United States
Department of
Agriculture

Soil
Conservation
Service

Albuquerque,
New Mexico

LITTLE PUERCO WASH AND CATALPA CANYON FLOODPLAIN MANAGEMENT STUDY

Gallup, New Mexico

LITTLE PUERCO WASH
AND
CATALPA CANYON
FLOODPLAIN MANAGEMENT
STUDY

Gallup, New Mexico

May 1992

Prepared for and in cooperation with

City of Gallup

and

McKinley Soil and Water Conservation District

Prepared by
U.S. Department of Agriculture
Soil Conservation Service
Planning Staff
Albuquerque, New Mexico

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INTRODUCTION

LOCAL STUDY NEEDS - The City of Gallup requested the Soil Conservation Service, through the McKinley Soil and Water Conservation District, to conduct a study of the Little Puerco Wash and Catalpa Canyon. Residential and commercial development within the study area and potential for continued expansion mandate a responsible land management plan to ensure reduction of soil erosion and flood risk. This report presents several recommendations and alternatives to minimize or alleviate reoccurring flood damages. The implementation of a comprehensive management plan will promote the welfare of the community, provide wise land use and a development process for the benefit of all residents.

STUDY AUTHORITIES - The study was conducted by the Soil Conservation Service in cooperation with the City of Gallup under the authority of Public Law 83-566, Section 6, Floodplain Management Studies. The program is designed to assist communities evaluate flood damage risks and measures that will promote the reduction of those flood hazards.

The intent of this study is to provide flood hazard information and recommendations for the City of Gallup to help decrease drainage and sediment problems.

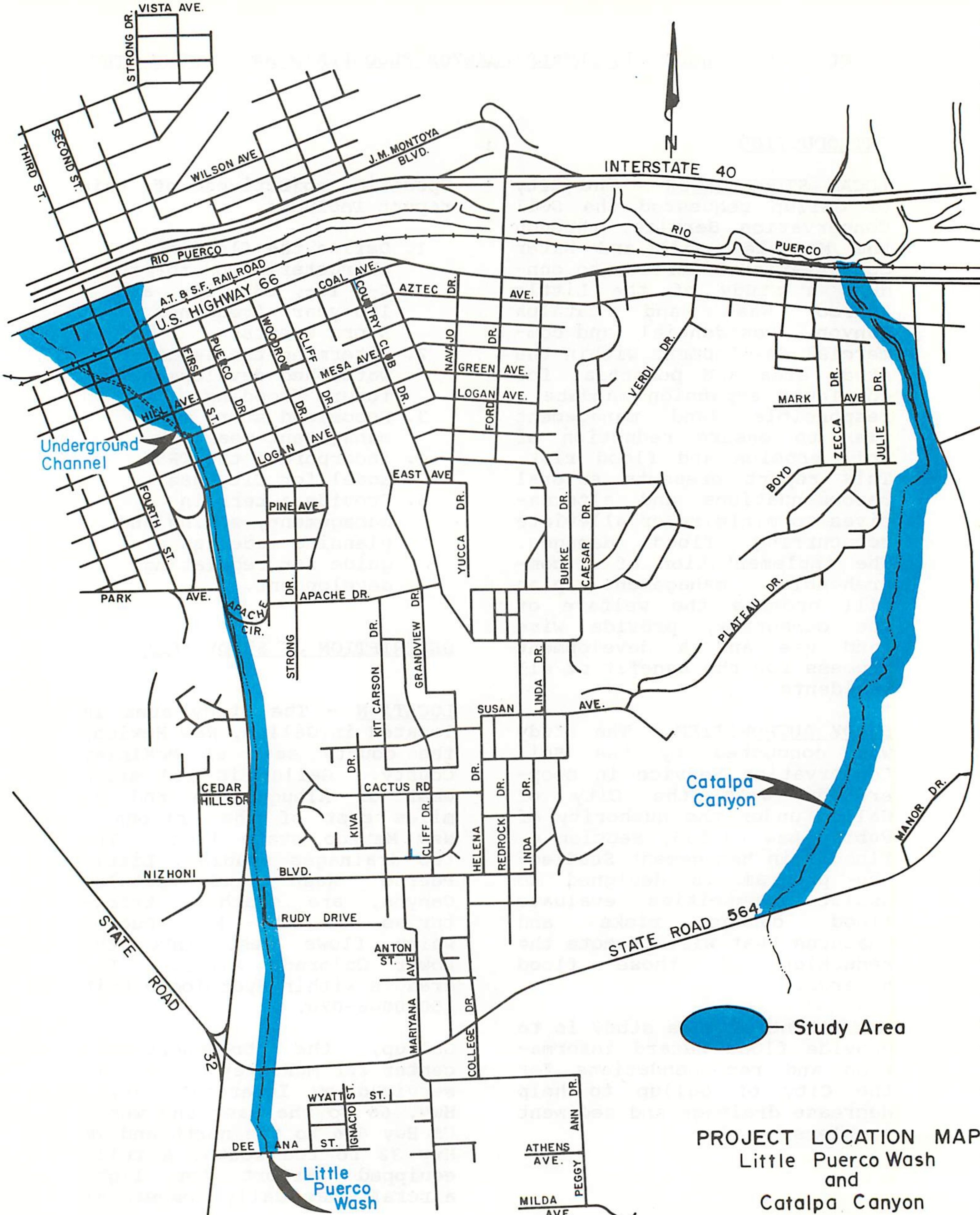
Specific objectives of this report include:

1. Define the flooding characteristics for the 2-, 10-, 25-, 50-, and 100-year frequency storm events.
2. Determine the impact of watershed development on future flooding.
3. Recommend storm water management measures.
4. Incorporate the TR55 model for City use.
5. Provide a terrain management, zoning and planning model as a guide for regulating development.

DESCRIPTION OF STUDY AREA

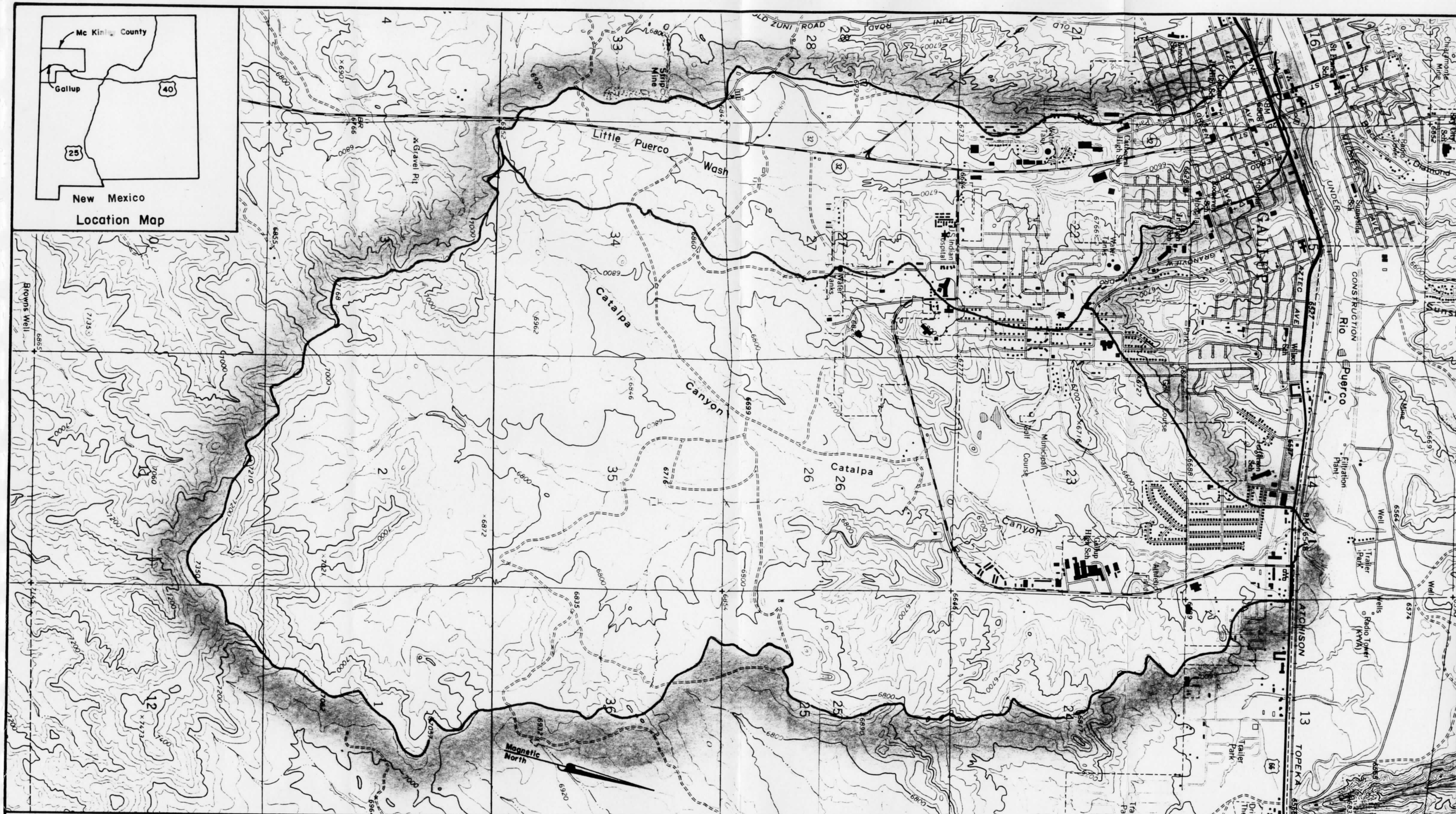
LOCATION - The study area is located in Gallup, New Mexico, the county seat of McKinley County. Gallup is 140 miles west of Albuquerque and 22 miles east of the Arizona - New Mexico state line. The two drainages studied, Little Puerco Wash and Catalpa Canyon, are southern tributaries of the Rio Puerco which flows west into the Lower Colorado River. The area is within Hydrologic Unit 15020006-020.

Gallup, the transportation center for McKinley County, is serviced by Interstate 40/US Hwy. 66 to the east and west, US Hwy 666 to the north and NM Hwy 32 to the south. A fully equipped airport for light aircraft has daily commercial



PROJECT LOCATION MAP
Little Puerco Wash
and
Catalpa Canyon
Floodplain Management
Study

SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE



2000 1000 0 2000 4000

Scale in Feet

Source Map - USGS Quadrangle
7.5 Minute Series

SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

ROAD CLASSIFICATION

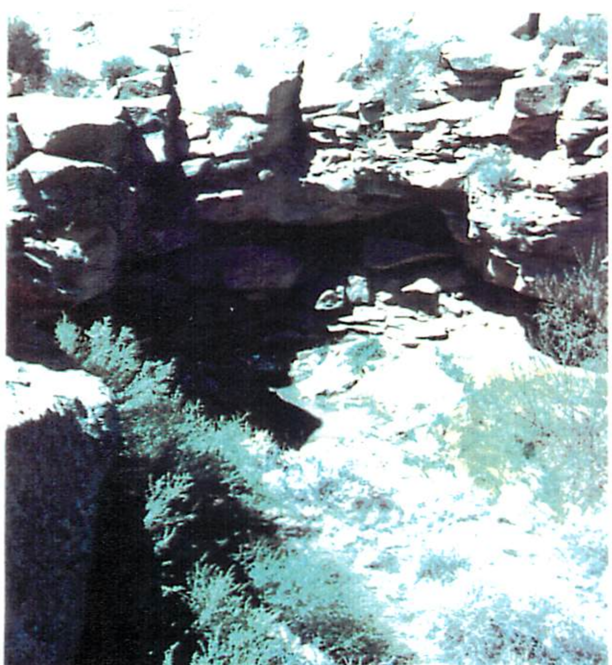
Heavy-duty	Light-duty
Medium-duty	Unimproved dirt
Interstate Route	U.S. Route
State Route	

Watersheds
Little Puerco Wash
and
Catalpa Canyon
Floodplain Management Study

flights. The Santa Fe railroad carries about 40 freight and 2 Amtrak passenger trains per day. In addition, numerous truck companies and a bus company operate in the area.

The Little Puerco Wash is a 2.1 square mile drainage with a channel length of 3.6 miles, running adjacent and parallel to the Zuni Hwy. Catalpa Canyon drains 7.46 square miles and is 5.34 miles in length. Both arroyos are ephemeral with flows occurring only during storm events and snow melt.

<u>CLIMATE</u> - Gallup is located in an arid region of the Southwest with characteristic low annual precipitation, low humidity, high evaporation, wide temperature variations and an abundance of clear sunny days. Average daily temperatures reach a low in January of 28 degrees Fahrenheit and a high of 70 degrees Fahrenheit in July.



Rock Falls in Little Puerco Wash

Catalpa Canyon north of High School

Precipitation averages range from a low in June of .36 inches to a high in August of 1.79 inches. July through November constitute the wetter months with July and August being the wettest, averaging 1.8 inches each.

Moist Gulf air from Mexico or California and the Pacific produce the typical short duration high intensity summer thunderstorms.

Average annual precipitation is 11.10 inches. There is an average of 28 days with precipitation equal to or greater than .10 of an inch each year. A storm with 2.8 inches of rainfall or more in 24 hours is estimated to occur once every 100 years on the average. This means it has a 1% chance of being equalled or exceeded each year. The storm of July 13, 1990, is estimated as a 4% chance event. A storm of this magnitude is expected to occur once every twenty-five years on the average.

<u>GEOLOGY</u> - The geology of the Gallup area consists of

Cretaceous rocks of the Mesaverde Group. Sandstone and shale components of the Menefee Formation including the Mancos shale occur to the north and west of the City. Gallup Sandstone occurs to the east of town near the Hogback. Crevasse Canyon sandstone and shale are found to the south. Soils in the study area are locally derived from these rock formations.

SOILS - Preliminary soil mapping has been conducted in most of the study area. Some revisions in soil map delineations and mapping unit names will occur when the McKinley County soil survey, currently in progress, reaches Gallup. Interpretations for use and management will not vary significantly.

The deep, heavy textured soils in the floodplain areas of the two drainages consist mostly of San Mateo, Sparank and Catman Venadito Series. These soils are in hydrologic group D, which means they typically have a high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential and shallow soils over nearly impervious material. These soils have a very low rate of water infiltration (0 to 0.05 in/hr). A group A soil on the other hand has a low runoff potential and a high infiltration rate. They consist chiefly of deep, well drained sands or gravels and have a high rate of water transmission (greater than 0.30 in/hr)

Surface textures in the study area are typically clay loam and clay with small areas of loam and fine sandy loam. The fine sandy loam is found where significant overwash of lighter textured materials has occurred. Slopes are typically 0 to 2 percent but range up to 5 percent. The subsoils of San Mateo and Sparank soils consist of stratified alluvial deposits of loam, clay loam and clay. Some thin intervening layers of sandy material are also present, but are typically found at depths below 40 inches. Shrink-swell potential is moderate to high. Catman and Venadito soils have heavy clay textures throughout and exhibit high shrink-swell characteristics.

Many of the soils in the Gallup area are sodium and salt affected. The presence of black greasewood, slick spots, and surface salt crusts indicate the presence of sodium and or salts.

Most of the channel along Catalpa and its tributaries is characterized by vertical cutbacks ranging in height from two feet up to about 30 feet. Flow in the channel bottom undermines the vertical banks, which then collapse into the channel. Very few coarse fragments are found in the drainages of the study area. Small areas within the floodplain and above it may consist of coarser textured soils, but these areas are of minor extent. In addition, erosion in some channel reaches has completely removed surface soils, and exposed the underlying shale and sandstone bedrock.

Soils of the upland areas in the study area are typically shallow (less than 20 inches) underlain with either sandstone or shale. Textures range from loamy sand to clay. These soils are in hydrologic group D due to their shallow depth. Typical soils which occur in the area are Celacy, Atarque, Mion, and Skyvillage. Slopes are highly variable ranging from nearly level to 70 percent. Rock outcrop is a significant component in some areas. Vegetation is sparse on most of these soils and surface runoff is rapid.

SOCIAL AND ECONOMIC

Gallup is the economic center for about 90,000 people in a 15,000 square mile trade area that includes the Pueblo of Zuni and portions of the Navajo Indian Reservation in northwestern New Mexico and northeastern Arizona. Growth and expansion in the Gallup area is due primarily to its function as a commercial center. The economy of the region is primarily dependent on retail and wholesale trade; federal, state, and local government agencies; tourism; light manufacturing; and agriculture and the energy extraction industries. Gallup also serves as a retail, wholesale, and distribution center for Indian-manufacturing goods. The 1980 population of McKinley County and Gallup was 56,449 and 18,161 respectively, up 30.3 and 24.4 percent, respectively since 1970.

UNIQUE OPPORTUNITIES AND PROBLEMS

The Soil Conservation Service Planning Team inventoried the natural and unique resources of the two arroyos. The following is a discussion of this inventory.

A unique and beneficial area was identified along the Little Puerco Wash upstream of the Pepsi Plant south of Apache Circle. It could be used as a park or natural open area, making it valuable to Gallup's long-range recreation plan. This area could provide esthetic and economic benefits by protecting it from subdivision or industrial development.

A community group could convert this area to a park; however, the work should be done before any more of the riparian area is filled or altered. Park development could be as simple or as intense as the community desires.

A significant problem was also identified. Large reaches of both the Catalpa and Little Puerco have been filled with dirt and debris. This filling brings the ground surface out of the flood zone for commercial and residential development. The dirt which is used as fill consists mostly of fine-loamy soil with a mixture of concrete, asphalt, sandstone and shale from excavations and other sources. In some areas, the fill contains commercial "garbage", such as scrap lumber, tires, metal pipe, ducts, refrigerators and automobiles. Typically fill is pushed into the floodplain. No shaping of the backslope is done and the slope assumes the angle of repose for the "mix".

The continued filling and development in the watercourses of the Little Puerco and Catalpa accentuates the potential for even greater flooding in the community.

Loose fill material dumped in the arroyo to develop commercial lots causes reduced flow capacity and increased soil erosion.

VEGETATION - This area is in the Western Plains Subresource Area of the New Mexico and Arizona Plateaus and Mesas Major Land resource area. The drainage area above Highway 564 is primarily native rangeland. The area below Highway 564 is a mixture of urban area and native vegetation. Little Puerco Wash has some pinon, one-seed juniper, and a few remnant ponderosa pine on the uplands. The rest of the native vegetation is a variety of native grasses and shrubs including big sage, rubber rabbit brush, fourwing saltbush, broom snakeweed, prickly pear cactus, yucca, black grease-wood and winterfat. Grasses include Indian ricegrass, western wheatgrass, blue grama, sand dropseed, and spike muhly. A variety of annual and perennial forbs exist in the area.

RIPARIAN - The Little Puerco Wash has a well developed riparian area starting just above Apache Circle and upstream to the rock falls. Native willows (Salix species) are growing in the bottom of the arroyo and they are 30 to 40 feet tall. This area is significant because it provides a diversity of trees for wildlife and esthetics not common to the City of Gallup. These trees can provide a ready source of poles for riparian plantings where water is available. Catalpa Canyon has very little woody vegetation. Some reed canary grass is growing in the bottom of the canyon.

Apache Circle Arch Pipe culvert after July 13, 1990 flood. Capacity is 100 CFS. Storm flow was estimated at 1000 CFS.

WILDLIFE - The steep dirt and rock banks, and the variety of vegetation along Catalpa Canyon and Little Puerco Wash provide habitat for a variety of wildlife. These include songbirds, rock squirrels, ground squirrels, gray fox, coyotes, raptors, cottontails, jackrabbits, ravens, amphibians, skunks, rattlesnakes, and dove. Mule deer have been seen on the upper end of Catalpa Canyon. The main limiting factor for wildlife habitat is the distribution of permanent water within the study area. The riparian area on Little Puerco Wash provides a diversity for wildlife not found anywhere else within the City of Gallup.

THREATENED AND ENDANGERED SPECIES The U.S. Fish and Wildlife Service (USFWS) has indicated that no listed species would be affected by the proposed alternatives. The occult little brown bat, mountain plover, and long-billed curlew are Category 2 candidate species which may be affected by some of the alternatives. Category 2 candidate species are those that the USFWS considers appropriate for possible listing (See Appendix F).

HISTORIC, ARCHAEOLOGICAL, AND CULTURAL RESOURCES - The New Mexico Office of Cultural Affairs, Historic Preservation Division has determined that no properties are listed on or determined eligible for inclusion in the National Register of Historic Places or the State Register of Cultural Properties. There are, however, numerous archaeological sites near the area. The Division has recommended that an intensive cultural resource survey of the affected area be conducted to identify historic resources prior to any land disturbing activities that may be recommended in this study. (See Appendix F).

FLOOD HISTORY

The City of Gallup has an extensive history of flooding with accounts dating back to 1881. Precipitation and stream gage records, however, are either too recent or nonexistent. No gage data exists for either Little Puerco Wash or Catalpa Canyon. Precipitation data at the airport does not always reflect the local thunderstorm precipitation amounts or intensities that occur in the downtown area. This is readily evident from the rainfall records of the July 13, 1990, storm. Newspaper accounts are helpful but do not always give enough detail to distinguish between Rio Puerco floods and floods from local tributaries. Notable floods on the Little Puerco Wash probably occurred in 1923, 1933, 1959, 1964 and 1990.

The July 13, 1990, rain and hail storm occurred between 3:30 and 4:30 PM. Rainfall within the previous 10 days of the storm amounted to 1.14 inches. High soil moisture and flow restrictions caused by the hail accumulation aggravated the flood damage. This flood resulted in the death of one man and over one million dollars in damages to streets, sidewalks, drainage facilities, homes, and commercial and retail property. Table 1 itemizes by category the dollar amounts of damage. This flood damaged 41 homes on the south side of Gallup. Eight of these homes were totally destroyed and the remaining homes received slight to major damages. Approximately 70% of the residents of damaged or destroyed homes have an income of less than $10,000. These income levels magnify the economic hardship placed on area residents from flooding.

Zuni and Ford Canyons may have contributed to the damages, but the Little Puerco Wash played a significant role. The tunnel buckling at Coal Avenue and reverse flow at the storm sewer inlets along Highway 66 are two indicators of the system's insufficient capacity.

Rainfall reports varied across the city:

	Inches
Airport	0.79
Catalpa Canyon	
East Fork	0.82
Middle Fork	1.3
West Fork	1.2
Stage Coach Subdivision	1.2
Gallup Sand & Gravel bucket measurement	2.5

Since most of the precipitation fell within a 20 to 30-minute period, this storm is estimated to be a 25-year frequency event. A storm of this magnitude or greater could be expected, on the average, to occur once every 25 years.

Historical flood damages of the incised Catalpa Canyon, with its tremendous capacity, have not been documented. Aztec Avenue Crossing, built about 15 years ago, has not been overtopped. The primary damages along the Catalpa have been the erosion and head cutting in the reach between Aztec Avenue and the middle of the golf course. Side tributaries in this reach have also suffered from severe head cutting and channel widening.

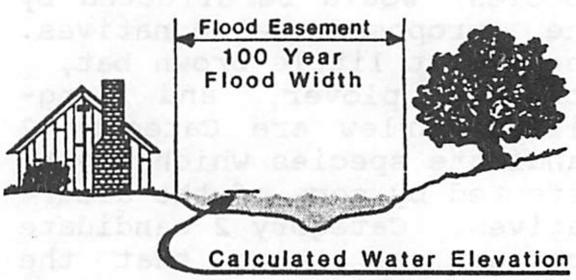
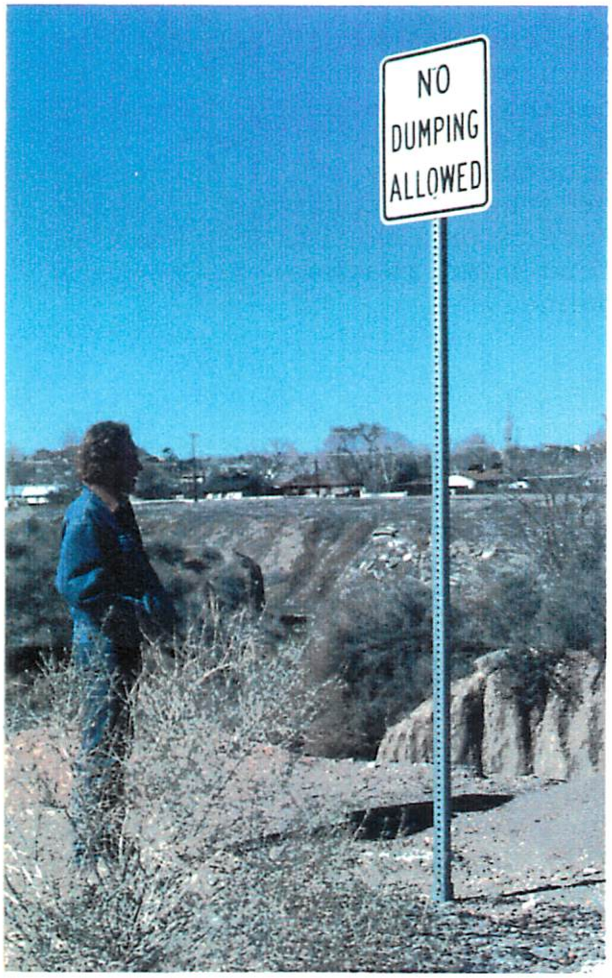


TABLE 1

DAMAGES RESULTING FROM JULY 13, 1990 FLOOD

Residential Property	39 Homes	$ 509,825	45 %
Commercial Property	17 Buildings	450,000	39 %
Streets and City Property		184,000	16 %
TOTAL		$ 1,143,825	

Note: Damages reported here occurred in the Little Puerco Wash and Zuni Canyon



<u>EXISTING STORM WATER MANAGEMENT</u>

Currently the City of Gallup is a participant in the National Flood Insurance Program which requires communities to enforce the Federal Emergency Management Agency's (FEMA) minimum standards within the designated (mapped) flood zones. This program primarily targets proposed developments in the floodway to ensure they will not be flooded or cause an increase in flood damages elsewhere. The problem in Gallup is that most of the damages are repetitive to buildings and property that have existed for years. A more aggressive plan is needed to control new development and to reduce flood risks to existing properties, located downstream from developing areas. FEMA has recognized the benefits of such a program and has developed the Community Rating System (CRS) to promote and encourage communities to reduce existing flood risks by offering insurance premium credits.

Control of filling in water courses and arroyos can currently be regulated indirectly with the existing building code which requires a minimum compaction and adequate bearing strength for a building site. Loose fill placed in an arroyo would be removed and replaced with compacted fill suitable for building before a permit is issued. Historically this scenario has not been the case. While ensuring a safe foundation, this procedure will not control bank erosion or provide the adequate arroyo cross section needed to carry

Repairing head cuts is a continuous expense at the Municipal Golf Course.

the storm runoff. This situation is especially critical on the Little Puerco between Dee Ann Street and the rock overall north of Nizhoni Boulevard.

RECOMMENDATIONS AND ALTERNATIVES FOR FLOODPLAIN MANAGEMENT Two basic differences exist between the Little Puerco and Catalpa. The Catalpa channel has a very large flow capacity with very little development adjacent to it. The opposite is generally the case for the Little Puerco. Consequently the recommendations are much different except in the areas of channel stability and controlling future development. Guidelines for developing a management plan are presented in Appendices A & B.

CATALPA CANYON - The Catalpa Canyon channel has tremendous potential as a scenic park, open space area or numerous other types of developments. However, the growing "little grand canyon" is far from being a tourist attraction. Instead, current landowners, such as the Municipal Golf Course and Gallup School District, are fighting to save their real estate from washing into the Rio Puerco and on into Arizona. Channel stabilization measures are recommended to stop the channel widening and head cutting of tributary channels. Grade stabilization structures would be located throughout the reach between Aztec Avenue and the golf course. The channel would aggrade to a cross section capable of carrying the 100-year flow. Aggrading the main channel would benefit the tributary channels by eliminating or reducing the drop in elevation. Some drop structures may still be needed for the tributaries. Bank protection would be needed along some reaches of the main channel.

LITTLE PUERCO WASH - One advantage of the watershed is that existing runoff volumes are not expected to increase greatly in the future. This projection is due primarily to the extent of fairly tight soils.

The Little Puerco Wash has some serious capacity limitations, especially in the lower fully developed reach. Recommendations for the Little Puerco include storm sewer improvements, channel improvement, tunnel maintenance, culvert replacements and a floodwater retarding dam. The construction of a dam is the critical measure in providing the downtown area with a 100-year frequency flood protection level. Without a dam or major tunnel reconstruction, the best possible protection would be something less than the 25-year level. The alternative, tunnel reconstruction, would mean increasing the capacity between Aztec Avenue and the Puerco River five times its current capacity. Construction of a new tunnel between Aztec Avenue and the railroad tracks is deemed impractical. The channel between the railroad tracks and the Rio Puerco would also need to be rebuilt including the recently constructed gates at the Rio Puerco junction.

Culvert at Roundhouse Rd. with 200 cfs capacity. At least 800 cfs is needed.

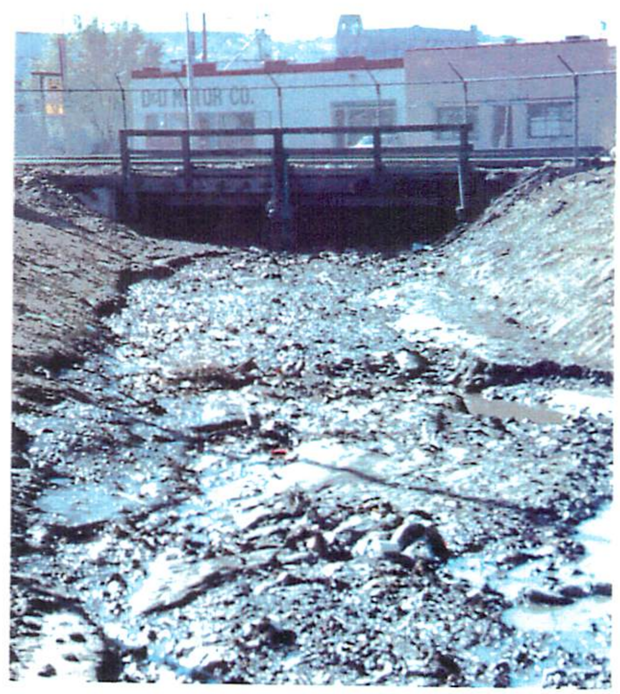
FLOODWATER RETARDING DAM

A detention dam is needed and recommended to reduce peak flows to a level that can be safely handled by the existing channel and culverts. A dam with a maximum principal spillway release of less than 200 cfs and some additional improvements to the downstream channel and storm sewer would allow the 100-year flood to pass through the system safely.

The detention dam would need to be approximately 40 feet high with flood storage of 65 acre feet which includes 8-10 acre feet of sediment storage. This sediment pool would require periodic cleanout. The principal spillway conduit (3 ft. in diameter by 200 ft. in length) would have a capacity of 180 cfs. This system would reduce the peak flow at the tunnel entrance to less than 800 cfs and the total peak flow at the Rio Puerco to 1150 cfs. This capacity is somewhat higher than the 800 cfs design capacity of the Corps of Engineers' gate at the Little Puerco mouth. However, with some improvements to the storm sewer system in the downtown area, the capacity should equal the 100-year flood peak. (See Appendix E for hydrologic/hydraulic, structural and geotechnical information).

STORM SEWER IMPROVEMENT

Storm sewers in the downtown area are undersized with capacity estimated at less than the 25 year storm frequency requirement. Reports



Sediment accumulation at the tunnel outlet has reduced flow capacity to half of what the clean channel carries.

of four to five foot water spouts flowing up at the inlet grates testify to their inadequacy. Two areas of needed improvement were identified: along Second Street and adjacent to the underground tunnel. Currently, the limited access of street inlets to the underground tunnel results in most of the surface runoff generated downstream of the tunnel entrance to flow north along Second Street or in a northwesterly direction to the Zuni Canyon drainage. This area is where much of the flood damage occurred during the July 13, 1990, storm. With improved storm sewer capacity, the flood risk along Second Street could be alleviated and the underground tunnel would be better utilized during periods of less than design flow (approximately 800 to 1,000 cfs). It is recommended that the storm sewer system be evaluated for upgrading to the 100-year capacity.

CHANNEL IMPROVEMENTS DOWNSTREAM OF THE RAILROAD TRACKS

The maximum capacity of the open channel and road culverts between the railroad tracks and the Corps of Engineers' gate is 200 cfs. A capacity of 800 to 1,000 cfs is required to remove the bottleneck in the tunnel system. A trapezoidal channel with a 12-foot bottom width and 3:1 side slopes would meet the requirements. Culverts at the entrance to Gallup Sand and Gravel Inc. and at the Roundhouse Road crossing would be replaced, preferably with a bridge crossing instead of culverts.

CULVERT IMPROVEMENT AT NIZHONI BLVD.

The culvert crossing at Nizhoni Boulevard has a flow capacity of 250 cfs. The existing culvert can handle the runoff from a five-year frequency storm. A ten-year frequency storm exceeds the culvert capacity by about 130 cfs. It is recommended that this culvert be replaced with an 8.5 foot diameter concrete pipe with a conventional beveled entrance and headwall to carry the 100 year peak flow of 940 cfs.

CULVERT IMPROVEMENT AT APACHE CIRCLE AND DOWNSTREAM CULVERT ENTRANCE

The arch pipe culvert at Apache Circle, along with the downstream five-foot diameter by 1,000-foot-long culvert, are also bottlenecks. Existing storm flow capacity at this point is estimated to be 100 cfs, primarily because of the restrictive entrance of the five-foot diameter culvert. Both culverts are capable of trapping significant amounts of trash during flood flows. These two culverts need to be upgraded to handle a minimum of 350 to 450 cfs if the upstream flood control dam is installed. The alternatives, without the dam, is to upgrade this reach to handle the 100-year flood of 1900 cfs.

TUNNEL MAINTENANCE

Tunnel maintenance should be considered the most important immediate treatment to reduce flood risk. The underground tunnel between Mesa Avenue and Roundhouse Road has been operating for the past 25 years or more at less than half of its capacity. Considering that the tunnel represents the most critical reach in the channel system and that the design capacity is only 22 % of the required 100-year flood flow, maintaining its maximum capacity is essential. Sediment and trash accumulation mainly occurs between Aztec Avenue and the tunnel exit where the slopes become flatter and the box channel widens. Flow depths have been restricted to 2.0 to 3.0 feet with no cleanout. When this reach is cleaned down to the concrete floor, it has a depth of 4.0 to 5.0 feet.

In addition to inspecting the tunnel annually before the rainy season and after each major flow and removing sediment and trash when needed, a structural inspection should be made of the tunnel. Although the overall structural condition is fair, parts of the tunnel warrant the attention of the City before these deficiencies become much more costly to remedy. Immediate attention should be given to the entrance and to deterioration of the walls at storm sewer pipe outlets and sanitary sewer crossings.

FLOODPLAIN MANAGEMENT REGULATIONS

The City is required to meet minimum FEMA regulations to participate in the Flood Insurance Program. These floodplain regulations apply to those areas within the 100-year floodway. However, many of the opportunities to reduce flood risk lie outside the designated floodway. Since these regulations concentrate on preventing future development from becoming flood risks, Gallup needs to decide what degree of regulation is needed to reduce recurring flooding.

The City first must develop, adopt and enforce regulations to control erosion, sedimentation and flooding. Appendices A & B of this report, "Preparing and Enacting Floodplain and Watercourse Management Ordinances" and "Elements of Terrain Management Plans" provide guidance.

INVESTIGATION AND ANALYSIS

HYDROLOGY

Several hydrologic models are available to estimate existing and future runoff volumes (acre feet) and peak flows (cubic feet per second or cfs). TR20 - Computer Program for Project Formulation, Hydrology - by the USDA Soil Conservation Service was selected because of familiarity with the program, multiple subwatershed and routing capabilities and ability to model reservoir routing and channel modifica tions. The flexibility of TR20 was useful in developing flood reducing alternatives, especially for the Little Puerco Wash detention reservoir. TR55 - URBAN HYDROLOGY FOR SMALL WATERSHEDS will be made available to the City to estimate runoff for subdivisions and development sites.

Although not as complex as TR20, TR55 will provide a close approximation to the TR20 results.

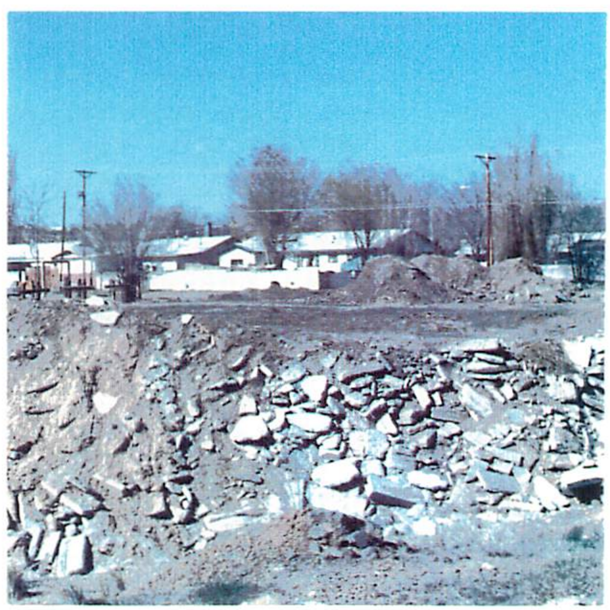
Nizhoni Blvd. culvert inlet.

The Little Puerco Wash runoff joins runoff from Zuni Canyon as the surface flows converge in the downtown area; especially at Coal, Aztec, Highway 66 and Maxwell. The underground tunnel is the only direct conveyance to the Rio Puerco. Excess surface (street) flows separate in two different directions by the time they reach Historic Hwy 66. Excess flood flows enter the Zuni Canyon drainage to the west. Consequently any flood studies of the adjacent areas must account for the impacts of the Little Puerco Wash flows as well.

Catalpa Canyon hydrology is less complicated since the floodplain is bisected by a deep canyon in the lower reach of the watershed.

Rainfall values for the 2-, 10-, 25-, 50- and 100-year 24-hour events were used to develop the existing and future runoff hydrology and evaluate alternatives. Precipitation values were obtained from NOAA Atlas 2, <u>Frequency Atlas of the Western United States</u>. Soils information was derived from unpublished surveys. Runoff curve numbers were assigned for existing and future conditions based on field investigations, aerial photography and the soil survey. Time of concentration was computed by the Modified Kirpich Equation. This was deemed reasonable since well defined drainage channels are normal throughout the subwatersheds. Two previous studies were used for comparative purposes, which showed that the TR20 analysis was reasonable.

Peak flows for various loca tions are shown for the selected return frequencies in Table 2. Table 4 summarizes the subarea parameters and results from the TR20 model.



Floodplain regulation is needed to control filling of arroyos.

TABLE 2

PEAK FLOWS FOR VARIOUS RETURN PERIODS

CATALPA CANYON

Return Period (Yrs)	2	10	25	50	100	100 year Elevations
St Rd 564 (cfs)	200	850	1405	1720	2235	6653.4
High School at Athletic Field. (Sta. 61+05) to Rio Puerco	430	1510	2235	2740	3340	6562.8

LITTLE PUERCO WASH

Return Period (Yrs)	2	10	25	50	100	100 year Elevations
Dee Ann (cfs)	50	180	275	320	400	6736.8
St Rd 564	100	325	500	600	750	6715.3
Nizhoni	110	400	620	745	950	6685.3
Above Rock Falls	125	520	830	1000	1250	6652.3
Below Rock Falls	170	710	1100	1300	1625	6617.6
Apache Circle	150	730	1140	1530	1890	6601.2
CM Overflow	0	530	950	1330	1700	6601.1
Tunnel Entrance at Mesa Ave.*	185	540	1035	1470	1900	6528.2
Tunnel Outlet** at RR Tracks	135	400	400	400	400	6497.5

*Maximum Watershed Discharges
**Assumes tunnel in clean condition - without sediment/debris accumulation

TABLE 3

ONE HOUR AND 30 MINUTE DURATION
PRECIPITATION VALUES (Inches)

Return Period Yrs.	STORM DURATION 1 HR.	30 MIN.
2	.62	.49
5	.80	.63
10	1.0	.79
25	1.3	1.03
50	1.55	1.22
100	1.8	1.42

HYDRAULICS

Water surface elevations were determined for the various storms with the use of the SCS WSP2 computer program. Table 4 shows selected locations with the 100-year water surface elevations. Over 30 cross sections were used on each arroyo in the evaluation. The channel reach for the Little Puerco Wash extends from Dee Ann Street at the upper end to the Rio Puerco. On Catalpa Canyon, flow depths were generated from Highway 564 south of the Municipal Golf Course to the Rio Puerco. Water surface profiles were limited to subcritical flow analysis by the program, which means critical flow depths were assumed when velocities exceeded subcritical conditions. This computation may give slightly higher water surface elevations at several cross sections. This occurs primarily in the underground tunnel on the Little Puerco Wash where a slightly higher water surface elevation will not affect the width of the flood zone.

Table 5 illustrates the excess runoff that cannot be handled by the existing underground tunnel and outlet channel in the downtown area. Three factors affect the tunnel capacity through the downtown area. They are 1) limited storm sewer inlets, 2) limited tunnel capacity in the lower section of Aztec Avenue to the railroad tracks and 3) limited channel and culvert capacities between the railroad tracks and the Rio Puerco.

TABLE 4

SUBWATERSHED PEAK FLOWS
CATALPA CANYON

SUBAREA	AREA SQ MI	LENGTH FT	RUNOFF PRES.	CN FUT.	Tc Hrs	100-YEAR PRESENT CFS	AC FT	100-YEAR FUTURE CFS	AC FT
1	3.58	18,000	71	75	0.85	1082	101	1477	132
2	1.36	11,600	84	86	0.65	1268	5	1425	95
3	0.81	9,000	85	86	0.91	605	53	641	56
4	1.02	9,200	83	88	0.52	1085	61	1443	79
5	0.68	8,400	91	92	0.55	1071	61	1124	64
TOTALS	7.45						281		426

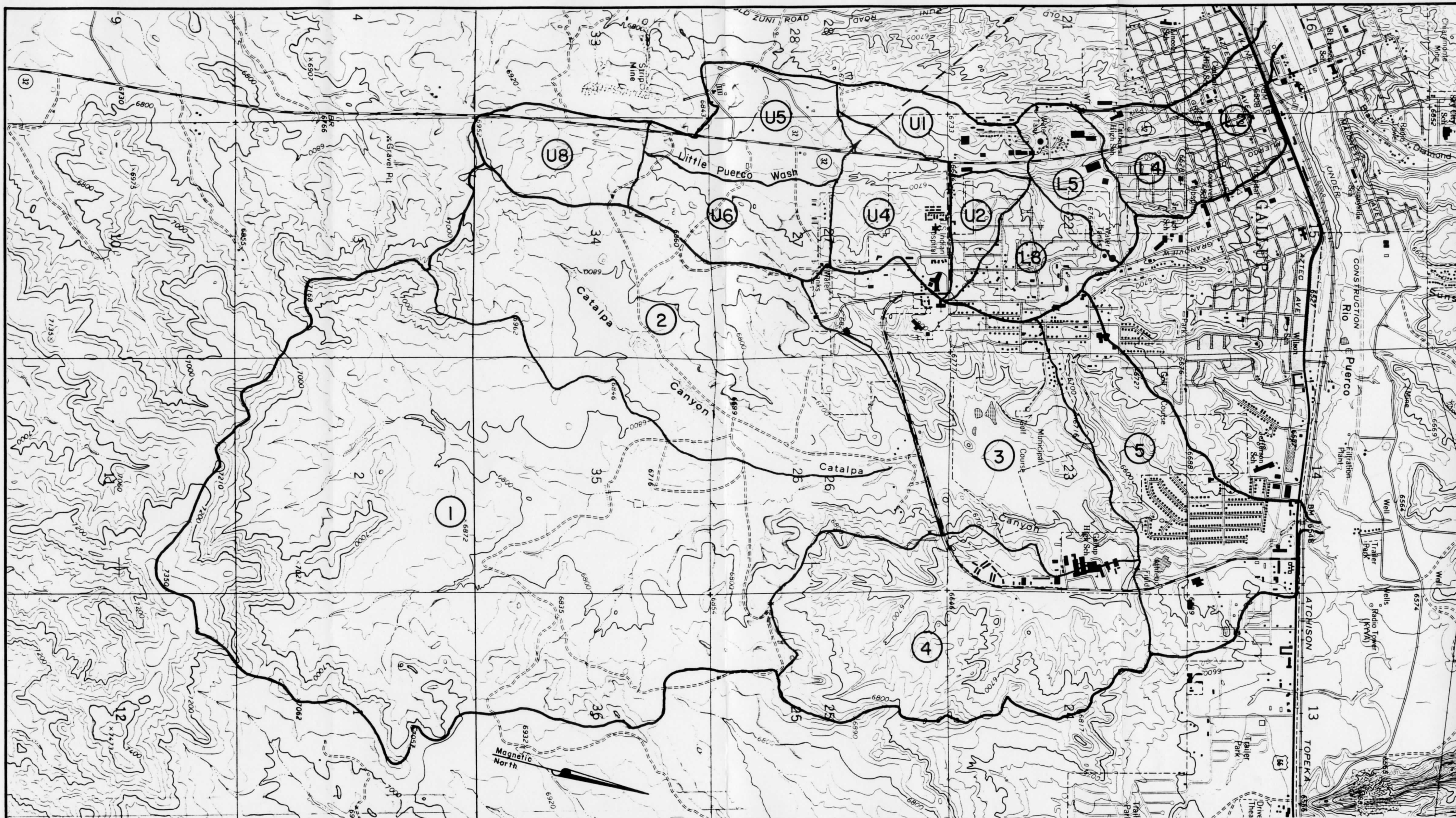
LITTLE PUERCO WASH

SUBAREA	AREA SQ MI	LENGTH FT	RUNOFF PRES.	CN FUT.	Tc Hrs	100-YEAR PRESENT CFS	AC FT	100-YEAR FUTURE CFS	AC FT
U8	0.24	3,600	81	84	0.21	400	15	495	16
U6	0.40	4,700	84	88	0.32	645	29	800	32
U5	0.18	4,200	68	75	0.28	100	5	180	7
U4	0.23	3,800	83	89	0.24	405	16	570	20
U2	0.13	4,400	85	88	0.30	230	10	270	11
U1	0.13	3,700	78	88	0.26	170	7	295	11
L8	0.20	3,700	85	86	0.23	435	15	435	15
L5	0.18	2,300	86	88	0.14	515	14	515	15
L4	0.18	3,000	90	92	0.18	580	18	580	18
L2	0.14	2,680	95	95	0.31	390	17	390	17
TOTALS	2.01						146		162

TABLE 5

RUNOFF IN EXCESS OF CAPACITY
LITTLE PUERCO WASH

Return Period in years	100	50	25	10	5
Tunnel - Aztec to Railroad outlet (cfs)	1400	930	330	0	0
Outlet Channel Railroad outlet to Rio Puerco	1600	1130	530	50	0



2000 1000 0 2000 4000
Scale in Feet

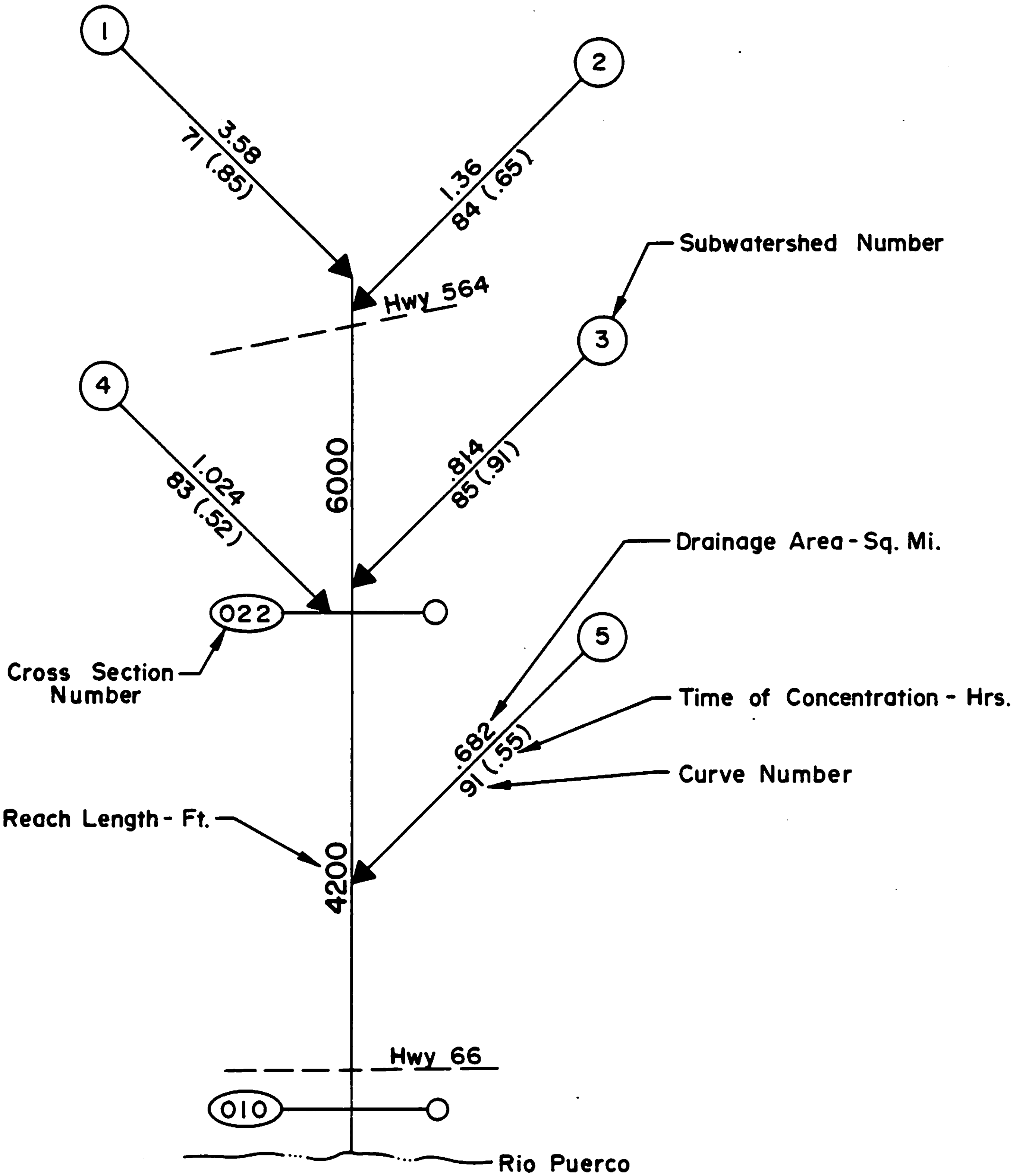
SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

Source Map - USGS Quadrangle
7.5 Minute Series

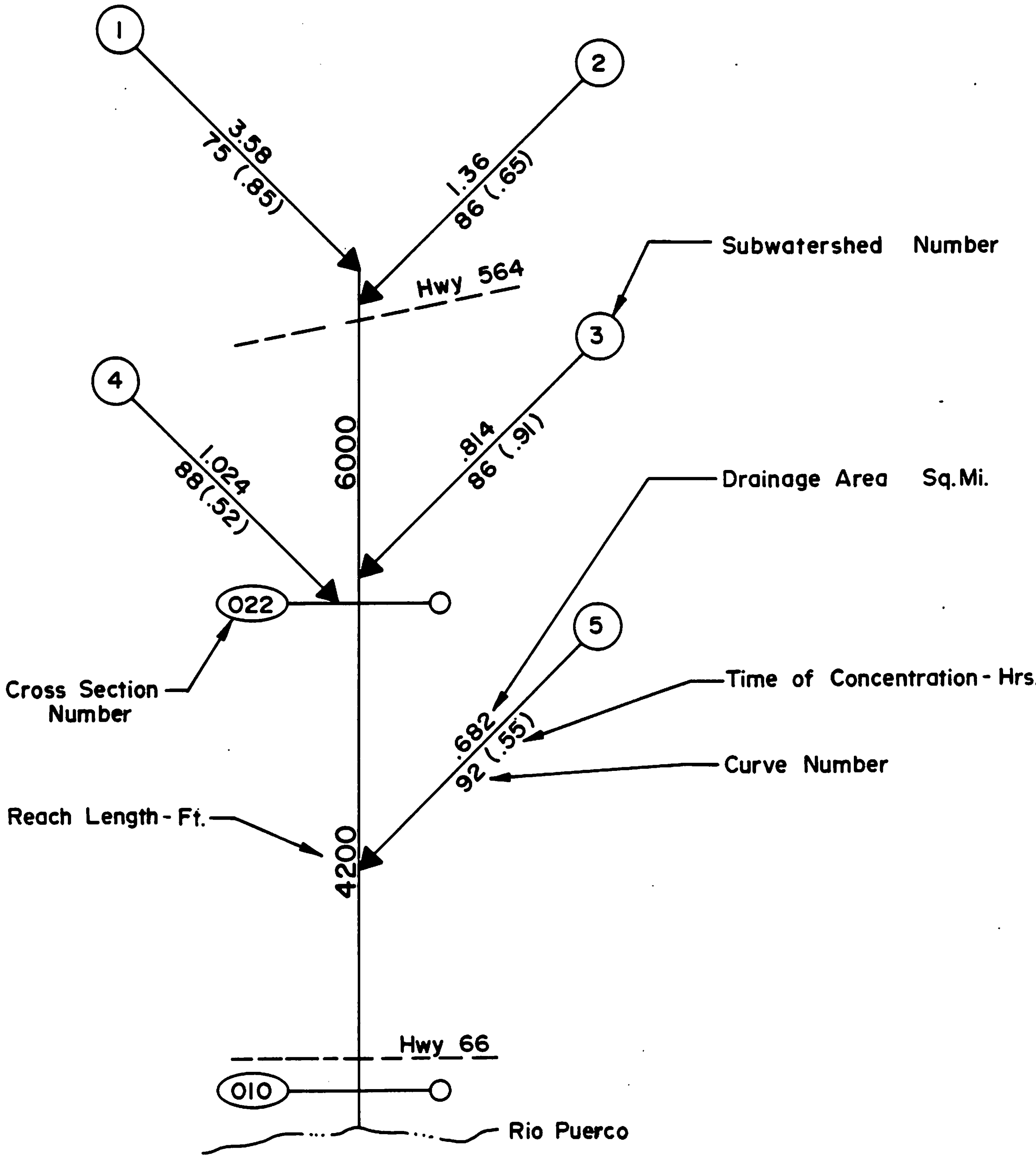
ROAD CLASSIFICATION
Heavy-duty
Medium-duty
Light-duty
Uniproved dirt
Interstate Route
U.S. Route
State Route

Subwatersheds
Little Puerco Wash
and
Catalpa Canyon
Floodplain Management Study

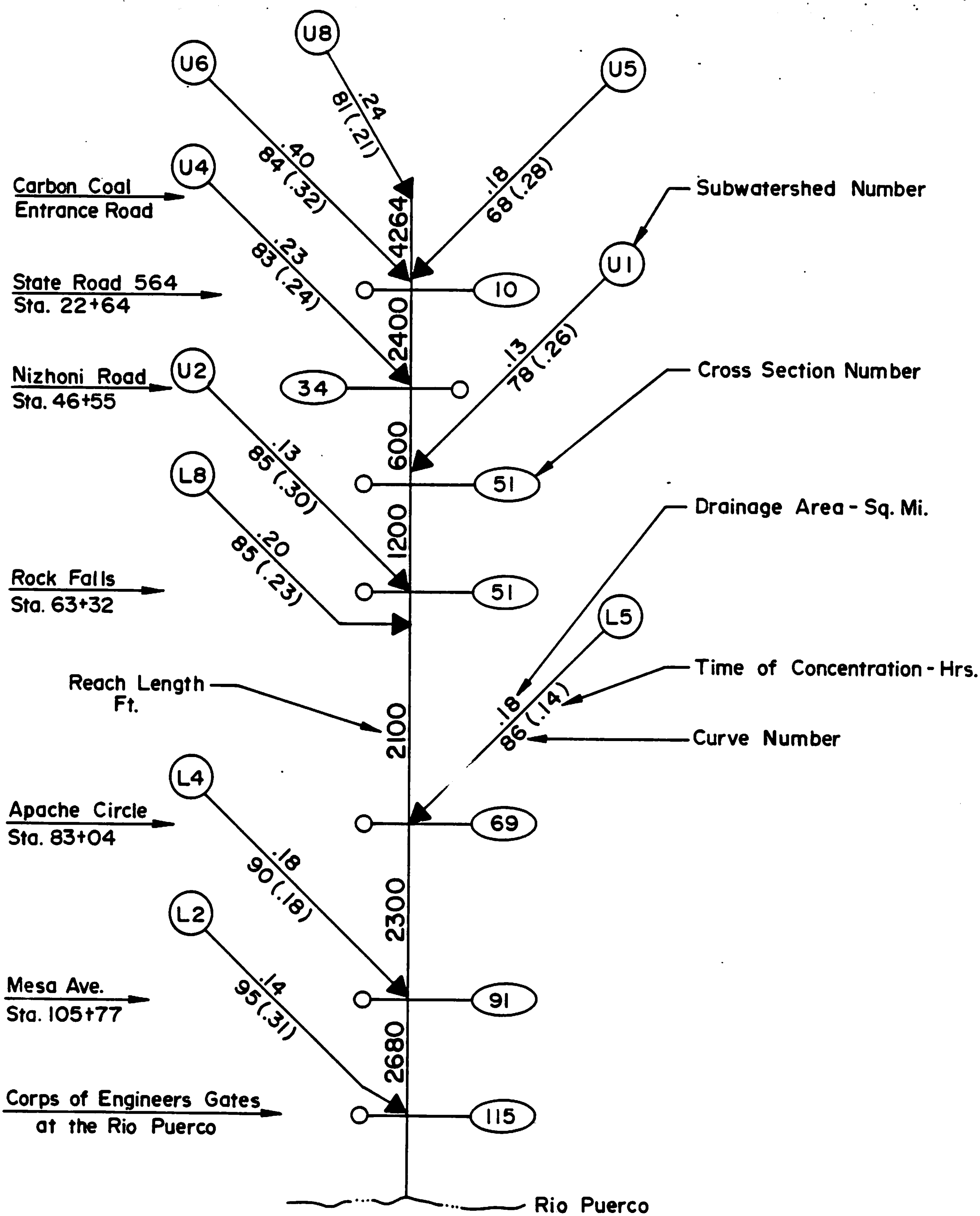
Catalpa Canyon
Watershed Schematic
Present Conditions



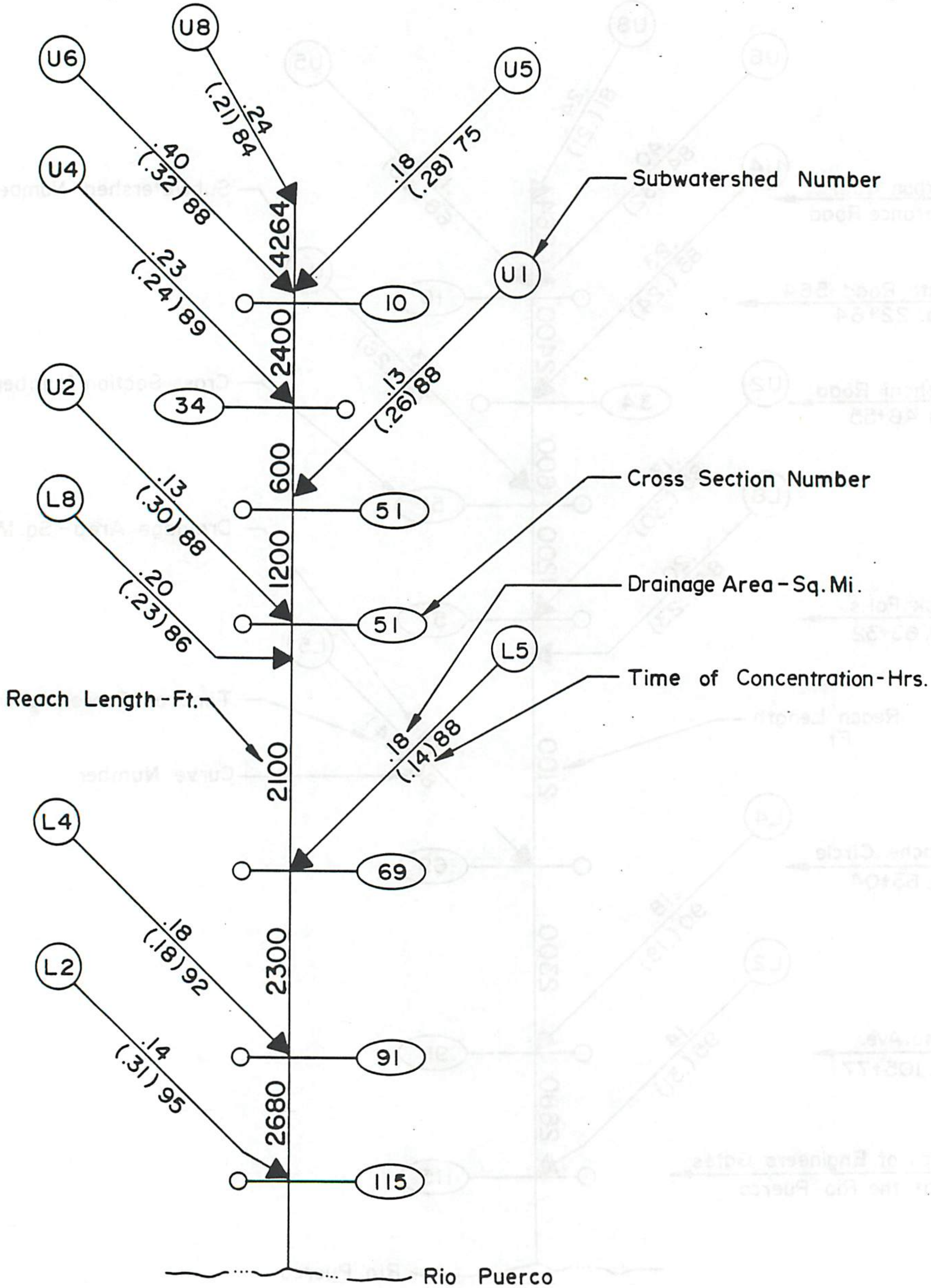
Catalpa Canyon
Watershed Schematic
Future Condition



Little Puerco Wash
Watershed Schematic
Present Conditions



Little Puerco Wash
Watershed Schematic
Future Conditions



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APPENDICES

APPENDIX A

DEVELOPING FLOODPLAIN MAPS AND PREPARING AND ENACTING A FLOODPLAIN MANAGEMENT ORDINANCE

INTRODUCTION

This appendix has been edited from Regulating Floodplain Development - A Handbook for Local Officials, by Department of Community Affairs, Commonwealth of Pennsylvania and the Chaperon Park Watershed Area Study, El Dorado County, CA, Soil Conservation Service, Davis, CA, July 1985. It summarizes procedures local governments can use for watercourse and floodplain management. The first half of this Appendix describes the steps that this study went through to develop floodplain data. The second half of this Appendix describes the most important aspects of preparing and enacting local floodplain management ordinances.

WATERCOURSE MANAGEMENT

Watercourse management may be defined as the full range of carefully planned public policy and action designed to promote the wise use of watercourses and to reduce future flood damages. A comprehensive watercourse management program includes corrective measures to rectify existing problems and preventive measures to keep new problems from developing as listed below:

WATERCOURSE MANAGEMENT TECHNIQUES

I. Actions to Protect Existing Watercourse Development and to Correct Existing Problems:

- -flood control devices such as dams, levees and floodwalls
- -floodproofing of existing structures
- -clearance and/or relocation of existing structures
- -public works projects to remove or minimize water obstructions or to control stormwater runoff
- -regulation of existing nonconforming uses or structures
- -flood forecasting and warning
- -evacuation planning

II. Actions to Guide Future Watercourse Development:

- -public acquisition of undeveloped land
- -local building and land development regulations
- -flood insurance
- -comprehensive planning
- -compatible public improvements
- -public awareness

Local governments have the primary responsibility for establishing watercourse management programs. They have the authority to guide land use and development within their jurisdictions and are more familiar with their own flooding problems and what might be done about them. State and federal governments can play a significant role in helping communities develop the necessary financial and technical assistance which local governments might not otherwise have.

LOCAL REGULATION

This section is directed at just one aspect of local watercourse management - the regulation of construction and development within flood prone areas. Communities are encouraged to develop and administer regulations as part of a broader watercourse management plan or program that establishes defined goals and objectives, within which specific regulatory actions can be guided.

Local land use regulations can be an important part of an overall watercourse management program. Zoning regulations can control the type, density and location of uses within flood prone areas. Subdivision regulations can be used to ensure that known flood prone areas are clearly described on plans for effective management and for adequate notification to potential buyers.

Building codes set forth flood-proofing design and construction standards to lessen the vulnerability of new buildings to flood damage. Each type of regulation achieves a slightly different objective and all are important in reducing future flood damages.

The limitations of local regulations must be recognized, however. While they are important in an overall program of watercourse management, they are almost exclusively aimed toward future construction. That is, although they can be used effectively to help prevent the problem from becoming any worse, they will not be very useful in reducing damage potential to existing structures. This situation emphasizes the need for both corrective and preventive measures to achieve adequate watercourse management.

NATIONAL FLOOD INSURANCE PROGRAM

The National Flood Insurance Program (NFIP) was created by the National Flood Insurance Act passed by Congress in 1968. The purpose of the NFIP is twofold:

1. To provide the general public with the opportunity to obtain flood insurance at reasonable rates to cover damages to buildings and their contents due to flooding; and

2. To reduce future flood damages by requiring the regulation of new development in flood prone areas.

The NFIP is administered by the Federal Insurance Administration (FIA) within the Federal Emergency Management Agency (FEMA). The insurance is sold through local insurance agencies. Insurance companies in Gallup currently have forty policies in effect with a total of $2,488,800 worth of flood coverage under the NFIP. In addition, there are 150 to 200 mobile home policies with some flood damage coverage.

A property owner may buy flood insurance if the community within which the property is located participates in the NFIP. The community must adopt and enforce local land development regulations which, at a minimum, meet NFIP requirements.

MAPPING METHODS

A number of different methods can be used to map flood prone areas, including the analysis of soils, vegetation, physiography, flood of record and hydrologic and hydraulic factors. The type of mapping needed by a community will depend on many things, but most importantly, it will depend upon the ultimate use of the map.

For regulating watercourse development, a map developed through hydrologic and hydraulic analysis is preferable. The advantage of this method is that specific frequencies of flooding can be selected for delineating flooded areas. It is often difficult to associate the delineation of a floodplain based on soils, physiography or vegetation with a particular frequency of flooding. If applied properly, this method provides a sound technical and legal basis for adopting and administering watercourse management regulations for urban areas.

However, if it is too costly to do so or if adequate flood data are lacking, other types of maps can be used. Communities utilizing other types of maps are encouraged to incorporate ordinance provisions which require that floodplain data be refined when considering individual permit applications.

Since the National Flood Insurance Program uses hydrologic and hydraulic analysis in preparing Flood Insurance Studies, it is helpful for those involved in the preparation and administration of floodplain management ordinances compliant with NFIP requirements to have a general understanding of how these maps are developed.

Simply stated, the science of hydrology is used to determine the amount of water which an arroyo or river must convey for a given storm. This involves calculating the amount of runoff that can be expected to drain from the surrounding watershed. The principles of hydraulics are applied to help determine how the arroyo or river will handle the flow and to what extent the excess water will spread over the floodplain when the flood is at its peak. Specialized computer programs are used to perform most hydrologic and hydraulic computations.

The following subsections give a brief description of the procedures involved in applying these techniques to prepare floodplain maps.

STEP 1

SELECTING A FLOOD

Step 1 in preparation of a floodplain map is to select a flood of a certain frequency of occurrence. The 100-year frequency flood is the standard typically used throughout the United States. For this type of flood there is one percent or 1 in 100 chances of this size of flood being equalled or exceeded in any given year. A flood of this size could strike twice in the same year, but over a long period of time it should occur on an average of once every hundred years. In more practical terms, a property owner having a 30-year mortgage on a house located within a 100-year floodplain has a 25 percent chance of experiencing a flood equal to, or greater than, a 100-year flood before the final mortgage payment is due.

STEP 2

CALCULATING FLOOD FLOWS

Various techniques can be used to estimate flood flows. Preferred techniques use statistical analysis of actual stream gage data. If stream gage data is not available, other methods which consider the measurable characteristics of the drainage basin can be applied, depending on the size of the watershed.

Stream Records

The data collected from rivers and streams with stream gaging systems can be used to compute flow in the stream for a 100-year flood. For example, it can be computed by using the highest peak flow each year in a statistical analysis. Data points are plotted on a special type of graph paper (log probability) and a line is drawn through these data points. From that graph the flow for a particular frequency flood can be determined. The flow is usually given in the number of cubic feet of water that passes a given location in one second (cfs).

Estimating Flow

When stream gage records are not available or are incomplete, flood peaks must be estimated. Numerous equations for estimating the flood peak have been developed. Their applicability can vary over a wide range. Thus, it is important to choose a procedure that best fits the size and locality of the drainage basin. The techniques for large watersheds are usually based on gaged stream data that have been correlated to physical characteristics of the drainage basin. For example, the Federal Highway Administration method takes into consideration drainage area, rainfall, difference in elevation of the main channel between the most distant point in the watershed and the location of interest, the climatic zone, and the percentage of surface water storage area in the watershed such as lakes, swamps, etc.

The procedures for small ungaged watersheds are usually simpler in nature. An example is U.S.D.A.-Soil Conservation Service TR-55 "Urban Hydrology for Small Watersheds." TR-55 presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for channel design and floodwater storage. These procedures are applicable to small watersheds (up to 20 square miles), especially urbanizing watersheds in the United States.

Whatever technique is used, a combination of the rainfall or stream flow records and the physical characteristics of the drainage basin, such as soils, slope, vegetation and land use, should be taken into consideration.

STEP 3

PREPARING FIELD MEASUREMENTS

Once the flow is known, the particular slope and shape (cross section) of the stream channel and adjoining floodplain are determined at numerous points. A cross section is a graphic picture of a section of the stream and adjoining floodplain cut at right angles to the direction of flow. The best method is by actual field measurement, but the data may be taken from topographic maps. Measurements of man-made encroachments such as dams, bridges and culverts are also obtained.

STEP 4

ESTIMATING RESISTANCE TO FLOW

The resistance to the flow is then needed to complete the data required to calculate the height of water. The resistance to flow, or roughness factor (called roughness coefficient) is determined by analyzing the character of the landscape. For example, a wooded floodplain would tend to hold back the water, causing a higher flood level than a grassed floodplain. A smooth concrete-lined channel will obviously convey water with less resistance than a channel with large rocks and fallen trees. Man-made objects such as buildings, fences, highways and bridges will all have an effect on resistance to the flow.

Since each situation is unique, it is often difficult to estimate the roughness coefficient. However, if there are known high-water marks, the roughness coefficient can be adjusted so the calculated water surface profile agrees with the high-water mark elevation. The equation then would give more reliable elevations for the 100-year flow.

STEP 5
CALCULATING FLOOD HEIGHT

Factors such as stream slope, shape of channel and floodplain, man-made obstructions and natural obstructions are then used in conjunction with the frequency of flood flows (such as the 100-year flow) to compute the flood height.

STEP 6
PREPARING A PROFILE

The flood elevations for each cross-section are then plotted on a profile and the points are connected. A profile is a graphic picture of a section of the stream as if it were cut lengthwise down the centerline giving a side view. The profile shows the water surface for a given flood frequency. Locations of points on the profile can be identified on the aerial map showing the floodplain. (See Appendix C).

STEP 7
DELINEATING THE FLOODPLAIN

The final step is to translate from the profile the height of the flood at each cross section onto a topographic map. The flood elevation for each cross section is plotted on both sides of the stream and the points are connected by lines following contours to show the boundary of the floodplain.

The reliability of the floodplain delineation is dependent on the accuracy of the data used to calculate the elevation and on the accuracy of the topography and features shown on the floodplain map. For example, if the topographic map has five-foot contour intervals and the flood elevation was calculated to the nearest foot, a judgment has to be made where that elevation is located on the map. If that judgment causes a building to be in the floodplain, more accurate data should be obtained to check the validity of the decision. This example indicates the importance to knowing generally what data was used in preparing the floodplain map.

FIA MAPS

Floodplain mapping has been performed for some years by different agencies of federal and state governments. It was not until passage of the National Flood Insurance Act of 1968, that floodplain mapping became a major effort nationwide. The Federal Insurance Administration (FIA) is responsible for preparing maps of flood hazard areas as part of its duties in administering the NFIP. The remainder of this appendix explains the type of mapping FIA provides to municipalities.

FLOOD HAZARD BOUNDARY MAPS

The time and cost involved in preparing detailed floodplain maps made it impossible for the FIA to provide accurate mapping immediately for every flood prone community throughout the country. Consequently, the initial effort was aimed at providing Flood Hazard Boundary Maps (FHBM). Because of the lack of detailed flood data and topographic information to serve as a basis for mapping, FHBMs only show the approximate area of the floodplain and do not show 100-year flood elevations. In addition, not all flood hazard areas may be delineated. For example, FIA does not usually delineate flood hazard areas along streams with drainage areas less than one square mile or flood hazard areas having widths of less than 200 feet. The FHBM also shows the location of roads and highways, railroads, streams and municipal boundaries. Since the FHBM is designed to be used for insurance purposes as well as for municipal use, it identifies "A" Zones (flood hazard areas) and "C" Zones (areas of minimal flood hazard) which are used by insurance agents to determine insurance rates.

When a community receives a FHBM from FIA, it must enact an ordinance regulating all future construction and development within the floodplain based, at a minimum, on the requirements of Sections 60.3 (a) and (b) of the NFIP.

OBTAINING MAPS AND STUDIES

When FIA prepares maps for a community, copies are sent to the municipal secretary or to the chairman of the governing body. Additional copies of FHBMs may be obtained by completing and submitting a map order form to the NFIP map depository in Bethesda, MD. Map order forms may be obtained by contacting the regional office of FIA.

LOCAL FLOODPLAIN OR WATERCOURSE MANAGEMENT ORDINANCES.

An ordinance is the legal means by which communities can set standards and procedures for regulating floodplain development. To comply with the National Flood Insurance Program (NFIP) a community must adopt an ordinance that:

* includes all necessary federal and state floodplain management requirements

* is legally enforceable

* applies uniformly to all floodplain areas

* takes precedence over any less restrictive conflicting local ordinances or codes

THE LEGALITY OF REGULATING FLOODPLAIN DEVELOPMENT

The courts have generally upheld challenges to local floodplain management ordinances as long as the degree of regulation can reasonably be related to the danger posed to the public interest. If a definite danger exists, even strict regulations have been upheld.

Court decisions on floodplain ordinances support local regulations when it can be proven the ordinances:

* comply with statutory procedures to adopt, administer, and enforce the regulations

* properly balance public interests with private rights.

* treat similarly situated landowners according to the same standards

* do not go beyond the powers granted in the enabling legislation

Therefore, it is important to review carefully what is proposed and to follow closely the enacting procedures which apply.

DEGREE OF REGULATION

Communities are required to adopt development controls which, at a minimum, meet federal and state floodplain management requirements.

The extent to which a community may want to regulate floodplain development beyond the federal and state minimum requirements is a local matter and will depend on a number of factors, including the following:

* the extent and severity of flooding

* the amount of land subject to flooding

* the type, amount and location of existing floodplain development

* future growth and development patterns

* the detail to which floodplains are mapped and

* the need to protect natural resources and environmental quality

Floodplain regulations should be part of an overall floodplain management program designed to guide and promote the wise use of floodplain lands and resources. In this respect, floodplain regulations become one of several management techniques employed to attain the goals and objectives of a broader effort to reduce or avoid future flood damages. Having a floodplain or watercourse management plan or program will help communities design regulations which meet local needs and conditions rather than regulations which simply copy state and federal minimum requirements.

Communities that decide to take stronger measures to control future floodplain development have several options. Some of the more commonly applied regulatory approaches are described in the following subsections.

PROHIBITING CERTAIN TYPES OF DEVELOPMENT

Some communities prohibit certain types of development within the floodplain, especially those which present a significant hazard to people or property. Examples include schools, nursing homes, hospitals, jails, mobile home parks, landfills, sewage treatment plants, cemeteries, chemical plants and warehouses, as well as other similar kinds of development that could cause widespread public health and safety problems in the event of flood damage. Emergency facilities such as fire stations, ambulance services, and emergency management offices, which are critically needed in times of flooding, should also be excluded from the floodplain or any other area where they would be cut off in case of flood.

PROHIBITING FLOODWAY DEVELOPMENT

Some communities prohibit development only within the floodway portion of the floodplain, since this is the area which conveys the bulk of the floodwater downstream and is the area where water velocities and forces are the greatest and most destructive. Communities having Flood Insurance Studies are likely to have floodway areas delineated on the Flood Boundary and Floodway Map and can readily use the map description as a basis for prohibiting development. Communities which do not have detailed studies can establish a simulated floodway by the use of a setback distance from the stream.

Some communities use a 50-foot set back measured landward from the top of the channel to regulate encroachments along watercourses which do not have an identified floodway. A community could decide to use a lesser or greater distance, depending on the size and direction of flow of the stream and other features of the floodplain area.

MAINTAINING THE FLOOD FLOW CAPACITY OF STREAMS

Communities which do not have identified floodway areas should consider including ordinance provisions which would only allow future floodplain development if it would not cause an increase in flood heights above a stated limit. The maximum allowable increase is usually one foot above the base flood elevation. This provision would be administered on a case-by-case basis evaluating the effect of a proposed project and other anticipated floodplain development on flood flows.

Communities which have Flood Hazard Boundary Maps (FHBM) or which have detailed Flood Insurance Studies showing approximate flood prone areas should seriously consider this option. Section 60.3(b) requirements of the NFIP are specifically designed to protect structures and not the carrying capacity of streams and adjacent floodplains. Excessive filling and developing of a floodplain without regard to effects on flood flows can result in greater flood velocities and increased flood heights.

SELECTING A REGULATORY FLOOD

Many communities use the 100-year flood as the minimum standard for regulating floodplain development. Under certain circumstances, communities have found it advantageous to regulate development using a flood of greater magnitude, such as any larger flood of record. Some communities with detailed Flood Insurance Studies have adopted the 500-year flood as the regulatory flood. Still other municipalities have used the county soil surveys to regulate development on floodplain soils.

Again, the 100-year flood is a minimum standard. Where it makes sense to do so, larger floods can and should be used.

FURTHER INFORMATION

These are just a few examples of the things that can be done to develop an ordinance which best meets local needs. The local official should ask: "What needs to be done to protect the community?" The following publications and reports provide additional information on this subject matter:

* A Perspective on Floodplain Regulation for Floodplain Management (U.S. Army Corps of Engineers)

* Regulations for Floodplains (ASPO Planning Advisory Service)

* Regulation of Flood Hazard Areas to Reduce Flood Losses (U.S. Water Resources Council)

SELECTING THE TYPE OF ORDINANCE

Once the regulatory approach is selected, the next step before actually drafting an ordinance is to decide which type of ordinance is best suited for the community to regulate floodplain development. Floodplain requirements may be contained in a single ordinance or may be incorporated into building permit ordinances.

SPECIAL PURPOSE ORDINANCES

One option is to develop a special purpose ordinance, a local law designed to address a particular problem affecting the general health, safety, and welfare of the community. Junkyard, weed, and nuisance ordinances are examples of special purpose ordinances.

Certain advantages of special purpose ordinances make them a commonly used means for regulating floodplain development. Perhaps the greatest advantage is that a special purpose ordinance contains all the watercourse or floodplain management provisions in one document, making the ordinance easier to understand and administer. Some people think dividing the provisions among the zoning, building codes, and subdivision and land development ordinances can complicate the matter, especially for communities without full-time ordinance administrators. Furthermore, a special purpose ordinance can be enacted in less time and with less expense. Since zoning is often a controversial issue at the local level, the enactment of a special purpose ordinance may avoid the problems and delays associated with the adoption of zoning ordinances.

ZONING, SUBDIVISION AND LAND DEVELOPMENT ORDINANCES AND BUILDING CODES

Another option to regulating water course or floodplain development is to include provisions in zoning and subdivision and land development ordinances and in building codes. Communities having enacted or proposed ordinances may find it advantageous to incorporate watercourse or floodplain management provisions into these regulations. Since the legal and administrative framework is already set up and functioning, it may be best to try to mold the floodplain regulations into the existing system rather than trying to enact an entirely new and distinct ordinance.

ENACTMENT PROCEDURES

The procedure for enacting floodplain ordinances is basically the same, whether it is for zoning or subdivision ordinances or for special purpose ordinances. However, minor variations between the two types of ordinances should be recognized. In either case, the District Attorney should be involved to ensure that proper procedures are followed. Generally, the following steps are involved in adopting an ordinance:

* Advertise the ordinance in a community newspaper outlining the proposed action and notice of when

the ordinance will be considered in a public meeting.

* Readvertise if significant changes are made as a result of the first meeting and before adoption.

* Vote to adopt by the governing body.

* Record the ordinance in the official records.

CONCLUSIONS

Local ordinances regulating development are one of the most important aspects of an effective watercourse or floodplain management program. If they are properly written and administered, they can accomplish the objectives of making available to residents the protection offered by the National Flood Insurance Program and helping to reduce future losses to the community and to others downstream.

ORDINANCE ADMINISTRATION

Once enacted by the governing body, the responsibility for administering the watercourse or floodplain management ordinance is usually assigned to the zoning officer, code enforcement officer, permit clerk, municipal secretary or some other appointed individual. This person is usually referred to as the permit officer.

In regard to administering a watercourse or floodplain ordinance, the permit officer should be familiar with the objectives and policies that were used as a basis for adopting the ordinance. This will help him or her explain the reasoning behind the building restrictions to applicants who may question the need for them.

The permit officer should also have a thorough understanding of the contents of the ordinance, especially the procedural provisions and the technical standards. Not following the proper procedures or misinterpreting the technical requirements can lead to problems for the applicant and the local government.

Local watercourse or floodplain ordinances establish permit systems as the means for ensuring that all watercourse or floodplain development activities conform with the applicable ordinance provisions. Unlike conventional building permit ordinances which only require permits for the construction of buildings and other structures, watercourse or floodplain management ordinances require permits for all construction and development within the watercourse zone or floodplain. Development covers any activity considered a man-made change to real estate, including but not limited to, buildings or other structures, mining, dredging, filling, grading, paving excavating or drilling operations.

PERMIT APPLICATION

A person planning to do any construction or development in a watercourse zone or floodplain must apply for a permit. Ordinances usually specify the type of information which the applicant must provide. Most ordinances require the applicant to fill out a permit application form.

A standard application has two parts. The first part is an administrative form which serves as an official record of certain facts, such as name and address of the applicant, a brief written description of what is to be done, and the final action of the permit officer. The most important piece of information is the elevation of the 100-year flood and the elevation of the lowest floor (including the basement) of any structure.

The second part of the application is a map or drawing which clearly illustrates the location of the project, all proposed structures, property lines, rights-of-way and setback distances. For floodplain management purposes, the location of the floodplain boundary; the stream channel; and, if applicable, the boundary of the floodway should also be shown along with the direction of flow and approximate water velocities. There may be instances when, because of the type or size of a proposed development, the permit officer will need additional information to make a complete and adequate review of the project. In these cases, he or she should notify the applicant as soon as possible of the nature and detail of this supplemental information so it can be submitted along with the application package.

Upon receipt, the application should be checked to make sure it is complete. An incomplete application should be returned to the applicant immediately with a written explanation of any deficiency. When satisfactorily completed, the applicant should provide a sufficient number of copies for the local government to initiate its review.

APPLICATION REVIEW

Once a completed application is received and recorded, copies should be submitted to all other reviewers as required in the ordinance. The reviewers may include the official engineer, planning commission, local conservation district or water and sewer authority.

Even if it is not actually required by the ordinance to have others involved in the review of permit applications, permit officers can seek the help of other agencies with expertise in these matters.

Next, the permit officer should read the application form and study the accompanying plan carefully. Any discrepancies or conflicting information should be noted.

CHECKING THE ELEVATION

Most important, the elevation of the 100-year flood should be checked. This matter is relatively simple where a detailed FIS has been prepared. In this case, the flood profiles are used to determine the elevation at the point along the stream adjacent to the proposed development.

The procedure is more complicated when the community has only a Flood Hazard Boundary Map. With this type of map, elevations are not provided. In these instances, where elevation information is available from other sources, such as the Corps of Engineers, Soil Conservation Service, U.S. Geological Survey, New Mexico Department of Transportation, etc., it should be used. If other elevation information is not available, an elevation can be obtained by using the Flood Hazard Boundary Map and a field survey.

Some communities with Flood Hazard Boundary Maps require the applicant to determine the 100-year flood elevation using accepted hydrologic and hydraulic engineering techniques. If an applicant submits an elevation based on an individual engineering analysis, the permit officer should request a copy of the engineering documentation.

In any event, the permit officer should carefully check the 100-year flood elevation and determine whether the applicant's figure is correct.

VISITING THE SITE

Another important step in the review of any application is visiting the site. It will give the permit officer a better understanding of the proposed project and its relationship to the flood hazard.

It will also give the permit officer an opportunity to verify the location of the property in question and to determine to what extent the proposed project may affect adjacent properties.

In some cases, visiting the site may be necessary or helpful in determining the elevation of the 100-year flood.

DETERMINING COMPLIANCE

The purpose of the permit system is to ensure that the proposed construction or development is designed and constructed in a manner which complies with the technical standards and specifications of the ordinance. It is the most important aspect of the application review procedure.

APPROVAL OR DISAPPROVAL OF PERMIT REQUEST

Once the review and evaluation of the permit application is completed, the permit officer must approve or disapprove the permit request. If approved, the applicant is issued a permit. If denied, the permit officer should explain the reasons for denial in a letter to the applicant. Keeping careful notes throughout the review of the application will be helpful in the event a disapproval letter must be prepared. The letter should include references to the specific sections of the ordinance which have not been met.

INSPECTIONS

Site inspections must be conducted to make sure that the actual construction of the proposed project is performed according to the approved plans. Inspections should be done in a timely manner to avoid construction delays.

APPENDIX B

ELEMENTS OF TERRAIN MANAGEMENT PLANS

Appendix A provides details specific to floodplain management and regulation of development within the floodplain. However, many of the problems associated with flood damages are a direct result of man-made changes beyond the floodplain but within the watershed. Sediment producing activities within a watershed should be a major concern of any floodplain management office. One means of controlling sediment producing activities, as well as flood damages, is with terrain management plans. This appendix has been edited from New Mexico Subdivision Review Guide (USDA-Soil Conservation Service). Elements of a terrain management plan include:

1. Soils
2. Grading
3. Floodplain Management
4. Storm Drainage
5. Roads
6. Erosion Control
7. Revegetation or Landscaping

Listed under each element there are listed the essential features which should be included in the plan and a description of how these features should be planned.

It should be noted if the terrain management plan does not contain sufficient information about particular features, and the needed information should be obtained from the developer.

1. SOILS

SCS single phase interpretation sheets are available for many of the soils in the state. These interpretations may be used in reviewing terrain management plans. Published soil surveys will also provide the needed information. In the case of McKinley County and the City of Gallup where a soil survey has not yet been published, the "Guide for Interpreting Engineering Uses of Soils" (USDA-SCS), should be used. In this reference the principal detrimental or unfavorable features of the soils are listed. Limiting features are described by one of three terms:

Slight - Good suitability, a rating given soils with properties favorable for the intended use. The degree of limitation is minor and can be overcome easily.

Moderate - Fair suitability, a rating given soils with properties moderately favorable for the intended use. This degree of limitation can be overcome or modified by special planning, design, or maintenance. Some soils rated Moderate require treatment such as artificial drainage.

Severe - Poor suitability, a rating given soils that have one or more properties unfavorable for the rated use; such as steep slopes, bedrock near the surface, flooding hazard, high shrink-swell potential, a seasonal high water table, or low bearing strength. This degree of limitation generally requires major soil reclamation, special designs, or intensive maintenance.

Soils having several limitations, or which are shown as unsuitable, for the intended purpose should not be used for the purpose unless the developer has clearly shown in the plan how these limitations will be overcome.

Below are the major categories used in reviewing the terrain management plan:

A. Building Site Development
B. Construction Material
C. Local Roads and Streets
D. Underground Utilities
E. Water Control Structures
F. Erosion Control Structures

Evaluation of suitability provided by an SCS soil survey is limited to a five foot depth. These are general suitability estimates and are not to be used for foundation design.

2. <u>GRADING</u>

Land grading, filling, and clearing operations can cause many problems when performed incorrectly: such as leaving large bare areas subject to wind or water erosion. Grading should not proceed beyond actual development needs. Topsoil should be replaced to aid in revegetation of construction sites. Operations should be planned and designed to enhance natural scenic beauty of the area. Special erosion control measures are usually necessary on sandy soils. The following is a list of questions and requirements that should be addressed in the plan:

A. Preserve, match or blend with the natural contours of the land.

   1. Does the plan adequately describe how grading operations will be performed to blend slopes and fills into the natural contours of the land?

   2. Does the plan retain or replace trees and other native vegetation, to stabilize hillsides, retain moisture, reduce erosion, reduce runoff, and preserve the natural scenic beauty?

   3. Have cuts and fills been designed to minimize the area of exposure and reduce the sharp angles at the toe and sides?

   4. Does the plan prevent the deposit of sediment into floodplains, drainage channels, watercourses, and water bodies?

B. The following discharges attributable to grading are prohibited whether the discharge is direct or indirect:

   1. Sediment and other organic or earthen materials discharged into a watercourse, water body, drainage channel or floodplain.

2. Materials placed in any position which would make it susceptible to erosion and deposition into a watercourse, water body, drainage channel or floodplain.

   a. Does the plan for grading, land forming, and protective cover provide for the prevention of sedimentation?

   b. Does the plan call for temporary or permanent structural measures to prevent damaging runoff waters originating on the slope itself?

   c. Do planned structural measures adequately provide for the limitations of the site?

C. Whenever the native ground cover is removed or disturbed or whenever fill material is placed on a site, does the plan call for the exposed surface to be treated to the extent necessary to prevent dust from blowing off the construction site?

D. Does the work schedule for grading and filling operations limit the soil exposure period to the shortest possible time before cover is established?

E. What provisions are made for disposal of vegetation during clearing operations?

F. What is the disposition of earth removed during grading operations?

G. Are the maximum cut and fill slopes compatible with soil stability or erodibility as shown on the soil survey or city regulations?

H. What provisions were made to prevent runoff from flowing over the face of the slope?

I. Are mechanical stabilization measures planned for slope containment?

J. If a borrow area is shown, is revegetation planned for the disturbed area?

K. If arroyos or other overfall areas are in the planning area, are rundowns to a safe outlet planned?

L. Are provisions made for water and erosion control in borrow ditches along streets and roads?

3. <u>FLOODPLAIN MANAGEMENT</u>

Subdivisions and developments shall be planned, constructed, and maintained so that:

   A. Dwellings are not located within the 100-year floodplain.

B. Structures, material deposits, or excavations, alone or in combination with present or future works, do not adversely affect the capacity of the floodplain.

C. Roads are not located in the floodplain unless specifically approved by the State Highway Department and the road does not conflict with B. above.

D. Structures with a potential for high flood damage and confined animal shelters are not located in the floodplain.

E. Existing utilities and proposed utilities will be free from the threat of flood damage.

4. STORM DRAINAGE - DRAINAGE PLAN

Subdivisions and developments shall be planned, constructed and maintained to:

A. Protect and preserve existing natural drainage channels except where erosion and water control measures are approved.

B. Provide temporary measures to prevent damaging runoff waters from leaving the site until construction is completed and permanent control measures are installed.

C. Protect structures and other works from flood hazards using the 100-year frequency storm for calculating flood levels.

D. Provide a system in which runoff water within the subdivision is removed without causing harm or damage to the environment, property, or persons inside or outside the subdivision area.

E. Assure that waters drained from the subdivision does not contain pollutants or sedimentary materials of any greater quantity than would occur in the absence of the subdivision.

F. Assure that waters are drained from the subdivision in such a manner that they will not cause erosion outside of the subdivision to any greater extent than would occur in the absence of the subdivision.

If the drainage basin in which the subdivision is located is only partially developed, it should be required that the design and construction of the drainage system have sufficient inlet flow capacities and inlet flowline elevations to adequately serve the entire drainage basin. This suggested requirement is based on the assumption that the entire basin will eventually be developed.

5. ROADS

Roads shall be located and designed to:

A. Preserve natural features, vegetation, and topography and to protect the natural environment.

B. Create conditions to ensure proper drainage.

6. EROSION CONTROL

The plan should clearly indicate that installed measures will prevent or control erosion. As a minimum the following items should be considered:

A. Are designed road grades flat enough to prevent erosion based on the soils involved?

B. Are borrow areas or drainage features designed to prevent erosion or sediment deposition?

C. Are culvert inlets and outlets properly protected from erosion and sedimentation?

D. Will critical area treatment or special plantings be needed? If so, are the plans adequate?

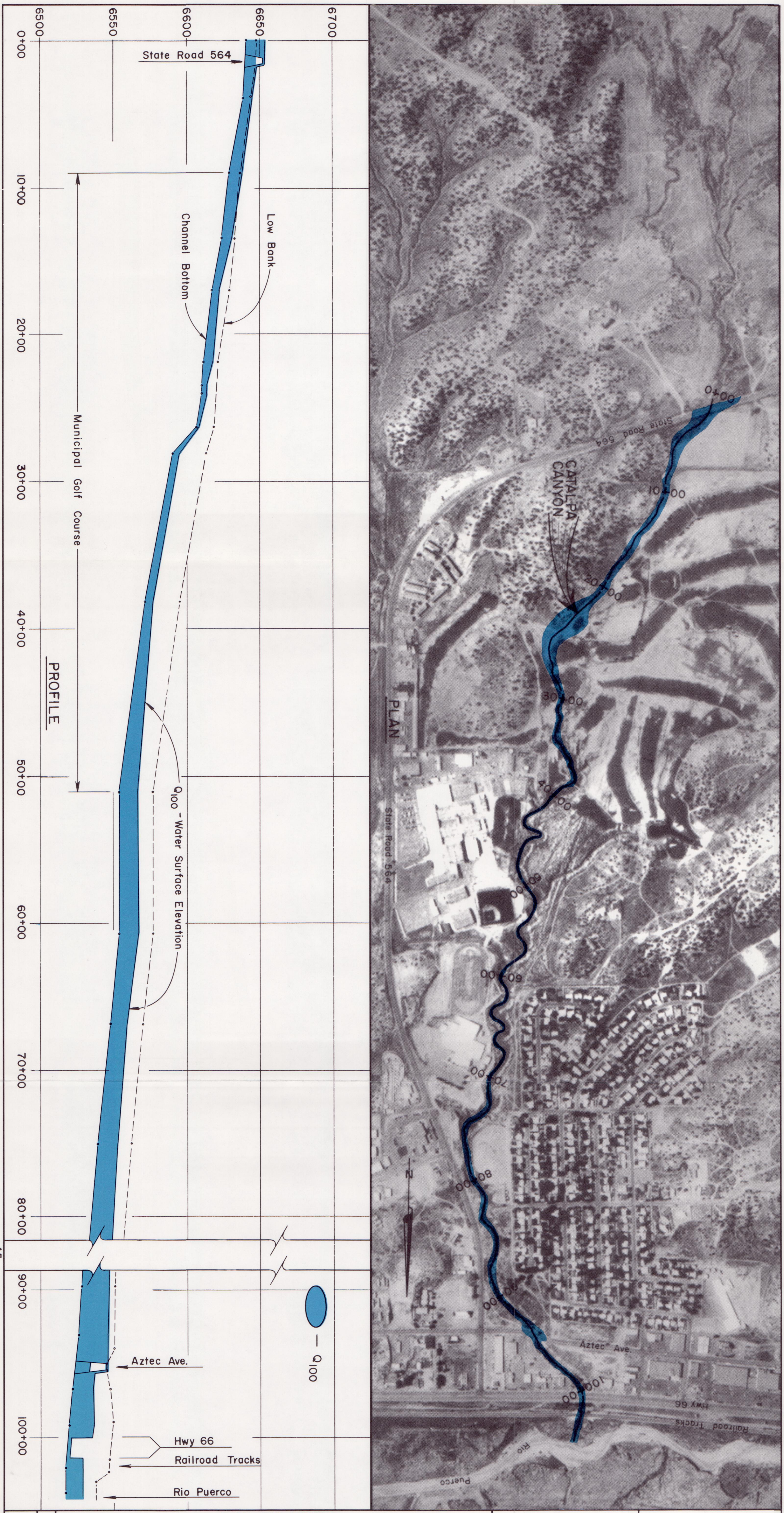
E. Will temporary soil stabilization be needed? If so, is it adequately planned?

F. Is adequate soil stabilization planned on permanent slopes?

7. LANDSCAPING AND REVEGETATION

Revegetation is an important part of any subdivision plan. A definite time schedule for installing plant cover is necessary to prevent erosion, particularly in areas with sandy soils. The need for revegetation is an integral part of several of the other sections.

APPENDIX C
FLOODPLAIN MAPS AND FLOOD PROFILES



PLAN AND PROFILE
CATALPA CANYON
FLOODPLAIN MANAGEMENT STUDY

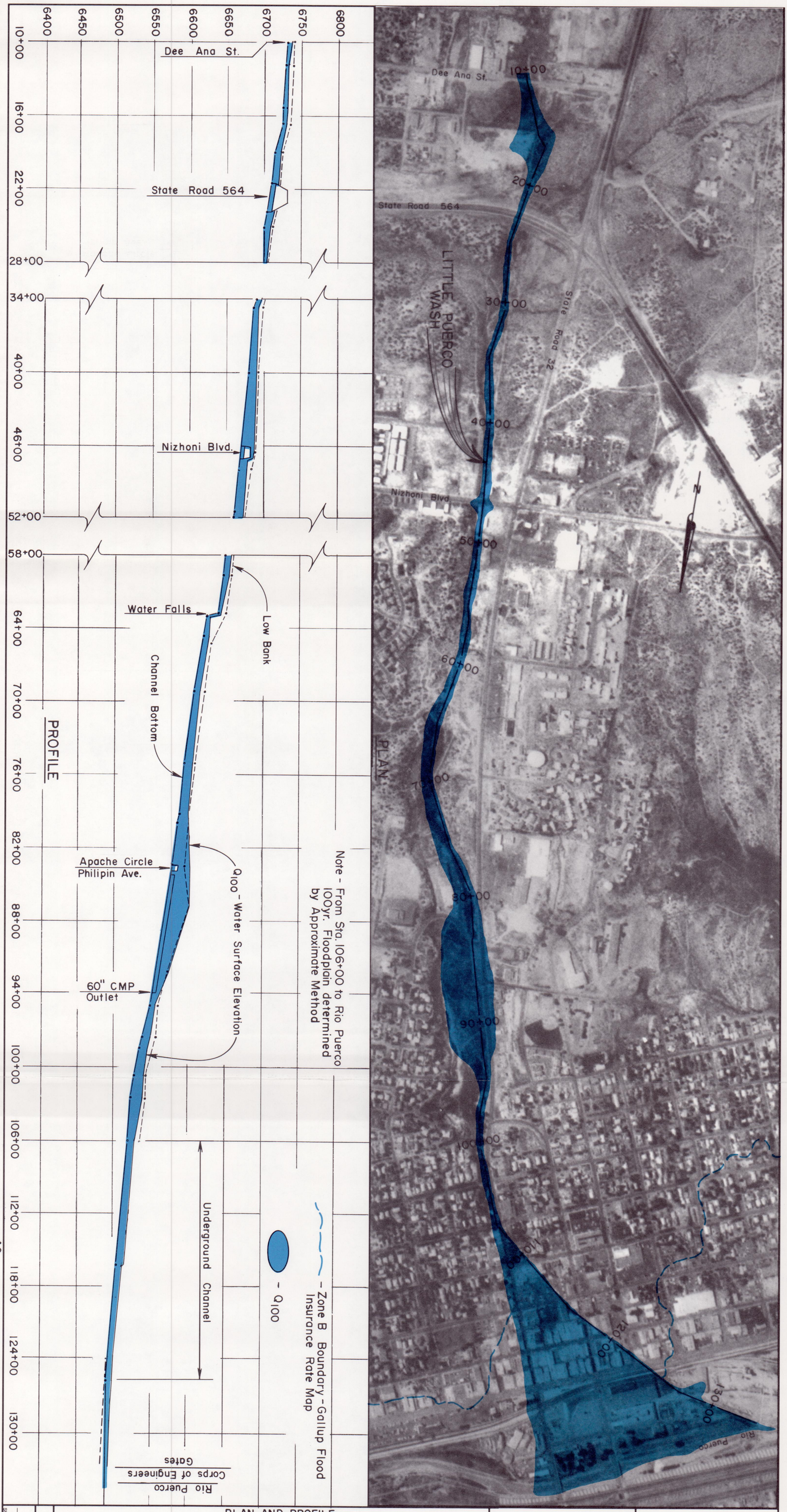
GALLUP NEW MEXICO

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

Designed	D. Murray	Date	9-91
Drawn	R. Armijo	Date	1-92
Traced		Date	
Checked		Date	

Approved by
Title
Title

Drawing No.
Sheet No. ___ of ___



PLAN AND PROFILE
LITTLE PUERCO WASH
FLOODPLAIN MANAGEMENT STUDY

GALLUP — NEW MEXICO

U.S. DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE

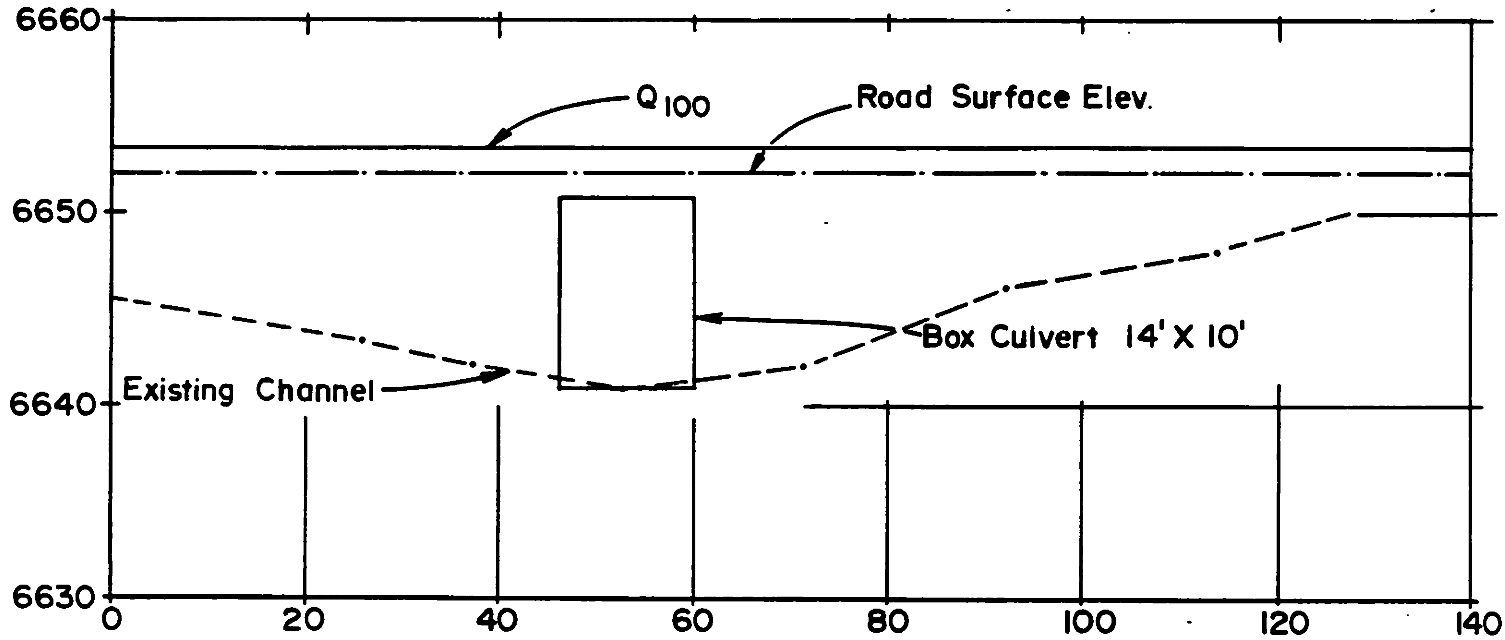
Designed D. Murray Date 9-91
Drawn R. Armijo Date 1-92
Traced ____ Date ____
Checked ____ Date ____

Approved by ____
Title ____
Title ____

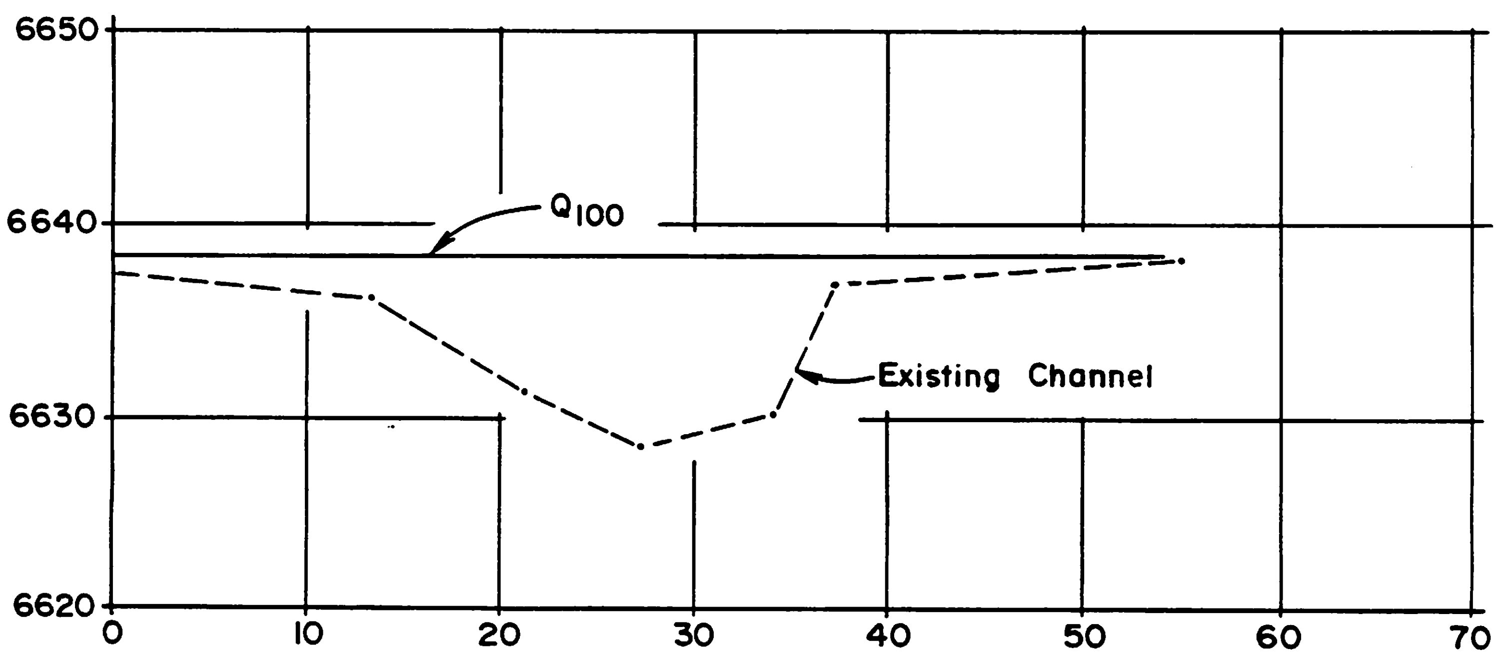
Drawing No. ____
Sheet No. ___ of ___

APPENDIX D
CHANNEL CROSS SECTIONS

CATALPA CANYON CROSS SECTIONS

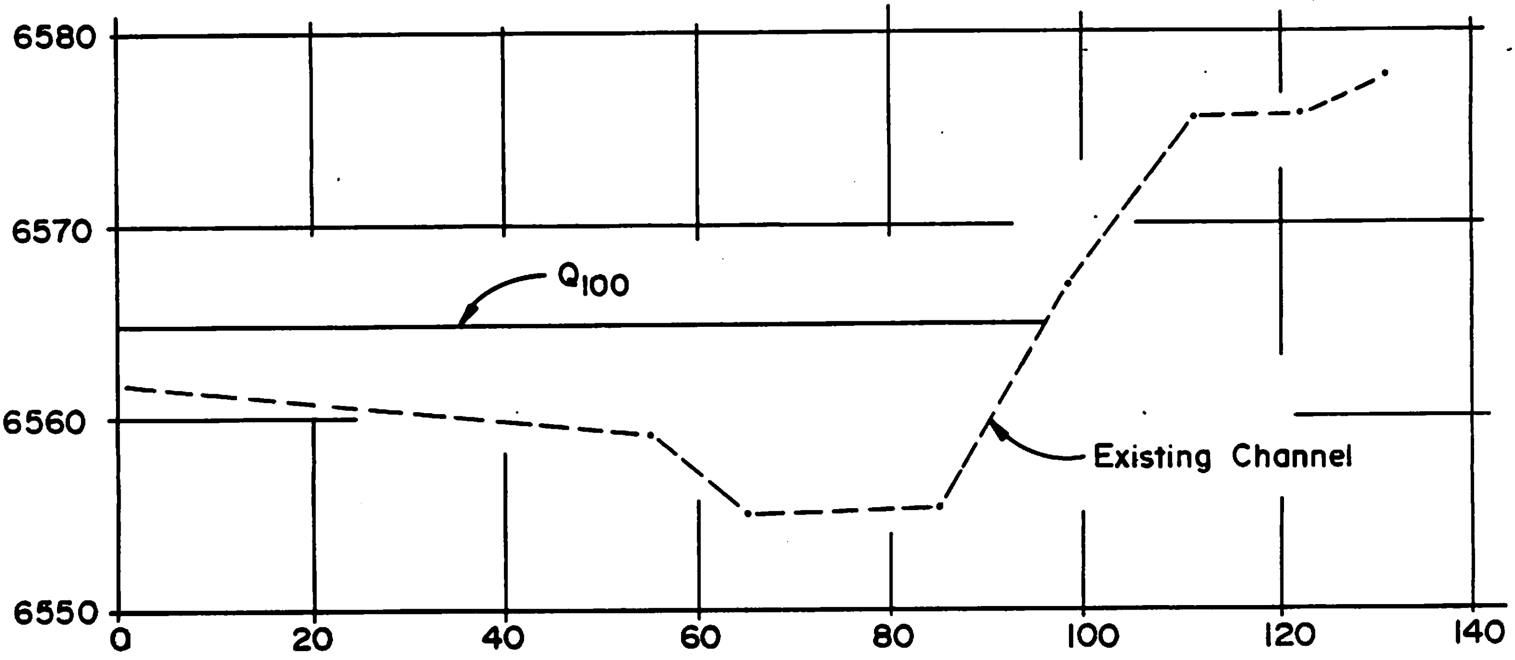


STATION - 1+54
(State Road 564)

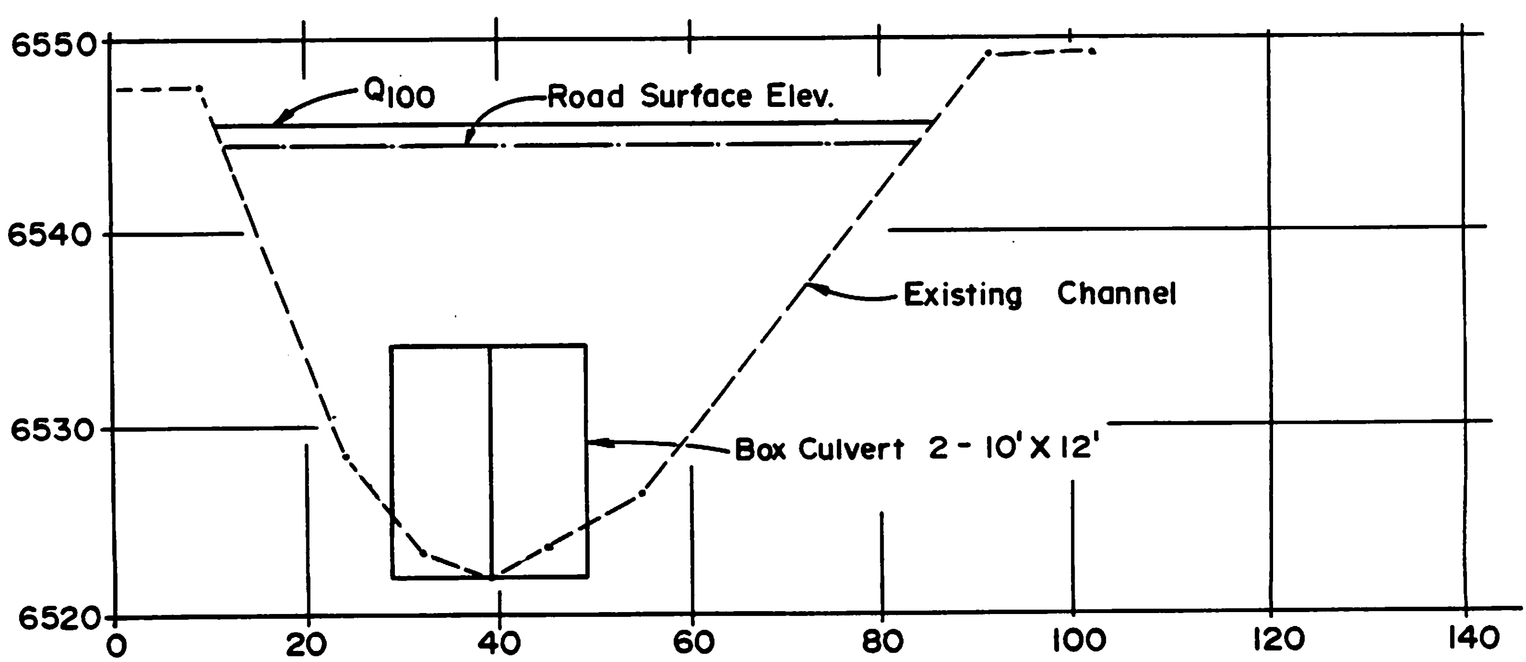


STATION - 9+10

CATALPA CANYON CROSS SECTIONS

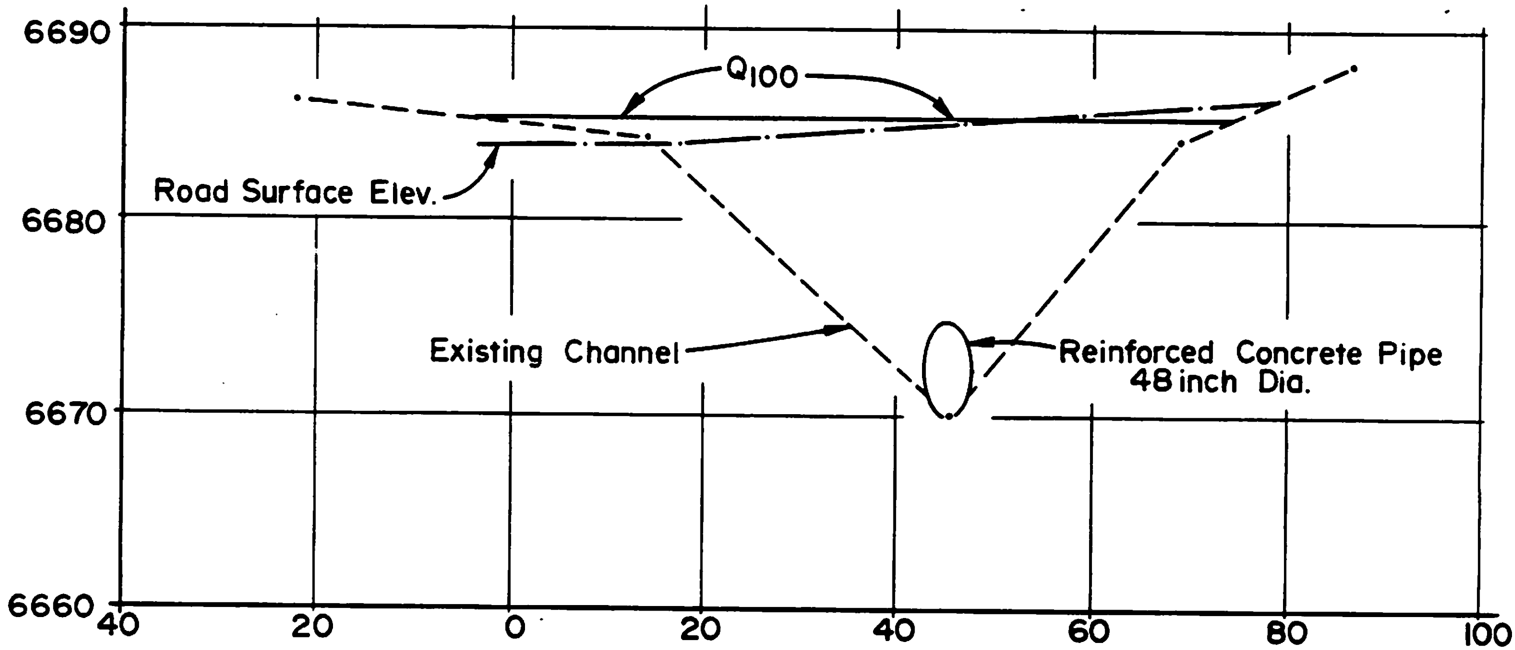


STATION - 51+53

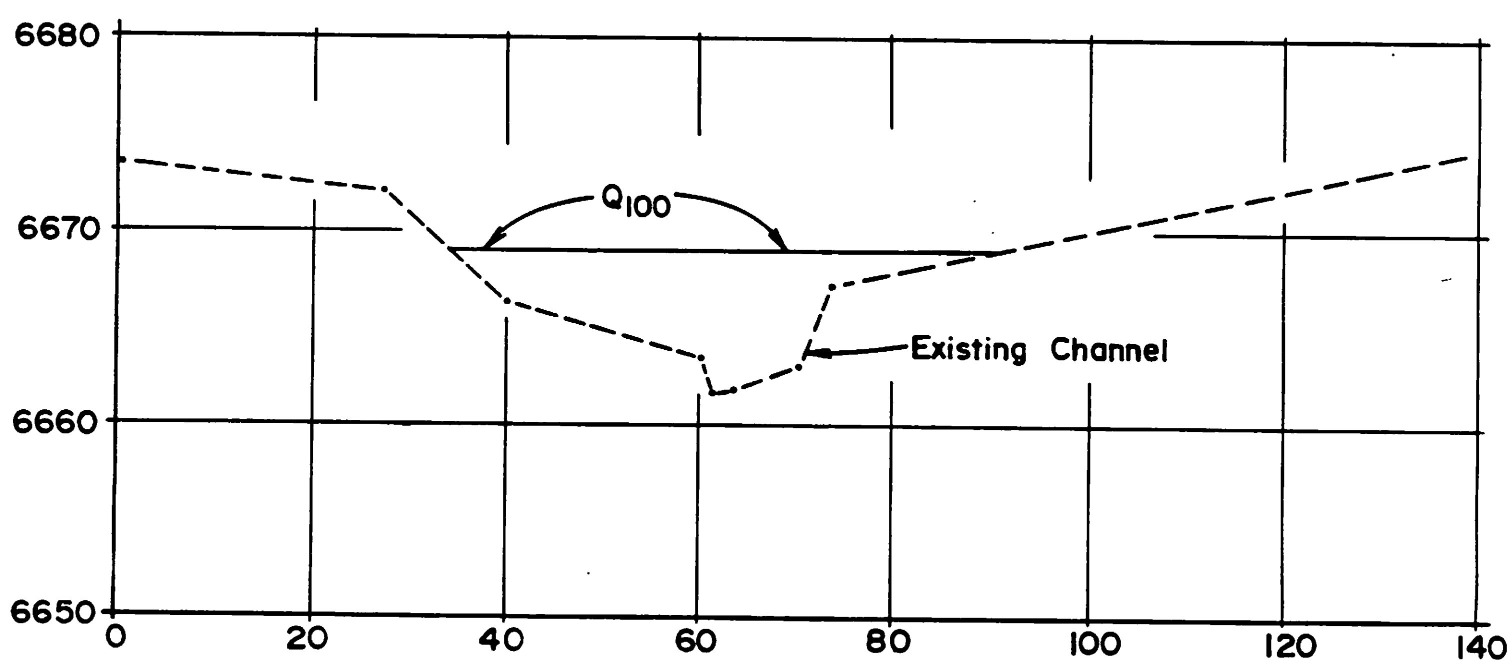


STATION - 96+75
(Aztec Ave.)

LITTLE PUERCO WASH
CROSS SECTIONS

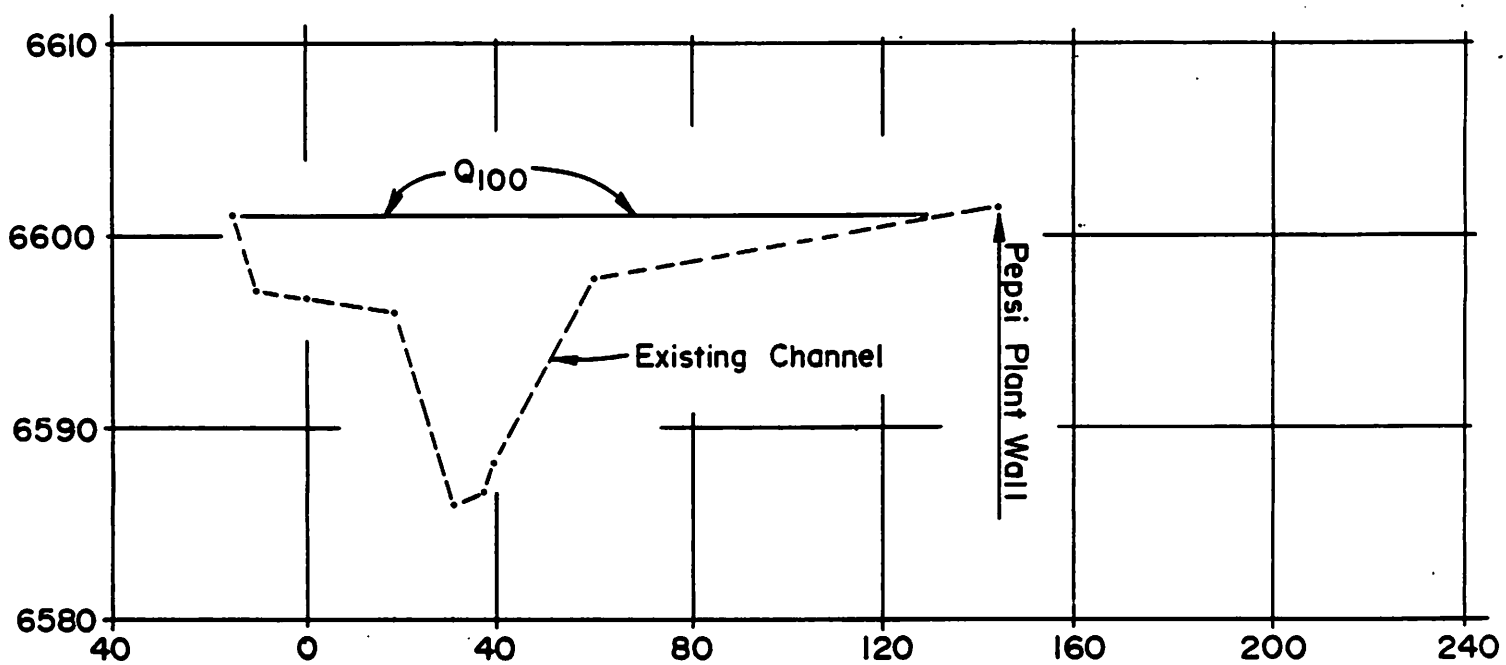


STATION - 46+23
(Nizhoni Road)

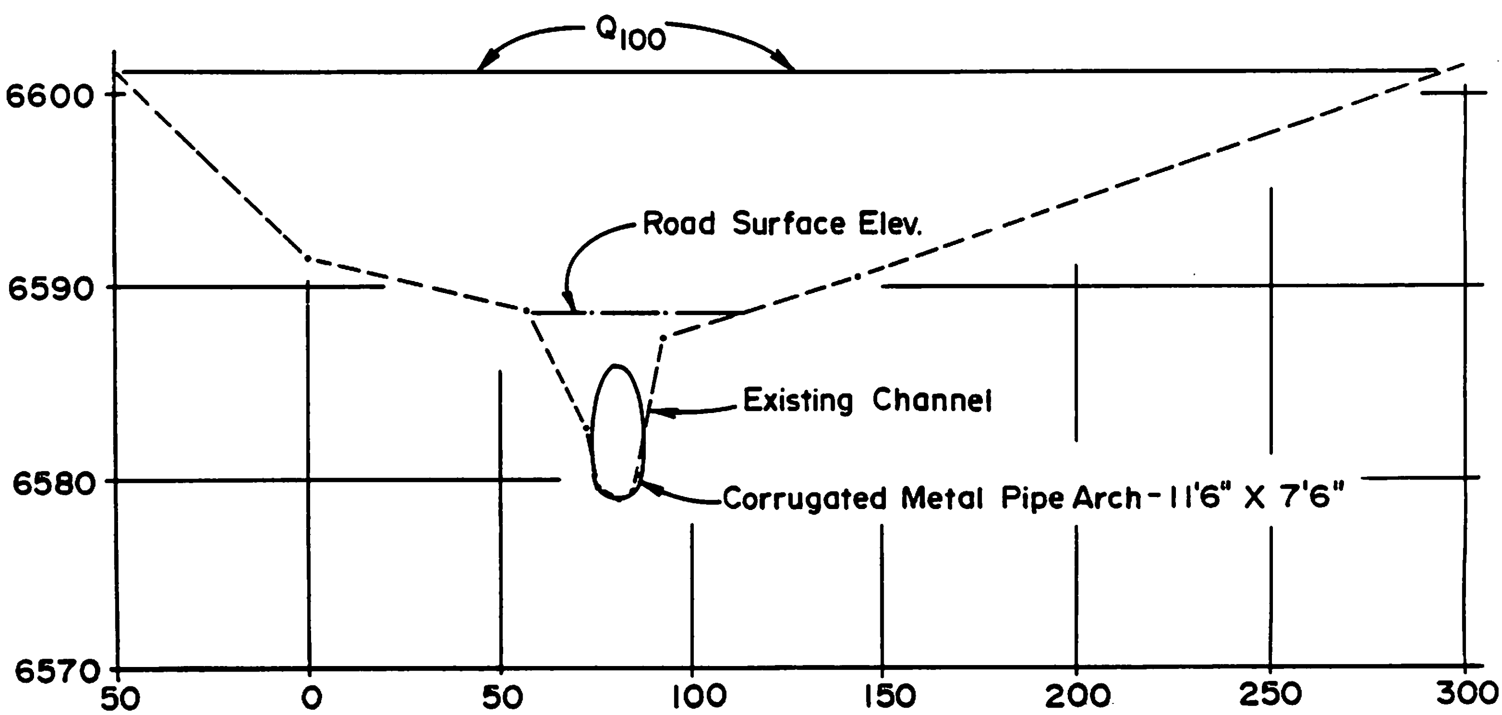


STATION - 51+81

LITTLE PUERCO WASH
CROSS SECTIONS

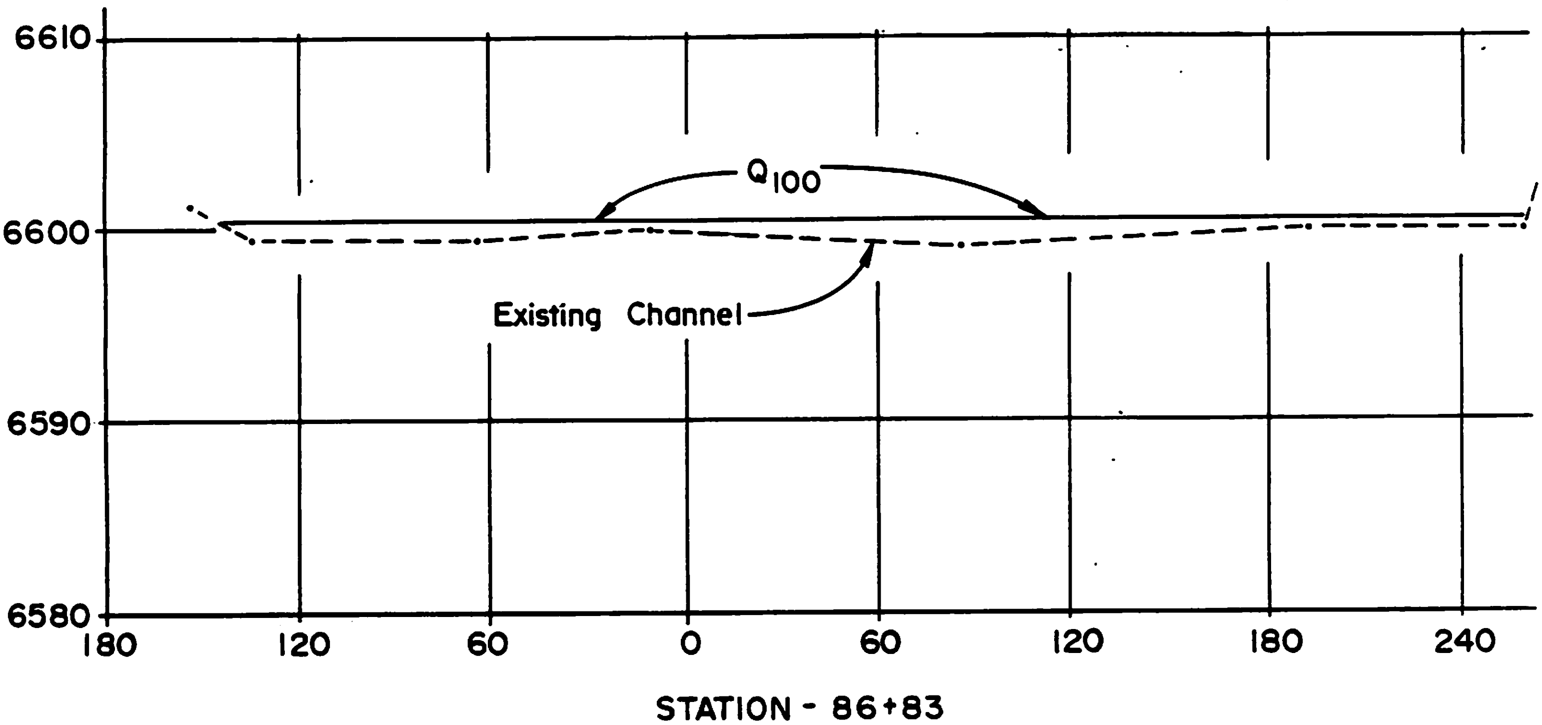


STATION - 79+64



STATION - 83+04
(Apache Circle)

LITTLE PUERCO WASH CROSS SECTIONS



APPENDIX E
FLOODWATER RETARDATION DAM
TECHNICAL DATA

United States Department of Agriculture
Soil Conservation Service
517 Gold Ave., SW
Room 3301
Albuquerque, NM 87102

May 17, 1991

Mr. John Haynes
City Engineer
City of Gallup
P.O. Box 1270
Gallup, NM 87301

Dear John:

This letter provides input and observations on the detention structure proposed for the Little Puerco. The proposed site is in a natural canyon just south of the Pepsi plant.

The site is in a relatively narrow, steep arroyo with significant outcrops of highly fractured and jointed sandstone. The arroyo appears to follow a broken anticline. Stress relief has caused cracking and fracturing of the sandstone resulting in very large blocks. Fracture openings vary from a few inches to as much as a foot and appear to be void except for near surface filling with clays and colluvial debris. The fracture spacing varies from several feet to 20 feet or more. The orientation of the primary fracture system is approximately northwest to southeast with a secondary joint system more or less perpendicular to the primary system. The secondary joint system is similar to the primary one.

The sandstone is interbedded with thin and thick seams of clay shale some of which is soft coal. These seams vary in thickness from several inches to a foot or more and dip to the east and west along the direction of the anticlinal slopes. Spacing of the seams is unclear, but some at 10 to 12 feet apart were observed.

There is a thin mantle of soil over the sandstone on the arroyo floor. This appears to be clay or a sandy clay weathered from the sandstone. It is probably two to five feet thick.

The proposed structure site appears to be the best available in terms of topography, geology, utilities, etc. It is recommended that the centerline be aligned on the right abutment so that the embankment material will blanket the jointed rock on the north slope of the draw that comes in from the east. The surface and joints in this rock will likely require cleaning and dental concrete grouting before earth fill materials are placed on it.

Sediment delivery to the site should not be extremely high as there are no major or active erosion sources and no areas of sediment deposition along the arroyo. Sediment delivery was estimated at less than 1 acre-foot per square mile per year. An estimate of 0.5 acre-foot per square mile per year may be closer. The primary sediment source appears to be the weathering of sandstone and minor erosion along arroyo banks. The sediments will likely consist of fine sandy clays with very minor amounts of small gravels. Most of these sediments would stay in suspension and be transported through the reservoir. Given the fine particle size and the long narrow configuration of the pool, sediment trap efficiency of the pool will be very low. Using most any type of riser configuration, the trap efficiency would probably be less than 50 percent.

This low predicted sediment yield may increase significantly if the floodplain areas which are being filled for commercial construction become erosion sources. This is likely to occur if the slopes of these fill areas are not protected.

The available storage from the stage-storage data is about 100 acre-feet. This appeared realistic from observations and site configuration. It is somewhat limited in the upstream direction by an existing rock overfall. Based on inflow, sediment yield, and outflow, the structure would need to be about 40 feet high. This would allow the 100 year frequency storm outflow to be limited to 177 cubic feet per second which is within the capacity of the 60 inch conduit north of Apache Circle Street. The peak flow generated at the tunnel outlet is estimated to be 1155 cfs, which is just slightly over the maximum capacity.

There are very few nearby sources for borrow materials to build an earthen structure. If an earthen embankment is proposed, two possible zonings are suggested: 1) an upstream section of clays from the weathered sandstones and a downstream section of coarse rock which would provide for embankment and foundation drainage or 2) a rock fill dam with a relatively thin clay core section. The sandstones in the area are not suitable for use as rock fill as they are too soft and would quickly weather into impermeable clay.

With either of the suggested zonings, the upstream portions of the abutments and foundation would need to be cleaned, the joints and seams filled with a dental concrete, and the surface capped with concrete. This would reduce seepage pressures and prevent the movement of embankment fines into the joint systems. The downstream coarse rock section or shell would probably provide adequate relief and seepage capacity. For this high hazard site, the structure would be required to pass the probable maximum precipitation (PMP). Since there is no readily available location for an emergency spillway on either abutment, a chute spillway will likely be used for an earth fill dam.

Roller compacted concrete (RCC) might also be considered. This may be cost effective in that a lesser quantity of materials due to steeper slopes would be required and an overflow section over the structure, instead of a chute, could be included to function as the emergency spillway. The PMP would be passed through this overflow section. A RCC section would likely require a combination of a concrete cutoff with drainage blankets or trenches to ensure relief of seepage pressures and provide a stable gravity section. Relief wells alone may not be effective with the jointed sandstone since its permeability is not homogeneous enough for this type of seepage control.

Regardless of the type of embankment, there could be considerable downstream seepage losses through the abutments and foundation. This would need to be evaluated during the geologic investigation and design. During the investigation, the geologist and soils mechanical engineer should attempt to predict outflow areas and potential impacts. The design should provide for monitoring of this potential after construction. If the seepage losses were considered to present a safety problem, an upstream blanket, grout curtain, and/or additional downstream drainage could be required during design or installed after construction and monitoring.

Uncontrolled seepage losses through the sides of the pool could also present a problem. The joint and fractures of the sandstone are considered open enough to allow significant losses even with the short duration storage in the flood pool. Uncontrolled seepage could occur within a few hours of flood pool storage. Methods normally used to address this problem include: 1) intensive site investigations, analyses, and evaluations with the objective of either disposing of the potential as non-significant or identification of specific remedial measures that can be taken, 2) blanketing of the pool area with impermeable materials, and 3) observation, monitoring, and post construction actions.

The first measure would likely be fairly expensive, however it may reveal subsurface conditions that would either dispose of the potential at no further cost, or it may identify cost effective remedial measures that can be taken. On the other hand, it may point to method 2, blanketing of

A Proposed Flood Control Structure in Gallup, NM, on Little Puerco Wash.

Location: Appr. center of the W 1/2 of Sec. 22, T15N, R18W.

Geology: This location is situated on rocks of the Upper Cretaceous age Gallup Sandstone.
The Gallup Sandstone is overlain by the Crevasse Canyon Fm., and underlain by the Mancos Shale Fm., both of Cretaceous age.
The Gallup Sandstone is:

lenticularly bedded
massively to moderately thick bedded
fine to coarse grained
poorly to moderately well-cemented

The Gallup Sandstone was deposited in an alternately very shallow to moderately deep, brackish to freshwater environment. It contains interbedded thin to massive lenses of shales, carbonaceous shales, organic shales, and coals. In this outcrop area the Gallup Sandstone is fractured along planes parallel to the existing channel of Little Puerco Wash. These fractures are due to mass wasting (slumping) of the canyon walls into the channel, but also can be attributed to stresses applied to rocks in the area during the development of the Gallup Anticline. This upward flexure of a localized portion of the earths crust parallels the drainage of Little Puerco Wash. The apex of this anticlinal structure is located a short distance to the east of the channel, and it plunges into the subsurface in a northerly direction.

Potential Problems:

1. Vertical fractures extend into the subsurface, and are potentially very permeable.
2. Horizontal bedding planes within the existing rocks (mainly the Gallup Sandstone) are also potential zones of permeability which may have been enhanced by the development of the Gallup Anticline.
3. The zones discussed in 1 and 2 (above) intersect each other in the foundation of this proposed structure.
4. Slump block movement can be accelerated by the saturation of the foundation materials.
5. The rapid drawdown of the pool impounded by a flood control dam also can influence the stability of slump prone abutments.
6. The underlying rocks of the Mancos Shale Fm. are of a strictly marine origin and contain a considerable quantity of highly soluble salts. The solution of these salts can cause severe foundation problems, and also can provide a source of contamination for existing fresh groundwater supplies.
7. There is not enough material on-site to construct a dam of the size proposed in this plan.

8. Impounded water would be a potential hazard to down slope and down dip property owners if permitted to leak into the bedrock foundation.
9. Impounded water would also be a potential source of pollution to existing groundwater supplies if permitted to leak into the bedrock foundation (due to contaminants acquired in its overland flow).

An adequate investigation of this potential dam site will require the following:

1. A drill rig and crew properly equiped and trained to:
    - A. Drill angle holes
    - B. Core with water, mud, and/or air
    - C. Perform downhole (packer type) pressure tests
    - D. Use the 3", Hollow Stem Auger-Continuous Sampler
    - E. Perform the Standard Penetration Test as required by ASTM standards.
2. A backhoe and operator that meets the requirements of Specification # 24 of the SCS geotechnical investigation contract.

Sediment Potential:
This watershed is basically one of low potential sediment yield. The State Erosion Rate Map indicates that this area yields about 1.Ø ac.ft./sq.mi./ year.
A visual reconnaissance of the watershed revealed no naturally eroding areas which would be capable of causing this watershed to exceed this estimated sediment yield.
There is considerable evidence however that poorly planned and managed construction site preparation, roadside maintenance, waste dumping, and off road vehicle use have contributed to an increase in sediment yield in the recent past.
An estimate made of the sediment yield potential of this watershed by the PSIAC method indicates that the current sediment yield would be about 1.2 ac.ft./sq.mi./year.
The"sediment delivery ratio" on a watershed of this size and shape should be about 7Ø percent, and the "trap efficiency" about 65 percent or less. If these figures were found to be reasonably accurate during the final planning and design of this structure than about .55 ac.ft./sq.mi./year of storage would be needed in this proposed structure.

It is my opinion that there is much room for improvement of the watershed condition. Substantial improvement could significantly reduce the sediment yield potential.

Rufus D. Meadows, Geol.,NMSO

Rio Puerco del Oeste Watershed NM State ________ Condition

Little Puerco R. Subwatershed Name Rufus D. Meadows

1287 Acres

PSIAC - 1968

Date 1-91

SEDIMENT YIELD FACTOR RATING

SURFACE GEOLOGY (a)	SOILS (b)	CLIMATE (c)	RUNOFF (d)	TOPOGRAPHY (e)
(10) a. Marine shales and related mudstones and siltstones	(10) a. Fine textured; easily dispersed; saline-alkaline; high shrink-swell characteristics b. Single grain silts and fine sands	(10) a. Storms of several days' duration with short periods of intense rainfall b. Frequent intense convective storms c. Freeze-thaw occurrence	(10) a. High peak flows per unit area b. Large volume of flow per unit area	(20) a. Steep upland slopes (in excess of 30%) b. High relief; little or no floodplain development
(5) a. Rocks of medium hardness b. Moderately weathered c. Moderately fractured	(5) a. Medium textured soil b. Occasional rock fragments c. Caliche layers	(5) a. Storms of moderate duration and intensity b. Infrequent convective storms	(5) a. Moderate peak flows per unit area b. Moderate volume of flow per unit area	(10) a. Moderate upland slopes (less than 20%) b. Moderate fan or floodplain development
(0) a. Massive, hard formations	(0) a. High percentage of rock fragments b. Aggregated clays c. High in organic matter	(0) a. Humid climate with rainfall of low intensity b. Precipitation in form of snow c. Arid climate, low intensity storms d. Arid climate; rare convective storms	(0) a. Low peak flows per unit area b. Low volume of runoff per unit area c. Rare runoff events	(0) a. Gentle upland slopes (less than 5%) b. Extensive alluvial plains
Factor value 7	6	5	7	14

GROUND COVER (f)	LAND USE (g)	UPLAND EROSION (h)	CHANNEL EROSION AND SEDIMENT TRANSPORT (i)
(10) Ground cover does not exceed 20% a. Vegetation sparse; little or no litter b. No rock in surface soil	(10) a. More than 50% cultivated b. Almost all of area intensively grazed c. All of area recently burned	(25) a. More than 50% of the area characterized by rill and gully or landslide erosion	(25) a. Eroding banks continuously or at frequent intervals with large depths and long flow duration b. Active headcuts and degradation in tributary channels
(0) Cover not exceeding 40% a. Noticeable litter b. If trees present understory not well developed	(0) a. Less than 25% cultivated b. 50% or less recently logged c. Less than 50% intensively grazed d. Ordinary road and other construction	(10) a. About 25% of the area characterized by rill and gully or landslide erosion b. Wind erosion with deposition in stream channels	(10) a. Moderate flow depths, medium flow duration with occasionally eroding banks or bed
(−10) a. Area completely protected by vegetation, rock fragments, litter b. Little opportunity for rainfall to reach erodible material	(−10) a. No cultivation b. No recent logging c. Low intensity grazing	(0) a. No apparent signs of erosion	(0) a. Wide shallow channels with flat gradients and short flow duration b. Channels in massive rock, large boulders, or well vegetated c. Artificially controlled channels
Factor value 6	4	12	11

Subtotal (a)—(g) 49		Subtotal (h)—(i) 23	TOTAL RATING 72 = 1.2 ac.ft./sq. mi./yr.

(Instructions on reverse)

SHEET 1 OF 1

GENERAL INSTRUCTIONS

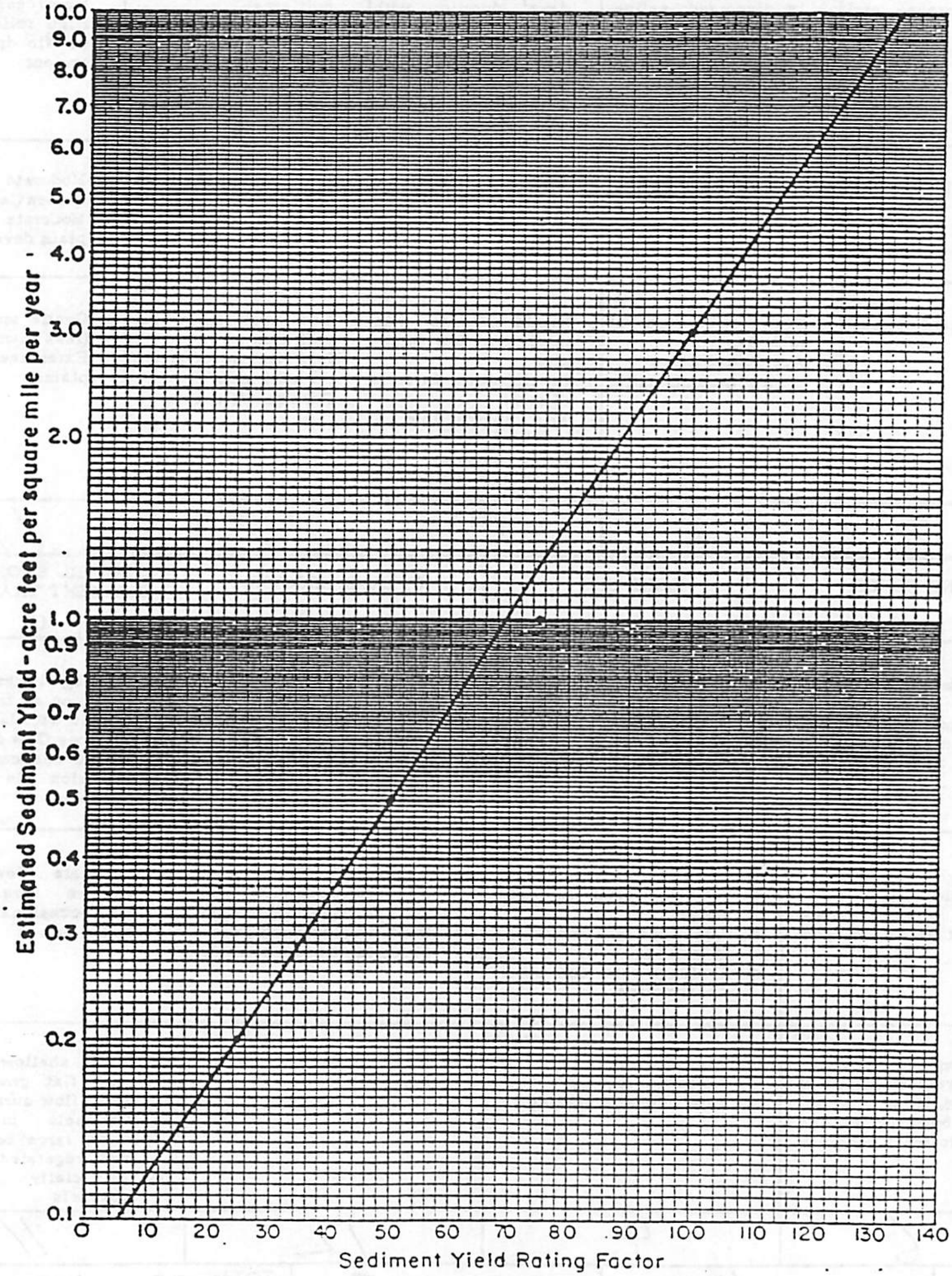
District Office prepares one copy for District file.

SPECIFIC INSTRUCTIONS

(Items not listed are self-explanatory)

Numbers indicate values assigned appropriate characteristics. Letters a, b, c, and d refer to independent characteristics to which full value may be assigned. Interpolation between the sediment yield levels may be made. High values for columns (a) through (g) should correspond to high values for (h) and (i). If they do not, factors (a) through (g) should be reevaluated. If they do not correspond, then a special erosion condition exists.

Convert *Total Rating* to sediment yield by use of graph.



APPENDIX F
ENVIRONMENTAL AGENCY LETTERS

STATE OF NEW MEXICO
OFFICE OF CULTURAL AFFAIRS
HISTORIC PRESERVATION DIVISION
VILLA RIVERA, ROOM 101
228 EAST PALACE AVENUE
SANTA FE NEW MEXICO 87503
(505) 827-6320

BRUCE KING
GOVERNOR

HELMUTH J. NAUMER
CULTURAL AFFAIRS OFFICER

THOMAS W. MERLAN
DIRECTOR

November 26, 1991

Bob McQueen
State Resource Conservationist
Soil Conservation Service
517 Gold Ave., S.W.
Albuquerque, New Mexico 87102

Dear Mr. McQueen:

Thank you for your letter of November 12, which I received on November 18, 1991, requesting my comments on the proposed Flood Plain Management Study for the Gallup, New Mexico. My review and comments are being provided under the provisions of Section 106 of the National Historic Preservation Act, and its pursuant regulations 36 CFR part 800.

No properties entered in or determined eligible for inclusion in the National Register of Historic Places or the State Register of Cultural Properties are presently known to exist in the immediate vicinity of the proposed undertaking. A review of the Archaeological Records Management System files shows that, while no sites are located within the areas marked as direct impact, numerous archaeological sites are located near the proposed project areas. It does not appear that the proposed project's area of effect has been previously inventoried.

It is my opinion that significant cultural resources may be adversely affected by land-disturbing activities associated with this undertaking, but that adequate data to make a formal determination of effect do not exist. Therefore, in accordance with the provisions of 36 CFR 800.4(a), I recommend that an intensive cultural resource survey of the affected area be performed by a qualified professional archaeologist to determine if archaeological or historical resources are present and if so, to provide documentation of those resources. This information can then be used to evaluate the importance of any resources, and to consider measures necessary to mitigate adverse effects of the undertaking on resources eligible for inclusion in the National Register. Upon receipt of a report on the results of the recommended survey, I am prepared to continue this consultation as further specified in 36 CFR 800.

Please contact Jim O'Hara of this office with any questions you may have regarding my comments and recommendations regarding this application. Otherwise, I look forward to receiving a copy of the report on the results of the recommended survey, so that we may continue this consultation in accordance with the provisions of 36 CFR 800.

Sincerely,

Thomas W. Merlan
State Historic Preservation Officer

TWM:JMO/Log 33810

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Ecological Services
Suite D, 3530 Pan American Highway, NE
Albuquerque, New Mexico 87107

December 13, 1991

Cons. #2-22-92-I-053

Mr. Daniel K. Bloedel
District Conservationist
USDA, Soil Conservation Service
Federal Building, Room 162
301 West Hill
Gallup, New Mexico 87301

Dear Mr. Bloedel:

This responds to your letter dated November 27, 1991, requesting a list of species Federally listed or proposed to be listed as threatened or endangered. The proposed action involves a flood plain management study which may recommend flood retention structures, tree plantings, and recreational park development. Your geographic area of interest is within the city limits of Gallup, McKinley County, New Mexico.

Our data indicate no listed species would be affected by the proposed action. The occult little brown bat, a Category 2 candidate species, may be found in the project area. If a dam is built which will create an area of standing water, the mountain plover and long-billed curlew, also Category 2 candidate species, may be attracted to the area.

Category 2 candidate species are those for which the U.S. Fish and Wildlife Service (Service) has information indicating that proposing to list is possibly appropriate, but for which substantial data on biological vulnerability or threats are not currently known to support the immediate preparation of such rules. They have no legal status under the Endangered Species Act and are included in this document for planning purposes only. However, the Service is concerned and would appreciate receiving any status type information that is available or gathered on these species.

Information relating to the Section 7 consultation process is enclosed for your use in project planning. We suggest you contact the New Mexico Department of Game and Fish and the New Mexico Energy, Minerals and Natural Resources Department for information concerning fish, wildlife, and plants of state concern.

If we can be of further assistance, please call Mary Orms at (505) 883-7877.

Sincerely,

for Jennifer Fowler-Propst
Field Supervisor

Enclosures

cc: (wo/enc)
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals and Natural Resources Department, Forestry and Resources Conservation Division, Santa Fe, New Mexico
Regional Director, U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Albuquerque, New Mexico

Species List
Soil Conservation Service Flood Plain Management Study
Gallup, McKinley County, New Mexico
December 13, 1991

Category 2 Candidates

Occult little brown bat (Myotis lucifugus occultus) - This species is a montane dweller and roosts in natural caves, mine tunnels, hollow trees, or buildings.

Authority: Scott Altenbach, University of New Mexico, Department of Biology, Albuquerque, New Mexico 87131, (505) 277-3411.

Mountain plover (Charadrius montanus) - This species is primarily found in short grass prairies often associated with prairie dog towns. Nest sites are chosen in flat country with sparse and low-lying vegetation. This bird feeds exclusively on insects; primarily beetles, grasshoppers, and crickets.

Authority: Sandy Williams, New Mexico Department of Game and Fish, Villagra Building, Santa Fe, New Mexico 87503, (505) 827-9914.

Long-billed curlew (Numenius americanus) - This species inhabits grassy plains and prairies, lakes and rivers, mud flats, and salt and freshwater marshes. Birds usually associate with wetlands that are located in grasslands area.

Authority: Sandy Williams, New Mexico Department of Game and Fish, Villagra Building, Santa Fe, New Mexico 87503, (505) 827-9914.