River than would be provided by power development alone. Such a combination is necessary if irrigation is to be provided, since cheap secondary power is essential to economic feasibility and combined revenue is necessary to meet construction costs.

2018. The use of revenue from the sale of power as a subsidy for irrigation development by the pumping plan is justified on the following grounds: First, irrigation development alone, when judged from the standpoint of the local and regional values which it creates, is economically feasible. Second, the establishment of a primary industry, such as agriculture, represents an expansion in the wealth producing capacity of the Nation and creates opportunity for productive activity that is available to any citizen of the United States. Third, increased production due to irrigation development would reduce the cost of farm produce to the consumer in the Northwest, provided production was sufficient to exclude marginal supplies of produce now imported from distant points.

2019. Government participation in irrigation development, either by a loaning of credit or by providing interest-free money, may be justified on a basis of the second and third classes of benefits named above. Participation of business interests, both local and regional, through assessments imposed by a large district organization, may be justified on the basis of the first class of benefits named above. A combined revenue from the sale of water and power and from an assessment of benefits, created by the irrigation development, would provide better security for repayment and would permit repayment in a shorter period than would be possible where revenue is secured from the sale of water and power alone.

V. Conclusions and Recommendations

A. CONCLUSIONS

2020. The purpose of this investigation and report is to produce a comprehensive plan for the use of the waters of the Columbia River above the Snake—a plan which could be used as a guide to all future construction on the river.

2021. Such a plan is given in chapter IV. Future conditions now unforeseen may dictate some modifications, such as slight changes in locations and heights of dams; but the general plan is believed sound. It should not be modified, except in detail, without mature consideration.

2022. It is not to be understood that the particular designs of the structures, such as dams and power plants, are essential to the comprehensive plan. The designs are submitted to indicate what could be done and to furnish data on which to estimate the cost as a basis for the economic study. The comprehensive plan is the general method of using the waters of the stream—it sets forth a principle rather than a specific design.

2023. Navigation on the Columbia above the Snake is not and probably never will be important. Some local traffic connecting with the nearest railway points may develop in quiet stretches of the river and in the pools above power dams. Although future traffic on the river will probably never be important, provision should be made in all plans of power dams for future construction of navigation locks should commerce develop to a point where the expenditure would be justified.

2024. *Power development offers the greatest opportunity for use of the waters of the Columbia.*—There are four sites at which power in large amounts could be generated at low cost per kilowatt-hour, viz: Priest Rapids, Foster Creek, Grand Coulee, and Kettle Falls. If the high dam at Grand Coulee be built, Kettle Falls would be submerged, leaving only three sites. All of these plants would generate large amounts of electrical energy and, before construction is started, it should be certain that there would be a market for this energy, as otherwise the carrying charges would be so great as to prohibit cheap rates.

2025. Storage on the tributaries and behind the power dams in the river, if properly regulated, would greatly increase the prime potential power on the main stream and on the Clark Fork, both in Canada and the United States.

2026. Storage in Hungry Horse Reservoir could be regulated in the interest of power at the site and also, without greatly affecting the power possibilities, to reduce flood heights on Flathead and Pend Oreille Lakes.

2027. Regulation of Flathead storage in the interest of power at the outlet of the lake has been provided for in the license issued to Rocky Mountain Power Co.

2028. Regulation of Pend Oreille Lake in the interest of power on the Clark Fork could be effected by regulating works at Albany Falls or by a power dam of proper height at Z-Canyon.

2029. The investigation shows the important results that could follow proper regulation of storage and indicates the desirability of coordination in the control of storage if the greatest benefit is to obtain.

2030. In studying the water supply of this river system, allowance was made for all future irrigation withdrawals. Irrigation of lands within the basin of the Columbia although important in itself does not, in general, greatly affect other uses of Columbia water, as irrigation withdrawals and power consumption for irrigation pumping occur during the higher river stages.

2031. The Columbia Basin irrigation project is, however, a special case that does affect other uses of Columbia water, power in particular. It has a large area, and water to irrigate it can be diverted from the river system at more than one point. Irrigation of this project is an important element of the comprehensive plan, and the method, costs, and economic aspects of its development, and the relation it bears to other uses of Columbia water were given special attention in this investigation.

2032. It was found: That none of the gravity projects studied were economically feasible; that plans nos. 4 and 4-A (pumping) were economically feasible but that the returns from agriculture alone were not sufficient to pay the cost of irrigation; that if the pumping project were combined with the Grand Coulee power project, in which the high Grand Coulee Dam is included, the entire investment for the combined project, with interest at 4 percent, could be returned within 60 to 90 years if the following precepts were adhered to:

The pumping plan of irrigation should be followed.

The high Grand Coulee Dam should be included as a part of the irrigation project, this combined project having two sources of income—returns from the farmer and returns from sale of power.

Detailed topographic surveys and a reclassification of the land should be made to determine the exact areas. This should be done prior to construction.

The area should not be settled at a too rapid rate, nor should the irrigation part of the project be started until the power development is well under way.

No construction work should be started until contracts have been made for the sale of sufficient power at a rate that will finance that stage of the combined project which it is then contemplated to construct, and until it is reasonably certain that additional contracts for the sale of power can be made to finance the additional stages when undertaken.

It should also be determined before work is started that production from this new area can be absorbed in the markets of the country without causing damage to existing interests through overproduction.

2033. Although it is concluded that the pumping plan for the development of the Columbia Basin irrigation project has merit and that, under proper conditions, it would be capable of returning the investment, with interest, and would yield benefits of value to the Northwest—it does not necessarily follow that the proper conditions exist at the present time.

2034. The economic feasibility of the project depends, in part, upon the rate of interest charged on the investment. Participation of the Federal Government will be necessary to secure an interest rate of 4 percent. The question as to Federal participation involves a matter of national policy, which is not a province of this report.

2035. The investigation indicated the great importance of basic stream-flow data and the desirability of obtaining additional records of discharges. The War Department provided funds for the establishment and maintenance by the United States Geological Survey of 14 gages which are furnishing records that will be of the greatest value to any further study or work on the Columbia, Clark Fork, or Flathead Rivers. All of these gages except two, one on the Clark Fork at Missoula and one on the little Spokane, should be continued in operation. For complete list, see table no. 11, page 604.

B. RECOMMENDATIONS

2036. It is, therefore, recommended:

First. That the comprehensive plan as given and summarized in chapter IV be adopted as covering the attitude of the United States toward future work on the Columbia above the Snake.

Second. That when applications for preliminary permits or licenses for power dams on the Columbia are referred to the War Department by the Federal Power Commission, as required by section 4 (d) of the Federal Water Power Act, no dams be approved the plans of which do not contain provisions for the construction of navigation locks when future conditions may require.

Third. That no construction of power dams at Kettle Falls or Grand Coulee on the Columbia nor at the Narrows or Fish Hawk sites on the Spokane be permitted until provision has been made for irrigation on the Columbia Basin irrigation project area or until it is certain that that area is not to be irrigated.

Fourth. That irrigation within the Columbia Basin in Montana, Idaho, and Washington be given the first right to the use of the waters of the Columbia and tributaries, and that no power rights be granted which will interfere with future irrigation requirements.

Fifth. That it be required that storage above power dams be so regulated as to interfere as little as possible with navigation and fish life above and below the dam.

Sixth. That regulation of Hungry Horse storage in the interest of flood control as well as power be given consideration before license is issued for the construction of the dam.

Seventh. That stream gaging be continued to the end that adequate basic data be made available for future studies and construction.

Eighth. That the Federal Government participate in the execution of the comprehensive plan to the extent of supervising the work to see that the general principles of the plan are adhered to and the fullest utilization obtained; that it participate in the construction of navigation locks through the power dams when prospective traffic justifies such work.

Ninth. That the Federal Government do not contribute to the cost of these power developments as an aid to navigation, as the benefit to navigation would not be sufficient to justify such participation.

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APPENDIX 1

THE MINERAL RESOURCES OF THE COLUMBIA RIVER BASIN IN EASTERN WASHINGTON AND PARTS OF NORTHERN IDAHO

By HENRY LANDES, *Geologist*, together with reports on the Coeur d'Alene, Idaho, and Butte, Mont., mining districts, by FRANK H. DICKEY, *Assistant Geologist*, Seattle, Wash., March 27, 1931

TABLE OF CONTENTS

THE NONMETALLIC RESOURCES

CLAY—GENERAL DISTRIBUTION

(See pl. no. 148 [2] for map references)

1. The raw clays of the Columbia Basin have a very irregular distribution. As a rule there is very little clay in the high mountainous areas, and the deposits are mainly limited to the plains and plateaus, the foothills, the terraces, and flats along the streams and to the former lake basins that have been partially or entirely filled by sedimentation.

2. Probably the best-known occurrences of clay are those in the territory along the Washington-Idaho line, from the southern limits of Spokane to points beyond Moscow. The clay lies in a belt but a few miles wide, between the rising Rockies to the east and the margins

[2] Not printed.