

ENGINEERING PROGRESS REPORT  
ON  
TOLANI LAKES DEVELOPMENT

Since submitting my report of Nov. 16th. on the foregoing project, much in the way of additional informative data relative to the project has been gathered.

Authentic records of the U.S.G.S. Water Supply papers were used dating from Oct. 1926 to Sept. 1934, which cover the known runoff of the Moenkopi Wash in acre feet. These records were used as a basis for establishing a mean annual runoff expectancy from the Oraibi Wash, which is to be given primary consideration in this report.

The Moenkopi Wash being the only stream running into the Little Colorado River from its Northeasterly watershed, which can be used for comparison and which has a watershed which is considered comparable in character and rainfall.

The average annual runoff of the Moenkopi Wash for 8 years is 17,705 Ac. Ft. The records show this runoff flow hit peaks during 2 of the 8 years and also hit decided slumps in runoff flow during 2 of the 8 years, with 6 of the 8 years showing less runoff than that of the average for the whole time. This would indicate that the figure determined for the average annual runoff is too high and not a true value.

However by using this average annual figure of 17,705 Ac.Ft. for the 2270 sq. miles of watershed on the Moenkopi Wash, gives a resultant of 7.8 Ac.Ft. runoff per sq. mi. of watershed. By eliminating the 2 peak years of flow the resultant is approximately 4 Ac.Ft. runoff per sq.mi. of watershed. One of the lean years of flow shows a minimum resultant of only 2 Ac.Ft. per sq.mi. of watershed, with the other lean year showing only slightly higher. The highest of the peak runoff years shows a resultant of better than 20 Ac.Ft. runoff per sq.mi. of watershed.

It is recalled that the Oraibi wash watershed contains 728 sq. miles, while that of the Polacca Wash contains 1105 sq. miles.

Following is given the Moenkopi Wash runoff as taken from the U.S.G.S. Water Supply papers:

Year	Acre Feet	Mean Sec. Ft.	Maximum Sec. Ft.
1927	9,750	13.5	12,900
1928	4,510	6.2	3,800
1929	41,200	56.8	15,100
1930	46,000	63.6	14,100
1931	5,500	7.6	2,760
1932	7,890	10.9	5,300
1933	10,200	14.1	4,400
1934	16,590	22.9	14,500
Totals:	8)141,640	8)195.60	8)72,860
Means:	17,705	24.45	9,107.5

$\frac{17,705}{2,270}$  equals 7.7995 average annual runoff in acre feet per sq. mile

of water-shed from the Moenkopi Wash.

The Oraibi Wash expected runoff equals 728 x 7.8 or 5678.4 Ac. Ft.

The Polacca Wash expected runoff equals 1105 x 7.8 or 8619 Ac. Ft.

The maximum or peak flood during the recorded time being equal to 6.652 sec. ft. per sq. mile of watershed.

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The foregoing data reduced to flow by months is as follows: In Ac. Ft.

Yr.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
27	301	375	369	400	328	289	4	0	1610	234	756	5080
28	117	518	443	566	265	338	30	154	6	234	1580	256
29	851	716	424	210	121	169	143	0	0	8530	18000	12000
30	430	321	298	405	268	137	89	22	2	12100	30600	1380
31	325	294	250	353	385	155	60	258	2	1150	930	1340
32	961	361	309	331	2890	194	33	44	14	727	1590	436
33	535	263	238	229	412	237	105	38	0	5100	2010	1010
34	5210	453	325	339	240	69	261	339	38	700	8430	186
Tot:	8730	3301	2655	2833	4909	1588	725	854	1672	28775	63896	21688
Means	1091	413	332	358	614	198	91	107	209	3597	7987	2711

The runoff in acre feet per sq. mile of watershed per month is as follows:  
0.481 0.182 0.146 .158 .270 .087 .040 .047 .092 1.584 3.518 1.194

This flow applied to the watershed of the Oraibi Wash would produce as follows:

350 133 106 115 197 63 29 34 67 1153 2561 869

Which shows a total flow over the average year of 5678 Ac. Ft., with 4583 Ac.Ft. of that total coming during July, August and Sept., while the balance of 1095 Ac.Ft. comes during Oct. to June inclusive or nine month of the year, which does not show a very equitable distribution of flow and therefore will necessitate the storing of flood flow of the summer and fall runoff, to be carried through the winter in order to have water available for spring and early summer irrigation, when it is most needed.

The above rates of runoff per sq. mile of watershed per month are applicable to any comparable watershed running into the Little Colorado River from the Northeastern portion of its watershed.

Since the factor of 7.8 Ac. Ft. runoff per sq. mile of watershed applied to the Oraibi watershed indicates an average annual discharge of 5678 Ac. Ft. this means slightly less than 0.15 inches of rainfall runoff over that area.

Due to water losses from percolation, evaporation and other means unknown with the fact staring one in the face of a possible drought coming most any year, it was deemed untra conservative to hold the agricultural development down to approximately 1000 acres, which it is believed can be adequately irrigated even in a sub-normal year. With the working plan of the project so designed and laid out that the advantage can be taken of all of the so-called marginal or surplus water available during either a normal or ab-normal year.

The plan in general is to construct a dike with the ditch or borrow pit on the upper side, just below or south of the abrupt turn or swing in the Oraibi channel at approximately an elevation of 4950 ft. as sketched on the map prepared. The dike at this point should be constructed on a long radius curve to the West straightening out to flow directly into the present chain of lakes.

Check or control gates should be constructed in a bridge on the main Oraibi highway, and the heavily laden peak floods carried on through these gates and spread over the range land lying Northwesterly of the highway, clear on down to the Dinnebito Wash if found expedient to do so. After the peak flood has passed the bridge gates can then be closed and the flow diverted through gates leading into the storage reservoir, from which the water can be distributed as needed for irrigation. No definite figures are yet available on the possible storage, but it is believed that approximately 2000 to 2500 acre feet may be stored from the summer floods.

Another angle of the proposed project is to establish possibly 3 minor diversion gates directly through the main diversion dike, in order to take advantage of the diversion of the normal flows, as well as participate to some extent in

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some of the flows of the summer floods. This latter however is submitted contingent on other factors of the project which are open for discussion in many phases.

A rough estimate of the yardage required in all of the earth dikes and dams, exclusive of any which may be built for a spreading system, is about 125,000 cu. yds. another 25,000 to 30,000 cu. yds will be required on the ditch and lateral distribution system.

This earth construction should be handled at not to exceed 15¢ per cu.yd. with adequate power equipment, but if teams are to be used it would be quite difficult to make an estimate of the cost, or time required to complete the project.

I have not as yet gone into detail as to costs on such structures as main headgates, diversions etc. primarily because of the lack of time and the necessary data, and largely due to awaiting the final approval of the general plan of scheme of the project, before advancing too far along on plans.

A conference with Mr. Lovald and Mr. Finley of the Soils Division show from their survey of this area, that a high percentage of the land proposed for agricultural development to be of Class A and B types, some of it being at present farmed by the Indians. We also discussed the need of tests being carried on for a determination of the ground water-table fluctuations if there be any, particularly in the area to be farmed and irrigated. Indications are that the present water table is fairly close to the surface at present in certain portions of the area, and were definite data of this kind available it no doubt would be of considerable value to the Agronomy and Forestry Divisions in planning their crop distribution and planting locations.

Shortly after the November meeting on this project, Mr. Ray Walker accompanied me on a trip of examination of the middle-upper watersheds of the Oraibi, Polacca and Jeditto Washes. We found only one project on the Oraibi of considered merit, one which was developed by the Indian Irrigation Service there they constructed a masonry diversion dam on outcropping bedrock, along with  $1\frac{1}{2}$  to 2 miles of diversion ditch, having two 5 ft. drops in that length.

I understand this work was done about 2 years ago, and no beneficial use has been made of it since. Their preliminary plat of this project shows a tract of 230 acres irrigable area with a possible extension of 250 acres.

I note from the report of the Water Spreading Committee, that this project shows a possible irrigable area of 300 acres with an additional 200 acres subject to water spreading. It is my belief from a casual survey that this project would provide with an adequately designed diversion and distribution system, almost twice the estimated amount of irrigable land made by the I.I.S. in addition to a considerable amount of spreading ground. I hereby strongly recommend it as a project for immediate further investigation and consideration, by our Service.

We examined several other sites on the Polacca Wash and its tributaries, no attempt being made to estimate acreage on any of these latter, all of which could be given serious consideration by our Service, depending on just how far we want to go into the heavier type of diversion construction, as they all have a direct relation to water and soil conservation work, serving a dual purpose of conserving water and retarding soil erosion as well as aiding the local Indian farmers and enhancing his rangeland by spreading.

One particular such project lies near Pinon on the Wepo Wash, where a wide shallow wash is cutting through a wide level valley of good soil, natural conditions therefore being of the best, for our purpose of either irrigation or spreading or both.

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Two similar projects are located on the Polacca Wash, one being where the road from Pinon intersects the main road down the Polacca, the other being several miles below.

Another quite large project lies near the mouth of the Burnt Corn Wash where it empties into the Polacca.

Still another is on the Polacca Wash below the mouth of the Wepo Wash, where the wash is 30 to 40 ft. deep cutting through a wide flat valley with unlimited ground for agricultural development and spreading purposes.

On the Jeditto Wash just below the Keams Canyon-Winslow highway a valley varying in width from  $3/4$  to  $1\frac{1}{2}$  miles extends down stream some 8 to 10 miles, the land is being farmed at present in patches. The wash while fairly deep is narrow and would not present any difficulty in diverting it out over the land.

None of the projects mentioned are of the hard labor class, and not much could be accomplished on them with teams, except over a long period of time, and this manner of working them is not at all advisable due to the extreme flashiness of the floods which occur in these streams. This work if undertaken should have the main diversion dam structures completed just as soon as possible after starting, or take the risk of losing it all if subjected to a flash flood while under construction.

These diversion dams would essentially have to be of the large earth fill type, and definite assurance could be had that they would not be overtopped by a flash flood. This could be accomplished by providing adequate gates through the structures, at the present stream bed level, through which the peak flows could be dissipated, which could not be handled by the diversions.

These gates would also serve to sluice off down the main channel the heavy sands and silts which would otherwise, if diverted, soon choke up the diversion channels to such an extent that they would fail to function properly by building up an alluvial fan similar to that at the mouth of the Oraibi and many other streams.

My recommendation is that if we are going to seriously consider the construction of any of the foregoing projects, our immediate need is for some sizable 'Gats' and Tumbæbugs, as several of these will really move the dirt in yardage quantities. I do not have much fear that by so doing we shall not then be able to give the Indians hand and team labor, as I have never seen a construction project of this type undertaken that did not also provide a considerable amount of labor for both, in finishing and smoothing up the rough work of the larger construction, as well as the considerable amount of minor constructions in connection therewith to small to be done with the heavy equipment.

I have planned the general layout for the use of the waters of the Oraibi at Tolani Lakes in such a manner that after all possible future developments on the upper Polacca Wash and its tributaries have been completed, and it is found that there is still some water available at the rock crossing on the lower Polacca, then this water if sufficient is available can be diverted and carried over into the Tolani Lakes system to augment that supply, or can be allowed to continue on down to a diversion just below the mouth of the Jeditto Wash where it can be spread over level terrain for whatever purpose desired.

Without attempting to touch on the many other phases of the assets and advantages of the Tolani Lakes project, my recommendations are fully in accord with it as a development from an engineering standpoint.

Respectfully submitted,

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