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REPORT ON FOUNTAIN HILLS FLOOD CONTROL STRUCTURES

This report was prepared in accordance with the request by the Citizens' Advisory Board, made on December 18, 1974, that the Flood Control District (FCD) study the proposal of the McCulloch Properties that flood control structures in Fountain Hills be included in the County flood control system. A preliminary report was submitted on March 18, 1975.

CULVERTS AND CHANNELS

Culverts. No data were furnished on the culverts nor their capacities. It is believed that culvert maintenance is the responsibility of the road and highway agency and not a Flood Control responsibility. Therefore, no further consideration is given to the Flood Control District accepting responsibility for culverts.

Channels. In general the channels are not improved except for some clearing. They are more properly described as ordinary washes. It is recommended that the washes not be accepted as a Flood Control responsibility for the following reasons:

a. Experience has shown that adjoining property owners may insist that washes be kept clear of brush, and that dumped debris and waterborne deposits be kept clear.

b. The Flood Control District is not prepared at this time to accept maintenance responsibility for improved channels. If we begin to accept washes in this area the program will mushroom rapidly into other areas. It probably would be better to wait until major flood control projects are nearly complete before we consider accepting improved channels as a responsibility of the Flood Control District. Unimproved washes normally are not flood control projects.

DAMS

COMMENTS APPLICABLE TO ALL DAMS

Licenses. All five structures have been approved and licensed by the Arizona Water Commission (AWC).

Liability. The paramount consideration in studying these dams has been the liability that the Flood Control District incurs when it accepts the dams for maintenance and operation. If a dam fails, the Flood Control District might then be subject to suit. In discussing this liability with the administrator of insurance for the Flood Control District several points were brought out:

a. If the failure were due to faulty design or construction, of which the Flood Control District had no knowledge or control, the District would probably not be liable. However, if the District held the constructor free from liability, the opposite might be true.

b. The insurer has no criteria upon which dams should be designed. If the dams were constructed in accordance with the criteria of some supervisory agency (in this case, the Arizona Water Commission), reconstruction to a more rigorous criteria would not be required for insurance coverage. Infrequent probability of failure would make the risk low.

c. If there were a failure, the risk would increase and premiums would increase, with the possibility that companies might not be willing to issue insurance.

d. It appears that our current insurance program would not be adversely affected, except that there might be some increase in cost because the total of dams is being increased.

Soundness. The dams were designed by a qualified consultant who required that compaction be at 95% of maximum density, with not less than half of the tests to be 97% or better. The soil tests show compliance with this requirement. It is concluded that the dams are structurally sound. The tests of concrete cylinders for the structural concrete for headwalls, cradles, seepage collars, etc., show that strengths are satisfactory.

Spillways. Comments on the principle spillways will be made in the discussion for each dam. Comments on problems in the emergency spillways are also included in discussion for individual dams. Generally, emergency spillways are provided for each dam; the capacities to pass major floods is dependent only upon the depth of water over the spillway crest. The impact of this depth on dam height is discussed for each dam. In addition, the downstream slopes of the emergency spillways are quite steep, and velocities may be high. Table 1 shows the slopes of the spillways, with an approximate value for computed velocity. Further discussion on the erosion hazard is made in comments for each dam.

Trash Barriers. These barriers consist of 8" posts set in a "V" shape at the inlets. The posts are creosoted and are durable. However, they extend only a short distance above the stream bed. Small trash will float between the posts and probably will not lodge in the pipes. Large trash may float over the posts and through the gaps between the downstream posts and the slope of the dam, and may block the pipes. Frequent, and perhaps costly, maintenance of the inlets is probable.

Criteria for Dam Height. The top of dam is based on the maximum water surface in the pool, which is in turn controlled by the capacity of the emergency and principle spillways. It is essential that an earthfill dam not be overtopped and all criteria are developed upon this basic principle. The five criteria studied are outlined briefly.

a. The Soil Conservation Service (SCS) criteria, January 1, 1970, for Class C structures (failure may cause loss of life and serious damage) requires that the dam height be designed for detention of a 6-hour Probable Maximum Precipitation (PMP). In the Trico design data this storm was indicated as 19".

b. The Soil Conservation Service is giving consideration to modifying the storm for dam height on a Class C structure to a 6-hour thunderstorm distribution. This distribution and intensity are in general agreement with the Corps of Engineers Maximum Probable storm developed for the Fountain Hills area which is a 6-hour 14.01" rainfall.

c. The District Engineer, Los Angeles (Engineer Manual), applies the criteria in Engineer Manual No. 1110-2-1101, February 19, 1968; where the dam is upstream from human habitation, the criteria requires safe passage of the Probable Maximum Precipitation, plus 2' of freeboard. As stated above, the Probable Maximum Precipitation is 14.01" in 6 hours.

d. The District Engineer, Los Angeles (Dam Safety) is using the Preliminary Guideline for Safety Inspection of Dams, August 1970, which states that where there is hazard of some loss of life for failure of a small dam, the dam height should be based on 50% of the Probable Maximum Storm plus freeboard in accordance with local experience. One-half the Maximum Probable Storm, as derived by their hydrology section, is 7". Arizona Water Commission has indicated a freeboard of 3' is desirable.

e. The Arizona Water Commission has adopted a criteria by which these dams would fall in the category of moderate hazard, medium size, requiring selection of a Standard Project Storm. The District Engineer derived this storm for Fountain Hills as 5.99" in 7 hours. To this pool elevation, the Arizona Water Commission advises 3' of freeboard, based on observed wave runup on dams in the area during a recent intense storm.

Property Transfer. If the dams are accepted, descriptions of property will be required. The property to be transferred will include the reservoir areas, and areas covered by the dams and spillways. Descriptions may be made by tracts or lots on recorded plats, or by metes and bounds.

Comments Applicable To Individual Dams

Dam No. 19

Height. The top of dam is at elevation 1711.25, which is about $\frac{1}{2}$" higher than the water surface elevation from the PMP storm (19"). The dam is higher than the elevation for the other criteria, except the District Engineer (Engineer Manual) criteria. See Table 2.

Sewer Line. A sewer line, size not indicated, is shown beneath the dam. There is no visible evidence of the sewer. Inasmuch as the line is shown to be in a trench excavated in cemented material, and was encased in concrete, no adverse effect is forseen.

Emergency Spillway.

a. Upstream from the concrete sill, the material is dense and compacted, partly cemented.

b. Downstream from the sill the material is soft. Runoff from rainfall on the crest of the dam has caused significant gullying in the material. In the event of a major flow through the spillway velocities would be high (see Table 1) and serious erosion would occur. Such serious erosion might cause problems downstream. In any event, maintenance will be costly; repair of the rainwash is already required.

c. The right abutment is a dense, compact, partly cemented vertical cut over 20' high. If this is typical of the original material where the spillway is constructed, it appears that the area was excavated and the spillway constructed as a fill.

Dam No. 36

Height. The top of dam, at elevation 1896.0, is slightly below the SCS PMP and Modified SCS criteria, well below the District Engineer (Engineer Manual) criteria, and equal to or above the Arizona Water Commission and District Engineer (Dam Safety) criteria, (see Table 2).

Emergency Spillway. The spillway slope has about 6" uncemented material on the surface; below that the material resembles hardpan. Velocities on the spillway in a major flood will be rather high and some erosion may occur, but the hardpan will probably withstand serious erosion.

Dam No. 6

Concrete. The concrete paving at the left and right (edge of dam) sides of the emergency spillway appears sound. However, the expansion joints are not functioning and shrinkage cracks have developed outside the joints. No serious adverse effect is visualized but regular inspection, with repair as required, is recommended.

Height. The top of dam is above the elevation for Modified SCS, AWC, and District Engineer (Dam Safety) criteria. It is slightly below the SCS PMP criteria, and about 1' below the District Engineer (Engineer Manual) criteria (see Table 2).

Emergency Spillway. The material is compact, granular material, with some cementation. Velocities in a major flood may be fairly high and some erosion may occur but serious erosion is not anticipated.

Dam No. 7

Height. The top of dam is above the elevations set by the Modified SCS, the AWC, and District Engineer (Dam Safety) criteria. It is approximately one foot below the District Engineer (Engineer Manual) and SCS PMP criteria (see Table 2).

Saddle Dike. The plans show that a dike was to be constructed across a low saddle about 500' northwest of the dam; its maximum height was to be approximately 4' (top elevation 1934.0). Apparently it was not constructed and in the event of a major flood, by three of the considered criteria, water would flow across the saddle. Under existing conditions the overflow would proceed via an adjoining

wash to Dam No. 4 reservoir; there would be no significant difference in the impact of this flow as compared with flow only through the emergency spillway of Dam No. 7. Consideration of these flows will need to be given as future development is planned in the washes.

Emergency Spillway. Visual inspection of the surface showed much loose, granular material. A staff member of AWC explained that during construction much hard rock was encountered. Further inspection (by FCD) led to the conclusion that there were many huge boulders, with both hard-cemented and soft-granular materials between the boulders. In the event of a major flood passing through the spillway, velocities would be very high over the steep slope. Erosion would definitely occur and the loose granular materials would be quickly washed away. It is probable that the large boulders would not be moved, and smaller rocks would fill the intervening spaces where granular material was lost. Some loss in spillway crest elevation might occur, but the spillway would probably stabilize before serious erosion occurred.

Dam No. 4

Outlet. The as built drawing for the principle spillway (2-60" pipes) shows that No. 3 (3/8") reinforcing bars at 18" center-to-center were used as longitudinal steel in the concrete. It is preferred that the bars be No. 4 at 12" centers. Examination of the structure in the field indicated that no serious overstressing of the steel is likely to occur.

Height.

a. The top of dam is below the elevation required by the SCS PMP, SCS Modified, and District Engineer (Engineer Manual) criteria. It is about 6" below the District Engineer (Dam Safety) criteria, and meets the criteria of AWC. (See Table 2).

b. The spillway crest is at elevation 1716. The right abutment for the spillway is a low ridge, an estimated 6' higher than the spillway. This elevation does not meet any of the criteria for height of dam, although it is higher than the computed water surface for the criteria of the AWC and the District Engineer (Dam Safety). Inasmuch as the ridge is broad, shallow flow over it is not likely to cause a serious problem; it should be recognized in computations for downstream channels.

Upstream Dams. The hydrography for this dam was based on dams Nos. 6, 7 and 11 being constructed. Dams Nos. 6 and 7 have been constructed but Dam No. 11 will not be constructed for another year or two. For this reason, the hydrographic design for Dam No. 4 is inaccurate. The design agency expressed the opinion that the probability of a Maximum Probable, or even Standard Project, storm is a remote contingency and that a chance can reasonably be taken on operating Dam No. 4 as constructed until Dam No. 11 is completed.

Emergency Spillway. The boring log shows that materials in the spillway, below the crest elevation and below the bottom of the sill, are sands, gravelly sands, and clayey gravels. Inspection shows that where the spillway cut was 3 to 4' deep the material is compact and firm 6" below the surface. Where the cut was shallow, the material is soft and doesn't become compact for at least 1' below the surface. Velocities will be high on the spillway and erosion will

occur. Even though there is riprap and a concrete sill, the loss of material may be serious enough to undermine those structures.

CONCLUSIONS

It is concluded with regard to the proposal on Fountain Hills that:

a. The Flood Control District is not in position to accept channels and culverts.

b. Dams Nos. 6, 7, 19, and 36 meet reasonable criteria for height above spillway floods. The height of Dam No. 4 is questionable because Dam No. 11 has not yet been constructed.

c. The slopes of the emergency spillways on Dams Nos. 19, 7, and 4 are susceptible to erosion and additional stabilization is advisable. The emergency spillways for Dams Nos. 6 and 36 are acceptable.

d. Trash barriers are substandard for all dams.

RECOMMENDATIONS

It is recommended that:

a. Dam No. 19 be accepted provided ~~the trash barrier is modified to meet standard SCS specifications and the~~ spillway ~~slope be~~ is modified to prevent erosion below the sill.

b. Dam No. 36 be accepted ~~provided the trash barrier is modified to meet standard SCS specification~~.

c. Dam No. 6 be accepted provided the ~~trash barrier is modified to meet standard SCS specifications~~.

d. Dam No. 7 be accepted ~~provided the trash barrier is modified to meet standard SCS specifications and the~~ spillway is modified to prevent erosion.

e. Dam No. 4 not be considered for acceptance until Dam No. 11 is constructed.

f. Suitable transfer of title or right-of-way to affected lands be arranged for dams when they are accepted.

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TABLE 1

Emergency Spillways
Slopes and Approximate Velocities

Dam No.	Slope	Assumed depth water on spillway	V (Manning's formula) n=.03 ft./sec.	Crest
4	.05	2'	17	4' deep sill; Conc. riprap
6	.11	2'	26	nothing
7	.273	2'	41	nothing
19	.18	2'	33	4' deep conc. sill
36	.11	2'	26	4' deep conc. sill; riprap

TABLE 2

COMPARISON OF CRITERIA AND
TOP OF DAMS, FOUNTAIN HILLS

	DAMS				
	No. 4	No. 6	NO. 7	No. 19	No. 36
Top of Dam	1723.0	1845.0	1934.0	1711.25	1896.0
SCS 19" Storm	1732.3	1845.3	1934.9	1711.20	*1896.5±
District Engineer (Engineer Manual) 14" + 2' Freeboard	*1729.7±	*1845.9±	*1935.2±	*1711.7±	*1898.2±
SCS Modified 14"	1727.7±	*1843.9±	*1933.2±	*1709.7±	*1896.2±
District Engineer (Dam Safety) (7") + 3' Freeboard	*1720.5 1723.5±	1840.6 1843.6	*1930.0± 1933.0	*1706.8± 1709.8±	1893± 1896±
AWC SPF (6") + 3' Freeboard	*1720± 3 1723±	*1840± 3 1843±	*1929± 3 1932±	*1706± 3 1709±	*1892± 3 1895±

* Approximations

ACCEPTABILITY OF DAM HEIGHT
AND SPILLWAY MATERIAL

	4	6	7	19	36
SCS 19" storm	No (9.3)	? (.3)	No (.9)	Yes	? (.5)
SCS Modified 14"	No (4.7)	Yes	Yes	Yes	? (.2)
Corps of Engineers 14" + 2'	No (6.7)	? (.9)	No (1.2)	? (.45)	? (2.2)
AWC 6" + 3'	Yes	Yes	Yes	Yes	Yes
Corps of Engineers (Dam Safety) 7" + 3'	? (.5)	Yes	Yes	Yes	Yes
Spillway erosion	moderate	some	moderate	serious	some
Spillway sill	4' deep concrete & riprap	none	none	4' deep concrete	4' deep concrete & riprap