STATE OF OREGON

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

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Dredging of Farmland in Oregon

By

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With Introduction

By

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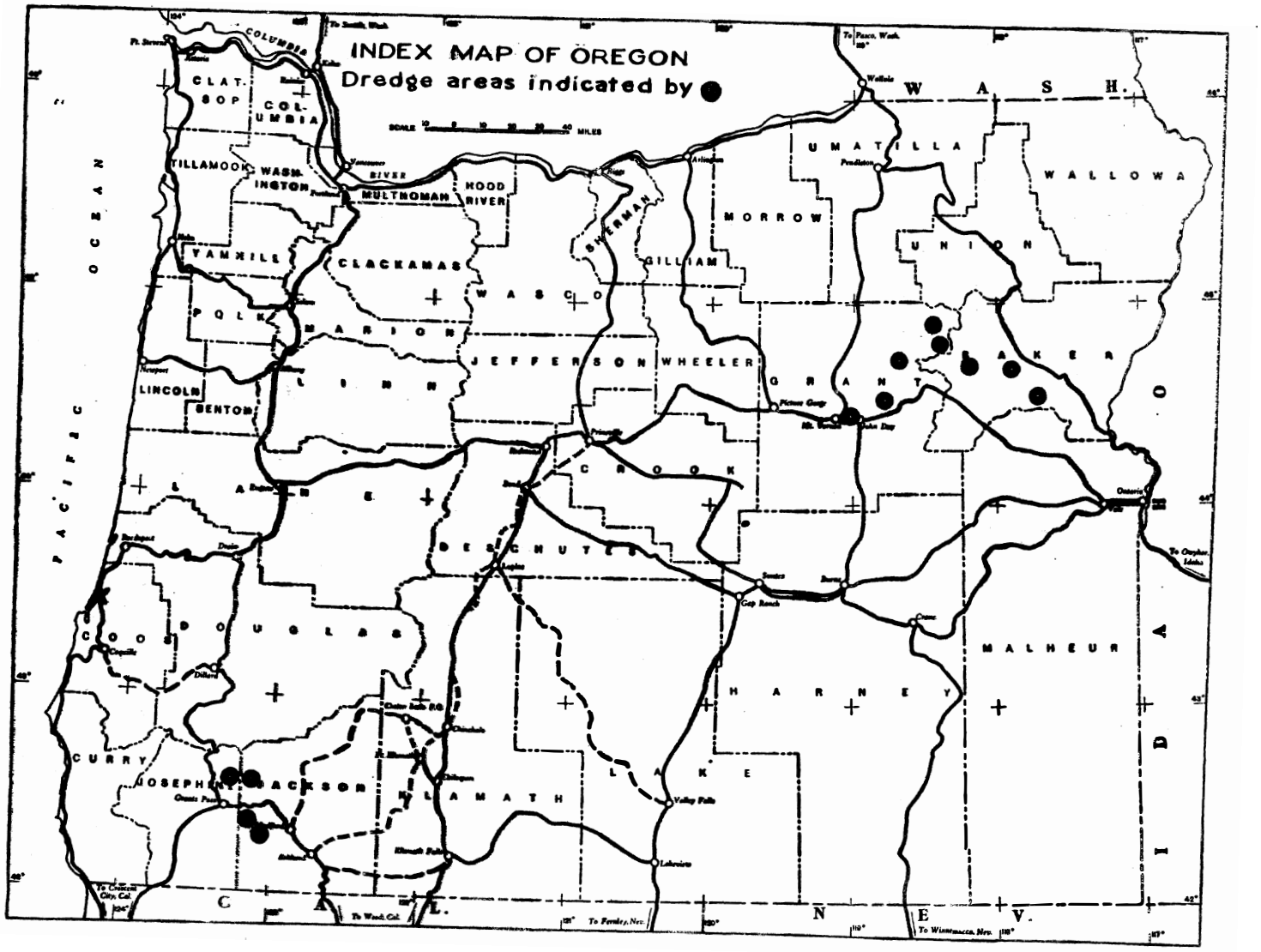
1939


INDEX MAP OF OREGON
Dredge areas indicated by
PACIFIC OCEAN
CLAT.
SOP
COL-
UMBIA
TILLAMOOK
WASH-
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MULTNOMAH
HOOD
RIVER
SHERMAN
MORROW
UMATILLA
WALLOWA
UNION
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CLACKAMAS
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GILLIAM
POLK
MARION
JEFFERSON
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INTRODUCTION

by

Earl K. Nixon

In connection with the Department's undertaking a study of dredging in relation to resoiling, a brief bit of history may be appropriate.

Late in October, 1938, a well known Oregon dredge man and the writer made a long auto trip together. Partly to pass the hours and partly to maintain a friendship of years standing by facetiously assuming, as always, opposite sides of any subject of discussion, we arrived quite promptly at the stage of debate in regard to the economic possibility of resurfacing or resoiling after dredging. Naturally, impressions were given first, but we soon agreed that impressions are indeed hollow when one sets out to reach conclusions. Next came facts. While I drove, he covered some pages of scratch paper with figures and calculations, following the lines of my suggestion; then he drove and I figured. And, as always, during our peregrinations in former years, we reached some definite conclusions, although the debate was a draw. We concluded that: (1) our preliminary and offhand conclusions based on impressions were vulnerable; that (2) our first-expressed ideas showed us to be too human and thus fallible - that our subconscious wishes were fathering our thoughts; that (3) there are indeed two legitimate and substantial sides to the argument, not one - the cost accountant's angle; and that - and this is most important - (4) we didn't have enough facts available (nor had anyone else to our knowledge) to arrive at a really satisfactory conclusion.

This lack of facts on a matter of controversial nature and of interest to a large number of people in this state, led the writer to start a Departmental study of the subject in November 1938. During January 1939 the Department was requested by Governor Sprague to complete the study and present the facts and conclusions. This report is the result of the study in question.

It is an engineering study of facts concerning dredging in Oregon, particularly those relating to the alleged damage done to farm lands. The conclusions reached are believed to be justified by logical analysis of the facts, and the report, it is hoped, will be constructive in its effect.

Land value figures used in this report are based on (1) assessed valuations as obtained from the several county assessors, and (2) estimates as given in "Basic Data of Oregon Counties", by Arthur Damschen and Welles Bushnell of the Oregon State Planning Board. These latter estimates were obtained by the authors from the United States Census of Agriculture (1935).

The discussions concerned with the technical features of dredging are not presented with the idea of instructing experienced dredge operators. However, the upping of the price of gold from $20.67 to $35.00 per fine ounce in 1934 has caused relatively inexperienced investors and operators to enter the dredging business. This is especially true in regard to the so-called "doodle-bug" or dragline type of dredge. The newer operators (and possibly one or two of the older) may find some meat in this report, especially in the appended section.

In carrying out and reporting on a study of this kind, affecting a substantial industry in Oregon - and because it is the job of this Department to encourage mineral production - it has been difficult for us to state our case without seeming to place ourselves in the position of an advocate. We offer no apology for being human. In weighting the emphasis placed on our various interpretations of facts collected, we have endeavored, however, to be unbiased and judicial in attitude.

Before getting very deeply into the matter of resoiling after dredging, it became apparent that a study of stripping (of overburden) and stripping costs must receive careful study. We doubt if the average dredge operator in Oregon or elsewhere has given sufficient consideration to the matter of stripping in advance of dredging, especially in those cases in which the ground to be dug has an upper lean or barren zone. In such cases, careful preliminary planning based on intelligent investigation and calculation to determine the feasibility and economics of stripping may indicate a modified program. It is so much simpler and - ostensibly, at least - cheaper to operate without stripping that there is a tendency to avoid it. For this reason, it seemed advisable to include as a part of this report (as an appendix) some results of our study of stripping and stripping costs. For the purpose of arriving at a unit cost of resoiling, we went so far as to devise a mathematical formula - perhaps terrifying at first sight but quite simple of solution - embodying those essential factors which need to be evaluated in a resoiling operation. Some old operators may challenge our findings; some new ones may profit by more seriously taking into account certain items of cost that are all too often neglected. In either or both events, the mental exercise shall have benefitted all of us.

Certain facts which are indisputable stand out in connection with the dredge situation in Oregon. One of these is the almost negligible amount of land, tillable or otherwise, in comparison with the total area of Oregon, tillable or otherwise, that is affected by dredging. The land area of Oregon is 61,887,360 acres; her farm land area is 17,357,549 acres; and her cropland area is 4,971,491 acres. Now, each year, about 420 acres of land are dredged in the state. Of these, about 192 acres are waste land, 158 acres are grazing meadow or hay land of low value but nevertheless classed as "tillable", and about 70 acres are classed as actual crop land. Thus, less than .0007 of one percent of the area of Oregon is affected each year by dredging, and .0015 of one per cent of the actual crop land area of the state is dredged each year.

The total ultimate amount of estimated dredgeable ground in the state would only amount to removing .04 of one per cent of the state's crop land from production. Whereas, there are about 280,426 acres, or 5.6% of the crop land of the state taken out of production each year (according to the State Planning Board figures) for no other apparent reason than that it doesn't pay to farm this land.

It is somewhat difficult to make an accurate comparison of the good accruing to the community and state in the production of new wealth by dredging an acre of cropland with the benefits gained by continuous crop production of that same acre of land. Using the figures on page 19 of $10.43 for the average per acre yearly return of good cropland in the John Day Valley and one-half of the gross gold estimated as producible from that acre - $1815 (on the assumption that one -half of the gold is immediately returned to circulation locally and within the state), it would seemingly be fair to divide the latter figure by $10.43 to determine the length of time it would take an average acre in continuous production to

equal the good done by dredging, or 175 years. This must be in a manner a generalization, as there is no demonstrably accurate method of making a true comparison. It must be remembered that $1815 placed in immediate circulation is re-used and reinvested in various ways by various recipients and its good does not terminate but carries on over a period of years.

There are those who make the impassioned plea, "See those acres of dredge tailings! They look like hell, and think of the ruined land we are leaving for posterity." On the first count we are indeed licked; tailings not only have no esthetic value, they are offensive - as much so or more than a stretch of hundreds of acres swept clean by a forest fire or the thousands of acres of cut-over stump land up and down western Oregon (acres that at this time don't help the Oregon tax rolls much). The purely esthetic aspect of dredge tailings is indefensible. However, let us ponder a moment and consider unbiasedly the reason for our attitudes toward unsightly surroundings.

In driving 300 miles up the Pacific Highway recently the writer tried to assay the esthetic qualities of the areas along the highway. At one point in the suburbs of a well known Oregon city we passed a waste dump filled with badly wrecked cars, broken down machinery, trash, torn bed ticks, baby carriages, wrecked bed springs, and unsightly rubbish of all kinds. In the next town we saw another waste dump equally as unsightly; farther on we passed near a bog, presumably mosquito infested, and a menace to health, of no earthly utility and objectionable from all angles. Coming into Portland we passed through acres of ramshackle timber sheds and a fuel yard of disgusting appearance.

Thinking again of the relation between the effect on us of such a series of unsightly areas and the effect of the sight of an area of dredge tailings, the conclusion is immediately reached that we have come to look on mosquito ponds, trash dumps, and unsightly suburbs as things to be taken for granted. We take for granted our acres of burnt-over and cut-over lands, and come to forget their unsightliness. We are used to them. The pain of their unsightly presence is dulled by time and consistent repetition of observation. Yet when we see an area of dredge tailings for the first time or second time, it is something we are not used to. We immediately recoil. If those same piles of washed rocks were heaved up by the sea and deposited along a coast highway, we would comment without esthetic objection to the unique way nature has of depositing boulders along a beach. We expect them that way. But if man changes nature, washes the boulders and deposits them on surface at some inland point, even though he may do thereby a tremendous good to the property owners and to the people of the state, we see only the objectionable quality of appearance and fail entirely to credit the direct and indirect good of the act.

The unsightliness of dredge tailings is the angle that receives the most adverse comment, especially from the few out-of-state tourists who see the tailings. As a matter of fact, there is so much sparsely populated area in Oregon that esthetic considerations are very difficultly reducible to dollar valuations. If these tailings were in suburban Los Angeles, such would not be the case. In the John Day valley with a population of 2000 the spending by dredge operators of more than a quarter-million dollars is a direct good which transcends and renders puny our arguments about the esthetic aspect, however true and apt these arguments may be. It's really an economic matter, not one of esthetics, and one to be settled in the areas affected, by the people affected.

On the second count, that of the effect of a relatively few ruined acres on posterity, let us give that some moments' thought. Has not every generation of our people been better able to utilize the facilities with which it finds itself provided, than the preceding generations? Has not each succeeding generation proved itself smarter, more progressive, easier to adapt itself to conditions, and less handicapped by the supposedly destructive acts of its forefathers than the preceding generation?

Dredging has been practiced only during one generation. No one has a right to say that dredged areas represent "land taken out of production for the next thousand years." We have seen stripped land in Illinois and Kansas planted to black locust which bore crops of fence posts as valuable to the owners as any crops the area had produced before as farm land. A U.S. Bureau of Mines Report (R.I. 3440) shows several pictures even of peach orchards in southeastern Kansas on spoil piles from mine stripping. By proper fertilization and scientific methods we are now producing greater farm crops in many areas than were ever known before in the history of the country. In the last fifteen years the cost of handling earth, using heavy machinery, has been halved two or three times. Who can say what will be the disposition of these relatively few acres of dredge tailings a few decades hence? Opposite page 18 of this report is a picture taken near John Day showing a spot of levelled-off tailings where a man has built a house and planted a garden.

One man in the John Day valley told the writer, "This meadow land would never grow anything but grass because the land was water-logged and the water table only a foot below surface. Now, the dredge has cut a straight channel through and lowered the water table to 3 or 4 feet. It will raise good alfalfa now." The valuation of that land in alfalfa will jump from $15 to $17.50 per acre up to $50 or more.

As to the alleged menace to the stock raisers in the John Day valley of the taking of stockfeed-producing land out of production by dredges, the Forestry Department estimates (page 17) that since early times the capacity of range land has been reduced from three to five acres - say, four - per cow month, to ten to fifteen acres - say, twelve - per cow month. We interpret this as meaning that soil erosion and overgrazing (principally the latter) have changed the situation so that only four cattle can graze now, whereas the ranges would support twelve before - a 300% reduction in range capacity. Compare this with a 2% reduction in crop land due to areas dredged in the John Day valley, and the "menace" argument loses all point. As a matter of fact, it appears that the loss in range capacity has been made up in considerable part by increased stockfeed-producing capacity of the tillable land in the valley, regardless of the obviously small part played by dredge area withdrawal.

One angle of the economic effect of dredging in Grant county is worth pointing out: Taxes received in Grant county (see page 14) amounted to $127,216.00. Presumably some such similar amount will be paid for 1938. During 1938 the total taxes paid by dredges in Grant county was $63,553. We do not know what proportion of the dredge taxes were income taxes and went directly into the General Fund. However, it is indeed interesting to observe that six dredge concerns in Grant county made tax payments just half as great as the total tax receipts of the county in a similar year. Also, these same dredge concerns paid $546,344 in labor and supplies and taxes in 1938 - doubtless 3/4 of a million dollars if one includes amounts paid for capital expenditures and for land purchased.

Now, as to who is responsible for the tailings: Landowners normally ask the highest possible price they can get for their land. No one can blame them. Three hundred dollars per acre is not an uncommon price, for example, in the John Day valley. What farm acre in that or any other dredge area in the state will produce enough to pay income on such a valuation? With such a price for his land, a farm owner can pay his debts (as most of them did) and have enough left to enable him to lead an easier life for some time to come. Knowing that only a small fraction of the valley can be dredged anyway - not enough to interfere seriously with the stock feed supply, he takes a "What did posterity ever do for me?" attitude.

To us who do not live in a dredge area the thought immediately comes, "Why doesn't the land owner take less for his land, and make a bargain with the dredge company to level the tailings and replace the soil?" That question may be answered in a manner by recounting a statement made to the writer by a leading citizen of Canyon City. He told of a conversation that took place in his office between a farm land owner and a contractor who offered to level an area of his tailings and replace top soil for a certain per-acre figure (less than $100 per acre). The farmer said, "Nothing doing. If you did that, they'd slap a tax valuation of $75 to $100 on it and I couldn't pay the taxes and raise enough alfalfa and other truck through the years to pay interest on my investment. I can take the money I'd pay you for levelling and resoiling and go out and buy a lot more acres of other good land and put it in production". Anyway, that was the farmer's idea.

The problem seems to add up to this: there is no point, obviously, in resoiling waste land, which forms the largest part of the land that is being dredged in this state. Much of the land classed as "tillable" is actually meadow or grazing land, often brushy, which has so low a valuation that it would be economically unfeasible to resoil because of the cost involved. Resoiling would and probably could be done where land actually produces high value crops or fruit and where the average yearly net farm profit would make the land have a value of $200 or $300 per acre. Little or none of this kind of land is known to exist or be affected in the dredge areas in Oregon.

Conditions vary so much in different dredge areas in Oregon that no general regulatory rule or law could be devised that would be fair and equitable. A rule that would be applicable at one point would be apt to work an extreme hardship somewhere else. Taking only the esthetic angle, and forgetting for the moment the value in dollars to the state of the dredging industry, there is a difference of opinion as to the constitutionality of laws that try to define so-called "public nuisances". In some states sign boards have been declared public nuisances when located within certain distances from the highways; in others, such prohibitions, we understand, have been declared unconstitutional, presumably on the theory that a man owning land owns also the space from the top of the sky to the center of the earth and it is his to do with as he wishes so long as he does not create a condition potentially or tangibly dangerous to his neighbor. The building of a powder factory in a built-up community would be a potential danger; an industrial plant that actually pollutes and poisons the air or water in a residential community might be proved to be a tangible menace to health and in such case a public nuisance. The determination of local public nuisances seems to be based on the effect of the said nuisance on adjacent property values and on health. This effect would be negligible in Oregon dredge areas.

Resoiling after dredging is compulsory in one or two countries in certain areas where peculiar conditions exist. It might become a legal requirement under certain conditions in California and Oregon, but under present conditions of dredge technique any such requirement would probably ruin the dredge industries in both states. Legislators entertaining thoughts of resoiling legislation should be certain first to analyze the overall economic aspect of the industry and loss of revenue if the industry were terminated.

The Department desires to acknowledge the kindness of and express its sincere thanks to many individuals including various county officials, Federal bureaus, and especially to the dredge operators for supplying facts and figures and much helpful information and assistance in the course of this study.

The following dredge concerns kindly furnished facts and data at our request:

Rogue River Gold Company, Rogue River, Oregon
Porter Brothers, Porter Building, Portland, Oregon
Mr. Norman Parker, Elk Creek Placers, Baker, Oregon
H. F. England & Co., Prairie City, Oregon
Ferris and Marchbank, John Day, Oregon
Oregon Mining Co., 1926 Second Ave., Seattle, Washington
Western Dredging Co., 650-5th Street, San Francisco, Calif.
Oroplata Mining Co., Granite, Oregon.
Mr. Max Hoffman, Sumpter, Oregon
Sumpter Valley Dredging Co., Public Service Bldg., Portland, Ore.
Timms Gold Dredging Co., Galena, Oregon

ABSTRACT.

Because of adverse criticism of gold dredging in certain farm areas, Governor Charles A. Sprague requested the State Department of Geology and Mineral Industries to report upon the economic phases of dredging in Oregon and the possibilities of resoiling of cropland after dredging operations.

In 1937, out of a total gold production in Oregon of $1,843,170, dredges accounted for $920,640, or about 50 per cent. In 1938, gold valued at $2,860,515 was produced and dredges recovered $1,573,075, or 55 per cent. The average unit value recovered in 1937 was 12.9 cents a cubic yard; in 1938 the figure was 15.5 cents.

Jackson and Josephine counties of southwestern Oregon and Baker and Grant counties of the northeastern part of the State contain the dredged and dredgeable areas. At the present time there are three operations in Jackson county; six in Baker county, three of which are in Sumpter Valley; and five in Grant county, two of which are in the John Day Valley.

The classification "farm land" includes all types from very low-value, brushy grazing land to the high-value irrigated lands. Most operations are in the low-value lands.

Jackson and Josephine counties contained, in 1935, about 415,000 acres of farm land with an average estimated value per acre of $61. The proportion of farm land, nearly all marginal and valued as farm land from $3 to $10 an acre, removed from use by dredging would be less than a quarter of one per cent.

Baker county had in 1935 714,187 acres of farm land with an average estimated value of $15.59 an acre. With the exception of part of Sumpter Valley, all of the land so far dredged is in low value grazing land, and the proportion of farm land removed from use by dredging would be less than a quarter of one per cent. The proportion of county cropland removed from use by Sumpter Valley operations would be less than one per cent.

Sumpter Valley is high, the growing season short, and the proportion of hay grown to total production of hay in the county is considerably less than the equivalent proportion of acreages.

There has been in recent years a general shortage of water for farming in Baker county. At some time in the future it is probable that a dam will be built on Powder River southeast of Sumpter Valley to store water for the Baker Valley. A report on such a project has been prepared by the United States Reclamation Service in cooperation with the State of Oregon. When filled the reservoir would cover 1,700 acres of present cropland in the southeastern part of the valley. It is likely that this area, whether or not dredged, will eventually be taken out of production.

In Grant county there were 985,975 acres classed as farm land in 1935 with an average estimated value of $6.77 an acre. With the exception of the John Day Valley the dredge areas are in low value land and the percentage of county farm land removed from use would be a small fraction of one per cent.

John Day Valley operations have been criticized for destroying cropland. The location of dredge tailings piles at points close to the main highway gives a disproportionate idea of the amount of cropland taken out of production. There are approximately 30,000 acres of irrigated land in the Valley. In 35 years about 600 acres, or 2 per cent, have been taken out of production by dredge operations. It is probable that future workable dredge ground in the Valley will not exceed 1000 acres.

Facts show that, in return for loss of a relatively small proportion of farm productivity, dredges throughout the State create new wealth and spend a large proportion of it in the local community and the State at large in the form of taxes, wages, purchases of land, supplies, and repair parts.

The livestock industry is the most important in the John Day Valley. At present there is a close balance between summer range and quantity of hay raised for winter feed. Unbiased people have been concerned that a bad year would mean the necessity of bringing in winter feed from outside the county and that the crop land lost by dredging would be a factor in lessening the amount of winter feed available. This amount of cropland taken out of production appears to be of minor importance in the problem. Moreover, range land contiguous to and dependent upon cropland dredged has been taken over by other livestock operators who have been thus benefitted. For best results there is probably insufficient range land adjacent to the Valley, and it is likely that herds will be gradually reduced in size and increased thereby in quality. In addition, available winter feed is being increased by enlarging alfalfa acreage. By replacing meadow hay with alfalfa both the quantity and quality of winter feed will be greatly increased and improved. These factors are lessening the possible hazard of a lack of winter feed.

In making a comparison of monetary return on low value land used as farm land and as dredging ground, figures given evidence the great advantages in favor of dredging the ground.

Comparing destruction of farm land by dredging with other destructive agencies such as soil erosion and over-grazing gives a perspective of the insignificance of loss of farm productivity by dredge operations.

The total area of farm land in five counties which contain dredged and potentially dredgeable ground is 2,796,665 acres, containing 518,361 acres classed as tillable, or cropland. It is probable that the amount of dredgeable ground in the State is not more than 10,000 acres, of which not more than 2000 acres would be tillable. These figures indicate that a maximum of a little over three-tenths of one percent of farm land and a little less than four-tenths of one per cent of cropland of the five counties could be taken out of production by dredging operations.

Considering monetary return from high-priced land, that is, land worth, say, $100 an acre as farm land, in the application of such return to the needs of the community and the State, it is entirely probable that greater financial benefits accrue from dredging the ground than farming it. It is believed, however, that in most cases, with the proper cooperation between the land owner and dredge operator, it would be economically feasible to resoil such high value land, provided there are no special operating problems. This would mean that the land owner would need to accept a lower original price for the land dredged and resoiled in order

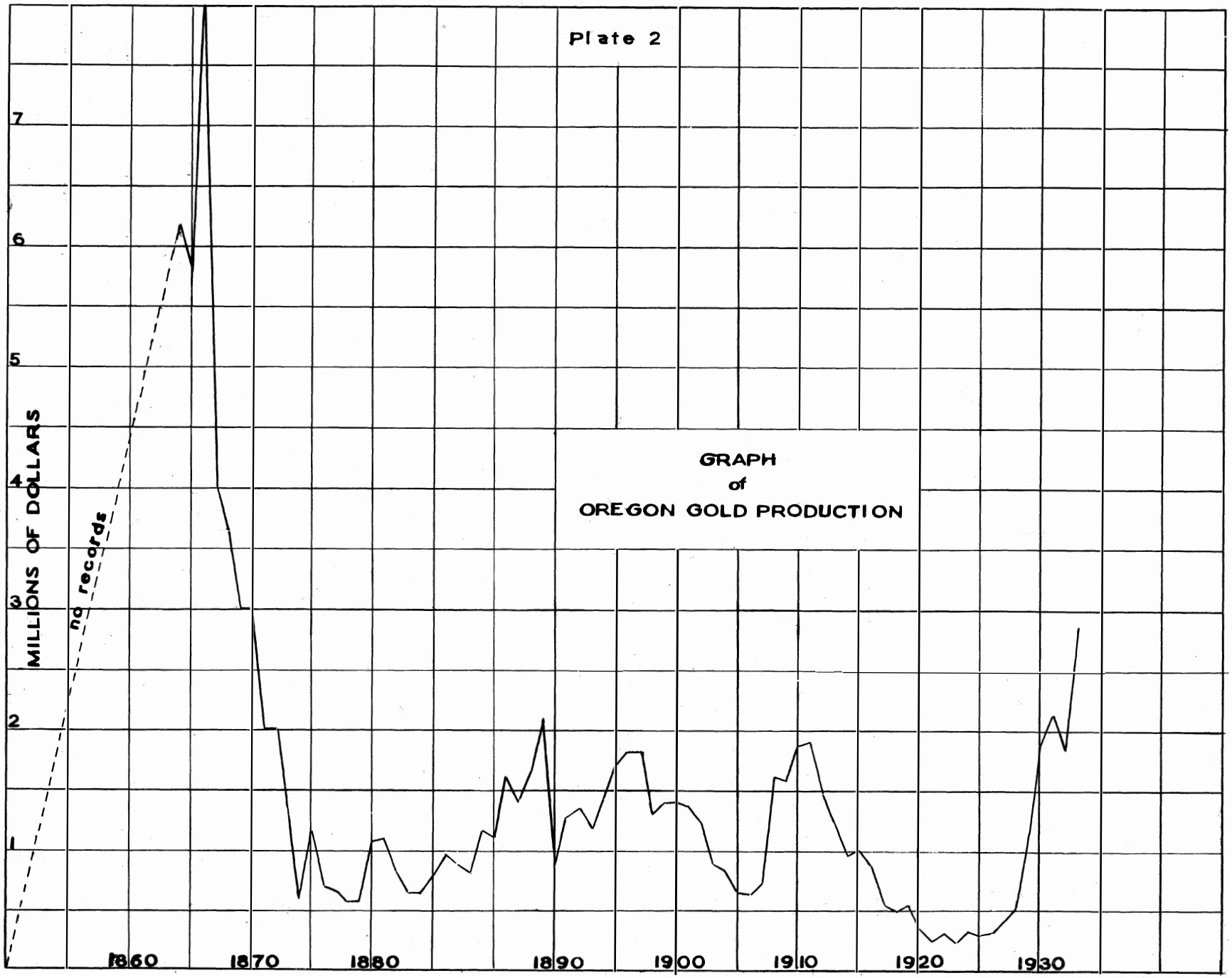


Plate 2
GRAPH
of
OREGON GOLD PRODUCTION
MILLIONS OF DOLLARS
7
6
5
4
3
2
1
no records
1860
1870
1880
1890
1900
1910
1920
1930

to cover the cost of resoiling. He would probably receive his land back in better condition than it was originally.

Most dredges operate on a small margin, and, when all costs are figured, the evidence is that operators usually pay a fair price for mineral rights.

Attempts to resoil lands by transporting excavated overburden in water have not been successful. The only practical method known is to excavate the soil dry and return it mechanically to the tailings pile.

Disregarding the possibilities of resoiling, stripping of barren or very low grade overburden is desirable and usually necessary in order to make the most economical operation.

If stripping on a tract of high-priced land (that is, land valued at around $100 an acre as farm land) is to be practiced then resoiling would, in most cases, be economically feasible. The cost should not exceed the resale value of the land, provided the tract is large enough to warrant the investment in stripping machinery.

Resoiling of low value land is not practical.

Legislative action designed to regulate dredging operations would be a strong deterrent not only on established operations but also on exploratory work by prospective operators. Conservation of cropland is, of course, greatly to be desired but in the few cases where resoiling can be done, decision as to conservation should be left to the land owner and dredge operator.

Object of Survey.

There has been criticism from time to time of dredging practice in certain Oregon farm areas. Much of this criticism is the result of impressions gained by people who have driven through such areas and observed rock pile dredge tailings which have apparently replaced green fields. The problems involved are neither new nor peculiar to this state; they have been a subject of controversy in California for years.

The State Department of Geology and Mineral Industries has been studying the matter for over a year, feeling that facts rather than impressions were essential in order to evaluate properly the indicated destruction of farm land. Governor Charles A. Sprague requested early this year that a report be prepared by the Department which would present results of a factual survey of dredging in Oregon in relation to damage to cropland. The following report covers studies of land values, economics of dredge operations, including the effects on local communities as well as the State at large, and the possibilities of reclaiming land after dredging operations.

History.

The first gold discovery in Oregon was reportedly by a member of an emigrant train on the headwaters of a branch of the John Day River in 1845. Placer gold was found on the Rogue River in 1849, but the first discovery that resulted in production and the formation of a mining district was on Jackson Creek in 1851. The town of Jacksonville was founded and a large production was maintained for several years. Other discoveries were made on the Rogue and its tributaries and the producing area broadened to include many localities in both Jackson and Josephine counties.

In Eastern Oregon the first discovery of gold which resulted in production was in 1861 in Griffin Gulch southwest of Baker. This was soon followed by other discoveries and that section of the State took the lead in gold production since the very rich placer diggings of southwestern Oregon had become exhausted. Gold was discovered on Canyon Creek in Grant county in 1862 and production from placer mining has continued in that general area with few interruptions to the present day.

Dredging began in Oregon in 1904 when one dredge started work in the John Day Valley, another in Jackson county, and a third project, guided by Albert Burch, operated near Granite. This type of placer mining had become effective in California at about the turn of the century, and California operators built two of the first three dredges in Oregon. It is interesting to note that in 1910 the United States Geological Survey reported in Mineral Resources that the Rogue River Dredging Company had a dragline bucket dredge under construction. This type of dredge excavator was not generally successfully applied until over twenty years later.

Statistics of gold production for the early years of the industry are very incomplete. A federal agency for collecting such figures was not established until 1866 and estimates made of production in prior years were little more than guesses. Undoubtedly annual production increased rapidly in the 1850's. Probably a maximum was reached in 1866 when it was variously estimated at amounts up to $20,000,000. One estimate of $8,000,000 may have been near the actual amount.

Then production began to decline and the varying yearly output is shown graphically on the accompanying chart. The all-time low was in 1928 when $225,968 in gold and $18,091 in silver was produced. The rise in the price of gold stimulated production, and since 1934 there has been an increase. The production for 1938 was $2,860,515, and it is probable that there will be a further increase in 1939.

Practically all of the production in early years came from placers. With the exhaustion of the rich placers, producing quartz mines increased in number and importance so that quartz mine production exceeded that of placers during the latter part of the last century and in the present one until after the World War. Then placer production, chiefly from dredges, again became important and in the last decade it has been generally greater than that from quartz mines.

There were eight operating dredges in Oregon in 1937, four with dragline excavators and four of connected bucket type. The number increased in 1938 and at the present time (mid-1939) there are, not counting dry-land plants, fourteen active dredging operations, - 3 in Jackson county, 6 in Baker county, and 5 in Grant county.

At present there is an increased activity in prospecting placer ground both in the southwestern and northeastern parts of the State. Two factors are responsible for this: first, the $35 an ounce price for gold, and, second, the growing application of dragline excavators to placer mining.

Production Statistics.

Oregon gold production from dredging operations for four years, 1935-1938, inclusive (compiled from U.S.B.M.Minerals Yearbook 1938 and preprint from Minerals Yearbook 1939).

Type of excavator	Year	Number Mines Producing	Material treated cu.yds.	Gold recovered			Percent total gold production
				fine ounces	value	Average per cu.yd.	
connected bucket	1935	5	3,440,000	12,720.13	$ 445,205	$0.129	23.5
	1936	5	5,148,000	17,067.26	597,354	.116	28.1
	1937	4	5,017,000	17,178.00	601,230	.120	32.6
	1938	5	7,258,226	29,006.00	1,015,210	.140	35.5
dragline	1935	3	1,237,000	4,008.23	140,288	.113	7.4
	1936	4	2,066,000	12,989.42	454,630	.220	21.4
	1937	4	2,085,000	9,126.00	319,410	.153	17.3
	1938	11	2,890,588	15,939.00	557,865	.193	19.5
combined types	1935	8	4,677,000	16,728.36	585,493	.125	30.9
	1936	9	7,214,000	30,056.68	1,051,984	.146	49.5
	1937	8	7,102,000	26,304.00	920,640	.129	49.9
	1938	16	10,148,814	44,945.00	1,573,075	.155	55.0

Summary of Oregon gold production for four years, 1935-1938 inclusive (compiled from U.S.B.M. Minerals Yearbook).

Year	Total gold production	Production from (2) types of dredges	Production all other placer methods	Production lode mines	Percent from (2) dredge types	Percent from all other placer methods	Percent from lode mines
1935	$1,895,604	$ 585,493	$ 559,148	$ 750,963	30.9	29.5	39.6
1936	2,126,355	1,051,984	327,751	746,620	49.5	15.4	35.1
1937	1,843,170	920,640	277,025	645,505	49.9	15.0	35.1
1938	2,860,515	1,573,075	328,510	958,930	55.0	11.5	33.5

These figures show the increasing importance of dredges in gold production in Oregon. The U. S. Bureau of Mines reports that of placer gold produced in 1938, 54 percent was recovered by connected bucket type dredges, 29 per cent by dragline dredges, 7 per cent by small-scale hand methods, 6 per cent by hydraulicking and the remaining 4 per cent by dryland washing plants with mechanical excavators and by drift mines.

Placer Types and Mining Methods

A placer, as applied to gold occurrence, is a deposit of alluvial or detrital material from which the gold may be obtained by the various methods of placer mining. Such deposits may be river gravels of present-day streams; they may exist in old or buried stream channels; they may occur as beach placers resulting from active surf, or in ancient and elevated sea beaches. Residual gold placers formed by the weathering of rocks in place are of minor importance economically in the United States. Glacial deposits containing gold are of small economic importance unless there has been a concentration of values by post-glacial stream action.

Various placer mining methods are used depending on several factors such as character of material to be worked, amount and distribution of gold values, quantity of water available, topography of the ground, areal extent, thickness and character of overburden, depth below surface, and character of bedrock. Of these methods the two most important for handling large quantities of material are: (1) hydraulicking, in which excavation is by high pressure water through nozzles, and (2) dredging, in which workable ground is mechanically excavated and the gold recovered in a washing plant usually floating on an artificial pond. This report is concerned with the second method of placer mining.

Suitable areas for dredging are limited to ground possessing certain characteristics, although the development and application of the dragline excavator have very materially enlarged the field. The critical natural conditions which govern the selection of dredge ground are as follows:

Dredge of Rogue River Gold Co., Graves Creek, Josephine County.

Dragline and washing plant of the Glide Foundation, Poorman Creek, Jackson County.

View northeast across Sumpter Valley. Pasture land in foreground. Sumpter Valley dredge left center.

PLATE 3.

deposits must be relatively flat with abundant water, such as river-bar or gravel plain accumulations; they must be extensive as to yardage in order to amortize the capital expenditure and provide a profit; ground should be relatively free of large boulders; bed rock should be flat or gently sloping and of such a character that it may be cleaned efficiently by the bucket or buckets; cemented gravel or that containing much buried timber precludes the satisfactory use of a dredge; other factors, such as depth of gravel and thickness of overburden, distribution and characteristics of the gold, possibility of freshets or floods, transportation facilities, and climate all have an important bearing on the selection of dredging as the proper method of mining a placer deposit.

These governing conditions have been modified somewhat in recent years by the application of draglines as referred to above. Although such excavators were used in placer mining in isolated instances as far back as 1910, it was not until 1933 that dragline dredges were successfully applied in this country. Since then, increase of application has been rapid. As compared to standard bucket line dredges their advantages lie in a lower first cost, a much greater flexibility of movement, and a greater resale value. Their disadvantages are: (1) a higher unit operating cost, particularly for labor and some items of overhead; (2) they are less efficient in cleaning bedrock, and dig economically to shallower depths than bucket line dredges; (3) the surge caused by intermittent feeding of gravel reacts against the most efficient operation of the washing plant. However, on certain types of deposits the dragline dredge is superior if not the only type which may be used economically; and an expanding application in its use seems assured.

Intelligent and extensive investigation is necessary to evaluate all the factors concerned in selecting dredge ground. Under favorable conditions dredging is a cheap method of excavating deposits, and, in conjunction with the simple methodsused in recovering the gold, its unit cost of production is such that ground carrying very low values may be treated profitably. Unit operating costs (as distinguished from total unit costs) for large capacity dredges may be as low as five or six cents a cubic yard.

Favorable dredge areas may be in river or stream valleys which have a soil cover, and which either are used or have a potential use for agricultural purposes; hence the dredging in areas classed as farm lands.

Dredge Areas in Oregon.

The localities where dredging was active in 1938 and 1939 were (1) Jackson and Josephine counties, (2) Baker county, and (3) Grant county. Douglas county has potential dredge ground, but there was no activity in 1938.

(1) Jackson and Josephine counties are taken as a unit since all of the dredge areas are on tributaries of the Rogue river. An outline of individual operations is given below.

(a) Burdick and Horner have two dredges, one a connected bucket, sluice type on Pleasant creek, and the other a dragline on Forest creek. The former, on a tributary of Evans creek, north of the town of Rogue River, started work in 1939; the capacity is about 3000 cubic yards a day. The area purchased or leased is said to be about 600 acres in sections 22, 27, 28, 33, and 34, T.34 S., R.4 W., Jackson county. This ground is classed as non-tillable, grazing land and

is assessed at valuations ranging from $2 an acre in sec.22 to $4 an acre in sec.33 and $7 an acre in sections 27 and 28. (Assessed valuation in the county is 70% of the supposed true value).

The dragline dredge on Forest creek, a tributary of the Applegate river, is in sections 3, 10, 14, and 15, T.38 S., R.3 W., and lies southwest of Jacksonville. The property was formerly known as the Albert Sturgis mine. Capacity of the dredge is about 1000 cubic yards a day. The assessed valuation of the land is about $4 an acre.

(b) Rogue River Gold Company has dredged approximately 150 acres on Graves creek, west of U.S. Highway 99 and east of the town of Leland, in sections 3 and 4, T.34 S., R.6 W., Josephine county. A bucket line dredge with a capacity of about 6000 cubic yards a day was used. The assessed valuation of the land dredged was about $7.50 an acre (with assessed valuation at about 66-2/3% of the "true" value). Operations were suspended in 1938.

(c) The Glide Foundation worked with a dragline dredge on Poorman creek, southwest of Jacksonville, in sec.7, T.38 S., R.2 W. Capacity was about 1000 cubic yards a day. Assessed value of the land dredged was about $3 an acre. This company has now moved its outfit to Foots creek south of the town of Rogue River.

(2) Baker County.

There are six active dredges, three of which are in Sumpter Valley, - an area in T.10 S., Rs.37 and 38 E., extending southeast from the town of Sumpter in the western part of the county. The Valley, watered by Powder River, contains both meadow land and range land. Assessed valuations are about 70% of the "true" value. A summary of individual operations follows:

(a) Sumpter Valley Dredging Company, the largest individual placer operation in the State, has a connected bucket type dredge working about five miles below or southeast of Sumpter. With 9 cubic feet buckets, capacity is about 280,000 cubic yards a month, which at the depth dug accounts for about 10 acres. The company controls in excess of 1200 acres, approximately seven-twelfths of which is meadow land with an assessed valuation of about $27.50 an acre, and five-twelfths range land with an assessed valuation of nearly $5.00 an acre, giving an average assessed valuation of $18.50 per acre.

(b) The K. R. Nutting Company and Little, Harris, and Wolfinger, both under the same management, each operates a dragline dredge about 1½ and 2 miles respectively southeast of Sumpter. Capacity of each of these plants is from 1800 to 2000 cubic yards a day. Assessed valuation of the land controlled is approximately the same as for Sumpter Valley Dredging Company. However, 680 acres of their land in Bear Gulch, tributary to Sumpter Valley, is jackpine land assessed at about $1.50 an acre.

(c) Max Hoffman has a dragline dredge on Cracker creek about 3 miles north of Sumpter. Capacity of the plant is 1200 to 1400 cubic yards a day. The dredge area is low value grazing land.

(d) Norman Parker, on Elk creek, southwest of Baker in sec.4, T.10 S., R.39 E., operated in 1938 a dragline with a dry land plant, that is, a washing plant

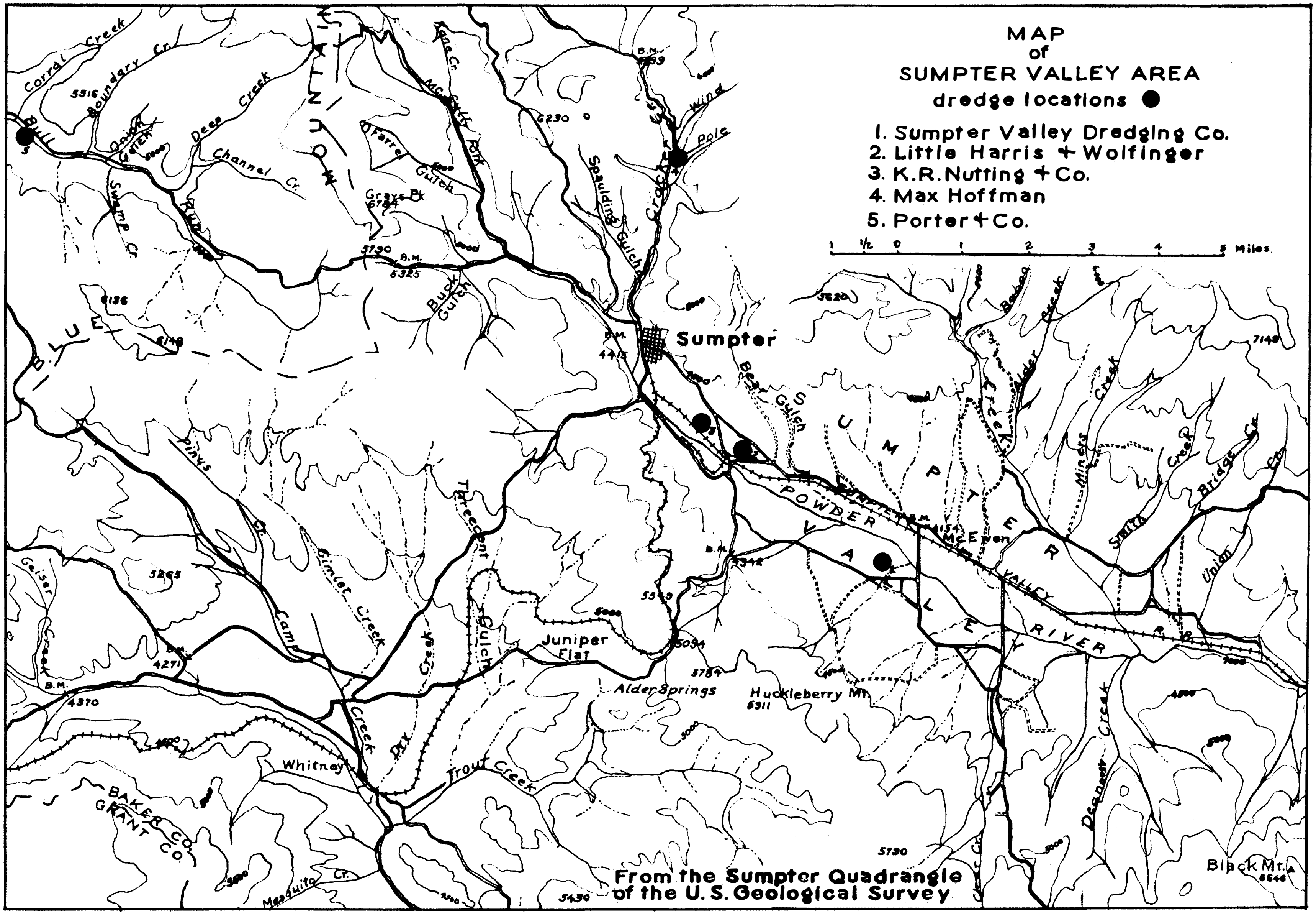

MAP
of
SUMPTER VALLEY AREA
dredge locations
1. Sumpter Valley Dredging Co.
2. Little Harris + Wolfinger
3. K.R. Nutting + Co.
4. Max Hoffman
5. Porter + Co.
Miles
Sumpter
POWDER
RIVER
SUMPTER
VALLEY
BLUE
MOUNTAINS
Juniper Flat
Alder Springs
Huckleberry Mt.
Whitney
BAKER CO.
GRANT CO.
Black Mt.
McEwen
From the Sumpter Quadrangle
of the U. S. Geological Survey

Plate 4

on skids. Capacity was about 1000 cubic yards a day. Work was in low-value grazing land. This plant has been rebuilt and moved to Indian Creek below Granite in Grant county.

(e) Oregon Mining Company operates on Burnt river, northeast of Bridgeport in Sections 3 and 9, T.12 S., R.41 E., using a dragline and floating washing plant. Capacity is about 2000 cubic yards a day. Low-value grazing land is being dredged.

(3) Grant County.

There were five active dredges in the county, one of which suspended work in 1938. Assessed valuation of land ranges between 50 and 60 percent of the "true" value. A summary of operations is given below.

(a) Western Dredging Company has a connected bucket type dredge now working just west of the town of John Day in old placer tailings from early-day mining. Capacity is about 6000 cubic yards a day. Assessed valuation of this old tailings area is $1 to $2 an acre. Some of the better class of farm land with assessed valuation of $55 an acre has been dredged.

(b) Ferris and Marchbank, using a dragline dredge, are working about 5 miles west of the town of John Day in the NE¼ of sec.25, T.13 S., R.30 E. Capacity is about 6000 cubic yards a day, and this is one of the largest, if not the largest, dragline dredge in the world. Farm land being dredged in June, 1939, has an assessed valuation of $55 an acre. This dredge will be out of ground by the end of 1939.

(c) H. F. England and Company have a dragline dredge on Dixie creek about 2 miles north of Prairie City. Capacity is about 2500 cubic yards a day. The land being dredged is grazing land assessed at $3 to $5 an acre.

(d) C. H. Timms Gold Dredging Company, using a connected bucket type dredge, operated near Galena on the Middle Fork of the John Day river. Capacity was about 2500 cubic yards a day. Work was stopped in the latter part of 1938. Of the 148 acres dug in the six years' operations of the company, 26 acres were hay land, and the balance was in old tailings from early-day placer mining.

(e) Porter and Company started work with a new electric, bucket line dredge in September, 1938, on Bull Run, about 1½ miles southeast of Granite in eastern Grant County. Bull Run drains to the north fork of the John Day river. Capacity is about 2000 cubic yards a day. The area is brushy, very low value land for any agricultural use.

(f) Oroplata Mining Company, called the Atkinson dredge, has a dragline on Granite creek, about 2 miles northwest of Granite. Capacity is about 1500 cubic yards a day. The area to be dredged is very low-value grazing land.

Economic Factors:

In the counties under discussion the classification "farm land" includes all types which might have an agricultural use and ranges all the way from some

grazing land valued at $1.50 an acre to irrigated orchard land with an average valuation of over $300 an acre. Specific and general relationships of dredge land values in the various localities, together with the evidence of new wealth created in the communities as shown by dredge expenditures are outlined below.

The fact that new wealth is created by dredging and that this new wealth is distributed in the local communities as well as the State at large in exchange for the removal of farm land from use is not generally recognized, and the amount and effects of this new wealth are not generally appreciated. In other words, the loss is charged, but the gain is not credited.

1. Jackson and Josephine Counties.

The dredges in Jackson county are all working on land classed as grazing land having an assessed valuation of from $2 to $7 an acre with the exception of 30 acres assessed at an average value of $22.33 an acre (assessed valuation at about 70% of the "true" value). The land is nearly all non-tillable and possible crop return would be negligible, compared with the total crop return of the county. The amount of land to be actually dredged as distinguished from the acreage bought for dredging purposes is a matter of a few hundred acres, while the total acreage of farm land in Jackson county was estimated in 1935 as 303,493 acres and that of Josephine county as 111,378 acres. Tillable crop land in the two counties amounted to 108,928 acres, and the average value of farm land was estimated at a little over $61 an acre.

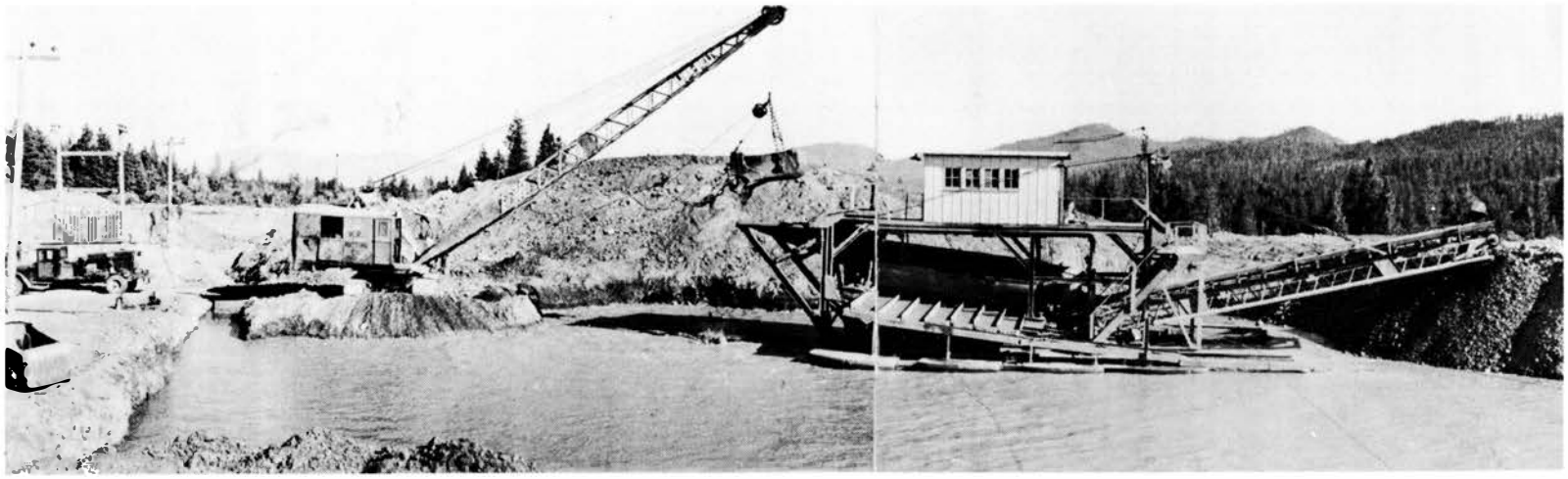
The operation by the Rogue River Gold Company on Graves creek in Josephine county in 1938 was on land with an assessed valuation of about $7.50 per acre with assessed valuation at 66-2/3% of the "true" value. From 1928 to 1938 this company mined 270 acres of land, of which a tract of about 50 acres was worked on Foots creek in Jackson county. Of this total acreage only 23 acres were tillable. More than an equivalent amount of new land was made by the action of settling basins constructed on former rocky waste land.

Summarizing the above, the value of nearly all of the land being dredged is from $2 to $10 an acre as agricultural land while the average value of farm land is about $61 an acre. Farm land in the two counties amounts to about 415,000 acres. The proportion of farm land, nearly all marginal, removed from use by dredging would be less than a quarter of one per cent.

Because of failure to obtain complete figures on expenditures by operators of southwestern Oregon, an accurate tabulation cannot be given, but an idea of amounts involved may be had from the report of one company. In ten years of not continuous operation in southwestern Oregon, this company spent about $780,000 in the community, not counting capital expenditures.

2. Baker County.

Of the two classes of land being dredged, meadow land in the Sumpter Valley is assessed at about $30 an acre and range land at from $1.50 to $10.00 an acre. The average assessed value of lands in the Sumpter Valley now controlled by the three operating companies is about $18 an acre with the assessment ratio about 70% of the "true" value. However, one of the companies has bought 680 acres, assessed valuation of which is $1.50 an acre. In 1935, farm land acreage in Baker county was estimated at 714,187, with an average value of



Dragline and washing plant of K. R. Nutting & Co., Sumpter Valley.

View of old Chinese tailings near the town of John Day showing pond of stagnant water. Western Dredging Co. dredge extreme left.

PLATE 5.

$15.59 per acre. Crop land was estimated at 24,642 acres. Outside of about 1000 acres of meadow land in Sumpter Valley, present-day dredging areas in the county are in low-value, non-tillable land and would be a lower percentage of the total farm acreage than in Jackson and Josephine counties.

Sumpter Valley is high, the growing season is short, and the meadow land is of rather low value as hay land. The proportion of county crop land to be dredged in the valley by operations planned at present is less than one per cent. It should be pointed out, however, that proportion of areas concerned is not as important as proportion of total crops raised in the areas, and Sumpter Valley meadow land is not as productive as most other Baker county crop lands.

A probable factor in the extension of future dredging area in Sumpter Valley is the proposed reclamation project on Powder river for the principal purpose of storing water for the Baker Valley. A survey has been made by the U.S. Reclamation Service in cooperation with the State of Oregon, and a report of the project has been submitted. The plans include a dam at one of two sites but preferably at the Mason site about seven miles up the river from the Baker-Unity highway. The top of the dam would be at the 4,070 contour. At this elevation the surface of the reservoir would be approximately 2,300 acres and cover about 1,700 acres of cropland of lower Sumpter Valley. When full, the reservoir would extend to within a short distance southeast of McEwen near which the Sumpter Valley Dredging Company is now operating.

Lack of water and not lack of cropland is the critical factor in raising crops in Baker county, so that at some future time this reclamation project will probably be completed. This would mean that the lower end of Sumpter Valley would be destroyed as farm land whether or not it were dredged.

Reports of expenditures of only four of the six operations described have been received and one of these operated but a short time in 1938. Some idea of the importance of such expenditures may be gained, however, by citing those of the Sumpter Valley Dredging Company, which, as has been stated, is the largest in the State.

In the four years from July 1, 1935 to July 1, 1939, this company spent about $850,000 in wages, supplies, repairs, taxes, and capital expense.

All of the items of expense of dredging operations, except Federal income taxes and capital expenditures, are of direct benefit to the local communities and the State as a whole; also a part of the capital expenditure, aside from the purchase of land, affects the State directly and indirectly. Such items as lumber, steel castings, and earth-moving machinery purchased in Oregon, as well as the labor of construction, make up a material part of dredge capital expense.

3. Grant County.

In 1935 the county had 985,975 acres classed as farm land. Of this acreage, 63,126 were classed as cropland, 27,340 as plowable pasture land, and the balance as woodland or "other" pasture land. The average value of farm land was $6.77 an acre. Some of the best bottom land in the John Day Valley is valued at $100 or more an acre, while other more elevated irrigable land in the same valley is valued at around $50 an acre. The great bulk of the county's farm acreage is low-value land with average valuations around $4 or $5 an acre.

All of the dredging operations of the county are in low-value land with the exception of the two working in the John Day Valley. One of these, as mentioned above, is now working in an area of old placer tailings having no value as farm land, and the other will cease work within a few months.

Much of the feeling against dredging in farm lands of the State is the result of operations in the John Day Valley. Some crop land has been dredged and tailings piles are in evidence at points along the highway which runs through the Valley for its entire length. The fact that these tailings are so easily seen from the much-traveled highway, combined with the marked contrast between green crop land and rock piles, gives a distorted perspective of the amount of actual destruction of crop land. Much of the area dug was originally brush land along the river channel and of little use as farm land, but to the uninformed observer the present rock piles represent land that was once all green cropland similar to that which the piles now border.

This impression of apparent destruction of cropland is, in the main, misleading; a study of all related facts creates a quite different picture. For this reason conditions in the John Day Valley and Grant county are discussed in more detail than those of the other dredge districts.

The John Day Valley, formed by the John Day river, extends from above Prairie City on the east to beyond Dayville on the west, a distance of about 50 miles. A large part of the valley is in cropland and represents a substantial part of the economy of the county.

In two general areas of the valley there either have been or still are workable gravels representing concentrations of gold along old and present channels of the river. The smaller of the two areas, now inactive as far as dredging is concerned, occupies a relatively narrow strip extending west for nearly two miles from Prairie City; the second is at and west of the town of John Day extending for several miles down the river valley.

In this latter locality where two dredges are now operating, placer mining has been carried on since early times. Canyon creek drains from the south into the river at John Day and was in early-day mining a prolific producer of placer gold both from river gravels and from higher benches where a considerable area was hydraulicked. Chinese worked the river gravels near John Day leaving tailings mounds included in an area of something over 100 acres. One of the dredges has been working through these old mounds during the past year and has (in July 1939) a considerable proportion yet to dig. The area covered by these old tailings was valueless as farm land and contained many small ponds and sloughs. A constructive result of drdging this area is the draining of these old pools which were very favorable breeding ground for mosquitoes and other pests.

The area dredged at and west of John Day is around 650 acres; that at Prairie City has not been determined, but it is probably less than 100 acres. The total area dredged is probably less than 800 acres. Not all of this was cropland; some was brushy and swampy so that the real acreage of cropland dredged has not been greater than 600 acres in an elapsed time of about 35 years.

The total area classed as irrigated land in the John Day Valley is approximately 30,750 acres. Therefore, the amount of cropland taken out of production by dredging in 35 years is less than 2 per cent. Moreover, it should be pointed out that it would be erroneous to assume that 20 per cent would be taken out of

production by dredging in 350 years. The amount of dredgeable ground in the Valley is limited. While all of the area has not been prospected, many places have been tested and found to be unworkable. It is fairly well established that the economic concentrations of gold occurred in the alluvials from two general localities, namely, those of the Dixie creek and Canyon creek areas, with the latter forming the greater amount of workable ground. From information obtained by the Department of Geology and Mineral Industries it is reasonable to assume that future profitable dredgeable ground in the Valley under present conditions will not exceed 1000 acres, or 3 per cent of the valley irrigated acreage.

Plate 9 shows an area near Mt.Vernon where a dredging project is planned. The workable area has been outlined by drilling, and the map clearly shows that much of the ground to be dredged is in river gravels bordering the stream and that a relatively minor proportion of cropland is to be taken out of production by the operation. Some of the adjoining land, of low value because of high water table, will be drained by the dredging operations and its value as farm land greatly increased.

As against the reduction in acreage of cropland by a very small percentage, there has been a large return of new wealth to the community and the State in the form of wages, expenditures for supplies and repair parts, in capital expenditures, in taxes of various kinds, and in payments for parcels of land, some heavily mortgaged and with small chance of redemption or refinancing.

The several outlays by operators in this locality (including the operations on Dixie creek near Prairie City) are given below as quantitative evidence of the economic importance of such operations to the John Day Valley.

1.	Total taxes paid in 1938 (inc.income taxes)	$ 38,207.50
2.	Amount paid out in wages, fees, and salaries in 1938 (including amounts for prospecting)	172,611.81
3.	Amount paid for supplies and repair parts in 1938	89,238.80
	Total for 1938	$296,837.82
4.	Capital expenditures (other than land) for the operations (incomplete for two operations)	256,661.00
5.	Amount paid for land for the operations	474,884.17
6.	Number of Mortgaged parcels taken over	15
7.	Face values of mortgages paid	93,000.00
8.	Number of men employed (including those engaged in prospecting)	148

The population of the five towns of the area is 1319, and it is likely that the population of the whole valley does not exceed 2000 people. Therefore, the importance to the community of the above figures becomes quite apparent.

About half the land dredged was old tailings and gravel bars assessed at about $1.00 an acre. The balance of about 60 acres was in land assessed at about $55 an acre. Assuming a tax levy of $2.05 per acre, total taxes on the land dredged would have been about $125 as farm land to compare with $38,207 actually paid by dredge operators. This latter amount, undoubtedly, was made up largely of income taxes which went directly into the State's fund.

Some further statistics relating to county and state economy seem pertinent and are shown in the following tabulation.

Taxes levied in Grant county in 1937	$ 171,201.38
Taxes received in Grant county in 1937	127,216.00
Delinquent taxes in Grant county in 1936	41,056.88
Accumulated delinquent taxes to and including 1936	331,372.35
Foreclosable delinquent taxes to and including 1936	229,266.80
Per capita accumulated delinquent taxes (estimated pop.1937)	53.11
Ditto for the state	38.55
Taxes levied per capita Grant county in 1937	27.44
Ditto for the state	38.12
Total county public debt 1938	533,492.22
Per capita public debt	85.50
Ditto for the state (including county indebtedness)	129.08
Per capita effective buying income 1937	382.00
Ditto for the state	608.00

These figures show the desirability, if not the necessity, of encouraging enterprises which produce new wealth for the county as well as for the state. In fact it is evident that without the income which the county receives directly and indirectly from the dredges, not only would business in the John Day Valley be depressed but also additional burdens would develop in county finances.

In this connection it is interesting to compare the man-hours of farm labor necessary to farm an acre of alfalfa with the man-hours required to dredge an acre of ground. It has been estimated that, in the John Day Valley for an average section of 20 feet dredged, an acre of ground requires 1200 man-hours of labor at an average wage of 82.5 cents an hour, or a total of $990.00 an acre in wages. To farm an acre of alfalfa, authorities have estimated that, in irrigated areas, there are from 16 to 22 man-hours of labor required for planting, care, and harvest. The average wage would probably be about 25 cents an hour, or a total of from $4.00 to $5.50 an acre to compare with the $990 for dredging.

An economic factor not generally realized is that of the number of mortgaged farms involved, in the sale of land to dredge operators. Farmers have been contending against low prices for many years. In order to meet obligations and in the hope that conditions would improve farms were mortgaged. In many cases the loans were made on land valuations much higher than could be obtained at present, and consequently refinancing of mortgages when due has been difficult, if not impossible. In the John Day Valley many parcels of land have been near foreclosure when taken over by dredge operators. In these cases not only has the farmer saved his property but the mortgagor has had his loan repaid, the face value of which was above the actual value without mineral rights. In the John Day Valley the face value of mortgages on parcels of land taken over by present dredge operators was approximately $93,000. Most of this land had unpaid taxes and many faced foreclosure on land valuations that would not justify refinancing for ranch purposes.

The total amount of expenditures by Grant county dredges is outlined below.

1.	Total taxes paid in 1938 (inc.income taxes)	$ 63,553
2.	Amount paid out in wages, fees, and salaries in 1938 (including amounts for prospecting)	322,103

3.	Amount paid for supplies and repair parts, 1938	$ 160,688
	Total for 1938	$ 546,344
4.	Capital expenditures (other than land) for the operations	533,810
5.	Amount paid for land for the operations	784,856
6.	Number of men employed	214

Note: Capital expenditures are incomplete for two operations.

In both the John Day and Sumpter Valleys better drainage of land has resulted from dredging in certain sections. Especially in the John Day Valley, some localities have a high water table which has precluded the use of the land as cropland. After adjacent land was dredged, thus effecting drainage to the water-logged land, good hay crops have been grown on the land thus affected.

In the past, there has been a rather close balance between available winter forage and the number of livestock to be fed in the John Day Valley. People without bias have been sincerely concerned over the removal from farm use of even the small proportion of crop land dredged, thinking that, in the event of a bad year, there would be a shortage of winter forage and that then it would be necessary to bring in feed from outside the county. There are several factors to be considered in discussing this problem.

Information from authoritative sources apparently shows that, for obtaining the best operating results, there has been generally insufficient range land adjacent to the valley for best results. In other words, speaking generally, farmers would gain by ranging a less number of livestock on a given range and by so doing would improve the condition of their range stock. A gradual reduction in number will probably be effected, thus reducing the possible hazard of lack of winter forage.

Most of the hay acreage of the Valley is in meadow hay which yields a considerably less quantity of forage than it would if it were planted in alfalfa, and is inferior in quality to that of alfalfa hay. Ranchers have been shown the desirability of replacing meadow hay with alfalfa wherever possible, and the acreage of alfalfa is materially increasing. As the alfalfa acreage increases the danger of a scarcity of winter forage will decrease.

The factor of dredging has had and will have very little influence on this matter of winter feed. Aside from the small proportion of hay land taken out of production by dredging, the range land contiguous to and dependent upon the crop land dredged has been taken over by other livestock operators who have thus benefitted by acquiring additional range land.

Pertinent to the matter of seasonal balance in available stock feed is the following extract from a letter to the Department from the office of the Regional Forester, United States Forest Service, Portland:

> "It is a reasonable statement, I believe, that there is insufficient summer range if not overgrazed, in eastern Oregon, to go with the winter, spring and fall capacity. The latter includes hay, range and grain for winter feed. In the higher valleys such as the John Day Valley, in a

> "normal year the conservative capacity for winter use of cropland and winter ranges is at present in excess of that for spring, fall and summer."

Comparison of Farm and Dredge Land Values.

Outside of the Sumpter and John Day Valleys, dredge land has a theoretical valuation as farm land of from $2 to $10 an acre. In order to obtain a perspective of the value of such land it is enlightening to make certain reasonable assumptions and compare monetary return from the land as farm land with it as dredge ground.

Assume that farm land having a value of $6 an acre contains workable gravel 15 feet in thickness with recoverable values of 15 cents a cubic yard in gold. The gross value of the land for its gold content would then be $3,630 an acre. Assuming the same net percentage return in each case, it would take 600 years for the $6 land to equal the return on the dredge ground for one year.

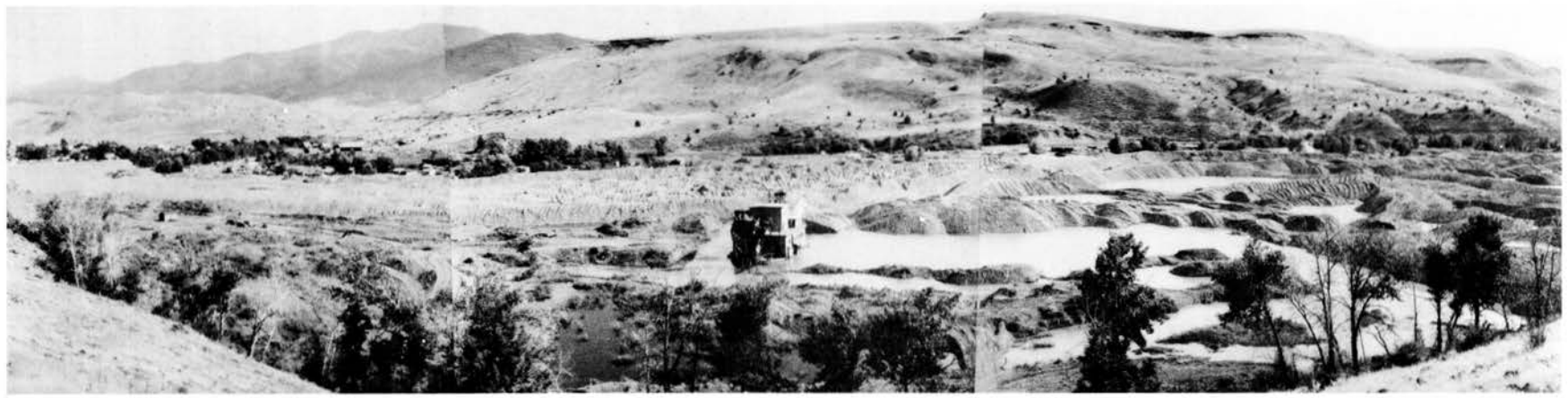
From another viewpoint, assuming a 10 per cent net return on the dredge land, $363 deposited at 2½ per cent simple interest returns more each year than the total value as farm land. Of course, if $363 were compounded annually at 2½ per cent it would reach astronomical figures in 600 years.

From still another point of view - that of the farmer who owns the dredgeable ground, the comparison would be between the value of the land as farm land and that paid him for the land as dredge ground. Farmers have been paid from $100 to $600 an acre by dredge operators. This is for the land bought, not for the land dredged; in those cases in which not all the land bought is dredged, the cost per acre of land dredged would be higher than the cost per acre of land bought. Comparing the income from low-value land with that which could be received as bank interest on the cash received shows the great advantage to the farmer in selling acreage to be dredged. The fact that a small percentage of land is taken out of use appears to be of minor importance when compared with all the advantages gained by dredging the ground.

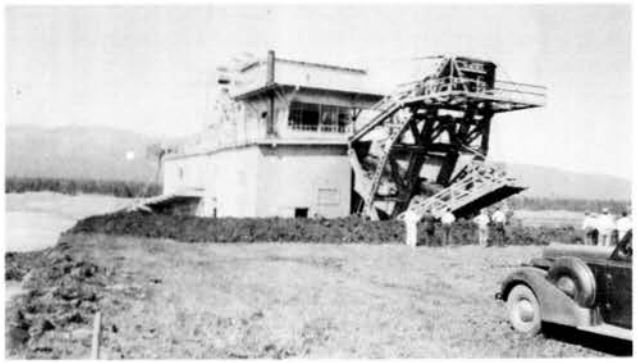
Destruction of Farm Land.

To aid in obtaining a true perspective of the proportion of farm land removed from use by dredging operations a comparison may be made with other agencies, which in the aggregate are incomparably more destructive to agricultural land than dredging. These are soil erosion and over-grazing. Results from dredging are quickly evident but a matter of hundreds of acres only is concerned. The destructive results of over-grazing and soil erosion are insidious in that they become noticeable gradually, while the cumulative destructive effect is enormous and concerns hundreds of thousands of acres.

Because of the magnitude of the problem, and because of the large proportion of Federal-owned land, states have relied on the Federal government to combat these destructive agencies, or at least have allowed the Federal government to initiate and pioneer remedial measures; thus it appears to be somewhat out of proportion for the state to single out the comparatively insignificant destructive action of dredging operations for corrective action when equivalent but immeasurably greater destruction of farm land is going on throughout a very large part of the State's agricultural area.



View of Western Dredging Company bucket line dredge digging in old Chinese tailings mounds. Town of John Day at left.



Sumpter Valley Dredging Co.

Ferris & Marchbank dragline, John Day Valley.

PLATE 6.

A measure of the extent of reduction in numbers of livestock, caused by overgrazing, is indicated by a further extract from the letter from the office of the Regional Forester as mentioned on page 15; it is as follows:

> "Types of range other than bunchgrass, properly fenced and protected, or cheat grass contiguous to or near the valley croplands I should estimate have been reduced in capacity since early settlement from three to five acres per cow month to from ten to fifteen acres per cow month."

It would be a difficult matter to estimate closely the amount of productivity destroyed each year by failure of farmers throughout the State to add the necessary amounts of fertilizers and limestone to soils in order to maintain fertility, but that this loss of productivity is very large is a certainty; it probably exceeds many times over that due to dredging operations.

Comparison of Total Areas Involved.

The area of farm land in 1935, including that classed as tillable, in the several counties containing dredged and potentially dredgeable ground, is given below.

	Farm Land acres	Cropland acres	Crop Land	
			Failed	Idle or fallow
Baker	732,099	141,360	10,480	13,175
Douglas	663,720	145,876	1,801	10,547
Grant	985,975	90,466	4,255	8,003
Jackson	303,493	105,521	1,362	8,141
Josephine	111,378	35,138	822	4,608
Total (5) Counties	2,796,665	518,361	18,720	44,474
State	17,357,549	4,971,491	280,426	1,085,286

It is impossible to state accurately the amount of possible dredging ground in the State, but an estimate of 10,000 acres of farm land including but 2,000 acres of cropland would undoubtedly not be too low under present monetary and commodity price conditions. Using this estimate would mean that a little more than three-tenths of one per cent of farm land and a little less than four-tenths of one per cent of the cropland of the five counties involved would be removed from production. The ratio for the whole State would be a little more than five one-hundredths of one per cent and about four one-hundredths of one per cent respectively.

It seems relevant to note that in 1935, in the five counties under consideration, cropland in the amount of 18,720 acres failed and 44,474 acres were either idle or fallow. The figures for the whole state were 280,426 and 1,085,286 acres respectively. While the practice of allowing a certain proportion of cropland to lie fallow is normal, it is presumed that, in a large measure, the reasons for the other categories, "failed" and "idle" would be economic; and that much of such

land could be kept in production if market conditions were such as to make farming the land profitable. Apparently, therefore, there is no real lack of cropland and in all probability a fair-sized proportion of the idle land would be kept in production if the proper incentive existed.

Bearing on this matter is the following quotation from Basic Data of Oregon Counties (X):

> "Estimated that Owyhee irrigation project will add 20,000 acres to privately owned tillable lands and area in farms."

Malheur adjoins both Baker and Grant counties; alfalfa is an important crop and there is a direct highway connection between Vale, Malheur county, and John Day. The distance is 118 miles.

In the light of these circumstances the destruction of a very small fraction of cropland where that destruction is accompanied by a substantial income to the owners of the land appears to be of secondary importance.

High-Value Croplands in Relation to Dredging.

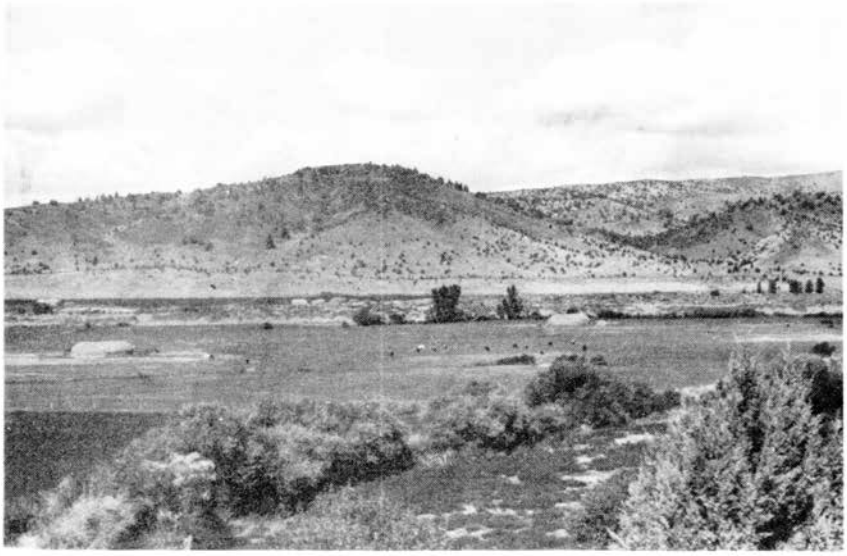
In most cases it probably would not be difficult to show that as far as net financial return to the farmer and to the State is concerned, it is more profitable to dredge even high-priced land, that is, land valued at, say, $100 an acre, than to farm it. From an accounting standpoint, if that part of the gold taken from the ground and spent in the State were invested to return 3 per cent interest, such return would greatly exceed the probable average return of the land as farm land. To illustrate, using Grant county as an example: in 1930, the last year for which U. S. census reports are available, the return on the best cropland is shown below.

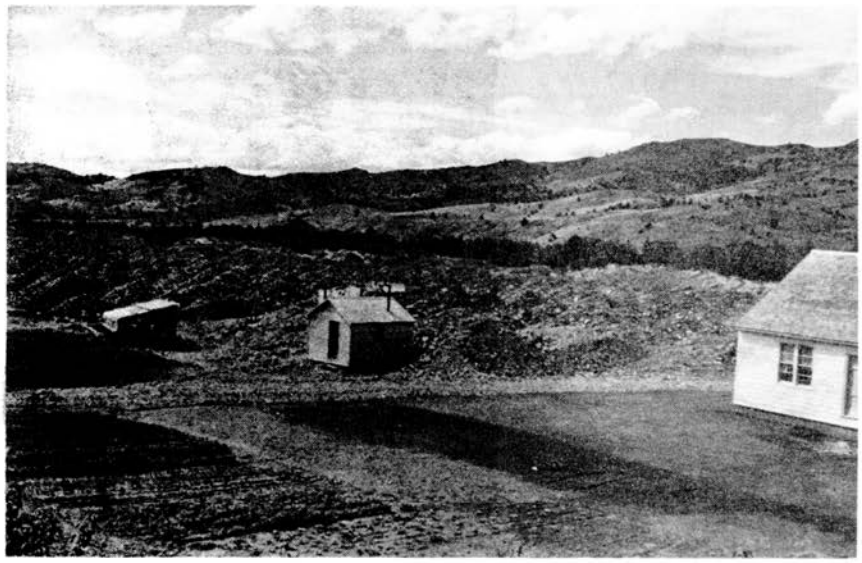
Value of Farm Products from Selected Types of Farms, Grant County.
(U. S. Census, 1930)

Type	Acres in farms	Average size of farms--acres	Harvested Cropland--acres		Value Products	
			Total	per farm	Total	Per farm
General	42,771	570	4,325	58	$122,739	$1,673
Cash Grain	6,796	680	764	76	21,126	2,113
Crop Specialty	61,202	816	6,313	--	140,907	--
Dairy	28,421	568	3,072	61	130,671	2,163
Whole County	899,329	1,423	51,111	81	$2,448,823	$4,068

(X) Damschen and Bushnell, Oregon State Planning Board.

View, looking north, of hayland west of John Day. Ferris & Marchbank dredge tailings in strip along the John Day river in center of picture.





Small plot of reclaimed ground on dredge tailings on highway west of the town of John Day.

Looking west, middle fork of John Day river showing hayland and Timms dredge building right center.

PLATE 7.

In order to get the per-acre return for the selected farms, only the cropland acreage is used for the first three types, but for "dairy" the whole farm acreage is used. The weighted average per acre return is then $10.43.

Assuming as in an early paragraph under Comparison of Farm and Dredge Land Values, that land as dredge land would recover $3630 an acre and that at least half would be spent in the State, then 3 per cent interest on $1815 would be $54.45 per acre to compare with the $10.43 per acre return for crops.

Even assuming a probable extreme hypothetical case of a farm producing on an average of 4 tons of alfalfa per acre per year with a sales price of $9.00 a ton for the hay, this would be a gross return of $36.00 an acre as compared with the interest return of $54.45. (In the John Day Valley alfalfa is not generally a money crop; it is fed to livestock. In Baker county alfalfa was selling for about $4.00 a ton in 1939).

However, there are other factors than those of monetary return to be considered in dredging high-value cropland. If the destruction were always necessary in order to dredge the ground, the damage might still be warranted, but this is not true in all cases. With proper planning by the operator and cooperation by the land owner, resoiling could be feasible where soil cover is unprofitable to dredge, and where the area is large enough to warrant a resoiling operation. This has been done in several parts of the world. Resoiling is discussed later on in the report.

Dredge operators are usually held responsible for the destruction of farm land. While in the rare, highly profitable operations criticism of the condition in which tailings piles are left may be warranted, the dredge operator should not be held accountable for not resoiling cropland. That is chiefly the responsibility of the owner of the land. If the latter should get his land back in as good or better condition than it was before being dredged, then this factor should be considered in the purchase price of the land. In nearly all cases farm land owners have been unwilling to accept less than the maximum price obtainable and, therefore, any resoiling has been economically impossible. If resoiling is warranted, the work should be done by the dredge operator, but the cost should be borne by the land owner. It will be argued that the cost of resoiling is greater than the value of the land as farm land. While this may be true in many cases, it is not necessarily true where proper equipment can be used and the operation planned adequately in advance. Moreover the farmer would get his land back in better condition than it was originally because of the better drainage and the thorough aeration of the ground.

It is usually taken for granted that dredging operations are very profitable and that, therefore, dredge operators should be held responsible for resoiling farm land. This is an erroneous idea. Most dredges work on a narrow margin of profit. As shown in the table on page 5, average recovery per cubic yard from both types of dredges, 1935-1938, inclusive, was 12.5¢, 14.6¢, 12.9¢, and 15.5¢, respectively. Operating costs, as distinguished from total costs, vary depending on many conditions and might be from 6¢ to 10¢ or more per cubic yard. Within certain limits and speaking generally, unit operating cost varies inversely with capacity, that is, the larger the capacity the lower the unit cost. But to get such low unit costs a large investment is required, and a large yardage of dredgeable ground is necessary to justify the investment. It is not generally realized how large a

factor these capital costs are and to what an extent they cut down profits. To illustate this point these costs are figured below on a hypothetical project, assuming certain reasonable conditions similar to those in the John Day Valley.

Capital cost of land purchased must all be paid from the one operation; the cost of equipment does not necessarily have to be so paid, but during any delay in moving from one location to another the latter cost must be paid the same as if the equipment were profitably employed. Thus, in order to keep equipment busy, operators prefer to undertake ventures which will yield even a small profit rather than allow equipment to remain idle.

Assume that a connected bucket type dredge with an annual capacity of 1,500,000 cubic yards is to mine acreage with an average section of 20 feet and recoverable gold value of 15¢ per cubic yard to be mined out in five years. The total acreage mined would be 232. The capital investments are assumed as:

For equipment and working capital	$250,000.
Purchase of land at $350 an acre (dredged)	81,200.

To amortize the full purchase price of the land plus one-half the purchase price of equipment (total $206,200) in five years, assuming 2 per cent interest compounded annually on sinking fund and 10 percent interest return on investment, and using Hoskold's formula, the amount of sinking fund each year is $39,590, and the yearly interest $20,620. The total yearly cost is $60,210, which is equivalent to 4¢ a cubic yard of gravel, or more than 25 per cent of the gross value of the recoverable gold value.

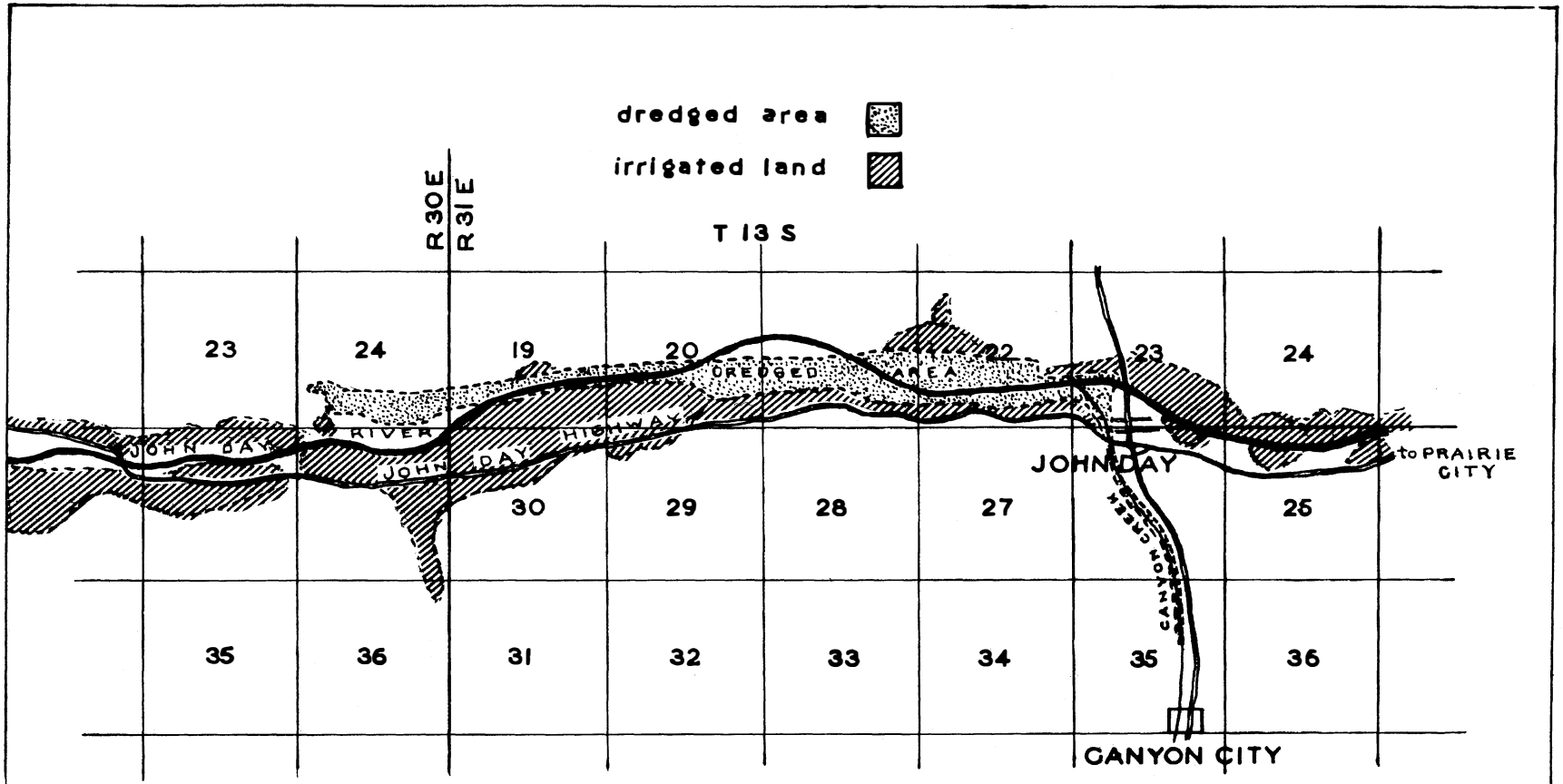
A similar method may be used to calculate the value of the ground bought.

Assume costs:	Operating	6.5¢ per cu.yd.
	Depreciation (10 years)	1.5¢ "
	Capital costs	4.0 "
	All other, including taxes, & insurance	1.5¢ "
	Total	13.5¢

The net profit would then be 1.5¢ a cubic yard and on 1,500,000 yards would be $22,500 annually. Again using Hoskold's method, the "present worth" of an investment yielding $22,500 annual profit with interest rates computed as before would be $77,055. Therefore, the present worth for mineral rights of the 232 acres dredged is $77,055, or $332 an acre.

Under the conditions assumed, it is evident that an operator would pay the land owner fully as much as the land is worth for the mineral rights.

Footnote: To persons not experienced in mining investments 10 per cent interest rate may seem too high. However, it could reasonably be criticized as too low. Capital demands a high rate of interest on money loaned to mining enterprises, because of the supposed speculative nature and insecurity of return. If properly planned and managed, a gold dredging operation is at least as secure as most other business investments. Nevertheless, a high interest rate is considered warranted.



MAP SHOWING TOTAL DREDGED AREA
AT AND WEST OF THE TOWN OF JOHN DAY
Scale 1 inch = 1 mile

Plate 8

Resoiling.

For the purpose of this report, and applying definitions particularly to dredging, a distinction is made between reclamation of land and resoiling. Reclamation is a broader term and may be considered as any act or process of reclaiming waste land in making it suitable in any degree for cultivation or habitation. Resoiling is considered as the act or process of restoring land after dredging so that both the resulting surface and vertical cross section will be in at least as good condition for raising crops as it was prior to the excavating operation. Reclamation of tailings might be done by simply leveling, or planting trees without leveling, and these things have been done in reclaiming stripped coal lands in the Central states and in dredging operations in New Zealand. Resoiling would be reclamation, but reclamation would not necessarily be resoiling.

It has been fairly well established that by methods so far tried, resoiling cannot be done satisfactorily by transporting soil suspended in water. Not only are humus and soluble salts lost but classification or segregation of sands and slimes makes a poorly-conditioned soil.

Apparently the only satisfactory method of resoiling is to strip the necessary amount of soil dry and return it to the leveled tailings in that condition. In order to have a properly conditioned section of tailings as a base for the soil, oversize from the washing plant should be deposited on the bottom and undersize, insofar as possible, on top; reversing the usual practice. With a thick soil cover the above procedure would not be so important, but with, say, three feet of soil, the oversize alone without provision for filling the voids with undersize might cause excessive drainage of the superimposed soil.

In dredging shallow ground it is evident that it might be impossible to keep the level of the pond at a sufficient distance below the top of the overburden so that the latter could be stripped dry and at the same time maintain sufficient depth of pond for floating the dredge. Under such conditions resoiling would not be practicable.

A possible factor in resoiling, not usually realized, is that the topography of bedrock does not necessarily correspond to the surface of the land. Thus inequalities in the depth of section dug to height of bedrock are reflected in corresponding unequal heights of the tailings piles. This could result in general hills and valleys in the tailings from a perfectly flat land surface. In such a case cost of leveling tailings, in order to make the land irrigable, might be prohibitively high.

Often placer gold occurs in narrow pay streaks suitable only for dragline operations. Under such conditions, probably a resoiling operation could not be planned economically.

Methods of resoiling are described in the following pages. The cost of resoiling is chiefly dependent upon the cost of stripping and the subject is discussed in the appendix.

If a tract to be dredged was of a sufficient areal extent and dimensions so that a resoiling operation could be laid out in strips, then an economical method would be to use a bulldozer to strip in front of the dredge, pushing the overburden to one side in a windrow parallel to the strip dredged, and pushing the windrow

back on top of the tailings in the rear of the dredge as the latter moved along. This method would probably require the least haul, if auxilliary earth-moving equipment is to be used.

On such an operation it is probable that a contractor, possessing heavy earth-moving machinery and experienced in handling large quantities of material, would do a cheaper job than the dredge operator. It is, however, quite obvious that in order to get low costs, a contractor would need to keep his machines employed continuously for at least one shift a day, but if the resoiling work were intermittent then low costs would not be obtainable. For example, if a hundred acres of cropland in a fairly regular tract were to be dredged and resoiled, the project could be planned and executed economically. If, however, a tract containing a hundred acres in an irregular-shaped strip were to be worked, part of which was cropland to be resoiled and part brushy river land of little agricultural value, this would mean an intermittent resoiling operation with attendant higher costs.

The many variables in physical conditions of different dredging operations, as outlined above, show the difficulty of generalizing on the feasibility of resoiling, but assuming that high-value farm land would be stripped in any event and that conditions for handling overburden are favorable, then it is believed that the excess cost of the resoiling operation over stripping alone should not be materially more than $100 an acre, or the equivalent value of the original farm land.

Examples of Resoiling Operations.

Some typical resoiling operations are outlined below.

Pantle Brothers.

At the Amodei ranch near Lincoln, Placer County, California, these operators mined with a one cubic yard dragline and a stationary washing plant with a capacity of about 75 cubic yards an hour.

The land worked was nearly level except for some mounds resulting from early day placer mining. Depth of top soil plus gravel varied from 12 to 27 feet. Over half of the section was top soil or overburden and was stripped with the dragline.

Ground was worked in long windrows 50 feet wide and about 1000 feet long. Oversize from the trommel, with the exception of the first pile made at the end when operations were started, was dumped in the pit with a long swinging conveyor. Sand was pumped to the pit and the stripped overburden was always cast on top of the sand and gravel tailings.

Tailings were leveled with a Diesel tractor, a large"carryall", and a bulldozer. The cost of this was reported at $65 an acre. Unit cost of mining (presumably operating cost) was given as about eight cents a cubic yard.

It is reported that the land is in much better condition for irrigating than it was before being mined.

Natomas Company of California.

Over a number of years, extensive experimental work in resoiling under operating conditions has been done by the Natomas Company chiefly in the Folsom District, California. Dredges were equipped with from two to four stackers. The largest oversize from the screen was dumped closest to the hull of the dredge. The smaller sizes were conveyed farther away. Tailings wheels attached to the dredge raised sand from the pond, and, after dewatering, dumped it on the conveyors which carried it to the top of the rock piles. By this means a fairly regular surface was obtained, but scrapers were necessary in order to level the ground for farming. Since, in transporting by means of water, the very finely divided material was held in suspension, the resulting surface of the ground on top of the tailings represented a classified product very different from the original soil. Experiments in digging the top soil dry with the bucket line, and by-passing around the trommel to the stacker which conveyed the material to the top of the tailings pile were considered unsuccessful. No information on costs of this work is available, but resoiling under the operating conditions which then existed (up to the late 1920's) was considered impracticable. In the State Mineralogist's Report XXI, 1925, some figures concerning costs were given. The average unit operating cost for the dredges in the district was reported as 6.5 cents per cubic yard. There were six dredges which handled from 150,000 to 225,000 cubic yards each monthly.

Cullengoral Alluvial Gold Sluicing, N.L.

This company at Gulong, New South Wales, Australia, according to the Mining Magazine of London (August 1936) has been working agricultural ground containing 8,400,000 cubic yards of gravel with a recoverable gold content of 10 d. (20 cents) per cubic yard.

A recent private communication to the Department from the Manager of Operations conveys some pertinent facts concerning their resoiling. The connected bucket type dredge has a capacity of about 20,000 cubic yards per six-day week with the bucket line capable of dredging 26 feet below, and 14 feet above, water level. Superstructure is on an all-welded steel pontoon. Electric power, supplied by a 400 h.p. Diesel engine direct, connected to a generator, is used.

Overburden is stripped with the bucket line and when so operating the soil is by-passed around the screen to the stacker belt which conveys the material to the top of the tailings.

Oversize rock from the screen is dumped as close to the boat as possible without interfering with freedom of movement of the dredge. Undersize of sand, after passing over riffles, is conveyed by launders to the top of the rock pile being dumped from the screen.

As described by the management:

> "A rock pile of sand and stone is built up quite close to the dredge stern but not close enough to make the paddock tight. When the bottom has been cleaned up and the stripped wash put through the boxes, it is necessary to strip another cut of overburden, the worm driven door is changed-over and the buckets tip their load of soil and mud through the stacker drop-chute, over the stacker belt, which carries the soil, mud, etc., 40 feet behind the rock piles built up by the screen

"stone chute and the box tailings, covering the previously screened rock piles with the same thickness of soil as originally existed. Of course pinnacles and hollows are more or less in evidence after re-soiling has been completed by the stacker; these are levelled off by contract.

"The overburden in Cullengoral leases is a detrital earth easily worked with only a small percentage of clay, which presents itself in lenticular bodies and is obviously more expensive to work than the good soil; the buckets are run 20 per minute on overburden as against 16 on wash and the cost of digging overburden per cubic yard is approximately 6 cents after stacking has been completed. Now the pinnacles require levelling and the cost to this Company amounts to $15\frac{1}{2}$ dollars per acre; any banks that are abrupt need sloping off to the water's edge at a batter of 32 degrees, to ensure that stock are not endangered by steep sides, when they come to drink, especially sheep; this operation is also completed by contract the price of which is $9\frac{1}{2}$ dollars per chain. (x)

"This dredge is not of the spud type and uses a head-line and backer-hole to pull on the cut, the working face at present is $14\frac{1}{2}$ chains wide, this is cut continuously in three paddocks on three different headlines with a straight pull through of 5 chains to each paddock, the water being carried with the dredge from the river, the river bed has very low values and is not dredged, but must be kept open to the paddock, care must also be taken not to let any of the three faces lag too far behind, the reason being obvious and this applies especially to the river paddock."

Victoria Gold Dredging Company N.L.

At Newstead, near Castlemaine, Victoria, Australia, this company has been mining gravel under farm land from which, according to the Engineering and Mining Journal (xx) a value of 4.27 grains (about 31 cents) per cubic yard has been recovered. For the year ending March 31, 1939, 1,217,750 cubic yards of gravel were handled by a $9\frac{1}{2}$ cubic foot dredge.

Resoiling is done along the same lines as practiced by Cullengoral Company described above. According to the Chemical Engineering and Mining Review of Melbourne, Australia, equipment drops the large rocks 12 to 15 feet behind the stern of the dredge. Undersize, after passing through the gold-saving boxes, is delivered at a point about 25 feet from the stern on top of the rock pile. The soil overburden is stripped dry with the bucket line, by-passed around the screen, and delivered to points about 104 feet from the stern by a stacker conveyor 160 feet long. Chutes at the end of the stacker assist in distributing the material. Ground is finally leveled off by scrapers and scoops. Originally it was planned to apply superphosphate to the soil and plant it with grasses selected by the owners of the land. Whether or not this was done has not been verified by the writer.

In addition to resoiling, it was necessary to prevent silt from getting into the Lodden river and also to prevent river flood waters from getting to the dredge

(x) 1 chain = 66 feet.
(xx) August 1939.

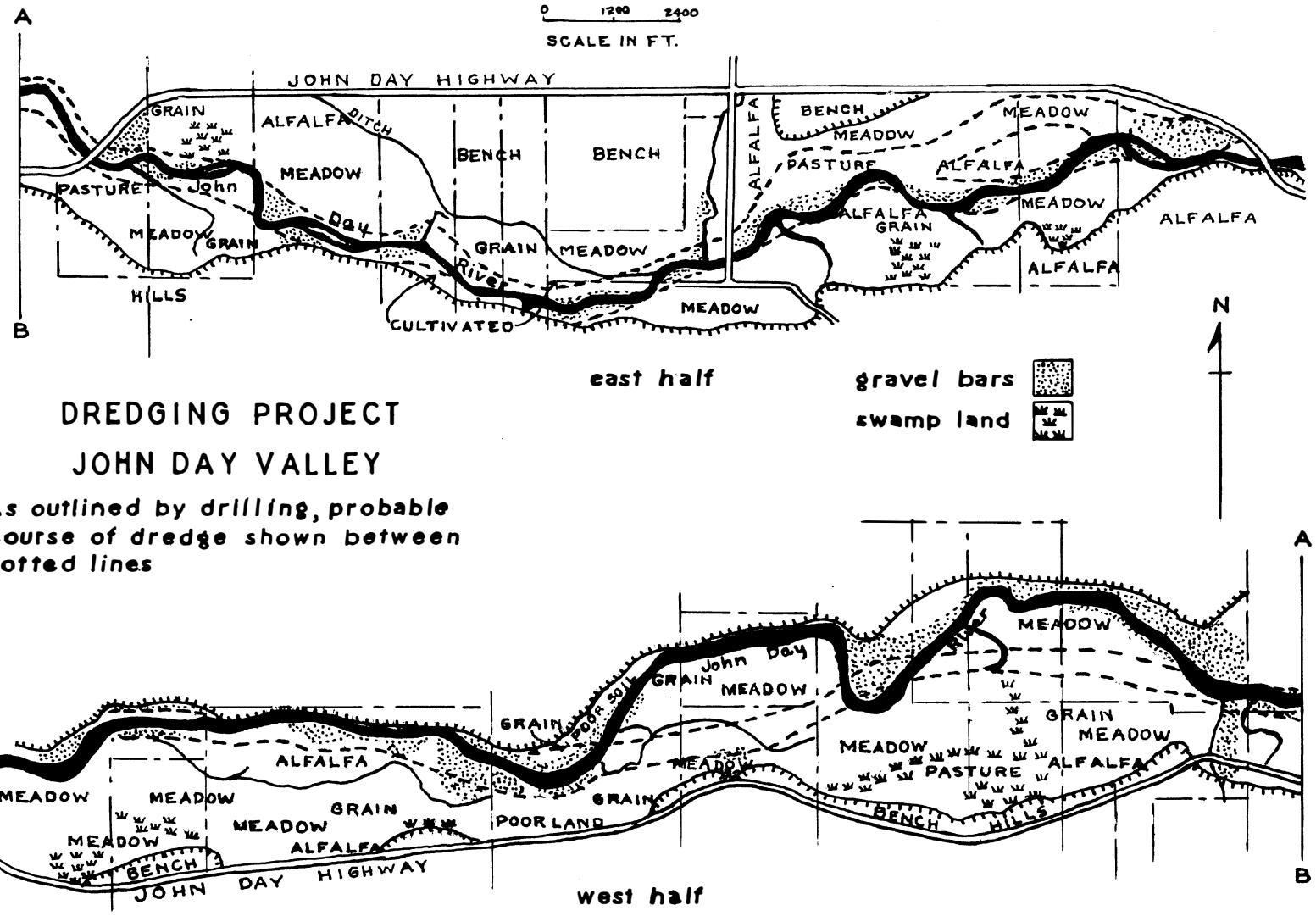

A
B
0 1200 2400
SCALE IN FT.
JOHN DAY HIGHWAY
GRAIN
ALFALFA
DITCH
MEADOW
BENCH
BENCH
ALFALFA
BENCH
MEADOW
MEADOW
PASTURE
ALFALFA
PASTURE
John
Day
River
MEADOW
GRAIN
GRAIN
MEADOW
ALFALFA
GRAIN
MEADOW
ALFALFA
HILLS
CULTIVATED
MEADOW
ALFALFA
N
east half
gravel bars
swamp land
DREDGING PROJECT
JOHN DAY VALLEY
As outlined by drilling, probable course of dredge shown between dotted lines
A
B
MEADOW
MEADOW
MEADOW
GRAIN
ALFALFA
MEADOW
BENCH
JOHN DAY HIGHWAY
GRAIN
POOR SOIL
GRAIN
POOR LAND
GRAIN
John Day
River
MEADOW
MEADOW
GRAIN
MEADOW
MEADOW
PASTURE
ALFALFA
GRAIN
MEADOW
BENCH
HILLS
west half

Plate 9

workings. Levees, 35 feet wide at the bottom, 4 feet wide at the top, and averaging 9 feet high were built.

Cost of the resoiling has not been reported, but a cost (presumably operating cost) of 4.89 pence (9.78 cents) per cubic yard has been reported by the Engineering and Mining Journal (see preceding page). This cost reportedly includes 0.81 pence (1.62 cents) charged for redemption of the cost of resoiling and earth work construction over the life of the enterprise.

****

In Japan resoiling after dredging has been done with equipment similar to that developed and used by the Natomas Company of California. It was reported that the "swell" in excavated material caused the resoiled surface to lie about 3 feet above the former position, but subsidence soon brought it down nearly to the original level.

Reclamation Other Than Resoiling.

Possibilities of reclaiming land, other than resoiling, after dredging operations are shown in comparable work on stripped coal lands in Illinois, Indiana, Kansas and Missouri. This reclamation is described in U.S. Bureau of Mines Report of Investigations 3440.

In localities where coal seams have occurred near the surface, overburden of rock and soil has been stripped, usually with large power shovels, and the coal mined by surface methods. The stripped material was left in piles and ridges separated by narrow valleys from 10 to 20 feet deep.

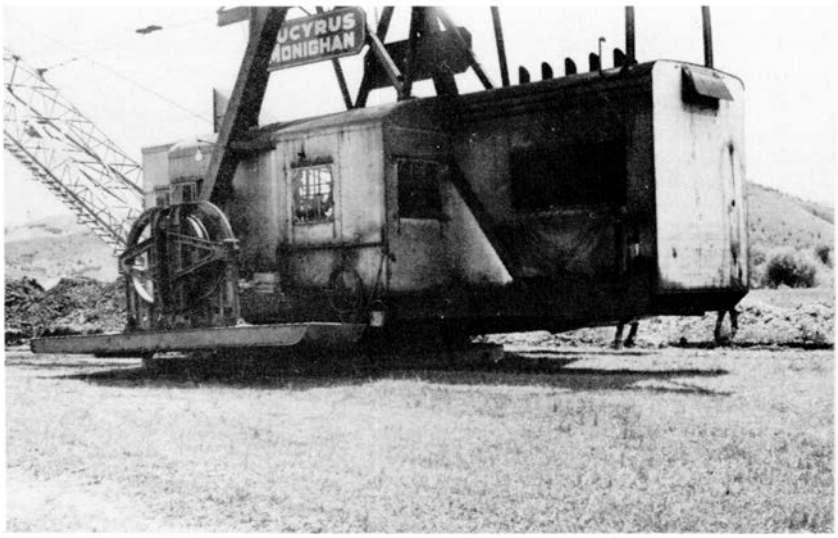
Most of the reclamation of these stripped areas has been on piles of material placed about 20 years ago. Considerable weathering has taken place with resulting formation of new soil. In some localities there is now a heavy natural growth of large trees. In many districts reclamation has been systematically planned; orchards have been planted with or without leveling; recreational parks have been constructed; and in Indiana and Illinois a systematic reforestation program has been carried out for the past several years. Cost of the reforestation is given as from about $14 to about $45 per acre. At 21 Indiana strip mines, the average cost of tree planting from 1934 to 1938, inclusive, was $14.50 an acre.

A similar use has been made of some dredged areas in California. The subject is described by Charles Janin in U.S.Bureau of Mines Bulletin 127 (1918) as follows:

> "The removal of the tailing for use in the rock-crushing plants is a step toward the ultimate reclamation of that land. After the larger stones have been removed from the ground at Natoma, experiments have been made in planting olive and eucalyptus trees without any further treatment than the addition of a shovelful of loam around the roots of the trees as they are put in place. Although only a few acres have been planted in this way, enough has been done to demonstrate the feasibility of the plan and to give ample evidence of the fertility of this part of dredged ground. Successful experiments in planting trees and grape vines in the dredge tailing have been made at Oroville. Much of

> "the success of the experiments was due to the abundance of clay present, which added greatly to the fertility of the tailing. The results show that the ground after dredging is not so worthless as was at first supposed."

A case more nearly like conditions in certain parts of Oregon is that of a dredging operation in New Zealand described in a private communication to the writer. At one operation the gravel treated was originally covered with a thin layer of soil not over 6 to 12 inches thick and supporting a scrub growth of trees, possibly a few suited for firewood but for the most part valueless. No attempt to resoil has been made, but trees of a better variety than originally existed have been planted extensively on the rock piles. The growth of the trees has been remarkably good, and while it is too early to judge whether or not a growth of commercial timber will result, the operators are hopeful that this will be the case. At a new operation by the same company it is the intention to pursue a similar course in planting trees on rock piles. Costs were not given.



Ferris and Marchbank 4½ yd. Monighan dragline, John Day Valley, showing travelling mechanism.

Porter and Company dredge and tailings on Bull Run, Grant County.

Atkinson dredge tailings (Oroplata Mining Co.) on Granite Creek, Grant County.

PLATE 10.

CONCLUSIONS

The essential facts to be considered in judging the results of dredging in farm areas are as follows:

1. The proportion of crop land taken out of use by dredging in those counties containing dredged or dredgeable ground is very small.

2. The amount of dredgeable ground in the state is limited to a few counties and a small acreage and would have an insignificant effect on production of crops.

3. There is no lack of cropland in the state or the counties concerned.

4. The John Day Valley has been considered a critical area because livestock is the principal money crop and the hay land of the valley, some of which has been dredged, is essential to provide winter feed. The small amount of hay land dredged or dredgeable would probably have little effect on the total amount of winter feed available, but, aside from this, measures are being taken to improve the winter feed condition - measures which would have been taken had there not been any valley land dredged. The most important of these improvements are the progressive replacement of meadow hay land by alfalfa land in order to increase the amount and quality of winter feed, and "deferred" or planned grazing designed to improve the quality of range land contiguous to the valley.

5. The dredging industry produces new wealth, a large part of which is distributed in various forms to the people of the state. Lack of such distribution would materially affect county and state taxable income.

6. Resoiling of low-value agricultural land is economically impractical.

7. The economic advantages of stripping overburden should be carefully investigated by dredge operators.

8. Land owners and dredge operators should cooperate in conserving crop land wherever possible. If, in a dredgeable tract of high-value land, that is, land valued at $100 or more per acre, stripping of top soil ought to be done in order to make the most economic operation, then it is believed that such cooperation could result in both dredging the ground economically and the return of the land to the owner in as good if not better condition for farming than it was originally. In other words, if the land is to be stripped in any event, the added cost of resoiling should not be more than $100 an acre. Effective cooperation implies voluntary agreement as to terms and procedure.

9. Conservation of high-value dredgeable land rests principally with the land owner. If his main concern is to get the highest cash price obtainable, then resoiling is impracticable.

10. Legislative action designed to restrict or control dredging operations would affect the operating industry adversely and prospective dredging enterprises would look to other fields for profitable investment.

APPENDIX

STRIPPING.

Because of the close relationship of stripping to resoiling the subject is treated in some detail.

Stripping of soil cover or any other overburden may be done dry in different ways: three methods applicable to usual dredging practice will be mentioned.

In this country stripping with machines is done with greatest facility in favorable ground with a dragline, overcasting the material. The disadvantage of this method is that, using a dragline for both stripping and digging gravel, the washing plant is idle while stripping is done.

In Australia stripping is being done dry with bucket line dredges and the stripped material returned to the leveled tailings. This requires a specially designed dredge in which the stripped material is by-passed around the screen to a long belt stacker which conveys the dirt to the top of the tailings in the rear of the dredge. Material which may be dug successfully with a bucket line must be of such consistency that it can be picked up and discharged readily by the buckets. It is a cheap method of stripping favorable ground but is subject to the same disadvantage as the dragline, for, while stripping is going on, the washing plant is idle.

Auxiliary equipment in the form of heavy earth-moving machinery may be used efficiently in stripping. Such equipment is far more economical for handling large quantities of material than it was a few years ago, and, especially as used by experienced contractors, can move ground at a low unit cost. Auxiliary equipment suitable for stripping means a higher capital cost to the dredge operator either in the form of such machinery purchased or in the price paid a contractor for moving material. The advantage of such equipment is that dredge excavating machinery may work always on gravel and the washing plant is kept working continuously. Thus the whole plant works at maximum capacity.

The cost of stripping could vary over a wide range depending on characteristics of ground handled and type of equipment used. Operating costs (as distinguished from total costs) of from 3 cents up to 10 cents per cubic yard have been reported for operations comparable to those in Oregon. In the 10 cent cost probably clearing of ground was included. Stripping with a medium-sized dragline and overcasting material under favorable conditions could be done for about 6 cents a cubic yard total cost; with heavy earth-moving equipment total cost of about 7 cents a cubic yard under favorable conditions should be obtainable.

Unless there are special problems which make the operation impractical, stripping of overburden is or should be done in all cases where intelligent prospecting has proved that the section of pay gravel is overlain by a barren section or a section too low-grade to be profitable.

It is often decided that it is cheaper to dredge overburden and run it through the washing plant than to strip it. Also that if the overburden contains a few

cents a yard, the recovery of these low values will pay for handling, and, therefore, stripping is unnecessary. It is easier and simpler to dredge without stripping, and it is believed that in many cases such factors are given too much weight. Even disregarding any possibility of resoiling all the advantages of stripping overburden should be carefully weighed. The subject has a close analogy to lode mining in which an operator finds it easier to run everything broken in the stopes through the mill, although the added operation of sorting out waste from the broken ore might make a more profitable operation.

Each dredging operation is a separate problem as to the economy of stripping, yet it is possible to make certain applicable generalizations. Stripping of barren or near-barren overburden from a placer deposit could result in the following operating advantages.

(1) The grade of material treated in the washing plant would be raised in proportion to the thickness of overburden stripped; that is, for example, if a total section or thickness, including 5 feet of barren overburden, is 20 feet and contains a recoverable value of 15 cents a cubic yard, then by stripping this 5 feet of overburden, the remaining 15 feet would have a recoverable value of 20 cents a cubic yard.

(2) In those cases where soil is involved, the material treated in the washing plant would have a much smaller proportion of slimes, colloids, and vegetable matter, thus increasing screening efficiency and, probably, the gold recovery of the plant.

(3) Since for a given ground area a smaller quantity of material would be run through the plant, wear and tear on equipment would be reduced and a smaller charge for repairs made against the operation.

(4) There would be in most cases a smaller proportion of slimes to handle in the pond, a better conditioned wash water to pump, and the effluent would have a smaller proportion of solids to discharge to settling basins or stream outlet.

(5) Using auxiliary machinery for stripping, the time of mining out the deposit would be lessened with attendant reduction in fixed charges. While there would, of course, be no increase in the total gross production from a deposit, a greater annual gross production could result from the higher grade material dug so that there would be a larger annual depletion allowance, (if depletion is figured on a percentage of income basis), provided the ground is bought and not worked on a royalty basis. A governing factor would be, of course, that depletion allowance, figured on percentage of income basis may not exceed 50 per cent of the net income before depletion.

Even considering a case in which an operation has a thickness of overburden with a recoverable unit value approximately equal to the unit operating excavating cost, it is entirely possible that if all costs dependent upon time are figured, it would be shown that there would be an advantage in stripping such overburden rather than running it through the washing plant.

The following examples, making arbitrary assumptions, are given to illustrate those of the above points which can be evaluated. These examples are intended to indicate comparative results only.

Assumed Conditions:

I.

A dragline operation digging 1,000,000 cubic yards a year on a section averaging 20 feet thick including 5 feet of barren overburden with a recoverable value of 15 cents a cubic yard. Stripping is done with dragline and material overcast.

Without stripping:

Recovery 1,000,000 yards at 15 cents		$150,000
Operating cost " 8 cents		80,000
Operating Profit		$ 70,000

With Stripping:

Recovery 750,000 yards at 20 cents		$150,000
Treatment cost 750,000 yards at 8 cents	$60,000	
Stripping 250,000 yards at 4 cents (operating)	10,000	70,000
Operating Profit		$ 80,000

II.

The same conditions as in I except that stripping is done with auxiliary machines.

Without stripping:

Recovery 1,000,000 yards at 15 cents	$150,000
Operating cost 1,000,000 cubic yards at 8 cents	80,000
Operating Profit	$ 70,000

With stripping:

Recovery 1,000,000 yards at 20 cents		$200,000
Treatment cost 1,000,000 yards at 8 cents	$80,000	
Stripping 333,333 yards at 5 cents (operating)	16,667	96,667
Operating Profit		$103,333

III.

Same conditions as to capacity and thickness of section. The whole 20 foot section has a recovery value of 15 cents a cubic yard, but the top 5 feet has 3 cents a cubic yard. Stripping is done with own dragline.

Without stripping:		
Recovery 1,000,000 yards at 15 cents		$150,000
Operating cost 1,000,000 yards at 8 cents		80,000
Operating Profit		$ 70,000
With stripping:		
Recovery 750,000 yards at 19 cents		$142,500
Treatment cost 750,000 yards at 8 cents	$60,000	
Stripping 250,000 yards at 4 cents (operating)	10,000	70,000
Operating Profit		$ 72,500

IV.

The same conditions as in III except that stripping is done with auxiliary machines.

Without stripping:		
Recovery 1,000,000 yards at 15 cents		$150,000
Operating cost 1,000,000 yards at 8 cents		80,000
Operating Profit		$ 70,000
With stripping:		
Recovery 1,000,000 yards at 19 cents		$190,000
Operating cost 1,000,000 yards at 8 cents	$80,000	
Stripping 333,333 yards at 5 cents (operating)	16,667	96,667
Operating Profit		$ 93,333

. The following table shows calculated gains by stripping using auxiliary machines with assumed arbitrary thickness of sections and gold values. .

Assumed total cost of stripping with auxiliary machines at 7 cents a yard.

Total thickness or depth of ground ft.	Thickness of overburden ft.	Recovery of gold from total thickness. ¢ per cu.yd.	Recovery of gold from overburden ¢ per cu.yd.	Calculated recovery of gold from gravel if stripped. ¢ per cu.yd.	Percent unit recovery gained by stripping	Percent gain in wear and tear on equipment if soil stripped.	Cost of stripping ¢ per cu.yd. of gravel	Calculated gain by stripping ¢ per cu.yd. of gravel.
10	5	15	0	30	100	50	7.0	8.0
			3	27	80			5.0
15	5	15	0	22.5	50	33 1/3	3.5	4.0
			3	21	40			2.5
20	5	15	0	20	33 1/3	25	2.3	2.7
			3	19	26.7			1.7
25	5	15	0	18.75	25	20	1.75	2.0
			3	18	20			1.25
30	5	15	0	18.0	20	16 2/3	1.4	1.6
			3	17.4	16			1.0

Disregarding the idea of resoiling in any dredging operation except on high-priced land, stripping should be planned so that the soil removed could be available for future resoiling. In cases where stripping is done with a bulldozer, overburden is usually left in piles adjacent to the dredge tailings and could be used in any desired future reclamation of the tailings. Where stripping is done with a dragline and the material overcast into the pond, the soil is covered with rock tailings and is forever lost. In many cases the operation could be so planned that the soil could be either overcast on top of the tailings or cast in a windrow on one side, where it would have some value in a possible future reclamation of the land. The very slight increase in cost would be more than recompensed by having less slime to handle in the pond.

In Alaska stripping with hydraulic giants is generally practiced where water conditions and gradients permit. In the Fairbanks district frozen overburden consisting of moss and tundra blanket underlain with muck, all up to 120 feet thick, has been thawed and removed hydraulically before gravels are dredged.

Quoting from U.S. Bureau of Mines Bulletin 259 (X): "Where an appreciable depth of barren or very low-grade overburden exists, it is generally customary and good practice first to remove as much of it as is consistent with the conditions and the available facilities before actual mining and sluicing of the gravels are started, not for the possible purpose of thawing alone, but because this overburden can generally be handled thus more cheaply than by putting it through the sluice boxes; such action may also be necessary in connection with the tailing disposal, or in keeping such material as clay and roots from passing through the sluice boxes.

Many Alaska placers are of too low grade to be mined at a profit unless this overburden can first be removed at comparatively low cost. Stripping reduces the volume of material to be handled later by more expensive methods, and the gold content of the deposit is not disturbed. These important features deserve consideration when a placer deposit is being studied, and the stripping operation should be considered in preparing the ground for mining, much the same as at porphyry-copper, coal, phosphate, and other deposits in the United States."

In this connection, U.S. Bureau of Mines Bulletin 298* gives a measure of the scale of stripping operations in the United States as follows:

"During an average year approximately 19,000,000 tons of coal, 24,000,000 tons of copper ore, 32,000,000 tons of iron ore, 150,000 tons of bauxite, and 2,700,000 tons of pebble phosphate are mined in the United States by open-pit or stripping methods. These quantities total 78,000,000 tons, and at least four times (in cubic yards) that amount of overburden is stripped to expose these minerals for mining."

These figures are probably high for the past several years, but, even with a considerable reduction, the matter of handling 2 to 3 hundred million cubic yards annually shows the importance of stripping overburden in mining operations.

(X) Placer Mining Methods and Costs, by Norman Wimmler, pp.65-66.

* Methods, Costs, and Safety in Stripping and Mining Coal, Copper Ore, Iron Ore, Bauxite and Pebble Phosphate by F. E. Cash and M. W. von Bernewitz, p.1

Stripping and Resoiling Cost Factors.

It is difficult to set up definite costs to apply to dredging operations generally, and it is realized that each dredging enterprise is a separate problem. However, certain cost factors have simple mathematical relationships, and these are set down below in order to supplement and correlate statements made previously. Using these relationships, the cost of resoiling may be computed in terms of unit value of gravel to be mined after certain factors are either determined by prospecting or estimated.

The conditions assumed are idealized; relationships are based on a rectangular block with yardage proportional to the depth of section. All the factors used are convertible into cents per cubic yard of gravel. In assuming gains obtained by stripping, which would be done with auxiliary machines, a comparison is implied with an operation on the same ground without stripping. Resale value of the land would be the value for agricultural purposes after resoiling.

The cost factors assumed are:

(1) Cost of stripping.
(2) Cost of leveling tailings.
(3) Cost of replacing and leveling soil.
(4) Increased value of treatable gravel.
(5) Lowering of fixed charges by gain in time of treatment.
(6) Resale value of land.

Note: For simplicity items (2) and (3) are considered as distinct. In practice they might be more or less combined.

For convenience the following letters are used to represent unit quantities as factors:

d_1 =depth of gravel in feet.
d_2 =depth of soil in feet.
d =depth of soil plus gravel in feet.
a_1 =recoverable value of gravel in cents per cubic yard.
a_2 =recoverable value of soil in cents per cubic yard.
a =recoverable value of soil plus gravel in cents per cubic yard.
V =gain in unit value obtained by stripping.
c_1 =cost of stripping in cents per cubic yard of material handled.
c_2 =cost of leveling tailings and replacing and leveling soil in cents per cubic yard of material handled.
c =c_1 plus c_2.
C =c converted to cents per cubic yard of gravel.
t_1 =unit cost of fixed charges for treatment of gravel in cents per cubic yard of gravel.
t =unit cost of fixed charges for treatment of soil plus gravel in cents per cubic yard.
T =gain by stripping in unit cost of fixed charges.
r =resale value of land.
R =resale value of land in cents per cubic yard of gravel.

Let X = net cost of resoiling in cents per cubic yard of gravel, then:

(I) $X = C - (V + T + [redacted]R)$.

(II) $C = \frac{d_2}{d_1} c$

$V = a_1 - a$

$d \times a = ad$

$d_2 \times a_2 = a_2 d_2$

$\frac{ad - a_2 d_2}{d - d_2} = a_1$

(III) $V = \frac{ad - a_2 d_2}{d_1} - a$ If $a = 0$ $V = a\left(\frac{d}{d_1} - 1\right) = \frac{a(d-d_1)}{d_1} = a\frac{d_2}{d_1}$

$\frac{t_1}{t} = \frac{d_1}{d}$ $t = \frac{td_1}{d}$

(IV) $T = t - \frac{td_1}{d} = t\left(1 - \frac{d_1}{d}\right)$

(V) $R = \frac{r}{\frac{4840\ d_1}{3}}$

Combining II, III, IV and V in I.

$$X = c\frac{d_2}{d_1} - \left(\left(\frac{ad - a_2 d_2}{d_1} - a \right) + t\left(1 - \frac{d_1}{d}\right) + \frac{r}{\frac{4840\ d_1}{3}} \right)$$

For example: Assume that a parcel of farm land valued at $100 an acre had been prospected and shown to have an average section of 20 feet with a recoverable value of 15 cents a cubic yard. This section has an average top soil overburden of 5 feet containing recoverable values of 3 cents per cubic yard. Assume the cost of stripping soil and leveling tailings at 7 cents a cubic yard, the cost of replacing and leveling soil on leveled tailings at 8 cents, and the unit fixed charges for treating the full 20 foot section at 4 cents.

Then:

$$X = 15\ .\frac{5}{15} - \left(\frac{(15 \times 20) - (3 \times 5)}{15} - 15 + 4\left(1 - \frac{15}{20}\right) + 0.41\right) = 5.00 - 5.41$$

X = 0.41 cents

or a gain of 0.4¢ per cubic yard of gravel and including resoiling as compared to such an operation conducted without stripping.

In comparing an operation in which stripping would be practiced with auxiliary machines without resoiling and one on the same ground in which resoiling would be done, the stripping operation might be so planned that it would merge or continue on into the resoiling work as in a dragline resoiling job. That is, there would not be two separate operations as has been assumed in estimating costs in the case above, but essentially one operation up to the point of leveling the soil on top of the tailings. Stripped material would not be dumped in piles or windrows, later to be picked up and deposited on the tailings. Large bulldozers and carry-alls in the work of stripping would transport the material in the one operation to the leveled tailings. In this way, on a large operation, the cost of resoiling would be only a little more than the cost of stripping. The critical factor in such an operation is the distance which material must be transported. About 300 feet is considered a maximum for bulldozer work.

Data supplied by the Natt McDougall Company, contractors of Portland, Oregon, give a measure for such operations. A cost figure usually used for an RD8 (95 H.P.) tractor and 4 cubic yard capacity bulldozer, moving an average of 100 cubic yards an hour with a maximum haul of 300 feet is $6.00 per hour to cover both operating and capital costs. A formula used to get the unit cost of material handled is:

$$X = \frac{D}{S} \times \frac{C}{L}$$

Where X = cents per cubic yard of material

D= Distance hauled in feet
S= Speed in feet per minute
C= Cost per minute
L= Cubic yards per trip

Thus, if an average of 2 cubic yards a trip is hauled 300 feet at a speed of 250 feet a minute at a cost of 10 cents a minute, the unit cost is 6 cents a cubic yard.

EXAMPLES OF COST OF STRIPPING SOIL OVERBURDEN.

Accurate costs of stripping were kept by E. T. Fisher & Co. in their dragline operations at Atlantic City, Wyoming, a description of which is given in U.S. Bureau of Mines Information Circular 6846 (X) (June 1935).

The channel mined averaged about 200 ft. wide along Rock Creek. The depth of gravel averaged 10 feet and the upper 3 feet of the deposit was barren loam. The dragline had a $1\frac{1}{4}$ yard bucket. Quoting from the above report:

"The Creek was first diverted into a canal dug by the dragline at one side and 50 to 100 feet from the edge of the gravel channel. Stripping is done in two swaths. The shovel travels up one side and back the other. The machine can dig across a strip 180 feet wide without moving from side to side. As the gravel is stripped a drain ditch is dug 4 feet into the decomposed bedrock on either side of the tract to be worked. The overburden is piled in rows back of the drain ditches. The material dug from the ditches is piled on top of the gravel to be washed. On the creek side a berm is left next to the pit to hold the water pipe.

"The stripping is kept a minimum of 50 feet ahead of the other work. Some stripping is done in the spring and fall when freezing weather prevents washing. During the spring of 1934 stripping was done 44 days before washing was begun. Until other operations catch up to the stripping (which will be about August 15) washing will be done on three shifts. Thereafter, stripping will be done on one shift (the midnight) and washing on the other two. Between 1,000 and 1,200 cubic yards of overburden (average 1,150) is stripped per 8-hour shift. . . ."

"The cost of removing the overburden, including digging the ditches, was $0.05 per cubic yard."

****

An example of the economies effected in stripping overburden by the use of modern earth moving machinery is given in The Coal Age.* At the Blue Bird strip coal mine in Northern Ohio, overburden above the coal seam to be mined by surface methods ranges up to 40 feet thick. Typical section being stripped consists of 6 feet of clay and top soil and 20 feet of gray shale containing hard irony bands. Stripping equipment includes two 95 h.p. Diesel RD-8 tractors, one 10-yard wagon scraper, one LeTourneau 12-yard "carryall", one LeTourneau "Rooter", one LeTourneau "Angle-dozer", and one 80 h.p. tractor with a 7-yard wagon scraper. Coal to be mined underlies about 250 acres.

Formerly stripping at this property was done by contractors, using power shovels, at a price of 14 cents a cubic yard. By the use of the tractor and scraper equipment the cost has been reduced to 7 cents a cubic yard.

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(X) Placer Mining Methods of E. T. Fisher & Co., by Charles L. Ross and E. D. Gardner. (1935)

* April 1939. Strip Cost Halved at Blue Bird "Cash and Carry" Mine Serving Northern Ohio Territory.

Although not generally applicable to dredging operations outside of Alaska, hydraulic stripping is done where practical at various iron ore and pebble phosphate properties. The following is extracted from U.S. Bureau of Mines Bulletin 298* in order to indicate possible costs as compared to the other examples given:

"Iron ore was cheaply uncovered by hydraulic stripping at one operation in Minnesota. The overburden was of a sandy loam character, and with water available the stripping and transportation of overburden by this means, as compared to steam or electric power, was an attractive problem. In the removal of 613,810 yards of waste during a period of 10 months the operations and cost were as follows: . . . . .

Cost per yard	
Labor	2.53 cents
Supplies	.29 "
Power	3.75 "
Repairs	.66 "
General Expense	.57 "
Total	7.80 cents "

****

"The Coronet Phosphate Company, through its manager, H. F. Greene, submits these costs:

Operation	Hopewell Mine	Pembroke Mine
Method of stripping	Hydraulic	Steam shovel
Cost	10 cents per yard	15 cents per yard. "

****

Some further facts concerning hydraulic stripping particularly as applied to marble quarrying are taken from U.S. Bureau of Mines Bulletin 106 (#):

"Hydraulic stripping is employed with success in several marble quarries. There are certain conditions, however, that must be met in order that hydraulic stripping may be successful or even possible. Two important conditions are an adequate water supply and easy drainage. If the water supply is obtained from drilled wells or small streams that may go dry, the process will probably fail."

"Those who have had experience in hydraulic stripping estimate that the cost of soil removal by that method may be as low as 2 cents per cubic yard."

The Technology of Marble Quarrying, by Oliver Bowles, pp.47-48, (1916).

* Methods, Costs, and Safety in Stripping and Mining Coal, Copper Ore, Iron Ore, Bauxite, and Pebble Phosphate, by F. E. Cash and M. W. von Bernewitz, pp.216-217, p.246. (1929).

The following extract concerning cost of power shovel stripping at rock quarries is taken from U.S. Bureau of Mines Bulletin 160*:

"Usually the material overlying a rock deposit is soft enough to be handled readily with the steam shovel without blasting. In some localities, however, blasting is necessary. If large bowlders that require blasting are encountered, the rate of progress may be greatly reduced.

"The cost of stripping with a steam shovel depends on the depth and nature of the materials to be removed, capacity of the shovel, condition of the rock surface, and facilities for removal of cars. Four cents a ton, actual working cost for loading only, is the minimum figure obtained. At one quarry having 1 to 10 feet of overburden, the total operating cost of stripping, including transportation, was 11 to 13 cents a ton. At an Illinois quarry having 20 to 30 feet of soil overburden, the operating cost of stripping, including transportation to a near-by dump, averaged 16 cents per cubic yard. Where the overburden is thin, the cost per ton will be relatively high, but the cost of stripping, per ton of rock obtained, will be relatively low.

"A stripping conveyor operated in connection with a steam shovel by one Ohio company is noteworthy. The soil to be removed is 30 to 45 feet thick, and the bed of rock beneath is only 8 feet thick. With the low efficiency of stripping observed in some localities, profitable quarrying under such conditions would be almost impossible. As the rock is removed, the area worked out is available for disposal of overburden. The equipment . . . consists of an inclined bridgelike structure of steel mounted on wheels. On this incline, two independent cable cars on separate tracks are operated with an electric hoist. The cars are loaded with the steam shovel, hauled up the incline, and dumped. The total length of the conveyor is 175 feet, and it places the material 150 feet from the steam shovel. The shovel has a $2\frac{1}{2}$-yard dipper, and each car is of 5-yard capacity. The whole machine may be moved forward as the shovel is advanced. The company claims that stripping can be done by this method at an actual working cost of 2 cents a cubic yard, not including overhead charges, depreciation, or interest on the investment, and that with a gang of 9 men, 2,000 yards can be handled per day. The equipment is well adapted for stripping back into pits from which all serviceable stone has been removed."

Also from U.S. Bureau of Mines Bulletin 124**:

"The expense involved in the removal of stripping depends on the amount of material to be moved, the convenience of a place of disposal, and the degree of efficiency attainable in the method and equipment employed. The cost of removal of a heavy stripping may constitute one of the largest items in the cost of quarrying. The author is convinced, however, that in many places this item of expense could be greatly reduced by using improved methods and machinery. Figures obtained from various quarry operators show a remarkable range in the cost of soil removal. The lowest was 3 cents and the highest 31 cents per cubic yard. The low figure was obtained through the use of a large steam shovel at a quarry where the place of disposal was within reach of the shovel, no car transportation being necessary."

* Rock Quarrying for Cement Manufacture, by Oliver Bowles, pp.39-40 (1918).
**Sandstone Quarrying in the United States, by Oliver Bowles, p.27 (1917)

In the Mining World* a description is given of the Quartz Creek Dredging Company's enterprise near Pierce, Idaho, in which stripping plays an important part in the operation. Digging is done with a close-coupled bucket line dredge using 2.8 cu.ft. buckets, and the capacity has been consistently around 3,000 cubic yards a day. Stripping is done ahead of the dredge with a 2 yd. dragline, the stripped overburden being piled along one side of the dredging ground. Neither the depth of overburden nor the cost of stripping is given, but it is stated that the material stripped has many roots, and that the stripping operation adds fully 500 cubic yards a day to the capacity of the dredge.

Under the conditions as described and with the apparently efficient operation of the enterprise, it seems probable that the cost of stripping here is at least no greater than that given for E. T. Fisher and Company, on page 37.

* October 1939, p.17