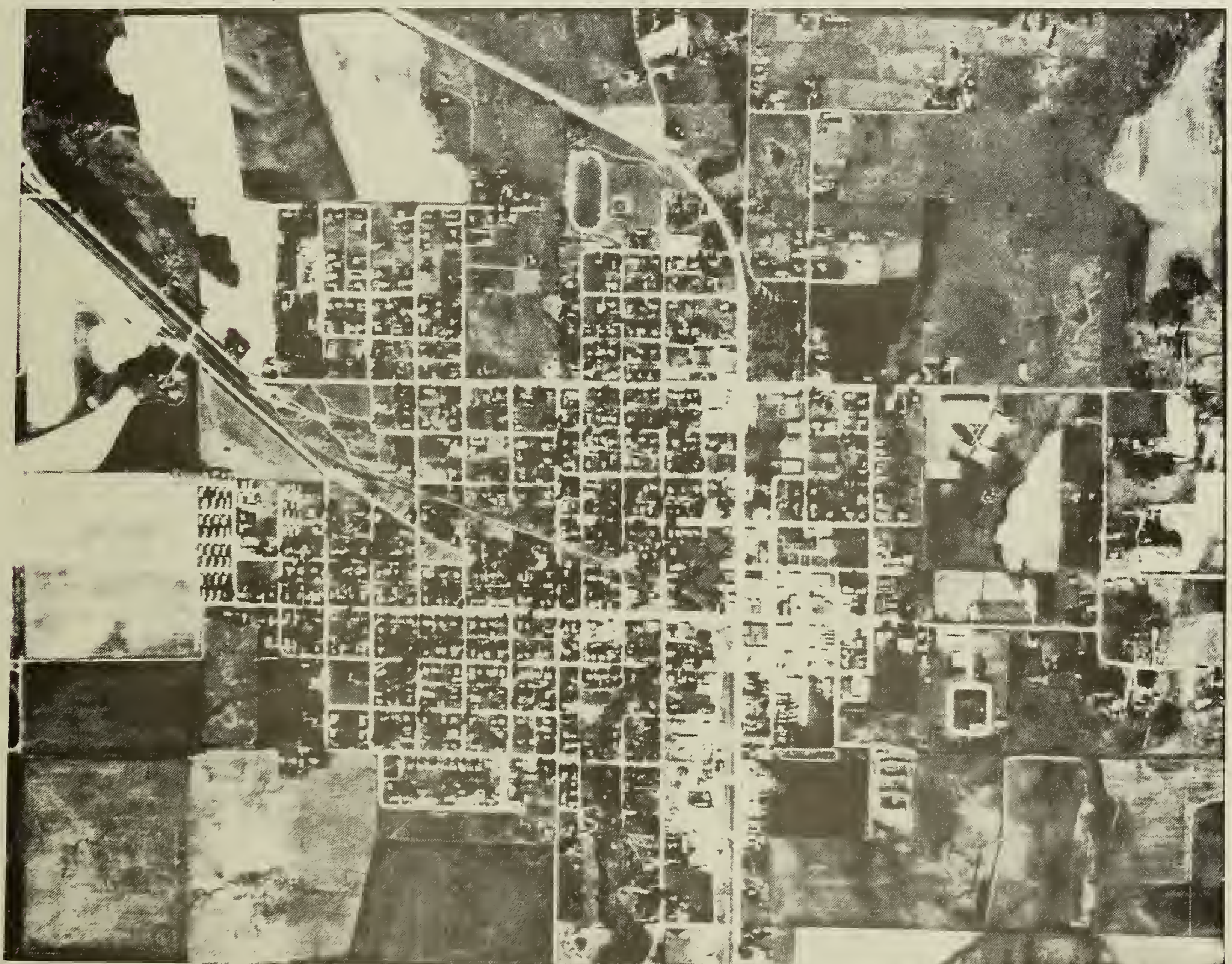
FLOOD PLAIN MANAGEMENT STUDY

CITY OF CHEWELAH

STEVENS COUNTY, WASHINGTON



IN COOPERATION WITH
CITY OF CHEWELAH

STEVENS COUNTY CONSERVATION DISTRICT

WASHINGTON DEPARTMENT OF ECOLOGY

PREPARED BY
SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

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INTRODUCTION

Need for Study

The City of Chewelah has experienced several floods in the past. This report will act as a guide in managing and planning the development of land within the city. Assistance is targeted to communities where flood damages are a serious problem and local governments are sincerely interested in taking actions to reduce present and future damages.

Requesting Authority

In January 1980 the City of Chewelah sent a request to the Office of Planning and Development, State Department of Ecology (DOE), requesting a detailed hydrologic study of the several streams within the city limits. The State DOE then asked the SCS to make the study.

The Authority for the Flood Plain Management Study

The authority for carrying out flood plain management studies is provided by Section 6 of Public Law 83-566, which authorizes the Department of Agriculture to cooperate with other federal and "with states and local agencies to make investigations and surveys of the watersheds of rivers and other waterways as a basis for the development of coordinated programs." A description of the program is covered in Subpart C of Part 621, 40 FR, 12474, March 19, 1975.

Flood studies performed by the SCS respond to recommendations in a report by the Task Force on Federal Flood Control Policy, House Document No. 465 (89th Congress, August 10, 1966), especially recommendation 9(c), "Regulation of Land Use."

In carrying out flood studies, the SCS is also responding to Executive Order 11988, "Flood Plain Management," and Executive Order 11990, "Protection of Wetlands," both effective May 24, 1977.

The priorities regarding the location and extent of such studies in Washington are established by the Washington Department of Ecology in accordance with the April 1973, Joint Coordination Agreement with the Soil Conservation Service

The Purpose of the Study

The purpose of this technical study is to provide flood hazard and other related information to the involved local governments and residents of the study area. This study provides flood frequencies, boundaries, profiles, and encroachment information. This study provides information which can assist state and local planners and officials in making wise land-use decisions regarding these flood plains.

Description of Study Area

The study area includes the corporate boundary of the City of Chewelah. It is in the Stevens County Conservation District. The area studied, shown on the study area map on page 4 , is in Hydrologic Unit 17020003. Chewelah Creek, Paye Creek and Thomason Creek are tributaries to the Colville River. Approximately 5.2 miles of stream were studied in detail to determine flood potential.

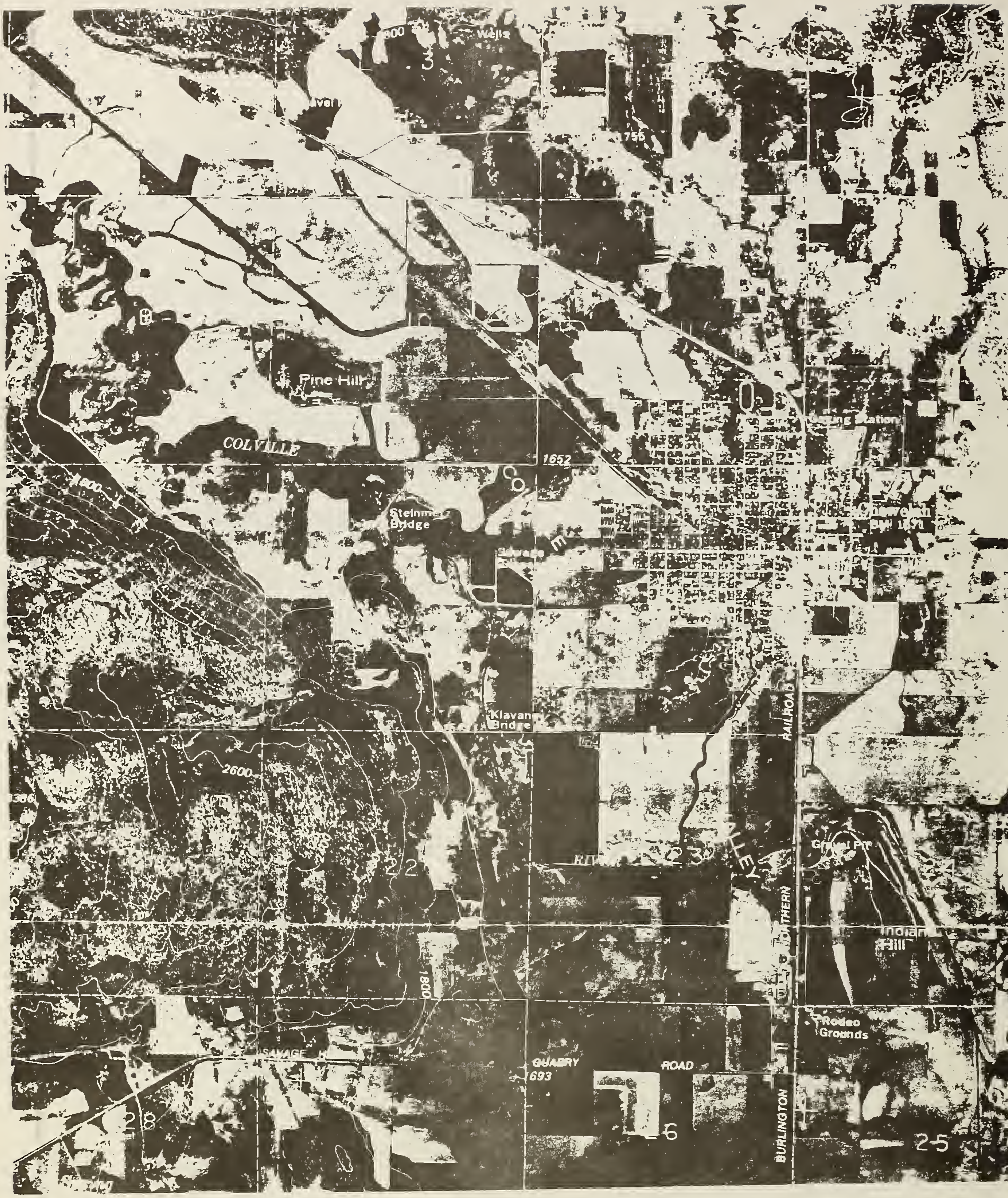
Paye Creek is a small stream draining 2.5 square miles of low lands containing pastures, cropland, small woodlands and swampy area.

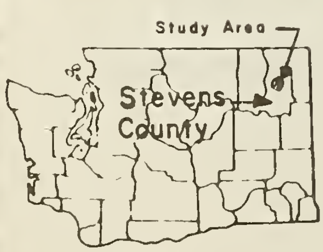
Chewelah Creek is the largest creek having a watershed of 94.1 square miles above town. This drainage area is predominately forest (94%) with some hay and pasture on the lower areas. The mean elevation is 3160 feet, with an annual precipitation of 22 inches

Thomason Creek drains 6.5 square miles including the eastern part of the city. A stream gage is located above the city limits at 4.08 square miles. This area is predominately forest (90%), while the area below the gage contains urban areas, pastures and haylands. Two small tributaries to Thomason Creek drain the majority of the city east of Third Street.

Table 1
Drainage Area of Streams at Various Locations

Stream	Location	Drainage Area Square Miles
Paye Creek	North Corporate Limits	2.0
Paye Creek	South Corporate Limits	2.5
Chewelah Creek	North Corporate Limits	94.1
Chewelah Creek	South Corporate Limits	94.7
Thomason Creek	At Flowery Trail Road	4.08
Thomason Creek	At South Corporate Limits	7.93
West Thomason Trib.	At Main Street	0.22
East Thomason Trib.	At Main Street	1.03





LOCATION MAP

STUDY AREA MAP

FLOOD PLAIN MANAGEMENT STUDY

CITY OF CHEWELAH

STEVENS COUNTY, WASHINGTON

Chewelah, with a population of 2,011, is located 46 miles north of Spokane and 22 miles south of Colville. Chewelah is located about midway of the Colville Valley.

The Colville Valley is flat bottomed and ranges from 1 mile to 3 miles in width. The valley floor is made up of water-laid deposits of considerable thickness throughout its entire length. The sides of the valley slope gradually and appear as the weathered slopes of an aggrading stream or of a youthful stream that is actively eroding its valley.

One of the most conspicuous topographic features in the central part of Stevens County is Old Dominion Mountain about 7 miles east of Colville. It has an elevation of 5,774 feet. Other lofty ridges and peaks in the same area are Old Douglas Mountain, which is northeast of Colville, and Addy Mountain, which is east of the Town of Addy. Old Douglas Mountain has an elevation of 5,245 feet, and Addy Mountain has an elevation of 4,885 feet. At the headwaters of Chewelah Creek, Calispel Peak rises to 6,837 feet, the tallest peak in the middle portion of the county. These mountains are isolated from the main ranges by minor stream valleys.

Precipitation in summer falls as showers, although some thunderstorms occur. The gound is covered with snow much of the time in winter. However, warm and dry chinook winds blow downslope and often cause rapid snowmelt and subsequent runoff.

In winter the average temperature is 28 degrees F, and the average daily minimum temperature is 21 degrees.

In summer the average temperature is 65 degrees, and the average daily maximum temperature is 82 degrees. The highest recorded temperature, which occurred at Colville on July 18, 1960, is 107 degrees.

Annual precipitation at Chewelah is 19.8 inches. Of the total annual precipitation, 7 inches, or 40 percent, generally falls in April through September. Table 2 gives the monthly distribution of annual precipitation.

Table 2
Average Monthly and Annual Precipitation (inches)

Station	Elevation	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Chewelah 2S	1,635	2.25	1.83	1.70	1.29	1.67	1.58	0.64	0.59	1.08	1.85	2.34	2.73	19.32

Flood Plains

Historic settlement in the flood plains have been on low terraces slightly above the normal flooding of the Colville River.

Chewelah, Paye and the west boundary of Thomason Creeks have been developed for homesites nearly their entire length through Chewelah. Many homesites have landscaped and/or riprapped the channels. The eastern branch and main Thomason Creek are relatively undeveloped.

Flood History

Newspaper records have been researched back to 1903. Flooding was reported in 1904, 1927, 1953, 1956, 1960, and 1974. There was no estimate of damage found, although it was noted that some damage was done to roads and bridges.

"According to the reports, the first recorded instance of high water occurred April 22, 1904, when a big runoff put the Colville River out of its banks. Most of the damage was confined to the area from Blue Creek north to Colville, but there was high water experienced in the Chewelah area, although no damage was reported.

"The next high water was reported in October of 1927 after 6.25 inches of rain fell during the month of September. There was minor flooding in the Chewelah area and some damage to the Bulldog Creek Electric Company installation south of town near Valley.

"On April 30, 1953, heavy rains flooded the lowland farms along the Colville River. Thirty to forty acres were flooded northwest of Chewelah and there was some high water recorded in town.

"On April 14, 1956, 70°F. plus temperatures melted the snowpacks in the surrounding drainage basins causing Chewelah Creek to overflow its banks. The 42" culverts under Highway 395 at Webster and Park and at Main and Second Street were insufficient to handle the water causing flooding around City Hall and the surrounding properties. At this time many places were flooded and water was up over the lawns of property in the flood plain area adjacent to the creek. The two footbridges in the park were washed out and the bridge on Lincoln Avenue had to be closed for several days. One section of Second Street south of Main was swept out. Two other bridges were washed out on the North Fork of Chewelah Creek. In this particular newspaper article it was indicated that this was the second flood in Chewelah's history, the first being in May 1948. However, in the edition of the Chewelah Independent of May 27, 1948, the only story referred to approximately 20,000 acres in the Colville Valley being under water and therefore we can assume that some of the area in the Chewelah vicinity was flooded. In this major flood of 1956 it was indicated that the overflow problem was created almost entirely from runoff in the Sand Canyon area. Apparently the South Fork of Chewelah Creek had a normal runoff.

"On May 29, 1960, the water in Chewelah Creek rose 9" and reached its peak on May 30, forcing out a retaining wall in Chewelah and washing out one section of the road in Burnt Valley completely. In Chewelah proper there was no serious damage since the culverts had been replaced after the 1959 flood, (which for some reason was not mentioned in the Chewelah Independent in 1959 and the only reference to flooding at that time was in this 1960 article).

"The January 24, 1974, edition of the paper indicates that early in the week heavy snows, followed by chinook winds caused flooding. The Wrights Valley road washed out and the water came up over 395 at City Hall and traveled down the adjacent streets. By January 23, the city park was entirely underwater and water was over the bridges on East Lincoln, Webster and 395. There was flooding at the intersections of Main Avenue and Second Street and at King and Second. Some flooding in basements was reported." /1.

/1. Letter dated 4/19/82 from William D. Weaver, Public Works Director City of Chewelah.

Chewelah Creek had a stream gage from 1957 to 1975, Table 3 shows the peak flows measured.

Table 3
Peak Flow Chewelah Creek (Gage 12407700)

Year	CFS	Year	CFS	Year	CFS
1957	191	1964	75	1971	188
1958	259	1965	222	1972	134
1959	153	1966	78	1973	136
1960	355	1967	162	1974	392
1961	308	1968	77		
1962	106	1969	257		
1963	153	1970	83		

From the watershed area of 94.1 square miles, high waters have historically come from snowmelt alone or snowmelt accompanied by a rain and chinook wind. Some overbank flows occur as a result of ice blocking culverts.

Thomason Creek also has a stream gage. Records were kept from 954 to 1973 as shown in Table 4.

Photo showing flooding near city hall at the corner of Highway 395 and Webster Avenue.

Table 4
Peak Flows Thomason Creek (Gage 12407600)

Date	Peak Discharge (CFS)	Date	Peak Discharge (CFS)
1954	3.7	1964	5.0
1955	5.4	1965	6.2
1956	5.8	1966	4.5
1957	7.0	1967	4.8
1958	8.0	1968	4.0
1959	6.9	1969	4.6
1960	12.9	1970	4.4
1961	7.0	1971	4.8
1962	14.2	1972	4.6
1963	11.0	1973	6.8

Natural and Beneficial Flood Plain Values

Land use in the flood plain is mainly agriculture and urban development. Small, scattered areas of wetlands, uplands and woodlands are also present.

Vegetation along the creek in the undisturbed areas includes redosier dogwood, golden willow, cottonwood, alder and nightshade. These areas are small, narrow lands that provide wildlife habitat as well as aesthetic values. The remaining areas adjacent to the creek have been cleared for urban landscaping purposes. Vegetation in these areas include Engleman's spruce, bluegrass, quack grass and ornamental species.

Undisturbed stretches of the creek have beaded areas of cattails, sedges, reed canary grass, water hemlock and watercress. Other stretches have been influenced by landscaping techniques, such as rock riprap, concrete banks, and grading and shaping of the streambanks. These stretches of the creek have limited vegetation if any. Some of these areas also have accelerated bank erosion due to the lack of adequate vegetation.

Wetlands in the flood plain are high water table, Type 2. These wetlands are presently undisturbed and provide excellent habitat for upland game and non-game species. Urbanization, however, is encroaching upon these wetlands and their value to wildlife will obviously decrease.

Vegetation in the flood plain includes introduced pasture grasses, worm wood, tansy, golden rod, quack grass, aspen, brome grass, and stinging nettle.

Recreational values of the flood plain include activities that are associated with non-game and game wildlife species, fishing, cross country skiing, bird watching, and picnicking.

Wildlife species common to the area include pheasants, quail, white tailed deer, coyote, beaver and song birds. The fisheries of the creek include German and brown trout.

Soils within the flood plain area in Chewelah are all on the list as prime agricultural lands. These soils include Chewelah fine sandy loam, Hodgson silt loam, Chamokane loam and Peone silt loam. These soils are deep

ANALYSIS

Data Sources

Basic data in this study include U. S. Geological Survey (USGS) topographic maps, bench mark and streamflow records. Survey bench mark information was also provided by the Washington State Department of Highways.

High water marks were provided by landowners and field estimates of survey crews. Survey crews provided valley cross-section information at all bridges and valley areas along with bridge and culvert opening information.

Precipitation data came from U. S. Department of Commerce NOAA Atlas 2 and soils data from the Stevens County Soil Survey Report, SCS.

Methodology

The data in Tables 3 and 4 was used to compute a Log Pearson Type III frequency analysis by USGS.

With only minor areas within the City of Chewelah contributing water to Chewelah Creek the gage data was used with no modifications for the hydrology. For the other streams a TR-20 computer hydrology model was compiled. This model utilized data gathered by field surveys, soils information, land use, and precipitation records to compute flow data for 10-, 50-, 100- and 500-year events.

The second portion of the SCS model (WSP-2) forecasts the hydraulics of the streams based upon the physical characteristics of the channel and overbank flow. High water marks establised during the field surveys were used to check the resulting water surface profiles.

These water surface profile elevation-discharge relationships were used to establish elevations for the various events at each of the surveyed cross-sections. Flood lines were located between valley cross-sections by use of the topographic maps, stereoscopic interpretation of aerial photographs and field flood plain mapping and by historical records of high water marks.

Water surface profile computations at bridges are based upon present normal bridge openings. Consideration was not given to possible blockage of the openings by sediment or debris.

The first two portions of the SCS computer model were used to simulate the 10-, 50-, 100- and 500-year frequency flood events. However, only the 100-year flood event was delineated on the flood hazard photo and the 10-, 50-, 100- and 500-year flood events on the profiles. Water surface elevations and peak discharges for all the above flood frequencies analyzed are provided (see Table 5).

The third portion of the hydraulic study model, TR-64 provides changes in the 100-year water surface elevation due to filling or other encroachments in the flood plain. A theoretical floodway for the streams was computed which applies a normal reduction in the 100-year frequency flooded area, based on equal reduction in flood conveyance on both sides of the channel. It is strictly an engineering computation and does not include any economic, legal or social consider ations. When the theoretical encroachment causes a change in the water surface profiles of more than one foot, this marks the inner limit of the floodway fringe and no further encroachment should be allowed without serious consideration of the resulting increased flood levels.

Table 6 lists the present channel width and left and right overbank widths determined by the floodway analysis.

The Washington State Department of Ecology and the Soil Conservation Service will, upon request, provide technical assistance to local, state or federal agencies and organizations in the interpretation of information developed in this study.

RESULTS OF THE ANALYSIS HAZARDS OF LARGE FLOODS

A flood having an average frequency of occurrence of once in 100-years (a one percent chance of being equaled or exceeded in any given year) was selected as the base flood for reference purposes. The area flooded by the 100-year frequency flood was assumed to reflect the present flood hazard in the study area. The selection is based upon the recommendation of the U. S. Water Resource Council "Flood Hazard Evaluation Guidelines for Federal Executive Agencies." May 1972

The 10-, 50-, 100- and 500-year water surface elevations, discharges, and the channel bottom at each cross-section are shown on Table 6. The approximate areas flooded by the 100-year flood, under existing conditions are shown on plates 2 through 8.

Hydraulic studies of the streams were done assuming that all hydraulic structures (bridges and culverts) would be free of debris when the high waters came. Using this assumption, flooding from the 1% event would be limited to damage to roads and bridges, with a few structures on Park Street having water on the first floor. It was assumed that most flood events in the past are associated with some type of channel obstruction, such as ice at the bridges, beaver dams, and accumulated gravel bars.

84 acres were determined to be subject to inundation by the 100-year flood in the study area. Trash and debris may cause an increase in flood elevations. Gravel bars may develop which will raise the channel bottom and reduce the channel flow area. The profiles shown are for existing conditions with bridges considered open.

Floodways

Encroachment on flood plains such as buildings and fills reduce the flood-carrying capacity and increase flood heights. This increases the flood hazard in areas above and below the encroachment. One realistic aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard and potential damage.

Table 5

Water Surface Elevations and Discharges
Chewelah Creek

Cross Section No.	Channel Bottom Elevation	Frequency*			
		10-year	50-year	100-year	500-year
CC-1	1653.2	1656.0 / 317	1656.8 / 462	1657.0 / 526	1657.6 / 680
CC-2	1656.8	1660.0 / 317	1660.8 / 462	1661.5 / 526	1662.1 / 680
CC-3	1657.9	1660.7 / 317	1661.5 / 462	1662.0 / 526	1662.7 / 680
CC-4	1658.9	1663.4 / 317	1664.5 / 462	1665.0 / 526	1665.8 / 680
CC-5	1664.5	1669.2 / 317	1669.6 / 462	1669.7 / 526	1669.9 / 680
CC-6	1667.2	1669.6 / 317	1670.1 / 462	1670.2 / 526	1670.5 / 680
CC-7	1669.3	1672.1 / 317	1672.6 / 462	1672.8 / 526	1673.3 / 680
CC-8	1676.6	1680.5 / 317	1680.9 / 462	1681.0 / 526	1681.2 / 680
		Paye Creek			
PC-1	1649.2	1651.8 / 79	1652.7 / 152	1652.9 / 183	1653.6 / 261
PC-2	1656.6	1658.2 / 79	1658.7 / 152	1658.9 / 183	1659.0 / 261
PC-3	1664.1	1665.9 / 81	1666.6 / 154	1666.9 / 186	1667.2 / 265
PC-4	1669.7	1672.4 / 81	1672.6 / 154	1673.0 / 186	1673.3 / 265
PC-5	1677.4	1679.5 / 87	1679.9 / 161	1680.0 / 193	1680.3 / 269

*Elevation--Mean Sea Level Feet/Discharge cfs

Table 5

Water Surface Elevations and Discharges
Thomason Creek

Cross Section No.	Channel Bottom Elevation	Frequency*			
		10-year	50-year	100-year	500-year
TC-1	1649.1	1653.6 / 86	1654.6 / 180	1655.9 / 233	1656.8 / 298
TC-2	1655.6	1658.1 / 90	1658.6 / 184	1658.9 / 246	1659.0 / 315
TC-3	1657.1	1658.7 / 90	1659.3 / 184	1659.6 / 246	1659.8 / 315
TC-4	1662.3	1663.0 / 38	1663.5 / 95	1663.8 / 140	1664.0 / 175
West Fork Thomason Creek					
WTC-1	1660.6	1661.9 / 19	1662.0 / 32	1662.1 / 39	1662.2 / 46
WTC-2	1665.3	1667.6 / 19	1667.6 / 33	1667.7 / 41	1667.7 / 48
WTC-3	1667.2	1671.5 / 25	1671.6 / 39	1671.6 / 46	1671.7 / 54
East Fork Thomason Creek					
ETC-1	1657.6	1658.7 / 35	1659.3 / 64	1659.4 / 81	1659.8 / 98
ETC-2	1680.7	1681.8 / 38	1682.1 / 66	1682.1 / 82	1682.2 / 100

*Elevation--Mean Sea Level Feet/Discharge cfs

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
Cross Section	1/ Distance	Width (Ft.)	Section Area (Sq.Ft.)	Mean Velocity (F.P.S.)	With Floodway (NGVD)	Without Floodway (NGVD)	Difference (Ft.)
Chewelah Creek							
CC-1	1150	24	93	5.68	1658.0	1657.0	1.0
CC-2	2020	23	102	5.15	1662.5	1661.5	1.0
CC-3	2280	21	100	5.27	1663.0	1662.0	1.0
CC-4	2590	45	209	2.51	1666.0	1665.0	1.0
CC-5	3520	43	160	3.30	1670.7	1669.7	1.0
CC-6	3760	53	159	3.30	1671.2	1670.2	1.0
CC-7	4400	39	112	4.7	1673.8	1672.8	1.0
CC-8	5760	60	177	2.97	1682.0	1681.0	1.0
Paye Creek							
PC-1	744	33	63	2.89	1653.9	1652.9	1.0
PC-2	1422	19	44	4.17	1659.9	1558.9	1.0
PC-3	2800	19	59	3.15	1667.9	1666.9	1.0
PC-4	3881	13	41	4.48	1674.0	1673.0	1.0
PC-5	5699	18	47	4.15	1681.0	1680.0	1.0

1/ From city limits.

Table 6

CHEWELAH FLOOD HAZARD STUDY

FLOODWAY TABLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
Cross Section	1/ Distance	Width (Ft.)	Section Area (Sq.Ft.)	Mean Velocity (F.P.S.)	With Floodway (NGVD)	Without Floodway (NGVD)	Difference (Ft.)
Thomason Creek							
TC-1	0	171	558	.31	1656.9	1655.9	1.0
TC-2	1038	25	71	3.45	1659.9	1658.9	1.0
TC-3	1338	29	65	3.76	1660.6	1659.6	1.0
TC-4	2038	44	159	.83	1664.8	1663.8	1.0
West Fork Thomason Creek	2/						
WTC-1	902	9	15	2.53	1663.1	1662.1	1.0
WTC-2	1690	83	106	.39	1668.7	1667.7	1.0
WTC-3	2410	47	101	.45	1672.6	1671.6	1.0
East Fork Thomason Creek							
ETC-1	00	17	28	2.89	1660.4	1659.4	1.0
ETC-2	2810	9	20	4.14	1683.1	1682.1	1.0

1/ Distance from city limits.
2/ Distance from confluence with Thomason Creek.

CHEWELAH FLOOD HAZARD STUDY

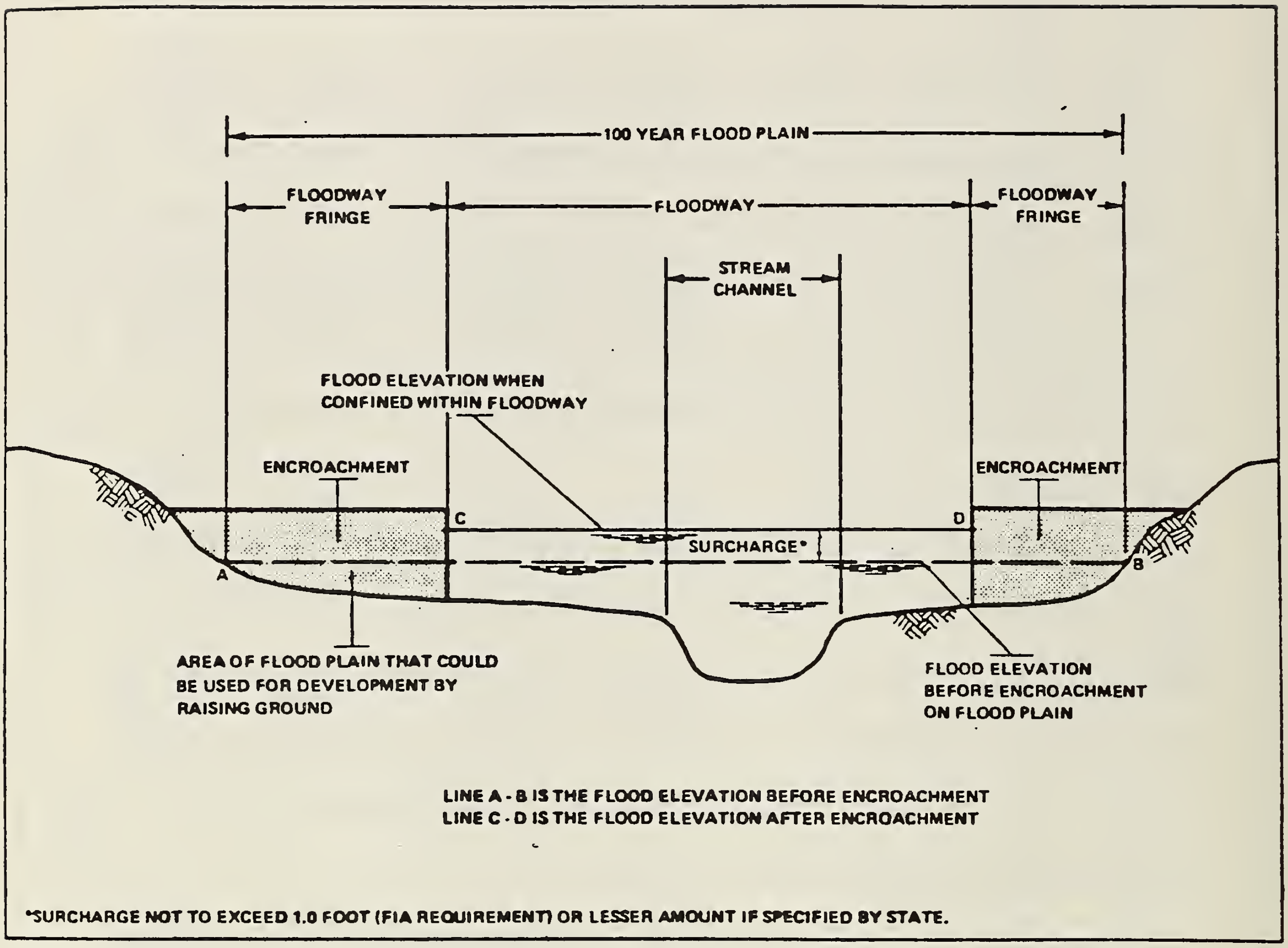
FLOODWAY TABLE

Table 6

The concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area inundated by the 100-year flood is divided into "floodway" and "floodway fringe" areas. The floodway is the channel of a stream plus any adjacent flood plain area that must be kept free of encroachment in order that the 100-year flood is carried within a 1 foot maximum increase in flood elevation.

The area between the designated floodway and the original boundary of the 100-year flood is called the floodway fringe. This fringe comprises the portion of the flood plain that could be completely obstructed without raising the water surface of the 100-year flood more than one (1) foot. Typical relationship between the floodway and the floodway fringe are shown in Figure 2.

Regulations enacted by Federal Insurance Administration (FEMA) limit such increases in flood heights to a maximum of one foot, provided hazardous velocities are not produced. Diking is considered an encroachment on the flood plain the same as filling. Diking should only occur in the floodway fringe area.



FLOODWAY SCHEMATIC FIGURE 2

Diking is considered an encroachment on the flooplain the same as filling. Diking should only occur in the floodway fringe area.

Recommendations

Some specific recommendations are being made here to assist the city in developing an effective flood plain management program.

1. Adopt a building permit system that recognizes special requirements for building in a floodway fringe area.
2. Require flood proofing of existing commercial buildings in the flood plain.
3. Zone flood plain for uses compatible with occasional flooding.
4. Assess the possibility of acquiring federal money to purchase flood plain for public recreation areas or wildlife habitat.
5. Continue in the Flood Insurance Program of the Federal Insurance Administration (FEMA).
6. Adopt a regulatory floodway.

In this report, floodways are suggested to the local government as minimum standards for their use in developing flood plain management plans.

FLOOD PLAIN MANAGEMENT OPTIONS

Proper management of the flood plain can minimize flood damage losses in most flood hazard areas. Several management options are available that could be used by local governments and individual landowners to improve management of the flood plain. This section discusses those options on a conceptual basis, and summarizes the potential for reducing flood damages in the Chewelah flood hazard area.

Existing Options

Existing flood plain management options include enrollment in the emergency flood insurance program and individual efforts by a few landowners at building floodwalls and dikes to exclude floodwater from their property. Flood insurance, in itself, does not directly prevent flood losses, but by encouraging communities to adopt building codes and management regulations, may help avert future losses. However, in order to establish sound building codes and management regulations, the hydraulic characteristics of the flood hazard area should be known. These characteristics are normally not developed under the emergency program making enforcement of emergency flood plain regulations difficult. However, enrollment in the emergency flood insurance program makes it possible for flood plain residents to be partially reimbursed for flood losses sustained. Individual efforts at flood plain management in the Chewelah flood hazard area are directed toward protecting individual homes. Unless highly intensified and enforced, these efforts have a low potential for reducing flood damages in the Chewelah flood hazard area.

Critical Area Treatment

Critical area treatment consists of applying conservation land treatment practices to bare or poorly vegetated areas to reduce runoff, erosion, and sedimentation of stream channels. Proper vegetation reduces runoff and erosion several ways. Rainfall penetrates open spaces around roots, being absorbed by the plants and stored in a humus layer formed by decaying organic material. Some of this absorbed rainfall is used to process soil nutrients into plant food and then transpired into the atmosphere, thus reducing runoff. Vegetation protects the soil from the impact of raindrops while the root system binds the soil together reducing erosion and sediment.

Most of the Chewelah drainage area is properly covered with trees and grass, with less than five percent bare or partially vegetated. Critical areas consist primarily of improperly vegetated surface mines and access roads, overgrazed pastures, and dirt roads (farm road and jeep trails) located on steep hillsides.

Treating these areas by planting trees and grasses, applying lime and fertilizer, and using correct management may reduce runoff about one percent.

Nonstructural Measures

Nonstructural measures are flood protection techniques, normally applied to individual buildings, that differ from the conventional flood protection methods such as dams, dikes, and channel work generally used to protect groups of buildings. Nonstructural measures include the following: (1) acquisition, (2) relocation, (3) floodproofing, (4) flood warning, and (5) flood insurance. There are 19 commercial buildings that could be protected by nonstructural measures.

(1) Acquisition and (2) Relocation - These options are expected to have a low potential for implementation because of its high cost, adverse social impacts, and unpopularity with local landowners.

(3) Floodproofing - Floodproofing consists of elevating buildings above the 100-year frequency flood by jacking up the building and extending the height of the foundation and plumbing; sealing low openings and porous foundation walls; and intentionally flooding buildings to equalize hydrostatic pressures and prevent wall collapse.

(4) Flood Warning - A flood warning system normally consists of National Weather Service weather monitoring, a recording gage to monitor runoff, a flood watch, flood warning, and evacuation plan. The limiting factor in a flood warning system for the Chewelah flood hazard area would probably be the warning time available.

Warning time is a product of the hydrologic and hydraulic characteristics of the drainage area upstream from the flood hazard area. Maximum anticipated warning time is 30 minutes or less which may render a flood warning system ineffective for protecting the Chewelah flood hazard area. Because of the limited warning time, a flood warning system for this area would have a low potential for reducing flood damages, but may provide time for local residents to reach safety in very hazardous situations.

(5) Flood Insurance - Stevens County is participating in the flood insurance program ; however, the preparation of insurance rates and flood plain management regulations has been delayed by the lack of detailed hydrologic and hydraulic data. Hydraulic data developed during this study may be sufficient for use in preparing insurance rates and management regulations for the flood insurance program.

The Chewelah flood hazard area is highly developed containing 58 buildings that would experience some degree of flooding from a 100-year frequency flood. If hydraulic structures should fail in the near future, flood insurance could reimburse owners for flood damage losses they sustain, while associated management regulations could guide future improvements to avoid developments that would be flood prone. It is anticipated that flood insurance, with a good educational program to acquaint local landowners with its advantages, would have a high potential for implementation.

Structural Measures

Structural measures were not considered for analysis of flood plain options. Such measures as dams, channel work, enlarging bridges, culverts and dikes could provide protection along the streams.

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Channel - A natural or artificial water course of perceptible extent with definite bed and banks to confine and conduct continuously or periodically flowing water.

Encroachment - The act of advancing development into the flood plain beyond the flood hazard boundary.

Flood - An overflow of lands not normally covered by water and that are used or usable by man. Floods have two essential characteristics: the inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water. Normally a "flood" is considered as any temporary rise in streamflow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased streamflows, and other problems.

Flood Frequency - A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative streamflow or rainfall and runoff records. It is customary to estimate the frequency with which specific flood stages or discharges may be equalled or exceeded, rather than the frequency of an exact stage or discharge. Such estimates by strict definition are designated "exceedence frequence," but in practice the term "frequency" is used. The frequency of a particular stage or discharge is usually expressed as occurring once in a specified number of years. Also see definition of "Recurrence interval."

10-year Flood - A flood having an average frequency of occurrence in the order of once in 10 years. It has a 10 percent chance of being equalled or exceeded in any given year. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the general region of the watershed.

100-year Flood - A flood having an average frequency of occurrence in the order of once in 100 years. It has a 1 percent chance of being equalled or exceeded in any given year. This flood is comparable to the "Intermediate Regional Flood" used by the U.S. Army Corps of Engineers. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the general region of the watershed.

<u>Rare Flood</u> - The flood that may be expected from a combination of meteorological and hydrological conditions that are considered extreme but reasonable for that geographical area, excluding extremely unlikely conditions. It may be considerably larger than any flood that has occurred in the watershed. However, an even larger and more severe flood can, and probably will, occur.

For the purpose of this study, it is considered to have an approximate average frequency of occurrence in the order of once in 500 years although the flood may occur in any given year. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the general region of the watershed.

<u>Flood Peak</u> - The highest stage or discharge attained during a flood event; also referred to as peak stage or peak discharge.

<u>Flood Plain</u> - The relatively flat area or lowlands adjoining the channel of a river, stream or watercourse or ocean, lake, or other body of standing water, which has been or may be covered by floodwater.

<u>Flood Profile</u> - A graph showing the relationship of water surface elevation to stream channel location. It is generally drawn to show surface elevation for the peak of a specific flood, but may be prepared for conditions at a given time or stage.

<u>Flood Stage</u> - The elevation of the overflow above the natural banks of a stream or body of water sometimes referred to as the elevation at which overflow begins.

<u>Flood Storage</u> - The difference in the volume of storage between the initial base flow elevation and the flood peak elevation, measured for a specific area.

<u>Floodway</u> - The channel of the stream and those portions of the flood plain which are required to carry and discharge floodwater of a 100-year event with no more than a 1.0 foot increase in water surface elevation due to encroachment.

Floodway Fringe - That area of the flood plain lying outside the floodway but within the flood plain. Without land fills, the area will be inundated by floodwater that provides backwater storage.

High Water Mark (HWM) - The maximum observed and recorded height or elevation that floodwater reached during a storm, usually associated with the flood peak. The high water mark may be referenced to a particular building, bridge or other landmark, or based on debris deposits on bridges, fences or other evidence of the flood.

Recurrence Interval - The average interval of time, based on a statistical analysis of actual or representative streamflow records, which can be expected to elapse between floods equal to or greater than a specified stage or discharge. Recurrence interval is generally expressed in years. Also see definition of "Flood Frequency."

Runoff - That part of precipitation, as well as any other flow contributions, which appears in surface streams of either perennial or intermittent form.

Stream Channel - A natural or artificial water course of perceptible extent, with definite bed and banks to confine and conduct continuously or periodically flowing water.

Stream Channel Bottom - The lowest part of the stream channel (either in a constructed cross section or a natural channel). Bottom elevations at a series of points along the length of a stream may be plotted and connected to provide a stream bottom profile.

Stream Channel Flow - That water which is flowing within the limits of a defined water course.

Watershed - A drainage basin or area which collects runoff and transmits it usually by means of streams and tributaries to the outlet of the basin.

Watershed Boundary - The divide separating one drainage basin from another.

Wetland - Areas where the water table is at or near the surface of the ground and the soil remains wet for more than seven months of each year. Wetlands include swamps, marshes and wet meadows.

APPENDIX B

LIST OF TBM'S

TBM No.	Elevation NGVD	Location
1	1673.3	Top of fire hydrant at corner of 1st Street and Webster Avenue
3	1674.23	Top of fire hydrant at corner of Webster Avenue and 4th Street
5	1666.53	Top of fire hydrant at corner of King Street and Center Street
6	1662.07	Top of fire hydrant at corner of King Street and Bernard Street
8	1653.75	Top of water meter cover 80'± southwest of intersection of West and Court Streets
9	1663.41	On rim of fire hydrant (.5± below top of turn bolt) at intersection of Kruger Street and Roberts Street
10	1665.87	Top of fire hydrant at intersection of Roberts and Stevens Streets
11	1688.04	Top of fire hydrant at intersection of Grant Avenue and 4th Street
15	1699.95	Top of south end of south most CMP at intersection of Pay Creek and Highway 395
14	1683.49	Top of west most guard post on south side of Burnt Valley Road (Grant Ave.) at Highway 395 and Chewelah Creek
BM H24	1671.165	USGS BM at City Hall corner of Park Street and Webster Avenue
16	1686.64	Top of fire hydrant at east entrance to Elementary School on East Lincoln Street
17	166.52	On northeast corner of bottom step of house No. E. 802 Main Street (south of road)
18	1665.77	Top of curb at southeast corner of sidewalk at King and 5th Street East

APPENDIX B

LIST OF TBM'S

TBM No.	Elevation NGVD	Location
19	1664.16	Top of concrete foundation for fireplace on east end of house 770' south of Quartzel Blvd.
20	1662.97	On lip of hydrant (.5± below top bolt) on east side of apartments on 6th Street East 1300' south of Main Street
21	1678.20	Top of fire hydrant at the intersection of Webster Avenue and 5th Street East

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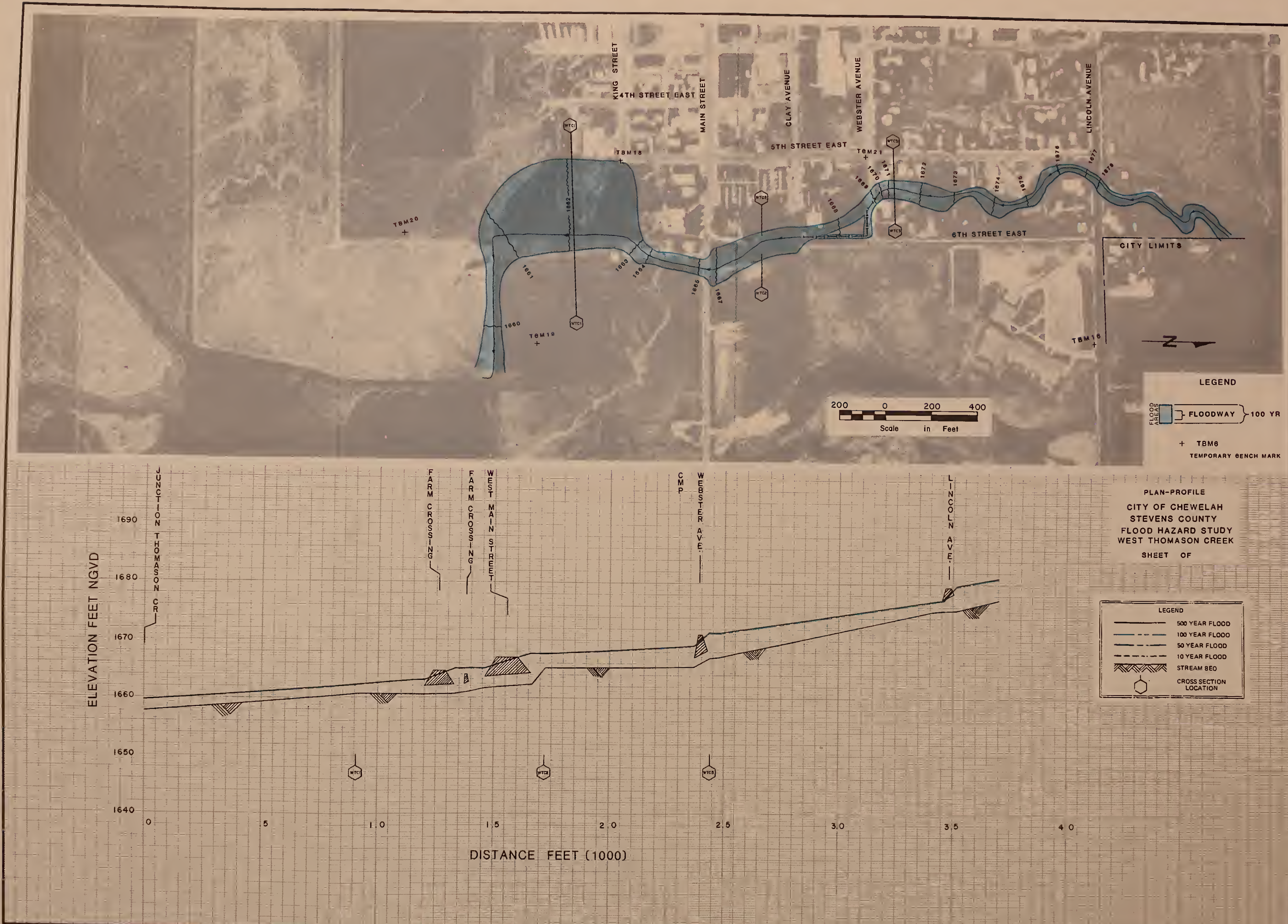
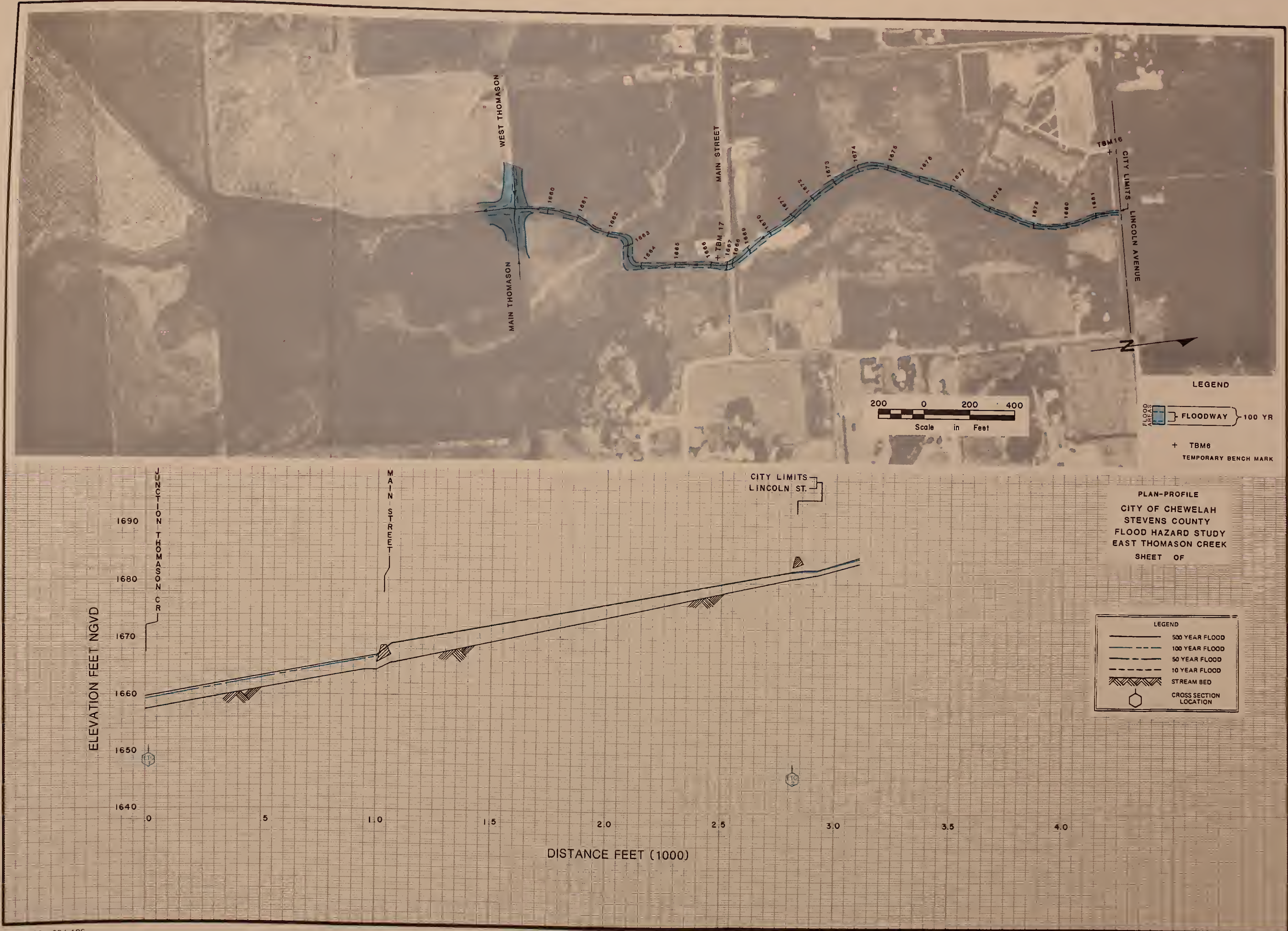

KING STREET
4TH STREET EAST
MAIN STREET
CLAY AVENUE
WEBSTER AVENUE
LINCOLN AVENUE
5TH STREET EAST
6TH STREET EAST
CITY LIMITS
TBM18
TBM19
TBM20
TBM21
TBM16
Scale in Feet
LEGEND
FLOODWAY
100 YR
TBM6
TEMPORARY BENCH MARK
JUNCTION THOMASON CR
FARM CROSSING
FARM CROSSING
WEST MAIN STREET
CMP
WEBSTER AVE.
LINCOLN AVE.
ELEVATION FEET NGVD
DISTANCE FEET (1000)
PLAN-PROFILE
CITY OF CHEWELAH
STEVENS COUNTY
FLOOD HAZARD STUDY
WEST THOMASON CREEK
SHEET OF
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION


WEST THOMASON
MAIN THOMASON
MAIN STREET
+ TBM 17
TBM16
CITY LIMITS
LINCOLN AVENUE
200 0 200 400
Scale in Feet
LEGEND
FLOOD AREAS
FLOODWAY
100 YR
+ TBM8
TEMPORARY BENCH MARK
JUNCTION THOMASON CR
MAIN STREET
CITY LIMITS
LINCOLN ST.
PLAN-PROFILE
CITY OF CHEWELAH
STEVENS COUNTY
FLOOD HAZARD STUDY
EAST THOMASON CREEK
SHEET OF
ELEVATION FEET NGVD
DISTANCE FEET (1000)
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION