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COMMENTS UPON DEVELOPMENT
OF THE
VOLCAN PROJECT

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THE ESCONDIDO-SAN CLEMENTE PIPE LINE
AND THE
WARNER-PAMO-SAN CLEMENTE CONDUIT ROUTES.

Under date of December 1, 1915, in a report on the Escondido-San Clemente Pipe Line Project, Mr. W. S. Post proposes a design for the construction of a "High Line" pipe conduit, to be operated under gravity pressure and connecting Escondido reservoir with the projected San Clemente reservoir. The design involves the laying of some twenty-one miles of concrete and steel pressure pipes between terminals at a cost estimated at \$790,000. for pipe line and the San Clemente dam. In addition to the above outlay there would be required a practical investment of \$200,000. (as capitalized rental), in the Escondido ditch for the privilege of conducting water through the latter from the San Luis Rey River to the head of the pipe line and the further additional expenditure of \$347,000 for the construction of Warner dam, making the total investment required as follows:

Brown

Warner dam, - - - - -	\$347,000
Escondido Ditch, - - - - -	200,000 +
Pipe Line, from Escondido Reservoir to San Clemente reservr,	562,300
San Clemente dam, 65', - - -	<u>227,700</u>
Total, - - - - -	<u>-\$1,337,000*</u>

Additional items, for the completion of the Volcan system, are estimated to cost as follows:

Sutherland dam, for diversion into Ramona conduit, - - - -	\$75,000
Ramona Conduit, - - - - -	140,000
Santa Maria Impounding dam, 130',	300,000 #
Santa Maria pipe line, - - - - -	80,000
15% of foregoing for Overhead, -	<u>89,000</u>
Total, - - - - -	<u>-\$684,000</u>

The total estimated cost of complete development would thus be \$2,021,000 for a delivery capacity of 45 second-feet, or twenty-nine million gallons daily, into the San Clemente reservoir°.

- + \$10,000 yearly rental capitalized at 5%.
- * This amount includes 15% of cost for overhead charges.
- # Storage capacity of reservoir with 130 foot dam is given at 34,000 acre-feet.
- ° The storage capacity of San Clemente reservoir, with 65 foot dam is given as 3250 acre-feet.

Mr. Post's purpose embraces two desirable features in the Volcan development; - to effect an early and useful diversion from the San Luis Rey River and also the designing of a conduit route which may be installed rapidly and at low cost, and with these very essential factors in mind I have consulted with Mr. Post and, with his assistance, surveys have been examined and notes made therefrom for the purpose of viewing, from other angles, a construction program which might develop advantages.

Upon the face of the various construction reports submitted to you, and now in my possession, it appears that the estimates of unit costs as given in the report of Mr. H. Hawgood have been drawn from sources giving greater detail than is observable in any of the other reports. In the report mentioned a detail profile has been made, from a plane-table survey conducted by Mr. Post, covering the territory from Warner reservoir site to the proposed San Clemente reservoir and itemized account has been taken of the classification of materials to be excavated, - a feature which does not appear to have been employed, in any detail, in cost estimates made in other reports. For this reason the route as surveyed by Mr. Post, and as estimated upon by Mr. Hawgood, has been given first consideration. Mr. Post's familiarity with the territory and the information he has given has been of assistance in forming conclusions as to conditions to be expected along the original conduit survey which would conduct water from Warner reservoir to the Pamo drop, thence, on an even gradient, to San Clemente reservoir.

To determine if it would be advisable to adopt the pipe line route, from Escondido reservoir to San Clemente reservoir, thus permanently abandoning opportunity for the development of power at the Pamo drop, the possibility of generating energy with Warner water at the available drop at the intake of the Escondido ditch has been cursorily examined in the following way; there are no survey notes available.

A conduit line from the outlet of Warner reservoir to the site of the drop at the head of the Escondido ditch, as appears from the topographic sheet, would be approximately 15 miles in length and, based upon the estimated cost of 30,000 linear feet of the Warner-Pamo conduit, would cost about \$250,000. with the possibility that a physical examination of the route traversed would result in this estimate being increased materially. Assuming that the available drop would be 900 feet there could be generated and delivered, at the power-house switch-board, 1900 K.W. of electrical energy. With the installation of 3800 K.W plant capacity the pressure-pipe, electrical equipment and transmission line, to San Diego, would cost approximately \$330,000 making the direct charge to power development \$580,000 or about \$300 per K.W.

With the comparatively small amount of energy obtainable from this source, its cost per K.W., (about 100% greater than at the Pamo drop), and the inability to regulate either water or power, would make it appear

inadvisable, in the light of present information, to include power possibilities as an asset to the general project in the development of the system if the Escondido-San Clemente pipe-line plan were adopted.

COMPARISON.

PIPE LINE FROM ESCONDIDO RESERVOIR TO SAN CLEMENTE RES.
WITH
CONDUIT FROM WARNER TO SAN CLEMENTE VIA PAMO.

From estimates given in greater detail elsewhere in this report it is found that the approximate cost of developing the Volcan system along the general route of the original Post survey and as reported upon by Mr. Hawgood, but with a carrying capacity of 67 second-feet, (43 M.G.D.) would be:

Warner dam, (Hawgood estimate) - - - -	\$238,000
Warner conduit, - - - - -	360,500 +
Pamo-San Clemente conduit, - - - - -	728,000 +
San Clemente dam, (Hawgood estimate) -	<u>276,000</u>
Total, - - - - -	\$1,602,500

+ Using Hawgood's classification for excavation and unit costs per cubic yard. Overhead charges are included as specified in the Hawgood report, i.e. 12-1/2 %.

This tentative estimate does not include development on the Santa Ysabel River nor does it include any

storage at or near the Pamo drop or reservoir site. The plan does permit, however, the utilization of the 1,500 drop at Pamo for the generation of power with water from Warner reservoir making possible the generation of 3,000 K.W. of electrical energy.

The U.S. topographic sheet indicates that storage may be secured at the Pamo power site, on Temescal creek, sufficient in size, at least, to care for fluctuating or peak flows through the Warner conduit which would be occasioned by the character of its use. Mr. Post is of the opinion that an hydraulic-earth-fill dam can be constructed near this site at moderate cost, utilizing hydraulic giants with water secured from Sutherland reservoir. I have made no personal inspection of the ground but have discussed the subject quite fully with Mr. Post. Pertinent to this subject is a condition which developed during my study of the hydrology of the Sutherland and Pamo watersheds which has not yet been submitted to you. It appears from this study that a larger water product may be secured from the combined watersheds by the construction of a dam of maximum capacity at Sutherland and a reservoir of comparatively small storage capacity at Pamo and, in this connection, it may develop that an equalizing reservoir, constructed on Temescal creek, as Mr. Post suggests can be done, would answer all purposes, in the economic conservation of the run-off tributary to the Sutherland reservoir.

A dam approximately 200 feet high at Sutherland would impound 62,000 acre-feet of water and would provide a constant flow of 15.75 second-feet or a little in excess of 10 M.G.D. From this water there could be generated 1,000 K.W. of electrical energy. Mr. Post's opinion is that the tail water from this power plant could be conducted into the Pamo regulating reservoir, (built off of the main Santa Ysabel River), on Temescal creek where the Warner water peaks would also be stored, or regulated, and diverted through the Pamo conduit to San Clemente reservoir. The plan suggested is similar to the original design with the exception that the Pamo equalizing reservoir is built off the main stream thus leaving the natural run-off below Sutherland reservoir for restoring the water plane in the San Pasqual gravel areas. Some provision would have to be made for conducting the water from this reservoir on Temescal creek to the so-called head of the Pamo conduit at about the point of the originally proposed Pamo dam site. There are no surveys of this section and no estimates of cost have been attempted but the character of the ground to be traversed, as reported to me, would indicate inexpensive construction. The length of this connection would be, probably, three to four miles.

Returning to a previous paragraph where the cost of construction from Warner dam to and including San Clemente dam was shown to be \$1,602,500. (p.5) comparison is made

with the estimated cost of the Escondido-San Clemente pipe line project given on page 2 at \$1,337,000 and adding to this latter amount the sum of \$49,000, being the difference in cost between the Hawgood and the Post estimates for the San Clemente dam; this being done for the purpose of facilitating comparison of project costs by using, in each case, the same sized structure at San Clemente. This addition to the cost of the San Clemente dam would bring the cost of the Escondido pipe line project to, (\$1,337,000 + \$49,000) \$1,386,000 making a difference in cost of the two projects of \$216,000, the concrete conduit line (via Pamo) costing that much more than the Escondido-San Clemente pipe line. This additional expenditure, however, would permit the utilization of the Pamo power drop with the generation of 3,000 K.W. which, at \$0.004 per K.W.H. would produce a net profit of \$105,000 annually. This latter amount, capitalized at 5%, adds in excess of \$2,000,000 to the value of the system. There are still further values to be gained in the utilization of the power possibilities from Sutherland reservoir which will be mentioned later.

It is here assumed that the power could be disposed of at a net profit of four mills per K.W. hour insomuch as the flexibility of the system would permit service with unusually low load factors and it is quite probable that by operating the plant almost entirely for peak loads that a greater income than that suggested could be secured.

Charges against power development would probably include the greater part of the cost of constructing the equalizing reservoir suggested on Temescal creek at or near the Pamo power drop and the cost of the mechanical equipment and the transmission line. The cost of the equalizing reservoir has not been estimated because of lack of data relating to both the hydraulic requirements and limitations, not now known, and the absence of data concerning the physical conditions. For present purposes the cost of the mechanical equipment, including a double circuit transmission line to San Diego, may be taken as not in excess of \$450,000.

In addition to the foregoing there is to be considered the cost of building the Sutherland dam whereby in excess of 10 million gallons daily, or 15.75 second-feet of water may be secured. The cost of this structure, in any event would hardly be chargeable to power development as such cost should properly go to hydraulic development in securing the Sutherland run-off. No estimates nor data are at hand for estimating the cost of the dam at this point where a structure approximately 200 feet high would be required. The energy that could be generated from Sutherland water, as lowered into the Pamo conduit, would produce a net revenue, (at the 4 mill rate previously mentioned), of \$35,000 annually while the cost of the plant installation, and connecting to the Warner transmission line, should not exceed \$150,000.

The income to be secured from the disposal of electrical energy generated on the "Pamo Conduit Route" and which would not be obtainable with the construction of the Escondido-San Clemente pipe-line route, amounts to \$140,000 per annum, at a four mill rate. This income would justify an additional expenditure, over the Escondido pipe-line project, of some \$2,800,000, on a 5% basis and though I am unable, at this time, to estimate the additional costs consequent upon the building of the Pamo regulating reservoir, and the Sutherland dam, I am of the opinion that the total of both items would not reach the foregoing sum.

WARNER DAM.

In the Hawgood report Warner dam, as an earth-fill structure, with high water at elevation 2715, is given as containing 295,000 cubic yards, costing, with overhead charges, \$237,768.

In the Lippincott-O'Shaughnessy report a structure of the same character and height, with high water elevation at 2710, is given as containing 475,900 cubic yards and costing, with overhead charges, \$499,850.

Mr. Post estimates the cost of a structure serving the same purpose and duty at \$347,000, including overhead but with no yardage given.

Mr. Harroun omits detail data but evidently figured on a structure 90 feet high and estimates its cost at \$325,000.

COMPILATION OF COST OF WARNER DAM.

AUTHORITY.	HEIGHT OF DAM. Feet.	STORAGE CAPACITY. Acre-Feet.	COST.
Lippincott-O'Shaughnessy, -----	105 - - - - -	117,600	\$499,850
Post, - - - - -	100 - - - - -	117,000	347,000
Harroun - - - - -	90 - - - - -	106,000	325,000
Hawgood - - - - -	100 - - - - -	157,000	237,768

For present purposes the estimate submitted by Mr. Hawgood, at \$238,000 is used in this report for purposes of equalizing the comparison sought.

WARNER CONDUIT.

On the route surveyed by Mr. Post and estimated upon by Mr. Hawgood.

To determine the probable cost of the Warner-Pamo conduit recourse is had to the Post survey for distances and classification for excavation and, based thereon, the estimates of cost of construction made by Mr. Hawgood. In the latter's report excavation is estimated under three classifications;

Earth, - - - -	18 cents per cu. yd.
Loose rock, - -	35 " "
Solid rock, -	\$1.10 per cubic yard.

For a conduit carrying 87 sec. ft. the estimated excavation is 156,000 cu. yds. costing \$57,780, or an average of 37 cents per cubic yard. The average of excavation per linear foot of conduit is 5.14 cu. yds.

For a conduit of reduced dimensions, having a capacity of 67 second-feet, (43 M.G.D.) the average excavation required, per linear foot of "bench" or "road-way" is, according to the Lippincott-O'Shaughnessy cross section, 1.35 cubic yards which, at 37 cents per cubic yard would bring the cost of benching, per linear foot, to 50 cents.

Excavating the canal proper along this bench

required the removal of 0.8 cubic yard per linear foot. The cost of this excavation is here taken, because of the care required in trimming the sides and bottom, at 43-1/2 cents per cubic yard or 35 cents per linear foot of canal. The sum of the costs for the two classes of excavation would bring the cost per linear foot of conduit to 85 cents.

Cost of concreting the Warner conduit is based on the Lippincott-O'Shaughnessy estimate of \$8.10 per cubic yard for concrete in place and includes the cost of reinforcing in the conduit slab cover. The amount of concrete required is 0.26 cu. yd. per linear foot which would amount to \$2.10 per linear foot. The total cost of the conduit, including excavation and concreting and covering, would thus be \$.85 + \$2.10 = \$2.95 per linear foot,

FLUMES.

The Hawgood estimate calls for \$35,000 for 5,290 linear feet of flumes and though the design provides for a capacity of 87.5 second-feet the same cost is used in my estimate for flumes of 67 second-feet capacity. Some reduction in cost should, properly, be made because of the reduced dimensions permitted, but in the absence of detail data necessary for a new estimate the estimate as given is used in this report.

TUNNELS

On this route 10,360 linear feet of tunnels are yet to be bored. Mr. Hawgood estimates the cost as:

5,870 linear feet @ \$20.00,	\$117,400
4,490 " " @ \$18.00,	<u>71,840</u>
Total, - - - - -	\$189,240

These costs are confirmed by Mr. Post, based upon his experience in constructing the Warner outlet tunnel.

WARNER CONDUIT.

On the route estimated upon by Lippincott and O'Shaughnessy.

The cost of excavating the bench for the Warner conduit is estimated, in the Lippincott-O'Shaughnessy report, at 60 cents per linear foot for a conduit of 100 second-feet capacity (64.6 M.G.D.) For a conduit of 67 second-feet capacity the required width of bench would be less and is figured in this estimate at 50 cents per linear foot.

The cost of excavating the canal along the bench is estimated at the Lippincott figure of 67-1/2 cents per cubic yard. There being 0.8 cu.yd. of excavation in the ditch proper the cost per linear foot would be 55 cents, making the total cost of benching and ditching \$1.05 per linear foot of conduit.

CONCRETING.

The Lippincott-O'Shaughnessy figure of \$8.10 per cubic yard for concrete, including reinforcing for the cover, is used. With 0.26 cu.yd. of concrete per linear foot the per foot cost would be \$2.10, the same as used for the Hawgood measurements.

FLUMES.

850 linear feet of steel flumes, on trestles, are estimated upon in the Lippincott-O'Shaughnessy report at \$7.10 per linear foot and as in the case of the Hawgood estimate these figures are used without alteration in forming the comparative statement.

TUNNELS.

Tunnels of a total length of 10,100 feet are called for in the L-O'S. report costing \$20.90 per linear foot. In the estimate I have prepared for a conduit of 67 second-foot capacity these tunnel costs have been classified according to the Hawgood estimates of cost and classification at \$20.00 and \$16.00 per linear foot. In this correction Mr. Post concurs.

The Lippincott-O'Shaughnessy report calls for tunnels six feet by seven feet, with 100 second-foot capacity while those figured upon in this report are of smaller dimensions and sufficiently large to carry 67 second-foot, (43 M.G.D.)

WARNER CONDUIT.

Observations drawn from the various reports.

The Lippincott-O'Shaughnessy route of the Warner conduit differs from the Hawgood route as shown in the following tabulation.

Lippincott-O'Shaughnessy Route.	Warner to Pamo.	Post-Hawgood Route.
22,250 feet. - - -	Concreted Canal - - - -	30,560 feet.
850 " - - -	Flumes - - - -	5,290 "
<u>10,100 " - - -</u>	Tunnel bores, - - - -	<u>10,360 "</u>
33,100 " - - - -	Total - - - -	46,210 "
Capacity, 100 sec.ft. - - - -		Capacity 87.5 sec.ft.
64.6 M.G.D.		52 M.G.D.

While there is a difference of about 2-1/2 miles in the length of the proposed routes, - the L-O'S. route being the shorter, - there is not appreciable difference in the cost of construction, on either route, when the respective unit costs are applied to the excavation required for a conduit of 67 second-foot capacity.

The Post Hawgood route calls for 46,210 linear feet of conduit with a carrying capacity of 87.5 sec.ft. The Lippincott-O'Shaughnessy route calls for 33,100 linear feet with a carrying capacity of 100 sec.ft. Using their respective unit costs for excavation and concreting and retaining their original figures for the cost of flumes, the cost of a conduit of 67 sec.ft. capacity works out as follows:

Lippincott-O'Shaughnessy route, 33,100 ft.,	\$346,173.00
Post-Hawgood route, - - - - - 46,210 "	\$360,468.00

Overhead charges as specified in each report are included.

These estimates are tabulated on a separate sheet herewith.

The Harroun estimate for the Warner conduit is \$429,000. Its carrying capacity is not given in the report, though the Harroun estimate of the yield of the Warner watershed is given as a little in excess of 23 sec.ft., or 15 M.G.D. and the conduit is probably designed to carry a larger quantity than 23 second-feet.

Summarized, the estimates of cost of the Warner conduit are as follows:

Lippincott-O'Shaughnessy, - - - - Capacity 100 sec.ft., - - -	\$ 397,600
Hawgood, - - - - - " 87.5 " - - -	\$ 380,146
Harroun, - - - - - No detail information, - - -	\$ 429,000

PAMO-SAN CLEMENTE CONDUIT.

The distances and estimated costs of the Pamo-San Clemente conduit in the reports examined are as follows:

<u>Report.</u>	<u>Length in Feet.</u>	<u>Estimated Cost.</u>	<u>Capacity Sec.Feet.</u>
Lippincott-O'Shaughnessy, - -	130,720 - - - -	\$1,158,500	54.
Hawgood, - - - - -	131,100 - - - -	\$1,033,000	174.
Harroun, -	No detail information given,	\$ 862,000	?

Though the Lippincott-O'Shaughnessy and the Hawgood routes for this conduit practically agree as to total length, the makeup of the structures as regards concrete conduit, flumes and tunnels, differ. These items, segregated, and with original cost estimates are given in tabulated form on page 25. Overhead charges as given in the respective reports are included in the items.

PAMO-SAN CLEMENTE CONDUIT
OF 67 SECOND FEET
CAPACITY.

Estimates of cost of a conduit, with concrete lining and cover, extending from Pamo to San Clemente, have been prepared, (as shown on page 24), based on both

the Lippincott-O'Shaughnessy unit prices and distances and on the cost figures and classification submitted in the Hawgood report. The original estimates are for conduits of widely differing capacities, the latter design being for 174 second-feet and the former for 54 second-feet. The unit costs for excavation and concrete work have been reduced to a yardage base and the resulting figures applied, as nearly as is permitted by the original figures, to the construction of a conduit of 67 second-feet (43 M.G.D.) capacity. With the inclusion of overhead charges as specified in the original estimates, given as a per centage of the construction cost, the total cost of the 67 second-foot conduit, based on the unit prices in the two estimates named, would be:

CONCRETE LINED AND COVERED CONDUIT OF 67 SEC. FT. CAPACITY.
WITH FLUMES AND STEEL SYPHONS.

Using the Route and Unit Costs Estimated by	Total length in Feet.	Cost.
Lippincott and) O'Shaughnessy,)	130,720	\$1,178,800
Post Survey and) Hawgood Estimate)	131,100	\$ 727,869
Difference, - - - - -		\$ 450,931

The Harroun report does not state the capacity of the Pamo-San Clemente conduit, its length nor the character of construction and design. The cost is estimated, however, at \$862,000.

COMMENTS ON
PAMO - SAN CLEMENTE CONDUIT.

The method of stating the character of the work and its classification and of arriving at conclusions are more clearly set forth in the Hawgood report than in the Lippincott-O'Shaughnessy estimates and as the unit prices, or costs, for classified materials used by Mr. Hawgood are about as generally found, I am inclined to feel that estimates based on his calculations may be reasonably used in predicting the cost of a conduit, along the same route, having a carrying capacity of 67 second-feet, or 43 M.G.D.

The classification of excavation materials is largely a matter of individual judgment based upon personal inspection of the materials to be encountered and it is quite possible that the Hawgood unit prices should be raised because of present labor conditions as compared with now and the time the estimates were made. A readjustment of these unit costs should not, however, cause a large increase in the total estimate.

The inverted syphons on the route of the Pamo-San Clemente conduit, (of 67 sec. ft. capacity), are figured at 42" diameter and of steel construction, with a carrying capacity of 31 second-feet or 20 million gallons daily. When additional capacity is required another syphon line

may be installed in parallel with the original line. It should be stated that estimates on this class of work have been made from data not at all complete and the figures given should be considered as provisional. The cost has been estimated on a basis of 5 cents per pound, installed, for double riveted steel pipe, dipped.

It is likely that in places where ideal conditions may be found, and assured to continue so, that continuous wood-stave pipe could be used to advantage. Recent investigations by officials of the U.S. Reclamation Service, covering some 80 installations, result in the conclusion that the life of continuous wood-stave pipe, where proper conditions are observed, is 30 years and over. The life of steel pipe is considered, by the California Railroad Commission Engineer Department, at 30 years.

SAN CLEMENTE DAM.

The San Clemente dam has been estimated to cost as follows:

REPORT.	HEIGHT IN FEET.	CAPACITY ACRE-FT.	MILLION GALS.	CUBIC YARDS.	COST.
Lippincott-O'Shaughnessy,	90	8,570	2792	984,400	\$691,000
Hawgood, - - -	65	4,500	1466	350,000	\$275,625
Post, - - - -	65	3,250	1059	---	\$227,700

Harroun, - - - Neither details nor costs are given.

Note:- The Lippincott-O'Shaughnessy report gives a table showing the capacity of San Clemente reservoir, at 65 feet, to be approximately 3,800 acre-feet. At 60 feet the capacity is stated, by the same report, to be 3,070 acre-feet. See page 72 of the Copy of the L.-O'S. report.

There are no reasons given, in the reports, for the determinations of the foregoing reservoir capacities. It is obvious that the demands of the City of San Diego, with the requirements of the Volcan system, may both be met and satisfied by a reservoir, at San Clemente, of some definite capacity; economic or engineering considerations, if undertaken, do not appear in the texts of any of the reports examined.

Reservoirs of the capacities designated would perform the following service, without replenishment during the periods stated.

DESIGN.	Would supply 10 Million Gallons daily for number of days stated.
Lippincott-O'Shaughnessy, - - - - -	279.
Hawgood, - - - - -	146.
Post, - - - - -	105.

WARNER CONDUIT.
 (Concrete lined and covered)
 +++++
 On the Route Surveyed by Post
 and Estimated upon by Hawgood.

	Length in Feet.	Character of Section.	Cost.	
CONDUIT. EXCAVATION.		Conduit bench @ 50 ¢ pr. ft. " excavation, .8 cu. yd. per ft. at 43.5 cents. per cu. yd. - - - 35 ¢ pr. ft.		CONDUIT EXCAVATION.
	30,560, - - -	Cost pr. lin. ft. 85 ¢ at 85 ¢ per linear foot, - -	\$26,000	
CONCRETE LINING & COVER FOR CONDUIT.		Concrete lining and reinforced cover for conduit. Theoretically 4" thick and requiring .26 cu. yds per lin. ft. and costing \$8.10 per cu. yd. in place. Totals \$2.10 per linear foot.		CONCRETE LINING COVER FOR CONDUIT.
	30,560 - - - -	at \$2.10 per linear foot,	\$64,176.	
FLUMES.	5,290 - - - -	Flumes, lump sum, - - - - Approx. the Hawgood est.	\$35,000.	FLUMES.
TUNNELS.	10,360	Tunnels, lined. 5,870 ft. @ \$20) = 4,490 ft. @ \$16) =	\$117,400 71,840	TUNNELS.
ROADS.		New roads, - - - - - Changing old roads, - - - -	4,000 2,000	ROADS.
Overhead, - - - - -		-12-1/2 % of cost, - - - -	\$320,416. 40,052	OVERHEAD.
		Total, - - - - -	\$360,468.	

WARNER CONDUIT.
 (Concrete lined and covered)
 =====
 On the Route Estimated Upon by
 Lippincott and O'Shaughnessy.

	Cost.	Length in Feet.	Character of Section.	Cost.
			Conduit bench @ 50 ¢ pr. ft. " excavation, .8 cu. yd. pr. ft. @ 67-1/2 ¢ per yd. = total cost per lin. ft. of \$1.05.	
	\$26,000	22,250 - - - -	at \$1.05 per linear ft.,	\$23,362.
			Concrete lining and reinforced cover for conduit. Theoretically 4" thick and requiring .26 cu. yd. per lin. ft. and costing \$8.10 per cu. yd. in place. Totals \$2.10 per linear foot.	
	\$64,176.	22,250 - - - -	at \$2.10 per lin. ft. - - -	\$46,725
	\$35,000.	850 - - - -	Flumes, lump sum as per Lip. O'S. estimate, - - -	\$ 6,000
	\$117,400 71,840	10,100 - - - -	Tunnels, lined. 5,610 ft. @ \$20. 4,500 ft. @ \$16.	\$112,200 72,000
	4,000 2,000		New Roads, - - - - - Changing old roads, - - - -	4,000 2,000
	\$320,416. 40,052		30% of cost as given in the Lip. O'S. report, - -	79,886.
	\$360,468.		Total, - - - - -	\$346,175.

PAMO-SAN CLEMENTE CONDUIT.
(Concrete lined and covered)

On the Route Surveyed by Post
and Estimated upon by Hawgood.

Length in Feet.	Character of Section.	Cost.	Length
	Bench, 1.35 yd. per ft. at 32.2 ¢ per cu. yd. = 44 ¢ per linear foot.		47.9
85,380 - - - -	at 44 ¢ per linear foot, - -	\$37,570	
EXCAVATION AND CONCRETING.	Ditch excavation on the bench, .8 cu. yd. per lin. ft. at 32.2 ¢ per cu. yd. = 26 ¢ per linear foot.		47.9
85,380 - - - -	at 26 ¢ per linear foot, - -	\$22,200	
CONCRETE LINING & COVER.	Concrete lining and reinforced cover. All theoretically 4" thick. .26 cu. yds. per lin. ft. at the Lippincott est. of \$5.80 per cu. yd. = cost of \$1.51 per lin. ft.		47.9
85,380 - - - -	at \$1.51 per linear foot,	\$128,925.	47.9
FLUMES.	Flumes at approximately the Hawgood estimate. (\$45,000 per mile.) - - -	\$100,000	37.0 6.6
SYPHONS.	Syphons, of 31 sec. ft. capacity. Double riveted, and dipped. 42" diameter. at 5 ¢ per lb. installed.	96,500	14.7
19,700 - - - -			
CULVERTS	Lump sum, - - - - -	5,000	
ROADS?	" " - - - - -	10,000	
Tunnels, -	7,120 ft. @ \$18.00 per ft.	128,160	
	7,415 ft. @ 16.00 " "	118,640	
OVERHEAD, - - - -	12-1/2 % as per Hawgood report	80,874	24.6
	Total, - - - - -	\$727,869	24.6

OVERHEAD

PAMO-SAN CLEMENTE CONDUIT.
(Concrete lined and covered)

On the Route Estimated upon by
Lippincott and O'Shaughnessy.

Cost.	Length in Feet.	Character of Section.	Cost.
	47,951 - - - -	Bench for concrete conduit, at 50 ¢ per ft. at 50 ¢ per linear ft. - -	\$24,000
- - \$37,570			
	47,951 - - @	Ditch excavation on the bench at 70 ¢ per cu. yd. 0.8 cu. yds. per lin. ft. = 55 ¢ per linear foot, -	26,370
- - \$22,200			
	47,951 - - - - @	Concrete lining and reinforced cover. All theoretically 4" thick. .26 cu. yd. per lin. ft. at Lippincott est. of \$5.80 per cu. yd. = cost of \$1.51 per linear foot.	72,300
\$128,925.			
	37,080 - - - -	Flumes at Lip.-O'S. est. at \$3.85 per linear ft.	142,800
\$100,000	6,576 - - - -	at 5.75 " " "	37,300
	14,727 - - - -	Syphons. At Lip.-O'S. est. at lump sum, - - - - -	105,800
96,500			
5,000		Roads. (Not estimated in the Lip.-O'S. estimate. Taken at lump sum of - - - -	10,000
10,000			
128,160		Tunnels are taken at the estimate in the Lip.-O'S. report.	
118,640			
80,874	24.86	at \$20.00 per linear foot,	487,700
\$727,869	24.86, - - - -	taken from the L.-O'S. report at 30%	272,030
	OVERHEAD	Total, - - - - -	\$1,178,800

Ed Fletcher Papers

1870-1955

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**Business Records - Reports - Brown, Walter H.Y
- Comments on the Development of the Volcan
Project, the Escondido-San Clemente Pipe Line and
the Warner-Pamo-San Clemente Conduit Routes**



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