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PRELIMINARY REPORT
to
Col. Ed Fletcher
on the
COST TO DELIVER WATER FROM WARNERS TO
VISTA VICINITY

Proposed by
VOLCAN LAND & WATER COMPANY.

Thos. P. Ellis, Engr.
February 4, 1918

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REPORT ON COSTS TO DELIVER WATER FROM WARNERS TO

VISTA VICINITY.

By Thos. P. Ellis,

February 4, 1918.

INTRODUCTION.

This report is intended to emphasize which of two routes should be selected in order that final survey data may be collected so as to arrive at an exact cost of a conveying system for the Warner Runoff in delivering its water westerly to the territory between Escondido and Oceanside.

The net safe yield of Warner Reservoir is 34 second feet or twenty-two million gallons per day and this is assumed to be delivered continuously.

Estimate No. 1 sets forth the cost of the most economic route wherein power plants, reservoirs and transmission works are planned to utilize most economically all the available head and water crop from Warner Reservoir. Estimate No. 2 gives cost based upon minimum expenditure wherein the larger of two power units is omitted and the water by-passed down the San Luis Rey River into the Escondido Ditch, as a community conveyer, thence westerly as in Estimate No. 1.

The data upon which this report is based was obtained from the Report on Net Safe Yield of the Board of Engineers, from a preliminary survey of W. S. Post over part of the high conduit line (viz., Monarch Canal), and from data obtained from a preliminary topographic survey and also from the Government Topographic Survey. The inaccuracy of this information has been penalized so that a fair idea may be obtained of the merits of the alternate estimates.

The ground is exceedingly inaccessible and brushy and perfected surveys will be expensive.

The report is arranged as follows:

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SYSTEMATIC DESCRIPTION OF ALTERNATE SYSTEMS

The San Luis Rey River water to be collected in Warner Reservoir with earth fill dam at upper site or multiple arch dam at lower site depending upon contract price and merits of foundations as finally determined. This water to be discharged either into the proposed Monarch Canal or San Luis Rey River channel.

OUTLINE OF ROUTE USED IN ESTIMATE NO. 1

Warner Reservoir

To be the source of the Water Supply, with water surface elevation of 2727 ft. Reservoir Capacity 203,000 acre feet.

Water to be diverted at the rate of 34 sec. ft. into the Monarch Canal (Length 13.7 miles)

This open canal to be built of Gunite Concrete, constructed on a roadway bench over which structural materials have been hauled. Construction to start at midpoint and work toward the ends. Outside width of canal 6 ft. Height 2' 3". Grade 1 ft. per 1,000 feet. Capacity 35.6 sec. ft. The thickness of walls and bottom to be 2 inches. Excess width of conduit designed to take repair automobile. This canal skirts the tops of the mountains on the south bank of the San Luis Rey River and terminates above Hellhole Canyon at which point heads the

Hell Hole Power Drop.

This drop has a static head of 875 feet (1770 K.W. Efficiency 70%). The pressure pipe to pass beneath the Escondido Ditch to a power plant 40 feet below. At this point the plant discharges into the

Merriam Pipe Line (Length 13.5 miles)

This to be a 34 inch concrete line on hydraulic grade extending from the Hellhole Power Plant to Merriam Reservoir near Live Oaks, this being also the easterly limits of the proposed Irrigation District, extending between Escondido and Oceanside.

The Merriam Pipe line discharges into the

Merriam Power Drop

This drop has a static head of 430 feet (870 K.W. Eff. 70%) and discharges directly into

Merriam Reservoir

This reservoir acts as a distribution reservoir for the proposed irrigation district and also a storage reservoir for 4 months run of the power plants during winter months when the average draft on the reservoir does not exceed 25% of the 34 sec. ft. flowing.

The outlet elevation to be 960 feet which is sufficiently high to furnish all arable lands within the district with gravity water.

The water surface elevation to be 1050 allowing a reservoir capacity of 6500 acre feet. The main dam is on the west side of the reservoir basin; on the north a low pass will necessitate the construction of an earth dike 30 ft. in height. The proposed main dam to be 120 feet high and while no extended view can be obtained of the foundation, it is thought because of the height and narrowness of the gorge and the nature of the out-croppings that bed rock may be found within eight feet, sufficiently firm to warrant a multiple arched type of dam. The surface indications present a mass of drift or loose granite boulders and badly disintegrated rock starts about one foot below the surface.

Distribution System

From the outlet of Merriam Reservoir the Distribution System to follow the contour to the south about one mile, thence by syphon across the valley at Live Oaks. Thence skirting the high contours westerly to dominating points, whence three main laterals with total length of thirty miles can divert the full flow to all lands within the proposed district.

OUTLINE OF ROUTE USED IN ESTIMATE NO. 2

Warner Reservoir

To be the Source of the Water Supply, with water surface elevation of 2727 feet. Reservoir capacity 203,000 acre feet. Type of dam either Earth fill or Multiple Arched. Water is diverted into

San Luis Rey River Channel (Length used 10 miles)

Wherein it is conveyed to Escondido Ditch, with intake on the San Luis Rey River. The average transportation loss in volume has been estimated by various engineers to be 10 percent.

Escondido Ditch

To carry the water 8 miles to the point of the proposed Hellhole Syphon. The present Escondido Ditch is capable of diverting only 43 second feet. In case of joint usage this ditch may be required to carry at least 90 second feet which would necessitate rebuilding the entire structure and lining same against leakage. This leakage loss is thirty percent of the amount diverted (or 1100 ac. ft. per season). This lining to terminate at the point of above mentioned syphon on the north side of Hellhole Canyon and from here the

Merriam Pipe Line (Diameter 34")

Starts at head of said Hellhole Syphon and conveys the water across the saddle forming the San Pasqual Indian Reservation. Thence westerly 13.5 miles to the Merriam Power Drop and so through the

Merriam Power Drop the Merriam Reservoir and the Distribution System as in Estimate No. 1.

Tabulation Showing Grades, Elevations, etc. of each Unit

(Quantities in feet)

Accompanying Estimate No. 1

Order	Elev. Intake	Elev. Outlet	Length	Di. or Width	Depth or Drop	% grade	Capacity
Warner Res'r	2727 WS	2640	630	-	107	-	0.2 M. Ac. Ft.
Monarch Canal	2640	2567	13.7 mi.	6.00	2.25	0.1	35.6 sec. ft.
Hellhole Drop	2567	1692	3300	1.67	875	-	1770 K.W.
Merriam Pipe	1690	1487	13.5 mi.	2.83	0	0.284	40 sec. ft.
Merriam Drop	1487	1052	1700	1.67	435	-	880 K.W.
Merriam Res'r	1050 WS	960	600	-	120	-	6400 ac. ft.
Distr. Line	960	?	-	-	-	-	-

Accompanying Estimate No. 2

Order	Elev. Intake	Elev. Outlet	Length	Di. or Width	Depth or Drop	% grade	Capacity
Warner Res'r	2727 WS	2640	630	-	107	-	0.2 M. ac. ft.
S. L. Rey River	2640	1780	10 mi.	-	-	-	34 sec. ft.
Escondido Ditch	1780	1732	8 mi.	3.8	2.8	0.155	-
Merriam Pipe	1690	1487	13.5 mi.	2.83	0	0.284	40 sec. ft.
Merriam Drop	1487	1052	1.67 ID	1.67	435	-	880 K.W.
Merriam Res'r	1050 WS	960	600	-	120	-	6500 ac. ft.
Distr. Line	960	(?)	-	-	-	-	-

ESTIMATE NO. 1

Cost of Monarch - Merriam Canal System.

(27 miles continuous new construction)

A	Water Rights along San Luis Rey River at \$1,000 per M.I. -----	\$ 1,700,000	
B	Lands and Rights of Way (Warner Reservoir & Monarch Canal) -----	662,000	
C	Construction Cost (Upper or Monarch Section)		
	(1) Warner Dam (incl. tunnel & weir basin) -----	350,000	
	(2) Monarch Canal (13.7 miles)		
	11 miles Gunits Canal at \$24,000 -----	\$264,000	
	2.5 miles Tunnel at \$110,000 -----	275,000	
	1,100 ft. Siphon & Trestle at \$10 -----	11,000	
		<u>\$550,000</u>	
	15% -----	82,500	632,500
	(3) Hellhole Power Plant		
	Reinforced Concrete Headworks -----	6,000	
	3,000 ft. pressure pipe at \$20 -----	60,000	
	2,000 K.W. plant at \$40 -----	80,000	
		<u>\$146,000</u>	
	15% -----	21,900	167,900
	Total for Section C - \$1,160,400.		
D	Lands and Rights of Way (Merriam Section) -----	40,000	
E	Construction Cost (Lower or Merriam Section)		
	(1) Merriam Dam (Multiple Arched) -----	\$150,000	
	15% -----	22,500	172,500
	(2) Merriam Pipe Line (13.5 mi. of 34" concrete pipe on hydraulic grade)		
	62,680 ft. Conc. pipe at \$6 -----	\$376,080	
	1,250 ft. Conc. pipe low head at \$7.50 -----	9,375	
	6,100 ft. Conc. pipe high head at \$9.00 -----	54,900	
	1,250 ft. pipe in tunnel at \$20 -----	25,000	
		<u>\$465,255</u>	
	15% -----	69,805	535,160
	(3) Merriam Power Plant (34 sec. ft.)		
	1,700 ft. pressure pipe at \$20 -----	34,000	
	900 K.W. plant at \$40 -----	36,000	
		<u>70,000</u>	
	15% -----	10,500	80,500
	Total for Section E - \$788,160.		
	Cost of Monarch - Merriam Canal System Complete -----	\$4,350,520	

ANNUAL OPERATIVE COSTS - ESTIMATE NO. 1

(See Sheet 9)

1.	(A) Annual Interest on Water Rights Investment		
	\$1,700,000 at 7% -----		\$ 119,000
2.	<u>Annual Costs Monarch Division</u>		
	(B) Interest on Lands \$662,000 at 7% -----	\$46,340	
	Taxes \$3 per \$100 on 1/3 value -----	6,620	52,960
	(C-1) Warner Dam Interest at 10% -----	\$36,000	
	Depreciation ----- 1% -----	3,600	
	Taxes \$3 per \$100 on 1/5 value -----	2,160	
	Maintenance and Operation -----	2,500	44,260
	(C-2) Monarch Canal Interest at 10% -----	\$63,250	
	Depreciation ----- 2% -----	12,650	
	Taxes \$3 per \$100 on 1/5 value -----	3,400	
	Maintenance and Operation -----	5,000	84,300
	(C-3) Hellhole Power Plant Interest at 10% -----	\$16,790	
	Depreciation -- at 5% -----	8,400	
	Taxes \$3 per \$100 on 1/5 value -----	1,010	
	Labor 4 men at \$1,800 -----	7,200	
	Waste and Supplies -----	2,000	35,400
	Total Monarch Division (2) -----		\$ 216,920
3.	<u>Annual Costs Merriam Division</u>		
	(D) Interest on Lands \$40,000 at 7% -----	\$ 2,800	
	Taxes \$3 per \$100 on 1/3 value -----	400	\$ 3,200
	(E-1) Merriam Dam Interest at 10% -----	\$17,250	
	Depreciation 1% -----	1,730	
	Taxes \$3 per \$100 on 1/5 value -----	1,040	
	Maintenance and Operation -----	2,500	22,520
	(E-2) Merriam Pipe Line Interest at 10% -----	\$53,520	
	Depreciation 2% -----	10,700	
	Taxes \$3 per \$100 on 1/5 Value -----	3,020	
	Maintenance and Operation -----	5,000	72,240
	(E-3) Merriam Power Plant Interest at 10% -----	\$ 8,050	
	Depreciation 5% -----	4,030	
	Taxes \$3 per \$100 on 1/5 Value -----	490	
	Maintenance and Operation -----	7,000	
	Waste and Supplies -----	1,500	21,070
	Total Merriam Division (3) -----		\$ 119,030
	Total Annual Cost (10.4% of investment) -----		\$ 454,950
	Interest correction to 3.1% for \$1 -----		\$ 65,680
	Annual Operating Cost (Laterals excluded) -----		\$ 389,270

ESTIMATE NO. 2

Cost of Escondido - Merriam Canal System.

(10 miles S.L.R. River, 8 miles Escondido Ditch, 13 1/2 miles new construction)

A	Water Rights along San Luis Rey River at \$1000 per M.I. -----	\$ 1,700,000	
B	Lands and Rights of Way (Warner Reservoir) -----	600,000	
C	Construction Cost (San Luis Rey - Escondido Section)		
	(1) Warner Dam (incl. tunnel & weir basin) -----	360,000	
	(2) Escondido Ditch (Reconstruction)		
	8 miles rebuilt & lined at \$30,000-----	\$240,000	
	15% -----	36,000	276,000
	Total Covering Section C -----	\$636,000	
D	Lands and Rights of Way (Merriam Section) -----	40,000	
E	Construction Cost (Lower or Merriam Section)		
	(1) Merriam Dam (Multiple Arched) -----	\$150,000	
	15% -----	22,500	172,500
	(2) Merriam Pipe Line (13.5 miles of 34" concrete pipe on hydraulic grade)		
	62,680 ft.conc. pipe at \$6-----	\$376,080	
	1,250 ft.conc. pipe low head at 7.50	9,375	
	6,100 ft.conc. pipe high head at \$9	54,900	
	1,250 ft.pipe in tunnel at \$20.00--	25,000	
		\$465,355	
	15% -----	69,805	535,160
	(3) Merriam Power Plant (31 sec.ft.)		
	1,700 ft. pressure pipe at \$20 ----	\$ 34,000	
	900 K.W. plant at \$40 -----	36,000	
		\$ 70,000	
	15% -----	10,500	80,500
	Total Covering Section E -----	\$788,160	
	Cost of Escondido - Merriam Canal System -----		3,764,160

ANNUAL OPERATING COSTS - ESTIMATE NO. 2
(See Sheet 11)

1.	(A) Annual Interest on Water Rights Investment		
	\$1,700,000 at 7% -----		\$ 119,000
2.	Annual Costs San Luis Rey River Division		
	(B) Interest on Lands \$600,000 at 7% -----	\$42,000	
	Taxes \$3 per \$100 on 1/3 Value -----	6,000	48,000
	(C-1) Warner Dam Interest at 10% -----	\$36,000	
	Depreciation 1% -----	3,600	
	Taxes \$3 per \$100 on 1/5 value -----	2,160	
	Maintenance and Operation -----	2,500	44,260
	(C-2) Escondido Ditch Interest at 10% -----	\$27,600	
	1/2 Depreciation 2% -----	2,760	
	1/2 Taxes \$3 per \$100 on 1/5 Value -----	830	
	1/2 Maintenance and Operation -----	2,500	33,690
	Total San Luis Rey River Division -----		\$ 125,950
3.	Annual Costs Merriam Division		
	(D) Interest on Lands \$40,000 at 7% -----	\$ 2,800	
	Taxes \$3 per \$100 on 1/3 value -----	400	\$ 3,200
	(E-1) Merriam Dam Interest at 10% -----	\$17,250	
	Depreciation 1% -----	1,730	
	Taxes \$3 per \$100 on 1/5 value -----	1,040	
	Maintenance and Operation -----	2,500	22,520
	(E-2) Merriam Pipe Line Interest at 10% -----	\$53,520	
	Depreciation 2% -----	10,700	
	Taxes \$3 per \$100 on 1/5 Value -----	3,020	
	Maintenance and Operation -----	5,000	72,240
	(E-3) Merriam Power Plant Interest at 10% -----	\$ 8,050	
	Depreciation 5% -----	4,030	
	Taxes \$3 per \$100 on 1/5 Value -----	490	
	Maintenance and Operation -----	7,000	
	Waste and Supplies -----	1,500	21,070
	Total Merriam Division (3) -----		\$ 119,030
	Annual cost -----		\$ 363,980

(363,980 \$ 3,764,160 = 9.7%)

COMPARISON OF CONSTRUCTION AND OPERATING COSTS MONARCH DIVISION VS
SAN LUIS REY DIVISION

1. Monarch Division (Dam and Lands Excluded)

(A) Construction Cost of Canal & Power Plant

Canal see p.9, pp. C (2) -----	\$532,500	
Power Plant see p.9, pp C (3) -----	167,900	\$ 800,400

(B) Annual Costs of Canal & Power Plant

Canal see p. 10, pp (C-2) -----	\$ 84,300	
Power Drop, see p. 10, pp. (C-3) ---	35,400	119,700

$$\frac{(B)}{(A)} = 15\%$$

2. San Luis Rey River Division

(A) Reconstruction Cost of Escondido Ditch

See p. 11, pp C (2) -----	276,000
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(B) Annual Costs of Ditch

See p. 12, pp (C-2) -----	33,690
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$$\frac{(B)}{(A)} = 12\%$$

The figures above represent the relative cost of conducting water by continuous conduit to Hellhole Canyon as against the cost via San Luis Rey River and Escondido Ditch and their respective operating costs.

Allowing the predetermined factor of 10% for losses in the river sands, the loss of revenue from the Hellhole Power Plant and also the decrease by 10% of revenue from the Merriam Power Plant (structural and operating expense taken as originally estimated), we have the following losses in earnings for each year, provided the San Luis Rey River Route is adopted, viz:

10% of 22 M.G.D. or say 2.0 M.G.D. at 3¢ per 1000 gals.-----	\$24,000
Hellhole Power 1770 K.W. (Head 875 ft. Vol. 34 sec.ft.) at \$40 -----	70,800
Merriam Power 88 K.W. (Head 435 ft. Vol. 3.4 sec.ft.) at \$40 -----	3,520
Total Losses in Earning -----	\$98,320

Hence with an additional structural cost of \$524,400, an additional annual expense of \$86,010 is incurred and to offset this annual expense of \$86,010, an amount \$98,320 is earned by penalizing the water loss in San Luis Rey River. From an economic standpoint then the Monarch Canal with power fully developed would be the logical route between Warner Dam and Hellhole Canyon.

These preliminary figures do not show that the construction of the Monarch Canal and Hellhole power house are fully warranted because of the value of the power alone. (The income from the sale of power being only \$74,320)

When making the location survey a lighter grade, for Monarch Canal, can be adopted. This will serve the double purpose of cutting down the length of tunnels or doing away with some of them completely and increasing the head on the power house without materially increasing the cost of the canal. It is apparent from the local scarcity of the hydro-electric power and the ever increasing cost of fuel that the price of \$40 per K.W. year for power at the Hellhole Switch-board may be considered low, to the end that the construction of these two units (Monarch Canal and Hellhole Power Plant) will "practically finance themselves" without reference to the value of water lost in transmission through the channel of the San Luis Rey River. It must be kept in mind, however, that this Canal is not designed with a view to making it a highly economic unit within itself

for the reason that a much shorter canal could be used to convey the same water to a much greater height, but considered in connection with the value of water losses in the San Luis Rey River Channel (if the water was carried by that route) the value of the canal becomes at once apparent, when linked with the fact that approximately four miles length of this canal takes the place of eight miles of the Escondido Ditch.

SELLING PRICE OF WATER FOR VARIOUS USES

One second foot continuous flow of water is equal to 50 miners inches or 645,000 gallons daily and has the following approximate prices for the various uses.

One second foot falling 1310 feet in two stages (which is the power head available in this report) will develop 78 K.W. on the switchboard, having a commercial value of \$40 per K.W. year or a total value of \$3,120.

Six hundred forty-six thousand gallons of water devoted to domestic purposes, sold at 20 cents per 1,000 gallons will yield a gross income of about \$47,100 per year. If applied to irrigation 905 acres may be irrigated to eight-tenths of a one foot depth of water. Figuring water at 3-1/3 cents per 1,000 gallons, the gross income would be about \$7,800 per year or \$8.62 per acre.

<u>Unit</u>	<u>Annual Gross Income For</u>		
	<u>Power</u>	<u>Domestic</u>	<u>Agriculture</u>
One Second Foot -----	\$3120	\$47,100	\$ 7,800
One Million Gallons Daily -----	\$4800	\$72,900	\$12,000
One Miners Inch (1sec.ft. = 50 M.I.) -----	\$ 62	\$ 942	\$ 156

DEVELOPMENT COST PER ACRE(A) Using Estimate No. 1

The plant to cost \$4,350,560 plus an additional cost of \$250,000 for distribution mains or in all a probable cost of \$4,600,560 with an annual expense of 10.4% on the investment (See p.10) or \$478,400. Under full demand we may assume the system to sell all of its power, five percent of its water for domestic purposes and 95% of its water for irrigation purposes. On say, 32 second feet net, this would yield annual revenue of

Power	\$3,120 x 32	-----	\$ 99,840
Domestic	\$47,100 x 1.60	-----	75,360
Irrigation	\$ 7,800 x 30.4	-----	237,120
			<u>\$ 412,320</u>

The difference between \$478,000, the operating expense, and \$412,320, the annual revenue, or \$65,680 to be taken care of either by cutting off a portion of the capital amount allowed for the value of water rights or reducing the interest charge on \$1,700,000 to a minimum of 3.1% whenever the earnings could not pay the 7% allowed. With this adjustment the annual operating cost and annual revenue will balance each other.

$$\text{(Capital reduction needed)} \quad \frac{65,680}{.07} = \$938,300$$

From estimate No. 1 the minimum area subject to water supply within the proposed district should not be less than (905 ac. x 32) 29,000 acres. Allowing 10% excess for roads and other unirrigated tracts, the size would increase to 32,000 acres. All waste and unarable lands excluded.

The cost of this development per acre using the cost of \$4,600,000 given above will be (\$4,600,000 ÷ 29,000 or) \$158 per acre

net or distributed to all lands within the district, the average cost will be \$144 per acre.

(B) Using Estimate No. 1 With power omitted.

If the layout in Estimate No. 1 is adopted with the exclusion of power, the Volcan Company to deliver the safe yield to Merriam Pipe Line at Hellhole Canyon, the District responsibility would decrease as follows:

Cost of Monarch Canal	-----	\$ 632,500
Cost of Hellhole Power Plant	-----	167,900
Cost of Merriam Power Plant	-----	80,500
		<u>\$ 880,900</u>

The cost of the plant decreased by this amount would then be:

Cost of Plant as in (A) above	-----	\$ 4,600,560
Deduction as above	-----	880,900

Corrected Total Cost power omitted ---- \$ 3,719,660

The Cost of this development per acre

Assuming the acreage to be decreased by penalizing the district for the 3 second feet loss in the San Luis Rey River because of adopting and building this route in preference to route set forth in Estimate No. 2, we would have for the net area of district (905 ac. x 29) 26,200 acres which when divided into \$3,719,660 would give \$142 cost per acre for the project.

The annual revenue reasonably expected by the Volcan Company, if the power generation formed a separate project, would be:-

2,650 K.W. - Hellhole & Merriam Power at \$40 K.W.	-----	\$ 106,000
Maintenance and Operation Costs received by excluding Escondido Ditch Estimate #2 (C-2)	-----	33,690
Sale of 3 Sec.Ft. received by not using the San Luis Rey River at \$7,800	-----	23,400
Total Annual Revenue	-----	<u>\$ 163,090</u>

The annual operating costs on the above power installations would be:

Monarch Canal	- Operating costs, Est. #1, 2 (0-2) ----	\$ 84,300
Hellhole Power Plant	- " " Est. #1, 2 (0-3) ----	35,400
Merriam Power Plant	- " " Est. #1, 3 (E-3) ----	21,070
		<u>\$ 140,770</u>

This would decrease the entire annual operating cost of main project to (\$478,400 - \$140,770) \$337,630 plus (penalties above) 33,690 + 23,400 = \$394,720.

The annual income from the sale of water would be:

Domestic	47,100 x (5% of 29) -----	\$ 68,295
Irrigation	7,800 x (95% of 29) -----	214,890
		<u>\$ 283,185</u>

(C) Using Estimate No. 2

The cost of the conveying system (Estimate #2) is \$3,764,160 plus \$250,000 for the distribution system, gives a total plant cost of \$4,014,160 with an annual expense of 9.7% (see page 12) or \$389,400. Under full demand we may assume the system to sell all of its power, five percent of its water for domestic purposes and 95% of its water for irrigation purposes. On say 29 second feet net this would yield an annual revenue of

Power	880 K.W. at \$40 -----	\$ 35,200
Domestic	\$47,100 x (5% of 29) -----	68,295
Irrigation	\$ 7,800 x (95% of 29) -----	214,890
		<u>\$ 318,385</u>

The difference between the above operating expense of \$389,400 and the annual revenue of \$318,385 or \$71,015 to be taken care of either by cutting off a portion of the capital amount allowed for the value of water rights or reducing the interest charge on \$1,700,000 to a minimum of 2.8% whenever the earnings could not pay the 7% allowed. With this adjustment the annual operating cost and

annual revenue balance each other.

(Capital reduction needed $\frac{71,015}{.07} = \$1,014,500$)

We will have for the net area of the district by this estimate (905 x 29) 26,200 acres paying for a development to cost \$4,014,160 or \$153 per acre.

Tabulated Cost of Development

Estimate	Cost of System	Annual Expense	Annual Revenue	Annual Deficit	Amount to Decrease Capital	Price per acre	Capital Expenditure must not exceed
1-(A)	\$4,600,560	478,400	412,320	65,680	938,300	\$158	\$3,600,000 \$124 per acre
1-(B)	3,719,660	394,720	283,185	111,535	1,593,400		Eliminate
Power	880,900	140,770	163,090	none			
2-(C)	4,014,160	389,400	318,385	71,015	1,014,500	153	3,000,000 \$114 per acre

Note: The system development proposed in Estimate No. 1 is the more advisable design as it conserves more water and power with less sacrifice of capital. The expenditure of \$938,300 is excessive and points to the fact that a more economic structure must be finally planned or in default the water right value must be sacrificed. The final cost not to exceed \$3,600,000, i.e., \$125 per acre.

CONCLUSIONS

In view of the foregoing analysis, I wish to recommend for your final consideration the Monarch - Merriam Hydro-electric Power Canal as the most economical method of conveying the Warner runoff (22 M.G.D.) to the Irrigation District proposed (29,000 acres net). The continuity of the design permits of an economic co-ordination of power, agricultural and domestic supply possibilities.

The preliminary nature of this report, due to the lack of perfected surveys, will not permit of very reliable construction estimate. This fact, together with the price of \$2,300,000 allowed for water rights and Warner Reservoir site, causes this estimate to appear \$1,000,000 too high for economic operation. Assuming that \$250,000 can be cut from the construction cost and \$750,000 from the value allowed for water rights and Warner Reservoir site, we have:

Water Rights -----	\$1,000,000
Warner Reservoir -----	550,000
Construction Cost, etc. -----	<u>2,050,000</u>
Entire Cost of System -----	\$3,600,000

This \$3,600,000 represents the price that may be paid for this development to insure a reasonable return on the investment when all water and power is sold. A duty of water of 0.8 of a foot per acre per year is provided for 29,000 acres. This with a plant costing \$3,600,000 will necessitate an outlay of \$124.00 per acre served.

No estimate is made for a purely irrigation supply each year covering an eight months period continuous flow. If a 50% supply was allowable for two consecutive years, 2,800 M.I. would be available for all 8 month periods. The uniform draft of 32 second feet for power with a pure irrigation use could still be maintained, without increasing

the size of any unit.

Due allowance in figuring the net safe yield has been made for the water priorities of Escondido as per their agreement.

The incorporation of the power into a separate project is not advised. The reason for this is set forth on page 13 under Comparison of Construction and Operating Costs - Monarch Division vs San Luis Rey River Division. The power heads assumed have a tendency to be low.

The relative advantages of this selection are that:

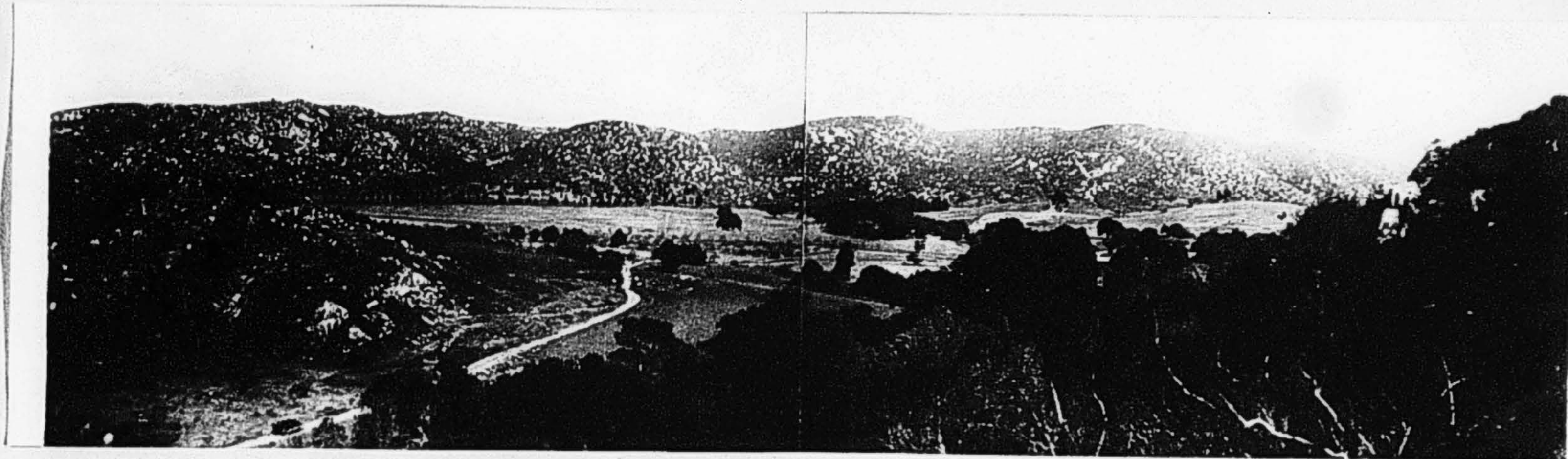
- (1) The water will be conveyed by direct route to the central part of the territory to be served. Here a ready market will dissipate the supply so that a more circuitous route would have no additional advantages.
- (2) The Merriam Reservoir exists below both power plants thereby conserving the constantly discharging waters when the demand is low. This reservoir is located at a sufficiently high elevation to afford good pressure through economic distribution mains.
- (3) Both conduit sections dominate the range traversed. This not only shortens the distance (as in the case where four miles of Monarch Canal offsets eight miles of Escondido Ditch), but makes it possible on the Merriam line to supply water to the valleys on either side of the line as well as to the proposed district which lies to the west.
- (4) It eliminates the use of the Escondido Mutual Water Company system which would need considerable expenditure to make it an asset to both companies. The ditch elevation is too high to obtain the maximum head at the Hellhole Power Plant and its length is excessive in comparison. The Bear Valley Reservoir is isolated from the proposed district and its elevation does not work in so

conveniently for a lower power and distribution scheme. It is an open question whether the joint use of this system would prove good policy.

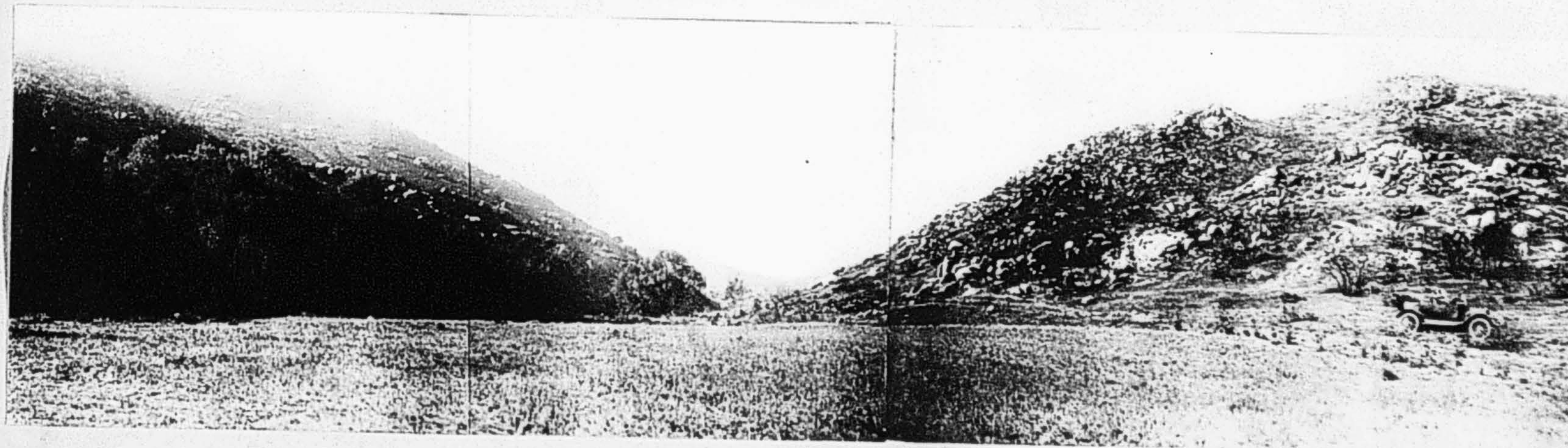
(5) The use of the San Luis Rey River Channel as a conveyer is eliminated, thereby saving an average daily supply of at least two million gallons. This water would have a yearly irrigation value of \$24,000 and if adopted would cause a yearly power loss of \$74,320.

Respectfully submitted,

TPE:RK



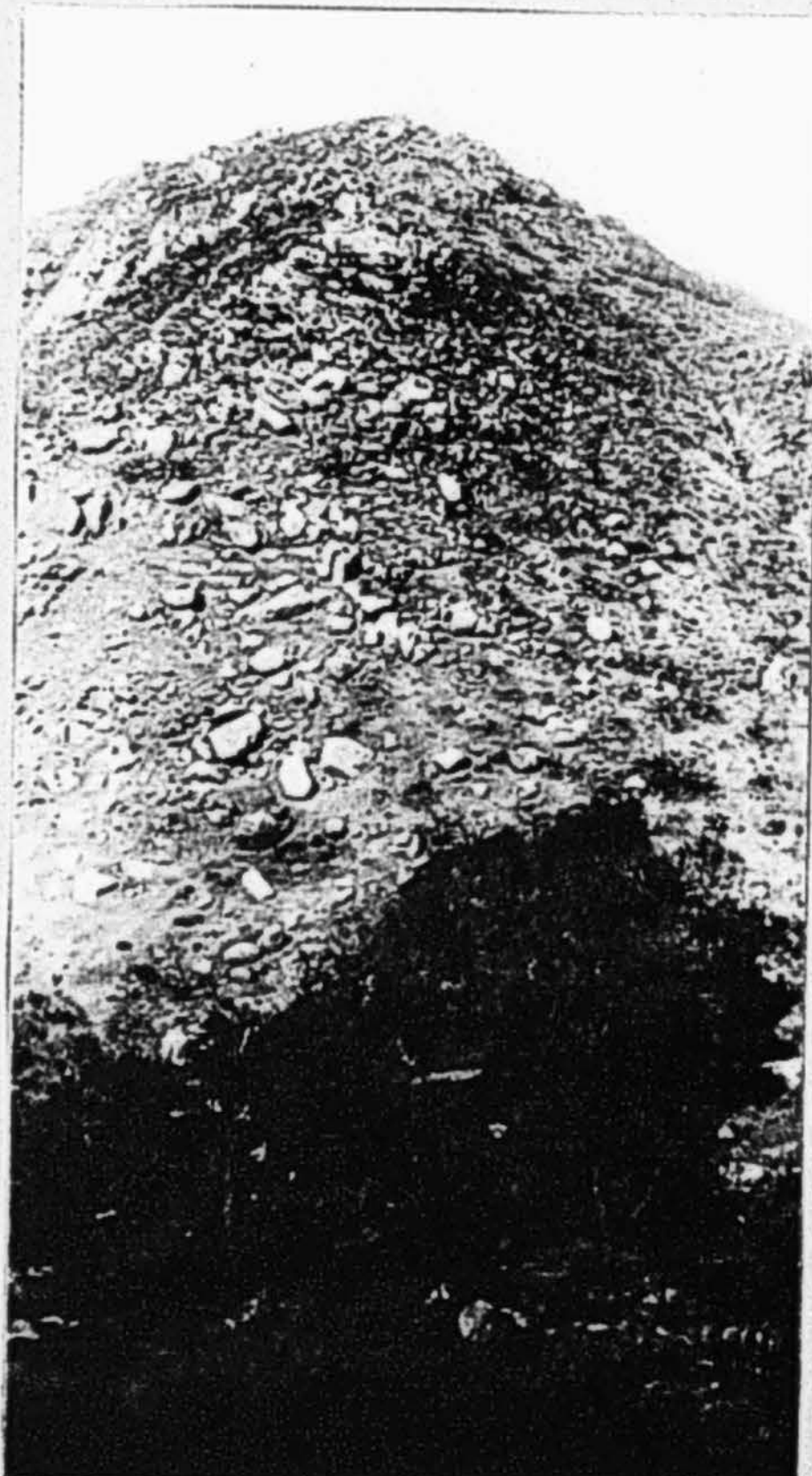
1. Reservoir Basin - Looking East from left bank of damsite.



2. General View of Damsite.



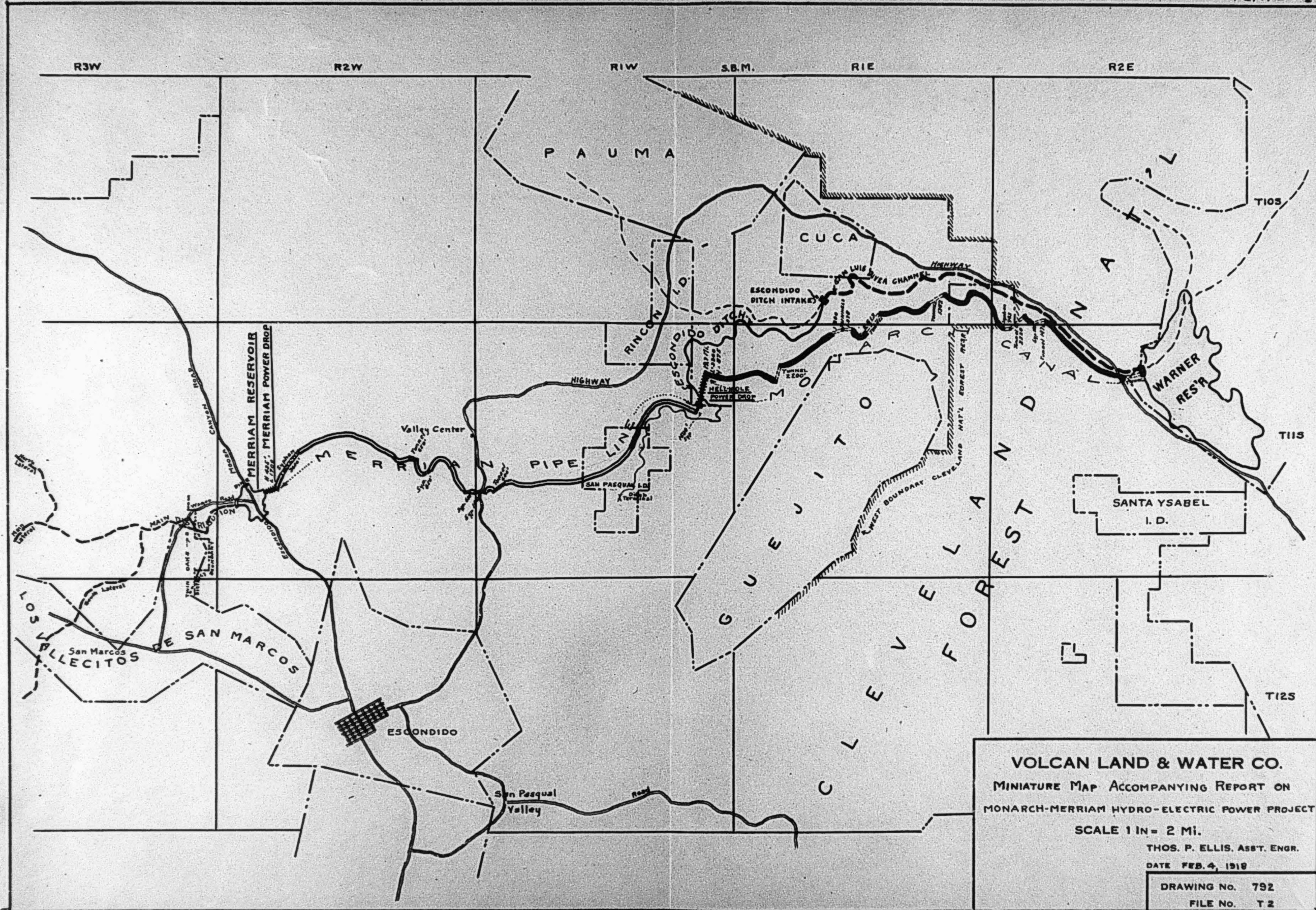
3. View showing saddle where dike is required.



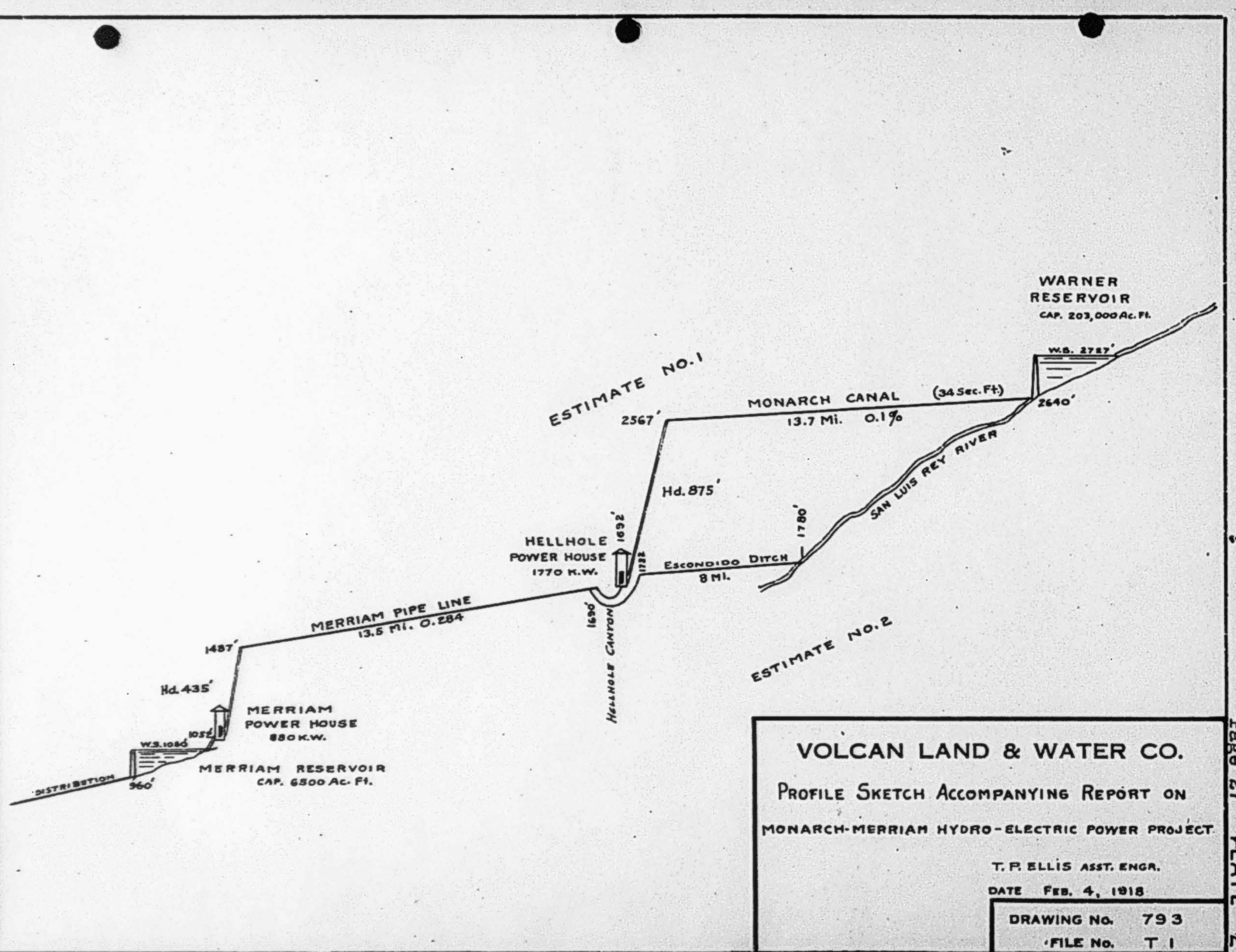
4. Right bank of damsite.



5. Nature of bedrock.



VOLCAN LAND & WATER CO.
 MINIATURE MAP ACCOMPANYING REPORT ON
 MONARCH-MERRIAM HYDRO-ELECTRIC POWER PROJECT
 SCALE 1 IN = 2 MI.
 THOS. P. ELLIS, ASST. ENGR.
 DATE FEB. 4, 1918
 DRAWING No. 792
 FILE No. T 2

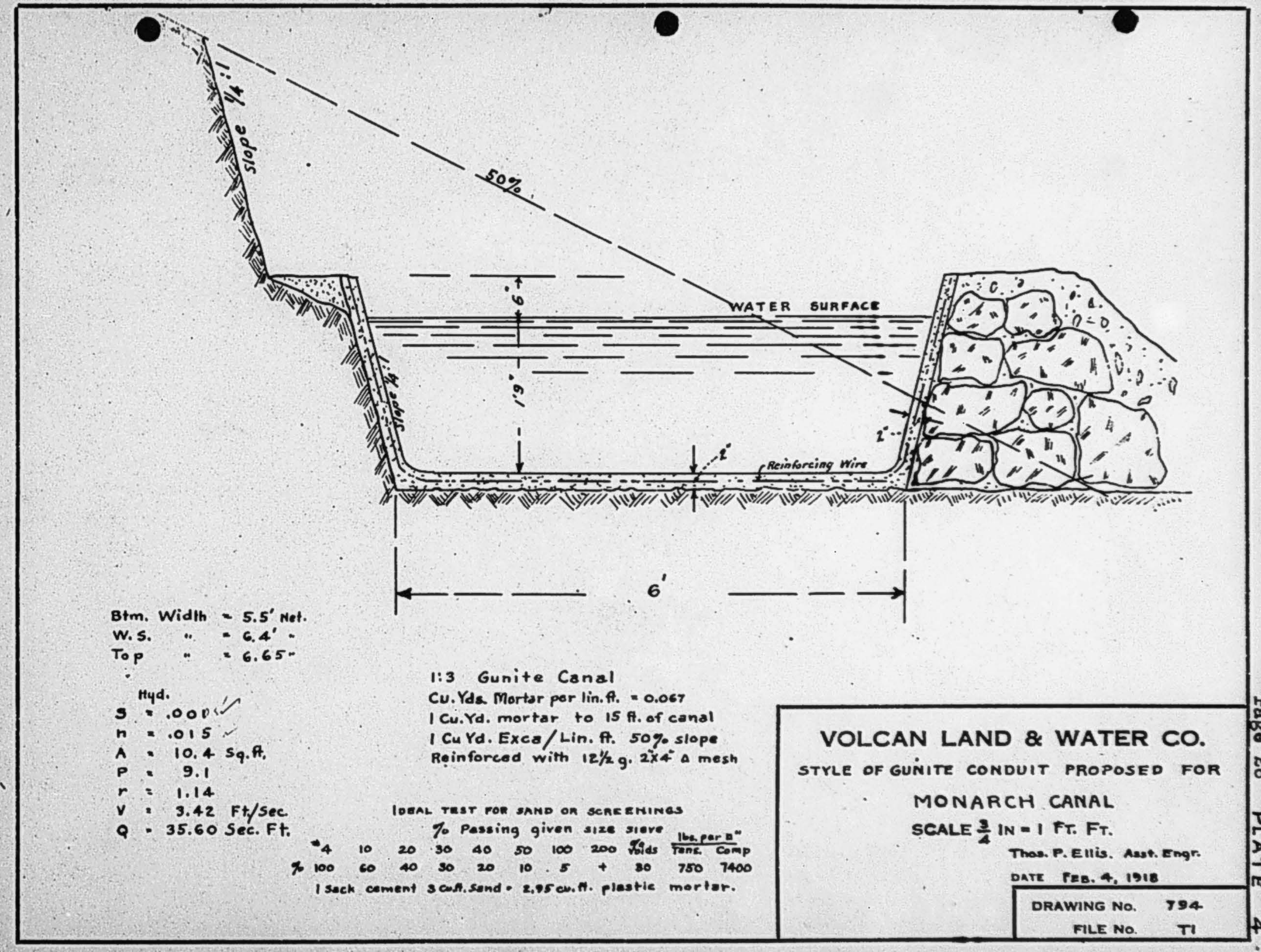


VOLCAN LAND & WATER CO.
 PROFILE SKETCH ACCOMPANYING REPORT ON
 MONARCH-MERRIAM HYDRO-ELECTRIC POWER PROJECT

T. P. ELLIS ASST. ENGR.
 DATE FEB. 4, 1918

DRAWING NO. 793
 FILE NO. T 1

PAGE 27 PLATE 2



Btm. Width = 5.5' Net.
 W.S. " = 6.4' -
 Top " = 6.65'

Hyd.
 S = .000 ✓
 n = .015 ✓
 A = 10.4 Sq. ft.
 P = 9.1
 r = 1.14
 V = 3.42 Ft./Sec.
 Q = 35.60 Sec. Ft.

1:3 Gunitite Canal
 Cu. Yds. Mortar per lin. ft. = 0.067
 1 Cu. Yd. mortar to 15 ft. of canal
 1 Cu. Yd. Exca./Lin. ft. 50% slope
 Reinforced with 12 1/2 g. 2x4 mesh

IDEAL TEST FOR SAND OR SCREENINGS

% Passing given size sieve	lbs. per cu. ft.
4	100
10	100
20	100
30	100
40	100
50	100
100	100
200	100
voids	100
Tang. Comp	100
750	100
7400	100

1 Sack cement 3 cu. ft. sand = 2.95 cu. ft. plastic mortar.

VOLCAN LAND & WATER CO.
 STYLE OF GUNITITE CONDUIT PROPOSED FOR
 MONARCH CANAL
 SCALE 3/4 IN = 1 FT. FT.

Thos. P. Ellis, Asst. Engr.
 DATE FEB. 4, 1918

DRAWING NO. 794
 FILE NO. T 1

PAGE 28 PLATE 4

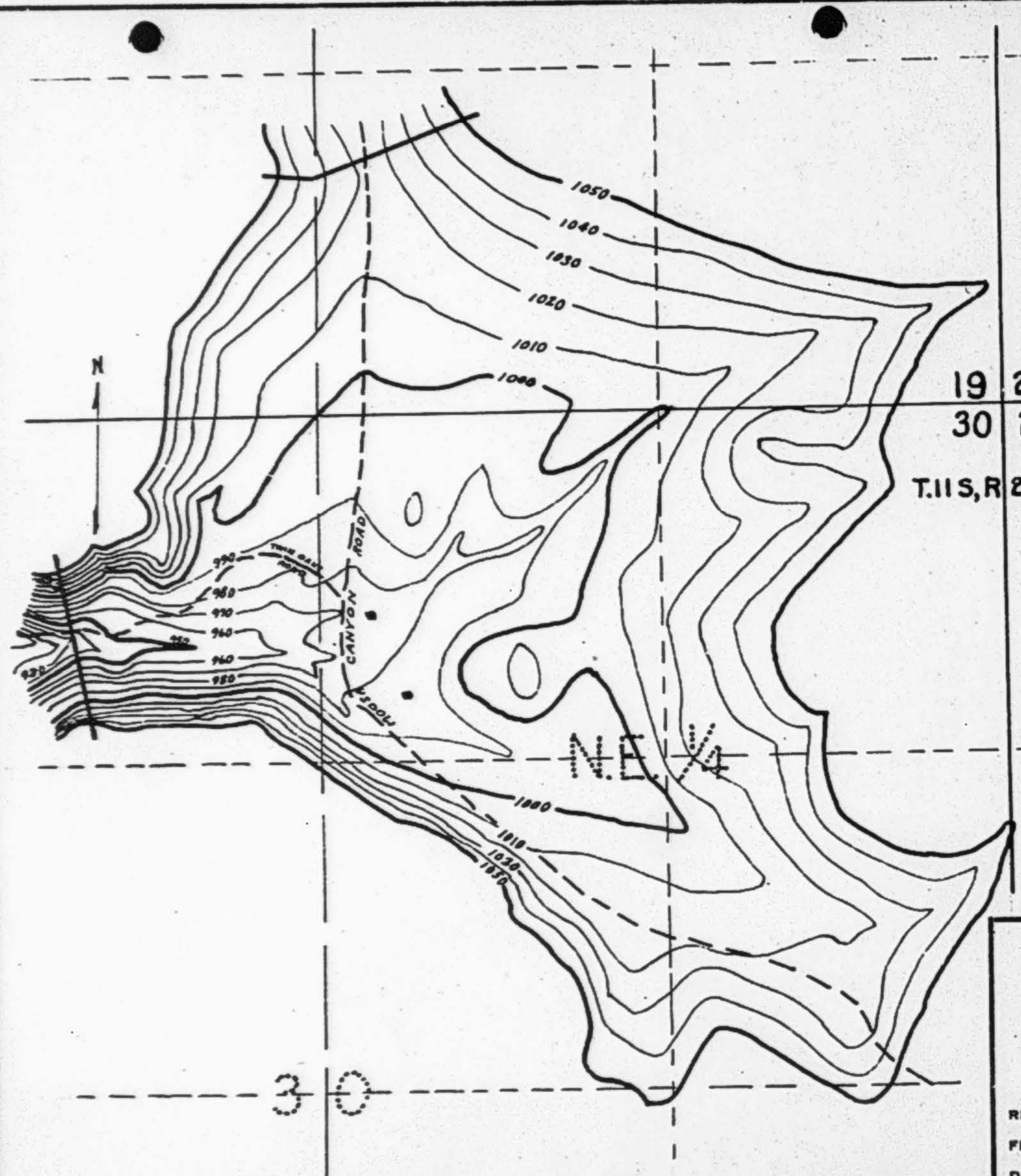
PLATE 5.

VOLCAN LAND & WATER COMPANY

WARNER RESERVOIR CAPACITIES

July 17, 1917

Contour U.S.G.S.	Depth	Acres Flooded	Total Acre Feet
2620	0	0	0
2630	10	17	58
2640	20	58	433
2650	30	250	2,023
2660	40	875	7,698
2670	50	1,405	19,098
2680	60	1,822	35,233
2690	70	2,300	55,845
2700	80	2,960	82,145
2710	90	4,010	116,995
2715	95	4,560	138,420
2720	100	5,340	163,170
2727	107	6,080	203,140



AREA AND CAPACITY TABLE

Contour	Depth	Acres	Ac. Ft. Cap.
930	0	0	0
940	10	0	0
950	20	0.7	3
960	30	3	21
970	40	5	61
980	50	11	141
990	60	23	311
1000	70	48	666
1010	80	76	1286
1020	90	106	2196
1030	100	133	3341
1040	110	158	4796
1050	120	176	6466

• OUTLET
MERRIAM DAM (Multiple Arch)
 Earth-rock Fill to 1060' Contour, alternative
 Top width 20'
 Slopes { Upstream 2 1/2 to 1
 Downstream 2 to 1
 Volume 480,000 Cu. Yds.

MERRIAM DIKE
 Earth fill to 1060' Contour.
 Top width 20'
 Slopes { Upstream 3 to 1
 Downstream 2 1/2 to 1
 Volume 85,580 Cu. Yds.

VOLCAN LAND & WATER CO.
MERRIAM RESERVOIR SITE
 (Miniature)

SCALE 1 IN = 600 FT. Approx.

REFERENCE MAP 789 T3
 FIELD BOOK No.
 DRAWN BY Ellis
 CHECKED BY _____
 Thos. P. Ellis, Engr.
 DATE Feb. 1918
 DRAWING No. 791
 FILE No. T 1

Page 29 PLATE 3

Checked 077

PRELIMINARY REPORT
to
Col. Ed Fletcher
on the
COST TO DELIVER WATER FROM WARNERS TO
VISTA VICINITY

Proposed by
VOLCAN LAND & WATER COMPANY.

Thos. P. Ellis, Engr.
February 4, 1918

PRELIMINARY REPORT
to
Col. Ed Fletcher
on the
COST TO DELIVER WATER FROM WARNERS TO
VISTA VICINITY

Proposed by
VOLCAN LAND & WATER COMPANY

(Conclusions on Page 21)

Thos. P. Ellis, Engr.
February 4, 1918

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3. View showing saddle where dike is required.
4. Right bank at Damsite.
5. Nature of Bed Rock.

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2. Profile Sketch of Project. 793-T-1
3. Contour Map of Merriam Reservoir. 791-T-1
4. Cross Section of Sunite Canal Proposed. 794-T-1
5. Area and Capacity Table Warner Reservoir.

REPORT ON COSTS TO DELIVER WATER FROM WARNERS TO

VISTA VICINITY.

By Thos. P. Ellis,

February 4, 1918.

INTRODUCTION.

This report is intended to emphasize which of two routes should be selected in order that final survey data may be collected so as to arrive at an exact cost of a conveying system for the Warner Runoff in delivering its water westerly to the territory between Esccondido and Oceanside.

The net safe yield of Warner Reservoir is 34 second feet or twenty-two million gallons per day and this is assumed to be delivered continuously.

Estimate No. 1 sets forth the cost of the most economic route wherein power plants, reservoirs and transmission works are planned to utilize most economically all the available head and water crop from Warner Reservoir. Estimate No. 2 gives cost based upon minimum expenditure wherein the larger of two power units is omitted and the water by-passed down the San Luis Rey River into the Esccondido Ditch, as a community conveyor, thence westerly as in Estimate No. 1.

The data upon which this report is based was obtained from the Report on Net Safe Yield of the Board of Engineers, from a preliminary survey of W. S. Post over part of the high conduit line (via, Monarch Canal), and from data obtained from a preliminary topographic survey and also from the Government Topographic Survey. The inaccuracy of this information has been penalized so that a fair idea may be obtained of the merits of the alternate estimates.

The ground is exceedingly impassible and brushy and perfected surveys will be expensive.

The report is arranged as follows:

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Tabulation showing Grades, Elevation, etc., -----	8
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Development Cost per Acre:	
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(D) Tabulated Cost of Development -----	20
Conclusions -----	21
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SYSTEMATIC DESCRIPTION OF ALTERNATE SYSTEMS

The San Luis Rey River water to be collected in Warner Reservoir with earth fill dam at upper site or multiple arch dam at lower site depending upon contract price and merits of foundations as finally determined. This water to be discharged either into the proposed Monarch Canal or San Luis Rey River channel.

OUTLINE OF ROUTE USED IN ESTIMATE NO. 1

Warner Reservoir

To be the source of the Water Supply, with water surface elevation of 2727 ft. Reservoir Capacity 203,000 acre feet.

Water to be diverted at the rate of 34 sec. ft. into the Monarch Canal (Length 13.7 miles)

This open canal to be built of Gunite Concrete, constructed on a roadway bench over which structural materials have been hauled. Construction to start at midpoint and work toward the ends. Outside width of canal 6 ft. Height 2' 3". Grade 1 ft. per 1,000 feet. Capacity 35.6 sec. ft. The thickness of walls and bottom to be 8 inches. Excess width of conduit designed to take repair automobile. This canal skirts the tops of the mountains on the south bank of the San Luis Rey River and terminates above Hellhole Canyon at which point heads the

Hell Hole Power Drop.

This drop has a static head of 875 feet (1770 K.W. Efficiency 70%). The pressure pipe to pass beneath the Escondido Ditch to a power plant 40 feet below. At this point the plant discharges into the

Merriam Pipe Line (Length 13.5 miles)

This to be a 34 inch concrete line on hydraulic grade extending from the Hellhole Power Plant to Merriam Reservoir near Live Oaks, this being also the easterly limits of the proposed Irrigation District, extending between Escondido and Oceanside.

The Merriam Pipe line discharges into the

Merriam Power Drop

This drop has a static head of 430 feet (870 Kw. Eff. 70%) and discharges directly into

Merriam Reservoir

This reservoir acts as a distribution reservoir for the proposed irrigation district and also a storage reservoir for 4 months run of the power plants during winter months when the average draft on the reservoir does not exceed 25% of the 34 sec. ft. flowing.

The outlet elevation to be 960 feet which is sufficiently high to furnish all arable lands within the district with gravity water.

The water surface elevation to be 1050 allowing a reservoir capacity of 6500 acre feet. The main dam is on the west side of the reservoir basin; on the north a low pass will necessitate the construction of an earth dike 50 ft. in height. The proposed main dam to be 120 feet high and while no extended view can be obtained of the foundation, it is thought because of the height and narrowness of the gorge and the nature of the out-croppings that bed rock may be found within eight feet, sufficiently firm to warrant a multiple arched type of dam. The surface indications present a mass of drift or loose granite boulders and badly disintegrated rock starts about one foot below the surface.

Distribution System

From the outlet of Merriam Reservoir the Distribution System to follow the contour to the south about one mile, thence by syphon across the valley at Live Oaks. Thence skirting the high contours westerly to dominating points, whence three main laterals with total length of thirty miles can divert the full flow to all lands within the proposed district.

OUTLINE OF ROUTE USED IN ESTIMATE NO. 2

Warner Reservoir

To be the Source of the Water Supply, with water surface elevation of 2727 feet. Reservoir capacity 203,000 acre feet. Type of dam either Earth fill or Multiple Arched. Water is diverted into

San Luis Rey River Channel (Length used 10 miles)

Wherein it is conveyed to Escondido Ditch, with intake on the San Luis Rey River. The average transportation loss in volume has been estimated by various engineers to be 10 percent.

Escondido Ditch

To carry the water 8 miles to the point of the proposed Hellhole Syphon. The present Escondido Ditch is capable of diverting only 45 second feet. In case of joint usage this ditch may be required to carry at least 90 second feet which would necessitate rebuilding the entire structure and lining same against leakage. This leakage loss is thirty percent of the amount diverted (or 1100 ac. ft. per season). This lining to terminate at the point of above mentioned syphon on the north side of Hellhole Canyon and from here the

Merriam Pipe Line (Diameter 34")

Starts at head of said Hellhole Syphon and conveys the water across the saddle forming the San Pasqual Indian Reservation. Thence westerly 13.5 miles to the Merriam Power Drop and so through the Merriam Power Drop the Merriam Reservoir and the Distribution System as in Estimate No. 1.

Tabulation Showing Grades, Elevations, etc. of each Unit

(Quantities in feet)

Accompanying Estimate No. 1

Order	Elev. : Intake	Elev. : Outlet	Length	Di. or : Width	Depth or : Drop	% : grade	Capacity
Warner Res'r	: 2787 WS	: 2640	: 630	: -	: 107	: -	: 0.2 M.Ac.Ft
Monarch Canal	: 2640	: 2567	: 13.7 mi.	: 6.00	: 2.25	: 0.1	: 35.5 sec.ft
Hellhole Drop	: 2567	: 1692	: 3300	: 1.67	: 875	:	: 1770 K.W.
Merriam Pipe	: 1490	: 1487	: 13.5 mi.	: 2.83	: 0	: 0.284	: 40 sec.ft
Merriam Drop	: 1487	: 1052	: 1700	: 1.67	: 435	:	: 880 K.W.
Merriam Res'r	: 1050 WS	: 960	: 600	: -	: 120	:	: 6500 ac.ft.
Distr. Line.	: 960	: ?	:	:	:	:	:

Accompanying Estimate No. 2

Order	Elev. : Intake	Elev. : Outlet	Length	Di. or : Width	Depth or : Drop	% : grade	Capacity
Warner Res'r	: 2727 WS	: 2640	: 630	: -	: 107	: -	: 0.2 M.ac.ft.
S.L. Bay River	: 2640	: 1780	: 10 mi.	: -	: -	: -	: 34 sec.ft
Escondido Ditch	: 1780	: 1732	: 8 mi.	: 3.8	: 2.8	: 0.155	:
Merriam Pipe	: 1490	: 1487	: 13.5 mi.	: 2.83	: 0	: 0.284	: 40 sec.ft.
Merriam Drop	: 1487	: 1052	: 1.67 ID	: 1.67	: 435	: -	: 880 K.W.
Merriam Res'r	: 1050 WS	: 960	: 600	: -	: 120	: -	: 6500 ac.ft
Distr. Line	: 960	: (?)	:	:	:	:	:

ESTIMATE NO. 1

Cost of Monarch - Merriam Canal System.
(27 miles continuous new construction)

A	Water Rights along San Luis Rey River at \$1,000 per A.I.		\$ 1,700,000
B	Lands and Rights of Way (Warner Reservoir & Monarch Canal)		662,000
C	Construction Cost (Upper or Monarch Section)		
	(1) Warner Dam (incl. tunnel & weir basin)		360,000
	(2) Monarch Canal (13.7 miles)		
	11 miles Gunita Canal at \$24,000		\$284,000
	2.5 miles Tunnel at \$110,000		275,000
	1,100 ft. Siphon & Trestle at \$10		11,000
			\$550,000
	13.7 miles Canal <i>Interest</i>		82,500
	(3) Hellhole Power Plant		
	Reinforced Concrete Headworks		6,000
	3,000 ft. pressure pipe at \$20		60,000
	2,000 K.W. plant at \$40		80,000
			\$146,000
	15%		21,900
	Total for Section C		\$1,160,400
D	Lands and Rights of Way (Merriam Section)		40,000
E	Construction Cost (Lower or Merriam Section)		
	(1) Merriam Dam (Multiple Arched)		\$150,000
	15%		22,500
	(2) Merriam Pipe Line (13.5 mi. of 34" concrete pipe on hydraulic grade)		
	62,680 ft. Conc. pipe at \$6 ^{1/4}		\$376,080
	1,250 ft. Conc. pipe low head at \$7.50		9,375
	6,100 ft. Conc. pipe high head at \$9.00		54,900
	1,250 ft. pipe in tunnel at \$20		25,000
			\$465,355
	15%		69,805
	(3) Merriam Power Plant (34 sec. ft.)		
	1,700 ft. pressure pipe at \$20		\$34,000
	900 K.W. plant at \$40		36,000
			70,000
	15%		10,500
	Total for Section E		\$738,160
	Cost of Monarch - Merriam Canal System Complete		\$4,350,560

ANNUAL OPERATIVE COSTS - ESTIMATE NO. 1
(See Sheet 9)

1.	(A) Annual Interest on Water Rights Investment		\$ 119,000
	\$1,700,000 at 7%		
2.	Annual Costs Monarch Division		
	(B) Interest on Lands \$662,000 at 7%	\$46,340	
	Taxes \$3 per \$100 on 1/3 value	6,620	52,960
	(C-1) Warner Dam Interest at 10%	\$36,000	
	Depreciation 1%	3,600	
	Taxes \$3 per \$100 on 1/5 value	2,160	
	Maintenance and Operation	2,500	44,260
	(C-2) Monarch Canal Interest at 10%	\$63,250	
	Depreciation 2%	12,650	
	Taxes \$3 per \$100 on 1/5 value	3,400	
	Maintenance and Operation	5,000	84,300
	(C-3) Hellhole Power Plant Interest at 10%	\$16,790	
	Depreciation -- at 5%	8,400	
	Taxes \$3 per \$100 on 1/5 value	1,010	
	Labor 4 men at \$1,800	7,200	
	Waste and Supplies	2,000	55,400
	Total Monarch Division (2)		\$ 216,920
3.	Annual Costs Merriam Division		
	(D) Interest on Lands \$40,000 at 7%	\$ 2,800	
	Taxes \$3 per \$100 on 1/3 value	400	\$ 3,200
	(E-1) Merriam Dam Interest at 10%	\$17,250	
	Depreciation 1%	1,730	
	Taxes \$3 per \$100 on 1/5 value	1,040	
	Maintenance and Operation	2,500	22,520
	(E-2) Merriam Pipe Line Interest at 10%	\$53,520	
	Depreciation 2%	10,700	
	Taxes \$3 per \$100 on 1/5 Value	3,020	
	Maintenance and Operation	5,000	72,240
	(E-3) Merriam Power Plant Interest at 10%	\$ 8,050	
	Depreciation 5%	4,030	
	Taxes \$3 per \$100 on 1/5 Value	490	
	Maintenance and Operation	7,000	
	Waste and Supplies	1,500	31,070
	Total Merriam Division (3)		\$ 119,030
	Total Annual Cost (10.4% of investment)		\$ 454,950
	Interest correction to 3.1% for #1		\$ 65,680
	Annual Operating Cost (Laterals excluded)		\$ 589,270

ESTIMATE NO. 2

Cost of Escondido - Merriam Canal System.

(10 miles S.L.R. River, 8 miles Escondido Ditch, 13 1/2 miles new construction)

A	Water Rights along San Luis Rey River at \$1000 per A.F. -----	\$ 1,700,000	
B	Lands and Rights of Way (Warner Reservoir) -----	600,000	
C	Construction Cost (San Luis Rey - Escondido Section)		
	(1) Warner Dam (incl. tunnel & weir basin) -----	360,000	
	(2) Escondido Ditch (Reconstruction)		
	8 miles rebuilt & lined at \$30,000-----	\$240,000	
	15% -----	36,000	276,000
	Total Covering Section C -----	\$636,000	
D	Lands and Rights of Way (Merriam Section) -----	40,000	
E	Construction Cost (Lower or Merriam Section)		
	(1) Merriam Dam (Multiple Arched) -----	\$150,000	
	15% -----	22,500	172,500
	(2) Merriam Pipe Line (13.5 miles of 34" concrete pipe on hydraulic grade)		
	62,680 ft. conc. pipe at \$6-----	\$376,080	
	1,250 ft. conc. pipe low head at 7.00	9,375	
	6,100 ft. conc. pipe high head at \$9	54,900	
	1,250 ft. pipe in tunnel at \$20.00--	25,000	
		\$465,355	
	15% -----	69,805	535,160
	(3) Merriam Power Plant (31 sec. ft.)		
	1,700 ft. pressure pipe at \$20 -----	\$ 34,000	
	900 K.W. plant at \$40 -----	36,000	
		\$ 70,000	
	15% -----	10,500	80,500
	Total Covering Section E -----	\$788,160	
	Cost of Escondido - Merriam Canal System -----		3,764,160

ANNUAL OPERATING COSTS - ESTIMATE NO. 2
(See Sheet 11)

1.	(A) Annual Interest on Water Rights Investment		
	\$1,700,000 at 7% -----		119,000
2.	Annual Costs San Luis Rey River Division		
	(B) Interest on Lands \$600,000 at 7% -----	\$42,000	
	Taxes \$3 per \$100 on 1/3 Value -----	6,000	48,000
	(C-1) Warner Dam Interest at 10% -----	\$36,000	
	Depreciation 1% -----	3,600	
	Taxes \$3 per \$100 on 1/5 value -----	2,160	
	Maintenance and Operation -----	2,500	44,260
	(C-2) Escondido Ditch Interest at 10% -----	\$27,600	
	1/2 Depreciation 2% -----	2,760	
	1/2 Taxes \$3 per \$100 on 1/5 Value -----	830	
	1/2 Maintenance and Operation -----	2,500	33,690
	Total San Luis Rey River Division -----		\$ 125,950
3.	Annual Costs Merriam Division		
	(D) Interest on Lands \$40,000 at 7% -----	\$ 2,800	
	Taxes \$3 per \$100 on 1/5 value -----	400	3,200
	(E-1) Merriam Dam Interest at 10% -----	\$17,250	
	Depreciation 1% -----	1,730	
	Taxes \$3 per \$100 on 1/5 value -----	1,040	
	Maintenance and Operation -----	2,500	22,520
	(E-2) Merriam Pipe Line Interest at 10% -----	\$53,520	
	Depreciation 2% -----	10,700	
	Taxes \$3 per \$100 on 1/5 Value -----	3,020	
	Maintenance and Operation -----	5,000	72,240
	(E-3) Merriam Power Plant Interest at 10% -----	\$ 8,050	
	Depreciation 5% -----	4,030	
	Taxes \$3 per \$100 on 1/5 Value -----	490	
	Maintenance and Operation -----	7,000	
	Waste and Supplies -----	1,500	21,070
	Total Merriam Division (3) -----		\$ 119,030
	Annual cost -----		\$ 365,980

(365,980 ÷ 3,764,160 = 9.7%)

COMPARISON OF CONSTRUCTION AND OPERATING COSTS MONARCH DIVISION VS
SAN LUIS REY DIVISION

1. Monarch Division (Dam and Lands Excluded)

(A) Construction Cost of Canal & Power Plant

Canal see p. 9, pp. C (2) ----- \$832,500
Power Plant see p. 9, pp C (3) ----- 167,900 \$ 900,400

(B) Annual Costs of Canal & Power Plant

Canal see p. 10, pp (C-2) ----- \$ 84,300
Power Drop, see p. 10, pp. (C-3) --- 35,400 119,700

$\frac{(B)}{(A)} = 15\%$

2. San Luis Rey River Division

(A) Reconstruction Cost of Escondido Ditch

See p. 11, pp C (2) ----- 275,000

(B) Annual Costs of Ditch

See p. 12, pp (C-2) ----- 33,690

$\frac{(B)}{(A)} = 12\%$

The figures above represent the relative cost of conducting water by continuous conduit to Hellhole Canyon as against the cost via San Luis Rey River and Escondido Ditch and their respective operating costs.

Allowing the predetermined factor of 10% for losses in the river sands, the loss of revenue from the Hellhole Power Plant and also the decrease by 10% of revenue from the Merriam Power Plant (structural and operating expense taken as originally estimated), we have the following losses in earnings for each year, provided the San Luis Rey River Route is adopted, viz:

10% of 22 M.G.D. or say 2.0 M.G.D. at 3¢ per 1000 gals. -----	\$24,000
Hellhole Power 1770 K.W. (Head 875 ft. Vol. 34 sec.ft.) at \$40 -----	70,800
Merriam Power 88 K.W. (Head 435 ft. Vol. 3.4 sec.ft.) at \$40 -----	3,520
Total Losses in Earning -----	\$98,320

Hence with an additional structural cost of \$524,400, an additional annual expense of \$86,010 is incurred and to offset this annual expense of \$86,010, an amount \$98,320 is earned by penalizing the water loss in San Luis Rey River. From an economic standpoint then the Monarch Canal with power fully developed would be the logical route between Warner Dam and Hellhole Canyon.

These preliminary figures do not show that the construction of the Monarch Canal and Hellhole power house are fully warranted because of the value of the power alone. (The income from the sale of power being only \$74,320)

When making the location survey a lighter grade, for Monarch Canal, can be adopted. This will serve the double purpose of cutting down the length of tunnels or doing away with some of them completely and increasing the head on the power house without materially increasing the cost of the canal. It is apparent from the local scarcity of the hydro-electric power and the ever increasing cost of fuel that the price of \$40 per K.W. year for power at the Hellhole Switch-board may be considered low, to the end that the construction of these two units (Monarch Canal and Hellhole Power Plant) will "practically finance themselves" without reference to the value of water lost in transmission through the channel of the San Luis Rey River. It must be kept in mind, however, that this Canal is not designed with a view to making it a highly economic unit within itself

for the reason that a much shorter canal could be used to convey the same water to a much greater height, but considered in connection with the value of water losses in the San Luis Rey River Channel (if the water was carried by that route) the value of the canal becomes at once apparent, when linked with the fact that approximately four miles length of this canal takes the place of eight miles of the Escondido Ditch.

SELLING PRICE OF WATER FOR VARIOUS USES

One second foot continuous flow of water is equal to 50 miners inches or 648,000 gallons daily and has the following approximate prices for the various uses.

One second foot falling 1310 feet in two stages (which is the power head available in this report) will develop 78 K.W. on the switchboard, having a commercial value of \$40 per K.W. year or a total value of \$3,120.

Six hundred forty-six thousand gallons of water devoted to domestic purposes, sold at 20 cents per 1,000 gallons will yield a gross income of about \$47,100 per year. If applied to irrigation 905 acres may be irrigated to eight-tenths of a one foot depth of water. Figuring water at 3-1/3 cents per 1,000 gallons, the gross income would be about \$7,800 per year or \$8.62 per acre.

<u>Unit</u>	<u>Annual Gross Income For</u>		
	<u>Power</u>	<u>Domestic</u>	<u>Agriculture</u>
One Second Foot -----	\$3120	\$47,100	\$ 7,800
One Million Gallons Daily -----	\$4800	\$72,900	\$12,000
One Miners Inch (1 sec. ft. = 50) (M.I.) -----	\$ 62	\$ 942	\$ 156

DEVELOPMENT COST PER ACRE(A) Using Estimate No. 1

The plant to cost \$4,350,560 plus an additional cost of \$250,000 for distribution mains or in all a probable cost of \$4,600,560 with an annual expense of 10.4% on the investment (See p.10) or \$478,400. Under full demand we may assume the system to sell all of its power, five percent of its water for domestic purposes and 95% of its water for irrigation purposes. On say, 32 second feet net, this would yield annual revenue of

Power	\$5,120 x 32	-----	\$ 99,840
Domestic	\$47,100 x 1.60	-----	75,360
Irrigation	\$ 7,800 x 30.4	-----	237,120
			<u>\$ 412,320</u>

The difference between \$478,000, the operating expense, and \$412,320, the annual revenue, or \$65,680 to be taken care of either by cutting off a portion of the capital amount allowed for the value of water rights or reducing the interest charge on \$1,700,000 to a minimum of 3.1% whenever the earnings could not pay the 7% allowed. With this adjustment the annual operating cost and annual revenue will balance each other.

$$\text{(Capital reduction needed)} \quad \frac{65,680}{.07} = \$928,300$$

From estimate No. 1 the minimum area subject to water supply within the proposed district should not be less than (905 ac. x 32) 29,000 acres. Allowing 10% excess for roads and other unirrigated tracts, the size would increase to 32,000 acres. All waste and unarable lands excluded.

The cost of this development per acre using the cost of \$4,600,000 given above will be (\$4,600,000 ÷ 29,000 or) \$158 per acre

net or distributed to all lands within the district, the average cost will be \$144 per acre.

(B) Using Estimate No. 1 * With power omitted.

If the layout in Estimate No. 1 is adopted with the exclusion of power, the Volcan Company to deliver the safe yield to Merriam Pipe Line at Hellhole Canyon, the District responsibility would decrease as follows:

Cost of Monarch Canal	-----	\$ 632,500
Cost of Hellhole Power Plant	-----	167,900
Cost of Merriam Power Plant	-----	80,500
		<u>\$ 880,900</u>

The cost of the plant decreased by this amount would then be:

Cost of Plant as in (A) above	-----	\$ 4,600,560
Deduction as above	-----	880,900
Corrected Total Cost power omitted	-----	\$ 3,719,660

The Cost of this development per acre

Assuming the acreage to be decreased by penalizing the district for the 3 second feet loss in the San Luis Rey River because of adopting and building this route in preference to route set forth in Estimate No. 2, we would have for the net area of district (905 ac. x 29) 26,200 acres which when divided into \$3,719,660 would give \$142 cost per acre for the project.

<u>The annual revenue</u> reasonably expected by the Volcan Company, if the power generation formed a separate project, would be:-	
2,650 K.W. - Hellhole & Merriam Power at \$40 K.W.	----- \$ 106,000
Maintenance and Operation Costs received by excluding Escondido Ditch Estimate #2 (C-2)	----- 33,690
Sale of 3 Sec. Ft. received by not using the San Luis Rey River at \$7,800	----- 23,400
Total Annual Revenue	----- \$ 163,090

The annual operating costs on the above power installations would be:

Monarch Canal	- Operating costs, Est. #1, 2 (C-2)	-----	\$ 84,300
Hellhole Power Plant	- " " Est. #1, 2 (C-3)	-----	35,400
Merriam Power Plant	- " " Est. #1, 3 (E-5)	-----	21,070
			<u>\$ 140,770</u>

This would decrease the entire annual operating cost of main project to (\$478,400 - \$140,770) \$337,630 plus (penalties above) 33,690 + 23,400 = \$394,720.

The annual income from the sale of water would be:

Domestic	47,100 x (5% of 29)	-----	\$ 68,295
Irrigation	7,800 x (95% of 29)	-----	214,890
			<u>\$ 283,185</u>

(C) Using Estimate No. 2

The cost of the conveying system (Estimate #2) is \$3,764,160 plus \$250,000 for the distribution system, gives a total plant cost of \$4,014,160 with an annual expense of 9.7% (see page 12) or \$389,400. Under full demand we may assume the system to sell all of its power, five percent of its water for domestic purposes and 95% of its water for irrigation purposes. On say 29 second feet net this would yield an annual revenue of

Power	880 K.W. at \$40	-----	\$ 35,200
Domestic	\$47,100 x (5% of 29)	-----	68,295
Irrigation	\$ 7,800 x (95% of 29)	-----	214,890
			<u>\$ 318,385</u>

The difference between the above operating expense of \$389,400 and the annual revenue of \$318,385 or \$71,015 to be taken care of either by cutting off a portion of the capital amount allowed for the value of water rights or reducing the interest charge on \$1,700,000 to a minimum of 2.8% whenever the earnings could not pay the 7% allowed. With this adjustment the annual operating cost and

annual revenue balance each other.
(Capital reduction needed $\frac{71,015}{.07} = \$1,014,500$)

We will have for the net area of the district by this estimate (905 x 29) 26,200 acres paying for a development to cost \$4,014,160 or \$153 per acre.

Tabulated Cost of Development

Estimate	Cost of System	Annual Expense	Annual Revenue	Annual Deficit	Amount to Decrease Capital	Price per acre	Capital Expenditure must not exceed
1-(A)	\$4,600,560	478,400	412,320	65,680	938,300	\$158	\$3,600,000 \$124 per acre
1-(B)	3,719,660	394,720	283,185	111,535	1,593,400		Eliminate
Power:	880,900	140,770	163,090	none			
2-(C)	4,014,160	389,400	318,385	71,015	1,014,500	153	3,000,000 \$114 per acre

Note: The system development proposed in Estimate No. 1 is the more advisable design as it conserves more water and power with less sacrifice of capital. The expenditure of \$938,300 is excessive and points to the fact that a more economic structure must be finally planned or in default the water right value must be sacrificed. The final cost not to exceed \$3,600,000, i.e., \$125 per acre.

CONCLUSIONS

In view of the foregoing analysis, I wish to recommend for your final consideration the Monarch - Merriam Hydro-electric Power Canal as the most economical method of conveying the Warner runoff (22 M.G.D.) to the Irrigation District proposed (29,000 acres net). The continuity of the design permits of an economic co-ordination of power, agricultural and domestic supply possibilities.

The preliminary nature of this report, due to the lack of perfected surveys, will not permit of very reliable construction estimate. This fact, together with the price of \$2,300,000 allowed for water rights and Warner Reservoir site, causes this estimate to appear \$1,000,000 too high for economic operation. Assuming that \$250,000 can be cut from the construction cost and \$750,000 from the value allowed for water rights and Warner Reservoir site, we have:

Water Rights -----	\$1,000,000
Warner Reservoir -----	550,000
Construction Cost, etc. -----	2,050,000
Entire Cost of System -----	\$3,600,000

This \$3,600,000 represents the price that may be paid for this development to insure a reasonable return on the investment when all water and power is sold. A duty of water of 0.8 of a foot per acre per year is provided for 29,000 acres. This with a plant costing \$3,600,000 will necessitate an outlay of \$124.00 per acre served.

No estimate is made for a purely irrigation supply each year covering an eight months period continuous flow. If a 50% supply was allowable for two consecutive years, 2,800 K.F. would be available for all 8 month periods. The uniform draft of 32 second feet for power with a pure irrigation use could still be maintained, without increasing

the size of any unit.

Due allowance in figuring the net safe yield has been made for the water priorities of Esccondido as per their agreement.

The incorporation of the power into a separate project is not advised. The reason for this is set forth on page 13 under Comparison of Construction and Operating Costs - Monarch Division vs San Luis Rey River Division. The power heads assumed have a tendency to be low.

The relative advantages of this selection are that:

(1) The water will be conveyed by direct route to the central part of the territory to be served. Here a ready market will dissipate the supply so that a more circuitous route would have no additional advantages.

(2) The Merriam Reservoir exists below both power plants thereby conserving the constantly discharging waters when the demand is low. This reservoir is located at a sufficiently high elevation to afford good pressure through economic distribution mains.

(3) Both conduit sections dominate the range traversed. This not only shortens the distance (~~as in the case where four miles of Monarch Canal equals eight miles of Esccondido Ditch~~), but makes it possible on the Merriam line to supply water to the valleys on either side of the line as well as to the proposed district which lies to the west.

(4) It eliminates the use of the Esccondido Mutual Water Company system which would need considerable expenditure to make it an asset to both companies. The ditch elevation is too high to obtain the maximum head at the Hellhole Power Plant and its length is excessive in comparison. The Bear Valley Reservoir is isolated from the proposed district and its elevation does not work in so

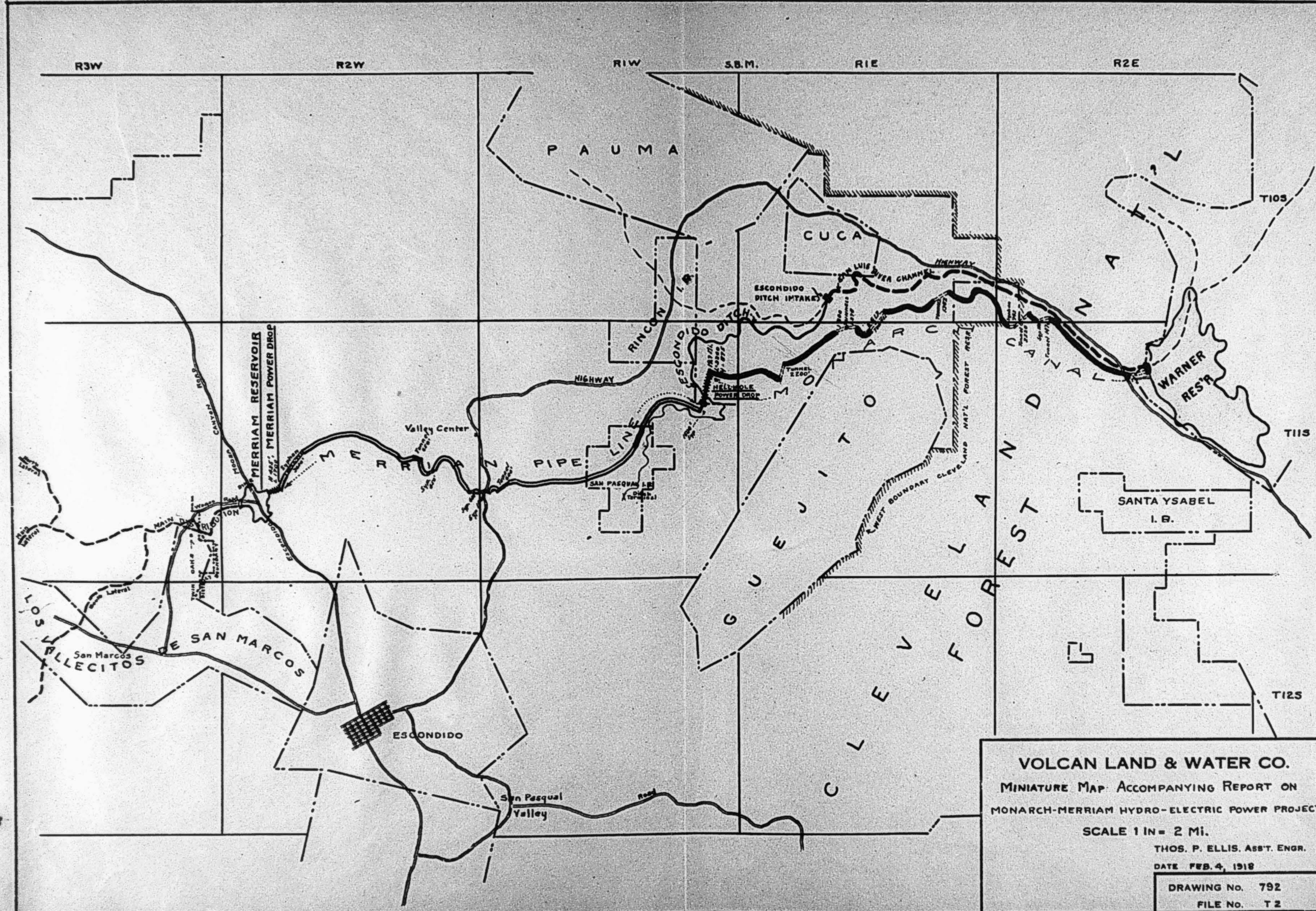
conveniently for a lower power and distribution scheme. It is an open question whether the joint use of this system would prove good policy.

(5) The use of the San Luis Rey River Channel as a conveyer is eliminated, thereby saving an average daily supply of at least two million gallons. This water would have a yearly irrigation value of \$24,000 and if adopted would cause a yearly power loss of \$74,320.

Respectfully submitted,

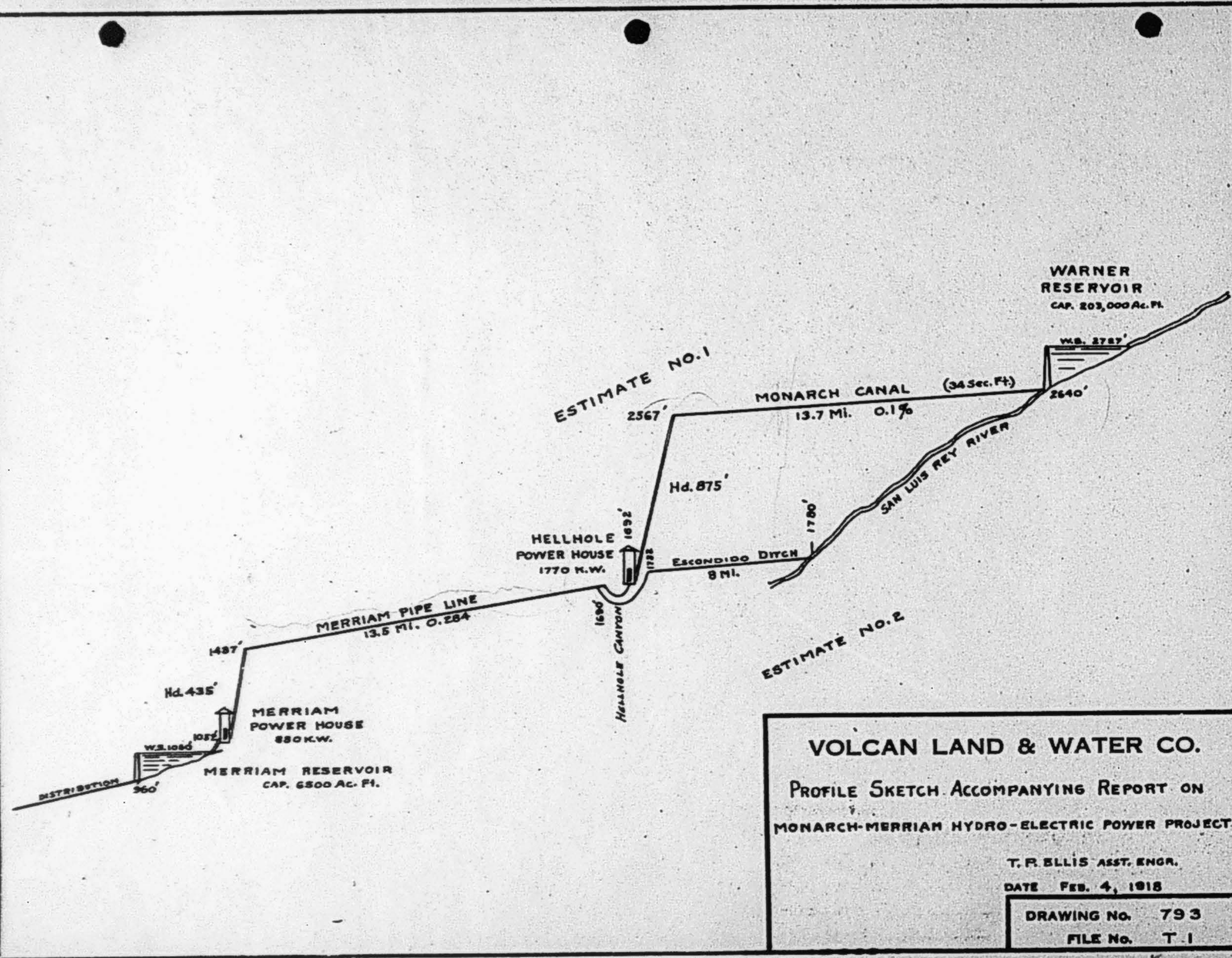
TEB:HK

Thos P. Ellis



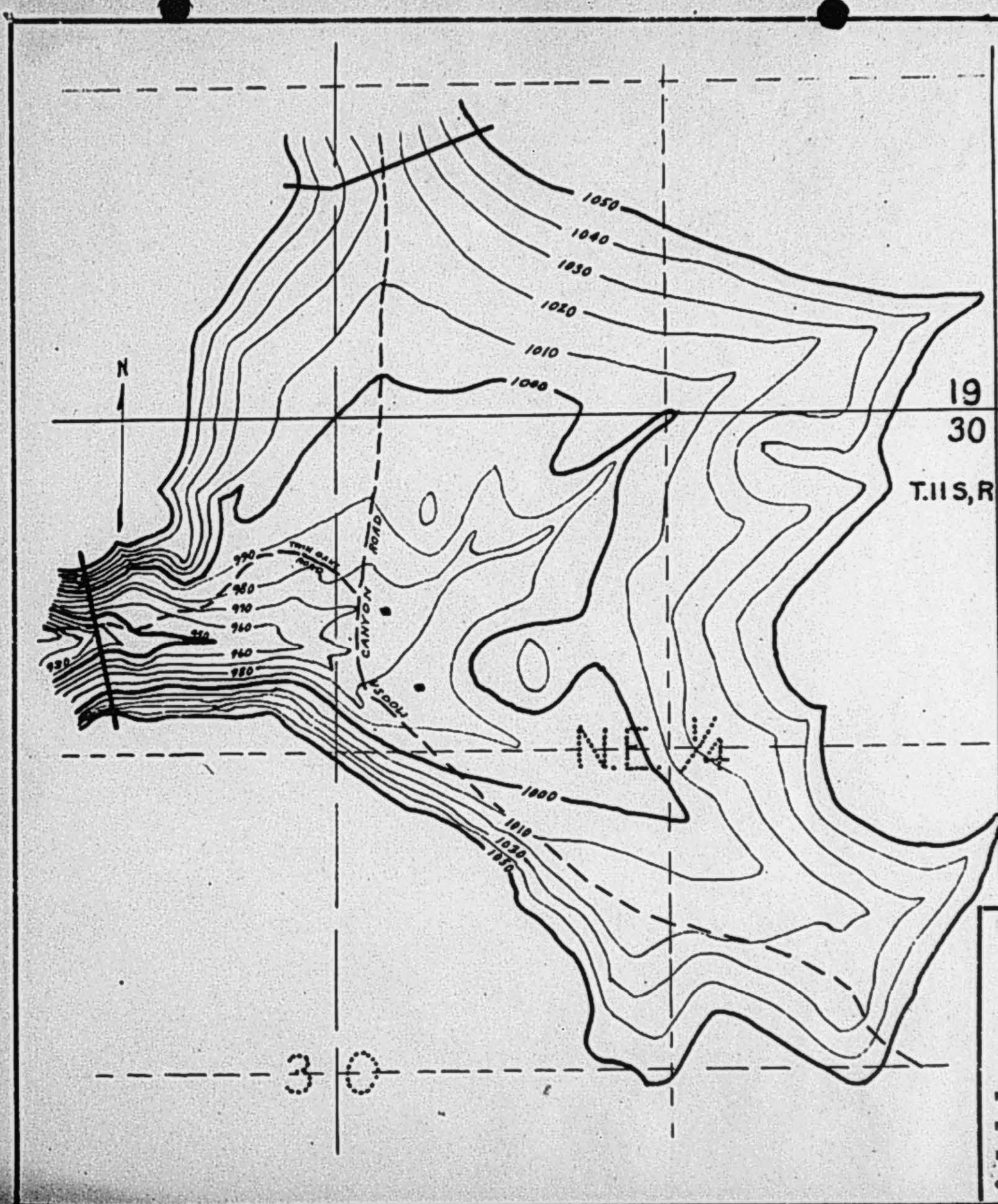
VOLCAN LAND & WATER CO.
 MINIATURE MAP ACCOMPANYING REPORT ON
 MONARCH-MERRIAM HYDRO-ELECTRIC POWER PROJECT
 SCALE 1 IN = 2 MI.
 THOS. P. ELLIS, ASST. ENGR.
 DATE FEB. 4, 1918

DRAWING No. 792
FILE No. T 2



VOLCAN LAND & WATER CO.
 PROFILE SKETCH ACCOMPANYING REPORT ON
 MONARCH-MERRIAM HYDRO-ELECTRIC POWER PROJECT
 T. P. ELLIS ASST. ENGR.
 DATE FEB. 4, 1918
 DRAWING No. 793
 FILE No. T. I

Page 27 PLATE 2



AREA AND CAPACITY TABLE

Contour	Depth	Acres	Ac. Ft. Cap.
930	0	0	0
940	10	0	0
950	20	0.7	3
960	30	3	21
970	40	5	61
980	50	11	141
990	60	23	311
1000	70	48	664
1010	80	76	1286
1020	90	106	2196
1030	100	133	3341
1040	110	158	4796
1050	120	176	6466

OUTLET
MERRIAM DAM (Multiple Arch)
 Earth-rock Fill to 1060' Contour, alternative
 Top width 20'
 Slopes { Upstream 2 1/2 to 1
 Downstream 2 to 1
 Volume 480,000 Cu. Yds.

MERRIAM DIKE
 Earth fill to 1060' Contour.
 Top width 20'
 Slopes { Upstream 3 to 1
 Downstream 2 1/2 to 1
 Volume 85,580 Cu. Yds.

VOLCAN LAND & WATER CO.
MERRIAM RESERVOIR SITE
 (Miniature)
 SCALE 1 IN = 600 FT. Approx.
 REFERENCE MAP 789 T3
 FIELD & COPI No.
 DRAWN BY Ellis
 CHECKED BY _____
 THOS. P. ELLIS, 'ENGR.
 DATE Feb. 1918
 DRAWING No. 791
 FILE No. T. I

Page 28 PLATE 3

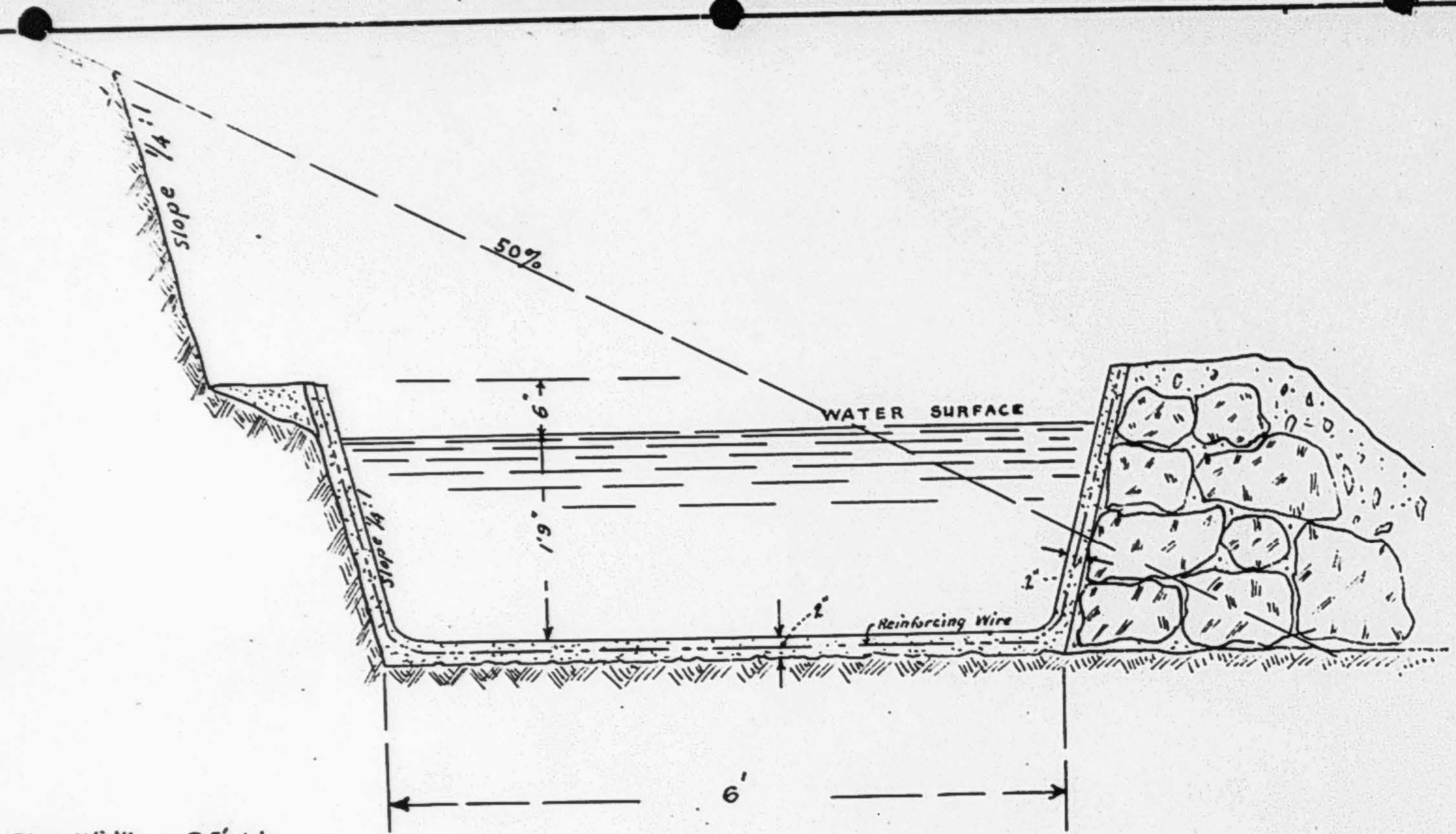
PLATE 5.

VOLCAN LAND & WATER COMPANY

WARNER RESERVOIR CAPACITIES

July 17, 1917

Contour U.S.G.S.	Depth	Acres Flooded	Total Acre Feet
2620	0	0	0
2630	10	17	58
2640	20	58	433
2650	30	260	2,023
2660	40	875	7,698
2670	50	1,405	19,098
2680	60	1,822	35,233
2690	70	2,300	55,945
2700	80	2,960	82,145
2710	90	4,010	116,995
2715	95	4,560	138,420
2720	100	5,340	163,170
2727	107	6,080	205,140



Btm. Width = 5.5' Net.
 W.S. " = 6.4' -
 Top " = 6.65'

Hyd.
 S = .001
 n = .015
 A = 10.4 Sq. ft.
 P = 9.1
 r = 1.14
 V = 3.42 Ft/Sec.
 Q = 35.60 Sec. Ft.

1:3 Gunite Canal
 Cu. Yds. Mortar per lin. ft. = 0.067
 1 Cu. Yd. mortar to 15 ft. of canal
 1 Cu Yd. Exca / Lin. ft. 50% slope
 Reinforced with 12 1/2 g. 2x4" A mesh

IDEAL TEST FOR SAND OR SCREENINGS

% Passing given size sieve	lbs. per cu. ft.
4	750
10	740
20	730
30	720
40	710
50	700
100	750
200	740
Voids	750
Tens. Comp	7400

1 Sack cement 3 Cu. ft. Sand = 2.95 cu. ft. plastic mortar.

VOLCAN LAND & WATER CO.
 STYLE OF GUNITE CONDUIT PROPOSED FOR
 MONARCH CANAL
 SCALE $\frac{3}{4}$ IN = 1 FT. FT.
 Thos. P. Ellis, Asst. Engr.
 DATE FEB. 4, 1918
 DRAWING No. 794
 FILE No. T1

Page 29 PLATE 4

Ed Fletcher Papers

1870-1955

MSS.81

Box: 36 Folder: 13

**Business Records - Reports - Ellis, Thomas P -
"Preliminary report to Col. Ed Fletcher on the cost
to deliver water from Warners to Vista Vicinity"**



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