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Albuquerque
New Mexico

Chamberino Floodplain Management Study

Dona Ana County, New Mexico

CHAMBERINO
FLOODPLAIN MANAGEMENT
STUDY

Chamberino, New Mexico

June 1996

Prepared for and in cooperation with

Village of Chamberino

and

Dona Ana County Flood Commission

Prepared by
U.S. Department of Agriculture
Natural Resources Conservation Service
Albuquerque, New Mexico

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Abbreviations Used in this Report

Ac	Acres
Ac-Ft	Acre-feet
BLM	Bureau of Land Management
cfs	Cubic feet per second
CN	Runoff Curve Number
D.A.	Drainage Area
EBID	Elephant Butte Irrigation District
EPA	Environmental Protection Agency
E.S.	Emergency Spillway
FT	Feet
m.s.l.e.	mean sea level elevation
NAFTA	North American Free Trade Agreement
NFIP	National Flood Insurance Program
NM	New Mexico
NMCRIS	New Mexico Cultural Resources Information System
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PCI	Per Capita Income
PS	Practise Standard from the Field Office Technical Guide
PSIAC	Pacific Southwest Interagency Committee
SC	Clayey Sand
SC-SM	Silty and Clayey Sand
SM	Silty Sand
SP	Poorly Graded Sand
Sq. Mi.	Square Mile
Tc	Time of Concentration
TR	Technical Release
US	United States
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

CHAMBERINO FLOODPLAIN MANAGEMENT STUDY

INTRODUCTION

LOCAL STUDY NEEDS - The Dona Ana County Flood Commission requested the United States Department of Agriculture's Natural Resources Conservation Service to conduct a study of the Chamberino area. Potential residential and commercial development in the area necessitate responsible management of land and water to reduce soil erosion and flood hazard. This report presents map data, the 100-year flood zone delineation, and recommendations for flood plain management. The Office of the Flood Commissioner will use the information to promote the welfare of the community, ensure wise land use, and provide a consistent process for development. Implementation of a development process will benefit all residents.

STUDY AUTHORITIES - This study was conducted by the Natural Resources Conservation Service in cooperation with the Dona Ana County Flood Commissioner under the authority of Public Law 83-566, Section 6, Flood Plain Management Studies. The program is designed to assist communities evaluate flood damage risks and alternatives that will reduce those risks.

The intent of this study is to provide flood hazard information and recommendations for the Dona Ana County Flood Commissioner and the Village of Chamberino to help address runoff and sediment problems.

Specific objectives of this study include:

1. Determine the effect of current and future development on the existing drainage system, and
2. Study alternatives for storing and disposing of storm water for the future development condition.

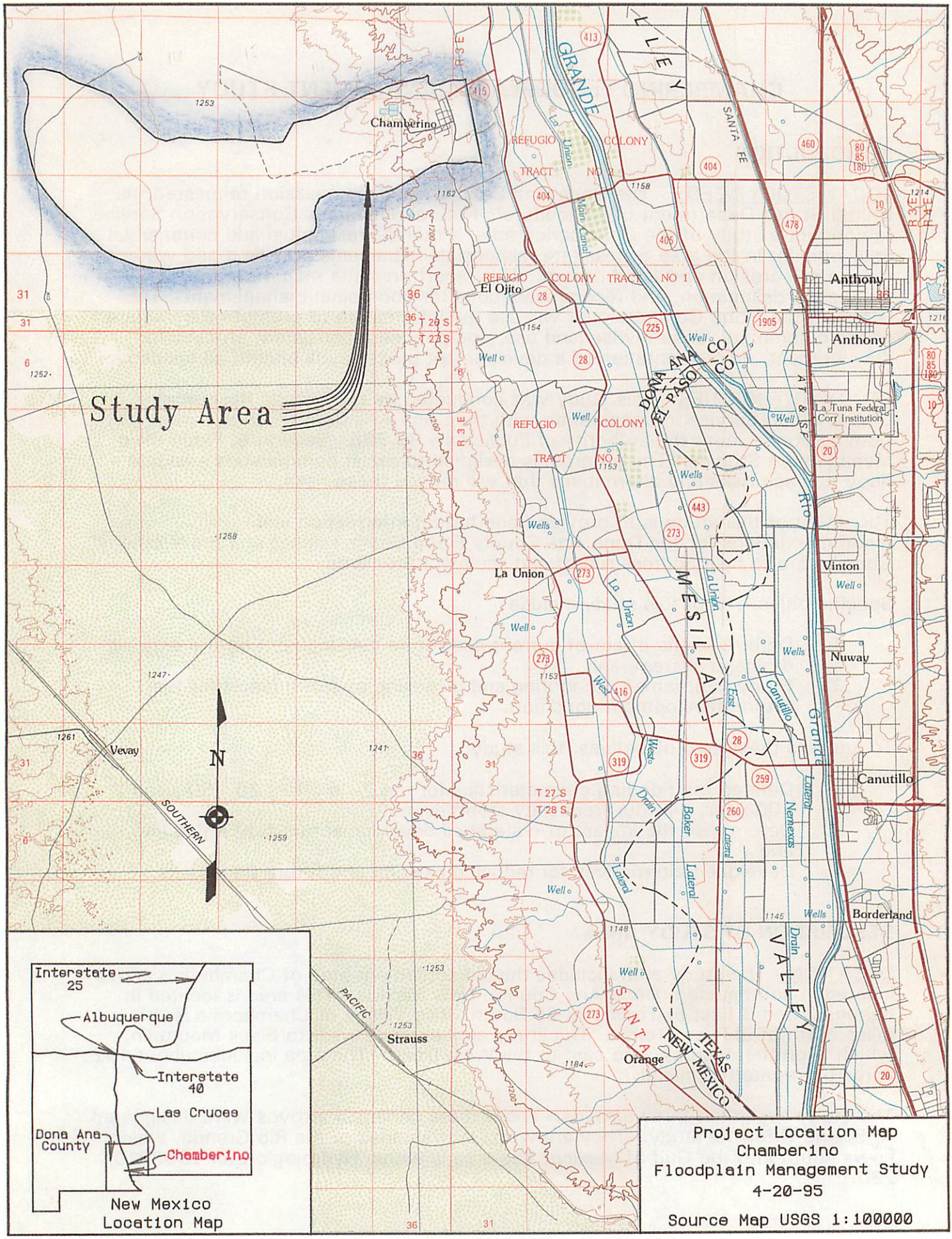
To address these two objectives, this study:

1. Defined the flooding characteristics for the 2-, 5-, 10-, 25-, 50-, and 100-year; 24-hour frequency storm events,
2. Determined the impact of watershed development on future flooding, and
3. Developed alternatives for reducing existing and future flood risks.

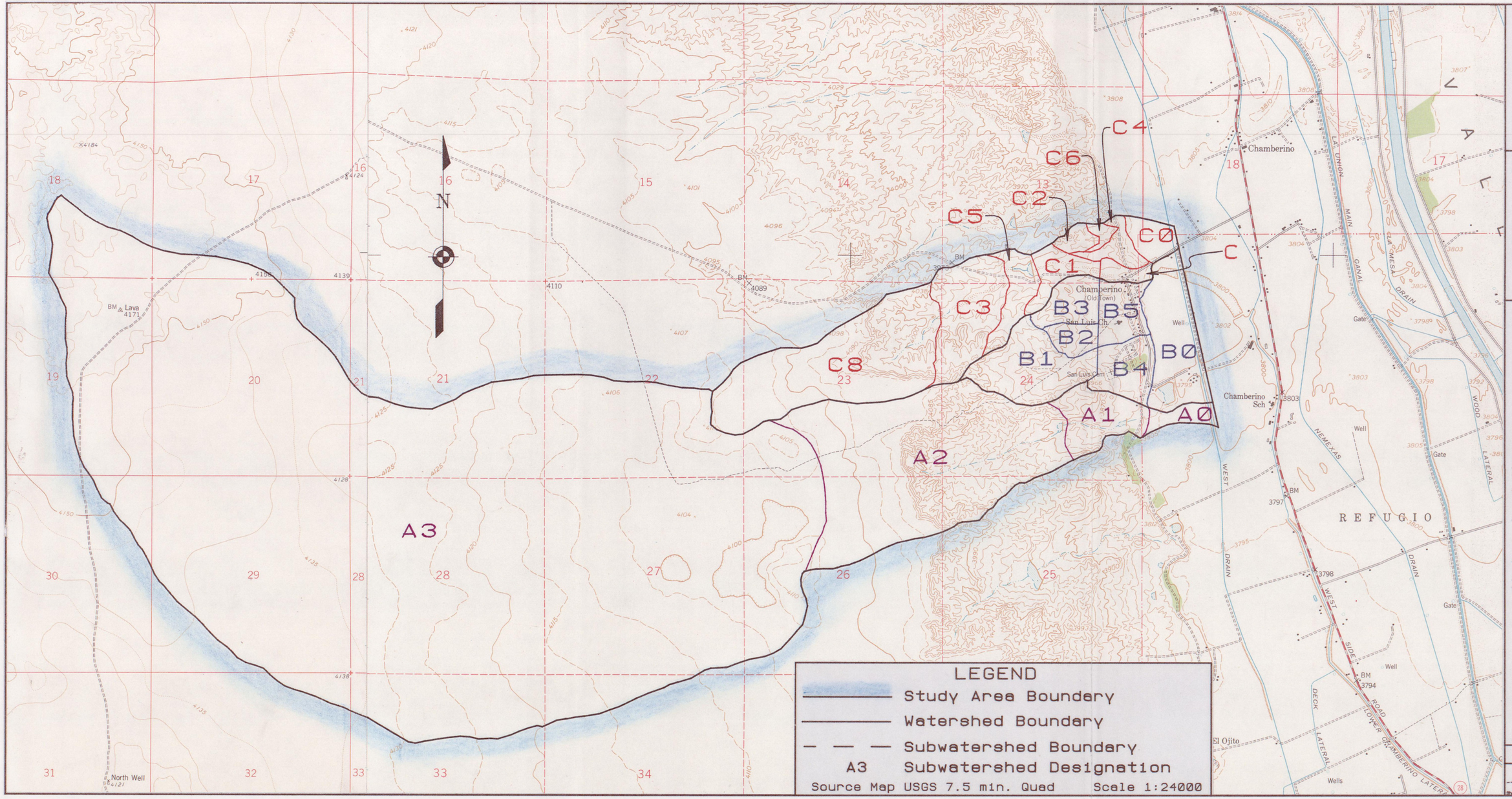
DESCRIPTION OF STUDY AREA

LOCATION - The study area includes the old settlement area of Chamberino and is located in southeastern Dona Ana County, New Mexico. This area is located in Ranges 2 and 3 East of Township 26 South. The Village of Chambernio is 20 miles north of El Paso, Texas. The study area extends west to Black Mountain, which is on the caprock, and east to the West Drain. The area includes about 192 acres of irrigated cropland.

The study evaluated three arroyos. These three unnamed arroyos were designated A, B, and C for the study. They are western tributaries of the Rio Grande, which flows south into the Gulf of Mexico. The area is within Hydrologic Unit 13030102-290.



Project Location Map
Chamberino
Floodplain Management Study
4-20-95
Source Map USGS 1:100000



Watershed Map
Chamberino
Floodplain Management Study

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE

Designed R. Ford Date 5/94
Drawn R. Armijo Date 2/95
Traced Date
Checked Date

Approved by Title
Title

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CLIMATE - The climate in the Chamberino area is semiarid, averaging eight inches of precipitation per year. Hot summers and mild winters are typical. Temperatures ranged between -10 and 112 degrees Fahrenheit during the period 1949 - 1993. Average daily temperatures are the lowest in January, 42.4 degrees, and highest in July, 82.3 degrees. The average annual temperature is about 62 degrees. For nine out of 10 years, there will be about 190 frost-free days per year. Chamberino has an average of 14 days per year with precipitation of 0.10 inch or more. Over 50 percent of the annual precipitation falls in the three-month period from July to September. The average annual snowfall is 5.1 inches. Typically, severe thunderstorm activity occurs during the summer months as a result of warm moist air from the Gulf of Mexico. Weather station summaries for stations at New Mexico State University and El Paso Airport are in Appendix C.

GEOLOGY AND GEOMORPHOLOGY - For the purpose of determining sediment yield, the Chamberino flood plain management study area can be divided into three geomorphic units, which are mesa surface, dissected slope, and flood plain. These units are described below.

The mesa surface, which includes the upper three-quarters of the watershed, is nearly level (less than 1 percent average slope). It forms part of the "La Mesa" surface, which is underlain by a fluvial facies of the Camp Rice Formation. These materials are ancestral Rio Grande deposits of Pleistocene age (0.5-2.0 million years old) and consist of sand, pebble to cobble gravel, calcite-cemented sandstone and conglomerate, and minor volcanic ash lenses. These deposits are estimated to be about 700 feet thick. The upper few feet of surface materials are windblown sands distributed into shallow blow-out depressions and small mounds 1 to 3-feet high around the mesquite and creosote bushes. The micro-lows are probably temporary local repositories for some sediment deposition during heavy rainfalls. These eolian sands are underlain at about 2 to 3-feet depth by a thick indurated caliche layer. This layer is generally exposed only along the escarpment to the east, where the La Mesa surface has been truncated by erosion. Where exposed, the caliche is rubbly and strongly fractured from mechanical weathering.

The dissected slope includes most of the lower end of the study area and consists of an intensely dissected slope coming off the La Mesa escarpment. It is underlain by deposits (up to 50 feet thick) associated with the latest entrenchment and backfilling of the Rio Grande valley, consisting mainly of nonindurated sand with pebble to boulder gravel zones and some loam to clay interlayers. These materials are a mixture of channel, terrace and fan deposits, and some recent colluvium near the base of the slope.

The third geomorphic unit used for determining sediment is the Rio Grande flood plain. This lowlands portion makes up only three percent of the study area. It is situated upon recently deposited Rio Grande flood plain and channel alluvium, consisting of up to 80 feet of nonindurated clay to sand with basal gravelly zones.

EROSION AND SEDIMENT YIELD - A Pacific Southwest Interagency Committee (PSIAC) evaluation of sediment yield was done for the study area of 8.7 square miles. A combined average sediment yield of 0.43 acre-feet per square mile per year (ac-ft/sq. mi./year) was estimated for the present condition. This means that approximately 3.7 acre-feet of sediment is deposited in an average year at deposition points along the lower reaches of the arroyos, either in basins upstream of existing drainage structures or on the Rio Grande flood plain. If no action is taken (future, forecasted condition), sediment yield during the next 20 to 25 years

will increase to an estimated 0.61 ac-ft/sq. mi./year, or a total of 5.3 acre-feet of sediment per year. Nearly all of this sediment originates on the dissected slope, as explained below.

The mesa surface geomorphic unit yields very little sediment from water erosion and transport. (Sediment yield from wind erosion undoubtedly exists in this area, but determining the off-site distribution of wind-derived sediment is complicated and goes beyond the scope of this study.) A PSIAC rating of only 0.24 ac-ft/sq mile/year was obtained. Although the loose, single-grain fine sandy soils are potentially very erosive and ground cover is only about five percent on the mesa top, these erosive characteristics are nearly offset by the high permeability of the soils and the level surface of the mesa. These two factors combine to allow most precipitation to infiltrate the ground before runoff can form. Some sediment is yielded at the edge of the mesa, as evidenced by the exposed caliche zone at the contact between mesa and slope. Sediment yield from this geomorphic unit will be unaffected by the project.

Erosion in the dissected slope geomorphic unit varies from moderate to severe, with the greatest erosion occurring at the head of the slope on the steep cliffs of the escarpment. Most of the unit has slopes between 5 and 30 percent, with a weighted average slope of 14 percent. Permeability of the soils is also variable, and ground cover is typically 5 percent. These factors contribute to moderately high runoff over nonindurated, erosive, single-grain soils. The estimated sediment-yield rating for this unit was 1.26 ac-ft/sq mile/year for the present condition and 2.26 ac-ft/sq mile/year for the future, forecasted condition. The rate of off-site sediment yield would be reduced considerably by improving existing flood-control structures and/or building new structures. The amount of reduction will depend on the number, location, and trap efficiency of the measures.

The flood plain geomorphic unit was determined to be a site of sediment deposition and received a sediment-yield rating of zero. Measured sedimentation data is not available from this part of the State for a watershed with the same type of physiography. However, the average present-condition rating of 0.43 ac-ft/sq mile/year corresponds well with measured sediment yields from watersheds with similar geology and climate; for example, the Tortugas Arroyos (0.4-0.7 ac-ft/sq mile/yr) southeast of Las Cruces.

SOIL - The soils information for this study came from the Soil Survey for Dona Ana County, New Mexico. The soils were mapped at a scale of 1:24,000 and can be divided into three broad groups. The first group is on top of the caprock. The second group includes the soils on alluvial fans, escarpments, and drainage areas. The third group includes all of the irrigated soils. The map units in this area are either associations of two or more soils or consociations of a single soil series.

Soils on top of the caprock include the Akela, Harrisburg, Pintura, Simona, Wink, and Rock Outcrop. These soils have less than 5 percent slopes and are derived from wind-blown sediments from mixed sources. The Akela soils are shallow sandy loams and gravelly sandy loams, well drained soil over basalt bedrock. Simona soils are shallow sandy loams over a petrocalcic horizon (indurated caliche). The Harrisburg soils are moderately deep loamy sands and sandy loams over a petrocalcic horizon. Wink soils are deep fine sandy loams and sandy loams. Rock Outcrop consists of recent basalt deposits that have slopes less than 10 percent.

Soils on the alluvial fans, escarpments, and drainage areas include Bluepoint, Caliza, Yturbide, and Outcrops. These soils have 5 to 35 percent slopes and are derived from wind-blown sediments from mixed sources. Bluepoint soils are deep loamy sands. Caliza soils are deep, very gravelly sandy loams with high calcium carbonate content. Yturbide soils are deep loamy sands and gravelly loamy sands (river deposits). This landscape also has intermingled outcroppings of clay, sandstone, dissected Haplaraids, and Torrifluvents that make up a small percentage of the area.

Anthony, Bluepoint, Glendale, Harkey, and Vinton soils are nearly level and are on the flood plain of the Rio Grande. They formed in alluvium from mixed sources. Anthony soils are deep loam and fine sandy loams. Bluepoint and Harkey soils are deep fine sandy loams and sandy loams. Glendale soils are deep clay loams. Vinton soils are deep loamy fine sands and fine sandy loams.

SOCIAL AND ECONOMIC - The Village of Chamberino is located in Dona Ana County, which has the second largest population of counties in New Mexico and is the sixteenth largest county in land area. Situated in the south-central portion of the State, Dona Ana County has a common border with both Texas and Mexico. The El Paso-Juarez metropolitan area lies just across the border and is located approximately 20 miles from Chamberino. Agriculture and population centers are located along the Rio Grande, which traverses the county from the northwest to the southeast corner. Crop production is an important aspect of the county economy, particularly cotton, pecans, and vegetables (lettuce, onions, and chile). Outside of the Rio Grande Valley, most of the county is sparsely populated, semiarid, flat, low mountain land suitable for ranching. In addition to agriculture, Dona Ana derives substantial economic benefit from Federal expenditures associated with the White Sands Missile Range and New Mexico State University, the State's second largest university located in Las Cruces. The county is served by two major interstate highways, Interstate 10 and Interstate 25, which intersect in Las Cruces.

Based on the latest general census, the population of the project area was estimated at 620 in 1990. Of this 1990 population, it is estimated that 79 percent is of Hispanic origin, and the median age of a Chamberino resident is 29 years of age. Table 1 shows the county population by age group.

The 1990 Census of Population and Housing estimates that about 70 percent of the housing units in the project are owner occupied. The median value of these owner occupied homes is $56,000. The per capita income (PCI) for the project area was estimated at $6,600 in 1990, which compares to a county and state PCI of $9,374 and $11,246, respectively. The 1990 Census estimates that approximately 25 percent of the project area residents are at or below poverty level.

The 1990 Census estimates in the unemployment rate for the project area at approximately 4.8 percent in 1990, which compares to a county and state unemployment rate of 9.4 and 8.0 percent, respectively. Most of the employment for the area is provided by agriculture, manufacturing, retail trade, and educational services. Table 2 displays nonagricultural employment in Dona Ana County.

The land ownership status in Dona Ana County is shown on Table 3. Most of the land in the watershed is undeveloped as shown on Table 4.

Table 1. Population By Age for Dona Ana County in 1990

Age	Population	Percent
Under 6 years	14,730	10.3
6 - 17 years	25,570	17.9
18 - 24 years	20,820	14.6
25 - 34 years	23,820	16.7
35 - 49 years	27,950	19.6
50 - 64 years	21,380	14.9
65 and over	8,550	6.0
County Total	142,820	100.0

Table 2. Nonagricultural Employment in Dona Ana County

Industry	Number Employed
Construction and Mining	2,200
Manufacturing	3,600
Transportation and Utilities	1,600
Wholesale Trade	950
Retail Trade	8,300
Finance, Insurance, and Real Estate	1,600
Services	7,800
Federal Government	4,700
State Government	7,300
Local Government	6,000
Total Nonagricultural Employment	44,050

Table 3. Land Ownership in Dona Ana County

Private	326,135 Acres	13 %
State	286,910 Acres	12 %
Federal	1,821,515 Acres	75 %
Total acres	2,434,560 Acres	100 %

Table 4. Land Use within the Study Area

Rangeland	5,104 Acres
Irrigated Cropland	192 Acres
Residential	127 Acres
Commercial/Industrial	73 Acres
Study Area Total	5,496 Acres

Table 5. Gross Receipts from Selected Agricultural Enterprises, Dona Ana County

Cattle and calves, milk	$53,607,000	2nd in New Mexico
Cotton and Chile	$16,350,000	2nd in New Mexico
Vegetables and Fruits	$30,678,000	1st in New Mexico
Pecans	$34,220,240	1st in New Mexico

Dona Ana County includes 96,030 acres of irrigated land. Cash receipts from all farm commodities amounted to $196,273,000 in 1991. Dona Ana County ranked first in agricultural production in the State for 1991. Table 5 lists gross receipts from selected agricultural enterprises and their rankings in the State for 1991.

FLOOD DAMAGES - Flood damages from the arroyos addressed in this report are primarily to irrigated cropland and to the Village of Chamberino. Crops grown include cotton, chile, onions, and spices. These are high-value crops which are susceptible to flood damage.

Floodwaters in the village flow in the streets, because arroyos have been constricted. This street flow is shallow but has high velocities, which is hazardous. Floodwaters, also cause damage to streets through erosion and sediment deposition. After a flood, there are expenses for removing sediment and grading the streets. As the watershed west of the village is developed, there is a potential for increased flood damages in the present village and on the downstream cropland.

Flood damage on the cropland is caused by flood water and water-borne sediment deposited on growing crops. The arroyos have no outlet to carry flood water around or through the cropland. Fields are level, and when large amounts of flood water and sediment are deposited on them, it takes several days to drain the water. EBID drains were constructed to remove a volume of water over several days and to drain the soil profile by lowering high groundwater levels. The drains do not have the capacity to drain floodwater quickly. Chile, onions, and spices are sensitive to damage from standing water. After flood waters recede, deposited sediment decreases the uniformity of application during irrigation, further damaging the growing crop. These are high value crops that require a large investment for planting but have potential for high returns. Chile has the potential gross return of $2,350 per acre. The timing of a flood has a significant effect on the extent of damages. If the ground is saturated (just after irrigation) when flood water inundates the field, extensive damages will occur sooner than if the ground is dry. The intensive, summer thunderstorms which cause flooding usually occur during the summer when crops are growing. Temporary dikes have been constructed on the upper end of the fields, and these dikes divert water away from the fields. However, these dikes are effective for only small storms. Large runoff events overtop and erode these temporary dikes.

NATURAL RESOURCE INVENTORY

VEGETATION - The study area is within the Southern Desertic Basins, Plains and Mountains Major Land Resources Area. The western portion of the drainage area is native rangeland. The eastern portion of the area which is in the Rio Grande flood plain is irrigated cropland. The soils in the study area are naturally droughty, and will support both grassland and mixed grassland-shrubland vegetation. The temperature and moisture regimes of the area favor warm season perennial plants. Rangeland in the study area is predominantly made up of three range sites: Deep Sand, Shallow Sandy, and Sandy. Desert shrubs and half shrubs dominate these rangeland sites. Typical shrubs and half shrubs are creosote bush, broom snakeweed, tarbush, mesquite, and fourwing saltbush. An occasional yucca or prickly pear cactus can be found. Grasses include mesa dropseed, sand dropseed, and bush muhly. Annual forbs vary greatly in both kind and amount from year to year, depending on rainfall. Perennial forbs are sparse. Range condition, using

the NRCS rating system in which existing vegetation is compared to potential vegetation for each range site, is estimated to vary from poor to low fair over most of the area.

WILDLIFE - Wildlife habitat in the study area is dominated by gently sloping undulating sandy and loamy sites. A shallow, steep escarpment, the caprock, separates the upper rolling sandhills from the lower sand wash arroyos. The plant community is dominated by Southern Desert short-grass shrub sites which are dissected by arroyos in the lower part of the watershed. Wildlife species occurring on these sites include black tailed jackrabbit, desert cottontail, thirteen lined round squirrel, kit fox, coyote, scaled quail, mourning dove, raven, rattlesnake, kangaroo rat, southern plains woodrat, desert pocket mouse, desert pocket gopher, roadrunner, and desert mule deer. Where large mesquite, yucca, and cholla cactus are present, this site is a breeding area for Swainson's hawk, mockingbird, Scott's oriole, mourning dove, and white-necked raven. Dune and interdune areas with mesquite provide habitat for burrowing mammals, their predators, and shrub dependent birds.

Any alternatives developed for the study area should include a detailed inventory of wildlife species and habitat to account for other wildlife species and habitat occurring in this study area. As the Southern Desert short-grass shrub sites are developed and urbanized, wildlife species occurring in these sites will be replaced by those species that can adapt to the urban setting.

THREATENED AND ENDANGERED SPECIES - No endangered and threatened animals were observed during the inventories conducted for this study. As alternatives are developed, the U.S. Fish and Wildlife Service (USFWS) must be consulted to assure that no listed species would be affected by proposed alternatives. Those species that may occur in the study area, which are listed by Federal and state governments, include Aplomado falcon, whooping crane, American peregrin falcon, and bald eagle. Several species are aslo listed on the state list as Group II, Endangered and Threatened. State Group II species include those species whose prospects of survival or recruitment within the State may become jeopardized in the foreseeable future. These species include Bell's vireo, Baird's sparrow, and the Anthony blister beetle. As alternatives are developed and implemented, care must be taken to assure that no threatened and endangered species are adversely affected.

Rare and endangered plants that may be found within the Chamberino flood plain Management Study, Dona Ana County, New Mexico include night-blooming cereus, Orcutt's pincushion cactus, button cactus, sand prickly pear, grama grass cactus, and Payson's cryptanth. Night-blooming cerus, Orcutt's cactus, button cactus, Sandberg's pincushion cactus, Wilcox pincushion cactus, Visnagita cactus, sand prickly pear, and grama grass cactus are New Mexico List 1 species. Taxa listed as List 1 are included for any one of the following criteria:

1. The taxon is listed as threatened or endangered under the provisions of the Federal Endangered Species Act;
2. The taxon is so rare across its entire range and of such limited distribution and population size that unregulated collection could jeopardize its survival in New Mexico; or
3. The taxon may be widespread in adjacent states or Mexico, but its numbers are being significantly reduced to such a degree that within the

foreseeable future the survival of the taxon within New Mexico is jeopardized.

Payson's cryptanth is a New Mexico List 2 species. New Mexico List 2 taxa are considered to be rare because of restricted distribution or low numerical density. They need not be endemic to New Mexico but must be regionally endemic or rare throughout their range. Since they are rare, these species are sensitive to long-term or cumulative land use impact and are vulnerable to biological or climatic events that could eventually threaten them with extinction or extirpation. Therefore, List 2 species are monitored by the State of New Mexico to determine if they should ever be elevated to List 1 endangered species status. They are not protected by state statute or policy.

HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

A check of the New Mexico Cultural Resources Information System (NMCRIS) for the area of sections 13, 14, 15, 16, 21, 22, 23, and 24, Range 2 East, Township 26 South, reveals the presence of 16 currently recorded archaeological sites. These sites range in size from less than 100 square meters to large pithouse and pueblo occupation sites in excess of 30,000 square meters in area. Ages for these sites cover the entire range of prehistoric occupation, from Paleoindian through late Pueblo. Given the physiographic setting of the proposed project area, the probability of encountering archaeological materials is very high. Considerably less than 100 percent of the area noted above has been subjected to intensive pedestrian inventory. Such inventory will undoubtedly record additional sites. The majority of archaeological sites in the area are low-visibility artifact scatters. Structural materials are rarely visible on the surface, and artifact density is often relatively low.

A check of the most recent listings of the National Register of Historic Places and the New Mexico State Register of Cultural Properties shows that no properties within the proposed project area are entered on either register.

If Federal monies, permits, or assistance are used to implement any undertakings within the proposed project area, the stipulations of section 106 of the National Historic Preservation Act and 36CFR800 must be complied with. Professional archaeological inventory and assessment would be a primary part of such compliance.

INVESTIGATION AND ANALYSIS

<u>HYDROLOGY</u> - Several hydrologic models are available to estimate existing and future runoff volumes (acre-feet) and peak flows (cubic feet per second). "Computer Program for Project Formulation Hydrology" Technical Release 20 (TR-20), February 1992, USDA-Natural Resources Conservation Service was selected because of proven reliability, familiarity with the program, multiple sub-watershed and routing capabilities, and ability to model reservoir routing and channel modifications.

The study area was divided into three main arroyos, and these were subdivided into a total of 19 basins. TR-20 input parameters include basin size, time of

Table 6. 24-Hour Duration Precipitation Values

Return Period in Years	Percent Chance of An Equal or Larger Storm Event	24-Hour Precipitation in Inches
2	50	1.23
5	20	2.07
10	10	2.52
25	4	3.00
50	2	3.30
100	1	3.60

concentration, rainfall, and runoff curve number. Basin sizes ranged from 0.01 to 6.06 square miles. The total watershed area is 8.6 square miles.

Time of concentration (Tc) is the time in hours that it takes runoff to travel from the most distant point to the basin outlet. Time of concentration values were computed with the Modified Kirpich Equation. No adjustment was made to the Tc values for the future condition hydrology. Due to the generally high length to width ratios of the basins, decreasing the Tc values was not considered appropriate for future conditions. If extensive concrete channel improvements are installed in the middle and upper portions of the watershed, the future condition Tc values may need to be reconsidered. Decreasing Tc values would tend to increase the peak flows. However, runoff volumes would not be affected by a change in Tc.

NRCS NM-II-75 rainfall distribution was used to represent the high intensity storms of the Chamberino area. The type NM II-75 places 75 percent of the 24-hour precipitation in the most intense one-hour period. Rainfall values for the 2-, 5-, 10-, 25-, 50- and 100-year, 24-hour events were used to develop the existing runoff hydrology. Precipitation values were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 2, Frequency Atlas of the Western United States. The 24-hour rainfalls used are shown in Table 6.

Soils information was derived from the NRCS Dona Ana County Soil Survey Report. Curve numbers are used in the computer model to define the infiltration/runoff phenomena for various soils, cover types, and conditions. Runoff curve numbers are based on field investigations, aerial photography, soil textures, land use, cover, and cover condition. These six factors were used with Table 2-2, in TR-55, to assign runoff curve numbers for existing conditions. Runoff volumes are determined from curve number and rainfall values. A curve number of 98 indicates very little infiltration, resulting in almost all precipitation becoming runoff (road surfaces). A curve number of 65 indicates high infiltration (sandy soil) and low runoff. Curve numbers ranged from 68 to 80. Two scenarios for basin runoff conditions were developed: existing condition and future developed condition. The flood hazard zone maps and profiles are based on existing conditions. The alternatives for reducing flood risks are based on the future high density developed condition. This future condition was based on projected land use 25 to 50 years in the future. The projected land use includes industrial and residential land uses. The future residential areas were assumed to be high density developments with 1/10 to 1/8-acre lots and fifty percent of each lot being impervious.

Basin hydrologic parameters and delineations were developed using ortho-topographic maps (1 inch = 200 feet) provided by the Dona Ana County Flood Commission (dated April 1992). Contour intervals consisted of 2 and 4 feet. Basin delineations are shown on page 3. Table 9, in Appendix B on page B-1, shows the basin characteristics and hydrologic properties for the existing condition and the future developed condition.

The three main arroyos studied were subdivided into four or more basins each. Currently, the analysis points of interest are at the western edge of the old settlement. Arroyo C contains two existing dams in series and Arroyo A contains one existing dam. On Arroyo C, three additional dams had failed through their earthen spillways. Detailed field surveys were completed for the three functioning dams, and this data was used to develop input parameters for routing the structures.

Two-year, 10-year, and 100-year basin discharges and runoff volumes for the existing condition are displayed in Table 10, page B-2. The high density, future condition, 100-year flood event is displayed in Table 11, page B-3. For the future condition, development is projected to occupy 18 percent (120 additional acres) of Arroyo A, 98 percent (376 additional acres) of Arroyo B, and 89 percent (249 additional acres) of Arroyo C.

Dams protecting downstream residents and property pose a risk or hazard. If the embankment fails, floodwater can be suddenly released, producing very high peak discharges. This condition is referred to as a breach failure. Breach analyses were completed for the three existing structures. The peak discharges for these analyses were developed using NRCS criteria in Technical Release 60. This NRCS criteria is based on empirical data obtained from measurements of dams after failure and is accepted by the New Mexico State Engineer Office. A breach hydrograph was developed using the peak discharge and volume of floodwater stored in the reservoir. This hydrograph had a rising limb of 0.1 hour. Since the three existing dams normally have dry pools, they will most likely fail due to overtopping. Therefore, the breach hydrographs were added to the 100-year storm event using TR-20.

HYDRAULICS - The Chamberino arroyos were analyzed by detailed methods using numerous cross sections and the "HEC-2 Water Surface Profiles," September 1990 (Revised 9/91), U.S. Army Corps of Engineers. Sheets D-1 through D-11, in Appendix D, show the 100-year flood plain and water surface profiles for the three arroyos. The present (or existing) condition 100-year flood is displayed as flood hazard zones and water surface profiles. In addition, the flood hazard zones for a sudden breach of Chamberino Dam No. 1 and Structure No. 4 are shown on Sheets D-1 through D10.

The average annual sediment yield of 0.43 acre-feet per square mile is relatively low. Therefore, the amout of suspended sediment in flood flows will be small. The discharges used in the HEC-2 model are the clean water discharges computed by TR-20.

Cross section data for the three main arroyos were obtained from the ortho-topographic maps (1 inch = 200 feet) provided by the Dona Ana County Flood Commission (dated April 1992). Contour intervals consisted of 2 and 4 feet.

Friction losses due to floodwater flowing against the arroyo bottom and sides are modeled by channel roughness. For this study, Manning's "n" values were used for channel roughness. Field investigations and Supplement B of Hydraulics, Section 5 of the NRCS National Engineering Handbook, were used to estimate "n" values. A value of 0.025 was used for the arroyo channel. The "n" value was increased to 0.035 for out of bank flows through rangeland. This increased value reflects vegetation and desert pavement. In residential areas, a value of 0.030 was used.

EXISTING DRAINAGE STRUCTURES

In Arroyo A, the southern-most arroyo in the study area, is one existing dam, which is about 2,400 feet west of the irrigated cropland. In Arroyo C, the northern arroyo, there are two existing dams, which are about 820 feet from each other. The downstream dam is about 1,600 feet west of Chamberino. The dam in Arroyo A is located on BLM land, and no design or construction records were available during the study. The two dams in Arroyo C are located on private property and were originally constructed by the landowner in the late 1940's or early 1950's. No design and construction information is available for these two structures.

The Dona Ana Flood Commissioner's Office has named the downstream structure in Arroyo C, Chamberino Dam No. 1. For the study and in this report, this designation is maintained. For the study and in the report, the upstream dam in Arroyo C is designated Structure No. 2. The structure in Arroyo A is designated Structure No. 4, and a natural depressional area in Arroyo A and on top of the caprock was modeled as Structure No. 3.

CHAMBERINO DAM NO. 1 - The embankment has an effective height of 14 feet, which is the vertical dimension from the earthen emergency spillway to the downstream valley floor. The total height of the dam is 16 feet. It is about 600 feet long. Currently, sediment in the reservoir is 10 feet below the top of the dam. The reservoir has a maximum capacity of 24.7 ac-ft. The lowest ungated spillway is a 30-inch diameter steel pipe which is 38 feet long. The inlet invert of the pipe is 3.7 feet below the top of dam. The earthen emergency spillway is approximately 12 feet wide with its crest 2 feet below the top of the dam. For this earthen spillway, the control section and exit slope are on a relatively flat grade. The embankment side slopes appear to be about 3:1 (3 feet horizontal for every 1 foot vertically) on the upstream face and 1.25:1 on the downstream face. The earthfill materials appear to be reasonably well compacted sands with a very modest amount of clay fines. These materials would probably classify as silty sand (SM) or silty to clayey sand (SC-SM).

Table 12 (Appendix B, page B-4) displays elevation, capacity, and discharge data for each of the four structures. Chamberino Dam No. 1 will store the two-year storm event without discharge. It will also store most of the five-year event. For the five-year storm, the conduit will release 0.8 cubic feet per second (cfs), which is equivalent to 360 gallons per minute (gpm). For the ten-year storm, the conduit will release 10 cfs. The earth spillway will begin to operate during the 25-year storm with a peak discharge of 41 cfs. The 50-year and 100-year events will be contained by the dam with the 100-year storm cresting 0.2 foot below the top of dam. However, during the 100-year storm, the earth spillway will discharge 102 cfs and will operate for 6.61 hours. The velocity of flow will be in excess of 4.5

feet per second (fps), which will erode the earth spillway. The breach discharge for this structure is 1,012 cfs.

STRUCTURE NO. 2 - In 1992, floodwater filled this structure and flowed over its top, eroding the dam. The structure failed, or breached. Later that summer, the dam was repaired by pushing sediment from the pool into the breach.

The present embankment is 820 feet upstream and in series with Dam No. 1. The embankment has an effective height of 7 feet with total height of 10 feet. It is 360 feet long, and currently, the sediment in the reservoir is 6 feet below the top of the dam. The lowest ungated outlet is an earthen spillway. The crest of this spillway is approximately 10 feet wide and 3 feet below the top of dam. The earth control section and exit slope are on a relatively flat grade. The embankment side slopes appear to be about 2:1 on the upstream face and 0.75:1 on the downstream face. The earthfill materials are very loose, clean, medium grained sands and would probably classify as poorly graded sand (SP).

Due to the loose sandy material, this structure will not withstand any prolonged storage without failure by piping or sliding. It will definitely breach when it is overtopped. Breaching would endanger the downstream structure and could cause it to fail, increasing flooding in the village. If Dam No. 1 did not fail, breaching of this structure will allow erosion of the dam and stored sediment to prematurely fill the pool of Dam No. 1.

Table 12, page B-4, shows that Structure No. 2 will store the two-year storm event without discharge. The five-year event will discharge 67 cfs through the earth spillway with a flow depth of 1.8 feet. The ten-year event will be contained by the dam and crest 0.1 foot below the top of dam. The 25-year, 50-year, and 100-year events will overtop the dam by 0.2, 0.4, and 0.5 feet, respectively. During the 10-year storm, the earth spillway will discharge 133 cfs and will operate for 20.3 hours. The velocity of flow will be about 3.5 fps, which will erode the earth spillway. The breach discharge for this structure is 345 cfs.

STRUCTURE NO. 4 - This dam and reservoir are in Arroyo A. The embankment has an effective height of 10 feet and a total height of 15.24 feet. It is 820 feet long, and currently, the sediment in the pool is 8 feet below the top of the dam. The reservoir has a maximum capacity of 37.4 ac-ft. The lowest ungated outlet is an earthen spillway. The crest of this spillway is approximately 7 feet wide and 5.24 feet below top of dam. The earth control section and exit slope are on a relatively flat grade. However, the grade of this exit slope is steeper than the exit slopes for the dams in Arroyo C. The embankment side slopes appear to be about 3:1 on the upstream face and 2:1 on the downstream face. The earthfill materials appear to be reasonably well compacted sands with a modest amount of clay fines. They would probably classify as clayey sand (SC) or silty to clayey sand (SC-SM).

Table 12, page B-4, shows that Structure No. 4 will receive very little water during the two-year storm event. The five-year event will discharge 58 cfs through the earth spillway with a flow depth of 2.1 feet. The 50-year event is contained by the dam and crests at the top of dam. The 100-year event overtops the dam by 0.1 foot. However, the earth spillway will discharge 293 cfs and will operate for over 40 hours. The velocity of flow will be in excess of 3.0 feet per second. The earth spillway will be eroded and may fail due to the depth, duration, and velocity of flow. The breach discharge for this structure is 624 cfs.

Table 7. Strategies and Measures for Flood Loss Reduction

Modify Flooding
Dams and Reservoirs
Levees and Walls
Channel Alterations
Diversions
Land Treatment
Onsite Detention
Modify Susceptibility to Flooding
Flood Plain Regulations
Development and Redevelopment
Warning and Preparedness
Floodproofing
Modify Impact of Flooding
Flood Insurance
Relief and Recovery

STRUCTURE NO. 3 - This is not a man-made feature; it is a natural depressional area that catches and detains floodwater. For this study, it was modeled in the TR-20 hydrology program as an embankment and reservoir. It is located on the caprock about two miles west of Chamberino. The area will store 70 acre-feet of floodwater with no downstream discharge.

Table 12, page B-4, shows that this natural depression will receive very little water during the two-year storm event. The five-year event will release 72 cfs downstream with a flow depth of 0.2 feet. The 100-year event releases 402 cfs downstream and flows with a depth of 1.0 foot.

RECOMMENDATIONS FOR FLOOD PLAIN MANAGMENT

The primary objectives of flood plain management are the reduction of flood loss and the preservation (or restoration) of natural flood plain values. The sponsors are in a relatively good position to develop and adopt a comprehensive watershed management plan. Fortunately, very little development has taken place in the flood plain. Many communities are faced with costly remedies such as having to floodproof and/or remove existing structures in order to reduce repetitive flood damages. Preventing development in the flood plain and floodway is the preferred and least costly solution. It also promotes the maintenance of the natural resources of the flood plain.

The following information has been edited from Flood Plain Management Handbook, US Water Resources Council, September 1981. In addition, the information in Appendix A will assist in the review and regulation of future development. The three general strategies for reducing flood losses are: modifying the flood, reducing the danger and susceptibility to damage, and reducing the financial and social impacts of flooding. Table 7 displays these three strategies and measures for implementing each strategy.

MODIFY FLOODING - The first strategy involves keeping flood waters away from developments and populated areas by decreasing runoff; increasing channel capacity; or containing, diverting, or storing floodwater. These measures typically mean high capital costs in large public project activities.

Dams and reservoirs capture and temporarily hold floodwater upstream of flood-prone areas. Excess water is gradually released after the flood threat has passed. Use of dams requires sites capable of storing sufficient amounts of water which are upstream but fairly close to the area to be protected. Because of their cost, large dams and reservoirs are usually feasible only where they protect urban areas or high value agricultural lands. For some heavily developed urban areas, dams and reservoirs may provide the only practical means for significantly reducing flood damage.

The protection afforded by a dam is greatest in the area immediately downstream. Protection further downstream is reduced by flows from tributaries and by runoff from areas of land below the dam. Protection can also decrease over time if the reservoir gradually fills with sediment.

Levees and walls confine floodwater to the existing stream and a selected portion of the flood plain. Each of these measures protects only the area immediately behind it and only against the selected flood height for which it was designed.

Levees are normally constructed of earth. The width of a levee's base must be several times greater than the levee's height for stability. As a result, levees more than a few feet in height require significant land rights between the stream and the property to be protected. Significant space may also be required for setting levees back far enough from the channel to provide adequate flow capacity. Levees are best suited for use along large rivers where their construction is less likely to be a severe encroachment on the flood plain. Floodwalls are usually constructed of concrete or steel and take up far less room. They are more suitable for use in congested areas.

Channel alterations reduce flooding by increasing the capacity of the stream or arroyo. The various types of alterations include: deepening or widening the channel, removing debris, paving the channel, and raising or enlarging bridges and culverts that restrict flow. Underground conduits can also be installed to carry part or all of a small stream's flow.

All of these channel alterations contribute toward reducing the height of a flood. It is sometimes possible, by extensively reconstructing an arroyo channel, to contain major floods within its banks. Unfortunately, such alterations sometime increase flooding downstream by accelerating the flow of flood water.

Diversions intercept flood flows upstream of a damage-prone area and route them around the area through an artificial channel. Diversions may either completely reroute an arroyo or only collect and transport flows that exceed the normal capacity of the channel or that would cause damage.

Diversions are particularly well suited for protecting developed areas because they don't require land acquisition or construction within the protected area. However, opportunities for diversions are often limited by the nature of local land formations and soil conditions. There must also be a channel available into which the diversion can empty. The receiving channel must have enough capacity to carry the flow diverted of through the diversion without causing further flooding.

Land treatment measures are used to reduce runoff of water to arroyos or other areas. Techniques of land treatment include maintenance of trees, shrubbery and

vegetative cover, terracing, slope stabilization and waterways. These measures reduce water flow by improving infiltration of rainfall into the soil, slowing and reducing runoff, and reducing the sedimentation that can clog culverts or storage reservoirs. While the effect of any individual measure is small, extensive land treatment programs can effectively reduce flooding.

The main objective of onsite detention is to prevent excessive runoff from developed or developing areas. Flooding can be increased significantly by runoff from lands which have been stripped of vegetation or covered with buildings, pavements and other impervious materials. Also, onsite detention can trap pollutants which would improve water quality.

The principal onsite detention measures are reducing land clearing and providing temporary storage for some or all runoff from a property. Use of these measures may be voluntary or required by regulatory or permit programs. Regulations requiring onsite detention are often part of zoning or other broad programs controlling land use and development in upland areas.

The cost of individual onsite detention measures is usually not high. However, the cost often falls on the owner of the land where flood waters arise, while most other flood control measures are paid for by the people in the protected area or by the general public.

Onsite detention ponds or reservoirs can lose their effectiveness over time if they're not regularly cleaned and maintained. This can involve a significant cost. Another potential is the lack of unified control over patterns of flow drainage. However, this problem can be handled through broad scale planning of the overall system.

MODIFY SUSCEPTIBILITY TO FLOODING - A diverse range of measures is available to reduce the danger and susceptibility to damages from flooding. By and large, they involve little or no construction and have low capital cost.

Flood plain regulations designate flood-prone areas and limit their uses to those compatible with the degree of flood risk. They serve several purposes including:

1. Preventing new development that could result in loss of life and excessive damage to property or reduce the potential for such losses and damages.
2. Protecting unwary buyers from purchasing land or homes in flood-prone areas.
3. Preventing encroachments that decrease the flood carrying capacity of floodplains, increase flood heights, or otherwise aggravate flood problems.
4. Reducing public costs for emergency operations, relief, evacuations, and restoration.
5. Reducing the need for future expenditures for construction, operation and maintenance of reservoirs, levees and other flood control measures.
6. Preserving natural flood plain values.

Development and redevelopment are implemented through public policies which encourage development away from flood prone areas. Utilities, streets, schools and other community facilities attract developers and purchasers to an area. Public policies that limit the extension of services and construction of community

facilities in flood plain areas discourage unwise private development. Actions to adopt this kind of public policy must usually be taken well before development pressures occur and should be supplemented with other regulatory measures to ensure success. Limiting extension of utilities and other public facilities into flood-prone areas also limits the need for their repair and replacement after floods.

Redevelopment programs can also be undertaken to correct existing problems. They can include relocating existing buildings to safe sites or demolishing undesirably located structures and providing replacements in a flood-free site. Areas vacated in either way are usually converted to a suitable open space use. Remaining structures may be modified to make them more resistant to flood damage.

Warning and preparedness assist residents and businesses located in flood-prone areas by allowing time for evacuation. The National Weather Service makes flood forecasts for about 2,500 locations, mostly along major streams. The availability of specific flood warnings for other locations depends on the development of flood warning systems by local authorities.

In local flood warning systems, measurements of precipitation, temperature or stream levels upstream of an area are used to predict whether flooding will occur, when it will arrive, and its severity. Local flood warning programs must provide for collecting data, making flood predictions, and disseminating warnings. Warning systems are normally established on a community, county or watershed basis.

The concept of floodproofing (or more accurately, flood resistant construction practices) is to modify buildings, their sites or their contents to keep water out or to reduce the damage caused by water entry. Floodproofing can also be used to reduce disruption of activities, to maintain vital services in operation during a flood, and to permit faster recovery from flooding.

Unlike dams and other measures protecting large areas or long sections of streams, floodproofing is used to protect individual buildings or small groups of buildings. The most frequently used method of floodproofing is the elevation of buildings above expected flood levels. Small flood walls or levees can be used to protect single buildings or small groups of properties. They have the advantage of protecting the whole enclosed area rather than just the building.

These measures are also useful for protecting buildings for which other floodproofing measures cannot be used because of the building's size or lack of structural strength.

MODIFY THE IMPACT OF FLOODING - Some flood losses are likely to take place in developed areas despite measures to control flooding and reduce susceptibility to damages. The primary means for reducing the catastrophic financial impact of flooding on individuals and communities are flood insurance and provisions for relief and recovery.

Flood insurance is offered through private insurance companies and is underwritten or guaranteed by the Federal government. The National Flood Insurance Program (NFIP) provides an opportunity for owners and renters of flood-prone properties to insure against some flood losses. The insurance is available to all persons in areas in which the local government is participating in the Federal

program. The 100-year flood plain map provided by the Natural Resources Conservation Service in this study could be adopted by the county to regulate development and allow residents to obtain flood insurance.

Flood insurance is applicable to all areas subject to flooding. It can be used along with other flood plain management measures which act directly to reduce losses. Owners and renters of existing structures have the option of purchasing flood insurance. However, financial institutions making loans for purchase of new or existing buildings in flood-prone areas often require the purchaser to buy the insurance.

The major costs to the local government for participation in the National Flood Insurance Program are those for developing and enforcing the required flood plain regulations. The cost to policyholders depends on the amount of coverage purchased and the degree of flood risk.

Relief and recovery occurs after flood damage occurs. The impact of floods on individuals and communities can be reduced by these relief and recovery measures. Losses caused by disruptions and interruptions to businesses, industry, utilities and transportation facilities can be reduced if these activities are quickly returned to normal operation after a flood. This can be accomplished through advance planning for debris removal, pumping of flood water, and restoration of utilities and other community services. This advance planning can be included in flood preparedness plans.

Simply returning a community to its pre-flood condition re-establishes the original risk of flooding. In many cases, opportunities arise after floods to eliminate unsuitable developments which have been damaged or to rebuild essential structures in a way that will minimize future flood losses.

ALTERNATIVES

During the field reconnaissance, the NRCS interdisciplinary team learned that within the next 10 years, more urban development is expected to occur between El Paso and Las Cruces. This expansion of urban area will be partially due to the North American Free Trade Agreement (NAFTA) and the new port of entry at Santa Teresa, New Mexico. The developer of a large subdivision near La Mesa recently received county approval. La Mesa is six miles northwest of Chamberino, and the subdivision will be built on the escarpment and alluvial fans west of the irrigated floodplain of the Rio Grande. This situation would indicate that the area west of Chamberino and east of the caprock is potential urban land.

The New Mexico Environment Department has conducted two public meetings in the Village of Chamberino regarding a water system and a sewerage system. These infrastructure improvements would be financed by EPA grants for Colonias. In addition, the Village has a new fire station. These improvements will attract developers to the Chamberino area.

Using this information, the future forecasted conditions included high density residential development and industrial use for the private land in the watershed. The future conditions were modeled by revising the runoff curve numbers to reflect the forecasted land use. The values for time of concentration were not

revised; however, future developers and subdivision plans should address these changes.

The NRCS interdisciplinary team discussed four alternative approaches for the reduction of current and future flood risk. The first was vegetative management which would improve the plant community, slow runoff, and increase infiltration. The climate in the study area makes vegetative improvement very difficult to attain. Therefore, this approach was not pursued.

The second approach was to repair and maintain the small existing structures in the watershed. This approach would repair the failed dams in Arroyo C and maintain all existing and the repaired structures. For existing conditions, the existing two sturctures in Arroyo C and the existing structure in Arroyo A are providing good protection for the Village and downstream cropland. Therefore this approach can be considered as development occurs in the future. Under this approach, developers could rehabilitate the failed dams in Arroyo C or develop onsite detention structures to reduce the future condition peak discharges.

The third approach was to construct additional small structures and to repair and maintain the small existing structures in the watershed. This approach would repair the failed dams in Arroyo C, construct additional onsite detention and grade stabilization structures, and maintain all structures in the watershed. Available site locations for additional structures are limited, and there is additional cost to construct these additional structures. This approach, also, was not pursued. However in the future, developers may use this approach and construct many onsite detention basins to reduce future peak discharges.

The fourth approach was to use the existing large structures (Structures 1, 2, and 4) to control floodwaters. These structures would be operated and maintained, and if necessary, could be improved or enlarged. These structures are functioning and in good condition. This approach appears very cost effective. This approach would provide protection for the existing condition. Onsite detention could be used to address future conditions flood flows. The onsite detention structures could be required through subdivision reviews and other regulatory authorities.

<u>ALTERNATIVE 1--NO ACTION</u> - This alternative discusses the future developed condition which forms a baseline for measuring the other alternatives, which are discussed later. The present capacity and functioning of the existing dams is discussed in the section entitled Existing Drainage Structures. Refer to page 14 and Table 12 on page B-4. When development occurs in the escarpment area between the Village and the caprock, floodwater discharges will increase. These future peak discharges and runoff volumes are displayed in Table 11 on page B-3, and Table 13 on page B-5 displays the future functioning of the existing structures. The information on Tables 11 and 13 are discussed in the following paragraphs.

Chamberino Dam No.1 is presently in good condition. For the future condition, Chamberino Dam No.1 will store the two-year storm event and most of the five-year event. For the five-year storm, the conduit will release 6.0 cfs. The earth spillway will begin to operate during the ten-year storm with a peak discharge of 27 cfs. The 25-year and 50-year events will be contained by the dam with the 50-year storm cresting 0.15 foot below the top of dam. The future 100-year storm will overtop the dam by 0.12 feet and will discharge 330 cfs. The dam will

be overtopped for 0.6 hour, and the earth spillway will operate for 7.2 hours. The velocity of flow will be in excess of 4.5 fps which will erode the earth spillway.

Structure No. 2 is in poor condition. For the future condition, the earth spillway will begin to operate during the two-year storm with a peak discharge of 3 cfs. The five-year event will be contained by the dam with the storm cresting 0.7 foot below the top of dam. The future 10-, 25-, 50-, and 100-year storms will overtop the dam by 0.1, 0.4, 0.5, and 0.8 feet and will discharge 294, 536, 691, and 932 cfs, respectively. During the ten-year storm, the dam will be overtopped for 0.4 hour, and the earth spillway will operate for 20.4 hours. The velocity of flow will be about 3.5 fps which will erode the earth spillway. During the 100-year storm, the dam will be overtopped for 0.7 hour, and the earth spillway will operate for 20.9 hours.

Structure No. 4 is in good condition and will contain the 100-year storm event. For the future condition, the earth spillway will begin to operate during the five-year storm with a peak discharge of 58 cfs. The 10-year, 25-year, and 50-year events will be contained by the dam with the 50-year storm cresting at the top of dam. The future 100-year storm will overtop the dam by 0.03 foot and will discharge 293 cfs. This is essentially the same crest elevation and discharge as the existing condition.

For this alternative, the present flood plain, as shown on Sheets D-1 through D-11 in Appendix D, will represent the flood hazard zones and water surface profiles until industrial and residential development occurs in the watershed. This alternative and county flood plain management regulations can require developers to install strategies to modify future flooding and maintain future flood discharges within the delineated flood hazard zones. Therefore, development would need to detain all increased peak discharges and runoff volumes.

This alternative does not require public investment for capital improvements and relies on existing flood plain management regulations. The existing regulation would be used to control and regulate future development so that future flood discharges would not increase.

<u>ALTERNATIVE 2--IMPROVE EXISTING STRUCTURES</u> - This alternative would make Chamberino Dam No. 1 and Structure No. 4 stable against the future condition, 100-year storm. This alternative would, also, remove Structure No. 2 and remove or control the sediment stored in its reservoir. This alternative would alter the structures with improvements and maintenance to enhance their stability. The following paragraphs discuss the recommended improvement and maintenance needed to implement this alternative. The following paragraphs also present observations made during a visual inspection of each dam's structural condition

From the visual inspection of Chamberino Dam No. 1, a few significant rills on the downstream slope are clearly associated with woody vegetation. The abutments and downstream valley have fairly gentle slopes down to relatively thick layers of valley alluvium. There are no anomalies that suggest potential differential settlement. There are no subtle signs of slope instability, uncontrolled seepage, or excessive settlement. A surficial inspection of the dam did not reveal any significant cracking, settlement, or other unusual soil problems.

For Chamberino Dam No. 1, improvements and maintenance needed for this alternative include:

1. Remove all woody vegetation, preferably by excavation rather than burning. Burning leaves the stem and roots in place which is very undesirable.
2. Regrade and dress the structure to obtain a uniform top-of-dam elevation and to fill all rills on the side slopes.
3. Regrade the emergency spillway crest back to its full 12-foot width. This will remove sluff materials from the toes of the sideslopes. Also, remove woody vegetation from the emergency spillway area.
4. Riprap the earth spillway to reduce erosion and damage during discharge events. Average rock size should be at least four to eight-inch diameter.
5. Place a two to six-inch layer of gravel (1.5 inch maximum size) on the top of the dam and sideslopes. This cover layer will reduce rilling and encourage germination of natural vegetation. If angular or crushed rock is not available, the downstream slope should be flattened to at least 2:1 before adding the gravel layer.
6. Install a corrugated metal conduit and riser through the dam. This principal spillway would slowly release flood water and lower the crest elevation of the 100-year storm.

From the visual inspection of Structure No. 2, the crest of the dam is very irregular and has several low areas along its length. There are several significant rills on the downstream slope near the crest. Some of these rills are related to the woody vegetation. The abutments and downstream valley areas have fairly gentle slopes down to a relatively thick layer of valley alluvium. There are no geologic anomalies that suggest potential differential settlement. However, due to the loose density of the fill it is not possible to observe any surficial signs of cracking or settlement. There are subtle signs of shallow slips (side slope failures) on the downstream slope which should be expected.

Structure No. 2 is in poor condition and will be overtopped by the ten-year storm. It has been previously noted that this structure will fail during any prolonged storage and will breach if it is overtopped. If Structure No. 2 failed by piping or overtopping, the pool of Dam No. 1 would experience sediment deposition which would reduce the ability of Dam No. 1 to detain floodwater. Therefore, this alternative removes Structure No. 2 and controls erosion of sediment stored in the reservoir.

For Structure No. 2, improvements and maintenance needed for this alternative include:

1. Remove the embankment from the top of dam to the elevation of the stored sediment. This operation would convert the structure to a grade control structure, and the crest of the remaining embankment must be left very level. The remaining embankment and stored sediment could then be stabilized against erosion by several methods, such as:
   a. Install Net Wire Diversions (PS 362-B) across the sediment pool and remaining embankment. This will slow runoff velocity and distribute flow across the valley. However, runoff will still flow over the remaining embankment, and the downstream slope of the remaining embankment will remain very erosive even if flattened. This slope will require a high level of maintenance.
   b. Place soil cement on the top of the remaining embankment and its downstream slope. A six to twelve-inch layer, using 10 percent

cement and compacted to 95 percent of standard proctor density, could stabilize the remaining embankment and stored sediment. A soil cement treatment should have very low operation and maintenance costs.

c. Riprap the downstream slope of the remaining embankment. Rock with average sizes of 15 to 24 inches could provide effective grade control and energy dissipation. Rock riprap should also have very low operation and maintenance costs.

From the visual inspection of Structure No. 4, the crest of the dam is reasonably uniform. A few rills on the downstream slope are associated with woody vegetation. In general, the abutments and downstream valley have fairly gentle slopes down to relatively thick layers of valley alluvium. In the left abutment area, a natural low ridge just downstream of the dam suggests the potential for differential settlement and cracking. The surface of the structure, however, did not reveal any cracking other than some minor desiccation cracks. There are concentrations of vegetation downstream of the dam near the left (or north) abutment. In the same vicinity and about 30 feet upstream from the upstream toe, there is an oblong depressed, or "sink," area in the sediment. This sink area is about 10 feet by 40 feet and two to three feet deep. The downstream vegetation may be the result of surface runoff concentrated by the arroyo and the natural low ridge, or it may indicate seepage through the dam from the sink area. If water is seeping through the dam, piping or internal erosion may become a problem. A relatively long trench has been dug along a portion of the downstream toe of the dam. The trench is five to six feet deep, and material from the trench has been stacked on the upstream (dam) side of the trench.

For Structure No. 4, improvements and maintenance needed for this alternative include:

1. Remove all woody vegetation, preferably by excavation rather than burning. Burning leaves the stem and roots in place which is very undesirable.
2. Regrade and dress the structure to obtain a more uniform top-of-dam elevation and to fill the minor rills on the side slopes.
3. Regrade the emergency spillway crest back to the full 7-foot width. This will remove sluff materials from the toes of the sideslopes. Also, remove woody vegetation from the emergency spillway area.
4. Fill the downstream trench with compacted earth materials, and install other means to deter damage from recreational vehicles. For example, a post and cable fence should deter such traffic.
5. Riprap the earth spillway to reduce erosion and damage during discharge events. Average rock size should be at least four to eight-inch diameter.
6. Place a two to six-inch layer of gravel (1.5 inch maximum size) on the top of the dam and sideslopes. This cover layer will reduce rilling and encourage germination of natural vegetation.
7. Install a corrugated metal conduit and riser through the dam. This principal spillway would slowly release flood water and lower the crest elevation of the 100-year storm.
8. Visually monitor the sink area for open holes or for increased depth or area of depression. Also, monitor the downstream area for indications of increased seepage. Indications of increased seepage include: unexplained gullies in the middle or lower slope areas, piped fines in the

bottom of the gully, increased vegetation (particularly non-woody species), etc.

This alternative would alter the delineated flood hazard zones downstream of Structure No. 2. With Structure No. 2 removed, future condition storms will crest about 0.2 foot higher in Dam No. 1. Chamberino Dam No. 1 would store the two-year storm event and most of the five-year event. For the five-year storm, the conduit will release 8.0 cfs. The earth spillway will begin to operate during the ten-year storm with a peak discharge of 42 cfs. The 25-year event will be contained by the dam. The 50-year and 100-year storms will overtop the dam by 0.1 feet and 0.3 feet, respectively. The 50-year and 100-year storms will discharge 362 cfs and 644 cfs, respectively. During the 100-year event, the dam will be overtopped for 0.6 hour, and the earth spillway will operate for 6.6 hours.

If the corrugated metal conduits and risers are installed in Dam No. 1 and Structure No. 4, the flood hazard zones downstream of the dams will be slightly reduced and the pattern of flood flows downstream of the dams will also change. The new principal spillway conduits will release flood water which was previously detained in the reservoirs. Smaller storms will send water down the existing arroyo for a period of several days. Streets which have conveyed water during large storms will now convey water during smaller storms and the flood water will flow in those streets for several days instead of several hours. Therefore, the arroyos through the Village may need to be cleaned and maintained as flood channels. The cropland east of the Village will receive flood waters more frequently, and detention basins and outlets into the West Drain may be needed.

This alternative would safely detain and convey floodwater from the watershed west of the Village to the West Drain at the east edge of the study area. After installation of this alternative, county flood plain management regulations can be used to maintain future flooding within the delineated flood hazard zones. Future development plans would include strategies to modify flooding, such as on-site detention to maintain peak discharges and runoff volumes at present values. This alternative requires public investment for improvements and maintenance on the existing dams. Agreements should be established for needed improvements, operation, and maintenance.

<u>ALTERNATIVE 3--UPGRADE EXISTING STRUCTURES</u> - This alternative would upgrade Chamberino Dam No. 1 and Structure No. 4, remove Structure No. 2, remove or control the sediment stored in the reservoir of Structure No. 2, improve the arroyos through Chamberino, develop detention and drainage across the irrigated cropland, and construct outlets into the West Drain.

The dams and reservoirs would provide storage for ten years of sediment accumulation and detain the 100-year, 24-hour storm. The spillway system would safely route the Probable Maximum Precipitation past the dams. The discharges released from the two dams and from Arroyo B would be conveyed downstream through the Village, across the cropland and outlet into the West Drain.

For Chamberino Dam No. 1, the existing embankment would be stripped of vegetation and loose material and used as the lower core section of the larger embankment. The material downstream of the existing embankment toe would be removed and replaced or treated. This area would become the foundation for the larger embankment. An embankment drain would be placed on the downstream slope of the existing dam. The principal spillway system would include a 2.5 foot

by 7.5 foot reinforced concrete ported riser, a 30-inch diameter reinforced concrete pressure pipe and supporting cradle, and an outlet impact basin to dissipate energy. The emergency spillway would be set at the crest of the 100-year, 24-hour storm and would be a 50 foot wide concrete baffle block chute. Refer to Table 8a for information on the minimum size and configuration of Dam No. 1.

For Structure No. 2, the embankment would be removed from the top of dam to the elevation of the stored sediment. The crest of the remaining embankment would be left very level, and the remaining embankment would have a fifteen foot top width and 3:1 slope on its downstream side. Soil cement would be placed on the top and downstream slope of the remaining embankment. On the slope, the soil cement would be placed in horizontal layers about six to twelve inches thick and eight to twelve feet wide, and on the top, soil cement would be placed in a horizontal layer about twelve inches thick. This treatment would stabilize the remaining embankment and stored sediment.

For Structure No. 4, the existing embankment would be stripped of vegetation and loose material and used as the lower core section of the larger embankment. The material downstream of the existing embankment toe would be removed and replaced or treated. The ridge downstream of the left abutment would be removed or treated. These downstream areas would become the foundation for the larger embankment. An embankment drain would be placed on the downstream slope of the existing dam. In addition, foundation and abutment drainage of the left abutment may be needed. The principal spillway system would include a 2.5 foot by 7.5 foot reinforced concrete ported riser, a 30-inch diameter reinforced concrete pressure pipe and supporting cradle, and an outlet impact basin to dissipate energy. The emergency spillway would be set at the crest of the 100-year, 10-day storm and would be a 150 foot wide concrete baffle block chute. Table 8a presents the minimum size and configuration of Structure No. 4.

The principal spillway conduits through the two dams will release flood water which is no longer sediment laden, since the sediment will have deposited in the reservoir. The released water will be very erosive unless the natural arroyos are improved to prevent down-cutting and widening. The channels downstream of Dam No. 1 and Structure No. 4 will be constructed rectangular reinforced concrete channels, and both will be about 3,000 feet long with fifteen foot bottom widths. These channels will extend from the principal spillway impact basin, through the Village, and to the irrigated cropland. Table 8b presents the minimum size and configuration for these improved channels.

Two storm channels will be constructed in Arroyo B. One channel will collect and convey storm water from drainage areas B1 and B4. These drainage areas are shown on the map on page 3. This channel will be a rectangular reinforced concrete channel about 2,000 feet long, and the bottom width will vary from 20 to 30 feet. The channel will begin at station 40+00, which is about 600 feet west of the Village, will extend east and south past the San Luis Cemetery, and will end at the irrigated cropland. Station 40+00 is where drainage B1 is constricted by hills on each side of the plant road. The plant road will be modified with a low water crossing to divert water from the north side of the road into the channel. Refer to Table 8b for the minimum size and configuration of this improved channel which is designated Arroyo B-South.

The second channel for Arroyo B will collect and convey storm water from drainage areas B2, B3, and B5. See the map on page 3. This channel will be a rectangular reinforced concrete channel about 1,500 feet long with a 24 foot bottom width. Two diversions along the Village boundary will collect flood water from drainage areas B2 and B3. The diversions would outlet storm water into the channel at the western edge of the Village. The channel will end at the irrigated cropland. Refer to Table 8b for the minimum size and configuration of this improved channel which is designated Arroyo B-North.

The four concrete channels will outlet flood water onto the irrigated cropland which is downstream and east of the Village. The conduits installed through the dams will release flood water which was previously retained in the reservoirs. The two channels in Arroyo B will convey flood water through the Village without ponding water. Therefore, the cropland will receive flood water more frequently and with higher discharge rates. The West Drain is owned, operated, and maintained by the EBID. Within the study area, the maximum capacity of West Drain is 200 cfs, and the discharge rates for the four channels will be: Arroyo A-230 cfs, Arroyo B-South-650 cfs, Arroyo B-North-374 cfs, and Arroyo C-160 cfs.

Four excavated detention structures are planned at the edge of the cropland near the east side of the Village. The four structures will be five to ten feet deep with two to fives acre of surface area. Sediment storage will be provided in each structure, and the structures will have capacity for the five- to ten-year storm event from each channel. Storms larger than the design event would fill the excavated pit and then flood onto the adjacent fields. Stored sediment will be regularly removed. The minimum size and configuration of these excavated detention structures has not been determined since their location will effect surface area and depth.

The delineated flood hazard zones between Structure No. 2 and Chamberino Dam No. 1 will change, and this change is discussed on page 25 under Alternative 2. This alternative would also alter the delineated flood hazard zones in Arroyo B and downstream of Dam No. 1 and Structure No. 4. The flood hazard zones would be reduced to the area of the constructed channels, since the 100-year storm would be controlled by the constructed channels and upgraded dams. For storms up to and including the 100-year event, this alternative would safely detain and convey floodwater from the watershed west of the present Village to the cropland east of the Village. For storms up to and including the 5- or 10-year storm events, this alternative would protect the cropland from flood damages. In any year, there will be a ten to twenty percent chance of floods damaging the cropland. Table 8c presents approximate costs for this alternative.

This alternative requires public investment for capital improvements and would require expenditures for operation and maintenance. Therefore, formal agreements between landowners, the Dona Ana County Flood Commissioner, and the Village should be established. Such agreements would provide details regarding funding and responsibilities for improvements, operation, maintenance, and equitable sharing of public and private resources.

Table 8a. Structural Data--Measures with Planned Storage
Chamberino Flood Plain Management Study

Item	Unit	Chamberino Dam No. 1	Structure No. 4	Total
Class of Structure		C	C	
Seismic Zone		2	2	
Drainage Area				
Controlled	Sq. Mi.	0.71	6.92	7.63
Uncontrolled	Sq. Mi.	0.19	0.18	0.97
Total	Sq. Mi.	0.90	7.10	8.60
Runoff Curve No. (1 day, AMC II)		77	78	
Time of Concentration	Hours	N/A[1]	N/A	
Elevations				
Top of Dam	Feet	3918.4	3919.1	
Emergency Spillway Crest	Feet	3910.4	3911.3	
Crest of Principal Spillway	Feet	3903.6	3899.8	
Emergency Spillway				
Frequency of Operation	% Chance	1%	1%	
Type		Concrete	Concrete	
Bottom Width	Feet	50	150	
Exit Slope	%	25	25	
Maximum Height of Dam	Feet	27.6	36.1	
Volume of Fill	Cubic Yds.	N/A	N/A	
Total Capacity				
Sediment, Aerated	Acre Feet	6.6	25.7	32.3
Principal Crest	Acre Feet	6.6	25.7	32.3
Emergency Crest	Acre Feet	41.4	190.1	231.5
Top of Dam	Acre Feet	133.0	413.3	546.3
Surface Area				
At Top of Dry Sediment Pool	Acres	2.6	7.4	
At Crest of Principal Spillway	Acres	2.6	7.4	
At Crest of Emergency Spillway	Acres	8.2	21.8	
Principal Spillway Design				
Rainfall Volume (1 day)	Inches	3.6	3.6	
Rainfall Volume (10 day)	Inches	5.16	5.16	
Runoff Volume (1 day)	Inches	1.79	1.44	
Runoff Volume (10 day)	Inches	3.13	2.67	
Max. Capacity--Principal Spillway	cfs	103	122	
Conduit Type		Concrete	Concrete	
Conduit Dimensions--Diameter	Feet	2.5	2.5	
Emergency Spillway Hydrograph				
Rainfall Volume	Inches	6.55	6.2	
Runoff Volume	Inches	4.39	3.55	
Storm Duration	Hours	6.0	6.0	
Velocity of Flow	Feet/Sec.	8.2	7.2	
Maximum Water Surface Elev.	Feet	3913.8	3914.0	
Freeboard Hydrograph				
Rainfall Volume	Inches	16.67	15.34	
Runoff Volume	Inches	14.15	12.11	
Storm Duration	Hours	6.0	6.0	
Maximum Water Surface Elev.	Feet	3918.4	3919.1	
Discharge per Ft. of Width-Oe/b	Ac-Ft/Ft	8.7	27.0	
Bulk Length	Feet	120	120	
Capacity Equivalents				
Sediment Volume	Inches	0.09	3.33	
Floodwater Retarding Volume	Inches	0.46	21.3	

[1] N/A indicates that this information is not available.

Table 8b. Structural Data--Channel Improvements, Chamberino Flood Plain Management Study

Location and Discharge Information							Channel Dimensions				Stability Parameters				Environmental Considerations			
Channel or Reach	Station	Drainage Area	100 Year Design Discharge	Water Surface Elevation	Elevation of HGL	Hydraulic Gradient	Invert Gradient	Bottom Width	Invert Elevation	Side Slopes	"n" value Aged	"n" value As Built	Velocities Aged (1)	Velocities As Built	Excavation Volume	Type of Work (2)	Existing Channel Type (3)	Present Flow Type (4)
		(sq. mi.)	(cfs)	(msl)	(msl)	(ft./ft.)	(ft./ft.)	(ft.)	(msl)	(hor : vert)			(fps)	(fps)	(cu. yd.)			
Arroyo A	5,500	6.91	230	3,881.94	3,882.91			15.0	3,880.00	0:1	0.015	0.015	7.9	7.9		I	N	E
						0.024	0.025											
(Channel	5,600	6.91	230	3,879.20	3,880.46			15.0	3,877.50	0:1	0.015	0.015	9.0	9.0	800.0	I	N	E
						0.025	0.030											
below	6,000	6.91	230	3,866.48	3,870.26			15.0	3,865.50	0:1	0.015	0.015	15.6	15.6	1,500.0	I	N	E
						0.035	0.038											
Structure	6,200	6.91	230	3,858.81	3,863.19			15.0	3,857.90	0:1	0.015	0.015	16.8	16.8	300.0	I	N	E
						0.036	0.035											
No. 4)	6,500	7.02	230	3,848.33	3,852.50			15.0	3,847.40	0:1	0.015	0.015	16.4	16.4	500.0	I	N	E
						0.025	0.025											
	8,350	7.02	230	3,795.94	3,799.32			15.0	3,794.90	0:1	0.015	0.015	14.7	14.7	17,800.0	I	N	E
														Total	20,900.0			
Arroyo B	4,000	0.17	411	3,884.69	3,885.14			20.0	3,881.80	0:1	0.015	0.015	5.8	5.8		I	N	E
-South						0.018	0.031											
	4,100	0.17	411	3,880.12	3,883.36			20.0	3,878.72	0:1	0.015	0.015	14.4	14.4	200.0	I	N	E
						0.032	0.040											
	4,200	0.17	411	3,875.52	3,880.14			30.0	3,874.72	0:1	0.015	0.015	17.3	17.3	100.0	I	N	E
						0.048	0.049											
	4,800	0.28	650	3,846.75	3,851.11			30.0	3,845.46	0:1	0.015	0.015	16.8	16.8	1,000.0	I	N	E
						0.029	0.042											
	4,900	0.28	650	3,843.07	3,848.26			20.0	3,841.30	0:1	0.015	0.015	18.3	18.3	200.0	I	N	E
						0.034	0.034											
	5,900	0.28	650	3,808.91	3,813.79			20.0	3,807.08	0:1	0.015	0.015	17.7	17.7	1,900.0	I	N	E
														Total	3,400.0			
Arroyo B	4,700	0.09	220	3,859.37	3,860.07			24.0	3,858.00	0:1	0.015	0.015	6.7	6.7		I	N	E
-North						0.028	0.031											
	5,200	0.09	220	3,843.16	3,846.26			24.0	3,842.50	0:1	0.015	0.015	14.2	14.2	600.0	I	N	E
						0.035	0.036											
	5,600	0.09	220	3,828.61	3,832.11			24.0	3,828.00	0:1	0.015	0.015	15.0	15.0	500.0	I	N	E
						0.036	0.040											
	5,800	0.15	374	3,820.98	3,824.98			24.0	3,820.00	0:1	0.015	0.015	16.1	16.1	200.0	I	N	E
						0.045	0.047											
	6,100	0.15	374	3,806.92	3,811.41			24.0	3,806.00	0:1	0.015	0.015	17.0	17.0	600.0	I	N	E
														Total	1,900.0			
Arroyo C	6,800	0.71	160	3,888.32	3,889.10			15.0	3,886.80	0:1	0.015	0.015	7.0	7.0		I	N	E
						0.020	0.021											
(Channel	7,500	0.71	160	3,872.32	3,875.28			15.0	3,872.10	0:1	0.015	0.015	12.2	12.2	1,700.0	I	N	E
						0.027	0.028											
below	8,000	0.71	160	3,858.90	3,861.66			15.0	3,858.10	0:1	0.015	0.015	13.3	13.3	800.0	I	N	E
						0.025	0.025											
Dam	8,400	0.76	160	3,848.93	3,851.51			15.0	3,848.10	0:1	0.015	0.015	12.9	12.9	700.0	I	N	E
						0.029	0.030											
No. 1)	8,700	0.76	160	3,839.89	3,842.77			15.0	3,839.10	0:1	0.015	0.015	13.6	13.6	600.0	I	N	E
						0.026	0.025											
	9,200	0.76	160	3,827.42	3,830.00			15.0	3,826.60	0:1	0.015	0.015	12.9	12.9	1,100.0	I	N	E
						0.026	0.028											
	9,300	0.78	160	3,824.60	3,827.36			15.0	3,823.80	0:1	0.015	0.015	13.3	13.3	200.0	I	N	E
						0.025	0.025											
	9,800	0.78	160	3,812.08	3,815.01			15.0	3,811.30	0:1	0.015	0.015	13.7	13.7	1,300.0	I	N	E
														Total	6,400.0			

(1) Velocities are for the 100 year discharge.
(2) I – Establishment of new channel including needed stabilization measures.
II – Enlargement of existing channel.
III – Stabilization is the primary purpose--present capacity is adequate.

(3) N – Unmodified, well defined natural channel.
M – Manmade ditch or previously modified channel. Date of original work is in parenthesis.
O – No or practically no defined channel.
(4) E – Ephemeral, Flow occurs only during periods of surface runoff.

Table 8c. Preliminary Cost Estimate for Alternative 3

Item	Estimated Construction Cost	Estimated Total Installation Cost	Estimated O&M Cost
Rebuilding Existing Structures			
Dam Number 1	$705,000	$822,000	$1,420
Structure Number 4	$1,587,000	$1,851,000	$2,760
Concrete Channels			
Arroyo A (below Str. No. 4)	$1,150,000	$1,340,000	$3,000
Arroyo B-South	$940,000	$1,100,000	$2,500
Arroyo B-North	$710,000	$825,000	$2,000
Arroyo C (below Dam No. 1)	$1,180,000	$1,380,000	$3,200
Detention Ponds			
Arroyo A (below Str. No. 4)	$225,000	$265,000	$50
Arroyo B-South	$1,130,000	$1,320,000	$220
Arroyo B-North	$1,130,000	$1,320,000	$210
Arroyo C (below Dam No. 1)	$2,260,000	$2,640,000	$430
Total	$11,017,000	$12,863,000	$15,790

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APPENDIX A

ELEMENTS OF TERRAIN MANAGEMENT PLANS

This appendix provides details specific to flood plain management and regulation of development within the flood plain. Many of the problems associated with flood damages are a direct result of human caused changes beyond the flood plain but within the watershed. Sediment-producing activities within a watershed should be a major concern of any flood plain manager. One means of controlling sediment producing activities as well as flood damages is with terrain management plans.

The New Mexico Subdivision Act (Chapter 348 of the Laws of 1973, 31st Legislature, First Session), as amended, requires the counties of New Mexico to establish subdivision regulations. In making a determination as to whether or not a subdivider can fulfill the proposals contained in his disclosure statement and whether or not the subdivision plans conform to county regulations and the Act, the County Board of Commissioners must request opinions from the local Soil and Water Conservation District and others. The local Soil and Water Conservation District reviews the subdivision proposal in relation to terrain management. To assist districts with their reviews, the NRCS developed the New Mexico Subdivision Review Guide. This appendix has been edited from that guide.

Elements of a terrain management plan include: Soils, Grading, Flood Plain Management, Storm Drainage-Drainage Plan, Roads, Erosion Control, and Landscaping and Revegetation. Listed under each element below are the essential features which should be included in the plan and a description of how these features should be planned.

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

SOILS

The Dona Ana County Soil Survey will provide needed information to determine the principal detrimental or unfavorable features of the soils. Limiting features are described by one of three terms: Slight, Moderate and Severe. These terms are defined in the following paragraphs.

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

Moderate means fair suitability and is 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 as moderate require treatment such as artificial drainage.

Severe means poor suitability and is 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.

The major categories shown in a soil survey and used in reviewing a terrain management plan are: Building Site Development, Construction Material, Local Roads and Streets, Underground Utilities, Water Control Structures, and Erosion Control Structures

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

GRADING

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 text lists 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 flood plains, drainage channels, watercourses and water bodies?

B. Discharges attributable to grading should be prohibited whether the discharge is direct or indirect:

   1. Does the plan prevent sediment and other organic or earthen materials from being discharged into a watercourse, water body, drainage channel, or flood plain?
   2. Does the plan store, stockpile or waste materials where they are not susceptible to erosion and deposition into a watercourse, waterbody, drainage channel, or flood plain?
      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. When native ground cover is planned to be removed or disturbed or when fill material is planned to be 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 in the soil survey or in 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?

FLOOD PLAIN MANAGEMENT

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

A. Dwellings are not located within the 100-year flood plain.

B. Structures, fill or excavations, alone or in combination with present or future works, do not adversely affect the capacity of the flood plain.

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

D. Confined animal shelters and other structures with a potential for high flood damage are not located in the flood plain.

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

STORM DRAINAGE--DRAINAGE PLAN

Subdivisions and developments should 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 do 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.

ROADS

Roads shall be located and designed to:

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

B. Ensure proper drainage.

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. Based on the soils involved, are designed road grades flat enough to prevent erosion?

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?

LANDSCAPING AND REVEGETATION

Revegetation should be an important part of any subdivision plan. A definite time schedule for installing plant cover would be necessary to prevent erosion, particularly in areas with sandy soils.

APPENDIX B

Table 9. Summary of Watershed Hydrologic Parameters

Watershed or Basin	Basin Drainage Area		Longest Water Course	Difference in Elevation	Slope	Time of Concentration	Lag Time	Runoff Curve Numbers	
								Present or Existing Conditions	Future Condition High Density
	(Acres)	(Sq.Mi.)	(Feet)	(Feet)	(Ft./Ft.)	(Hours)	(Hours)		
A0	56.7	0.0886	2,700	8.0	0.0030	0.54	0.32	74	74
A1	66.5	0.1039	2,460	94.0	0.0382	0.19	0.11	68	74
A2	548.0	0.8563	7,200	212.6	0.0295	0.47	0.28	75	76
A3	3,876.7	6.0573	26,400	75.0	0.0028	3.16	1.90	78	78
Subtotal	4,547.9	7.1061							
B0	107.4	0.1678	1,400	6.0	0.0043	0.28	0.17	74	74
B1	109.6	0.1713	3,900	220.0	0.0564	0.23	0.14	68	80
B2	21.1	0.0330	1,580	104.0	0.0658	0.11	0.06	68	77
B3	36.1	0.0564	2,000	116.0	0.0580	0.14	0.08	68	77
B4	68.7	0.1073	2,140	78.0	0.0364	0.17	0.10	77	77
B5	40.9	0.0639	1,400	36.0	0.0257	0.14	0.08	77	77
Subtotal	383.8	0.5997							
C0	27.4	0.0428	1,480	6.0	0.0041	0.30	0.18	74	74
C1	31.2	0.0488	2,700	108.0	0.0400	0.20	0.12	68	79
C2	15.8	0.0247	1,280	32.0	0.0250	0.13	0.08	68	77
C3	131.2	0.2050	3,640	127.0	0.0349	0.26	0.16	68	78
C4	16.3	0.0255	1,600	66.0	0.0413	0.13	0.08	75	78
C5	36.6	0.0572	2,900	142.0	0.0490	0.19	0.12	68	81
C6	6.4	0.0100	900	34.0	0.0378	0.09	0.05	68	77
C7	14.8	0.0231	1,500	42.0	0.0280	0.14	0.09	77	77
C8	284.2	0.4441	7,000	141.0	0.0201	0.53	0.32	76	76
Subtotal	563.9	0.8811							
Total	5,495.6	8.5869							

TABLE 10. Summary of Discharges and Runoff Volumes – Existing Conditions

Basin	2 YEAR EVENT				10 YEAR EVENT				100 YEAR EVENT			
	Basin Peak cfs	Basin Volume ac–ft	Accumulative Peak cfs	Accumulative Volume ac–ft	Basin Peak cfs	Basin Volume ac–ft	Accumulative Peak cfs	Accumulative Volume ac–ft	Basin Peak cfs	Basin Volume ac–ft	Accumulative Peak cfs	Accumulative Volume ac–ft
A												
A3	116.00	42.00			891.00	258.60			1828.00	507.40		
A2	34.00	3.67	34.00	3.70	466.00	30.30	466.00	214.10	1056.00	62.83	1056.00	490.90
A1	0.00	0.00	0.00	0.00	46.00	2.08	115.00	205.90	130.00	5.07	293.00	483.00
A0	–	0.33	0.00	0.33	–	2.94	115.00	208.80	–	6.24	293.00	489.20
B & Ca												
B												
B1	0.00	3.00			70.00	3.60			199.00	8.70		
B2	0.00	0.00	0.00	0.00	17.00	0.62	78.00	4.20	48.00	1.50	120.00	8.10
B3	0.00	0.00	1.00	0.22	27.00	1.25	102.00	5.50	77.00	3.00	196.00	11.20
B5	7.00	0.35	7.00	0.58	71.00	2.40	142.00	7.90	155.00	4.70	329.00	16.00
B4	11.00	0.65	11.00	0.60	113.00	4.40	113.00	4.35	245.00	8.80	363.00	10.90
Ca												
C8	21.00	2.35			237.00	16.70			524.00	33.80		
C3	1.00	0.21	21.00	2.43	80.00	4.30	287.00	21.10	227.00	10.20	667.00	44.70
C5	0.00	0.03	1.00	0.38	25.00	1.25	135.00	20.45	71.00	3.00	657.00	45.40
C1	0.00	0.00	0.00	0.00	21.00	1.04	21.00	13.20	60.00	2.50	104.00	39.60
C7	2.00	0.11	2.00	0.00	26.00	0.80	35.00	14.10	56.00	1.60	105.00	41.60
B0	–	0.62	11.00	1.80	–	5.57	142.00	31.90	–	11.80	363.00	80.30
Cb & Cc												
Cb												
C4	2.00	0.13			24.00	1.04			55.00	2.16		
Cc												
C2	0.00	0.00			12.00	0.62			35.00	1.50		
C6	0.00	0.00	0.00	0.00	5.00	0.21	17.00	0.83	15.00	0.50	50.00	2.00
C0	–	0.16	2.00	0.30	–	1.42	24.00	3.30	–	3.00	55.00	7.20

TABLE 11. Summary of Discharges and Runoff Volumes – Developed Conditions

Basin	2 YEAR EVENT				10 YEAR EVENT				100 YEAR EVENT			
	Basin Peak cfs	Basin Volume ac–ft	Accumulative Peak cfs	Accumulative Volume ac–ft	Basin Peak cfs	Basin Volume ac–ft	Accumulative Peak cfs	Accumulative Volume ac–ft	Basin Peak cfs	Basin Volume ac–ft	Accumulative Peak cfs	Accumulative Volume ac–ft
A												
A3	116.00	42.00			891.00	258.60			1828.00	507.40		
A2	43.00	4.60	43.00	3.70	505.00	32.60	505.00	214.00	1118.00	66.00	1118.00	490.90
A1	5.00	0.40	5.00	0.00	82.00	3.30	115.00	209.70	193.00	6.90	294.00	490.50
A0	–	0.33	5.00	0.33	–	2.94	115.00	212.60	–	6.24	294.00	496.70
B & Ca												
B												
B1	27.00	1.50			202.00	8.20			411.00	15.50		
B2	4.00	0.18	28.00	1.70	39.00	1.20	111.00	7.10	84.00	2.40	148.00	10.60
B3	6.00	0.35	32.00	2.00	62.00	2.40	171.00	9.60	135.00	4.70	281.00	15.30
B5	7.00	0.35	36.00	2.30	71.00	2.40	229.00	11.90	155.00	4.70	435.00	20.20
B4	11.00	0.65	11.00	0.60	113.00	4.40	235.00	6.70	245.00	8.80	574.00	16.10
Ca												
C8	21.00	2.35			237.00	16.70			524.00	33.80		
C3	22.00	1.40	37.00	3.80	199.00	8.50	390.00	25.60	422.00	16.70	846.00	51.30
C5	12.00	0.60	12.00	2.30	78.00	3.00	300.00	26.10	156.00	5.60	954.00	53.80
C1	7.00	0.40	7.00	0.40	57.00	2.20	57.00	20.40	118.00	4.30	334.00	50.00
C7	2.00	0.10	6.00	0.40	26.00	0.80	65.00	21.60	56.00	1.60	336.00	52.40
B0	–	0.62	36.00	3.90	–	5.57	235.00	45.80	–	11.80	574.00	100.50
Cb & Cc												
Cb												
C4	3.00	0.20			31.00	1.30			65.00	2.50		
Cc												
C2	3.00	0.18			28.00	1.20			62.00	2.40		
C6	1.00	0.06	4.00	0.23	12.00	0.40	40.00	1.60	26.00	0.80	88.00	3.20
C0	–	0.16	4.00	0.60	–	1.42	40.00	4.30	–	3.00	88.00	8.70

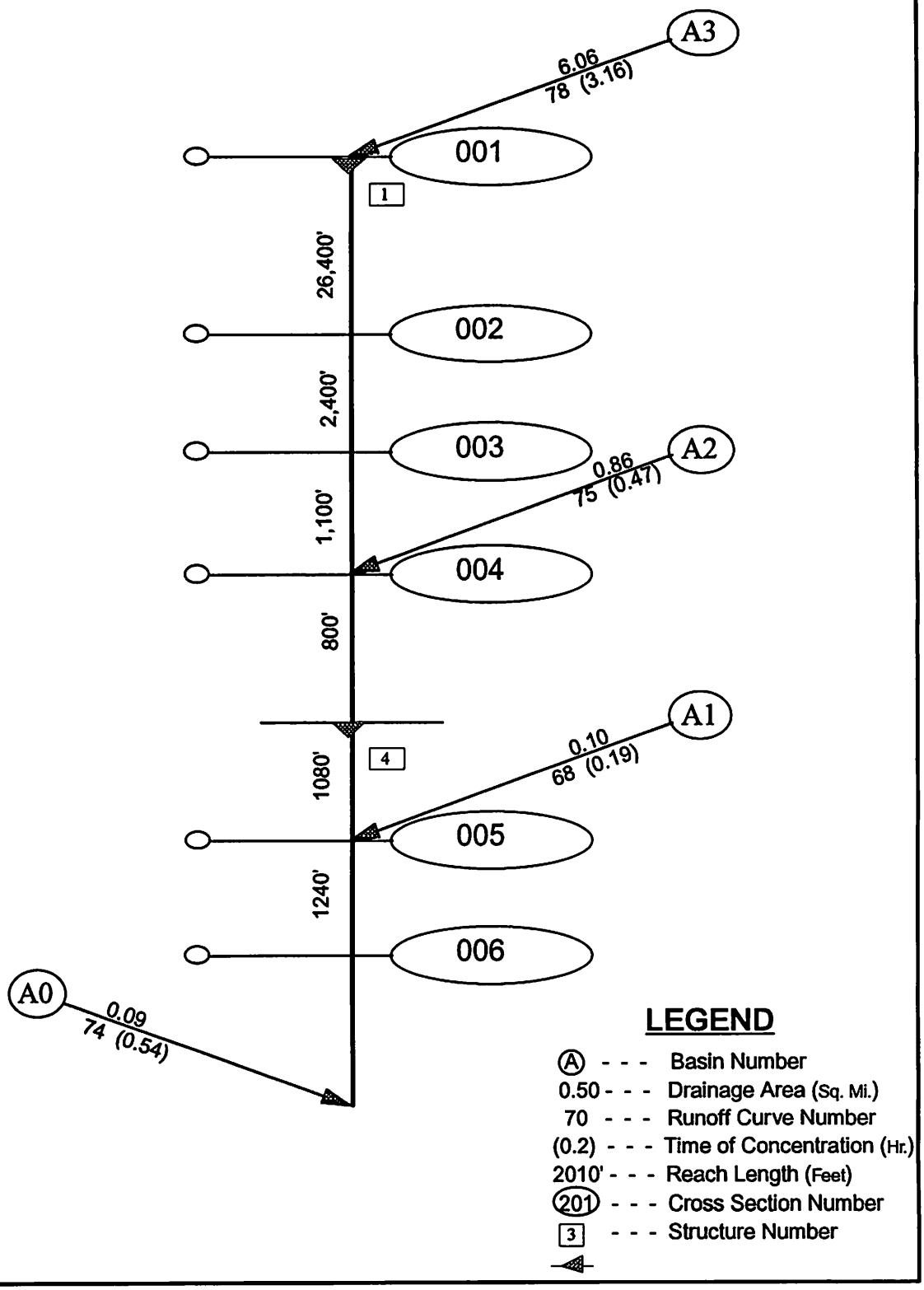
Table 12. Summary of Existing Structures – Existing Conditions

	Arroyo C						Arroyo A					
Structure	Chamberino Dam No. 1			Structure No. 2			Structure No. 4			Structure No. 3		
Structure Type	Dam and Reservoir			Dam and Reservoir			Dam and Reservoir			Natural Depression/Detention Area		
	Elevation (m.s.l.e.)	Capacity acre–feet	Discharge cfs	Elevation (m.s.l.e.)	Capacity acre–feet	Discharge cfs	Elevation (m.s.l.e.)	Capacity acre–feet	Discharge cfs	Elevation (m.s.l.e.)	Capacity acre–feet	Discharge cfs
Sediment in Pool	3,898.0	0.0	–	3,916.0	0.0	–	3,893.0	0.0	–	4,098.0	0.0	–
Pipe Invert	3,904.3	8.8	0.0	–	–	–	–	–	–	–	4.0	–
Earth Spillway	3,906.0	14.7	12.0	3,919.0	2.0	0.0	3,896.0	5.1	0.0	4,100.0	68.0	0.0
Top of Dam	3,908.0	24.7	119.0	3,922.0	8.1	140.3	3,901.2	37.4	227.0	4,102.0	570.0	2217.0
Storm Event												
2 year–24 hour	–	8.0	0.0	3,919.0	2.1	0.0	–	–	–	–	–	–
5 year–24 hour	3,904.5	9.2	2.0	3,920.8	5.3	67.0	3,898.1	14.6	58.0	4,100.2	120.5	72.0
10 year–24 hour	3,905.7	13.8	10.0	3,921.9	7.8	133.0	3,899.3	22.3	114.0	4,100.4	173.0	147.0
25 year–24 hour	3,906.7	18.2	41.0	3,922.2	8.7	385.0	3,900.5	31.4	183.0	4,100.7	238.0	238.0
50 year–24 hour	3,907.2	20.8	69.0	3,922.4	9.2	602.0	3,901.2	37.4	235.0	4,100.9	280.5	299.0
100 year–24 hour	3,907.8	23.4	102.0	3,922.5	9.3	648.0	3,901.3	37.7	293.0	4,101.0	325.6	402.0
Breach Disharge			1,012.0			345.0			624.0			Not Applicable

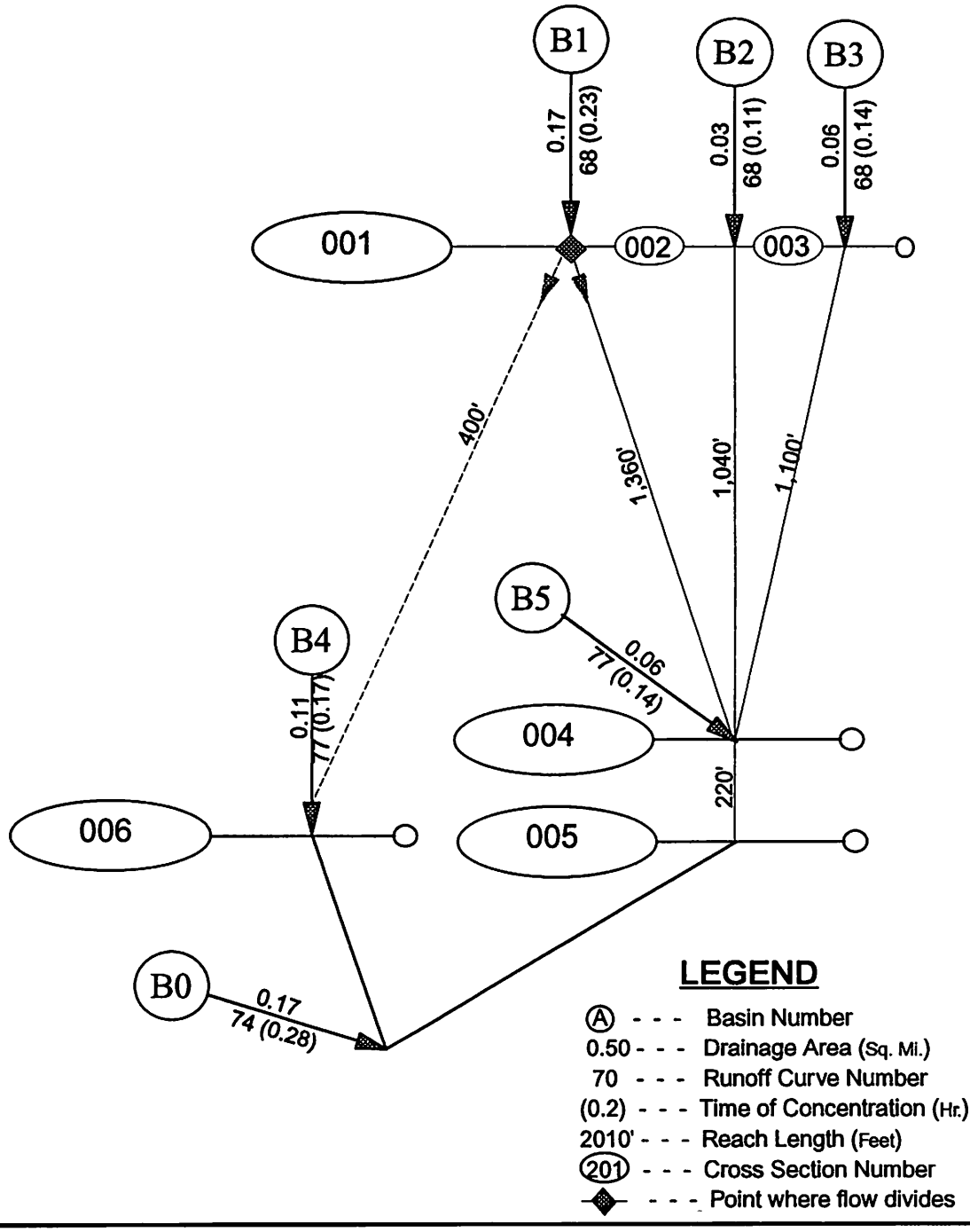
Table 13. Summary of Existing Structures – Future Conditions

	Arroyo C						Arroyo A					
Structure	Chamberino Dam No. 1			Structure No. 2			Structure No. 4			Structure No. 3		
Structure Type	Dam and Reservoir			Dam and Reservoir			Dam and Reservoir			Natural Depression/Detention Area		
	Elevation (m.s.l.e.)	Capacity acre–feet	Discharge cfs	Elevation (m.s.l.e.)	Capacity acre–feet	Discharge cfs	Elevation (m.s.l.e.)	Capacity acre–feet	Discharge cfs	Elevation (m.s.l.e.)	Capacity acre–feet	Discharge cfs
Sediment in Pool	3898.0	0.0	–	3916.0	0.0	–	3893.0	0.0	–	4098.0	0.0	–
Pipe Invert	3904.3	8.8	0.0	–	–	–	–	–	–	–	–	–
Earth Spillway	3906.0	14.7	12.0	3919.0	2.0	0.0	3896.0	5.1	0.0	4100.0	68.0	0.0
Top of Dam	3908.0	24.7	119.0	3922.0	8.1	140.3	3901.2	37.4	227.0	4102.0	570.0	2217.0
Storm Event												
2 year–24 hour	–	8.0	0.0	3919.1	2.1	3.0	–	–	–	–	–	–
5 year–24 hour	3905.1	9.2	6.0	3921.3	5.3	95.0	3898.1	14.6	58.0	4100.2	120.5	72.0
10 year–24 hour	3906.4	13.8	27.0	3922.1	7.8	294.0	3899.3	22.3	114.0	4100.4	173.0	147.0
25 year–24 hour	3907.3	18.2	72.0	3922.4	8.7	536.0	3900.5	31.4	183.0	4100.7	238.0	238.0
50 year–24 hour	3907.9	20.8	109.0	3922.5	9.2	691.0	3901.2	37.4	235.0	4101.0	280.5	299.0
100 year–24 hour	3908.1	23.4	330.0	3922.8	9.3	932.0	3901.3	37.7	293.0	4101.0	325.6	402.0

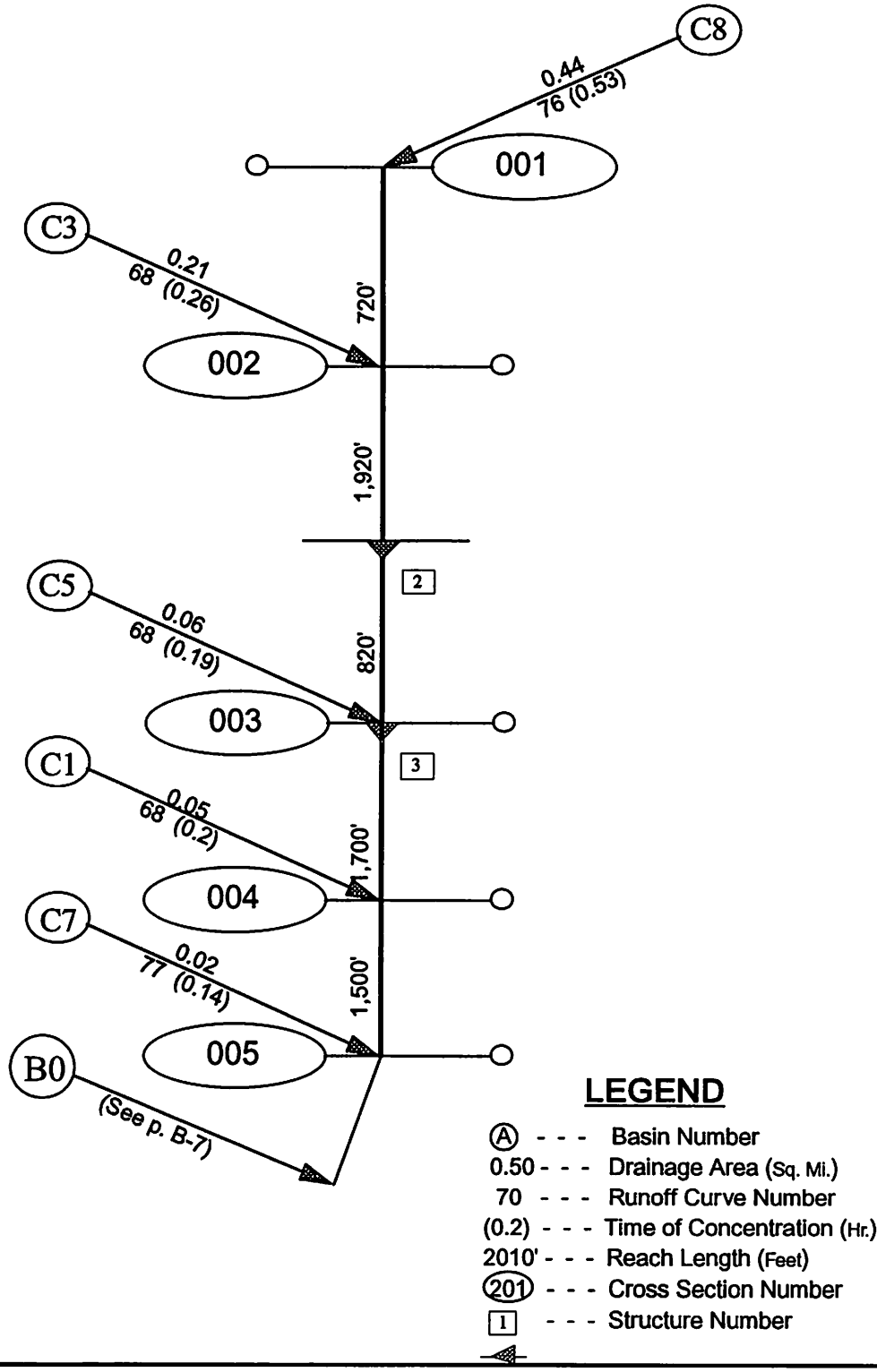
TR-20 Schematic for Chamberino FPMS
Arroyo A - Existing Condition



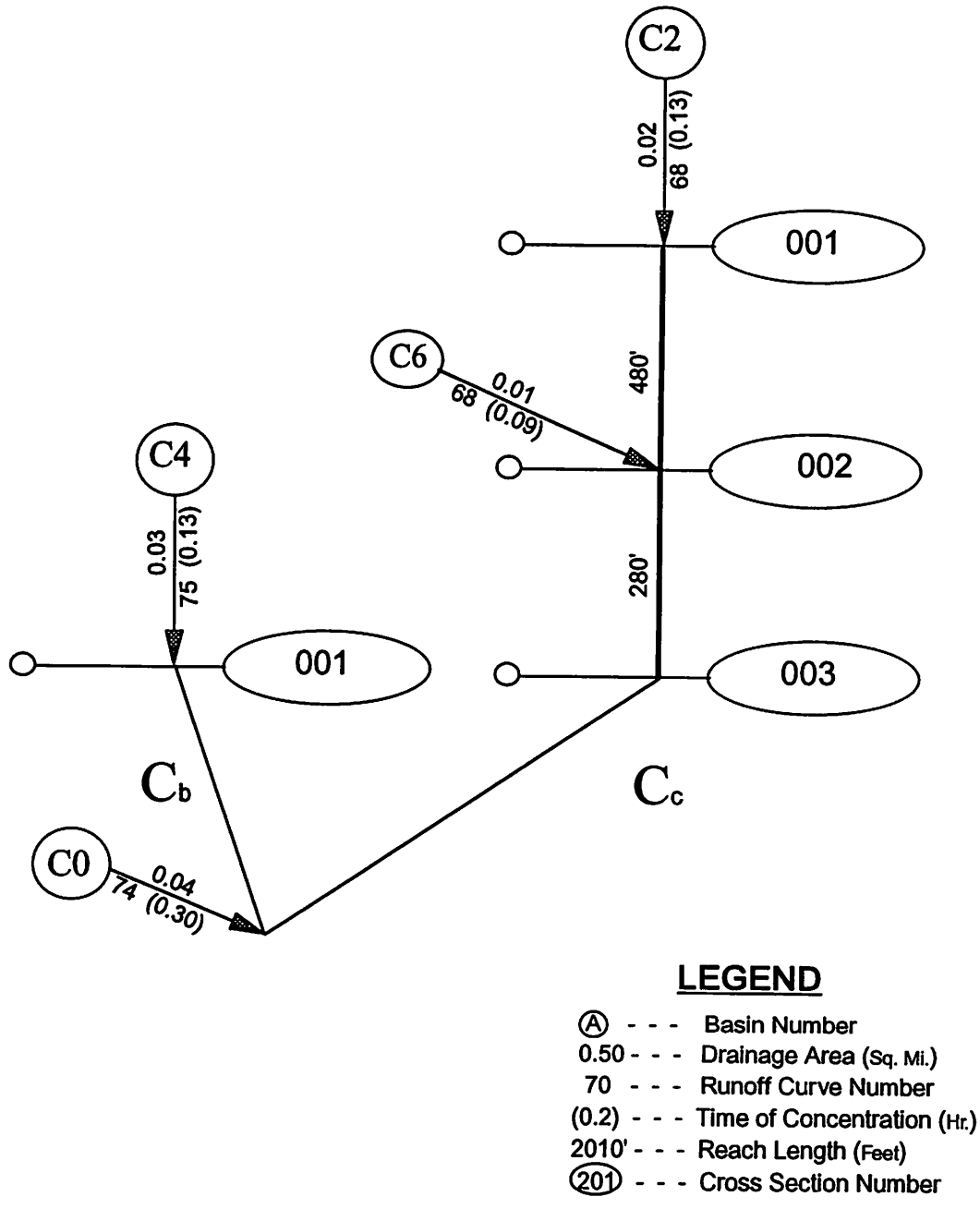
TR-20 Schematic for Chamberino FPMS
Arroyo B - Existing Condition



TR-20 Schematic for Chamberino FPMS
Arroyo Ca - Existing Condition



TR-20 Schematic for Chamberino FPMS
Arroyo Cb & Cc - Existing Condition



APPENDIX C

TAPS Station : STATE UNIVERSITY, 8535
Start yr. - 1961 End yr. - 1990

Month	Temperature: avg daily max	avg daily min	avg	2 yrs in 10 will have: max temp. >than	min temp. <than	avg no of grow deg days*	Precipitation: avg (in.)	2 yrs in 10 will have: less than (in.)	more than (in.)	avg no of days w/ 0.10 inch or more	avg snow-fall
January	57.7	27.0	42.4	74	9	127	0.45	0.23	0.77	1	1.3
February	63.0	30.5	46.8	79	15	209	0.37	0.14	0.72	1	0.8
March	69.7	36.1	52.9	85	19	403	0.22	0.08	0.42	0	0.1
April	77.7	43.0	60.3	91	28	611	0.21	0.06	0.54	0	0.2
May	85.7	51.1	68.4	98	36	880	0.29	0.09	0.55	0	0.0
June	94.1	60.4	77.2	104	46	1117	0.72	0.15	1.36	1	0.0
July	94.6	66.7	80.6	104	59	1259	1.36	0.56	2.04	3	0.0
August	91.6	64.3	77.9	101	56	1176	2.29	1.07	3.35	4	0.0
September	86.3	57.7	72.0	96	44	960	1.36	0.61	2.00	3	0.0
October	78.1	45.0	61.5	91	29	667	0.91	0.23	1.57	2	0.0
November	66.8	34.0	50.4	81	17	320	0.53	0.11	0.96	1	1.0
December	58.0	27.8	42.9	73	12	131	0.68	0.20	1.20	2	1.7
Yearly :											
Average	76.9	45.3	61.1	---	---	---	---	---	---	---	---
Extreme	107	-10	---	105	6	---	---	---	---	---	---
Total	---	---	---	---	---	7858	9.40	6.78	11.83	18	5.1

*A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minumum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (Threshold : 40.0 deg. F)

FROST Station : STATE UNIVERSITY, 8535
Start yr. - 1961 End yr. - 1990

Probability	Temperature		
	24F or lower	28F or lower	32F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	March 23	April 14	April 25
2 year in 10 later than--	March 15	April 7	April 19
5 year in 10 later than--	March 1	March 23	April 8
First freezing temperature in fall:			
1 yr in 10 earlier than--	November 11	October 31	October 18
2 yr in 10 earlier than--	November 16	November 4	October 23
5 yr in 10 earlier than--	November 27	November 13	November 2

GROWTH Station : STATE UNIVERSITY, 8535
Start yr. - 1961 End yr. - 1990

Probability	Daily Minimum Temperature		
	# days > 24F	# days > 28F	# days > 32F
9 years in 10	244	202	181
8 years in 10	253	213	190
5 years in 10	270	234	207
2 years in 10	286	255	224
1 year in 10	295	266	233

TAPS Station : EL PASO WSO AP, 2797
start yr. - 1949 end yr. - 1993

Month	Temperature						Precipitation			
	avg daily max	avg daily min	avg	2 years in 10 will have max temp. >than	2 years in 10 will have min temp. <than	avg no. of grow'n degree days*	avg (in.)	2 yrs in 10 will have less than (in.)	2 yrs in 10 will have more than (in.)	average number of days with 0.10 inch or more
January	57.3	30.7	44.0	74	11	171	0.44	0.15	0.74	1
February	63.0	34.7	48.8	79	16	264	0.42	0.20	0.79	1
March	69.7	41.0	55.4	86	22	478	0.32	0.13	0.63	1
April	78.6	49.0	63.8	93	31	711	0.21	0.05	0.46	0
May	86.8	57.3	72.1	99	40	995	0.35	0.06	0.67	0
June	95.8	66.1	81.0	107	52	1228	0.62	0.09	1.25	1
July	95.0	69.5	82.3	106	61	1308	1.67	0.59	2.56	3
August	92.8	67.9	80.4	103	59	1251	1.51	0.57	2.35	3
September	87.6	61.6	74.6	99	47	1036	1.46	0.27	2.49	2
October	78.6	50.0	64.3	92	33	752	0.76	0.20	1.31	2
November	66.1	37.8	51.9	81	19	369	0.35	0.12	0.71	1
December	58.1	31.3	44.7	74	13	180	0.60	0.13	1.10	1
Yearly :										
Average	77.5	49.8	63.6	----	----	----	---	---	---	---
Extreme	112	-8	---	108	8	----	---	---	---	---
Total	---	---	---	----	----	8744	8.72	6.09	11.14	16

*A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minumum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (Threshold : 40.0 deg. F)

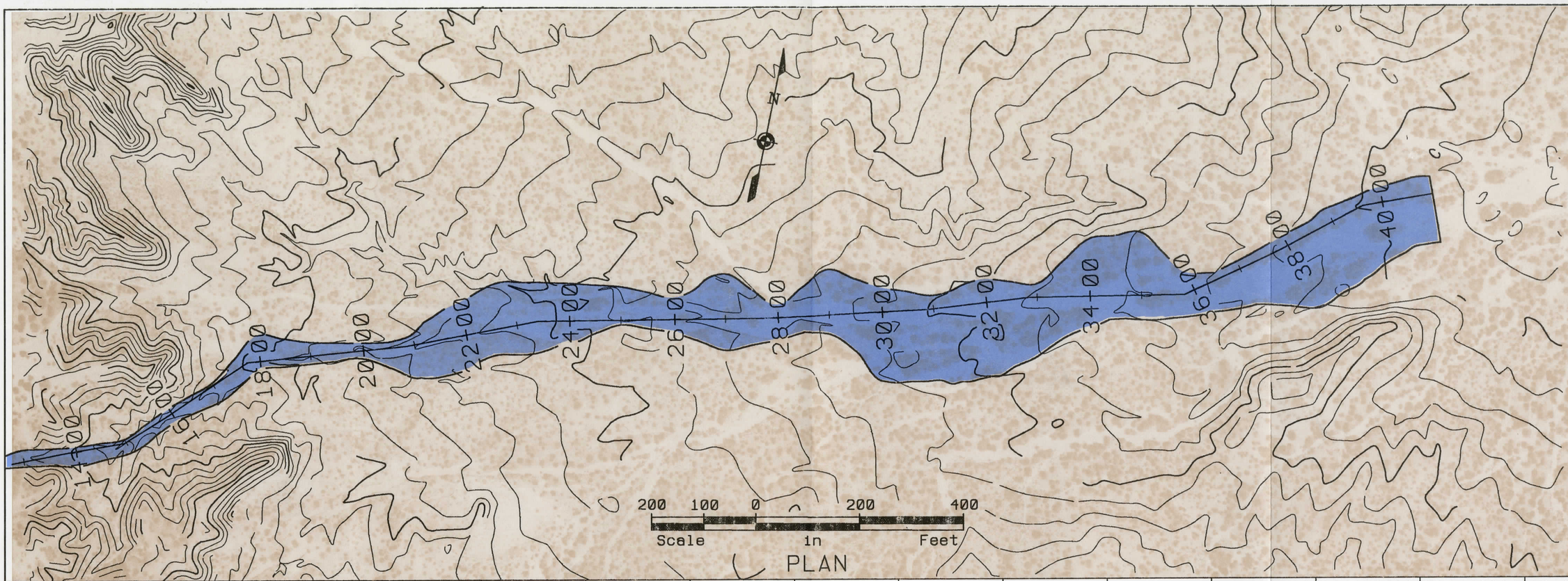
FROST Station : EL PASO WSO AP, 2797
start yr. - 1949 end yr. - 1993

Probability	Temperature		
	24F or lower	28F or lower	32F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	March 22	April 3	April 10
2 year in 10 later than--	March 12	March 26	April 3
5 year in 10 later than--	February 20	March 9	March 21
First freezing temperature in fall:			
1 yr in 10 earlier than--	November 12	November 2	October 28
2 yr in 10 earlier than--	November 19	November 8	November 1
5 yr in 10 earlier than--	December 3	November 19	November 9

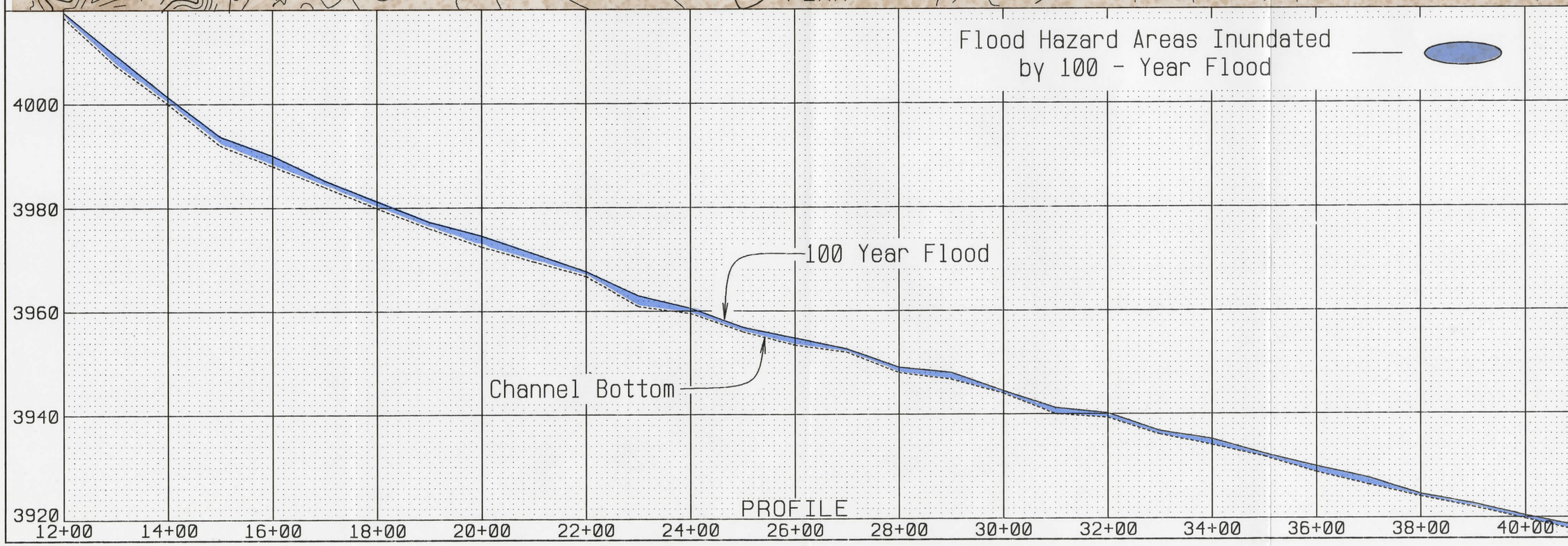
GROWTH Station : EL PASO WSO AP, 2797
start yr. - 1949 end yr. - 1993

Probability	Daily Minimum Temperature		
	# days > 24F	# days > 28F	# days > 32F
9 years in 10	238	220	207
8 years in 10	249	230	216
5 years in 10	271	249	232
2 years in 10	292	267	248
1 year in 10	303	277	256

APPENDIX D



PLAN



PROFILE

Approved by _____ Title _____ Title _____

Designed R. Ford \ E. Rokni Date 11-95
Drawn R. Armijo Date 11-95
Traced _____ Date _____
Checked _____ Date _____

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Drawing No.

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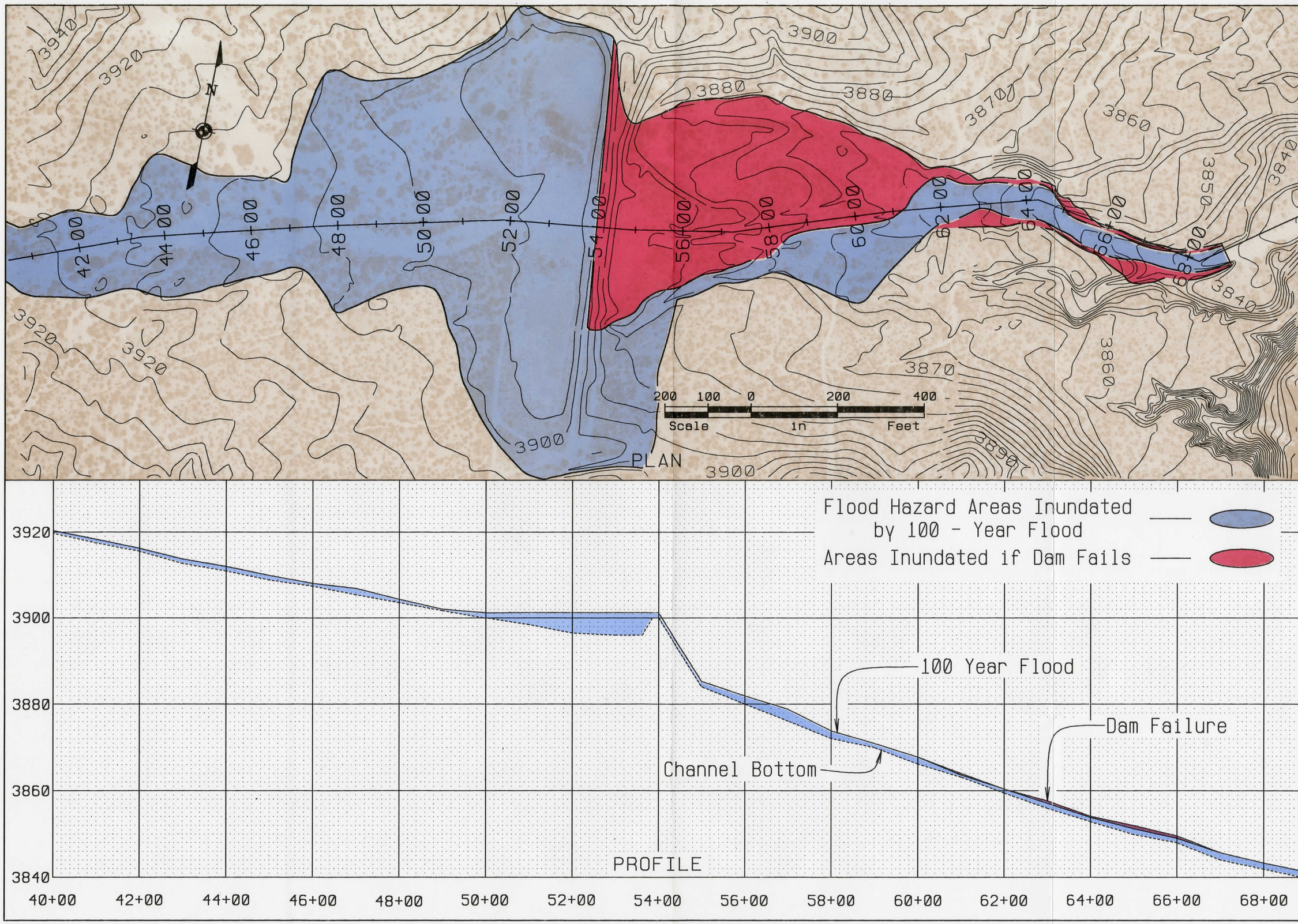

Designed Roger Ford Date 4-95
Drawn Richard Armijo Date 4-95
Traced Date
Checked Date
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Title
Title

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Drawing No.

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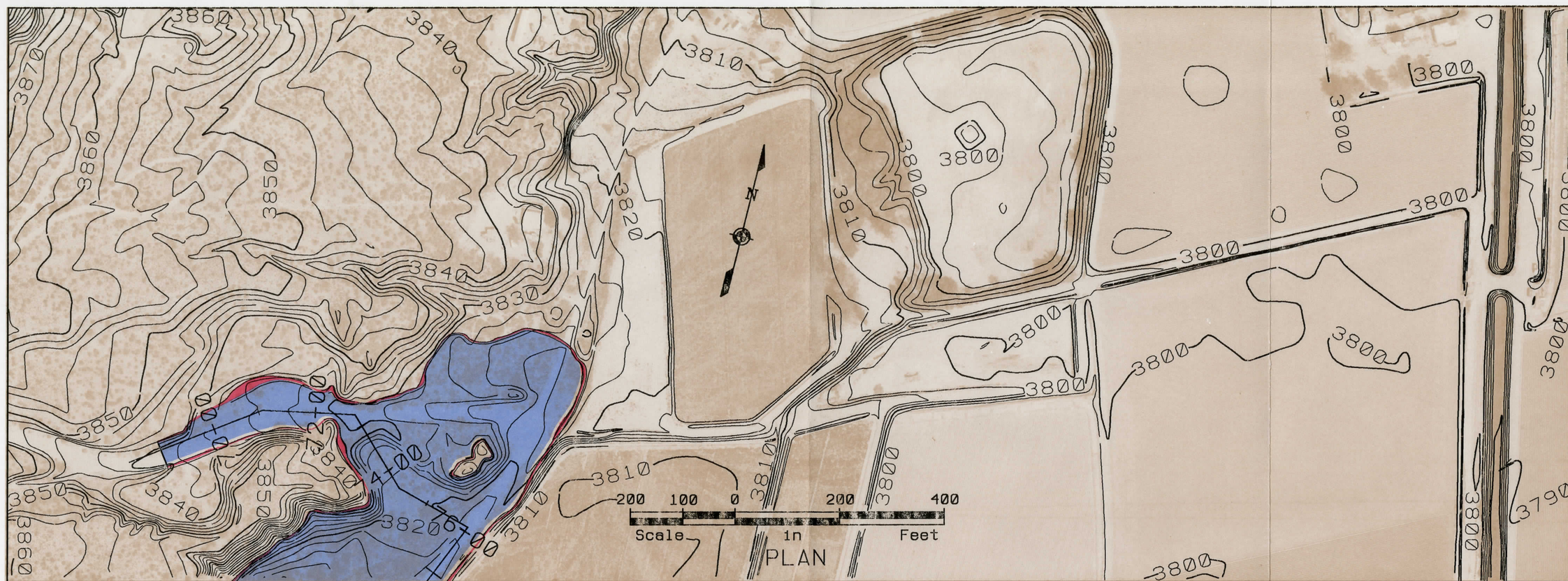

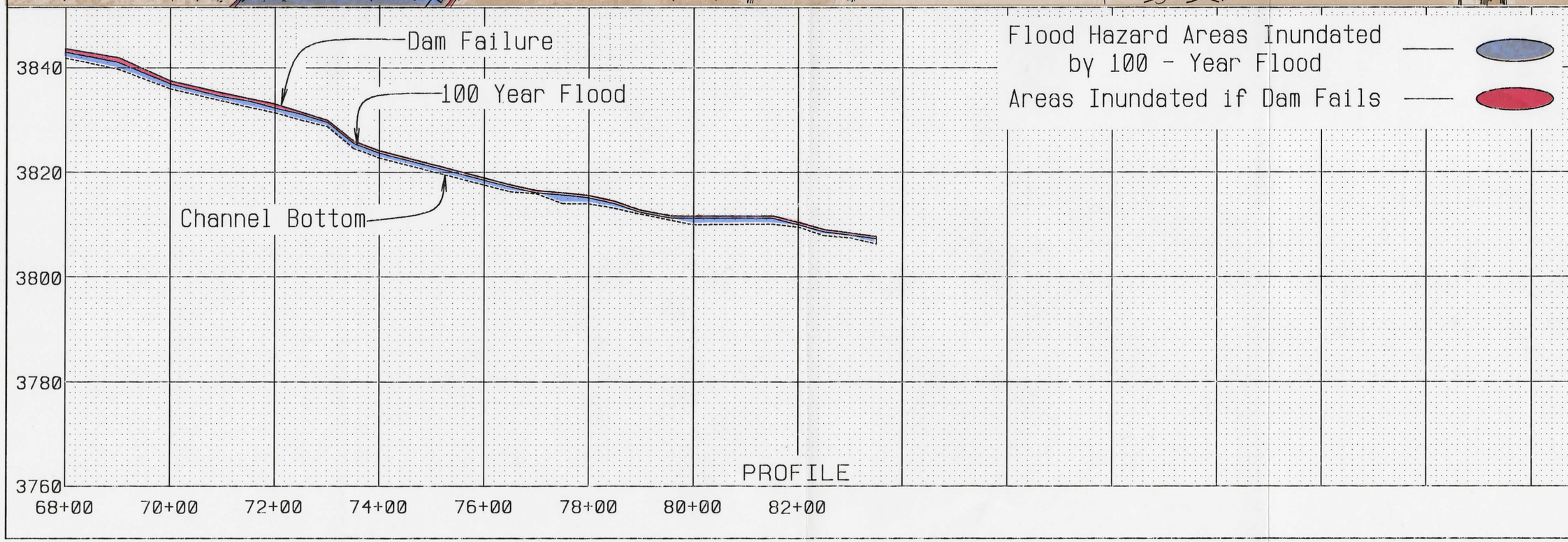

Designed Roger Ford Date 4-95
Drawn Richard Armijo Date 4-95
Traced Date
Checked Date
Approved by Title
Title

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Drawing No.

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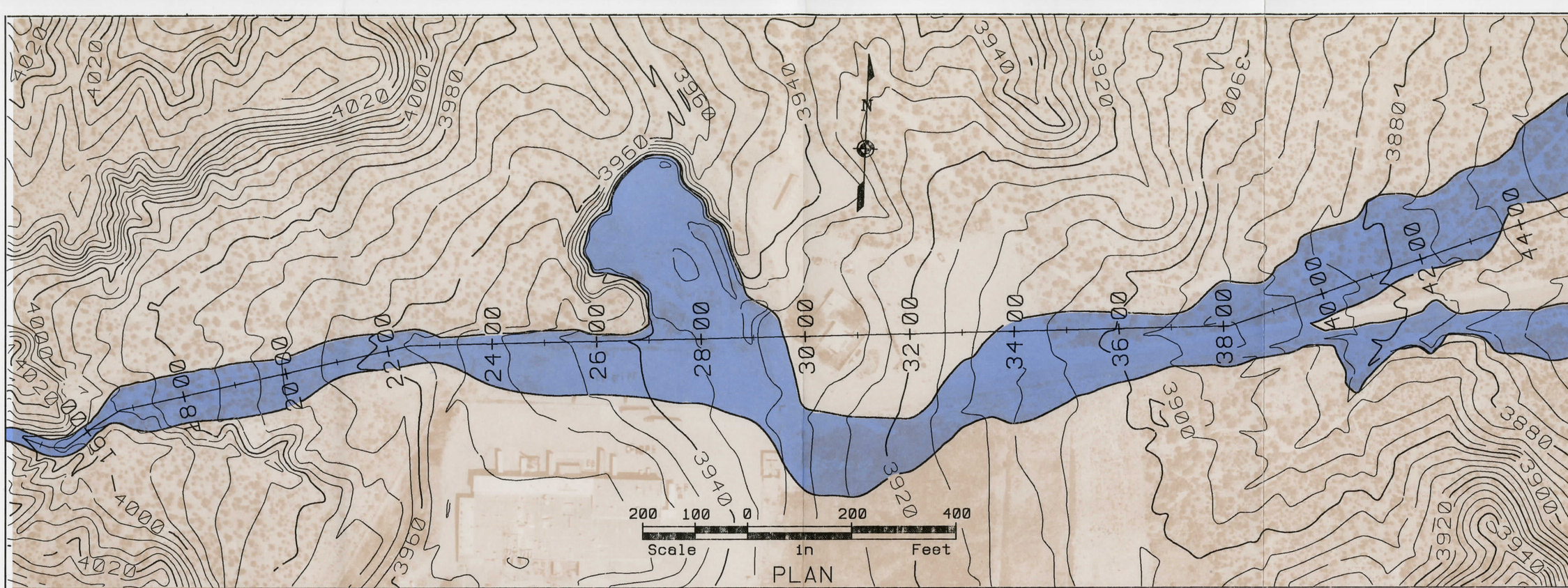

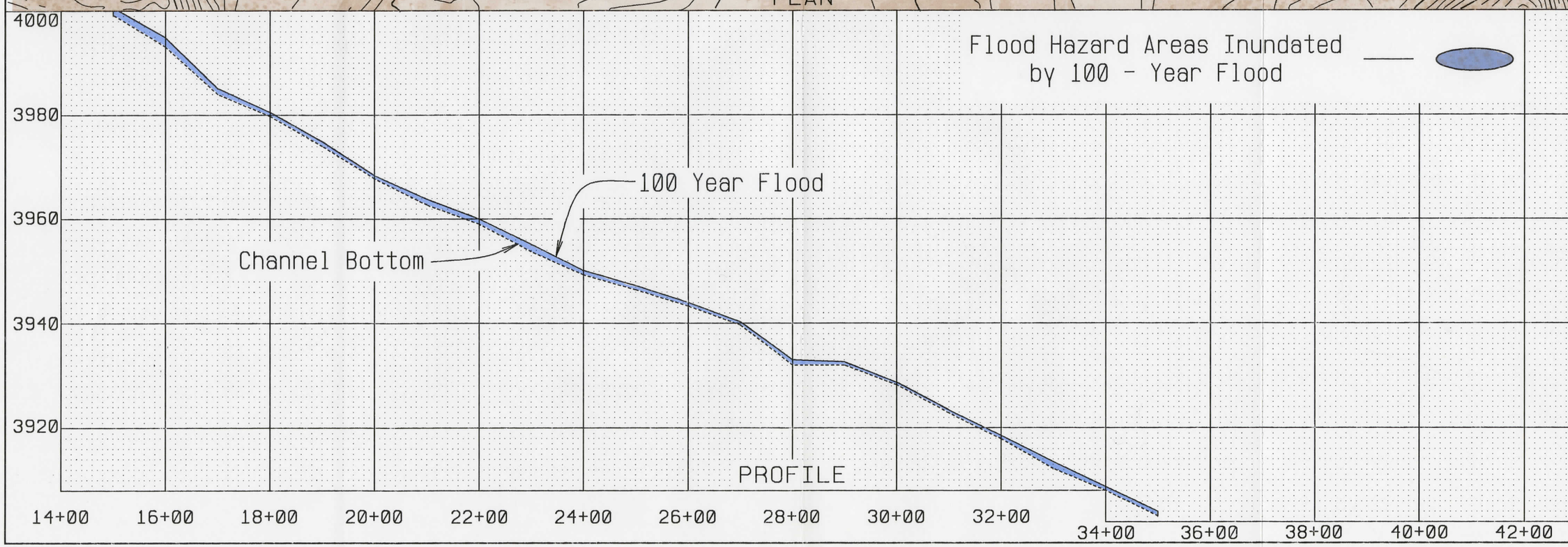

Designed Roger Ford Date 4-95
Drawn Richard Armijo Date 4-95
Traced Date
Checked Date

Approved by
Title
Title

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Drawing No.
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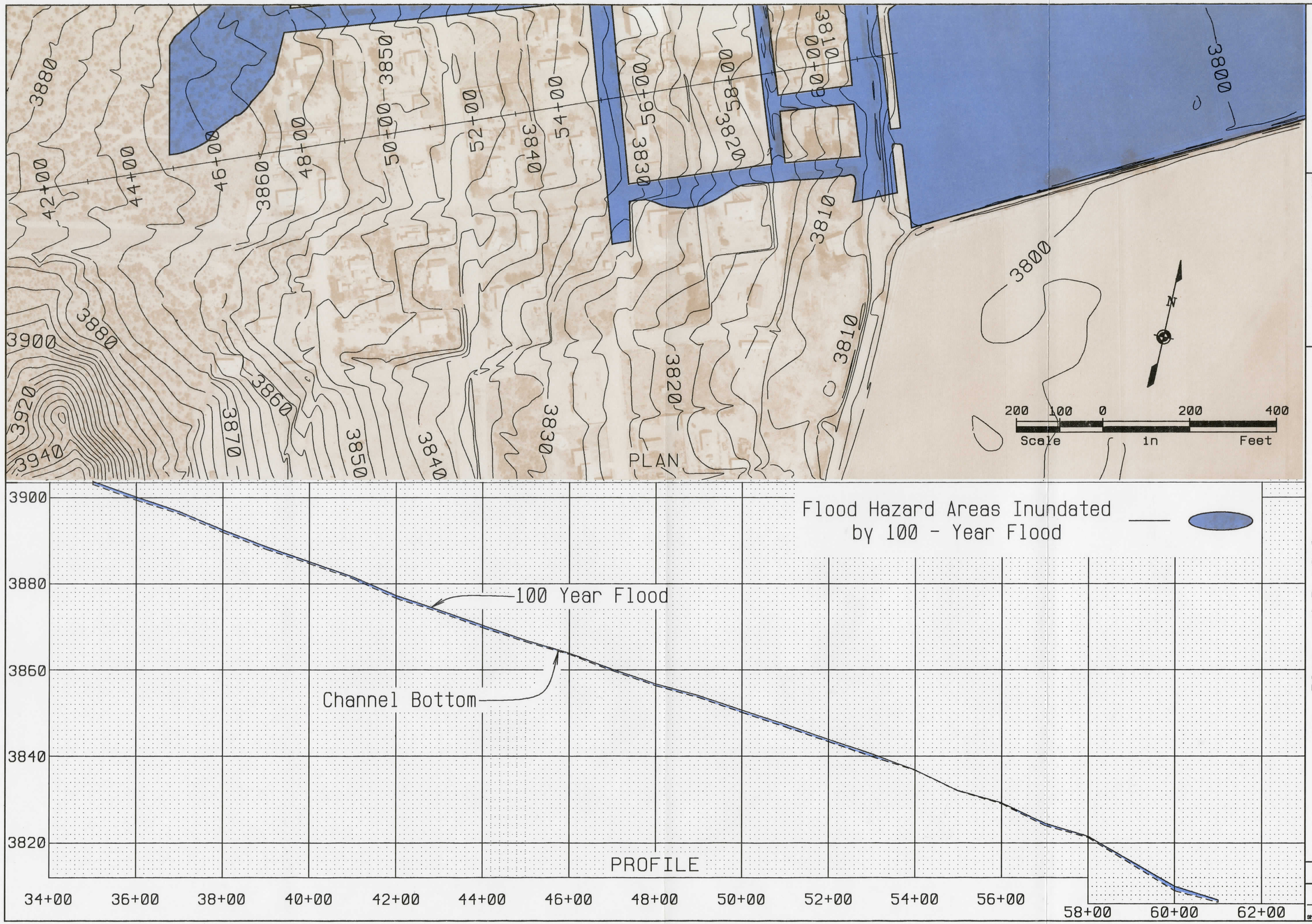

Designed Roger Ford Date 4-95
Drawn Richard Armijo Date 4-95
Traced ____ Date ____
Checked ____ Date ____

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Title ____
Title ____

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Drawing No.

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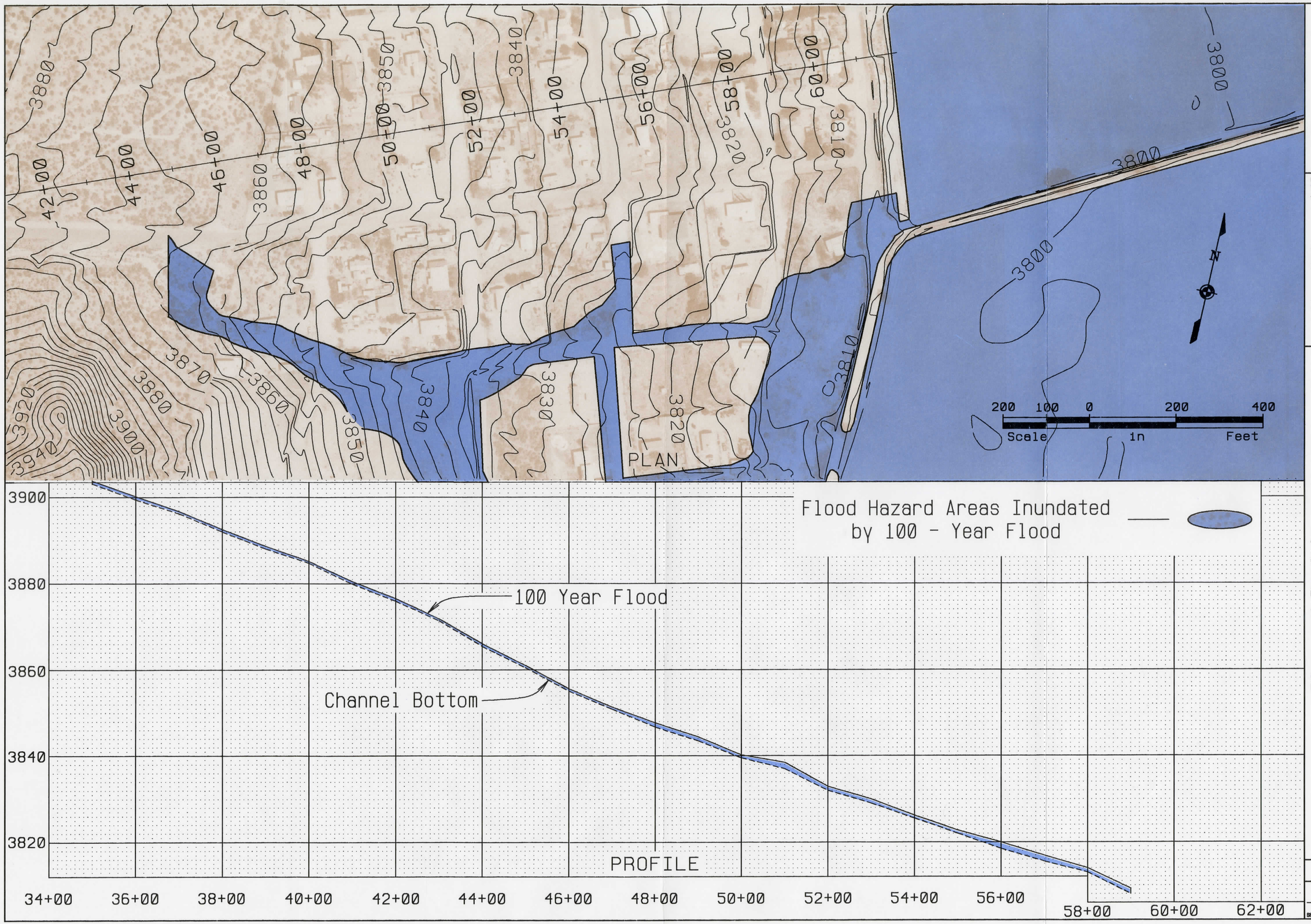

Designed Roger Ford Date 4-95
Drawn Richard Armijo Date 4-95
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Drawing No.
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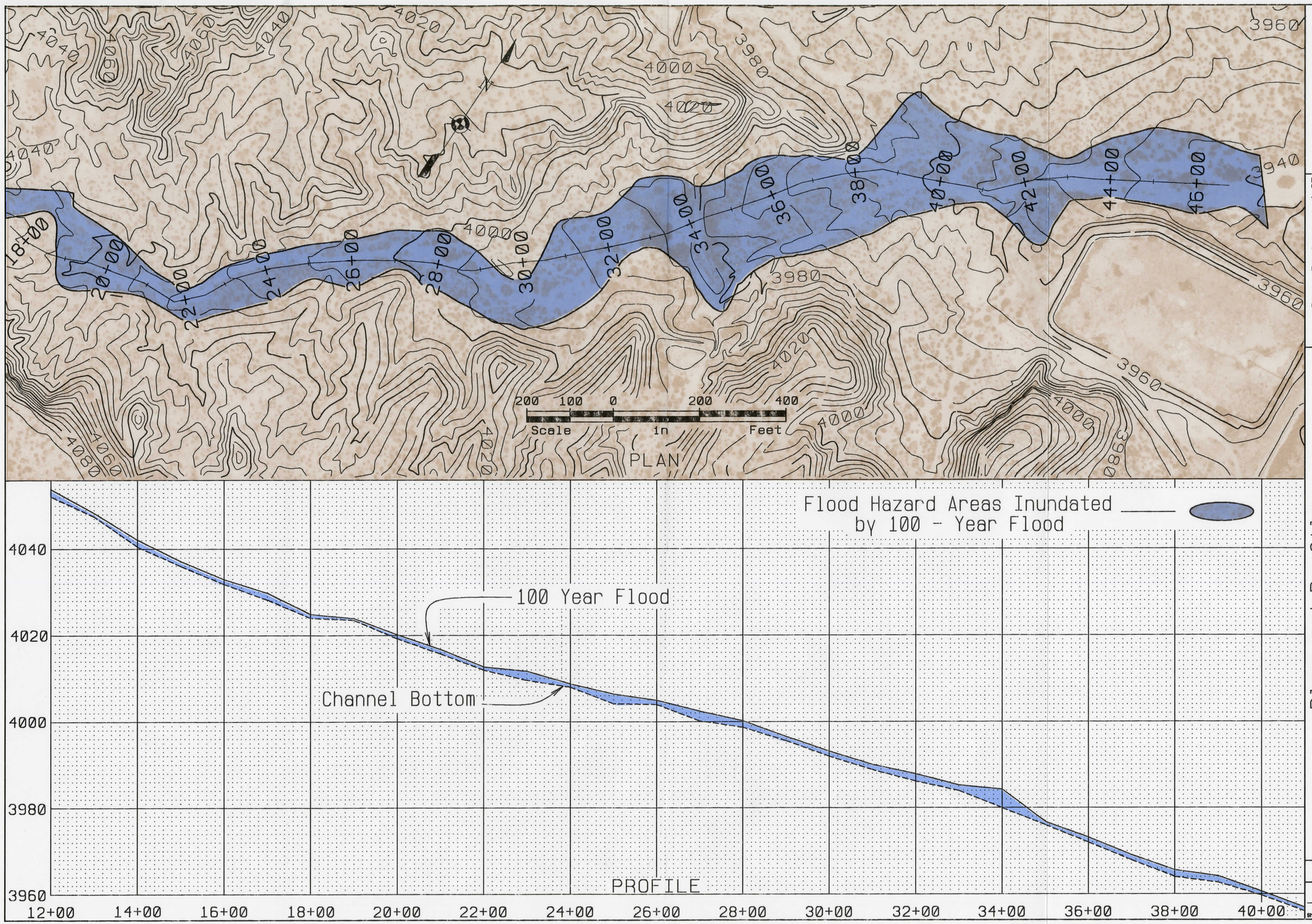

Approved by ____ Title ____

Designed Roger Ford Date 4-95

Drawn Richard Armijo Date 4-95

Traced ____ Date ____

Checked ____ Date ____ Title ____

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Drawing No.

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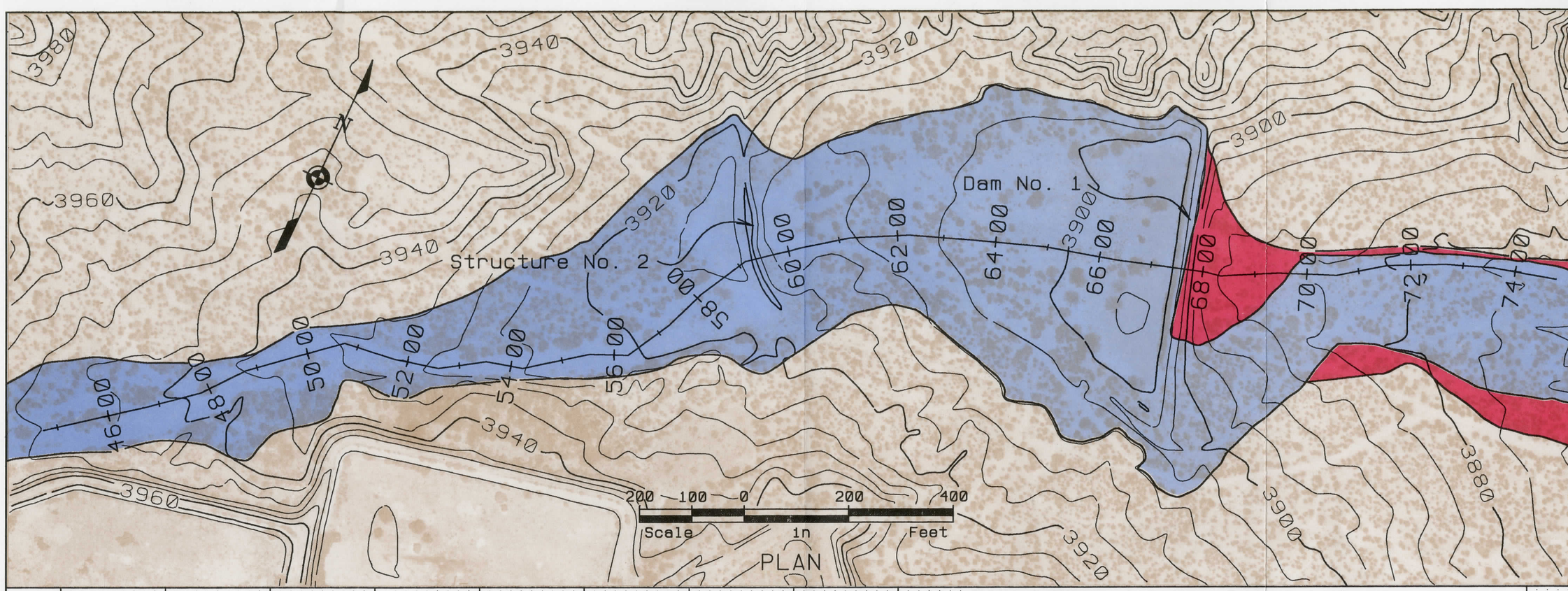

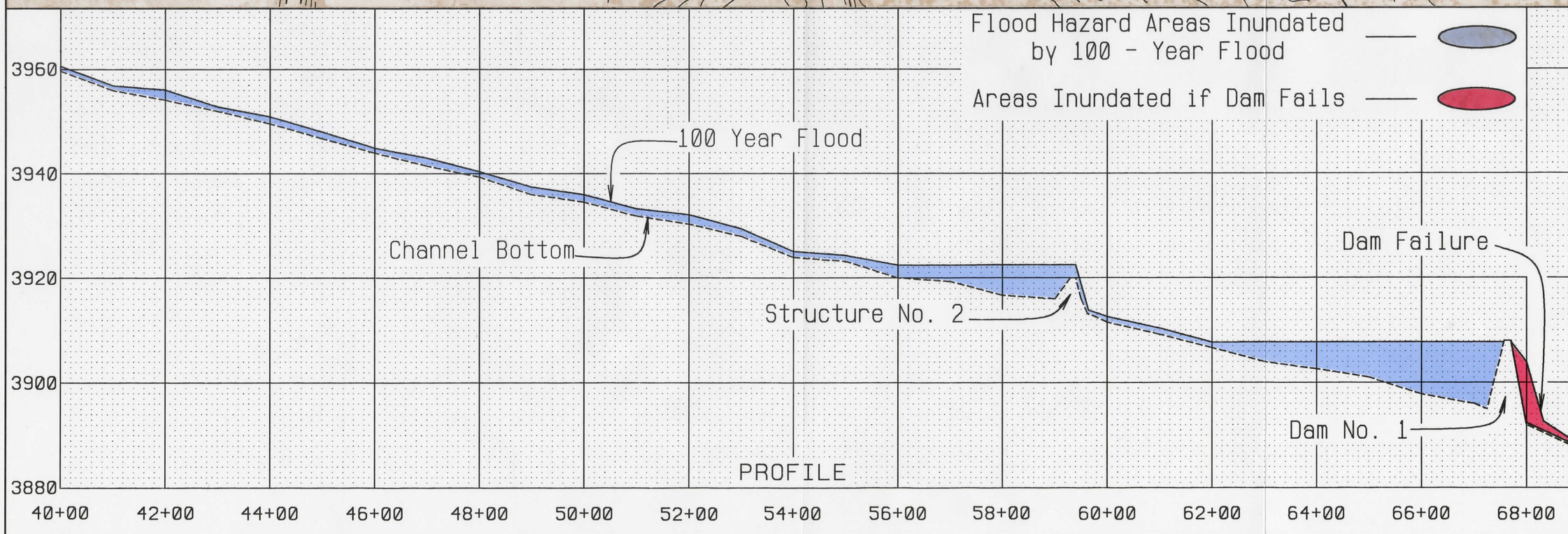

Designed Roger Ford Date 4-95
Drawn Richard Armijo Date 4-95
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Drawing No.
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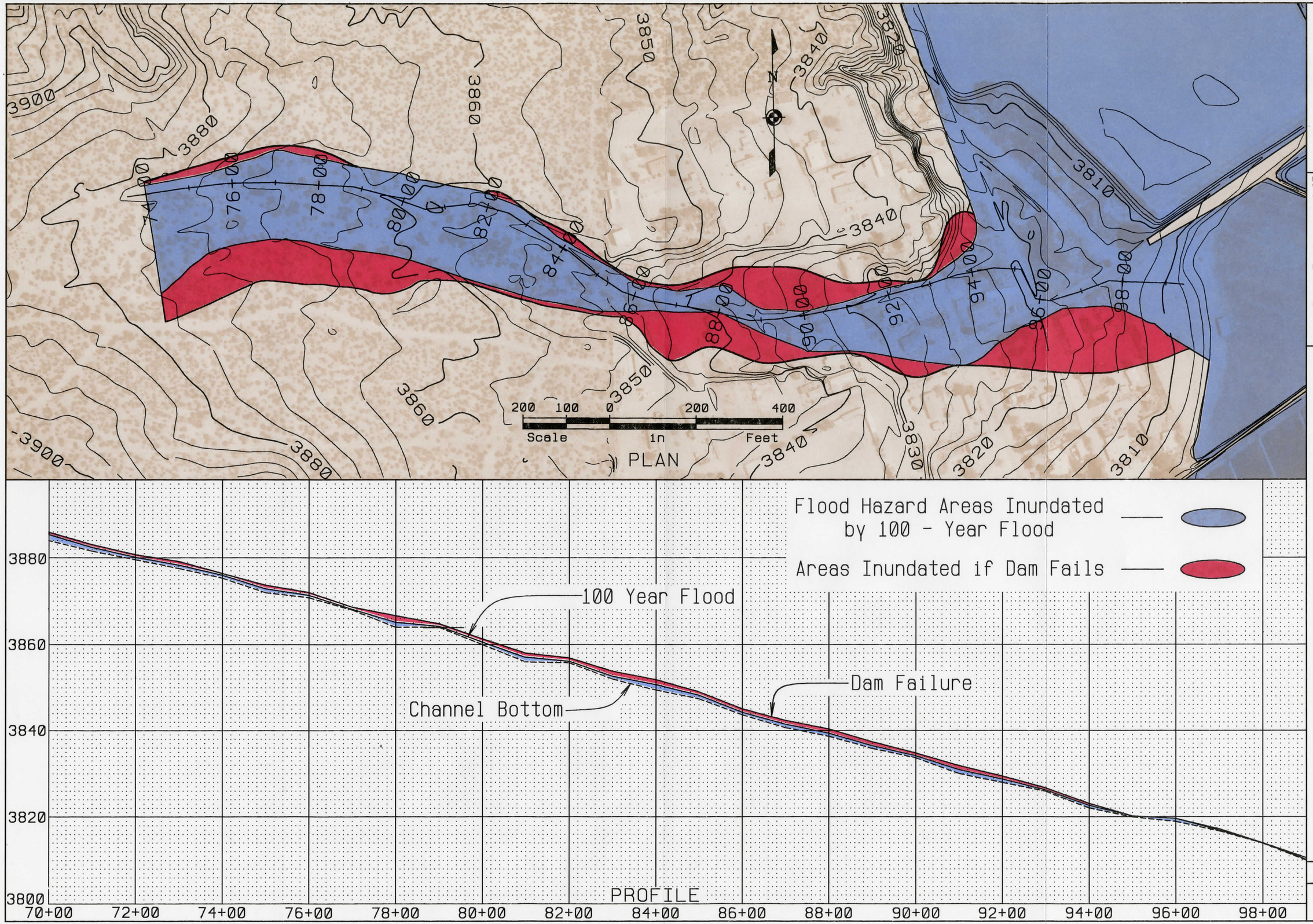

Designed Roger Ford Date 4-95
Drawn Richard Armijo Date 4-95
Traced Date
Checked Date
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Title

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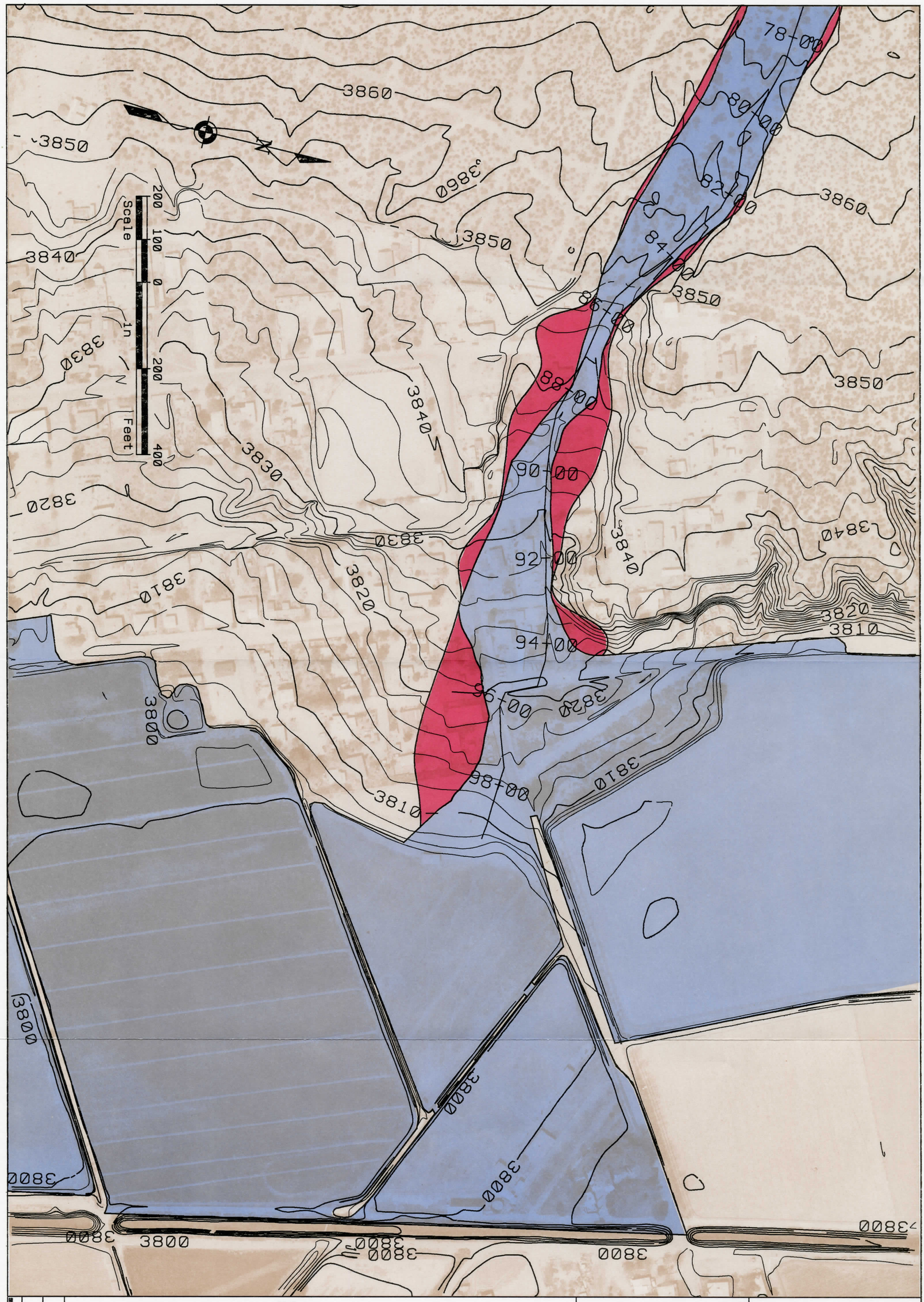

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Drawn Richard Armijo Date 9-95
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Checked Date

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Designed Roger Ford Date 4-95

Drawn Richard Armijo Date 4-95

Traced Date

Checked Date

Approved by

Title

Title