¼, SE¼SW¼, and SW¼SE¼;
sec. 11, NE¼SW¼ and N½SE¼;
sec. 12, S½NW¼, NW¼SW¼, SE¼SW¼, and S½SE¼;
sec. 14, W½NE¼, NW¼, and NE¼SW¼;
sec. 15, NE¼NE¼, S½NE¼, E½NW¼, and SW¼SW¼;
sec. 17, N½NE¼, SE¼NW¼, NW¼SW¼, NE¼SE¼, and SW¼SE¼;
sec. 19, lots 4, 5, 6, 9, 10, 11, SE¼NE¼, and W½SE¼;
sec. 21, N½NE¼ and SE¼NE¼;
sec. 22, N½NE¼, NE¼NW¼, SW¼NW¼, NE¼SW¼, and N½SE¼;
sec. 30, lots 4, 5, 6, 8, 9, and 10;
sec. 31, lots 1, 3, 4, 9, and W½NE¼.

Power Site Reserve 566 (continued)

Land with power value	Land with negligible power value

T. 2 S., R. 19 E. (592.38 acres) (Tenmile Falls)
sec. 5, SW¼NW¼ and W½SW¼;
sec. 6, lots 1, 2, 4, 6, 7, SE¼NE¼, E½SW¼, and W½SE¼;
sec. 7, lots 2 and 3.

T. 4 S., R. 19 E. (1,184.61 acres) (Jackknife)
sec. 19, SW¼SE¼;
sec. 29, NW¼NW¼;
sec. 30, lots 1, 2, 3, NE¼, E½NW¼, and E½SE¼;
sec. 31, NE¼ and E½SE¼;
sec. 32, SW¼NE¼, W½, and E½SE¼.

T. 5 S., R. 19 E. (1,442.38 acres) (Jackknife or Butte Creek)
sec. 5, lots 1, 2, SW¼NE¼, and N½SW¼;
sec. 6, lot 1;
sec. 8, S½NE¼ and NW¼NW¼;
sec. 17, E½NE¼ and NE¼SE¼;
sec. 20, SE¼NE¼, S½SW¼, NE¼SE¼, and S½SE¼;
sec. 28, NW¼, N½SW¼, and SW¼SW¼;
sec. 29, N½NE¼ and NW¼NW¼;
sec. 30, lots 2, 3, 4, S½NE¼, SE¼NW¼, NE¼SW¼, and NW¼SE¼.

T. 6 S., R. 19 E. (120.00 acres) (Butte Creek)
sec. 6, SE¼NW¼;
sec. 7, NW¼SE¼;
sec. 30, NW¼NE¼.

T. 8 S., R. 19 E. (40.00 acres) (Butte Creek)
sec. 10, NE¼SW¼.

T. 9 S., R. 23 E. (40.00 acres) (Twickenham)
sec. 11, SW¼NW¼.

Total with power value - 13,448.82 acres

Land with power value

T. 6 S., R. 19 E. (440.00 acres) (Butte Creek)
sec. 17, SE¼SW¼;
sec. 20, W½NE¼, E½NW¼, NE¼SW¼, and NW¼SE¼;
sec. 31, W½NE¼ and W½SE¼.

T. 7 S., R. 19 E. (2,323.15 acres) (Butte Creek)
sec. 7, W½NE¼ and W½SE¼;
sec. 17, SW¼NW¼, S½SW¼, and SW¼SE¼;
sec. 18, W½NE¼;
sec. 19, lots 2, 3, SW¼NE¼, E½NW¼, NE¼SW¼, W½SE¼, and SE¼SE¼;
sec. 20, W½NE¼, SW¼SW¼, W½SE¼, and SE¼SE¼;
sec. 28, S½NE¼, W½NW¼, SE¼NW¼, N½SW¼, SE¼SW¼, and SE¼;
sec. 30, NE¼NE¼, S½NE¼, N½SE¼, and SE¼SE¼;
sec. 31, NE¼SW¼, N½SE¼, and SE¼SE¼;
sec. 32, NW¼;
sec. 33, N½NE¼ and SW¼NW¼;
sec. 34, N½S½.

T. 8 S., R. 19 E. (2,009.35 acres) (Butte Creek)
sec. 3, lot 3, SW¼NE¼, SE¼NW¼, and W½SE¼;
sec. 4, SE¼SW¼ and SE¼;
sec. 5, lots 3, 4, 5, SW¼NE¼, and SE¼NW¼;
sec. 9, lots 3, 4, NE¼NE¼, S½NE¼, and NE¼SW¼;
sec. 10, W½NE¼;
sec. 15, lot 1, E½SW¼;
sec. 20, NW¼NE¼;
sec. 21, lot 1, SE¼NE¼, NE¼NW¼, NE¼SE¼, and SW¼SE¼;
sec. 22, lots 3, 4, NE¼SW¼, and SW¼SE¼;
sec. 23, lot 2, NE¼SW¼, and NW¼SE¼;
sec. 24, SE¼NW¼ and SW¼;
sec. 25, NE¼NW¼, SW¼NW¼, and SE¼SW¼;
sec. 26, lot 1, W½NE¼, and NE¼NW¼;
sec. 27, lot 1.

Land with negligible power value

T. 7 S., R. 19 E. (120.00 acres) (Above Butte Creek flowline)
sec. 28, NW¼NE¼;
sec. 31, SE¼SW¼ and SW¼SE¼.

T. 8 S., R. 19 E. (189.25 acres) (Above Butte Creek flowline)
sec. 3, lot 2;
sec. 4, lot 7;
sec. 10, SE¼SW¼;
sec. 22, SE¼SW¼;
sec. 25, SW¼SE¼.

Power Site Classification 383 (continued)

Land with power value

T. 9 S., R. 19 E. (240.00 acres) (Butte Creek)
sec. 1, SE¼SE¼;
sec. 12, NE¼NE¼ and SW¼NW¼;

T. 8 S., R. 20 E. (157.24 acres) (Butte Creek)
sec. 31, SE¼NE¼;
sec. 32, lots 2, 4, and SE¼SW¼.

T. 9 S., R. 20 E. (210.11 acres) (Butte Creek or Twickenham)
sec. 5, SW¼NW¼;
sec. 6, lots 3, 5, and SE¼NW¼;
sec. 30, NW¼SE¼;
sec. 32, NW¼SW¼.

Total with power value - 5,379.85 acres

Land with negligible power value

T. 9 S., R. 19 E. (120.00 acres) (Above Butte Creek flowline)
sec. 1, SE¼NE¼ and NE¼SE¼;
sec. 12, SE¼NE¼.

T. 8 S., R. 20 E. (78.43 acres) (Above Butte Creek flowline)
sec. 31, lot 4 and SW¼NE¼.

Total with negligible power value - 507.68 acres

Federal Power Project 683 - 12/12/25

T. 14 S., R. 34 E. (729.13 acres)
sec. 19, SE¼SE¼;
sec. 20, N½SW¼, and SW¼SW¼;
sec. 29, NW¼NW¼;
sec. 30, N½NE¼, SW¼NE¼, SE¼NW¼, SE¼SW¼, and W½SE¼;
sec. 31, lots 2, 3, 4, NW¼NE¼, and E½NW¼.

Total with negligible power value - 729.13 acres
(Strawberry Lake)

Federal Power Project 810 - 6/1/27

Land with power value

All portions of the following described tracts lying within 50 feet of the center line of the transmission line location shown on a map designated "Exhibit JK" and entitled "Sherman Electric Co. 22 K.V. Transmission Lines in Sherman, Gilliam, and Morrow Counties, Oregon," and filed in the office of the Federal Power Commission on June 1, 1927:

T. 1 N., R. 20 E.,
  sec. 31, lot 4 and SE$\frac{1}{4}$SW$\frac{1}{4}$.

T. 1 S., R. 19 E.,
  sec. 1, lots 3 and 4.

T. 1 S., R. 20 E.,
  sec. 6, lots 2 and 3.

T. 1 S., R. 21 E.,
  sec. 35, NE$\frac{1}{4}$SE$\frac{1}{4}$.

Total with power value - 13 acres
(General Determination applies)

Federal Power Project 942 - 12/1/28

Land with negligible power value

An estimated 150 acres within project boundary as shown on Exhibit H & I accompanying the filing for the project. Project lands appear to lie in T. 14 S., R. 34 E. (est. 150 acres)
secs. 19, 20, 30, and 31.

Total with negligible power value -
Est. 150 acres

(Strawberry Lake)

Table 12.--Public lands affected by potential sites.

Picture Gorge site - 1,263.77 acres

T. 12 S., R. 26 E.,
sec. 21, S½;
sec. 26, N½SW¼, SE¼SW¼, NW¼SE¼, and S½SE¼;
sec. 30, lots 1, 2, E½NE¼, and NE¼NW¼;
sec. 33, NE¼, NE¼NW¼, and NE¼SE¼;
sec. 34, NE¼SW¼, S½NE¼SE¼, and NW¼SE¼;
sec. 35, W½SW¼.

T. 13 S., R. 27 E.,
sec. 12, NE¼SE¼;
sec. 18, lot 3.

Willow Creek Cooling Pond site - 120 acres

T. 11 S., R. 24 E.,
sec. 9, SE¼SW¼;
sec. 19, SE¼SE¼;
sec. 21, NE¼NW¼.

Frog Hollow Cooling Pond site - 120 acres

T. 11 S., R. 23 E.,
sec. 27, N½SW¼ and NW¼SE¼.

Nelson Meadows (Camas Creek) site - 1,117.60 acres

All within Umatilla National Forest

T. 4 S., R. 33 E.,
sec. 33, SE¼NE¼, NE¼SW¼, and S½S½;
sec. 34, SW¼NE¼ and W½SW¼;
sec. 35, SW¼NW¼, N½SW¼, and S½SE¼.

T. 5 S., R. 33 E.,
sec. 1, lot 2, SE¼NW¼, and NW¼SW¼;
sec. 2, SW¼NW¼, NW¼SW¼, and NE¼SE¼;
sec. 3, lots 3, 4, and S½N½;
sec. 4, lots 1 and 2.

Dale site - 1,002.50 acres

T. 6 S., R. 31 E.,
sec. 33, SW¼NW¼;
sec. 36, S½SW¼ and SE¼.

Table 12 (continued).

T. 6 S., R. 32 E.,
sec. 27, N½SW¼;
sec. 28, N½SE¼;
sec. 29, SE¼SW¼ and S½SE¼;
sec. 31, lot 3, NE¼NE¼, S½NE¼, SE¼NW¼, NE¼SW¼, and N½SE¼;
sec. 32, N½NW¼ and SW¼NW¼.

Twomile Canyon site - 3,972.42 acres

T. 8 S., R. 28 E.,
sec. 1, lots 1, 2, S½NE¼, and NW¼SE¼.

T. 7 S., R. 29 E.,
sec. 1, SE¼NE¼, NE¼SW¼, and SW¼SW¼;
sec. 2, S½SW¼ and NW¼SE¼;
sec. 3, SW¼;
sec. 5, S½SE¼;
sec. 6, S½SE¼;
sec. 7, lots 1, 2, 11, 14, 15, 22, 23, 24, N½NE¼, SE¼NE¼, and NE¼SE¼;
sec. 8, NW¼NW¼;
sec. 9, SW¼NW¼;
sec. 12, NW¼NW¼;
sec. 18, lots 2, 3, 6, 10, 11, 14, 15, 22, and 23;
sec. 19, lots 2, 3, 10, 11, 14, 15, 16, 22, and 23;
sec. 30, lots 2, 3, 9, 10, 15, 16, 21, and 22;
sec. 31, lots 6, 7, 15, and 21.

T. 8 S., R. 29 E.,
sec. 5, SW¼NW¼;
sec. 6, lots 5, 6, 8, 12, and 16;
sec. 7, lots 9, 16, 21, and 22;
sec. 9, SW¼NW¼.

T. 6 S., R. 30 E.,
sec. 35, NE¼NE¼, N½SW¼, SW¼SW¼, and SE¼SE¼;
sec. 36, N½SW¼.

T. 7 S., R. 30 E.,
sec. 2, lot 2 and SW¼NE¼;
sec. 3, lots 1, 2, 3, S½NW¼, and NW¼SW¼;
sec. 4, N½SW¼;
sec. 5, lot 2 and NE¼SE¼.

T. 6 S., R. 31 E.,
sec. 29, SE¼SW¼;
sec. 30, lot 4;
sec. 31, lot 1 and NE¼NE¼;
sec. 32, NE¼NE¼.

Table 12 (continued).

Thompson Flat pumped-storage reservoir site - 1,200 acres

T. 6 S., R. 29 E.,
sec. 14, SE¼SW¼ and SW¼SE¼;
sec. 22, SE¼NE¼, SE¼SW¼, and SE¼;
sec. 23, W½NE¼, E½NW¼, SW¼NW¼, NE¼SW¼, and W½SW¼;
sec. 26, W½NW¼, SE¼NW¼, and W½SW¼;
sec. 27, NE¼, E½NW¼, E½SE¼, and NW¼SE¼.

Wickiup Spring pumped-storage reservoir site - 640 acres

T. 6 S., R. 29 E.,
sec. 18, lots 10, 11, 14, 15, 16, NW¼SE¼, SW¼SE¼, and SE¼SE¼;
sec. 19, lots 1, 2, 3, 6, 7, N½NE¼, and SW¼NE¼.

Kimberly - Monument site - 2,234.44 acres

T. 10 S., R. 25 E.,
sec. 1, E½SE¼;
sec. 12, E½NE¼ and NE¼SE¼;
sec. 24, NE¼NE¼ and NE¼SE¼;
sec. 25, W½E½.

T. 9 S., R. 26 E.,
sec. 9, SE¼SE¼;
sec. 10, SE¼SW¼;
sec. 14, NW¼SW¼ and NE¼SE¼;
sec. 15, NE¼NE¼;
sec. 17, S½NE¼, E½SW¼, and N½SE¼;
sec. 18, SE¼SE¼;
sec. 19, NE¼NE¼, S½NE¼, and W½SE¼;
sec. 20, SE¼NE¼ and NW¼NW¼;
sec. 21, SW¼NW¼;
sec. 22, SW¼NE¼ and W½SE¼.

T. 10 S., R. 26 E.,
sec. 6, lots 4, 5, 6, and 7;
sec. 19, SE¼SW¼ and SW¼SE¼;
sec. 30, lot 1, W½NE¼, and E½W½;
sec. 31, NE¼NW¼.

T. 9 S., R. 27 E.,
sec. 3, lots 2, 3, and NW¼SE¼;
sec. 5, W½SW¼.

T. 8 S., R. 28 E.,
sec. 17, W½NE¼;
sec. 19, SE¼NE¼.

Table 12. (continued).

Hoogie Doogie site - 1,129.58 acres

T. 9 S., R. 23 E.,
sec. 1, lots 1, 2, S½NE¼, and N½SW¼;
sec. 12, NE¼NE¼.

T. 9 S., R. 24 E.,
sec. 5, SE¼SW¼.

T. 8 S., R. 25 E.,
sec. 31, lot 4 and SW¼SE¼.

T. 9 S., R. 25 E.,
sec. 3, SW¼SW¼;
sec. 4, SW¼SW¼ and SE¼SE¼;
sec. 6, lots 3, 4, 6, and SE¼SW¼;
sec. 8, NE¼SE¼;
sec. 9, N½NE¼, NE¼NW¼, and S½NW¼;
sec. 10, NW¼NW¼;
sec. 14, W½SW¼;
sec. 23, SW¼SE¼;
sec. 26, NE¼NE¼.

Upper Bear Creek site - 40 acres

T. 11 S., R. 20 E.,
sec. 4, SW¼SE¼.

Bridge Creek Cooling Pond site - 160 acres

T. 10 S., R. 20 E.,
sec. 24, E½NW¼ and W½SE¼.

Twickenham site - 1,234.83 acres

T. 9 S., R. 20 E.,
sec. 32, N½NE¼ and S½S½;
sec. 34, N½SW¼ and N½SE¼.

T. 10 S., R. 20 E.,
sec. 4, lot 4 and S½NE¼.

T. 9 S., R. 21 E.,
sec. 28, N½SW¼ and NW¼SE¼;
sec. 29, NW¼SW¼;
sec. 30, NE¼SE¼;
sec. 31, lot 1 and NE¼SE¼;
sec. 32, SW¼NW¼.

Table 12 (continued).

T. 9 S., R. 22 E.,
sec. 14, SE¼SW¼ and NW¼SE¼;
sec. 22, SW¼NE¼, SE¼NW¼, NW¼SW¼, and SE¼SE¼;
sec. 23, NE¼SW¼;
sec. 28, NW¼SW¼.

T. 10 S., R. 22 E.,
sec. 5, SW¼NW¼.

T. 9 S., R. 23 E.,
sec. 9, NW¼NE¼.

<u>Butte Creek site - 694.64 acres</u>

T. 5 S., R. 18 E.,
sec. 25, SE¼NE¼ and NE¼SW¼.

T. 5 S., R. 19 E.,
sec. 31, lots 1, 2, 3, and NE¼NW¼.

T. 6 S., R. 19 E.,
sec. 17, SW¼SE¼.

T. 7 S., R. 19 E.,
sec. 20, NE¼SE¼;
sec. 33, SE¼NE¼;
sec. 34, SE¼NE¼.

T. 8 S., R. 19 E.,
sec. 20, SW¼NE¼ and SE¼NW¼;
sec. 23, NE¼SE¼;
sec. 25, SE¼NW¼.

T. 9 S., R. 19 E.,
sec. 12, NW¼NE¼ and NE¼NW¼;
sec. 24, NW¼NW¼.

<u>Thirtymile Creek site - 120.85 acres</u>

T. 5 S., R. 20 E.,
sec. 3, lot 4 and SW¼SW¼;
sec. 4, lot 1.

Table 12 (continued).

Jackknife site - 1,478.88 acres

T. 3 S., R. 18 E.,
sec. 10, S½S½;
sec. 11, SW¼NW¼ and NW¼SW¼;
sec. 15, N½NW¼ and SW¼NW¼;
sec. 23, NE¼SE¼;
sec. 26, W½SE¼;
sec. 27, SE¼SE¼.

T. 4 S., R. 18 E.,
sec. 2, N½SW¼;
sec. 11, E½W½;
sec. 23, NE¼NE¼;
sec. 24, SW¼NW¼.

T. 4 S., R. 19 E.,
sec. 19, lot 4, and SE¼SW¼;
sec. 29, SE¼NW¼;
sec. 32, W½SE¼.

T. 5 S., R. 19 E.,
sec. 4, SW¼;
sec. 7, lot 2, E½NE¼, and SE¼NW¼;
sec. 8, NW¼SW¼;
sec. 9, NW¼SE¼ and SE¼SE¼.

Mikkalo site - 11,011.51 acres

T. 2 S., R. 18 E.,
sec. 1, lots 3, 4, S½NW¼, NW¼SW¼, and S½SE¼;
sec. 12, SE¼NW¼;
sec. 13, S½SE¼;
sec. 14, E½SW¼ and SE¼;
sec. 21, SE¼;
sec. 22, SW¼SW¼ and S½SE¼;
sec. 23, E½NW¼, NE¼SW¼, and S½SW¼;
sec. 24, NE¼NE¼ and SE¼SE¼;
sec. 25, NE¼NE¼;
sec. 26, W½W½;
sec. 27, N½NE¼, SE¼NE¼, and N½NW¼;
sec. 28, NE¼NE¼;
sec. 35, NW¼NW¼ and W½SE¼.

T. 1 S., R. 19 E.,
sec. 1, S½;
sec. 2, lots 10, 11, 12, and S½SE¼;
sec. 3, S½SE¼;
sec. 8, SE¼SW¼ and SW¼SE¼;
sec. 9, SE¼NE¼, SW¼SW¼, and E½SE¼;

Table 12 (continued).

T. 1 S., R. 19 E. (continued)
  sec. 10, lots 1, 2, 3, 4, $SW\frac{1}{4}NW\frac{1}{4}$, $W\frac{1}{2}SW\frac{1}{4}$, and $E\frac{1}{2}SE\frac{1}{4}$;
  sec. 11, lots 2, 3, 4, $W\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}SW\frac{1}{4}$, and $S\frac{1}{2}SE\frac{1}{4}$;
  sec. 12, lots 1, 2, 3, 4, and $SW\frac{1}{4}SW\frac{1}{4}$;
  sec. 13, $SE\frac{1}{4}NW\frac{1}{4}$;
  sec. 14, $E\frac{1}{2}NE\frac{1}{4}$ and $N\frac{1}{2}SE\frac{1}{4}$;
  sec. 15, $W\frac{1}{2}NW\frac{1}{4}$, $N\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}SW\frac{1}{4}$, $NW\frac{1}{4}SE\frac{1}{4}$, and $S\frac{1}{2}SE\frac{1}{4}$;
  sec. 17, $N\frac{1}{2}NW\frac{1}{4}$, $SW\frac{1}{4}NW\frac{1}{4}$, and $SE\frac{1}{4}SE\frac{1}{4}$;
  sec. 18, lots 1, 2, 3, 6, 12, $NE\frac{1}{4}$, $N\frac{1}{2}SE\frac{1}{4}$, and $SW\frac{1}{4}SE\frac{1}{4}$;
  sec. 19, lots 1, 2, 3, and $E\frac{1}{2}SE\frac{1}{4}$;
  sec. 20, $N\frac{1}{2}$, $N\frac{1}{2}SE\frac{1}{4}$, and $SW\frac{1}{4}SE\frac{1}{4}$;
  sec. 22, $W\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}SW\frac{1}{4}$, and $S\frac{1}{2}SE\frac{1}{4}$;
  sec. 23, $NE\frac{1}{4}$, $NE\frac{1}{4}SW\frac{1}{4}$, $S\frac{1}{2}SW\frac{1}{4}$, and $SE\frac{1}{4}$;
  sec. 24, $W\frac{1}{2}$;
  sec. 25, $W\frac{1}{2}NW\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, $SW\frac{1}{4}$, and $S\frac{1}{2}SE\frac{1}{4}$;
  sec. 26, $NE\frac{1}{4}NW\frac{1}{4}$;
  sec. 30, lots 2, 3, 12, $E\frac{1}{2}NE\frac{1}{4}$, $NE\frac{1}{4}SE\frac{1}{4}$, and $S\frac{1}{2}SE\frac{1}{4}$;
  sec. 31, $E\frac{1}{2}E\frac{1}{2}$;
  sec. 35, $SW\frac{1}{4}NE\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, $E\frac{1}{2}SW\frac{1}{4}$, and $W\frac{1}{2}SE\frac{1}{4}$.

T. 2 S., R. 19 E.,
  sec. 7, $S\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, and $NE\frac{1}{4}SE\frac{1}{4}$;
  sec. 8, $NE\frac{1}{4}SW\frac{1}{4}$;
  sec. 19, lots 1, 2, 3, 4, $SE\frac{1}{4}NW\frac{1}{4}$, $E\frac{1}{2}SW\frac{1}{4}$, and $SE\frac{1}{4}$;
  sec. 20, $SW\frac{1}{4}SW\frac{1}{4}$;
  sec. 29, $W\frac{1}{2}W\frac{1}{2}$ and $SE\frac{1}{4}SW\frac{1}{4}$;
  sec. 30, $NE\frac{1}{4}NE\frac{1}{4}$;
  sec. 32, $SW\frac{1}{4}NE\frac{1}{4}$, $NW\frac{1}{4}$, and $E\frac{1}{2}SW\frac{1}{4}$.

T. 1 S., R. 20 E.,
  sec. 5, $S\frac{1}{2}SW\frac{1}{4}$;
  sec. 7, lots 1, 2, $SE\frac{1}{4}NE\frac{1}{4}$, $NE\frac{1}{4}SW\frac{1}{4}$, $NE\frac{1}{4}SE\frac{1}{4}$, and $S\frac{1}{2}SE\frac{1}{4}$;
  sec. 8, $N\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}NE\frac{1}{4}$, $NE\frac{1}{4}NW\frac{1}{4}$, $SW\frac{1}{4}NW\frac{1}{4}$, $SW\frac{1}{4}$, and $S\frac{1}{2}SE\frac{1}{4}$;
  sec. 9, $N\frac{1}{2}NW\frac{1}{4}$, $SW\frac{1}{4}NW\frac{1}{4}$, $N\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}SW\frac{1}{4}$, $W\frac{1}{2}SE\frac{1}{4}$, and $SE\frac{1}{4}SE\frac{1}{4}$;
  sec. 15, $NW\frac{1}{4}NW\frac{1}{4}$;
  sec. 21, $NE\frac{1}{4}$ and $E\frac{1}{2}SE\frac{1}{4}$.

T. 2 S., R. 20 E.,
  sec. 3, lot 4, $SW\frac{1}{4}NW\frac{1}{4}$, and $W\frac{1}{2}SW\frac{1}{4}$;
  sec. 4, lots 1, 2, 3, 4, $S\frac{1}{2}NE\frac{1}{4}$, and $SE\frac{1}{4}$;
  sec. 9, $E\frac{1}{2}E\frac{1}{2}$;
  sec. 10, $W\frac{1}{2}W\frac{1}{2}$;
  sec. 15, $W\frac{1}{2}SW\frac{1}{4}$.

Table 12 (continued).

Rock Creek Cooling Pond site - 80 acres

T. 1 N., R. 20 E.,
  sec. 14, S½SW¼.

Alkali Canyon Cooling Pond site - 40 acres

T. 2 N., R. 21 E.,
  sec. 32, SE¼NE¼.

Tenmile Falls site - 1,904.74 acres

T. 1 N., R. 19 E.,
  sec. 2, lots 1, 2, 3, 4, SW¼NE¼, SE¼NW¼, N½SE¼, and SW¼SE¼;
  sec. 10, NE¼, NE¼NW¼, S½NW¼, SW¼, N½SE¼, and SW¼SE¼;
  sec. 14, SW¼SW¼;
  sec. 36, NE¼.

T. 2 N., R. 19 E.,
  sec. 18, NW¼NE¼;
  sec. 19, lots 1, 2, 3, and E½NW¼;
  sec. 28, NW¼NE¼, S½NE¼, and NW¼;
  sec. 30, NE¼NW¼.

T. 1 S., R. 19 E.,
  sec. 1, lot 2 and SW¼NE¼.

T. 1 N., R. 20 E.,
  sec. 30, lot 2.

T. 1 S., R. 20 E.,
  sec. 6, lot 2.

Total affected by potential sites - - - - - - - - - - - - - 29,565.76 acres

(p. 115 follows)

MAPS OF JOHN DAY BASIN

An Oregon State Water Resources Board planimetric map of the basin, File No. 6.70146, November 1960, is available from that agency and has been used to determine river miles. Planimetric maps of the Malheur, Ochoco, and Wallowa-Whitman National Forests include parts of the basin. These maps may be obtained from the U.S. Forest Service, Department of Agriculture. The Portland, LaGrande, and Boise sheet of the sectional aeronautical chart series, scale 1:500,000 and contour interval of 1,000 feet, show the basin. These charts are available from the National Ocean Survey, Department of Commerce.

Figure 35 shows the current index of topographic quadrangle maps prepared by the U.S. Geological Survey, at scales of 1:24,000 and 1:62,500. A major portion of the study area is covered by quadrangles. Bend, Burns, Canyon City, Pendleton, and The Dalles, Army Map Service 1° by 2° quadrangles, scale 1:250,000, contour interval 200 feet, show the entire basin. A base map of Oregon gives a generalized topographic picture of the basin at a scale of 1:500,000 and a contour interval of 500 feet. The Cascade Range, Mount Shasta, and Snake River sheets of the International Map of the World series, scale 1:1,000,000, contour interval 100 meters, includes the study area. All of the topographic maps mentioned above can be obtained from the U.S. Geological Survey, Map Distribution Section, Federal Center, Denver, Colorado, 80225.

Detailed maps of approximately the lower 30 miles of the John Day River have been completed and are available through the Portland District, Corps of Engineers.

(p. 119 follows)

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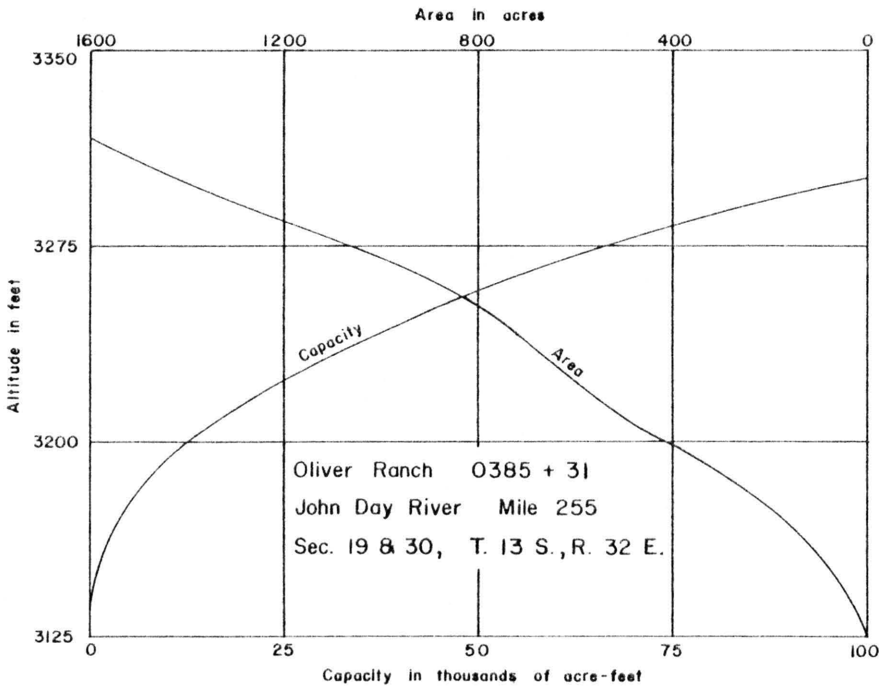
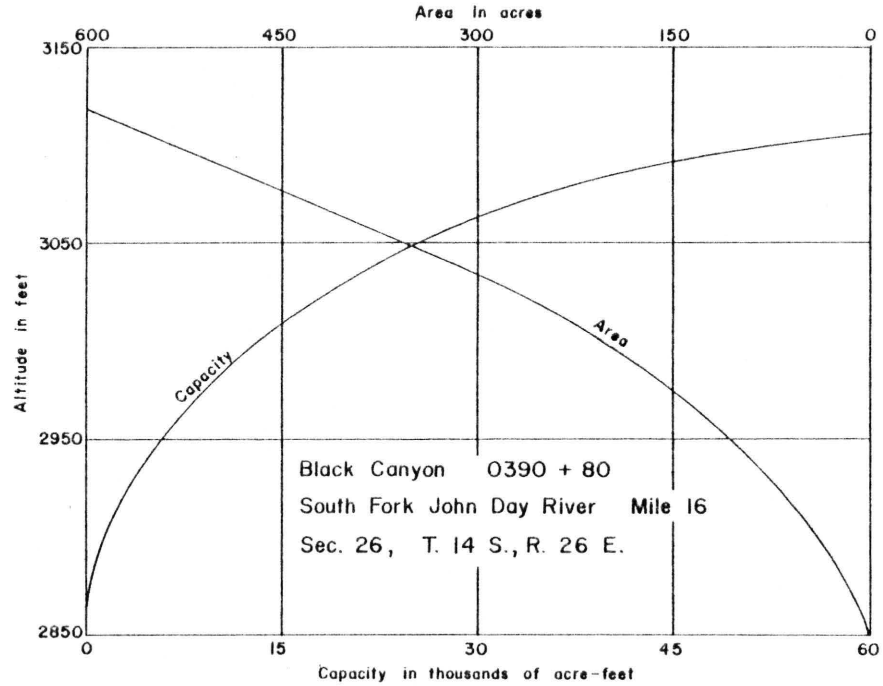
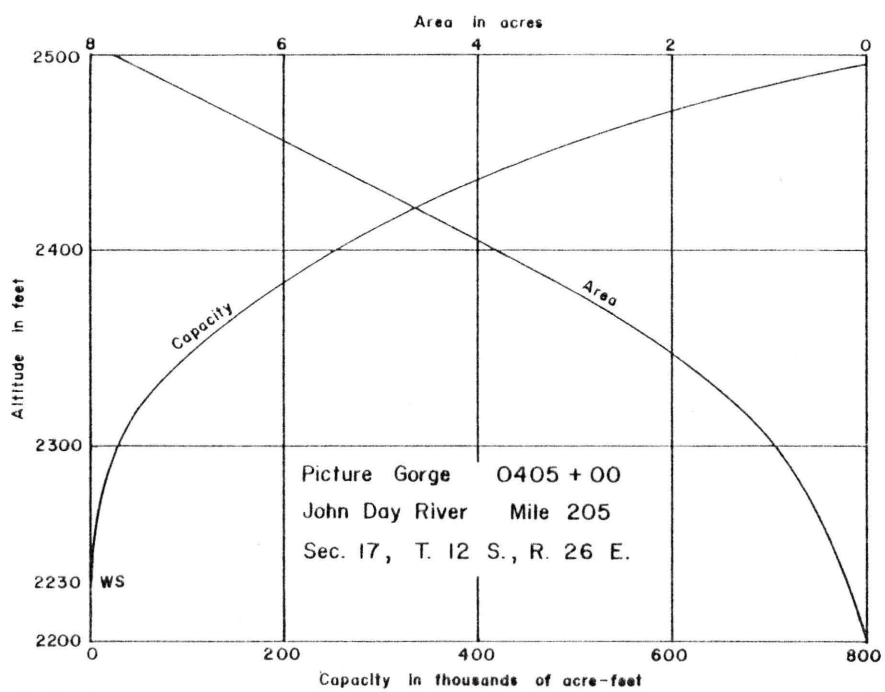
APPENDIX

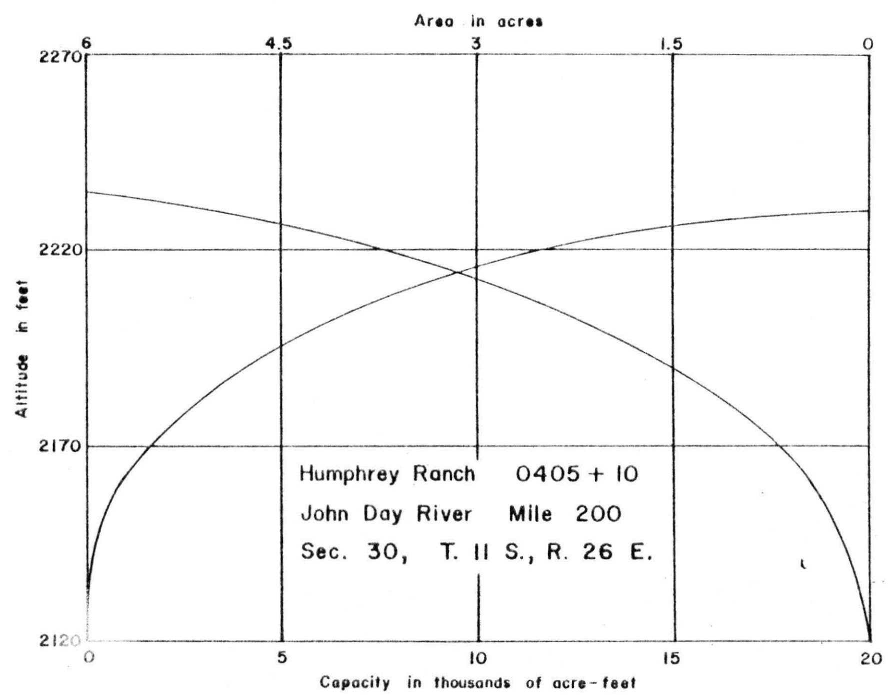
Area-capacity curves

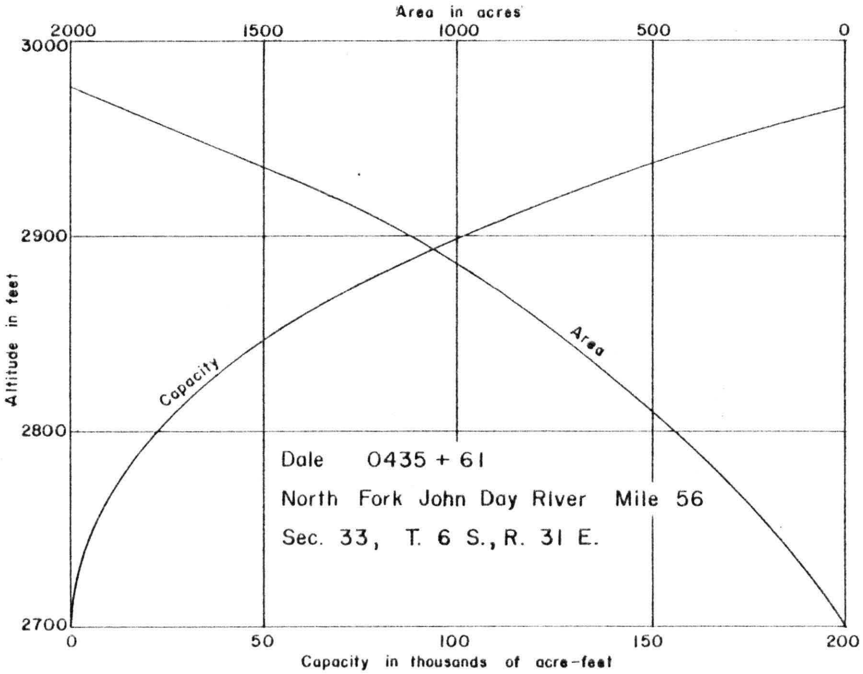
Oliver Ranch	0385+31
Black Canyon (South Fork)	0390+80
Picture Gorge	0405+00
Humphrey Ranch	0405+10
Dale	0435+61
Hunt Gulch	0435+64
Sunshine	0435+65
Galena	0435+66
Indian Creek	0435+68
Johnson	0435+69
Sugar Loaf Mtn.	0435+75
Twomile Canyon	0441+20
Thompson Flat	0441+20P1
Wickiup Spring	0441+20P2
Monument	0460+00
Kimberly	0460+50
Board Creek	0460+50P1
Hoogie Doogie	0460+60
Spray	0460+60P1
Harper Creek	0460+60P2
Twickenham	0466+58
Butte Creek	0470+70
Sorefoot Creek	0470+70P1
Big Lakes	0470+70P2
Jackknife	0473+40
Mikkalo	0473+55
Cottonwood Canyon West	0473+55P1
Tenmile Falls	0480+82
Cottonwood Canyon East	0480+82P1
Hay Creek	0480+82P2
Grass Valley Canyon	0480+82P3
Blalock Canyon	0481+P1


Area in acres
1600
1200
800
400
0
3350
3275
3200
3125
Altitude in feet
Capacity
Area
Oliver Ranch 0385 + 31
John Day River Mile 255
Sec. 19 & 30, T. 13 S., R. 32 E.
0
25
50
75
100
Capacity in thousands of acre-feet

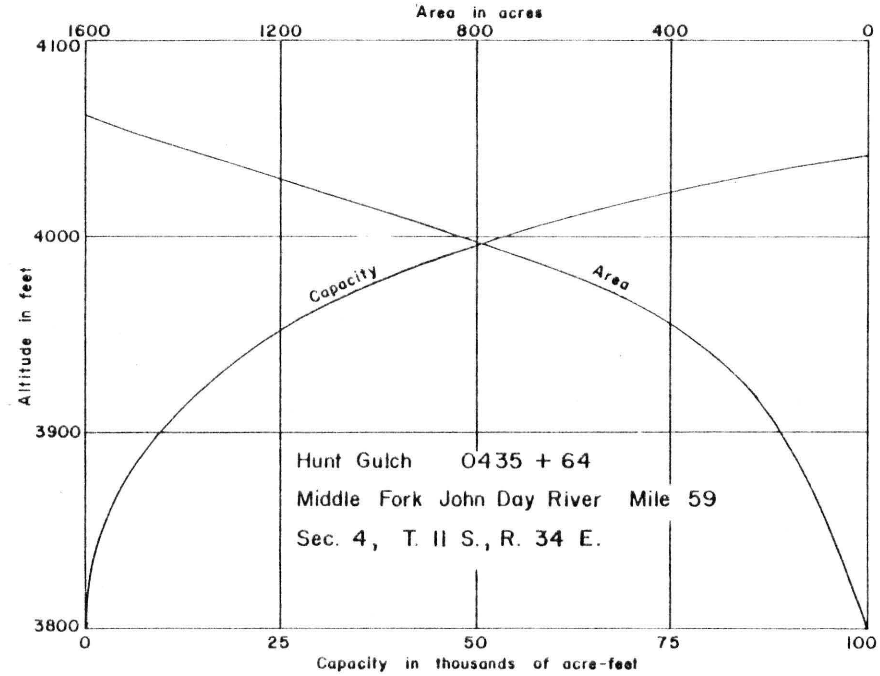

Area in acres
600
450
300
150
0
3150
3050
2950
2850
Altitude in feet
Capacity
Area
Black Canyon 0390 + 80
South Fork John Day River Mile 16
Sec. 26, T. 14 S., R. 26 E.
0
15
30
45
60
Capacity in thousands of acre-feet


Area in acres
8
6
4
2
0
2500
2400
2300
2230
WS
2200
Altitude in feet
Capacity
Area
Picture Gorge 0405 + 00
John Day River Mile 205
Sec. 17, T. 12 S., R. 26 E.
0
200
400
600
800
Capacity in thousands of acre-feet

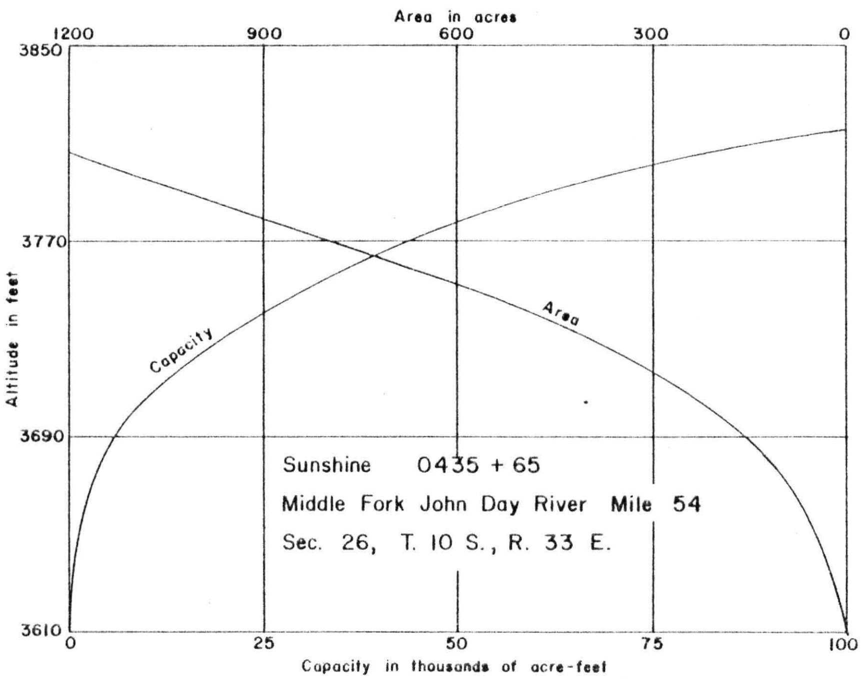

Area in acres
6
4.5
3
1.5
0
2270
2220
2170
2120
Altitude in feet
Humphrey Ranch 0405 + 10
John Day River Mile 200
Sec. 30, T. 11 S., R. 26 E.
0
5
10
15
20
Capacity in thousands of acre-feet



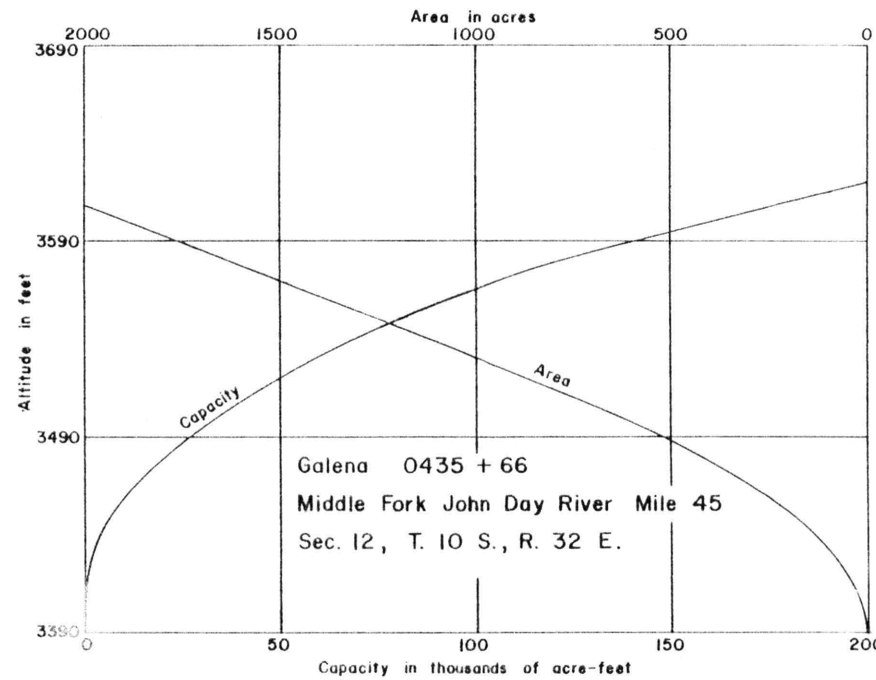
Area in acres
2000
1500
1000
500
0
3000
2900
2800
2700
Altitude in feet
Capacity
Area
Dale 0435 + 61
North Fork John Day River Mile 56
Sec. 33, T. 6 S., R. 31 E.
0
50
100
150
200
Capacity in thousands of acre-feet



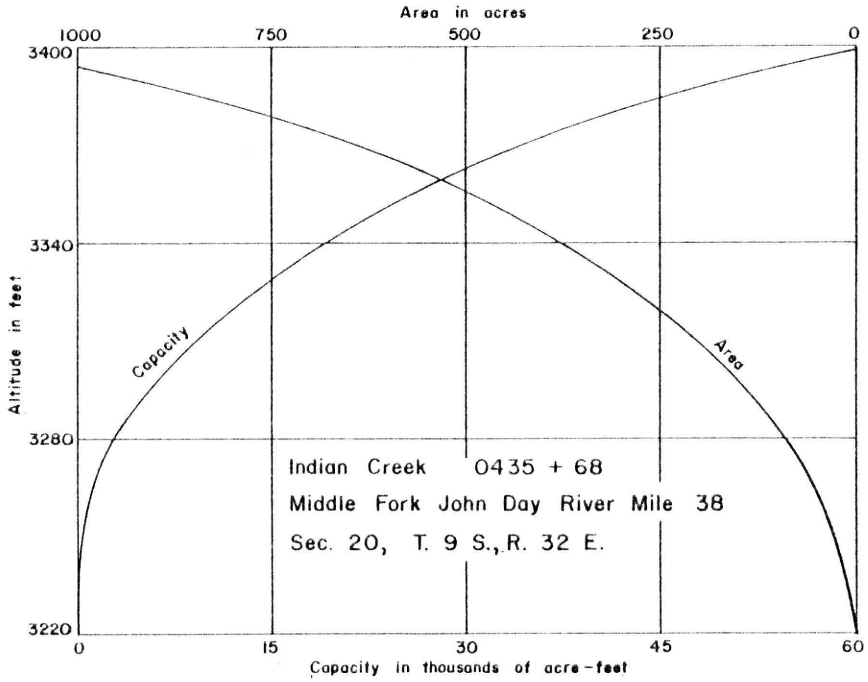
Area in acres
1600
1200
800
400
0
4100
4000
3900
3800
Altitude in feet
Capacity
Area
Hunt Gulch 0435 + 64
Middle Fork John Day River Mile 59
Sec. 4, T. 11 S., R. 34 E.
0
25
50
75
100
Capacity in thousands of acre-feet

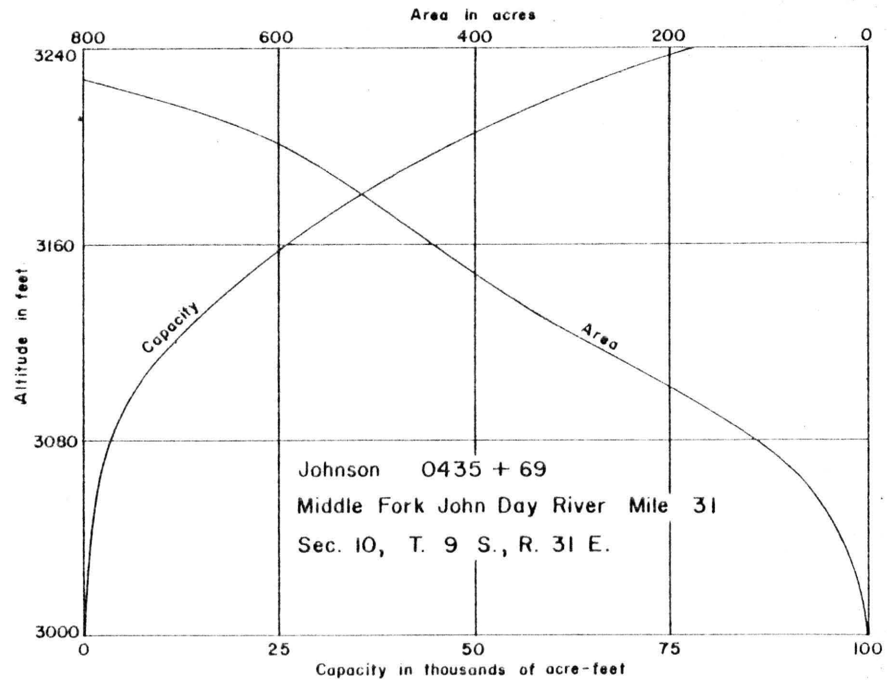


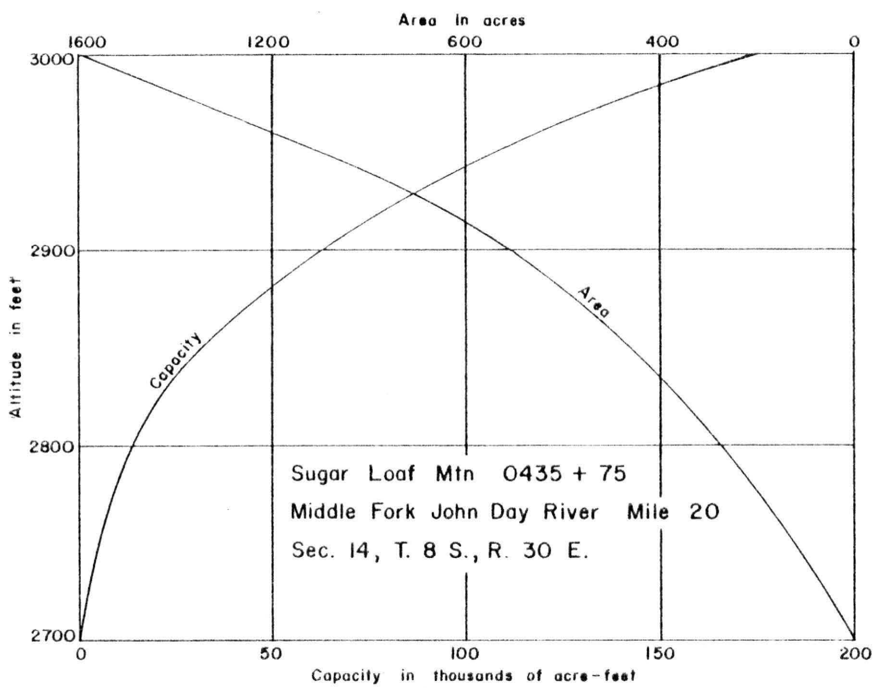
Area in acres
1200
900
600
300
0
3850
3770
3690
3610
Altitude in feet
Capacity
Area
Sunshine 0435 + 65
Middle Fork John Day River Mile 54
Sec. 26, T. 10 S., R. 33 E.
0
25
50
75
100
Capacity in thousands of acre-feet

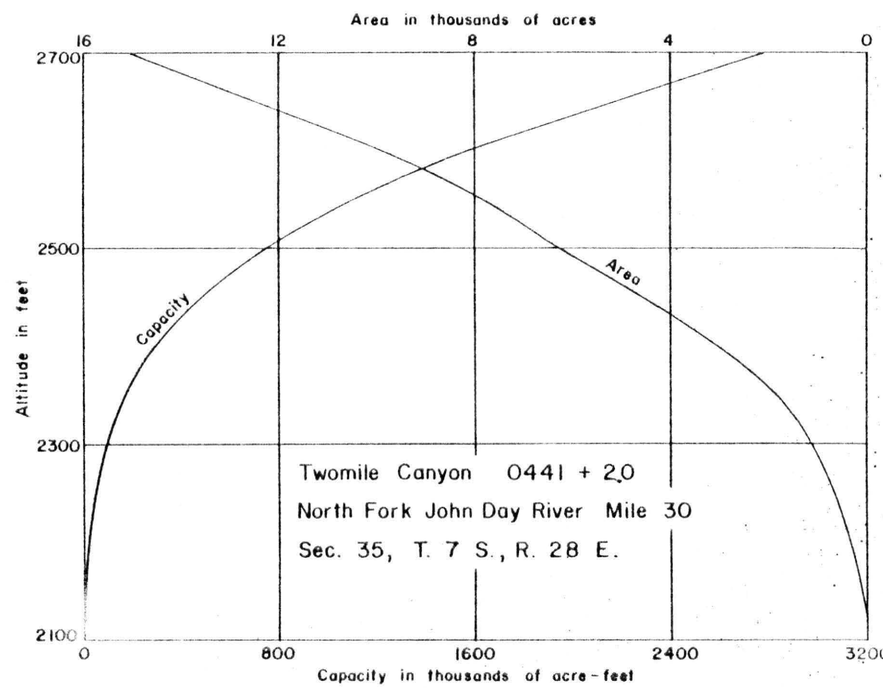


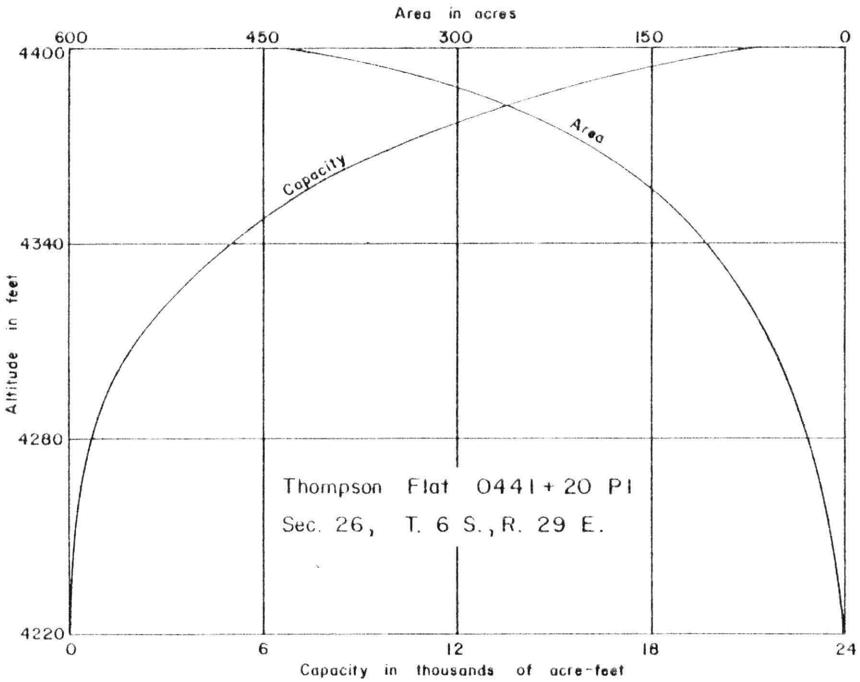
Area in acres
2000
1500
1000
500
0
3690
3590
3490
3390
Altitude in feet
Capacity
Area
Galena 0435 + 66
Middle Fork John Day River Mile 45
Sec. 12, T. 10 S., R. 32 E.
0
50
100
150
200
Capacity in thousands of acre-feet

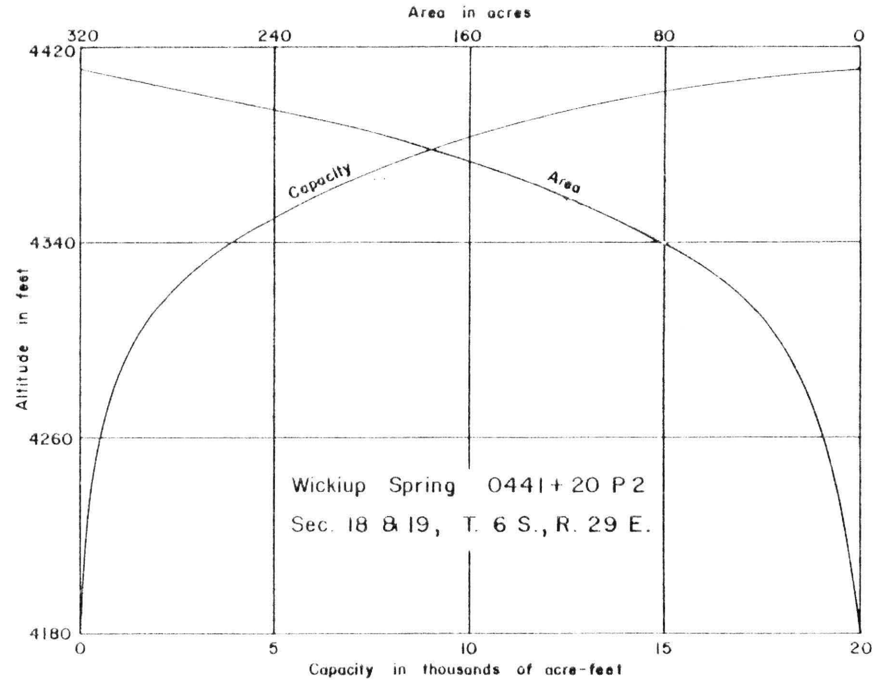

Area in acres
1000
750
500
250
0
3400
3340
3280
3220
Altitude in feet
Capacity
Area
Indian Creek 0435 + 68
Middle Fork John Day River Mile 38
Sec. 20, T. 9 S., R. 32 E.
0
15
30
45
60
Capacity in thousands of acre-feet

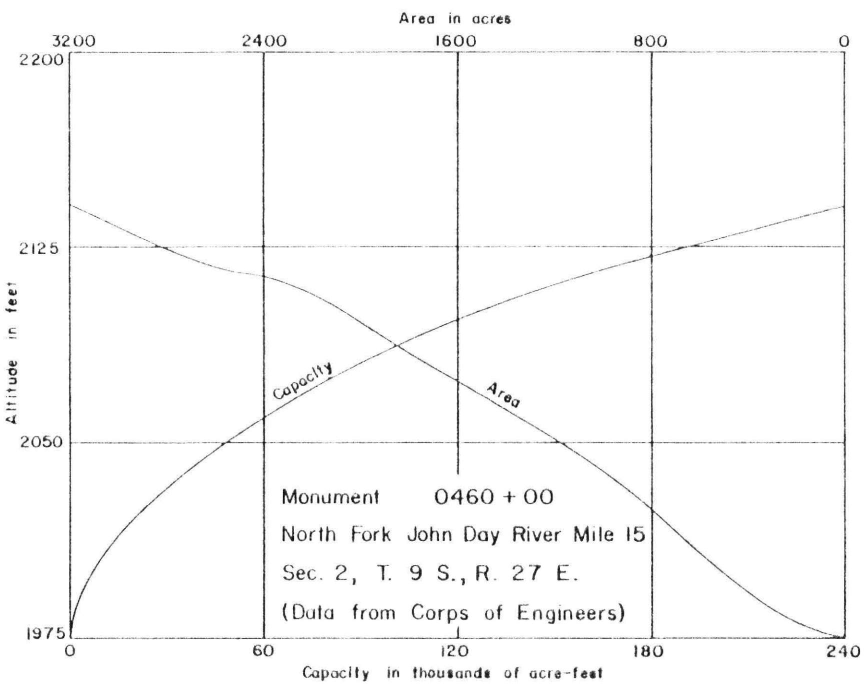

Area in acres
800
600
400
200
0
3240
3160
3080
3000
Altitude in feet
Capacity
Area
Johnson 0435 + 69
Middle Fork John Day River Mile 31
Sec. 10, T. 9 S., R. 31 E.
0
25
50
75
100
Capacity in thousands of acre-feet

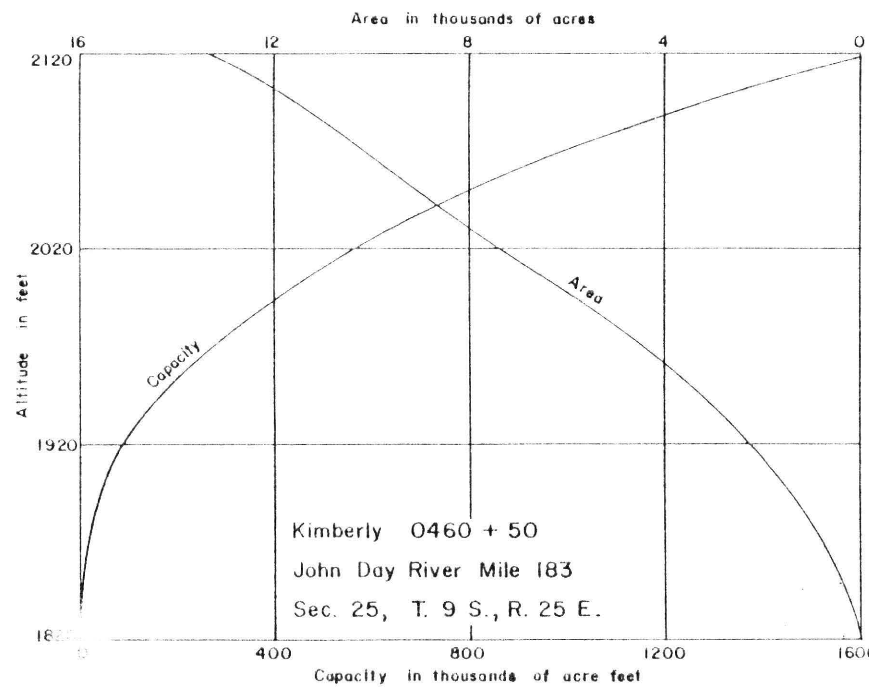

Area in acres
1600
1200
600
400
0
3000
2900
2800
2700
Altitude in feet
Capacity
Area
Sugar Loaf Mtn 0435 + 75
Middle Fork John Day River Mile 20
Sec. 14, T. 8 S., R. 30 E.
0
50
100
150
200
Capacity in thousands of acre-feet

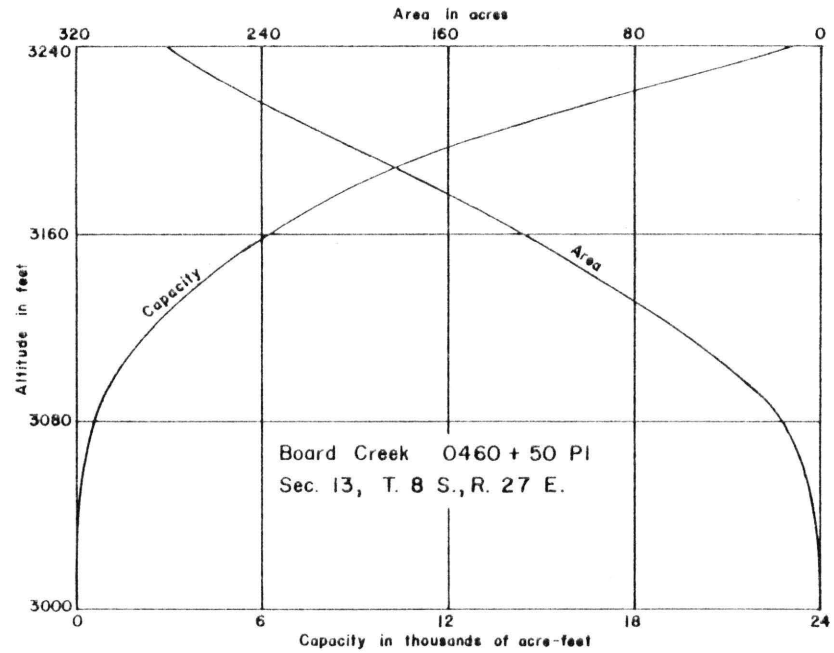

Area in thousands of acres
16
12
8
4
0
2700
2500
2300
2100
Altitude in feet
Capacity
Area
Twomile Canyon 0441 + 2.0
North Fork John Day River Mile 30
Sec. 35, T. 7 S., R. 28 E.
0
800
1600
2400
3200
Capacity in thousands of acre-feet

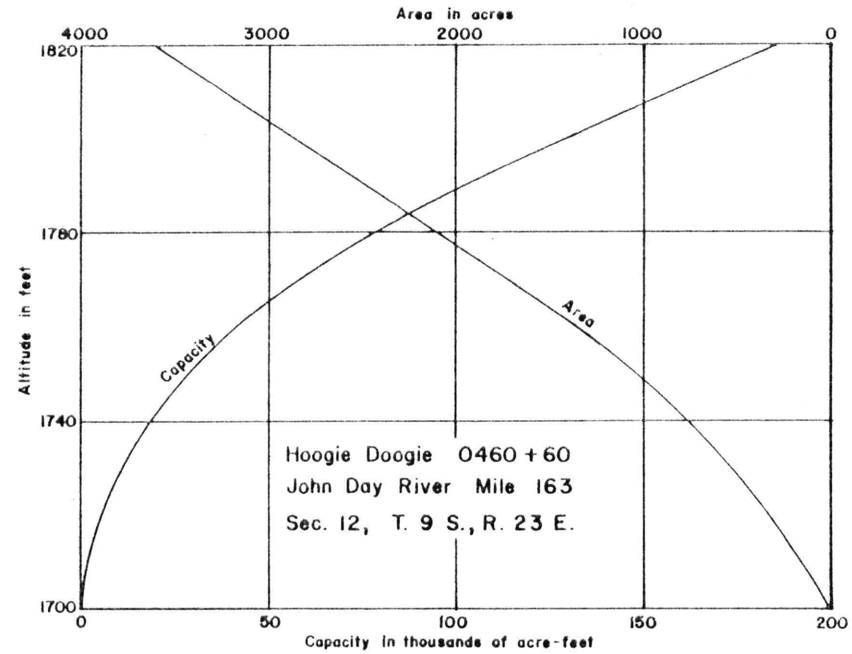

Area in acres
600
450
300
150
0
4400
4340
4280
4220
Altitude in feet
Capacity
Area
Thompson Flat 0441 + 20 P1
Sec. 26, T. 6 S., R. 29 E.
0
6
12
18
24
Capacity in thousands of acre-feet

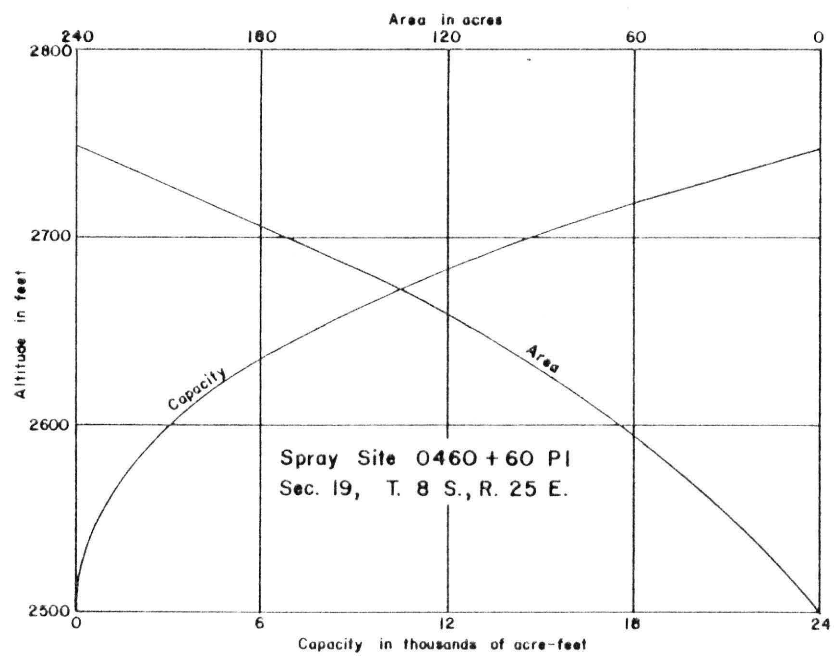

Area in acres
320
240
160
80
0
4420
4340
4260
4180
Altitude in feet
Capacity
Area
Wickiup Spring 0441 + 20 P2
Sec. 18 & 19, T. 6 S., R. 29 E.
0
5
10
15
20
Capacity in thousands of acre-feet

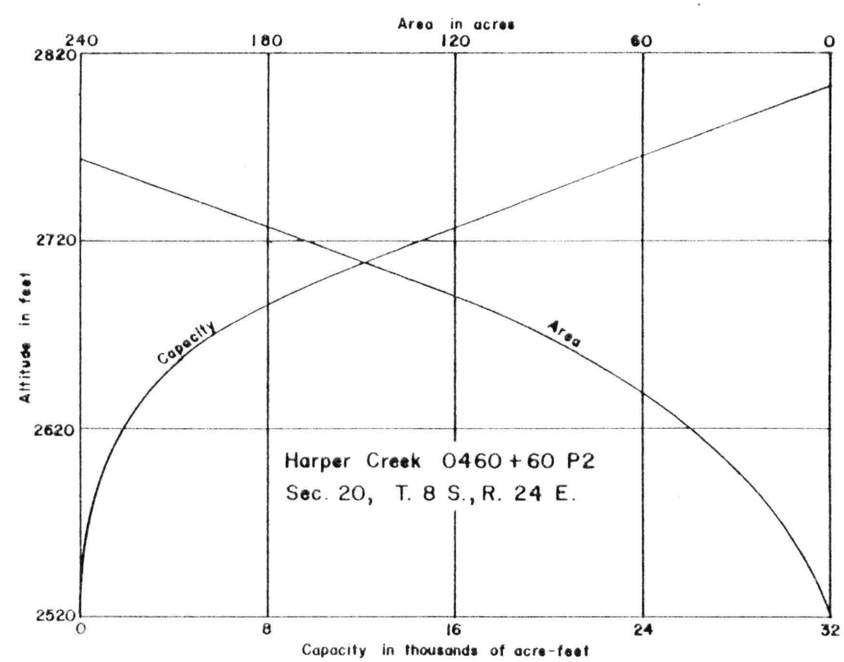

Area in acres
3200
2400
1600
800
0
2200
2125
2050
1975
Altitude in feet
Capacity
Area
Monument 0460 + 00
North Fork John Day River Mile 15
Sec. 2, T. 9 S., R. 27 E.
(Data from Corps of Engineers)
0
60
120
180
240
Capacity in thousands of acre-feet

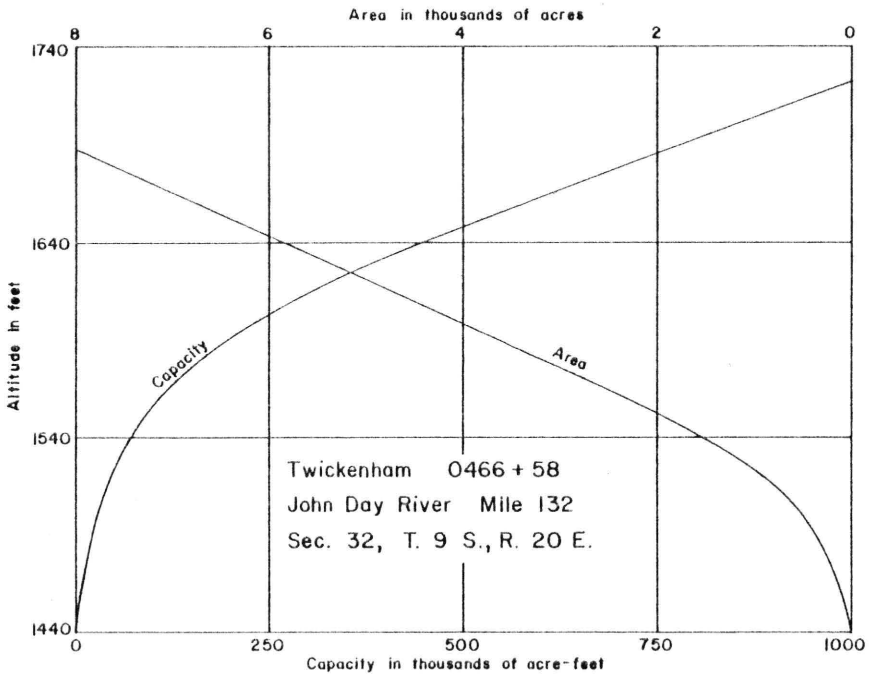

Area in thousands of acres
16
12
8
4
0
2120
2020
1920
Altitude in feet
Capacity
Area
Kimberly 0460 + 50
John Day River Mile 183
Sec. 25, T. 9 S., R. 25 E.
400
800
1200
1600
Capacity in thousands of acre feet

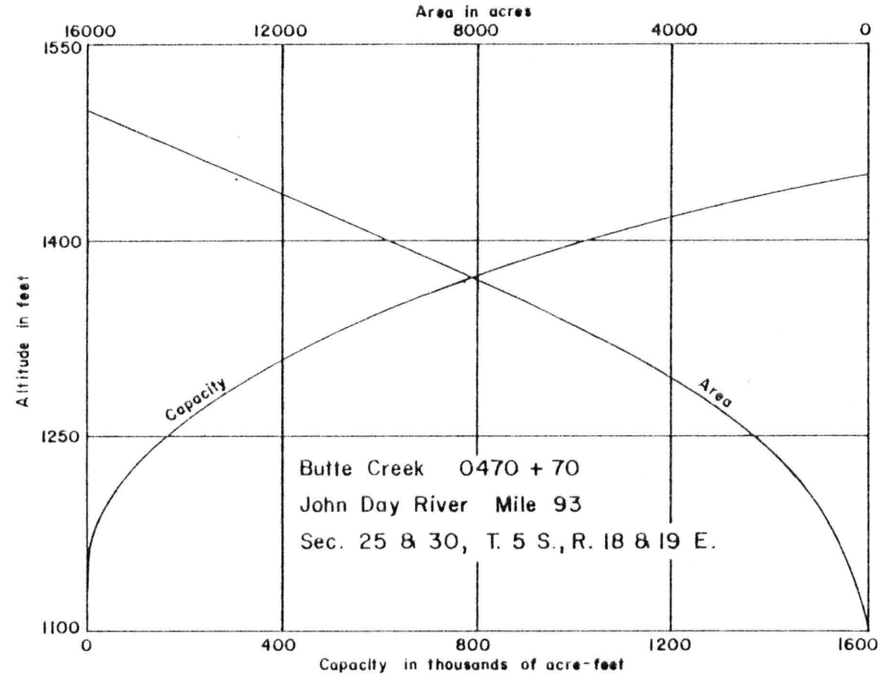

Area in acres
320
240
160
80
0
3240
3160
3080
3000
Altitude in feet
Capacity
Area
Board Creek 0460 + 50 P1
Sec. 13, T. 8 S., R. 27 E.
0
6
12
18
24
Capacity in thousands of acre-feet

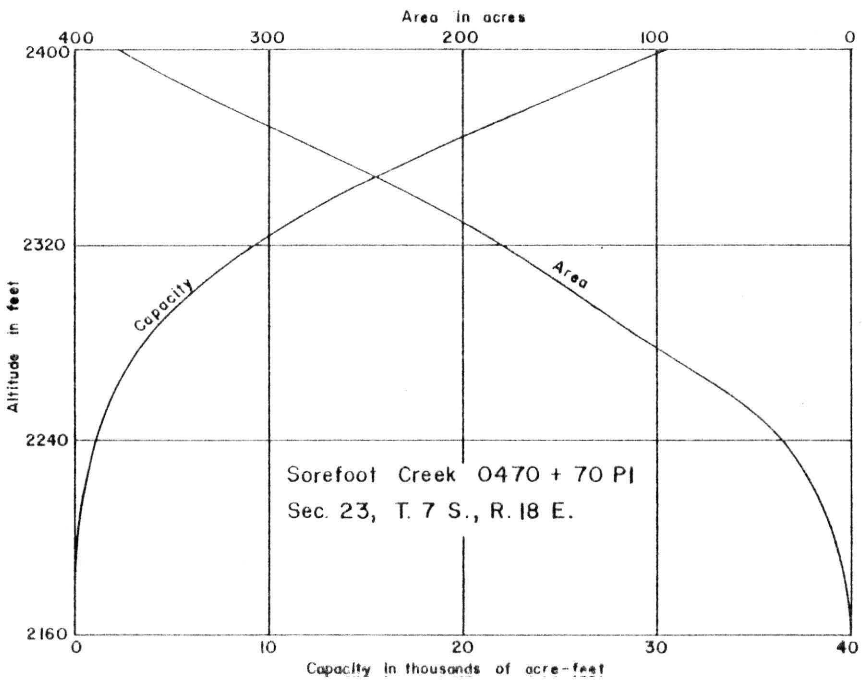

Area in acres
4000
3000
2000
1000
0
1820
1780
1740
1700
Altitude in feet
Capacity
Area
Hoogie Doogie 0460 + 60
John Day River Mile 163
Sec. 12, T. 9 S., R. 23 E.
0
50
100
150
200
Capacity in thousands of acre-feet

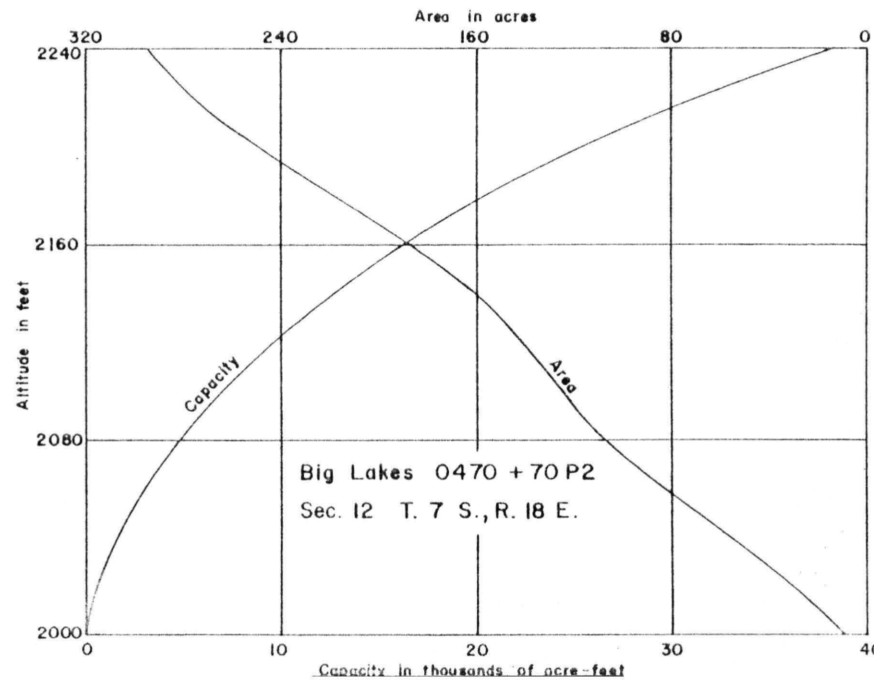

Area in acres
240
180
120
60
0
2800
2700
2600
2500
Altitude in feet
Capacity
Area
Spray Site 0460 + 60 P1
Sec. 19, T. 8 S., R. 25 E.
0
6
12
18
24
Capacity in thousands of acre-feet

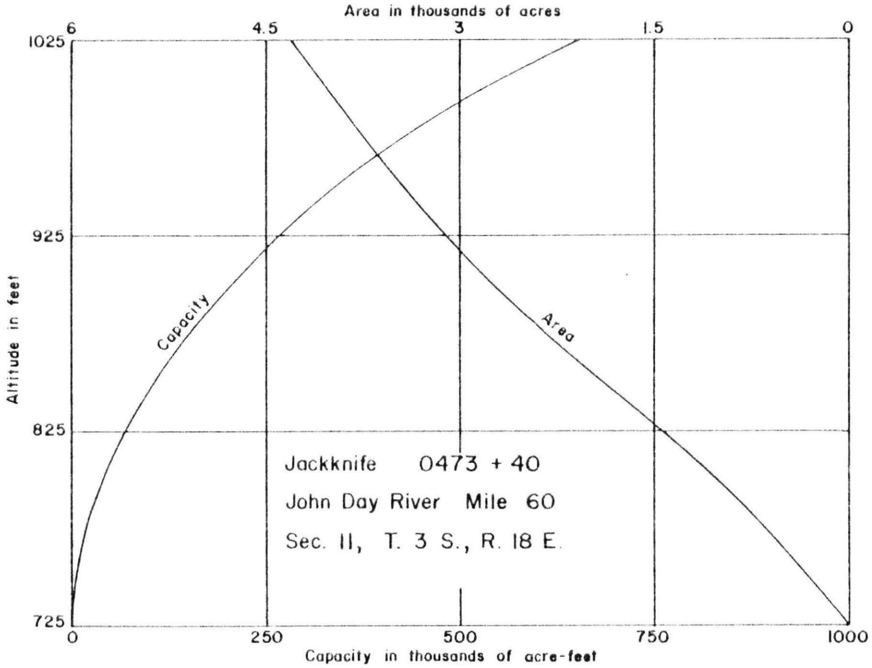

Area in acres
240
180
120
60
0
2820
2720
2620
2520
Altitude in feet
Capacity
Area
Harper Creek 0460 + 60 P2
Sec. 20, T. 8 S., R. 24 E.
0
8
16
24
32
Capacity in thousands of acre-feet

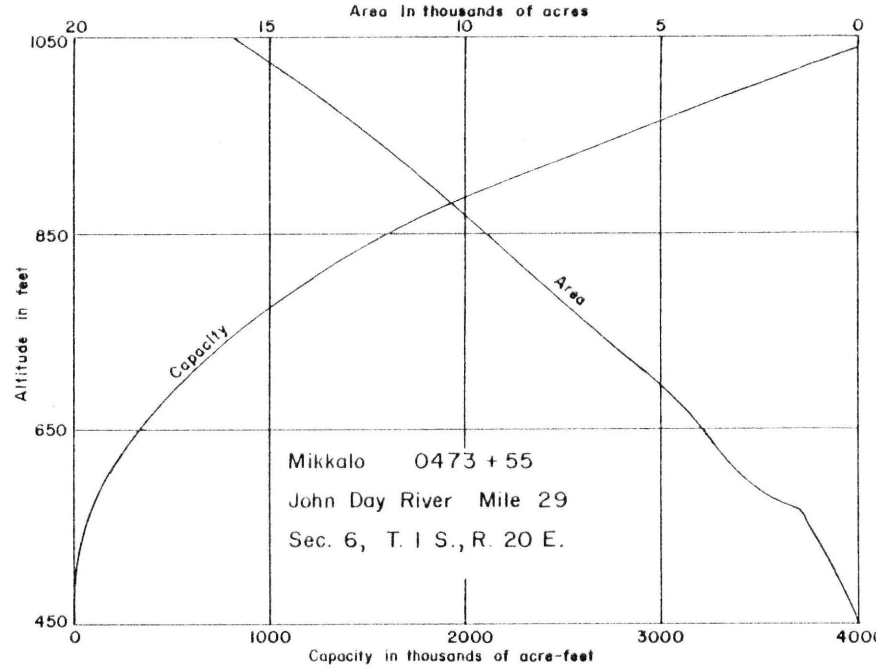

Area in thousands of acres
8
6
4
2
0
1740
1640
1540
1440
Altitude in feet
Capacity
Area
Twickenham 0466 + 58
John Day River Mile 132
Sec. 32, T. 9 S., R. 20 E.
0
250
500
750
1000
Capacity in thousands of acre-feet

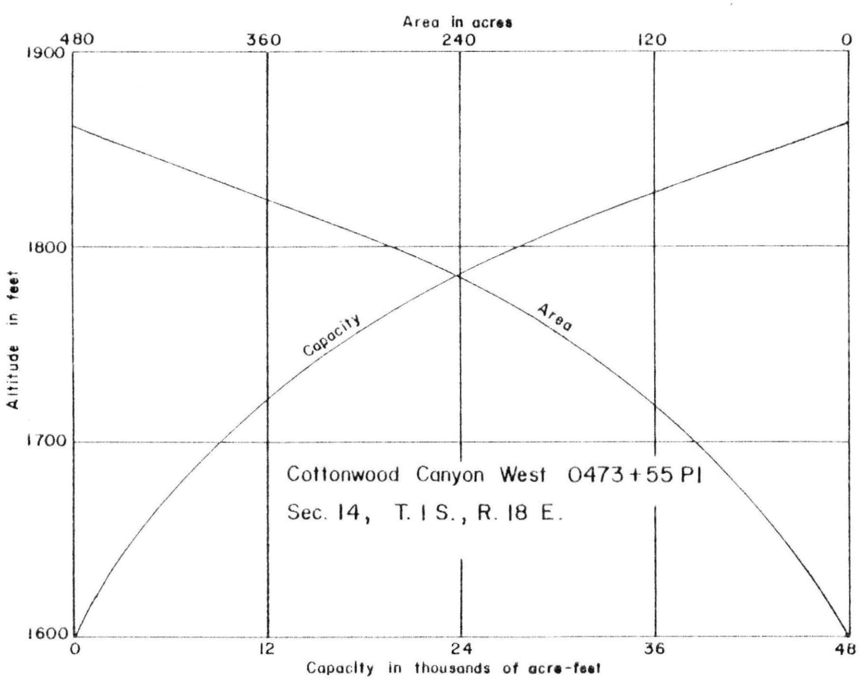

Area in acres
16000
12000
8000
4000
0
1550
1400
1250
1100
Altitude in feet
Capacity
Area
Butte Creek 0470 + 70
John Day River Mile 93
Sec. 25 & 30, T. 5 S., R. 18 & 19 E.
0
400
800
1200
1600
Capacity in thousands of acre-feet

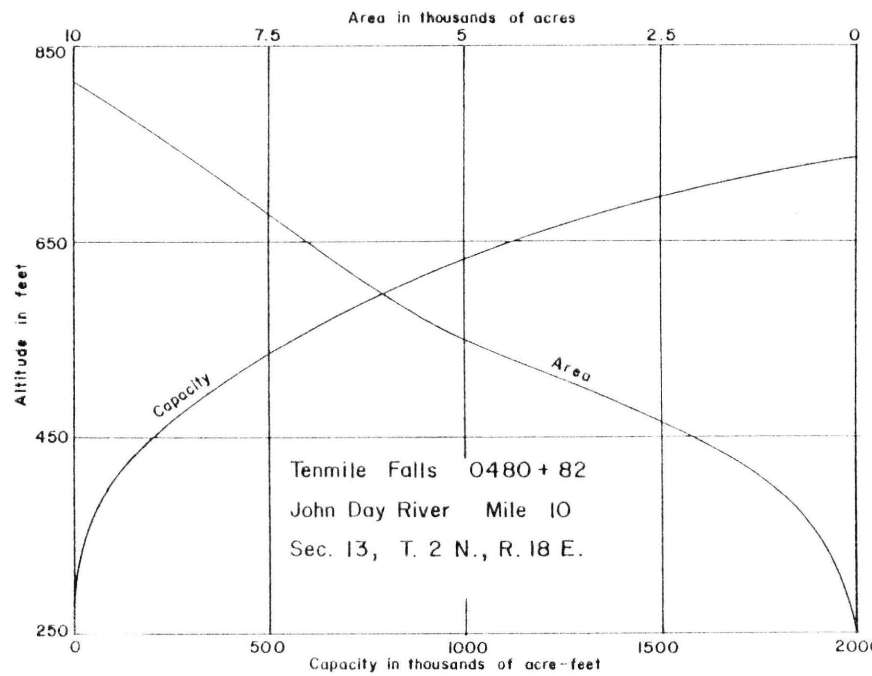

Area in acres
400
300
200
100
0
2400
2320
2240
2160
Altitude in feet
Capacity
Area
Sorefoot Creek 0470 + 70 P1
Sec. 23, T. 7 S., R. 18 E.
0
10
20
30
40
Capacity in thousands of acre-feet

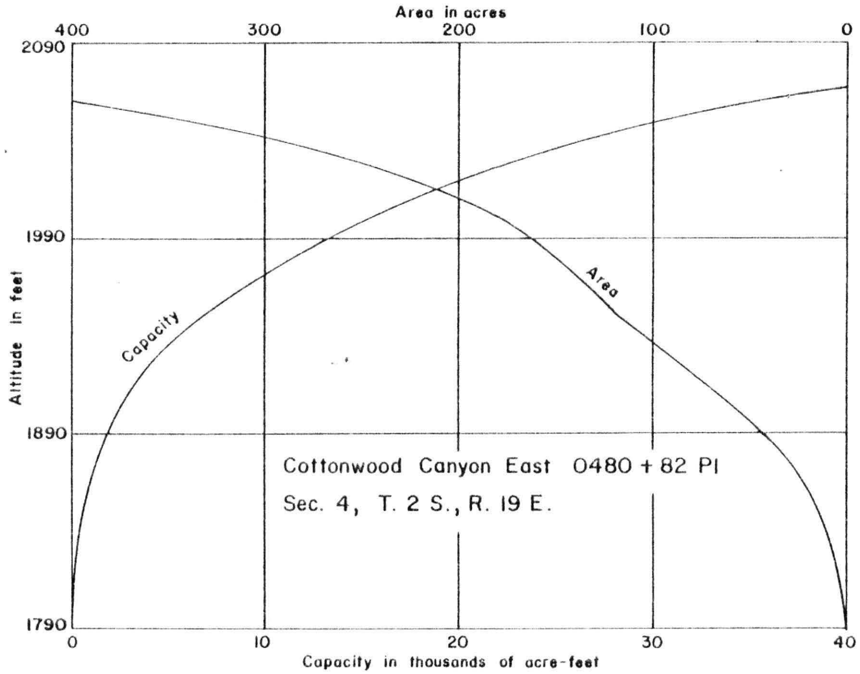

Area in acres
320
240
160
80
0
2240
2160
2080
2000
Altitude in feet
Capacity
Area
Big Lakes 0470 + 70 P2
Sec. 12 T. 7 S., R. 18 E.
0
10
20
30
40
Capacity in thousands of acre-feet

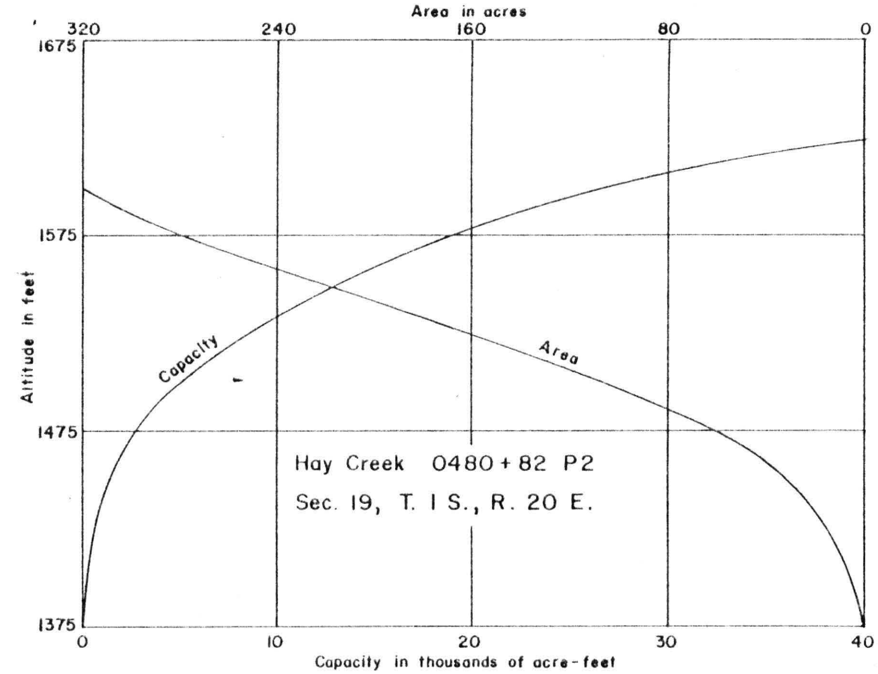

Area in thousands of acres
6
4.5
3
1.5
0
1025
925
825
725
Altitude in feet
Capacity
Area
Jackknife 0473 + 40
John Day River Mile 60
Sec. 11, T. 3 S., R. 18 E.
0
250
500
750
1000
Capacity in thousands of acre-feet

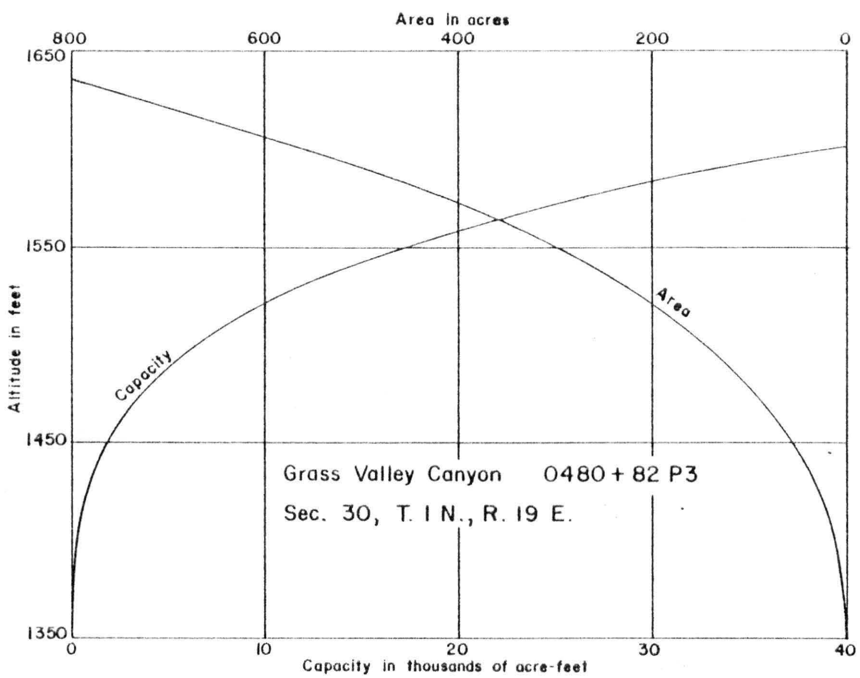

Area in thousands of acres
20
15
10
5
0
1050
850
650
450
Altitude in feet
Capacity
Area
Mikkalo 0473 + 55
John Day River Mile 29
Sec. 6, T. 1 S., R. 20 E.
0
1000
2000
3000
4000
Capacity in thousands of acre-feet

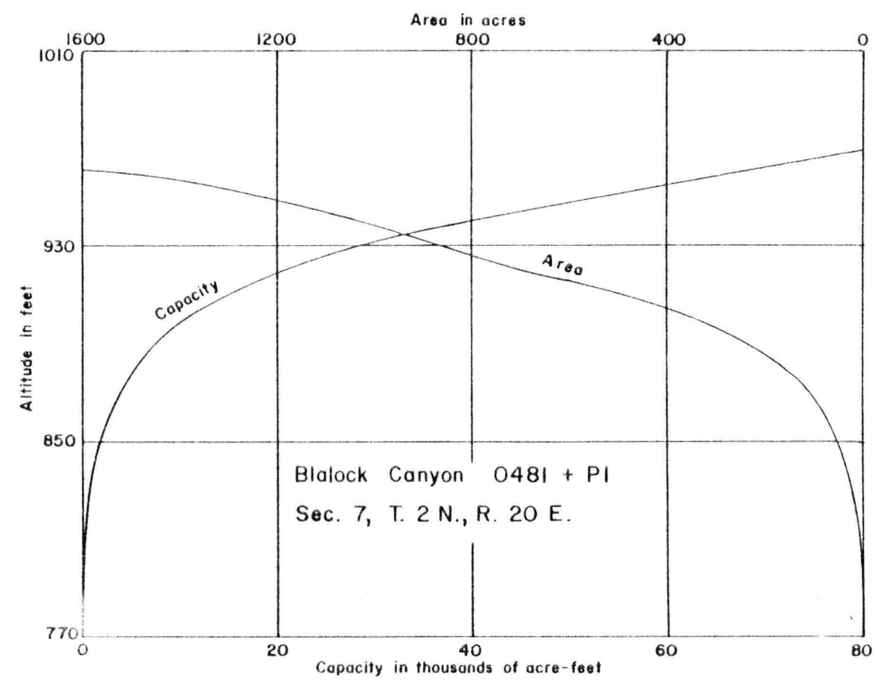

Area in acres
480
360
240
120
0
1900
1800
1700
1600
Altitude in feet
Capacity
Area
Cottonwood Canyon West 0473 + 55 PI
Sec. 14, T. 1 S., R. 18 E.
0
12
24
36
48
Capacity in thousands of acre-feet


Area in thousands of acres
10
7.5
5
2.5
0
850
650
450
250
Altitude in feet
Capacity
Area
Tenmile Falls 0480 + 82
John Day River Mile 10
Sec. 13, T. 2 N., R. 18 E.
0
500
1000
1500
2000
Capacity in thousands of acre-feet









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