REPORT

ON THE

IRRIGATING AND RECLAIMING

OF CERTAIN

DESERT LANDS

IN

IDAHO

AND

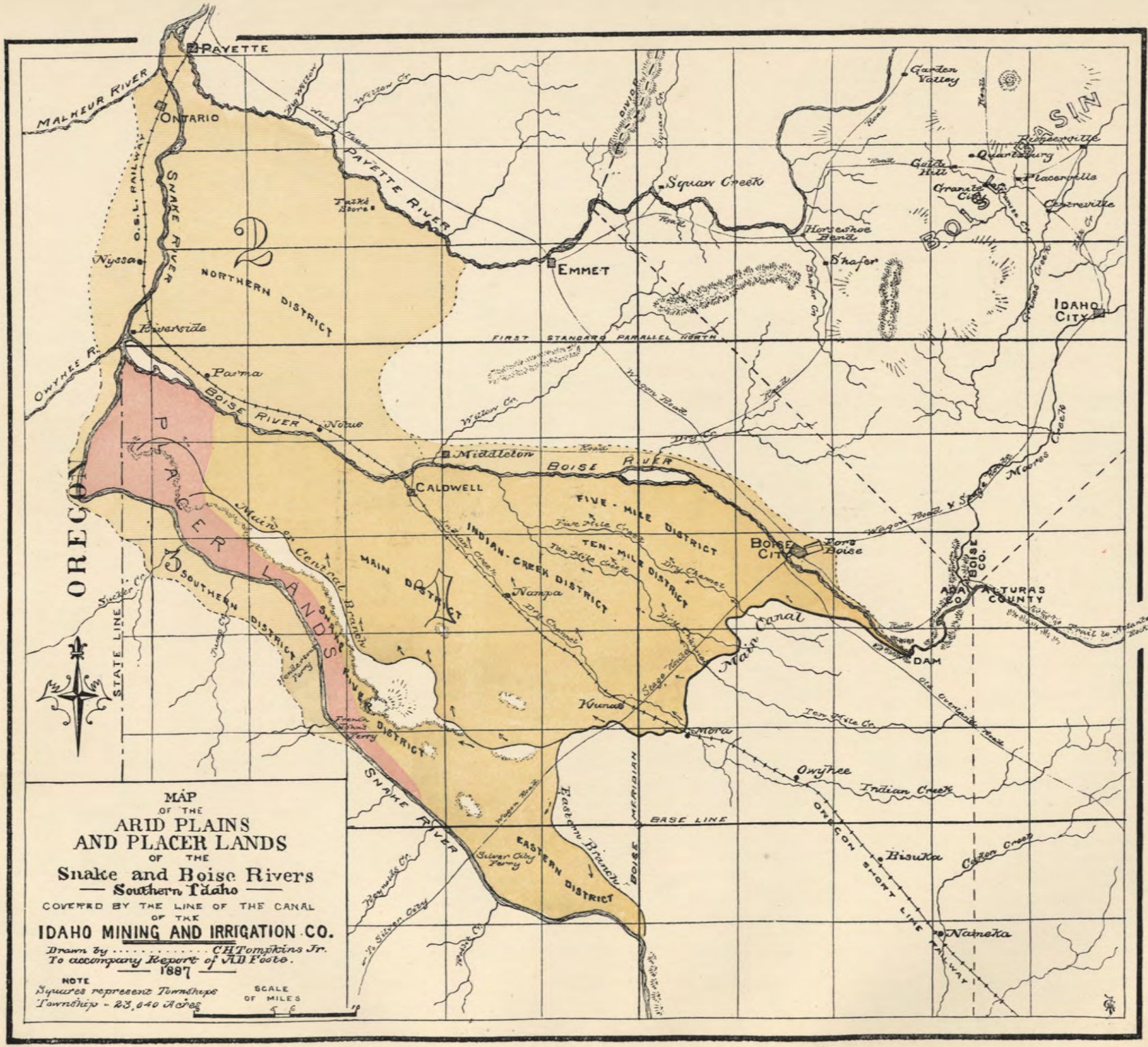
OTHER PROJECTS CONNECTED THEREWITH

BY

A. D. FOOTE

"I removed his shoulder from the burden:
his hands were delivered from the pots."
—PSALMS lxxxi. 6.

1887



MAP
OF THE
ARID PLAINS
AND PLACER LANDS
OF THE
Snake and Boise Rivers
— Southern Idaho —
COVERED BY THE LINE OF THE CANAL
OF THE
IDAHO MINING AND IRRIGATION CO.

Drawn by ..... C.H. Tompkins Jr.
To accompany Report of A.D. Foote.
1887

NOTE
Squares represent Townships
Township - 23,040 Acres

SCALE
OF MILES
5 0 10

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THE LANDS AND THE WATER SUPPLY.

Description of Lands.

THE greater portion of the lands which form the subject of the following paper are situated in the southern part of Ada County, Idaho Territory, between the Snake and Boise rivers. They may be roughly described as lying in the form of a triangle, two sides of which are formed by the Snake and Boise rivers; the other side, or base, being the line of the proposed canal necessary for the irrigation of these lands.

This triangle is nearly equilateral, measuring about sixty miles on each side, and containing, approximately, four hundred thousand acres of land, three hundred and fifty thousand of which are available for irrigation and cultivation.

The land in this triangle lies in two great plains, with a high ridge between them trending nearly parallel to the Snake River, and dividing them unequally. The larger plain slopes toward the Boise River, the smaller toward the Snake, and both slope toward the confluence of these rivers.

Upon the opposite or north side of the Boise River, and along the eastern side of the Snake River, lies a second tract of nearly two hundred thousand acres of land, susceptible of irrigation; and on the west side of the Snake River, above and below the mouth of the Boise, there is a third tract of excellent land, easily irrigated, comprising some fifty thousand acres.

In the first-mentioned tract of land (the triangle between the Boise and Snake rivers) there is a vast body of auriferous gravel or sand, to which attention will be called hereafter.

It is proposed to convey the water of the Boise River upon the above-described lands for the purposes of irrigation and mining.

For some time past I have been engaged in the surveys and examinations requisite to determine, from a financial point of view, the advisability of undertaking this work.

Questions to be Determined

It was necessary to determine:

1. The water supply, with the legal measures necessary for, and the aspect of the law toward, its appropriation for the purposes desired.

II. The quantity, quality, and position of the lands, both in regard to irrigation and drainage.

III. The various conditions appertaining to the lands, including climate, productiveness, situation, railroad communications, timber, and other inducements for settlers to occupy the lands.

IV. The lines of canal and cost of building them, and the methods of distribution and sale of water.

V. The extent, value, and method of working the placer mines.

The value and importance of irrigation being as yet, in this country, but little understood, I have deemed it advisable to make comparisons between this and similar undertakings oftener than conduces to brevity, or perhaps, clearness of statement, in order to show that irrigation is no novel thing, but, as history proves, has been successfully practiced in all the civilized ages of the world. In fact, all the earliest civilized communities we know of, could not have existed without it.

Catchment Basin of Boise River.

The Boise River, heading in the Saw Tooth Mountains of Central Idaho, has a catchment basin of about 1,600,000 acres. The amount of moisture which falls in this region, chiefly in the form of snow, is wholly a matter of conjecture, as there are no statistics on the subject to be had. Trappers and prospectors estimate the depth of snow anywhere from five to fifty feet, depending somewhat on the locality or elevation.

No Statistics of Rainfall.

It was necessary, therefore, to determine the discharge of the river by measurements made throughout the year. From reasonably accurate measurements of this discharge, extending over four years, I am able to give the following as a close approximation to the river volume, for each month of the year:

Volume of Boise River.

January.....	1,200	varying	to	1,500	cubic	feet	per	second.
February.....	1,200	"	"	1,500	"	"	"	"
March.....	1,500	increasing	"	5,000	"	"	"	"
April.....	5,000	"	"	15,000	"	"	"	"
May.....	15,000	"	"	30,000	"	"	"	"
June.....	30,000	decreasing	"	10,000	"	"	"	"
July.....	10,000	"	"	3,000	"	"	"	"
August.....	3,000	"	"	1,200	"	"	"	"
September.....	1,200	varying	"	2,000	"	"	"	"
October.....	1,200	"	"	2,000	"	"	"	"
November.....	1,200	"	"	2,000	"	"	"	"
December.....	1,200	"	"	2,000	"	"	"	"

Gen. C. H. Tompkins and Associates

Of the Idaho Mining and Irrigation Company:

Gentlemen:

Herewith I have the honor to submit to you a short report, embodying a description of your properties in Idaho, and a general review of the promise and prospects of your enterprise.

Since the writing of the report formerly submitted to you, I have resided continuously upon the tract to be irrigated. During this time close observation and investigation of this tract, of the conditions governing it, of the further results meanwhile obtained by irrigation here and elsewhere, and of the quality of the Snake River placers, have brought out many new facts, and confirmed most fully the opinions expressed in that report of the great value of these properties, and of the certainty of a speedy, large, and permanent return on the investment.

Very respectfully, your obedient servant,

A. D. FOOTE,

Engineer in Charge.

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The river appears never to rise suddenly to a dangerous degree. For many miles I have carefully examined its banks to find, if possible, any signs of ice-gorges, water-spouts, or other sudden changes in its habits, but could discover no evidences of the kind. Beginning about the first of March, it rises gradually, reaching its greatest height and volume about the first of June, then, gradually falling, reaches its lowest during the frozen period of winter. The great banks of snow in the mountains serve as self-acting reservoirs better than those artificially constructed, as these natural dams appear never to give way, but hold the year's collection of moisture until the time when it is most needed on the plains, and then send it down in a steady stream, increasing as the crops grow and diminishing as they ripen.

Habits of the River.

Natural Reservoirs.

While the majority of crops need little or no irrigation during the latter part of July and through August, grass and trees must have it. Fearing that there might be an insufficient quantity of water for the purposes requiring it during this period, I made an examination of the upper region of the Boise, for the purpose of discovering localities favorable for the cheap storage of water.

Artificial Reservoirs.

On Smith, Blind, and Fall creeks, tributaries of the South Boise, I found that the peculiarities of a former lava flow have rendered the construction of enormous reservoirs a matter of trifling expense, compared with the cost of such undertakings elsewhere. The lava has formed immense dikes across the valleys, in some cases resembling the work of man, through which the creeks have broken narrow channels. To build the reservoirs, it is only required that these channels should be dammed with earth, of which there is a sufficient quantity convenient in each case, thus raising the water by obstructing its natural outlet, so that the waste will flow over the lava dikes, which become indestructible waste weirs.

Lava Dikes as Waste Weirs.

Reservoirs easily Constructed.

The estimated capacity, cost, and value of the reservoirs which I located are shown in the following table:

TABLE SHOWING ESTIMATED CAPACITY, COST, AND VALUE OF RESERVOIRS LOCATED ON THE UPPER WATERS OF BOISE RIVER.

Name of Reservoir.	Capacity in Cubic Feet.	No. Days' Supply at 1,000 cu. ft. p. sec.	Capacity in 24-hour-four-inch Miner's Inches.	No. Cubic Yards in Dam.	Material Used in Dam.	Price per Cubic Yard	Cost.*	First Cost per Min's Inch.	Value of Water each Year at 5c. per Min's In.
Upper Fall Creek.....	522,720,000	6.05	290,400	76,852	loose rock and gravel	35c.	$28,498	9.8 c.	$14,520
Lower " "	418,176,000	4.84	232,220	51,569	loose rock and gravel	35c.	19,849	8.5 c.	11,611
Smith Creek.....	1,672,704,000	19.36	929,280	69,154	loose rock and gravel	35c.	26,204	2.8 c.	46,464
Upper Blind Creek....	6,690,816,000	77.44	3,717,120	241,667	gravel	20c.	50,833	1.4 c.	185,856
Lower " "	313,632,000	3.63	174,240	96,666	gravel	20c.	21,833	12.53c.	8,712
Totals.....	9,618,048,000	111.32	5,343,260	535,908			$147,217		$267,163

Volume of Water throughout the Irrigating Season.

The maximum discharge of the main canal, as shown hereafter, being about 4,000 cubic feet per second, it is evident from the table showing the discharge of the river that the only time when an additional supply of water can be needed, will be from July 15th to September 1st, forty-six days; the above table showing the capacity of the reservoirs, gives one thousand cubic feet per second for one hundred and eleven days, or say, one thousand cubic feet per second for eighteen days in July, and three thousand for thirty-one days in August.

In order to determine what would be a sufficient supply for the success of the enterprise in question, it was necessary to ascertain, as nearly as possible, the amount which would be required for irrigation. The amount requisite for mining can be adopted arbitrarily, at any time, in agreement with the necessities of the irrigating season.

Duty of Water Defined.

The "duty of water," as it is usually called in irrigation, is the number of acres of land which one cubic foot of water per second, or "second foot" of water, will irrigate.

Variability as Shown in Different Countries.

It is difficult to state precisely what this number of acres will be in an untried locality, as experience in different localities in the same country gives varying results. The following table shows the variable duty of water in different countries:

* "COST" INCLUDES COST OF GATES AND CULVERTS AS FOLLOWS:

Upper Fall Creek Reservoir.....	$1,600 00
Lower " " "	1,800 00
Smith Creek Reservoir.....	2,000 00
Upper Blind Creek Reservoir.....	2,500 00
Lower " " "	2,500 00

TABLE SHOWING THE DUTY OF WATER IN VARIOUS LOCALITIES.

Locality.	Duty of Water.	Remarks.
	ACRES.	
Jumna Canal, India	306	E. B. Dorsey, C. E., Trans. Am. Soc. C. E.
Ganges " "	232	" " " " " " "
Canals of Upper India	267	" " " " " " "
Canals of India, average	250	Lieut. Scott Moncrieff, R. E.
Genil Canal, Spain	240	E. B. Dorsey, C. E., Trans. Am. Soc. C. E.
Henares " "	157	Geo. Higgin, C. E.
Canals of Valencia, Spain	242	E. B. Dorsey, C. E., Trans. Am. Soc. C. E.
" Northern Peru	160	" " " " " " " No rain-fall
" " Chili	190	" " " " " " " No rain-fall
" Lombardy, Italy	90	Baird Smith, R. E.—Including Rice Crops.
" Piedmont, "	60	" " Including Rice Crops.
" Southern France	60	Lieut. Scott Moncrieff, R. E.
" Algeria	140	Hall, State Eng. California.
" Kern Co., Cal	106	" " " "
" Los Angeles, Cal	300	" " " "
" San Bernardino, Cal.	300	" " " "
" Tulare & Fresno, Cal.	130	" " " "
S. Joaquin & King's R. Canal, "	150	" " " "
Chowchilla Canal, Cal	150	" " " "
Canals of Utah Territory	100	C. L. Stevenson, C. E., Trans. Am. Soc. C. E.
Canals of Colorado	100	Nettleton, State Eng., Colorado.
" Cache la Poudre, Col.	193	Prof. Mead, C. E. "

The Duty of Water.

Wm. Hammond Hall, State Engineer of California, in writing of the duty of water, says: "It is not proper to make a comparison with the water duty of Piedmont and Lombardy, where cereals require no irrigation, and where rice and marcite meadows consume so great a proportion of the water used." Further on in the same report from which the above was taken, Mr. Hall's assistant, J. D. Schuyler, says: "One hundred and fifty acres per cubic foot per second should not be taken as an unreasonably high duty for water."

The U. S. Commission on Irrigation, composed of Gen. B. S. Alexander, Col. Geo. W. Mendell, U. S. Eng'rs, and Prof. George Davidson, of the U. S. Coast Survey, reported that a duty of one hundred acres might be calculated upon for Central California.

The average duty of water given in the foregoing table for localities in the United States, amounts to one hundred and seventy acres, but owing to the scarcity of water and value of land in Los Angeles and San Bernardino counties, California, the duty of water there is far above the average.

In estimating the duty of water, however, climate, character of soil, and method of distribution, are by far the most important con-

Duty of Water for the Lands of the Snake River Valley.

siderations, particularly the latter, to which I shall call attention further on. Bearing these considerations in mind, and using the experience in other countries as a guide, I feel assured that one hundred and fifty acres per cubic foot per second may be safely assumed as the duty of water for the lands of the Snake River Valley.

Volume of Water Required by Canal.

The estimated area to be irrigated, as given before, is about six hundred thousand acres. Allowing one hundred and fifty acres per cubic foot per second, it will require four thousand cubic feet per second for irrigation during ninety to one hundred days in the year, beginning in the latter part of May, the exact time depending somewhat upon the spring rains. From what has already been written concerning the water supply, it will be seen that over four thousand cubic feet per second can be obtained from the Boise River, exclusive of all prior claims, the total amount of these being very small.

Sufficient in Boise River.

Water Right Appropriation.

The appropriation has been made under the laws of the United States and Territory of Idaho, and consists of two hundred and twenty-five thousand "miner's inches," or four thousand and seven hundred cubic feet per second, sufficient to supply both the main canal and the Boise branch.*

Validity of Water Right.

The question of the validity of the water right has been most thoroughly examined. The laws of Idaho, and of many other of the Western States and Territories, abrogate entirely the common law doctrine of riparian rights, and subject all the waters running through the public lands of the United States to appropriation according to the laws of Congress—differing in this respect from the statutes of California and Nevada, which recognize in a measure riparian rights.

Between appropriators, priority of time gives priority of right.

Prior Appropriations.

The prior appropriations on the Boise River amount to about

* A legal miner's inch, in Idaho Territory, is that quantity of water which will flow through an inch square orifice in an inch partition, with a pressure, or head, of water, extending four inches above the center of the orifice. Forty-eight of these miner's inches equal one cubic foot per second. In twenty-four hours, this miner's inch will discharge eighteen hundred cubic feet of water, which is a "twenty-four-hour miner's inch," and is the kind used in this paper, unless otherwise designated. The term appears to have originated as an *oncia*, in Piedmont, Italy, about the middle of the XVI. century, was first adopted in this country in the placer mines of Georgia, and afterwards throughout the West Coast, both for mining and irrigation. It has many different values, depending upon the head, size of orifice, etc.; the most common, perhaps, being a six-inch head, above an orifice two inches high, delivering 45.0 cubic inches per second, or 2,250 cu. ft. in twenty-four hours. One cubic foot per second equals 38.4 six-inch miner's inches, or 48.0 Idaho miner's inches.

9,600 miner's inches (200 cubic feet per second), a comparatively insignificant quantity.

Legal Opinion as to Title.

A full legal opinion as to the validity and incontestability of the water right under consideration has been obtained from the most eminent lawyers of the Territory (Messrs. Huston and Gray, and Mr. R. Z. Johnson, attorneys, of Boise City, Idaho), and this opinion, together with the abstract of title, deposited in the New York office of the Company.

The line of canal being on government land, the right of way is free, under the United States law.

Fertilizing Qualities of the Silt-bearing Water.

In obtaining water supplies for cities, purity is the first consideration. In supplying lands, however, impurity is the quality most desired; for water carrying sediment supplies the land with both food and drink.

Want of it Shown in the Henares Canal.

The Henares Canal, in Spain, although a beautiful piece of engineering and exhibiting every other factor of financial success, was yet a partial failure, for the reason that this subject of fertilization with water was not taken into consideration. The land had been exhausted by previous crops, and the cultivators were poor. The water brought by the canal was pure, and although it enabled the peasants who used it to increase their crops, the increase was not in proportion to the cost of the water, and they could not afford to pay for it. The canal company was forced to reduce its water rates below the cost of supply, with the hope of eventually improving the land by artificial fertilization. This hope is gradually being realized, and eventually the canal will be a profitable investment.

Value of Sediment in Lombardy.

One of the irrigating canals of Lombardy gets $22 per cubic foot per second more for its water than a neighboring canal "because of the valuable fertilizing matter brought down." *

In France.

"In the valley of the Moselle in Fran c on land absolutely barren and worthless and with no manure, save the alluvial matter deposited by constant irrigation, the produce of two crops a year after a few years attains to four tons (hay) per acre. . . . The difference is very marked between the meadows irrigated with the silt-bearing waters of the Durance Canals and those of the clear cold Sorgues. So much so that the cultivators prefer to pay for the former ten or twelve times the price demanded for the latter." † . . .

"Although there are no satisfactory experiments to show how much of the beneficial effects of irrigation can be attributed merely to the water supplying moisture to the land and crops, or to the matter in solution and mechanically suspended in it, yet it is well known that the waters of the Durance produce more satisfactory results than the waters of some other rivers, for example, the Sorgues.

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* Stewart: *Irrigation for Farm and Garden.*
† Moncrieff: *Irrigation in Southern Europe.*

The clear waters of that river can be had by the (land) proprietors almost gratis, nevertheless they prefer to form associations and at considerable expense to obtain water from the river Durance." *

In Spain.

On the Royal Jucar Canal in Valencia, Spain, and on the canals of the Turia, the silt is taken from the water channels and carefully saved for its value as manure.†

In California.

In California, "in filtering through the porous soil, all the sediment and fertilizing matter contained by the water is detained and acts as a perpetual restorative. Rich fields, producing large annual crops, are to be seen on Kern Island, that were barren wastes of pure sand before irrigation reclaimed and fertilized them." . . . In Los Angeles Co., "The clear pure water used for irrigation, coming as it does from artesian wells and springs, carries so little of the rich fertilizing sediment . . . that it does not restore the elements of plant growth to the soil and constantly enrich it, as does irrigation in some other parts of the State. . . . There are large tracts of land at a number of points along the foot-hills of the Sierras which are now fertile and productive, but which a few years ago were almost barren. The sediment in the water used for their irrigation has been retained on the surface and has made good soil. This is notably the case in the neighborhood of Folsome and also near Smartsville." ‡

In Kern County, California, the engineer in charge of Haggin and Carr's irrigation works there, "calculated that after the fifth year of cropping, the land irrigated with the river water carrying sediment gave eighteen per cent. better results than the land which was irrigated by the clear water from artesian wells."

In Utah.

Mr. Doremons, an engineer who has been employed on irrigation works in Utah since 1847, informed me that it was commonly known there that land too poor to grow a crop when first watered would in a few years become sufficiently enriched by irrigation from mountain streams to give fair results, and in time become as fruitful as the flat adobe lands of the valleys.

Value of Silt in Boise River Water.

Gen. L. F. Cartee, of Boise, late Surveyor-General of Idaho, said to me: "Open a trench or furrow through a newly-plowed field, and

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* Wilson: *Trans.* Inst. C. E., London.

† Moncrieff: *Irrigation in Southern Europe.*

‡ Wm. Hammond Hall, State Eng., California, *Report.*

Value of Silt in Boise River Water.

let that water (Boise River) run through it; at first it will soak through its banks, and by percolation wet the earth each side for a distance of perhaps two feet; by this time there will be a lining of fine silt to the trench, and no more water will go through it. You cannot irrigate by percolation with this water, and you need fear no seepage from your canals. There will be a little in the beginning, but it will not last. We have to irrigate here by letting the water flow over the surface in a sheet, or better, in little drills, such as are formed by a harrow, and the result is we get a layer of fine silt over our lands, which is the best fertilizer we can have. Our lands grow richer by cropping instead of poorer."

Mr. Stuart, whose farm is on the low land directly opposite Boise City, says: "If a ditch in which water has been running for several weeks be allowed to run dry, a fine grayish-green coating will be found to cover the bottom and sides from a quarter to half an inch thick. The sun shining on this will cause it to smell very badly in a few hours. I find my land does not grow wheat well at first, but after a couple of years I can get thirty to forty bushels to the acre. One portion of my land gets water from a pond or reservoir, where the water has stood and become clear. It does not make good crops like the muddy water. I would rather give two dollars an acre for muddy water than one for clear."

Mr. I. N. Coston, a member of the Legislature for many years, and one of the most successful farmers in Boise Valley, whose land is of much better quality than Mr. Stuart's, told me that it grew better and better with irrigation, and his statement is well supported by the yield from his land, as shown further on.

Mr. Payne, who has a large farm near Mr. Stuart, has been settled there several years longer than Mr. Stuart, and gets heavier crops. He says: "Constant cropping not only does not cause the land to deteriorate, but it improves under it, so long as we have this muddy water to irrigate with."

Much more testimony of this kind could be easily obtained, but I consider the foregoing sufficient to establish the value of silt-bearing water for irrigation, and also to prove that the water of the Boise River has this important quality, and that it will constantly restore to the lands irrigated by it those elements taken away by the crops, thus keeping them permanently fertile.

Importance of Drainage.

To an engineer the question of the drainage of a tract of land to be irrigated is quite as important as the water supply. The neglect of this subject in connection with irrigation has cost the government of India millions of dollars in reconstruction of canals, and, where the cost of re-alignment for the canals was too great, has left whole districts to deteriorate into uninhabitable marshes and white alkaline flats.

Alkali and Malaria from Want of Drainage.

In the San Joaquin Valley, near Lake Tulare, there are tracts of land which seem to be impregnated to a great depth with alkaline salts; the effect upon them of irrigation is to cause these salts to rise to the surface and render the lands useless. I can discover little or no land of this description along the Boise or Snake rivers. The lands have a natural drainage sufficient to prevent any accumulation of salts left by the evaporation or the water.

Lands not easily drained are unfit for irrigation, whether alkaline or not; for if alkali does not appear, malaria will, and the land will steadily deteriorate in value. The lands of which I am writing have ample slope for all drainage purposes, ranging from ten to as high as fifty feet to the mile. The winter rain-fall has been sufficient to carve these apparently level plains into miniature independent drainage systems, each with its divide and drainage channels or depressions.

Drainage Slope of Boise Lands.

Drainage of Boise Lands.

The main drainage of the tract of land south of the Boise is concentrated into Indian, Ten-Mile, Black, and Five-Mile creeks, which are creeks for a month or two only in the early spring, and dry for the remainder of the year.

Indian Creek, which is much the largest, is some forty miles in length, heading in the bare hills to the east of Boise, and becomes a torrent, at times, for a few days in the spring. Its channel is cut deep into the lava, which underlies the lands along its course, thus rendering it harmless even at its greatest height. The other streams are never large enough to become dangerous. Attention will be called to these creeks again in describing the alignment of the proposed canal. The tract of land upon the north side of the Boise River lies in such a position as to have no drainage across it from higher lands, as a glance at the map will show. It has plenty of slope, however, for the necessary local drainage channels.

It is evident, therefore, that the whole of the lands in question have all the conditions necessary for proper drainage, and with reasonable care in laying out the irrigating channels, not an acre of land need be lost in swamp or alkali; neither need there be a drop of water allowed to run to waste in drainage channels.

The land being almost entirely unoccupied, there need be no extra expense or trouble in placing each channel in its proper position where it can most perfectly do the work desired.

Advantages of Location.

These lands may, at first sight, appear somewhat isolated in their location, and without markets or outlets for their productions. On

Mining Markets.

the contrary, the extensive mining regions of Owyhee County on the south, of Western Idaho on the north, and of Wood River, Sawtooth, and Butte on the east, will for many years, as they do already, supply a lively market for fruit and vegetables.

These mining districts are giving evidence of great and continued productiveness, and their demands upon the agriculture of the neighboring plains will be enlarged in proportion to their own growth, as their climate does not permit of agriculture.

Oregon Short Line and Union Pacific R.Rs.

The Oregon Short-Line R.R. runs directly through the lands in question, and has at present four stations on them, viz.: Kuna,

Nampa, Caldwell, and Parma. With the exception of Caldwell, on the Boise River, these are merely water stations.

Caldwell has a trifling amount of cultivated farming land near it, and is a shipping point for mining districts both to the South and North.

Portland Wheat Markets.

This railroad is under the control of the Union Pacific, and gives an outlet to Portland for wheat; it may here be mentioned that as the Portland market price for wheat is only six cents a bushel lower than that of Chicago, it offers better prices for wheat grown in the Snake River Valley, than the Red River Valley of the North can secure.

Railroad Connections.

Eastward, the railroad connects at Shoshone with the branch road to the Wood River and Sawtooth mines; at Pocatello it connects with the Utah Northern for the Montana mines on the north, and Salt Lake City on the south; at Granger it connects with the main line of the Union Pacific, and through this to all points East.

Favorable Freight Rates.

Official letters from the President and Managers of the Union Pacific Railway guarantee to the company most favorable freight rates for traffic from and to these lands, both east and west. They also promise low rates for the carriage of immigrants and their effects to the tract, and express the readiness of the Union Pacific to aid in every way in its power the speedy settlement and subsequent prosperity of the section, rightly deeming it of great advantage to the railroad to have these desert plains converted to a vast farming and stock-raising district.

Quality and Productiveness of Boise Lands.

In regard to the quality and productiveness of these lands, there is a certain amount of evidence to be found on the farms which are now under cultivation along the banks of the Boise River. Owing to the difficulty, financially an impossibility, of taking water in small ditches from the river to lands distant from it, there is but a narrow strip of land, contiguous to the river, upon which crops are grown.

It is the universal opinion of the farmers upon these lands that the outlying higher lands are far richer than their own. That this opinion is correct may be inferred from the fact that the higher lands consist largely of decomposed lava, which makes the richest soil known, while the valley lands have a large proportion of clay and sand, brought down by the, geologically, modern river.

Analysis of Soils.

The following letter and analysis from Prof. Johnson, of Yale College, are the results of his examination of the samples of soils which I selected from different points on the higher lands:

"New Haven, Conn., *February* 25, 1884.

"A. D. Foote, Esq.:

"*Dear Sir:* I give you herewith the results of analyses of the two samples of soil lately received from you. The analyses show that both soils contain a good store of all the elements of fertility, with the single exception of nitrogen. The considerable quantity of matters soluble in hydrochloric acid and the fineness of the soils afford strong presumption that they will, under due supply of water, yield abundant nourishment to crops.

Since ordinary crops, under favorable conditions, forage, by their roots, through a depth of several feet, no less than ten million pounds of soil per acre contribute to their nourishment; and, in such a mass of soil, the small amounts of sulphuric acid and nitrogen stated in the analyses represent considerable quantities, each hundredth of a per cent. corresponding to one thousand pounds per acre.

"Yours very truly,

"S. W. Johnson."

ANALYSES OF SOILS.

By Professor S. W. Johnson.

	Sample No. 1.	Sample No. 2.
Silica (soluble in hydrochloric acid)	.016	.024
Oxide of iron and alumina	1.624	2.025
Lime	1.200	.383
Magnesia	.768	.503
Soda	.026	.043
Potash	.119	.259
Sulphuric acid (SO_3)	.026	.023
Phosphoric acid (PrO_5)	.111	.094
Carbonic acid (CO_2)	.866	trace
Chlorine	race	trace
Silica (soluble in carb. soda, sal.)	1.958	2.461
Titanic acid (TiO_2)	.869	.303
Matters dissolved or set free by cold concentrated hydrochloric acid	7.583	6.118
Sand, silicates, etc., insoluble in acid	92.417	93,882
	100.000	100.000
Organic matters contain of nitrogen	.055	.040

Placing no higher estimate, however, on the productiveness of the uplying lava lands than upon those along the river, the following statements of different farmers show what can be done on the low lands, and with absolutely no fertilizing element used except the water of the Boise River.

Examples of the Productiveness of the Boise Lands.

Mr. I. N. Coston, to whom I referred for information concerning the value of silt-bearing water, told me the following, as I noted it down:

"Last year, on ten acres of my poorest land, with imperfect irrigation, owing to a bar being formed in front of the headgate to my ditch at high water, as usual, I raised forty tons of red clover hay. I *sold* seventy-five thousand pounds (1,250 bushels) of onions, from two acres of land. Potatoes only gave me two hundred bushels to the acre. Have raised one thousand bushels on two acres. I have raised one hundred and thirteen bushels of barley on an acre; wheat from forty to sixty bushels; oats one hundred to one hundred and fifty bushels, carrots and turnips equally good in proportion with potatoes. Connecticut flint corn will grow well, especially upon the higher benches. I have raised sixty bushels to the acre in the bottoms. Prunes, the Germans say, grow better than in their own country. Apples, pears, peaches, plums, apricots, cherries, do as well if not better

Examples of the Productiveness of the Boise Lands.

than in the most favored spots in California. The elm, maple, black walnut, locust, etc., make our best shade trees."

Mr. B. B. Stuart, also referred to before, is said to have the poorest piece of land in the valley. He admits that it was rather poor when first plowed, but the water has improved it. He gives the following examples of what it will yield:

"I have been farming for five years on this tract. My principal crop has been grass, which improves under irrigation. I grow alfalfa and clover. My average crop is four tons to the acre in two cuttings. I can irrigate, cut, and put my hay in stack, for the cost of one ton per acre, leaving me three tons net. I raised fifteen acres of potatoes this year, which averaged one hundred and fifty bushels of marketable potatoes to the acre; about an average crop. I have raised corn every year until this year, never less than twenty-five bushels to the acre, and an average of thirty to thirty-five. I have raised wheat, but only in small quantities and not often, which averaged twenty-two bushels to the acre. I sold last summer from eighteen square rods of land, one hundred and twenty-five dollars' worth of strawberries, besides using all I wanted for the family. To sum up: I can, with irrigation, raise larger crops at about the same cost per acre here in this sage-bush desert, than I could, depending upon the rain-fall, in either Massachusetts, Missouri, or Oregon, in which States I have worked farms—besides always having clear weather to secure crops in."

Mr. Payne, a neighbor of Mr. Stuart's, having irrigated a year or two longer than Mr. Stuart, gets larger crops. This year he raised three hundred and sixty tons of alfalfa upon sixty acres of land (six tons per acre), and one hundred and sixty tons of red clover on forty acres (four tons per acre). He does not raise much wheat, because hay crops pay better at present. Oats sown with clover yielded thirty bushels per acre. He has usually very good flint corn. Potatoes yielded two hundred bushels per acre. Four years ago he set out two hundred apple trees, and this year realized two bushels per tree.

Doctor Wright, of Boise City, who has a farm near Middleton, told me that one field of his produced continuously for fourteen years, from fifty to sixty bushels of wheat per acre, and this year looks as well as ever.

C. W. Moore, the wealthiest farmer in Boise Valley, said that the

Examples of the Productiveness of the Boise Lands.

average yield for his farm was six tons of alfalfa, or four tons of clover, per acre, in addition to excellent pasturage from September to March.

"One acre of clover, after furnishing its two crops of hay, will keep and fatten for market, during the winter, two beef animals, without grain or any other food whatever. There is something wonderful to the Eastern farmer in the fattening qualities of our clover. I think it is partly owing to the fact that we have no dew to injure it while it is being cured. My milk cows are as fat and give as much milk as anybody's, and I never feed them anything but clover hay in the winter. My hogs—and I have a large drove of them—I fatten in the clover fields the same as I do cattle. If we have snow enough to trouble them, I take them up and feed them on clover and alfalfa hay the same as other stock. I prefer clover to alfalfa in this country."

I have condensed the testimony of different farmers in the following table. It was very carefully prepared, and represents the average crops as given by each individual from his personal experience. In no case are the large or exceptional crops given.

TABLE.

SHOWING THE AVERAGE PRODUCTION PER ACRE OF LAND NEAR BOISE CITY, BEING THE ACTUAL EXPERIENCE OF EACH FARMER NAMED.

NAME.	Bushels Wheat.	Bushels Rye.	Bushels Oats.	Bushels Barley.	Bushels Corn.	Bushels Potatoes.	Bushels Apples.	Tons Alfalfa.	Tons Clover.	Tons Timothy.	Cost of applying Water per acre.	Cost of raising Hay per acre.	REMARKS.
B. B. Stuart..	18		35	40	25	250		6	4		$1.50	$6 00	Apple trees are from ten to fifteen years old only. "Cost of applying water" does not include annual water rent. Value of pasturage, after cutting hay crop, more than pays water rent.
Thos. Davis..	25		40	40	50	150	1,000						
Geo. Davis...	25		30	45	30	300							
Sam'l Aiken..	25		40	50	35								
G. W. Gess...	20		35	35				3	3	1½	1.00	4.00	
C. W. Moore..	31	15	43					5	4	2½	1.25	6 00	
G. D. Ellis...	25	20	40	50	25	300	800	4	4	2	0.50	4.00	
L. F. Cartee..							1,000	6	4		1.00	6.00	
M. E. Payne..	25		30		30	400		5	4		1.00	6.00	
John Buckley.			50	40	30	400							
Wm. Bryan..							1,000	5	5	2½	1.60		
Sam. McDowel	25	25	50		30			5	5	2½	1.00	5.00	
John Lemp...	25	25	45	45			800	6	6	1½	1.00	6.00	
I. N. Coston..	40		50	50	60	400	1,000	6	6	2	1.00	6.00	
Average..	25.8	21.25	40.67	43.90	35.0	314.3	936.66	5.1	4.5	2.07	$1.09	$5.44	

The foregoing statements concerning the productions of these lands will undoubtedly appear needless to any one acquainted with

the sage-covered lands of the arid West. I believe that without exception they are considered extremely fertile when water is applied to them. But the lava soil of these Boise lands is, I think, far above the average, more especially for growing grasses and cereals. These, I anticipate, will be the principal crops, because of the peculiar location of the lands in close proximity to an enormous extent of mountain pasture.

Surrounding Pastures—Their Extent and Richness.

ONE who has not seen them can form no idea of the extent and richness of these mountain pastures of Central Idaho. I have wandered on horseback over hundreds of miles of them, and speak from personal knowledge. The grasses are chiefly perennial, unlike those of the great plains, and consequently keep up like the pasture lands of the East, and their fattening qualities are remarkable. Horses will fatten on them when ridden all day, and only turned loose to feed at night. The soil is rich and moist; running brooks and springs abound; quaking asp thickets, pines, and larches line the gulches or are scattered over the hillsides, furnishing shelter from sun and storm.

Rolling hills, seldom rocky, and immense high prairies, with their thick bed of grasses and flowers, form the ideal wild pasture land. There are millions of acres of these lands surrounding the Snake River Valley. At present they can be utilized only to the extent allowed by the capacity of the low valleys near the river for keeping stock alive through the winter. Every year finds the low valleys with less capacity for feed, because they are overstocked; and hay feeding and clover pasturage is already resorted to in winter, by the better class of stock-raisers, to the fullest productive limit of the farming land. But when these vast lower plains are reclaimed and irrigated, and each acre of land is capable of not only keeping alive, but keeping fat, two or three head of stock, there will then be a hundred head of cattle pastured in the mountains where there is one now, and the business of shipping fat cattle from this great valley every day in the year will be carried on to an extent hardly to be imagined.

Stock Raising.

Experience in Truckee Valley.

In proof of the foregoing statement, I can cite the experience in the Truckee Valley, Nevada, where the winters are longer, surrounding pasturage no better, if as good, land stony and cleared with difficulty, and the price of water twice what it will be in the Snake River Valley.

Mr. Robt. H. Lindsay, attorney-at-law, of Reno, Nevada, kindly furnished me the following statistics concerning hay growing and winter feeding for stock in the valley.

"According to the assessor's estimate, there are twelve thousand acres of land in the valley growing hay, the average crop of which is

four or five tons to the acre. This hay is stacked in the fields and sold by measurement to stock-owners at an average price of six to seven dollars per ton; never less than five, and this year it was eight dollars.

"The cost of water is excessive, being five dollars an acre per year, so that hay costs the farmer three dollars per ton when in the stack.

"At the present time (January, 1887) there are nine thousand five hundred head of cattle feeding in the valley; there would be more if there were more hay."

Comparison between Truckee and Snake River Valleys.

From these facts it will be seen that the farmer makes a net profit of from eight to twenty dollars per acre. If it pays so well to irrigate in Nevada, it will certainly pay equally well in the Snake River Valley, where the water tax is reduced one-half. It may be supposed that the Truckee meadows pay because of their proximity to San Francisco. On the contrary, the freight rates guaranteed by the Union Pacific R. R. bring the Snake River Valley as near or nearer to Chicago, financially speaking, than the Truckee Valley is to San Francisco, on the Central Pacific R. R.

Feeding Stock in Winter.

In the Snake River Valley, although a great many stock men now feed more or less in the winter, it is usually in such a desultory manner that it is difficult to tell whether it pays them or not, except in the saving of absolute loss by deaths, which would otherwise occur. Mr. C. W. Moore, however, kept a very careful book account with his feeding stock in order to ascertain precisely what hay was worth to feed. He found that stock-owners could afford to pay from six to eight dollars per ton for hay for feeding purposes, depending of course upon the price of cattle and upon freight charges.

Messrs. Ballentine and Eastman, also of Boise, estimated that they could afford to pay six dollars a ton for hay, and actually did buy a large amount at that price and feed it out.*

Cost and Profit in Winter Feeding.

Mr. Moore and Mr. Ballentine both said that the profit in feeding was not so much the gain in pounds weight as that every pound of the animal was raised in value several cents by feeding.

Profit of Hay-making to the Farmer.

*Taking hay as worth $6 to $8 per ton, crops four to six tons per acre, and applying water, cutting and stacking $1.25 to $2.00 per ton, and we have a profit to the farmer from hay-raising, of from $16.00 to $40.50 per acre, the value of the land for pasturage after cutting the crop being more than sufficient to pay the water rent.

For example, an animal weighing in the spring,

when *not fed* during the winter, 800 lbs, is worth	3c. per lb, or	$24.00
When *fed* " " " 1000 " "	5c. " " "	50.00
	Difference,	$26.00
Cost of feeding and pasturage, - - - - - - -		16.00
Profit per head in feeding, - - - - - - - -		$10.00

Add to this the fact that there is no loss through exposure—and from this winter's experience it would seem that this item might occasionally be a large one—and it will be seen that there is profit in feeding stock in the winter, in addition to the fact that cattle will be larger, and calves healthier and of quicker growth, when properly cared for.

I repeat, therefore, that the peculiar location of these—when watered—rich hay-growing plains, near these vast grass-growing hills, forms a combination of pasture and feeding lands which cannot be excelled for stock-raising purposes in this country. It enables the stock-grower in Idaho to ship fat cattle East during the winter and spring with a decided advantage over the more expensive corn-fed stock of Nebraska and Kansas; and, through all the year, the mountains being so near the railroad, fat stock can be brought down and butchered and shipped, without danger from the excessive heats which prevail in the mid-West.

Combination of Pasture and Feeding Lands.

Advantages for Shipping Cattle.

It may be thought that the labor of watering the land several times every year may add so much to the cost of raising crops as to render it unprofitable. By referring to the table of crops, it will be seen that from one to two dollars per acre, per year, is sufficient for this work; and when the loss, in rainy countries, from showers, at the time of harvesting, or the loss from the want of them at growing time, is taken into consideration, I think it self-evident that to have absolute control of the water, and to put it on or off as desired, must be a surer and more profitable method of farming than that which leaves the farmer at the mercy of a variable climate.

Cost of Applying Water.

Another objection often made to the practice of irrigation is the labor of making ditches and getting the land prepared. This may be a very expensive operation upon stony and uneven, hard land, but on these mellow sage-bush plains it is quite another matter. A number

Cost of Making Ditches.

Preparing the Land.

of men from the mid-West have told me that it was far easier to clear and prepare these lands for irrigation than to break the new sod of the prairies. In fact, the preparing of these lands is often simply burning off the sage-bush, and harrowing in the wheat. No plowing done at all, except for the ditches.

C. W. Moore, before quoted, in speaking of a tract of several thousand acres which had been accidentally burned over, said that he "could put in a crop of wheat on that land for a dollar and a quarter an acre."

Lands: Increase in Value by Irrigation in Idaho.

It is advisable, in connection with the productions and cultivation of these lands, to look into the question of their probable increase in value, and of their improvement being permanent. That they will increase in value may be considered certain, from the evidence furnished by similar undertakings.

Lands capable of irrigation along the Boise River are worth now from ten to one hundred dollars per acre. There are none, I am sure, worth less than ten—if any are so cheap as that. Some of the land near Boise City is rented to Chinese gardeners at twenty-five dollars per acre, annually.

In the Truckee Valley, Nevada, Mr. Lindsay writes that the average value for the twelve thousand acres of irrigated land in the valley is forty dollars per acre, though there are choice lots worth one hundred.

In the Goose-creek Valley, Cassia Co., Idaho, I had occasion to inquire, several years ago, into the value of irrigated lands. At that time they were eighty miles from a railroad, one hundred and fifty from the nearest mines, and they are about fifteen hundred feet higher than the Boise lands; yet, wherever water could be had, they were worth from ten to twenty dollars per acre. I may add that there were thousands of acres that could not be watered, which were of no value.

In Utah.

C. L. Stevenson, C. E., of Salt Lake City, Utah, says, in a paper read before the American Society of Civil Engineers: "The lands in the Jordan Valley, from an original cost of one dollar and a quarter per acre, at once, on being watered, attained a value of fifteen to twenty dollars, and, in less than five years, a value of eighty to one hundred dollars per acre."

In Colorado.

Elwood Mead, C. E., Prof. of Irrigation Engineering in the Colorado Agricultural College, in a similar paper, says: "Land, with water, sells for twenty-five to one hundred and fifty dollars per acre, but has no market value without water."

Edward Bates Dorsey, C. E., in a paper read before the Am. Soc. C. E., said: "In Colorado land which can be irrigated sells for fifteen to fifty dollars per acre."

"George G. Anderson, Chief Eng. Northern Colorado Irrigation Co., in discussing Mr. Dorsey's paper, said: "The value he (Mr. Dorsey) gives for irrigable lands in Colorado is fully within the limits. Such lands, within a radius of ten miles of Denver, rate at seventy-five to one hundred dollars per acre."

H. V. Hinckly, M. Am. Soc. C. E., in discussing Mr. Dorsey's paper, wrote of his experience of nine years in Eastern Colorado and
In Kansas. Southwestern Kansas, along the Arkansas River: "I have seen land appreciate wildly from five up to two hundred dollars per acre, on the advent of a canal, and afterwards fall to twenty to thirty dollars, where it belonged. Land where *full* crops cannot be raised with an *annual* certainty without irrigation, is permanently increased in value by irrigating facilities."

F. Eaton, M. Am. Soc. C. E., writing of his experience at Riverside,
In California. San Bernardino Co., California, says: "These lands, before they were settled, were not even considered suitable for grazing purposes, as the average annual rain-fall did not exceed four inches; the wild grasses, in consequence, would seldom attain a growth that would furnish picking for sheep. The lands at that time, therefore, had hardly any value. When these lands were put under irrigation, some fourteen years ago, they sold for twenty-five dollars per acre. They have since been steadily advancing. I find them changing hands now at three hundred or four hundred dollars per acre for uncultivated lands, and from eight hundred to fifteen hundred for lands with matured vines and trees. It cannot be justly charged that these prices are stimulated by social, educational, and other advantages, while the products net the owners, annually, two hundred dollars per acre."

Wm. Hammond Hall, State Engineer of California, says in his last official report: "In California, lands purchased at three to ten dollars per acre, without opportunity or reasonable hope of irrigation, command fifty to two hundred dollars per acre when water is brought to them, and they have the privilege at hand to receive and pay for irrigation."

I could quote many more instances, if necessary, both in this and foreign countries, showing equally well the permanently increased
In Spain. value attained by lands brought under irrigation; as in Spain, where, Mr. ~~Bateman~~ J. F. Bateman reports, in a paper before the Institute of Civil Engineers,

London: "This rate (28 shillings—$7.00 per acre—for water) was cheerfully paid, and well it might be, because the increased value of the land was at least sevenfold;"—but enough, perhaps, has been said to prove that irrigation is profitable to the land-owners, at least.

Climate in the Valleys of Southwestern Idaho.

In regard to the climate of this portion of the Snake and Boise River Valleys, there seems to be an opinion, in the East especially, that, being so far north, it is necessarily very cold; forgetting that Washington Territory is still further north, and has a comparatively warm climate. Newspaper reports of snow-slides, great depths of snow, and extreme cold in Idaho, refer to the mountain mining camps and communities at an elevation of many thousand feet above the Snake and Boise River Valleys. The elevation of these lands is about twenty-five hundred feet above the sea; they are distant some four hundred miles from the west coast, but have no high mountains between them and the ocean. Possibly for this reason, and also because high mountains on the north protect them, the climate is neither so warm nor so cold as that of New York or New England. The snow-fall on the plains is very light, and the cattle are driven to them from all the surrounding country for wintering.

Usually the winters are short, clear, bright, and still. From my experience in these localities, I should compare them with the winters of Virginia rather than those of New England.

Climate is much a matter of personal feeling; but to any one desiring a temperate climate, with reasonable changes, the southwestern valleys of Idaho offer one as pleasant as can be found.

The peach crop is not injured oftener than about once in ten years, which is as good evidence, perhaps, as could be offered as to the evenness and temperate nature of the climate. Immigrants from all the northern States and from northern Europe will find this climate far preferable to that which they have left. The dry air and light snow or rain-fall make more difference, probably, in its favor than the temperature as shown by the thermometer.

Absence of Malaria.

If there were a possibility of developing malaria in this valley, irrigation, as practiced near Boise City, would have been the means of doing so already. A more slovenly system could not be imagined; yet this evil, combined with no system of drainage whatever, has as yet, apparently, done nothing to injure the health of the inhabitants.

Lumber Interests.

There is another advantage in the location of these lands which is

worthy of notice. The upper waters of the Boise River are heavily timbered with good varieties of pine and fir.

Mr. M. H. Goodwin and Mr. George Alexander, who are now engaged in the lumber business on the Boise River, have made careful estimates of the amount of standing timber within easy reach of the water, on the north and middle forks of the Boise River. I have examined the south fork myself, and together we found that there are about seventy-five millions of feet. At a distance from the streams, requiring roads and expensive hauling, there is probably as much more. At present, as the river's rapid current makes the booming of logs difficult, but little lumber is taken, and that by way of Moore's Creek very early in the spring, before the main river is high enough to break the booms.

By the building of the dam necessary for this irrigating canal, a long pond of dead water will be formed, where logs can be boomed or stopped, and then run down the canal to mills on the plains, as required.

While this floating of logs through the canal will be of considerable direct benefit to the canal owners, it will be of greater benefit to them as an inducement for incoming settlers to occupy lands. Cheap lumber, wood, fence-posts, etc., are of great importance to the farmer in a new country, and will often go far to determine his choice of residence.

Water Power.

There will be a great number of points along the canal line where power for mills can be readily furnished.

Immigration.

In providing facilities for irrigating so vast an area of unoccupied land as I have been describing, it is important to ascertain, if possible, what are the probabilities for its immediate settlement by farmers who will use the water. There is no doubt the land would be quickly taken up by speculators under the Desert Land Act, but this disposition of it would not be a desirable one for the water owners. Landowners, who are not also land cultivators, will not buy water. This speculative appropriation of the land can be easily prevented by the canal owners refusing any contracts for water. Desert land cannot be held without water, and if it is made known that no water will be sold except to actual settlers, others will be prevented from coming in.

It is somewhat difficult to form a positive opinion in regard to the rapidity with which actual settlers would occupy this land; but we

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Immigration.

can form some idea from the fate of similar enterprises, and the fact that more advantages are offered on this tract than on most others.

One who has traveled through the arid West, and seen how every nook and corner, even high up in the mountains, where a little land and water can be brought together, is occupied, would scarcely doubt that these rich and attractive lands will be taken up as rapidly as the water can be brought to them. However, six hundred thousand acres is an area as large as three-quarters of the State of Rhode Island, and, being all arable, has room for a great number of people.

In Colorado, all lands under the canals, and which belonged to the Government, have been taken usually before the canals were finished, although the canal companies there charge from one dollar and a quarter to as high as fifteen dollars per acre, for the water right alone, exclusive of the annual charge of one dollar and a half per acre for the use of the water. The lands owned by the canal companies have been sold at from five to twenty dollars per acre, though naturally not as rapidly as the free grounds were taken up.

If the canals in Colorado, with a far harsher climate and a much greater elevation above the sea, with poorer pasturage surrounding them, with longer distances to a market for their productions (excepting stock), with a much higher price for water and for land, found little difficulty in getting customers for their water, it seems but reasonable to expect that these Snake River lands will be taken up with at least equal rapidity.

Immigrant Rates: Union Pacific R.R.

The Union Pacific Railway Company has agreed to transport immigrants and their belongings at less than half rates over their lines. It has also agreed to open offices for information in the large cities, and to use all the power of its immense system of advertising and transportation offices in this country and Europe, to bring immigrants into the Snake River Valley.

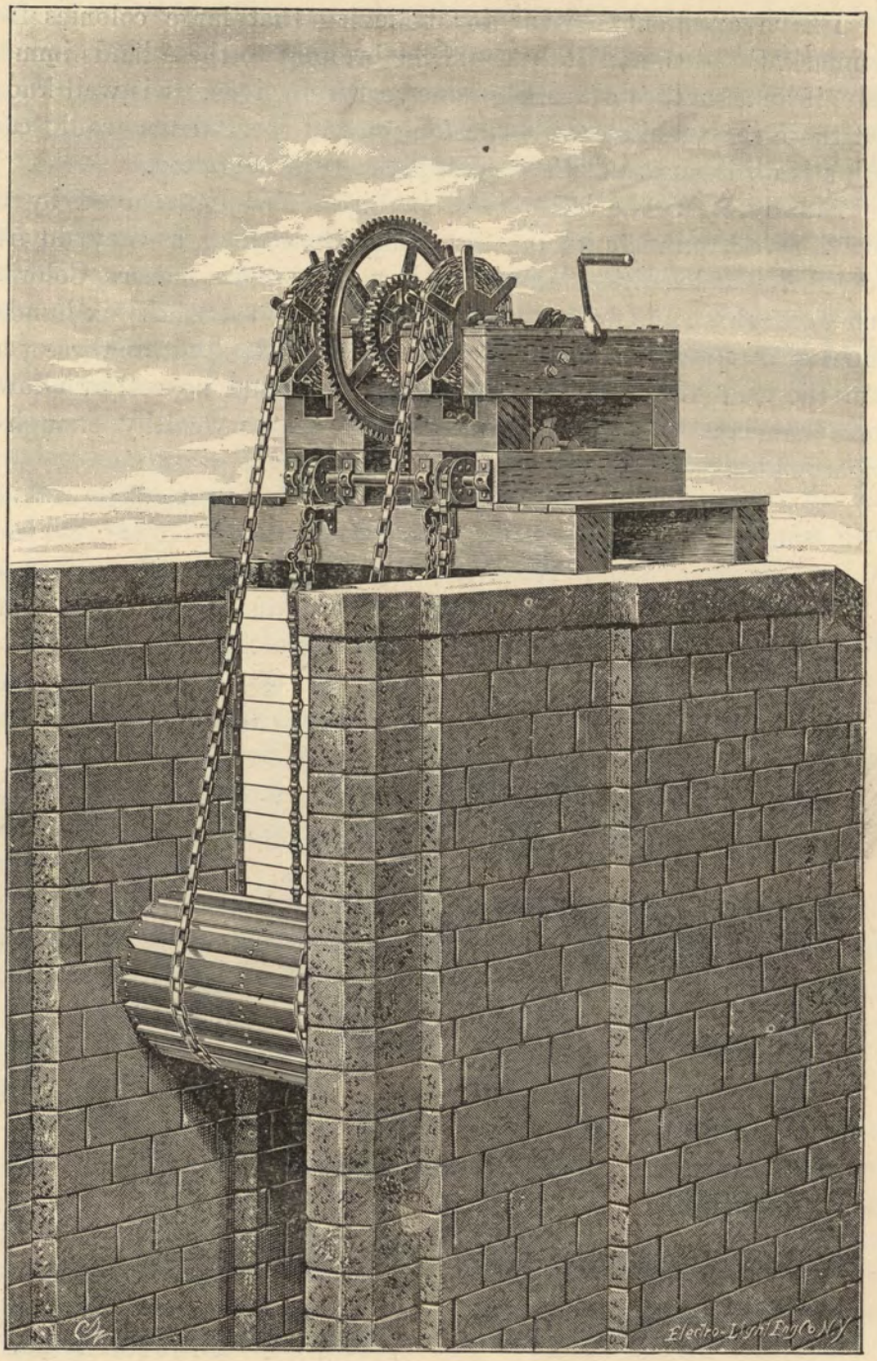
In building the canal, it will be good policy to employ, as far as consistent with economy, men who wish to settle on the lands, and their teams. If work for a year or two, at fair prices, can be offered as an additional inducement to immigrants, it will go far toward bringing them in, as it will give those who lack sufficient capital an opportunity to establish themselves comfortably, while getting their farms into productive condition.

Colonists from Europe.

I have excellent reasons for believing that large colonies from Denmark, Sweden, and Italy could be brought to these lands immediately, if an assurance of work for one year were given. It is well known that these races make excellent colonists, and the Italians would come with a traditionary and life-long experience in irrigation.

Probability of Speedy Settlement.

Finally, from the letters and inquiries already received by me, since I have been engaged in this enterprise, coming as they do from many different localities, Minnesota, Iowa, Nebraska, Kansas, Colorado, even California and Oregon, I am confident that the whole six hundred thousand acres will be occupied with actual settlers, within three years from the time water is brought to the land, and no settler allowed more than one hundred and sixty acres, unless wealthy enough to irrigate more.


Electric Light Eng Co N.Y.

CANAL LINES.

Position of Head-works.

General Fremont, in the report of his expedition of 1843, gives his first impressions of the Boise River in the following words: . . . "We were nearly opposite to the highest portions of the mountains on the left side of Snake River Valley, and, continuing on a few miles beyond, we came suddenly in sight of the broad green line of the Valley of the Rivière Boisé, black near the gorge where it debouches into the plains, with high precipices of basalt, between the walls of which it passes on, emerging from the mountains. Descending the hills, after traveling a few miles along the plain, the road brought us down upon the bottoms of the river, which is a beautiful rapid stream." . . .

In this gorge, about ten miles above the city of Boise, is the point selected for building the dam and head-works necessary for diverting the waters of the river into a canal, and spreading them out upon the plains below. This point is obviously the one to be chosen because of its natural peculiarities, singularly adapted for the building of the structures required.

The walls of the cañon are immense gravel banks, capped with basalt, and resting also on the basalt which at this point forms the bed of the river. Into this lower stratum the river has worn a channel a few feet deep. These combined advantages enable the engineer to construct the headgates and waste weir on opposite sides of the river, upon solid basalt foundations, while the river, undisturbed, is flowing between.

The steep gravel bluffs on either side are thickly strewn with broken fragments of rock fallen from the basalt bluffs above, which furnish excellent material for the masonry of the head-works; the same material, properly placed in the river, after the headworks are built, will, when backed with gravel and sand, dam the river permanently without fear of decay or movement, and raise it into the canal gates or over the waste weir.

The location is a very exceptional one; a broad bench of solid rock, not too smooth, slightly above the ordinary bed of the river, upon

which to build the head-works; a river bed of solid rock, upon which to build the dam and scouring-gate, and loose rock piled on either side, more than enough to supply the material for construction, needing only to be rolled down and placed in position. Certainly an engineer seldom finds natural conditions so favorable for his work.

Description of Head-works.

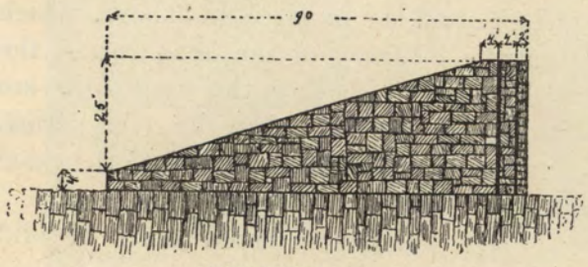
The headgates of the canal, of which there are to be six, each eight by twenty-four feet in the clear, are so constructed as to roll up like a curtain; the engraving on page 36, from a photograph of a working model, will give an idea of their construction. Their unusual size, which is necessary for the convenient admission of timber and wood, renders it impossible to use the ordinary sliding gate. This plan of a curtain is an adaptation from the gates used by the French Government in the slack-water navigation of the Seine.

These six gates are placed close to the south bank of the river, and adjoining them, on their north side, will be placed a similar gate, for scouring purposes, reaching to the bottom of the river, some twelve feet lower than the canal gates. By means of this gate, all the sand and gravel which comes down the river during the flood season will be prevented from passing into the canal.

It is mainly for the reasons stated that this particular point, two miles up the cañon, is selected for the head-works, although there are other important ones why this location for the headgates is preferred.

The dam, adjoining the scouring-gate, will be built of sufficient height never to allow the water to run over it, while the waste weir adjoining the dam, and resting on the basalt bench, will be five hundred feet in length and from eight to twelve feet high. Adjoining this again, on the north, is the proper position for the small gates of the Boise City line of Canal,

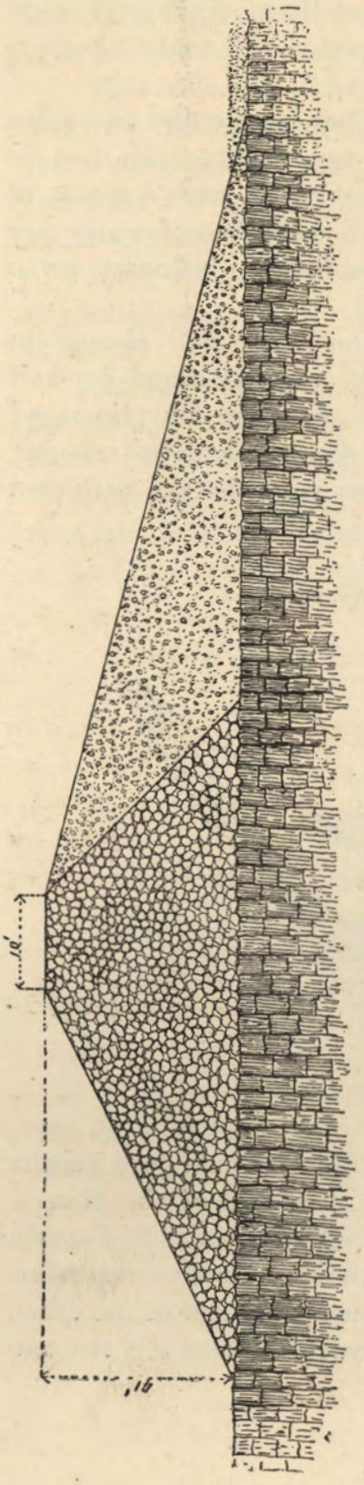
CROSS SECTION OF WASTE WEIR.



ELEVATION OF PIER.

running down the north side of the river, whenever it may be considered advisable that the latter should be built.

As before stated, the material for construction lies in great masses upon



CROSS SECTION OF DAM.

the steep slopes of the gravel bluffs, above the head-works. All the masonry for piers and waste weir will be built with this material, laid in Portland cement, with the exception of the jambs and coping of the piers and the crest of the waste weir. These will be of granite, taken from a fine ledge lying within half a mile of the dam, with a good wagon-road already built.

The sand, for mortar, lies in a large beach, within three hundred yards of the works. This sand is one of the products of hydraulic mining, on the river above, and is extremely clear and sharp quartz, entirely without the smooth, water-worn feeling of most river sand.

After the masonry is finished, the dam will be constructed by dumping the loose rock from the bluffs into the river channel, and allowing it to take its natural slopes. When the mass is high enough, gravel will be dumped upon the upper side, until the whole is tight. It is needless to say that, with the sediment of the river water closing all interstices, such a dam will never move or decay.

Main Line of Canal.

The first two miles of canal line will follow the river closely, and will be built in the gravel bluffs, which are quite steep—in places nearly twenty-five degrees from the horizontal.

In order to reduce its cost, the canal, through the cañon, will be built narrow and deep, and with a heavy grade. The walls will be revetted throughout with stone, and the bottom paved. Although this plan includes expensive work, even with the material for the stone work

lying immediately above, it will be far cheaper than building the canal its full size with less grade, and when completed will make a perfect and enduring water channel.

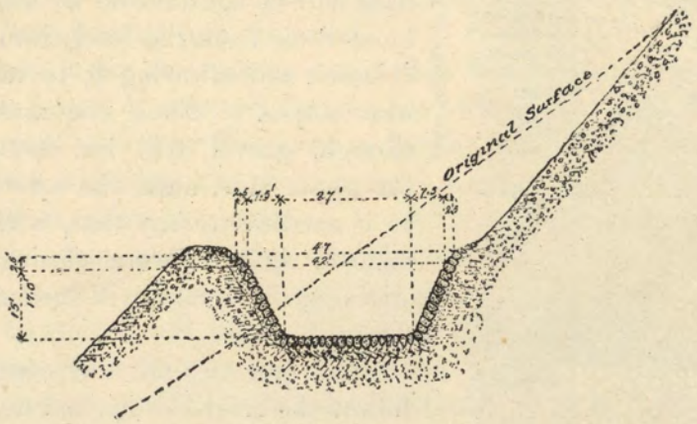
The dimensions of the canal in the cañon for the first two miles will be, therefore, forty-seven feet wide on top, twenty-seven feet on the bottom, and seventeen and one-half feet deep, with a grade of four feet per mile; carrying four thousand cubic feet of water per second, with fifteen feet depth of water; calculated velocity, seven and seven-tenths feet per second.

At the end of the second mile, the dimensions will change to ninety feet wide on top, sixty-five at the bottom, twelve and one-half feet deep and grade of two feet per mile, carrying four thousand cubic feet of water per second when ten feet deep; calculated velocity, five and three-tenths feet per second. These velocities are calculated from the formula:

Formula for Discharge.

$$V = 96.5 \sqrt{R\,S}$$

In which V = mean velocity of water in feet per second.
R = Hydraulic mean depth.
S = Slope in feet per foot.



CANAL IN CAÑON.

After careful comparison, I found that this formula gave results which agreed very closely with the actual discharge of the Ganges Canal, as found by a vast series of measurements made by Captain Allan Cunningham, R. E, near Roorkee, India. As these measurements were made with great care in the ordinary channel of the canal, without any special conditions interfering with or changing the nat-

ural flow through common earthen banks, I consider them a safe and accurate test for the formula.

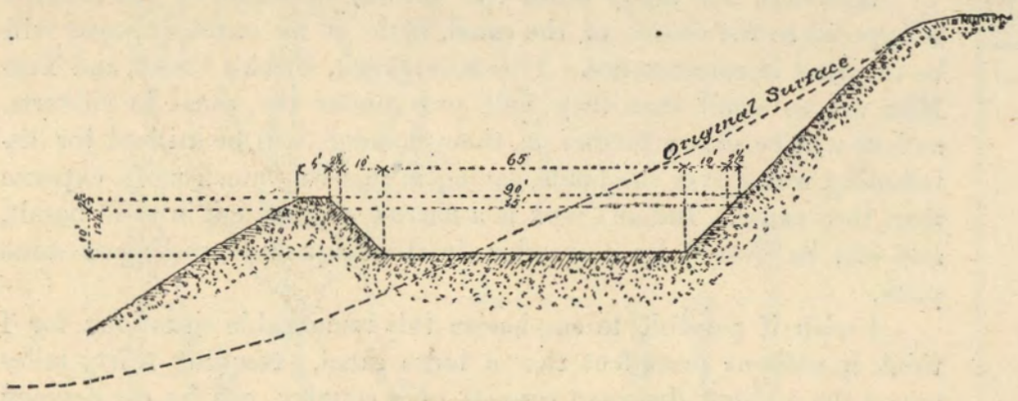
Velocity.

This velocity of five and three-tenths feet per second is not too great for the banks to withstand, the material of which they will be constructed being a heavy, coarse gravel, and both Moncrieff and Professor Davidson testify that the Cavour Canal, with similar banks and equal or greater velocity of current, shows no ill effects from it.

It is evident that the greater the velocity, the smaller, and consequently cheaper, the channel required for carrying a given amount of water.

Main Line of Canal.

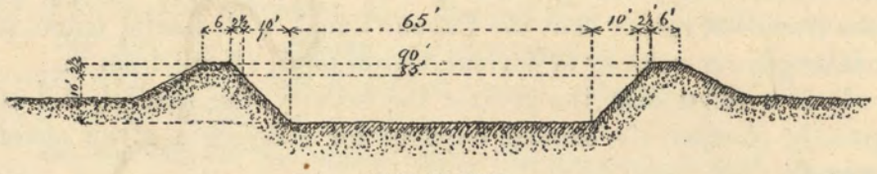
At the beginning of the third mile, just above the widening of the canal, will be placed a trap and small gate. This trap consists of a trench cut in the bottom of the canal and running diagonally upward across it from the gate. In this trench all small stones and sediment that fall, loosened by spring thaws, from the high bank of the canal in the cañon, will be caught, and pass out of the canal through the gate.



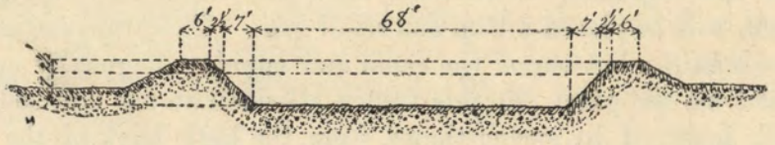
CANAL ALONG MESA.

From the beginning of the third mile the canal line passes along the mesa which forms a portion of one side of the valley of the Boise. Here heavy cutting and filling will be required, and though the work, owing to the nature of the material to be moved, will be inexpensive per yard, the aggregate cost will be heavy. In this part of the canal there will be one or two culverts, two bridges, and one or two small pipe openings in the banks to irrigate the lands between the canal and the river. At the tenth mile, opposite Boise City, the line turns

abruptly southward, and keeps a general trend from this point onward almost at right angles to the course of the Boise River, until it ends upon the divide between the Boise and Snake Rivers, some four miles south of Kuna, and thirty-two and one-half miles from the headgates.



CANAL ON LEVEL.



CANAL BEYOND INDIAN CREEK.

Main Line of Canal Crossing Natural Drainage.

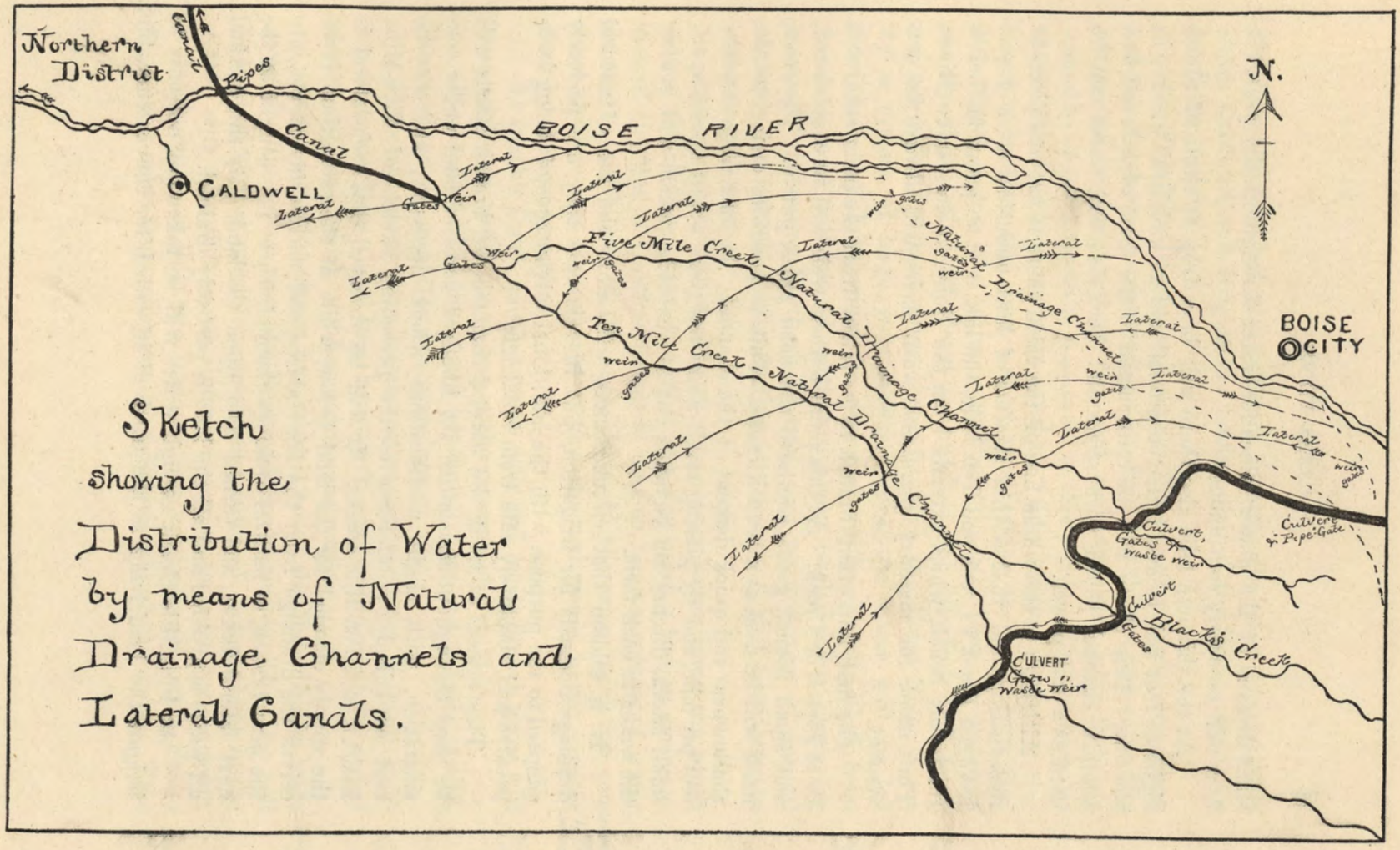
Although for thirty miles the natural drainage of the country is opposed to the course of the canal, little or no extra expense will be incurred in consequence. Five-Mile Creek, Black's Creek, and Ten-Mile are so small that they will pass under the canal in culverts, and, as will be shown further on, their channels will be utilized for distributing water over the lands, saving in this way much more expense than they cause. Indian Creek is a narrow channel cut in solid basalt, and will be crossed by a wooden or stone aqueduct, resting on stone piers.

I wish if possible to emphasize this remarkable situation; for I think it without precedent that a large canal, extending thirty miles across the natural drainage courses of a country, can be constructed with practically no expense beyond the usual cost of excavation.

Main Line of Canal.

From Five-Mile Creek onward the canal will be reduced in size one-third, because of the quantity of water taken out at this point to serve the lands north of the Boise River, as explained further on.

At Indian Creek there will be a drop of nine feet, in order to avoid rocky ground, and also for the purpose of passing under the railroad. This drop will be in the form of a chute across the creek, thus forcing the water through a small aqueduct. It will probably be also utilized for mill-power, as it is near the railroad, and, owing to the con-


Northern District
Canal
Pipes
Canal
BOISE RIVER
CALDWELL
Lateral
Gates
Weir
Five Mile Creek - Natural Drainage Channel
Ten Mile Creek - Natural Drainage Channel
Natural Drainage Channel
weir gates
Culvert, Gates & waste weir
Culvert & Pipe Gate
Culvert Gates
Blacks Creek
CULVERT Gates & Waste Weir
N.
BOISE CITY
Sketch showing the Distribution of Water by means of Natural Drainage Channels and Lateral Canals.

stant demand of the placer mines for water throughout the year, the flow will be nearly continuous.

At the thirtieth mile also there will be a drop or chute of about eighteen feet fall, to avoid uneven ground and an undesirable curve in the line. This chute will be constructed in the form of a broad and shallow channel paved with stone, and here, also, the water can be used as a mill-power.

Although in the whole line of the canal there is but one piece of rock-cutting, and that a thin stratum of lava underlaid with gravel between Black's Creek and Ten Mile, the line is at no point far below the basalt bench, which extends from the Boise to the Snake River. Thus stone for masonry, piers, and waste weirs will always be convenient.

Five-Mile Branch.

The first important branch to be taken from the main canal will be at Five-Mile Creek. At this point a waste weir will be constructed, and small branch gates, similarto the head gates, put in. The creek itself will be used as a branch canal. This is possible, owing to the shallowness and quick descent of the channel. It falls about twenty feet per mile, and by placing small weirs and gates about a mile apart, small lateral ditches can be taken out at the side, which will convey the water to each farm.

Use of Natural Drainage Channels, as Distributaries.

It is seldom that circumstances will allow the use of natural drainage channels for irrigation, but in this case they are perfectly adapted to the purpose, with the additional advantages of being inexpensive and absolutely safe from breakage.

This system of using the natural channels for branch canals will be used throughout the entire six hundred acres of land under consideration, with slight modifications where necessary, and may be best explained by reference to the preceding sketch of Five-Mile, Black's, and Ten-Mile creeks. It will be observed that each lateral is the supply channel for the land below, while at the same time it receives the drainage from the land above, and carries any excess into the next branch, or natural drainage channel, where it is caught by the next lateral below, and turned back upon the land. By this method all waste is avoided and all the land is perfectly drained.

Five-Mile District.

At Five-Mile Creek enough water will be taken out not only to irrigate the land lying to the north of it, called, for convenience, the

Five-Mile District, but also sufficient to cross the river about a mile above Caldwell, and irrigate the lands north of the Boise, called the Northern District.

The Five-Mile District will require three hundred and thirty-three, and the Northern District thirteen hundred and thirty-three cubic feet per second, making sixteen hundred and sixty-six cubic feet per second to be taken from the main canal at this point. This also includes the water taken from the main canal by "pipe" gates, above.

Northern District.

For crossing the river, a short canal, taking the water from Ten-Mile Creek, below the entrance to Five-Mile, will lead the water to the top of a basalt bluff, about one hundred and fifty feet high, forming one side of a short gorge through which the Boise River flows. By a system of large wrought-iron pipes, the water will be led from this point down under the river and up the opposite bluff, from which a canal will extend northward about twelve miles, conveying water to the entire Northern District, and by a system of natural channels and laterals, similar to that just described, will distribute the water to each farm.

It may appear undesirable thus to convey water down the south side of the river and thence carry it across in pipes. But an examination of the line of canal necessary to take so large a volume of water down the north side of the Boise River to the same point will convince any one that the expense by that method would be far greater than by the one proposed.

Ten-Mile District.

At Black's Creek another waste weir and small branch gates will be constructed, and a larger one at the crossing of Ten-Mile.

The channel of Indian Creek is narrow, deep, and in rock; it will, therefore, not be available as a branch canal.

Indian Creek District.

There are, however, a number of natural drainage channels leading from the Main Canal line, between Ten-Mile Creek and the end of the Main Canal, which will be used for the purpose.

Main Branch Canal.

At the end of the main line, what is called the Main Branch leads down the divide between the Boise and Snake rivers. This line will be kept as high as possible; occasional "saddles," or low places in the divide, will force it down until, forty-five miles from its starting-point, it terminates on a hill, two hundred feet vertically above the Snake River, and some four miles south of the mouth of the Boise. This

Main Branch is calculated to be much larger than will be necessary for irrigation, in order to supply the placer mines along the Snake River Where the line is forced vertically down by the depressions of the land, chutes, similar to the one already described, will be put in. Numerous branch "pipe" gates will be put in along this line, upon both sides of the canal, where natural drainage channels offer the desired opportunities for the distribution of water for irrigation; those upon the north side intended to irrigate the "Main District," as it is called, and those upon the south side to irrigate the Snake River District and furnish water to the mines. From this branch, also, lines of pipe (probably two) will extend across to the lands lying upon the southwest side of the Snake River, called the Southern District.

Main District.

Snake River District.

As the line of the Main Branch canal is nearly four hundred feet higher than these lands, it will require very small pipes to carry a large volume of water, and the expense will be proportionately lessened. From the ends of these pipes, canals will convey the water for irrigation along the foot-hills to the natural channels, distribute it to the laterals, and these in their turn to the respective farms, as in the preceding cases.

Another branch, called the Eastern Branch, will begin at the end of the Main Canal line and extend eastward up the Snake River about eighteen miles, to irrigate that track of land south of the divide, and east of the Silver City wagon road, called the Eastern District. By the same system of natural channels and laterals, the water from this branch will be distributed to each farm.

Eastern Branch.

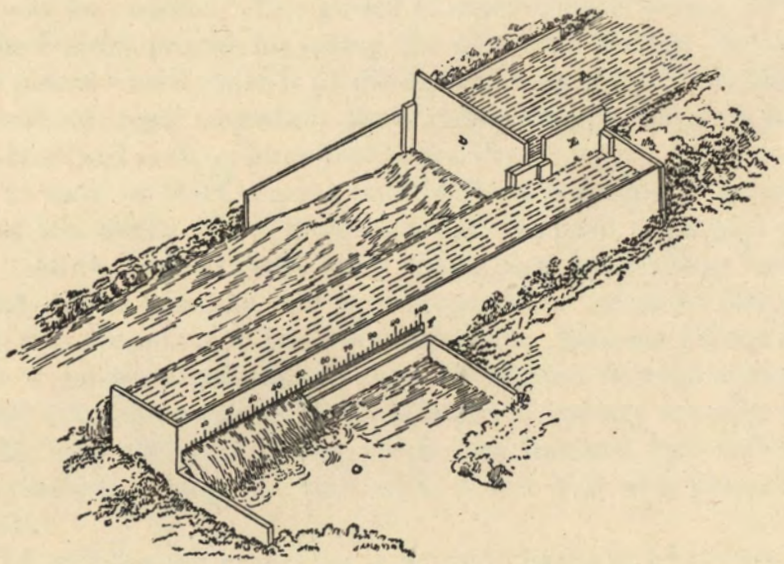
Eastern District.

Water-meters for Irrigation.

ENGINEERS of irrigation works are constantly referring to the want of some practical, inexpensive apparatus, by which small volumes of flowing water can be measured with reasonable accuracy, for delivering to consumers.

The common method of selling water, at a certain price per acre irrigated, has objections, in that it leads first to great waste of water, and second to dissatisfaction, both on the part of the irrigators and of the water owners.

It therefore seemed advisable to provide some method of selling water by a measured quantity, and at a regular price per unit of that quantity.



WATER METER.

In the *Transactions of the American Society of Civil Engineers*, a water-meter for irrigation is described, which has stood the test of long continued use under my own observation. I have found it to work admirably, and it is very easily and cheaply made. It is a modification of the common "measuring-box" used by the placer miners of the West. One side of the box is cut to the proper height to return all

Water-meters for Irrigation.

water above a certain level back into the ditch from which it came; thus keeping the head, or pressure, above the delivering orifice, at a permanent level, without regard to the flow of the supply ditch. The box is also kept clear of floating leaves or grass, and may be quickly and easily adjusted to measure the amount of water desired. Moreover, the consumer, with his pocket-rule, can satisfy himself, at any time, that he is getting the amount of water he pays for.

By this means it will be a comparatively simple matter to measure, to each irrigator, the water he desires each day.

PLACER MINES

Snake River Mines Long Known.

THE placer mines of Snake River have been known and worked for more than twenty years, but, owing to the scarcity of water, the fineness of the gold, and the large quantities of heavy black sand, their working has never been attended by that success which has characterized the other placers of Idaho.

Difficulty of Saving Fine Gold.

Where water could be easily obtained, moderate success has been achieved; but the difficulty of separating the black sand from the gold has told heavily against the miner, and only after long and costly experimenting has that knowledge been obtained through which large profits can be realized. This period of experiment is passed, however, and the desired process for saving the gold well proven; but nearly all the points where water is plentiful have been worked out, and new enterprises of larger magnitude are bringing water to the more inaccessible places and making large profits thereby.

Success Attained by Long Experiment.

Position of Canal in Reference to Mines.

The canal of this Company can distribute water along about sixty miles of the Snake River, lying immediately above the mouth of the Boise. As the upper twenty miles of this sixty has no large bodies of available placer mines on it, it is unnecessary for me to further allude to it in this connection. The lower forty miles, between French John's old ferry and the mouth of the Boise River, runs through a wide flat, bounded upon the north by bluffs of soft sedimentary deposits, which near the ferry rise precipitately about four hundred feet, and gradually dwindle to a long hill, two hundred feet high near the mouth of the Boise.

Amount of Auriferous Gravel Covered by Canal.

The gold-bearing gravel lies in immense banks, or what were, when the river was higher and larger than it is now, bars. They extend along the river continuously from French John's old ferry to the mouth of the Boise, with low channels sometimes cutting them in two or crossing them. They vary, therefore, in width from a few feet to many miles, and in thickness from a few feet to two hundred. The "bed-rock," or underlying rock of these banks, is below the level of the river in the upper portion, but begins to rise above the river at about twelve miles below the French John ferry.

Height of Canal above Placers.

The canal extends along the bluffs overlooking the upper part of the placers at an elevation of from three to four hundred feet above them. In the lower part the canal line extends along upon the gravel hills, but is still two hundred feet above the river. Thus it is evident that water, under a heavy pressure, can be conveyed to all the mines. The map accompanying this paper will show the position of the placers and canals.

Prospecting the Mines.

I have spent a great deal of time and labor prospecting these placer fields. I have sunk shafts, where the gravel was not so loose as to prevent; run tunnels into the sides of the bars, where I could not sink shafts; and dug hundreds of prospect holes, in order to get an accurate idea of the quantity and value of these immense auriferous deposits of gravel. I took accurately measured half cubic yards of gravel and washed them with rocker and pan, saving the black sand and gold. Some of these results were assayed and several were smelted. The results obtained varied from a few cents to eighty cents per cubic yard of gravel; assays made from the same sample by different assayers varied largely, while the gold visible in the sand was about the same in every instance. It is difficult to account for this great variation in the results of assays and smelting, but I find it is the experience of every one who deals with black sand. I quote an article written, I think, by Mr. Hanks, the well known metallurgist of San Francisco, who has studied and written much on the gravels and black sands of the West coast:

Inaccuracy of Assays for Gold in Black Sand.

"As a general proposition, the results from assays for gold are not as satisfactory or reliable as those for silver. The ordinary fire assay for gold, if the ore be of low grade, cannot be relied upon. Very great care has to be exercised in the selection of the sample in the first place, and the amount of gold is so minute that only delicate manipulation will probably save and weigh it. The finest of balances, with nicest adjustments, are required; and, altogether, when the whole is considered, miners of experience would *rather judge from the results of 'horning'* or *'panning out'* a good liberal sample of ore properly pulverized. *They can tell by the 'colors' about what the ore will yield* in the mill. In assaying the gold sands of the rivers, streams, and sea-beaches, the same difficulty is met with; it contains a great amount of specular and titanic iron, and is called black sand by the miners. Platinum and iridium are often found in the same sand."

"Panning" the Proper Method for Determining Value of Gravel.

I have therefore thrown aside my values as obtained by assaying and smelting samples, and first depended entirely upon panning in forming my estimate of the value of these placer lands; and then compared the results thus obtained with the results of actual mining on precisely similar gravel deposits on the river near by. Certainly nothing but actual work on the lands themselves can give nearer their true value than does this work on neighboring properties of a precisely similar character, especially as these great Snake River bars are remarkably uniform. From these neighboring properties a mass of evidence has been collected, based on engineers' reports, on actual profits "per man," on comparison of amount of gold deposited in the assay office with the amount of gravel washed at the mine, etc. This evidence points to a value of from twenty to forty cents per cubic yard. Most of these mines can be worked for only a few months in the year, owing to the shortness of their water supply, and the water is brought to them under no "head," being simply run down over the face of the bank. The fact that it pays at all to work them under these conditions necessarily implies a fair value per yard.

Value of Grave in Neighboring and Precisely Similar Mines.

Area of Placer Lands.

Assisted by the Government land surveys and the surveyed line of the canal, I have determined the area of the placer lands controlled by the canal line to be between thirty-five and forty-five thousand acres. It is difficult to determine it precisely, without an extensive system of shafts to prove its limit on the northern edge. I am perfectly safe, however, in placing the area of these placer lands at thirty-five thousand acres. I could only determine the thickness or depth of gravel by the thickness disclosed at the sides of faces of the bluffs. Often I could get on three sides, and there is no reason to suppose that a great flat plain, which shows stratified gravel, seventy-five feet thick on three sides, contains any less in the center. These bars run from twenty to two hundred feet thick, as seen from their sides, averaging at least fifty feet.

Depth of Gravel.

Amount of Gravel.

Supposing, however, that they are but twenty-seven feet thick, then each square foot of surface will make a cubic yard of gravel or forty-three thousand five hundred and sixty cubic yards to the acre, and thirty-five thousand acres would contain a little more than fifteen hundred million cubic yards of gravel. It is claimed for several mines on the river, as I have shown, that they obtain from twenty to

forty cents from each cubic yard of gravel washed. I prefer to value it, however, at twelve cents per cubic yard. Allowing the cost of mining, including water at five cents per miner's inch, to be four cents per cubic yard, there would remain eight cents per yard profit in mining the gravel. Fifteen hundred million cubic yards, at eight cents per yard, makes the enormous sum of one hundred and twenty million dollars, which is the profit to be realized from these placer lands at the low valuation and high cost of mining which I have used as a basis for my estimate. It is approximately a profit of thirty-five hundred dollars an acre.

Value of Mines in Aggregate.

The above profit will not appear so very large when the time required to obtain it is realized. There is a practical limit to the rapidity with which gravel can be washed. By the system of washing which is described further on, the lands can be attacked at a number of different points at the same time. Say five points were taken and four thousand inches were used on each, or twenty thousand per day, two hundred and fifty days in a year, this would amount to five million inches.

An inch of water will, in this loose gravel, wash from ten to twelve cubic yards in a day, but, as an elevator will have to be used for a portion of the gravel, it is, perhaps, as well to take as a basis for estimates the amount given by Hamilton Smith, Jr., as washed in the hard bottom gravel of the North Bloomfield mine, viz.: five cubic yards. Five million inches will, at this rate, wash twenty-five million cubic yards, or approximately six hundred acres of gravel, which, at a profit of thirty-five hundred dollars per acre, would yield a yearly income of two million dollars, and require sixty years to exhaust the supply of gravel.

Annual Income from Mines, and Time Required to Exhaust Gravel Supply.

The difficulty experienced in the past in effecting the separation of this Snake River gold has been overcome by the better methods now in use. As long as the endeavor was made to separate the gold at once from both the gravel and the black sand the results were disappointing; but by the principle now adopted of first separating by a simple method the sand and gold from the gravel, and then by a second operation separating the gold from the sand, very satisfactory results are obtained—even with the unfavorable conditions, resulting from lack of sufficient water supply and head, under which most of the mines along the river are at present worked. The canal of this com-

Methods of Separating Sand and Gold from Gravel.

pany, as has already been shown, will have, in addition to abundant supply, the advantage of from two hundred to four hundred feet head of water above the placers.

Smelting Black Sand and Gold.

Recently Mr. Chesebro, who owns and works a bar near Silver City Ferry, shipped a quantity of black sand to the Omaha smelting works, from which he obtained a return of $865 per ton. If this last manner of obtaining the gold proves successful, it will simplify the mining operations very much, and at the same time yield much more gold, apparently, than the other methods. It appears, from the results of this shipment, that there is gold in the grains of sand which is not obtained by the amalgamating method, but is abstracted by the lead in the smelting furnace. I have had numerous assays of this sand which ran from three to eight hundred dollars per ton, but was inclined to put little confidence in them; by the explanation given above, however, they can be accounted for.

No Danger from Accumulation of Tailings.

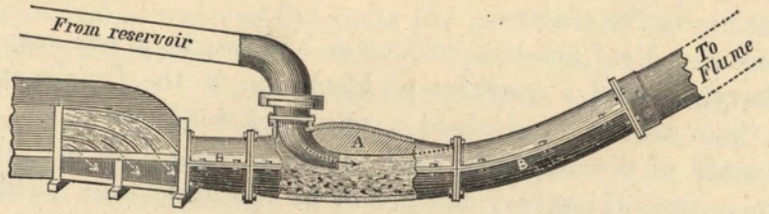
Placer mining in California has been seriously checked, if not practically stopped, by the accumulation of tailings in the rivers. In the case under consideration there is no danger of anything of this kind occurring, as only a very small portion of the tailings will be discharged into the river, and the stream is not navigable.

Overcoming Difficulty of Grade.

In working these wide bars there is a difficulty encountered in the way of grade which would have been insurmountable a few years ago. Take, for example, a bar of gravel extending back from the river, say two miles, and only one hundred feet high. Beginning at the river bank to wash, the grade necessary for the flume to carry the tailings into the river would bring the flume above the gravel long before the back side of the gravel bar was reached. In this case it would reduce the amount of available gravel more than one-half.

There is a machine invented by Mr. Cranston, formerly of California, improved and manufactured by Joshua Hendy, of San Francisco, California, by which this difficulty of grade is entirely overcome at slight additional expense; and by which all of these placer lands, which otherwise would be lost after washing, can be turned back into good agricultural land. The machine spoken of works upon the same principle as the sand blast, only using water instead of air to move the sand. It is in successful operation in Boise Basin, Idaho, and in several places in California and Oregon, and is thoroughly proved in regard

to its practicability. The following cut represents the original model, which has since been much improved in practice.



The gravel of these mines is generally so loose as to require little or no power to break or wash it down, and that which is usually exerted against the banks will here serve to raise the gravel into flumes. The machine will elevate to good advantage about twenty feet for every one hundred feet of water pressure, and its capacity depends upon the size of the machine and pressure of water used.

Placer Mining Lands Saved for Agriculture.

With this machine and the ownership of all these placer lands, the canal owners will be enabled to begin and carry through a systematic method of working this immense tract, and at the same time save it to agriculture. It is seldom that one company can control a tract of sufficient size to make such a system applicable; but in this case the ownership of the water controls the placers absolutely, because there is no other source from which water can be obtained for working them.

Cost of Washing Gravel.

The question of cheap washing is, of course, a very important one. In California the cost of mining a cubic yard of gravel has been determined with great care in various mines to be a general average of three and one-half cents.

The conditions in the case of the Snake River placers are somewhat different. There are, as a rule, no large bowlders, "cement," "lava," "pipe clay," or hard gravel to cause expense, but in their stead is the extra cost entailed by the elevating machine. Neither is there, in this case, the immense cost of the long tunnels and paved flumes of the California mines. The "cleaning up" in either case will be about the same. I think there is little doubt but that the expenses in all the large mines in California, with the drawbacks mentioned, are greater per cubic yard than they will be here, even when using the hydraulic elevator; but to be within safe limits I have estimated the cost at four cents per yard, or nearly twenty-five per cent. greater than that of the California companies.

WORK DONE.

FULL, careful and repeated surveys have been made, the line of canal definitely established, and right of way secured; the result of this careful work being that while the line fits the ground so as to make no undue excess of excavation or fill, at the same time the curvatures are very gentle—a matter of great importance in a canal carrying such a large volume of water.

The maps, plans, cross sections, profiles, and detailed estimates, based on this thorough and long continued field work, are in the New York office of the Company.

Careful examination has been made of the country higher up the river, for the purpose of ascertaining the amount and quality of available timber, and for the location of suitable reservoir sites.

The policy has been to provide for all contingencies, and by this thorough preliminary work to unearth every difficulty which may possibly arise during the progress of the undertaking.

The gold placers have been extensively prospected, and 20,000 acres located for the Company.

Roads have been built for the more convenient transport of supplies, and construction work has been and is being continuously prosecuted on the canal, near the head-works.

Close study during constant residence on the tract confirms fully the opinion first held as to the great fertility and value of the land when irrigated, and the thorough prospecting of the placers more than confirms my first opinion, both as to extent and value.