# MAMMOTH LAKES STORM DRAINAGE MASTER PLAN

PREPARED FOR

MONO COUNTY PUBLIC WORKS DEPARTMENT

JULY 1984

BROWN AND CALDWELL
AND
TRIAD ENGINEERING

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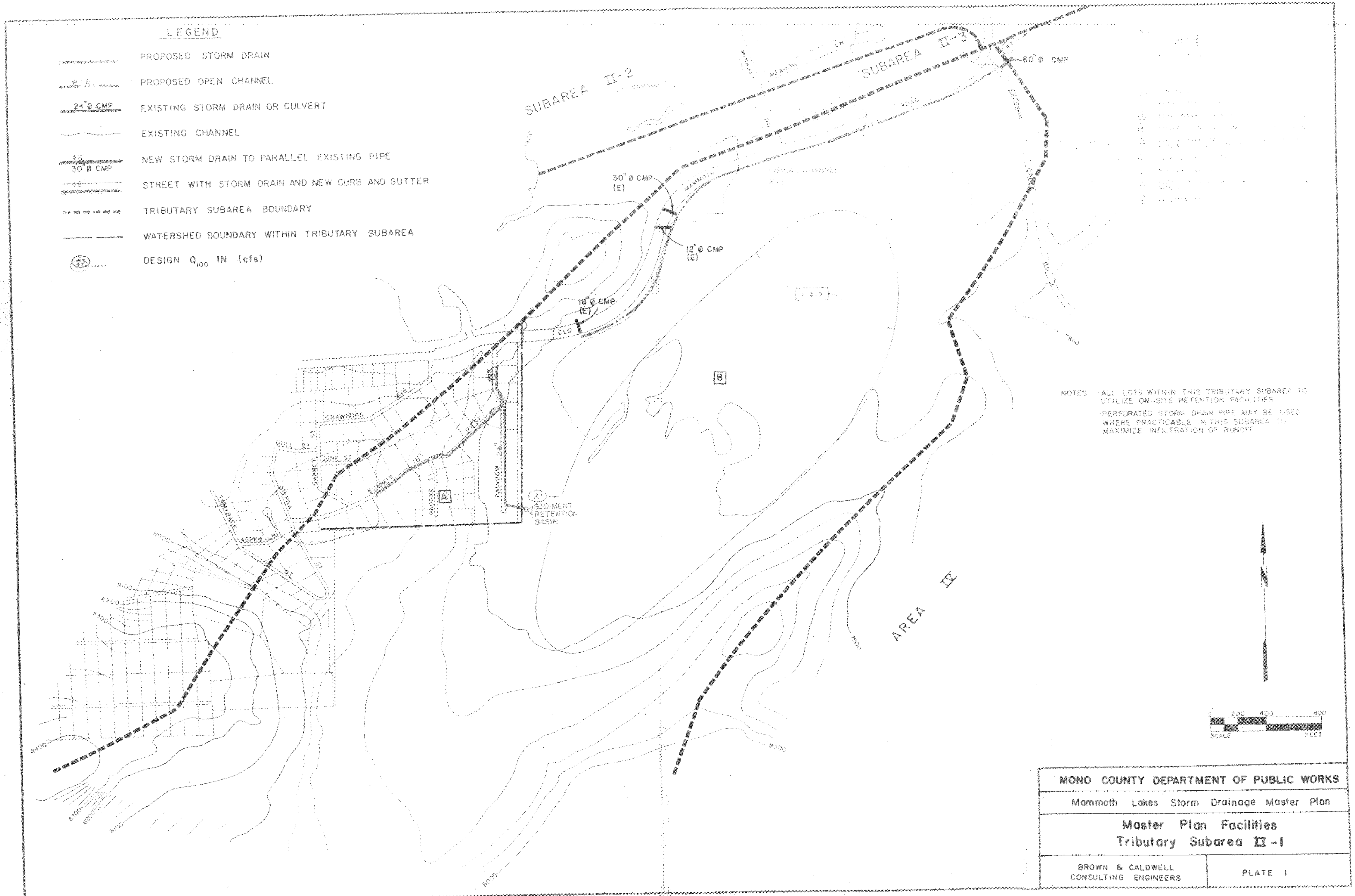
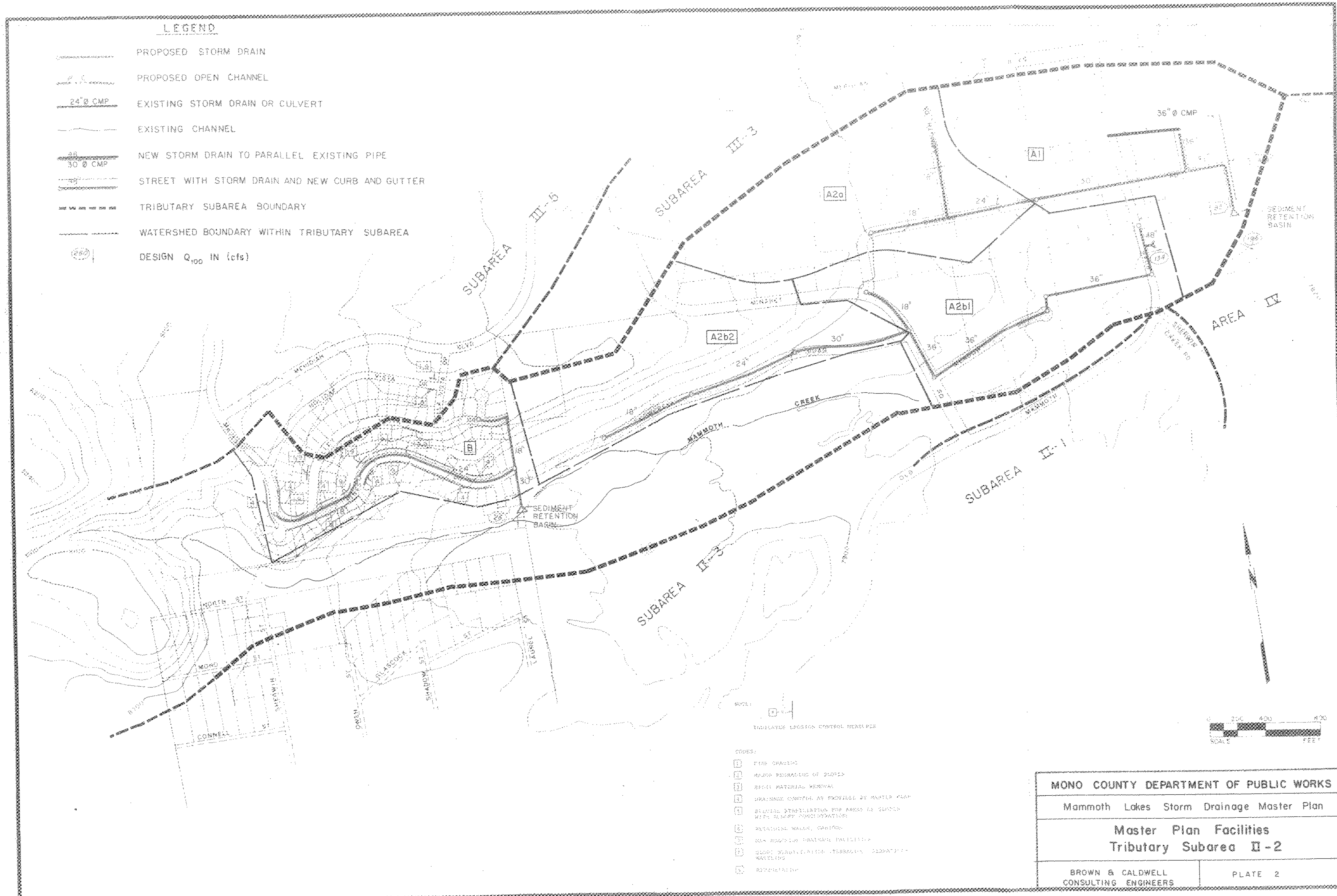
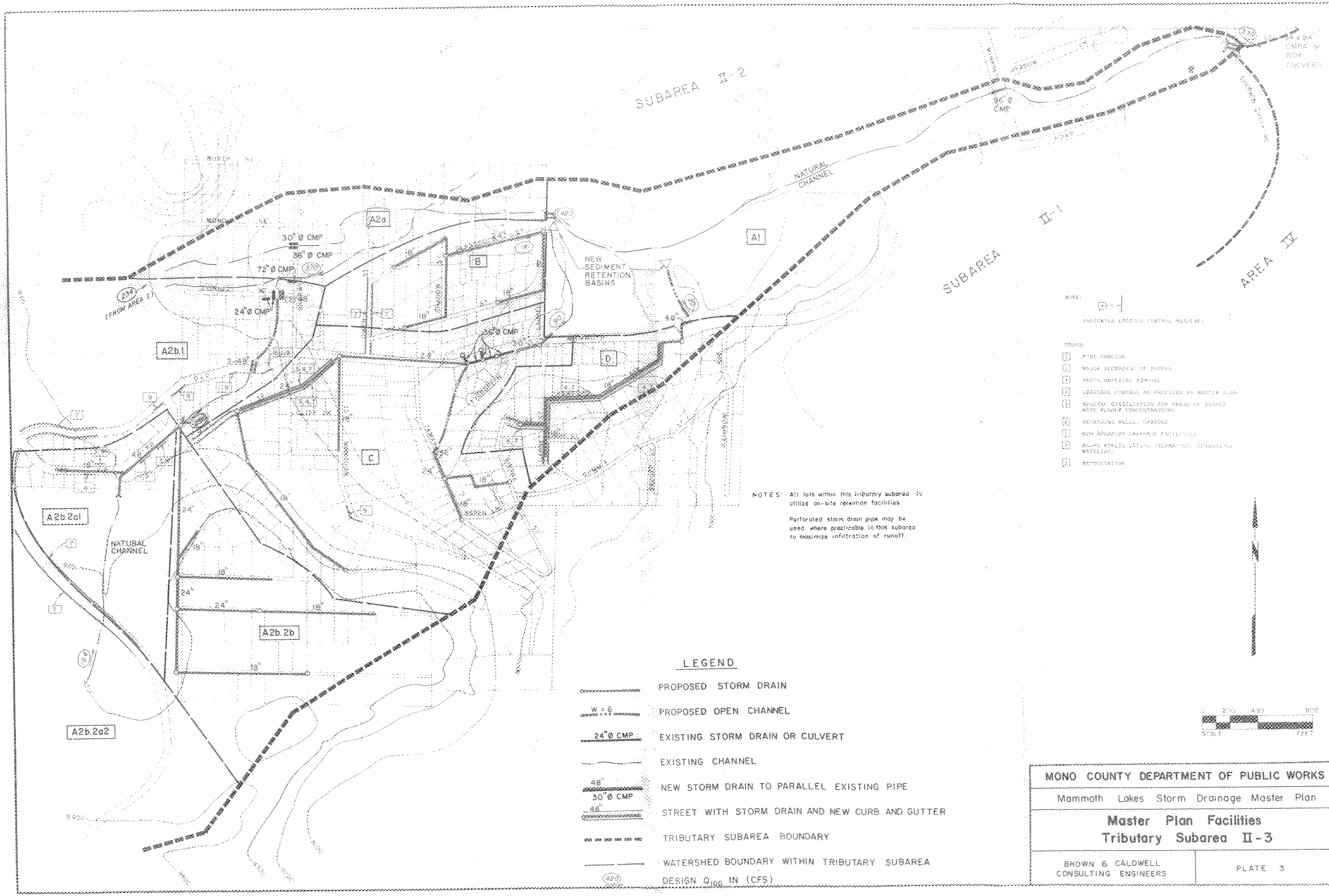
# CHAPTER 1

# SUMMARY

A summary of the Master Plan is presented on the folded map which is contained in the pocket following this page.


LEGEND
PROPOSED STORM DRAIN
PROPOSED OPEN CHANNEL
24"Ø CMP
EXISTING STORM DRAIN OR CULVERT
EXISTING CHANNEL
30"Ø CMP
NEW STORM DRAIN TO PARALLEL EXISTING PIPE
STREET WITH STORM DRAIN AND NEW CURB AND GUTTER
TRIBUTARY SUBAREA BOUNDARY
WATERSHED BOUNDARY WITHIN TRIBUTARY SUBAREA
DESIGN Q100 IN (cfs)
SUBAREA II-2
SUBAREA II-3
60"Ø CMP
30"Ø CMP (E)
12"Ø CMP (E)
18"Ø CMP (E)
SEDIMENT RETENTION BASIN
A
B
AREA IV
NOTES · ALL LOTS WITHIN THIS TRIBUTARY SUBAREA TO UTILIZE ON-SITE RETENTION FACILITIES
· PERFORATED STORM DRAIN PIPE MAY BE USED WHERE PRACTICABLE IN THIS SUBAREA TO MAXIMIZE INFILTRATION OF RUNOFF
0 200 400 800
SCALE FEET
MONO COUNTY DEPARTMENT OF PUBLIC WORKS
Mammoth Lakes Storm Drainage Master Plan
Master Plan Facilities
Tributary Subarea II-1
BROWN & CALDWELL CONSULTING ENGINEERS
PLATE 1


LEGEND
PROPOSED STORM DRAIN
PROPOSED OPEN CHANNEL
24" Ø CMP
EXISTING STORM DRAIN OR CULVERT
EXISTING CHANNEL
48
30 Ø CMP
NEW STORM DRAIN TO PARALLEL EXISTING PIPE
48
STREET WITH STORM DRAIN AND NEW CURB AND GUTTER
TRIBUTARY SUBAREA BOUNDARY
WATERSHED BOUNDARY WITHIN TRIBUTARY SUBAREA
250
DESIGN $Q_{100}$ IN (cfs)
SUBAREA III-5
SUBAREA III-3
SUBAREA II-1
SUBAREA II-3
AREA IV
A1
A2a
A2b1
A2b2
B
36" Ø CMP
SEDIMENT RETENTION BASIN
SEDIMENT RETENTION BASIN
MAMMOTH CREEK
MERIDIAN
BLVD
NORTH ST
MONO ST
SIERRA
CONNELL
LAUREL
SHADY ST
OLD MAMMOTH RD
SHERWIN CREEK RD
SCALE FEET
MONO COUNTY DEPARTMENT OF PUBLIC WORKS
Mammoth Lakes Storm Drainage Master Plan
Master Plan Facilities
Tributary Subarea II-2
BROWN & CALDWELL
CONSULTING ENGINEERS
PLATE 2


SUBAREA II-2
SUBAREA II-1
AREA IV
NATURAL CHANNEL
NEW SEDIMENT RETENTION BASINS
A1
A2a
A2b.1
A2b.2a1
A2b.2a2
A2b.2b
B
C
D
30" Ø CMP
36" Ø CMP
72" Ø CMP
24" Ø CMP
36" Ø CMP
(FROM AREA I)
NOTES: All lots within this tributary subarea to utilize on-site retention facilities.
Perforated storm drain pipe may be used where practicable in this subarea to maximize infiltration of runoff.
LEGEND
PROPOSED STORM DRAIN
W = 6 PROPOSED OPEN CHANNEL
24" Ø CMP EXISTING STORM DRAIN OR CULVERT
EXISTING CHANNEL
48" 30" Ø CMP NEW STORM DRAIN TO PARALLEL EXISTING PIPE
48" STREET WITH STORM DRAIN AND NEW CURB AND GUTTER
TRIBUTARY SUBAREA BOUNDARY
WATERSHED BOUNDARY WITHIN TRIBUTARY SUBAREA
(420) DESIGN $Q_{100}$ IN (CFS)
SCALE FEET
MONO COUNTY DEPARTMENT OF PUBLIC WORKS
Mammoth Lakes Storm Drainage Master Plan
Master Plan Facilities
Tributary Subarea II-3
BROWN & CALDWELL CONSULTING ENGINEERS
PLATE 3

# CHAPTER 2

# INTRODUCTION

The community of Mammoth Lakes has developed to the point where peak flows from spring snowmelt and fall and spring thunderstorms cause erosion and localized flooding in many areas of the community. Uncontrolled runoff is accelerating erosion and increasing sediment loads and attendant water quality problems in Mammoth Creek. These problems are also aggravated by discharges directly to Mammoth Creek of surface runoff from heavily developed commercial areas containing sediment, oil and grease, and nutrients.

The U.S. Forest Service (Forest Service) and California Department of Fish and Game have reported a trend in decreasing fish population and redd counts in Hot Creek, downstream of Mammoth Lakes. They are working with the California Regional Water Quality Control Board, Lahonton Region (Lahontan Regional Board), to identify upstream erosion and uncontrolled surface runoff which are believed to be a major contributor to the water quality problems in Hot Creek.

Development activites conducted under limited controls in the past have collectively created problems as the density and areal extent of the urbanized area has increased. Erosion and drainage problems, which in the past were a minor inconvenience, are thus accentuated and create flooding and water quality degradation.

Recognizing this, the Board of Supervisors of the County of Mono on May 24, 1983, authorized the Public Works Director to contract with Brown and Caldwell and Triad Engineering, Inc., to prepare a storm drainage master plan for Mammoth Lakes.

## SCOPE OF WORK

Planning to control these types of problems requires the development of an improvement program to rehabilitate existing areas; and policies, standards, and procedures to guide future development. This report documents existing conditions and presents a long-range master plan for control of drainage and erosion. Control priorities are defined, and a proposed method for financing a staged capital improvement program is presented. An institutional structure for implementation of the Master Plan is recommended, as are changes to existing County ordinances.

This report is supplemented by a design manual for storm drainage and erosion control that specifies design criteria, standard details, and runoff calculation procedures. This document, which can be secured from the Public Works Department, was the basis for development of the master plan, and is to be used as a design manual for future development. Limited copies were also developed of an appendix documenting the hydrologic data used to develop curves and runoff calculation procedures in the design manual.

## REPORT CONTENTS

The entire master plan report and improvement plan is summarized on the map contained in the pocket in Chapter 1. Chapters 3 through 5 present the data on which the plan has been developed, the hydrologic calculation procedures used, and the criteria for system design. The master plan is described in Chapter 6, and the financial and implementation plans are presented in Chapters 7 and 8.

## CHAPTER 3

## MAMMOTH BASIN CHARACTERISTICS

This chapter describes the characteristics of the Mammoth Basin (Basin), concentrating on the urbanized portion for which storm drainage and erosion control facilities have been developed in this master plan.

### GENERAL SETTING

The geographic location and hydrologic and water quality regime for the Mammoth Basin are described below.

#### Geographic Location

The Mammoth Basin is a distinct geographical area located on the eastern slope of the Sierra Nevada in central eastern California (see Figure 3-1). It is situated in southwestern Mono County at approximate latitude 37°38' and longitude 118°59'. The Basin contains the relatively remote resort community of Mammoth Lakes (population 6,000) and the nearest major population centers are Bishop, 40 miles to the south, and Carson City, Nevada, 120 miles to the north. With the exception of the 2,600 acres of private land which comprise the Mammoth Lakes community, the Basin consists primarily of wilderness and semi-wilderness lands under the jurisdiction of the Inyo National Forest. The Basin provides recreational opportunities for approximately 2.7 million tourists and vacationers annually.

#### Hydrologic Setting

The Basin encompasses approximately 71 square miles and includes the entire watershed of Mammoth Creek which is eventually tributary to the Owens River via Hot Creek (see Figure 3-2). Mammoth Creek and Hot Creek are really the same surface stream, but the name changes at U.S. Highway 395 due to historical precedent. The Mammoth Basin is within the Long Hydrologic subunit of the Owens Hydrologic unit of the Lahontan Drainage Province. Watershed boundaries are physically defined by the Mammoth Crest divide of the Sierra Nevada on the south and west, by the Dry Creek drainage divide on the north, and by the Convict Creek drainage divide on the east. The general trend of the Basin is northeasterly, extending from Mammoth Crest at elevation 11,600 on the southwest, to the Hot Creek Gorge in the Upper Owens Valley at elevation 6,960 on the northeast. Total length of the Mammoth Creek/Hot Creek drainage system is approximately 18 miles.

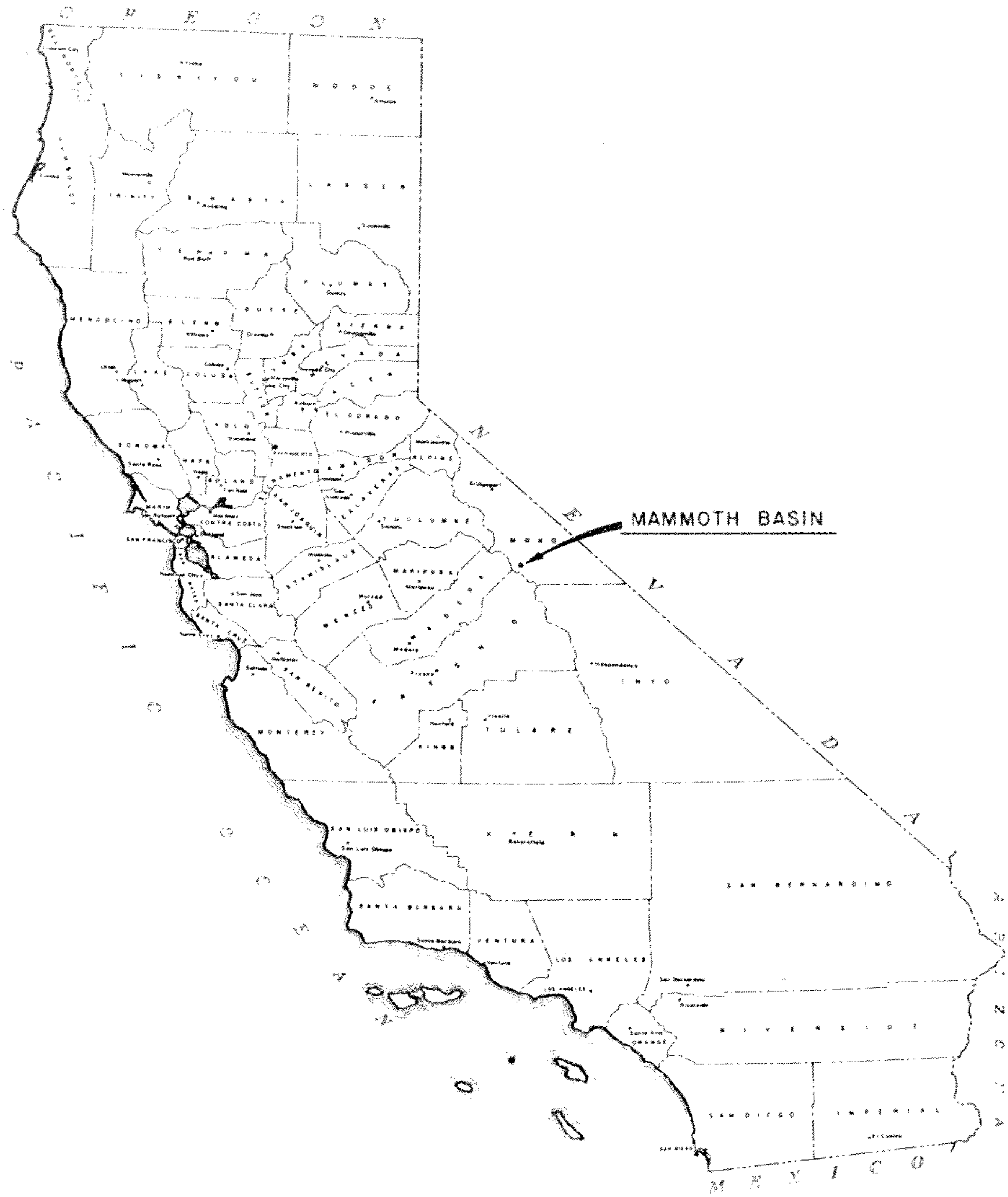



Figure 3-1
LOCATION MAP

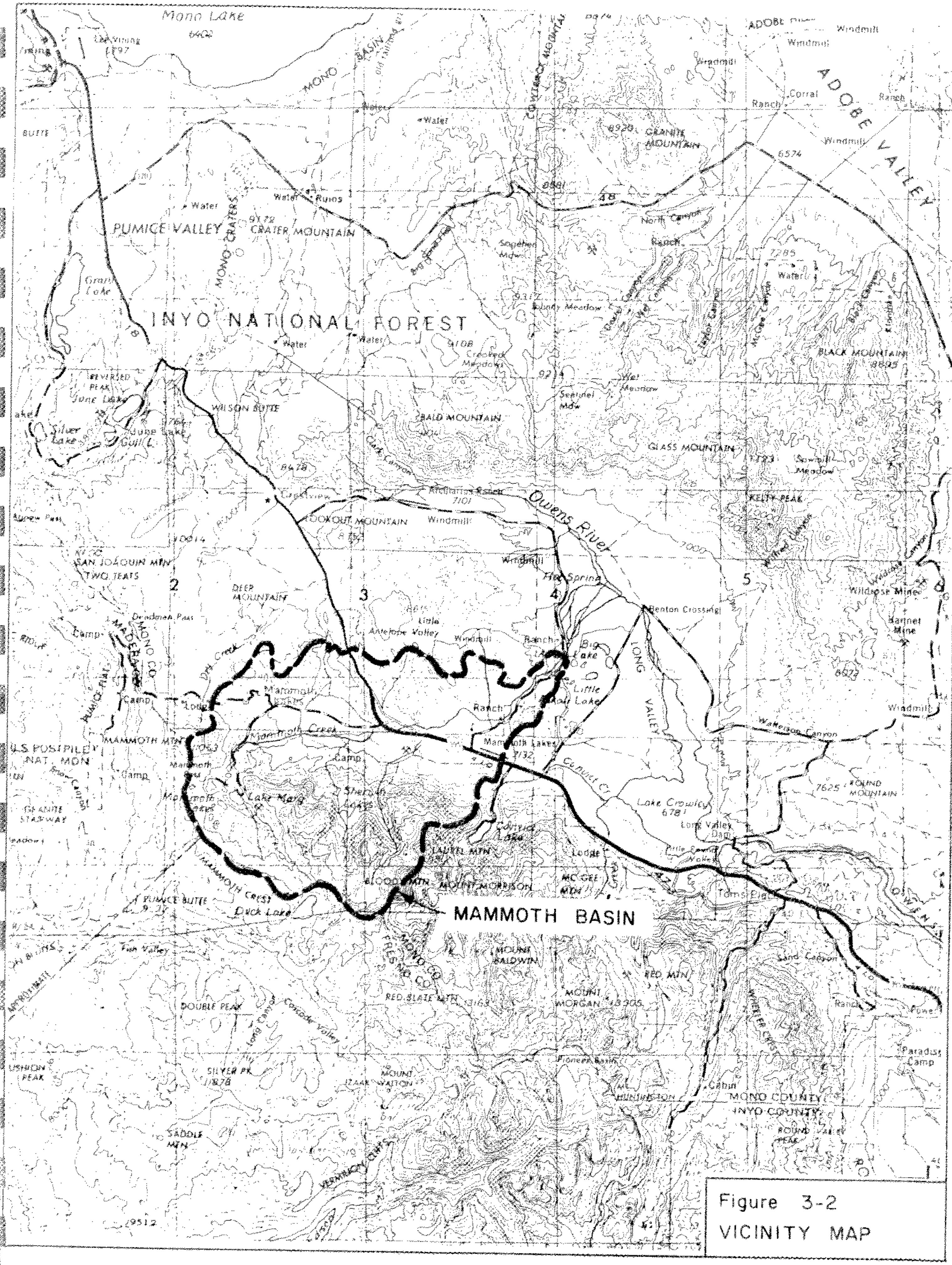



Figure 3-2
VICINITY MAP

The Basin includes a complex system of alpine lakes and interconnecting surface streams in the higher elevations of its southwestern portion. All of these lakes and streams are eventually tributary by either surface flow or underground flow to Mammoth Creek or Hot Creek.

## Water Quality

The lakes and streams of the Basin are generally of excellent quality and are used for a wide variety of beneficial uses, including municipal and domestic water supply, agricultural water supply, water contact and noncontact recreation, cold freshwater habitat, and wildlife habitat. Because of its size (average annual flow of about 20 cubic feet per second) and proximity to the community, accessible reaches of Mammoth Creek provide popular recreation areas for trout fishing and hiking. In addition, the contrast of characteristic riparian vegetation with surrounding pine forests and chaparral contributes to the aesthetic character and visual appeal which makes the Basin a popular resort recreational area.

Building and recreational activity has increased significantly within the Basin during the last decade, and the California Regional Water Quality Control Board, Lahontan Region (Lahontan Regional Board), has become concerned with the water quality impacts of runoff and drainage from urbanized areas. This concern has been accompanied by specific guidelines and waste discharge requirements for the control of drainage and erosion within the developed areas of the Mammoth Lakes community. At present, only portions of the community are served by an integrated storm drainage system. The majority of the area is traversed by numerous natural or man-made surface channels and drainage problems are prevalent throughout much of the community.

# PHYSICAL CHARACTERISTICS

Watersheds within the Basin and physical characteristics that affect the planning and design of storm drainage systems are described below.

## Major Watersheds

The Basin contains six distinct major watersheds as shown on Figure 3-3, and summarized in Table 3-1.

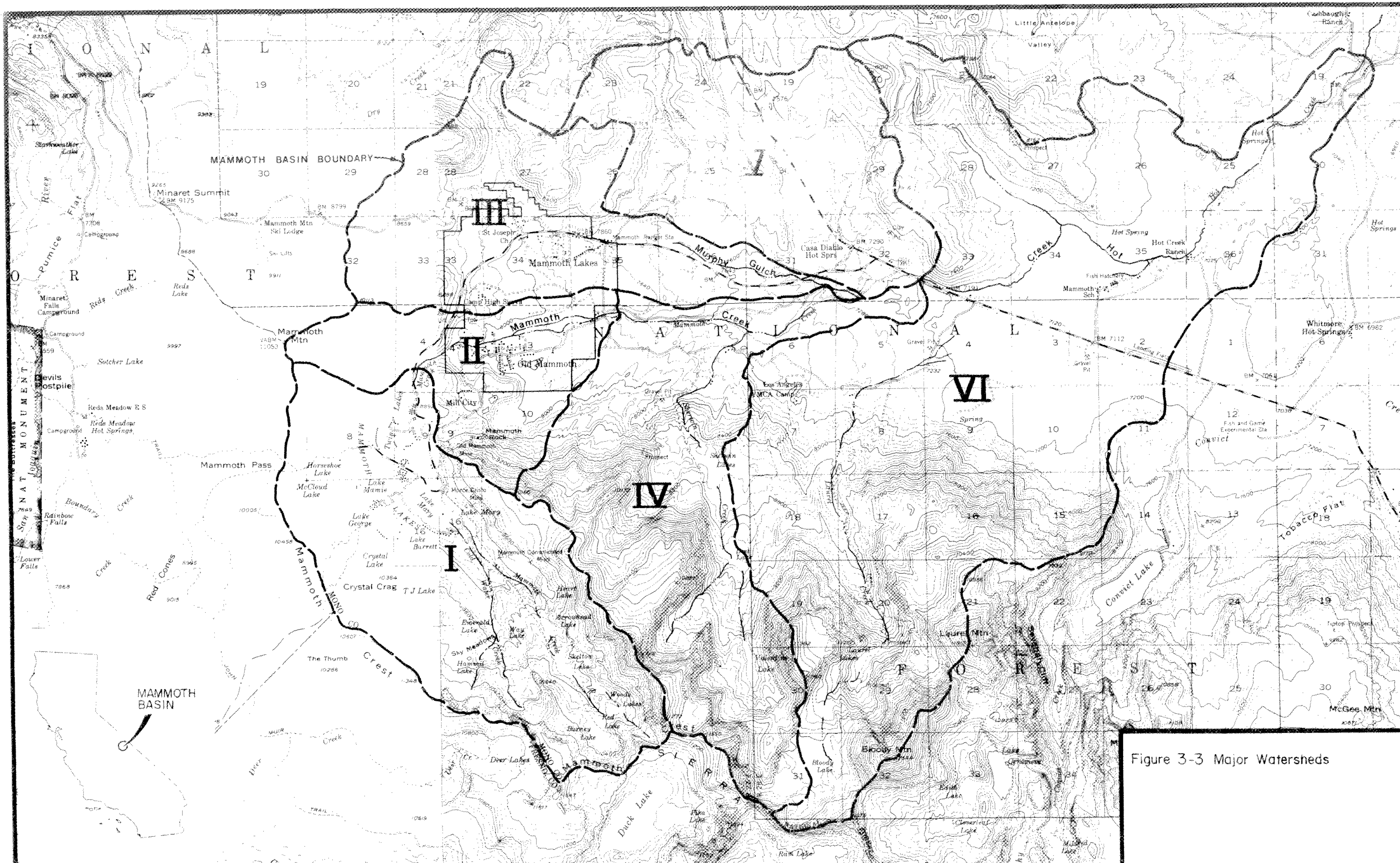



Figure 3-3 Major Watersheds

Table 3-1. Mammoth Basin Watersheds

| Watershed | Descriptive name | Area, acres |
|---|---|---|
| I | Lakes Basin | 6,920 |
| II | Old Mammoth | 2,710 |
| III | Murphy Gulch | 5,120 |
| IV | Sherwin Creek | 7,310 |
| V | Casa Diablo | 5,050 |
| Subtotal | Mammoth Creek | 27,110 |
| VI | Hot Creek and Laurel Creek | 17,990 |
| Total Basin | | 45,100 |

Watersheds I through V comprise the major tributary areas of Mammoth Creek upstream of State Highway 395. Downstream of Highway 395 (where the stream name changes to Hot Creek), all of the remaining Basin area has been simply lumped into Watershed VI, even though minor drainage distinctions could be made.

Watershed I encompasses the Lakes Basin which is the most distinct and complex tributary area within the Mammoth Creek drainage system. It is the only watershed for which lake storage is a significant factor because it contains the largest and most numerous lakes within the Mammoth Basin. Watershed II is immediately downstream of area I, and includes those portions of the Mammoth Lakes community and Mammoth Mountain which are directly tributary to Mammoth Creek. Watershed III encompasses a somewhat separate drainage system, known as Murphy Gulch, which is eventually tributary to Mammoth Creek near Highway 395. This watershed contains most of the more intensely developed areas of the Mammoth Lakes community.

Drainage Subareas

Watersheds II and III contain all of the private land holdings of the Mammoth Lakes community, and are the primary areas of interest in this study. These two watersheds have been further divided into more detailed drainage subareas as shown on Figure 3-4. Watershed II contains four distinct drainage subareas labeled II-1 through II-4, which are directly tributary to the main stream channel of Mammoth Creek. Watershed III has been subdivided into nine areas, labeled III-1 through III-9, which are all tributary to the Murphy Gulch drainage system.

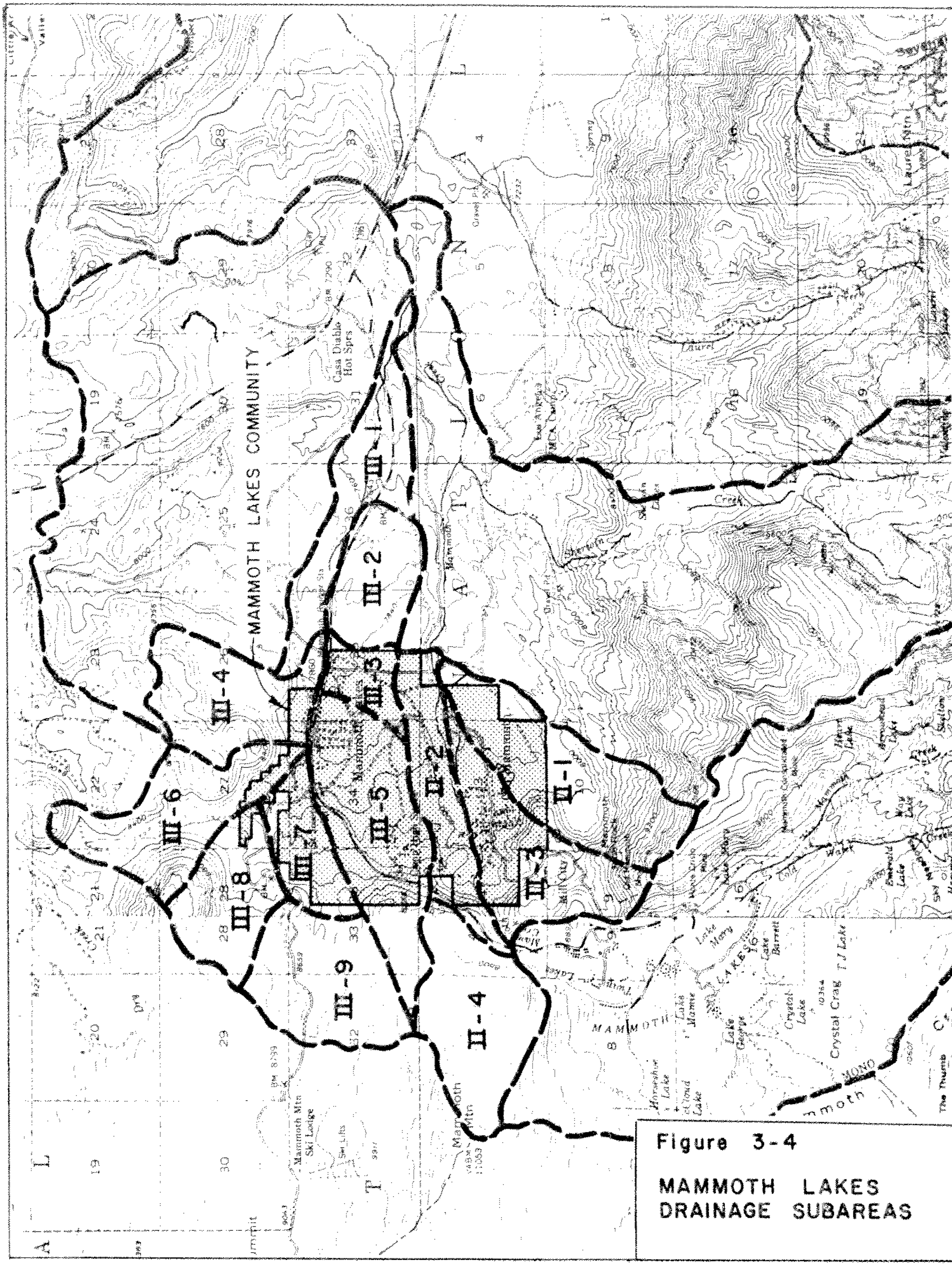



**Figure 3-4**

**MAMMOTH LAKES DRAINAGE SUBAREAS**

## Topography

The Basin is characterized as a relatively broad easterly trending valley confined by the Sierra Nevada mountain range on the south and west, and a series of lower knolls on the north. The mountain slopes are precipitous with considerable variation in relief, while the valley floor is relatively flat with moderate slopes of 0 to 10 percent. A graphic slope analysis of the Basin is presented on Figure 3-5 and summarized in Table 3-2. Approximately 40 percent of the Basin consists of land which has a slope steeper than 30 percent.

General topographical characteristics of the major watersheds and drainage subareas are presented in Table 3-3.

## Land Forms

The Basin is a region with a complex geologic history and the geomorphology of the area is varied and unusual. Pre-Tertiary metamorphic rocks form the backbone of the Sierra Nevada, but Tertiary volcanic rock, Quaternary glacial and lake deposits, and recent alluvial and volcanic materials are all interbedded throughout the Basin. The valley floor of much of the Basin has been formed by subsidence of the roof of a massive collapsed caldera centered in the Long Valley area. This floor has been filled alternately with volcanic rock, glacial deposits, lake deposits, and alluvial outwash from the Sierra Nevada.

General land forms of the Basin are depicted on Figure 3-6, with the legend and descriptive information presented in Table 3-4.

## Soils

Soil types throughout the Basin are characteristic of the parent rock materials and are relatively homogeneous. They consist predominantly of noncohesive decomposed granitic materials, pulverized fine-grained volcanic debris, and fine silts. Small pockets of meadow deposits with considerable organic fractions are sparsely distributed throughout the area.

Previous studies in the Basin have classified the various surficial soil types by the following characteristics: runoff potential, soil depth, erosion hazard potential, and vegetative productivity potential. Each characteristic is identified by the following rating system:

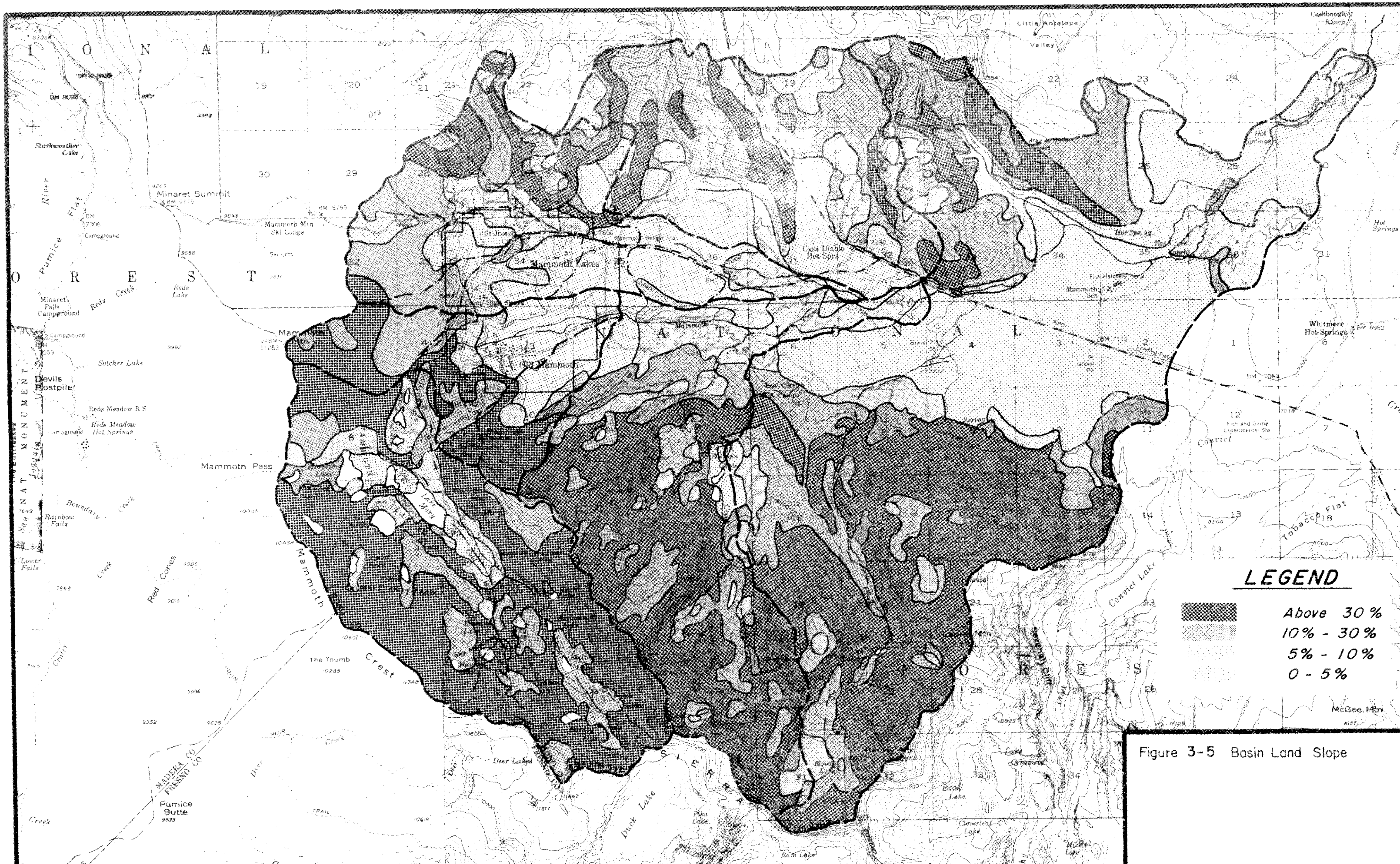



Figure 3-5 Basin Land Slope

Table 3-2. Slope Analysis

| Major watershed | Drainage area | Total area, acres | 0 to 5 percent | | 5 to 10 percent | | 10 to 30 percent | | Over 30 percent | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Acres | Percent | Acres | Percent | Acres | Percent | Acres | Percent |
| I | | 6,920 | 567 | 8.2 | 612 | 8.8 | 1,578 | 22.8 | 4,163 | 60.2 |
| | II-1 | 819 | 359 | 43.8 | 114 | 13.9 | 26 | 3.2 | 320 | 39.1 |
| | II-2 | 532 | 349 | 65.6 | 53 | 10.0 | 70 | 13.1 | 60 | 11.3 |
| | II-3 | 639 | 193 | 30.2 | 44 | 6.9 | 167 | 26.1 | 235 | 36.8 |
| | II-4 | 720 | -- | -- | -- | -- | 290 | 40.3 | 430 | 59.7 |
| II | | 2,710 | 901 | 33.3 | 211 | 7.8 | 553 | 20.4 | 1,045 | 38.5 |
| | III-1 | 690 | 408 | 59.1 | 272 | 39.4 | -- | -- | 10 | 1.5 |
| | III-2 | 350 | 310 | 88.6 | 40 | 11.4 | -- | -- | -- | -- |
| | III-3 | 206 | 206 | 100.0 | -- | -- | -- | -- | -- | -- |
| | III-4 | 644 | 161 | 25.0 | 103 | 16.0 | 187 | 29.0 | 193 | 30.0 |
| | III-5 | 811 | 281 | 34.7 | 255 | 31.4 | 275 | 33.9 | -- | -- |
| | III-6 | 819 | -- | -- | 172 | 21.0 | 280 | 34.2 | 367 | 44.8 |
| | III-7 | 265 | 66 | 24.9 | 179 | 67.5 | 20 | 7.6 | -- | -- |
| | III-8 | 580 | -- | -- | 167 | 28.8 | 281 | 48.4 | 132 | 22.8 |
| | III-9 | 755 | -- | -- | 145 | 19.2 | 436 | 57.8 | 174 | 23.0 |
| III | | 5,120 | 1,432 | 28.0 | 1,333 | 26.0 | 1,479 | 28.9 | 876 | 17.1 |
| IV | | 7,310 | 570 | 7.8 | 1,280 | 17.5 | 1,725 | 23.6 | 3,735 | 51.1 |
| V | | 5,050 | 1,005 | 19.9 | 1,540 | 30.5 | 1,434 | 28.6 | 1,071 | 21.2 |
| Totals | | 27,110 | 4,475 | 16.5 | 4,976 | 18.4 | 6,769 | 25.0 | 10,890 | 40.1 |

Table 3-3. Watershed Characteristics

| Major watershed | Drainage area | Elevation, feet | | Basin length, feet | Average slope, percent | Total area, acres | Natural area, acres | Developed area,[a] acres |
|---|---|---|---|---|---|---|---|---|
| | | High | Low | | | | | |
| I | | 11,600 | 8,400 | 39,600 | 8.1 | 6,920 | 6,920 | -0- |
| II | | 11,130 | 7,820 | 13,730 | 24.1 | 2,710 | 1,661 | 1,049 |
| | II-1 | 10,160 | 7,840 | 13,200 | 17.6 | 819 | 556 | 263 |
| | II-2 | 8,700 | 7,820 | 13,730 | 6.4 | 532 | 92 | 440 |
| | II-3 | 9,700 | 7,840 | 13,200 | 14.1 | 639 | 308 | 331 |
| | II-4 | 11,130 | 8,500 | 11,090 | 23.7 | 720 | 705 | 15 |
| III | | 10,110 | 7,380 | 29,700 | 9.2 | 5,120 | 3,508 | 1,612 |
| | III-1 | 8,200 | 7,380 | 17,420 | 4.7 | 690 | 690 | -0- |
| | III-2 | 7,900 | 7,650 | 4,800 | 5.2 | 350 | 52 | 298 |
| | III-3 | 8,020 | 7,800 | 6,000 | 3.7 | 206 | 19 | 187 |
| | III-4 | 8,760 | 7,720 | 9,000 | 11.6 | 644 | 543 | 101 |
| | III-5 | 9,300 | 7,840 | 13,200 | 11.1 | 811 | 146 | 665 |
| | III-6 | 9,380 | 8,000 | 10,560 | 13.0 | 819 | 760 | 59 |
| | III-7 | 8,500 | 7,940 | 7,000 | 8.0 | 265 | 44 | 221 |
| | III-8 | 9,380 | 7,940 | 7,920 | 18.0 | 580 | 510 | 70 |
| | III-9 | 10,110 | 8,300 | 6,330 | 28.6 | 755 | 744 | 11 |
| IV | | 11,760 | 7,190 | 44,880 | 10.2 | 7,310 | 7,310 | -0- |
| V | III-9 | 8,760 | 7,200 | 31,680 | 4.9 | 5,050 | 5,050 | -0- |
| VI | III-9 | 11,760 | 6,960 | 63,360 | 7.6 | 17,990 | 17,990 | -0- |
| Totals | | | | | | 45,100 | 42,439 | 2,661 |

[a]Area within boundary of community of Mammoth Lakes, plus areas proposed for community expansion.

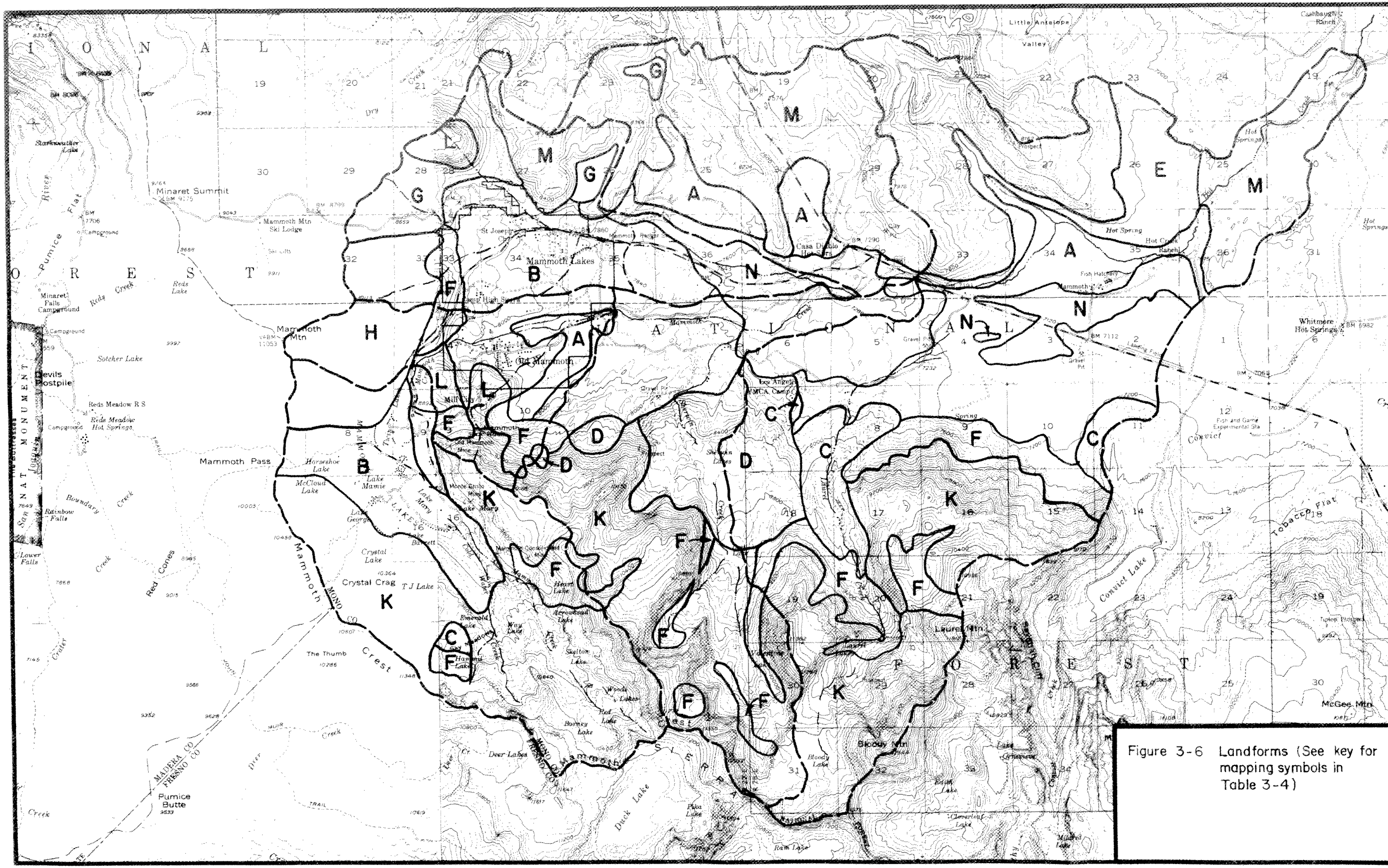



Figure 3-6 Landforms (See key for mapping symbols in Table 3-4)

Table 3-4. Landform Descriptions

| Symbol | Landform | Description |
|---|---|---|
| A | Alluvial | Unconsolidated sediments and detrital material deposited by water transport. Usually below 7,500 feet in flatter terrain. |
| B | Outwash Till | Undifferentiated glacial outwash and coarse till usually found at 7,500 to 9,500 feet. Associated with moderate to steep terrain. |
| C | Moraine | Undifferentiated till occurring as scattered knolls or ridges between 7,200 and 9,000 feet. |
| D | Rock Glacier | Glacial deposits with significant boulder and cobble fractions. Occurs primarily in Sherwin Lakes basin. |
| E | Lacustrine | Lake bed deposits, including consolidated sandstones, clays, and gravels. Occurs at lower elevations along Hot Creek. |
| F | Colluvial | Poorly consolidated terrace deposits, slope outwash, and talus occurring at the bases of steep mountain slopes. |
| G | Pumice | Recent volcanic ash deposits of significant depth occurring in northwestern portions of Basin. Associated with Mammoth Mountain volcanic activity. |
| H | Mammoth Mountain | Dormant volcano which dominates the westerly portion of the Basin. Moderate to steep slopes covered with pumice and volcanic debris. |
| I<br>J<br>K<br>L | Glaciated Rimland<br>Glaciated Mountainland<br>Glaciated Graniticland<br>Glaciated Volcanicland | Most prevalent general type of landform, includes granitic batholith, volcanics, and complex metamorphic materials modified by glaciation. The Sierra Nevada Range along the entire western, southern, and southeastern rim of the Basin is in this category, including Mammoth Mountain. |
| M | Dissected Domeland | Rhyolitic domes and intrusions of recent volcanic origin which generally rim the northern portion of the Basin. |
| N | Dissected Flowland | Basalt flows, weathered and glaciated, which dominate the lower portion of the Basin floor. Lower reaches of Murphy Gulch and Mammoth Creek traverse this landform near Highway 203 and U.S. Highway 395. |

Runoff Potential

- A Very low runoff potential
- B Low runoff potential
- C Moderate runoff potential
- D High runoff potential

Soil Depth

- 1 0 to 20 inches
- 2 20 to 36 inches
- 3 More than 36 inches
- 4 Variable conditions

Inherent Erosion Hazard

- 1 Low hazard
- 2 Moderate hazard
- 3 High hazard

Vegetative Productivity

- 1 Low potential
- 2 Medium potential
- 3 High potential

Soil types within the Basin are mapped on Figure 3-7 and summarized by watersheds and subareas in Table 3-5. The mapping symbols represent the above described characteristics in accordance with the following code:

Soil Symbol (Example B322)

| B | 3 | 2 | 2 |
|---|---|---|---|
| Runoff potential--low | Soil depth--over 36 inches | Erosion hazard--moderate | Vegetative productivity--medium |

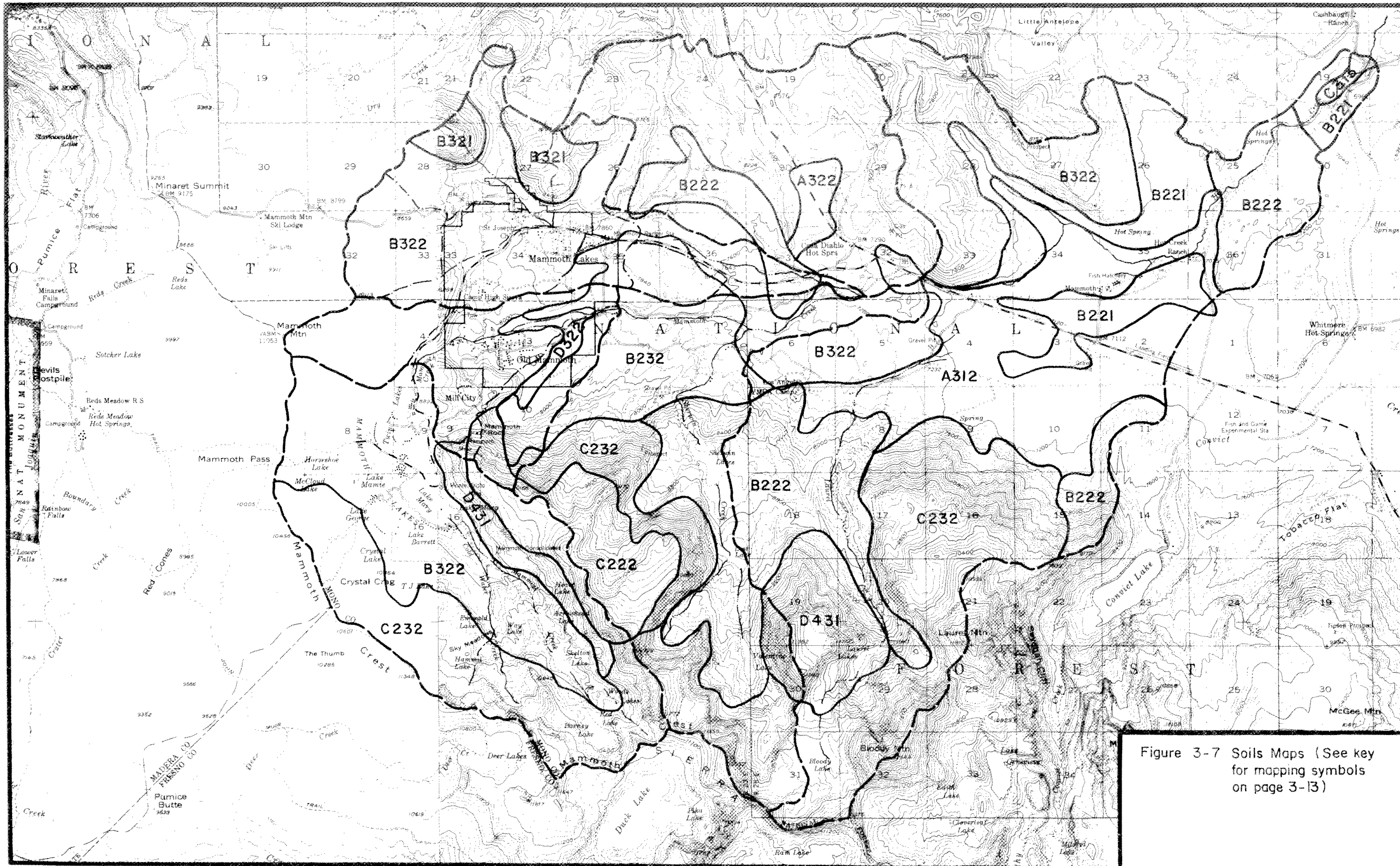



Figure 3-7 Soils Maps (See key for mapping symbols on page 3-13)

Table 3-5. Soil Type Distribution

| Major watershed | Drainage subarea | Soil Code/Percentage of Area | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A312 | A322 | B222 | B232 | B321 | B322 | C222 | C232 | D322 | D431 |
| I | | — | — | — | — | — | 45.0 | 4.4 | 47.0 | — | 3.6 |
| II | | — | — | — | 20.9 | — | 61.2 | 6.9 | 0.9 | 9.4 | 0.7 |
| | II-1 | — | — | — | 53.9 | — | 10.5 | 16.7 | 2.9 | 16.0 | — |
| | II-2 | — | — | — | 24.6 | — | 62.8 | — | — | 12.6 | — |
| | II-3 | — | — | — | — | — | 80.8 | 7.1 | — | 9.2 | 2.9 |
| | II-4 | — | — | — | — | — | 100.0 | — | — | — | — |
| III | | — | — | 2.3 | 10.9 | 15.9 | 70.9 | — | — | — | — |
| | III-1 | — | — | 14.9 | 8.5 | — | 76.6 | — | — | — | — |
| | III-2 | — | — | — | 97.6 | — | 2.4 | — | — | — | — |
| | III-3 | — | — | — | 53.5 | — | 46.5 | — | — | — | — |
| | III-4 | — | — | — | 1.6 | 28.4 | 70.0 | — | — | — | — |
| | III-5 | — | — | — | — | — | 100.0 | — | — | — | — |
| | III-6 | — | — | 2.0 | — | 57.9 | 40.1 | — | — | — | — |
| | III-7 | — | — | — | — | — | 100.0 | — | — | — | — |
| | III-8 | — | — | — | — | 29.1 | 70.9 | — | — | — | — |
| | III-9 | — | — | — | — | — | 100.0 | — | — | — | — |
| IV | | 0.3 | — | 14.0 | 18.4 | — | 5.1 | 43.5 | 18.7 | — | — |
| V | | 2.3 | 6.2 | 13.1 | — | — | 78.4 | — | — | — | — |

## Vegetation

Vegetative types found in the Basin are generally typical of the eastern Sierra region. The Basin includes portions of the Upper Sonoran life zone, the Canadian zone, and the Transition life zone, although there is considerable intermixing and classical zonal boundaries are not sharply delineated. General plant communities include the lodgepole pine-fir forest, montane chaparral, sagebrush scrub, meadow, riparian woodland, and grassland.

Vegetative types are mapped on Figure 3-8 and summarized by watersheds and subareas in Table 3-6 according to the following legend:

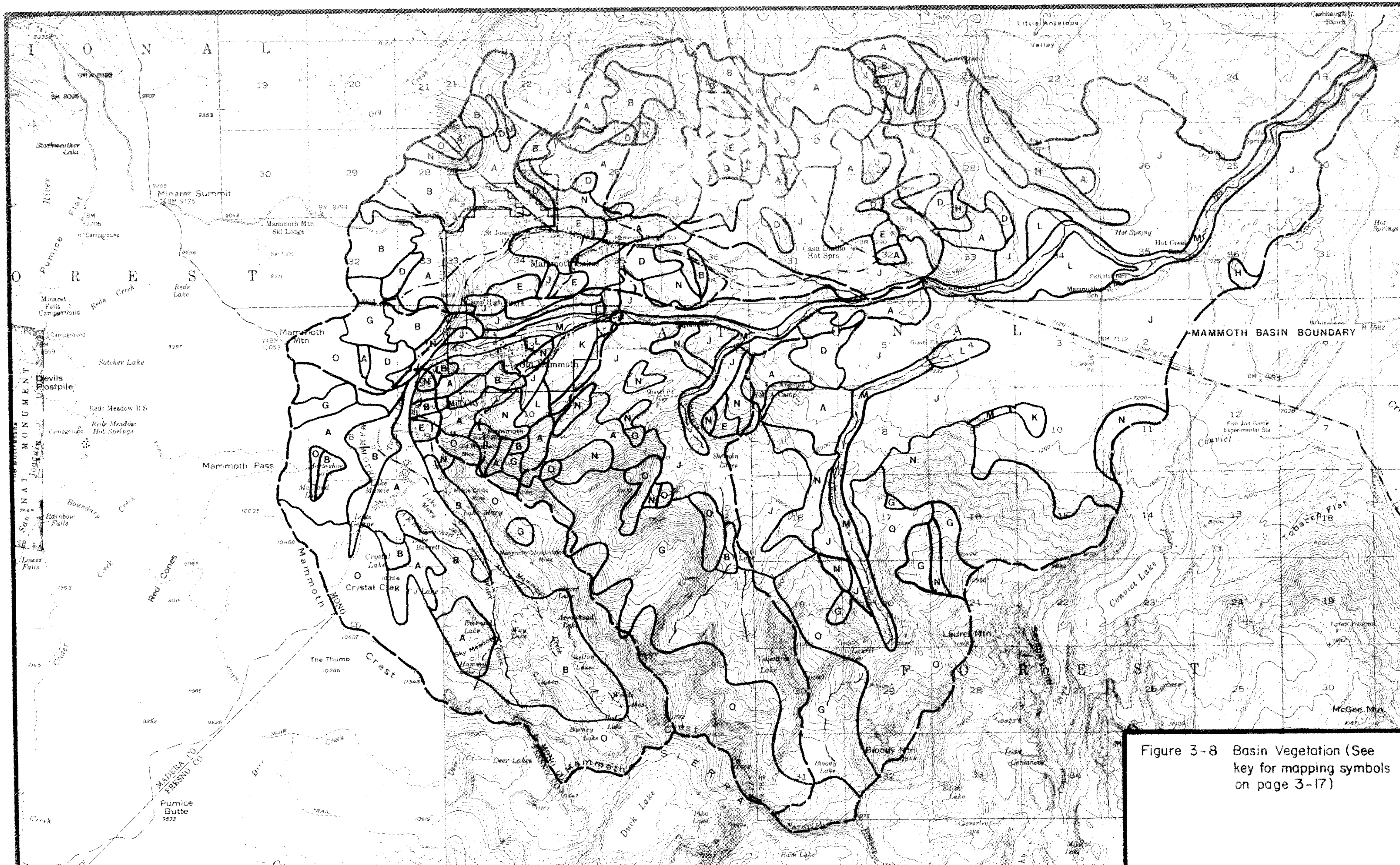



Figure 3-8 Basin Vegetation (See key for mapping symbols on page 3-17)

| Code | Dominant Vegetative Type[a] | |
|---|---|---|
| A | Coniferous forest | >11 inches, 10 to 40 percent |
| B | Coniferous forest | >11 inches, 40 to 70 percent |
| C | Coniferous forest | >11 inches, over 70 percent |
| D | Coniferous forest | <11 inches, 10 to 40 percent |
| E | Coniferous forest | <11 inches, 40 to 70 percent |
| F | Coniferous forest | <11 inches, over 70 percent |
| G | Subalpine forest | |
| H | Pinyon-Juniper woodland | |
| I | Deciduous forest | |
| J | Rangeland | |
| K | Grassland | |
| L | Natural meadow or pasture | |
| M | Riparian | |
| N | Mountain brush or chaparral | |
| O | Barren | |

[a]Coniferous forest designation are: >11 inches and <11 inches--meaning trees of diameter greater than or less than 11 inches. Percent values indicate the density of coverage.

Table 3-6. Vegetative Cover Analysis

| Major watershed | Drainage subarea | Vegetative Type/Percent of Area | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| I | | 28.9 | 12.5 | — | 0.1 | 0.8 | — | 9.7 | — | — | — | — | 0.1 | 2.4 | 1.4 | 44.1 |
| II | | 15.7 | 11.7 | — | 5.3 | 3.8 | — | 9.4 | — | — | 10.5 | 6.9 | 7.6 | 9.5 | 8.0 | 11.6 |
| | II-1 | 15.7 | 2.8 | — | — | — | — | 5.1 | — | — | 16.2 | 23.6 | 10.5 | 17.0 | 0.1 | — |
| | II-2 | 1.6 | 1.6 | — | 4.8 | 16.8 | — | — | — | — | 30.5 | — | 13.3 | 16.4 | 16.0 | — |
| | II-3 | 45.5 | 14.4 | — | — | 2.9 | — | — | — | — | — | — | 9.2 | 6.1 | 7.8 | 14.1 |
| | II-4 | 1.7 | 25.1 | — | 15.0 | 0.7 | — | 27.0 | — | — | — | — | — | — | 1.7 | 28.8 |
| III | | 39.4 | 20.1 | — | 10.3 | 5.9 | — | 1.5 | — | — | 16.1 | — | — | — | 6.2 | 0.5 |
| | III-1 | 9.8 | 4.3 | — | 8.4 | — | — | 2.9 | — | — | 71.5 | — | — | — | 3.0 | — |
| | III-2 | — | 12.7 | — | 26.2 | — | — | — | — | — | 31.2 | — | — | — | 29.9 | — |
| | III-3 | 9.7 | — | — | 44.0 | 20.5 | — | — | — | — | 25.9 | — | — | — | — | — |
| | III-4 | 38.1 | 19.7 | — | 14.8 | 14.9 | — | — | — | — | — | — | — | — | 12.6 | — |
| | III-5 | 61.9 | 4.0 | — | — | 22.0 | — | — | — | — | 12.0 | — | — | — | — | — |
| | III-6 | 71.7 | 7.2 | — | 8.8 | 1.1 | — | — | — | — | 3.5 | — | — | — | 7.4 | — |
| | III-7 | 93.6 | 4.2 | — | — | 2.1 | — | — | — | — | — | — | — | — | — | — |
| | III-8 | 29.8 | 55.9 | — | — | — | — | — | — | — | — | — | — | — | 9.3 | 5.0 |
| | III-9 | 37.3 | 47.7 | — | 8.9 | — | — | 6.1 | — | — | — | — | — | — | — | — |
| IV | | 3.0 | 0.2 | — | 0.8 | 1.2 | — | 9.9 | — | — | 25.5 | 0.3 | 0.2 | 2.8 | 6.0 | 50.1 |
| V | | 46.0 | 12.3 | — | 14.9 | 1.2 | 7.1 | 0.8 | 4.0 | — | 11.2 | — | — | — | 2.6 | — |

## Land Use

The Mammoth Lakes community is characterized by a mixture of relatively intensive commercial and residential land uses. All of the developed areas of the community are concentrated within watersheds II and III, as indicated previously on Figure 3-3. Current zoning designations for land within the community are presented on Figure 3-9 and summarized by drainage subareas in Table 3-7. Approximately 45 percent of the total land area of the community is presently undeveloped, most of which is designated for C-R (concentrated resort) land uses. Due to the limited supply of private land in the Mammoth Lakes area and the pressures created by increasing recreational demands, it can be anticipated that most of the remaining land will be built out within the next 20 years.

Table 3-7. Land Use Summary

| Drainage subarea | Total | Area, acres | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural | Urban Open | Planned Development | R-1[a] | R-2[b] | R-3[c] | CR[d] | CH[e] | Public |
| II-1 | 819 | 556 | 0 | 215 | 38 | 0 | 10 | 0 | 0 | 0 |
| II-2 | 532 | 92 | 125 | 113 | 68 | 0 | 76 | 0 | 54 | 4 |
| II-3 | 639 | 308 | 72 | 21 | 210 | 5 | 23 | 0 | 0 | 0 |
| II-4 | 720 | 705 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| III-1 | 690 | 690 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| III-2 | 350 | 52 | 11 | 81 | 21 | 47 | 78 | 0 | 0 | 60 |
| III-3 | 206 | 19 | 0 | 28 | 2 | 1 | 43 | 0 | 86 | 27 |
| III-4 | 644 | 543 | 0 | 0 | 32 | 0 | 0 | 0 | 31 | 38 |
| III-5 | 811 | 146 | 32 | 156 | 117 | 70 | 102 | 104 | 62 | 22 |
| III-6 | 819 | 760 | 0 | 0 | 57 | 0 | 0 | 0 | 0 | 2 |
| III-7 | 265 | 44 | 0 | 0 | 125 | 0 | 13 | 35 | 48 | 0 |
| III-8 | 580 | 510 | 0 | 0 | 34 | 0 | 0 | 0 | 11 | 25 |
| III-9 | 755 | 744 | 0 | 0 | 2 | 0 | 1 | 8 | 0 | 0 |
| Totals | 7,830 | 5,169 | 255 | 614 | 706 | 123 | 346 | 147 | 292 | 178 |

[a]R-1 = Single-family residential.

[b]R-2 = Duplex residential.

[c]R-3 = Multiple-unit residential.

[d]CR = Concentrated Resort (condominium).

[e]CH = Commercial.

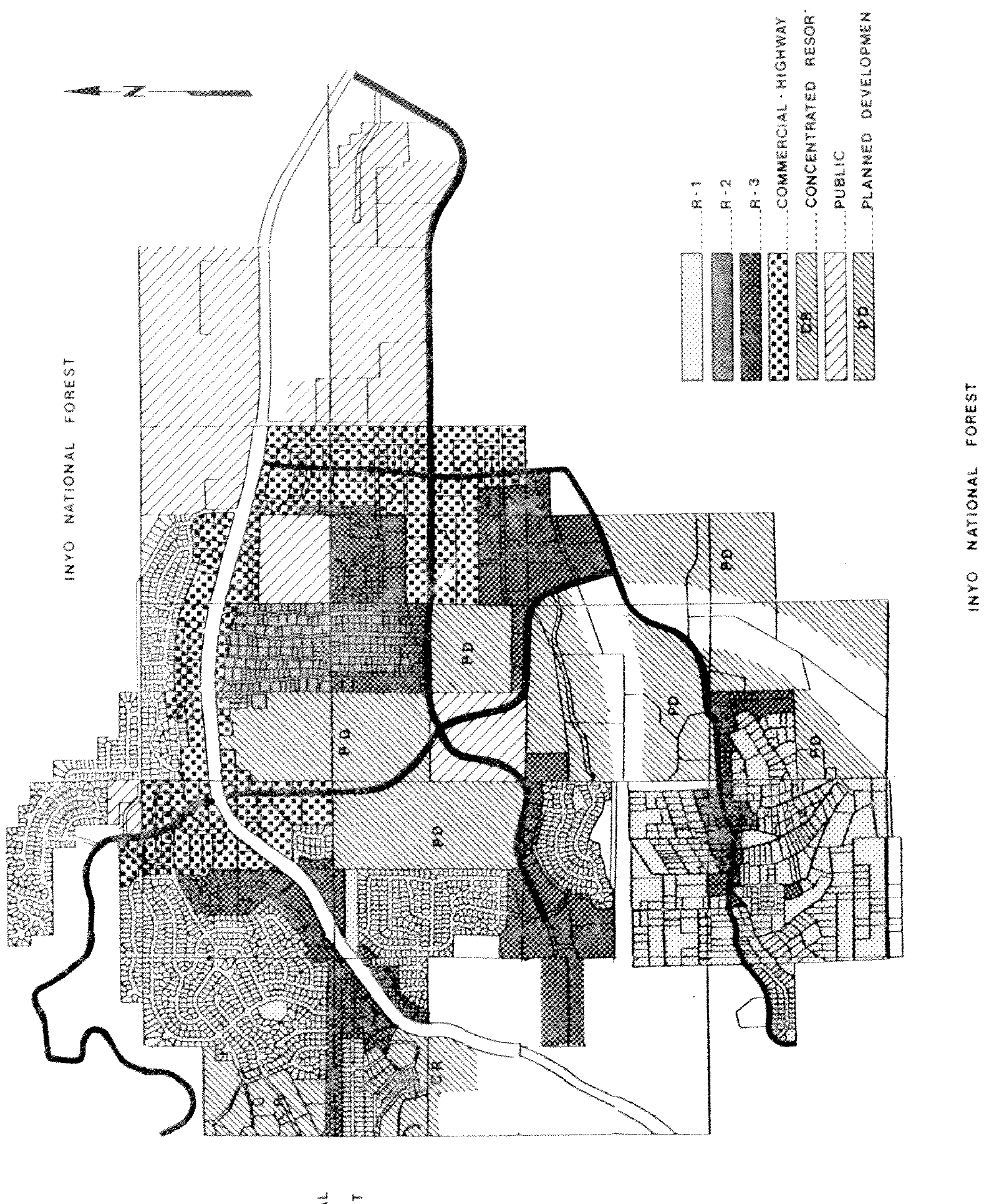



Figure 3-9
MAMMOTH LAKES
LAND USE MAP

The first comprehensive General Land Use Plan for the Mammoth Lakes area was originally adopted in 1975 after considerable study. This master plan document was known as the Monoplan and is currently in the process of being updated and revised. The preliminary master land use plan presently being considered for adoption is presented on Figure 3-10. Although several of the existing zoning categories are anticipated to be revised under the updated master plan, the changes are not expected to significantly affect the amount of impervious surface associated with various developments. Impervious surface areas currently associated with zoning designations are presented in Table 3-8.

Table 3-8. Impervious Surface Area Associated with Development Categories, percent

| Zoning designation | Development category | Individual parcel coverage | | Public streets and roadways | Overall percent of impervious area[c] |
|---|---|---|---|---|---|
| | | Building[a] | Parking/ driveways[b] | | |
| R-1 | Single-Family Residential | 35 | 5 | 15 | 55 |
| R-2 | Duplex Residential | 40 | 10 | 15 | 65 |
| R-3 | Multiple-Unit Residential | 40 | 10 | 15 | 65 |
| C-R | Concentrated Resort (condominium) | 50 | 10 | 15 | 75 |
| C-H | Commercial | 90 | 50 | 20 | 90 |
| P | Planned Development | 50 | 10 | — | 60 |
| Public | Schools, hospital, governmental office, maintenance yards | 90 | 50 | 15 | 90 |

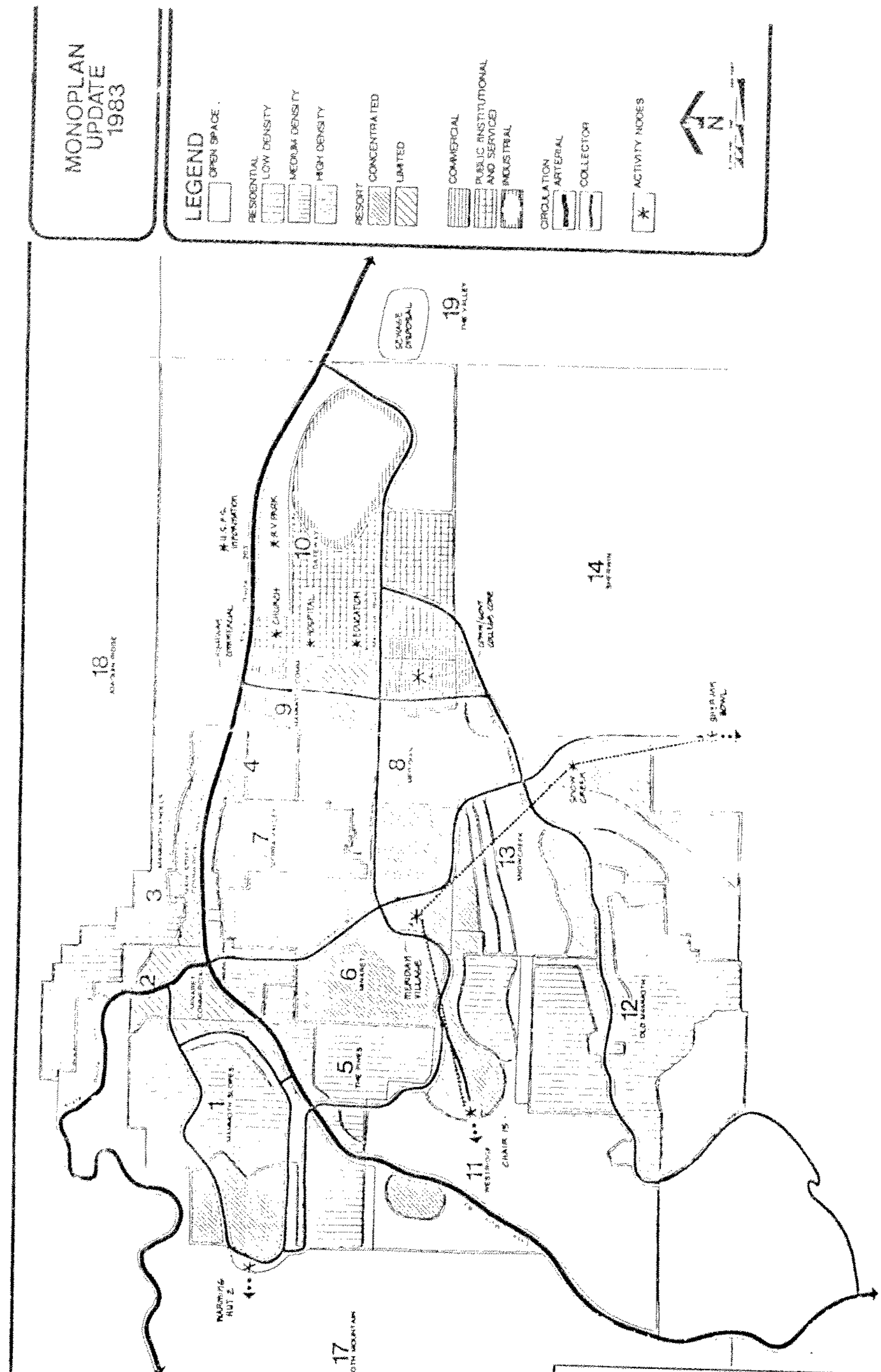
[a]Maximum coverage allowed by County Code.

[b]Estimated average coverage.

[c]Total expected impervious surface area based on gross acreage.

## HYDROLOGIC CHARACTERISTICS

Streamflow and precipitation records have been analyzed to develop depth-duration-frequency relationships for the Basin. The results are reported below.




MAMMOTH LAKES AREA
PLAN (TENTATIVE)

Figure 3-10

## Hydrologic Records

There are seven precipitation gauging stations in the general vicinity of the Basin, but only three stations within the Basin itself: Lake Mary Store, Mammoth Ranger Station, and Mammoth Pass. The Lake Mary Store and the Mammoth Pass gauges have over 35 years of record, but the Mammoth Ranger Station gauge has only been in operation for four years.

Similarly, although there are four streamflow gauging stations within the Basin, only one has been in long-term operation. Streamflow records for Mammoth (Hot) Creek at the Highway 395 crossing have been maintained by the City of Los Angeles for over a 50-year period. The flow recorded at this location essentially represents the surface outflow from all of Watersheds I through V.

The location of precipitation and streamflow gauging stations within the Basin is shown on Figure 3-11. Table 3-9 lists the data stations, the information collected, and the period of record for all gauging points in the general vicinity.

Table 3-9. Precipitation and Streamflow Data[a]

| Gaging station location | Agency | Type of data | Method of collection | Period of record |
|---|---|---|---|---|
| Lake Mary Store | LADWP | Precipitation | Continuous chart, summarized as daily volumes | 1946-present |
| Reds Meadow | USFS | Precipitation | Daily record | 1979-1983 |
| Mammoth Mountain | USFS | Precipitation | Daily record | 1979-1983 |
| Little Hot Creek | USFS | Precipitation | Daily record | 1979-1983 |
| Mammoth Ranger Station | USFS | Precipitation | Daily record | 1979-1983 |
| Convict Lake Sewage Plant | USFS | Precipitation | Daily record | 1979-1983 |
| Mammoth Pass | USBR | Precipitation | Storage gage | 1949-present |
| Lake Mamie Outlet | MCWD | Streamflow | Continuous chart | 1980-1983 |
| Mammoth Creek at Old Mammoth Road | MCWD | Streamflow | Continuous chart | 1980-1983 |
| Hot Creek at Highway 395 | LADWP | Streamflow | Continuous chart, summarized as average daily flows | 1931-1983 |
| Hot Creek at the Gorge | LADWP | Streamflow | Continuous chart, summarized as average daily flows | 1972-1983 |

[a]LADWP = Los Angeles Department of Water and Power.
USFS = U.S. Forest Service.
USBR = U.S. Bureau of Reclamation.
MCWD = Mammoth County Water District.

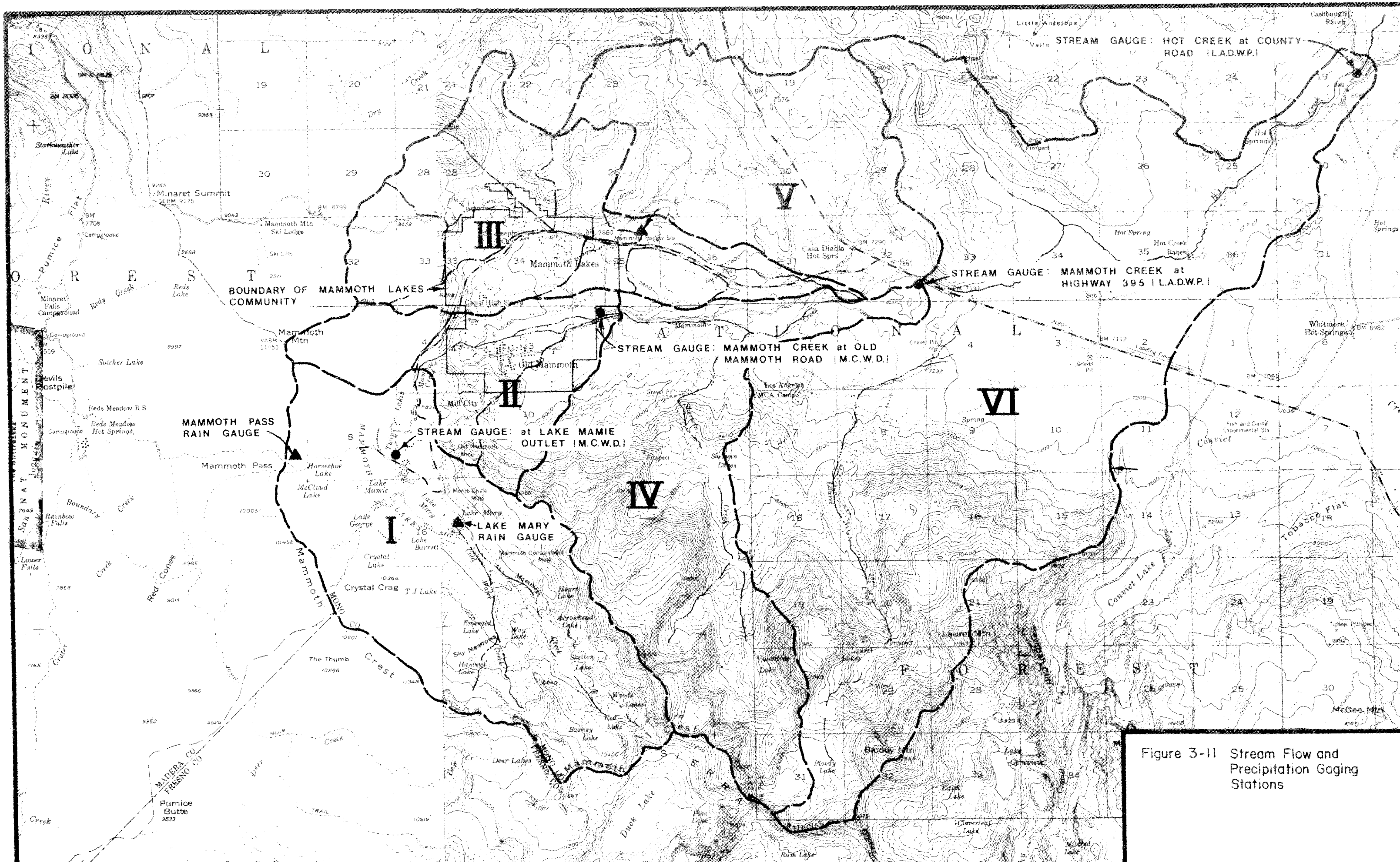



Figure 3-11 Stream Flow and Precipitation Gaging Stations

Precipitation

The Lake Mary Store rain gauge is situated at an elevation of 8,900 feet and has a 25-year recorded mean of 28.85 inches annually. Mean annual precipitation at the Mammoth Pass gauge (elevation 9,500 feet) is 59.46 inches. Studies conducted by the State Department of Water Resources (DWR) in 1973 correlated rain gauge data, snow gauge data, runoff data, and various other factors to produce projected 50-year mean isohyets for the Basin. The DWR isohyets are presented on Figure 3-12.

The projected 50-year annual precipitation for the entire Basin averages 27.5 inches based on the DWR studies. Total theoretical water production of the 45,100-acre Basin is therefore approximately 103,250 acre-feet annually.

Streamflow

Streamflow records for Mammoth Creek are available for the locations shown on Figure 3-11, but the only long-term record is for the Mammoth (Hot) Creek gauge at Highway 395. Flow in Mammoth Creek usually peaks in mid-June to early July in response to snowmelt at high elevations in the basin. However, flows may rise sharply in response to rainstorms between April and November.

Figure 3-13 shows the runoff hydrograph for Mammoth (Hot) Creek at Highway 395 for water year 1981-82. The hydrograph shows the typical peak which occurs in mid-summer due to snowmelt and also shows the effect of a major rainstorm in late September. The data for this station are recorded by the Los Angeles Department of Water and Power (LADWP) as mean daily flows. A frequency plot of annual maximum mean daily flows was constructed from the data for 1931 through 1982 for this station and is shown on Figure 3-14. Data for peak annual flows was not available for any of the stations in the Basin.

Storm Characteristics

Data on depth-duration-frequency relationships in the Mammoth Lakes area are not readily available. The DWR compiled some data on depth versus frequency for 24-, 48-, and 72-hour periods based on data collected between 1947 and 1968. Considering discontinuities in the collection of data, these relationships are based on 17 years of data. The accuracy of the relationships for 20- to 100-year return periods is therefore questionable. Shorter term depth-duration-frequency relationships are necessary to develop procedures for calculation of runoff in the master planning process. Data for precipitation at the Lake Mary Store are recorded by LADWP on

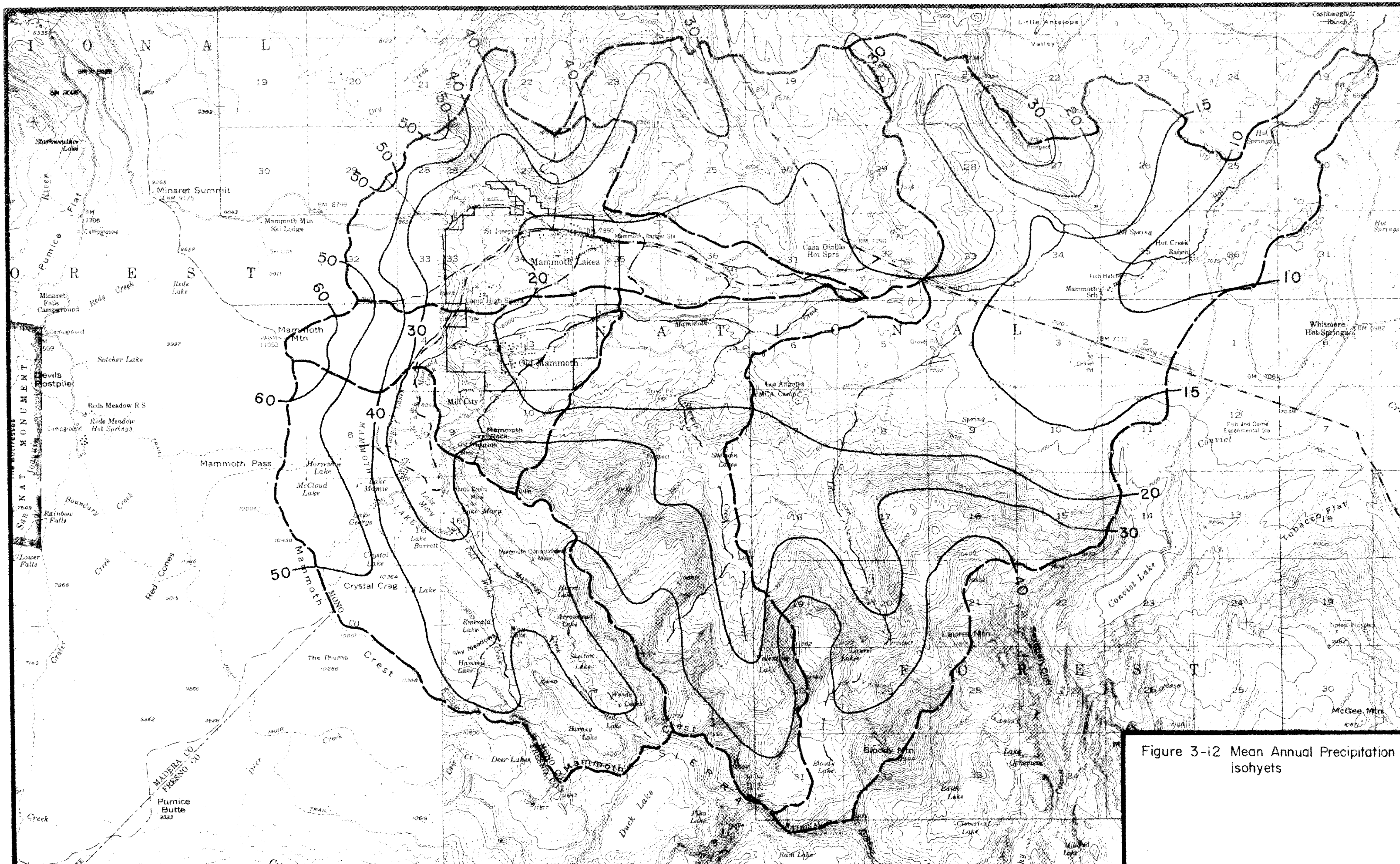



Figure 3-12 Mean Annual Precipitation Isohyets

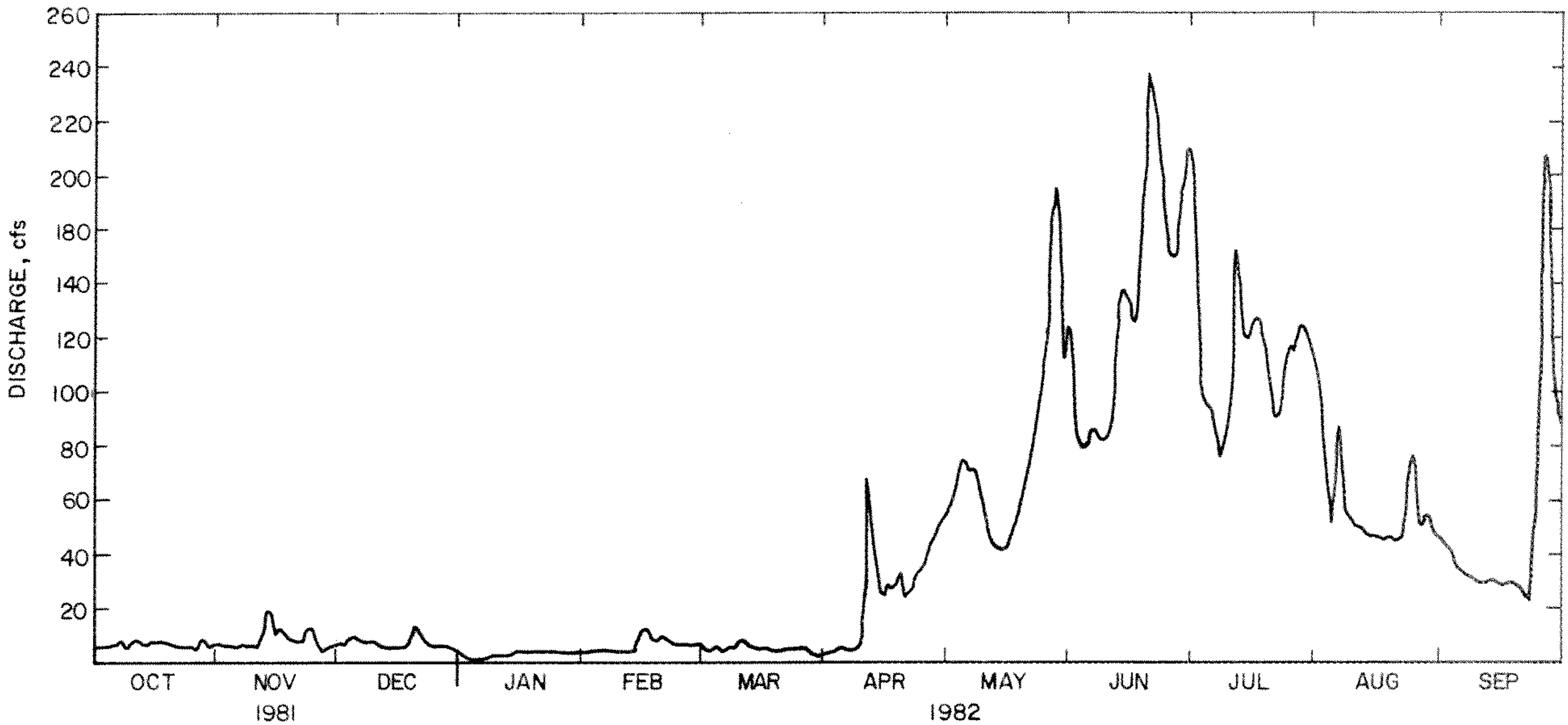



Figure 3-13 Hydrograph for Mammoth Creek at Old Hwy 395

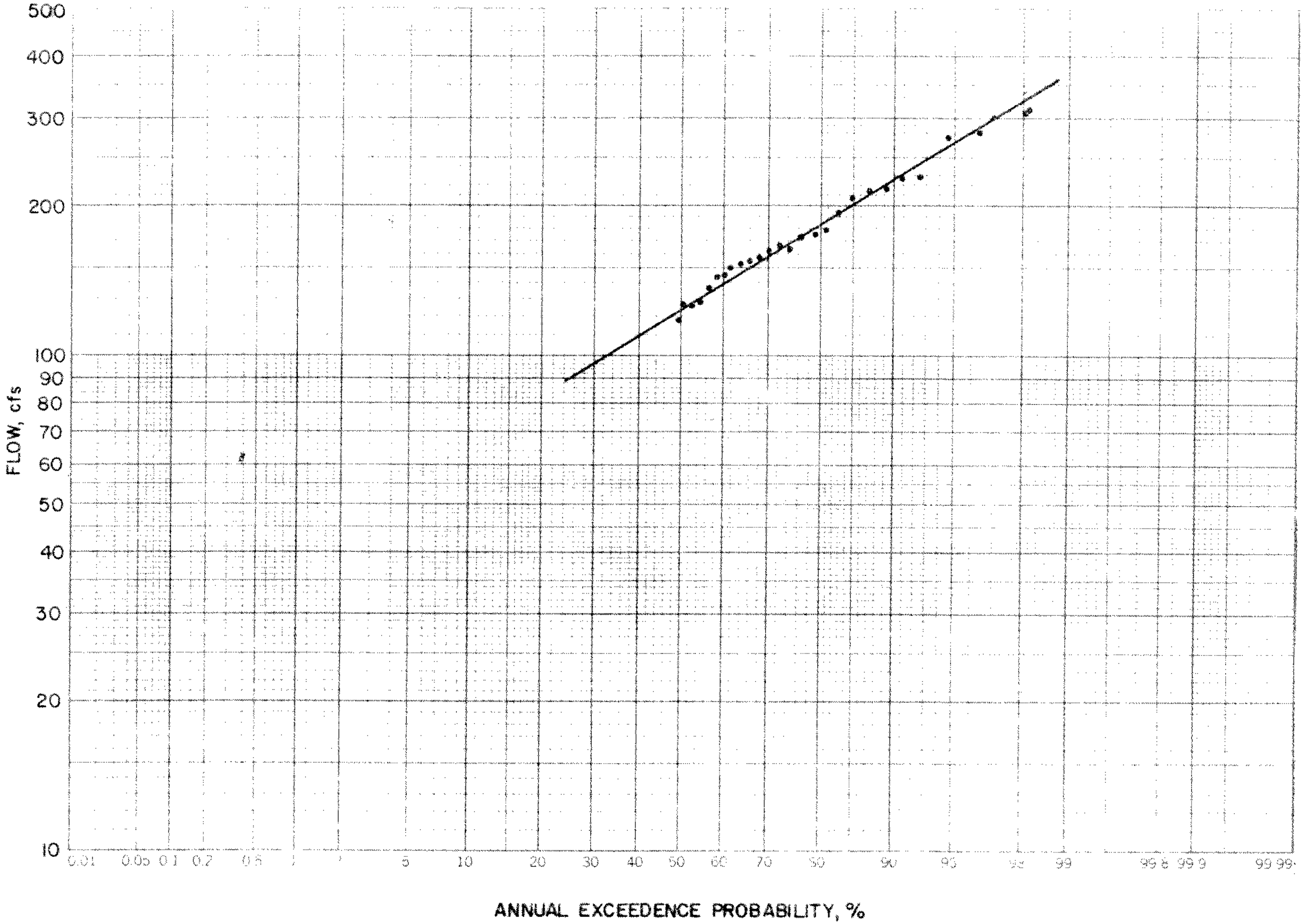



Figure 3-14 **Mean Daily Flow Frequency Diagram for Mammoth Creek at Highway 395**

drum charts, but the data are reduced and recorded as daily volumes only. No shorter term depth-duration-frequency relationships were available for any of the stations in the Mammoth area.

Actual rainfall drum chart records were available from LADWP for the years between 1973 and 1983. Because of their scale, the charts are very difficult to interpret for durations less than four hours. However, maximum hourly, 2-hourly, and 8-hourly intensities for all significant storms between 1973 and 1983 were determined as accurately as possible. Storms were analyzed which met the following criteria:

1. Occurred between November 1 and April 1 and had greater than or equal to 0.75-inch of precipitation during the 24-hour period, or

2. Occurred between April 1 and November 1 and had greater than or equal to 0.5-inch of precipitation during the 24-hour period.

The curve created from the short-term depth-duration data was compared with the daily depth-duration-frequency relationships developed by DWR and was found to agree reasonably well. In addition, data from several other stations outside the Basin, but in the same general vicinity and hydrologic setting were compared to the curve. The results of this analysis are shown by the precipitation versus frequency curve shown on Figure 3-15.

Because of its elevation, major storms in the Basin often occur as snowfall. Winter and summer storm patterns differ in that winter storms are typically associated with large frontal movements, while summer precipitation may occur as the result of local convective thunderstorms. Although much of the annual precipitation occurs in the winter months, winter storms tend to have slightly lower short-term intensities and longer durations than the summer rainstorms.

The precipitation intensity relationship must be modified for use in the master planning process and in the design manual for the design of storm drainage and flood control facilities. Because snowfall does not usually contribute to direct runoff, it was necessary to segregate the characteristics of winter and summer storms.

Data for snowfall and snow-on-ground for the 1973 through 1983 period was obtained from Caltrans District Headquarters in Bishop. The two reporting stations used were Mammoth Ranger Station and Mammoth Mountain Inn. This data was used to establish two precipitation seasons. For the period of May to

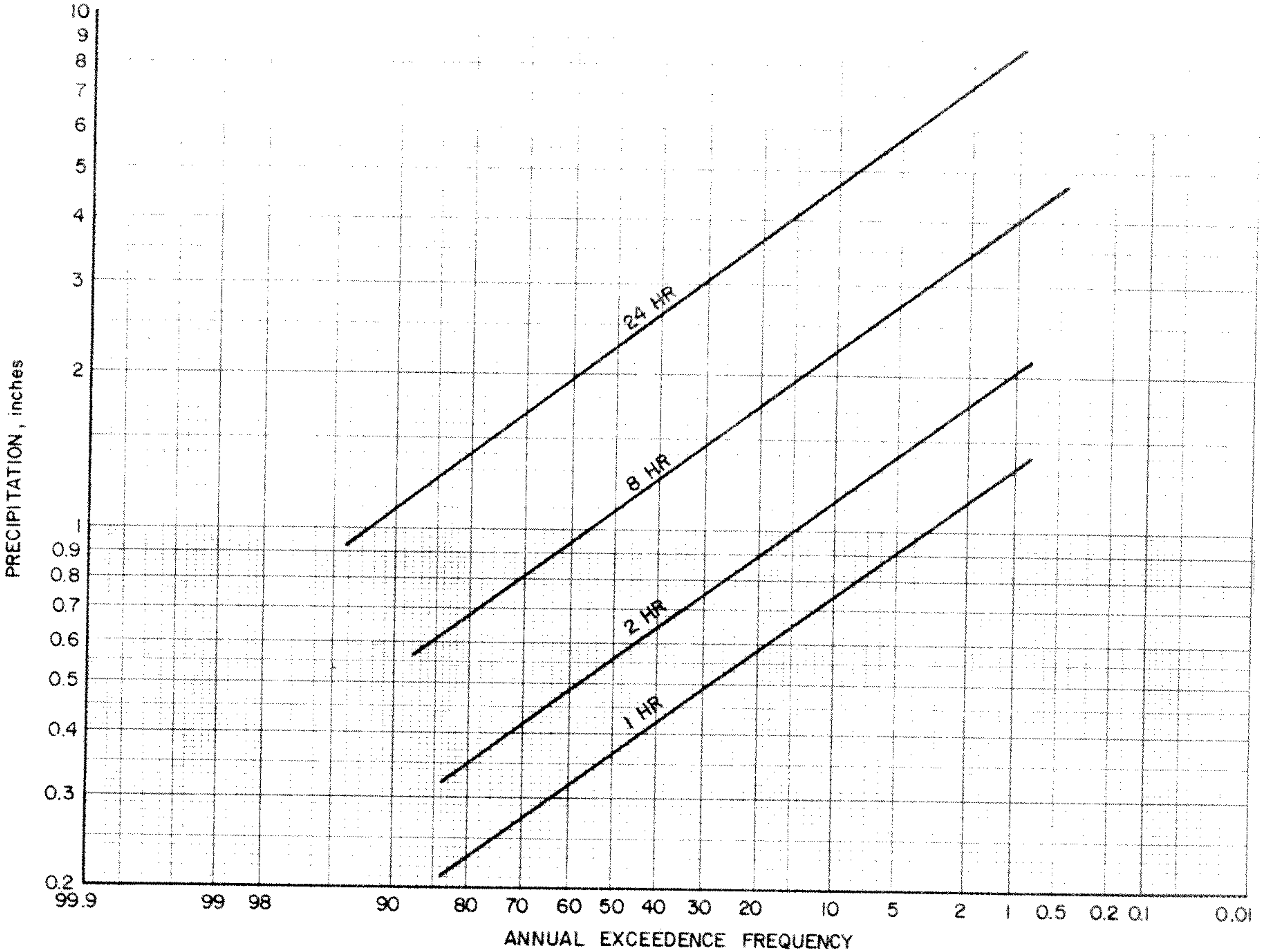



Figure 3-15 Precipitation Vs Annual Frequency

November, it was found that there was little chance of snow on the ground and little chance that precipitation during this period would occur as snow. Therefore, May through November was taken as the summer season, and December through April was taken as the winter season. The depth-duration-frequency data were then segregated by season and compared with several other stations and with the annual curve to produce the winter and summer precipitation versus frequency curves shown on Figures 3-16 and 3-17.

Spatial variations in short-term precipitation intensities in the Basin cannot be determined from the available data. Although the mean annual precipitation varies significantly with elevation and location, short-term intensities can be expected to have much less variation. Because the thunderstorms are not directly related to orographic lifting, the correlation between elevation and peak intensity is probably much weaker than it is for average annual precipitation. The elevation of the Lake Mary Store is near the average Basin elevation, and because it is slightly higher than the developed area, the intensity curves were used without elevation adjustments in the runoff calculation procedures described in Chapter 4.

## EXISTING DRAINAGE FACILITIES

Developed areas of the Mammoth Lakes community lie entirely within Watershed II and III. Approximately 40 percent of the land area is directly tributary to Mammoth Creek with the remainder tributary to a natural drainage course known as Murphy Gulch. Murphy Gulch is a seasonal stream and has very little (or even no) flow during dry months, but does carry significant runoff volumes during the spring snowmelt as well as during heavy rainfall events. Murphy Gulch eventually joins with Mammoth Creek just west of the intersection of U.S. Highway 395 and State Highway 203, approximately 2-1/2 miles east of the developed area of the community.

Watersheds II and III have been broken down into the drainage subareas shown previously on Figure 3-4. During the historical development of the Mammoth Lakes community, little attention was given to a coordinated drainage plan. Consequently, drainage improvements within the community have been built primarily in response to site-specific drainage problems, rather than integrated into a comprehensive drainage system. Much of the runoff from the community area follows a sheet-flow pattern to existing roadways or is carried in unimproved channels or ditches to drainage concentration points. Culverts at road crossings have been inconsistently designed and installed resulting in chronic ponding and maintenance problems in some areas.

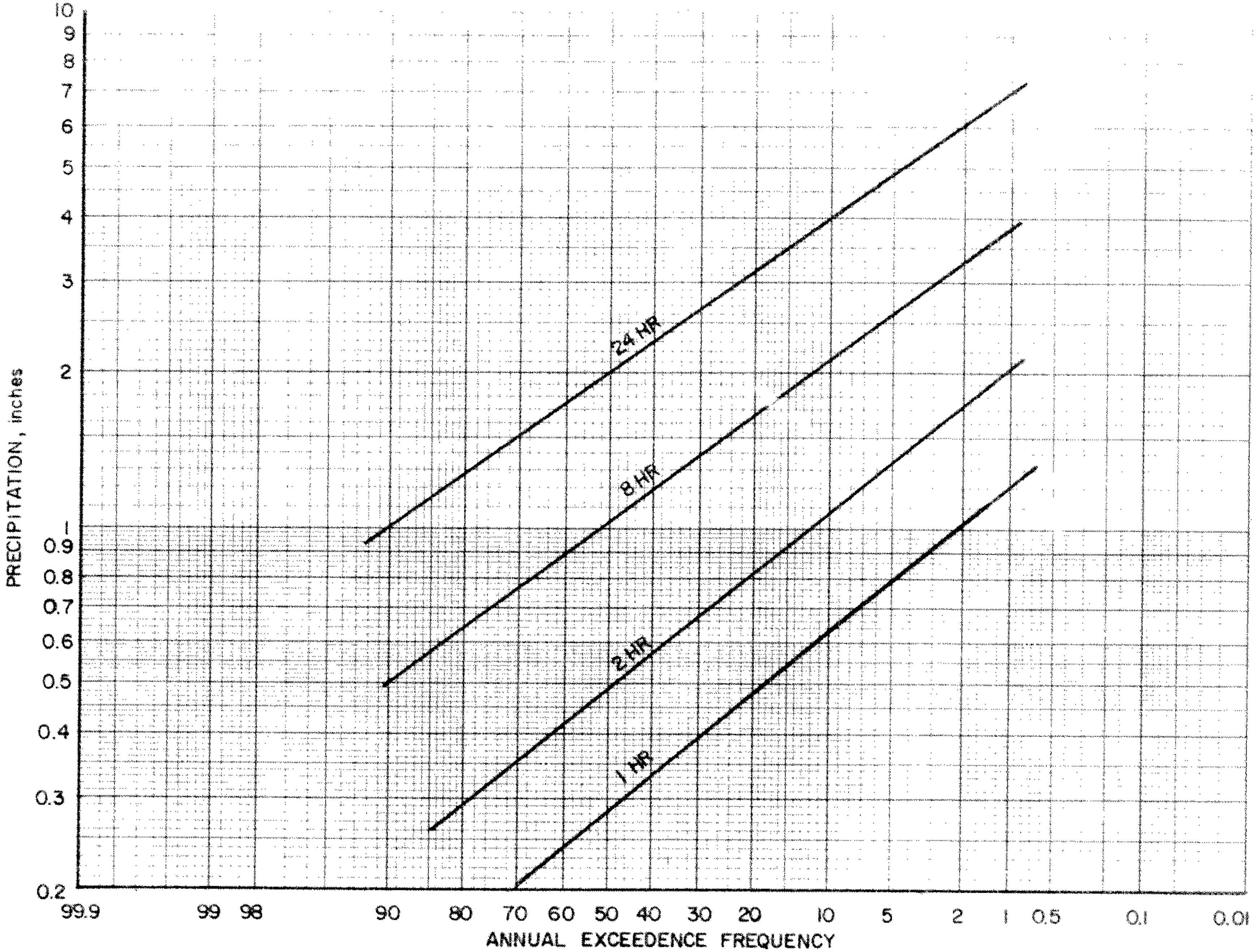



Figure 3-16 Winter Precipitation Vs Frequency

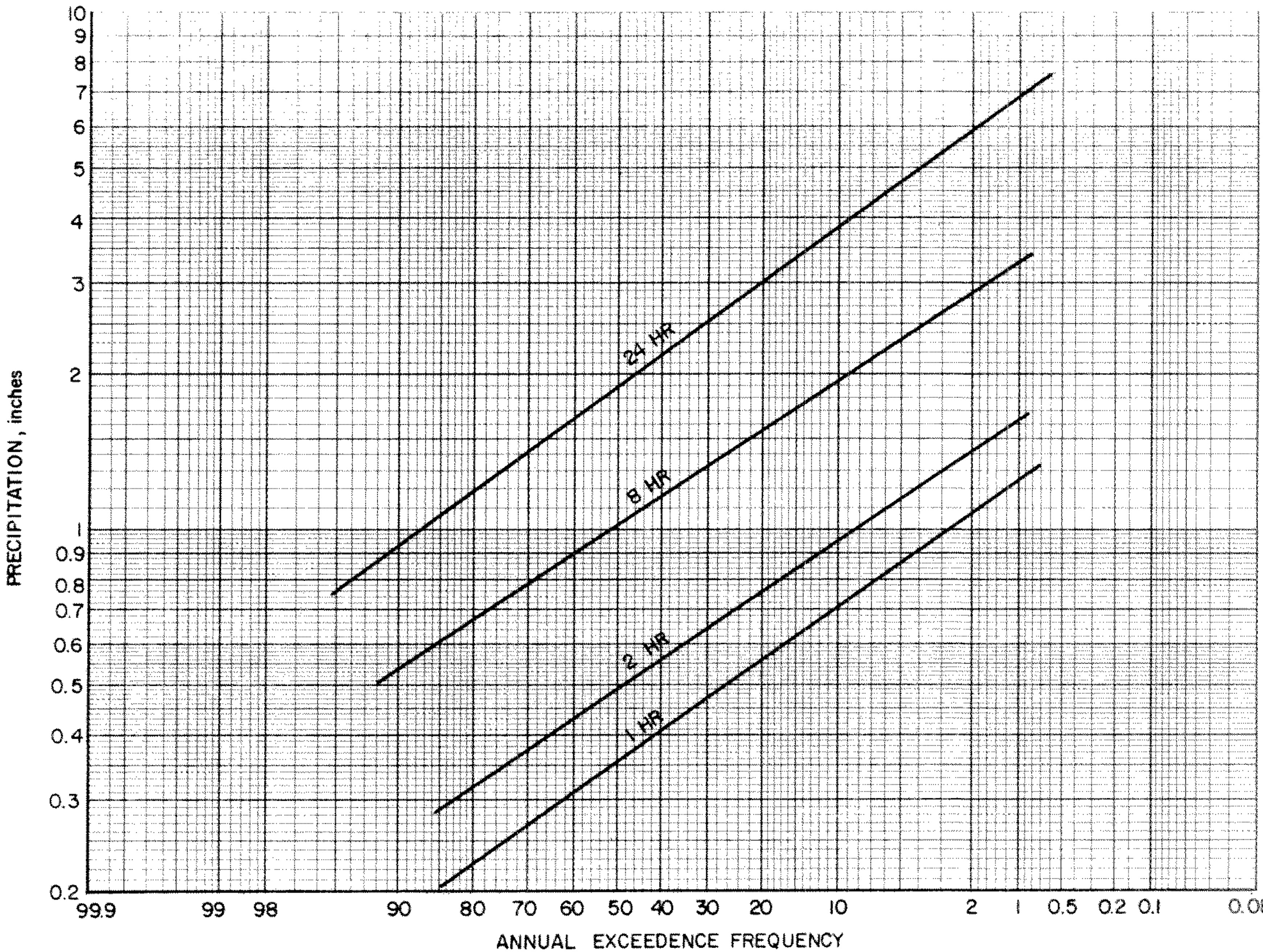



Figure 3-17 Summer Precipitation Vs Annual Frequency

The only major storm drainage project installed within the community area was undertaken in the period from 1975 through 1976. The improvements consisted of a "backbone" storm drain system extending from the Mammoth Slopes residential area to the Mammoth Ranger Station via Canyon Boulevard, Berner Street, Alpine Circle, and Main Street (Highway 203). The storm drain discharges directly to the Murphy Gulch drainage course just east of the Mammoth Ranger Station. Storm drain pipe sizes range from 72-inch at the lower end of the project to 24-inch at collection points in Canyon Boulevard. In conjunction with the project, a 260,000-cubic-foot siltation basin was constructed at the downstream end of the Murphy Gulch channel, approximately 1/4-mile from its junction with Mammoth Creek.

No other storm drainage systems or major facilities presently exist within the community.

Des_ription of Existing Facilities

Detailed maps of the existing drainage facilities within each subarea are presented in Appendix A on Figures A-1 through A-11. General drainage characteristics of each subarea are described in the following paragraphs.

Subarea II-1. Existing drainage is predominantly sheet flow across the Arcularius pasture south of Old Mammoth Road. The subarea includes major portions of the Snowcreek Planned Development. The subarea is directly tributary to Mammoth Creek in the vicnity of an existing bridge across Old Mammoth Road. The subarea receives upstream runoff from natural areas to the south of the community.

Subarea II-2. The westerly portion of the subarea (includes part of the Mammoth Vistas residential area and part of the Snowcreek Planned Development) drains by sheet flow and along roadways directly to Mammoth Creek. The easterly portion includes intensive commercial and condominium development and drains via Chateau Road and a northerly channel/culvert system to Inyo National Forest areas east of the community boundary. This portion is also tributary to Mammoth Creek.

Subarea II-3. This subarea includes most of the Old Mammoth rural-residential area and contains the main stream channel of Mammoth Creek. Drainage from developed areas is conveyed by sheet flow, unimproved ditches, and roadways directly to saturated meadow areas adjacent to the creek. The creek crosses Minaret Road and Old Mammoth Road via existing culverts.

Subarea II-4. This subarea consists of natural area and primarily includes offsite drainage from Mammoth Mountain, west of Lake Mary Road. There are no drainage improvements in this area except for culvert crossings on Lake Mary Road.

Subarea III-1. This subarea primarily consists of natural area which drains directly to the Murphy Gulch channel. The subarea includes the Murphy Gulch sedimentation/siltation basin.

Subarea III-2. This subarea is directly tributary to Subarea III-1 via existing culverts which cross Highway 203. The subarea basically encompasses lands known as the Gateway Planning Unit and includes the Mammoth Industrial Park, the Manzanita Recreational Vehicle Park, and portions of Mammoth High School and Mammoth Hospital sites. Existing drainage improvements consist of the industrial park storm drain system. All other areas are presently unimproved.

Subarea III-3. Intensive commercial and condominium development is contained in this subarea. The westerly portion drains by unimproved channels, culverts, and sheet flow; the easterly portion contains storm drain pipes and an improved channel along the easterly side of Sierra Park Road. The majority of the subarea is tributary to Murphy Gulch (Subarea III-1) via two large culverts at the intersection of Sierra Park Road and Highway 203. Some northerly areas are tributary to the existing "backbone" storm drain in Main Street (Subarea III-4) via drop inlets at the roadway edge.

Subarea III-4. Most of this subarea is natural area lying north of the community boundary, but it also includes the Sierra Vista Estates residential area and commercial development along the north side of Main Street. The subarea is tributary to the storm drain system in Main Street and most drainage is conveyed via existing improved roadways.

Subarea III-5. This is the most complex and extensive drainage subarea within the community. The drainage system extends from the lower slopes of Mammoth Mountain on the west to the Center Street commercial area on the east. All drainage is eventually tributary to the Main Street storm drain (Subarea III-4), but is conveyed by a wide variety of improved and unimproved means. The westerly portion is primarily drained by roadways and culverts; the central portion by semi-natural channels; and the easterly portion by meandering man-made channels which traverse the Sierra Valley Sites residential area. The area is characterized by both existing and proposed high density development and drainage patterns have been signficantly altered by land uses.

Subarea III-6. The majority of this subarea is natural, but the southerly portion includes the Knolls residential area. The primary drainage pattern is via existing roadways and culverts in developed portions of the subarea. Although the subarea is tributary to the existing storm drain in Alpine Circle (Subarea III-7), there is no direct improved connection.

Subarea III-7. This subarea includes the Mammoth Slopes residential area and dense condominium development in the vicinity of the Warming Hut No. 2 ski base. It receives offsite drainage from natural areas included in Subarea III-9, and is tributary to the Canyon Boulevard storm drain. The majority of the subarea drains via improved roadways to Canyon Boulevard, then down to a series of storm drain inlets at the easterly end of the subarea.

Subarea III-8. Most of this subarea is natural, but includes portions of the Knolls residential area at its downstream end. Drainage is primarily by natural channels, with some collection and drainage by improved roadways in the southeasterly portion. The subarea is tributary to the Berner Street/Alpine Circle storm drain although there is no direct improved connection.

General Drainage and Water Quality Problems

The lack of a coordinated, continuous system of drainage conveyance facilities, as well as the use of inconsistent design criteria has resulted in severe drainage problems in many areas of the Mammoth Lakes community. A general description of problem areas within each drainage subarea is presented in Table 3-10. The most prevalent problem within the developed portions of the community is related to ponding and localized flooding during periods of intense precipitation or rapid snowmelt. Significant roadside erosion problems are also common in steep areas where drainage facilities are lacking or improperly designed. Severe erosion problems also arise where drainage is concentrated at discrete points, conveyed for a short distance in culverts or storm drains, and then discharged directly to unimproved natural swales or channels.

Water quality impact arising from uncontrolled drainage discharges from the community area have become an increasing concern to the Lahontan Regional Board, the U.S. Forest Service, and the State Department of Fish and Game. Increased sediment and turbidity levels in Mammoth Creek have been monitored in the immediate vicinity of the community during significant storm events. Perhaps more disturbing is the fact that a consistent long-term increase in silt and sediment deposits in Mammoth Creek has been noted as far as 5 miles downstream from the community at the Hot Creek Fish Hatchery.

Table 3-10. Summary of Subarea Drainage and Erosion Problems

| Tributary subarea | Problems |
|---|---|
| II-1 | Uncontrolled runoff from steep slopes resulting in accelerated erosion and increased sediment loads to creek. |
| II-2 | Development of land near creek on steep slopes without provision for storm drainage control. Erosion of roadside areas, and high suspended sediment load to creek result. |
| II-3 | Direct discharge of runoff from residential development and unpaved streets to creek. Several small creeks in poorly defined and meandering channels through developed areas. High runoff causes flooding of residential lots. Culverts too small to carry runoff, result in erosion of roadside ditches, and flooding of some street areas. Severe erosion in steep upper portion of subarea by uncontrolled runoff along streets. |
| III-1 | Murphy Gulch Sediment Retention Basin not functioning satisfactorily on a consistent basis. |
| III-3 | Lack of drainage facilities in commercial area causes intersection and street flooding during intense precipitation events. Discontinuous channels and undersized culverts cause runoff flow to be carried on surface in streets, through parking lots, and across residential property. Drainage paths are poorly drained. This results in minor flooding of commercial and residential property. |
| III-4 | Residential area is near outlet of large natural tributary subarea. Lack of drainage facilities causes severe roadside erosion and flooding in residential lots. |
| III-5 | Flow from large tributary area carried through residential development in small, poorly defined channels and undersized culverts. Serious flooding of residential property in lower portions of tributary subarea. Extreme erosion problems in steep portions of upper portion of tributary subarea due to steep slopes and uncontrolled runoff. Drainage from roadways on steep slopes runs directly downslope resulting in erosion and flooding problems below. |
| III-6 | Residential area near outlet of large natural tributary subarea with no provision for transporting flow. Roadside erosion, flooding of residential lots, garages, and driveways result. |
| III-7 | Relatively heavy development on steep slopes without provision for drainage has resulted in several problem areas where runoff flows across residential property and perpendicular to streets. Problems include erosion of roadsides, uncontrolled runoff through residential properties, dead end drainage paths, flooding of intersections and streets, and deposition of sediment in streets and yards. At the upper end, flow from large natural area and ski area runs down Canyon Boulevard uncontrolled. Result is standing water in lots below Canyon Boulevard, ravines eroded in street, and erosional debris over large area. |

The Murphy Gulch siltation basin was originally constructed to control sediment discharges from most of the developed area of the community. The Basin is essentially formed by an earth fill dam which was originally constructed as part of an old roadway fill across the Murphy Gulch channel. At maximum ponded water level (approximately 7 or 8 feet deep), the Basin has a capacity of approximately 260,000 cubic feet. Although the Basin traps a significant volume of silt and sediment each year, there is considerable evidence that its performance is not completely satisfactory. During peak runoff periods, sediment removal efficiencies are drastically reduced (due to high flow-through velocities) resulting in visibly turbid effluent discharges. It appears that these velocities are frequently high enough to actually scour and resuspend sediments which have previously deposited in the Basin. The old earth fill dam is in relatively poor condition and there is some seepage on its downstream face. Although several proposals have been considered during recent years for the expansion and improvement of sediment control facilities, no significant progress has been made to date.

# CHAPTER 4

# RUNOFF CALCULATION PROCEDURE

This chapter describes the development of a runoff calculation procedure for use in designing storm drainage and flood control facilities. The procedure has been incorporated into the Mammoth Lakes Storm Drainage and Erosion Control Design Manual (Design Manual), which specifies return periods for storms to be used for design, provides typical design details, and presents the runoff calculation procedure in detail. This chapter describes how the procedure was developed. The reader should refer to the Design Manual for specific procedural details.

## SUMMARY OF METHODS IN COMMON USE

Several methods which are commonly used by public agencies in the design of storm drainage and flood control facilities are described below. The methods fall generally into three categories: (1) rational methods, (2) flow-frequency analyses, and (3) hydrograph methods.

This section is not intended to be a comprehensive discussion of runoff calculation methods in current use, but rather to present examples of some of the most commonly used methods, their advantages and disadvantages, and their applicability to the Mammoth Lakes Basin.

### Rational Method

The procedure most commonly used to calculate runoff from urban areas is the rational method, which has the general form:

$$Q = CiA$$

Where: $Q$ = runoff flow
$C$ = runoff coefficient or fraction
$i$ = precipitation intensity
$A$ = tributary area

This equation is popular because of its simplicity. The following steps are normally used to compute peak runoff flow:

1. Determine the tributary area, A.

2. Find the time of concentration for the tributary area, $t_c$.

3. Find the precipitation intensity, i, for the time of concentration of the tributary area and the return period of storm to be used for design.

4. Find the composite runoff coefficient, C, for the tributary area considering the specific improvements on the site or the general land use of the area.

5. Calculate Q from C, i, and A.

Individual procedures based on the rational method differ primarily in the way in which C, i, and $t_c$ are determined. Values of C for different types of surfaces or different land uses are usually specified by agencies which review drainage design. Some agencies specify corrections to coefficients to be used based on the size of the tributary area. These corrections are normally intended to account for the differences in infiltration-storage-runoff relationships between large and small areas, or may be used to provide safety factors in the design of facilities.

Runoff Coefficient. The accuracy of the rational method depends on the accuracy to which the C and i terms in the equation can be determined. Although C is normally taken as a constant for each type of land use or surface, the actual proportion of precipitation which runs off depends on factors such as slope, intensity of rainfall, soil type, vegetation, and antecedent soil conditions (e.g., moisture content, frozen depth, compaction). Although it is not practical to include all the factors in a runoff calculation procedure, the accuracy of the method can be severely limited unless the most important factors for a particular area are included. For example, Mammoth Lakes has a significant number of areas where slopes are steep and rocky. Unless corrections for general soil type and slope steepness are included in the runoff calculation procedure, the flows calculated using the rational method would incorrectly be the same from these areas as from the same acreage of flat, well vegetated park or meadow.

Another problem arises in determining C for an area with heavy snowfall. Snow has two major effects on the rainfall-runoff relationship. First, a small amount of snow on the ground can be converted to runoff very quickly by rainfall. In effect, this increases the runoff volume per unit of rainfall volume yielded from a tributary area. This effect increases the apparent C value. Second, snow on the ground increases the time of concentration of a basin by slowing the travel of water through the watershed. Because a longer time of concentration corresponds to a lower precipitation intensity (see depth-duration curves in Chapter 3), this effect decreases the apparent precipitation intensity. Areas with heavy snowfall are also likely to have frequent freezing and thawing of the soil, resulting in variations in the apparent C value. Where design flows may be caused by snowmelt alone, the rational method simply does not apply. Because of the hydrologic importance of snow and snowfall in the Mammoth Lakes area, a comprehensive runoff procedure for use in the area must include the effects of snow.

Precipitation Intensity. The accuracy of the precipitation intensity term, i, is also an important factor in the accuracy of the rational method equation. This term depends on two principal components--the time of concentration and the precipitation depth-duration-frequency relationship. The time of concentration is a function of length of travel, slope, antecedent precipitation and soil conditions, and nature of the surface (vegetative cover, depression storage, etc.). The time of concentration of flow through improved channels or pipes may be fairly accurately estimated for small areas from the hydraulic properties of the channel or pipe. Time of concentration for overland flow is more difficult to estimate due to large variations in velocity caused by difference in slope and nature of the surface. As discussed above, the time of concentration is also affected by snow on the ground. Accurate estimation of the time of concentration is important to the overall accuracy of the calculation, especially in smaller tributary areas. For relatively short times of concentration, the precipitation intensity may vary significantly with design precipitation duration. To maintain reasonable accuracy, the method of determining the time of concentration should at least include the general surface type (paved, vegetated, etc.) and whether or not the surface will be snow-covered during the design storm.

Precipitation depth-duration-frequency relationships provide the basic precipitation intensity information for use in design. They are generally statistically developed from long-term precipitation records. As discussed in Chapter 3, no depth-duration-frequency curves have previously been developed and published for the Mammoth Lakes area. The winter and summer curves presented in Chapter 3 are the result of data obtained during this study for the Lake Mary rain gage. It is important to separate snowfall and rainfall data in production of the curves, since snowfall does not directly relate to runoff. Use of annual depth-duration-frequency curves in snowy areas leads to erroneous results because they relate the intensity of precipitation, rather than rainfall, to a return period or frequency. It is also helpful to separate winter rainfall (that is, rainfall which falls or may fall on snow-covered ground) from summer rainfall because of the differences in the runoff coefficients and times of concentrations which may exist for the same tributary area in different seasons.

Unfortunately, the amount and accuracy of short-term precipitation depth-duration-frequency data available for Mammoth Lakes is limited. No information is available on the spatial variation of these relationships over the tributary area. An important step in the refinement of the runoff calculation procedure developed in this study should be to collect short-term precipitation intensity data at several stations in the basin. Unfortunately, an adequate data base for use in statistical analysis will require 10 to 20 years of data collection.

## Flow-Frequency Analysis

Runoff calculation methods which rely on flow-frequency analysis differ from the rational method in that they are developed from flow data rather than from precipitation data. In many ways, the flow-frequency approach is simpler than even the rational method. Where sufficient flow data exist, all that is required to develop the relationship is a plot of annual peak flows versus frequency. The difficulty arises when a flow-frequency relationship from one point must be transferred to another point in the basin where no data have been collected. Local conditions often introduce variations in peak flow rates per unit area which cannot be accounted for by this type of method. However, for relatively large areas in a fairly homogeneous watershed, a flow-frequency relationship from one point can be adapted to subwatersheds in its basin. The principal factors used to modify the relationship are usually area, elevation, and mean annual precipitation.

The flow-frequency method has an advantage over the rational method in that factors such as C, $t_c$, and i need not be estimated. This eliminates some of the potential sources of error, and the compounding of errors which can result from the use of an equation with several terms which must be estimated. Its primary disadvantage is that it cannot be easily or accurately transferred for use in small areas from one basin to another which have different hydrologic characteristics. For this reason, it is most applicable to relatively large undeveloped or lightly developed areas.

## Hydrograph Methods

The oldest and best known hydrograph technique is the unit hydrograph method which is often used for predicting peak flood flows and volumes where storage in reservoirs or lakes must be considered. The basic premises for predicting flood flow rates using the unit hydrograph method are that for a given watershed the flow at any time is proportional to the volume of runoff produced, and that the hydrograph resulting from a series of excess rainfall increments in unit time steps can be built up by superimposing the hydrographs for the individual time steps.

The first step in using the unit hydrograph method is generally to estimate the volume of runoff produced per unit of rainfall. This depends on losses to infiltration, evaporation and transpiration, and on retention in the basin. The losses may be estimated from the hydrologic characteristics of the basin or from actual precipitation runoff data. The second step is the development of the unit hydrograph, the hydrograph which contains a volume of one inch of runoff over a specified unit of time. The shape of the unit hydrograph may be determined from precipitation/flow data or it may be estimated from basin hydrologic characteristics such as soils, vegetation, and slope. A storm hydrograph is developed by dividing the storm event into unit time increments and finding the hydrographs which result from the rairfall excess in each time increment by multiplying the ordinates of the unit hydrograph by the actual rainfall excess in the time increment. The hydrographs for the unit time increments are then superimposed to find the storm runoff hydrograph. When the actual pattern of precipitation is not known, a storm hydrograph can be produced by assuming a typical storm distribution pattern and a given total volume of precipitation.

Expressions for the peak flow rate can be written as a function of total runoff volume per unit area, basin tributary area, basin time of concentration or lag time, and a coefficient. Where sufficient data are not available for derivation, the coefficient must be estimated from empirical relationships based on the watershed characteristics.

The unit hydrograph method is much more complex than the rational method, or the flow-frequency analysis method. Considerable effort and background data may be required to accurately estimate the shape of the unit hydrograph. Further, a precipitation pattern must be known or assumed to find the peak flow for a given storm duration and precipitation volume. To simplify the calculations, a standard unit hydrograph may be used and a storm pattern assumed. The peak flow rate can then be found relatively easily, but the results are then very general and may not apply with sufficient accuracy to particular tributary subareas with local differences in slope, soil, vegetation, or precipitation intensity. In general, the unit hydrograph method is best applied to fairly homogeneous tributary areas greater than ten acres in size. The method has been used extensively in forested and agricultural watersheds.

## COMPARISON OF SEVERAL PROCEDURES

For comparison, Table 4-1 presents the results of calculations using procedures adopted by six agencies. Four of the procedures are applications of the rational method, one is a flow-frequency analysis method, and one is based on the unit hydrograph method. All of the calculations are for the 100-year event in Mammoth Lakes and have been made for a sample tributary area before and after urbanization. The sample tributary area used for the calculations was Tributary Subarea III 5 B (see Chapter 3).

Many of the methods include rainfall data for use in the calculations which are specific to the area for which they are intended. In these cases, the depth-duration-frequency curves presented in Chapter 3 for summer precipitation in Mammoth Lakes were substituted for the intensities specified in the technique. This allows comparison of the methods when applied to the Mammoth Lakes area on a consistent basis.

Table 4-2 briefly lists the advantages and disadvantages of each method. As would be expected, the rational methods yield results which compare closely. The flow-frequency method and the hydrograph method give results which are somewhat lower. This is primarily because the flow-frequency and hydrograph methods have been developed from data on larger, more natural watersheds, while the rational method has been developed for use in smaller urban watersheds. The rational methods therefore tend to overestimate flows from larger homogeneous natural watersheds, while the other methods tend to underestimate flows from smaller urban watersheds.

The analysis described above was used to formulate an approach to the development of a runoff procedure for Mammoth Lakes. The main objectives in development of the procedure were:

1. It should be relatively simple to apply.

2. It should be flexible enough to account for differences in hydrologic characteristics of small basins such as soils, slopes, vegetation, land use, or density of development.

3. It should apply to both large, natural basins and smaller developed areas because in some cases flow from undeveloped areas must be conveyed through developed areas.

Table 4-1. Comparison of Results of Calculations for Several Common Procedures

| Agency | Description of method | Calculated 100-year peak flow, cfs | | Comments |
|---|---|---|---|---|
| | | Non-urban | Urban | |
| Placer County | Rational. Based on calculated time of concentration as a function of overland channel slope. Nomograph used to solve for intensity of precipitation given time of concentration, return period, and mean annual precipitation for specific basin. Runoff coefficient calculated using areas of surface types (e.g., paved, roofs, landscaped, etc.) Coefficient for natural areas is corrected for general classes of slopes, soil permeabilities, vegetation, and surface smoothness. Intensity and runoff coefficient used in second nomograph to find flow. | 140 | 242 | Precipitation intensity from Mammoth Lakes depth-duration-frequency curve for summer used in place of Placer County intensities in nomograph. |
| Caltrans | Rational. Based on change in stream elevation per unit length for time of concentration (solved by nomograph), general geographical location, tributary area, and runoff coefficient. | 180 | 300 | Time of concentration had to be estimated for urban watershed--procedure did not apply. Precipitation intensities from Mammoth Lakes depth-duration-frequency cuve for summer. Runoff coefficients very general, not easily applied to urban land uses or surface types. |
| Sacramento County Department of Public Works | Rational. Single graph for flow vs. tributary area. Choice of three curves for low, medium, and high densities. | 132 | 231 | Curve gives $Q^{10}$ only. Factor of 1.65 used by County to estimate $Q^{100}$. Method does not include precipitation intensity as a variable, so result adjusted by estimated ratio of Mammoth intensity divided by Sacramento County intensity. |
| City of South Lake Tahoe | Rational. Time of concentration calculated from nomograph based on exponential function of length of channel over change in elevation. Runoff coefficients based on general land use types (residential, commercial, etc.) and percent paved. Flow calculated from Q = CiA. | 141 | 209 | Time of concentration shorter than for other methods, runoff coefficient lower. Precipitation intensity from Mammoth depth-duration-frequency curve for summer. Less difference between developed and undeveloped runoff coefficients than for other methods. |
| U.S. Geological Survey | Flood Frequency Analysis. Equations developed from regressional analysis for regions of California. Equation for Sierra region used. Variables are area, elevation, and mean annual precipitation. Adjustment for urbanization included as a function of percent of basin developed and percent of channels improved or piped. | 70 | 110 | Although this result seems low, analysis of Mammoth Creek and Convict Creek 50-year flow records indicate that the equation gives results which are higher than actual flows. |
| U.S. Soil Conservation Service | SCS Hydrograph Method. Based on standard hydrograph shape, regional storm distribution pattern, hydrologic soil/vegetation classification, slope, and area. Precipitation used is 24-hour precipitation in 100-year event. Flow read directly from curves. | 120 | 225 | Procedure not strictly applicable to a developed area. Urban flow estimated based on curves for intense agricultural land use and roadways. |

Table 4-2. Comparison of Runoff Calculation Methods

| Agency | Method type | Advantages | Disadvantages |
|---|---|---|---|
| Placer County | Rational | 1. Easy to use.<br>2. Flexibility provided in calculation of runoff coefficient depending on surface types, slopes, vegetation.<br>3. Allows calculation of 10-, 25-, and 100-year flows.<br>4. Directly related to a precipitation depth-duration-frequency relationship. | 1. Nomograph is not accurate over entire range of flows to be calculated.<br>2. Precipitation intensities based on mean annual precipitation.<br>3. Cannot account for snowmelt or snow on ground. |
| Caltrans | Rational | 1. Easy to use. | 1. Nomograph is not very accurate.<br>2. Does not apply well to urban watersheds.<br>3. Runoff coefficients too general.<br>4. Only 100-year flow can be calculated.<br>5. Cannot account for snowmelt or snow on ground.<br>6. Precipitation intensities based on very general geographical relationship. |
| Sacramento County Department of Public Works | Rational | 1. Extremely easy to use. | 1. Relies heavily on very simple, general equations which may not be accurate for specific locations.<br>2. Little flexibility in assigning runoff coefficients.<br>3. Relationship between times of concentration, precipitation intensities, and runoff flows not clear. Only flow vs. area is shown.<br>4. Cannot account for snowmelt or snow on ground. |
| City of South Lake Tahoe | Rational | 1. Includes method for calculation of time of concentration based on function of length of flow and slope.<br>2. Easy to use.<br>3. Flow calculated from $Q = CiA$, and related directly to a design precipitation intensity for the calculated time of concentration. | 1. Runoff coefficients too general—not enough flexibility in calculation of C for different surface types, slopes, vegetation, etc.<br>2. Cannot account for snow on ground or snowmelt. |
| U.S. Geological Survey | Flow-frequency (by regression analysis of streams in regions) | 1. Based on actual flow data.<br>2. Easy to use.<br>3. Accounts for snowmelt flows. | 1. Very general relationship for streams in large region.<br>2. Best applied to larger watersheds which are not heavily developed.<br>3. Based on mean annual precipitation.<br>4. General equation apparently not very accurate for Mammoth Creek. |
| U.S. Soil Conservation Service | Hydrograph | 1. Uses 24-hour precipitation. Data for this period are more available than shorter durations.<br>2. Includes factors such as slope, soil types, and assumed storm distribution pattern.<br>3. Full procedure can be used to calculate runoff volume as well as peak flow for various precipitation patterns; nomograph procedure can be used to calculate only peak flow relatively quickly. | 1. Procedure not strictly applicable to a developed area.<br>2. Best applied to relatively large watersheds rather than small urban areas.<br>3. More complex and requires more subjective professional judgment in determining appropriate hydrologic soil/cover classfications than other procedures.<br>4. Does not account for snowmelt or snow on ground. |

4. It should account for major hydrologic factors and conditions important in the Mammoth Lakes area. For example, it should include the effects of snow on the ground, snowmelt, and changes in runoff coefficients resulting from antecedent conditions.

5. It should be based as much as possible on specific hydrologic data from the Mammoth Lakes area. This improves the accuracy of the procedure and allows adjustment in the future if additional data become available for analysis.

Based on the limited precipitation and flow data available, the general approach adopted was to develop two procedures for calculation of runoff--one which applied to smaller urbanized basins, and one which applied to larger natural areas. The procedure for smaller basins was based on the rational method, and the depth-duration-frequency curves presented in Chapter 3. The procedure for larger basins was based on streamflow data in Mammoth Creek and is a flow-frequency method. The development of the procedures is described in the following section.

## DEVELOPMENT OF RUNOFF CALCULATION PROCEDURES

This section describes the conceptual development of runoff calculation procedures for Mammoth Lakes. The process of development was necessarily an iterative one, with modifications made as the procedures were tested in calculation of flows for actual tributary areas. The procedure developed for small urban basins is called Procedure A, and the procedure for larger, natural basins is called Procedure B.

### Procedure A Development

The development of Procedure A began with the development of the depth-duration-frequency (DDF) curves for Mammoth Lakes. Because the effects of rain on snow were of interest, it was necessary to develop DDF curves which would separately represent winter (rain on snow a possibility) and summer (rain only) conditions. In addition, a method had to be devised to predict the "effective" precipitation intensity of rain on snow and the chances of its occurring. Figure 4-1 shows a flow chart for the development of the precipitation intensity design curves. The resulting DDF curves were really design curves--the winter curve represents depth of precipitation contributing to runoff, rather than a strict depth-duration-frequency relationship for precipitation. Analysis of snowfall and snow-on-ground data indicated that there was little chance of significant snow on the ground during a major storm from May to November, and that the storms during this period are generally rain. Therefore, the summer season was taken as May through November, and the

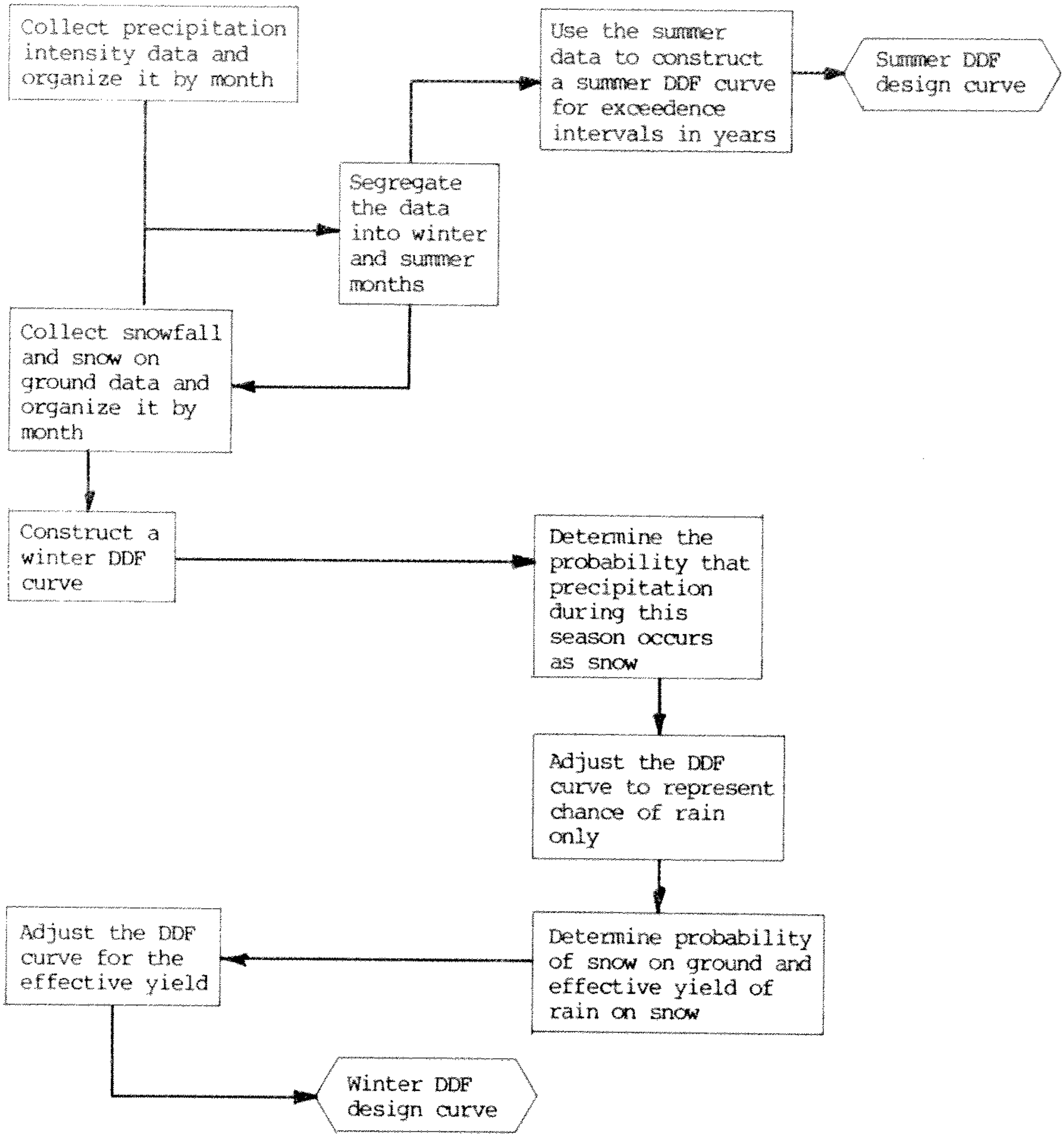



Figure 4-1. Depth-Duration-Frequency (DDF) Design Curve Development

winter season was taken as December through April. The resulting winter and summer depth-duration-frequency design curves were incorporated directly into Procedure A.

After development of the precipitation intensity curves, the next step was to define the procedures to be used for finding C, the runoff coefficient for a particular area or basin. As noted previously, most methods specify constant C values for use with particular surface types (paved, landscaped, etc.) or with land use types (residential, commercial, etc.). However, actual C values also depend on antecedent conditions, season, and rainfall intensity. This effect is especially important in natural or landscaped areas where soil moisture conditions and the amount of depression storage available are highly variable. A review of other procedures and various literature sources indicated that typical values commonly used with specific surface types were:

1. Pavement--0.85 to 0.95
2. Roofs--0.85 to 0.95
3. Natural or landscaped areas--0.15 to 0.75, depending mainly on slope, soils, and vegetative cover.

A runoff coefficient of C = 0.90 was selected for paving and roof areas. For aggregate driveways and walks, a coefficient of C = 0.80 was selected, and for unpaved corporation yards or similar compacted, relatively flat areas, a coefficient of C = 0.75 was chosen.

Coefficients for natural and landscaped areas were initially made a function of season and ground slope. When additional soils information became available, soil type was also included. It was assumed that vegetative cover was related to soil type (e.g., rocky soils have little vegetation), and that the calculation results should not rely too heavily on the establishment of heavy vegetative cover in developed areas. Figure 4-2 shows the resulting graph of design runoff fractions (RF) and reduction ratios (RR). The coefficient of runoff from a natural or landscaped area, Cn, is determined by:

$$C_n = RF \times RR$$

The purpose of the reduction ratio is to correct for infiltration losses on the flatter slopes. The overall runoff coefficient, C, for a tributary area is calculated by weighted average of the area in each category. For example, an area which is 30 percent roofs, 20 percent paved, and 50 percent natural or landscaped would have a runoff coefficient:

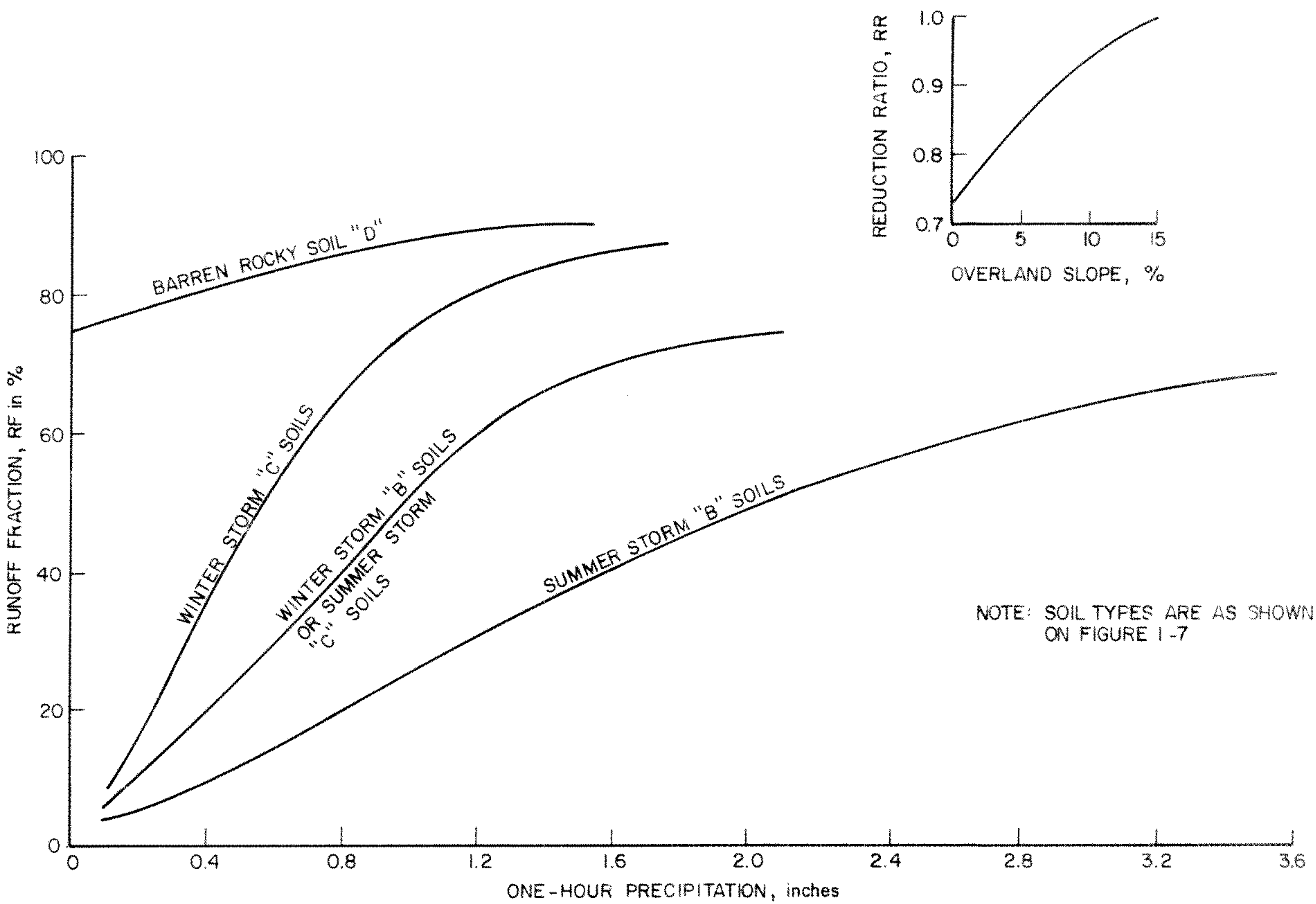



Figure 4-2 Natural Area Runoff Factor, RF, and Reduction Ratio, RR

$$C = (0.90)(0.30) + (0.90)(0.20) + (Cn)(0.50)$$

Where: Cn = natural runoff coefficient from graph = RR x RF

Two C values are required--one for a summer storm and one for a winter storm.

After a procedure for calculating C was defined, the next step in the development of the procedure was to specify the way in which the time of concentration would be calculated. The precipitation intensity used in the traditional rational formula depends directly on the time of concentration for the tributary area. The time of concentration has two components--the travel time required for overland flow of runoff to a defined channel (ditch, creek, gutter, storm drain, etc.), and the travel time required for flow in the channel to reach the basin outlet. One of the primary reasons for including both winter and summer storms in the procedure was to account for the difference in travel time caused by snow on the ground. Figure 4-3 shows the graph used in finding the variable $t_{co}$, the overland flow time of concentration. This graph can be used to find $t_{co}$ values for both winter and summer conditions, and includes corrections for pavement and snowplowing. The channel flow time of concentration, $t_{cc}$, can also be determined from a graph. Figure 4-4 shows the curves initially developed for finding this parameter. The curves are based on expected velocities in different types of channels over a range of slopes. The times of concentration from Figures 4-3 and 4-4 are added together to find the total time of concentration, $t_c$. A minimum time of concentration of 15 minutes should be used to prevent excessive extrapolation of the depth-duration-frequency data.

The resulting procedure can be used to find the design runoff flow for a particular tributary area by applying the rational formula in the traditional manner, except that flows are calculated for both winter and summer conditions. The larger of the two flows is taken as the design flow. The relationship between winter and summer flows varies according to design exceedence interval and relative proportions of natural and developed areas within the basin.

## Procedure B Development

Procedure B is intended for use in larger, natural areas. A flow-frequency analysis approach was adopted, based on the flow data available and the ease with which it could be applied. Sufficient concurrent precipitation and runoff data were not available to develop a hydrograph method with reasonable accuracy.

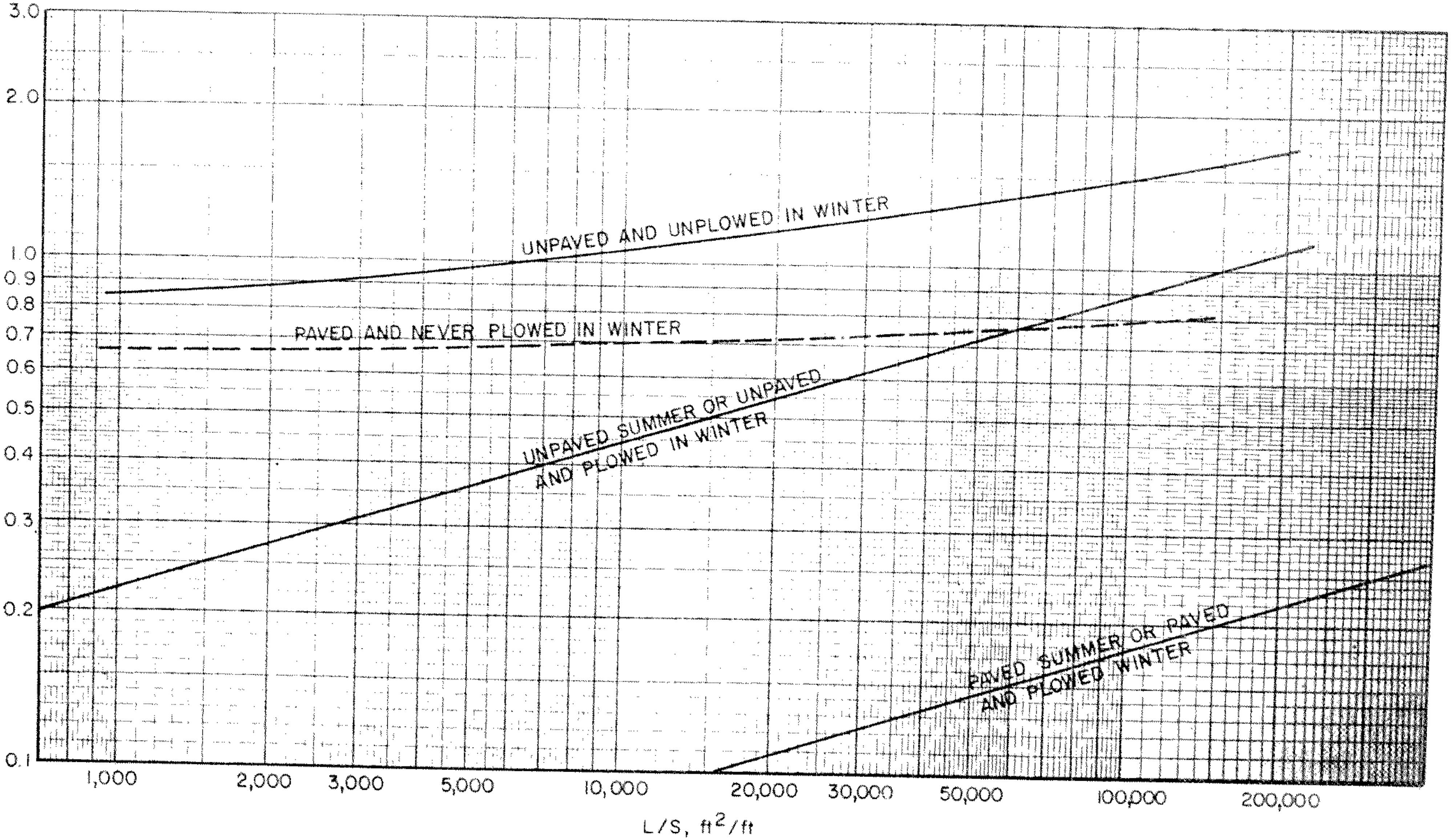



Figure 4-3 Overland Flow tc Component, tco

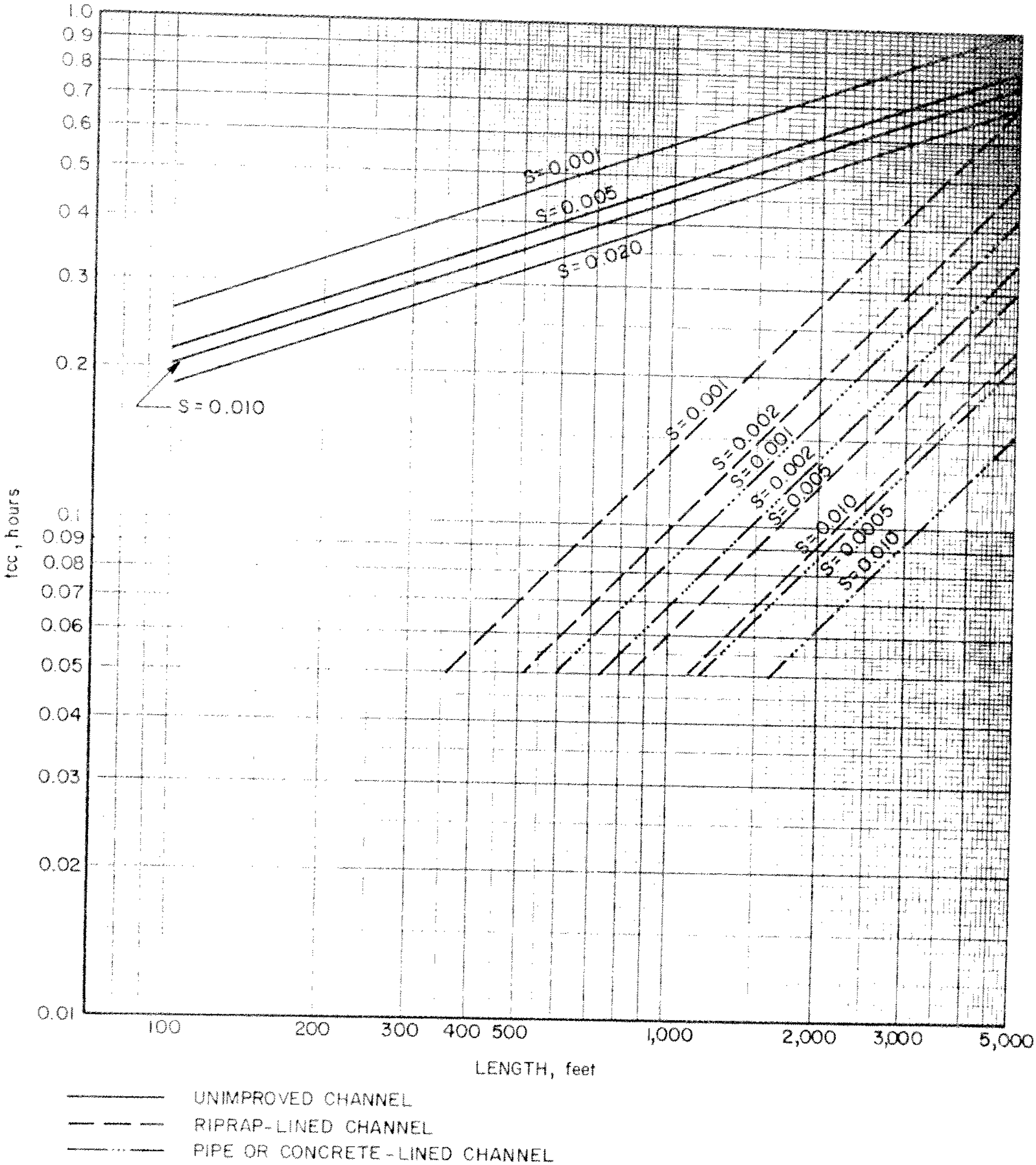



Figure 4-4 Channel Flow tc Component, tcc

The flow out of a large, natural basin in the Mammoth Lakes area has two principal components--snowmelt and rain flood flows. In general, flow records indicate that the peak flows in Mammoth Creek at Highway 395 are produced by snowmelt. Extreme rainfall events may produce short-term peaks on an annual hydrograph which is dominated by flows produced by snowmelt. This situation is typical of major basins on the eastern side of the Sierra Nevada.

The mean daily flow records for Hot Creek at Highway 395 were used to develop the flow-frequency relationships. Snowmelt flows were segregated from rain flood flows by plotting flow-frequency relationships separately for rainy and non-rainy periods.

Rain Flood Flows. To calculate rain flood flows from specific tributary subareas, a procedure for transferring the flow-frequency relationships developed for Hot Creek at Highway 395 to other areas had to be developed. These types of procedures have been developed by the U.S. Geological Survey, U.S. Army Corps of Engineers, and others. The procedure used here was one developed by the U.S. Army Corps of Engineers. The variables involved are a linear elevation factor, an exponential function of tributary area, and an exponential function of mean annual precipitation. The Hot Creek Basin characteristics and Hot Creek rain flood frequency curve were used to define a coefficient, C, to be used in calculating the maximum mean daily rain flood flow. The resulting equation for mean daily design flow has the form:

$$Q = CKA^{0.85}P^{2}$$

Where: C = a constant related to design exceedence interval and found from a graph

K = a linear elevation factor computed from the mean basin elevation and two constants

A = the basin area

P = the mean annual precipitation in the tributary area.

Peak runoff will be significantly greater than mean daily flow unless the stream system is highly regulated. Unfortunately, data on instantaneous peak flows in Hot Creek are not available. A peaking factor of 1.7 was therefore adopted based on data from other similar watersheds in the same general area. The calculated mean daily design flow is multiplied by the peaking factor to obtain a peak flow. One of the major tributary areas in the Hot Creek Basin is highly regulated.

This area is the Lake Mary Basin, shown as Basin I on Figure 3-3. Streams in this area flow through a number of lakes, and outflow from the basin is regulated. Therefore, the peaking factor adopted for flows which originate in this basin is 1.15.

Snowmelt Flows. The maximum mean daily flow-frequency relationship of the Hot Creek gage was used to develop a procedure for estimating mean daily snowmelt flow frequencies for subbasins of Mammoth Creek. Snowmelt season peak flows are primarily a function of the size of the snow covered area which is melting when the peak flows are produced. The procedure therefore is based on calculation of a melt band area. The melt band is the area contained within the tributary area which is undergoing snowmelt at a particular time. The area is bounded by a "top of melt" elevation contour and a "bottom of melt" elevation contour, or the basin outlet. The runoff produced per unit area is taken as a function of only the design exceedence interval. The area contributing to the flow (melt band area) therefore determines the design mean daily flow.

The procedure requires that an area elevation curve be developed for the basin, or at least that the area within the basin between elevation contours be determined from topographic mapping. Figure 4-6 shows the graphs developed for calculation of mean daily snowmelt flows. The melt band width is determined for a particular design exceedence interval by considering the elevation of the top of the melt band, and the melt band width. Design runoff per unit area for the exceedence interval is then multipled by the area within the melt band. A flow adjustment factor, based on elevation, compensates for changes in runoff efficiency due to factors such as shade produced by vegetation, soil types, and steepness. The factor is related directly to elevation of the top of the basin based on typical hydrologic characteristics of subbasins within the Mammoth basin. As for the rain flood flow calculations, the calculated mean daily flows should be multipled by a peaking factor of 1.7 for all tributary areas except Basin I, and 1.15 for Basin I flows.

## DEVELOPMENT OF A HYDROGRAPH PROCEDURE FOR STORAGE FACILITY DESIGN

In some cases, not only the peak flow rate but also the volume of runoff corresponding to a design storm condition must be calculated. This is true in the design of storage facilities, such as sediment retention and flow detention basins. The U.S. Soil Conservation Service unit hydrograph method was adopted for use in the Design Manual. As described previously, this procedure permits construction of a runoff hydrograph from a known precipitation pattern.

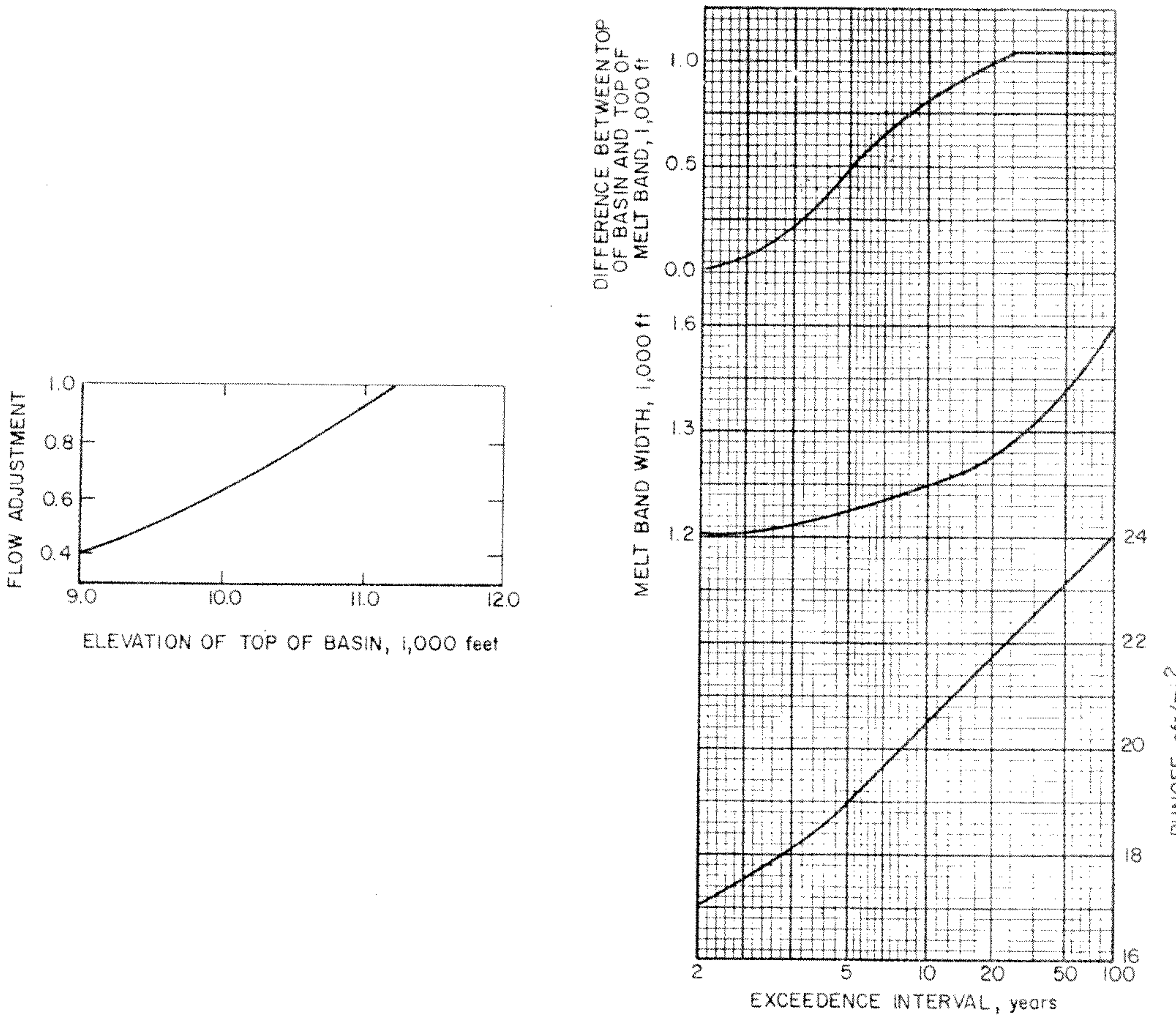



Figure 4-6 Snowmelt Runoff Graphs

A design precipitation pattern for a given exceedence interval and basin time of concentration may be constructed using the procedures given in Chapter 1 of the Design Manual. Basically, the precipitation pattern is built up in unit time steps from the center of a 24-hour period outward in both directions.

For any time period of x hours, the volumes of rainfall under the curve between t = -1/2 x and t = +1/2 x are equal to the precipitation depth for t = x from the DDF curve.

A unit hydrograph can be constructed using the standard hydrograph shape from the U.S. Soil Conservation Service procedure, and the basin time of concentration. Incremental precipitation volumes are multipled by the unit hydrograph ordinates and the resulting hydrographs superimposed to find a storm runoff hydrograph. The reader should refer to the Design Manual for complete details.

## TESTING AND MODIFICATION OF THE RUNOFF CALCULATION PROCEDURES

The best method of verification of a runoff calculation procedure is one which is based on a carefully collected set of precipitation/runoff data. This could typically include flow gaging data for several watersheds of different size and hydrologic characteristics during precipitation events. Short-term precipitation intensities could then be related to basin outflows to verify procedures used to calculate times of concentration and peak flows. Runoff coefficients for different surface types and land uses could also be verified. Unfortunately, no data like this have been collected in the Mammoth Lakes area. Even mean daily flows for the gaged stations on Mammoth Creek are often not available for days on which storms occur. Gaging in the basin is used primarily for determination of low flows, and measuring equipment is often washed out or submerged during peak flows. Where possible, calculated flows were compared with measured stream flows. However, only a few storm events had sufficient data for this type of comparison, and the flow data applied only to very large basins. The results of precipitation vs. flow comparisons were therefore extremely general and of little help in verification of the procedures.

In the developed area, the procedures were used to calculate flows for a 20-year exceedence interval for an initial layout of the master plan storm drainage system described in Chapter 5. Originally, Procedure A was used for all areas less than 160 acres in size and all developed areas. Procedure B was used for undeveloped areas larger than 160 acres in size. Later, the division point was increased to 320 acres because of the relatively low results from Procedure B and the possibility that undeveloped areas greater than 160 acres in size might be included within the general boundaries of development in Mammoth Lakes, and might not have hydrologic characteristics similar to strictly natural watersheds.

After completing a number of flow calculations using both Procedures A and B, it became evident that a significant discrepancy existed between the results from the two procedures. For example, from a 320-acre natural area, Procedure A yields results of approximately 120 to 180 cfs for the 20-year storm. Procedure B, for the same design, gives results of approximately 15 to 30 cfs. For an area of this size, Procedure A results are probably high because they do not account sufficiently for spatial variation in rainfall and various interception losses. Procedure B results are probably too low because they are based on a flow-frequency relationship for a much larger basin. For the larger basin, losses to groundwater may have a significant impact on the results. No data was available for evaluation of the discrepancy in watersheds of this size. Therefore, a conservative procedure was adopted which used both results. The resulting modification to the procedure consisted of two parts:

1. The minimum area for use of Procedure B was increased to 1,600 acres.

2. An adjustment to Procedure A was developed for areas between 160 and 1,600 acres in size.

The adjustment is used to decrease the results of Procedure A for areas larger than 160 acres. The correction varies from a factor of 1.0 at 160 acres to 0.3 at 1,600 acres. Figure 4-7 shows the natural area correction factor graph used in the design procedure. Results using Procedure A with the correction factor are still somewhat higher than Procedure B results for areas between 160 and 1,600 acres in size. For basins larger than 1,600 acres in size, Procedure B can be applied without correction.

Chapter 1 of the Design Manual gives a detailed description of the final runoff calculation procedures and presents sample calculations. The reader should refer to the manual for the specific details of the procedures and their application.

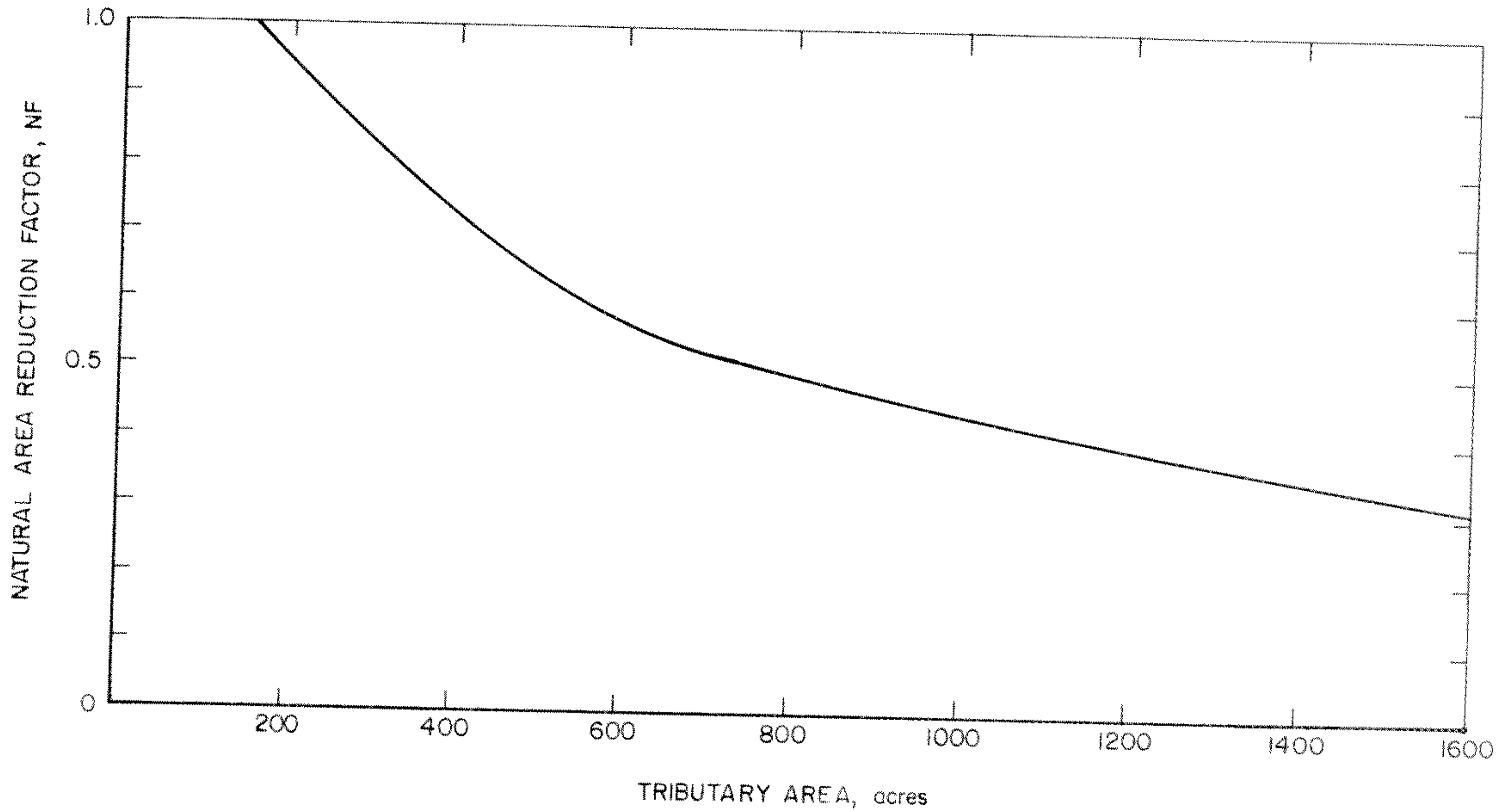



Figure 4-7 Natural Area Size Factor, NF

# CHAPTER 5

# BASIS FOR DEVELOPMENT OF THE MASTER PLAN

Elimination of localized flooding and concern for protection of the water quality of Mammoth and Hot Creeks are the two primary factors that precipitated the preparation of the master plan. The improvements proposed in Chapter 6 of this master plan report are designed to control the runoff and erosion in Mammoth Lakes that is the cause of these problems. This chapter presents the limited data that has been gathered to date to document water quality problems, and then describes the regulatory plans, policies, and standards which have been adopted by the Lahontan Regional Board. Objectives and design criteria which provided the basis for development of the master plan to achieve solutions to these problems, and to eliminate flooding and drainage problems in the urbanized areas are also described in this chapter.

## WATER QUALITY PROBLEMS

The headwaters of Mammoth Creek, fed by snowmelt and storm runoff, are near the Sierra Nevada crest at an elevation of over 11,500 feet. Mammoth Creek flows through a series of high mountain lakes, past the Mammoth Mountain ski area, and through the southern portion of the community of Mammoth Lakes. Murphy Gulch receives the drainage from the northern portion of Mammoth Mountain and Mammoth Lakes, and it then flows into Mammoth Creek. Downstream from Mammoth Lakes, Mammoth Creek and the discharge from the Hot Creek Fish Hatchery combine to form Hot Creek. Hot Creek, one of the most productive trout streams in California, has been classified as a Wild Trout Stream. Hot Creek flows into the Owens River and Crowley Lake.

The California Department of Fish and Game (DFG) has reported reductions in the number of brown trout produced naturally in the wild trout habitat of Hot Creek. This may be due to increased turbidity in the stream, but the data are inconclusive. The increased turbidity in Hot Creek may be partially attributed to the development that has occurred in the Mammoth Lakes area over the last 20 years. Previously natural ground surface has been covered by pavement and buildings, and has increased erosion. Sediment materials settle out and cover stream spawning gravels and also contain nutrients which may be biostimulatory.

A limited amount of water quality data have been gathered in the Mammoth Lakes area by the U.S. Forest Service and U.S. Geological Survey. Table 5-1 presents the mean suspended sediment concentrations and turbidity values at sampling sites in the Mammoth Lakes area. These data were gathered during the summer months between 1979 and 1982. Mammoth Creek above Lake Mary is the only sampling station that is clearly above the developed area. The mean suspended sediment concentration at this station is 5 mg/l and the mean turbidity is 0.6 NTU. As Mammoth Creek flows through the developed area, the suspended sediment and turbidity increase. Below Murphy Gulch, the mean suspended sediment concentration is 141 mg/l and the mean turbidity value is 86 NTU. The quality of Mammoth Creek improves, due to the settling of sediment and dilution from streams draining undisturbed areas, as the creek flows downstream past Old Highway 395 and the fish hatchery. At the sampling station located just above the fish hatchery, the mean suspended sediment concentration is 16 mg/l and the mean turbidity value is 10 NTU.

Data collected from disturbed areas within the community of Mammoth Lakes and on Mammoth Mountain area are also presented in Table 5-1. The mean suspended sediment and turbidity values are much higher in the runoff from these disturbed areas than the natural values in Mammoth Creek above the developed area. Mean suspended sediment concentrations range from 154 mg/l in the Minaret Village runoff to 8,250 mg/l in the runoff from Mammoth Mountain at Austria Hof. The mean turbidity values range from 190 NTU in the Minaret Village runoff to 2,570 NTU in the runoff from Mammoth Mountain at Austria Hof.

Table 5-1. Suspended Sediment and Turbidity Data in the Mammoth Lakes Area

| Sampling location | Suspended Sediment, mg/l | | | Turbidity, NTU | | |
|---|---|---|---|---|---|---|
| Mammoth Creek | N[a] | Range | Mean | N[a] | Range | Mean |
| Above Lake Mary | 9 | 0.7 - 18 | 5 | 15 | 0.2 - 1.0 | 0.6 |
| At Old Mammoth | 37 | 1 - 312 | 27 | 37 | 1.6 - 224 | 15 |
| Above confluence with Minaret runoff | 7 | 20 - 98 | 60 | 7 | 12 - 67 | 35 |
| Below confluence with Minaret runoff | 7 | 18 - 95 | 55 | 7 | 12 - 74 | 36 |
| Above Murphy Gulch | 23 | 3 - 184 | 44 | 23 | 3.1 - 131 | 23 |
| Below Murphy Gulch | 23 | 8 - 957 | 141 | 23 | 4.5 - 735 | 86 |
| At Old Highway 395 | 59 | 0.5 - 218 | 19 | 71 | 0.5 - 140 | 10 |
| Above fish hatchery | 37 | 1 - 63 | 16 | 37 | 2.7 - 33 | 10 |
| Mammoth Mountain at Austria Hof | 19 | 195 - 78,920 | 8,250 | 22 | 13 - 27,000 | 2,570 |
| Mammoth Mountain at Warming Hut II | 19 | 328 - 17,600 | 5,030 | 20 | 95 - 8,900 | 1,350 |
| Chairlift 9 watershed | 13 | 27 - 8,150 | 822 | 14 | 7 - 3,380 | 306 |
| Minaret Village runoff | 10 | 22 - 420 | 154 | 10 | 69 - 406 | 190 |
| Murphy Gulch at visitor center | 13 | 0.3 - 11,940 | 2,170 | 14 | 4.0 - 3,500 | 737 |
| Murphy Gulch at Mammoth Creek | 28 | 5 - 5,690 | 715 | 29 | 4.5 - 2,790 | 434 |

[a]N represents the number of samples collected.

These water quality data cannot be used to quantify the load of sediments reaching Mammoth Creek from various problem areas in the drainage because they represent occasional grab samples without corresponding flow data. The data do show, however, that the developed areas produce runoff with significantly higher suspended sediment concentrations and turbidity values. The data also show that the suspended sediment concentration and turbidity of Mammoth Creek increases as it flows through the developed area.

The Regional Board is currently planning to conduct a detailed sampling program in the Mammoth Lakes area to gather substantially more water quality data. This data will be used to determine whether the water quality objectives for Mammoth Creek and Hot Creek should be revised, and to more clearly identify the sources of pollutants to these creeks.

## WATER QUALITY POLICIES AND OBJECTIVES

The Regional Board has developed and adopted a series of regulatory plans, policies, and objectives over the last 10 to 15 years that contain specific references to control of surface runoff and erosion. Those which have been established by the Regional Board in the Water Quality Control Plan Report for the South Lahontan Basin (Basin Plan), 1975, which have direct applicability to the master plan, have been extracted from the Basin Plan and are summarized below.

### Nondegradation Policy

On October 28, 1968, the State Water Resources Control Board adopted Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California." While requiring the continued maintenance of existing high quality waters, the policy provides conditions under which a change in water quality is allowable. A change must:

1. Be consistent with maximum benefit to the people of the State,

2. Not unreasonably effect present and anticipated beneficial uses of water, and

3. Not result in water quality less than that prescribed in water quality control plans or policies.

General Objective

Wherever the existing quality of water is better than the quality of water established as objectives, such existing quality shall be maintained unless otherwise provided by the provisions of the State Water Resources Control Board Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California," including any revisions thereto.

Objectives for Surface Waters

In addition to the objective of nondegradation, the following water quality objectives apply to all surface waters of the Basin. These objectives represent maximum acceptable levels of water quality that shall be maintained in the event that exceptions are made with respect to nondegradation in accordance with the provisions of the State's Nondegradation Policy.

Color. Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses.

Tastes and Odors. Waters shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, that cause nuisance, or adversely affect beneficial uses.

Floating Material. Waters shall not contain floating material, including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.

Suspended Material. Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.

Settleable Material. Waters shall not contain substances in concentrations that result in the deposition of material that cause nuisance or adversely affect beneficial uses.

Oil and Grease. Waters shall not contain oils, greases, waxes, or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect beneficial uses.

Biostimulatory Substances. Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

Sediment. The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such manner as to cause nuisance or adversely affect beneficial uses.

Turbidity. Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity shall not exceed natural levels by more than 10 percent.

Dissolved Oxygen. The dissolved oxygen concentrations, in terms of percent saturation, shall not be depressed by more than 10 percent, nor shall the minimum, dissolved oxygen concentration at any time be less than 80 percent of saturation of less than the following limits, whichever is more restrictive:

- Waters designated WARM--5.0 mg/l
- Waters designated COLD--7.0 mg/l

Toxicity. All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses of human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalines, bioassays of appropriate duration or other appropriate methods as specified by the Regional Board.

Pesticides. The summation of concentrations of total identifiable chlorinated hydrocarbons, organophosphates, carbonates, and all other pesticide and herbicide groups, in all waters of the basin, shall not exceed lowest detectable levels, using the most recent detection procedures available. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.

Water Quality Objectives for Surface Waters. Numerical water quality objectives for specific surface waters in the Mammoth Basin are presented in Table 5-2.

Table 5-2. Chemical Water Quality Objectives for Surface Waters

| Surface water | Total dissolved solids | Objective, mg/l[a] | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cl | $SO_4$ | F | B | $NO_3$-N | N | $PO_4$ |
| Mammoth Creek (Twin Lakes Bridge) | 60<br>90 | 0.6<br>1.0 | | | 1.80 | 0.4<br>0.8 | 0.5<br>1.0 | 0.03<br>0.05 |
| Mammoth Creek (Old Mammoth Creek) | 85<br>115 | 0.8<br>1.4 | | | | 0.4<br>0.8 | 0.6<br>1.0 | 0.27<br>0.50 |
| Mammoth Creek (at Highway 395) | 75<br>100 | 1.0<br>1.4 | 6.0<br>11.0 | 0.10<br>0.30 | 0.03<br>0.05 | 0.4<br>0.8 | 0.6<br>1.0 | 0.11<br>0.22 |
| Sherwin Creek | 22<br>26 | 0.5<br>0.7 | | | | 0.4<br>0.6 | 0.5<br>0.7 | 0.05<br>0.08 |
| Hot Creek (at County Road) | 275<br>380 | 41.0<br>60.0 | 24.0<br>35.0 | 1.80<br>2.80 | 1.80<br>2.60 | 0.2<br>0.4 | 0.3<br>1.5 | 0.65<br>1.22 |

[a] 100 Upper number represents average value = arithmetic average of all data.

200 Lower number represents 90-percentile value = only 10 percent of data exceed this value.

## WATER QUALITY IMPLEMENTATION PLAN

In addition to the policies and objectives adopted in the Basin Plan, the Regional Board also incorporated a plan of action for their implementation. The following sections, which impact development of the master plan, have been extracted from the Basin Plan.

### Control of Urban Runoff

The effect of urban runoff on receiving water quality is a problem which has only recently come to be recognized. Most of the work up to the present has centered on characterizing urban runoff: concentrations of various constituents have been measured, attempts to relate these to such factors as land use and type and rainfall intensity have been made, and studies concerning the amounts of these constituents present on street surfaces have been conducted. It appears that considerable quantities of contaminants, heavy metals in particular, may enter through urban runoff. The federal Water Pollution Control Act Amendments of 1972 stress future "control of treatment of all point and nonpoint sources of pollution." Thus, the federal government has concluded that nonpoint sources, such as urban runoff, are indeed deleterious to the aquatic environment and that measures should be taken to control such emissions. The following discussion is presented in accordance with this view.

There are five basic approaches to controlling pollution from urban runoff: (1) prevent contaminants from reaching urban land surfaces; (2) improve street cleaning and cleaning of other areas where contaminants may be present; (3) treat runoff prior to discharge to receiving water; (4) diversion and infiltration; and (5) controls of land use and development. Which approach or combination of approaches is most effective or economical has not been studied extensively. Thus, only the basic characteristics of each approach can be discussed. In addition to these direct approaches are measures to reduce the problem by reducing the volume of runoff from urban areas.

Areas of concern in the South Lahontan Basin where urban runoff is or could cause a surface water quality problem include mountain communities in the Mono-Owens Planning Area such as June Lake and Mammoth Lake. Implementation of urban runoff controls will be initiated by the Regional Board where appropriate.

Source Control. The first approach, which emphasizes source control, has many aspects. Tough, effective air pollution laws can probably aid in reducing the amounts of certain materials deposited on the land. An obvious example is lead in automobile exhaust emissions. In order to meet future federal emission standards, automobile manufacturers will probably utilize a "catalytic converter" which requires nonleaded gasoline. Thus, the production of leaded gas will probably decrease in the future, cutting down the supply of lead which can be washed into receiving waters. Effective anti-litter ordinances and campaigns can aid in reducing floatable materials washed to surface waters. These materials are objectionable primarily from an aesthetics viewpoint. New construction techniques may reduce emissions to receiving waters. Erosion can be decreased by seeding, sodding, or matting excavated areas as quickly as practicable. Construction in certain critical areas can be limited to the dry season. Stockpiling of excavated material can be regulated to minimize erosion. Control of chlorinated hydrocarbon pesticide usage would reduce the amounts found on urban land surfaces and thus reduce the amounts washed to natural waters.

Street Cleaning. The second approach to reducing pollution from urban runoff involves improving street cleaning techniques. Generally, street cleaning as presently practiced is intended to remove large pieces of litter which are aesthetically objectionable. The removal of fine material which may account for most of the important contaminants is minimal. It may be possible to design mechanical sweepers to remove a greater fraction of the fine material. Alternatively, vacuum-type street cleaners could be developed to produce better results.

In addition to streets, sidewalks and roofs contribute large amounts of runoff. Controlling contaminants present on these surfaces would be more difficult and would be up to individuals. Advertising campaigns would probably be unproductive and legislation would be unworkable except perhaps in specific, localized situations. Therefore, contaminant removal will probably be limited to street surfaces.

In many areas streets are cleaned by flushing with water from a tank truck. If catch basins are present, this material may be trapped in them. If catch basins do not exist, the material will be simply washed to the sewers where subsequent rainfall will carry them to surface waters. Where catch basins are regularly cleaned out, they can be effective in removing materials during runoff. Where they are allowed to fill up with material, they add to the pollution loading during a storm by discharging septic material.

Treatment. The third approach to reducing the effects of urban runoff on receiving water quality involves collecting and treating the runoff. Physical or physical-chemical treatment would be required; the intermittent nature of storm flows precludes biological treatment. Examples of possible treatment processes are simple sedimentation, sedimentation with chemical clarification, and dissolved air flotation. A principal problem with this approach is collection. Present storm sewerage systems generally drain to open creeks and rivers. Even if treatment facilities were located at various sites in the Basin, a massive collection system would have to be built. The economic question of "treatment vs. transport" would have to be studied with specific regard to stormwater runoff. Local sewage treatment plants abandoned in favor or regional facilities could possibly be utilized in such a program. One method of cutting down the peak flow capacity required is to provide storage volume in the collection system.

Diversion and Infiltration. Another possible control measure to prevent pollution of surface waters by urban runoff is to eliminate runoff reaching surface waters in the first place. Storm drainage water could be diverted to engineered soil systems where percolation could occur. An obvious advantage to this method would be increased recharge of groundwater and reduction of some pollutants after benefit of passage through a soil layer. In some cases, however, conservative pollutants such as sodium chloride, may travel through the soil, entering and degrading groundwater.

A program of urban runoff management through diversion and infiltration may be implemented at various levels. Where storm drainage systems already exist it may be economical to construct a centralized infiltration facility to serve each system. Economics in this case would be dependent on availability of adequate land area.

For new development, it may be feasible to institute a program of urban runoff control by requiring design features promoting on-site percolation of runoff. Examples of such design features would be gravel percolation trenches on the down gradient side of impervious surfaces and under all structural drip lines. Variations in the diversion and infiltration technique may be selectively applied to effect a reduction in the total volume of runoff emanating from urban areas.

Control of Urbanization. A fifth approach is to encourage controls on urbanization which will either reduce the volume of runoff or at least not cause runoff to increase as a result of urban growth. The usual pattern is that incresed urbanization leads to higher runoff coefficients, reflecting the many impervious surfaces associated with development. Roof drains to storm sewers, paved parking lots and streets, installation of storm sewers, filling of natural recharge areas, and increased efficiency in realigned and resurfaced stream channels all are characteristics of urban growth. Development near streams and on steep slopes is deleterious to water resources; it is less disruptive to develop the lower portions of a watershed than the headwater areas, both from the standpoint of the length of channel effected and the extent of channel enlargement necessary to convey stormwater. Use of porous pavements and less reliance on roof connections to storm drains and more emphasis on local recharge would reduce the peak volume of runoff from storms. Urban planning should be more cognizant of land constraints to permit greater natural recharge where possible and feasible and to discourage intensive development of steep land particularly in headwater areas.

## EROSION CONTROL GUIDELINES

The Regional Board adopted a resolution and a set of erosion control guidelines for the Mammoth Creek watershed in June 1983. The guidelines require that a waste discharge report be submitted to the Board for new developments of six or more dwelling units and commercial developments greater than one-quarter acre in size. The waste discharge reports must include descriptions of erosion control measures during construction and after completion of the project. The guidelines also include a list of specific control measures which are required. A list of the specific guidelines is shown in Table 5-3. All of the specific control measures have been incorporated into the Mammoth Lakes Storm Drainage and Erosion Control Design Manual. In addition, the design manual specifies procedures to be used to meet the guidelines.

## MASTER PLAN CONTROL OBJECTIVES AND DESIGN CRITERIA

This section describes the methods and criteria used to select the types, locations, and sizes of proposed drainage facilities that will help achieve many of these regulatory policies and guidelines. The formulation of design objectives is also discussed, and the application of flow calculation procedures and system sizing criteria from the Mammoth Lakes Storm Drainage and Erosion Control Design Manual to the proposed Master Plan facilities is presented.

### Control Objectives and General Design Criteria

The proposed storm drainage system is formulated primarily to control the existing drainage and erosion problems. In general terms, the major problems are:

1. Severe roadside and slope erosion due to uncontrolled runoff flow in poorly defined channels from steep areas.
2. Drainage paths which cross private property, and development in or near the drainage paths.
3. Undersized culverts and channels.
4. Lack of maintenance to prevent clogging.
5. Discharge of runoff from developed areas directly to Mammoth Creek resulting in high sediment loads to the creek and water quality degradation.
6. Unsatisfactory performance of Murphy Gulch Sediment Retention Basin.

Table 5-3. Erosion Control Guidelines Adopted by Lahontan Regional Board

| | |
|---|---|
| 1 | Drainage collection, retention, and infiltration facilities shall be constructed and maintained to prevent transport of the runoff from a 20-year, 1-hour design storm from the project site.[a] |
| 2 | Surplus or waste material shall not be placed in drainage ways or within the 100-year flood plain of surface waters. |
| 3 | All loose piles of soil, silt, clay, sand, debris, or earthen materials shall be protected in a reasonable manner to prevent any discharge to waters of the State. |
| 4 | Dewatering shall be done in a manner so as to prevent the discharge of earthen material from the site. |
| 5 | All disturbed areas shall be stabilized by appropriate soil stabilization measures by October 15 of each year. |
| 6 | All work performed between October 15 and May 1 of each year shall be conducted in such a manner that the project can be winterized within 48 hours. |
| 7 | Where possible, existing drainage patterns shall not be significantly modified. |
| 8 | After completion of a construction project, all surplus or waste earthen material shall be removed from the site and deposited at a legal point of disposal. |
| 9 | Drainage swales disturbed by construction activities shall be stabilized by the addition of crushed rock or riprap as necessary or other appropriate stabilization methods. |
| 10 | All nonconstruction areas shall be protected by fencing or other means to prevent necessary disturbance. |
| 11 | During construction, temporary erosion control facilities (e.g., impermeable dikes, filter fences, hay bales, etc.) shall be used as necessary to prevent discharge of earthen materials from the site during periods of precipitation or runoff. |
| 12 | Revegetated areas shall be continually maintained in order to assure adequate growth and root development. Physical erosion control facilities shall be placed on a routine maintenance and inspection program to provide continued erosion control integrity. |
| 13 | Where construction activities involve the crossing and/or alteration of a stream channel, such activities shall be timed to occur during the period in which stream flow is expected to be lowest for the year. |

[a]The 20-year, 1-hour design storm for the Mammoth Lakes area is equal to 1.0 inch (2.5 cm).

The first step in the layout of the master plan was to define new drainage paths based on the existing ground and roadway slopes. In general, the drainage paths follow existing streets wherever possible. To confine runoff flow in the street and to prevent erosion and maintenance problems which would result from the use of roadside ditches, conventional curb and gutter, catch basins, and storm drainage pipe are proposed for many areas. In other areas, where a natural drainageway provides an aesthetic benefit to the community, the natural channels have been retained where possible. In some cases, several channels have been consolidated to form a major drainage path. This reduces the required maintenance and maintains the aesthetic quality of the area.

Direct discharge to Mammoth Creek has been eliminated in the proposed system. A combination of on-site retention facilities and sediment retention basins at major outlets to the creek is proposed. The design and construction of a new sediment retention basin in Murphy Gulch is also required to improve water quality in Mammoth Creek.

Storm drain pipes have been placed in streets wherever possible. In a few locations, pipes must cross private property. The proposed channels more commonly cross private property because existing development has occurred very near stream zones and existing drainage paths.

No attempt to analyze the problems associated with easement acquisition for construction of improvements on private property has been made in this report. Where possible, facilities which cross property were placed on property lines or in the least developed portion of the private area.

Although local conditions will determine the specific design criteria used for individual projects, the facilities are generally laid out in accordance with the following standards which are in conformance to the design manual.

1. In most areas, streets in which storm drains are to be constructed are provided with curb and gutter.

2. Manholes are assumed to be required at all intersections of pipes or every 400 feet, whichever is shorter.

3. Inlets are assumed necessary at street intersections (one for each corner) or every 400 feet, whichever is shorter.

4. All culverts are assumed to have flared end sections or transition structures at their inlets and outlets.

5. Storm drains in streets are assumed to be reinforced concrete pipe; culverts and small drain leads are corrugated metal pipe.

6. Improved channels are assumed to be riprap lined.

7. Natural channels which are utilized to carry flows in the master plan system are assumed to require minor improvements such as bank protection and channel clearing.

The development of the Mammoth Lakes Storm Drainage and Erosion Control Design Manual as part of this study will provide a basis for consistent design of storm drainage and erosion control facilities. In combination with the Master Plan, the design manual provides for adequate sizing of facilities to carry runoff flows from the areas when the community has reached its ultimate level of development. The procedures given in the design manual for calculating flows and designing facilities were followed in the development of the proposed Master Plan facilities. The flow calculations and system sizing are briefly described below.

Determination of Design Flows

Chapter 1 of the Mammoth Lakes Storm Drainage and Erosion Control Design Manual prescribes methods to be used for calculation of flows for return periods of 20 to 100 years. It also lists the return periods to be used for the design of specific types of improvements. The general criterion given in the design manual is that the drainage system should transport the 100-year flow without damage to property. Specific facilities may be designed for shorter return periods provided they are part of a system which will carry the 100-year flow. The design flow therefore depends on the type of facility and the rest of the drainage system of which it is a part.

An example of this type of sizing is the design of a storm drain in a street with curb and gutter. For storm drains under 48 inches in diameter, the design manual requires sizing for the 20-year flow. If the 20-year flow (as calculated using the design manual procedures) is 20 cfs, and the 100-year flow is 30 cfs, the storm drain may be sized for 20 cfs provided the street section with curb and gutter will carry the remaining 10 cfs. If the street section cannot convey this flow, the storm drain must be sized for the entire 100-year flow.

The layout of new drainage paths for proposed facilities changed the existing tributary subareas slightly. In most cases, major drainage divides were maintained, but the breakdown of the tributary subareas into smaller watersheds was changed by the proposed facilities. The 20-, 50-, and 100-year flows from each watershed were calculated using the design manual procedures and tabulated. The flows were used to size facilities in individual watersheds considering the drainage paths, locations of streets and street crossings, and the type of proposed facilities.

Sizing of Proposed Facilities

Mammoth Lakes differs from most communities in that the ground slope in much of the developed area is very steep. For this reason, the capacity of storm drainage facilities is seldom limited by the slope available for the hydraulic grade line. All pipes have been sized to provide a hydraulic grade line parallel to and at or below the street surface. However, because of the high street slopes, the energy grade line may be above the street in some locations. Wherever the calculated pipe velocity for the 100-year flow exceeded 15 feet per second (total velocity head = 3.5 feet), special structures for energy dissipation have been included in the costing of the facilities. The structures would be located at all major storm drain junctions, slope changes, and outlets to channels.

Although 20- and 50-year return periods are specified for design of storm drains in the design manual, in many areas the proposed facilities are sized to carry the 100-year flow. The 20- and 50-year design return periods are used primarily for storm drains in streets at the upper ends of tributary subareas. Where pipes crossed roads rather than following them, or where flow in the street would have been carried across watershed boundaries, the pipes were sized for the 100-year flow. Although street capacity can be a significant part of the total 100-year flow for small areas, it becomes a smaller and smaller portion of the flow for large areas. Therefore, facilities in the lower portions of the tributary subareas are generally sized to carry the entire calculated 100-year flow.

Storm Drainage Retention and Infiltration Facilities

Based on the limited water quality data available on suspended sediment concentrations in runoff from the Mammoth Lakes community, it appears that the Regional Board water quality objectives are currently being exceeded. To improve the quality of runoff, facilities must be constructed which will retain sediment rather than discharge it directly to the creek.

Figure 5-1 shows a plot of suspended sediment concentration in runoff versus time after the beginning of a storm for a typical urban area. The initial runoff flows carry the sediment which has accumulated in streets, ditches, creeks, gutters, and pipes since the last major storm. In addition to sediment, the

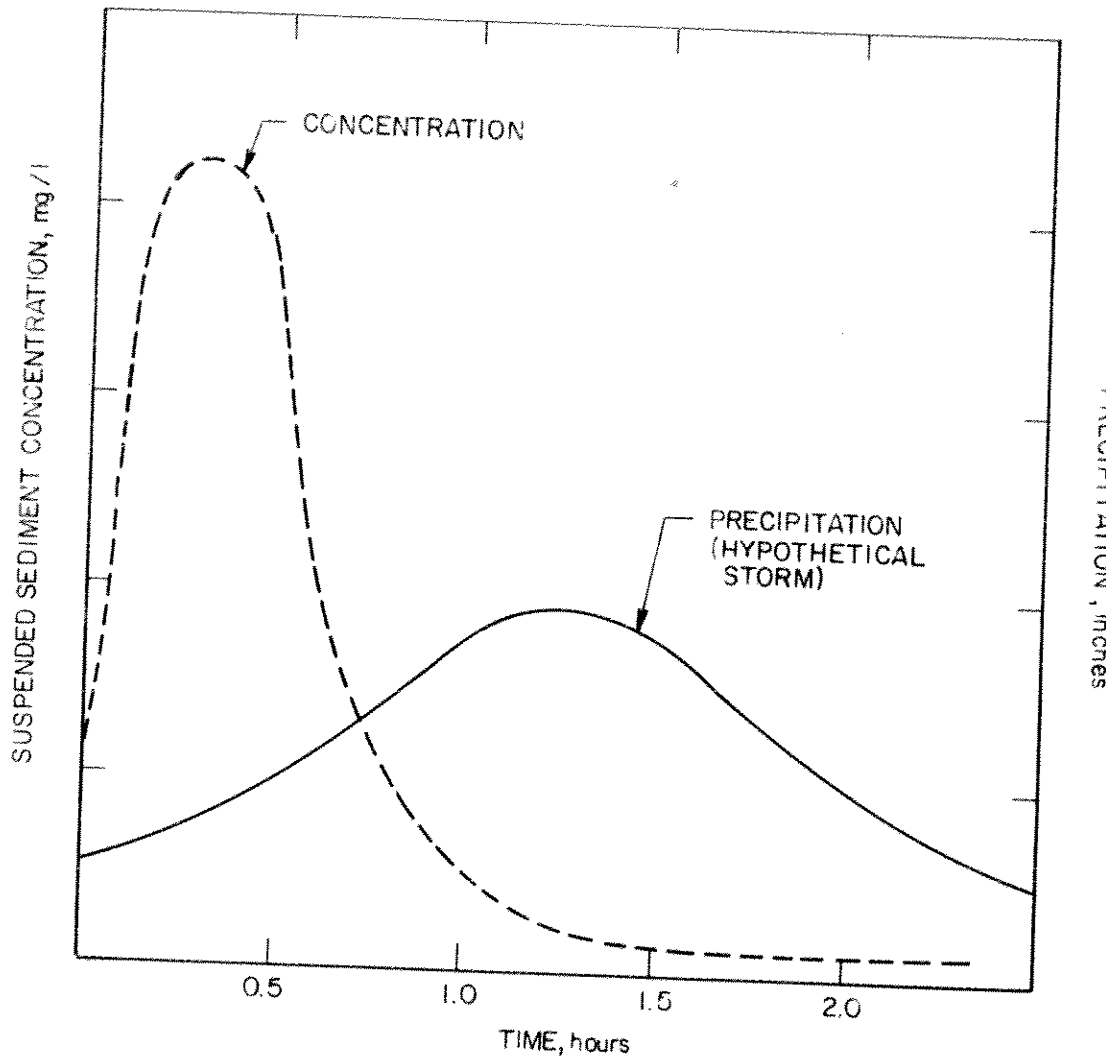



Figure 5-1 Typical Suspended Sediment Concentration Vs Time in Urban Runoff

initial flow carries oil and grease which has accumulated on streets and high levels of nutrients which may be in dissolved form or carried by the suspended sediment. Because of the high concentrations of pollutants in the initial runoff flows, facilities which are designed to retain the runoff volume from the initial portions of a storm are effective water quality improvement devices.

The Mammoth Lakes Storm Drainage and Erosion Control Design Manual requires that parking lots (except small residential lots) be equipped with storm drainage retention infiltration facilities. In addition, for all areas which discharge runoff directly to Mammoth Creek, on-site retention basins at outlets to the creek have been identified in the Master Plan. The Master Plan also includes a new sediment retention facility in Murphy Gulch, which will improve runoff water quality from all of Watershed III.

In addition to improving water quality, storm drainage retention and infiltration facilities have an effect on the quantity of runoff produced by an area. The principal effects are to increase the time of concentration for small areas and to reduce peak flows. For example, consider a percolation pit which is designed for a 20-year, 1-hour storm. If an actual 1-hour storm occurs which has the same volume as the 20-year design storm, the percolation pit will completely retain the runoff. However, if a 20-year design storm with a longer duration occurs, the runoff will not be completely contained by the pit. Figure 5-2 shows a hypothetical storm distribution for a 20-year, 6-hour design storm constructed in accordance with the procedures given in Chapter 1 of the design manual for an area with a 0.50-hour time of concentration. The cumulative precipitation volume curve crosses the level of available storage volume in the percolation pit before the peak storm intensity occurs. In this case, outflow from the percolation pit would be nearly zero for the first 2.5 hours of the storm and then increase sharply to the same rate that would occur with no percolation pit installed. If both infiltration in the pit and storage volume are considered, the peak outflow rate will be reduced by the rate of infiltration. However, for wet antecedent soil conditions the infiltration rate is likely to be extremely small compared to the peak runoff rate in a small basin.

This example illustrates the fact that the effect of retention facilities varies dramatically with storm distribution type. The effect also varies with return period. For long return period storms, the retention facilities may have little effect on the peak outflow rates because of extremely unusual soil moisture conditions and precipitation volumes which may precede the short-term, long return period event. The retention facilities are most effective in reducing the amount of runoff

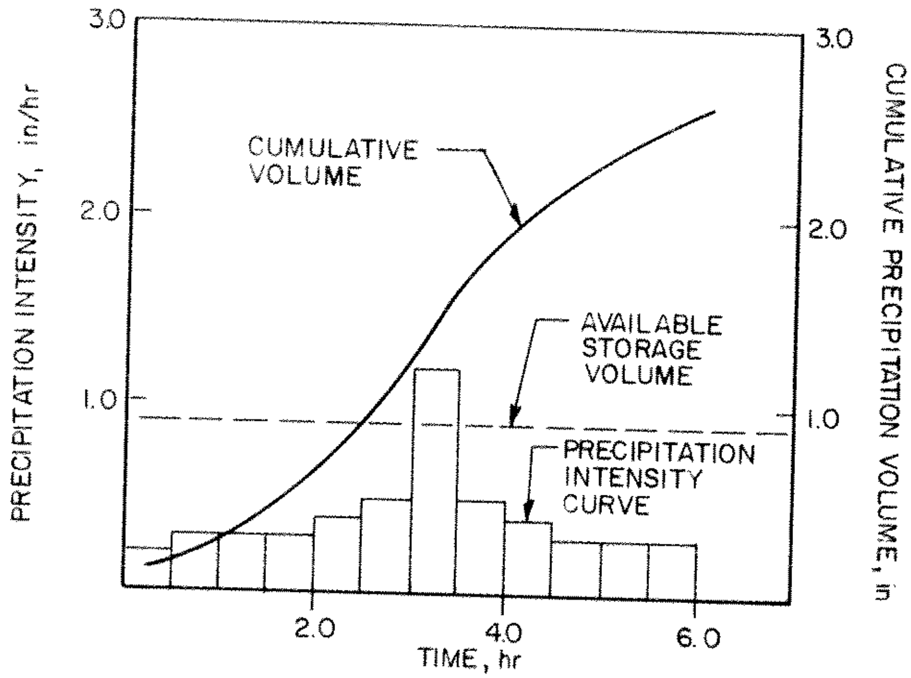



Figure 5-2 Percolation Pit Performance in 20-Year, 6-Hour Storm

which occurs on a mean annual basis--their effect on runoff from 50- to 100-year return period events may be minimal in some cases.

Probably the most significant effect of retention facilities on runoff quantity is to limit the minimum time of concentration in a watershed. For example, if each lot in a residential area is provided with on-site retention facilities, the time of concentration for the watershed cannot be less than the time of concentration for an individual lot plus travel time through the storm drainage system. A higher time of concentration results in a lower design precipitation intensity and lower design flow.

In the Master Plan for Mammoth Lakes, retention facilities are required for several residential areas. Flows for these areas were calculated using a minimum time of concentration equal to a calculated time of concentration for a typical lot with infiltration facilities. However, in most areas the time of concentration for design of storm drains was determined by natural areas and not by the residential development. Therefore, on-site facilities had little or no effect on the watershed time of concentration. Assuming that peak outflows might be reduced somewhat by infiltration in these areas, the 10- and 20-year flows were both calculated for the developed areas for use in design of the storm drains. Because of natural areas tributary to the storm drains (for which the 20-year flow was assumed) the resulting difference in design flow was found to be negligible. On-site retention in residential areas potentially has the largest impact on flows in small storm drainage laterals. However, to reduce the possibility of plugging, a minimum size of 18 inches in diameter was used for all storm drains in streets. Storm drains which would have been reduced below this size by on-site retention facilities were therefore not affected.

# CHAPTER 6

# STORM DRAINAGE AND EROSION CONTROL MASTER PLAN

This chapter describes the master plan facilities proposed for the Mammoth Lakes community. The proposed improvements are designed to serve the needs of the community after it is completely developed. Therefore, in most cases, the proposed facilities are larger than necessary to serve the existing needs of the community. The design flows and unit costs used to size and cost the facilities, the total costs, and a recommended improvement program which spreads construction out over a period of approximately 15 years are also presented here.

## MASTER PLAN FACILITIES

The proposed storm drainage facilities are shown by individual tributary subareas on Plates 1 through 10 at the end of this chapter. In general, the proposed drainage system utilizes storm drain pipes to convey runoff flows from developed areas. When possible, the master plan recommends retaining or improving natural streams rather than replacing them with storm drain pipe for aesthetic and cost reasons. In addition, the natural channels provide more storage capacity than pipes and therefore reduce the peak outflow from a tributary area.

Storm drain pipes have been placed in streets wherever possible. In a few locations, pipes must cross private property. The proposed channels more commonly cross private property because existing development has occurred very near stream zones and existing drainage paths.

No attempt to analyze the problems associated with easement acquisition for construction of improvements on private property has been made in this report. Where possible, facilities which cross property were placed on the property lines or in the least developed portion of the private area.

## DESIGN FLOWS

The design flows used to determine the required sizes of drainage facilities are shown in Table 6-1. The flows for 20-, 50-, and 100-year return periods at each tributary junction are shown. Most of the tributary subareas are made up of a

Table 6-1. Master Plan Design Flows, cfs

| Watershed | $Q_{20}$ | $Q_{50}$ | $Q_{100}$ | Design Season[a] |
|---|---|---|---|---|
| Subarea II-1 | | | | |
| A | 21 | 25 | 31 | S |
| Subarea II-2 | | | | |
| A2b.2 | 34 | 43 | 54 | S |
| A2b.1 | 20 | 26 | 32 | S |
| A2b | 54 | 69 | 85 | S |
| A2a | 31 | 39 | 48 | S |
| A2 | 85 | 100 | 134 | S |
| A1 | 42 | 50 | 65 | S |
| A | 127 | 158 | 196 | S |
| B | 18 | 21 | 26 | S |
| Subarea II-3 | | | | |
| A2b.2b | 35 | 46 | 56 | S |
| A2b.2a1 | 14 | 20 | 26 | W |
| A2b.2a2 | 98 | 143 | 194 | W |
| A2b.2a | 110 | 165 | 210 | W |
| A2b.2 | 138 | 197 | 250 | W |
| A2b.1 | 39 | 57 | 70 | W |
| A2b | 177 | 254 | 370 | W |
| A2a | 11 | 15 | 19 | W |
| A2 | 188 | 269 | 340 | W |
| A1 | 42 | 65 | 80 | W |
| A | 230 | 334 | 420 | W |
| B | 11 | 15 | 18 | W |
| C | 56 | 74 | 90 | W |
| D | 14 | 17 | 20 | W |
| Subarea III-2 | | | | |
| A3 | 54 | 73 | 90 | W |
| A2 | 103 | 135 | 165 | W |
| B | 24 | 34 | 42 | W |
| A | 157 | 208 | 260 | W |
| Subarea Total | 164 | 223 | 270 | W |

Table 6-1. Master Plan Design Flows, cfs, continued

| Watershed | $Q_{20}$ | $Q_{50}$ | $Q_{100}$ | Design Season[a] |
|---|---|---|---|---|
| Subarea III-3 | | | | |
| A2b.2a | 55 | 69 | 86 | W |
| A2b.2b | 31 | 37 | 46 | W |
| A2b.2 | 82 | 104 | 130 | W |
| A2b.1 | 20 | 25 | 31 | W |
| A2b | 97 | 124 | 152 | W |
| A2a | 39 | 48 | 62 | S |
| A2 | 130 | 161 | 200 | W |
| A1 | 4 | 5 | 6 | W |
| A | 134 | 172 | 212 | W |
| Subarea total | 134 | 172 | 212 | W |
| Subarea III-4 | | | | |
| B | 89 | 132 | 177 | W |
| A | 52 | 73 | 95 | W |
| Subarea total | 141 | 205 | 272 | W |
| Subarea III-5 | | | | |
| C2b.2b2.a2b | 105 | 145 | 180 | W |
| C2b.2b2.a2a | 12 | 15 | 18 | S |
| C2b.2b2.a2 | 115 | 158 | 195 | W |
| C2b.2b2.a | 121 | 166 | 210 | W |
| C2b.2b2.b | 21 | 25 | 30 | S |
| C2b.2b | 136 | 188 | 233 | W |
| C2b.2a | 28 | 34 | 41 | S |
| C2b.2 | 171 | 232 | 290 | W |
| C2b | 187 | 253 | 310 | W |
| C2a | 59 | 71 | 90 | S |
| C2 | 234 | 313 | 390 | W |
| C | 257 | 343 | 420 | W |
| B2a.2b | 70 | 84 | 105 | S |
| B2a.2a | 26 | 32 | 38 | S |
| B2a.2 | 96 | 114 | 140 | S |
| B2a | 136 | 164 | 200 | S |
| B2b | 13 | 17 | 22 | S |
| B2c | 41 | 54 | 70 | W |
| B2 | 168 | 218 | 270 | W |
| B | 198 | 245 | 300 | S |
| A2a | 23 | 27 | 36 | S |
| A2b | 22 | 27 | 36 | S |
| A2 | 45 | 54 | 69 | S |
| A1 | 48 | 56 | 70 | S |
| A | 91 | 108 | 135 | S |
| Subarea total | 510 | 660 | 800 | W |

Table 6-1. Master Plan Design Flows, cfs, continued

| Watershed | $Q_{20}$ | $Q_{50}$ | $Q_{100}$ | Design Season[a] |
|---|---|---|---|---|
| Subarea III-6 | | | | |
| III-6 | 139 | 205 | 280 | W |
| Subarea III-7[b] | | | | |
| From III-9 | 113 | 155 | 232 | W |
| C2.b1b | 143 | 214 | 294 | W |
| C2.b1a | 161 | 238 | 326 | W |
| C2.b2 | 17 | 22 | 33 | W |
| C2.b | 176 | 257 | 356 | W |
| C2.a | 24 | 31 | 39 | W |
| C2 | 197 | 285 | 395 | W |
| C1a | 10 | 12 | 15 | S |
| C1b | 25 | 35 | 44 | W |
| C1 | 34 | 47 | 59 | W |
| C2 | 16 | 19 | 24 | W |
| C3 | 19 | 23 | 30 | S |
| C | 242 | 348 | 466 | W |
| B | 15 | 18 | 22 | S |
| A | 30 | 37 | 48 | S |
| Subarea total | 279 | 394 | 528 | W |
| Subarea III-8 | | | | |
| A | 40 | 53 | 66 | W |
| B | 92 | 140 | 180 | W |
| Subarea total | 132 | 193 | 246 | W |
| Subareas III-7 and III-8 Combined | 390 | 552 | 720 | W |
| Main Street Trunk Flows | | | | |
| Mountain Boulevard | 529 | 757 | 1,000 | W |
| Center Street | 1,009 | 1,387 | 1,770 | W |
| Laurel Mountain Road | 1,150 | 1,592 | 2,042 | W |

[a]S means design flow occurs in summer; W means design flow occurs in winter.
[b]Flows in this subarea include flows from Subarea III-9 where applicable.

number of smaller watersheds which each have a major storm drain or channel outlet. To calculate the flow at a particular point requires "routing" the flow from upstream watersheds to the point by calculating individual watershed times of concentration and travel times through trunk storm drain or channel.

In Plates 1 through 10, each small watershed within a tributary subarea has a designation such as "A2b.2a." The designations are used to break down the tributary subarea into a series of watersheds. For example, watersheds A2b.2a and A2b.2b would together form a larger watershed, A2b.2. Watersheds A2b.2 and A2b.1 would combine to form a still larger watershed, A2b. The design flows shown in Table 6-1 use the same designations as those shown on Plates 1 through 10.

Design flows were routed through the tributary subareas using the following procedure:

1. Calculate the time of concentration for the uppermost watershed and the corresponding design flow.

2. At the first junction of two watersheds moving downstream, determine which one has the longer time of concentration. Add the design flow from this watershed to the flow calculated for the second watershed using the longer time of concentration. This gives the design flow at the first junction.

3. At the next junction downstream, determine the time of concentration by adding the travel time in the channel or pipe between the two junctions to the time of concentration used for design from Step 2. Calculate the flow by adding the original design flow from the uppermost watershed to new flows calculated for each of the other watersheds tributary to the junction using the time of concentration at the junction.

4. Continue downstream, calculating the time of concentration at each junction by adding the travel time in the channel from the last junction. Use the time of concentration at the point for which the design flow is being calculated to determine the contribution from each tributary watershed, except the uppermost watershed. Add the original design flow for the uppermost watershed (calculated based on its own time of concentration) to the flow from the other watersheds (calculated based on the time of concentration at the junction).

This procedure produces slightly conservative results for most storms, but allows a little excess capacity to be provided in case the runoff pattern from the watersheds is influenced by an unusual storm pattern or other factors and does not occur exactly as expected.

The routing procedure assumes that rainfall occurs over the entire basin at the same intensity at the same time. In reality, this would seldom be true. High precipitation intensities will normally occur in some areas while others have relatively low intensities. Most storms also have bands of relatively high or low intensities which move in the same general direction as the storm. Because a uniform precipitation intensity would seldom occur over a very large area, the flows calculated using design precipitation intensities probably slightly overestimate the runoff from large watersheds. This effectively provides an additional safety factor in the design of the trunk facilities which are especially important to the operation of the entire system.

## SYSTEM COSTS

The estimates for construction costs of the master plan facilities are based on the design standards listed in Chapter 5 and the unit costs shown in Table 6-2. The estimates are for current construction costs (Engineering News-Record, 20 Cities Average Construction Cost Index 4080) in Mammoth Lakes. The costs of field and office engineering, legal services, administration of construction contracts, and right-of-way acquisition are not included in the unit costs in Table 6-2.

Appendix B lists the quantities and costs of specific storm drainage items by tributary subarea. When reviewing the improvement plans shown on Plates 1 through 10, the reader should refer to Appendix B for details on the extent of proposed storm drainage improvements and the assumptions made in costing the facilities.

The costs of correcting erosion control problems not directly associated with drainage are shown by tributary subarea in Table 6-3. These problems include slope stabilization, revegetation, and cleanup of construction spoil piles and materials. The problem area locations and recommended solutions are shown on Plates 1 through 10. Table 6-3 separates the estimated costs to the County, private owners, and other agencies. This segregation is based on an estimation of the problem areas which occur in county road rights-of-way, on private lands, or in state highway rights-of-way. Detailed investigation of property line locations may change the proportion of responsibilities slightly.

Table 6-4 summarizes the total master plan facilities costs by tributary subarea. The total estimated construction cost for all the proposed improvements is approximately $13 million. To this total amount has been added a 10 percent contingency, and 25 percent for engineering, legal, and administration. These costs add about $5 million to the construction costs, and increase the total master plan cost to about $18 million.

Table 6-2. Unit Construction Costs for Storm Drainage Facilities

Storm Drainage Pipe and End Sections

| Diameter, inches | Installed unit cost, dollars/lineal foot | | | Unit cost of flared end sections, dollars/each |
|---|---|---|---|---|
| | Storm drain in street | Storm drain outside street | Culvert | |
| 18 | 40 | 32 | 32 | 125 |
| 24 | 46 | 36 | 30 | 150 |
| 30 | 57 | 44 | 49 | - |
| 36 | 64 | 50 | 56 | 300 |
| 42 | 75 | 60 | 65 | - |
| 48 | 89 | 73 | 76 | 650 |
| 54 | 103 | 86 | 87 | |
| 60 | 125 | 105 | 105 | |
| 66 | 141 | 120 | 117 | |
| 72 | 152 | 130 | 127 | |
| 84 | 194 | 170 | - | |
| 96 | 246 | 220 | - | |

Other Items

| Item | Basis of cost | Unit cost, dollars | Remarks |
|---|---|---|---|
| Drain inlets and leads | each | 900.00 | Typical inlet and connection to storm drain, installed |
| Manhole | each | 1,150.00 | Based on 48-inch diameter manhole, 6 to 8 feet deep |
| Curb and gutter | lineal foot | 12.00 | Based on 6-inch concrete curb and an 18-inch gutter |
| Channel | | | |
| 2-foot deep V-ditch | lineal foot | 5.00 | Based on improvements constructed in existing channel, including riprap lining |
| 4-foot bottom width | lineal foot | 15.00 | |
| 6-foot bottom width | lineal foot | 25.00 | |
| 8-foot bottom width | lineal foot | 35.00 | |
| Excavation | cubic yard | 2.50 | |
| Excavation and hauling | cubic yard | 5.00 | |
| Riprap | cubic yard | 5.00 | |

Table 6-3. Erosion Control Construction Costs[a,b]

| Tributary subarea | County costs, dollars | Private owner cost,[c] dollars | Other agency cost,[d] dollars | Total, dollars |
|---|---|---|---|---|
| II-1 | -- | -- | -- | 0 |
| II-2 | 12,000 | 3,000 | -- | 15,000 |
| II-3 | 3,000 | 5,500 | -- | 8,500 |
| III-1 | -- | -- | -- | 0 |
| III-2 | -- | -- | -- | 0 |
| III-3 | 7,500 | -- | -- | 7,500 |
| III-4 | 2,500 | 1,500 | -- | 4,000 |
| III-5 | 95,000 | 16,000 | -- | 111,000 |
| III-6 | 3,000 | 1,500 | -- | 4,500 |
| III-7 | 52,500 | 30,000 | -- | 82,500 |
| III-8 | 3,000 | 1,500 | 22,500 | 27,000 |
| Total | 178,500 | 59,000 | 22,500 | 260,000 |

[a]These costs are in addition to costs associated with control of storm drainage and improved roadway drainage facilities included in the Master Plan.

[b]Costs do not include design of erosion control treatments or long-term maintenance. All costs at June 1983 price level (ENR CCI = 4080).

[c]Erosion control facilities required on land outside the public right-of-way.

[d]Erosion control improvements in State Highway rights-of-way.

Table 6-4. Total Master Plan Facility Costs by Tributary Subarea

| Tributary Subarea | Total cost, dollars[a] |
|---|---|
| II-1 | 256,500 |
| II-2 | 1,081,500 |
| II-3 | 1,375,500 |
| III-1 | 165,000 |
| III-2 | 728,500 |
| III-3 | 1,101,000 |
| III-4 | 1,715,500 |
| III-5 | 3,184,000[b] |
| III-6 | 701,000 |
| III-7 | 2,490,000 |
| III-8 | 439,000 |
| Total construction cost | 13,238,000 |
| Contingency--10 percent | 1,323,000 |
| Engineering, legal, and administration--25 percent | 3,308,000 |
| Total | 17,864,000 |

[a]Based on June 1983 price level (ENR CCI = 4080).

[b]This is based on Alternative 1 which includes storm drain pipe in the area between Joaquin Street and Center Street; Alternative 2 includes open channel and culverts for this area and would cost $2,612,000.

# IMPROVEMENT PRIORITIES

Construction of the master plan facilities could be spread out over a number of years. This would allow facilities to be built as they are needed or as further development occurs. Three priority levels have been established for construction of the improvements.

Priority 1 improvements have been selected primarily to eliminate existing drainage and erosion control problems. These improvements are listed in Table 6-5 in their suggested order of construction. The total estimated construction cost for Priority 1 Improvements is approximately $4.7 million. To this figure have been added a contingency (10 percent) and engineering, administrative, and legal costs (25 percent) to bring the total cost to approximately $6.4 million.

Priority 2 Improvements include solutions to less critical drainage problems and facilities required to provide adequate drainage trunk capacity for the ultimate development. These improvements are listed in Table 6-6, and have an estimated total construction cost of approximately $6.4 million. Although Priority 2 Improvements are also listed in a suggested order of construction, the actual construction priority for each problem may be changed in response to drainage problems in specific areas or to new development.

Priority 3 Improvements include the remainder of master plan facilities, principally improvements for local storm drainage. The estimated construction cost for Priority 3 Improvements is $3.8 million. Adding contingencies, engineering, legal, and administrative costs produces a total cost of approximately $5.1 million. These improvements are shown in Table 6-7.

It is expected that the Mammoth Lakes community will be fully developed in 15 to 20 years. Therefore, the construction of the facilities could be accomplished in three 5-year periods, each corresponnding to a priority level for improvements.

Table 6-5. Priority 1 Improvements

| Item | Drainage subarea | Location | Description of improvement | Construction cost, dollars |
|---|---|---|---|---|
| a | III-1 | Murphy Gulch | Construct new siltation basin and improve existing basin. | 165,000 |
| b | All areas | All areas | Erosion control improvements. | 178,500 |
| c | III-5 | Lake Mary Road/ Majestic Pines Drive | Install new storm drain on Majestic Pines Drive to carry flow from Davison, John Muir, Lake Mary Roads; install new storm drain and curb and gutter on Lake Mary Road southwest of Lakeview Boulevard. | 267,400 |
| d | III-5 | Davison/John Muir Roads | Construct new storm drains; improve roadway drainage; stabilize roadside slopes. | 426,500 |
| e | III-5 | Lake Mary Road/ Hidden Valley Road | Install storm drain on Lake Mary and Hidden Valley Roads. Construct curb and gutter on east side of Lake Mary Road from Lakeview Boulevard to Minaret Road. | 162,700 |
| f | III-5 | Joaquin/Lupin/Mono/ Manzanita/Center Street | Construct new channel improvements and culverts or storm drain trunks from Joaquin Road to Center Street. Construct storm drain on Center Street. | 1,015,000[a] |
| g | III-7 | Canyon Boulevard | Construct new storm drain and curb and gutter improvements from Lakeview Boulevard to Warming Hut II parking lot. | 575,000 |
| h | III-3 | Sierra Park Boulevard | Install new storm drain trunk in Sierra Park Boulevard from Sierra Nevada Road to Main Street. | 201,500 |
| i | II-2 | Chateau Road near Old Mammoth Road | Construct new storm drain and curb and gutter from Azimuth Drive to outlet at creek. Construct new sediment retention basin. Construct new storm drain in Sierra Manor Drive. | 274,400 |
| j | II-3 | Old Mammoth Road | Mammoth Creek Drainage Crossing--Construct new box culvert creek crossing; stabilize creek channel near crossing. | 35,000 |
| k | III-6 | Mountain Boulevard to Vacation Place | Construct storm drain and curb and gutter improvements between Rusty Lane and Mountain Boulevard; on Rusty Lane; on Holiday Circle; between Holiday Circle and Vacation Place; and on Vacation Place. | 200,700 |
| l | III-8 | Forest Trail to Banner Street | Construct storm drain trunk from Forest Trail and Minaret to Banner Street. | 144,300 |
| m | II-3 | Old Mammoth residential area | Construct drainage improvements except in Area A2.b.2.b. Install sediment retention basins and require on-site retention facilities where applicable. | 1,060,000 |
| Total Priority 1 Improvements--Construction Costs | | | | 4,706,000[a] |
| Contingency--10 percent | | | | 471,000 |
| Engineering, legal, administrative--25 percent | | | | 1,177,000 |
| Total Cost | | | | 6,354,000 |

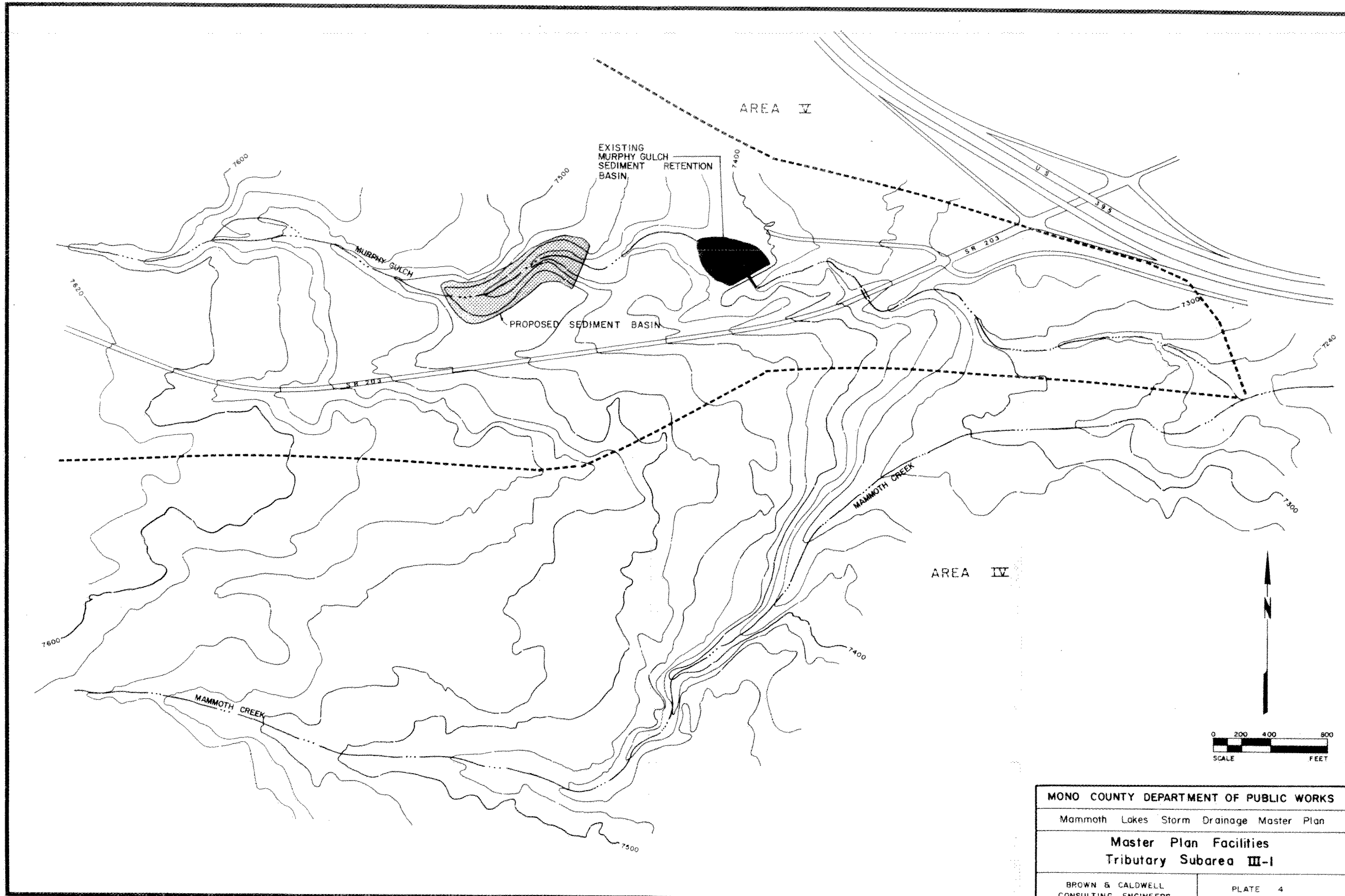
[a]These figures assume Alternative 1 is selected in Tributary Subarea III-5. If Alternative 2 is chosen, the Item f. cost and the total cost would be reduced by $476,500.

Table 6-6. Priority 2 Improvements

| Item | Drainage subarea | Location | Description of improvement | Construction cost, dollars |
|---|---|---|---|---|
| a | III-5 | Entire subarea | All master plan improvements not constructed in Priority 1, except Lakeview Boulevard. | 1,020,600 |
| b | II-2 | Entire subarea | All master plan improvements not constructed in Priority 1, except Snowcreek Road. | 596,000 |
| c | III-3 | Entire subarea | All master plan improvements not constructed in Priority 1. | 892,200 |
| d | III-4 | Main Street | Construct new drainage trunk from outlet at Murphy Gulch upstream. | 1,136,600 |
| e | III-7 | Canyon Boulevard, Minaret Road, Berner Street, Main Street | Construct drainage trunk from Canyon and Lakeview Boulevards to Main Street. | 591,500 |
| f | III-8 | Mammoth Knolls, Anton Circle | Construct storm drain and curb and gutter improvements on Minaret Road, Mammoth Knolls between Minaret Road and Sestriere Place, and on Anton Circle. | 261,800 |
| g | III-6 | Forest Trail | Construct storm drain and curb and gutter on Forest Trail, Holiday Circle to Grindelwald. Construct new drainage trunk on Main Street. | 241,400 |
| Total Priority 2 Improvements--Construction Cost | | | | 4,740,000 |
| Contingency--10 percent | | | | 474,000 |
| Engineering, legal, and administrative--25 percent | | | | 1,185,000 |
| Total Cost | | | | 6,399,000 |

Table 6-7. Priority 3 Improvements

| Item | Drainage subarea | Description of improvement | Construction cost, dollars |
|---|---|---|---|
| a | II-1 | Construct all Master Plan facilities. | 256,500 |
| b | II-3 | Construct drainage improvements in Area A.2b.2b. | 315,000 |
| c | III-2 | Construct all Master Plan facilities. | 728,500 |
| d | III-4 | Construct all Master Plan facilities not constructed in Priority 2. | 578,900 |
| e | III-5 | Construct facilities in Lakeview Boulevard. | 291,800 |
| f | III-6 | Construct all Master Plan facilities not constructed in Priorities 1 and 2. | 258,900 |
| g | III-7 | Construct all Master Plan facilities not constructed in Priorities 1 and 2. | 1,323,500 |
| h | III-8 | Construct all Master Plan facilities not constructed in Priorities 1 and 2. | 38,900 |
| Total Priority 3 Improvements--Construction Cost | | | 3,792,000 |
| Contingency--10 percent | | | 379,000 |
| Engineering, legal, and administrative--25 percent | | | 948,000 |
| Total Cost | | | 5,119,000 |



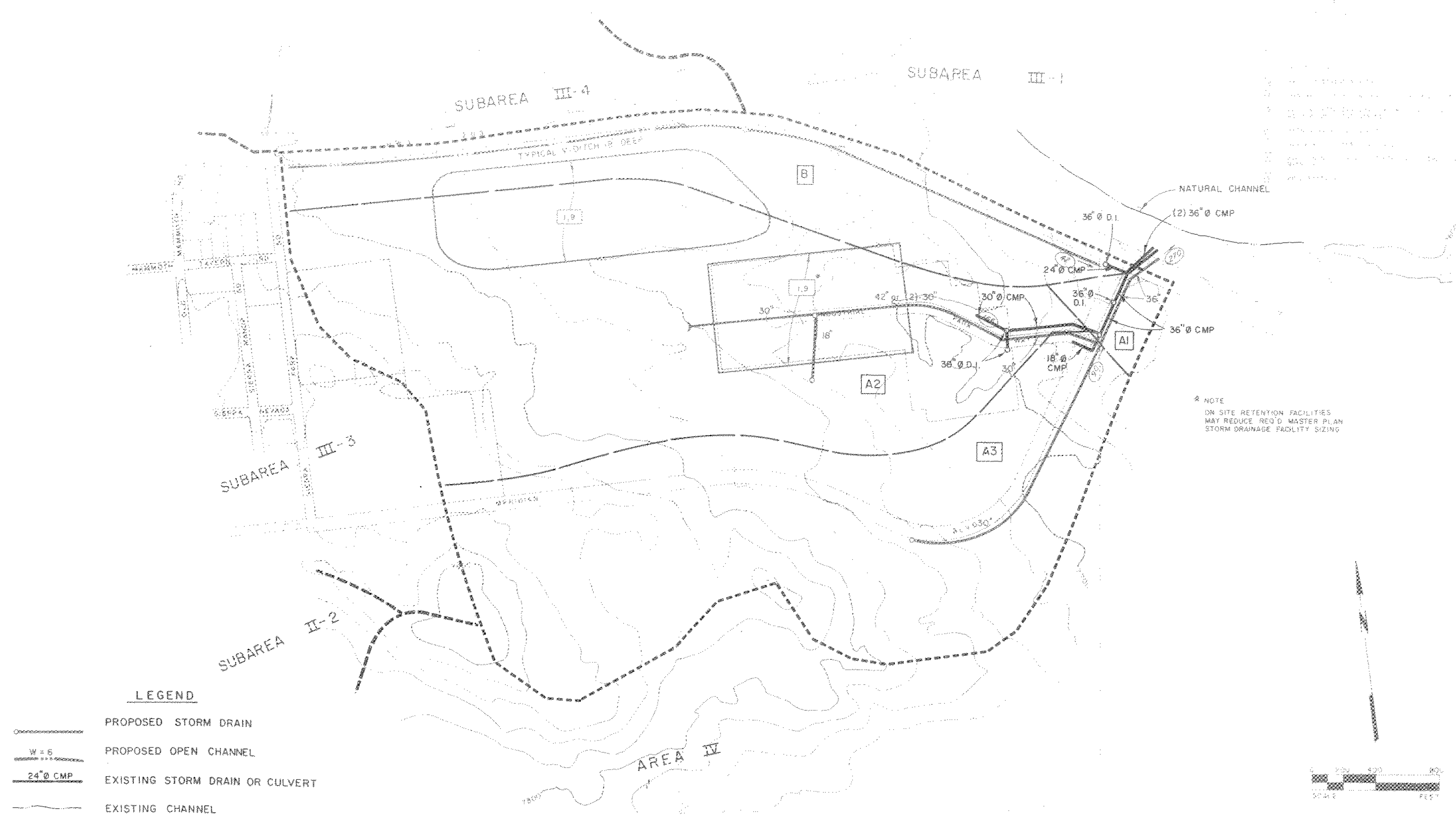

MONO COUNTY DEPARTMENT OF PUBLIC WORKS

Mammoth Lakes Storm Drainage Master Plan

Master Plan Facilities
Tributary Subarea III-1

BROWN & CALDWELL CONSULTING ENGINEERS

PLATE 4




## LEGEND

- PROPOSED STORM DRAIN
- W=6 — PROPOSED OPEN CHANNEL
- 24"Ø CMP — EXISTING STORM DRAIN OR CULVERT
- EXISTING CHANNEL
- 30"Ø CMP — NEW STORM DRAIN TO PARALLEL EXISTING PIPE
- 48" — STREET WITH STORM DRAIN AND NEW CURB AND GUTTER
- TRIBUTARY SUBAREA BOUNDARY
- WATERSHED BOUNDARY WITHIN TRIBUTARY SUBAREA
- (65) DESIGN $Q_{100}$ IN (cfs)

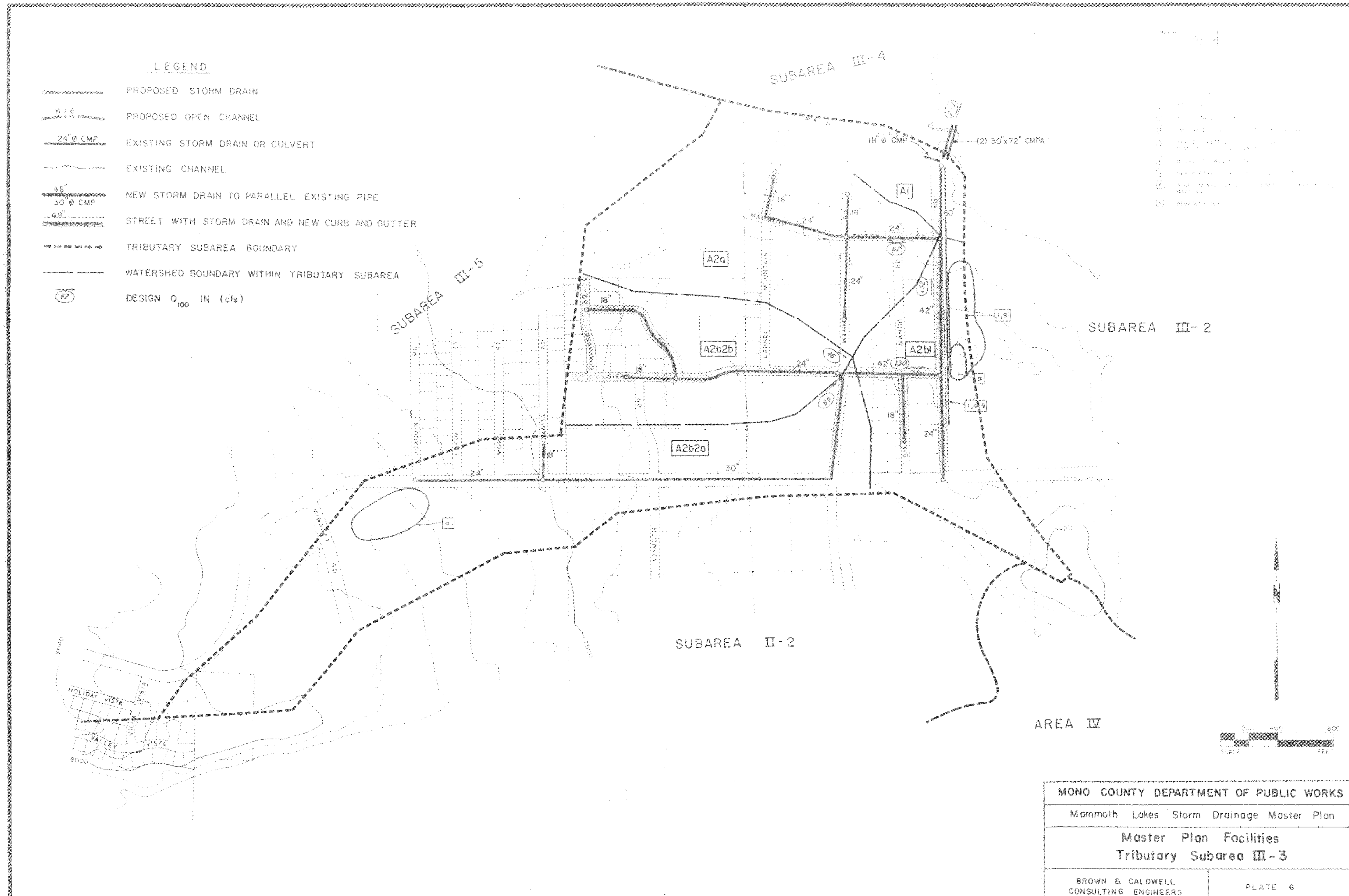
MONO COUNTY DEPARTMENT OF PUBLIC WORKS

Mammoth Lakes Storm Drainage Master Plan

# Master Plan Facilities
# Tributary Subarea III-2

BROWN & CALDWELL CONSULTING ENGINEERS

PLATE 5


LEGEND
PROPOSED STORM DRAIN
PROPOSED OPEN CHANNEL
24"Ø CMP
EXISTING STORM DRAIN OR CULVERT
EXISTING CHANNEL
48"
30"Ø CMP
NEW STORM DRAIN TO PARALLEL EXISTING PIPE
48"
STREET WITH STORM DRAIN AND NEW CURB AND GUTTER
TRIBUTARY SUBAREA BOUNDARY
WATERSHED BOUNDARY WITHIN TRIBUTARY SUBAREA
DESIGN $Q_{100}$ IN (cfs)
SUBAREA III-4
SUBAREA III-5
SUBAREA III-2
SUBAREA II-2
AREA IV
A1
A2a
A2b2b
A2b1
A2b2a
18"Ø CMP
(2) 30"x72" CMPA
HOLIDAY VISTA
VALLEY VISTA
MONO COUNTY DEPARTMENT OF PUBLIC WORKS
Mammoth Lakes Storm Drainage Master Plan
Master Plan Facilities
Tributary Subarea III-3
BROWN & CALDWELL
CONSULTING ENGINEERS
PLATE 6

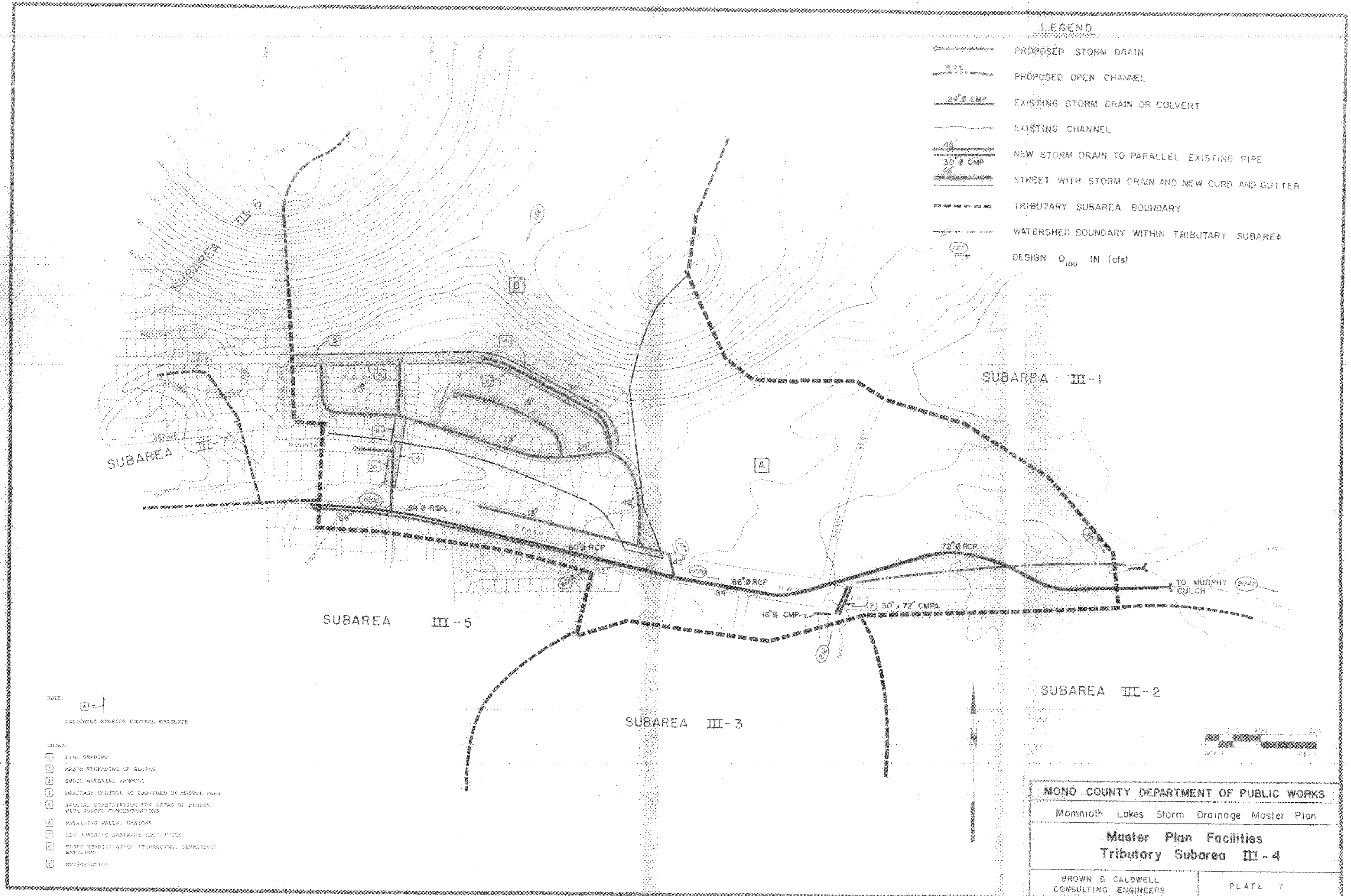

LEGEND
PROPOSED STORM DRAIN
PROPOSED OPEN CHANNEL
24"Ø CMP
EXISTING STORM DRAIN OR CULVERT
EXISTING CHANNEL
48"
30"Ø CMP
NEW STORM DRAIN TO PARALLEL EXISTING PIPE
STREET WITH STORM DRAIN AND NEW CURB AND GUTTER
TRIBUTARY SUBAREA BOUNDARY
WATERSHED BOUNDARY WITHIN TRIBUTARY SUBAREA
177
DESIGN $Q_{100}$ IN (cfs)
SUBAREA III-6
SUBAREA III-7
SUBAREA III-1
SUBAREA III-5
SUBAREA III-3
SUBAREA III-2
54"Ø RCP
60"Ø RCP
66"Ø RCP
72"Ø RCP
18"Ø CMP
(2) 30" x 72" CMPA
TO MURPHY GULCH
2042
MONO COUNTY DEPARTMENT OF PUBLIC WORKS
Mammoth Lakes Storm Drainage Master Plan
Master Plan Facilities
Tributary Subarea III-4
BROWN & CALDWELL
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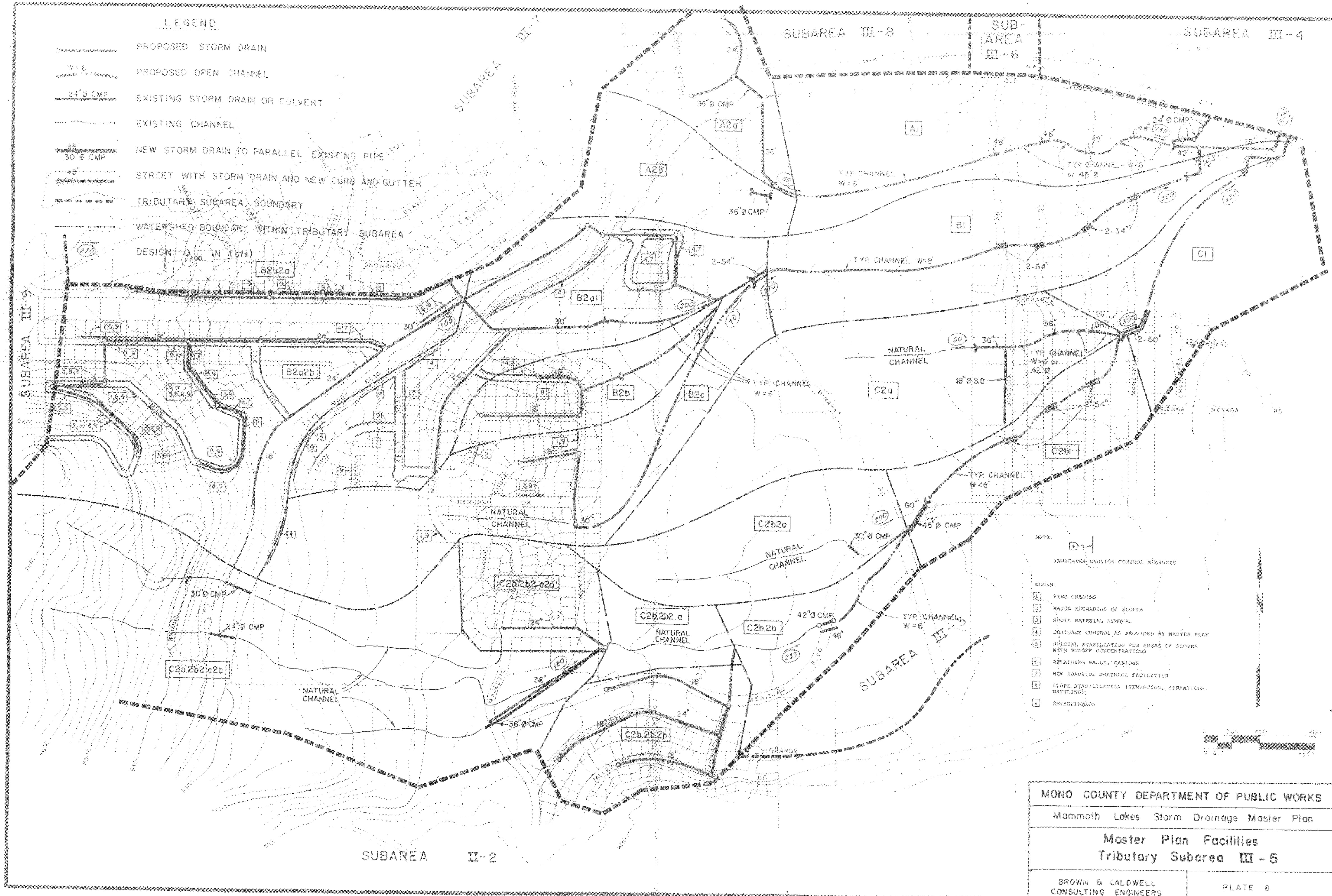
PLATE 7




MONO COUNTY DEPARTMENT OF PUBLIC WORKS

Mammoth Lakes Storm Drainage Master Plan

Master Plan Facilities
Tributary Subarea III - 5

BROWN & CALDWELL CONSULTING ENGINEERS

PLATE 8

C. Obstruct, divert, or interfere with natural or artificial surface drainage, swales, ditches, gutters, or other improved or unimproved drainage channels or drainageways.

D. Perform any work or construct any facility, including excavation or embankment, trenching, driveway construction, or drainage facilities within the right-of-way of a public road or street or within an easement under the jurisdiction of the Department without a permit from the Department.

13.08.060 Permit Exemptions

No permit shall be required for excavation below finished grade for building basements and footings, retaining wall, swimming pool, or other structure for which a permit has been issued by the Department.

13.08 070 Hazards

Whenever the Department determines that any natural slopes or excavation, embankment, or fill on private property is a menace to life and limb, endangers property, is a hazard to public safety, adversely affects the safety, use, or stability of adjacent property, a public way or drainage channel, or could adversely affect the water quality of any water bodies or streams, the owner of the property upon which the excavation or fill is located, or other person or agent in control of said property, upon receipt of notice in writing from the Department shall, within the period specified therein, repair or eliminate such excavation or embankment so as to eliminate the hazard and be in conformance with the requirements of this ordinance.

The Department may require the submission of plans, soils or geological reports and recommendations or other engineering data prior to and in connection with any corrective or proposed work or activity.

13.08.080 Permit Application

Application for a Grading Permit shall be submitted on the form provided by the Department. Additional documentation to be submitted with the application shall include but not be limited to:

A. Improvement Plan

An improvement plan, prepared in accordance with the requirements of Chapter 17.24 of the Mono County Code shall accompany the application. All roads, curb and gutter, storm drainage, flood control, erosion prevent water quality degradation. No person shall violate any conditions so imposed by the Director. Such conditions may include, but shall not be limited to:

1. Limitations on the hours of operation in which work may be performed.

2. Designation of routes upon which materials may be transported and means of access to the site.

3. The place and manner of disposal of excavated materials.

4. Requirements as to the mitigation of dust and dirt, the prevention of noises and other results offensive or injurious to the neighborhood, the general public, or any portion thereof, including due consideration, care, and respect for the property rights, convenience, and reasonable desires and the needs of said neighborhood or any portion thereof.

5. Designation of maximum or minimum slopes to be used.

6. Limitations on the areal extent and duration of time of exposure of unprotected soil surfaces.

7. Regulations as to the use of public streets and places in the course of the work.

8. A performance bond to cover landscaping, erosion control facilities, revegetation, or other conditions of the permit.

9. Mitigating measures recommended by the Lahontan Board, Forest Service, Soil Conservation Service, or other permit review agency.

10. Phasing of operations to minimize water or other environmental impacts.

G. There shall be no excavation on the site before the Department has approved the location of the stakeout of the drives, parking sites, building sites, and other areas to be graded or filled.

13.08.160 Denial of Permit

A. Hazardous Grading. The Director shall not issue a permit in any case where he finds that the work as proposed by the applicant is liable to constitute a hazard to the public welfare or endanger life or any private property or result in the deposition of debris on any public way or interface with any existing drainage course or cause any water quality degradation.

If it can be shown to the satisfaction of the Director that the hazard can be essentially eliminated by the construction of retaining structures, buttress fills, drainage devices, erosion control facilities, or by other means, the Director may issue the permit with the condition that such work be performed.

B. Geological or Flood Hazard. If, in the opinion of the Director, the land area for which grading is proposed is subject to geological or flood hazard to the extent that no reasonable amount of corrective work can eliminate or sufficiently reduce the hazard to human life or property, the grading permit and the building permits for habitable structures shall be denied.

C. Adverse Environmental Effect. The Director may require plans and specifications to be modified in order to mitigate anticipated adverse environmental effects of proposed grading projects and he may, under circumstances where the significant adverse environmental effects of a proposed grading project cannot be mitigated, deny the issuance of a grading permit.

13.08.180 Hauling Routes

The Department may attach as a condition to any permit issued hereunder a requirement that all equipment used to haul excavation or fill material from or to the site shall follow a designated route or routes in going from and coming to the site. An applicant shall be entitled to the designation of a route providing access to a specified place other than the site, when he has shown to the satisfaction of the Department that such specified place is a place where excavation material may be reasonably deposited or fill material may be obtained. Designation of such routes shall be subject to the following:

A. All equipment shall be limited to the actual area to be disturbed on all sites according to the approved plans. No vehicles of any kind shall pass over areas to be left in their natural state according to the approved plans. Steep banks and vegetative areas shall be avoided by traffic.

B. Access roads to the premises shall be only at points designated on the approved grading plan. Traffic in and along creeks or streams shall be avoided.

C. The last 50 feet of the access road, as it approaches the intersection with the public roadway, shall have a grade not to exceed 3 percent. There must be a 300-foot clear, unobstructed sight distance to the intersection from both the public roadway and the access road. If the 300-foot sight distance cannot be obtained, flagmen shall be posted.

D. Either water or dust palliative or both must be applied for the alleviation or prevention of excessive dust resulting from the loading or transportation of earth from or to the project site or public roadways. The permittee shall be responsible for maintaining public rights-of-way used for hauling purposes in a condition free of dust, earth, or debris attributed to the grading operation.

13.08.190 Fees

A. Plan-Checking Fee. For excavation and fill on the same site, the fee shall be based on the volume of the excavation or fill, whichever is greater. Before accepting a set of plans and specifications for checking, the Department shall collect a plan-checking fee. Separate permits and fees shall apply to retaining walls or any major drainage structures as indicated elsewhere in this ordinance. There shall be no separate charge for standard terrace drains and similar facilities. The amount of the plan-checking fee for grading plans shall be as set forth by resolution by the governing body of Mono County.

The plan-checking fee for a grading permit authorizing additional work to that under a valid permit shall be the difference between such fee paid for the original permit and the fee shown for the entire project.

B. Grading Permit Fees. A fee for each grading permit shall be paid to the Department as set forth by resolution of the governing body of Mono County.

The fee for a grading permit authorizing additional work to that under a valid permit shall be the difference between the fee paid for the original permit and the fee shown for the entire project.

If substantial grading is commenced prior to obtaining a permit, a fee equal to twice the amount provided for in this chapter shall be charged for the issuance of a grading permit.

13.08.200 Bonds

A. Bonds Required. A permit shall not be issued unless the permittee shall first post with the Department a bond executed by the owner and a corporate surety authorized to do business in the State of California as a surety in an amount sufficient to cover the cost of the grading project, including the construction of drainage and protective devices and any corrective work necessary to remove and eliminate engineering and geological hazards in a form prescribed by the Department or approved as to form by the counsel of Mono County.

In lieu of a surety bond, the applicant may file a cash bond or, if approved by the counsel of Mono County, a letter of credit from one or more financial institutions subject to regulation by the state or federal government in an amount equal to that which would be required in the surety bond.

Exceptions:

The Director may reduce the amount of the bond when he determines the proposed grading will not adversely affect the subject property or adjacent property or existing or proposed structures thereon, and will not create or cause slope failure, erosion, siltation, flooding, or other adverse environmental impact if, for any reason, the proposed project or grading is not completed.

On developments where progressive individual grading projects or several concurrent projects are being constructed by one owner, a continuing bond or single letter of credit may be provided which will cover all such projects; the amount thereof shall be determined by the Director.

B. Conditions. Every bond shall include the conditions that the permittee shall.

1. Comply with all of the provisions of this chapter and any other applicable laws and ordinances.

2. Comply with all of the terms and conditions of the permit for excavation or fill to the satisfaction of the Department.

3. Complete all of the work contemplated under the permit within the time limit specified in the permit or complete the work to a safe condition

satisfactory to the Department. (The Director may, for sufficient cause, extend the time specified in the permit, but no such extension shall release the surety upon the bond.)

C. Failure to Complete Work. The term of each bond shall begin upon the date of filing and shall remain in effect until the completion of the work to the satisfaction of the Department. In the event of failure to complete the work and failure to comply with all of the conditions and terms of the permit, the Department may order the work required by the permit to be completed or put in a safe condition to his satisfaction. The surety executing such bond or deposit shall continue to be firmly bound under a continuing obligation for the payment of all necessary costs and expenses that may be incurred or expended by the governing agency in causing any and all such required work to be done. In the case of a cash deposit, said deposit or any unused portion thereof shall be refunded to the permittee.

D. Default in Performance of Conditions. Whenever the Deartment finds or determines that a default has occurred in the performance of any requirement of a condition of a permit issued hereunder, written notice thereof shall be given to the principal and to the surety on the bond. Such notice shall specify the work to be done, the estimated cost thereof, and the period of time deemed by the Department to be reasonably necessary for the completion of such work.

After receipt of such notice, the surety shall, within the time specified, cause or require the work to be performed, or failing therein, shall pay over to the Department the estimated cost of doing the work as set forth in the notice. Upon receipt of such monies, the Department shall cause the required work to be performed and completed.

E. Substitution. A substitute bond or letter of credit may be filed in lieu of any above-mentioned bond or letter of credit, and the Department may accept the same if it is suitable to insure completion of the work remaining to be performed and in proper form and substance, and the bond or letter of credit for which it is substituted may be exonerated if the Department finds that the conditions of said bond or letter of credit for which a substitute has been filed have been satisfied and that no default exists as to the performance upon which the said bond or letter of credit is conditioned.

control, and other improvements for the subject project identified in the improvement plan shall be designed in accordance with the Design Manual and Road Standards. The improvement plan shall include the following items:

B. Construction Plan

All applicants for a Grading Permit involving disturbance of more than 10,000 square feet of land surface shall prepare and submit a construction plan subject to the following provisions:

1. Revisions in the proposed project shall be accompanied by necessary revisions in the construction plan.

2. All projects which will require more than one construction season to complete shall submit an annual progress report to the Department within three months after completion of the first, and any subsequent construction seasons.

3. All construction plans shall assess the water management implications of the proposed project, including water quality, erosion control, groundwater considerations, revegetation, surface runoff, the methods and procedures for construction, and the construction schedule.

The constructin plan shall include the following information. The Department shall determine the adequacy of the plan and may require the submission of additional information where necessary to adequately assess project implications.

1. Estimated schedule for project construction, including date of starting and completion of construction, and dates when major improvements will be started and completed.

2. Location map showing project site.

3. Map showing property boundaries and dimensions of area covered by application for permit.

4. Statement of the credentials of the person or persons who prepared the plan.

5. A plan drawn at a scale of 1 inch equals 20 feet or other appropriate scale that adequately shows the details of terrain and drainage for the conditions existing before and after the proposed work. The

use of a scale that does not adequately show project details may be cause for rejection of the application. The plan shall show contours and the limiting dimensions and elevations within the limits of the graded area on completion of the work; all temporary erosion control and storm drainage facilities to be used during construction; the proposed drainage channels and facilities; and the planned elevations, grades, and slopes of excavations and embankments. The plan shall show existing drainage patterns, the location of observed springs, swampy areas, areas subject to flooding, landslides, surface faults, and mud flows. Elevations shall be based on USGS datum, unless waived by the Director.

6. Cross-section of the ground showing both original and proposed ground surfaces, with grades, slopes, and elevations noted.

7. A soils report, including a general description of the earth and rock materials involved in the work as to classifications; bedding or other geological features; any other reports by soils engineer or geologist on the test borings and slide conditions existing or anticipated; the suitability of the material for its proposed use, including data on expansive soils; and recommendations for construction procedure to obtain required stability and relative compaction.

8. Calculations to show surface runoff flows from construction site in accordance with procedures defined in the Design Manual.

9. Calculations for design in accordance with procedures defined in the Design Manual of temporary drainage and erosion control facilities to be installed during construction.

10. Methods for winterization of the site if construction extends beyond October 15 of the year of initiation of construction.

11. A revegetation plan specifying methods to be used following completion of the project and at any intermediate stages of construction to stabilize soil surfaces on the site.

12. A written description of the site and proposed mitigation measures to be used to control runoff and prevent discharge of sediment from the site.

C. Minor Construction Plan

All applicants for a grading permit involving disturbance of 5,000 to 10,000 square feet of land surface shall prepare and submit a minor construction plan. The Department shall determine the adequacy of the plan and may require the submission of additional information where necessary to adequately assess project implications. Said plan shall include the following:

1. Construction schedule as described above.

2. Location map showing project site and map showing property boundaries and dimensions of area covered by application for permit.

3. Map at an adequate scale to show existing surface drainage paterns, how they will be affected by the proposed project, and location of all temporary storm drainage ard erosion control facilities to be used during construction.

4. Methods for winterization of the site if necessary.

5. A written description of the site and proposed mitigation measures to be used to control runoff and prevent discharge of sediment from the site.

13.08.090 Review of Grading Permit Application

Applications for grading permits will be reviewed by the Department. At the Department's discretion, the application may be submitted to the Forest Service, Soil Conservation Service, Lahontan Board, or other agency with specialized expertise necessary to evaluate the proposed action. The reviewing agency shall recommend to the Department that the application be approved, disapproved, or approved with mitigating measures. Any measured contained in such recommendations shall be incorporated into the construction and improvement plans if directed by the Department.

13.08.100 Additional Data

(Same as existing Section 13.08.070.)

13.08.110 Grading--Old Fill, Swamp, Slide Area

(Same as existing Section 13.08.080.)

13.08.120 Supplementary Data

(Same as existing Section 13.08.090.)

13.08.130 Plan Checking

(Same as existing Section 13.08.100.)

13.08.140 Fees

(Same as existing Section 13.08.110.)

13.08.150 Permit Issuance

The Department may require that grading operations and project designs be modified if delays occur which may lead to weather-generated problems not considered at the time the permit was issued. In addition, the following conditions shall apply:

A. The grading permit will be issued when all fees are paid and all bonds necessary to meet the requirements of this chapter are posted.

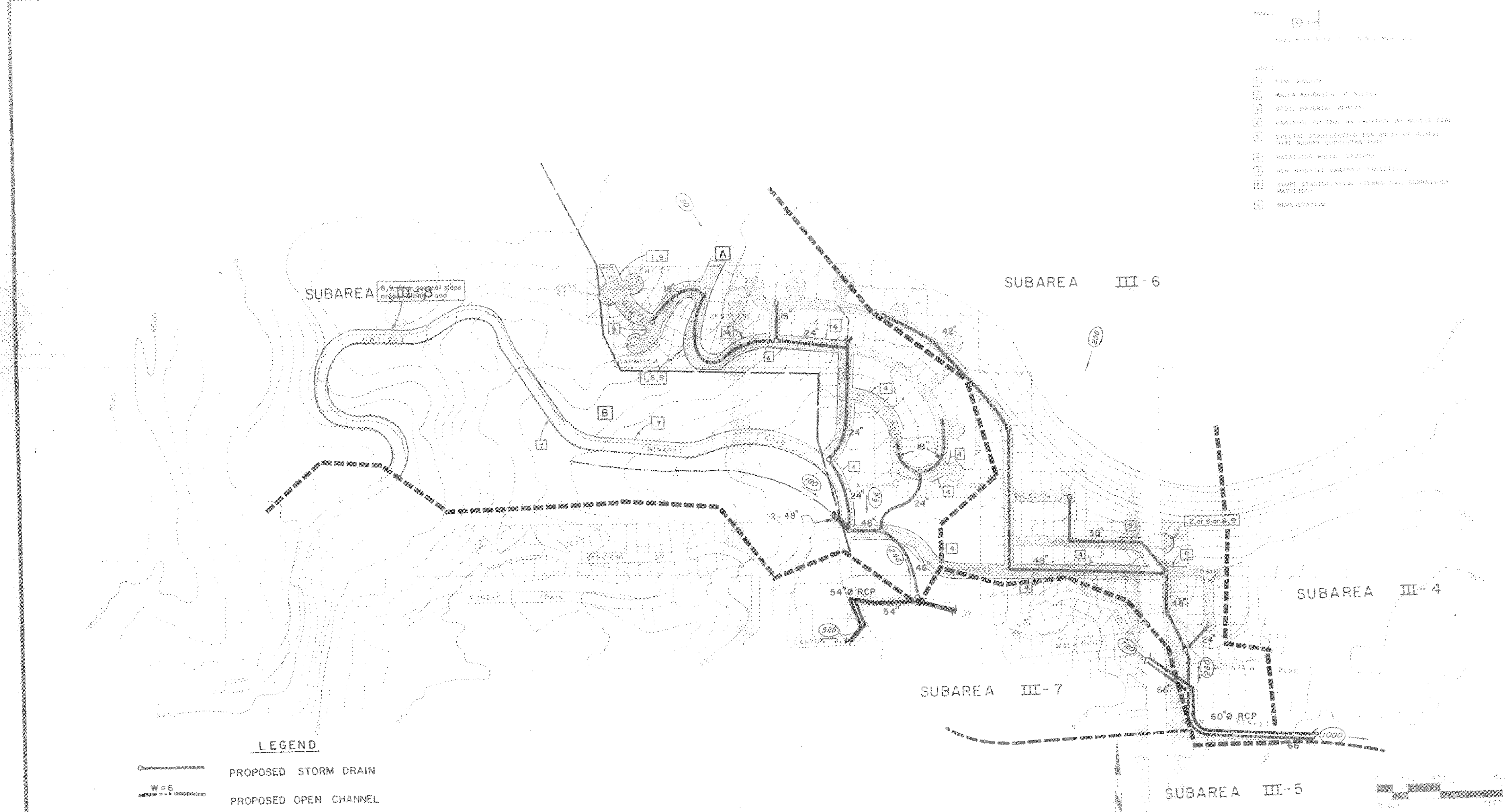
B. Every permit issued shall be valid for a period of no more than one year.

C. If the holder of a grading permit presents satisfactory reasons for his failure to complete the work during the period of validity of the permit, the Director, upon application by the permittee, may grant extensions of time deemed necessary by reason of such difficulties. No request for such extensions will be considered later than the 30th day following the date on which said permit would otherwise expire.

D. If a permit holder presents satisfactory evidence that unusual difficulties have prevented work being started within 60 days, or completed within one year, or continued without being suspended for 120 days, the Director may grant extensions of time reasonably necessary by reason of such difficulties. No request for such extensions will be considered later than the 30th day following the date on which said permit would otherwise expire.

E. Whenever in the judgment of the Department the proposed work would cause excessive and unnecessary scarring of the natural landscape through grading or removal of vegetation, the application shall be denied.

F. In granting any permit under this ordinance, the Director may attach such conditions thereto as may be reasonably necessary to prevent danger to public or private property, to prevent the operation from being conducted in a manner likely to create a nuisance, or to




## LEGEND

PROPOSED STORM DRAIN

W=6 PROPOSED OPEN CHANNEL

24"Ø CMP EXISTING STORM DRAIN OR CULVERT

EXISTING CHANNEL

48" NEW STORM DRAIN TO PARALLEL EXISTING PIPE

30"Ø CMP 48" STREET WITH STORM DRAIN AND NEW CURB AND GUTTER

TRIBUTARY SUBAREA BOUNDARY

WATERSHED BOUNDARY WITHIN TRIBUTARY SUBAREA

(126) DESIGN $Q_{100}$ IN (cfs)

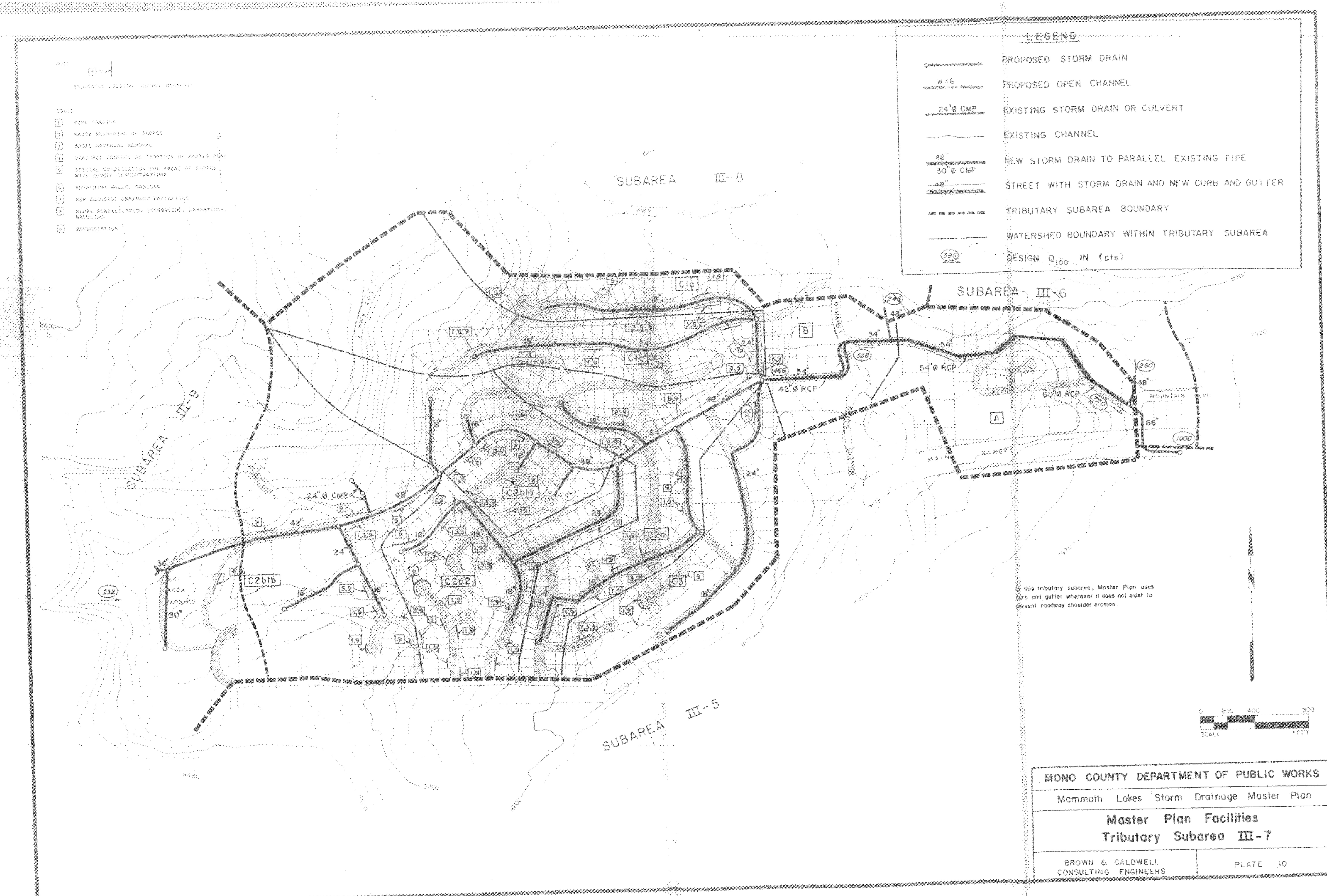
MONO COUNTY DEPARTMENT OF PUBLIC WORKS

Mammoth Lakes Storm Drainage Master Plan

Master Plan Facilities
Tributary Subareas III-6, III-8

BROWN & CALDWELL CONSULTING ENGINEERS

PLATE 9


LEGEND
PROPOSED STORM DRAIN
PROPOSED OPEN CHANNEL
EXISTING STORM DRAIN OR CULVERT
EXISTING CHANNEL
NEW STORM DRAIN TO PARALLEL EXISTING PIPE
STREET WITH STORM DRAIN AND NEW CURB AND GUTTER
TRIBUTARY SUBAREA BOUNDARY
WATERSHED BOUNDARY WITHIN TRIBUTARY SUBAREA
DESIGN $Q_{100}$ IN (cfs)
SUBAREA III-8
SUBAREA III-6
SUBAREA III-9
SUBAREA III-5
C1a
C1b
C2b1a
C2b1b
C2b2
C2a
C3
A
B
24" Ø CMP
42" Ø RCP
54" Ø RCP
60" Ø RCP
MOUNTAIN BLVD
In this tributary subarea, Master Plan uses curb and gutter wherever it does not exist to prevent roadway shoulder erosion.
MONO COUNTY DEPARTMENT OF PUBLIC WORKS
Mammoth Lakes Storm Drainage Master Plan
Master Plan Facilities
Tributary Subarea III-7
BROWN & CALDWELL
CONSULTING ENGINEERS
PLATE 10

# CHAPTER 7

# PROGRAM FINANCING

This chapter discusses alternatives for financing construction of Master Plan facilities and recommends a financing method. All program costs are identified, and the basis for cost-sharing and approximate user charges necessary to pay for system construction are presented. Financing alternatives using user fees as the basic revenue are analyzed and a recommended approach is identified.

## FINANCING METHODS

The recommended improvement program requires large capital expenditures for construction of new facilities and smaller annual expenditures for operation, maintenance, and administration of the system. Several alternative methods of financing are available to any district or agency which provides public services such as storm drainage and erosion control. This section describes several of these methods and compares their advantages and disadvantages. Alternative organizational frameworks which might be used to facilitate financing, construct the facilities, maintain and operate the system, and collect revenues are described in Chapter 8. Financing and organizational alternatives are not independent. The various types of financing available depend on the organization used and its powers under federal and state laws. Only the advantages and disadvantages of the financing methods and the revenue sources which can be used to support the financing methods are discussed in this chapter. The organizational alternatives are analyzed in Chapter 8.

Operating expenses are often paid from existing revenues commonly known as "pay as you go." Larger capital expenditures are often financed over a long term using "pay as you use." The term of the debt generally coincides with the useful life of the improvement. Cash expenditures have the advantage that interest expense and some administrative costs are saved, and that the public entity retains its ability to borrow money at a favorable rate. On the other hand, long-term debt provides a greater capacity to construct new facilities, allows the benefits and the cost of improvements to occur at the same time, and provides greater flexibility in cash flow management. To be effective and cost efficient, a public agency should consider the benefits of each approach for each function which the agency performs. In addition, the possibility of obtaining grant funds from state and federal governments should be explored.

Four types of financing which are discussed below are applicable to the construction and operation of new Master Plan facilities.

1. Cash expenditures.
2. Government grants and loans.
3. Municipal bonds.
4. Short-term loans.

Each method is discussed below.

Cash Expenditures

Cash expenditures have traditionally been used to pay the costs for operating public facilities. Cash expenditures may be supported by tax revenues, user fees, connection or capacity charges, special assessments, or any other means. Cash expenditures simplify the administrative work associated with operation of facilities by obviating the need for financing analysis and decisions. They also allow existing residents to determine how funds will be spent, rather than obligating future residents.

The primary disadvantage to cash expenditures is their limited capacity for financing improvements. To provide for a large capital expenditure, a large reserve must be built up over time. This requires that revenue be collected for many years before benefits can be provided, and that the charges or assessments to residents be large to limit the time required to create the necessary reserves. A similar drawback of a system which relies only on cash expenditures is that a relatively large reserve must be maintained to provide for unexpected repairs or emergencies. Short-term debt or emergency grant funds can often be used in combination with cash reserves to more efficiently provide for unexpected expenditures.

Long-term debt may also be used effectively in combination with cash expenditures to improve and operate a drainage system or other improvements. For example, bonds are often sold to finance capital improvements, while revenues produced from user charges are used to pay operation, maintenance, and administrative costs.

Because of the size of the expenditures required to construct Master Plan facilities, the use of only cash expenditures will extend program construction over a long time period. Establishment of cash reserves and the use of cash to pay operation, maintenance, and administrative costs will reduce the annual revenue available to finance capital improvements. Cash expenditures could be used in conjunction with a bond-financed major capital improvement program to finance construction of smaller, incidental improvements, to limit the administrative effort required, and to get the improvements built as quickly as possible.

Government Grant Funds and Loans

Table 7-1 summarizes contacts made with federal and state agencies to determine the availability of government financial assistance. Each program is identified by legislative authorization, purpose, type of assistance available, and funding potential.

As shown in the table, there is not great potential for government-assisted funding. The most promising sources are technical assistance from the U.S. Soil Conservation Service (SCS) and financial assistance through the Economic Development Administration (EDA).

Soil Conservation Service. Although relatively small in terms of financial value, technical assistance from the SCS may prove to be valuable to the long-term success of erosion control work. Through Resource Conservation District No. 44, the SCS could train county staff or others involved in supervision of erosion control improvements; assist in the design of treatments or improvements for particular areas; assist in the selection of appropriate vegetation types; and provide demonstration planting. The District Conservationist, Mr. Leonard Jolley, should be contacted for more information.

Economic Development Administration. Grants through the EDA may be available to finance construction of storm drainage improvements. To obtain financing, the improvements must be consistent with the Overall Economic Development Plan (OEDP) for the area. Mono County is currently developing an OEDP and expects to submit the document to EDA shortly. Under Title I funding of the EDA program, grants of 50 to 80 percent of the project cost may be available. Projects must improve long-term commerical development and employment prospects. Title I assistance also includes a Public Works Impact Program (PWIP), which is intended to generate short-term construction jobs. Projects must be in areas with substantial unemployment or low-income persons. Public Works Impact Program projects are not required to be related to the OEDP.

Bonds

Bonds are the form of long-term indebtedness most often used to finance major improvement projects. Several types of bonds may be used, depending on the needs of the project and the organizational framework through which bonds are issued. Several different types of bonds are discussed below.

Table 7-1. Government Grant Funds and Loans

| Administering agency | Program name and authorization | Purpose of program | Type of assistance | Potential for funding Master Plan improvements |
|---|---|---|---|---|
| Farmer's Home Administration U.S. Department of Agriculture | Community Facilities Loans--Consolidate Farm and Rural Development Act, Section 306, PL 92-419 | Loans to construct, enlarge, and extend community facilities to rural residents. Flood control, drainage facilities, curb, gutter, and bridges. Towns must be under 20,000 in population. | Loans | Approximately $3.5 million appropriated to California for Fiscal Year 1984. First priority to projects relating to public safety. Little chance of obtaining funds for Mammoth Lakes unless portion of project can be shown to correct unsafe conditions. |
| | Resource Conservation and Development Loans--Food and Agriculture Act of 1962; PL 87-703; 7 U.S.C. 1011; 7 U.S.C. 1010 | Loans to local sponsoring agencies in authorized areas. Loan funds may be used for soil and water conservation, control, and use. Project must be in authorized Resource Conservation and Development area. Program operates in conjunction with SCS. | Loans | Mammoth Lakes not in authorized Resource Conservation and Development area. Authorization controlled by SCS. Unlikely that loan could be justified by cost-benefit analysis. See remarks SCS. |
| Soil Conservation Service U.S. Departmentof Agriculture | Resource Conservation and Development--Soil Conservation Act of 1935; PL 7446 and Bankhead-Jones Farm Tenant Act; PL 74-210 | Assistance to local people in authorized Resource Conservation and Development areas in initiating and carrying out long-range programs of resource conservation and development. Technical and financial assistance for planning and installation of measures approved in resource conservation and development plans, such as flood prevention, sedimentation and erosion control, and water quality management. | Project grants and advisory services. | Mammoth Lakes not in authorized Resource Conservation and Development area. Very little money available nationwide through this program. Authorization by SCS as Resource Conservation and Development area not likely. |
| Soil Conservation Service U.S. Department of Agriculture | Watershed Protection and Flood Prevention Act; PL 83-566 | To provide technical and financial assistance in planning and constructing works to protect, develop, and utilize land and water resources in small watersheds. Flood prevention, drainage, sedimentation, and erosion control are eligible. | Project grants and advisory services, loans through Farmer's Home Administration. | Current cost of federal money very high. Grants difficult to justify on cost-benefit basis except in highly urbanized areas or where property damage may be extensive. |

Table 7-1. Government Grant Funds and Loans, continued

| Administering agency | Program name and authorization | Purpose of program | Type of assistance | Potential for funding Master Plan improvements |
|---|---|---|---|---|
| Soil Conservation Service U.S. Departmentof Agriculture | Plant Materials Soil Conservation and Domestic Allotment Act; PL 74-46 | Sale, exchange, or donation of plant materials for promoting use of new and improved plant materials for soil and water conservation. Uses include erosion control and sediment reduction. | Technical assistance only. | Funding not available. Technical assistance in training county personnel, private contractors, or public in soil stabilization and revegetation methods are available. Limited services for design of erosion control treatments may be available. Some trial plantings may be available at no cost or reduced cost. |
| Army Corps of Engineers U.S. Department of Defense | Small Flood Control Projects--1948 Flood Control Act, Sec. 205 | Design and construction of projects to reduce flood damages. | Corps of Engineers performs design and construction up to a limit of $4,000,000 for federal involvement. Local cost participation for portions of project. | Flood control projects only--no storm drainage. Flow in stream should have 10-year flow of 800 cubic feet per second. Little or no chance of authorization for Mammoth Lakes projects. |
| Army Corps of Engineers U.S. Department of Defense | Stream Bank and Shoreline Protection for Public Facilities--Section 14, 1946 Flood Control Act | Stream bank erosion control for protection of economic and environmental values. | Grant for construction or repair of stream bank protection facilities--$250,000 limit. | Generally used for emergency protection only where damage to a facility is imminent. Used to correct problems rather than improve facilities. Little or no applicability to Mammoth Lakes projects. |
| Army Corps of Engineers U.S. Department of Defense | Snagging and Cleaning for Flood Control--Section 208, 1954 Flood Control Act | Removal of channel restrictions which cause or could cause flooding. | Corps of Engineers produces two-phase report and performs channel improvements--$250,000 limit. | Work must be justified by prevention of property damage. Some assistance may be available for channel improvements in Mammoth Creek near developed area. |
| Economic Development Administration U.S. Department of Commerce | Public Works and Economic Development Act of 1965 | Alleviate unemployment and foster economic growth through various programs. | Grants, loans. | Projects must be consistent with areas OEDP. Assistance may be available after development of plan by Mono County. |
| U.S. Department of Housing and Urban Development | Community Development Block Grants, Small Cities Program--Housing and Community Development Act of 1974 | Neighborhood revitalization, economic development, and provision of improved community facilities and services. | Grants | Projects must benefit low or moderate income persons. Potential for funding Mammoth Lakes storm drainage is not very good because housing projects which show a high level of benefit to low income persons are favored over storm drainage. |

General Obligation Bonds. General obligation (GO) bonds have traditionally been used to finance public facilities because of their low interest costs. The bonds are sold by a public entity which pledges its full credit for the interest and prinicipal on the bonds. The bonds are secured by the entity's authorization to levy ad valorem taxes on all real property as necessary to pay the bond principal and interest. Therefore, security on the bonds is of the highest quality.

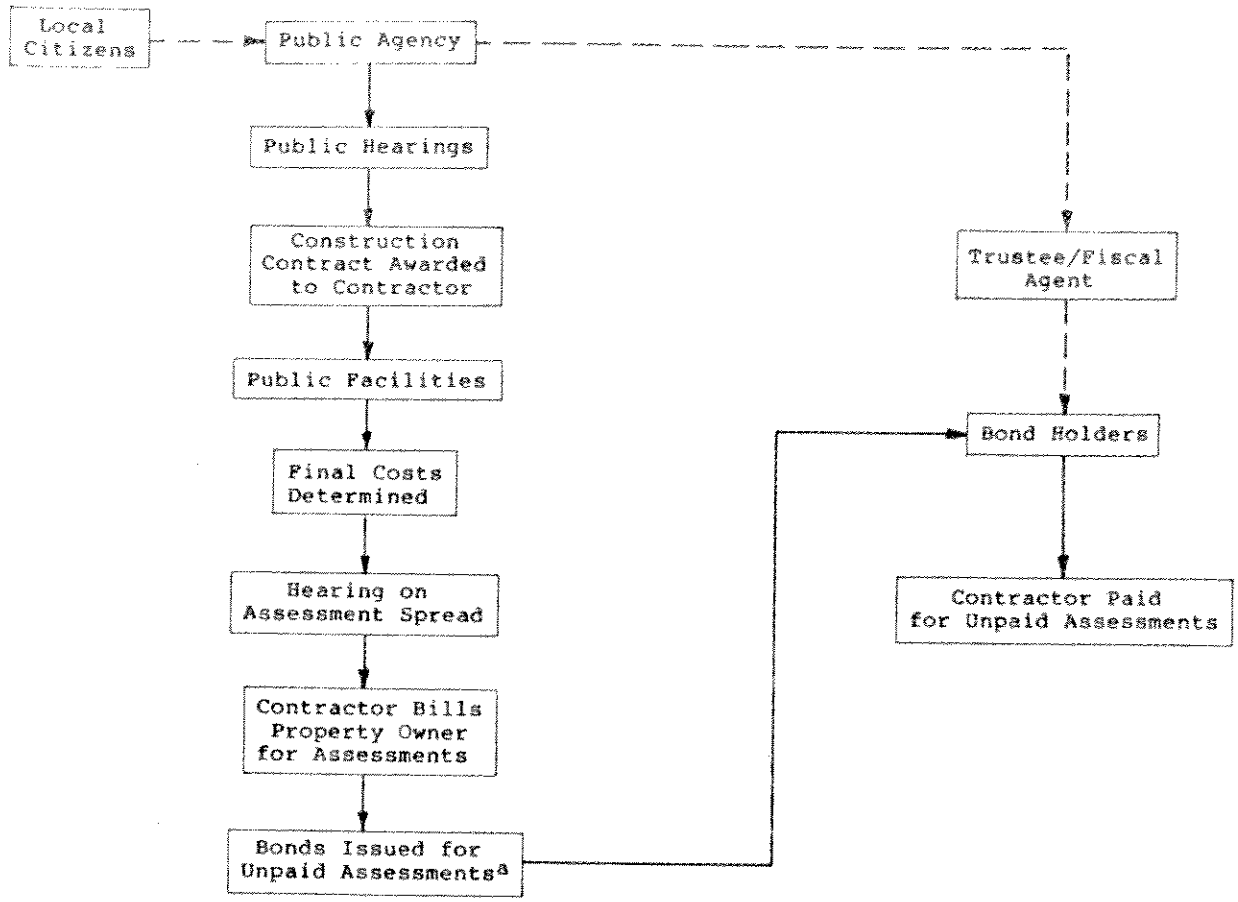
In California, Proposition 13 has limited total taxation to 1 percent of the full market value of all property. No additional ad valorem taxes may be levied to incur new debt. This eliminates the possibility of using GO bonds unless they can be secured within the tax limitation. General obligation bonds will not provide a significant source of revenue and are therefore not a potential financing method for use in constructing Master Plan facilities.

Special Assessments and Improvement Act Bonds. Special assessments are often used to finance municipal improvements. Assessments differ from taxes in that they may only be levied where property owners will be specially benefited by the improvement. Assessments are also apportioned according to benefit received rather than property value.

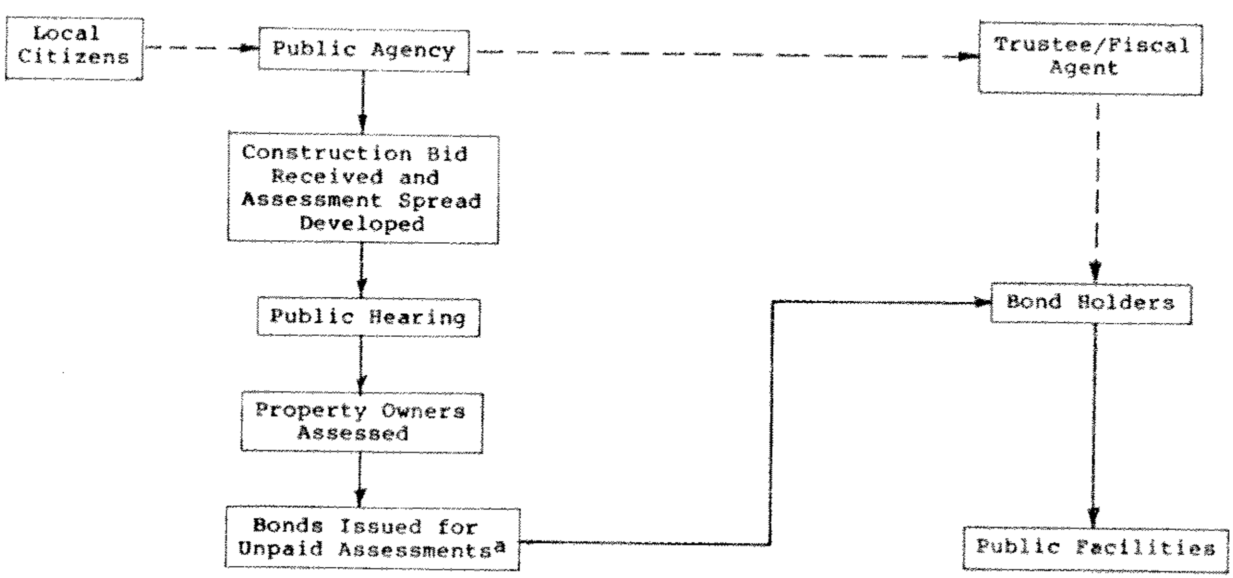
The most commonly used assessment proceedings are the Improvement Act of 1911 and the Municipal Improvement Act of 1913. Bonds may be issued under the Improvement Act of 1911 or the Improvement Bond Act of 1915. Each bond issued under the 1911 Act constitutes a direct lien against a specific piece of property. The 1915 Act provides a method of issuing bonds through which they are secured by assessments levied in accordance with the 1911 or 1913 Acts. Figure 7-1 schematically shows the 1911 and 1913 Act proceedings. The total assessments levied under these acts may not exceed the cost of improvements. Determination of the assessment spread generally requires considerable time and expenditure to equitably apportion the value of benefits received by each property owner.

The Benefit Assessment Act of 1982 differs from the 1911 and 1913 Acts in that the apportioned benefit is the value of service provided rather than the value of the improvements. Annual assessments may be levied for the total cost of providing the service, including debt service associated with constructing new improvements and operation, maintenance, and administrative costs. The 1982 Act, like the 1913 Act, does not provide for issuance of bonds, only the method of levying assessments and collecting revenues. Bonds must be issued according to the provisions of the Improvement Act of 1911 or the Improvement Bond Act of 1915.

Municipal Improvement Act of 1911




Municipal Improvement Act of 1913[a]




[a]Bonds are issued pursuant to the Improvement Bond Act of 1915.

Legend: ——— Financing Plan Formation Steps

- - - - Repayment Plan Flow of Revenue

Figure 7-1 Municipal Improvement Act of 1911 and 1913

Unlike the 1911 and 1913 Act proceedings, the proposed assessment to repay bonds issued under the 1982 Act must be submitted to the voters and passed by a majority vote. The 1982 Act is designed especially for flood control and drainage and specifically provides proportioning the assessments according to runoff from each parcel. Federal, state, and local agencies may not be assessed for benefits.

Revenue Bonds. This is a broad class of bonds which include general revenue bonds, lease revenue bonds, mortgage revenue bonds, and many others. The general revenue bond acts most commonly used for sewerage systems are the Sewer Revenue Bond Act of 1933 and the Revenue Bond Law of 1914. Only the 1914 law is applicable to stormwater and drainage. Revenue bonds are used to finance facilities which provide benefits to a group of readily identifiable users. The debt is paid for by charges placed on the users of the facilities. The user charges can include service charges, connection fees, standby charges, and others. Requirements for issuance of revenue bonds include the establishment of a reserve fund equal to the annual debt service and several operational requirements relating to the employment of professional staff, payment of bonds, maintenance of the system, and collection of fees. Majority voter approval is required. Figure 7-2 schematically shows revenue bond proceedings.

Revenue bonds generally have higher interest costs than assessment bonds because they are secured by an enterprise's pledge revenues rather than by liens on real property.

Lease Revenue Bonds. These bonds are typically issued by non-profit corporations to construct facilities which will be leased back to a public agency. The bonds are secured by pledged rental revenues, and title reverts to the agency after the bonds are paid off. There is no maximum interest rate. Voter approval is not required, but the leases and the issuance of bonds must be authorized by ordinances subject to voter referendum. Formation of the non-profit corporation and approval by the appropriate federal and state regulatory agencies is relatively complex. Only leasable improvements, such as pipelines, could be financed by this method. It would not be applicable to curb and gutter or erosion control work. The revenues pledged to secure the bonds may be project revenues, tax revenues, and the revenues and reserves of the general fund. A reserve fund equal to the maximum annual debt service must be maintained.

Certificates of Participation. Certificates of participation are a long-term financing method similar to the use of bonds. Financing is provided through a lease that does

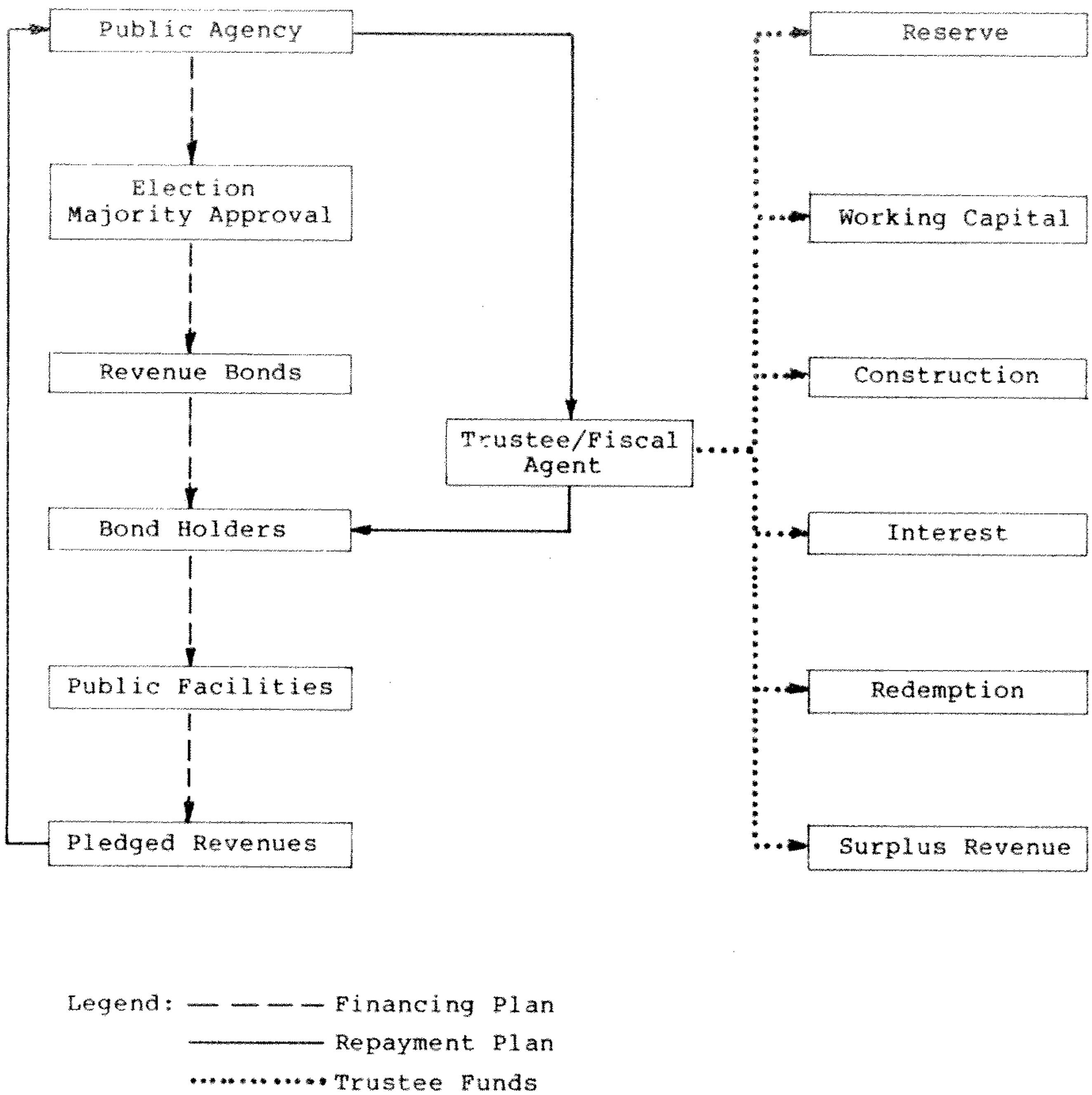



Figure 7-2 Schematic of Revenue Bond Proceedings

not constitute indebtedness under the state constitutional debt limit. Voter approval is not required. Project revenues (service and connection charges) may be used to make lease payments by a public agency to the lessor. The lessor may be a private corporation, non-profit corporation, or public agency. Capital is produced by investors who purchase certificates of participation in the lease. A reserve fund equal to one year's debt service is required. The procedure is shown schematically on Figure 7-3.

The certificates of participation can be secured by user charges or assessments. Use of the benefit assessment proceedings described above would allow the certificates to be secured by liens on real property, resulting in a relatively low interest charge.

Short-Term Debt

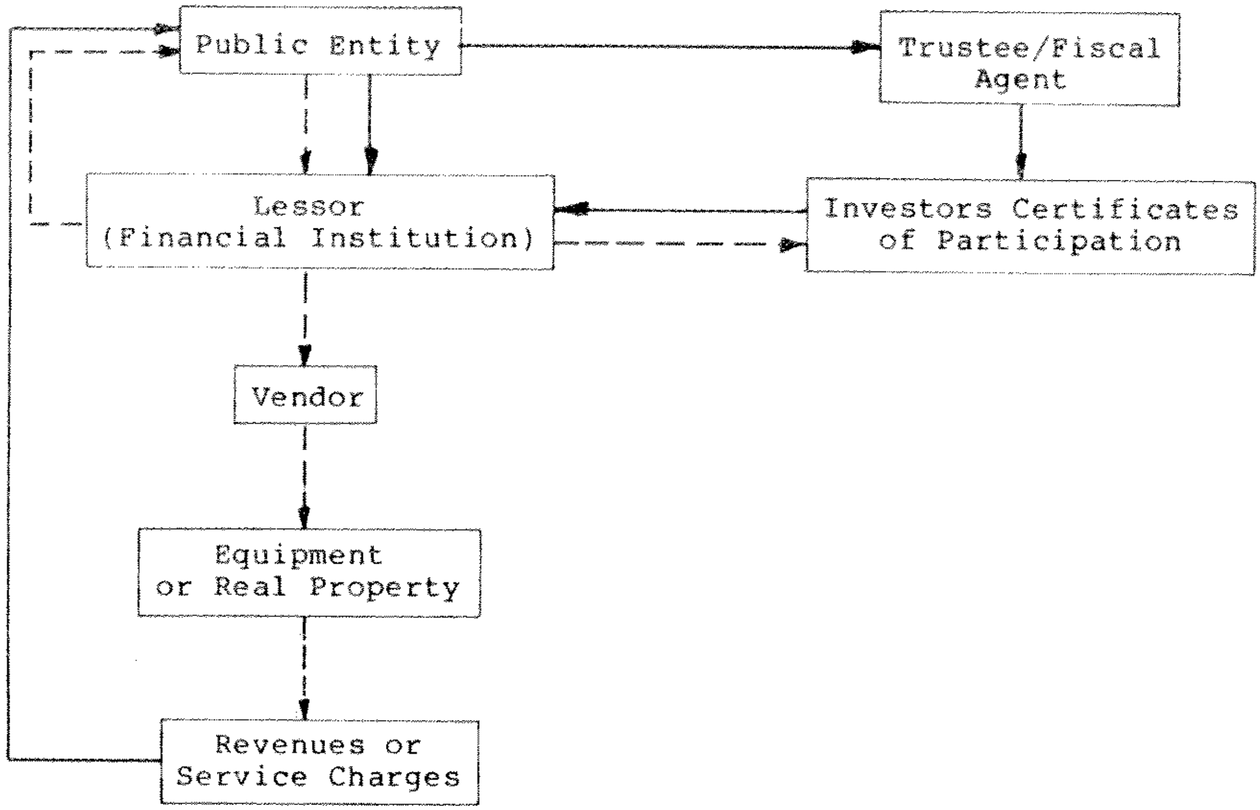
Short-term debt may be used by public agencies to meet cash flow requirements, to allow interim financing of a project, or to pay administrative costs and other costs associated with implementation of a project. Several available techniques are listed in Table 7-2. A technique should be selected to meet specific requirements.

Table 7-2. Summary of Short-Term Financing Techniques

| Technique | Purpose | Security |
|---|---|---|
| Bond anticipation notes | Finance project prior to issuance of bonds | Bond proceeds; project revenues; insurance |
| Grant anticipation notes | Cash-flow deficit prior to receipt of grant funds | Grant proceeds; project revenues; insurance |
| Tax and revenue anticipation notes | Cash-flow deficit in general fund, prior to receipt of tax or other revenues | Pledged tax revenues; pledged revenues |
| Tax-exempt commercial paper | Cash-flow deficit | Pledged revenues; revolving credit; agreement |

Recommended Financing Method

The details of project and operational financing depend on the type of district or agency used to implement the Master Plan. The general approach to financing, however, may be




(1) Financial institution pays vendor cash at present value of future lease payments.

(2) Ownership remains with financial institution until terms of lease are satisified or may be sold to trustee for $1.00.

(3) Equipment or property leased back to public entity.

(4) Lease rental payments which provide security for certificates of participation.

Legend: – – – – Financing Plan

——— Repayment Plan

Figure 7-3 Schematic of Proceedings for Certificates of Participation similar for several different institutional arrangements. The Benefit Assessment Act of 1982 provides a means for collecting assessments to pay both capital improvement and operation and maintenance cost, and may be used by any agency empowered to provide drainage services. Because this method involves an assessment, financing can be secured against liens on property, resulting in low interest costs, and the ability to raise capital to finance initial construction rather than just improvements to an ongoing enterprise. The disadvantages to the 1982 proceedings are that a majority vote is required to approve the proposed assessments, and that government agencies may not be assessed. In comparison, assessments under the Improvement Act of 1911 can be approved by public hearing and order of the Board of Supervisors.

Because the Benefit Assessment Act of 1982 provides a method for collection of revenues for all master plan facilities and associated services, its use is recommended. The establishment of a revenue stream by benefit assessment would allow bond financing under one of the Improvement Acts, revenue bonds, or certificates of participation. The appropriate financing vehicle depends on market conditions and should be determined by a bond counsel at the time funds are required. As is provided for in the Act, Master Plan improvements are assessed to system users based on the proportion of runoff from each class of parcel.

## PROGRAM COSTS

A problem facing the community of Mammoth Lakes is the almost complete lack of storm drainage facilities and the need for a very large capital improvement program. As shown in Chapter 6, Master Plan improvements have the following costs:

| Priority | Total capital cost,[a] million dollars |
|---|---|
| 1 | 6.354 |
| 2 | 6.399 |
| 3 | 5.111 |
| Total | 17.864 |

[a]Based on June 1983 price level (ENR CCI = 4080). Costs include construction, contingency of 10 percent, and engineering, legal, and administration at 25 percent.

In this section, the basis for financing these improvements is discussed and a plan recommended.

Program costs will include bond debt service, or other form of financing of capital improvements; operation, maintenance, and repair; and administration. These are discussed below.

Financing Costs

To finalize a financing plan and revenue program, prepare the bond prospectus and documents, conduct an election, and complete all other required activities to secure bond financing will add approximately 10 percent to project costs. The estimated size of bond issue required to finance the capital improvements defined in each control priority and for the entire program is shown in Table 7-3.

Table 7-3. Estimated Size of Bond Issues[a]

| Priority | Capital cost | Bond issue |
|---|---|---|
| 1 | 6.354 | 6.989 |
| 2 | 6.399 | 7.039 |
| 3 | 5.111 | 5.622 |
| Total | 17.864 | 19.650 |

[a]Values are in million 1983 dollars.

Operation, Maintenance, and Repair

Public works maintenance requirements will increase as project improvements are constructed. Expected additional efforts will be required to remove sediment materials from retention basins, periodically unplug and repair drainage inlets and culverts, maintain and repair slope stabilization and revegetated areas, and purchase some additional equipment. It is projected that the average annual cost for operation, maintenance, and repair will be about $100,000 for Priority 1 facilities, $100,000 for Priority 2 facilities, and $50,000 for Priority 3 facilities.

Program Administration

A system for collecting user fees, annual billing, coordination and superision of the design and construction of improvements, application for and coordination of grants, and other similar administrative activities will be required to implement the program. It is projected that costs for these activities will average about $20,000 per year.

## USER FEES

User fees can be used to pay all program annual costs, both capital costs and operating expenses. This section describes how the user fee is determined and the revenue that several alternative fee levels would generate.

### Basis for Fee

As stated in the Benefit Assessment Act of 1982, user fees are to be determined on the proportion of runoff from each type of land use. In general, the most significant factor in determining runoff quantity from a particular parcel is the proportion of impervious surface area (such as rooftop, driveway, parking lot, etc.) to the total parcel area. Table 7-4 lists the percentage of impervious surface associated with each land use class in Mammoth Lakes that was used to calculate surface runoff to size the master plan improvements. Assuming an average land slope of 5 percent and an annual average 1-hour storm, the design manual procedures can be used to calculate a typical runoff coefficient for each land use type. These are also shown in Table 7-4.

Table 7-4. Impervious Surface Proportions and Typical Runoff Coefficients by Land Use

| Land use class | Percentage of impervious surface | Typical runoff coefficient |
|---|---|---|
| R-1 | 55 | 0.58 |
| R-2 | 65 | 0.65 |
| R-3 | 65 | 0.65 |
| PD | 60 | 0.61 |
| CR | 75 | 0.72 |
| P | 90 | 0.83 |
| CH | 90 | 0.83 |
| Open | 0 | 0.18 |
| Undeveloped[a] | 0 | 0.18 |

[a]This is not a land use class, but is included to show the appropriate data for undeveloped land.

The runoff coefficients shown in Table 7-4 can be used to establish classes of user fees. Since the runoff coefficients are the same for several of the land use classes, a single user fee class can be established that includes both land use classes. Thus a single user class could cover R-2 and R-3, and another for P and CH. The enabling legislation for the Benefit Assessment Act of 1982 prohibits assessment of user fees for property owned by federal, state, or local agencies. Thus the land in land use classes P and Open cannot be assessed, and there is no need to develop a user class for these land uses. The resultant listing of five user fee classes is shown in Table 7-5.

Table 7-5. User Fee Classes

| User fee class | Land use class included |
|---|---|
| A | R-1 |
| B | R-2, R-3 |
| C | PD |
| D | CR |
| E | CH |

The runoff coefficient, and the acreage of developed and undeveloped land that falls into each user fee class, can be used to determine the portion of annual cost to be supported by each user fee class. Since the level of development will change during the implementation of this program, it is necessary to determine the portion of annual cost to be borne by each user class at both the start of the program (existing conditions) and when the community is fully developed. It has been assumed for this financial plan that the community will be fully developed in 20 years, that all land use classes will build out at the same rate, and that development over the 20-year period can be approximated by a straight line.

The share of annual costs to be borne by each user fee class in Year 1 and Year 20 of the program is shown in Table 7-6. These percentages are used later in this chapter to determine the annual user fees for alternative financing programs.

## Pattern of Revenue Generation

Because undeveloped parcels in all land use categories would be charged a lower fee while they remain undeveloped, and a higher fee after they are developed, the revenue generated by user fees will change substantially with time. The financing

Table 7-6. Distribution of Annual Costs to User Fee Classes[a]

| User fee class | | Existing land area, acres | | Runoff coefficient | | Existing equivalent runoff area,[b] acres | | Existing share of annual costs,[c] | | (9) Ultimate equivalent runoff area,[d] acres | (10) Ultimate share of annual costs,[e] percent |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) Developed | (2) Undeveloped | (3) Developed | (4) Undeveloped | (5) Developed | (6) Undeveloped | (7) Developed, percent | (8) Undeveloped, percent | | |
| A | R-1 | 341 | 365 | 0.58 | 0.18 | 198 | 66 | 21 | 7.1 | 410 | 29 |
| B | R-2,R-3 | 293 | 176 | 0.65 | 0.18 | 190 | 32 | 20 | 3.4 | 305 | 21 |
| C | PD | 87 | 527 | 0.61 | 0.18 | 53 | 95 | 5.7 | 10 | 374 | 26 |
| D | CR | 112 | 35 | 0.72 | 0.18 | 81 | 6.3 | 8.7 | 0.7 | 106 | 74 |
| E | CH | 241 | 51 | 0.83 | 0.18 | 200 | 9.2 | 22 | 1.0 | 242 | 17 |
| Total | | 1,074 | 1,154 | — | — | 722 | 208 | 77.4 | 22.2 | 1,437 | 100 |

[a]Existing refers to the year 1983; ultimate refers to the year 2003.
[b]Column (5) = Column (1) times Column (3); Column (6) = Column (2) times Column (4).
[c]Column (7) = Column (5) divided by the sum of the Columns (5) and (6) totals; Column (8) = Column 6 divided by the sum of the Columns (5) and (6) totals.
[d]Column (9) = [Column (1) plus Column (2)] times Column (3).
[e]Column (10) = Column (9) divided by the total of column (9).

alternatives presented later in this chapter assume that the community will be fully developed in 20 years, and that development will occur uniformly over that time. The present level of development in the community gives a ratio between the current and ultimate equivalent runoff area of 0.65. Therefore, assuming constant user fees, the revenue generated by annual fees will increase by approximately 50 percent over a 20-year period.

Connection fees will be charged at the time undeveloped parcels are developed. The basis for setting connection fees is that all property which benefits from construction of the improvements should ultimately pay an equal share of the cost. Charging undeveloped parcels at a rate computed using the runoff coefficient for open land provides a means for deferring payment of the full fees until development takes place. When the property is developed, a connection fee equal to the difference in the fees paid up to that time for an undeveloped status and the fees which would have been paid if the property had been developed at the start of the improvement program become due. For example, assume an owner of an R-1 lot which has not yet been built upon might be charged $3 per month while the lot remains vacant. When a house is constructed on the lot, the monthly user fees would increase by the ratio of the runoff coefficients for developed and undeveloped land for land use R-1 (0.58/0.18), or to about $9.67 per month. In addition, the owner would be charged the difference between the two monthly fees, $6.67 per month or about $80 per year, for the number of years since the beginning of the improvement program. Therefore, if development of the parcels occurred five years after the start of the improvement program began, a one time charge of $400 would be due.

Assuming that development occurs uniformly over a 20-year period, this system produces a stream of revenue which increases linearly with time. Each year, 1/20 of the undeveloped land in the community would be developed. Therefore, in the first year, 1/20 of the difference in starting and ultimate user fees would be charged in connection fees. In the second year, another 1/20 of the community would be developed, but the fees collected would be equal to 2/20 of the difference between the starting and ultimate fees (two years' charges). In the 20th year, connection fees would be exactly equal to the difference between the starting and ultimate annual user fee revenues.

Figure 7-4 schematically shows the pattern of revenues which would be generated by user fees and connection charges over the 20-year development period. The total amount of revenue collected over the 20-year period is equal to the fees which would have been collected if the entire community had been developed at the start of the improvement program. This pattern of revenue generation and alternative user fee levels are used in the next section to evaluate financing alternatives.

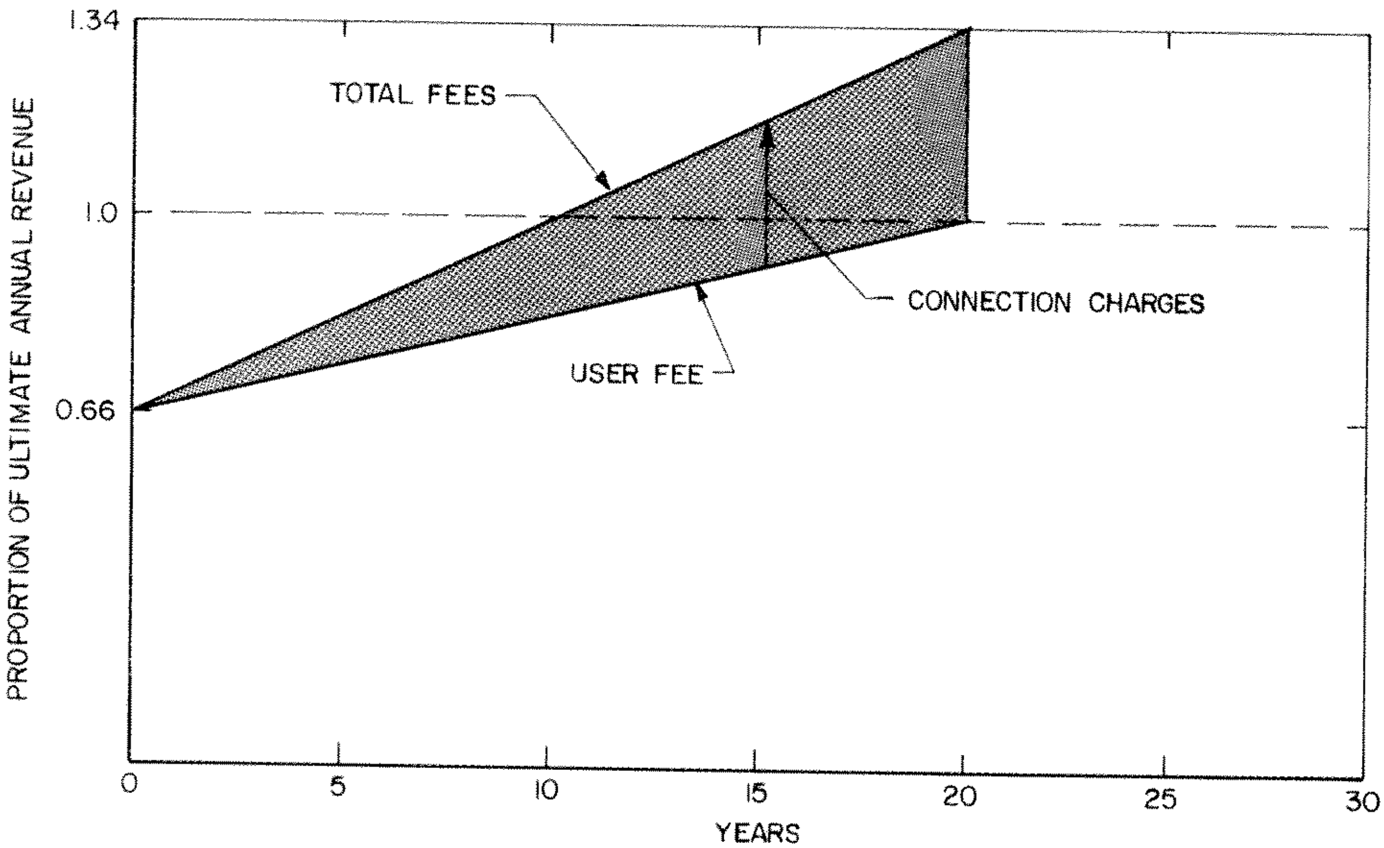



Figure 7-4 User Fee Revenue Pattern

## ANALYSIS OF FINANCING ALTERNATIVES

This section presents an analysis of three alternative financing methods:

1. Cash expenditure
2. Single bond financing
3. Multiple bond financing

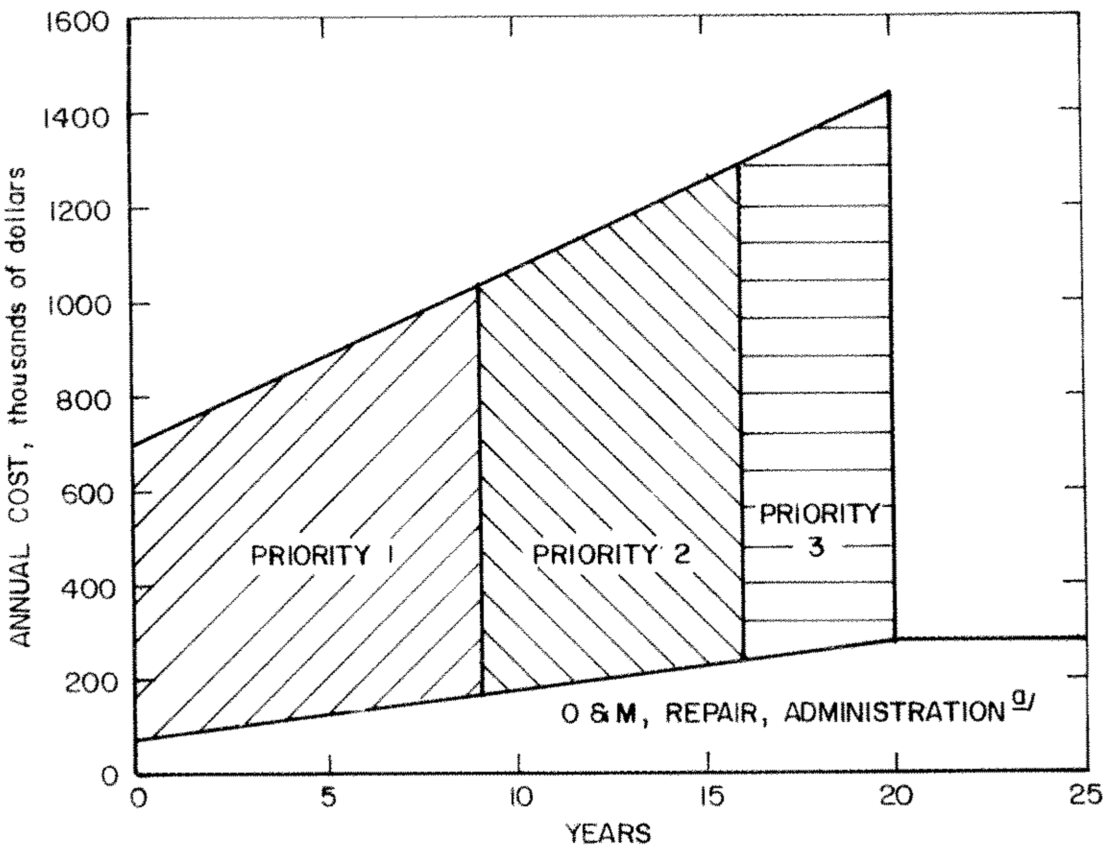
The analysis is based on the collection of fees in proportion to runoff and the revenue pattern which results from development of Mammoth Lakes within the next 20 years.

It has been assumed for the purpose of analysis that all users of the system will pay a fee based only on area of land and use fee class. As discussed previously in this chapter, properties which utilize on-site retention facilities could be charged a lesser user fee based on lower operation and maintenance requirements. This would require a corresponding increase in user fees for property without these facilities to provide the same level of total program revenue. It is estimated that 10 percent of the total number of ultimate users might install on-site systems. Since this represents such a small portion of annual revenue, it would have an insignificant effect on the user fees for the balance of the community. It is recommended that property owners who install on-site retention facilities be charged a lower rate which does not include a contribution to system operation and maintenance.

Caltrans, the U.S. Forest Service, and Mammoth Mountain have facilities on land which are tributary to Master Plan facilities. Under the Benefit Assessment Act of 1982, public agencies cannot be directly assessed. However, their contribution to flow in the system is significant, and an effort should be made to obtain a voluntary contribution from them to pay a portion of Master Plan facility costs. Their contributions should be calculated in proportion to runoff from their lands.

### Cash Expenditure

Because the level of cost of capital improvements is quite high, the program to construct the master plan on a cash expenditure basis must be relatively long to maintain a reasonable level of user fee. It seems appropriate to match the completion of the program with the 20-year projected time period for full developmment of the entire community. The annual cost to complete the entire master plan in 20 years is plotted on Figure 7-5. This cost curve is based on the annual costs for an $18 million improvement program; operation,




a/ Total revenue generated for project construction is $ 18 million, O & M, repair, and administration over the 20 - year period totals $ 3.2 million and would continue after completion of construction at annual level of $ 270,000 / year

Figure 7-5 Project Cost Allocations for Cash Expenditure Program maintenance, and repair increasing from $50,000 per year at the start of the program to $250,000 per year at year 20; and administrative costs of $20,000 per year. Total annual costs are matched to the pattern of revenue collection shown on Figure 7-4. This shows that the Priority 1 improvements would be completed in Year 9, Priority 2 in Year 16, and the entire program in Year 20. This type of program could be accelerated and/or the user fee reduced if grant funds could be obtained to supplement local financing.

The schedule for collection of revenue from both user fees and connection fees is shown in Table 7-7. Because a portion of the land in the community will be converted each year from an undeveloped user class to a developed user class with a higher use fee, the revenue from user fees during the year will increase by the end of the year. Similarly, the connection fee revenue will increase from the beginning to the end of the year. This analysis assumes that development will be uniformly spread out over the year, and is based on the average annual revenue for the year.

Table 7-7. Revenue Collection Schedule for Cash Expenditure Alternative,[a] thousand dollars

| Year | Annual user fee revenue | | | Annual connection fee revenue | | | Total average annual revenue |
|---|---|---|---|---|---|---|---|
| | Start | End | Average | Start | End | Average | |
| 1 | 701 | 719 | 719 | 0 | 18 | 9 | 719 |
| 2 | 719 | 737 | 728 | 18 | 26 | 27 | 755 |
| 3 | 737 | 755 | 746 | 36 | 54 | 45 | 791 |
| 4 | 755 | 773 | 764 | 54 | 72 | 63 | 827 |
| 5 | 773 | 791 | 782 | 72 | 90 | 81 | 863 |
| 6 | 791 | 809 | 800 | 90 | 108 | 99 | 899 |
| 7 | 809 | 827 | 817 | 108 | 126 | 117 | 934 |
| 8 | 827 | 845 | 836 | 126 | 143 | 134 | 970 |
| 9 | 845 | 863 | 854 | 143 | 161 | 152 | 1,006 |
| 10 | 863 | 881 | 872 | 161 | 179 | 170 | 1,042 |
| 11 | 881 | 899 | 890 | 179 | 197 | 188 | 1,078 |
| 12 | 899 | 917 | 908 | 197 | 215 | 206 | 1,114 |
| 13 | 917 | 934 | 926 | 215 | 233 | 224 | 1,150 |
| 14 | 934 | 952 | 943 | 233 | 251 | 242 | 1,185 |
| 15 | 952 | 970 | 961 | 251 | 269 | 260 | 1,221 |
| 16 | 970 | 988 | 979 | 269 | 287 | 278 | 1,257 |
| 17 | 988 | 1,006 | 997 | 287 | 305 | 296 | 1,293 |
| 18 | 1,006 | 1,024 | 1,015 | 305 | 323 | 314 | 1,329 |
| 19 | 1,024 | 1,042 | 1,033 | 323 | 341 | 332 | 1,365 |
| 20 | 1,042 | 1,059 | 1,051 | 341 | 359 | 350 | 1,401 |
| Total revenue | | | 17,614 | | | 3,586 | 21,200 |

[a]These fees are shown in 1983 dollars and would increase with the annual rate of inflation.

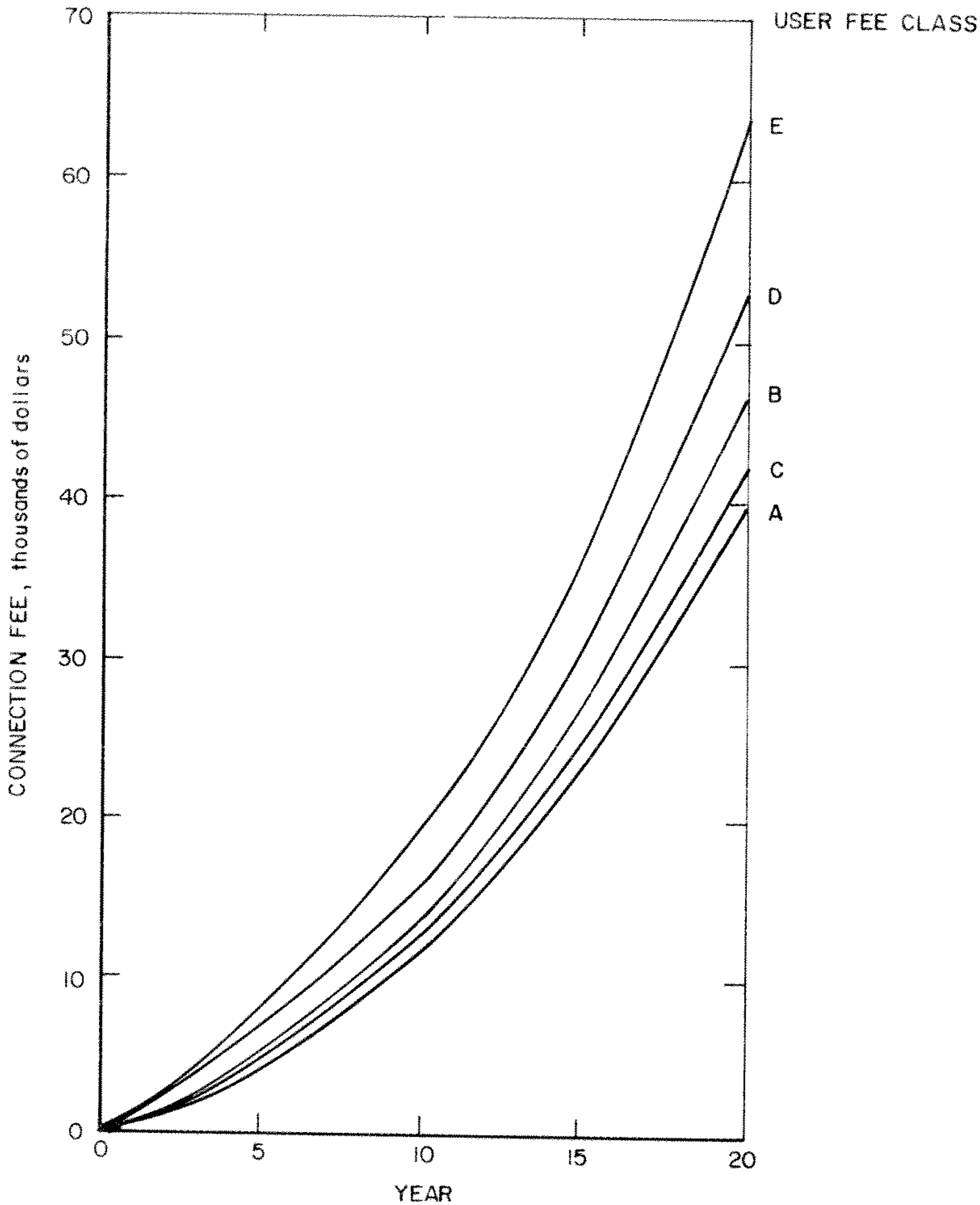



Figure 7-7 Connection Fees for Single Bond Financing Alternative

7. Use of the $2.7 million reserve fund after Year 30 to pay for unexpected repair or additional improvements. Alternatively, the reserve fund could be maintained after Year 30 and the interest used to pay operation, maintenance, and repair costs for an extended period. A second alternative would be to use the reserve fund to pay the debt service in Year 30. This would reduce the required user fees in Years 1 through 30 by an insignificant amount.

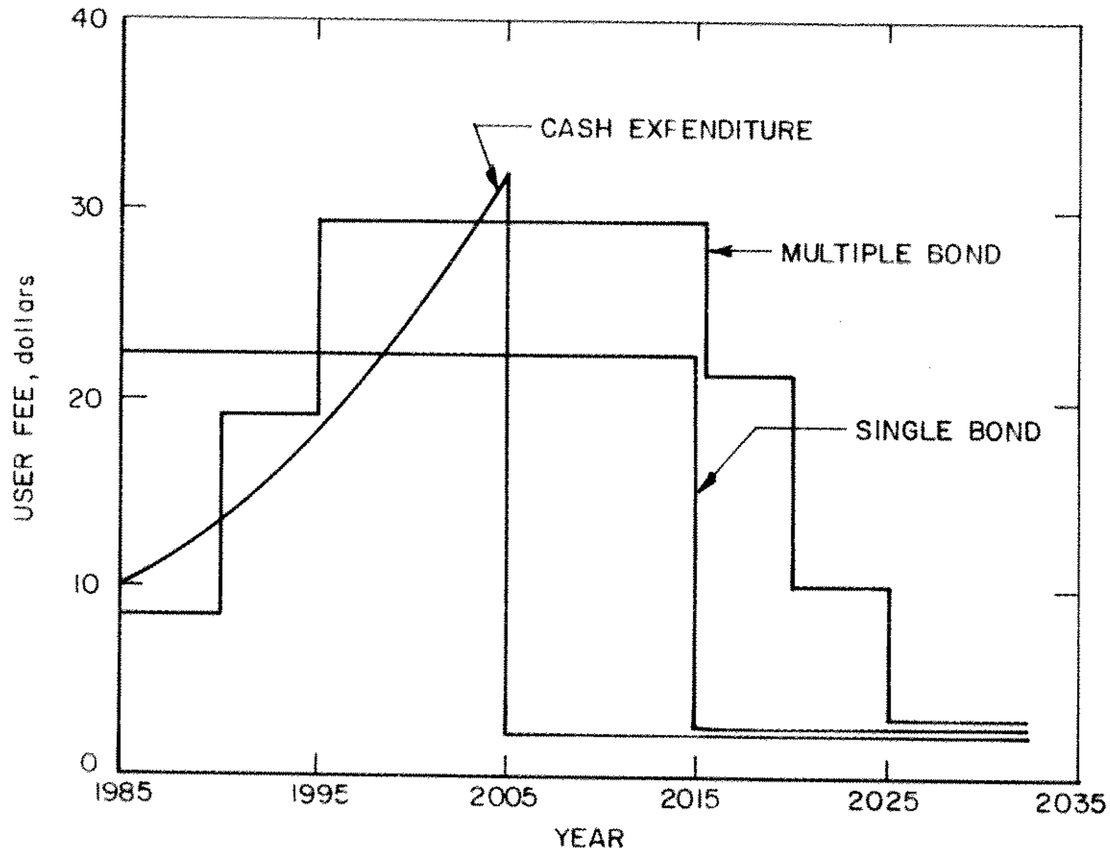
Table 7-10 shows the revenue collection schedule from user fees and connection fees over the 30-year bond financing period. Connection fees would be collected in Years 1 through 20. This analysis assumes that development occurs uniformly over the 20-year period. Although the proportion of property which becomes developed each year remains constant, the connection fee revenues increase with time because the fee is calculated as the difference in user fees between undeveloped and developed land over the entire period prior to development. The connection fees also include 10 percent interest, compounded annually, on the connection fees due.

The required user fee revenues in this alternative are higher than the Cash Expenditure Alternative because the fees must pay for the capital construction cost plus debt service on the money at 10 percent.

Table 7-11 shows the required fees for each user fee class for the Single Bond Financing Alternative. The monthly user fee required for a typical R-1 residential lot (1/4-acre) would be approximately $20. The fees are based on June 1983 costs (ENR CCI 4080). Unlike the Cash Expenditure Alternative, user fees and connection fees would not have to be increased annually at the annual rate of inflation in this alternative. However, the required fees should be calculated from the fees shown by adjusting for inflation from 1983 costs to the start of construction.

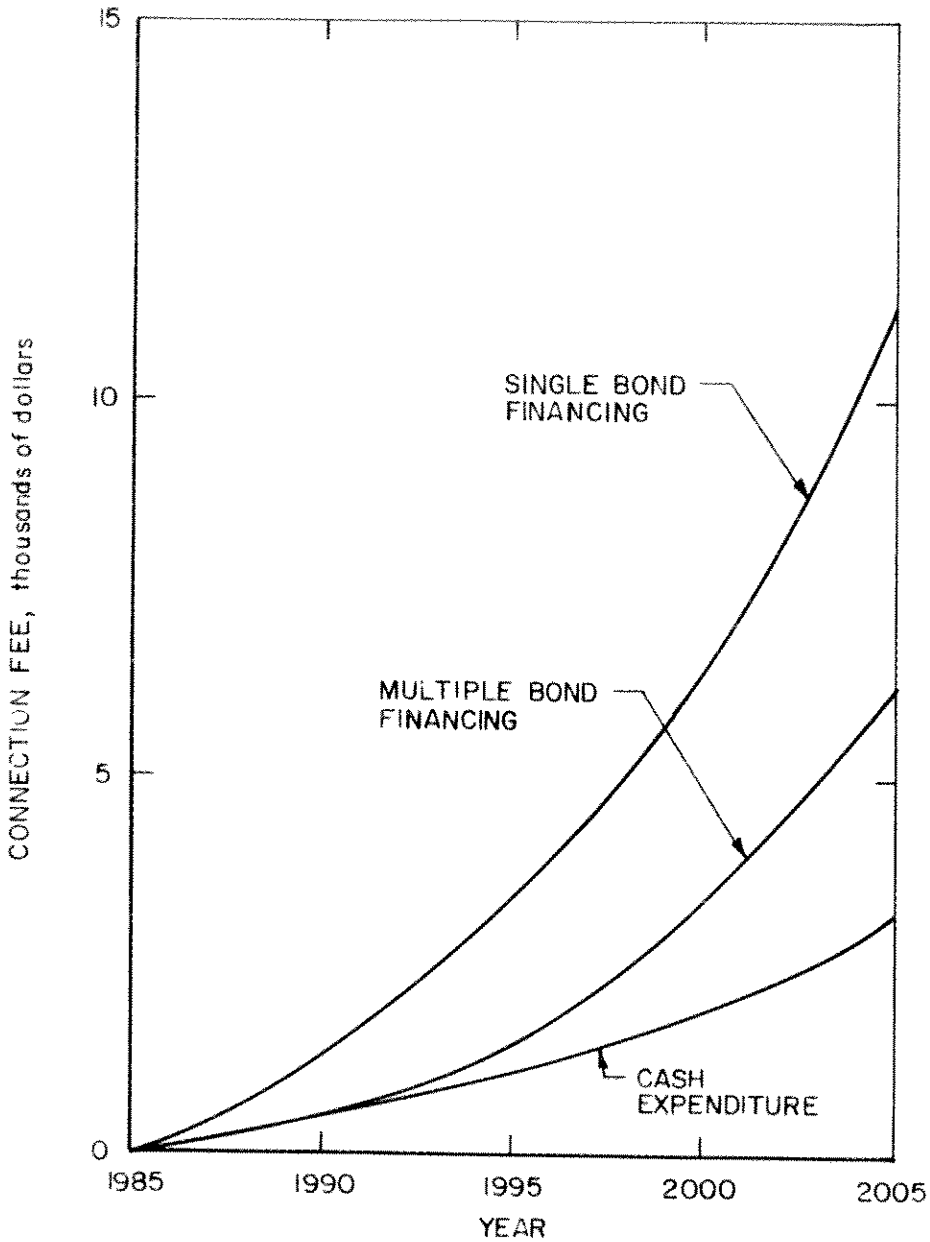
Table 7-12 presents connection fees which would be due for properties developed at the end of the 20-year period. These fees include the difference between user fees for developed and undeveloped property over the 20-year period, and 10 percent annual interest.

Figure 7-7 shows the increase in connection fees over the 20-year period for this alternative. These fees rise sharply over the period due to the compounding of interest.




NOTE: Assumes construction starts in 1985 and 6 % annual inflation. User fee shown is for typical residential lot (1/4 acre)

Figure 7-9 Comparison of User Fees for Financing Alternatives




NOTE: Based on construction of improvements beginning in 1985 escalated at 6 %/year. Connection fee is for typical residential lot (1/4 acre)

Figure 7-10 Comparison of Connection Fees for Financing Alternatives

Table 7-10. Revenue Collection Schedule for Single Bond Alternative, thousand dollars[a]

| Year | Annual user fee | | | Annual connection fee revenue | | | Total average annual revenue |
|---|---|---|---|---|---|---|---|
| | Start | End | Average | Start | End | Average | |
| 1 | 1,553 | 1,592 | 1,573 | 0 | 44 | 22 | 1,594 |
| 2 | 1,592 | 1,632 | 1,612 | 44 | 92 | 68 | 1,680 |
| 3 | 1,632 | 1,672 | 1,652 | 92 | 145 | 118 | 1,770 |
| 4 | 1,672 | 1,712 | 1,692 | 145 | 203 | 174 | 1,865 |
| 5 | 1,712 | 1,751 | 1,731 | 203 | 267 | 235 | 1,966 |
| 6 | 1,751 | 1,791 | 1,771 | 267 | 337 | 302 | 2,073 |
| 7 | 1,791 | 1,831 | 1,811 | 337 | 414 | 376 | 2,186 |
| 8 | 1,831 | 1,870 | 1,850 | 414 | 499 | 457 | 2,307 |
| 9 | 1,870 | 1,910 | 1,890 | 499 | 593 | 546 | 2,436 |
| 10 | 1,910 | 1,950 | 1,930 | 592 | 696 | 644 | 2,574 |
| 11 | 1,950 | 1,989 | 1,970 | 696 | 809 | 753 | 2,722 |
| 12 | 1,989 | 2,029 | 2,009 | 809 | 934 | 871 | 2,881 |
| 13 | 2,029 | 2,069 | 2,049 | 934 | 1,071 | 1,002 | 3,051 |
| 14 | 2,069 | 2,108 | 2,089 | 1,071 | 1,222 | 1,146 | 3,235 |
| 15 | 2,108 | 2,148 | 2,128 | 1,222 | 1,387 | 1,304 | 3,433 |
| 16 | 2,148 | 2,188 | 2,168 | 1,387 | 1,570 | 1,479 | 2,647 |
| 17 | 2,188 | 2,228 | 2,208 | 1,570 | 1,770 | 1,670 | 2,878 |
| 18 | 2,228 | 2,267 | 2,247 | 1,770 | 1,991 | 1,881 | 4,128 |
| 19 | 2,267 | 2,307 | 2,287 | 1,991 | 2,234 | 2,113 | 4,400 |
| 20 | 2,307 | 2,347 | 2,327 | 2,234 | 2,501 | 2,367 | 4,694 |
| 21 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| 22 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| 23 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| 24 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| 25 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| 26 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| 27 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| 28 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| 29 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| 30 | 2,347 | 2,347 | 2,347 | 0 | 0 | 0 | 2,347 |
| Total present worth at 10 percent | | | 17,311 | | | 4,619 | 22,350 |

[a]Expressed in 1983 dollars.

Table 7-11. Estimated User Fees for Single Bond Financing Alternative[a]

| User fee class | Monthly user fee, dollars/acre |
|---|---|
| A (R-1) | 80[b] |
| B (R-2, R-3) | 89 |
| C (PD) | 84 |
| D (CR) | 100 |
| E (CH) | 116 |

[a]Expressed in 1983 dollars.

[b]This is equivalent to $20 per month for a 1/4-acre residential parcel.

Table 7-12. Estimated Connection Fee for Single Bond Financing Alternative[a]

| User fee class | Connection fee @ Year 20, dollars/acre |
|---|---|
| A (R-1) | 39,500[b] |
| B (R-2, R-3) | 46,500 |
| C (PD) | 42,000 |
| D (CR) | 53,000 |
| E (CH) | 64,000 |

[a]Expressed in 1983 dollars.

[b]This is equivalent to approximately $10,000 for a 1/4-acre residential parcel.

4. Use of interest on the reserve fund to pay annual operation, maintenance, repair, and administrative costs. Ten percent per annum would pay the estimated annual costs of $120,000 in Years 1 through 5, $200,000 in Years 6 through 10, and $270,000 after Year 10.

5. Use of the $2.7 million reserve fund after Year 40 to pay for unexpected repairs or to construct additional improvements. The fund could alternatively be used to pay operation, maintenance, repair, and administrative costs for an extended period (thus eliminating user fees) or to pay the debt service for Years 38 through 40. Use of the fund to pay the debt service would reduce the size of the bond required (and therefore the user fees) by an insignificant amount.

6. Collection of connection fees, which are the difference between user fees for developed and undeveloped land in each user fee class accumulated over the period prior to development. The connection fees include 10 percent interest, on the difference in fees, compounded annually.

Tables 7-13 through 7-15 show the revenue collection schedule from user and connection fees over the three 30-year bond financing periods. Table 7-16 shows the total revenue collected as the sum of revenues from the three bond issues over the 40-year total financing period. Each of the bond issues have revenue collection patterns which match the expected development of the community over the next 20 years. Connection fees associated with each bond issue would therefore be collected until Year 20, and total annual revenues reach a peak at Year 20.

Table 7-17 shows the required user fees by user fee class and five-year period for this alternative. The monthly user fee required for a typical R-1 residential lot (1/4-acre) would be $7.50 in Years 1 through 5, $15 in Years 6 through 10, $20 in Years 11 through 30, $23 in Years 31 through 35, and $5.50 in Years 36 through 40. The fees shown are in 1983 dollars, based upon construction costs estimated at the June 1983 level (ENR CCI 4080).

The fees required for each bond issue have to be increased to account for the annual rate of inflation between June 1983 and the beginning of construction financed by the bond. For example, if the second bond is to be issued in 1990, the required additional user fee for the bond should be increased by an amount equal to the increase in estimated construction costs between 1983 and 1990.

Table 7-14. Bond No. 2 Revenue Collection Schedule,[a] thousand dollars

| Year | Annual user fee revenue | | | Annual connection fee revenue | | | Total average annual revenue |
|---|---|---|---|---|---|---|---|
| | Start | End | Average | Start | End | Average | |
| 1 | 632 | 647 | 640 | 0 | 16 | 8 | 647 |
| 2 | 647 | 661 | 654 | 16 | 33 | 24 | 678 |
| 3 | 661 | 675 | 668 | 33 | 52 | 43 | 711 |
| 4 | 675 | 690 | 683 | 52 | 73 | 63 | 745 |
| 5 | 690 | 704 | 697 | 73 | 96 | 85 | 782 |
| 6 | 704 | 718 | 711 | 96 | 122 | 109 | 820 |
| 7 | 718 | 733 | 726 | 122 | 150 | 136 | 861 |
| 8 | 733 | 747 | 740 | 150 | 180 | 165 | 905 |
| 9 | 747 | 761 | 754 | 180 | 214 | 197 | 951 |
| 10 | 761 | 776 | 769 | 214 | 251 | 233 | 1,001 |
| 11 | 776 | 790 | 783 | 251 | 292 | 272 | 1,055 |
| 12 | 790 | 804 | 797 | 292 | 337 | 315 | 1,112 |
| 13 | 804 | 819 | 812 | 337 | 387 | 362 | 1,174 |
| 14 | 819 | 833 | 826 | 387 | 441 | 414 | 1,240 |
| 15 | 833 | 847 | 840 | 441 | 501 | 471 | 1,311 |
| 16 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 17 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 18 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 19 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 20 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 21 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 22 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 23 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 24 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 25 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 26 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 27 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 28 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 29 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| 30 | 847 | 847 | 847 | 0 | 0 | 0 | 847 |
| Total present worth at 10 percent | | | 6,981 | | | 1,058 | 8,039 |

[a]Expressed in 1983 dollars.

facilities is not considered urgent, a smaller bond might be issued, or user fees increased gradually to finance a cash expenditure program to construct limited additional facilities.

During this period, the County should also actively pursue grant funding for portions of the Master Plan. Obtaining grants would allow smaller bonds to be issued in the future and thus reduce the size of user fee increases required.

Issuance of a bond to construct only Priority 1 facilities would also permit the option to form smaller improvement districts within the county service area to construct local, lower priority facilities. These districts could be formed in response to local neighborhood requests for improved drainage facilities and erosion control improvements.

# CHAPTER 8

# PROGRAM IMPLEMENTATION

Implementation of the Master Plan will require that a suitable public agency be established or empowered to administer funds, manage and operate the system, and collect revenues. Additional regulatory measures are also needed to assure that new facilities are constructed in accordance with the Mammoth Lakes Storm Drainage and Erosion Control Design Manual and the Master Plan, that the public agency has the power to collect revenues to finance the facilities, and that review and approval of plans for new drainage and erosion control improvements takes place efficiently and in conjunction with other public agency review processes. This section describes existing public agencies with interest and/or authority in management of a storm drainage and erosion control system, identifies future needs for implementation of the Master Plan, and recommends changes and additions to current regulatory practices.

## PRESENT INSTITUTIONAL FUNCTIONS AND POWERS

Figure 8-1 schematically shows the County's process for review of new development projects in the community. Review of drainage facilities, site grading, and changes to natural drainage patterns is done primarily by Mono County. There is presently no ordinance which relates directly to the design of drainage facilities, and no fees are charged specifically for drainage services.

The California Regional Water Quality Control Board, Lahontan Region (Lahontan Regional Board), reviews projects (except residential developments of less than six units and commercial developments of less than 1/4-acre) for erosion control and sediment retention facilities where required. A Waste Discharge Permit from the Lahontan Regional Board is required, and the permit is issued only if the project meets the specified Erosion Control Guidelines for Mammoth Lakes discussed in Chapter 5.

The Mammoth Lakes Design Review Authority principally reviews projects for conformance with aesthetic standards, including landscaping. This review therefore has a potential impact on erosion control for the area.

Construction and maintenance of drainage facilities in Mammoth Lakes is currently performed by the Mono County Public Works Department as an element of road maintenance

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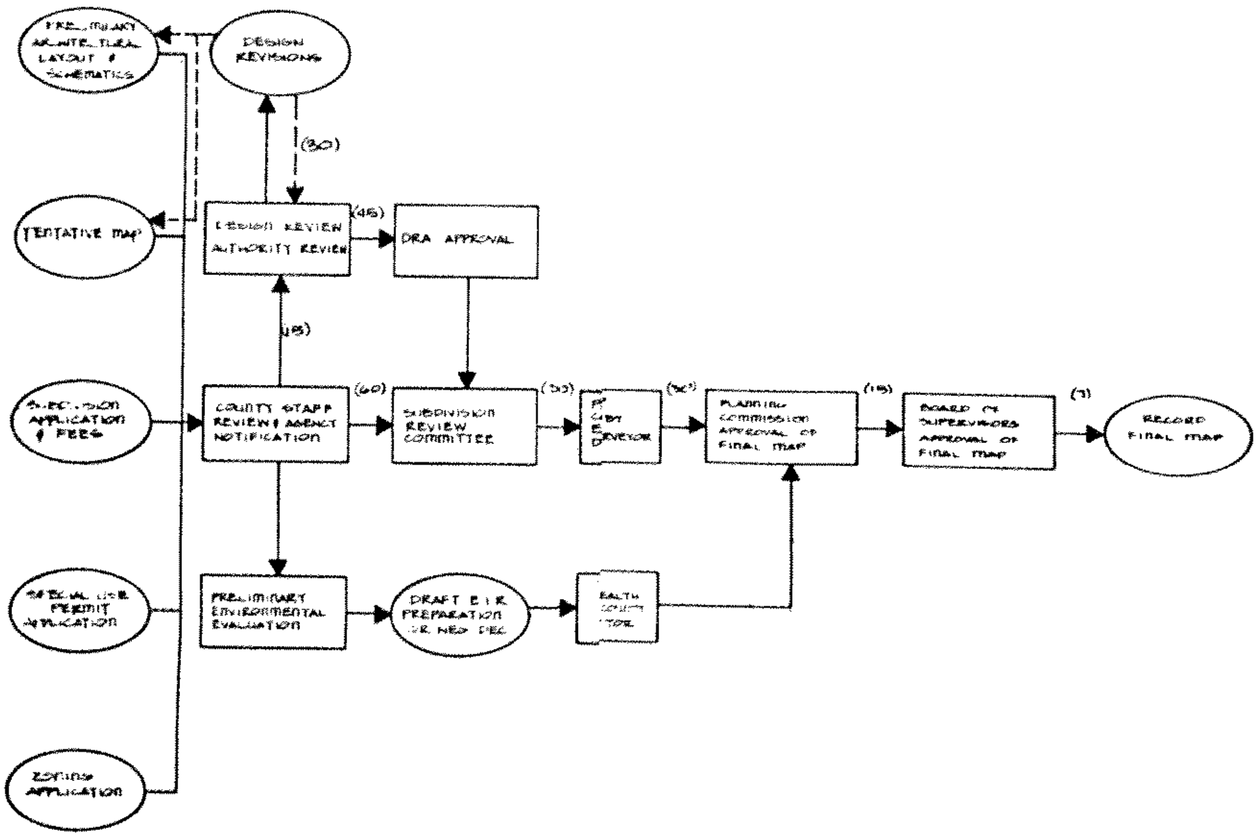



Figure 8-1
County Processing of Development Projects

and improvement projects. When drainage improvements not associated with new development are required, the County finances improvements using General Fund resources supplemented with grant funds if possible. Projects are selected for construction on an as-needed basis and are generally in response to specific drainage problems which are damaging or threatening to damage public or private property. There is no current program to finance construction of drainage or erosion control improvements, or to conduct operation and maintenance, in accordance with a formal plan.

Several additional existing public agencies in the Mammoth Lakes area are either currently involved in storm drainage or are empowered by law to perform some drainage or erosion control functions. Table 8-1 shows the existing agencies, their current functions, and a brief summary of their powers relating to storm drainage. Of the agencies listed, only Mono County, Mammoth County Water District, and Mammoth Lakes Community Services District are the existing agencies empowered to provide storm drainage. However, none of the agencies are presently organized to provide the service specifically to the area which will benefit from new facilities. The future institutional and regulatory needs, and a comparison of alternatives are presented below.

## PLAN IMPLEMENTATION

Implementation of the Master Plan will require the following functions:

1. More detailed planning, establishment of annual construction priorities, and management of facilities design.

2. Contract bidding, contract negotiation, and construction management.

3. Modification of existing County codes and ordinances to provide for review of proposed development projects for conformance with the Master Plan and Design Manual.

4. Operation, maintenance, and repair of the system.

5. Development and adoption of a financial plan, revenue program, and enabling ordinance to establish user fees and connection fees for financing construction and operation of the Master Plan.

6. Administration, billing, and collection of revenues.

Table 8-1. Functions and Powers of Existing Agencies

| Agency | Current functions | Powers relating to storm drainage and erosion control |
| --- | --- | --- |
| Mono County | Storm drainage facilities construction and maintenance. Review of development plans for grading and drainage design. Construction and maintenance of roads and frontage improvements. | May provide all storm drainage and erosion control facilities. May issue general obligation bonds, limited obligation bonds, and revenue bonds to finance improvements. |
| Lahontan Regional Water Quality Control Board | Issue waste discharge permits. Enforce erosion control guidelines. Review development plans for erosion control/ sediment retention facilities. | Regulatory powers. Charged with preventing harmful discharge of pollutants to waters of the state. Primarily involved in regulating quality of storm runoff discharges to natural waters. |
| Mammoth Lakes Fire Protection District | Reviews development plans for access, paving requirements. | Has an impact on the amount and location of impermeable surface (paving) in new development. No powers to provide storm drainage or erosion control. |
| Mammoth County Water District | Water and sanitary sewer service for area. Issues water and sewer permits. | May operate works for collection, treatment, and disposal of stormwater. May borrow money, issue general obligation bonds, and issue revenue bonds to finance improvements. |
| Mammoth Lakes Design Review Authority | Reviews development plans for landscaping and exterior building appearance. | Review powers could be used to require vegetation and other measures for erosion control. |
| Mammoth Lakes Community Services District | Not currently active. Previously issued bonds to construct road improvements in small local area. | May provide sewerage, street improvements, and other services. Area includes small portion of the community only. |
| Caltrans | Maintains Highway 203 and associated drainage and erosion control facilities. | No powers to operate public storm drainage or erosion control facilities not in lands owned by Caltrans. |
| U.S. Forest Service | Owns large proportion of land surrounding community. Leases land to Mammoth Mountain Ski Area and exercises control over drainage, flood control, and erosion control on lands which it owns. | Powers do not extend to lands not owned by U.S. Forest Service. |
| Los Angeles Department of Water and Power | Owns extensive water rights in Mammoth Lakes/Convict Lake area and regulates several lake levels for water supply. Controls flow in Mammoth Creek and maintains several rain and flow gages in watershed. | No powers to provide storm drainage or erosion control services to community. |

Mono County could perform all of the functions listed above. However, the County cannot utilize the Benefit Assessment Act of 1982 to establish user fees without forming a special purpose district whose boundaries match the area of benefit. Alternatively, an independent agency responsible for implementation of the Master Plan could be formed. In either case, the implementing agency must have adequate professional staff, or authority to contract for consultant services; have regulatory powers and enforcement abilities; have the resources and ability to purchase, operate, and maintain special equipment; have the authority to enter into construction contracts and financing agreements; and have a suitable administrative system. Several alternative agencies and districts which could be used to implement the Master Plan are compared below.

## Comparison of Alternative Implementing Agencies

Table 8-2 lists several alternative institutional mechanisms which might be used to implement the Master Plan. The broadest powers are provided by establishment of a county service area. This alternative is relatively easy to form, does not require an election except by referendum, and can apply a broad range of financing methods. Charges for services can be established without an assessment on property. Service charges could be extended on the county tax roll, eliminating the need for a separate billing system. Use of a county service area would also provide a relatively simple means of incorporating project review, enforcement, and regulatory powers into existing county procedures using county personnel.

A county drainage district offers no particular advantage over a county service area, cannot collect charges for services, and is more limited in powers. For example, a county drainage district is not empowered under the existing codes to provide for erosion control or soil conservation.

A community services district has relatively broad powers, but must be formed by election and majority vote. Some overlap of powers would occur with the existing Mammoth County Water District (MCWD) and formation of a new community services district might be opposed by MCWD on this basis. The existing Mammoth Lakes Community Services District (MLCSD) is an extremely small district organized for road improvement work and would not be capable of providing storm drainage service without reorganization and expansion.

The existing MCWD is authorized under county water district enabling legislation to provide storm drainage and flood control by general law. It is not specifically authorized to provide soil conservation or erosion control services.

Table 8-2. Comparison of Alternative Implementing Agencies

| Agency | Enabling legislation | Governing body | Formation procedure | Financing method | Revenue and assessments | Remarks |
|---|---|---|---|---|---|---|
| County Service Area | Government Code, Title 3, Div. 2, Pt. 2, Secs. 25210 through 25211 | County Board of Supervisors. | May be initiated by board of supervisors or by petition of 10 percent or more of voters in area. Formation must be abandoned if so requested by 50 percent or more of voters or owners of one-half the value of the land. May be subject to referendum election. May also be requested by governing body of a city and may include all or any part of a city. | Revenue bonds; Improvement Act of 1911; Improvement Bond Act of 1915; certificates of participation. | User charges; connection fees; special assessments; benefit assessments; standby charges. | This is an extension of county services to a particular area and therefore has broad powers, including storm drainage, flood control, and soil conservation. No new governing body is required, formation is relatively simple. Service charges may be extended on county tax roll. Could be expanded in future to other areas in Mono County. |
| County Drainage District | Water Code, Div. 17, Secs. 56000 through 56130 | Five directors. If only incorporated territory, may be County Board of Supervisors. If City is included, Board of Directors must include presiding officer and one other member of city's governing body. | Petition by 100 owners of property in district. Hearing and order of Board of Supervisors. Board may abandon formation or call election if written objection filed by 10 percent of registered voters. Majority vote required if election held. | Improvement Act of 1911 and Improvement Bond Act Act of 1915; certificates of participation. | Leases, benefit assessments; special assessments. | Authorized purpose is to control storm and other wastewaters; protect property from damage therefrom; conserve waters for beneficial purposes. |
| Community Services District | Government Code, Title 6, Div. 3, Secs. 61000 through 61800 | Three or five elected at large or County supervisors. | Petition by 10 percent of voters, hearing, and election by majority vote. | Revenue bonds; Improvement Act of 1911; Improvement Bond Act of 1915; certificates of participation. | Rates or charges for use of facilities; including standby charges; leases; benefit assessments; special assessments; standby charges may be collected on tax roll. | Territory must be unincorporated. Authority is relatively broad. Existing community services district not organized to provide storm drainage, area includes only small portion of community. |

Table 8-2. Comparison of Alternative Implementing Agencies, continued

| Agency | Enabling legislation | Governing body | Formation procedure | Financing method | Revenue and assessments | Remarks |
|---|---|---|---|---|---|---|
| County Water District | Water Code, Div. 12, Secs. 30000 through 33901 | Five directors, elected at large. | Petition by 10 percent of voters, hearing, and election by majority vote. | Revenue bonds; Improvement Act of 1911; Improvement Bond Act of 1915; certificates of participation. | Charges for services, leases; benefit assessments; special assessments. | Existing MCWD provides community water and sewer services. Authorized powers include control of drainage and flood waters. Delinquent charges may be added to annual taxes. |
| County Flood Control District | Water Code, Div. 5, Sec. 8110 | County Board of Supervisors | Resolution and ordinance by Board of Supervisors | Revenue bonds; Improvement Act of 1911; Improvement Bond Act of 1915; certificates of participation. | Ad valorem taxes. | Purposes defined in legislation includes only flood control. No provisions in legislation for special assessments or user charges. |
| Public Utility District | Public Utilities Code, Div. 7, Secs. 15001 through 18055 | Board of Directors, either three or five, elected at large. | Petition by 15 percent of votes cast for governor at last election, hearing, election by majority vote. | Revenue bonds; Improvement Act of 1911, Improvement Bond Act of 1915; may not exceed 20 percent of assessed valuation of real and personal property. | Charges for services, leases, benefit assessments; special assessments. | Utility district powers are relatively broad, but district administration more complicated than other districts. Restrictions on operating procedures are more extensive than other districts. |
| Storm Drain Maintenance District | Statutes of 1937, Chapter 265, Page 566 | County Board of Supervisors or legislative body of city. | Resolution by governing body, hearing, consent by board. | Improvement Act of 1911; Improvement Bond Act of 1915. | No provisions. | May not be formed if other districts may perform the function. |
| Storm Water Districts | Statutes of 1909, Chapter 222, Page 339 | Three trustees, County Board of Supervisors as to claims. | Petition by 25 percent of landowners, hearing, order of Board of Supervisors. | Only general obligation bonds provided for in legislation. | Assessments in proportion to benefits spread over 10 years maximum; County may pay up to one-half. | Authorized to prevent of control soil erosion and protect lands from damage from storm waters. |
| Flood Control and Water Conservation Districts | Water Code, Appendix 38-1 | Five trustees appointed by County Board of Supervisors | Petition by 25 percent of landowners, hearing, order of Board of Supervisors. | No provisions. | Assessments to maintain works already constructed. | Purposes defined in legislation include only flood control. No provisions for incurring indebtedness or collecting revenues. |

Although formation of a new water district requires an election, extension of the existing services of the MCWD to include storm drainage and flood control could be done relatively simply by authorization to serve that function from the Local Agency Formation Commission (LAFCO). Presumably, MCWD could also meet the needs for professional staff easier than a new district and could combine billing, revenue collection, and operation and maintenance functions for Master Plan facilities with existing water and sewer service operations. However, it is unlikely that MCWD wants to extend its current services to provide storm drainage and flood control as provided for in the Master Plan.

Public utility districts may perform a broad range of services, and may charge for the services in a variety of ways. However, operation of a public utility district is more closely controlled than that of other types of districts. An election is required to form the district and the governing board is elected at large. The formation of this type of district would offer no particular advantages and would be more expensive to form and to operate than other types.

Storm drain maintenance districts and stormwater districts are both authorized to provide for construction and operation of storm drainage systems. However, the authorized financing methods and revenue sources for each are extremely limited. Neither type offers an advantage over a county service area, county flood control district, or county water district.

Although the obligation for control of storm and flood waters currently rests with the county, the possibility of incorporation of the Mammoth Lakes community in the near future exists. If that occurred, the new city could assume responsibility for protecting private property from damage by flood and stormwaters. Although the city might elect to provide storm drainage services itself, separation of the storm drainage and flood control function from other city services could be beneficial. Because the capital expenditures required for construction of the new facilities are large, the best method for obtaining financing will be to separate the obligation for payment from city general fund revenues. A county service area could still be used in the incorporated area (and area outside the city limit). Mammoth County Water District could also provide services within the new city.

Because a county service area would provide the greatest immediate resources, be easiest and least expensive to operate, provide wide flexibility in financing, and would mesh well with existing county project review procedures, use of this alternative is recommended.

County Code Modifications

Mono County should enact a new ordinance or modify existing ordinances to require compliance with the design manual procedures, storm drainage design consistent with the Master Plan, and orderly review of storm drainage works for new development in Mammoth Lakes.

Specific regulatory needs in the Mammoth Lakes area include:

1. Submittal of improvement plans to the county to provide complete details on clearing, grading, drainage design, erosion control and revegetation, slope design, and provisions for winterizing the site.

2. Issuance of building permits by the county contingent upon satisfaction of Lahontan Regional Water Quality Control Board waste discharge permit requirements.

3. Design of drainage facilities, slope stabilization, and site grading as required by ordinance to conform to procedures prescribed in the Mammoth Lakes storm drainage and erosion control design manual.

4. Provision for storm drainage and erosion control facilities in all new development projects which are consistent with the adopted Master Plan.

5. Requirement for the posting of a bond by developers in the amount required to correct potential erosion control problems on construction sites by ordinance. The bond amount should provide for regrading, slope stabilization, revegetation, and maintenance of vegetation for a reasonable period should the developer or contractor fail to comply with design manual procedures or abandon the site, or should the revegetation effort fail due to unfavorable weather conditions.

6. The county should be empowered by ordinance to enforce design manual standards and to recover costs associated with correction for noncompliance.

As shown on Figure 8-1 and described earlier in this chapter, the county project review process has several requirements that partially address these needs. Rather than enact a new ordinance, the existing County Codes could be modified to effectively satisfy regulatory needs. It is recommended that the following actions be taken:

1. Ordinance No. 82-502, which amended Chapter 19.66 of the Mono County Code to establish design review policies and standards for the Mammoth Lakes design review district, should be modified to require compliance with Chapter 8 (Revegetation) of the Design Manual. Design review authority should be expanded to include site revegetation.

2. Chapter 13.08 of the Mono County Code should be revised so that it is compatible with the Design Manual and Master Plan. Suggested modifications to the existing ordinance which could be applied just in Mammoth Lakes are presented in Appendix C.

3. Chapter 15.06 of the Mono County Code should be expanded by adding Section 15.06.060 which would specifically require control of surface runoff on construction sites, prevention of erosion, and prohibit discharge of sediment from construction sites by requiring compliance with temporary runoff and erosion control procedures specified in the Design Manual.

4. Chapter 17.24 of the Mono County Code should be revised to include Section 17.24.010 D. which would require that all improvements, including but not limited to roads, storm drainage, curb and gutter, and slopes, be designed in accordance with procedures specified in the Design Manual.

Actions to Implement Program Financing

To establish a revenue program to finance Master Plan improvements, and subsequent operation and administration of the storm drainage system, a detailed financial plan, revenue program, and implementing ordinance should be completed and adopted. These efforts should expand on the information presented in this report in the following areas:

1. Establishment and adoption by the County of a capital improvement program defining the schedule for construction of improvements.

2. Selection of an institutional mechanism to implement the plan, and establishment of the mechanism by the County.

3. Application for grant assistance from HUD, EDA, or other possible sources to supplement local funds.

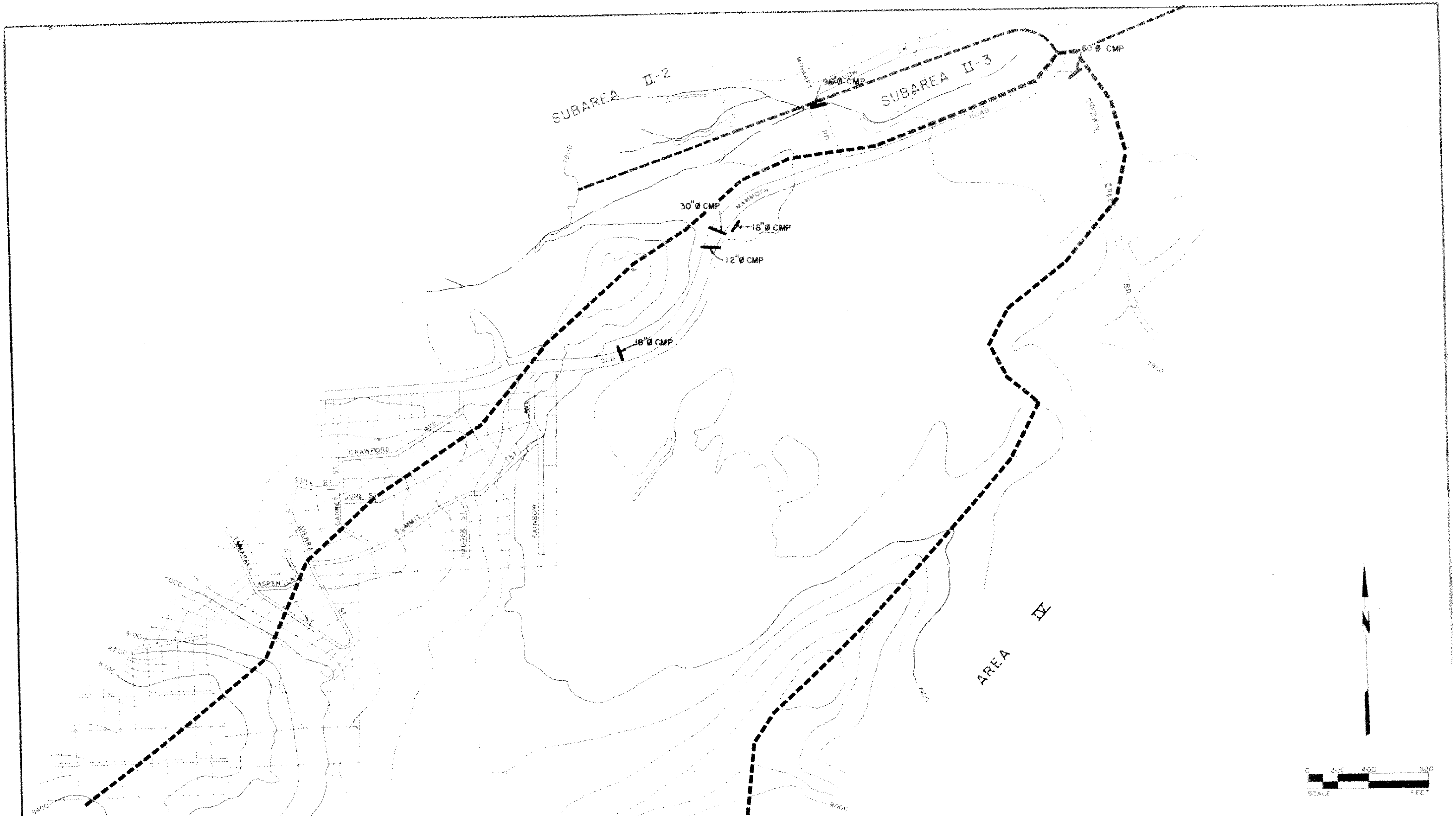
4. Caltrans, the U.S. Forest Service, and Mammoth Mountain should be contacted by the County to pursue voluntary contributions to program financing for their share of runoff.

5. Preparation of a detailed cost of service analysis to clearly define all costs for administration; operation, maintenance, and repair; and billing. This analysis should include preliminary budgeting for staff and equipment, consultant services, and other costs to implement the program.

6. Selection of a method of program financing and completion of a detailed revenue program to verify cash flow requirements, cash reserves, financing costs, and other similar items which have been assumed in this report.

7. Preparation and adoption of an ordinance containing a user fee schedule and connection charges to match the revenue program.

8. Selection of a bond counsel to advise the County on the best mechanism to use in program financing, and to prepare necessary documents to secure financing instruments.




**MONO COUNTY DEPARTMENT OF PUBLIC WORKS**

Mammoth Lakes Storm Drainage Master Plan

**Existing Drainage Facilities In Tributary Subarea II - I**

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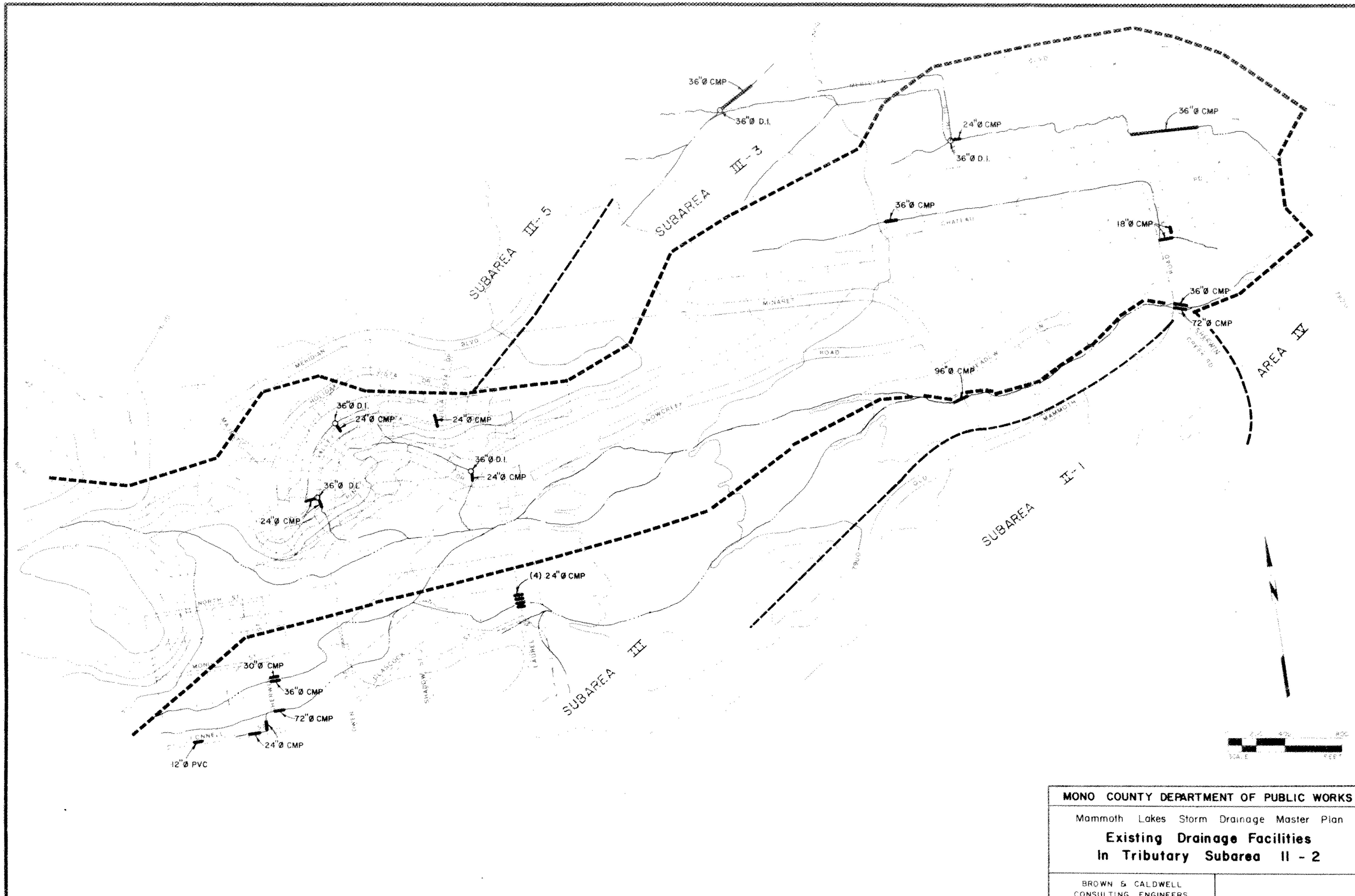


MONO COUNTY DEPARTMENT OF PUBLIC WORKS

Mammoth Lakes Storm Drainage Master Plan

**Existing Drainage Facilities In Tributary Subarea II - 2**

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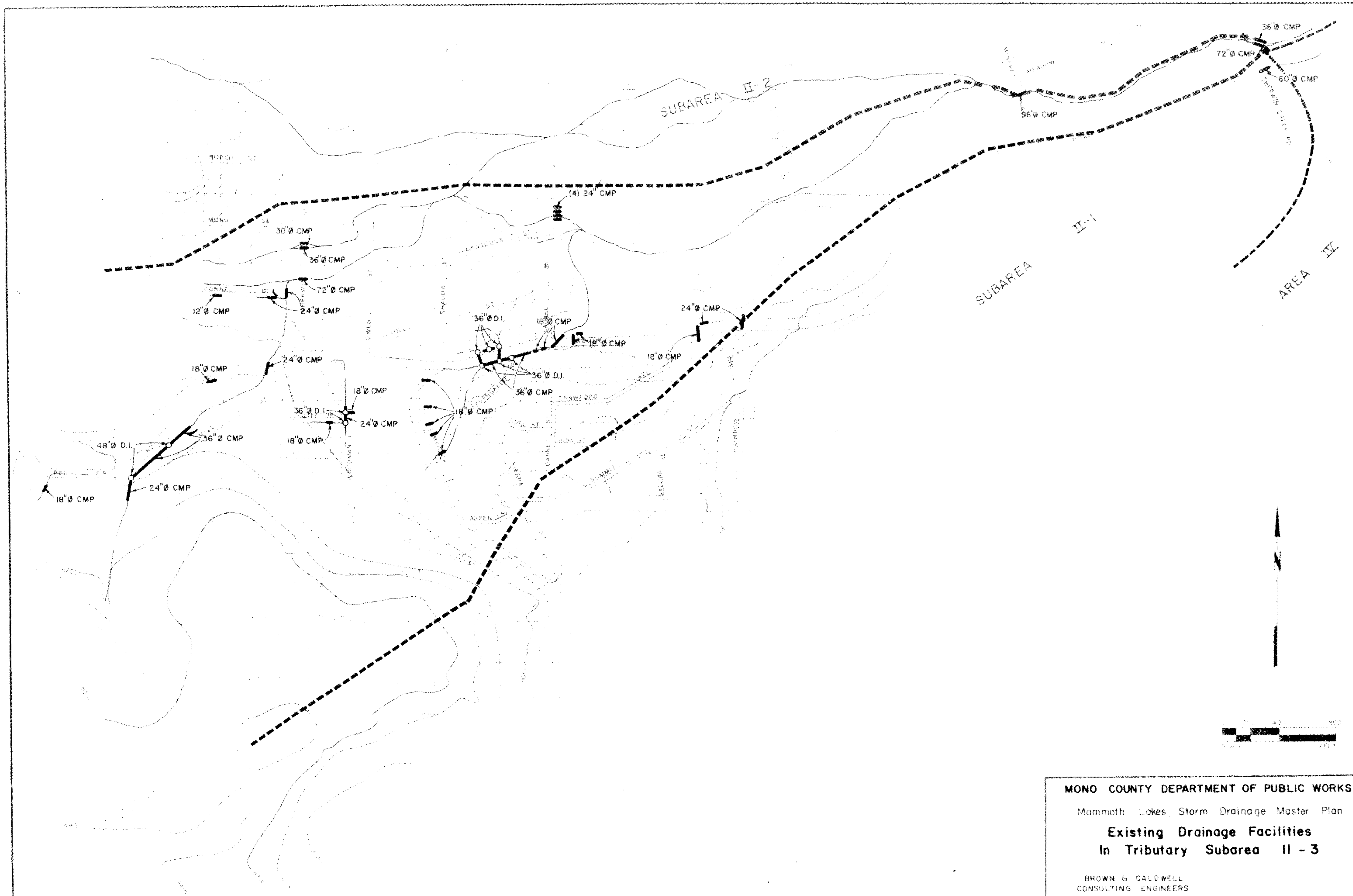


**MONO COUNTY DEPARTMENT OF PUBLIC WORKS**

Mammoth Lakes Storm Drainage Master Plan

## Existing Drainage Facilities In Tributary Subarea II - 3

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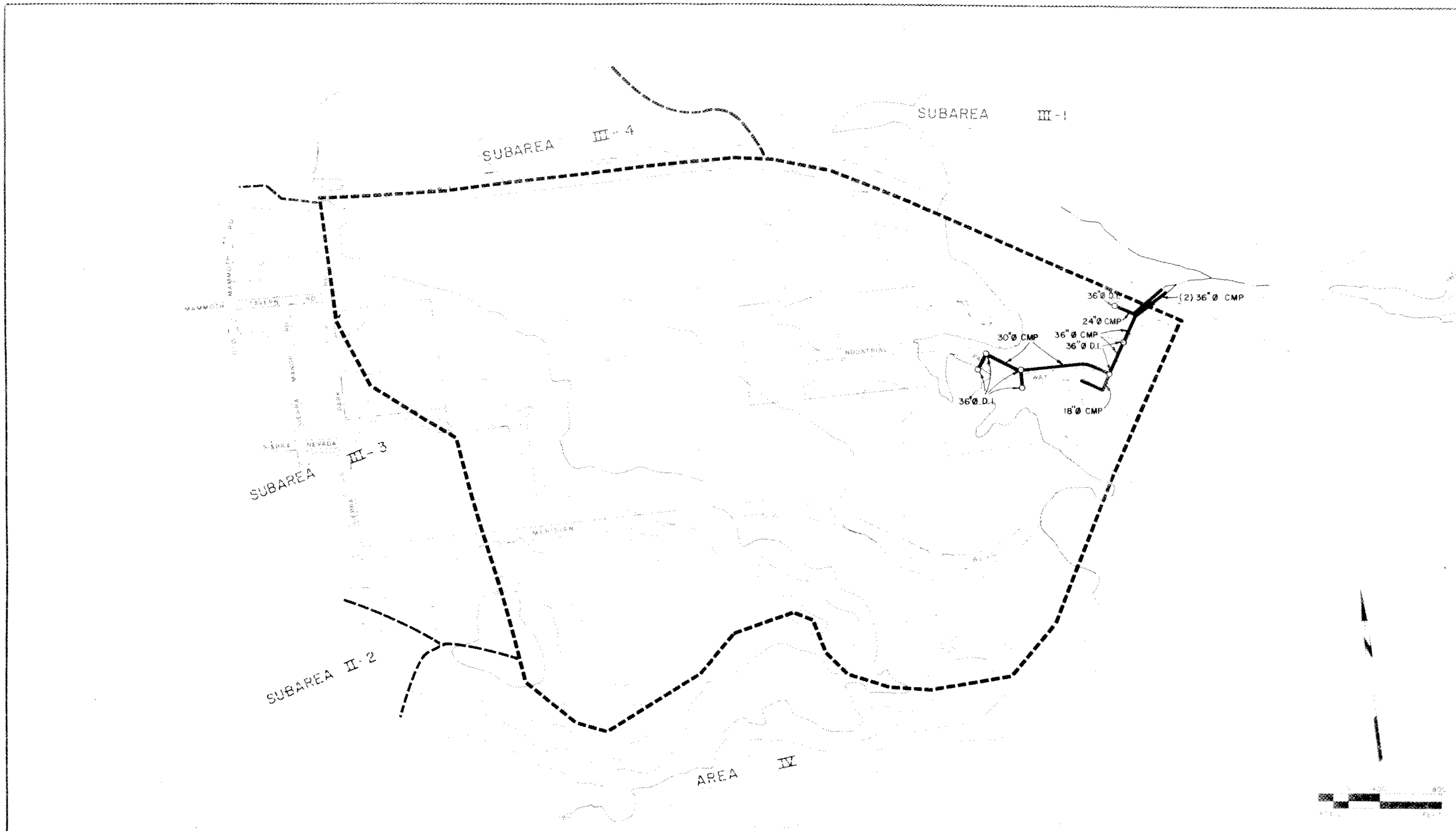


MONO COUNTY DEPARTMENT OF PUBLIC WORKS

Mammoth Lakes Storm Drainage Master Plan

**Existing Drainage Facilities In Tributary Subarea III - 2**

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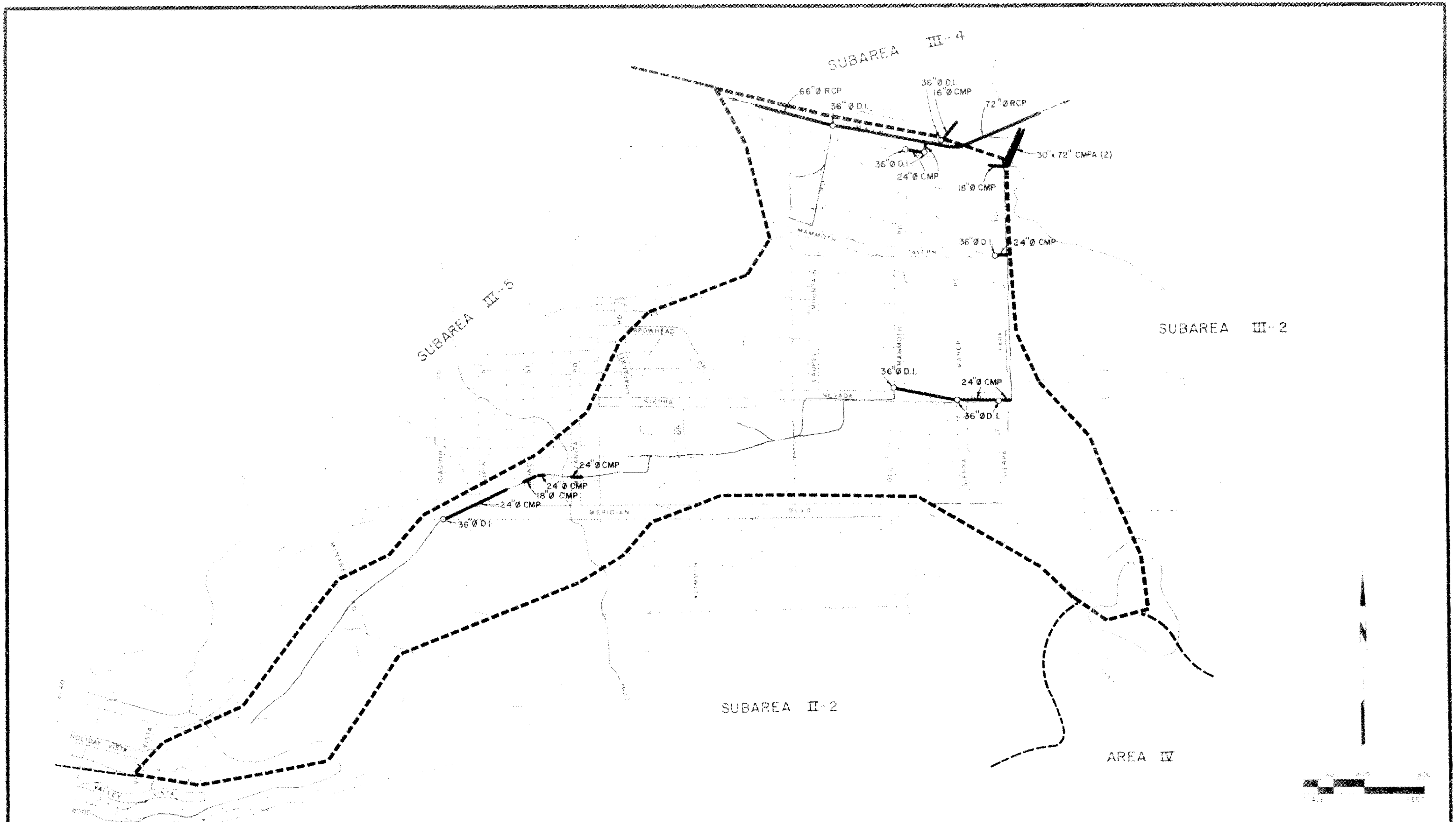


**MONO COUNTY DEPARTMENT OF PUBLIC WORKS**

Mammoth Lakes Storm Drainage Master Plan

**Existing Drainage Facilities**
**In Tributary Subarea III - 3**

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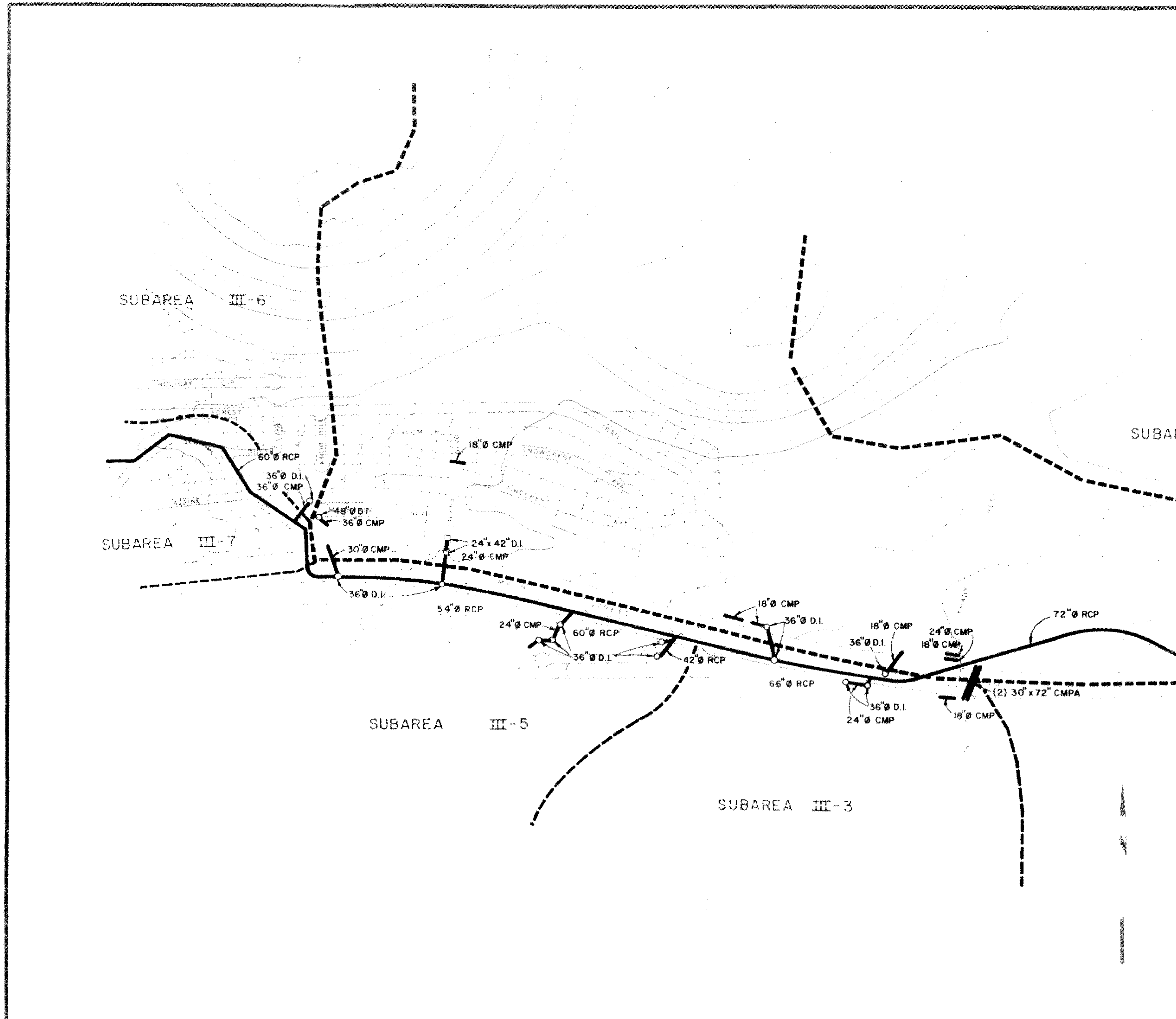


**MONO COUNTY DEPARTMENT OF PUBLIC WORKS**

Mammoth Lakes Storm Drainage Master Plan

**Existing Drainage Facilities In Tributary Subarea III - 4**

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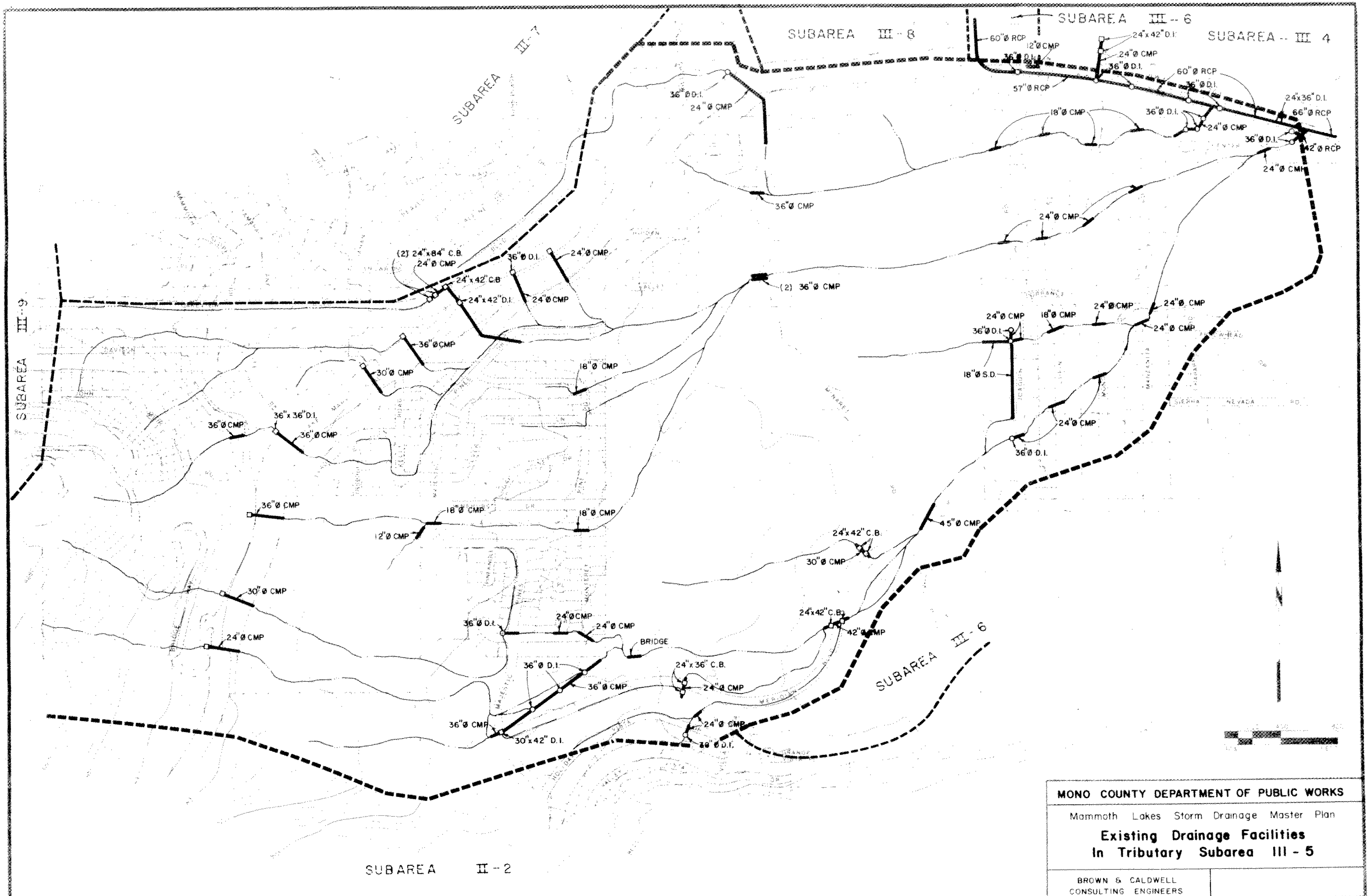


**MONO COUNTY DEPARTMENT OF PUBLIC WORKS**

Mammoth Lakes Storm Drainage Master Plan

**Existing Drainage Facilities**
**In Tributary Subarea III - 5**

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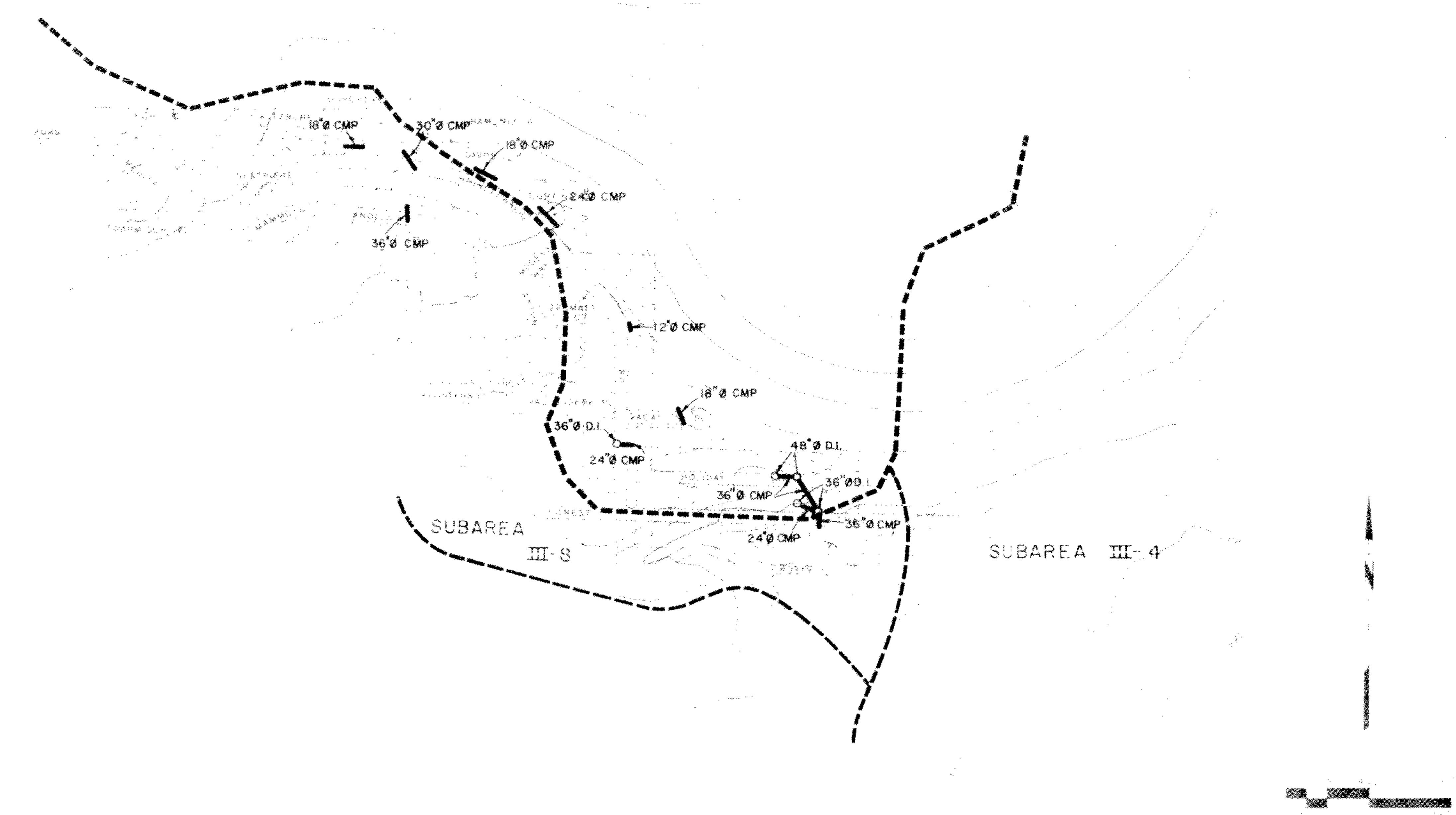


MONO COUNTY DEPARTMENT OF PUBLIC WORKS

Mammoth Lakes Storm Drainage Master Plan

**Existing Drainage Facilities In Tributary Subarea III - 6**

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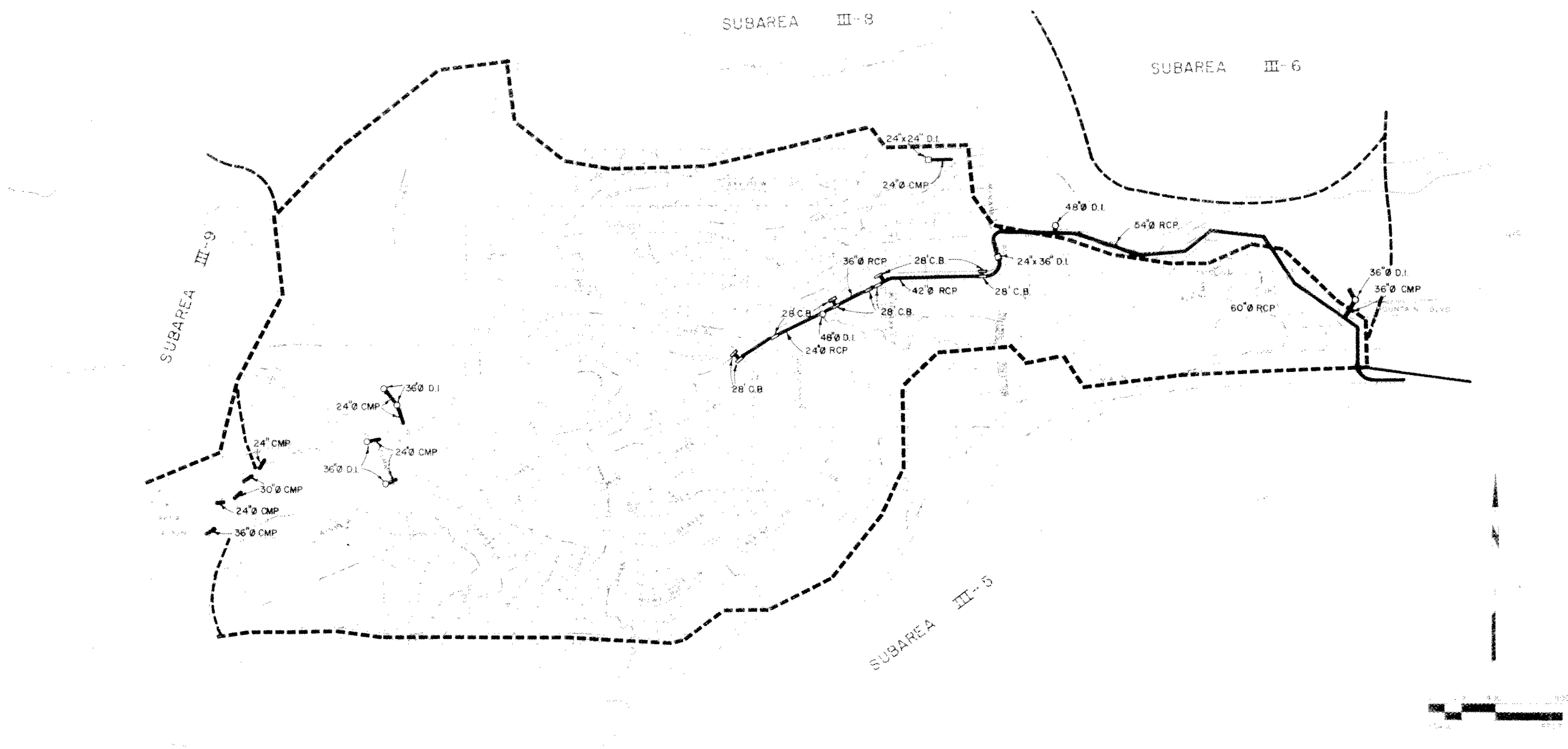


**MONO COUNTY DEPARTMENT OF PUBLIC WORKS**

Mammoth Lakes Storm Drainage Master Plan

**Existing Drainage Facilities In Tributary Subarea III - 7**

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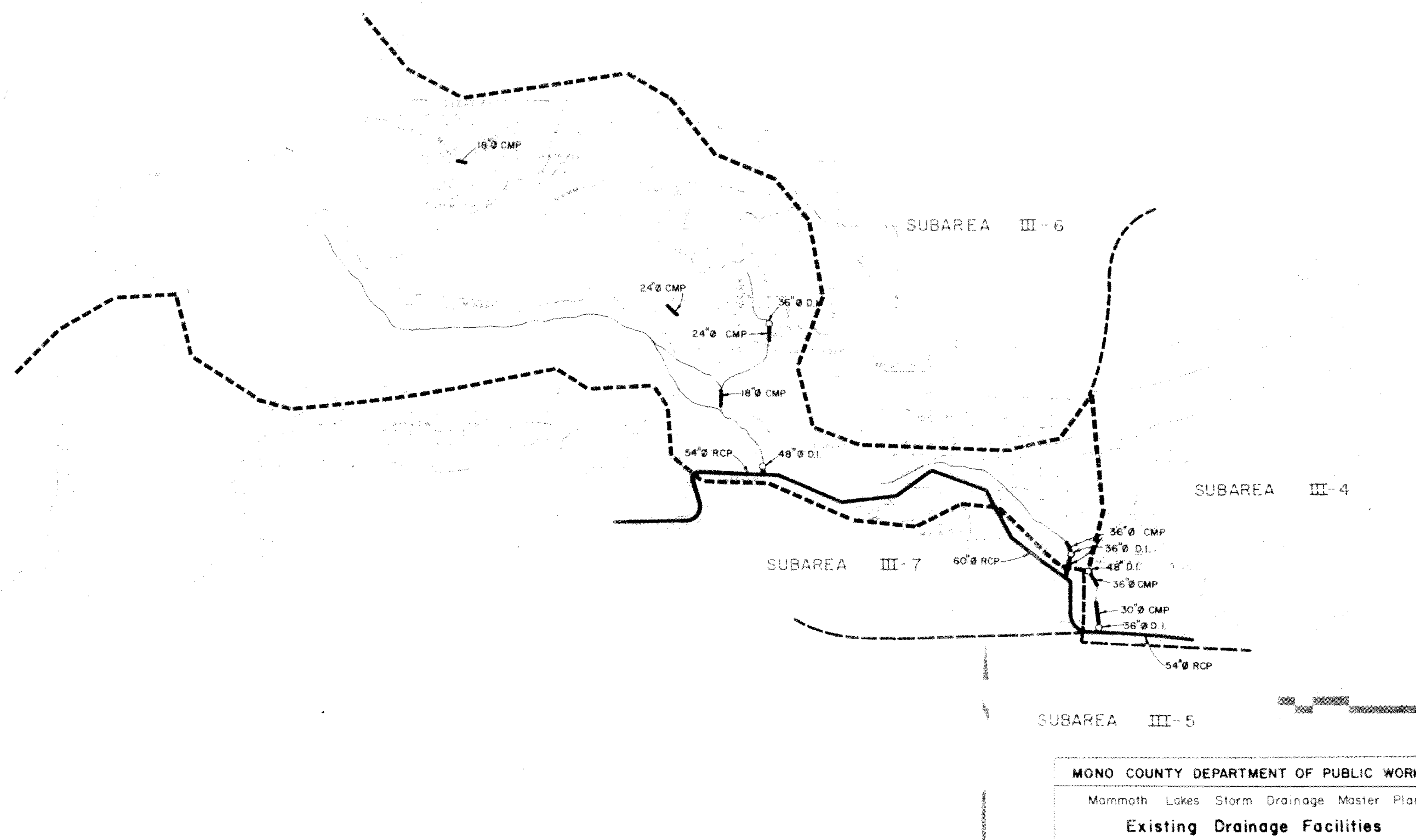


MONO COUNTY DEPARTMENT OF PUBLIC WORKS

Mammoth Lakes Storm Drainage Master Plan

**Existing Drainage Facilities In Tributary Subarea III - 8**

BROWN & CALDWELL
CONSULTING ENGINEERS

# APPENDIX B

## QUANTITY TAKEOFFS AND COST ESTIMATES FOR MASTER PLAN FACILITIES

QUANTITY TAKEOFF AND COST ESTIMATES

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea II-1 | | | | | |
| A | Summit Street | 18-inch storm drain | 500 L.F. | 40 | 20,000 |
| | | 24-inch storm drain | 700 L.F. | 46 | 32,200 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 7 each | 900 | 6,300 |
| | | Roadside V-ditch | 3,200 L.F. | 5 | 16,000 |
| | | Energy dissipation | 1 | Lump sum | 5,000 |
| | Rainbow Avenue | 18-inch storm drain | 300 L.F. | 40 | 12,000 |
| | | 24-inch storm drain | 800 L.F. | 46 | 36,800 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 9 each | 900 | 8,100 |
| | | Roadside V-ditch | 2,400 LF | 5 | 12,000 |
| A Subtotal | | | | | 156,500 |
| B | Summit Street | Improved 6-foot channel | 4,000 L.F. | 25 | 100,000 |
| Subarea II-1 Total | | | | | 256,500 |
| Subarea II-2 | | | | | |
| B | Majestic Pines Drive | 18-inch storm drain | 800 L.F. | 40 | 32,000 |
| | | 24-inch storm drain | 1,300 L.F. | 46 | 59,800 |
| | | Manholes | 7 each | 1,150 | 8,050 |
| | | Inlets, laterals | 18 each | 900 | 16,200 |
| | | Curb and gutter | 4,200 L.F. | 12 | 50,400 |
| | | Energy dissipation | 1 | Lump sum | 5,000 |
| | Valley Vista Drive | 18-inch storm drain | 200 L.F. | 40 | 8,000 |
| | | Manhole | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 3 each | 900 | 2,700 |
| | | Curb and gutter | 1,000 L.F. | 12 | 12,000 |
| | Valley Vista to Majestic Pines Drive | 18-inch storm drain | 400 L.F. | 32 | 12,800 |
| | | Manhole | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Energy dissipation | 1 | Lump sum | 5,000 |
| | South of Majestic Pines Drive | 24-inch storm drain | 300 L.F. | 46 | 13,800 |
| | | Sediment retention basin | 1 | Lump sum | 15,000 |
| B Subtotal | | | | | 244,900 |
| A2b.2. | Snowcreek Road | 18-inch storm drain | 600 L.F. | 40 | 24,000 |
| | | 24-inch storm drain | 850 L.F. | 46 | 39,100 |
| | | 30-inch storm drain | 850 L.F. | 57 | 48,450 |
| | | Manholes | 6 each | 1,150 | 6,900 |
| | | Inlets, laterals | 12 each | 900 | 10,800 |
| | | Curb and gutter | 5,800 L.F. | 12 | 69,600 |
| A2b.2. Subtotal | | | | | 198,900 |
| A2b.1. | Minaret Road | 18-inch storm drain | 500 L.F. | 40 | 20,000 |
| | | 36-inch storm drain | 350 L.F. | 64 | 22,400 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 7 each | 900 | 6,300 |
| | | Curb and gutter | 2,600 L.F. | 12 | 31,200 |
| | Meadow Lane | 36-inch storm drain | 1,000 L.F. | 64 | 64,000 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | East of Meadow Lane to Old Mammoth Road | 36-inch storm drain | 850 L.F. | 64 | 54,400 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 5 each | 900 | 4,500 |
| | Old Mammoth Road | 18-inch storm drain | 250 L.F. | 40 | 10,000 |
| | | 36-inch storm drain | 300 L.F. | 64 | 19,200 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 7 each | 900 | 6,300 |
| | Outlet at Old Mammoth Road | Outlet | 1 | Lump sum | 500 |
| A2b.1. Subtotal | | | | | 253,900 |

QUANTITY TAKEOFF AND COST ESTIMATES, continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea II-2 (continued) | | | | | |
| A2a. | Chateau Road | 18-inch storm drain | 600 L.F. | 40 | 24,000 |
| | | 24-inch storm drain | 650 L.F. | 46 | 29,900 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 7 each | 900 | 6,300 |
| | | Curb and gutter | 3,600 L.F. | 12 | 43,200 |
| | Azimuth Drive | 18-inch storm drain | 500 L.F. | 40 | 20,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Curb and gutter | 2,000 L.F. | 12 | 24,000 |
| A2a. Subtotal | | | | | 153,800 |
| A1 | Chateau Road | 30-inch storm drain | 1,100 L.F. | 57 | 62,700 |
| | | 42-inch storm drain | 300 L.F. | 75 | 22,500 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 8 each | 900 | 7,200 |
| | | Curb and gutter | 2,800 L.F. | 12 | 33,600 |
| | Sierra Manor Road | 36-inch storm drain | 300 L.F. | 64 | 19,200 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Curb and gutter | 600 L.F. | 12 | 7,200 |
| | South of Chateau Road | 42-inch storm drain | 400 L.F. | 60 | 24,000 |
| | | Sediment retention basin | 1 | Lump sum | 20,000 |
| | Old Mammoth Road to Sediment retention basin | Channel improvements | 600 L.F. | 25 | 15,000 |
| A1 Subtotal | | | | | 217,800 |
| Subarea II-2 Total | | | | | 1,069,300 |
| Subarea II-3 | | | | | |
| D | Crawford Avenue/Garnet Street | 18-inch storm drain | 1,700 L.F. | 36 | 61,200 |
| | | Manholes | 6 each | 1,150 | 6,900 |
| | | Inlets, laterals | 11 each | 900 | 9,900 |
| | | Roadside V-ditch | 3,400 L.F. | 5 | 17,000 |
| | Gull Street | 18-inch storm drain | 200 L.F. | 36 | 7,200 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | Old Mammoth Road | Sediment retention basin | 1 | Lump sum | 20,000 |
| | | Energy dissipation | 1 | Lump sum | 5,000 |
| D Subtotal | | | | | 130,200 |
| C | Tamarack | 18-inch storm drain | 300 L.F. | 36 | 10,800 |
| | | 24-inch storm drain | 250 L.F. | 41 | 10,250 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 7 each | 900 | 6,300 |
| | | Roadside V-ditch | 600 L.F. | 5 | 3,000 |
| | West of Tamarack | 18-inch storm drain | 500 L.F. | 36 | 18,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | Aspen Lane | Roadside V-ditch | 600 L.F. | 5 | 3,000 |
| | Evergreen | Roadside V-ditch | 1,000 L.F. | 5 | 5,000 |
| | South of Mill Street | 18-inch storm drain | 1,500 L.F. | 36 | 54,000 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 8 each | 900 | 7,200 |
| | | Roadside V-ditch | 4,000 L.F. | 5 | 20,000 |
| | Mill Street | 24-inch storm drain | 800 L.F. | 41 | 32,800 |
| | | Energy dissipation | 1 | Lump sum | 5,000 |
| | Old Mammoth Road | 30-inch storm drain | 1,650 L.F. | 50 | 82,500 |
| | | Outlet with energy dissipator | 1 | Lump sum | 1,000 |
| | Old Mammoth Road and Mill Street | Manholes | 8 each | 1,150 | 9,200 |
| | | Inlets, laterals | 19 each | 900 | 17,100 |
| | | Roadside V-ditch | 5,800 L.F. | 5 | 29,000 |
| | Woodman Street | 18-inch storm drain | 700 L.F. | 36 | 25,200 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Roadside V-ditch | 2,000 L.F. | 5 | 10,000 |
| C Subtotal | | | | | 365,100 |

QUANTITY TAKEOFF AND COST ESTIMATES, continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea II-3 (continued) | | | | | |
| B | Glasscock Street | 18-inch storm drain | 500 L.F. | 36 | 18,000 |
| | | 24-inch storm drain | 800 L.F. | 41 | 32,800 |
| | | Manholes | 5 each | 1,150 | 5,750 |
| | | Inlets, laterals | 10 each | 900 | 9,000 |
| | | Roadside V-ditch | 2,600 L.F. | 5 | 13,000 |
| | Hill Street | 18-inch storm drain | 700 L.F. | 36 | 25,200 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Roadside V-ditch | 2,800 L.F. | 5 | 14,000 |
| | Owen Street | Roadside V-ditch | 1,200 L.F. | 5 | 6,000 |
| | Laurel Street | 18-inch storm drain | 500 L.F. | 36 | 18,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Roadside V-ditch | 1,200 L.F. | 5 | 6,000 |
| | | Sediment retention basin | 1 | Lump sum | 15,000 |
| | Shadow Street | 18-inch storm drain | 500 L.F. | 36 | 18,000 |
| | | Roadside V-ditch | 500 L.F. | 5 | 2,500 |
| B Subtotal | | | | | 195,000 |
| A2b.1. | Natural channel south of Old Mammoth Road | Channel improvements | 700 L.F. | 10 | 7,000 |
| | Old Mammoth Road | Two 48-inch culverts | 1 | Lump sum | 14,700 |
| | Channel north of Old Mammoth Road | Improved Channel | 500 L.F. | 25 | 12,500 |
| | Channel Street | Two 48-inch culverts | 1 | Lump sum | 8,800 |
| | | Roadside V-ditch | 1,200 L.F. | 5 | 6,000 |
| | West of Sherwin Street | Channel improvements | 1,400 L.F. | 10 | 14,000 |
| | East of Sherwin Street | Channel improvements | 2,600 L.F. | 10 | 26,000 |
| | Sherwin Street | Inlets, laterals | 6 each | 900 | 5,400 |
| | | Roadside V-ditch | 2,400 L.F. | 5 | 12,000 |
| A2b.1 Subtotal | | | | | 106,400 |
| A2b.2a1. | Natural channel south of Red Fir | Channel improvements | 900 L.F. | 10 | 9,000 |
| | Red Fir | 18-inch storm drain | 900 L.F. | 40 | 36,000 |
| | | 48-inch storm drain | 800 L.F. | 89 | 71,200 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 6 each | 900 | 5,400 |
| | | Curb and gutter | 3,000 L.F. | 12 | 36,000 |
| | | Flared end sections | 2 each | 1,000 | 2,000 |
| A2b.2a1. Subtotal | | | | | 163,000 |
| A2b.2b. | | 18-inch storm drain | 900 L.F. | 40 | 128,000 |
| | | 24-inch storm drain | 800 L.F. | 46 | 92,000 |
| | | Manholes | 14 each | 1,150 | 16,100 |
| | | Inlets, laterals | 25 each | 900 | 22,500 |
| | | Roadside V-ditch | 10,800 L.F. | 5 | 54,000 |
| A2b.2b. Subtotal | | | | | 312,600 |
| A1 | Natural channel east of Laurel Street | Channel improvements | 900 L.F. | 10 | 9,000 |
| | Channel north of Old Mammoth Road near Crawford | Improved 4-foot channel | 450 L.F. | 15 | 6,750 |
| | Main channel | Channel improvements | 5,000 L.F. | 10 | 50,000 |
| | Minaret Road | Inlets, laterals | 2 each | 900 | 1,800 |
| | Old Mammoth Road crossing for main channel | Box culvert (twin 5-foot by 8-foot) | 1 | Lump sum | 35,000 |
| A1 Subtotal | | | | | 100,300 |
| Subarea II-3 Total | | | | | 1,372,600 |

QUANTITY TAKEOFF AND COST ESTIMATES, continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-1 | | | | | |
| | Murphy Gulch | New sediment retention basin | 1 | Lump sum | 150,000 |
| | | Modifications to existing sediment basin | 1 | Lump sum | 15,000 |
| Subarea III-1 Total | | | | | 165,000 |
| Subarea III-2 | | | | | |
| A3 | Meridian Boulevard | 30-inch storm drain | 1,900 L.F. | 57 | 108,300 |
| | | Manholes | 6 each | 1,150 | 6,900 |
| | | Inlets, laterals | 12 each | 900 | 10,800 |
| | | Curb and gutter | 11,400 L.F. | 12 | 136,800 |
| | | Energy dissipation | 1 | Lump sum | 5,000 |
| A3 Subtotal | | | | | 267,800 |
| A2 | Industrial Way | 30-inch storm drain | 3,300 L.F. | 57 | 188,100 |
| | | Flared end section | 1 | Lump sum | 450 |
| | | Manholes | 6 each | 1,150 | 6,900 |
| | | Inlets, laterals | 12 each | 900 | 10,800 |
| | | 18-inch storm drain | 400 L.F. | 32 | 12,800 |
| | | Curb and gutter | 4,200 L.F. | 12 | 50,400 |
| | | Energy dissipation | 1 | Lump sum | 10,000 |
| A2 Subtotal | | | | | 279,500 |
| B | South of Highway 203 | V-ditch | | | |
| | | 24-inch storm drain | 700 L.F. | 46 | 32,200 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 7 each | 900 | 6,300 |
| | | Energy dissipation | 1 | Lump sum | 5,000 |
| B Subtotal | | | | | 128,900 |
| A1 | Meridian Boulevard | 36-inch storm drain | 600 L.F. | 64 | 38,400 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Curb and gutter | 900 | 12 | 10,800 |
| Subarea III-2 Total | | | | | 728,400 |
| Subarea III-3 | | | | | |
| A2b.2a. | Meridian Boulevard | 18-inch storm drain | 250 L.F. | 40 | 10,000 |
| | | 24-inch storm drain | 900 L.F. | 46 | 41,400 |
| | | 30-inch storm drain | 2,050 L.F. | 57 | 116,800 |
| | | Manholes | 8 each | 1,150 | 9,200 |
| | | Inlets, laterals | 23 each | 900 | 20,700 |
| | | Curb and gutter | 6,000 L.F. | 12 | 72,000 |
| | | Energy dissipation structures | 1 | Lump sum | 10,000 |
| | Old Mammoth Road | 30-inch storm drain | 700 L.F. | 57 | 44,800 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| A2b.2a. Subtotal | | | | | 330,800 |
| A2b.2b. | Sierra Nevada Boulevard | 18-inch storm drain | 350 L.F. | 40 | 14,000 |
| | | 24-inch storm drain | 1,200 L.F. | 46 | 55,200 |
| | | Manholes | 5 each | 1,150 | 5,750 |
| | | Inlets, laterals | 17 each | 900 | 15,300 |
| | | Curb and gutter | 3,200 L.F. | 12 | 38,400 |
| | | Energy dissipation structures | 1 | Lump sum | 10,000 |
| | Arrowhead Drive | 18-inch storm drain | 900 L.F. | 40 | 36,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 5 each | 900 | 4,500 |
| | | Curb and gutter | 1,800 L.F. | 12 | 21,600 |
| A2b.2b. Subtotal | | | | | 203,000 |

QUANTITY TAKEOFF AND COST ESTIMATES, continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-3 (continued) | | | | | |
| A2b.1. | Sierra Nevada Boulevard | 42-inch storm drain | 700 L.F. | 75 | 52,500 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 6 each | 900 | 4,500 |
| | | Curb and gutter | 1,400 L.F. | 12 | 16,800 |
| | | Energy dissipation structures | 1 | Lump sum | 10,000 |
| | Sierra Manor Road | 18-inch storm drain | 500 L.F. | 40 | 20,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Curb and gutter | 1,400 L.F. | 12 | 16,800 |
| | Sierra Park Road | 24-inch storm drain | 750 L.F. | 46 | 34,500 |
| | | 42-inch storm drain | 950 L.F. | 75 | 71,200 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 8 each | 900 | 7,200 |
| | | Curb and gutter | 3,300 L.F. | 12 | 39,600 |
| | | Energy dissipation structures | 1 | Lump sum | 5,000 |
| A2b.1. Subtotal | | | | | 288,000 |
| A2a. | Mammoth Tavern Road | 24-inch storm drain | 1,300 L.F. | 46 | 59,800 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 11 each | 900 | 9,900 |
| | | Curb and gutter | 2,800 L.F. | 12 | 33,600 |
| | Laurel Mountain Road | 18-inch storm drain | 300 L.F. | 40 | 12,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Curb and gutter | 1,300 L.F. | 12 | 15,600 |
| | Old Mammoth Road | 18-inch storm drain | 320 L.F. | 40 | 12,800 |
| | | 24-inch storm drain | 550 L.F. | 46 | 25,300 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| A2a. Subtotal | | | | | 179,500 |
| A1 | Sierra Park Road | 60-inch storm drain | 600 L.F. | 125 | 75,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Curb and gutter | 1,200 L.F. | 12 | 14,400 |
| A1 Subtotal | | | | | 92,400 |
| Subarea III-3 Total | | | | | 1,093,700 |
| Subarea III-4 | | | | | |
| B | Pinecrest Avenue | 18-inch storm drain | 850 L.F. | 40 | 34,000 |
| | | 24-inch storm drain | 1,500 L.F. | 46 | 71,300 |
| | | 42-inch storm drain | 900 L.F. | 73 | 65,700 |
| | | Manholes | 10 each | 1,150 | 11,500 |
| | | Inlets, laterals | 24 each | 900 | 21,600 |
| | | Curb and gutter | 6,300 L.F. | 12 | 74,400 |
| | | Energy dissipation structures | 1 | Lump sum | 20,000 |
| | Sierra Boulevard/ Mountain Boulevard | 18-inch storm drain | 1,200 L.F. | 40 | 48,000 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 10 each | 900 | 9,000 |
| | | Curb and gutter | 800 L.F. | 12 | 9,600 |
| | | Energy dissipation structures | 1 | Lump sum | 5,000 |
| | Snowcrest Avenue | 18-inch storm drain | 1,000 L.F. | 40 | 40,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Curb and gutter | 2,400 L.F. | 12 | 28,800 |
| | Forest Trail | 36-inch storm drain | 1,300 L.F. | 64 | 83,200 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 6 each | 900 | 5,400 |
| | | Curb and gutter | 3,000 L.F. | 12 | 36,000 |
| B Subtotal | | | | | 576,300 |

QUANTITY TAKEOFF AND COST ESTIMATES, continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
| --- | --- | --- | --- | --- | --- |
| Subarea III-4 (continued) | | | | | |
| A | Main Street to Center Street | 66-inch storm drain | 1,400 L.F. | 141 | 197,400 |
| | Center Street to Pinecrest | 84-inch storm drain | 400 L.F. | 162 | 64,800 |
| | Below Pinecrest to outlet | 96-inch storm drain | 3,900 L.F. | 205 | 799,500 |
| | | Manholes | 10 each | 1,150 | 11,500 |
| | | Inlets, laterals | 26 each | 900 | 23,400 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | | Outlet | 1 | Lump sum | 5,000 |
| | West of Shady Rest | Improved 4-foot channel | 2,000 L.F. | 15 | 30,000 |
| A Subtotal | | | | | 1,136,600 |
| Subarea III-4 Total | | | | | 1,712,900 |
| Subarea III-5 | | | | | |
| C2b.2b2., a2b. | Majestic Pines Drive to channel | 36-inch storm drain | 1,000 L.F. | 64 | 64,000 |
| | | Flared end section | 2 each | 650 | 1,300 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlest, slaterals | 3 each | 900 | 2,700 |
| C2b.2b2.a2b. | Subtotal | | | | 69,200 |
| C2b.2b2., a2a. | Monterey Pines Road | 24-inch storm drain | 850 L.F. | 46 | 39,100 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 9 each | 900 | 8,100 |
| | | Curb and gutter | 1,000 L.F. | 12 | 12,000 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| C2b.2b2.a2a. | Subtotal | | | | 67,700 |
| C2b.2b2., a.1. | Channel | Channel improvements | 1,000 L.F. | 10 | 10,000 |
| C2b.2b2.b. | Holiday Vista Drive | 18-inch storm drain | 700 L.F. | 40 | 28,000 |
| | | 24-inch storm drain | 700 L.F. | 46 | 32,200 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 8 each | 900 | 7,200 |
| | | Curb and gutter | 2,800 L.F. | 12 | 33,600 |
| | Villa Vista | 24-inch storm drain | 500 L.F. | 46 | 23,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Curb and gutter | 1,200 L.F. | 12 | 14,400 |
| | | Energy dissipation structures | 1 | Lump sum | 15,000 |
| | Valley Vista | 18-inch storm drain | 650 L.F. | 40 | 26,000 |
| | | Manholes | | | |
| | | Inlets, laterals | | | |
| | | Curb and gutter | 2,000 L.F. | 12 | 24,000 |
| | Meridian Boulevard | 18-inch storm drain | 950 L.F. | 40 | 38,000 |
| | | Flared end section | 1 | 650 | 650 |
| | North of Meridian Boulevard | Improved 4-foot channel | 350 L.F. | 18 | 6,300 |
| C2b.2b2.b. | Subtotal | | | | 258,900 |
| C2b.2b1. | Channel | Improved 6-foot channel | 1,400 L.F. | 25 | 35,000 |
| | Meridian Boulevard | 48-foot culvert | 1 | Lump sum | 8,900 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| C2b.2b1. Subtotal | | | | | 46,900 |
| C2b.2a. | Channel | Channel improvements | 1,900 L.F. | 10 | 19,000 |
| | Meridian Boulevard | Manhole | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| C2b.2a. Subtotal | | | | | 22,000 |

QUANTITY TAKEOFF AND COST ESTIMATES, continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-5 (continued) | | | | | |
| C2b.1. | Minaret Road and Meridian Boulevard | 60-inch culvert | 1 | Lump sum | 41,500 |
| | Channel west of Joaquin | Improved 6-foot channel | 800 L.F. | 35 | 28,000 |
| | Meridian Boulevard | Inlets, laterals | 2 each | 900 | 1,800 |
| | Minaret Road | Inlets, laterals | 2 each | 900 | 1,800 |
| | Alternative 1—Storm Drain Pipe | | | | |
| | Joaquin to Manzanita | Two 48-inch storm drains | 2,400 L.F. | 73 | 115,200 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 6 each | 900 | 5,400 |
| | Alternative 1 Subtotal | | | | 184,000 |
| | Alternative 2—Channels and Culverts | Improved 8-foot channel | 1,200 L.F. | 35 | 42,000 |
| | Joaquin | Two 54-inch culverts | 1 | Lump sum | 10,400 |
| | Lupin | Two 54-inch culverts | 1 | Lump sum | 10,400 |
| | Mono | Two 54-inch culverts | 1 | Lump sum | 10,400 |
| | Joaquin to Mono | Inlets, laterals | 6 each | 900 | 5,400 |
| | Alternative 2 Subtotal | | | | 78,600 |
| C2b.1. Subtotal with Alternative 1 | | | | | 257,100 |
| C2b.1. Subtotal with Alternative 2 | | | | | 151,700 |
| C2a. | Channel west of Joaquin | Channel improvements | 200 L.F. | 10 | 2,000 |
| | Storm drain west of Joaquin | 36-inch storm drain | 300 L.F. | 50 | 15,000 |
| | | Flared end section | 1 each | 300 | 300 |
| | Alternative 1—Storm Drain Pipe | | | | |
| | Joaquin to Manzanita | 36-inch storm drain | 800 L.F. | 60 | 48,000 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 6 each | 900 | 5,400 |
| | Alternative 1 Subtotal | | | | 56,850 |
| | Alternative 2—Channels and Culverts | Improved 6-foot channel | 800 L.F. | 25 | 20,000 |
| | Lupin | 42-inch culvert | 1 | Lump sum | 4,400 |
| | Mono | 42-inch culvert | 1 | Lump sum | 4,400 |
| | Joaquin to Mono | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 6 each | 900 | 5,400 |
| | Alternative 2 Subtotal | | | | 37,700 |
| C2a. Subtotal with Alternative 1 | | | | | 74,200 |
| C2a. Subtotal with Alternative 2 | | | | | 55,000 |
| C1 | Alternative 1—Storm Drain Pipe | Two 48-inch storm drains | 3,800 L.F. | 73 | 277,400 |
| | | Manholes | 4 each | 1,150 | 4,650 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | Alternative 1 Subtotal | | | | 283,850 |
| | Alternative 2—Channels and Culverts | Improved channel | 1,900 L.F. | 35 | 66,500 |
| | Manzanita | Two 60-inch culverts | 1 | Lump sum | 22,500 |
| | Alternative 2 Subtotal | | | | 89,000 |
| C1 Subtotal with Alternative 1 | | | | | 283,900 |
| C1 Subtotal with Alternative 2 | | | | | 89,000 |

QUANTITY TAKEOFF AND COST ESTIMATES,
continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-5 (continued) | | | | | |
| A2b. | Minaret Road | 36-inch culvert | 1 | Lump sum | 6,200 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | Lake Mary Road | Curb and gutter | 900 L.F. | 12 | 10,800 |
| A2b. Subtotal | | | | | 18,800 |
| A1. | Channel east of Minaret Road | Improved channel (6-foot wide) | 1,600 L.F. | 25 | 40,000 |
| | Alternative 1--Storm Drain Pipe | | | | |
| | Joaquin Road to Center Street | 42-inch storm drain | 1,400 L.F. | 60 | 84,000 |
| | | Manholes | 5 each | 1,150 | 5,750 |
| | | Inlets, laterals | 10 each | 900 | 9,000 |
| | Alternative 1 Subtotal | | | | 98,800 |
| | Alternative 2--Channels and Culverts | Improved 6-foot channel | 1,400 L.F. | 75 | 35,000 |
| | Joaquin Road | 48-inch culvert | 1 | Lump sum | 5,900 |
| | Lupin Street | 48-inch culvert | 1 | Lump sum | 5,900 |
| | Mono Street | 48-inch culvert | 1 | Lump sum | 5,900 |
| | Manzanita Road | 48-inch culvert | 1 | Lump sum | 5,900 |
| | Joaquin Road to Manzanita Road | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 8 each | 900 | 7,200 |
| | Alternative 2 Subtotal | | | | 70,400 |
| A1. Subtotal with Alternative 1 | | | | | 138,800 |
| A1. Subtotal with Alternative 2 | | | | | 110,400 |
| Subarea III-5 Total | | | | | |
| Alternative 1 | | | | | 3,008,900 |
| Alternative 2 | | | | | 2,532,400 |
| Subarea III-6 | | | | | |
| | Grindelwald Road | 42-inch storm drain | 2,100 L.F. | 75 | 157,500 |
| | | Manholes | 5 each | 1,150 | 5,750 |
| | | Inlets, laterals | 12 each | 900 | 10,800 |
| | | Curb and gutter | 6,400 L.F. | 12 | 76,800 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | Forest Trail | 48-inch storm drain | 1,000 L.F. | 89 | 89,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Curb and gutter | 3,200 L.F. | 12 | 38,400 |
| | | Energy dissipation structure | 1 | Lump sum | 10,000 |
| | Vacation Place to Holiday Circle | 30-inch storm drain | 300 L.F. | 44 | 13,200 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | Vacation Place | Curb and gutter | 900 L.F. | 12 | 10,800 |
| | Holiday Circle | 30-inch storm drain | 700 L.F. | 57 | 39,900 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Curb and gutter | 2,400 L.F. | 12 | 28,800 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | South of Forest Trail | 48-inch storm drain | 700 L.F. | 89 | 62,300 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | 24-inch storm drain | 200 L.F. | 40 | 8,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Energy dissipation structure | 1 | Lump sum | 10,000 |
| | Main Street | 66-inch storm drain | 700 L.F. | 141 | 98,100 |
| Subarea III-6 Total | | | | | 698,000 |

QUANTITY TAKEOFF AND COST ESTIMATES,
continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-5 (continued) | | | | | |
| B2a.2b. | Lake Mary Road | 18-inch storm drain | 950 L.F. | 40 | 38,000 |
| | | 24-inch storm drain | 950 L.F. | 46 | 43,700 |
| | | 30-inch storm drain | 650 | 57 | 37,100 |
| | | Manholes | 8 each | 1,150 | 9,200 |
| | | Inlets, laterals | 16 each | 900 | 14,400 |
| | | Curb and gutter | 2,500 L.F. | 12 | 30,000 |
| | Davison Road | 18-inch storm drain | 1,100 L.F. | 40 | 44,000 |
| | | 24-inch storm drain | 900 L.F. | 46 | 41,400 |
| | | Manholes | 6 each | 1,150 | 6,900 |
| | | Inlets, laterals | 12 each | 900 | 10,800 |
| | | Curb and gutter | 4,500 L.F. | 12 | 54,000 |
| | | Energy dissipation Structure | 1 | Lump sum | 15,000 |
| | John Muir Road | 18-inch storm drain | 2,600 L.F. | 40 | 104,000 |
| | | Manholes | 8 each | 1,150 | 9,200 |
| | | Inlets, laterals | 18 each | 900 | 16,200 |
| | | Curb and gutter | 8,000 L.F. | 12 | 96,000 |
| | | Energy dissipation structure | 1 | Lump sum | 15,000 |
| | John Muir Road to Davison | 18-inch storm drain | 350 L.F. | 40 | 14,000 |
| B2a.2b. Subtotal | | | | | 598,900 |
| B2a.2a. | Lakeview Boulevard | 18-inch storm drain | 2,400 L.F. | 40 | 96,000 |
| | | Manholes | 7 each | 1,150 | 8,050 |
| | | Inlets, laterals | 14 each | 900 | 12,600 |
| B2a.2a. Subtotal | | | | | 116,650 |
| B2a.1. | Majestic Pines Drive | 24-inch storm drain | 1,300 L.F. | 46 | 59,800 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 11 each | 900 | 9,900 |
| | | Curb and gutter | 2,600 L.F. | 12 | 31,200 |
| | West of Majestic Pines Drive | 30-inch storm drain | 550 L.F. | 57 | 31,400 |
| | Majestic Pines Drive | 30-inch storm drain | 700 L.F. | 52 | 39,900 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Outlet | 1 each | 1,000 | 1,000 |
| | | Curb and gutter | 1,400 L.F. | 12 | 16,800 |
| | East of outlet on Majestic Pines Drive | Improved 6-foot channel | 1,200 L.F. | 25 | 30,000 |
| | Minaret Road | Two 54-inch culverts | 1 | Lump sum | 17,200 |
| | Lake Mary Road | 18-inch storm drain | 800 L.F. | 40 | 32,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | Hidden Valley Road | 18-inch storm drain | 700 L.F. | 40 | 32,200 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Curb and gutter | 3,000 L.F. | 12 | 36,000 |
| | Hidden Valley Road to channel | 24-inch storm drain | 350 L.F. | 46 | 16,100 |
| | | Energy dissipation structure and outlet | 1 | Lump sum | 6,000 |
| B2a.1. Subtotal | | | | | 381,600 |

QUANTITY TAKEOFF AND COST ESTIMATES,
continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-5 (continued) | | | | | |
| B2b. | Silver Tip Lane | 18-inch storm drain | 750 L.F. | 40 | 30,000 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 6 each | 900 | 5,400 |
| | | Curb and gutter | 2,800 L.F. | 12 | 33,600 |
| | Monterey Pines Road | 18-inch storm drain | 500 L.F. | 40 | 20,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Curb and gutter | 2,300 L.F. | 12 | 27,600 |
| | West of Monterey Pines Road | 18-inch storm drain | 300 L.F. | 40 | 12,000 |
| | | Roadside V-ditch | 900 L.F. | 15 | 13,500 |
| B2b. Subtotal | | | | | 151,500 |
| B2c. | Majestic Pines Drive | 30-inch culvert | 1 | Lump sum | 3,300 |
| | | Inlets, laterals | 2 each | 900 | |
| | Channel from Majestic Pines Drive to Monterey Pines Road | Improved channel | 1,000 L.F. | 10 | 10,000 |
| | Monterey Pines Road | 18-inch storm drain | 550 L.F. | 40 | 22,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Curb and gutter | 1,400 L.F. | 12 | 16,800 |
| | | 30-inch culvert | 1 | Lump sum | 3,300 |
| | Channel east of Monterey Pines Road | 6-foot channel | 2,100 L.F. | 75 | 52,500 |
| | Minaret Road | Inlets, laterals | 4 each | 900 | 3,600 |
| B2c. Subtotal | | | | | 117,400 |
| B1. | Channel west of Minaret Road | Improved 8-foot channel | 1,500 L.F. | 35 | 52,500 |
| | Alternative 1—Storm Drain Pipe | | | | |
| | Joaquin to Center Street | Two 42-inch storm drains | 5,000 L.F. | 60 | 300,000 |
| | | Manholes | 6 each | 1,150 | 6,900 |
| | | Inlets, laterals | 8 each | 900 | 7,200 |
| | Alternative 1 Subtotal | | | | 314,100 |
| | Alternative 2—Channels and Culverts | Improved 8-foot channel | 2,000 L.F. | 35 | 84,000 |
| | Joaquin Road | Two 54-inch culverts | 1 | Lump sum | 10,700 |
| | Lupin Street | Two 54-inch culverts | 1 | Lump sum | 10,700 |
| | Mono Street | Two 54-inch culverts | 1 | Lump sum | 10,700 |
| | Manzanita Road | Two 54-inch culverts | 1 | Lump sum | 10,700 |
| | South of Center Street | Two 42-inch storm drains | 800 L.F. | 60 | 48,000 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 8 each | 900 | 7,200 |
| | Alternative 2 Subtotal | | | | 185,500 |
| B1. Subtotal with Alternative 1 | | | | | 366,600 |
| B1. Subtotal with Alternative 2 | | | | | 238,000 |
| A2a. | Main Street | 24-inch storm drain | 300 L.F. | 46 | 13,800 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 3 each | 900 | 2,700 |
| | | Curb and gutter | 500 L.F. | 12 | 6,000 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| A2a. Subtotal | | | | | 28,700 |

QUANTITY TAKEOFF AND COST ESTIMATES,
continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-7 | | | | | |
| C2b.1b. | Canyon Boulevard | 30-inch storm drain | 1,000 L.F. | 57 | 57,000 |
| | | 36-inch storm drain | 100 L.F. | 64 | 6,400 |
| | | Flared end section | 1 each | 300 | 300 |
| | | 42-inch storm drain | 900 L.F. | 75 | 67,500 |
| | | 48-inch storm drain | 850 L.F. | 89 | 75,650 |
| | | Manholes | 6 each | 1,150 | 6,900 |
| | | Inlets, laterals | 14 each | 900 | 12,600 |
| | | Curb and gutter | 4,000 L.F. | 12 | 48,000 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | Mammoth Slopes | 18-inch storm drain | 300 L.F. | 40 | 12,000 |
| | | 24-inch storm drain | 450 L.F. | 46 | 20,200 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 6 each | 900 | 5,400 |
| | | Curb and gutter | 2,300 L.F. | 12 | 27,600 |
| | Rainbow Lane | 18-inch storm drain | 700 L.F. | 40 | 28,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| C2b.1b. Subtotal | | | | | 385,800 |
| C2b.1a. | Canyon Boulevard | 48-inch storm drain | 1,600 L.F. | 89 | 152,400 |
| | | Manholes | 5 each | 1,150 | 5,750 |
| | | Inlets, laterals | 15 each | 900 | 13,500 |
| | | Energy dissipation structure | 1 | Lump sum | 20,000 |
| | Forest Trail | 18-inch storm drain | 600 L.F. | 40 | 24,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Curb and gutter | 1,400 L.F. | 12 | 16,800 |
| | Ridgecrest Drive | 18-inch storm drain | 250 L.F. | 40 | 10,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Curb and gutter | 1,200 L.F. | 12 | 14,400 |
| | North of Rainbow Lane | 18-inch storm drain | 500 L.F. | 32 | 16,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | Rainbow Lane | Curb and gutter | 1,000 L.F. | 12 | 12,000 |
| | | 18-inch storm drain | 300 L.F. | 40 | 12,000 |
| | | 24-inch storm drain | 450 L.F. | 46 | 20,200 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 6 each | 900 | 5,400 |
| | | Curb and gutter | 2,300 L.F. | 12 | 27,600 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | Convict Drive | 18-inch storm drain | 300 L.F. | 40 | 12,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| C2b.1a. Subtotal | | | | | 301,600 |

QUANTITY TAKEOFF AND COST ESTIMATES,
continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-7 continued) | | | | | |
| C2b.2. | Rainbow Lane | 18-inch storm drain | 600 L.F. | 40 | 24,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | Forest Trail | 18-inch storm drain | 900 L.F. | 40 | 36,000 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 11 each | 900 | 9,900 |
| | | Curb and gutter | 2,600 L.F. | 12 | 31,200 |
| | Twin Lakes Lane | 24-inch storm drain | 1,200 L.F. | 46 | 55,200 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 7 each | 900 | 6,300 |
| | | Curb and gutter | 2,400 L.F. | 12 | 28,800 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| C2b.2. Subtotal | | | | | 215,400 |
| C2a. | Canyon Boulevard | 54-inch storm drain | 400 L.F. | 104 | 41,600 |
| | | 42-inch storm drain | 800 L.F. | 75 | 60,000 |
| | | 36-inch storm drain | 300 | 64 | 19,200 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 10 each | 900 | 9,000 |
| | | Curb and gutter | 250 L.F. | 12 | 3,000 |
| | | Energy dissipation structure | 1 | Lump sum | 15,000 |
| | Horseshoe Drive | 24-inch storm drain | 800 L.F. | 46 | 36,800 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 5 each | 900 | 4,500 |
| | | Curb and gutter (Canyon to Lakeview) | 2,400 L.F. | 12 | 28,800 |
| | Beaver Trail | 18-inch storm drain | 1,300 L.F. | 40 | 52,000 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 9 each | 900 | 8,100 |
| | | Curb and gutter | 2,600 L.F. | 12 | 31,200 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | Jahan Drive | 18-inch storm drain | 300 L.F. | 40 | 12,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 5 each | 900 | 4,500 |
| | | Curb and gutter (Twin Lakes to Lakeview) | 1,800 L.F. | 12 | 21,600 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | | 18-inch storm drain | 700 L.F. | 40 | 28,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Curb and gutter (Ridge-crest to cul-de-sac) | 2,600 L.F. | 12 | 31,200 |
| | Ridgecrest Drive | Curb and gutter | 1,600 L.F. | 12 | 19,200 |
| C2a. Subtotal | | | | | 453,100 |

QUANTITY TAKEOFF AND COST ESTIMATES, continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-7 continued) | | | | | |
| C1b. | Forest Trail Lane | 18-inch storm drain | 600 L.F. | 40 | 24,000 |
| | | 24-inch storm drain | 1,500 L.F. | 46 | 69,000 |
| | | Manholes | 6 each | 1,150 | 6,900 |
| | | Inlets, laterals | 15 each | 900 | 13,500 |
| | | Curb and gutter | 5,000 L.F. | 12 | 60,000 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | Crest Lane | Curb and gutter | 400 L.F. | 12 | 4,800 |
| | Ridgecrest Drive | Curb and gutter | 1,800 L.F. | 12 | 21,600 |
| | Lakeview Drive | 24-inch storm drain | 500 L.F. | 46 | 23,000 |
| | | Curb and gutter | 1,000 L.F. | 12 | 12,000 |
| C1b. Subtotal | | | | | 239,800 |
| C1a. | Lakeview Drive | 18-inch storm drain | 1,700 L.F. | 40 | 68,000 |
| | | Manholes | 4 each | 1,150 | 4,600 |
| | | Inlets, laterals | 10 each | 900 | 9,000 |
| | | Curb and gutter | | | 43,200 |
| C1a. Subtotal | | | | | 124,800 |
| C3. | Lakeview Boulevard | 18-inch storm drain | 700 L.F. | 40 | 28,000 |
| | | 24-inch storm drain | 1,500 L.F. | 46 | 69,000 |
| | | Manholes | 5 each | 1,150 | 5,750 |
| | | Inlets, laterals | 12 each | 900 | 10,800 |
| | | Curb and gutter (Lakeview Drive to Lake Mary Road) | 5,000 L.F. | 12 | 60,000 |
| C3. Subtotal | | | | | 173,600 |
| B | Canyon Road | 54-inch storm drain | 700 L.F. | 103 | 72,100 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Curb and gutter (one side only) | 700 L.F. | 12 | 8,400 |
| | Minaret Road/Berner Street | 54-inch storm drain | 600 L.F. | 103 | 61,800 |
| | | Manholes | 2 each | 1,150 | 2,350 |
| | | Inlets, laterals | 6 each | 900 | 5,400 |
| | | Curb and gutter (Berner Street) | 800 L.F. | 12 | 9,600 |
| | | Energy dissipation structure | 1 | Lump sum | 24,000 |
| B Subtotal | | | | | 186,600 |
| A | Berner Street | 54-inch storm drain | 2,000 L.F. | 103 | 206,000 |
| | | Manholes | 6 each | 1,150 | 6,950 |
| | | Inlets, laterals | 14 each | 900 | 12,600 |
| | | Curb and gutter (Baner to Main) | 9,600 L.F. | 12 | 115,200 |
| | | Energy dissipation structure | 1 | Lump sum | 16,000 |
| A Subtotal | | | | | 356,700 |
| Subarea III-7 Total | | | | | 2,437,400 |

QUANTITY TAKEOFF AND COST ESTIMATES,
continued

| Watershed | Location | Improvement | Quantity | Unit cost, dollars | Item cost, dollars |
|---|---|---|---|---|---|
| Subarea III-8 | | | | | |
| A | Mammoth Knolls Drive | 18-inch storm drain | 1,400 L.F. | 40 | 56,000 |
| | | 24-inch storm drain | 1,200 L.F. | 46 | 55,200 |
| | | Manholes | 7 each | 1,150 | 8,050 |
| | | Inlets, laterals | 17 each | 900 | 15,300 |
| | | Curb and gutter | 3,600 L.F. | 12 | 43,200 |
| | | Energy dissipation structure | 1 | Lump sum | 20,000 |
| | Sestriere Place | 18-inch storm drain | 200 L.F. | 40 | 8,000 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 2 each | 900 | 1,800 |
| | | Curb and gutter | 400 L.F. | 12 | 4,800 |
| | Minaret Road | 24-inch storm drain | 500 L.F. | 46 | 23,000 |
| | | Manholes | 2 each | 1,150 | 2,300 |
| | | Inlets, laterals | 5 each | 900 | 4,500 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| | Forest Trail south to Berner | 48-inch storm drain | 700 L.F. | 89 | 62,300 |
| | | Manholes | 1 each | 1,150 | 1,150 |
| | | Inlets, laterals | 4 each | 900 | 3,600 |
| | | Flared end section | 1 | Lump sum | 800 |
| | | Energy dissipation structure | 1 | Lump sum | 10,000 |
| | North of Forest Trail to Anton Circle | 18-inch storm drain | 500 L.F. | 36 | 18,000 |
| | | 24-inch storm drain | 700 L.F. | 40 | 28,000 |
| | | Manholes | 3 each | 1,150 | 3,450 |
| | | Inlets, laterals | 8 each | 900 | 7,200 |
| | | Curb and gutter | 400 L.F. | 12 | 4,800 |
| | | Energy dissipation structure | 1 | Lump sum | 5,000 |
| A Subtotal | | | | | 392,600 |
| Subarea III-8 Total | | | | | 392,600 |

# APPENDIX C

## RECOMMENDED MODIFICATIONS TO CHAPTER 13.08 OF MONO COUNTY CODE

APPENDIX C

RECOMMENDED MODIFICATIONS TO CHAPTER 13.08 OF MONO COUNTY CODE

13.08.010 Purpose

A. To establish regulations necessary to protect land and water quality in Mammoth Lakes.

B. To establish procedures for submittal of documents, project review, and issuance of permits to control erosion and surface runoff.

C. To establish design standards for storm drainage, flood control, and erosion control.

13.08 020 Definitions

In addition to those definitions given in Chapter 1.04 for this chapter, the following words and phrases shall have the meanings given in this section:

A. "Approval" means a written engineering or geological opinion concerning the progress and completion of the work.

B. "Bedrock" means the relatively solid undisturbed rock in place either at the ground surface or overlain by unconsolidated material.

C. "Borrow" means the relatively solid undisturbed rock in place either at the ground surface or overlain by unconsolidated material.

D. "Clearing" means the removal of vegetation.

E. "County Road Standards" means the Road Standards of the County of Mono.

F. "Department" means the Mono County Department of Public Works.

G. "Design Manual" means Mammoth Lakes Storm Drainage and Erosion Control Design Manual.

H. "Director" means the director of the Department or his duly authorized representative.

I. "Excavation" means a condition of the land resulting from removal by human action of rock or soil from its natural location.

J. "Fill" means rock or soil deposited by human action.

K. "Forest Service" means the U.S. Forest Service.

L. "Geologist" means engineering geologist, geophysicist, or such other persons having expertise in soil science and related fields.

M. "Grading" means the physical movement of earth, rock, or vegetation by human action.

N. "Lahontan Board" means the California Regional Water Quality Control Board, Lahontan Region.

O. "Project engineer" means the civil engineer responsible for the design and/or construction supervision for the project; may also be the soils engineer.

P. "Relative compaction" means the density of the material in place compared to the maximum density as determined using the California Department of Transportation's standard test procedures.

Q. "Revegetation" means restoration of the disturbed areas of a site by planting seeds or live plants and the necessary maintenance to ensure their survival.

R. "Soil Conservation Service" means the U.S. Soil Conservation Service.

S. "Soils" means all the relatively loose incoherent earth material or whatever origin which overlies the bedrock.

T. "Soils engineer" means a registered civil engineer licensed by the state, experienced in soil mechanics, who is responsible for the supervision of work outlined in this chapter.

U. "State specifications" means the current Standard Specifications of the California State Business and Transportation Agency, Department of Transportation.

V. "Test procedures" means testing and control procedures as modified from time to time in use by the State Department of Public Works, Division of Highways, shall be the standard test procedures for work performed under this chapter. The County may perform tests, and in case of conflict with the tests performed by others, the tests performed by the County shall be final.

13.08.030 Applicability

A. No person shall grade, excavate, or fill on any lands without first obtaining a grading permit from the Department, except as specified below.

B. A grading permit shall be granted only to the owner of the site.

C. Separate permits shall be required for each site unless the sites are contiguous. Sites are not defined to be contiguous if separated by a road.

13.08.040 Permits Required

Grading permits are required for:

A. Excavation, fill, or combination thereof, in excess of 50 cubic yards.

B. Excavation 3 feet or more below natural grade or fill 3 feet or more above natural grade.

C. Any grading, excavation, or filling involving disturbance of 5,000 square feet or more of land surface.

D. Any grading, excavation, or filling on any lands with a natural slope of 5 percent or greater, including but not limited to:

1. An excavation or fill within a public sewer, water main, storm drain, or power line easement.

2. An excavation or fill which will encroach on or alter a natural drainage channel or watercourse.

E. The construction, reconstruction, alteration, repair, or installation of any structure in any natural watercourse.

13.08.050 Prohibited Actions

No person shall:

A. Perform any work within the scope of this chapter without first having obtained a permit from the Department as provided for herein.

B. Excavate, grade, or place fill material on or within any property so that dirt or debris washed, eroded, or moved from the property by natural or artificial means creates a public nuisance or hazard on other property, public road, street, or utility easement.