

Q9791
Pam. 13

Arizona Water Users Plan
Immense Irrigation and
Power Program

BY
FRED T. COLTER

*Reprinted From
Hydraulic Engineering
September, 1929*

Arizona Water Users Plan Immense Irrigation and Power Program

BY

FRED T. COLTER

THE State of Arizona and its water users have forwarded fourteen applications for preliminary power permits for thirteen dam sites and one for the power to be

developed on Arizona Highline Irrigation power canal with canals and tunnel system to the Federal Power Commission, Washington, D. C.

These dam sites and the proposed Highline canal and tunnel system that irrigate the lands thereunder are to be developed in one large comprehensive unit, recognizing at all times that the Glen Canyon irrigation and flood control reservoir, storing 50,000,000 acre ft., the Bridge Canyon irrigation, power and diversion dam site and the Arizona all-gravity Highline irrigation and power

canal, to irrigate over four million acres thereunder, in Arizona, is to be the hub of this whole group unit. Preference and priority are to be given

to this so-called Glen Bridge Highline hub, and water therefor inclusive of reflow water, and the development of all these proposed dam sites is to be part of, subsidiary, and supplemental thereto.

This economic development plan is an inherent, and legal right initiated and vested belonging to Arizona and its water users, as Arizona has only the water of the Colorado River and lands to depend on for its existence. Forty-two per cent of the river's drainage area, ninety-six per cent of the electric H.P., and over three hundred miles of the Grand Canyon of the Colorado river are all entirely within Arizona, and its west boundary is the Colorado river. Practically the State's entire area is Colorado

river drainage area or contiguous thereto. This plan is indispensable to Arizona's present and future life and growth. It gives the maximum

THE Boulder Dam Compact has not been ratified, to date, by the State of Arizona. Herewith is presented, not as propaganda, but as a matter of general interest, an abstract of the application filed by State Senator Fred T. Colter, for and on behalf of Arizona and its water users, on June 14, 1929, with the Federal Power Commission. In every year since 1923, water rights have been filed on with this commission and the State Water Commissioner of Arizona by the applicant as trustee for Arizona, its water users, and landholders under the Arizona Highline Irrigation and Power Canal. Started as a counter-proposal to the Boulder Canyon project, this program is now being pressed forward with renewed vigor by its protagonists, with definite results yet to be determined.

economical beneficial development, flood and silt control of the Colorado River for all River States, and will irrigate by gravity over four million acres of fertile patented State and Government land in Arizona. It will develop around five million electrical horse power, thereby making the largest and most economical reclamation project group in the world, which can be so developed as it relates to the whole in small or large units, according to the requirements.

ARIZONA is more concerned with the Colorado River than any other State, and on account of its limited water supply it has to depend on the proper and legal course for protection and development (and only proposes and initiates a substitute for any wrong course) that serves all Basin States' legal requirements as well as its own. This plan of development would include the stabilization and storage of water above the Glen Canyon dam site or the Marble Gorge site at the head of the Grand Canyon, conforming with the old established equitable water laws, supreme court decisions and Federal Constitution; recognizing only beneficial, economical use of water and their works (not ownership) and the best engineering and reclamation principles which the Boulder Santa Fe compact does not conform with.

This plan has outstanding advantages in addition to the above statement, for by the Glen Canyon Dam being built first there can be developed three times the horse power at much less cost on each of

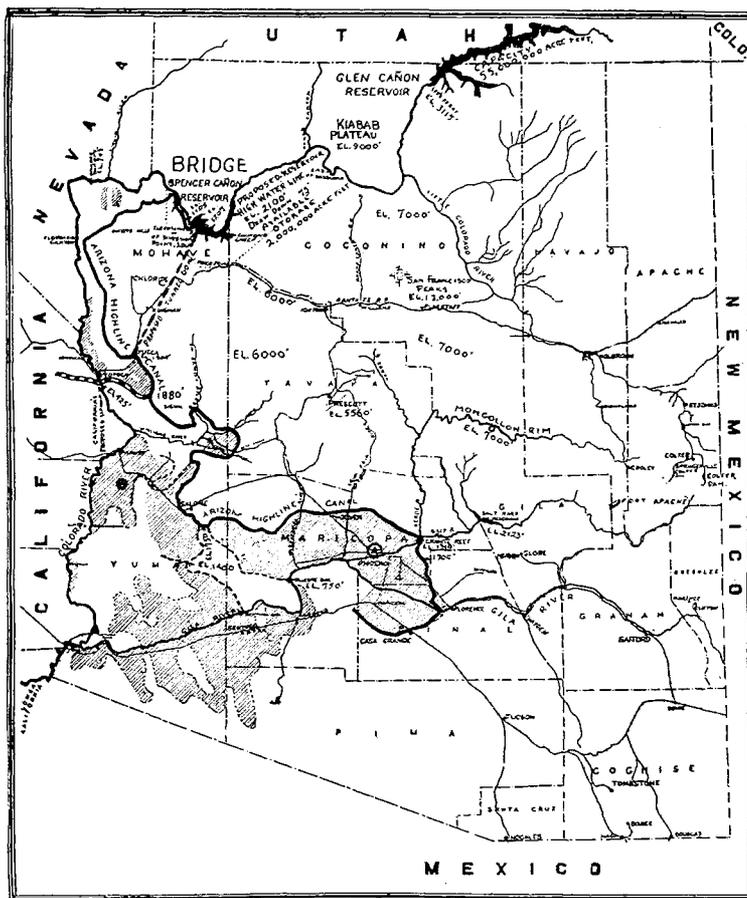
the proposed dam sites below. Commencing with the Grand Wash Dam site at an elevation of 867 feet, the water would back up to the foot of the next and each dam further up until it reached the Glen Canyon Dam site at the head of Grand Canyon at an elevation of 3,127 feet, situated below the Arizona-Utah line, embracing over three hundred miles of the main river, and having over 2,260 feet of water fall. In the close proximity of this great water fall lies over six million acres of fertile land for irrigation. This does not include the water fall on the Arizona Highline Irrigation and Power Canal which would develop over 600,000 H. P. by

diverting the water from the Bridge Canyon dam site, and still irrigates over four million acres under said canal, making total development around five million horse power, as much horse power as is now being developed in the nation by water.

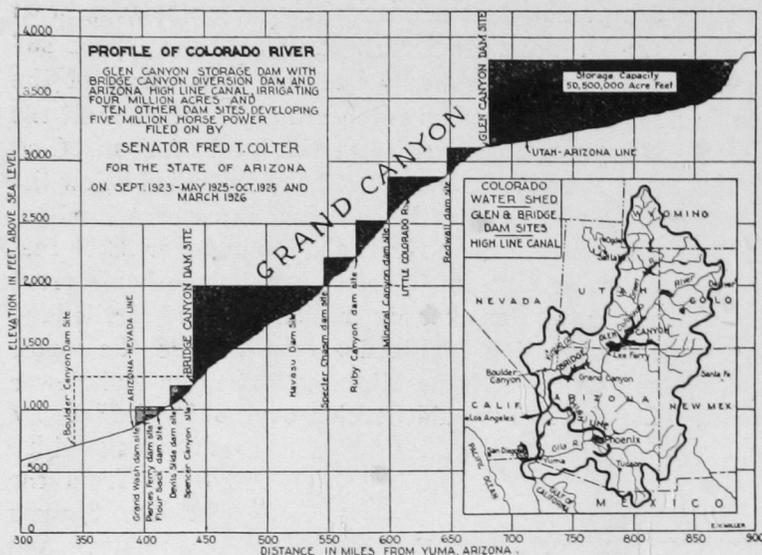
If Arizona permits, Southern California cities can share the cost of diverting Arizona's water from the Bridge Canyon dam site through the Arizona Highline all-gravity canal or tunnel to the forebay near Topock around an elevation of 1,880 feet and syphon under the Colorado

River, saving the coast cities much over 100 million dollars over Boulder pump lift of over 1,600 feet.

According to George W. Sturtevant, consulting engineer, the following is a brief summary of power which will be made available from the Glen Canyon-Bridge Canyon all gravity Arizona-California high line canal systems in Arizona



Lands to be reclaimed under State Appropriation are indicated by shaded areas, 4,500,000 acres



and dam sites between Glen and Bridge Dams.

At Glen Canyon Dam—average
 yearly 700,000 H.P.

At Needles Mountains—Water to Lower Colorado River District. 4,700,000 acre feet returned to Parker Reservoir from Needles Forebay through steel reinforced, concrete lined bed-rock tunnel penstocks, to 3 or 4 power stations—tail discharge into Parker Reservoir with net effective head of 1300 feet—Stabilized power output..... 750,000 H.P.

Along Arizona Distribution Canal System—Power available at 20 or more canal drops along the transmission canal system conveying water to 3,000,000 acres or more of land in Arizona 600,000 H.P.

Total Available Power from the Arizona Glen-Bridge High Line Plan on Colorado River will exceed 2,000,000 H.P.

THERE is between Glen Canyon storage dam site and Bridge Canyon diversion dam site, 1350 feet fall, which can produce an additional 2,000,000 H. P., produced by building four additional dams at Redwall or Marble, Mineral Canyon, Ruby Canyon, Specter Canyon. Grand total available power from the Arizona Glen-Bridge-High Line Plan of Colorado River Development, including dam sites between Glen and Bridge dam sites, 4,000,000 H.P.

The following is a summarized statement by Mr. Sturtevant, of mileage,

classification of materials, and estimated cost of construction made from the preliminary survey and inspection of the 185 miles of transmission canal leading from the Bridge Canyon Dam on the Colorado River to the Needles Mountain-Topock-Forebay of the all gravity Arizona-California transmission canal:

Length of Canal, Bridge Canyon Head Gates to the Needles Mountain Forebay 185 miles
 Total tunnel mileage along this canal..... 33 miles
 Mileage in rock side cutting 18 miles
 Mileage in mixed earth and rock excavation... 42 miles
 Mileage in all-rock excavation (no side cutting)... 24 miles
 Mileage in all-earth excavation, normal work... 68 miles

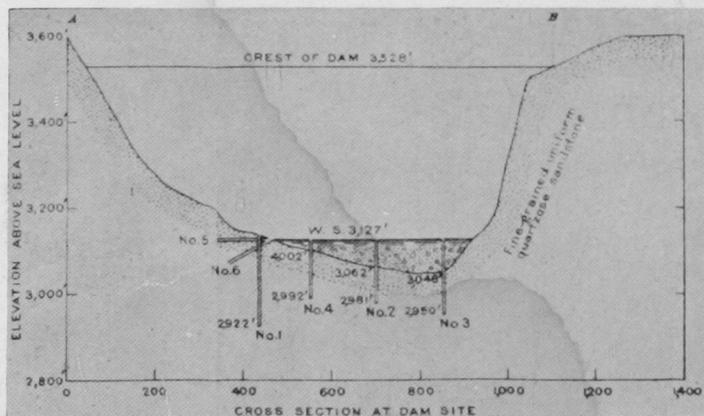
All tunnels and bridges will have 12 feet barge or boat-way clearance. Canal to be all concrete lined.

ESTIMATED COST

For 33 miles concrete lined canal tunnel in rock	\$25,160,000
For 18 miles concrete lined canal side cuts in rock	14,150,000
For 68 miles concrete lined canal in earth excavation	19,720,000
For 48 miles concrete lined canal in mixed earth and rock	17,472,000
For 18 miles concrete lined canal, all rock excavation	5,256,000
For roads, bridges, drainage, telephone line, fencing and station houses	375,000
For miscellaneous equipment	1,150,000
For legal, engineering, superintendence, insurance and miscellaneous expenses	2,250,000
Total cost 185 miles transmission canal	\$85,533,000

GLEN CANYON AND BRIDGE CANYON DAMS

Estimated cost of Glen Canyon Dam complete	..\$ 33,000,000
Estimated cost Bridge Canyon Dam and Head Gates 39,000,000
Total cost Glen and Bridge Canyon Dams and 185 miles transmission canal to Topock Forebay\$157,533,000

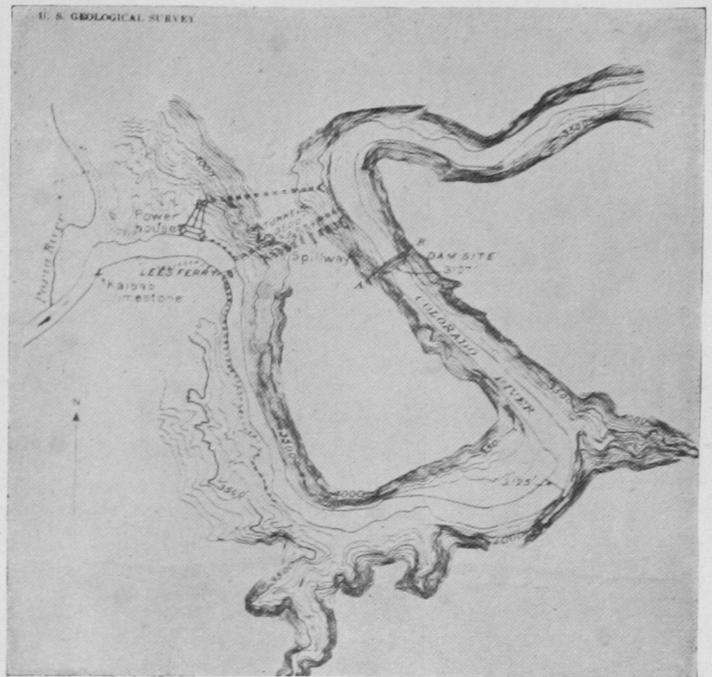


Cross-section at site of proposed Glen Canyon Dam above Lee's Ferry

The estimated cost of \$157,533,000 for storage, stabilization and diversion dams to provide flood control and transmission of 12,000,000 acre feet of Colorado River water to the centrally located Forebay from which waters will be conveyed by distribution canals to lands in Arizona, California and Mexico represents a cost of only \$35 per acre of the lands to be irrigated, and at the same time makes available a power development of more than 2,000,000 H.P.

THE Glen Canyon dam being built first will control flood menace, by stabilizing the water, and will prevent most of the silt of the Colorado River, of which 80 per cent is ground out of the Grand Canyon section. This figure is arrived at from U. S. Department of Agriculture Technical Bulletin No. 76 (year 1928), page four, and from table three, page seventeen, and U. S. G. S. records. The lives of the many reservoirs built below will be, by water stabilization, very much longer by preventing them from being filled up with this silt so rapidly ground out of Grand Canyon by uncontrolled floods.

The plan is made to conform with those fundamental principles of reclamation which have been in vogue since the early Egyptian time on the Nile up to the present. On account of water being limited and indispensable to life it is essential as by this plan and basic laws that the advantages be taken so that the same water, due to the evaporation, precipitation and reflow return, can be used over and over a multiplicity of times. The fundamental principles of reclamation are that water

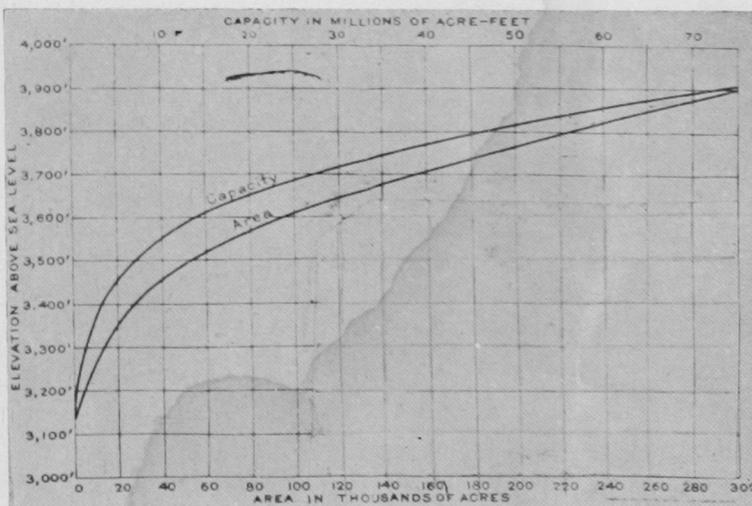


Contour map of Glen Canyon Flood Control Dam and Power Site No. 1

cannot be owned but can only be beneficially and economically used, including their works, and that domestic and irrigation water has priority and preference over power or when combined thereto; that development, appropriation and application is favored at the heads of streams and rivers and lands nearby in order to get the same use of the same water over and over hundreds of times, and that water as a rule is to be kept within the main river system.

When necessity and public welfare demand it, water is to be beneficially and economically stored and applied to the lands. No divisions, decisions or contracts for water are to be in perpetuity, especially for unappropriated waters. No act should restrict or bind the future of water, for the nature and objects of our natural water laws and constitutions are based so as not to restrict growth, human life, opportunity, and natural resources, especially such resources as water, which is so indispensable to all life.

The history of every river system where reclamation has been carried on a sufficient length of time and in conformity with these legal and proper engineering principles, allowing storage and applications of the water, has proven that a river never eventually depletes its flow, but in addition to the



Area and capacity curves for proposed Glen Canyon Dam in Two Hundred Million Dollar Project

over-ground storage there will be an under-ground supply, which becomes a mass of reservoirs and streams and thereby storing under-ground water, thus preventing erosions that even reforestation does not accomplish.

The Colorado River System, being the most rapid and steepest falling in the world, will make up its water depletion more wholly and immediate than any other known river system.

THEREFORE by proper development and taking into consideration its gradual development, the Colorado River will not deplete its flow below the Utah-Arizona line, nor eventually at its mouth.

The initiated plan of development applied for will eventually produce the same results. There will eventually be no water depletion below the United States-Mexican border line. This fact must be taken into consideration in any water treaty with Mexico and California, for any water given to them on the delta or lower river first, to the disadvantage of the upper lands, will deprive four acres from getting water to one acre toward the mouth of the river, because of the many times the same water can be used over and over again higher up.

The Arizona Highline Irrigation and Power Canal has some outstanding unusual advantages. It is so situated around the 2000 foot elevation that water being stored and regulated at Glen Canyon dam at an elevation of 3127 feet will eventually triple the irrigation on four million acres and increase the electrical and other values by, through and under said canal, due to the many times this same water can be used over and over by seepage and return on lands below. This return seepage water will keep the present underground water everlasting. The water table now is becoming lowered and exhausted by pumping. This Highline return flow not only keeps the present underground water permanent, but raises it up so deep and shallow pumping will become shorter and more shall-

ARIZONA-CALIFORNIA--ALL GRAVITY HIGHLINE CANAL				
	Tunnel	Open Cut	Miles	Elevation
At Bridge Canyon Diversion Dam.....				1900.6
Side cut inlet portal to Meriwitica Tunnel.....		1.2	1.2	1899.0
Tunnel to Meriwitica Spencer Canyon.....	6.2		7.4	1886.6
Along Spencer Canyon.....		0.3	7.7	1886.4
Along Spencer Canyon to W. side Meriwitica Canyon.....	0.5	2.2	10.4	1884.1
Along N. Side Canyon (A) on map.....	2.0	0.4	20.5	1873.5
Along Colo. River to N. Side Canyon (C).....	1.2	7.3	29.0	1866.7
To near end Grand Wash Cliffs along Colo. River to W. Portal Tunnel to Grapevine Wash.....	5.5	11.0	45.5	1849.1
To W. Portal Rualpai Hills Tunnel.....	3.0	2.0	50.8	1841.9
To W. Portal of White Hills or Squaw Peak Tunnel.....	6.5	14.5	71.8	1820.2
To W. Portal of Pilot Knob Tunnel.....	3.0	17.3	92.1	1803.8
To W. Portal of Yucca.....	3.1	56.8	152.0	1769.2
To Needles Mts-Topock Forebay (Canal Forks).....	4.3	28.8	135.1	1746.2
Total	36.5	148.3	185.1	1746.2
ARIZONA ALL GRAVITY CANAL--NEEDLES MTS. FOREBAY				
To W. Portal Sandy River flume or Siphon.....	13.0	38.0	51.0	1746.0
To S. Portal Santa Maria flume or Siphon.....	2.5	19.5	71.5	1686.7
To E. Portal Little Harqua Hala Tunnel.....	3.5	47.5	122.5	1651.2
To E. Portal Hassayampa Flume.....	3.0	64.0	139.5	1609.2
To E. Portal Agua Fria River Flume.....	1.5	29.0	220.0	1578.0
To R. Portal Salt River (Granite Reef) Siphon.....	1.5	47.0	268.5	1546.8
To S. Portal Gila River Flume, 3 miles West of Price.....		39.0	307.5	1523.0
To Near Head of Waterman Wash 7 miles S. of Maricopa.....		70.0	377.5	1450.0
Total	25.0	344.0		

low. Reflow water will be supplied to lands by seepage flow that have no underground water or other means of development.

The Highline Canal diverts water from the Grand Canyon and runs at such a high elevation and crosses practically all Arizona tributaries, including Salt and Gila Rivers, so as to supply the large acreage

present and future dams below, thereby giving the opportunity to reclaim the lands higher up and at the heads of all Arizona tributaries, and still enjoy their reflow water. The Highline Canal in crossing throughout Arizona will result in her tributaries developing from 600,000 to 2,000,000 H.P. on falls from the canals and present and future dams on tributaries to be filled and refilled and at the same time bring this cheap power near the door of the populous centers, cities, mines, and pump irrigation land throughout Arizona. The canals acting as power transmitting lines would save the enormous loss in expense and loss of power. The power would also be near to California.

IT IS proposed to construct the Williams Reservoir site as storage for power and irrigation to be supplied from the Williams River and to be filled and refilled from the Colorado River by the Arizona Highline Irrigation and Power Canal, or a 68-mile tunnel, either to be taken from the Bridge Canyon diversion and power dam site.

The Marble Gorge dam site would supply practically the same lands under the Arizona Highline Canal by the construction of a tunnel from this dam site about sixteen miles above mouth of the little Colorado River on the head of the Verde River. Said project is called the Colorado Verde Project.

The water rights which Arizona intends using under this application for preliminary permits will be determined by priority; sovereignty of the state of Arizona; initiated, vested rights and due diligence, and irrigation and power districts. Water rights, inclusive of reflow water having been filed

on in the years 1923, 1924, 1925, 1926, 1927, 1928, 1929, with the State Water Commissioner of Arizona and the Federal Power Commissioner, by the applicant, as trustee for Arizona, water users, and landholders under the Arizona Highline Irrigation and Power Canal. Before and since the year 1923, the State of Arizona, citizens, landholders, and applicant as leader, have used legal due diligence in keeping up the water filings made by applicant. The applicant has given a large fortune and his entire time for the past seven years, thousands of individuals have contributed their time and money, and the State of Arizona has appropriated much money to keep up and protect these water, irrigation, and power filings, and has made progress even against the greatest obstacles for which we were in no way responsible. We have now obtained vested rights.

MANY thousands of landholders and returned soldiers of the State, Government and patented lands are expecting water from the above projects, and several irrigation districts are being initiated and signatures have been filed for forming the Highline Irrigation and Power District embracing over two million acres under said project. When this district and others are completed, the applicant expects to turn over this trusteeship of the water rights to the Irrigation and Power Dis-

tricts, municipalities and landholders, and they, with the assistance of the State and applicant, will continue to perfect the water rights and do all things required to finance and construct said reservoirs and canals to get water on lands of said Irrigation Districts and State lands for landholders.

THE water and power, dams and canal sites, filings made by applicant with the Federal Power Commission on the Glen Canyon Storage Dam, the Bridge Canyon Diversion Dam and the Arizona Highline Irrigation and Power Canal and dams, are included and are supplemental to the filings made by applicant with the Federal Power Commission in October, 1925.

The said Glen-Bridge Canyon Dams and Arizona Highline Irrigation and Power Canal, with the water to irrigate over four million acres of land in Arizona under said canal is the predominating feature in applicants' plan of development. The water to irrigate the said lands is to have preference and priority, and is to be combined with the power. The power to be developed on all sites applied for is to assist in paying for the irrigation development. As a matter of justice and economy, and maximum beneficial use, the entire Grand Canyon and main stream of the Colorado River, including

Number and Name of Dam Site	Pages in U. S. G. S. Water Supply Paper giving Location Plan of Development	Pages in U. S. G. S. Water Supply Paper giving Plate Photo map cross sections etc.	Elevation above sea level in river at base of Dam	Height of Dam	Width of Dam at base between river banks	Width of Dam at top between river banks	Electric H. P. to be developed	Capacity of reservoir in acre ft.	Area of reservoir
(1) Glen Canyon storage flood control.	19 to 24 35-36	IV V	3127	693	275	1400	700,000	50,500,000	240,500
(2) Redwall	52 to 56	XXV XXIV	2886	222	150	300	362,000	160,000	2050
(3) Mineral Canyon	53 to 55	XXIX XXX	2531	345	150	650	588,000	810,000	6710
(4) Ruby Canyon	62	XXXI	2235	286	100	850	495,000	244,000	2050
(5) Specter Chasm	63	XXXII XXXIII	2002	223	100	250	392,000	169,000	1770
(6) Havasou	65	XXXIV XXXV	1783	209	150	222	387,000	147,000	1640
(7) Bridge Canyon Diversion	71 to 77 163 to 164 45-71	XLVIII XLIX	1207	566 785	100	900	1,100,000	6,238,050	22,000
(8) Devil's Slide	77 to 81	LI LII	1034	163	150	450	317,000	75,000	8585
(9) Flour Sacks	94 to 96	LXI LX	960	(70)	300	600	140,000	(24,440)	(422)
(10) Pierces Ferry	95	LXII	905	(50)	90	150	(60,000)	(13,050)	(680)
(11) Grand Wash	96		(867)	(30)	250	300	(60,000)	(9740)	(590)
(11) Grand Wash Dam 160 ft. back up Devil's Slide	96	LXIV LXIII	(867)	160	250	600	300,000	169,060	2497
(12) Marble Gorge Alternate	From U.S.G.S. year 1923	Year 1923 U.S.G.S. Chart No. 3	2838	675	250	500		25,000,000	
(13) Williams	Report of Arizona Engineering Commission with U.S.G.S. 1922-23		900	600	100	1800		2,000,000	
(14) Arizona Highline and Irrigation Power Canal.							600,000		

the fourteen sites applied for is to be developed as one large unit. The applicant has stipulated this in present and all past applications, and filings before the Federal Power Commission and Arizona Water Commissioner.

If the above is not complied with, and one permit solely for a power dam is given in Grand Canyon and main stream

of Colorado river in Arizona, as for instance the Diamond Creek dam or Boulder dam, this action would equalize the water for Mexico's first land development. It would give control to monopolize the five million horse power on the Colorado river, and control the power market and exhaust the power so that it would be impossible to finance and

develop millions of acres of land to be irrigated that Arizona and its people depend on for their present and future prosperity.

The proposed plan can be economically developed and financed from the power-sales proceeds, if the power is combined with irrigation and if irrigation is given preference and priority as nature and our laws require.

