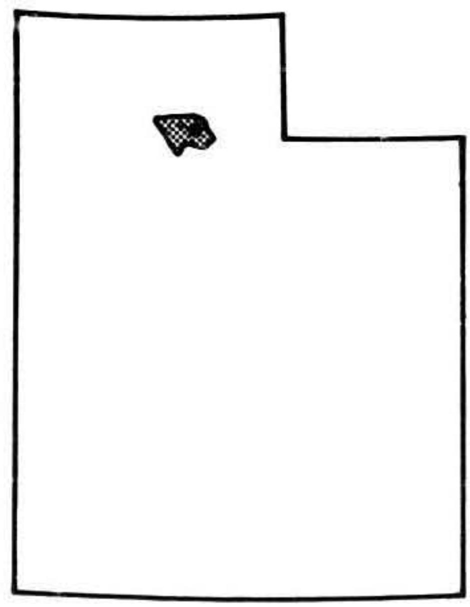
1996

Flood Insurance Study, City of Farmington, Utah, Davis County

Federal Emergency Management Agency

COMPLETED

FLOOD INSURANCE STUDY



CITY OF FARMINGTON, UTAH
DAVIS COUNTY

REVISED : FEBRUARY 16, 1996

Federal Emergency Management Agency

COMMUNITY NUMBER - 490044

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. Please contact the community repository for any additional data.

This publication incorporates revisions to the original Flood Insurance Study. These revisions are presented in Section 10.0.

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FLOOD INSURANCE STUDY
CITY OF FARMINGTON, DAVIS COUNTY, UTAH

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study report revises and updates a previous Flood Insurance Study/Flood Insurance Rate Map for the City of Farmington, Davis County, Utah. This information will be used by the City of Farmington to update existing floodplain regulations as part of the regular phase of the National Flood Insurance Program (NFIP). The information will also be used by local and regional planners to further promote sound land use and floodplain development.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the original study were performed by Gingery Associates, Inc., for the Federal Insurance Administration, under Contract No. H-4790. This work, which was completed in December 1979, covered all significant flooding sources affecting the City of Farmington.

The hydrologic and hydraulic analyses for the restudy were performed by the U.S. Army Corps of Engineers (COE), Omaha District, for the Federal Emergency Management Agency (FEMA), under Interagency Agreement No. EMW-84-E-1506, Project Order No. 1, Amendment 5A. This work was completed in June 1988.

1.3 Coordination

For the original study, streams requiring detailed and approximate study were identified at a meeting attended by representatives of the study contractor, the Federal Insurance Administration, and the City of Farmington on April 25, 1978. During the course of work done by the study contractor, hydrologic and other flood information was coordinated with the Federal Insurance Administration and the other agencies involved.

The results of the original study were reviewed at the final community coordination meeting held on September 10, 1980.

Attending the meeting were representatives of the Federal Insurance Administration, the study contractor, and the city. No problems were raised at the meeting.

On August 4, 1983, an initial coordination meeting was held at the Farmington City Building to determine which streams in the community were affected by mudflow and mud flood hazards, and what historical data were available for mudflow and flooding in Farmington. The meeting was attended by representatives of the City of Farmington, the State of Utah, Davis County, FEMA Region 8, the COE, Omaha District, and the Hydrologic Engineering Center (Davis, California).

On November 10, 1987, an intermediate coordination meeting was held in the Davis County Courthouse Building to present the preliminary results of the mudflow portion of the study to the community. This meeting was attended by representatives of the City of Farmington, the State of Utah, Davis County, FEMA Region 8, and the COE, Omaha District. Some minor revisions were incorporated into the final study results because of input from participants at this meeting.

On April 7, 1988, a second intermediate coordination meeting was held in the Davis County Courthouse Building to present the preliminary results of the total study to the community. This meeting was attended by representatives of the City of Farmington, the State of Utah, Davis County, FEMA Region 8, and the COE, Omaha District. Some minor revisions were incorporated into the final study results because of input from participants at this meeting.

The results of this study were reviewed at the final Consultation Coordination Officer meeting held on February 5, 1992, and attended by representatives of Farmington, Davis County, and FEMA.

At this meeting, the city protested the Special Flood Hazard Areas (SFHAs) on Shepard, Farmington, Rudd, Steed, and Davis Creeks. To support their protest, Farmington submitted to FEMA technical information regarding mudflow volumes and debris basin capacities developed by Davis County personnel. A review of this data showed that the mudflow volumes developed by the Davis County model more accurately represent the physical conditions of these canyons. Therefore, based on this information, the SFHAs on Shepard and Rudd Creeks were revised to show the flooding contained within the channel downstream of the canyon mouth to the debris basins. No information was submitted regarding the channel capacities of Farmington and Steed Creeks, and no debris basin exists along Davis Creeks. Therefore, no changes to those SFHAs were warranted.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Farmington, Davis County, Utah. The area of study is shown on the Vicinity Map (Figure 1).

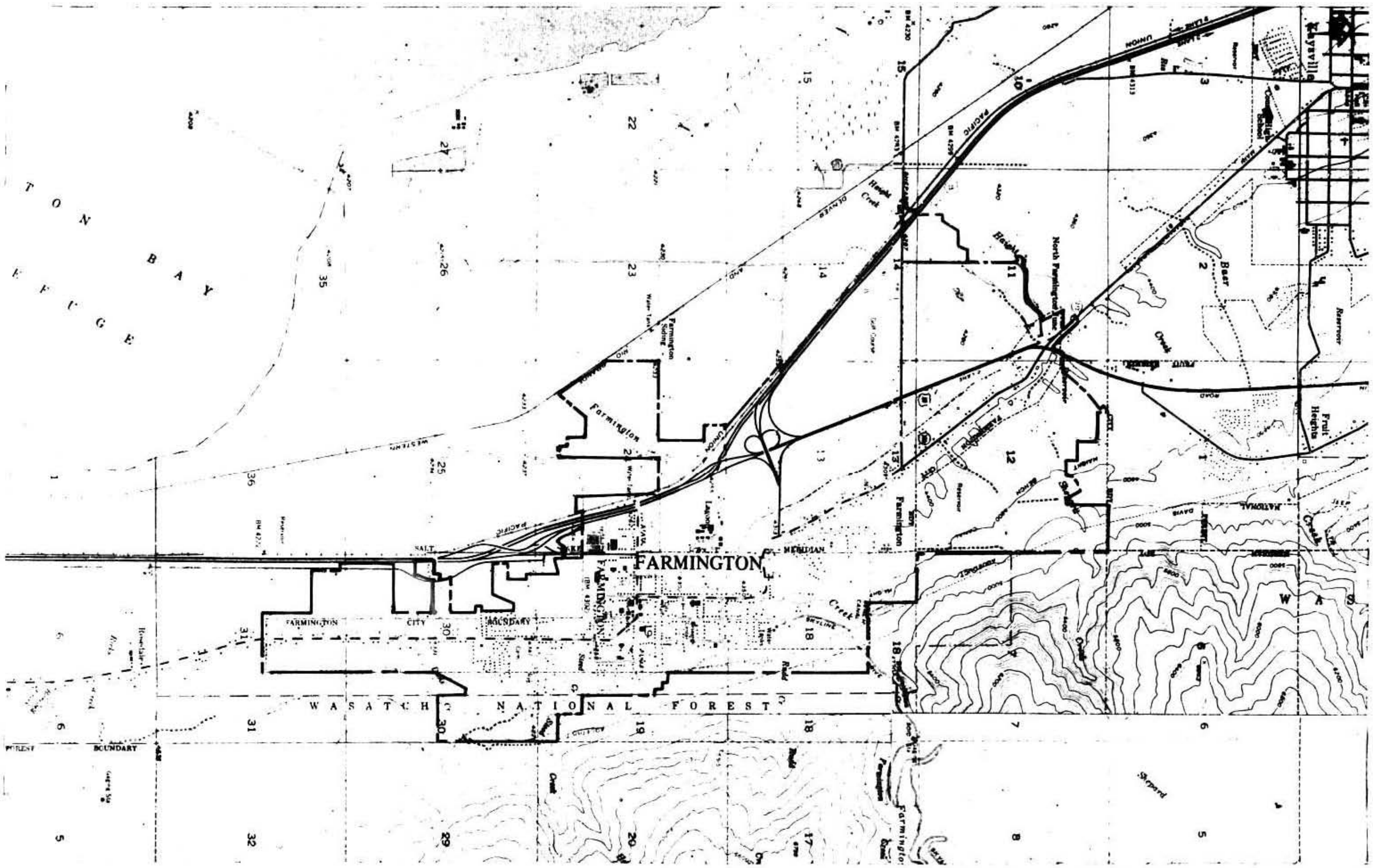

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FARMINGTON, UT
(DAVIS CO.)

APPROXIMATE SCALE

2000 0 2000 4000 6000 FEET

VICINITY MAP

Floods caused by the overflow of Davis Creek, Steed Creek, Farmington Creek, Rudd Creek, Shepard Creek, and Haight Creek were studied in detail for the original study. The upstream and downstream study limits of these streams, with the exception of Rudd and Shepard Creeks, were defined by the Farmington corporate limits. Rudd Creek was studied from its confluence with Farmington Creek upstream to the Farmington corporate limits. Shepard Creek was studied from approximately 1,000 feet downstream of State Highway 106 upstream to the corporate limits.

The areas studied by detailed methods in the original study were selected with priority given to all known flood hazards and areas of projected development or proposed construction through 1984.

Davis Creek, Steed Creek, Farmington Creek, Rudd Creek, and Shepard Creek were all restudied to determine the hazards associated with mudflow, and mud flood events. The upstream and downstream study limits of these streams are the same as the original study.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the City of Farmington.

2.2 Community Description

Farmington is in eastern Davis County, in north-central Utah, approximately 15 miles north of Salt Lake City. It was originally settled in 1848. Four years later, it was selected as the Davis County seat. The community is served by two major highways, Interstate Highway 15 and U.S. Highway 89.

The population of Farmington was 1,951 in 1960, 2,526 in 1970, and 4,691 in 1980. (Reference 1).

The corporate limits presently include an area of approximately 2,400 acres. Future growth is expected to occur through annexation of county lands.

There is low density development in the floodplain areas, with the exception of the lower end of Farmington Creek, which has some commercial development.

Farmington Creek is a perennial stream with a well-defined channel, and is the largest drainage through Farmington. It originates on Bountiful Peak at an elevation of about 9,300 feet above the National Geodetic Vertical Datum of 1929 (NGVD). It flows into the Farmington Bay of the Great Salt Lake approximately 2 miles west of the downstream corporate limit of the City of Farmington at an elevation of approximately 4,200 feet NGVD. The bed slope of Farmington Creek varies from 550 feet per mile in the upper reaches of the drainage basin, to 45 feet per mile near the downstream study limit, with an overall average basin slope of 290 feet per mile.

Rudd Creek is an intermittent left bank tributary of Farmington Creek. It originates about 2 miles east of Farmington at an elevation of about 8,300 feet NGVD. It flows into Farmington Creek at an elevation of about 4,260 feet NGVD. It has a large deep channel above the canyon mouth, but is undefined in the developed area of Farmington. Streambed slopes on Rudd Creek vary from over 2,000 feet per mile in the upper basin to 550 feet per mile in the lower basin near the mouth, with an overall basin slope of 1,500 feet per mile.

Both Steed and Davis Creeks are intermittent streams with well-defined channels above, and poorly defined channels below State Highway 106. Both creeks originate on Bountiful Peak east of Farmington. Steed Creek originates at an elevation of about 9,300 feet NGVD and Davis at an elevation of about 9,100 feet NGVD. Both streams flow westerly through the southern part of Farmington and empty into the Farmington Bay of the Great Salt Lake at an elevation of about 4,200 feet NGVD. Streambed slopes on both Steed Creek and Davis Creek range from over 2,500 feet per mile in the upper basin to 550 feet per mile in the lower basin near the mouth, with an overall streambed slope of 830 feet per mile on Steed Creek and 1,700 feet per mile on Davis Creek.

Shepard Creek originates approximately 3 miles northeast of Farmington at an elevation of about 9,200 feet NGVD and flows westerly through the northern end of Farmington. Shepard Creek has a steep well-defined channel above State Highway 106. Below that point the channel becomes small and ill-defined, and has been obliterated by commercial development at the downstream study limit, approximately 1,000 feet downstream of State Highway 106. Its elevation at the downstream study limit is about 4,290 feet NGVD. Streambed slopes range from over 2,600 feet per mile in the upper basin to around 150 feet per mile at the downstream study limit with an overall basin slope of 1,180 feet per mile.

The extremely steep slopes on the easternmost edge of the Farmington corporate limit are not conducive to development or agricultural uses. Below the steep mountainsides of the Wasatch Front the topography flattens to the foothills and then to the lake plain. As the slopes flatten traveling west from the mountains, the land use changes to agricultural, then to moderately dense developed city, and finally back to agricultural or swampy areas along the edge of the Great Salt Lake. Orchard fruits are grown on the relatively steep foothills with grains and vegetables grown on the undeveloped lake plain areas. Much of the swampy area along the Great Salt Lake near Farmington are part of the Farmington Bay National Wildlife Refuge.

The native vegetation consists mainly of saltgrass and wiregrass on the low terraces and bottom lands. Sagebrush and brushy oak grow on the higher terraces and as far up as approximately 7,500 feet.

Above that elevation, there are alpine forests of aspen, fir, pine, and spruce (Reference 2).

Farmington has a temperate, subhumid climate with four well-defined seasons. The summers are warm and dry and the winters are cold but usually not severe. The average annual temperature is 52 degrees Fahrenheit and the annual precipitation is about 20 inches (Reference 3).

The primary underlying soils east of State Highway 106 are of the Kilburn Association. They are well-drained to somewhat excessively well-drained, gravelly, sandy loams and comprise the alluvial fans and high terraces.

Most of the soils west of Highway 106 are in the Ironton-Logan-Draper Association. These are moderately well-drained to very poorly drained soils on floodplains and in depressions (Reference 2).

2.3 Principal Flood Problems

Flooding which caused damage had occurred frequently prior to 1939 on the streams studied for this report. Major mudflow or flood events occurred on some or all of the streams studied in 1862, 1878, 1901, 1903, 1912, 1923, 1926, 1929, 1930, 1932, 1936, 1947, and 1983. The most destructive floods were the large mudflows and mud floods which occurred in 1923 and 1930 on all the streams in Farmington (References 4, 5, 6, 7, 8).

Mudflows and mud floods can form in two different ways. In almost all flood events, floodwaters can scour significant amounts of material from the streambed, causing the flood waters to be heavily laden with sediment and debris. If the sediment and debris load exceeds 20% solids by volume it is termed a mud flood; if the sediment and debris load exceeds 45% solids by volume it is termed a mudflow. Mudflows and mud floods can also occur directly from shallow landslides caused when the water content of the soil is increased sufficiently to permit flow. Below the canyon mouth the velocities decrease and the material is deposited in a fan shape over the more gently inclined slopes. In some cases as the mudflows proceed downstream, some of the heavier solids will fall out of suspension, such that the flow evolves from a mudflow to a mud flood and then finally to a water flood.

On Farmington Creek, floods with abundant debris have occurred in 1878, 1923, 1926, and 1930. Seven people died in the mudflow event of August 13, 1923. On that date a man driving a four-horse team up Farmington Canyon heard a tremendous roar up the canyon and rushed up the mountainside just in time to see a mass of mud and rocks carry away his team and wagon. Observers in the canyon reported the crest of the mudflow to be 75 to 100 feet high in that part of the canyon at a width of about 200 feet. The crest farther down the canyon was estimated at 30 feet high. At Lagoon resort, about 2 km downstream of the mouth of Farmington Canyon, people were rescued from trees, where they had fled to escape rapidly rising water. On August 10, 1947, a mudflow occurred in Halfway Canyon, a tributary of Farmington Canyon, estimated at 210,000 cubic yards in volume. That mudflow damaged an instrument house and knocked a bridge off its foundation. A mudflow of approximately 22,000 cubic yards occurred in spring of 1983 on Farmington Creek (Reference 9).

Excavation for sewer lines downstream of the Shepard Creek Canyon has uncovered evidence of large boulders which may have been deposited by mudflows. Several mudflows did reach the main channel during the spring of 1983 (Reference 9).

On Davis Creek a mudflow on August 13, 1923, deposited "bouldery alluvium" over 31 acres with an average thickness of 1.5 feet. Records show floods on Davis Creek in 1878, 1901, 1903, 1929, and 1930, some of which may have been mudflows (Reference 9).

On Steed Creek in 1923 a mudflow deposited "bouldery alluvium" over an area of 21.6 acres. Below the Steed Creek Canyon mouth there is an historic 6.5 feet thick mudflow which is underlain by an older mudflow deposit. A mudflow of approximately 13,000 cubic yards occurred in the spring of 1983 (Reference 9).

Following the 1930 floods, a special commission concluded that the mudflows and mud flooding were caused by a depletion of plant cover due to overgrazing livestock and man-caused fires on headwater lands. As a result, revegetation and soil stabilization measures were instituted (Reference 10). The absence of large mudflows after the revegetation and soil stabilization measures were put in place seemed to indicate that there was no longer a significant mudflow hazard. However, in the spring of 1983, widespread landslides and mudflows caused an estimated $250,000,000 in damage in the State of Utah. Along a 30-mile stretch of the Wasatch Front, 92 significant landslides sent mudflows down on residential areas below. More than 1,000 landslides occurred along the Wasatch Plateau. The destruction was so extensive that 22 of Utah's 28 counties were declared National disaster areas (Reference 9).

A series of mudflows occurred on Rudd Creek in the spring of 1983, which deposited approximately 90,000 cubic yards of mud and debris over 17.9 acres to depths up to 20 feet within the canyon and from 12 to 2 feet deep just downstream of the canyon mouth. The largest flow occurred on Memorial Day, May 30, 1983, at about 7:00 p.m. That flow dumped mud and debris into a four-block area just downstream of the canyon, destroying five homes outright and damaging four others beyond repair. No one was killed in this catastrophic mudflow, probably because it occurred during the day. Figures 2 and 3 are photographs of the 1983 mudflow on Rudd Creek (Reference 9).

Figure 2. Channel of Rudd Creek near the canyon mouth after the 1983 mud flow event. Note the scouring of the stream bed that typically contributes much of the material in mud flow events.

Figure 3. Mud and debris on Rudd Creek near the canyon mouth after the 1983 mud flow event.

2.4 Flood Protection Measures

From 1933 to 1939, much of the flood-source land in the upper reaches of the basins was contour trenched and seeded by the Civilian Conservation Corps.

Also, structures designed to detain or retard mudflows and mud floods have been constructed on all the streams studied for this report. The debris basins on Farmington and Shepard Creeks, and floodwalls on Steed and Davis Creeks were built in the 1930s by the Civilian Conservation Corps. A debris basin was constructed at the canyon mouth of Rudd Creek, after the mudflow event of 1983.

The channels of all the streams studied for this report have been modified to some degree from their natural state, especially in developed areas. Most of these channel changes were designed to carry frequent flows and do not provide protection from the 100-year flood event.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1 and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, <u>average</u> period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

This study was conducted specifically to identify the flood hazards associated with mudflow and mud flooding. The standard hydrologic and hydraulic study methods usually employed for flood insurance studies do not adequately define the hazards associated with mudflows. A major portion of this study effort was expended on the development of a method to define mudflow hazards. The mudflow hazard identification method was developed by the COE's Hydrologic Engineering Center at Davis, California, in conjuction with the University of Utah and the COE, Omaha District.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.
For this Flood Insurance Study, the basic hydrology was taken directly from a hydrology report prepared for the Federal Insurance Administration in October, 1979 (Reference 11). The discharge-frequency relationships for each stream were developed for the snowmelt flood events, as well as for the rainfall flood events. These two distributions were statistically combined to give a discharge-frequency curve for the combined snowmelt-rainfall event.

The runoff records of 16 gaging stations located in the general vicinity of the study area were searched for the yearly peak flows caused by snowmelt and the yearly peak flows caused by rainfall.

For each gaging station, the 10-, 50-, 100-, and 500-year frequency discharges were developed for both snowmelt and rainfall events from U.S. Water Resources Council methods (Reference 12).

The stepwise regression approach was used in developing a total of eight regression equations for all four frequencies and the two types of flood events. Only drainage area was found to be the key independent variable in the regression equations.

The regression equations representing the snowmelt flood events resulted in a good correlation coefficient, but the regression equations for the rainfall flood events provided poor correlation and were unacceptable. It was found necessary to use a watershed model to simulate rainfall flood events.

The Storm Water Management Model (SWMM) developed by the U.S. Environmental Protection Agency was used to simulate rainfall flood events (Reference 13). A total of 16 streams were simulated by the SWMM model to yield hydrographs for 10-, 50-, 100-year frequency storms. Through the use of the stepwise regression approach, regression equations were developed to predict the 10-, 50-, and 100-year frequency discharges at two locations (for example, at the canyon mouth and at a location downstream of the developed area). The 500-year frequency discharge is obtained by extrapolation of the 10-, 50-, and 100-year frequency discharges.

In summary, the discharge-frequency distribution curve for a stream for snowmelt events was determined from an analysis of the gaging station records of the related regression equations. The discharge-frequency distribution curve for the rainfall events was evaluated from the results of the SWMM model simulation or the related regression equations. These two independent events were statistically combined to yield a discharge-frequency distribution for the combined event.

The resulting discharges were used in the analyses of Davis, Farmington, Rudd, Shepard and Steed Creeks with two modifications.

The first modification was to include the available data from the 1983 flood event in the hydrologic analysis. A second modification was needed to simulate the effect of potential high sediment loads in the flood waters. It was determined in this study that flood waters in the streams studied could contain up to 45% solids, including sediment, rocks, and debris (Reference 14). To account for the potential for high sediment and debris load the discharges were increased by a "bulking factor". The flows were increased by multiplying the basic discharges by a bulking factor of 1.82.

As part of this study, a mudflow hydrograph was required to determine the extent of the mudflow hazard. A methodology for calculating a mudflow hydrograph was developed as part of this study by the Hydrologic Engineering Center in conjunction with the University of Utah. The mudflow hydrograph methodology uses observed mudflow volumes along the Wasatch Front to develop a total mudflow volume potential versus drainage area curve. Using the drainage area, a mudflow volume was determined for each stream. The mudflow volume was then used as input to a one-dimensional routing model with a dambreak upstream boundary condition. The one-dimensional model provided a mudflow hydrograph for use in determining mudflow depths and boundaries.

Peak discharge-drainage area relationships for Haight Creek are shown in Table 1.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Starting water-surface elevations for Haight Creek were developed from rating curves. Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1). For Davis, Farmington, Rudd, Shepard and Steed Creeks the mudflow depths and boundaries were calculated using a two-dimensional finite element computer model which was developed specifically for this study by the Hydrologic Engineering Center and the University of Utah (Reference 14). The basic inputs required for the two-dimensional model are: an inflow mudflow hydrograph; a finite element grid network; a representation of the ground topography of the alluvial fan; mudflow fluid properties; and initial mudflow depths and velocities.

Topography for the two-dimensional model was taken from topographic mapping which was developed from aerial photographs flown in April 1982 (Reference 17). The mudflow fluid property values used for input into the two-dimensional model were selected using available data. The fluid properties required by the model included the plastic viscosity, the Bingham yield strength, and the unit weight. The values selected were 10 lb-sec/ft^2, 20 lb/ft^2,

Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Year	50-Year	100-Year	500-Year
Haight Creek:					
At Upstream Opening of Culvert Under Interstate Highway 15	0.8	15[1]	55[1]	85[1]	200[1]
Steed Creek:					
At Interstate Highway 15	3.5	55	140	215	590
At Canyon Mouth	3.3	50	90	140	300
Farmington Creek:					
At Interstate Highway 15	13.5	395	890	1,250	2,400
At Clark Lane	13.1	350	650	895	1,775
At Canyon Mouth	10.5	310	460	570	1,100

[1]Discharges Interpolated from Table 7 in Hydrology Report for Flood Insurance Studies in 20 Utah Communities (Reference 12)

and 125 lb/ft^3, respectively. These selected fluid property values were of the same order of magnitude as those used for the one-dimensional mudflow modeling that was done on the North Fork of the Toutle River in Washington (Reference 18). These values also agree with values measured by Thomas C. Pierson during a smaller Rudd Creek mudflow event which occurred about six days after the main event in 1983 (Reference 19). The initial mudflow depths were calculated at normal depth using the resistance equation for mudflow from the one-dimensional model.

Within the Davis County study area, little data were available with which the two-dimensional mudflow model could be calibrated. However, some data was available on the Rudd Creek 1983 mudflow events which included one main event followed by several smaller events. The data available on these events included:

1. An aerial photograph of the total inundation region.

2. A surveyed volume of the mudflow deposit of approximately 90,000 yd^3. This was the total mudflow volume for all of the 1983 events on Rudd Creek.

3. A mudflow front speed on the alluvial fan of approximately the speed that a man could walk.

4. Observed mudflow depths that ranged from approximately 20 feet within the canyon and 12 feet at the apex of the alluvial fan (Reference 18) to approximately 2 or 3 feet at the front.

Attempts were made to duplicate the Rudd Creek 1983 mudflow events using the two-dimensional mudflow model. The results of these attempts were checked against the available data on the Rudd Creek mudflow events, and the duplication served as a rough calibration of the two-dimensional mudflow model.

The mudflow volumes used in this study represent the total average potential mud volumes available for the respective drainage areas in question. Because of a lack of historical data, it is difficult to assign a probability to a mudflow. Therefore, mudflow depths have not been shown.

Additional information regarding the mudflow methodology used to develop the flood boundaries may be obtained from the COE, Omaha District.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to NGVD. Elevation reference marks and descriptions of the marks used in this study are shown on the maps.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2,400, with a contour interval of 2 feet.

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map. On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE) and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 100-year floodplain boundary is shown on the Flood Insurance Rate Map.

This Flood Insurance Study attempts to identify the entire area that may be subject to mudflows and mud flooding from those streams studied. Because of the effects of topography, floodplain development, and local obstructions, the path of mudflows and mud flooding on alluvial fans can vary from one flood event to another. In addition, areas which may appear "high" relative to adjacent areas may indeed be subject to flood hazards of the same degree, if a localized obstruction changes the course of the mudflow or mud flood such that it does not follow the lowest flow path through the area.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 2). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Haight Creek								
A	1,290	86	191	0.3	4,265.0	4,265.0	4,265.0	0.0
B	1,770	18	13	4.8	4,265.3	4,265.3	4,265.3	0.0
C	1,880	111	288	0.3	4,278.0	4,278.0	4,278.0	0.0
D	2,700	124	175	0.5	4,280.4	4,280.4	4,280.4	0.0
E	3,265	22	17	5.0	4,286.2	4,286.2	4,286.2	0.0
Farmington Creek								
A	60	45	170	4.7	4,230.3	4,230.3	4,230.3	0.0
B	530	31	92	8.7	4,232.1	4,232.1	4,232.1	0.0
C	1,305	49	211	3.8	4,235.7	4,235.7	4,235.7	0.0
D	2,205	46	145	5.5	4,237.4	4,237.4	4,237.4	0.0
E	2,960	31	87	9.2	4,241.8	4,241.8	4,241.8	0.0
F	3,045	36	138	5.8	4,243.4	4,243.4	4,243.4	0.0
G	3,485	41	183	4.1	4,244.5	4,244.5	4,244.6	0.1
H	3,865	37	137	5.1	4,244.8	4,244.8	4,245.3	0.5
I	4,550	29	114	7.9	4,254.6	4,254.6	4,255.6	1.0
J	5,160	35	144	6.2	4,258.8	4,258.8	4,258.9	0.1
K	5,785	26	97	9.2	4,262.8	4,262.8	4,262.8	0.0
L	5,867	61	249	3.6	4,262.9	4,262.9	4,263.7	0.8
M	6,035	35	132	6.8	4,267.1	4,267.1	4,267.1	0.0
N	6,085	26	86	10.4	4,267.5	4,267.5	4,267.5	0.0
O	6,660	277	396	2.3	4,270.8	4,270.8	4,271.0	0.2
P	7,090	25	85	10.5	4,274.3	4,274.3	4,274.3	0.0
Q	7,160	29	89	10.0	4,276.4	4,276.4	4,276.4	0.0
R	7,855	22	81	11.0	4,286.8	4,286.8	4,286.8	0.0
S	8,765	23	83	10.8	4,312.6	4,312.6	4,312.6	0.0
T	8,825	27	87	10.2	4,316.2	4,316.2	4,316.2	0.0
U	9,080	24	62	9.1	4,325.1	4,325.1	4,325.1	0.0
V	9,120	23	69	8.2	4,325.9	4,325.9	4,325.9	0.0
W	9,480	26	64	8.9	4,338.0	4,338.0	4,338.0	0.0
X	9,570	50	80	7.2	4,364.9	4,364.9	4,364.9	0.0

[1]Feet above Denver and Rio Grande Western Railroad

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FARMINGTON, UT

(DAVIS CO.)

FLOODWAY DATA

HAIGHT CREEK - FARMINGTON CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Steed Creek								
A	75	102	157	1.4	4,252.0	4,252.0	4,252.5	0.5
B	625	38	52	6.5	4,253.6	4,253.6	4,254.0	0.4
C	1,255	8	22	9.7	4,258.3	4,258.3	4,258.3	0.0
D	1,730	8	21	9.4	4,264.0	4,264.0	4,264.0	0.0
E	2,010	19	56	3.6	4,265.6	4,265.6	4,265.8	0.2
F	2,610	40	36	5.5	4,275.8	4,275.8	4,275.8	0.0
G	2,895	22	30	6.7	4,283.7	4,283.7	4,283.7	0.0
H	3,020	20	36	6.0	4,284.8	4,284.8	4,284.8	0.0
I	3,321	71	55	3.9	4,287.4	4,287.4	4,287.4	0.0
J	3,439	45	40	5.4	4,292.2	4,292.2	4,292.2	0.0
K	3,778	87	49	4.4	4,308.8	4,308.8	4,308.8	0.0
L	3,959	16	30	6.3	4,311.1	4,311.1	4,311.4	0.3
M	4,352	15	26	7.4	4,345.6	4,345.6	4,345.6	0.0
N	4,390	16	26	7.3	4,349.1	4,349.1	4,349.1	0.0
O	4,490	7	30	6.3	4,360.3	4,360.3	4,360.3	0.0
P	4,556	28	31	6.0	4,368.7	4,368.7	4,368.7	0.0
Q	4,664	21	28	6.7	4,376.9	4,376.9	4,376.9	0.0
R	4,754	40	28	6.7	4,382.6	4,382.6	4,382.6	0.0
S	4,859	14	25	7.5	4,395.7	4,395.7	4,395.7	0.0
T	4,883	31	90	2.1	4,396.7	4,396.7	4,396.7	0.0
U	5,288	16	26	7.2	4,414.6	4,414.6	4,414.6	0.0
V	5,385	41	32	5.2	4,424.8	4,424.8	4,424.8	0.0

[1]Feet above Interstate Highway 15 Frontage Road

TABLE 2	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF FARMINGTON, UT** (DAVIS CO.)	**FLOODWAY DATA** STEED CREEK

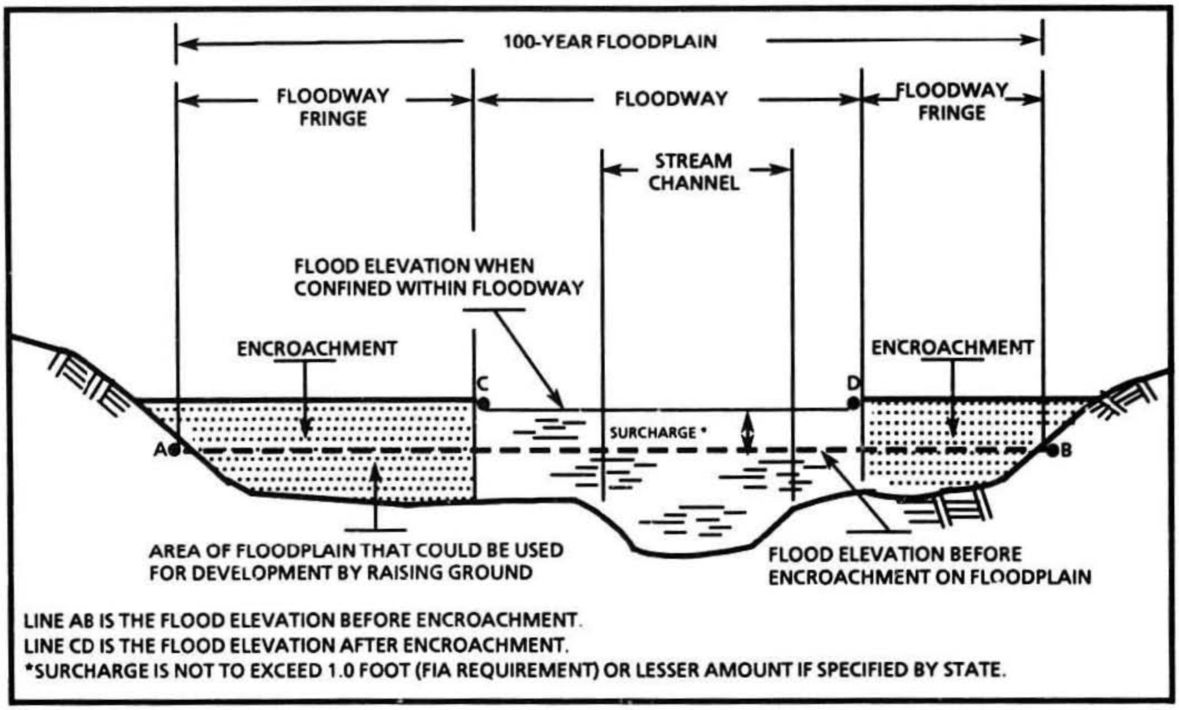

Figure 4. Floodway Schematic

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100- and 500-year floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

Farmington and Steed Creeks were included in the COE Flood Plain Information Report for Farmington Bay Tributaries, Farmington-Centerville, Utah (Reference 20).

All the streams studied for this report were studied in detail for water flooding for a Flood Insurance Study for the City of Farmington dated February 17, 1981.

Differences in flood boundaries between the Flood Plain Information report and the Flood Insurance Report and this study are attributable to updated hydrologic information and the addition of mud flood and mudflow hazard delineation.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Denver Federal Center, Building 710, Box 25267, Denver, Colorado 80225-0267.

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10.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To assure that any user is aware of all revisions, it is advisable to contact the community repository.

10.1 First Revision

This study was revised on February 16, 1996, to incorporate the results of revised hydraulic analyses along Farmington and Steed Creeks. In addition, a Letter of Map Revision dated February 7, 1994, for Davis Creek has been incorporated into this revised study.

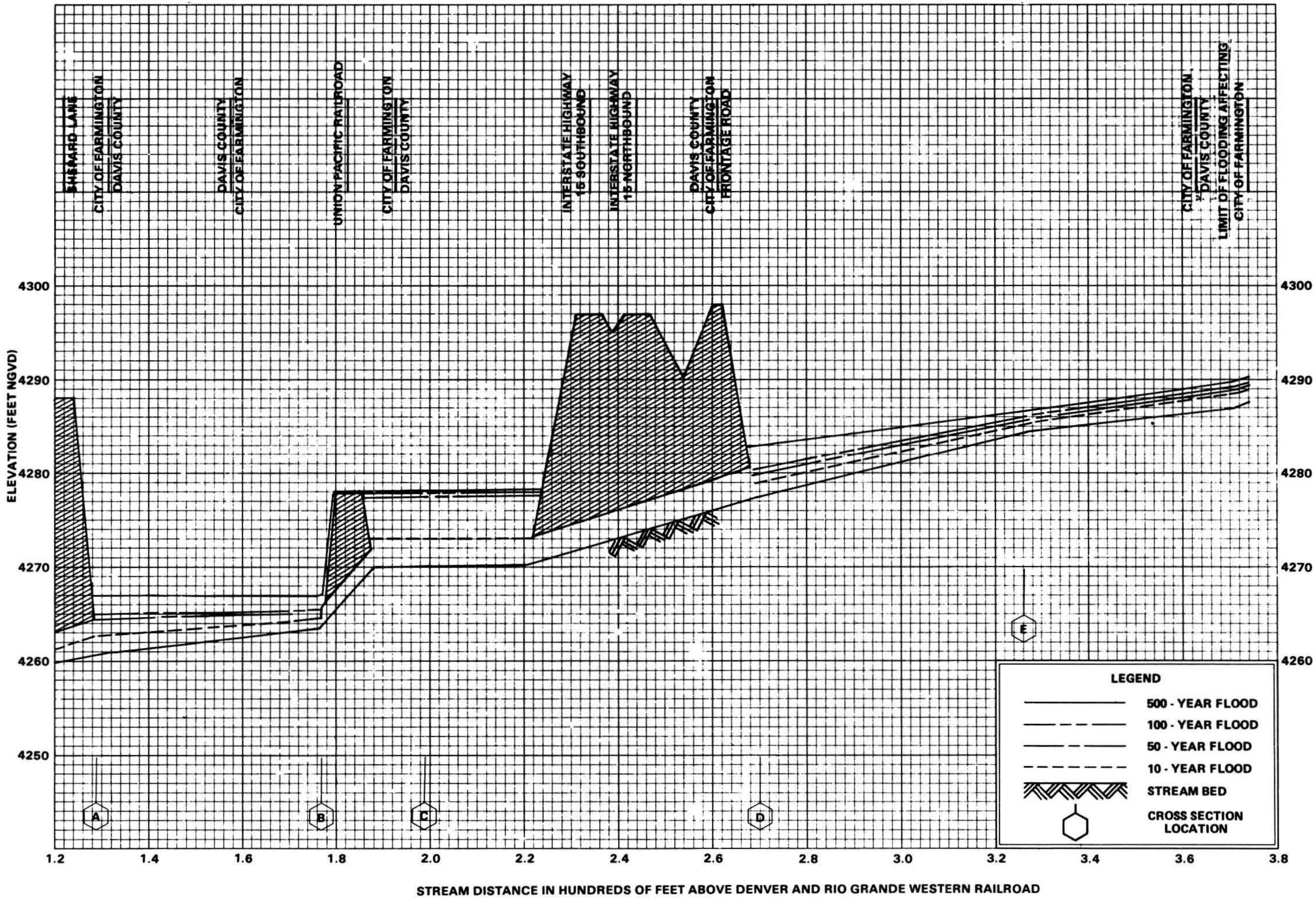
The hydraulic analyses for Farmington and Steed Creeks were performed by Perkins-Thurgood Consulting Engineers, Inc. The hydraulic analysis for Davis Creek was performed by the Davis County Department of Public Works.

As a result of more detailed topographic information along the Farmington and Steed Creek channels upstream of their respective debris basins, revised hydraulic analyses along these reaches indicated that flows much greater than the 100-year discharges will be contained within these channels from the canyon mouths downstream to the debris basins. In addition, based on a study conducted by Davis County (Reference 21), the Farmington and Steed Creek debris basins have the capacity to contain the debris flow expected to be generated by each flooding source. Downstream of the debris basins, revised hydraulic analyses were performed to reflect existing topographic conditions within the Farmington and Steed Creek floodplains. Because the debris basins will contain the entire expected 100-year debris flow, the discharges used in the hydraulic analyses downstream were not adjusted to account for debris. Water-surface elevations downstream of the debris basins were calculated using the U.S. Department of the Army, Corps of Engineers, HEC-2 step-backwater computer program (Reference 22).

The starting water-surface elevations were taken from the Flood Profiles presented in the previous Flood Insurance Study for the City of Farmington (Reference 23). Roughness coefficients (Manning's "n") were determined based on field observation and engineering judgment.

The revised hydraulic analysis for Davis Creek, based on more detailed topographic information, indicated that the expected 100-year debris flow generated at the mouth of Davis Canyon will be contained within the channel from the canyon mouth to approximately 250 feet upstream of 200 East (Highway 106). From this location, the debris flow will travel in a southwesterly direction where it will overtop 200 East. Downstream of 200 East, the debris flow will be contained within levees located north and south of the Davis Creek channel to the Interstate Highway 15 Frontage Road, where the debris flow will pond behind the Interstate Highway 15 embankment. No base flood elevations were determined for Davis Creek, and the Special Flood Hazard Area is shown as an area of approximate flooding (Zone A) on the Flood Insurance Rate Map.

As a result of this revised study, the Summary of Discharges Table (Table 1) has been revised. In addition, the Floodway Data Table (Table 2) and Flood Profiles (Exhibit 1) for Farmington and Steed Creeks have been added.



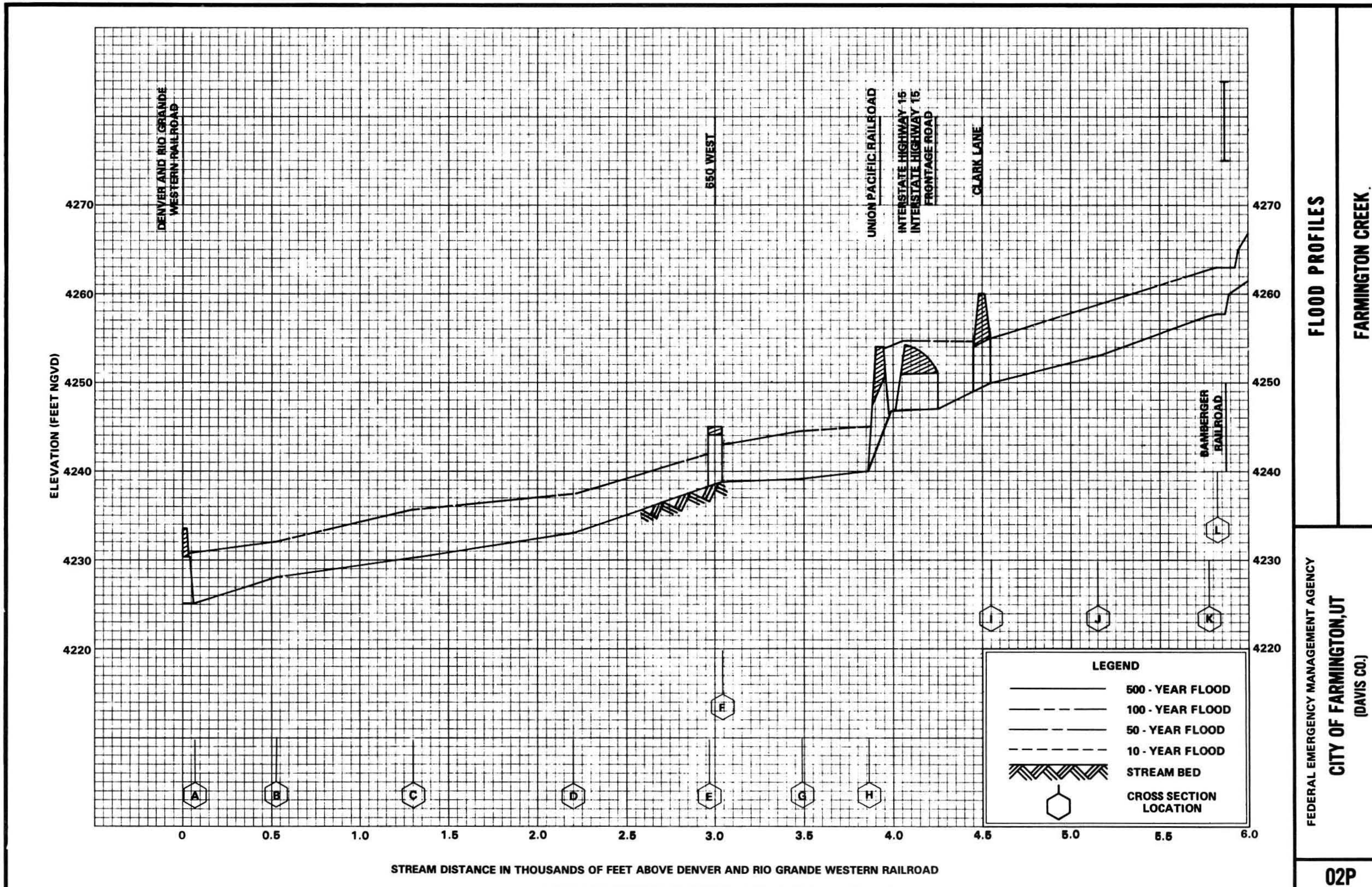
FLOOD PROFILES

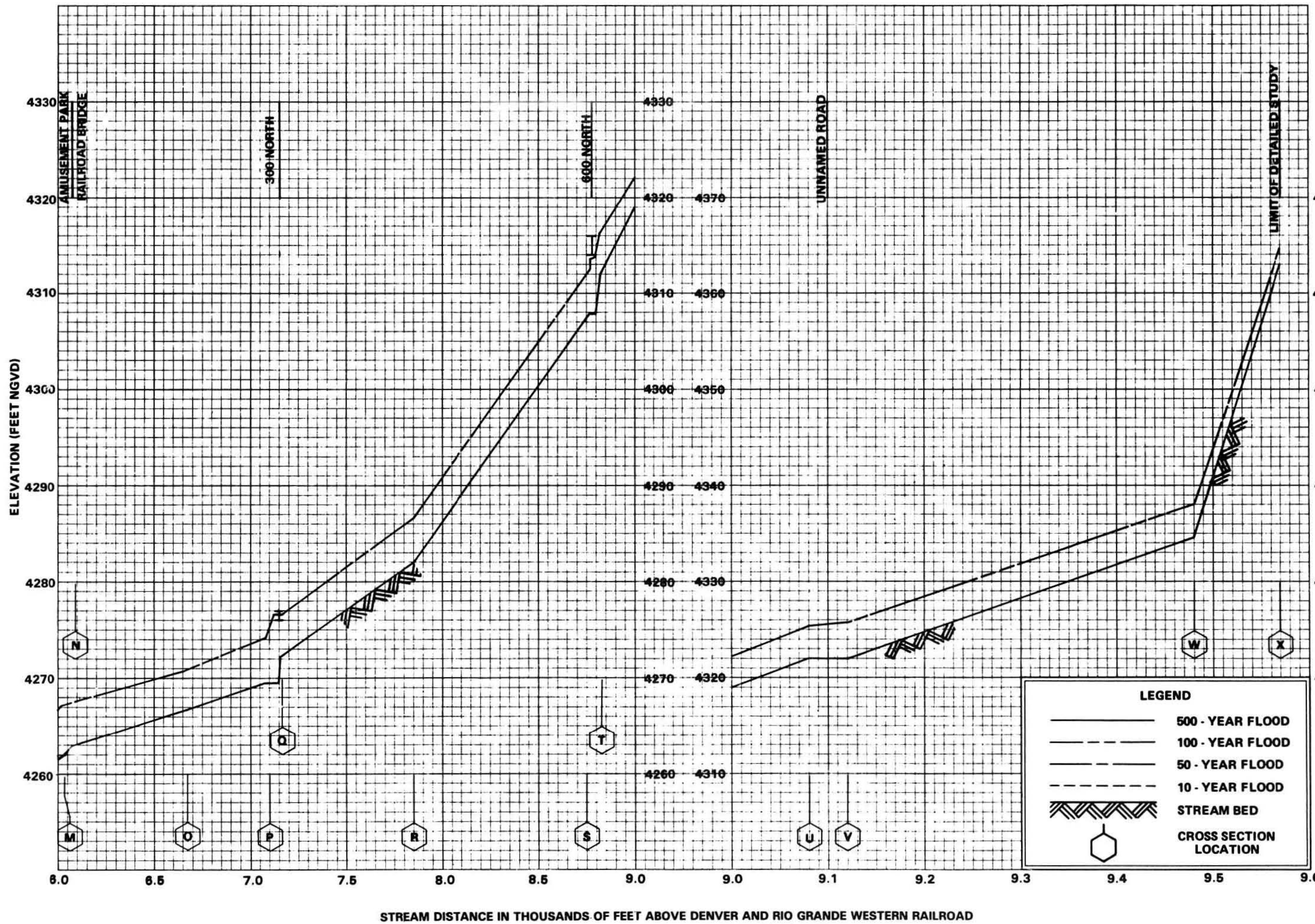
HAIGHT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FARMINGTON, UT (DAVIS CO.)

01P


DENVER AND RIO GRANDE WESTERN RAILROAD
650 WEST
UNION PACIFIC RAILROAD
INTERSTATE HIGHWAY 15
INTERSTATE HIGHWAY 15 FRONTAGE ROAD
CLARK LANE
BAMBERGER RAILROAD
ELEVATION (FEET NGVD)
4270
4260
4250
4240
4230
4220
A
B
C
D
E
F
G
H
I
J
K
L
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
STREAM DISTANCE IN THOUSANDS OF FEET ABOVE DENVER AND RIO GRANDE WESTERN RAILROAD
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
FARMINGTON CREEK
FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF FARMINGTON, UT
(DAVIS CO.)
02P



FLOOD PROFILES

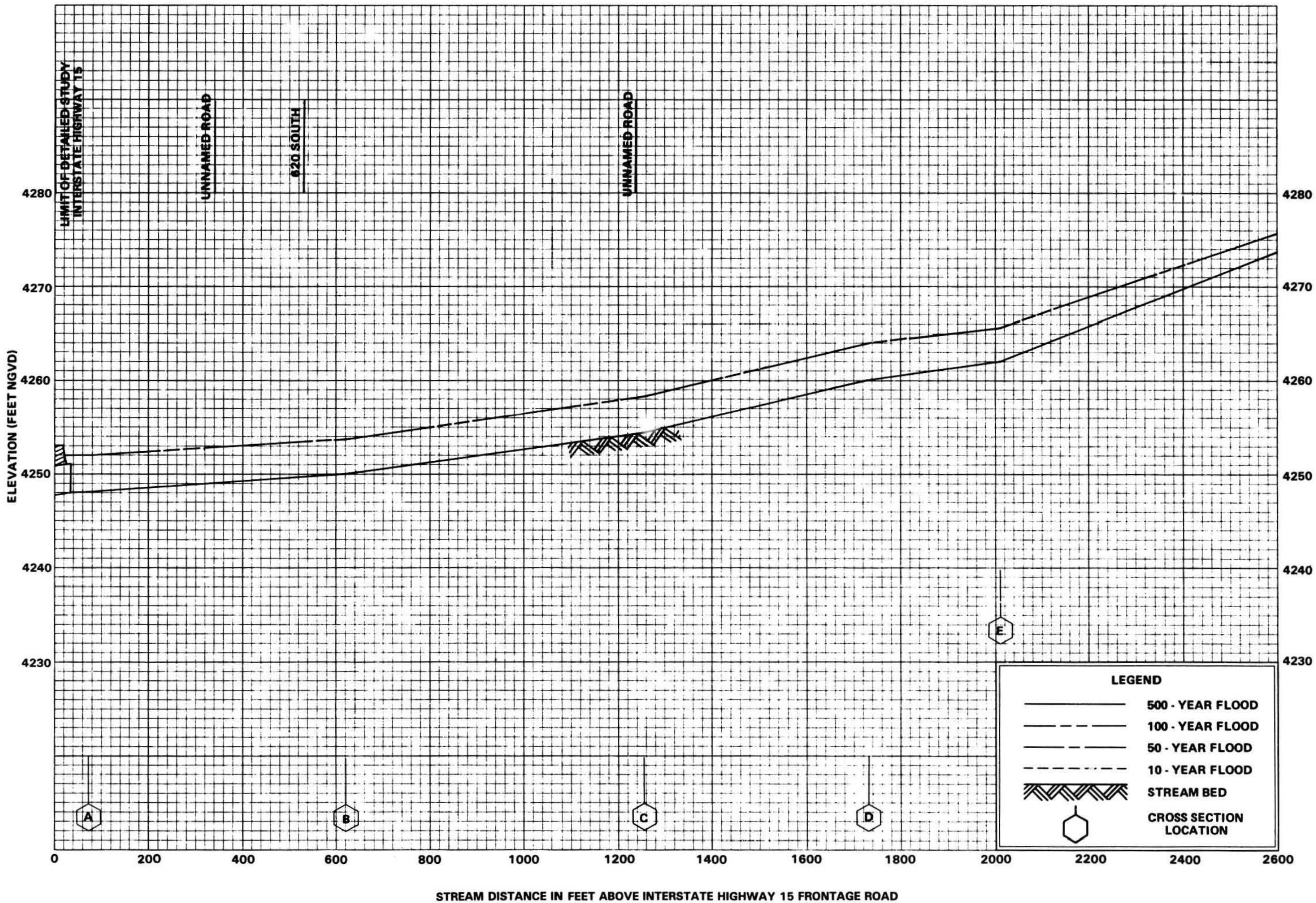
FARMINGTON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FARMINGTON, UT

(DAVIS CO.)

03P



FLOOD PROFILES

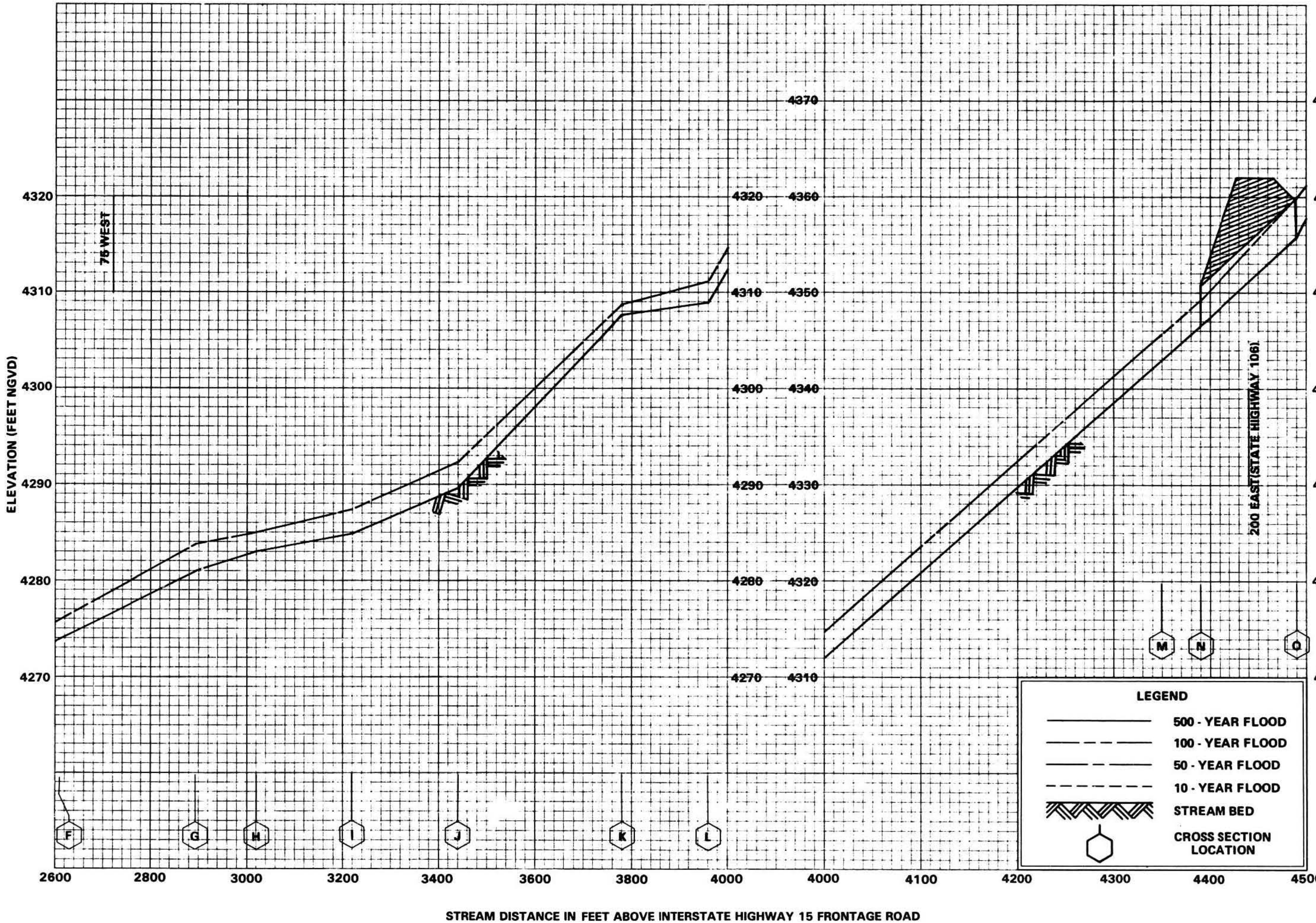
STEED CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FARMINGTON, UT

(DAVIS CO.)

04P



FLOOD PROFILES

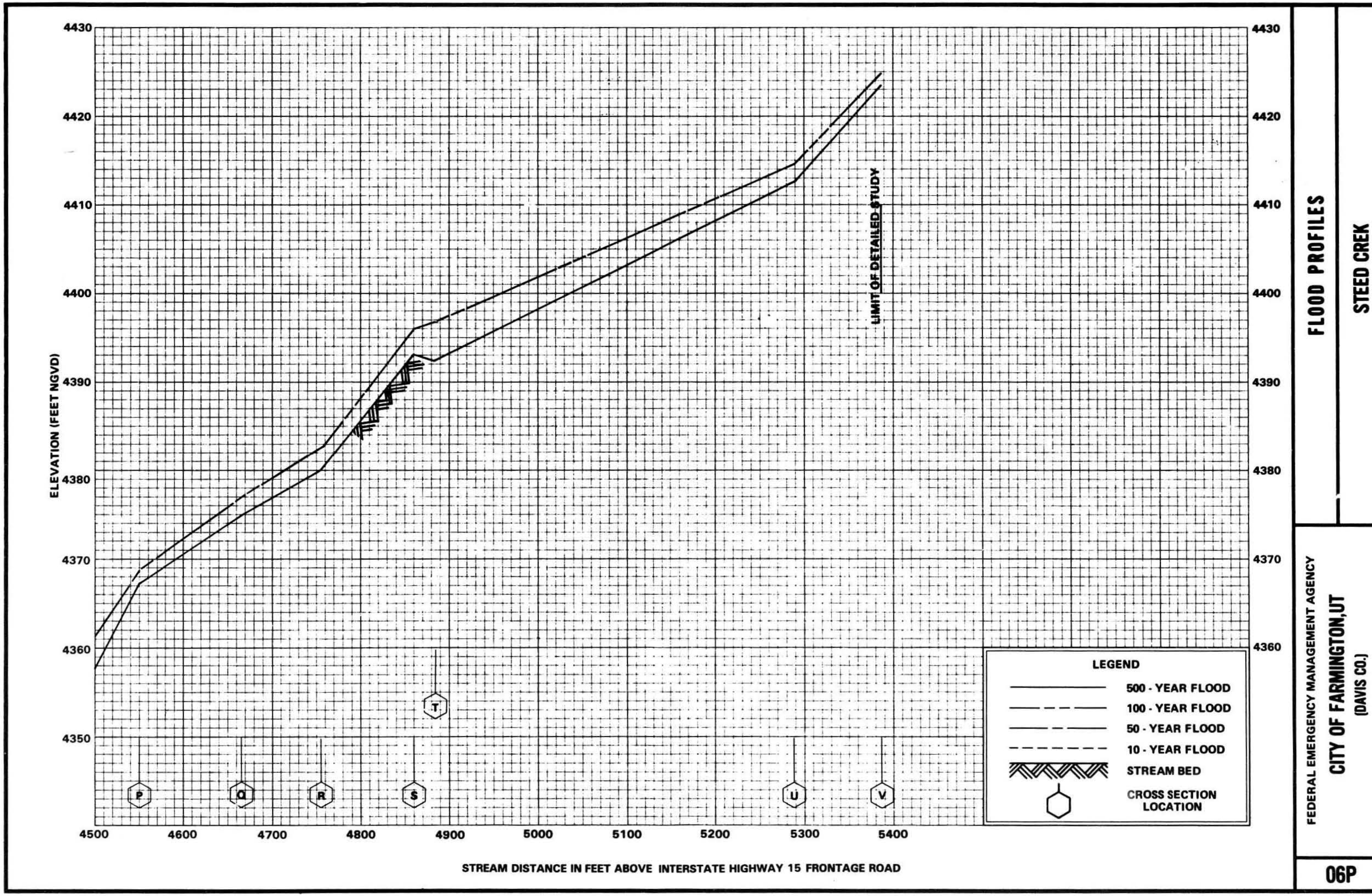
STEED CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FARMINGTON, UT

(DAVIS CO.)

05P


FLOOD PROFILES
STEED CREK
FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF FARMINGTON,UT
(DAVIS CO.)
06P
ELEVATION (FEET NGVD)
STREAM DISTANCE IN FEET ABOVE INTERSTATE HIGHWAY 15 FRONTAGE ROAD
LIMIT OF DETAILED STUDY
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
4430
4420
4410
4400
4390
4380
4370
4360
4350
4500
4600
4700
4800
4900
5000
5100
5200
5300
5400
P
Q
R
S
T
U
V