

can be produced in large modern generating stations when the price of fuel oil is \$1 per barrel.

(m) Works for flood control alone or for flood control in combination with navigation, power development or irrigation are neither needed nor feasible.

(n) The results of studies made by both the Seattle and the Portland districts of irrigable areas along the Columbia, not now irrigated, listed in table I in paragraph 230 above, definitely demonstrate that none of those areas can be considered as economically feasible of irrigation at this time with repayment of costs plus interest chargeable against the returns to the farmer from the sale of crops. The smaller tracts of land have an advantage in the economy represented by possible stage developments.

(o) Revenue from the sale of power could be applied as a subsidy for irrigation development. Such use of power revenue might perhaps be the best to which it can be applied, but the most beneficial use could be determined only by analyses and appraisals of the benefits that would flow from all possible uses.

(p) The so-called "pumping plan" for irrigating the Columbia Basin irrigation project would make possible the production of 400,000 kilowatts of prime power that would be lost should the "gravity plan" of development be adopted. Irrigation by the "pumping plan" would be served wholly by secondary power.

(q) As the development of the potential power of the river, the control of floods, the diversion for water for irrigation all depend largely on the quantity of water flowing in the stream and its tributaries, it is highly important that adequate records of stream flow should continue to be obtained.

#### IV. RECOMMENDATIONS

248. From the studies made it is concluded that the most feasible plan for ultimate utilization of the resources of Columbia River is as follows:

- (1) A system of 8 dams along the main stream located at:

Head of Grand Coulee, Wash.

Foster Creek, Wash.

Chelan, Wash.

Rocky Reach, Wash.

Rock Island Rapids, Wash. (now under construction).

Priest Rapids, Wash.

The Dalles, Oregon-Washington.

At the foot of Cascade Rapids, Oregon-Washington.

Such system would develop for power purposes 92.3 percent of the total head between the international boundary and tidewater and all of the head economically developable. It would receive full benefit of storage and regulation in the tributaries, as may be created in the future. It would benefit navigation by furnishing, except at high water, slack-water conditions. It would permit irrigation of large tracts of land on both sides of the river in Oregon and Washington. It would confer incidental benefits upon lowlands along the tidal section of the river through reduction of flood heights.

Provision should be made for locks through the dams below the mouth of Snake River to be installed simultaneously with the con-

struction of those dams and through the dams above the mouth of the Snake when river traffic justifies the cost of locks.

(2) Additional dams, with locks, for navigation only, at points 14 and 40 miles above the mouth of the Snake. These will be contingent on the development of a commerce justifying through canalization above the mouth of the Snake to the vicinity of Wenatchee, Wash.

249. It is recommended that the above-stated plan be adopted by the United States as its guide in controlling and supervising development of the Columbia River above tidewater, navigation being considered chargeable with the cost of locks through dams below the mouth of Snake River and subject to contribution of not over \$5,000,000 toward the cost of those dams; and that the plan for the tidal section of the river remain as at present, viz: Improvement as needed to meet the requirements of seagoing and river traffic.

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#### APPENDIX I

#### CONTENTS

	Page
1. Résumé of essential facts concerning electrochemical and other major power consuming industries.....	85
2. Power in aluminum production.....	108
3. Power in fertilizer-material production.....	133
4. Power in copper and copper-alloy production.....	196
5. Power and zinc and lead production.....	244
6. Power in the manufacture of chemicals and metals from brine.....	280
7. Power in the cellulose industries.....	309
8. The electric furnace in the iron and steel industry.....	384
9. The original and some new electric-furnace products.....	426
10. Electric reduction of gold and silver and rare or minor metals.....	445

#### RÉSUMÉ OF ESSENTIAL FACTS CONCERNING ELECTRO-CHEMICAL AND OTHER MAJOR POWER CONSUMING INDUSTRIES

1. Electrochemistry was first applied commercially to the manufacture of products which required temperatures too high to be achieved successfully with fuels or which could be dissociated from other materials only by electric current. The products which were rendered commercially available by electrochemical processes at the close of the nineteenth and at the beginning of the twentieth century, namely, aluminum, fused aluminous abrasives, calcium, calcium carbide, calcium cyanide, artificial graphite, silicon, silicon carbide, ferro-silicon, sodium, phosphorus, and refined copper are still manufactured solely by such processes. To their ranks have been added other ferro-alloys, metallic magnesium, fused quartz, fused mullite, tungsten, cadmium, bismuth, and a number of other substances, all requiring electrochemical treatment but for which there is still limited demand. In the last 15 years, electrochemical processes have also been extended to the manufacture of products long made by other processes, either because greater purity of product could be achieved by electrical methods or because such methods proved more economic under specific conditions. Today, caustic soda, phosphoric acid, potassium hydroxide, carbon bisulphide, the chlorates and hypochlorites, as well as the gases hydrogen and oxygen, are