Alluvial Mining in the Pacific Northwest

A report of the Alluvial Mining Subcommittee of the Columbia Basin Inter-Agency Committee

State of Idaho
ROBERT E. SMYLIE, Governor

Idaho Bureau of Mines and Geology
E. F. COOK, Director
ALLUVIAL MINING IN THE PACIFIC NORTHWEST

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IDAHO BUREAU OF MINES AND GEOLOGY MOSCOW, IDAHO
FOREWORD

Because dredge mining in its various aspects has been a matter of intense interest to many Idahoans I requested permission of the Columbia Basin Inter-Agency Committee to publish the report of their Alluvial Mining Subcommittee, which deals in large part with dredge mining, its extent and its regulation.

Publication of this report does not imply that the recommendations of the Subcommittee have been adopted by this Bureau as an official position--despite the fact that I was chairman of the Subcommittee. Nor should it be inferred that the State of Idaho is attempting to tell other states what to do.

The report is published under this cover because it represents the considered judgment of a group of resource experts on a problem of general concern and interest; their recommendations merit your careful consideration.

E. F. COOK, Director
Idaho Bureau of Mines and Geology
ABOVE: Windrows of gravel along the South Fork of the Clearwater River resulting from dredge operations at a time when leveling of tailings was not required. The gravel shown here was worked for its gold content; much of the recent dredging in Idaho has been carried on for the recovery of uranium, thorium, columbium, tantalum, and rare earths.

BELOW: Leveling of dredged ground in Bear Valley, Idaho. After smoothing of the tailings, topsoil, removed before dredging, was replaced and seeded. Present state law requires construction of settling ponds to clarify water used in dredge mining, and the replacement of disturbed watercourses after dredging.
TO: Columbia River Inter-Agency Committee

FROM: Alluvial Mining Subcommittee

SUBJECT: Final Report

Submitted herewith for your acceptance and approval is our final report. We have tried diligently to accomplish the task you set for us in 1958; we hope that we have succeeded and that our subcommittee may now be dissolved.

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INTRODUCTION

In 1958 the Columbia Basin Inter-Agency Committee set up an ad hoc Subcommittee on Dredge Mining, charging it "to investigate the extent of dredge mining in the Pacific Northwest and control measures governing such operations, and recommend such control measures as may be needed to protect beneficial water and land uses from unwarranted damage."

We (the new subcommittee) held five meetings and one field trip, as follows:

Meetings:  Portland, Oregon, January 26, 1959
           Boise, Idaho, September 24, 1959
           Moscow, Idaho, November 17, 1959
           Portland, Oregon, February 4, 1960
           Richland, Washington, April 12, 1960

Field trip: Boise to Lewiston, Idaho, September 25–26
           1959

Following the Boise meeting we requested and received permission of the Executive Subcommittee, CBIAC, to enlarge the scope of our activities to include sand and gravel operations that affect streams, and hydraulicicking as well as the various forms of dredging. The Subcommittee was thenceforth known as the Alluvial Mining Subcommittee.

Investigating the extent of alluvial mining operations and control measures governing such operations was not a difficult task. However, when the Subcommittee tackled the part of its charge that contains the subjective terms "beneficial" and "unwarranted," there arose differences of opinion that were not easily resolved.

Although diverse backgrounds and interests were represented on the Alluvial Mining Subcommittee we were able to come to agreement on the report which follows. This is not to say we have reached harmonious accord on all phases of the problem we were set to investigate and the remedies that should be proposed; however, our points of continuing disagreement are clearly set forth in footnotes instead of in a minority report.

We are indebted to the following persons, not members of the Subcommittee, who, as invited guests, gave freely of their time and knowledge in meetings with us:

- Hollis Dole, Director, Oregon Department of Geology and Mineral Industries.
- Ralph S. Mason, Mining Engineer, Oregon Department of Geology and Mineral Industries.
- Roy W. Scheufele, Executive Secretary CBIAC.
- George Lafferty, U. S. Forest Service, Boise
R. P. Porter, Porter Brothers Corporation, Boise.
R. B. Porter, Porter Brothers Corporation, Boise.
Forrest R. Hauck, Idaho Fish and Game Department.
John D. Walker, U. S. Corps of Engineers.
Glen D. Carter, Oregon Sanitary Authority.
EXTENT OF ALLUVIAL MINING IN THE PACIFIC NORTHWEST

State of Oregon

In 1959 there were 28 seasonal placer operations in Oregon. These yielded $15,000 in gold; with an average recovery of 30 cents per cubic yard it is estimated that about 45,000 cubic yards of gravel were moved to secure this gold production. No dredges were used; about three-fourths of the operations employed some sort of hydraulic method.

In 1959 there was a production of about 8,000,000 cubic yards of sand and gravel in Oregon, of which it was estimated that 6,000,000 cubic yards were recovered from stream bed operations. Because sand and gravel deposits not situated in or near stream beds are of limited occurrence in Oregon, the State relies primarily on stream-bed deposits for its sand and gravel production.

No expansion of gold placer operations in Oregon is foreseen; however, the production of sand and gravel from stream beds will probably continue to increase. From 1948 to 1957 sand and gravel production in Oregon increased from 8,384,755 tons to 12,843,000 tons; in the same period gold placer mining declined from 4,012,750 cubic yards of material treated to 41,000 cubic yards.

State of Washington

There have been no dredge or placer mining operations in Washington in recent years.

In 1960 there are 13 sand and gravel operations that disturb stream beds. In 1958 nine of these operations produced 887,920 cubic yards of sand and gravel; production figures for the other four operations were not available.

At the same time 66 fixed and 10 or more portable gravel washers in Washington discharge wastes characterized by their suspended inorganic solids content. These plants include all those that disturb stream beds as well as many that do not. The total discharge of these washers into rivers, estuaries, lakes, and the sea is 25,780,000 gallons per day. Total discharge of all industries to which permits have been issued by the Washington Pollution Control Commission is 1,114,000,000 gallons per day (does not include cooling water or irrigation return flows).

In the 1948-1958 period sand and gravel production in Washington rose from 9,267,225 tons to 24,389,000 tons.

State of Idaho

During the past several years Idaho dredge operations have been concentrated in Bear Valley, Valley County (two bucketline dredges recovering minerals contain-
ing columbium, tantalum, uranium, and rare earths); in the Elk City region of Idaho County (one dragline and one bucketline dredge and several washing plants recovering gold); and near Fernwood in Benewah County (two washing plants recovering garnet). Elsewhere, small hydraulic and hand operations have intermittently recovered gold. In 1958, placer gold production totaling $90,650 was recovered from 99,835 cubic yards of gravel processed by one bucketline dredge, 2 dragline dredges, 3 non-floating washing plants, 8 hydraulic operations, and 18 small-scale hand operations. Placer mining for gold in Idaho has drastically declined in recent years. In the period 1948–52 an average of 2,489,389 cubic yards of sand and gravel were processed each year for gold. The total fell to 1,238,100 cubic yards in 1954, to 351,978 cubic yards in 1956, and to 99,835 cubic yards in 1958. In this same period (1948–1958) sand and gravel production increased from 3,671,033 tons to 6,714,371 tons. How much of this production came from stream beds is not known; on the assumption that half of the production came from stream beds, about 2 1/4 million cubic yards of sand and gravel were removed from streams.

Figures on production and volume of gravel moved by the two dredges in Bear Valley are not available, but it seems reasonable to assume they have not processed more than 1,000,000 cubic yards a year.

The extent of placer mining for gold in Idaho will probably continue to decline unless the price of gold is raised by the U.S. Government. On the other hand placer mining for rare or strategic minerals is likely to be continued, perhaps at an accelerated pace, despite the fact that such mining is now suspended because of market conditions.

State of Montana

In 1958 eleven placer operations (1 bucketline dredge, 1 dragline dredge, 3 hydraulic operations, 2 nonfloating washing plants, 4 small-scale hand operations) produced 1,088 ounces of gold from 210,000 cubic yards of sand and gravel (down from 27,434 ounces in 1947, recovered from 6,093,609 cubic yards of material processed in 54 operations). In 1958 eleven other placer mines were intermittently active, but with no record of production.

Sand and gravel production in 1958 totaled 13,432,000 tons (up from 7,383,873 tons in 1948). There were 58 sand and gravel operations; 15 are known to have obtained water from rivers and streams; 9 obtained water from underground wells; 19 operated washing plants, but the source of water is not known. Fifteen were producers of pit run sand and gravel. It is assumed that water from streams was returned to streams, but that dry land operations were not stream contaminating.

Three dredges were operating in 1959, with an estimated production of less than $55,000. Nine other placer operations were active, but the value of production is not available. Sand and gravel production was 13,500,000 tons.
REGULATIONS GOVERNING ALLUVIAL MINING IN THE PACIFIC NORTHWEST

State of Oregon

Stream-bed sand and gravel deposits are exploited under leases from the State Land Board which can and does govern the nature of the operation through lease stipulations. However, the Board has not used lease stipulations as a means of closely policing siltation.

In addition the pollution of Oregon streams is controlled by the Oregon Sanitary Authority under Oregon Revised Statutes 449.005-449.070, 449.105-449.135, 449.215-449.245, 449.320-449.330, 449.505-449.580, 164.440, 164.820, 431.990, 449.990, 496.990, 509.460, 547.425, 547.430, and 549.400. Powers and duties of the Sanitary Authority include encouraging voluntary cooperation in restoring and preserving the purity of state waters, formulating rules and regulations pertaining to pollution control, establishing standards of purity of the various waters of the state, conducting research, receiving and acting on complaints received, and enforcing compliance with water-pollution laws. Mr. Kenneth H. Spies, Deputy State Sanitary Engineer, in a letter to the Chairman of the Alluvial Mining Subcommittee, states: "We are sorry to inform you that these laws contain no specific provisions relative to the discharge of harmful quantities of inorganic materials or to the problem of siltation caused by such materials in streams or lakes. Siltation caused by mining, gravel washing, timber harvesting, road construction and related operations on the upper water sheds of our streams has been one of our most difficult problems to solve."

A dredge-mining act was passed in May 1957 but there has been no application for a dredging permit since its enactment.

The Oregon dredging law defines "dredging operation" as any dredge mining operation except industrial mineral or sand and gravel production that substantially disturbs more than 15 acres per year of the topsoil of ground cover of the land on which it is conducted, if the land so disturbed constitutes the floor of a valley. It requires a license and a surety bond not to exceed $300 per acre. At the discretion of the State Land Board which shall cause to be conducted a field examination of the land covered by the application, the licensee may be required to:

(a) Replace the topsoil and ground cover disturbed in the course of the dredging operation and restore the area involved in the dredging operation to its reasonably useful condition.

(b) Replace any stream disturbed in the course of the dredging operation and with a pool structure conducive to good fish habitat and recreational use.

(c) Construct settling ponds of sufficient capacity and character to remove silt caused by the dredging operation before the water is discharged into a stream.
The act provides for an appeal to the circuit court after license revocation and requires the Board to make periodic inspections of dredging operations to determine whether the act is being complied with.

**State of Washington**

*Water quality protection* in Washington is provided by the Pollution Control Laws (Chap. 216, Laws of 1945 and Chap. 71, Laws of 1955). A resume of these statutes follows: Polluting State waters is declared unlawful. The Pollution Control Commission is made up of the Directors of the Departments of Conservation, Fisheries, Game, Health, and Agriculture. The Commission has the power to make its own rules to regulate pollution. It is required to determine what qualities and properties of water shall indicate a polluted condition. It may seek injunctive or abatement relief when pollution conditions warrant this action. A permit must be obtained from the Commission before any sand and gravel operation that affects a watercourse (or any other water-polluting operation) is allowed to start.

The Supervisor for Survey and Research of the Pollution Control Commission states "we have not yet established turbidity standards regarding all streams; rather we tailor requirements to the specific industry on the specific stream. Requirements ... vary from simple detention ponds to flocculation and sedimentation facilities. Requirements will vary according to stream flow, natural turbidity, size of operation, significance of the stream as to salmon propagation and rearing, etc."

*Land restoration* is governed by state law only when state lands are affected. No state mining law regulates dredge mining, placer mining, or sand and gravel operations with respect to restoration of land surface on federal land, or on private land. On private land each lessor and each lessee, of course, have the right to include in their lease any terms they may mutually agree upon with respect to land restoration. In addition, most cities and some counties in Washington have zoning laws that regulate the use that can be made of lands both public and private within the areas of their jurisdiction.

**State of Idaho**

Idaho laws governing stream pollution fall into three categories: The Dredge Mining Protection Act; pollution statutes administered by the State Board of Health; and a statute protecting fish from pollution. Only the dredge-mining act has any provision for land restoration.

In 1953 the Idaho legislature passed a Dredge Mining Protection Act (Chapter 183, S. B. No. 157) which required construction of settling ponds and leveling of tailings; it required the obtaining of a permit and placed administration in the hands of the State Inspector of Mines.

In the general election of 1954 a more stringent dredge-mining act was passed as an initiative, later to be signed into law by the Governor. This act, as amended
by a subsequent legislature (Idaho Code 47-1312 to 47-1321) requires, as did the
superseded law, the smoothing of dredged lands, the construction of settling ponds,
and operation under permit. In addition, it requires the posting of a surety bond of
$6,000 for the first tract of 20 acres or less to be dredged and $300 per acre for
tracts larger than 20 acres; it requires the replacement of disturbed watercourses
on meander lines with pool structure conducive to good fish and wildlife habitat and
recreational use; and it puts administration of the law in the hands of the State Board
of Land Commissioners instead of the State Inspector of Mines.

The 1953 law exempted from its provisions any operation with equipment not
capable of moving 1000 cubic yards of material per day. This exemption was reduced
to 500 cubic yards under the present law, which states: "For the purposes of this
act dredge mining means placer mining operations to recover minerals with the use
of a dredge boat or sluice washing plant whether fed by bucket line as part of such
dredge or by separate dragline or other supply capable of moving 500 cubic yards
of earth material per day."

Each operator is required to "construct settling ponds of sufficient capacity
and character to reasonably clarify the water used in the mining process before such
water is discharged into the stream."

The State Board of Land Commissioners is charged with causing periodic in-
spections to be made of operations under permit, the cost and expense of making
such inspections to be borne by the dredge operator, failure to pay such costs to
be cause for revocation of permit.

The act further requires that, should an applicant for permit not be the owner
of the lands to be dredged, the owner shall endorse his approval of the application.

Permits are not transferable.

The act provides for appeal from an adverse decision of the State Board of Land
Commissioners directly to the State Supreme Court. However, this provision of the
act was declared unconstitutional by the State Supreme Court in 1957 in the case of
State of Idaho v. Vernon B. Finch (315 P. 2d 529), in effect reversing a revocation
action of the State Board of Land Commissioners. Mr. John G. Walters, State Land
Commissioner, states: "Since the....decision of the Supreme Court ruling the direct
appeal procedure to be unconstitutional, the Land Board has not given consideration
to a procedure to be followed in the future in revoking a permit for noncompliance.
This question will be dealt with if and when it arises."

The State Board of Health (see Chapter 39-101, Idaho Code as amended by
Chapter 196 Idaho Session Laws passed at the 45th Session of the State Legislature,
1957) is empowered to establish and enforce minimum sanitary standards for the qual-
ity of water supplied to the public and the protection of watersheds used for public
water supplies. On May 11, 1959, the Board adopted a set of Water Pollution Con-
trol Regulations that includes the following statement:
"All wastes discharged to waters of the state shall be subjected to such treatment that they shall not create a health hazard or nuisance and such wastes shall not impair the quality or interfere, either directly or indirectly, with the treatment process of any public water supply. Waters of the state shall include surface waters and underground waters."

"Minimum acceptable treatment for any waste shall be equivalent to the removal of readily settleable and floatable solids."

Chapter 36-1101 of the Idaho Code, administered by the State Department of Fish and Game, makes it "unlawful for the owner...of any sawmill, reduction works...or any other person...to permit to pass into any stream or lake any sawdust, chemical or other substances that will or may tend to the destruction or driving away from such waters, any fish.....nothing in this act contained shall prevent the owners of any quartz mill or reduction works...to be located upon any natural stream or lake, from operating said quartz mill or reduction works where the said owner or owners thereof shall build or cause to be built a suitable dam for settling purposes...the director of the fish and game department shall first approve the plan for such dam..."

State of Montana

Montana has no dredge law; however, the Water Pollution Act of 1955 provides that operators must act under the supervision of the Water Pollution Council. The Montana Board of Health is the administrative agency of the Council, and may direct what waste treatment facilities are necessary (see Revised Codes of Montana 1947, Title 69, Chapter 13).

It is unlawful to cause the pollution of any waters of the State, except those that have been primarily and continuously devoted to industrial waste for over 30 years (unless that water is now used for human consumption as a single public supply system serving more than 100 persons), provided, however, that new industry discharging industrial or other wastes into waters shall be required to maintain the classification established by the council at the point of discharge and downstream. Permits must be secured from the State Board of Health. The Yellowstone, Clark Fork, and Kootenai watersheds have been officially classified by the Montana Water Pollution Control Council. The Missouri watershed has not been classified, but the State Board of Health has worked with a gold-dredging operation in order to keep down the silt load. Mr. Clairborne W. Brinck of the State Board of Health, source of this information, adds: "It is anticipated that we will be working with those who are washing sand and gravel as soon as our staff time permits."

Land restoration is covered by no Montana law, although it could be made a condition of a state mineral land lease by the Commissioner of State Lands and Investments or of an agreement on private land between lessor and lessee.
RECOMMENDED CHANGES IN EXISTING CONTROLS

Alluvial mining in perspective

During the work of this subcommittee, the members have felt that alluvial mining should be viewed in perspective, as one of several causes of stream pollution and of channel and bank disturbance. We have studied only one facet of a problem that is serious and growing: the problem of siltation and destruction of natural stream beds and bank cover—from deforestation, over-grazing, road-building and logging operations along and in streams, and from mining operations. Consequently, we do not favor the enactment or continuance of dredge-mining acts or alluvial-mining acts as such.* Particularly, we do not wish our set of recommended control measures to be taken as a "model law." We think that our recommendations should be incorporated into general laws and regulations governing stream pollution, channel disturbance, and bank destruction.

On the other hand, we recognize here a conflict between the ideal and the practical solutions. Existing control agencies in Oregon and Idaho are not organized on a commission basis, and do not have balanced representation of the various state conservation interests. Consequently it may be more practical to strengthen the existing agencies, even at the expense of overlapping and discriminatory legislation, with the ultimate hope of establishing a single agency to deal with problems of water pollution, channel disturbance, and bank destruction.

In order to get a basis of agreement and a set of standards by which present controls might be judged, the subcommittee has established the following recommended control measures which the members believe should be incorporated into statutes and regulations that govern alluvial mining activities.

*Although we may have gone somewhat beyond our charge in recommending against alluvial mining acts, it was necessary to do so to obtain agreement on the final report; some of us felt we could not subscribe to a final report that did not contain a statement to that effect. As a group we are in favor of legislation to properly control the use of stream waters, beds and banks, and to insure adequate land restoration when needed. Consequently, we are opposed to alluvial mining acts per se, because they cover only one phase of a large problem. On the other hand, it should be made perfectly clear that we prefer an alluvial mining act to the absence of controls: it is better to attack a problem piecemeal than not at all.
Recommended Alluvial Mining Control Measures*

General

1. **Definition**: Alluvial mining, for purposes of this report, means surface mining operations to recover minerals or mineral aggregates from alluvial deposits, where such mining disturbs or affects streams. Examples of surface alluvial mining methods include, but are not limited to, the following: dredging, hydraulicking, sand and gravel removal.

2. **Administration and inspections**: Appropriate administrative agencies shall be charged with the responsibility of administering these controls, granting permits, and making periodic inspections to determine compliance with the regulations thereunder.

3. **Permit and bond required**: No alluvial operation shall be conducted unless a permit has been obtained and an adequate bond posted.

Water control

4. **By-pass of excess water**: Where stream flow is in excess of that necessary for mining operations, such excess, when feasible and necessary, shall be by-passed from the working area. Determination of feasibility and necessity shall be by the appropriate regulatory agency of the state.**

5. **Treatment of water used in mining operation**: Where the water used in an alluvial mining operation flows into a stream, the operator shall construct settling ponds or a treatment plant (or both) of sufficient capacity, character, and stability to reasonably clarify the water used in the mining process before such water is discharged into the stream.

   (a) Reasonable clarity for each operation will be determined by the regulatory agency acting upon advice of the State Fish and Game Department and other concerned state and federal agencies.

   (b) Provisions may be made for controlled release of pond contents at times when damage to downstream uses will be at a minimum.

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*In order to arrive at agreement on needed changes in control measures, we found it necessary to set up a group of recommended standards that we all think should be incorporated into any set of statutes or regulations governing alluvial mining. Although at one time, for convenience, we called this group of standards "a model alluvial mining act," we do not so label it in this report because we are opposed on principle to laws that single out for control just one of several causes of siltation and bank destruction.

**At least two members of our group dissent, on the grounds that a regulatory agency, having little or no knowledge of mining, would not be qualified to determine feasibility or necessity; they would like the sentence deleted.
6. **Replacement of water courses:** Where feasible and necessary any water course disturbed by alluvial mining shall be replaced in a manner to restore the original stream capacity with pool structure and bank slopes conducive to good fish and wildlife habitat, recreation use and siltation control.

When determined necessary by the state regulatory agency, sand and gravel operations in stream course shall be conducted behind dikes or dams. Upon completion of the operations, such dikes or dams shall be opened for the free movement of stream flow through the mined area.

**Land control**

7. **Land restoration:** Before starting an alluvial mining operation (except sand and gravel operations) the top soil shall be removed and piled for use in subsequent land restoration. The amount of top soil necessary to be removed and piled shall be determined by the regulatory agency acting upon the advice of soil experts. All ground disturbed during the mining operation shall be smoothed over comparable to the natural contour of the ground prior to disturbance. The top soil removed from the area shall be placed on top of the disturbed area and after smoothing, seeded or planted as directed by the regulatory agency acting upon the advice of qualified experts.

In sand and gravel operations the land shall be restored in such a manner as to insure, as far as possible, the greatest degree of public safety and future land use.

**Distinction between water control and land control**

In the case of water-quality and even stream-channel controls, we are dealing with a state resource, that may be regulated by state laws, irregardless of ownership of the land along the streams.

In the case of the land along the streams, however, the question of land ownership enters. The subcommittee recommends as follows:

Land use controls on federal land should be administered by federal law. Land use controls on state land should be administered by state law. Land use controls
on private land should be at the lowest practical and effective government level.* State law will apply on federal land in the absence of appropriate federal law.**

Review by states

Although our recommendations for changes in existing controls on alluvial mining can easily be predicted by comparing our set of recommended controls with those existing in the four northwest states, we shall hereunder point out some of the more important changes we think should be made.

OREGON--Sand and gravel operations in Oregon do not appear to be adequately covered by existing law. In the existing general pollution law and its administration, public health phases are greatly emphasized; management groups and the activities with which they are concerned should be represented in the administration of this law. In short, we believe the general pollution law should be amended to provide for adequate and impartial control of siltation problems; when this is done, the dredge law should be repealed because it will be unnecessary. Channel and bank restoration should be provided for under new legislation in accordance with our general recommendations.

WASHINGTON--Water control laws are adequate, but the state has no land restoration law. Our general recommendations for land restoration control would be applicable.

IDAHO--The provisions of Idaho's Dredge Mining Protection Act are in general accord with our recommendations. We would remove the 500 cubic yard per day exemption, provide for flushing of settling ponds and require reseeding of restored land. We think the provisions of this Act, amended in accordance with our general recommendations, should be incorporated in inclusive pollution and land-use control legislation, making the Dredge Act, as such, unnecessary.

*The Committee is not in agreement on what "the lowest effective governmental level" should be. Some of us feel that the state level is the lowest practical level of governmental control of alluvial mining practices, even where private land is involved. Others of us feel equally strongly that laws or regulations for private land, if needed, should be enacted only at the county or municipal level.

**At least one member of the subcommittee disagrees, holding that controls on federal land should be in the federal law--nowhere else. However, it must be recognized that, by what might be called tacit agreement of the federal government, state laws are operative on federal lands in the absence of conflict with United States statutes.
MONTANA—Montana's stream pollution laws are adequate in terms of our recommended controls. As in the case of Oregon, however, the pollution laws emphasize public health and are administered by the State Board of Health; consequently, we must recommend representation of resource management agencies in the administration of these laws. Legislation is needed to govern land restoration on state land and replacement of stream courses wherever disturbed.

In summary, we recommend changes, where needed in existing water-pollution laws in the four northwestern states so as to incorporate our water control recommendations and to provide for inclusion of resource management agency representatives in administration; the incorporation of our land control recommendations into regulations of the agencies having control of the lands in each of the four northwestern states; and the concomitant or subsequent repeal of any existing dredge-mining acts.

The foregoing recommendations accord with our opinion, previously stated, that our suggested controls, although specifically designed for alluvial mining, should be applied as portions of general laws governing all users or disturbers of stream waters, beds, and banks.
SELECTED BIBLIOGRAPHY

For those persons wishing to consult more extensive available articles and reports on various aspects of alluvial mining, its effects and controls, the following bibliography has been compiled by the Alluvial Mining Subcommittee:

**Alluvial mining processes**


Contains a detailed discussion of placer mining methods, including dragline dredging, bucket-line dredging, dry-land dredges, hydraulic mining, and small-scale methods. Laws affecting placer mining in California are given.


**Alluvial resources of the Northwest**


Methods and appliances for individual prospectors. Placer-mining districts in Montana.


Description of placer areas in Montana with a summary of types of placers and methods of mining.


Occurrence and location of gold deposits, both placer and lode in Idaho. History of production and statistics.


Map of occurrence and nature of heavy alluvial minerals in Idaho.

Description of Bear Valley deposits.


Occurrence and description of gold deposits, both lode and placer in Washington.


Maps and descriptions of deposits, including sand and gravel.


Maps and descriptions of deposits, including placer gold.

Minerals Yearbooks, U. S. Bureau of Mines

Mineral production statistics, by state and commodity.

Effects of alluvial mining


Changes in conditions of rivers due to mining, accumulations of debris, restraint of debris.


Includes description of placer mining areas in the Boise Basin and data on the sediment load from watersheds in that area.

Report upon the feasibility of the resumption of hydraulic mining in California, by California Hydraulic Mining Commission, 85 p., 1927.

Presents results of an investigation relative to the practicability of resumption of hydraulic mining operations in California. Includes brief discussion on settlement behind dams and consequent relative turbidity of overflow, and on the value for flood control of the
restraining of natural debris. Brief data are given on sediment in samples from some rivers.


Discusses stream pollution, nature of pollutants, their effect on fish life. Includes two paragraphs on the way erosion silt affects the conditions of stream fish food, and fish life.


Effects of erosion silt on aquatic life, based on observations at more than 700 stations of the Mississippi-Ohio-Missouri system and on laboratory experimental work.


Sand bottoms are almost barren of benthic organisms. Addition of sand or silt to rubble or gravel bottom greatly decreases stream productivity.


Results of experiments conducted at a state fish hatchery.

**Hydraulic mining and debris control, Sacramento River and Tributaries, California**, by U. S. Engineer Dept., 12 p., 1938.

Discusses briefly the historical development of hydraulic mining methods, the debris problem and its effects on extreme floods, action taken against hydraulic mining, the California Debris Act creating the California Debris Commission, and efforts of the Commission to control deposits on the Yuba River where the most threatening volume of debris had accumulated.


Reports on investigations, for the Oregon Department of Geology and Mineral Industries, on the effects of placer mining operations on runs of fish in the Rogue River, Oregon.

A **critical review of the report by Dr. Henry B. Ward** titled:

"Placer mining on the Rogue River, Oregon, in its relation to the fish and


Concludes that slit is harmful to salmon and trout if it is heavy enough to form a layer on the stream bottom, or if it persists during periods between floods.


Effects on plant and animal life are included. Remedial measures are proposed.


Results of observations on the effect of silty or muddy water on fishes, and the effect of mining debris on fish foods.


Induced turbidity using montmorillonite clay reached concentrations of 20,000 ppm before harmful effects were shown by fishes. Most species withstood turbidities of 100,000 ppm for a week or longer, but died finally at 175,000 to 225,000 ppm.


Results of pond studies to determine effects of turbidity on growth rate.


Placer mining considered injurious to spawning of sockeye salmon.
Water quality standards and objectives

Sewage works design standards and water quality objectives, Pollution Control Council, Pacific Northwest Area, 72 p., 1952.

Water supply and watershed protection, Pollution Control Council, Pacific Northwest Area, 37 p., 1956.

Water supply watershed protection, CBIAC Subcommittee on Water Pollution Control, 17 p., 1954.

Laws governing alluvial mining


Mining laws of the State of Idaho. State Inspector of Mines (Boise),

