SECTION III

WATERSHED DESCRIPTION

INTRODUCTION

This section describes the overall watershed or basin in terms of soils, vegetation, climate, major features, water quality and special hydrologic aspects. The information used in the development of this section was obtained from the files and reports of the participating agencies to this study, and federal, state and local administrative and planning agencies, and from previous studies of the watershed. The watershed descriptions are further divided and presented in detail for:

- South Fork American River Sub-basin
- Middle Fork American River Sub-basin
- North Fork American River Sub-basin
- Folsom Reservoir and Lake Natoma
- Lower American River Sub-basin

GENERAL DESCRIPTION OF BASIN

The American River watershed is a major drainage of the Sierra Nevada Mountains of Central California. It lies on the tilted western slope of the granitic Sierra fault block. Approximately 1,900 square miles in size, it extends from the steep crest of the Sierra Nevada west of Lake Tahoe to the confluence of the American River with the Sacramento River located within the City of Sacramento. Elevations in the watershed range from over 10,000 feet above sea level at the headwaters to 23 feet at its mouth.

Prior to the 1987-1992 drought, the American River watershed was estimated to have an average annual unimpaired runoff of approximately 2,736,000 (MAF). The river is fed by three principal tributaries: the North Fork American River, Middle Fork American River, and South Fork American River. Figure III-1 illustrates the American River watershed, its tributaries, sub-basins, and major reservoirs.

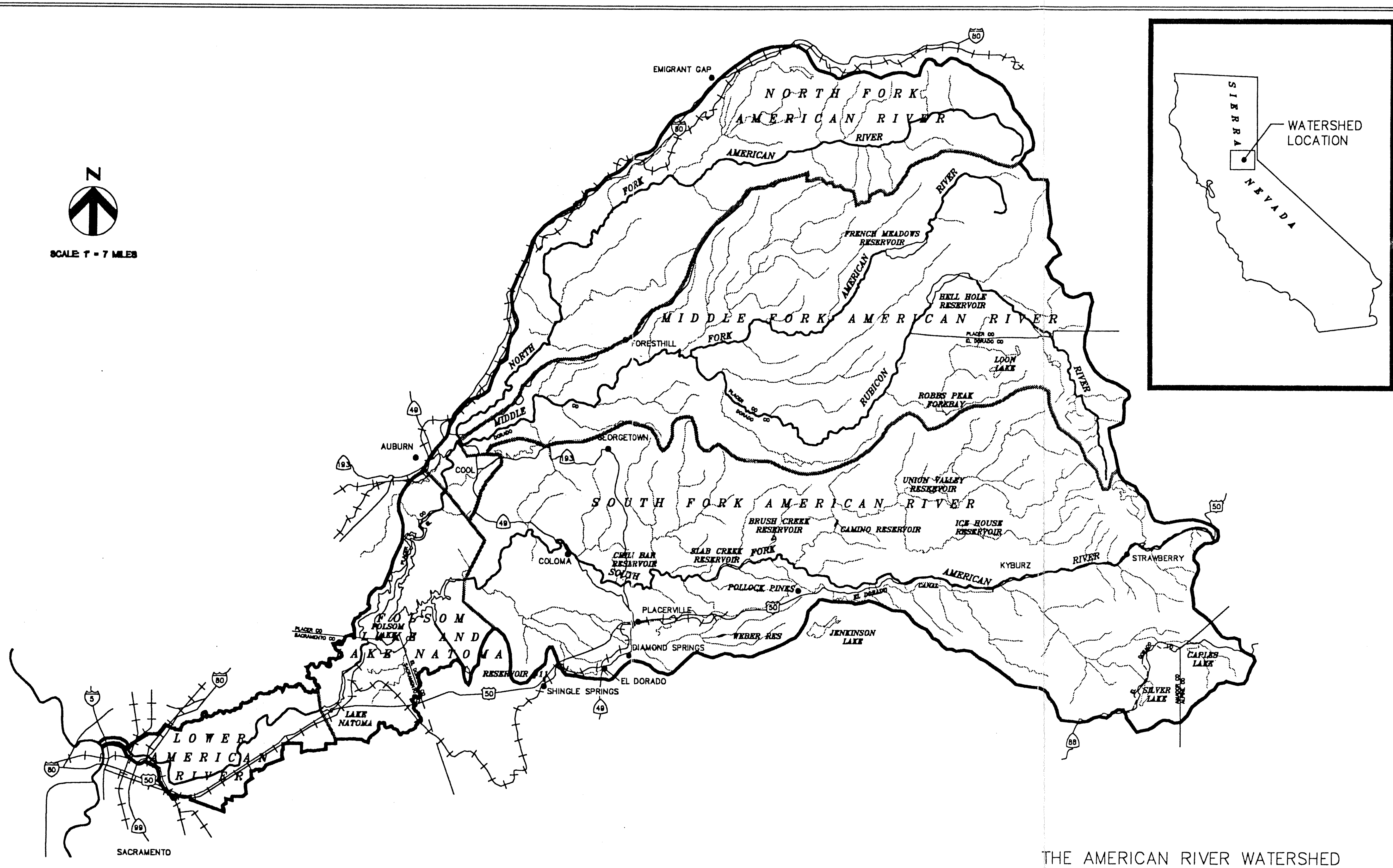
The upper watershed of the American River is characterized by granitic and lava domes and crests, with numerous glacial basins and lakes. Further downslope, older Mississippian deposits have been folded and metamorphosed along a northwest trending zone by the intruding granite batholith that forms the core of the range. Into this older, eroded surface, the canyons of the river forks and their tributaries have been incised. The lower watershed is primarily characterized by flood outwash deposits and valley floor floodplain deposits. Extensive dredges tailings line the river near Folsom, while natural levees further downstream have been largely replaced by artificially constructed and maintained levees.

Soils

Soils of the American River Watershed can be broadly described in four major zones distinguished by soil characteristics, vegetation and human use. These four zones are the Valley Zone, the Foothill Zone, the Upland Agricultural Zone, and the Forest/Recreational Zone.

The Valley Zone near the Sacramento River is typified by deep fertile soils developed in the flood plains and intensive agriculture. Upslope soils are thinner and often underlain by hardpans and claypans. Ancient meandering riverbeds have left deposits of gravels, cobbles and sand along their courses. Oak woodlands have been largely cleared for agriculture and urban development. Riparian woodlands line existing and ephemeral stream courses.

The Foothill Zone is comprised of rather shallow, somewhat rocky, red-colored upland soils that are presently being utilized largely for range grazing and suburban development with some agriculture (primarily orchards). The area is typified by a generous cover of oaks and grasses with spotty stands of dense chaparral. It occupies an elevation band extending from the valley floor on the west, to about 1,800-2,500 feet.



THE AMERICAN RIVER WATERSHED
AND ITS FIVE SUB-BASINS

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Figure III-1

The Upland Agricultural Zone comprises a broad belt that runs in a northwesterly direction across the watershed extending from the Cool-Georgetown area on the north to the Placerville-Camino area on the south. Soils in this zone are characteristically deep, reddish-brown in color, fertile, and quite permeable. Native vegetation varies from oaks and grasses at lower elevations to mixed conifers at the higher elevations up to 6,000 feet. Well suited for deciduous orchards, the soils are frequently planted with pears and apples.

The Forest/Recreational Zone comprises the major acreage of the watershed. It is typified by large areas of rough, broken and rocky land at the higher elevations (above 6,000 feet). Although soils in this zone possess physical properties normally associated with agricultural lands, their use is limited by the climate. Timber production for lumber harvest, watershed management and recreation are the predominant land uses.

Vegetation

At lower watershed elevations, oak-pine woodlands are found with a preponderance of oaks. Above 2,300 feet the coniferous forests begin to dominate, with ponderosa pine as the primary species. As elevation increases, sugar pine and white fir become increasingly prevalent. Above 5,500 feet, red fir becomes the dominant forest species with interspersed Jeffrey pine, sugar pine, Sierra juniper, and white fir. At higher elevations, lodgepole and white pine are found interspersed among the large areas of barren rock. Scrub and brush rangelands are scattered throughout each of these vegetation belts. Above the treeline, the grasses, sages, and numerous ground-hugging alpine plants predominate wherever protected pockets of soil occur.

Climate

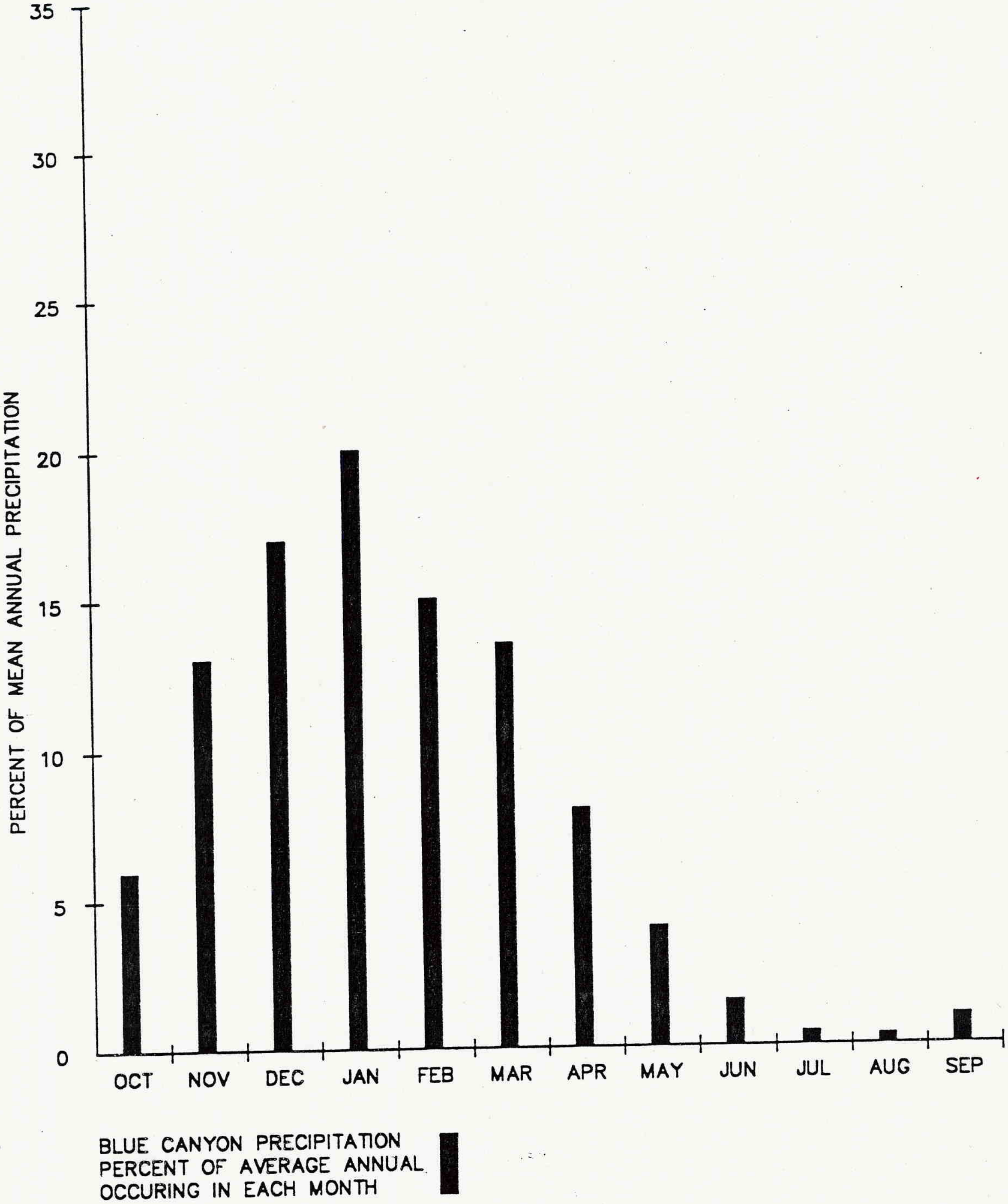
The climate at lower elevations of the watershed is Mediterranean, with cool, wet winters and long, hot and dry summers. At higher elevations it is more continental, with longer, colder winters, shorter cooler summers, and ample winter snows.

More than 95 percent of the precipitation occurs during the fall, winter and spring months from November through April. The average time distribution of precipitation at a representative location is shown by month in Figure III-2. At the lowest elevations (below 3,000 feet), precipitation falls mainly in the form of rain. At the mid-elevations (3,000-6,000 feet) it falls as a combination of rain and snow. Above 6,000 feet, most of the precipitation falls in the form of snow and is retained in the snowpack until spring and summer. The California State Water Resources Control Board has estimated the ratio of the contribution of snow versus rain to the total runoff to be 40 percent.

The water equivalent of precipitation ranges from 17 inches at Sacramento to more than 70 inches above 5,000 feet. Figure III-3 shows its average distribution throughout the watershed. During the past century, the American River has experienced repeated drought as well as flood events. During the single-year drought events of 1924, 1931, 1961, and 1976, the annual runoff of the American River averaged about 35 percent of normal. In 1977, the worst single-year drought event of record, runoff was less than 15 percent of normal. The combined two year runoff from the 1976/77 drought provided less than half of the runoff that would normally occur in a single year.

The extreme and prolonged drought of the last six years (1987-1992), coupled with unprecedented demands, has depleted reservoirs and stream-flows to the lowest levels since 1977 and exhausted the moisture content of the upper soil column. During this period, groundwater tables have declined and vegetative cover has been damaged. Historical tree ring data indicates that extremely variable conditions are the norm and that, between wet periods, droughts lasting six or seven years are not uncommon. Even with above normal rainfall in 1992-93, it will be many years before all the detrimental effects of the latest drought are erased and the watershed recovers. Prolonged reductions of flow, interspersed with flood events, tend to exacerbate the water quality and public health concerns on which sanitary surveys are focused.

Conversely, years of much higher than normal rainfall and runoff have occurred frequently. For example, 1986 peak flood flows in February on the Lower American River reached



AVERAGE TIME DISTRIBUTION OF PRECIPITATION
AT BLUE CANYON ON THE NORTH FORK
AMERICAN RIVER

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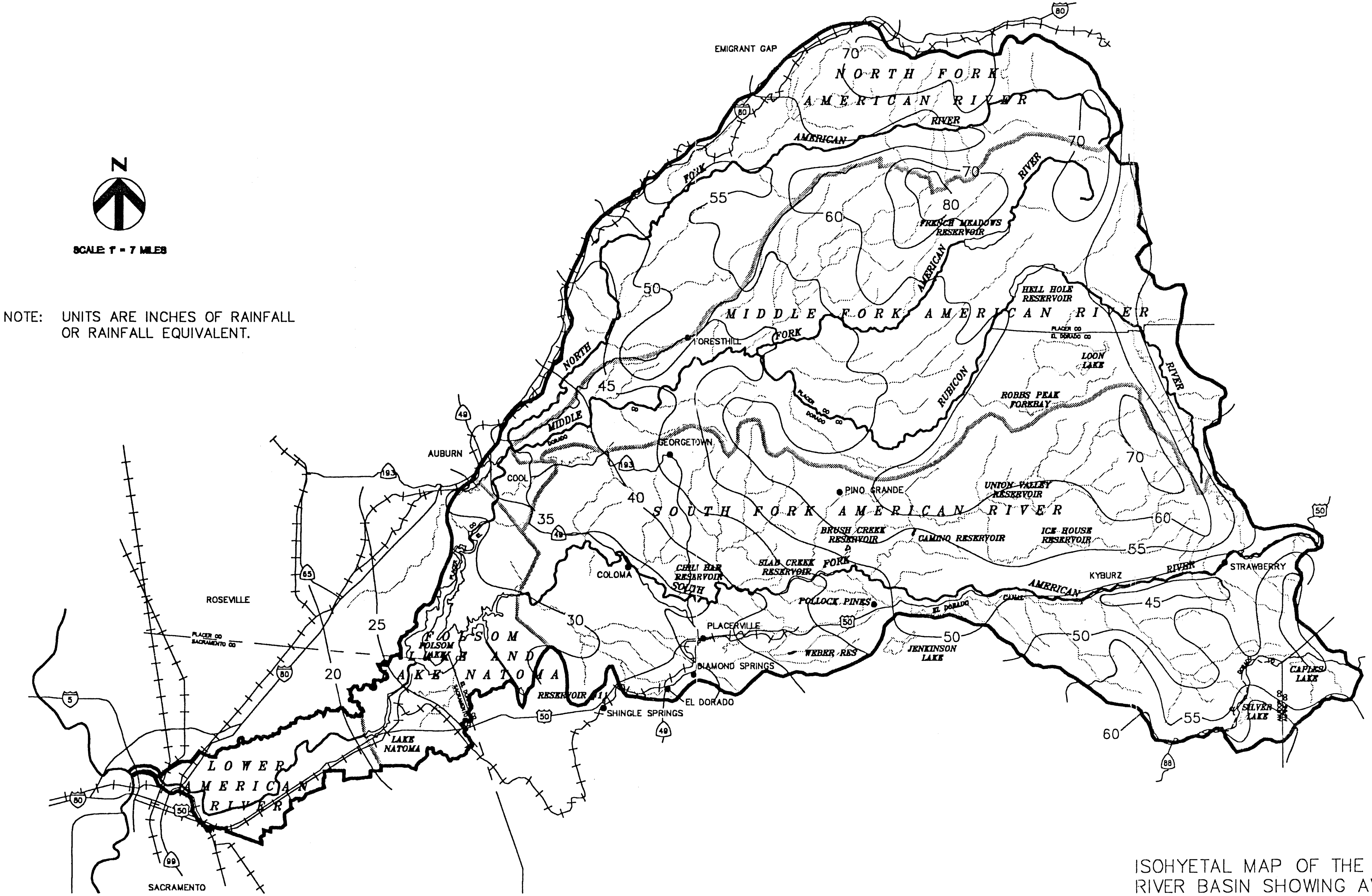
Figure II-2



ISOHYETAL MAP OF THE AMERICAN RIVER BASIN SHOWING AVERAGE DISTRIBUTION OF ANNUAL PRECIPITATION

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Figure III-3

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130,000 cfs, an unprecedented record high flow. This single event caused the U.S. Army Corps of Engineers to revise its estimate of the 100-year flood flows and corresponding extent of flood plain and height of flood peak. The 1986 flood, which tested the limits of the existing flood control system, is now estimated to have a probability of recurrence of about once every 63 years.

Major Features

Since the beginning of the California gold rush in 1849, numerous dams, canals, pipeline, penstocks, and levees have been constructed on the American River. These structures have significantly altered the natural flow regime. At present, there are 13 major reservoirs in the watershed with a maximum combined storage capacity of 1.75 million ac-ft (MAF). Folsom Reservoir with Lake Natoma is the largest with a combined capacity of 975,000[1] ac-ft. Together they control diversions into the Folsom-South Canal and releases to the lower American River. The operations of the upstream reservoirs, also affect flows throughout the American River system by releasing stored spring runoff to generate hydro-electric power and, to a more limited degree, supply the domestic industrial and agricultural needs of foothill and mountain county communities.

Additional facilities proposed for the American River watershed include the 2.3 MAF multipurpose Auburn Dam which the State is now reconsidering. Several more modest project proposals are being evaluated on the South Fork American River and its tributaries. Sacramento Municipal Utility District (SMUD), and El Dorado County Water Agency (EDCWA) are proposing new diversion, storage and pumped storage facilities on the South Fork and Silver Creek. El Dorado Irrigation District (EID) and EDCWA are proposing a new diversion from the South Fork at White Rock Penstock along with additional storage developments on Alder and Weber Creeks.

1 Recently reduced by 43,000 acre feet by the U.S. Army Corps of Engineers sedimentation estimates.

Water Quality

Logging, mining, and recreation are the primary activities with potential to cause surface water quality impacts in the upper watershed. Agricultural and urban development are responsible for most water quality effects in the lower watershed. Nearly 50 percent of the basin downstream from Folsom Reservoir is classified as urban, and 31 percent is classified as agricultural. Nearly 80 percent of the population of the American River basin resides in this lower basin area (QUAD Consultants, 1990).

Historical surface water quality data for the North, Middle, and South Forks of the American River above Folsom Reservoir are limited. The U.S. Geological Survey (USGS) has identified 168 intermittent sampling stations. The USGS currently measures discharge at sites on all three river forks and collects water samples on the South Fork near Lotus. The U.S. Bureau of Reclamation (USBR) collects water samples on the North Fork and Middle Fork, while the State Department of Water Resources (DWR) maintains a sampling site on the South Fork of the American River. Water quality is described and discussed in the water quality section.

Special Hydrologic Aspects of Mountainous Regions

In mountainous regions, slope aspect (slope direction and angle), is an important determinant of microclimates, evapotranspiration and hydrology. The mountains and canyons of the American River Watershed are steep-walled topographic elements with various slope aspects that modify climatic and hydrologic variables by controlling the intensity and duration of exposure to the sun and by producing large changes in elevation over short distances. South facing slopes receive the highest rates of solar insolation[2] during summer months and a much greater amount than north-facing slopes during the winter months. Western slopes receive their peak insolation during warm afternoons so they are subjected to higher rates of desiccation than the cooler eastern slopes.

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[2]At the latitude and altitude of the American River, solar insolation is considered extreme.

Each of the slope aspects receives approximately the same quantity of precipitation, but insolation creates a longer growing season and higher ground temperatures on the south and west facing slopes. However, evapotranspiration of soil moisture occurs early on the south and west slopes and continues throughout most of the year, inhibiting soil and vegetative development and variety. On the north- and east-facing slopes, insolation and temperatures are lower, limiting the growing season, but enhancing soil development.

As much as 99 percent of the annual precipitation falls on the American River watershed between October and April. Early season precipitation replenishes soil moisture depleted by solar insolation and evapotranspiration during the previous summer growth season. During later and longer winter storms, surface flow is initiated over areas of rock, shallow soils, and low permeability soils. Runoff from these areas usually augments base stream-flows by early winter.

Low fall soil moisture levels combined with a general lack of extreme low temperatures prior to the accumulation of the snowpack, tend to minimize the extent and depth of ground freezing in this watershed. Rain and snow melt-water can enter unfrozen soil more rapidly than frozen soil, so soil infiltration is normally satisfactory to meet soil moisture vegetation requirements and recharge shallow groundwater. When temperatures become low enough, above 4,500 feet to 5,000 feet, significant quantities of snow accumulate to depths sometimes exceeding 15 feet on the highest basins and drainage divides. Stream-flows are maintained by low elevation snowmelt and surface runoff, drainage of soil moisture near stream channels, and discharge of groundwater from fractured or porous bedrock.

Most of the air masses that approach the Sierra are maritime. Their relative warmth and high moisture content create snowfall that is high in water content. Diurnal winter temperatures often oscillate around the freezing point causing the snowpack surface to alternately freeze and thaw. These factors combine to produce a mature snowpack that is very dense and wet.

If rain or periodic snowmelt are prolonged, soils at lower elevations approach saturation and excess soil moisture drains downslope into the river and tributary streams. Soils at the higher elevations absorb moisture more slowly and only when the snowpack periodically melts. The high elevation snow pack is subject to melting only during periods of high solar insolation or rainfall induced by the occasional passage of western or subtropical Pacific storms which produce a high snow level. These events tend to melt snow at and immediately below the snow surface. As the melt water percolates deeper into the snowpack, the water content and density of the pack increases.

The timing and hydrologic significance of the spring snowmelt depends largely on the position and extent of the snowpack with respect to the watercourses, its internal structure, and the condition of the underlying soil and vegetative cover. Surface melting can occur sporadically through the season depending on temperatures, rainfall and solar insolation and can cause ice layers and lenses to develop as colder temperatures are encountered deep within the pack. During subsequent snowpack melting, the melt-water percolates downward through the porous snow unless it encounters ice layers. If it does, it is diverted laterally until it reaches porous snow, unfrozen soil, or a watercourse. The internal structure of the snowpack, and the presence or absence of ice layers in particular, strongly influence the residence time of melt-water in the snowpack and its travel time to watercourses. Thus, ice layers may prevent some of the snowmelt from reaching the soil or bedrock and may accelerate flow into streams. Other factors such as the various shade patterns, snow interception, and dripline characteristics of forest trees, also help determine the melt characteristics of the snowpack.

While storms become less frequent in the spring, snowpack density increases as the pack melts and stream-flow continues to increase from the increasing rate of snowmelt. As the snowpack continues to melt, more water is released per unit of snowpack depth, thus significantly increasing stream-flow in late spring. Also, warm, late season storms can melt large amounts of snow as a result of heat transfer from rainfall and moisture condensation at the snow surface. This can produce large spring stream-flows and high flood potentials adjacent to the downstream river channels. Snowmelt also reaches all soil surfaces, percolating downward where and when they are unfrozen. As the soil moisture increases and the soils become continuously wetted, the water begins to move downslope through the soil. If the soil surface is frozen, the downslope flow occurs without replenishing soil moisture capacity, resulting in more rapid runoff until the soil also melts.

Precipitation during the summer months, usually from thunderstorms, contributes only about 1 to 5 percent of the annual total. As soil moisture is used up by evapotranspiration by vegetation and by drainage to surface flow by gravity, this summer precipitation partially replenishes soil moisture. Some surface flow results in those areas with extensive bedrock outcrops such as glaciated areas and steeper canyon slopes. Excessive moisture also percolates into underlying weathered, fractured or permeable geologic formations. Fractured Paleozoic metamorphic rocks, permeable andesite mudflow materials and ancient morainal deposits provide important deep storage reservoirs for this groundwater, which slowly refills the storage capacity of the formations, replacing that which was discharged during the preceding dry season.

The various rock types have different characteristics of groundwater absorption, retention and discharge. Variably permeable andesite formations absorb downward, percolating groundwater until a less permeable layer such as the rhyolite ash unit intercepts it. The groundwater then pools and moves laterally until it reaches the surface on another formation. Seeps, springs and areas of wetland vegetation may occur on slopes near the tops of exposures of these less permeable units as the water moves laterally and is discharged to surface pools or watercourses. Waters percolating into the weathered zone of older metamorphic rocks may be stored and then slowly drain downslope within the fractured weathering zone, discharging water at the bases of slopes or into other formations.

Moisture percolating through the soil to the surface of granitic rocks moves downslope along the rock surfaces and drains into the joints, replacing water that drained from the formation during the preceding dry season. Seasonal springs and seeps often develop along the lower margins of soil-covered granite rock slopes, although the flow is usually restricted to the wet season and shortly afterward. Glacial deposits are important aquifers due to their abundance, thickness, distribution (near stream courses) and high capacity. Not only do they infiltrate rainfall and snowmelt rapidly, but they also absorb and store surface flows that they intersect.

The snowmelt and rainfall that has infiltrated into the soil mantle during the winter and spring largely comprises the soil moisture supply and groundwater replenishment for the year. The soil moisture slowly moves downslope through the soil mantle, supplying the vegetation with moisture to satisfy evapotranspiration requirements. Soils on the upper slopes usually drain earlier in the season, while the soils on lower slopes receive this moving water for a longer period, enabling more vegetative growth and reproduction.

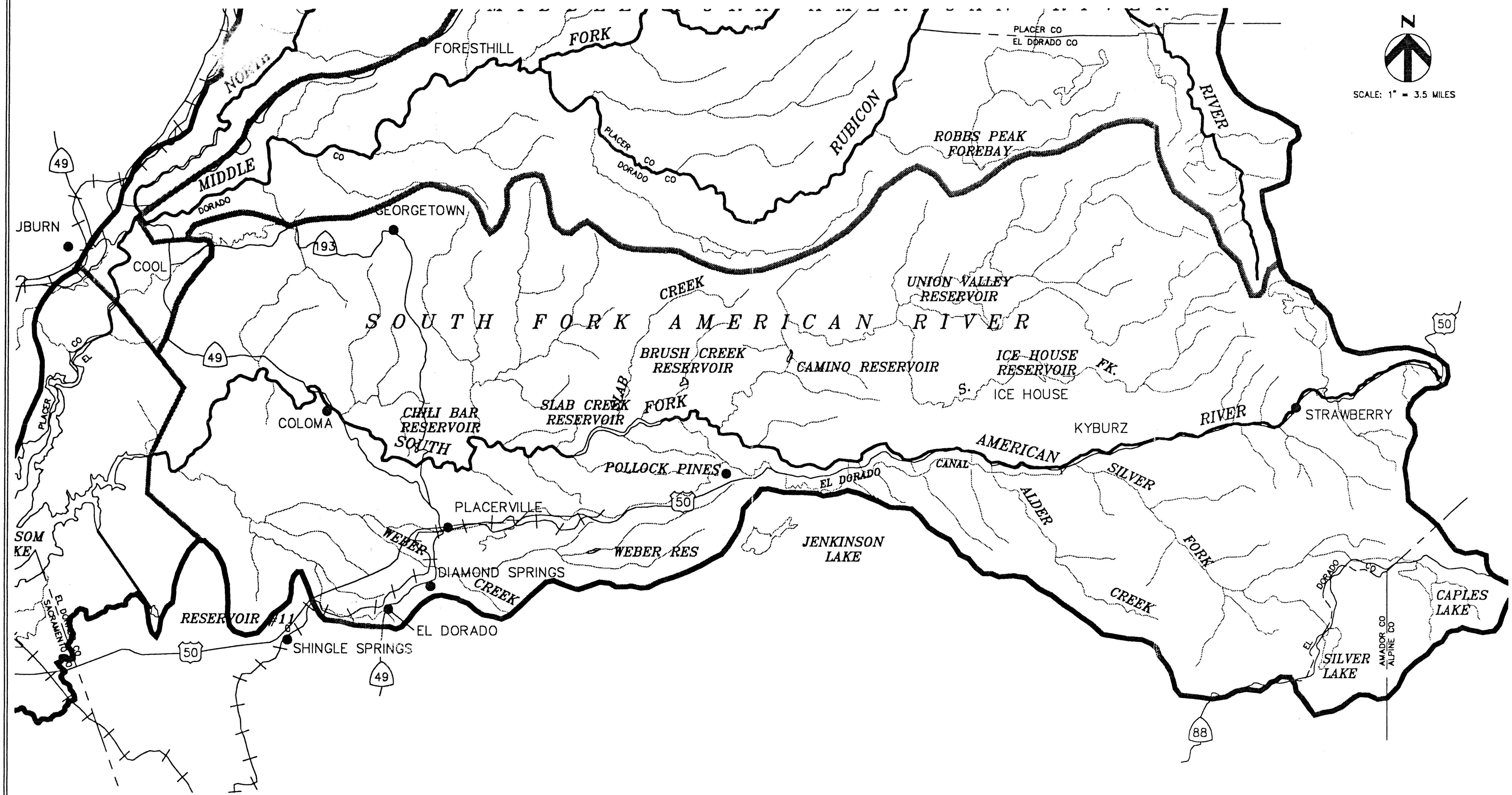
Meadows can accumulate moisture from direct snowpack melt, infiltration from snowmelt and rainfall runoff from upslope, and from downslope water movement within the soil mantle. Meadows represent important water storage areas in the drainage basin which slowly release water to surface streams. In many places in the basin, dry stream channels can be observed upstream from meadows, with stream flows emerging below the meadows. During the low-flow periods, these meadows are an important supplemental source of surface flows.

SOUTH FORK AMERICAN RIVER SUB-BASIN

Geography

Location--

The South Fork American River subbasin is located east of Sacramento and west of Lake Tahoe. Its position in relation to the neighboring sub-basins was shown in Figure III-1 and Figure III-4 is a detailed map of the subbasin. U.S. Highway 50 passes through the basin, paralleling the South Fork through much of the 55 mile length of the watershed. It lies almost wholly within El Dorado County except for the highest corner, in Alpine County. The largest towns include Placerville, Coloma and Pollock Pines. Geographic characteristics tend to be different above Chile Bar Dam, Elevation 1,000 feet, as compared to below it. As a result, most of the descriptions are organized as either above, or below, this boundary.



SOUTH FORK SUB-BASIN OF
THE AMERICAN RIVER WATERSHED

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Figure III-4

Watershed Area--

The South Fork of the American River watershed constitutes approximately 828 square miles which converts to 530,000 acres of the 1,900 square mile watershed of the American River. Its major tributaries include the Silver Fork, Alder Creek, Silver Creek, Slab Creek, and Weber Creek (Figure III-4). Minor tributaries include Plum Creek and Rock Creek.

Topography

The watershed ranges in elevation from less than 500 feet near Folsom Reservoir to approximately 10,300 feet at Round Top Mountain. The highest headwaters rise at two heavily glaciated locations. Silver Fork drains the Carson Pass region and the north slope of Round top Mountain (elevation 10,380 ft). Pyramid Creek drains the southern part of Desolation Valley and the eastern slopes of Pyramid Peak (elevation 9,983 ft). Both streams descend fairly rapidly through glaciated granite valleys into the main valley of the South Fork where they are joined by the other tributaries. The river continues to drop fairly rapidly through the canyon, interrupted only by the numerous diversions, reservoirs, and hydropower facilities that are described in detail later.

West of Chile Bar Dam, the last controlled release before Folsom Lake, the river descends through the lower and middle foothills of the western part of El Dorado County. These foothills are rolling to steep, with few conspicuous peaks. Steepness of slope is related to the underlying geologic formation. Areas underlain by metamorphic rock are, in general, steep and angular, whereas slopes in granitic areas tend to be rounded and smooth. Flat-topped ridges and smooth slopes are most prevalent in the areas underlain by volcanic material.

The mean elevation of the South Fork American River is approximately 4,400 feet, and the average stream gradient is about 120 feet per mile (FERC, 1981).

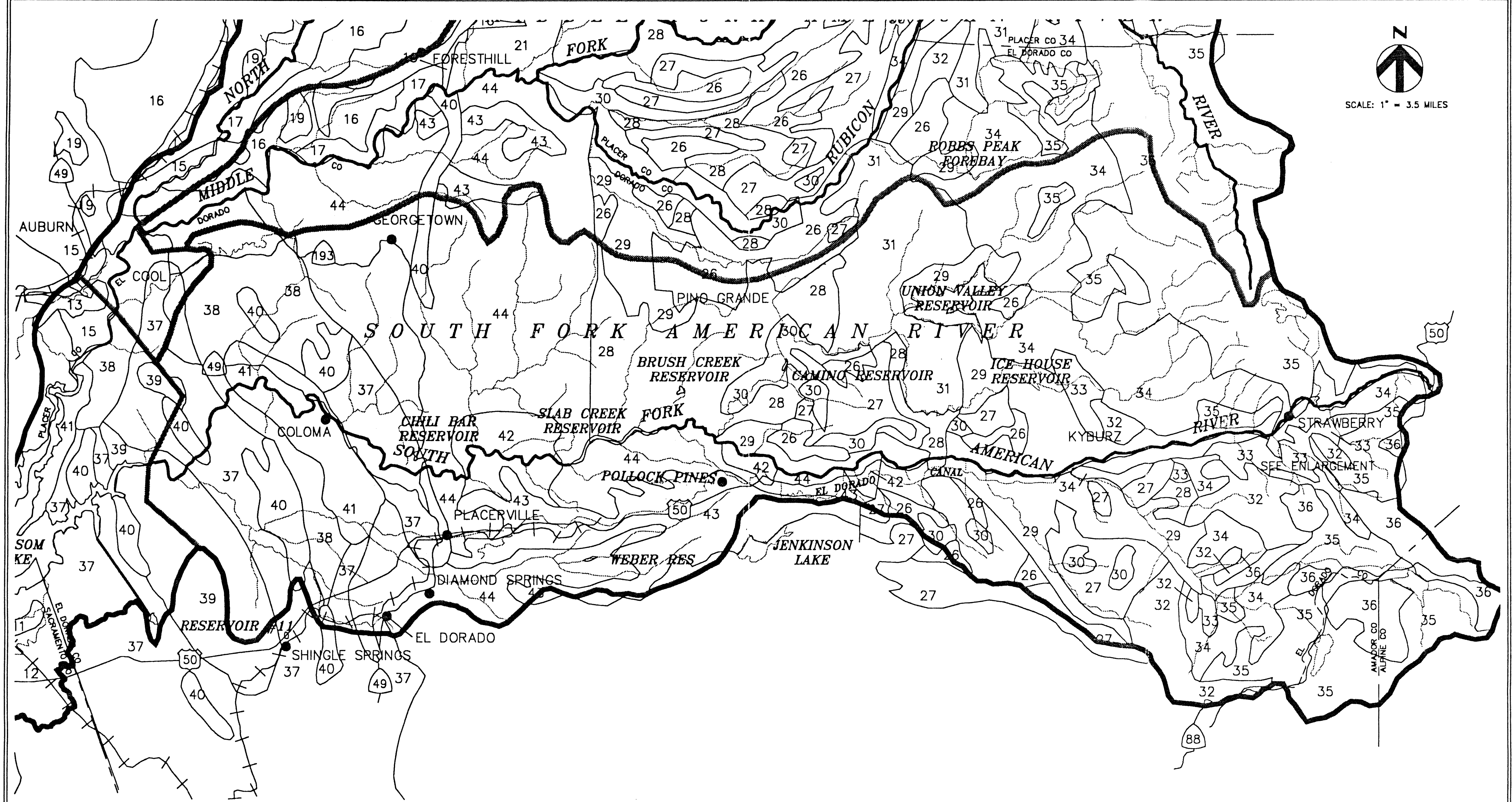
Geology

The eastern part of the South Fork watershed, from the crest of the Sierra to about 5 to 10 miles west of Kyburz, is underlain by the Sierra Nevada Batholith: granitic rocks chiefly of Mesozoic age. From this area westward to about 10 miles east of Chili Bar the principal formations are Paleozoic sedimentary and volcanic rocks, which in some cases are extremely metamorphosed. From here westward to Chili Bar, the underlying rocks are Mesozoic sedimentary and volcanic rocks, older than those of the Sierra Nevada, and strongly metamorphosed in places. The famed Mother Lode passes through the heart of this region. From Chili Bar westward, the watershed is underlain by three principal kinds of geologic materials: Mesozoic sedimentary and volcanic rocks older than the Sierra Nevada and strongly metamorphosed in places, and two types of intrusive igneous rocks: granitic rocks of chiefly Mesozoic age, and ultramafic rocks, high in iron and magnesium, which are also mainly of Mesozoic age.

Between Chili Bar and Coloma, the river's course is through the metamorphosed sedimentary and volcanic rocks. From Coloma to just west of Clark Mountain its course is mainly through the granitic rocks of Mesozoic age. West of Clark Mountain the river again enters the formation of metamorphosed Mesozoic sedimentary and volcanic rocks. The river then transects a small body of Mesozoic granites and finally flows through an area of Mesozoic ultramafic rocks before entering Folsom Lake. Throughout the lower watershed (west of Chili Bar) there are small inclusions of other rocks including Mesozoic ultrabasic intrusives and Jurassic sediments of marine origin.

Soils and Soil-Plant Associations

The upper reaches of the South Fork drainage basin are typical of the high Sierra Nevada, with only a thin mantle of soil, extensive areas of barren rock, and sparse vegetation. The intermediate elevations are characterized by deeper soils on the ridges covered by dense stands of pine, fir and cedar; and canyons that are steep, with highly erosive soils covered by oak, brush,and grasslands. Agricultural and residential development have been primarily restricted to the lower portion of the mid-elevation zone and the foothill areas. Soils and soil-plant associations are discussed in the following order: the Foothill Zone, the Upland



SOIL TYPES OF THE SOUTH FORK SUB-BASIN

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Figure III-5

Agricultural Zone, and the Forest/Recreational Zone. Figure III-5 is a generalized soil map of the South Fork Sub-basin.

In the Foothill Zone (west of Chile Bar Dam) soils are derived primarily from the weathering of slates, schists, serpentines and of metabasic, basic and acid igneous rocks. (Soil Conservation Service, 1974.) They are characteristically young or immature and shallow to moderate in depth. Factors limiting the uses of soils of the lower watershed include steep slopes, shallow soil depths, coarse fragments in the soil profile, low water-holding capacity and large areas of rocky outcrops.

Principal uses of the soils include range forage production for domestic livestock, watershed yield, and wildlife habitat production. Where water is available there is a significant agricultural industry which produces deciduous tree fruits and irrigated pasture. During recent years there has been a considerable amount of growth, especially urban development.

Five distinctive soil associations (U.S.D.A., 1974, and EDAW, Inc., 1979) of the Foothill Zone are described below, along with their characteristic vegetation and land capabilities:

Auburn-Argonaut Association--Well-drained silt loams and gravelly loams formed in material weathered from basic rocks (primarily diabase) and metasedimentary rocks (primarily andesite). They occur mostly at elevations of 500 to 1,800 feet, on generally undulating to hilly terrain, except adjacent to major streams, where terrain is steep to very steep. Rock outcrops are common. Vegetation is mostly grassland and oak woodland, with some areas of chaparral and Digger pine woodland. Principal uses of these soils are for range, watershed, and wildlife habitat. Secondary uses include woodland, pasture, hay, grain, and orchards.

Boomer-Auburn Association--Well-drained silt loam and gravelly loam soils formed in material weathered from basic igneous rocks or metasediments, diabase, slates and schists. Soils of this association are found on undulating to hilly terrain, which becomes steep to very steep adjacent to major streams. Slopes range between 2 and 70 percent, with numerous rock outcrops. They occur mainly at elevations between 1,000 and 2,000 feet. Vegetation consists primarily of grassland, oak woodland, and conifers. These soils are used mainly for range, water supply, wildlife habitat and some commercial timber production. Limited areas are used for pasture, hay, grain, and orchards.

Rescue Association--Well-drained sandy loam soils formed in parent materials weathered from basic rocks, primarily gabbrodiorite. The association occurs in small areas of the western part of the Lower Watershed, at elevations between 1,000 and 2,000 feet. Topography is mostly undulating to steep. Vegetative cover is principally chamise chaparral, with scattered areas of pine, oak woodland, and grassland. Chief uses of these soils are grazing, watershed, and wildlife habitat. There is some use for hay, grain, and pasture.

Serpentine Rock Land-Delpiedra Association--Somewhat excessively to excessively drained rock land and loams formed in material weathered from ultrabasic rocks, primarily serpentine. This association is scattered along the American River and some of its tributaries. Elevations range from 500 to 1,800 feet. Topography is undulating to very steep. Rock outcrops are frequent. Vegetation is chamise chaparral, grassland, and scattered areas of Digger pine. Serpentine rock land is used mainly for watershed, wildlife habitat, and as a source of rock for surfacing roads. There is some mining for chrome. Delpiedra soils produce some forage for domestic livestock.

Auberry-Ahwahnee-Sierra Association--Well-drained coarse sandy loams and sandy loams developed in parent materials from granitic rocks. In general, the terrain covered by these soils is gently rolling to hilly, but along major streams may be steep. The surface is broken by numerous rock outcrops. Vegetation is grassland and oak woodland, with occasional areas of coniferous timber. Elevation varies between 500 and 2,500 feet. Principal uses are range forage production, watershed, and wildlife habitat. Some areas have been planted to tree fruits and nuts, and to pasture. Forested areas produce commercial timber.

In addition to the soil associations described above, at least three "land types"[3] occur in the Foothill Zone. They are metamorphic rock lands, placer diggings and dredger tailings:

Metamorphic Rock Land--Occurs where bedrock consists of highly resistant schist and slate formations that break into major drainages or river canyons. Slopes are steep to very steep. Rock outcrops and stones occupy 50 to 90 percent of the surface area and there is only a thin mantle of soil materials elsewhere. Areas where this land type occurs are excessively drained; surface runoff is very rapid, but erosion hazard is slight to moderate. Principal uses of metamorphic rock land are for watershed and wildlife habitat. It has no farming value, but may have considerable potential for recreation. Extensive tracts of metamorphic rock land occur along the South Fork American between Chili Bar Dam and Dutch Creek.

Placer Diggings--Consist of stones, cobbles, and gravels, redeposited as symmetrical piles in active or inactive stream beds or stream deposits that have been placer-mined. If sufficient quantities of fine sand or silt are present some plant growth may be supported. Materials making up this land type were derived from rock mixtures and are commonly unstratified or poorly sorted. In some cases where slopes are steep, the material consists of fines from stamp mills or tailings from placer mining. Natural drainage varies and stream beds with placer diggings frequently are flooded. Vegetation is variable, consisting mainly of grasses, shrubs, oak, and a few conifers. Alder, willow, cottonwood, and bigleaf maple generally are found along streams. This land type has limited value for grazing, and is nearly marginal for wildlife habitat.

Tailings--Consists of cobbly and stony tailings from dredger mining, hydraulic mining, and hardrock mine dumps. All soil material has been either washed away in the case of hydraulic mining, or buried in the case of dredging or mine dumps. Surface runoff is slight, and erosion hazard is none to slight. This land type has no farming value, but does have some use for watershed and wildlife habitat. Both placer diggings and tailings occur alongside a

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[3]Land types are land forms with uniformly distinguishing characteristics, that have little or no natural soil, or that have soil that is not feasible to classify. They are named primarily in terms of land form and secondarily in terms of composition. (U.S. Dept. of Agr., 1951).

significant reach of the South Fork between Chili Bar Dam and Clark Creek.

The soils of the Upland Agricultural Zone were formed in residual parent materials weathered from slates and schists, metabasic rocks, volcanic conglomerate, and granitic rocks. Typically, they are young to immature, shallow to moderate in depth and have relatively coarse textures. Depths to bedrock range from 15 inches to more than 60 inches, with numerous rock outcrops. The six basic associations of the Upland Agricultural Zone are described below, along with their vegetation and land use capabilities:

Holland-Musick-Chaix Association--Well-drained coarse sandy loam soils formed from parent material weathered from granitic rocks. Soils of this association occur on gently rolling to hilly uplands. Relief generally is smooth and rounded, except adjacent to river canyons where steep to precipitous slopes are characteristic. Rock outcrops are common, especially on steeper slopes. The principal vegetation is coniferous forest with an intermixture of hardwoods. Elevations range from 1,800 to 5,000 feet. Soils of this association are useful mostly for commercial forests, water supply, and wildlife habitat. Some areas have been cleared for grazing and dryland walnuts. Where water is available for irrigation, some deciduous fruits and pasture have been planted.

Cohasset-Aiken-McCarthy Association--Well-drained cobbly loam and loam formed in material weathered from volcanic conglomerates. The soils cover broad, sloping surfaces and steep side slopes of tabular ridges, at elevations between 2,000 and 5,500 feet. Principal vegetation is coniferous forest with an admixture of hardwoods. The soils are used chiefly for commercial timber production, water supply, and wildlife habitat. Large acreages have been planted to deciduous fruits in the Camino-Pollock Pines area.

Mariposa-Josephine-Sites Association--Well-drained gravelly silt loams, silt loams, and loams formed in materials weathered from metasedimentary rocks. The association occurs on rolling to steep uplands that have sharp ridges, at elevations of 1,500 to more than 5,500 feet. Soils adjacent to major streams commonly are on very steep, rocky terrain and are quite variable within short distances, due to vertical uplifting of the parent rock, its mixed mineralogy, and varying degree of metamorphism. Primary uses of these soils are commercial timber, water supply, and wildlife habitat. Some areas have been cleared and planted to deciduous tree crops.

Chaix-Chawanakee-Shaver Association--Well-drained to somewhat excessively drained sandy loam and coarse sandy loam soils formed in materials weathered from granitic rock. The soils occur on topography that is rolling to very steep, on toes, side slopes, saddles and spur ridges of granitic mountain slopes. There are few rock outcrops. Elevations are between 2,000 and 5,500 feet. Vegetation consists mainly of mixed coniferous forest and brush (mountain chaparral). Soils of this association are used chiefly for woodland and watershed. Some Shaver soils have been planted to deciduous fruits and nuts.

Iron Mountain-McCarthy Association--Well-drained cobbly sandy loams and cobbly loams formed in materials weathered from andesitic bedrock. The soils are on gently sloping to moderately steep side slopes and spur ridges, and on steep to very steep volcanic uplands. Rock outcrops are numerous. Elevations are mostly from 2,000 to 6,000 feet. Vegetation is mixed coniferous forest with hardwoods on the deeper McCarthy soils. On the shallower Iron Mountain soils it is mountain chaparral, grasses, and hardwoods. Soils with this association are used mostly for woodland, watershed, and wildlife habitat.

Chaix-Chawanakee-Granitic Rock Land Association--Excessively-drained, barren, exposed granitic rock outcrops and coarse sandy loams formed in material weathered from granitic rocks. These soils occur on steep to very steep ridges and sideslopes of granitic mountains. Elevations are between 2,000 and 6,000 feet. Vegetation consists of open stands of mixed coniferous forest with an understory of mountain chaparral. Principal uses of the lands of this association are watershed and wildlife habitat.

Soils of the Forest Recreational Zone formed from granitic and andesitic parent materials under colder, wetter climatic conditions. Large rocky areas remain with poorly developed soils which, when formed, are limited in their use by the adverse climate. Two typical associations occur:

Cagwin-Toem-Granitic Rock Land Association--Somewhat excessively drained and excessively drained exposed barren granitic rock outcrops, and loamy and gravelly coarse sands formed in soil parent material weathered from granitic rock. The soils occur on gently rolling to very steep slopes at elevations of about 6,500 feet and higher. Vegetation consists of open to dense stands of coniferous forest, with an understory of mountain chaparral. These soils are used mostly for watershed, wildlife habitat, and commercial timber production.

Meiss-Waca Association--Well-drained and excessively drained cobbly coarse sandy loam and cobbly loam soils formed in parent material weathered from andesitic rocks. The association occurs on strongly sloping to steep slopes, in scattered patches, at elevations from about 6,500 feet upwards. Waca soils support dense to semi-dense stands of coniferous forest. Vegetation of Meiss soils consists of scattered stands of coniferous forest, Great Basin sagebrush, bushy herbs, and grasses. Soils of this association are used mostly for commercial timber, watershed, wildlife habitat, recreation, and limited grazing.

Limited areas of three "land types" also occur in both the Upland Agricultural and the Forest/Recreational Zones of the South Fork American River:

Glacial Lands--Well-drained to somewhat excessively drained bouldery and stony sandy loam formed in materials of mixed origin deposited by glaciers. Some moderately deep to deep soils occur in small scattered deposits on the crests of old moraines, outwash fans, and in depressions that formerly were glacial lakes. Slopes are nearly level to steep. Vegetation is principally sparse to dense coniferous forest with an understory of mountain chaparral. This land type is useful principally for commercial timber, recreation, and limited grazing.

Granitic Rock Lands--Somewhat excessively drained to excessively drained loamy coarse sand to sandy loam material of very shallow depth, occurring as an incomplete mantle in the crevices of granitic rock. Terrain is undulating to very steep. Rock outcrops and stones occupy 50 to 90 percent of the surface. Depths to weathered materials usually are less than 10 inches. Vegetation is open stands of mountain chaparral and scattered conifers. Granitic rock land is used mainly for watershed and wildlife habitat. Some portions may have considerable potential for recreation due to their aesthetic attractiveness.

Metasedimentary Rock Lands--Moderately well-drained gravelly to stony loam material which has weathered from and been deposited in the crevices of metasedimentary rocks. This land type occurs on undulating to very steep slopes at higher elevations. Rock outcrops and stones cover 50 to 90 percent of the surface. Vegetation consists of mountain chaparral, or scattered patches of coniferous forest. The land type is useful for watershed, wildlife habitat, and recreation. Some portions have a strong aesthetic appeal.

Vegetation

Vegetation conforms generally with the basinwide trends as modified by the soil plant associations described earlier. Vegetation in, and adjacent to the riparian zone warrants particular discussion due to its proximity to the water and the sensitivity of the river to changes within the canyon. The lower canyon, between Lotus and Salmon Falls, features grasslands, oak woodland, chaparral and bare rocky areas. The oak-riparian community is extremely diverse due to the high degree of variation among topographically induced microclimates. The dominant community on north facing slopes is blue oak while southern exposures support chamise and mixed chaparral. Other slopes are dominated by oak in various mixtures with riparian, digger, yellow pine and chaparral species. Alongside the Chile Bar to Lotus reach, grassland, chaparral and oak woodland still dominate, but montane forest with yellow pine is more abundant on the northern slopes due to the lower rates of evapotranspiration. Scrub oak, chamise and mixed chaparral species occur on the drier south-facing slopes. The riparian community is dominated by cottonwood, willows and alder.

From Chile Bar upstream, coniferous mountain forest becomes more dense and consistent on the south facing slopes, while dense hardwood mixtures dominated by oak occupy the north-facing slopes. The upper canyons are dominated by Ponderosa pine and other conifers mixed with riparian species. With higher elevations coniferous species composition shifts in turn to include sugar pine and white fir, red fir, and finally lodgepole and white pine.

Areas of the canyon from Riverton to below Kyburz and adjacent uplands recently burned in the Cleveland fire constitute a separate soil/vegetation classification, with profoundly different characteristics. The extent and effects of this and earlier fires will be discussed in the watershed activities section.

Climate

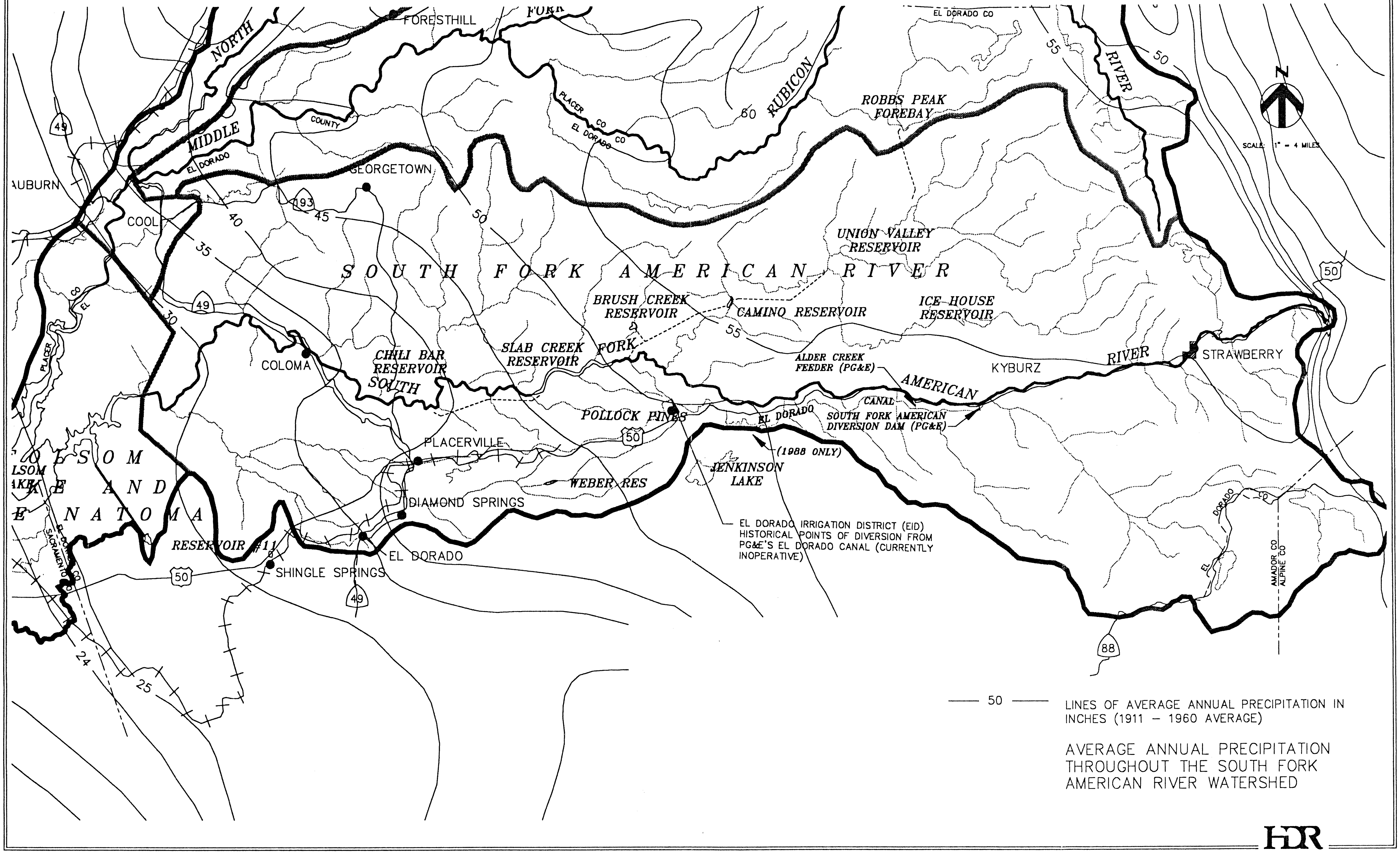
Temperatures--

Temperature ranges and means for this subbasin conform generally with those of the overall basin described earlier. Mean minima and maxima for three stations are listed below:

- Folsom Lake, July mean maximum, 94.4° F (elevation = 350 ft)
- Folsom Lake, January mean minimum, 39° F
- Placerville, July mean maximum, 95.1° F (elevation = 1,890 ft)
- Placerville, January mean minimum, 37° F
- Caples Lakes, July mean maximum, 71.4° F (elevation = 7,829 ft)
- Caples Lakes, January mean minimum, 15° F

Precipitation--

Like most Sierra Nevada watersheds, the South Fork American River experiences its heaviest precipitation from November through April. Figure III-2 in the basinwide description showed the average time-distribution of precipitation at Blue Canyon throughout the year. Annual precipitation in the South Fork watershed averages about 55 inches, varying from a low of 22 inches near Folsom Reservoir to highs of 65 to 70 inches at the higher elevations near the eastern boundary. Figure III-6 is an isohyetal map showing average annual precipitation in inches throughout the subbasin watershed. Figure III-7 is a precipitation-topographic profile showing the variation in October through April precipitation along a transect from southwest to northeast across the South Fork American River basin. In years of low rainfall, annual precipitation may be only two thirds to one half, or an even smaller fraction of the average amount.



— 50 — LINES OF AVERAGE ANNUAL PRECIPITATION IN INCHES (1911 – 1960 AVERAGE)

AVERAGE ANNUAL PRECIPITATION THROUGHOUT THE SOUTH FORK AMERICAN RIVER WATERSHED

HDR

FIGURE III–6

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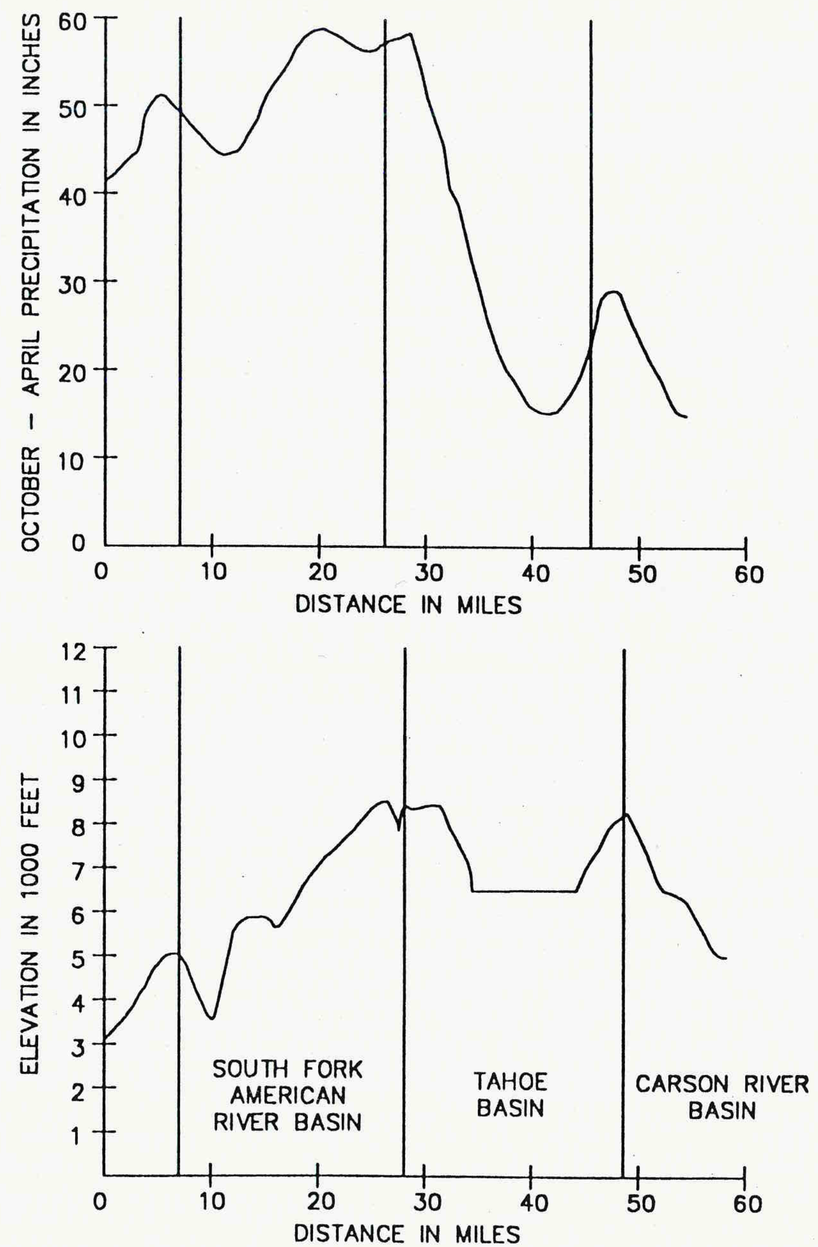

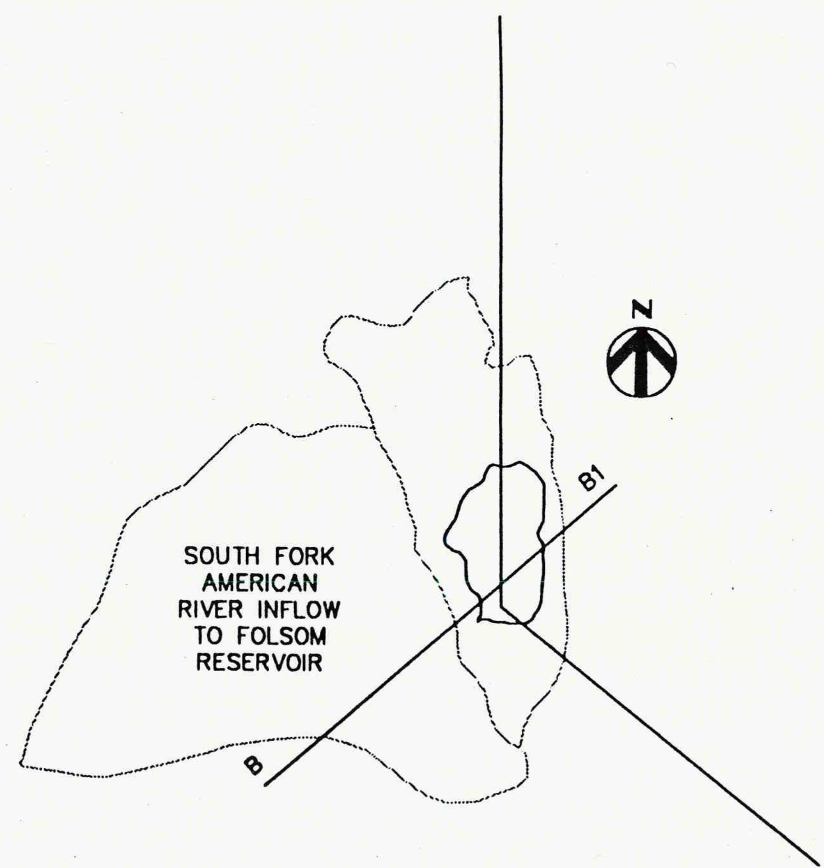

PRECIPITATION - TOPOGRAPHIC PROFILE B - B1
SOUTH FORK AMERICAN RIVER WATERSHED

SOURCE: EID SOFAR APPLICATION TO FERC

HDR

Figure III-7

Figure III-8 illustrates the variation in area with elevation for the South Fork American River above Salmon Falls, near its terminus at Folsom Reservoir. Also shown is an area elevation curve of the South Fork near Kyburz which typifies watersheds tributary to the South Fork. Note that approximately 43 percent of the South Fork above Salmon Falls lies above the 5,000 foot elevation while about 96 percent of the area above Kyburz lies above 5,000 feet.

As demonstrated by Figure III-9, the winter snowpack stores about 50 percent of the annual runoff of the South Fork for discharge as surface flow after the winter period of maximum precipitation has passed. The average April 1 snow line is below 5,000 feet, with snow covering about 50 percent of the watershed. Figure III-10 shows the average time-distribution of water accumulation in the snowpack along with similar data for a heavy season (1969) and a dry season (1977). The accumulation and melt of the winter snowpack is an extremely important factor in the time-distribution of runoff.

Hydrology

Runoff varies widely at different locations in the watershed. Figure III-11 shows average unit runoff calculations (expressed in ac-ft per square mile) at various locations within the watershed. This map also shows the percentage of the average annual runoff which occurs during the April-July snowmelt period.

The minimum annual "unimpaired"[4] runoff of the South Fork, of the American River near Kyburz was 62,320 ac-ft in water year 1977, while the maximum annual runoff during more recent years was 511,400 ac-ft (in water year 1969). These amounts represent 22 percent and 176 percent of the average annual flow at Kyburz (291,110 ac-ft). Figure III-12 illustrates the seasonal variation of runoff at Kyburz, expressed as a percentage of average annual runoff. Flow generated from the lower, drier portion of the watershed is even more

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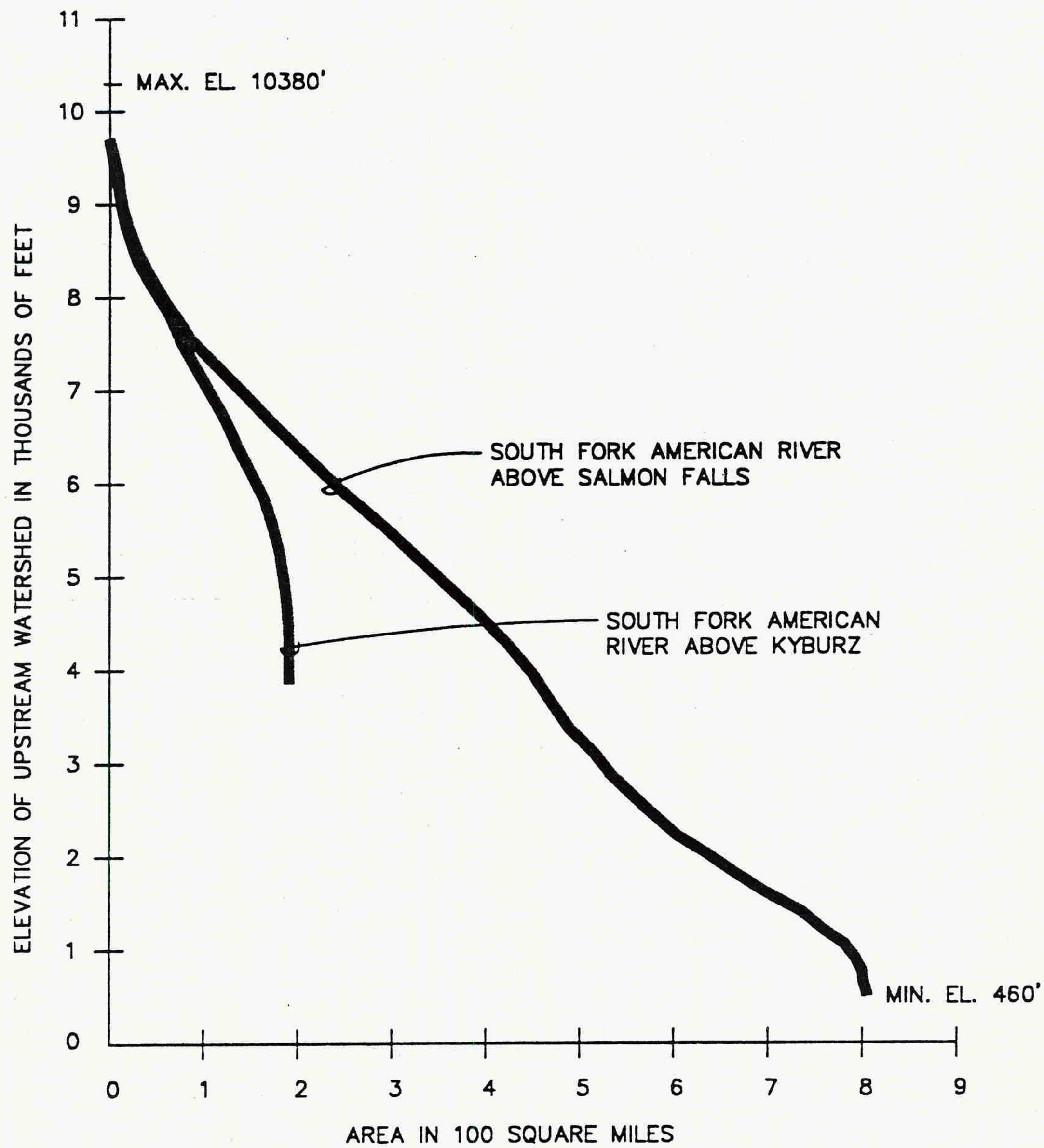
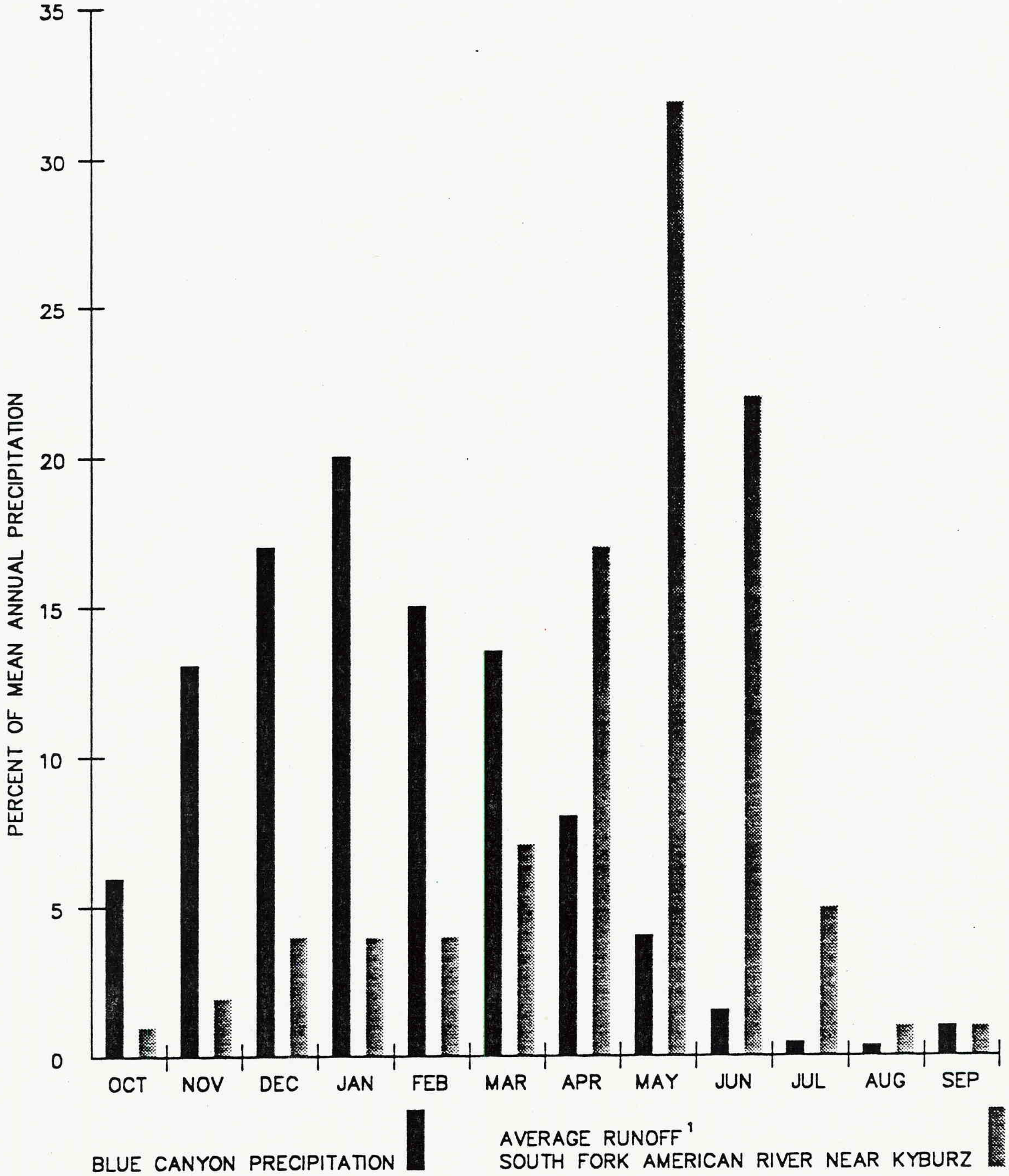
[4]Unimpaired runoff is the flow that would have been observed under natural conditions at the gaging station, had the flows not been impaired by import, storage, diversion, or other works of man.



AREA ELEVATION CURVES
SOUTH FORK AMERICAN RIVER

SOURCE: EID SOFAR APPL. TO FERC, ___________.

Figure III-8



[1] A REPRESENTATION OF FLOWS WITHOUT ARTIFICIAL IMPEDIMENTS SUCH AS DIVERSIONS, DAMS AND RESERVOIRS.

TIME DISTRIBUTION OF
AVERAGE PRECIPITATION AND AVERAGE RUNOFF
SOUTH FORK AMERICAN RIVER NEAR KYBURZ

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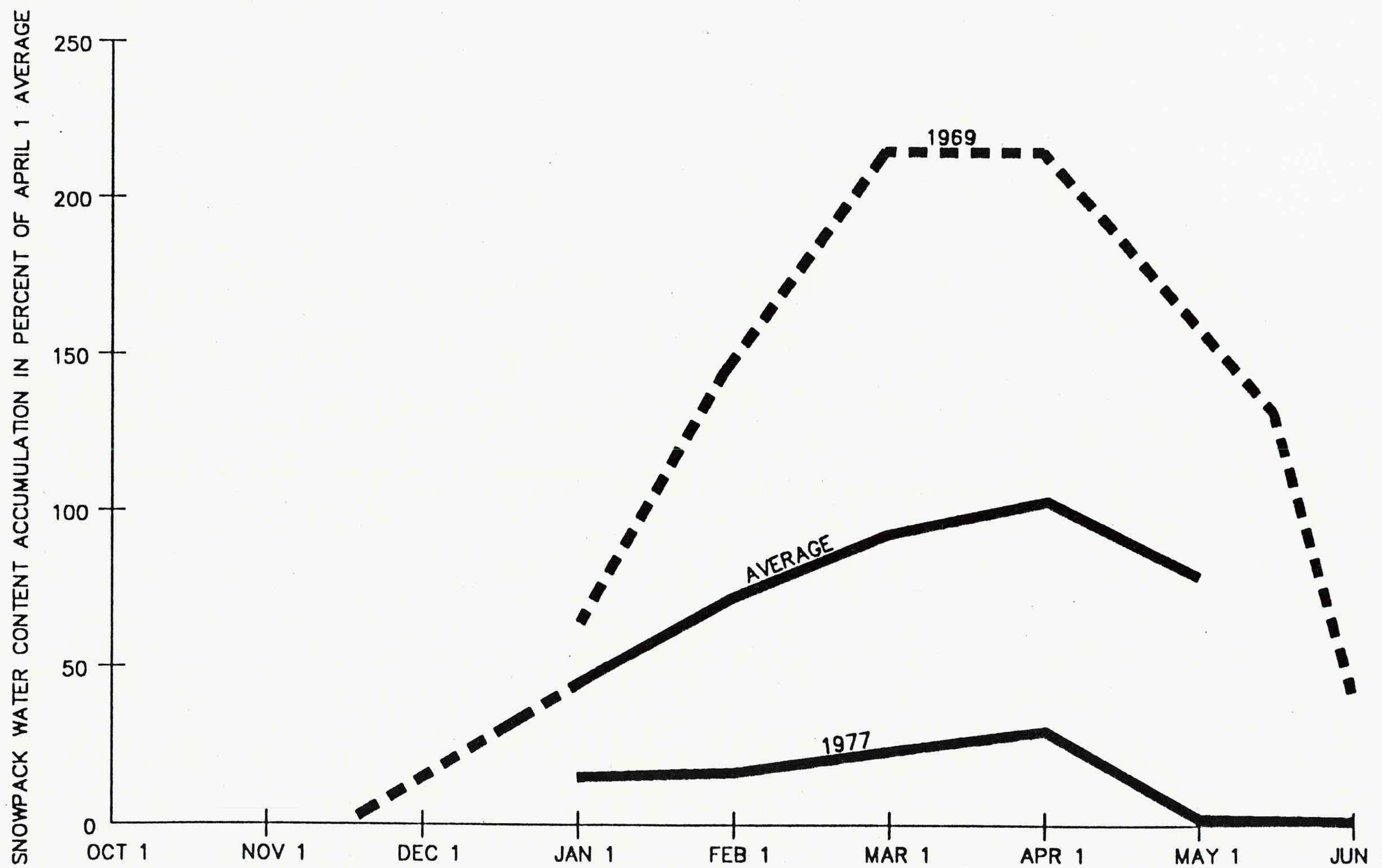
Figure III-9



TIME DISTRIBUTION OF
SNOWPACK WATER CONTENT ACCUMULATION
SOUTH FORK AMERICAN RIVER

HDR

Figure III-10

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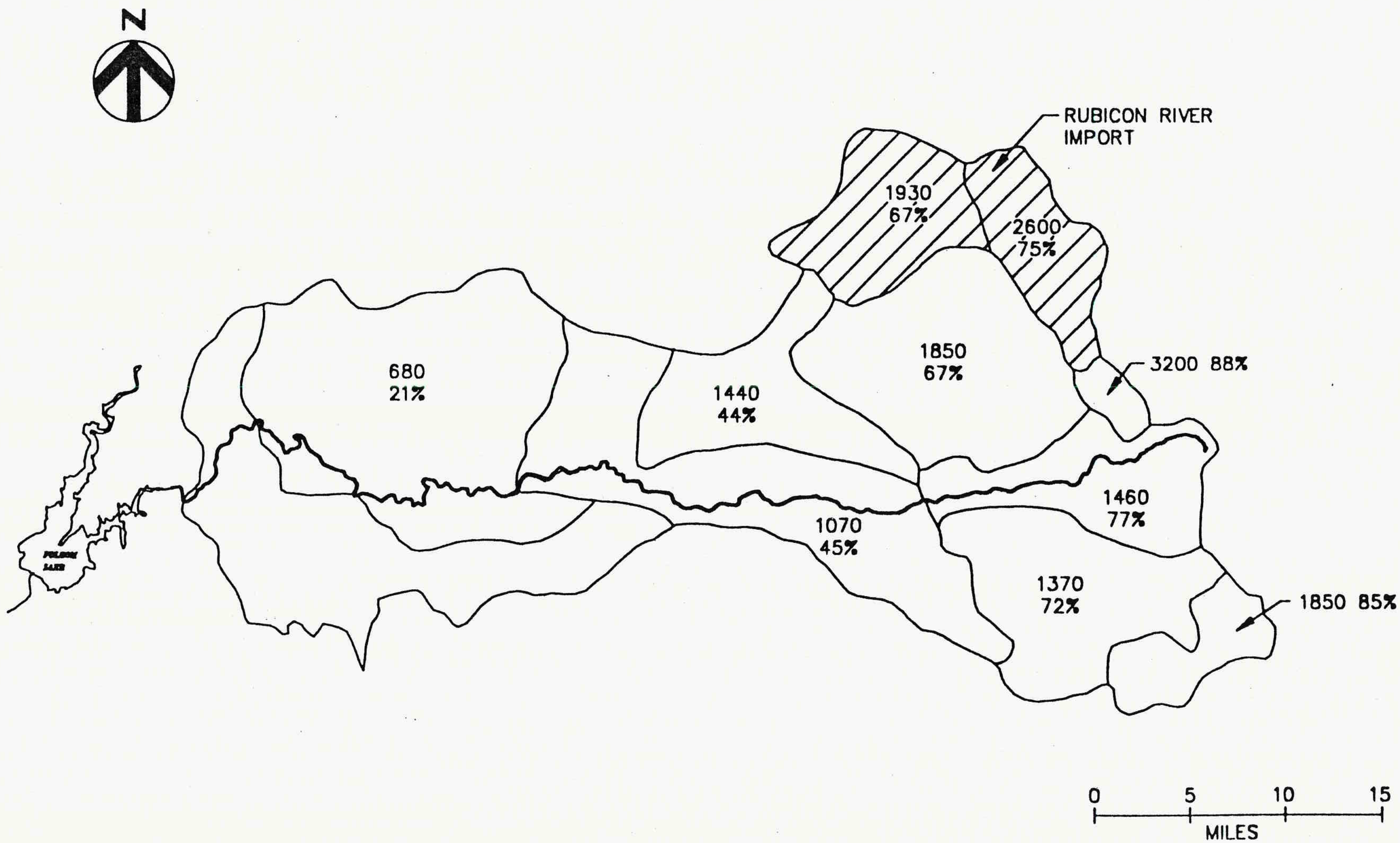
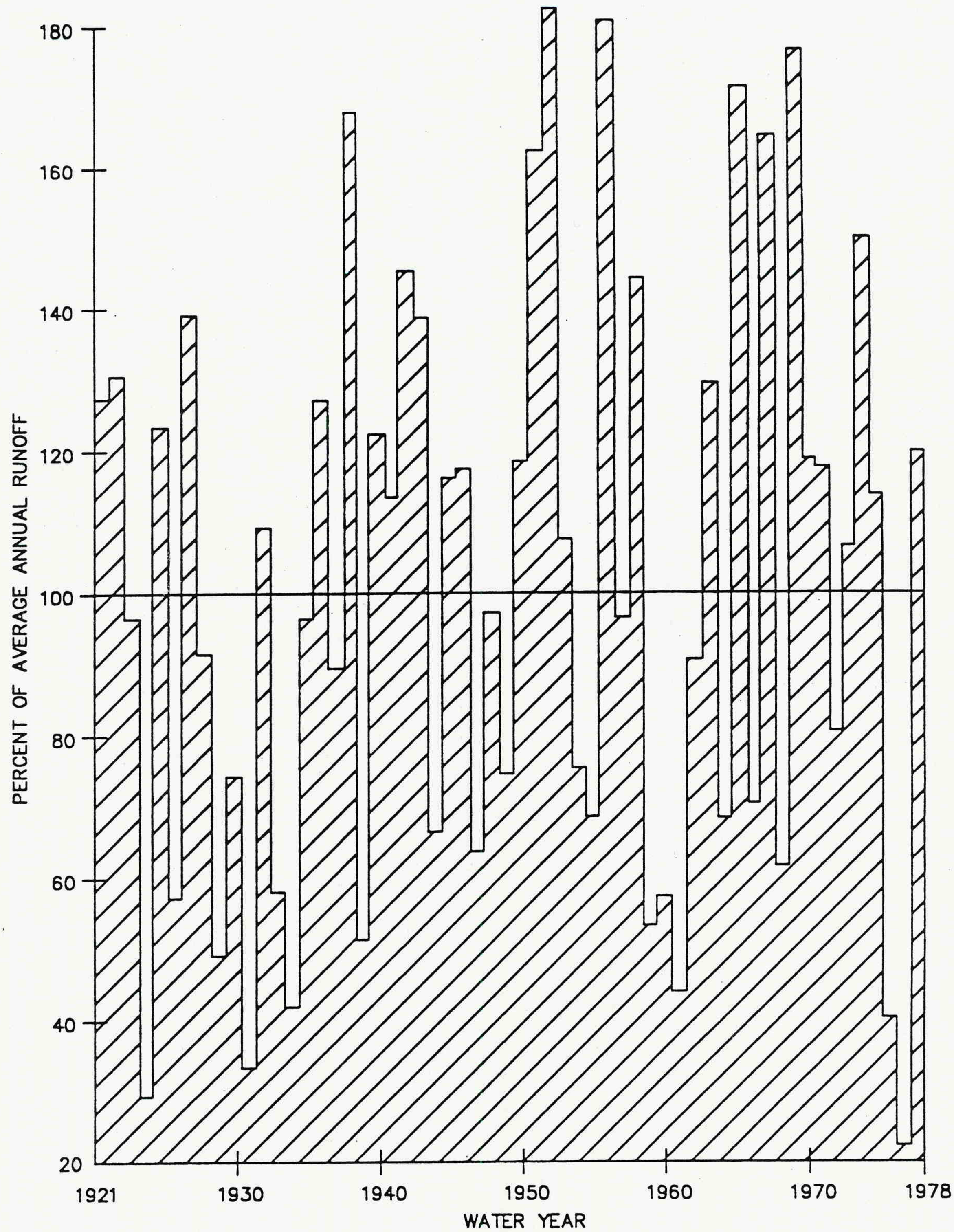


SOUTH FORK AMERICAN RIVER SUB-BASIN SHOWING AVERAGE WATER YEAR RUNOFF IN ACRE-FEET/SQUARE MILE AND PERCENT OF AVERAGE WATER YEAR RUNOFF OCCURRING DURING APRIL-JULY

HDR

Figure III-11



VARIATION IN ANNUAL RUNOFF BY WATER YEAR
FROM 1921 TO 1978
SOUTH FORK AMERICAN RIVER NEAR KYBURZ

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Figure III-12

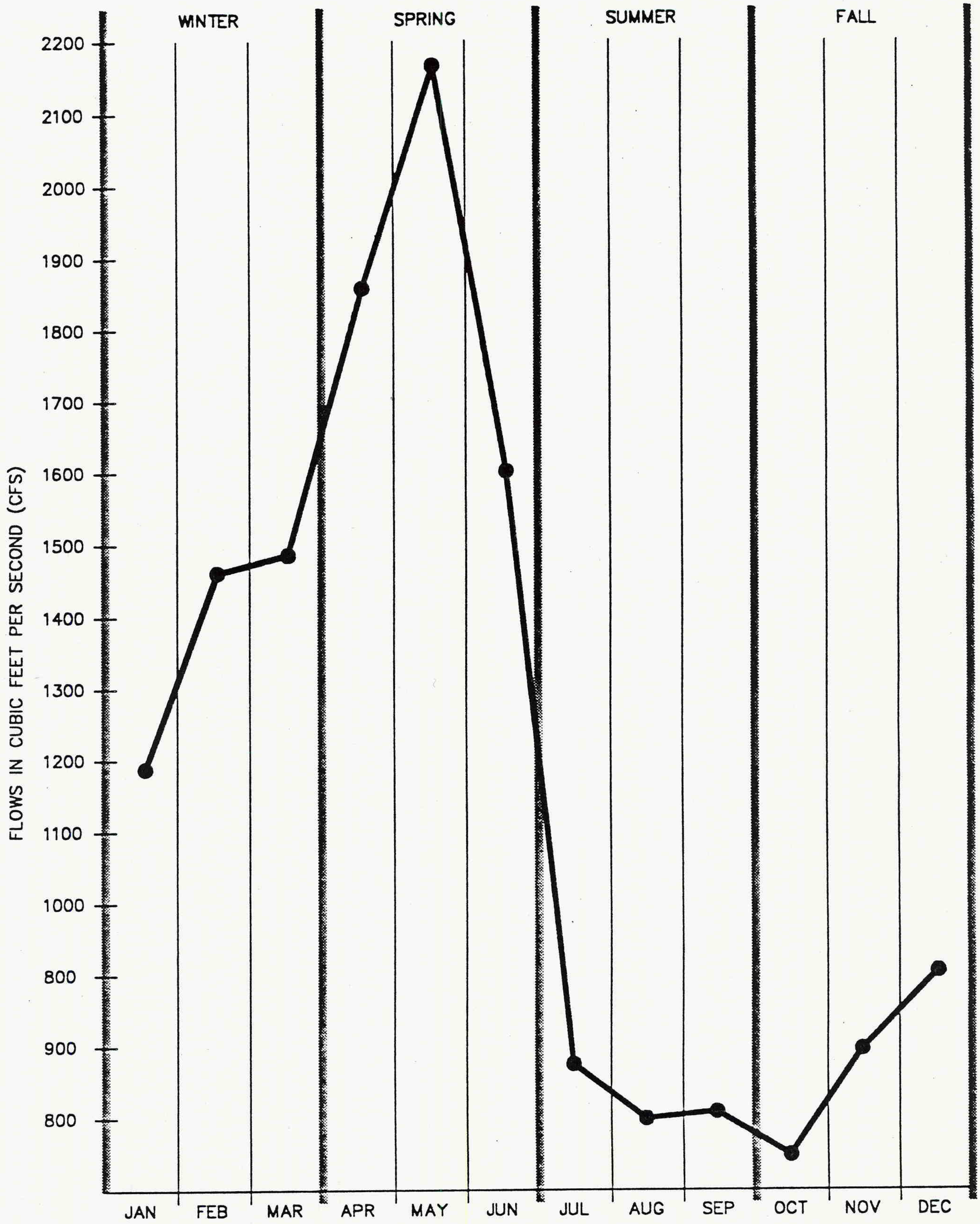
variable from season to season. Figure III-9 showed the monthly distribution of seasonal runoff compared to the monthly distribution of precipitation at Blue Canyon (which was selected because it is the closest station with continuous historical precipitation records).

The average historic monthly flows below Chili Bar powerhouse are plotted on Figure III-13. The dramatic differences between spring and summer flows are evident. Average flows reach a level of just over 2200 cfs in May and fall to a low of about 750 cfs in October.

Large diurnal variations in flow are also normal during operations of the Chili Bar Powerhouse. Figure III-14 shows two eight-day periods in 1981: April 12 to 20 and July 5 to 13. Note in both cases that daily maximums are approximately 1600 cfs except on weekends. Daily minimums are slightly higher in April. In general, peak flows are experienced from about 1300 to 2000 and minimums from 2300 to 0700. Narrower peaks are not uncommon in the full record, only 5 to 6 hours. Diurnal flow data are from uncorrected strip chart records from the U.S.G.S. Chili Bar Gaging Station.

Water Supply Systems

There are three major water systems in the South Fork American River watershed which substantially modify the magnitude and time-distribution of flows in the river and physically convey flows downslope. Two of them are power production systems. They are described along with the water supply system since they perform both physical storage (on which the water supplier depends) and conveyance of the water supplies. Pacific Gas and Electric Company (PG&E) operates a hydroelectric project with a small import from the Tahoe basin and regulates the bulk of the flows tributary to the upper portion of the drainage. El Dorado Irrigation District (EID) diverts flows from the PG&E system for consumptive use in its service area. Sacramento Municipal Utility District (SMUD) operates a major hydroelectric project on Silver Creek which joins the South Fork just upstream from Slab



AVERAGE MONTHLY FLOWS (CFS)
BELOW CHILI BAR POWERHOUSE

SOURCE: EID SOFAR FERC APPLICATION

HDR

Figure III-13

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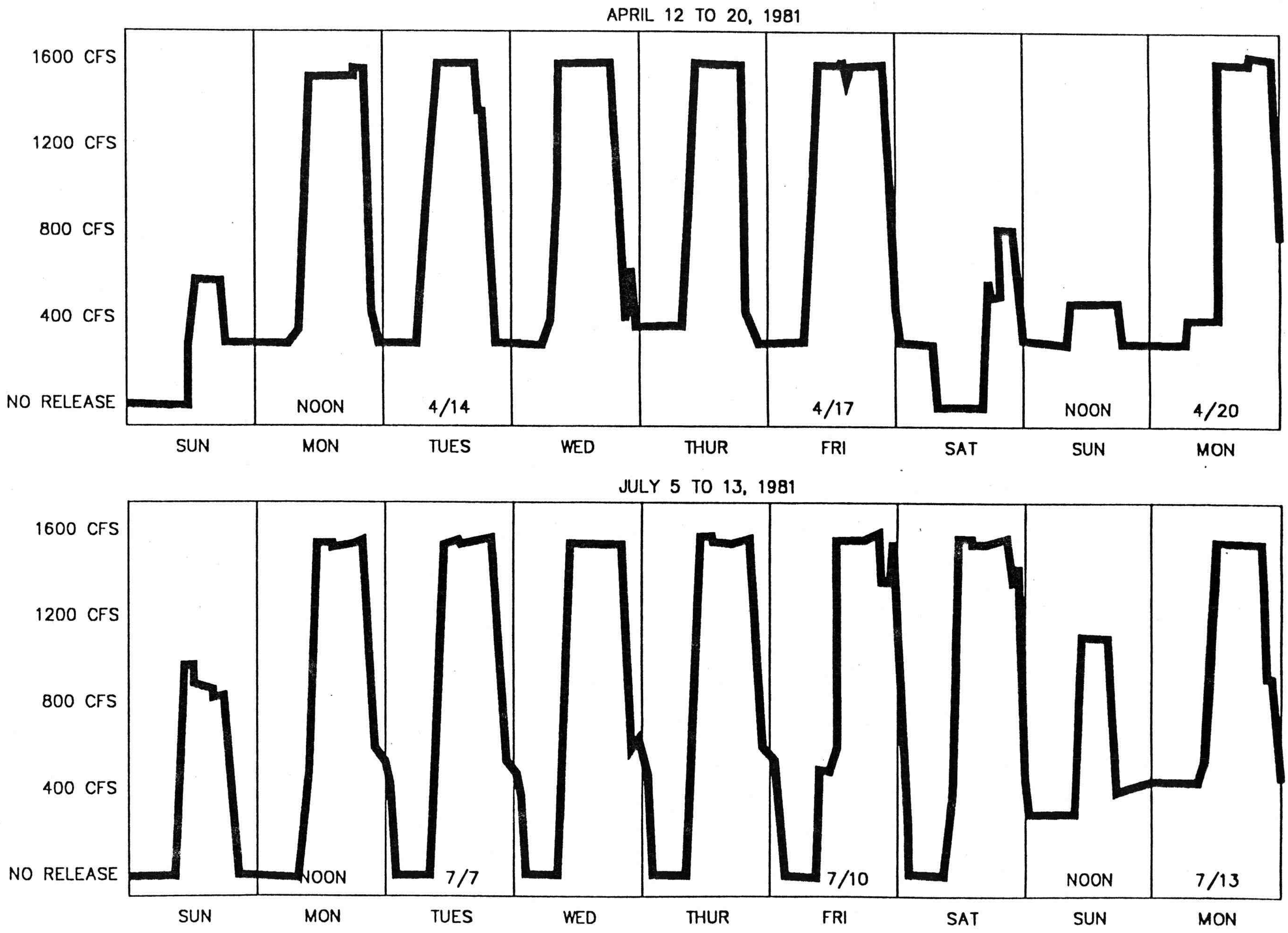


TYPICAL FLOWS BELOW CHILI BAR: APRIL & JULY 1991
(ALL FLOWS APPROXIMATE)

SOURCE: USGS GAUGE: UNCORRECTED READINGS

HDR

Figure III-14

Creek Reservoir. The SMUD system imports large quantities of water from the Rubicon River basin and substantially regulates and re-regulates flows for power generation. Major features of these projects are shown on Figure III-15.

PG&E System--

PG&E imports up to 1900 ac-ft annually from the Echo Lake watershed which is tributary to the Little Truckee River. This import generally starts after the main recreational season and continues through the fall months. It enters the South Fork watershed through a tunnel in the vicinity of Echo Summit.

A dam on Lake Aloha (Medley Lakes) in the Pyramid Creek drainage tributary to the South Fork forms a small reservoir with a storage capacity of approximately 5,100 ac-ft. Snowmelt fills the reservoir during the spring and is released during late summer to augment flows in the South Fork.

There are two reservoirs located on tributaries to the Silver Fork of the South Fork American River. Silver Lake, with a drainage area of 15.2 square miles, has an average annual runoff of about 27,800 ac-ft. Useable storage capacity at spillway level is 8,590 ac-ft with flashboards. Caples Lake (Twin Lakes) has a drainage area of 13.5 square miles and an average annual runoff of about 26,900 ac-ft. The storage capacity is 21,600 ac-ft with flashboards. Releases from these reservoirs are increased to augment the flow of the Silver Fork in late summer, after snowmelt has ceased. Releases generally continue on through the following winter until natural streamflows are adequate to meet downstream needs.

The Silver Fork joins the South Fork near Kyburz. Just below the confluence, PG&E has historically diverted flows up to approximately 160 cfs into the El Dorado Canal. The 1992 Cleveland fire temporarily destroyed flume sections of the canal and it could not be used at the time of this writing. When it is repaired, diversions through 22 miles of open canal to the El Dorado Powerhouse will resume. Here the EID canal diverts its present share of South Fork water (15,080 ac-ft) to its service area and the remainder is returned to the

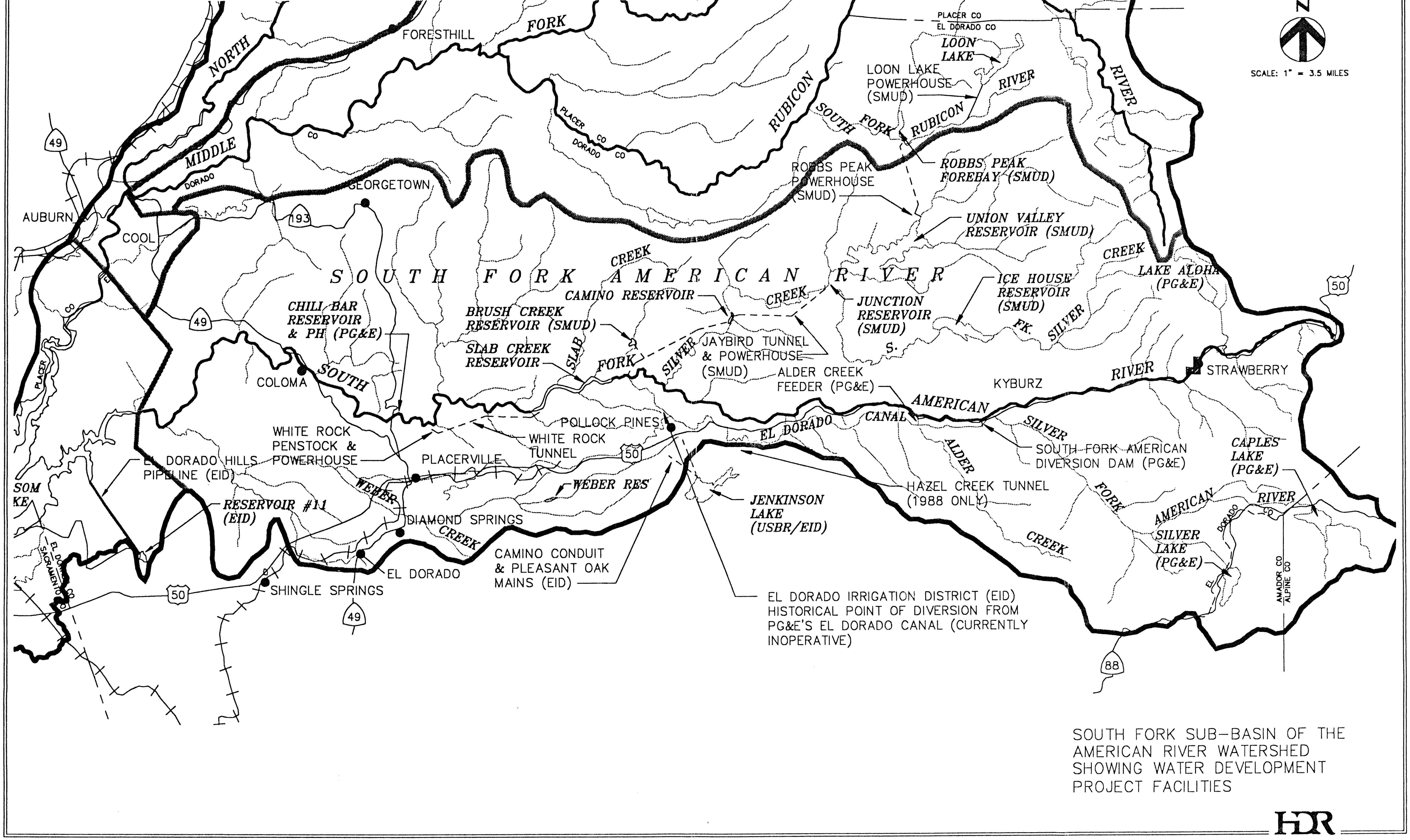


Figure III-15

South Fork below its confluence with Silver Creek. There is some enroute interception and diversion to the canal, including a diversion near the mouth of Alder Creek.

A Dam and Powerhouse is operated by PG&E at Chile Bar. The purpose of Chili Bar Reservoir is to re-regulate peaking power releases from SMUD's upstream system in order to maintain more consistent flows in the river. These flows are utilized heavily by white water rafters and boaters on the Chile Bar to Coloma, Coloma to Lotus, and Lotus to Salmon Falls reaches of the river.

SMUD System--

Elements of SMUD's Upper American River Hydroelectric Project provide the major sources of import and storage in the South Fork basin. Imports from the Rubicon River (tributary to the Middle Fork American River) through Robbs Peak Tunnel and Powerhouse increase South Fork flows by approximately 20 percent annually. SMUD reservoirs provide almost 400,000 ac-ft of useable storage to regulate South Fork flows and distribute releases of winter and spring snowmelt runoff throughout the entire season. Under a 1957 Agreement of Assignment, the consumptive benefits of SMUD releases from its upper American River Project reservoirs have been assigned to the City of Sacramento for municipal and industrial uses. By agreement to settle historic water rights, SMUD has also guaranteed EDCWA's and EID's water rights to specified quantities prior to release into the White Rock Penstock.

SMUD's project, which was designed solely for power production, developed the Silver Creek drainage basin with an area totalling about 180 square miles. Average annual runoff from the Silver Creek basin is about 300,000 ac-ft. Diversions into Silver Creek are made from approximately 80 square miles of the upper Rubicon River watershed. Annual diversions which have averaged about 180,000 ac-ft, are stored in Loon Lake Reservoir (useable capacity 74,100 ac-ft) in the South Fork Rubicon River drainage. From here releases are made into the Silver Fork American River drainage through the Loon Lake Powerhouse, Robbs Peak Tunnel and Powerhouse, and Union Valley Reservoir (useable capacity 270,000 ac-ft). Flows are then released through the Union Valley Powerhouse into Junction Reservoir. A second storage facility in the Silver Creek drainage, Ice House

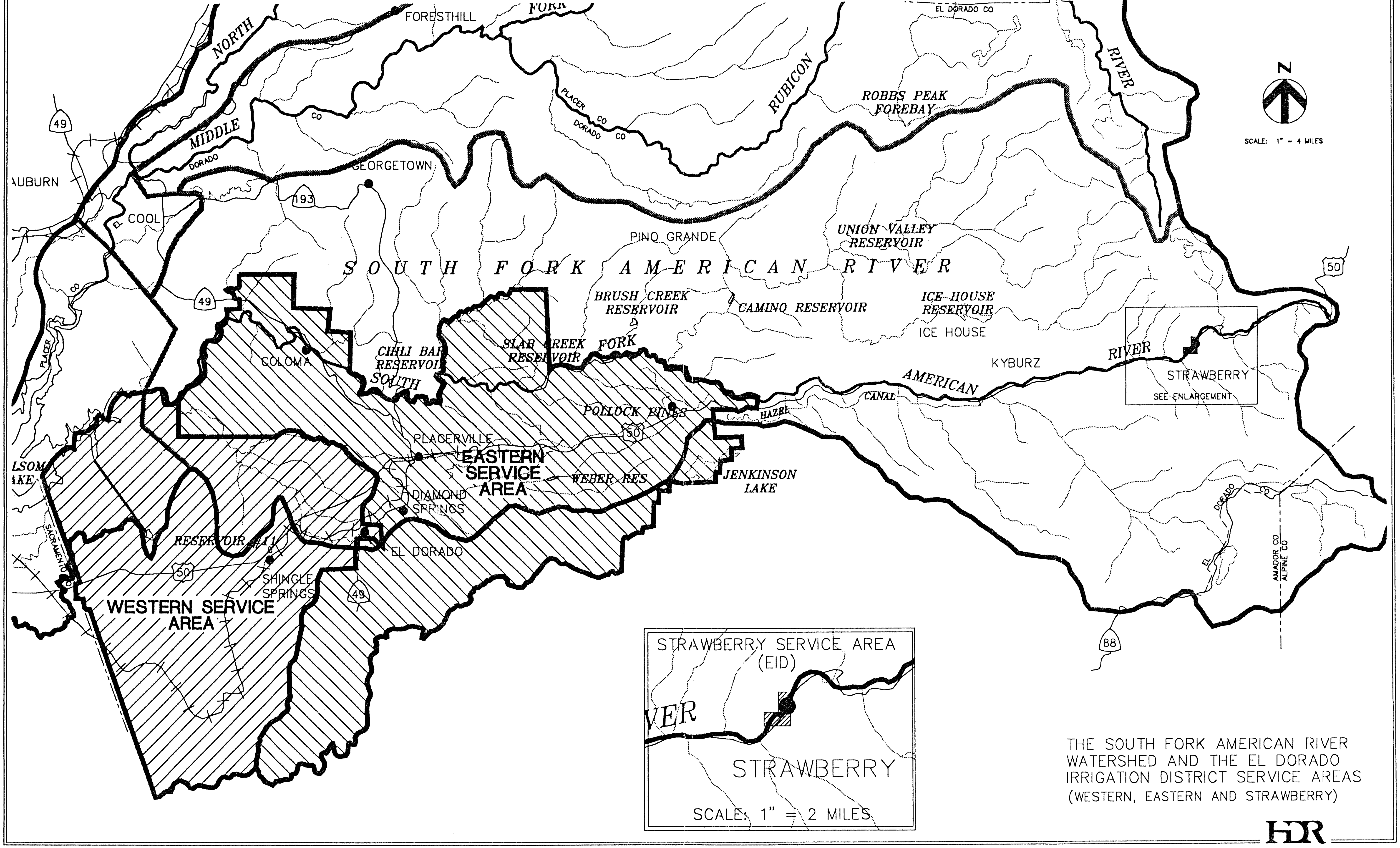
Reservoir (useable capacity 45,800 ac-ft), also releases flows to Junction Reservoir via the South Fork of Silver Creek. Releases are then made from Junction Reservoir, through Jaybird Tunnel and Powerhouse, back into Silver Creek at the Camino Powerhouse Forebay. Silver Creek flows then enter the Camino Tunnel. Releases from Camino Powerhouse (including Brush Creek Reservoir releases) enter Slab Creek Reservoir on the South Fork American River. Diversions from Slab Creek Reservoir traverse White Rock Tunnel, Penstock, and Powerhouse, returning to the South Fork upstream of Chili Bar for re-regulation by PG&E. The five SMUD powerhouses have a combined capacity of about 650,000 kW. Key features of the SMUD project were shown in Figure III-15.

El Dorado Irrigation District System (EID)--

Figure III-16 shows the location and large areal extent of El Dorado Irrigation District's (EID's) service areas. To serve them, EID operates a somewhat complex, system of diversion and interconnected conveyance facilities, part of which has been built to draw its domestic water supply from PG&E's older power generating system (see Figure III-15). Prior to the Cleveland fire, waters originating from the South Fork American River and upstream tributaries and reservoirs were diverted into PG&E's El Dorado Canal near Kyburz. By contract, based on a senior water right, EID then rediverted up to 15,080 af/yr through its main ditch which begins at the Forebay to PG&E's El Dorado powerhouse (the terminus of the El Dorado Canal).

EID also diverts water from the North and Middle Forks of the Cosumnes River and local creeks within the Cosumnes watershed.

EID's primary storage facility is Sly Park Reservoir (also known as Jenkinson Lake), from which water is released into the Camino conduit and Pleasant Oak mains. EID had the capability to redivert water from PG&E's El Dorado Canal through Hazel Creek tunnel in lieu of the forebay. From the tunnel port it would flow into Sly Park Reservoir as it did on an emergency basis in 1988. Here it was mixed with supplies from Sly Park and Camp Creeks. However, this connection has not been useable since the Cleveland fire. Sly Park Reservoir is owned by the U.S. Bureau of Reclamation (USBR) but operated by EID.



THE SOUTH FORK AMERICAN RIVER WATERSHED AND THE EL DORADO IRRIGATION DISTRICT SERVICE AREAS (WESTERN, EASTERN AND STRAWBERRY)

HDR

FIGURE III-16

EID also has a contractual entitlement to divert up to 7,550 ac-ft/yr of water directly from USBR's Folsom Reservoir through a pipeline leading to the El Dorado Hills Water treatment Plant. This source may be subject to substantial deficiencies in dry years like 1977 when deliveries were cut to 3,750 ac-ft. Altogether, EID's water supplies from El Dorado Forebay and Folsom Reservoir total 22,630 ac-ft/yr of safe yield.

Limited conveyance capacity already creates operational difficulties for EID. This problem has the potential to worsen in the future because most of the water sources are located in the eastern part of the district, while most of the future demand will be in the western part of the district (See Figure III-16). The EID water system also has a limited storage capability. Twenty-six small reservoirs with capacities ranging from 2.5 to 21.3 ac-ft are used to accommodate short-term, local fluctuations in pressure and water use but do not constitute a water source. Except for Sly Park Reservoir, EID is dependent for its water supply on storage facilities owned and operated by other agencies. This becomes a particularly difficult problem during summer and extended drought periods.

El Dorado County Water Agency (EDCWA) and EID have made joint application to the California State Water Resources Control Board (SWRCB) for consumptive use rights to waters stored by PG&E and on certain direct diversion amounts using PG&E facilities. The yield from these rights could be as high as 17,000 ac-ft/yr, assuming that water is available on a schedule, and at locations (such as Folsom Reservoir) that meet EID's requirements, and that PG&E continues its current mode of operation. The PG&E source could meet EID requirements until about 2017 assuming additional conveyance capacity (such as the proposed White Rock Project) becomes available in EID's service area.

Land Use and Ownership

Land Use--

There are five principal categories of land use within the South Fork American River Watershed (El Dorado County Planning Department, July 1981 and El Dorado National Forest Land and Resource Management Plan, 1988). The Planning Department has designated Agricultural, Forestry, Urban, Low Density Residential and Rural categories in its Long Range Land Use Plan to year 2000. El Dorado National Forest has designated Wilderness and Special Areas, High Country Areas, Developed Recreational Areas, Wildlife Areas, General Forest Areas and Streamside Areas in its National Forest Plan. These lands are also included in the Forestry Designation. A description of each land use category follows:

Forestry consists of those parcels that are currently zoned Timber Preserve or are part of the National Forest.

The Urban Land designation incorporates lands that have the existing or potential ability to support land uses such as industrial, commercial, multi-family and high density residential.

Low Density Residential consists of those lands zoned residential with a 3-acre minimum parcel size.

The Rural Residential designation applies to lands zoned for 10-acre minimum parcel size and includes areas that are "residual" lands not previously designated or not suitable for urban use which do not have good agricultural capability or a public water supply.

The Agricultural Lands designation includes both existing agricultural lands and potential agricultural lands. Existing Agricultural Lands are defined as lands contracted as Williamson Act Agricultural Preserve and lands which are presently involved in some sort of commercial crop or orchard production. Choice Agricultural Lands are defined as those potential agricultural lands that exhibit choice or high quality soil characteristics, as rated by the Soil Conservation Service.

Designated Wilderness and Special Areas include nationally approved and recommended wilderness areas, wild and scenic river reaches, natural resource research areas, and special areas. High Country Areas include semi-primitive or primitive areas or natural areas with some roads. Developed Recreational Areas include both existing and potential recreational sites, administrative sites, plant propagation and genetic sites, and transportation corridors. Wildlife Areas include sites inhabited by sensitive species. General Forest Areas include scenic viewsheds and timber stands designated for harvesting in accordance with forest practice rules. Streamside Management Zones include riparian and wetland zones as well as all zones within 100 feet of perennial streams, lakes and ponds.

El Dorado National Forest and Wilderness Lands are further subdivided into the following specific management areas under each land use category:

- Designated Wilderness and Special Areas: wilderness, wild and scenic river, research natural, and special.

- High Country Areas: primitive, semi-primitive, non-motorized, semi-primitive motorized, and roaded natural.

- Developed Areas: existing or potential recreation, existing or potential winter sports, private sector recreation, administrative sites, Placerville Nursery, Institute of Forest Genetics and transportation utility corridors.

- Wildlife Areas: spotted owl and goshawk.

- General Forest Areas: visual foreground retention and partial retention, visual middleground retention and partial retention; high site timber, uneven aged timber, and low site timber, type conversion, meadow management and meadow maintenance.

- Streamside Management Zones: (no further subdivisions)

- Rare II (roadless) areas: a land restriction that is occasionally superimposed on other National Forest land designations (see detailed El Dorado National Forest Map, 1988).

Figures III-17A and III-17B are maps of the South Fork American River subbasin watershed, showing the locations and areas of the general principal categories of land use. Urban, Residential and Rural Lands are shown in Figure III-17A and the Agricultural and Forest Lands are shown in Figure III-17B. Acreages of the 30 Management areas in the El Dorado National Forest are tabulated in Table III-1 and permitted activities in each Management Area are described in the Watershed Activities Chapter.

Land Ownership--
Categories of land ownership in the South Fork subbasin are delineated in Figure III-18.

MIDDLE FORK AMERICAN RIVER SUB-BASIN

Geography

Location--
The Middle Fork America River subbasin is located north-east of Sacramento and west of Lake Tahoe. Its position in relation to the neighboring sub-basins was shown in Figure III-1, and Figure III-19 is a detailed map of the subbasin. There are no major transportation routes through the watershed. A county road approximately follows the crest of the divide between the North and Middle Forks, connecting Forest Hill, its only major settlement, with Auburn. It lies partially within El Dorado County and mostly in Placer County. The watershed area includes the drainage of the Rubicon River, its largest tributary.

Watershed Area--
The Middle Fork American River watershed constitutes approximately 616 square miles (394,240 acres) of the 1,900 square mile watershed of the American River. In addition to the three forks on the Rubicon, its major tributaries include Indian Creek, Duncan Canyon Creek, North Fork of the Middle Fork American River, and Pilot Creek. Minor tributaries include Deep Canyon Creek, Screwauger Creek, Long Creek, Georgetown Divide Creek, El Dorado Creek, Gerle Creek and Otter Creek (Figure III-19).

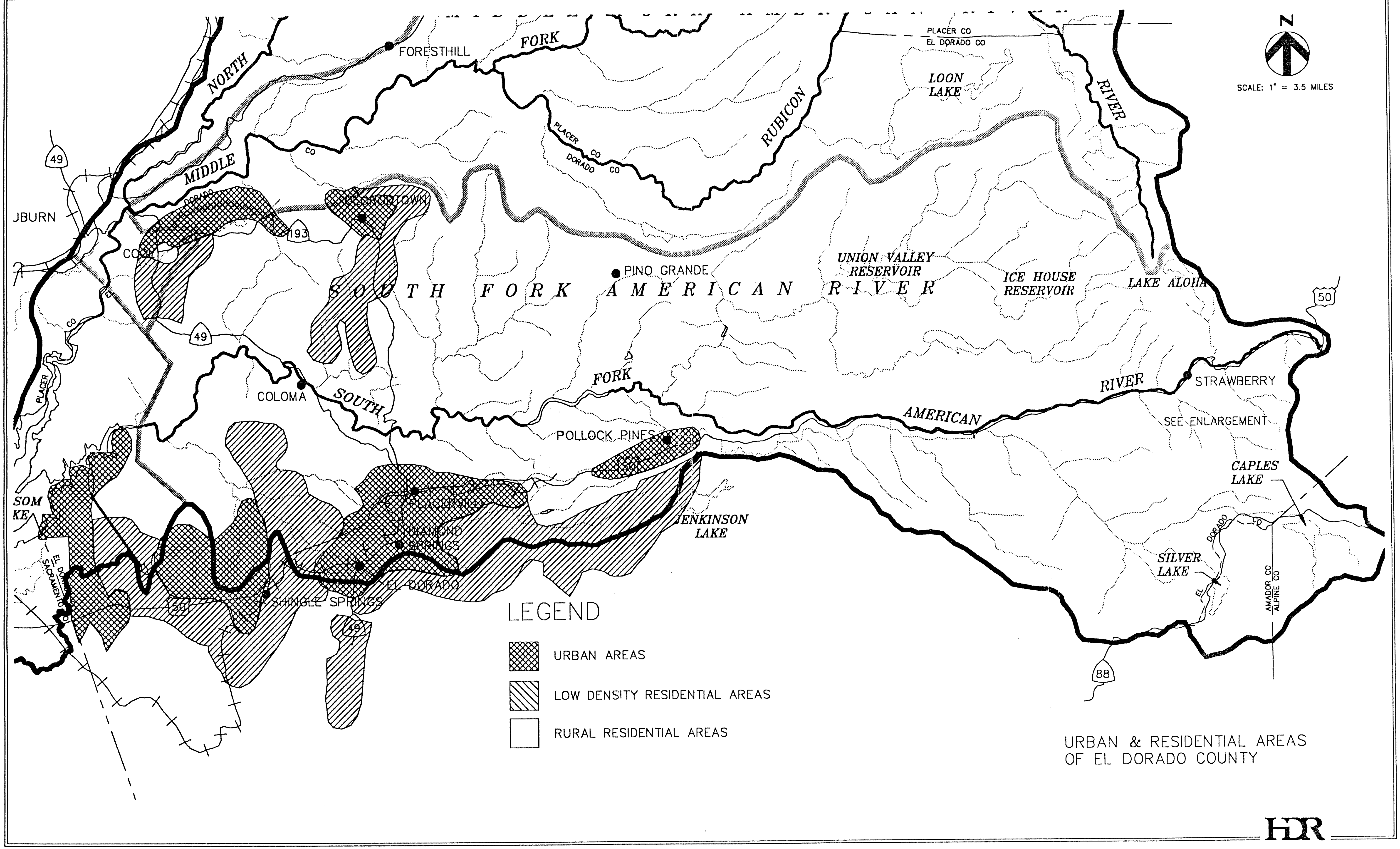


Figure III-17A

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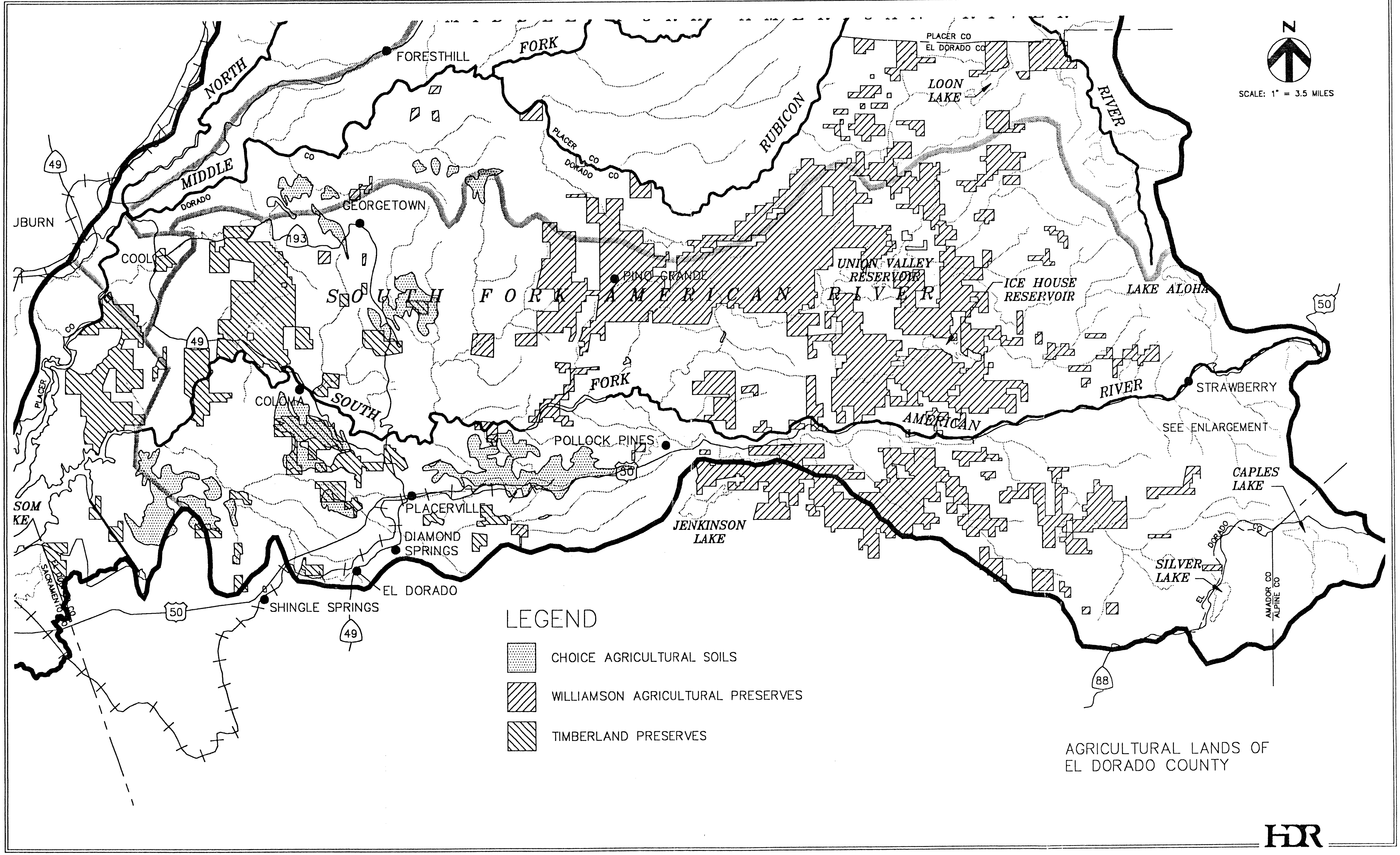

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Figure III-17B

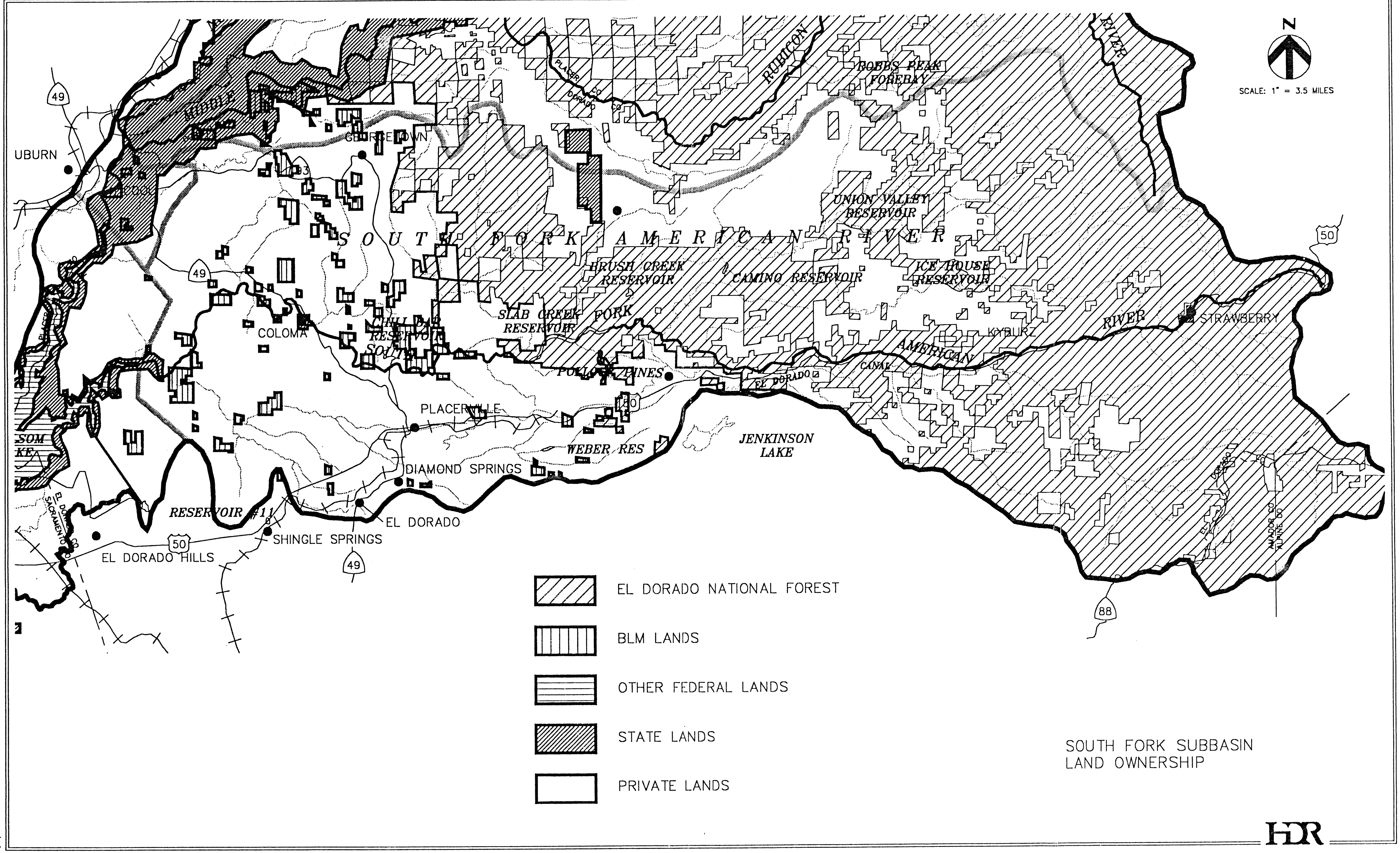
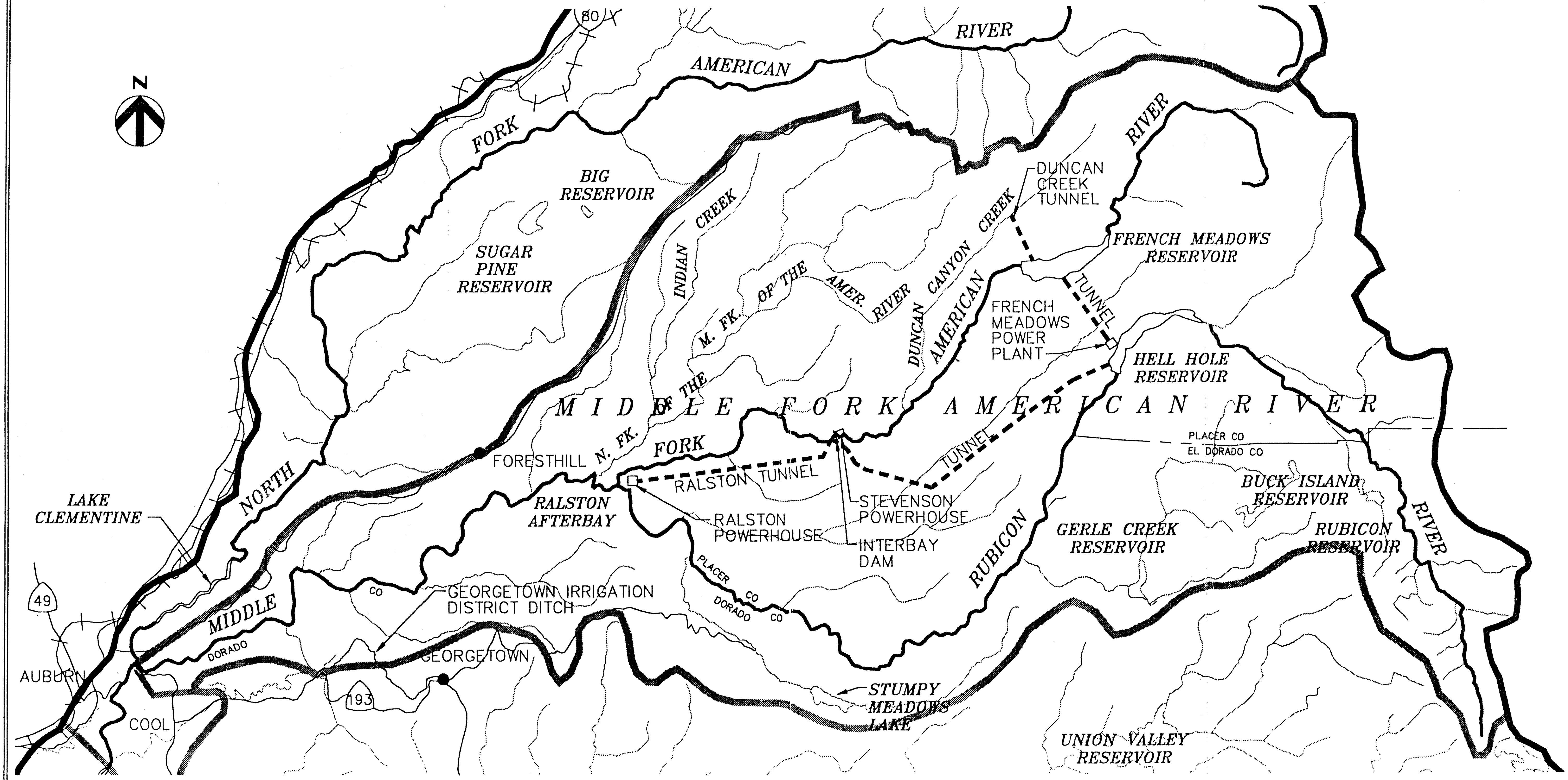


Figure III-18



MIDDLE FORK SUB-BASIN OF THE AMERICAN RIVER WATERSHED

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Figure III-19

Table III-1. National Forest, Wilderness and Primitive Areas Within the South Fork American River Watershed		
Management Area/Index		
Mgmt Area	Emphasis Zone	NF Acres
Designated		
1.	Wilderness	115,753
2.	Wild and Scenic River	14,361 1/
3.	Research Natural Area	2,562 2/
4.	Special Area	20,623 3/
High Country		
5.	Primitive	281
6.	Semiprimitive Nonmotorized	16,833
7.	Semiprimitive Motorized	27,569
8.	Roaded Natural	13,855
Developed		
9.	Existing Recreation	884
10.	Potential Recreation	2,535
11.	Existing Winter Sports	5,255
12.	Potential Winter Sports	4,017
13.	Private Sector Recreation	2,279
14.	Administrative Sites	250
15.	Placerville Nursery	218
16.	Institute of Forest Genetics	234
17.	Transportation Utility Corridor	0
Wildlife		
18.	Spotted Owl	60,800 4/
19.	Goshawk	4,473 5/

Table III-1. National Forest, Wilderness and Primitive Areas Within the South Fork American River Watershed		
Management Area/Index		
Mgmt Area	Emphasis Zone	NF Acres
General Forest		
20.	Visual Foreground Retention	19,306
21.	Visual Foreground Partial Retention	14,885
22.	Visual Middleground Retention	22,315
23.	Visual Middleground Partial Retention	29,967
24.	High Site Timber	131,795
25.	Uneven Aged Timber	25,401
26.	Low Site Timber	23,844
27.	Type Conversion 0	
28.	Meadow Management	2,937
29.	Maintenance	27,817
Streamside		
30.	Streamside Management Zone	27,200
TOTAL AREA		(sum)

1/ 2,880 acres overlap wilderness
2/ 300 acres overlap wilderness
3/ 5,476 acres overlap wilderness
4/ 21,200 acres included in suitable land base
5/ 755 acres overlap other management areas

Source: El Dorado National Forest Land and Resource Management Plan, 1988.

Topography

The watershed ranges in elevation from over 9,800 feet to about 520 feet at the confluence of the North and Middle Forks. The higher headwaters rise on the northern slopes of Dick's peak (9,970 feet) at the head of Rockbound Valley, and the western slopes of the main divide in Granite Chief Wilderness.

The upper watershed is characterized by rugged granite and volcanic peaks and ridges, heavily glaciated valleys, and numerous glacially-formed lakes. From these heights, the rivers descend generally southwestward through the mid-elevation Sierra and foothill regions. The foothills are rolling to steep, with few conspicuous peaks. Steepness of slope is related to the underlying geologic formations. Areas underlain by metamorphic rock are, in general, steep and angular, whereas slopes in granitic areas tend to be rounded and smooth. Flat-topped ridges and smooth slopes are most prevalent in the areas underlain by volcanic material.

Both the Middle Fork and the Rubicon River descend over a series of steps and drops to the point of their confluence at about 1,200 feet. The Middle Fork of the American River heads at an elevation of 8,500 feet and cascades down steep slopes, losing 3,000 feet of elevation in about six miles, to the upper end of French Meadows Reservoir. Just below the dam site, at an elevation of about 5,000 feet, the stream again attains a steep gradient, incising itself deeply into a 2,000-foot canyon for 20 miles. Throughout this reach there is little side drainage with the exception of Duncan Creek from the north and runoff from the canyon walls. At the lower end of this reach, at an elevation of 1,100 feet, the Rubicon River enters from the south, and the North Fork of the Middle Fork enters from the north. The North Fork of the Middle Fork and its numerous tributaries flow through steep ravines, draining the area between the Foresthill Divide and the Middle Fork Canyon from Duncan Creek to Volcano Creek.

The Rubicon contributes its flow along with the combined flows of its tributaries: Pilot Creek, Gerle Creek and Long Canyon Creek. This highly productive watershed feeds a number of small lakes and impoundments at altitudes above 6,000 feet, the largest being Loon Lake. The gradients of these tributary streams are generally steep: 100 feet or more to the mile.

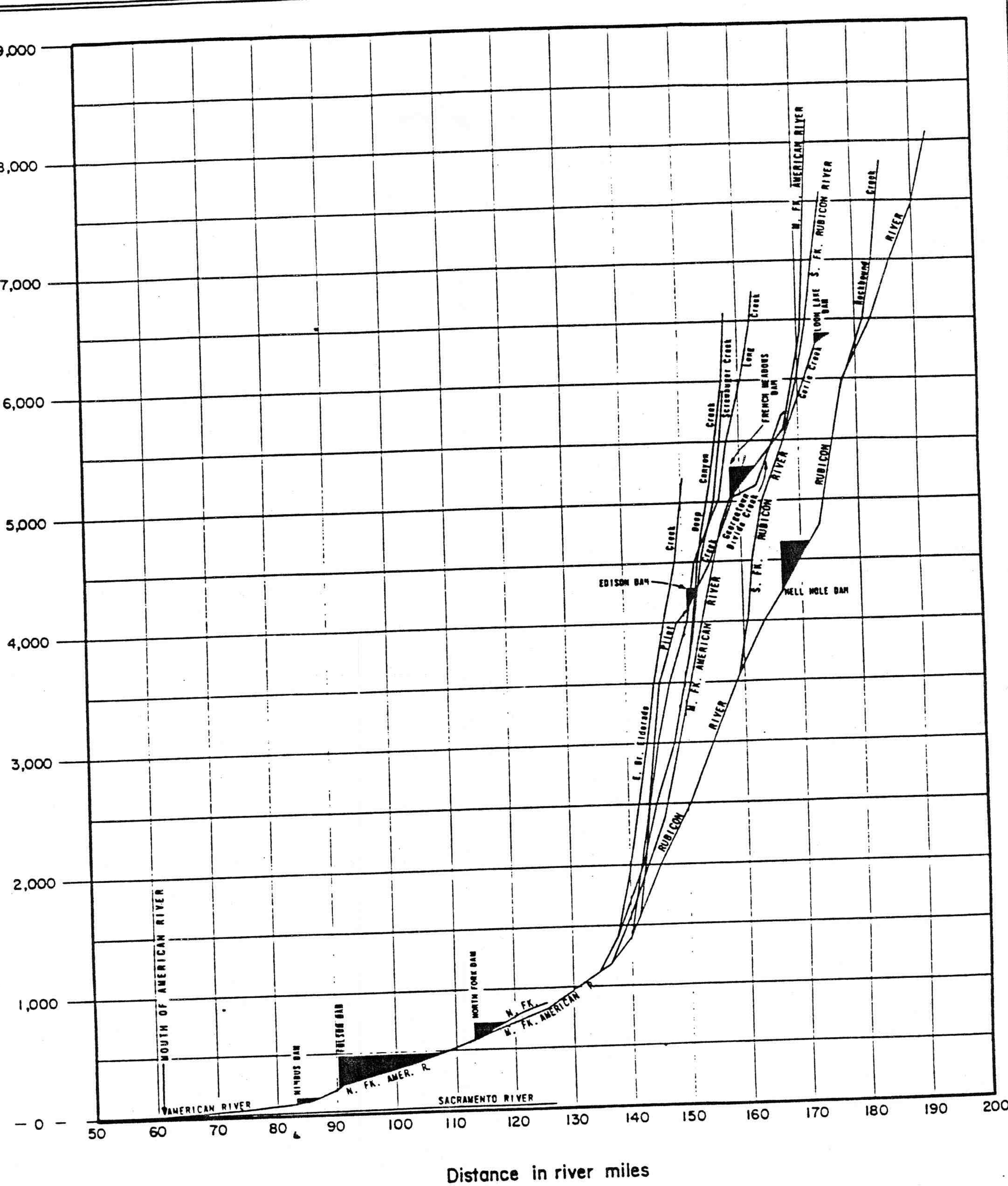
From its confluence with the Rubicon, the Middle Fork continues to flow through a 1,100-foot canyon for 25 miles to its junction with the North Fork at an elevation of 540 feet. In this reach the gradient is reduced to approximately 20 feet per mile, with numerous gravel and sand bars along the streambed. The mean elevation of the Middle Fork American River is approximately 3,500 feet, and the average stream gradient is about 200 feet per mile. Figure III-20 is a stream profile of the Middle Fork American River, the Rubicon, and its other major tributaries.

Geology

The eastern part of the Middle Fork watershed is underlain by the Sierra Nevada Batholith: granitic rocks chiefly of Mesozoic age. The tilted block fault dips gently beneath the sediments of the valley floor on the west, and is down-faulted sharply on the east. The geologic ages of the basin formations vary from Mississippian to Recent. The oldest geologic formations of the basin lie in a northwest-trending zone part-way up the west slope of the mountains, where they have been folded and metamorphosed by the intruding granitic mass which forms the core of the range. The granitic core is exposed at higher elevations throughout most of the range. Many of the larger ridges are capped by Tertiary volcanics and/or gold-bearing river gravels. The present stream channels are filled with Recent boulders and gravels.

The general region is not strongly active seismically, although numerous faults are known to exist within the American River Basin.

The geology of the Pilot Creek drainage is dominated by Tertiary andesitic volcanic mudflows of the Mehrten Formation. In the conditions of high precipitation and relatively mild temperatures of this mid-elevation drainage the mudflows have weathered to deep clay-



STREAM PROFILES FOR MIDDLE FORK AMERICAN RIVER

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Figure III-20

rich soils. These soils are moderately permeable and well drained, with a significant water holding capacity. Thus they are highly suited to support mixed coniferous forests. In their natural, vegetated state, they are stable; however, road cuts and unvegetated, disturbed surfaces are highly erodible.

The high, eastern reaches of the watershed are dominated by Paleozoic metasedimentary rocks. These rocks are vertically fractured, hard, and relatively resistant to weathering. They form the steep, deep canyons of the Rubicon River and Silver Creek, and the adjacent ridge tops. It is on the ancient serrated surface of these Paleozoic metamorphic rocks that the younger mudflows of the Mehrten formation lie like a blanket, forming the broad, gentle, ridge top relief between Edson Dam and Uncle Tom's.

Granitic rocks are exposed below Edson Dam and between Pilot Creek Diversion Dam and Tunnel Hill, in the small portion of the watershed that is tapped by enroute diversions into the El Dorado Conduit.

Soils and Soil-Plant Associations

As stated in the overall watershed description, soils can be broadly described into four major zones distinguished by soil characteristics, vegetation and human use. These four zones are the Valley Zone, the Foothill Zone, the Upland Agricultural Zone, and the Forest/ Recreational Zone.

The Foothill Zone consists of rather shallow, somewhat rocky, red-colored upland soils that are presently being utilized largely for range grazing, limited suburban development and some agriculture (primarily orchards). The area is typified by a generous cover of oaks and grasses or spotty stands of dense chaparral. It occupies the elevation band extending from the western edge of the Middle Fork watershed to about 1,800-2,500 feet.

The Upland Agricultural Zone extends in a northwesterly direction across the watershed from the Cool-Georgetown area. Soils of this zone are characteristically deep, reddish-brown in color, fertile and quite permeable. Native vegetation varies from oaks and grasses at lower elevations to mixed conifers at the higher elevations up to 6,000 feet. It is also suitable for deciduous orchards.

The Forest/Recreational Zone comprises the major acreage of the watershed. It is typified by large areas of rough, broken and rocky land at the higher elevations (above 6,000 feet). Although soils in this zone possess physical properties normally associated with agricultural lands, their use is limited by their limited extent and the harsh climate. Timber production for lumber harvest, watershed management and recreation are the predominant land uses.

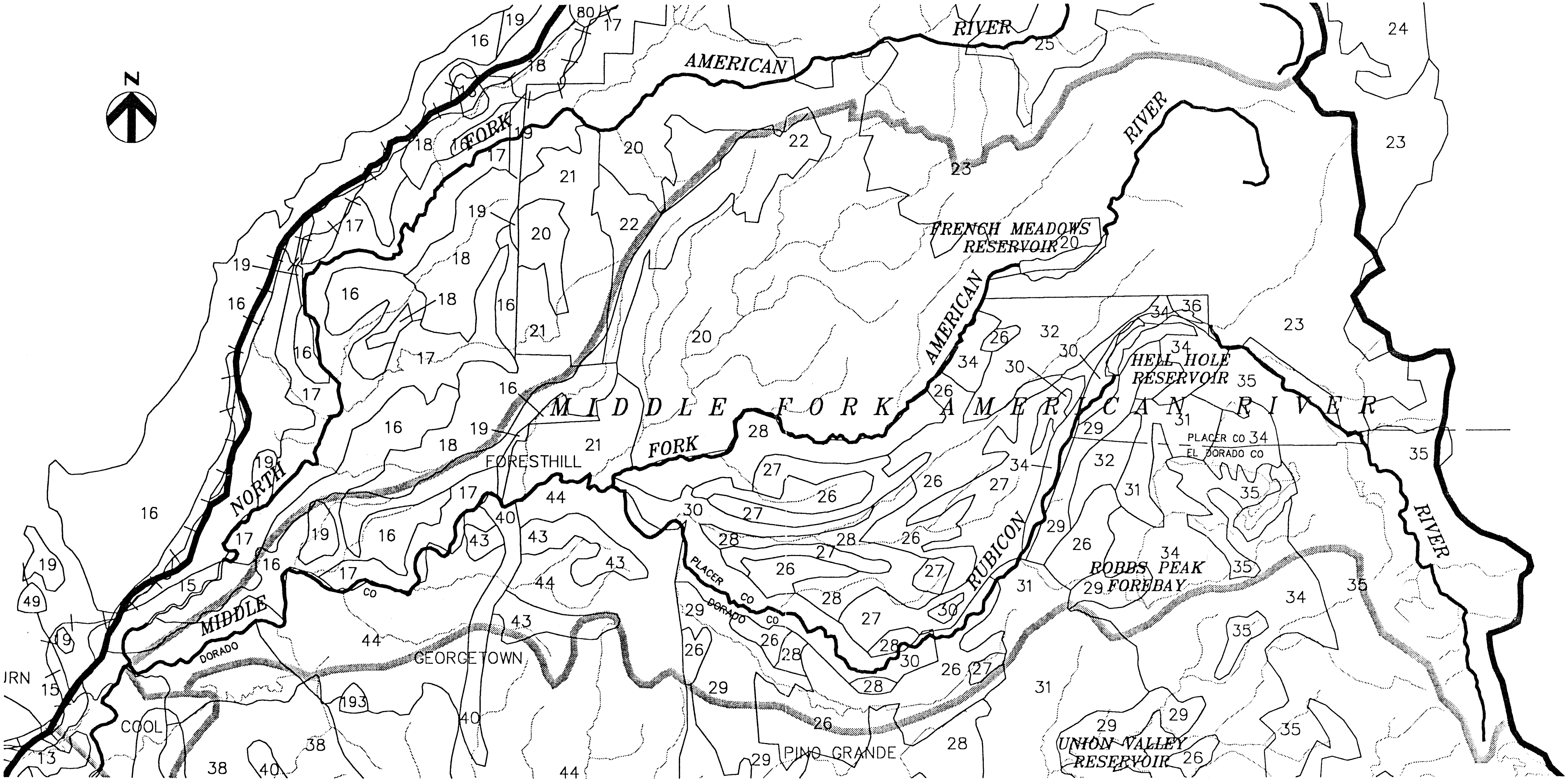
A general soils map for the Middle Fork American River is shown in Figure III-21.

In the Pilot Creek drainage, soils formed from the granitic rocks have little cohesive clay, are slowly permeable and highly erodible. Numerous slides have occurred along the El Dorado Conduit where the granite forms a barrier to groundwaters percolating through the overlying permeable volcanics. At the contact zone, the volcanics become saturated and the granite surface lubricated, leading to slope failures where gravity can accelerate rock and soil masses.

The hard metamorphic rocks form deep soils when weathered. These soils are highly erodible when disturbed, and very susceptible to compaction when wet.

Small remnants of Quaternary glacial deposits still remain in the Pilot Creek drainage. Moderately deep soils have developed on this permeable, unconsolidated material, which supports mixed coniferous forests. Vegetated, glacial deposits are fairly stable; however, they also become highly erodible when disturbed.

The high water holding capacities of the predominant soil types in the Pilot Creek drainage provide significant infiltration potential. The infiltration potential and water holding capacities of the soil buffer the runoff response of the watershed to irregularities in



SOIL TYPES OF THE MIDDLE FORK SUBBASIN

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Figure III-21

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precipitation. Large precipitation spikes can be absorbed by the soil, thus ameliorating flood potential. Moisture is released from the soil gradually, thus sustaining the yield of the watershed. A summary of characteristics of rock and soil types in the Pilot Creek watershed is presented in Table III-2.

Vegetation

Vegetation belts of the Middle Fork American River subbasin are intermediate in character between those of the North Fork and those of the South Fork. In general, at lower watershed elevations, oak-pine woodlands are found with a preponderance of oaks. Above 2,300 feet the coniferous forests begin to dominate with ponderosa pine as the primary species. As elevation increases, sugar pine and white fir become increasingly prevalent. Above 5,500 feet, red fir becomes the dominant forest species with interspersed Jeffrey pine, sugar pine, Sierra juniper, and white fir. At higher elevations lodgepole and white pine are found interspersed among the large areas of barren rock. Scrub and brush rangelands are scattered throughout each of these vegetation belts. Above the treeline, the grasses, sages, and numerous ground-hugging alpine plants predominate wherever protected pockets of soil occur.

Climate

The climate at lower elevations of the watershed is Mediterranean, with cool, wet winters and long, hot and dry summers. At higher elevations it is more continental, with longer, colder winters, shorter cooler summers, and ample winter snows.

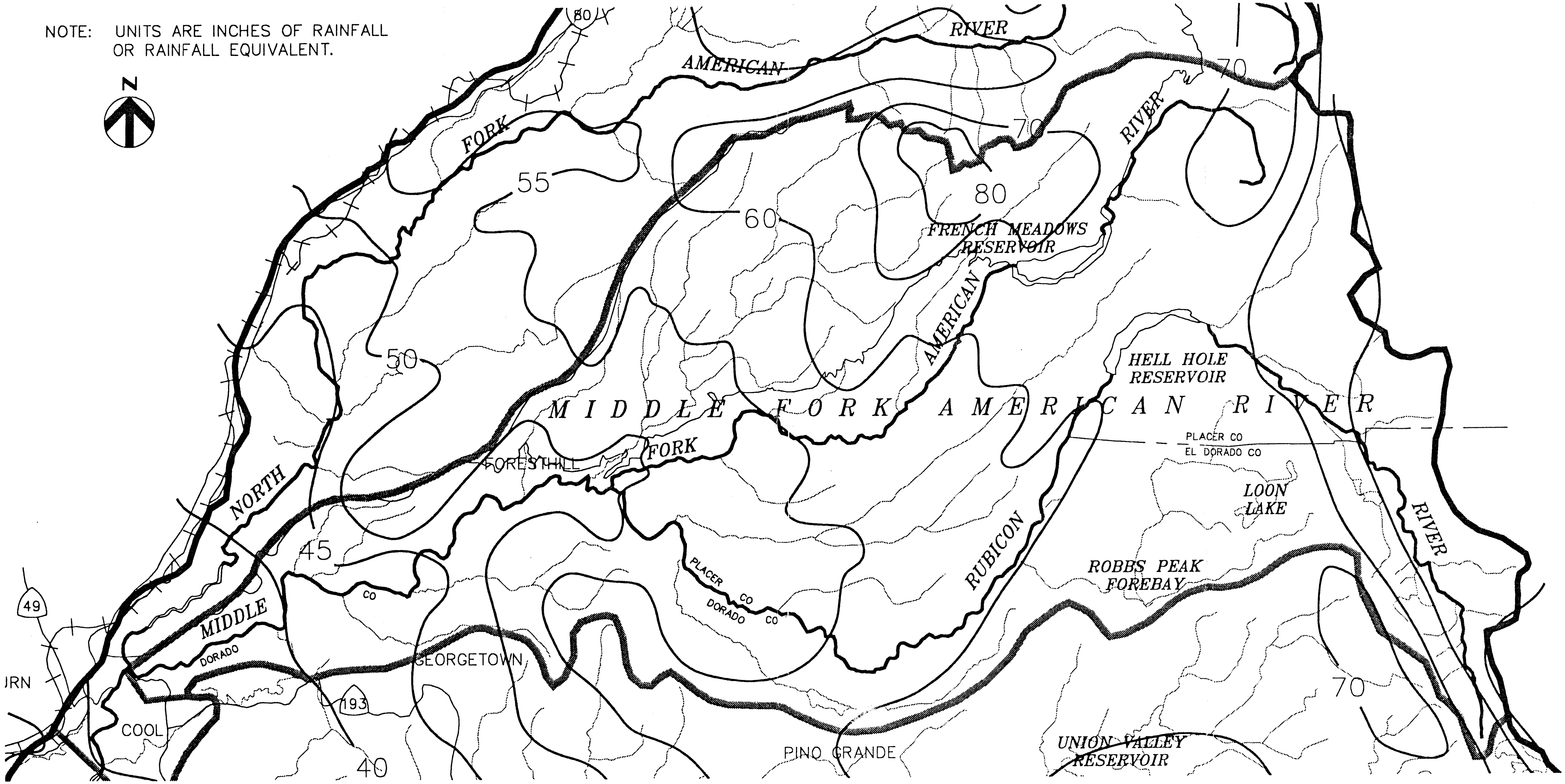
More than 95 percent of the precipitation occurs during the fall, winter and spring months from November through April. The average time distribution of precipitation at a representative location was shown by month in Figure III-2. At the lowest elevations (below 3,000 feet), precipitation falls mainly in the form of rain. At the mid-elevations (3,000-6,000 feet) it falls as a combination of rain and snow. Above 6,000 feet, most of the precipitation falls in the form of snow and is retained in the snowpack until spring and summer. The

Table III-2. Pilot Creek Watershed Rock and Soil Types Summary and Characteristics						
Rock Types	Volcanic Rocks		Metamorphic Rocks		Granitic Rocks	Glacial Deposits
Percentage of Watershed	40% ±		45% ±		14% ±	≤5%
Soil Types:	McCarthy	Cohasset	Josephine & related series	Mariposa & related series	Pilliken & related series	
Percentage of Watershed	7% ±	33% ±	23% ±	22% ±	14% ±	≤1%
Permeability	Moderate	Moderate	Moderate	Moderate	Moderately Slow	Moderate
Runoff	Medium to Rapid	Slow to Rapid	Medium to Rapid	Medium to Rapid	Medium	Medium
Erosion Hazard	Moderate to High	Slight to High	Moderate to High	Slight to High	Moderate to High	Moderate to High
Slopes/ Geomorphology	Strongly sloping on ridges. Steep on side.	Moderate to steep on side slopes.	Gently rolling to very steep.	Rolling to very steep.	Gently rolling to very steep	Broad ridge tops.
Depth at Bedrock (Feet)	2-3.5'	3.5-5'+	3.5-5'	1.5-2.5'	3.5-5'+	2-5'

California State Water Resources Control Board has estimated the ratio of the contribution of snow versus rain to the total runoff to be 40 percent.

The water equivalent of precipitation ranges from 35 inches near Cool to more than 70 inches above 5,000 feet. Figure III-22 shows its average distribution throughout the watershed. During the past century, the subbasin has experienced repeated drought as well as flood events. During the single-year drought events of 1924, 1931, 1961, and 1976, the annual runoff to the Middle Fork American River averaged about 35 percent of normal. In 1977, the worst single-year drought event of record, runoff was less than 15 percent of normal.

The average annual precipitation in the Pilot Creek drainage, the water source for Georgetown Divide Public Utility District ranges from about 54 inches at the lower western



AVERAGE ANNUAL PRECIPITATION THROUGHOUT THE MIDDLE FORK SUB-BASIN

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Figure III–22

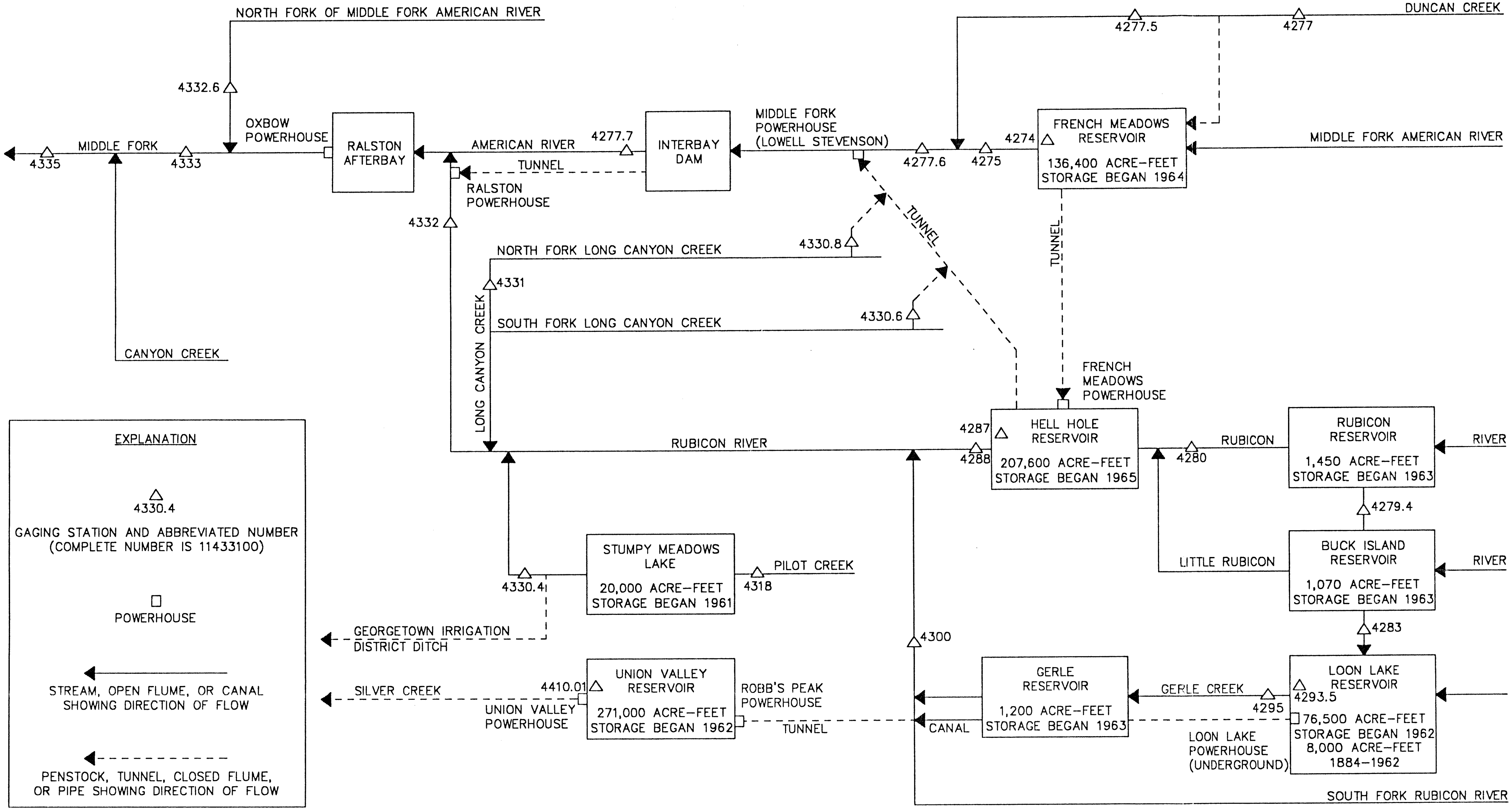
boundary to about 61 inches at the higher, eastern elevations. The average throughout the drainage, which is tributary to Stumpy Meadows Reservoir, is about 56 inches per year. Although much of the precipitation occurs as rain, particularly at the lower elevations, the runoff hydrograph is still controlled by snow accumulation and melt.

Hydrology

The Middle Fork subbasin has a fairly complex system of impoundments and diversions which is shown schematically in Figure III-23. This series of storage and diversion structures significantly alters the natural flow characteristics as recorded near the mouth of the Middle Fork. Water storage in the reservoirs tends to reduce peak flows and raise minimum flows at downstream locations, moderating seasonal streamflow variability. This moderating effect can be seen in the postregulation (1961-80) streamflow hydrograph shown in Figure III-24. Some water is diverted out of the subbasin at the Robbs Peak Powerhouse to Union Valley Reservoir on the South Fork American River subbasin for hydroelectric power generation. Hydrologic characteristics of the Middle Fork American River are summarized in Table III-3.

Water Supply Systems

Placer County Water Agency System (PCWA)--
The Placer County Water Agency Middle Fork Project is a multiple purpose project designed to conserve and control waters of the Middle Fork American River, the Rubicon River, and certain tributaries. Beneficial uses include irrigation, municipal and industrial use, and hydropower generation. Principal project features include two storage reservoirs, five diversion dams, five power plants, diversion and water transmission facilities, four tunnels, and appurtenances. The powerplants (French Meadows, Hell Hole, Lowell J. Stephenson, Ralston, and Oxbow) have a combined generating capacity of 210,870 kilowatts. The two storage reservoirs (French Meadows and Hell Hole) have a combined usable capacity of approximately 327,600 ac-ft. A schematic of the entire watershed and its water development facilities was shown in Figure III-23.



SCHEMATIC DIAGRAM SHOWING DIVERSIONS & STORAGE IN MIDDLE FORK AMERICAN RIVER BASIN

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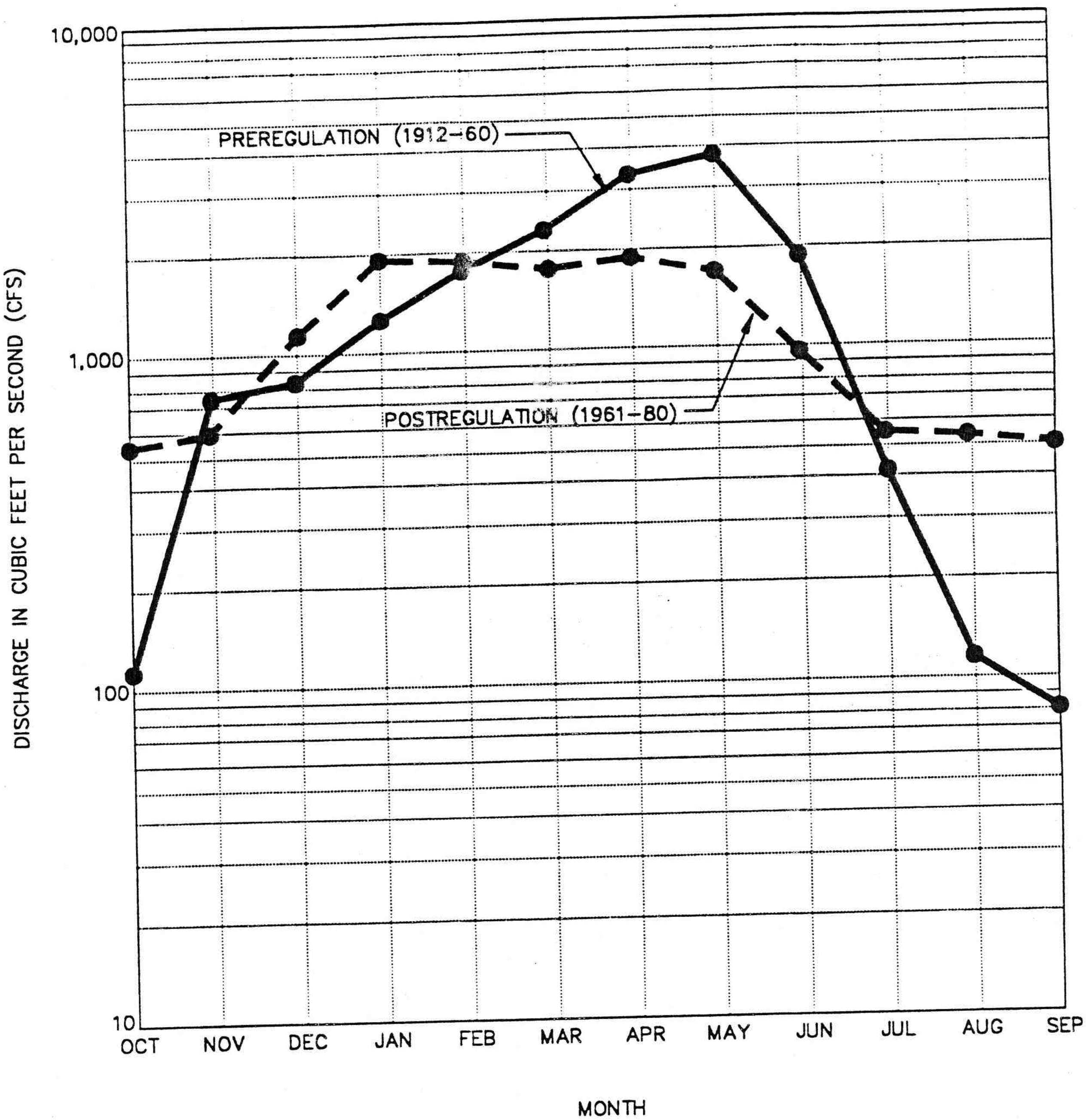
Figure III-23



MEAN ANNUAL DISCHARGE FOR 68 YEARS = 1,304 CUBIC FEET PER SECOND

EXTREMES:
MINIMUM DISCHARGE = 20 CUBIC FEET PER SECOND (SEPTEMBER 6, 1931, SEPTEMBER 19, 1934)
MAXIMUM DISCHARGE = 253,000 CUBIC FEET PER SECOND (DECEMBER 23, 1964)

PREREGULATION & POSTREGULATION HYDROGRAPHS OF MEAN MONTHLY DISCHARGE AT MIDDLE FORK AMERICAN RIVER NEAR AUBURN

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Figure III-24

Table III-3. Recorded Runoff* At Selected Stations In Or Near The Middle Fork American River Sub-Basin	
Drainage Area (square miles)	619
Period of Record	1911-1961
Annual Discharge	
Maximum (ac-ft)	1,909,000
Date	1952
Minimum (ac-ft)	229,000
Date	1924
Average (ac-ft)	997,700
Discharge - 1911 - 1960 (ac-ft)	670,400
Percent of average	67
Monthly Discharge	
Maximum (ac-ft)	588,000
Month and year	5/15
Minimum (ac-ft)	1,380
Month and year	9/31
Instantaneous Discharge	
Maximum (cfs)	79,000
Date	12/23/55
Minimum (cfs)	20
Date	9/6/31
	9/19/34
*Data obtained from USGS Water Supply Papers.	

Upper Middle Fork American River flows are captured, and a portion is diverted out of French Meadows Reservoir to Hell Hole Reservoir through the French Meadows Powerhouse. Hell Hole Reservoir also receives most of the flow from the Upper Rubicon and Little Rubicon River systems (SMUD has a small diversion into Loon Lake). Hell Hole water re-enters the Middle Fork either via a tunnel and Stevenson Powerhouse, or via the Rubicon River through the Hell Hole Powerhouse, together with excess flows from Pilot Creek and Long Canyon Creek. From Interbay Dam on the Middle Fork, flows are released into the river channel and through the Ralston tunnel and Powerhouse into the Rubicon, just upstream from its confluence with the Middle Fork. Ralston afterbay collects all the upstream flows and feeds them through Oxbow Powerhouse. The Middle Fork receives drainage from the North Fork of the Middle Fork and Canyon Creek before entering the North Fork American River.

The Placer County Water Agency Middle Fork Development was planned and designed to meet the water requirements of Placer County for irrigation and domestic uses for the foreseeable future. Figure III-25 is a map of PCWA's Service area.

Information regarding the major storage projects is summarized in Table III-4. The SMUD and PCWA projects account for 77,000 and 331,000 ac-ft, respectively.

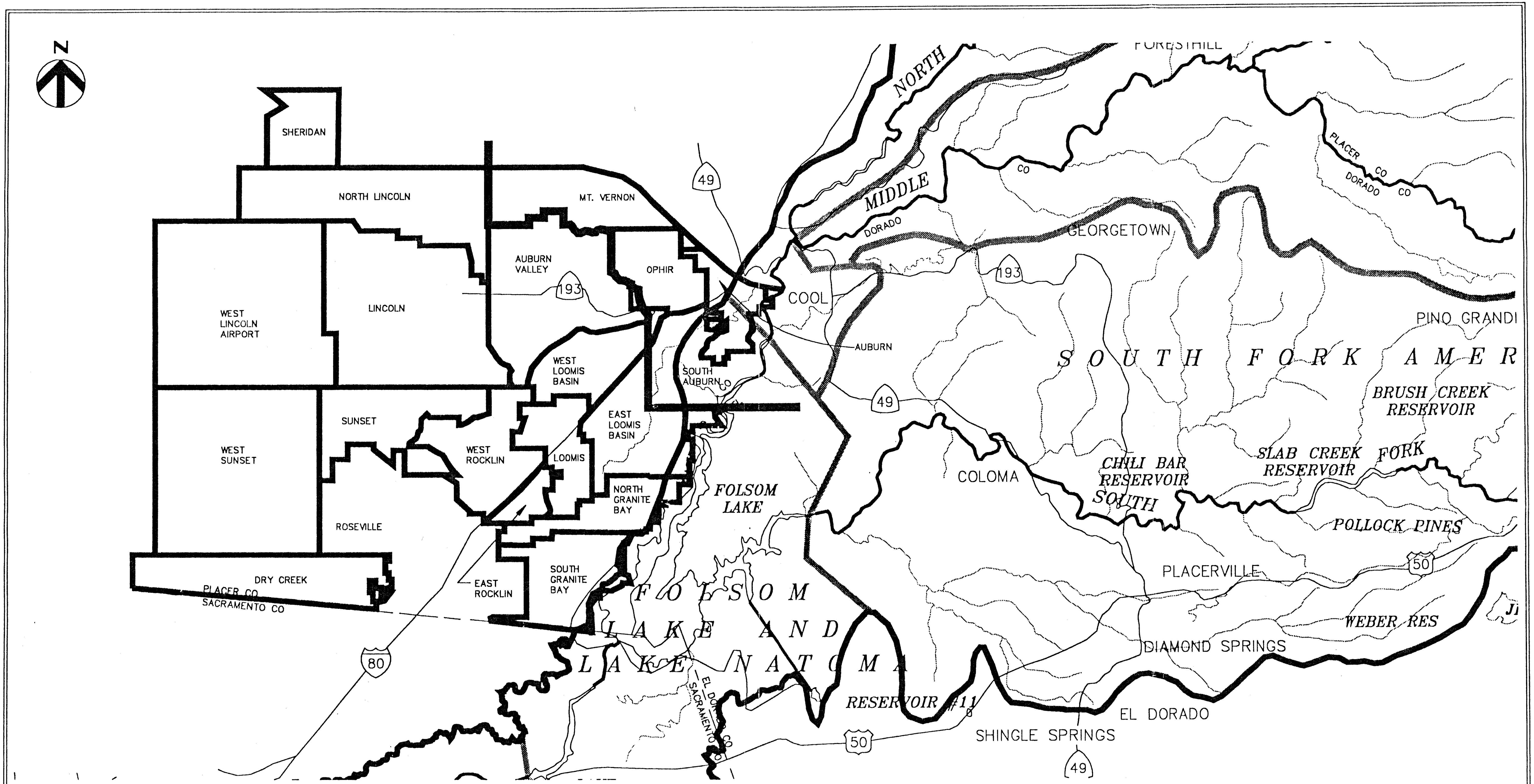
From the Middle Fork American River, reservoir releases enter the North Fork American River. PCWA may then divert from the North Fork when water is needed for emergency supplemental supplies to its service area in southwest Placer County (for description, see North Fork American River). The remaining flows enter Folsom Lake for storage to meet the needs of downstream users.

Georgetown Divide Public Utility District (GDPUD)--
The GDPUD system is described in some detail since it is the only utility to serve municipal and domestic users with water diverted directly from the Middle Fork American River Watershed. The GDPUD service area is situated approximately 45 miles northeast of Sacramento straddling the divide immediately south of the Middle Fork American and Rubicon Rivers.

The service area is shown in Figure III-26. It covers approximately 72,000 acres (112 square miles) of which about 30,000 acres has water service.

The primary source of water to GDPUD is the Stumpy Meadows Project, which includes storage facilities, diversion structures, and a conveyance system to the service area. A sanitary survey was conducted by Davis and Prince (1991) and it is the source of the following area-specific information.

Stumpy Meadows Reservoir is formed by a 162 foot high rock and earth fill dam (Mark Edson Dam) on Pilot Creek. Total storage is 20,000 ac-ft of which approximately 18,800 ac-ft is active. The water surface covers 330 acres at maximum pool. The outlet



PLACER COUNTY WATER AGENCY
SERVICE AREAS

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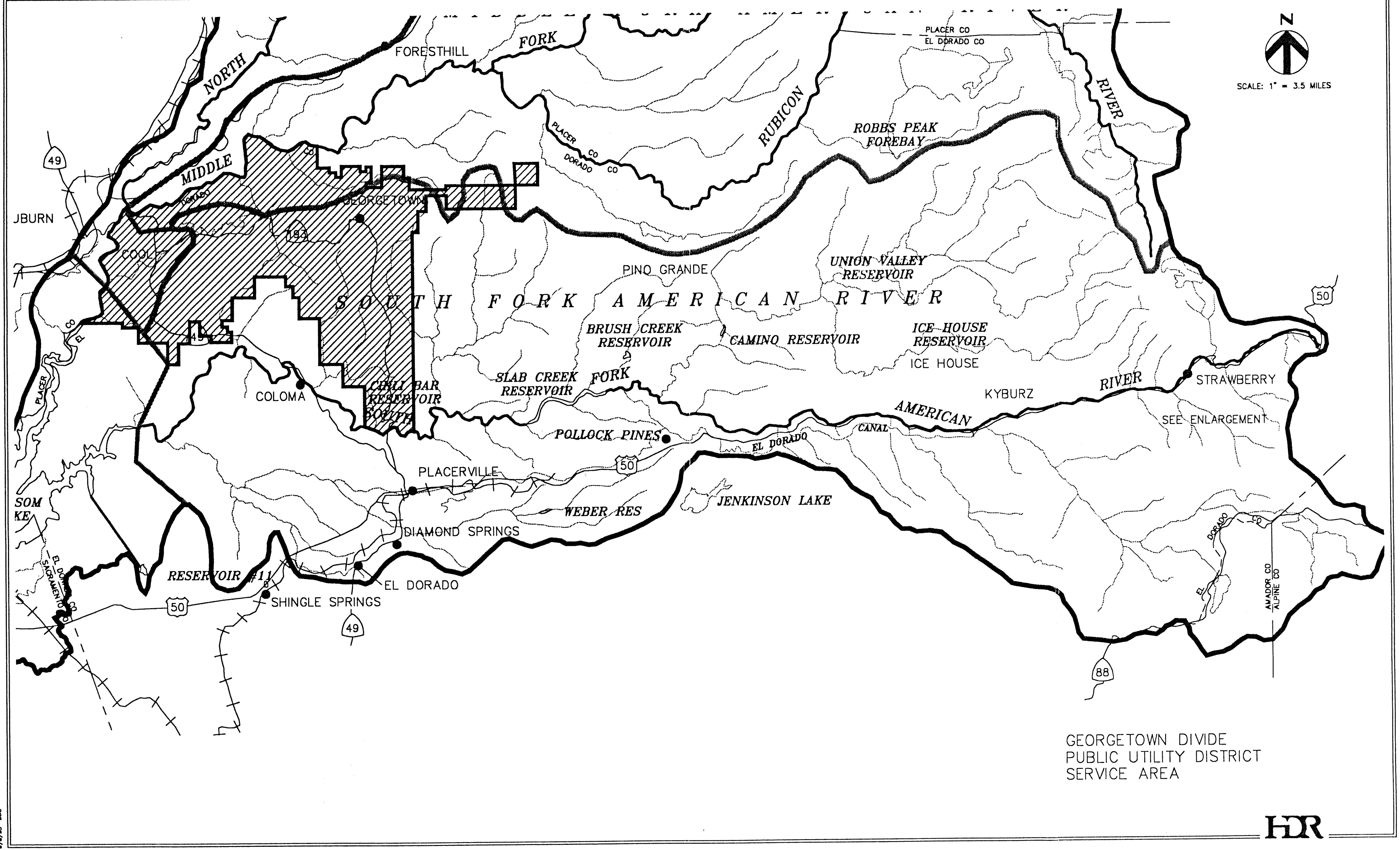
Figure III–25



GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
SERVICE AREA

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Figure III-26

Table III-4. Storage Reservoirs Middle Fork American River Sub-Basin					
Reservoir	Stream	Normal Water Surface Elev. (ft)	Useable Storage Capacity	Purpose [1]	Owner
Ralston Afterbay	Mid. Fork Amer. Rvr.	1,178	3	P	PCWA
Loon Lake	Gerle Creek	6,410[2]	77	P	SMUD
Hell Hole	Rubicon River	4,630	203	P,I	PCWA
French Meadows	Mid. Fork Amer. Rvr.	5,263	125	P,I	PCWA

[1] P - Power Generation; I - Irrigation.
[2] SMUD diverts a portion of the reservoir yield through its Robb's Peak Powerhouse and out of the SMUD basin via the Silver Creek drainage.

structure to Pilot Creek is a screened, 5' x 5' precast reinforced concrete intake tower with a sill elevation of 4132 feet (130' below the crest of the spillway).

The catchment area of the watershed supplying the Stumpy Meadows project is approximately 15.1 square miles, ranging in elevation from 4,170 feet to 6,190 feet. It is typical of small, mid-elevation watersheds of the western slope.

Water is released into Pilot Creek and is rediverted into the GDPUD water supply system by the Pilot Creek Diversion Dam, two miles downstream of Edson Dam, near the mouth of Mutton Canyon Creek. The Pilot Creek Diversion Dam is a 110' x 20' reinforced concrete structure which diverts water into the El Dorado Conduit. A 36-inch sluice gate controls the flow into an open concrete channel which provides the headworks for a 48-inch RCP conduit. The inlet structure is screened by a trash rack constructed of No. 8 rebar on 9-inch centers. The portion of the watershed above the diversion structure, which is not included in the Stumpy Meadows Reservoir watershed, is about 4.1 square miles.

Diversion structures along the El Dorado Conduit, capture water from cross drainages between Mutton Canyon and Tunnel Hill. These enroute cross diversions provide minimal supplementary supply to the GDPUD system; they drain only three square miles, all above Tunnel Hill.

Land Use and Ownership

Land Use--

The five principal categories of land use that were designated in the El Dorado County portion of the Middle Fork American River subbasin are Urban, Low Density Residential, Rural, Forestry, and Agricultural.

Most of the Middle Fork American River watershed lies within Placer County. Land use in the Placer County portion has been divided into the following five main categories which were developed with those used in El Dorado County:

- Urban (Cities, Commercial and Industrial).
- Residential (Urban and Suburban).
- Forestry, (including Tahoe National Forest).
- Agricultural).
- Rural (excluding agriculture and forestry).

These were derived from categories used in the Placer County General Plan (1992). The Planning Department has further defined its land use designations to include Incorporated, Commercial and Industrial, and Resource-based Categories (Timberlands, Agriculture, and Mining). A description of each of the general and more detailed land use categories follows:[5]

- Urban lands are those already designated for urban uses including the cities, and commercial and industrial uses.

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[5]Maps of these more detailed subcategories may be found in the Placer County General Plan. They have not been mapped for this report.

- The Incorporated designation includes areas designed of outside the cities of Colfax and Auburn that have the existing or potential ability to support residential, commercial or industrial land uses and are already incorporated.

- The Residential designation includes urban and suburban areas of single family homes, multi-family housing, and mobile homes.

- The Commercial designation includes lands used for offices, retail establishments, gas stations and highway oriented commercial use (including convenience stores and tourist oriented retail outlets.

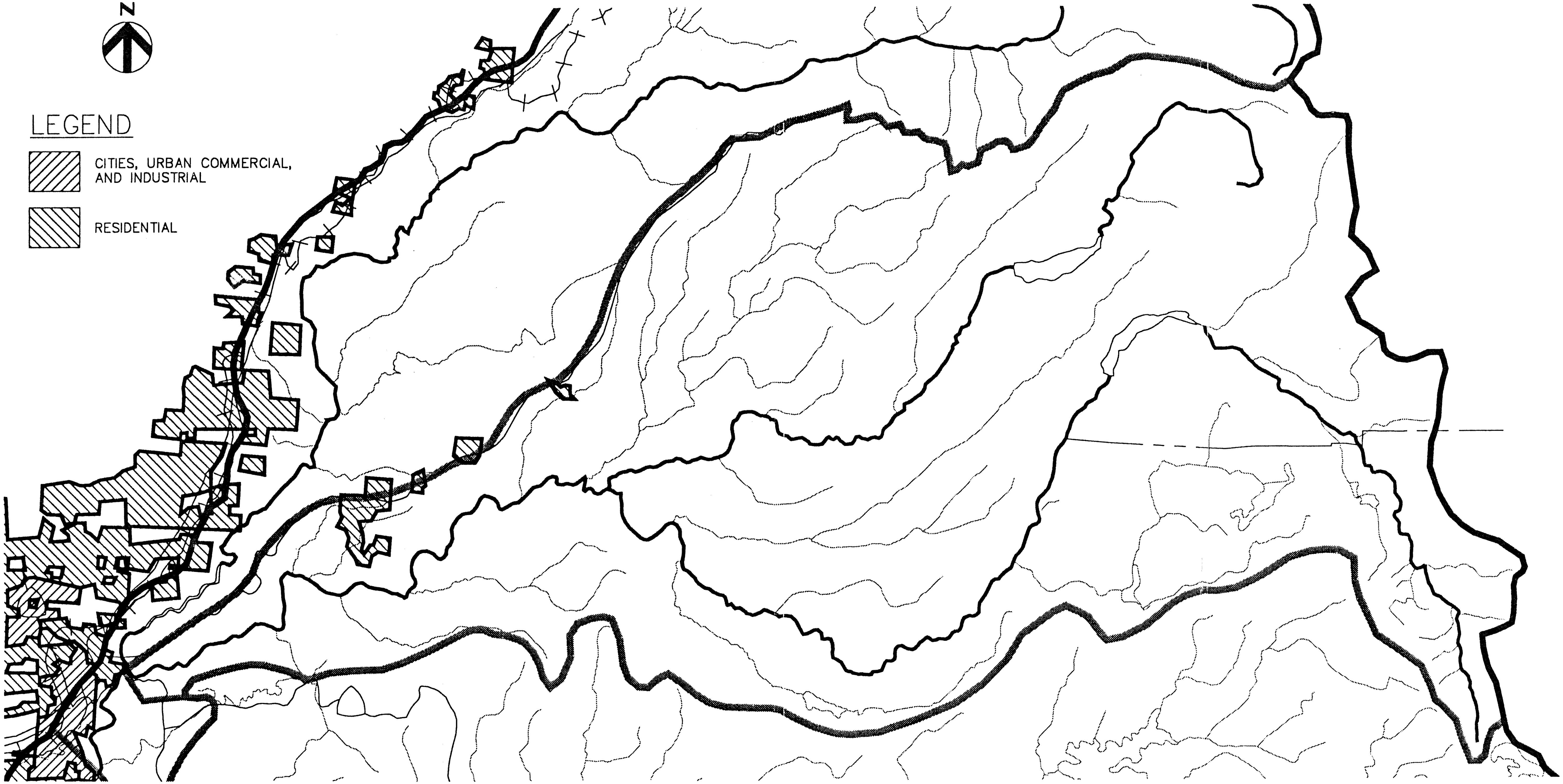
- The Industrial designation includes light warehousing, industrial and heavy industrial sites utilizing heavy manufacturing equipment or manufacturing large items.

- The Agricultural designation includes irrigated row crop production, dry land farming, livestock grazing, poultry production, orchards and vineyards.

- The Resource based designation includes timberlands, mines, and quaries.

Figures III-27A and III-27B are maps of the Middle Fork American River subbasin showing the distribution of the principal land use designations described above. Urban, Residential and Rural lands are shown in Figure III-27A and the Agricultural and Forest lands are shown in Figure III-27B.

The Middle Fork American River subbasin contains a portion of the Tahoe National Forest. Land use decisions and resource management within the National Forest are outside the jurisdiction of Placer County. The U.S. Forest Service has developed a Resource Management Plan to control future land use which is summarized below.



LAND USE IN THE
MIDDLE FORK SUB-BASIN OF
THE AMERICAN RIVER WATERSHED

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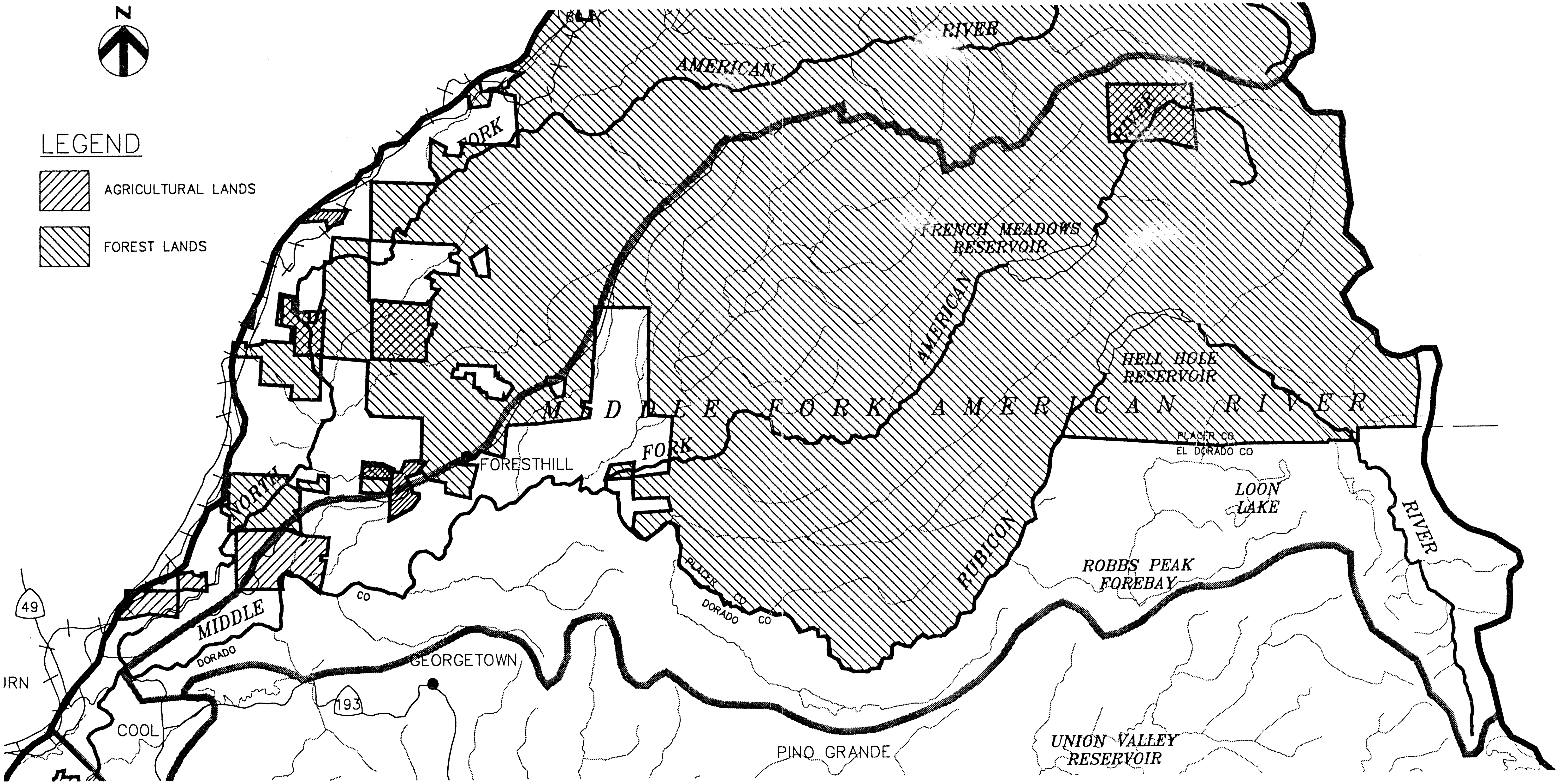
Figure III–27A



FORESTRY AND AGRICULTURAL LANDS IN THE MIDDLE FORK SUB-BASIN OF THE AMERICAN RIVER WATERSHED

HDR

Figure III-27B

- Grazing and timber harvest activities are to be maintained near present levels throughout the next ten to fifteen years. Timber production is proposed to be reduced after fifteen years.

- Existing ski areas and developed public recreation areas are proposed for expansion.

- Habitat protection areas are proposed for rare, threatened, and endangered species and about 18,700 acres is proposed for wilderness designation under the California Wilderness Act of 1984.

- The North Fork American River will be managed as a "Wild and Scenic River," which means that special management practices will be employed to preserve it in its natural state. The Resource Management Plan recommends study of the upper Rubicon River (in the Middle Fork American River subbasin) for possible designation as "Wild and Scenic."

- Activities that diminish or degrade views from scenic roadways, wilderness areas, and other sensitive areas will be reduced or eliminated.

Land Ownership--

For the purposes of this report land ownership is divided between public and private ownership. Figure III-28 contains the categories and acreages of land ownership in the subbasin and is a land ownership map of the watershed. The public lands within the Middle Fork American River subbasin are owned by either federal, state, or local governments. These public lands may be used for federal wilderness areas, national forests, multipurpose water supplies, parks, transportation right-of-ways, schools, and public buildings. The most significant public land holdings within the subbasin are subject to the jurisdiction of the U.S. Forest Service, Bureau of Reclamation, and the State of California Department of Parks and Recreation. These holdings are described below.

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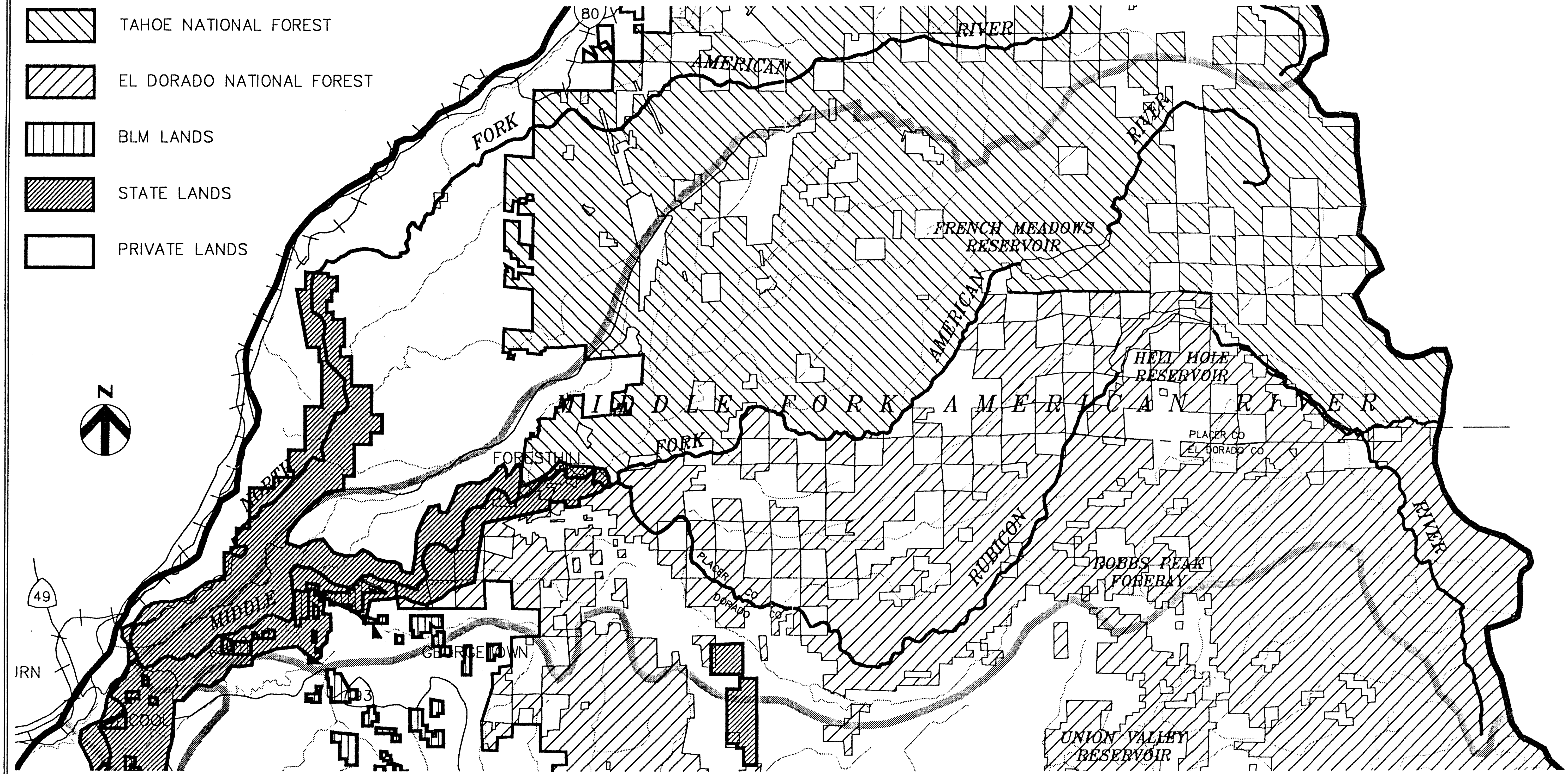


MIDDLE FORK SUBBASIN
LAND OWNERSHIP

HDR

Figure III-28

- The U.S. Forest Service manages the Tahoe National Forest (only the southern third is within the Middle Fork American River subbasin) which contains about 1,175,000 acres with 794,000 acres under National Forest ownership and the remaining 381,000 acres under private ownership. Most of the privately owned lands are in an "alternate section," or checkerboard pattern, and are surrounded by National Forest lands. This ownership pattern has caused problems between the National Forest and the private owners due to incompatible land use goals and objectives. The National Forest is continuing a program to consolidate ownership within the boundaries of the Forest, with existing private ownership being phased out through purchases, exchanges, and donations.

- The Bureau of Land Management (BLM) is a federal agency within the U.S. Department of Interior. BLM administers many lands scattered along the foothills of the Sierras but outside of the National Forest. They consist of several thousand acres of riparian lands and some timberlands and water supply reservoirs. The BLM water supply reservoirs within the Middle Fork American River subbasin include Lake Clementine and Sugar Pine Reservoir.

- The California Department of Parks and Recreation administers state park lands. Two of these state parks are located within the Middle Fork American River subbasin: about half of the Auburn State Recreation Area and a small portion of the Folsom Lake State Recreation Area. The Auburn State Recreation Area is located at the confluence of the North and Middle Forks of the American River. Folsom Lake is owned by BLM while the recreational facilities are administered by the State Parks Department.

NORTH FORK AMERICAN RIVER SUB-BASIN

Geography

Location--

The North Fork American River sub-basin watershed is located northeast of Sacramento and west of Lake Tahoe. Its position as the most northerly sub-basin was shown in Figure III-1; Figure III-29 is a detailed map of the sub-basin. U.S. Highway 80 passes through the sub-basin at or near the northern boundary of the watershed and Highway 49 crosses the river just below the mouth of the Middle Fork. Access to most of the canyon is very restricted, consisting only of a few trails and fourwheel drive tracks. The sub-basin lies almost wholly within Placer County except for the southerly drainage of the western reaches, which is in El Dorado County. The largest towns within the sub-basin are Auburn and Colfax. Because of the primitive, undeveloped condition of the North Fork American River, it has been designated by both the Federal and State governments as a National Wild and Scenic River.

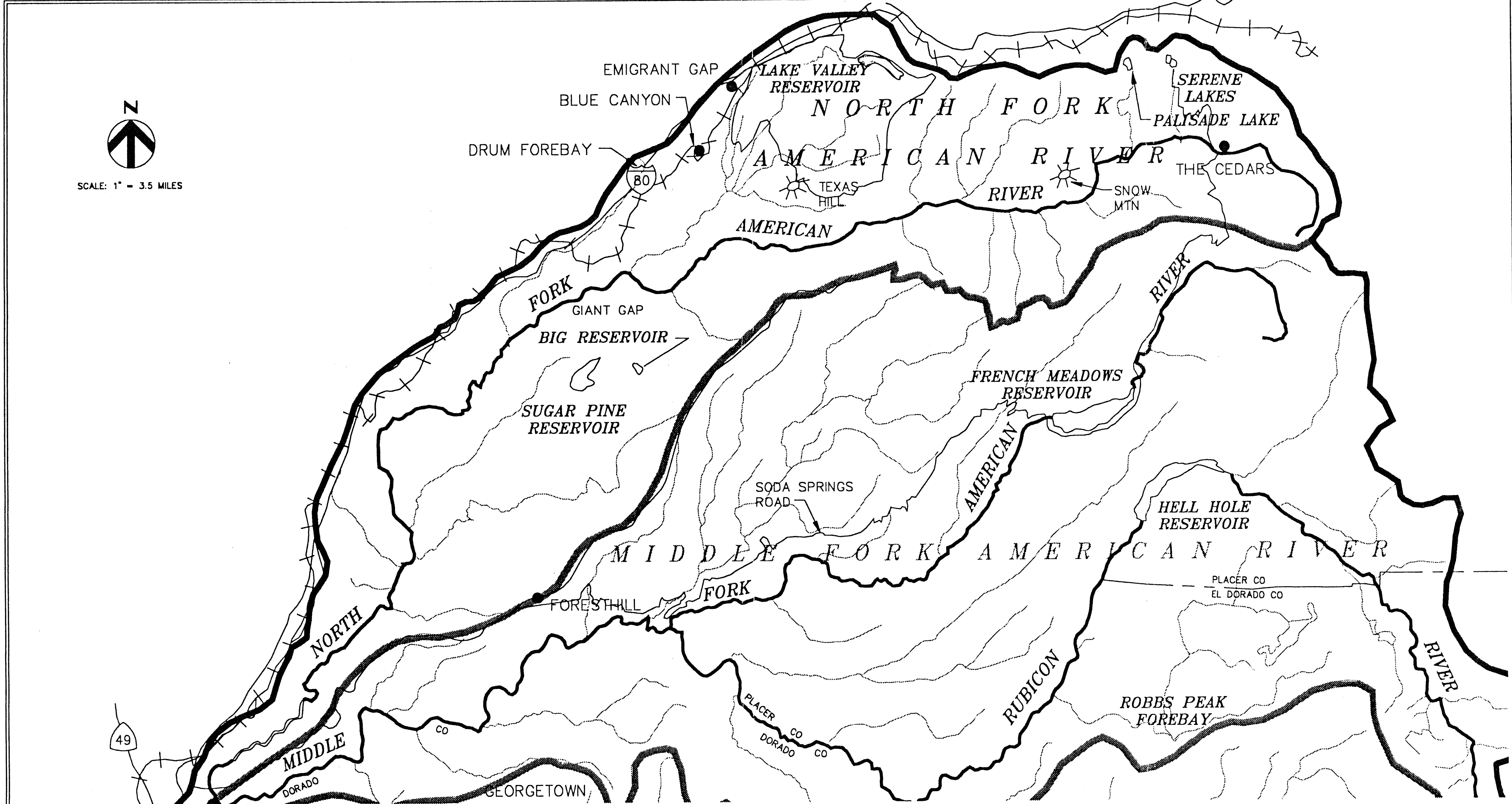
Watershed Area--

The North Fork American River sub-basin watershed constitutes approximately 308 square miles (197,120 acres) of the 1,900 square mile watershed of the American River. Tributaries of the North Fork American River include the North Fork of the North Fork, Shirttail Canyon Creek, Canyon Creek, and the Middle Fork American River (Figure III-29).

Topography

The headwaters of the North Fork American River rise just to the west of the Sierra Nevada crest on the northern slope of Granite Chief (elevation 9,005 feet) near Squaw Valley, and two miles north of the source of the Middle Fork. Initially, the North Fork American River plunges at a steep gradient of 200-600 feet per mile for 11 miles; then westward about 25 miles at a gradient of 50 feet per mile; and then at a gradually lessening gradient, as low as 20 feet per mile, southwestward another 20 miles to the mouth of the Middle Fork. From here it flows another 8 to 10 miles along a mild gradient to Folsom Lake, near Oregon Bar (elevation 466 feet). Tributary stream systems are generally steep in gradient.

For most of its length, the river occupies a deep, narrow "V" shaped canyon with steep and rocky, often precipitous slopes. The deepest and most rugged canyon of the entire American River Watershed is known as Royal Gorge and Giant Gap. The maximum elevation



NORTH FORK SUB-BASIN OF THE
AMERICAN RIVER WATERSHED

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Figure III-29

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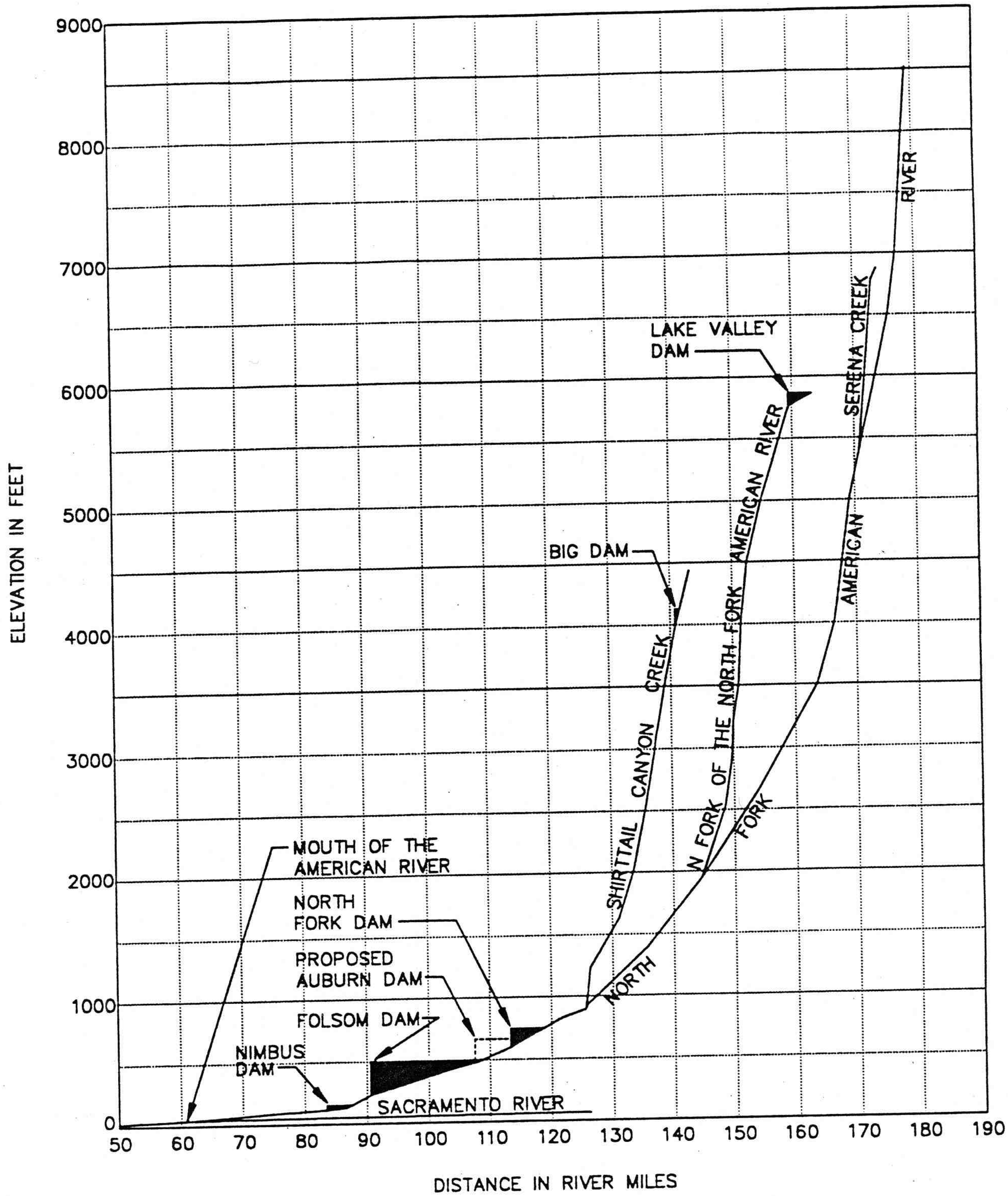
differential is 4,400 feet from the top of Snow Mountain to the canyon floor. The average basin slope is approximately 80 feet per mile (USCE, April 1991). There are a few relatively flat valley or plateau areas. A profile of the stream gradient is shown in Figure III-30. The relative inaccessibility of most of the watershed has left the river largely undeveloped and unmodified. The major land forms of the sub-basin are described below.

Major River Canyons--The deep, nearly straight middle reach of the North Fork, was formed during the period of erosion that followed the covering of the range by andesite mudflows. Slopes of this landform are generally steep to very steep, varying from about 30 percent to over 100 percent, while the stream gradients are generally low to moderate. The character of the canyon faces and slopes vary due to the variability of the metamorphic rock material that the North Fork American River traverses. In the Giant Gap area, the rock faces are extremely steep, nearly vertical in places, but the massive unfractured character of the rock results in little talus accumulation near the river.

Farther upstream in the Royal Gorge and on the slopes of Snow Mountain, the rocks are not as massive and are more susceptible to fracturing. Here the slopes are not as steep, and talus does accumulate on the lower slopes.

Dissected Uplands--The areas where small drainages are back-cutting and eroding at their heads into the flat-topped andesite uplands. The extent of this landform is limited to the area drained by the North Fork of the North Fork and the area along the north drainage divide of the lower reaches of the North Fork American River. Land surface erosion of these areas has occurred at slower rates than in the major canyon and side canyons due to the small size of the drainage areas and the low streamflows. The stream gradients are generally fairly steep.

Uplands--The remnants of the flat surfaces and gently rounded slopes created by the andesite mudflows. The lack of incised stream channels indicates low rates of runoff with much of the moisture infiltrating into the permeable rock. Hydraulic mining produced large areas of open, rock-strewn surfaces from ancient streambeds located on uplands in the Iowa Hill and Gold Run areas.



STREAM PROFILES
NORTH FORK AMERICAN RIVER

Figure III-30

Glaciated Uplands--Those areas in which the erosive forces and depositional products of glacial activity have profoundly sculpted and shaped the landscape. Included are steep peaks and crags, broad U-shaped valleys, abundant lakes, broad basins with very little soil, sporadic small areas of deep soil accumulation, and moraines. Meadows are widespread resulting from the filling of lakes and soil moisture damming by uneven bedrock or morainal deposits.

Geology

Most of the geologic formations consist of a wide variety of metamorphic rocks with intrusions of granitic rocks in the headwaters and along the northern drainage divide. The upper third of the sub-basin has been intensely glaciated and is characterized as alpine, with bare peaks and ridges, considerable areas of granite pavement, and only scattered areas of timber.

Paleozoic Metamorphic Rocks--These rocks have been cut and exposed by the North Fork from the vicinity of Big Granite Creek and New York Canyon downstream to Folsom Lake. Nearly the entire canyon and much of the uplands are composed of this unit. The only exception is in the Green Valley area where serpentine comprises the canyon walls and bottom.

The original marine sediments have been variously metamorphosed to phyllites with some slates and schists. These rocks may be deeply fractured as a result of internal physical stresses or heavy surface weathering, or massive where no joints were formed in the parent rock, or along streambeds and other freshly exposed surfaces.

Minor instability and erosion may occur on steep slopes with surface fracturing. Most natural slopes within the North Fork sub-basin are insufficiently steep or too massive to generate slides or rock fall. The lack of developed talus slopes in this sub-basin is a good indication that most slopes are relatively stable.

Base flows for many of the North Fork tributaries are produced from water infiltrating these rocks through fractures and fracture zones. These fracture zones have poor filtration characteristics.

Mesozoic Metamorphic Rocks--These rocks are metamorphosed marine sediments and volcanic materials that were deposited over the Paleozoic meta-sediments. They are found upstream from Big Granite Creek to the Serene Creek-Onion Creek area of the main canyon, and in much of the uplands.

There is less fracturing at depth and as a result, less water infiltration and exfiltration than in the Paleozoic rocks. More physical weathering and less chemical weathering have occurred where these formations lie close to the Sierra crest. Glaciation has stripped away most of the preglacial surface fracture zone from these rocks.

The stability of this geologic unit is variable. In areas with little surface fracturing the stability may be very high. However, physical weathering of the steep slopes, can produce extensive fracturing. Failures of this unit can increase local erosion and stream sedimentation, however they are not likely to result in any long-term or widespread effects.

Serpentine Rocks--There are two bodies of serpentine rock in the sub-basin; the larger one comprises the canyon walls and bottom in the Green Valley area and the smaller one is an isolated body near the Colfax-Iowa Hill Bridge. The Green Valley serpentine body continues north and outcrops occur along the uplands.

Physical weathering causes minor fine fracturing of the surface zone. Given sufficient moisture, clays form on the surfaces of serpentine rocks. While clay formation can contribute to unstable slopes, slope instability following disturbance and heavy rainfall is minor.

Disturbance of steep slopes with moderate to intensive fracturing could result in mass movements of sufficient size to disrupt the natural character of the canyon. However such fractures are rare or local in their scale.

Groundwater moves through surface fractures in this unit and is generally routed down slopes rather than deeper into the rock. However, in fault-shear and deeply fractured zones, water could percolate to considerable depths.

Granitic Rocks--Massive granitic formations left from those magma bodies that cooled at depth and are not high in magnesium or iron, are exposed in the headwaters and along the north drainage divide. Granitic rocks probably underlie the metamorphic rocks and most of the glacial deposits.

The granitic rocks are typically unfractured at depth, and in massive cliffs or outcroppings, with resultant low porosity and permeability. Physical and chemical weathering near the surface are accelerated in the joints since they provide routes for percolating waters. Thus, the weathering process produces granitic blocks which have regionally characteristic sizes and shapes. The nature and size of these blocks, and the angle of the joint planes help determine slope stabilities.

Tertiary Gravels--Rivers that flowed over the gentle, ancient western Sierran slope carried and deposited fine muds, silts, sands and gravel-sized material in their channels. These streams flowed over metamorphic and granitic bedrock until volcanic ash falls and mudflows buried the streams, as well as most of the surrounding topography. Thus these stream channel deposits lie under the rhyolitic ash fall material and above the surface of the metamorphic rocks. There are isolated areas where the channel deposits have been exposed by the physical removal of the overlying volcanic material.

On steep slopes, this geologic unit is occasionally unstable, particularly where the slope is wetted by surface flows or seepage. Slope failures are unlikely to have widespread effects unless surface erosion is accelerated and significant quantities of sediments reach the streams. Increased erosion and sediment transport is most probable when streamflows are high.

Due to the very limited extent of this unit in the drainage basin and its generally low permeability, it contributes little to the base flows.

Volcanic Ash--The volcanic ash unit is limited to ridge tops and dissected uplands. It is usually buried by volcanic mudflow material. It is generally stable except where saturated conditions exist and the natural slope has been over-steepened.

Ash units are usually composed of fine individual particles of volcanic glass, but sometimes occur as welded tuffs if the hot grains fused together. Where the unit is comprised of individual grains, it has high porosity but low permeability, due to the fineness of the particles. Ash deposits can hold large amounts of water, but movement occurs at slow rates, causing wet spots and low yield springs where exposed at the surface. Springs are commonly located near the top of the ash where water percolates through the overlying mudflow unit at a faster rate than the ash can absorb. Many of the perennial streams of the headwaters region originate within this unit. The water percolates along the buried upper surface of the unit until it intersects the surface.

Andesite Mudflows--Large quantities of volcanic materials were vented at the surface in the vicinity of the Sierra crest after the ash extrusions. This material mixed with snowmelt or rain and flowed over the landscape resulting in extensive formations. Several phases of activity resulted in a unit consisting of distinct horizontal layers of material with varying particle sizes, composition and hardness. Some lava flows occurred near the headwaters during later stages of the extrusive activity.

The stability of this unit tends to be fairly good. Talus slopes occur on the steeper slopes at higher elevations where physical weathering processes are active. Middle elevation occurrences are more stable unless slope alterations have been made in saturated areas.

The porosity and permeability of the unit are generally good. The amount of infiltration depends on the permeability of the overlying layer and the degree of weathering. Water tends to percolate down through the unit until a less permeable layer is reached. The water then flows horizontally to the surface where it emerges as a spring or broad seep.

Glacial Deposits--Repeated glacial advances in the North Fork drainage tended to scour the bedrock, removing loose material. This material became available for stream transport at the melting front of the glacier or was deposited on the land surface as moraines of various thicknesses. Only limited areas have accumulated thick deposits of morainal materials. This landscape includes the headwaters of the North Fork, and the North Fork of the North Fork American River.

There is little internal structure to moraines and alteration of the natural slopes can result in local slope instability. Resultant stream sedimentation problems are generally limited due to coarse nature of the deposits.

Generally, the moraines are highly permeable with little evidence of erosion. The water storage capacity of the thickest deposits is high and the unit can contribute significant quantities of surface flow during the dry season.

River Terraces--The scouring action of the glaciers produced large quantities of morainal materials, but stream-flows were not great enough at the time to transport all the material downstream. The stream beds aggraded through deposition of the surplus material. Since then, erosion has exceeded deposition and the streams have cut through the deposits leaving only occasional benches of material along the stream courses.

The stream deposits were highly permeable, well sorted and fairly stable where eroded. The cut slopes facing the stream tend to be steep, with an accumulation of loose material at their bases. During short periods of high stream discharge, the loose material is quickly eroded, contributing to the high bed load and turbidity.

Soils and Soil-Plant Associations

Soils in the North Fork American River sub-basin watershed vary with age, geologic parent material, topographic position, climate, vegetation, other biological factors and recent geologic events.

As described in the geology section, parent material varies considerably throughout the North Fork drainage. Although parent material continues to play the dominant role, most of the North Fork soils are strongly influenced by climate and vegetation.

In the scoured cirques and basins near the headwaters areas, glaciation (particularly during the past 100,000 years) caused the removal of the weathered material that developed prior to each advance. While the glaciation scoured the surface to bedrock in some areas, it deposited thick accumulations in other areas. The sparse soils of the most recently scoured bedrock areas have had only about 12,000 years to form. They are thin to nonexistent, and immature where present, consisting primarily of pulverized and weathered granite. Areas with thick glacial deposits of material are also very immature; however, due to wetter conditions, they are slightly more advanced than the bedrock soils.

Climatic conditions and the effect of slope aspect in the canyons and mountains on microclimatic variations are important determinants of the variety of soils (and vegetation) found on slopes.

On south- and west-facing slopes, soil development has been inhibited by drought conditions and restricted diversity of vegetation, while on the north-and east-facing slopes reduced temperatures have enabled better soil development, particularly at the middle and lowest elevations. Vegetation can also alter soils by shading. This can enhance the soil moisture capacity of the soil and extend the duration of moisture retention, resulting in improved soil development and vegetative growth. The ability of soils to infiltrate and percolate water in part depends of these factors and is highly variable. Soils with good water transmitting capabilities, which overlay geologic units that provide significant water storage capacity, are most important to the long-term, low flow conditions of the North Fork American River.

Soil depth, as related to other soil factors, influences its productivity and is, the same soil factors that contribute to soil depth also contribute to soil productivity. The areas of highest timber production are found on north-facing slopes and areas of relatively level topography at the middle elevations.

In the granular moraines and glacial till deposits just downslope from the highest basins, the soils are generally immature and they strongly reflect the physical characteristics of the parent material. These soils allow rapid infiltration, while those areas largely stripped of weathered material tend to be slowly permeable to impervious. In those areas that were not overrun by the Wisconsin glaciers, the soil mantle is well developed and good timber stands are supported. Where small, isolated areas of thick soil were deposited, timber growth characteristics are excellent because of the high availability of soil moisture.

Soils derived from the older metamorphic units tend to have a high clay content that decreases with depth to the zone where bedrock fragments and soil intermingle. The andesite mudflows are composed of variously sized particles, from fines to cobbles and boulders, randomly arranged within the individual layers. In some areas weathering processes have resulted in the development of clay-rich layers at depth.

Soils that have developed on the serpentine bedrock of the Green Valley area are very thin and rocky. Serpentine has high proportions of magnesium, nickel, chromium and cobalt. A low silica content precludes thick soil development except in regions of intense weathering and stable topography. The heavy metals that remain in the soil can retard plant growth, especially when the primary plant nutrients (nitrogen, phosphorus and potassium) are deficient. Where plant growth is impeded, biochemical weathering is usually restricted, and the end result is often perpetuation of the thin soils along with very low soil moisture storage capacity. As a result, the plants that grow on these serpentine soils tend to be very short, sparse, thin, and often misshapen. Many drought-resistant plants prefer these soils over those with greater moisture storage conditions, because available water meets their minimal needs and there is less competition from other species.

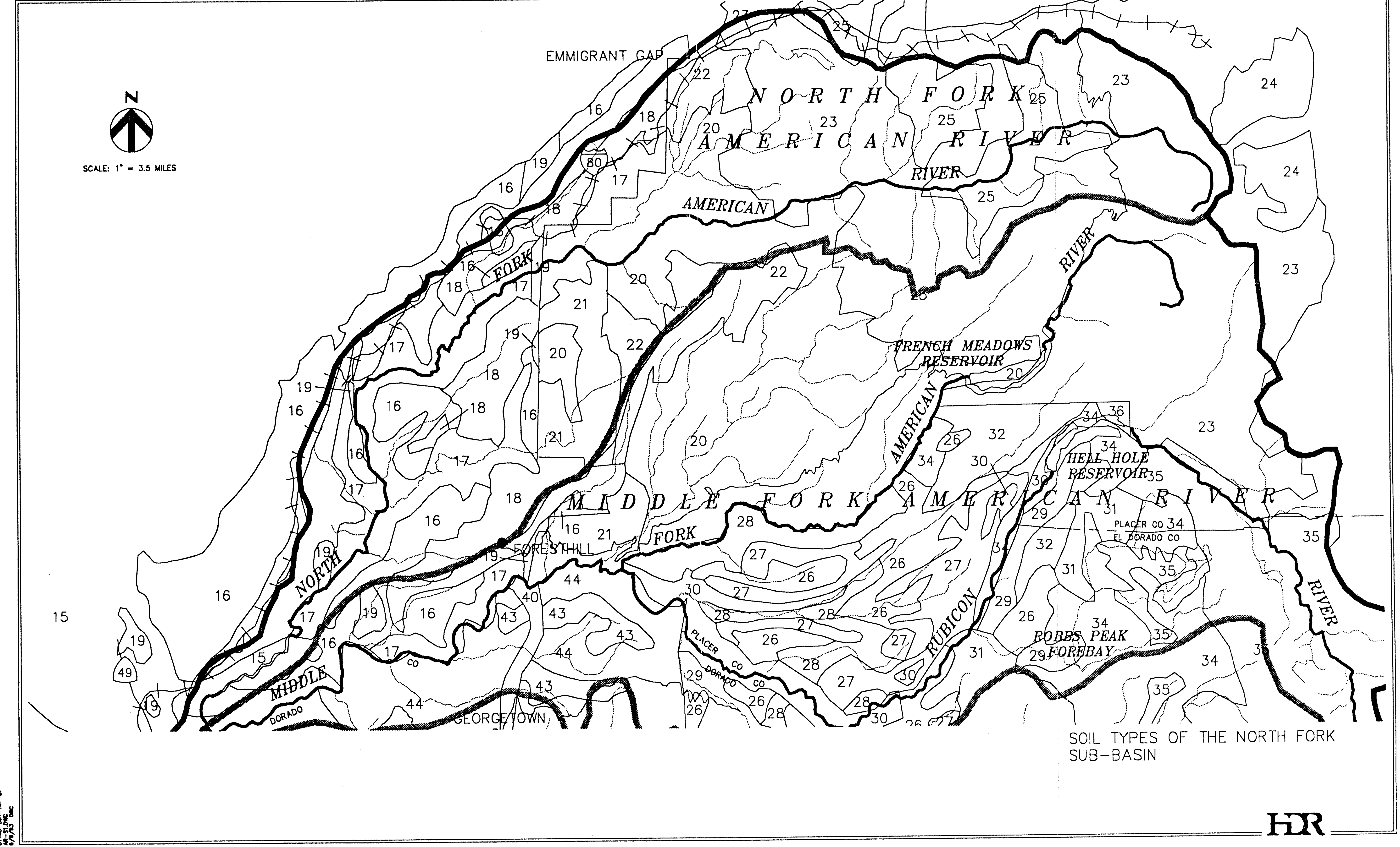
Deep red soils are found along the ridges in the lower reaches of the North Fork. These are highly oxidized soils that developed under the warm, humid conditions that existed about 40 million years ago. This soil has survived the extensive land surface erosion that has occurred since that time.

Throughout the remainder of the sub-basin, present climatic conditions act in concert with the physical properties of the parent materials to override other soil-forming factors. Soil development is most advanced in the lower half of the watershed where the deepest soils have formed under the most optimal humic and moisture conditions.

Principal uses of these soils include livestock forage production, deciduous orchards, timber production, and wildlife habitat. During recent years, the agricultural uses in the western portion have been reduced by expanding urban encroachment.

Soil associations of the sub-basins are described in the following paragraphs, along with their characteristic vegetation and land capabilities. They are subdivided for two purposes of description into the western associations and the eastern associations. Figure III-31 shows the areal distribution of the soils and land forms. Seven distinct soil associations (U.S.D.A., 1974) are found in the western portion of the North Fork American River sub-basin.

Exchequer--Shallow, well drained to somewhat excessively drained stony and cobbly loams overlying volcanic rock. They occur at elevations of 200 to 1,200 feet, on undulating to steep slopes. Plant cover consists of annual grasses, blue oak, and live oak. The principal use of this soil is cattle rangeland. A few areas are used for irrigated pasture and deciduous orchards.



SOIL TYPES OF THE NORTH FORK SUB-BASIN

Figure III-31

Andregg-Caperton-Sierra--Shallow, well drained to somewhat excessively drained sandy loams overlying granitic rock. They occur at elevations of 200 to 1,600 feet, on undulating to very steep slopes. Plant cover consists of annual grasses, oak, scattered brush and pine. The principal uses of this soil are cattle rangeland, watershed, and wildlife habitat. A few areas are used for irrigated pasture and deciduous orchards.

Mariposa-Josephine-Sites--Well drained, shallow to moderately deep, gravelly loams and clay loams overlying metamorphic rock. They occur at elevations of 1,200 to 3,500 feet, on undulating to steep slopes. Plant cover consists of conifer-hardwood forest and scattered brush. The principal use of this soil is timber production. A few areas have been cleared and used for deciduous orchards.

Maymen-Mariposa--Shallow to moderately deep, well drained to somewhat excessively drained gravelly loams overlying metamorphic rock. They occur at elevations of 1,200 to 3,500 feet, on hilly to very steep slopes. Plant cover consists of brush, scattered stunted conifers, and hardwoods. The principal use of this soil is watershed.

Cohasset-Aiken-McCarthy--Well drained, moderately deep to very deep, cobbly loams overlying volcanic rock. They occur at elevations of 2,000 to 5,300 feet, on undulating to steep slopes. Plant cover is conifer-hardwood forest. The principal use of this soil is timber production.

Dubakella-Rock Outcrops--Hard serpentine rock formations and moderately deep, well drained very stony loams overlying serpentine. They generally occur at elevations of 1,200 to 4,000 feet, on rolling to steep slopes. Plant cover consists of sparse brush and digger pine. The principal use of this soil is watershed. Some areas are quarried for crushed rock or mined for chromium.

Where well developed soils occur in the eastern portion of the North Fork American River sub-basin, six distinct soil associations (U.S.D.A., 1982) have been found. They are described below, along with their characteristic vegetation and land capabilities:

Hurlbutt-Deadwood-Putt--Shallow to moderately deep, well drained to somewhat excessively drained gravelly loams overlying metasedimentary rock. They occur at elevations of 2,000 to 6,000 feet, on nearly level to very steep slopes. The principal use of this soil is timber production.

Cohasset-Jocal-Holland--Deep to very deep, well drained clay loams overlying weathered andesitic conglomerate. They occur at elevations of 1,800 to 5,800 feet, on nearly level to very steep slopes. The principal use of this soil is timber production.

McCarthy-Crozier-Ledmont--Well drained, moderately deep gravelly and sandy loams overlying weathered andesitic tuffs and breccias. They occur at elevations of 2,000 to 6,000 feet, on nearly level to very steep slopes. The principal use of this soil is timber production.

Tallac-Smokey-Meiss--Shallow to deep, moderately well drained to somewhat excessively drained gravelly sandy loams overlying cemented glacial tills. They occur at elevations of 5,500 to over 9,000 feet, on nearly level to very steep slopes. The principal use of this soil is cattle rangeland.

Fugawee-Waca-Ahart--Moderately deep, well drained sandy, and gravelly sandy loams overlying weathered andesite. They occur at elevations of 5,500 to over 9,000 feet, on nearly level to very steep slopes. The principal use of this soil is timber production.

Rock Outcrop--Volcanic, granitic, rhyolitic, ultrabasic, or metasedimentary bedrock, exposed by glaciation, flowing water or surface erosion. They occur at elevations of 5,400 to over 9,000 feet, on nearly level to very steep slopes. Principal uses of this soil are watershed, wildlife habitat and recreation.

Vegetation

Variation in elevation, topography, micro-climate, and soil type impart wide diversity to the North Fork sub-basin. Most of the vegetation is typical of the western slopes of the Sierra

Nevada as modified by the soil-plant conditions. At the lower elevations, oak-pine woodlands are found with a preponderance of oaks (especially Black Oak) on all but the driest sites. At about 2,300 feet the coniferous forests begin to dominate with ponderosa pine the primary species. Knob Cone Pine may be found on fire-prone sites. As elevation increases, sugar pine and white fir become increasingly prevalent. Above 5,500 feet, red fir becomes the dominant forest species with interspersed Jeffrey pine, sugar pine, Sierra juniper, and white fir. At subalpine elevations Lodgepole and White pine are the dominant species with isolated stands of Mountain Hemlock. Aspen appear on moist or avalanche-prone sites throughout the upper forest belt. Above the treeline, willows, grasses and sages predominate as groundcovers.

The steep slopes support a wide variety of vegetation. A high level of biological activity occurs on north-facing slopes due to lower summer temperatures and more sustained soil moisture through the summer. These factors combine to support an upland vegetation assemblage dominated by Douglas fir and California nutmeg. Deciduous species include black oak and big-leaf maple. The high ground, soil and air temperatures of south-facing slopes, cause soil moisture losses that inhibit soil development and dessicete soils and plants throughout most of the growing season. Plant species that inhabit these slopes are either drought tolerant, annuals, and perennials or other plants that are active only during the more temperate spring and fall growing seasons. Canyon live oak are well-suited to the most extreme exposures. Ponderosa pine and deciduous oaks are limited to areas with less extreme conditions.

Microclimates along the canyon rim and walls cause unusual plant distribution anomalies. For example, vegetation next to the canyon rim that is representative of high elevation belts may be juxtaposed with south facing slope assemblages that are representative of vegetation belts normally found thousands of feet lower in elevations. Conversely, north facing slopes in the lower reaches of the canyon may support vegetation assemblages that are normally representative of much higher and cooler elevations. These anomalies are caused by the cool air drainage patterns that occur during the nights combined with the high solar insolation effects on south facing slopes as compared to the shaded conditions on the north-facing slopes.

Climate

Temperatures--

Air temperatures vary with elevation within the North Fork sub-basin. At 2,500 feet, the mean annual air temperature is 58°F, at 5,000 feet it is 51°F and at 8,000 feet is 39°F. At lower elevations winters are mild, but the summers are relatively long and hot, resulting in vegetation most suited to drought conditions. At middle elevations greater precipitation and cooler summer temperatures promote more substantial vegetative growth and enhanced soil quality. At higher elevations, longer, more severe winters, with prolonged snowpack cover and short cool summers result in inhibited soil development and vegetative growth.

Precipitation

The climatic character of the North Fork sub-basin watershed is dominated by the seasonal atmospheric pressure shifts off the California coast. These shifts generally produce wet winters and dry summers characteristic of the Mediterranean climate type at low elevations, becoming more continental at the higher elevations.

More than 95 percent of the precipitation received within the watershed comes from winter storms. Annual precipitation varies from 25 to over 70 inches, with an average, the highest of all the sub-basins, of 61 inches. Figure III-32 is an isohyetal map showing the average annual precipitation throughout the sub-basin. The average time distribution of precipitation at Blue Canyon, throughout the year was shown in Figure III-2. Forty percent of the total annual precipitation occurs as snowfall; at 5,000 feet 35 percent is snowfall, and at 7,000 feet 75 percent is snowfall (California Department of Fish and Game, July 1977). The distribution of precipitation is such that in a normal year, the soil column attains the moisture saturation level by the end of the winter or spring snowmelt period.

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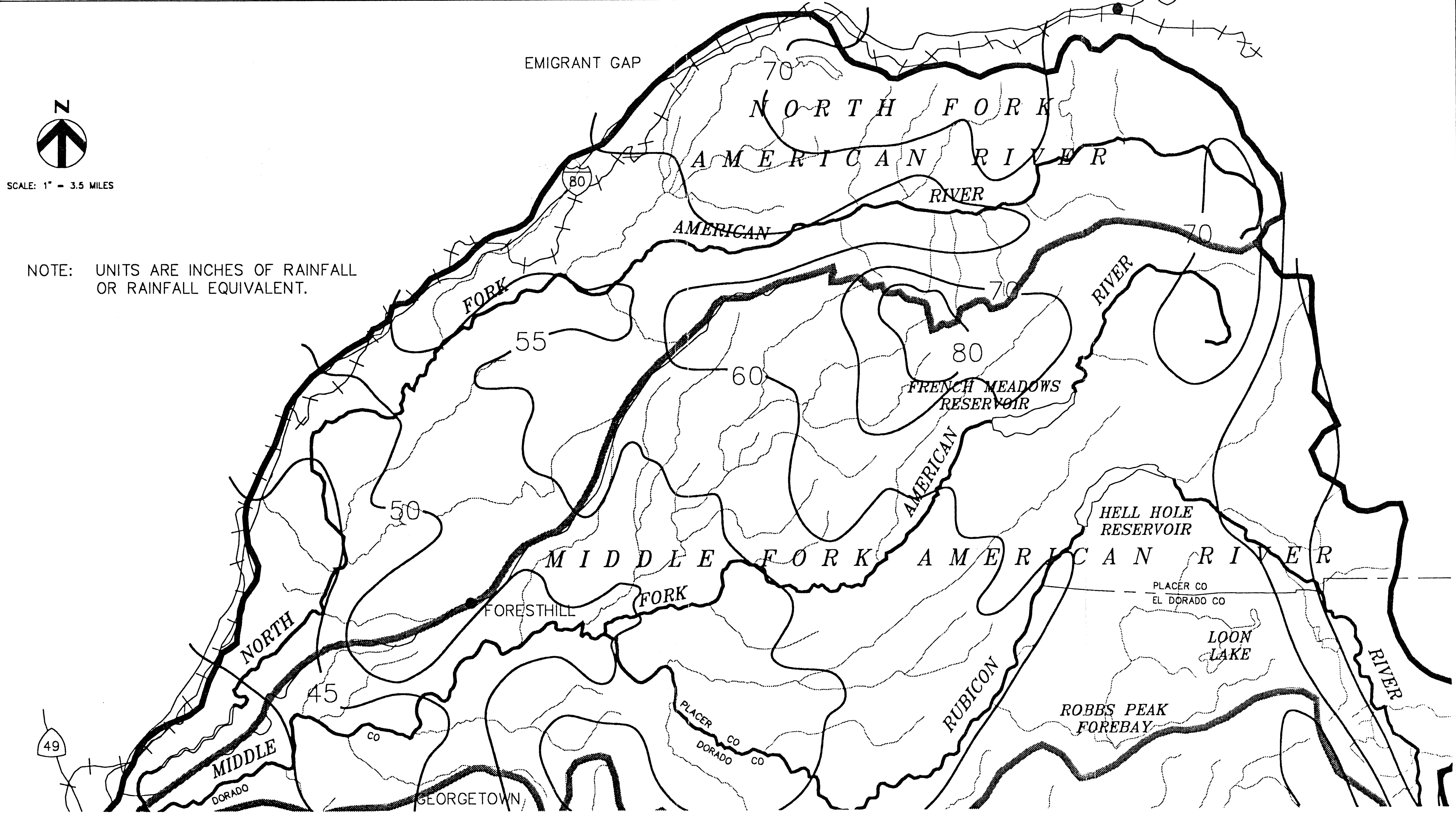


NOTE: UNITS ARE INCHES OF RAINFALL OR RAINFALL EQUIVALENT.

AVERAGE ANNUAL PRECIPITATION
THROUGHOUT THE NORTH FORK
SUB-BASIN

HDR

Figure III–32

Summer thunderstorms are infrequent, of short duration, but usually accompanied by localized high-intensity rainfall.

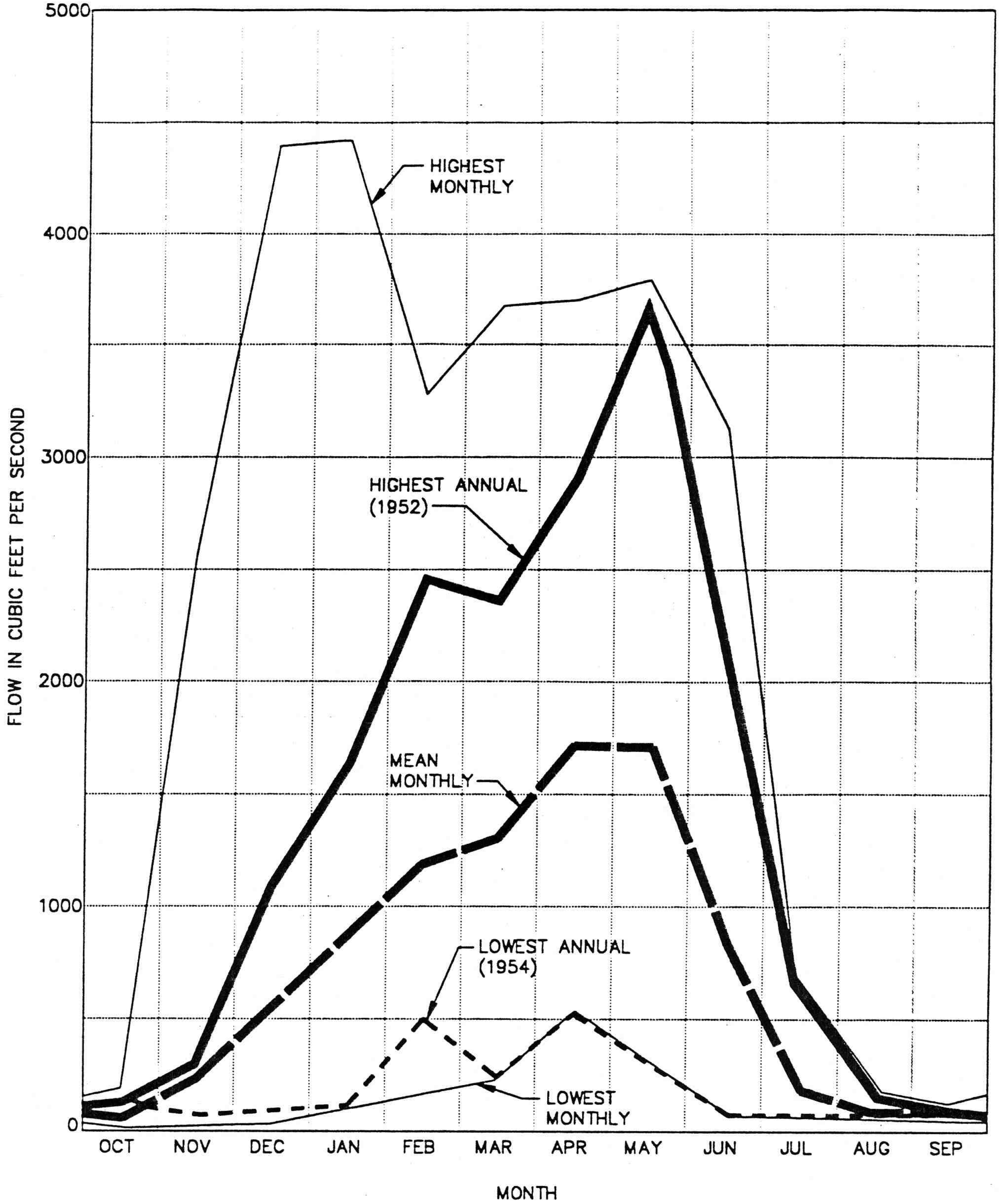
Hydrology

Many factors are important in the determination of the hydrologic systems of the North Fork American River. Climatic factors control the seasonal availability of moisture; and soil development, vegetation, and slope control the rate of surface runoff and percolation of water to underlying geologic formations. An understanding of this hydrologic system is necessary for a competent evaluation of the effects of human activities (described in the subsection entitled Special Hydrologic Aspects, page 8).

As a result of the relatively low soil and groundwater storage capacity of the North Fork sub-basin, the hydrologic system is closely tied to variations in precipitation from year to year. Figure III-33 demonstrates the extreme variance of seasonal and annual stream discharges from the sub-basin. Side drainage into the North Fork consists principally of Bunch Canyon Creek entering from the north and draining an area south of Colfax, Shirttail Creek entering from the south and draining the major portion of the Foresthill Divide, and drainage from the canyon walls.

Of the annual average precipitation (61 inches), an estimated average of 32 inches flows out of the sub-basin as streamflow (California Department of Fish and Game, July 1977).[6] Recorded flows in the North Fork American River vary greatly from year to year. The average flow at the North Fork Dam was 809 cfs between 1941 and 1991. Actual flows ranged from zero in 1944, 1963, and 1965 (due to closure of the valve at the base of the dam) to 65,400 cfs in 1964. The backwater of the North Fork Dam forms Lake Clementine; the dam is owned and operated by the U.S. Army Corps of Engineers and the lake by the

[6]Since there is negligible groundwater outflow, the remaining 21 inches is assumed to be stored as soil moisture and shallow groundwater that is available to be tapped by vegetation during the growing season.



RANGE AND DISTRIBUTION OF ANNUAL & MONTHLY FLOW REGIMES IN THE NORTH FORK AMERICAN RIVER NEAR COLFAX (1911–1960 WATER YEARS)

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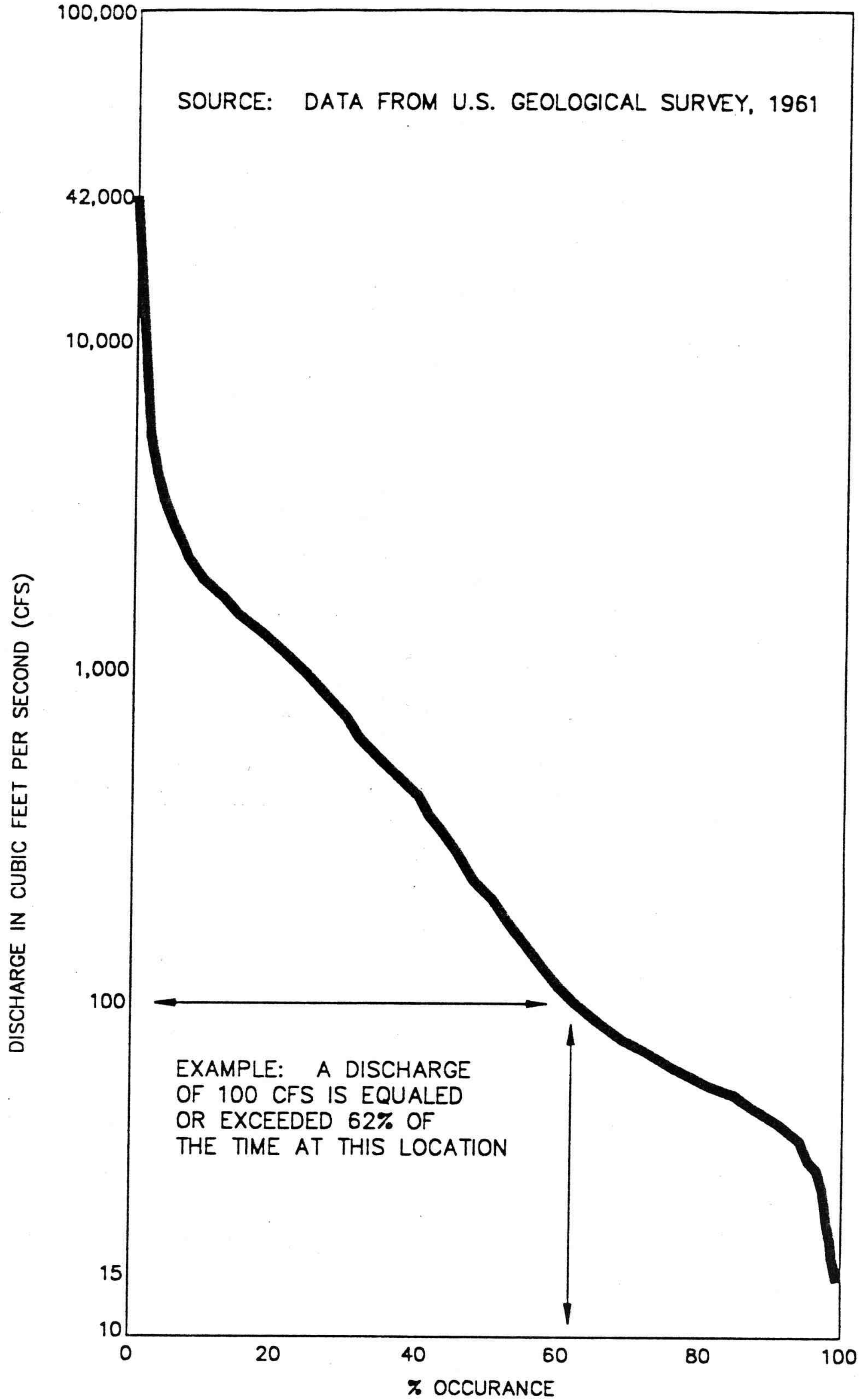
Figure III-33



ANNUAL FLOW DURATION CURVE
FOR THE NORTH FORK OF THE AMERICAN RIVER
NEAR COLFAX FOR THE PERIOD 1911–1941

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Figure III-34

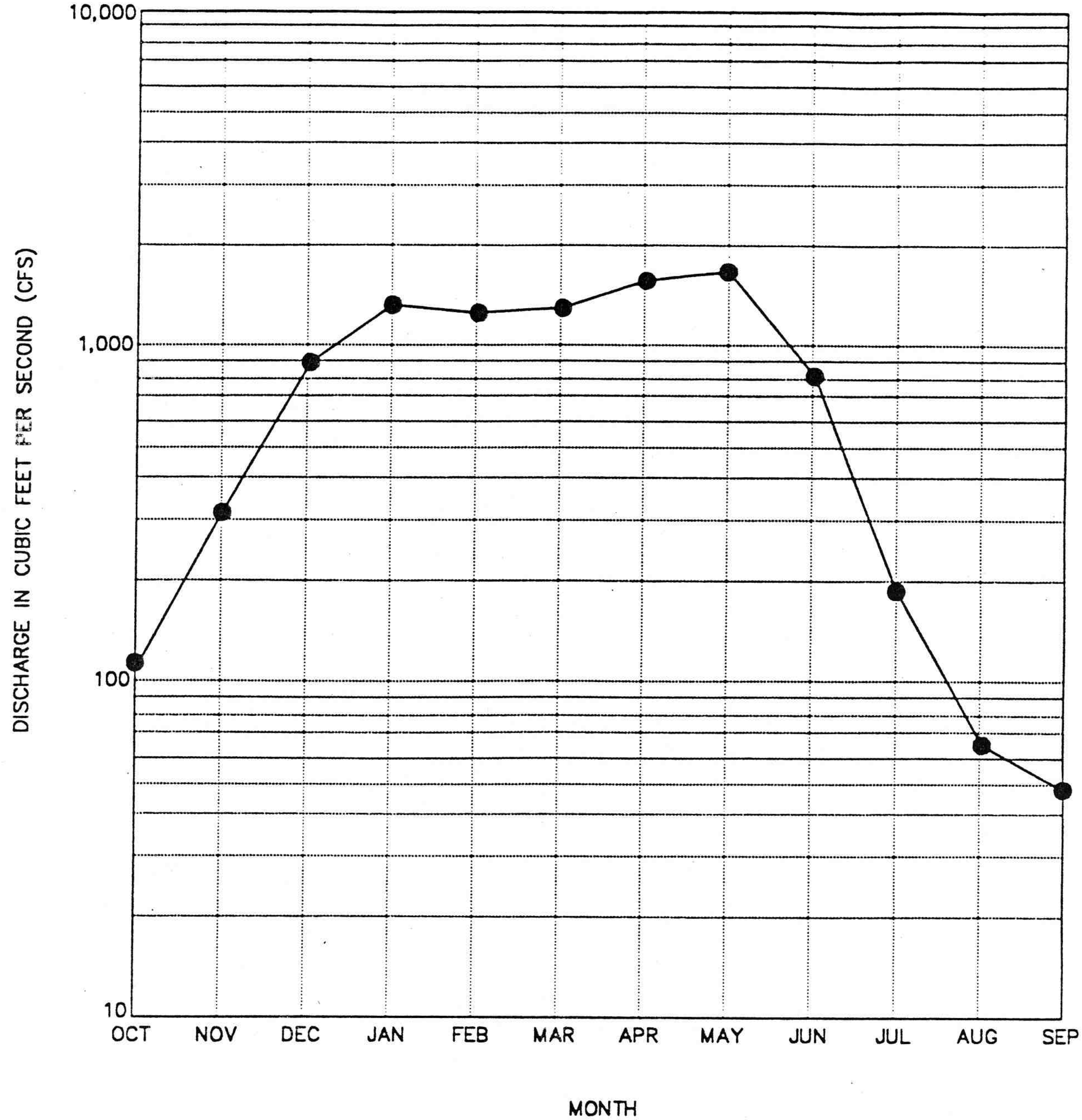
Bureau of Land Management. Minor regulation is provided by the North Fork Dam and Lake Clementine, which has a usable storage capacity of 12,800 ac-ft.

The range and distribution of annual and monthly flows in the North Fork American River above Lake Clementine from 1911 until 1960 was shown in Figure III-33. The annual flow duration curve for the period of 1911 until 1941 is shown in Figure III-34. This graph illustrates the probability of various flow levels on the river near Colfax.

Figure III-35 is a mean monthly hydrograph for the regulated discharge from North Fork Dam for the period 1942 to 1980. The stream flow hydrographs of the North Fork American River (Figures III-33 and III-35) are typical for an unregulated stream emanating from the high western slopes of the Sierra Nevada. Low base flows, which consist primarily of groundwater discharge, occur in the late summer and early fall. From the onset of the rainy season in autumn, flows increase until January. With much of the precipitation in the upper basin being stored as snow between January and March, there are resulting drops in stream-flows during this period. As spring approaches and air temperatures increase, a period of rapid snowmelt occurs, and stream-flows increase. After peak flows occur in May or early June and the snowpack becomes depleted, streams recede rapidly and return to low flow conditions again by late summer.

Note that although the flow volumes can vary significantly during the winter season, the low base flow periods show uniformity and consistency. This demonstrates the presence of soil-geologic units within the watershed that, although limited in capacity, have good soil moisture and groundwater storage characteristics, and thus the capability to sustain water discharges throughout the dry season.

Some water is diverted out of the sub-basin above Lake Clementine from the North Fork of the North Fork American River by the Lake Valley Canal. The canal is two miles downstream from Lake Valley Reservoir and it diverts water into the Drum Canal in the Bear River watershed to the north for hydroelectric power generation by Pacific Gas and Electric Company (PG&E), and ultimately for irrigation, industrial, and domestic use by



MEAN ANNUAL DISCHARGE = 809 CUBIC FEET PER SECOND (1941–1991)

EXTREMES:

MINIMUM DISCHARGE = NO FLOW (MANY TIMES)
MAXIMUM DISCHARGE = 64,400 CUBIC FEET PER SECOND (DECEMBER 23, 1964)

HYDROGRAPH OF MEAN MONTHLY DISCHARGE
FOR THE PERIOD 1942–80 AT
NORTH FORK AMERICAN RIVER AT NORTH FORK DAM

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Figure III-35

others. Diverted flows range from nothing on many days of most years to 75 cfs in 1980. The average annual diverted flow was 16.1 cfs between 1964 and 1991. PG&E diverts water into Auburn Tunnel and South Canal for power generation and domestic use by Placer County Water Agency two miles downstream from the mouth of the Middle Fork. Diversions average <2,000 ac-ft per year as supplied by Bureau of Reclamation.

The combined storage and diversion is minimal and has little effect on the natural flow as recorded at the North Fork American River at the North Fork Dam gaging station.

Sugar Pine Reservoir, a Bureau of Land Management (BLM) facility, with a capacity of 7,000 ac-ft, and Big Reservoir, a private recreational facility with a capacity of 1,000 ac-ft, are located on the north Shirttail Creek.

The combined storage capacities of Lake Valley, Sugar Pine, Big and North Fork Reservoirs total approximately 25,000 ac-ft. A limited quantity of water is imported into the sub-basin from the Bear River via the South Bear River Canals. Some of the water is distributed for irrigation and the remainder is spilled into the North Fork American River near Newcastle. Average diversions into the Bear River Canal were 309 cfs from 1913 to 1953 and from 1965 to 1991.

Water Supply Systems

Placer County Water Agency (PCWA) receives water from the North Fork American River only during the winter, when PG&E terminates canal deliveries to perform annual maintenance and repairs. Water is diverted from the river via an intake structure, with trash rack, and pump sump located near the river level just upstream of the failed cofferdam. Per the 1972 Bureau of Reclamation land purchase contract, PCWA pumping facilities were removed and the Bureau is obligated to deliver water as needed by PCWA into the Auburn Tunnel inlet in the American River Canyon (outlet near Ophir) until or unless Auburn Dam is completed. The Bureau of Reclamation installs temporary pumps to accomplish this upon request by PCWA. Water then flows through the Auburn Tunnel by gravity. A coffer dam located near Auburn Ravine backs up water in the tunnel. Six well pumps lift water from bowls located in the tunnel into PG&E's South Canal. All of the water is transported by gravity to the Foothill Water Treatment Plant (WTP). Figure III-36 is a schematic representation of the water intake system.

PCWA's entitlements to the American River waters total 210,000 ac-ft per year by the year 2007. PCWA diverts water from the American River only during PG&E's winter outage of the South Canal or in case of an emergency with PCWA's primary water source. The remainder of the year Foothill WTP meets its demands from the Yuba/Bear River.

Land Use and Ownership

Land Use--

The five principal categories of land use that were designated in the El Dorado County portion of the North Fork American River sub-basin are Urban, Low Density Residential, Rural, Forestry, and Agricultural.

Most of the North Fork American River watershed lies within Placer County. Land use in the Placer County portion has been divided into the following five main categories which were developed to be consistent with those used in El Dorado County:

- Urban (Cities, Commercial and Industrial).
- Residential (Urban and Suburban).
- Forestry (including Tahoe National Forest).
- Agricultural.
- Rural (excluding Agriculture and Forestry).

These were derived from categories used in the Placer County General Plan (1992). The Planning Department has further defined its land use designations to include Incorporated,

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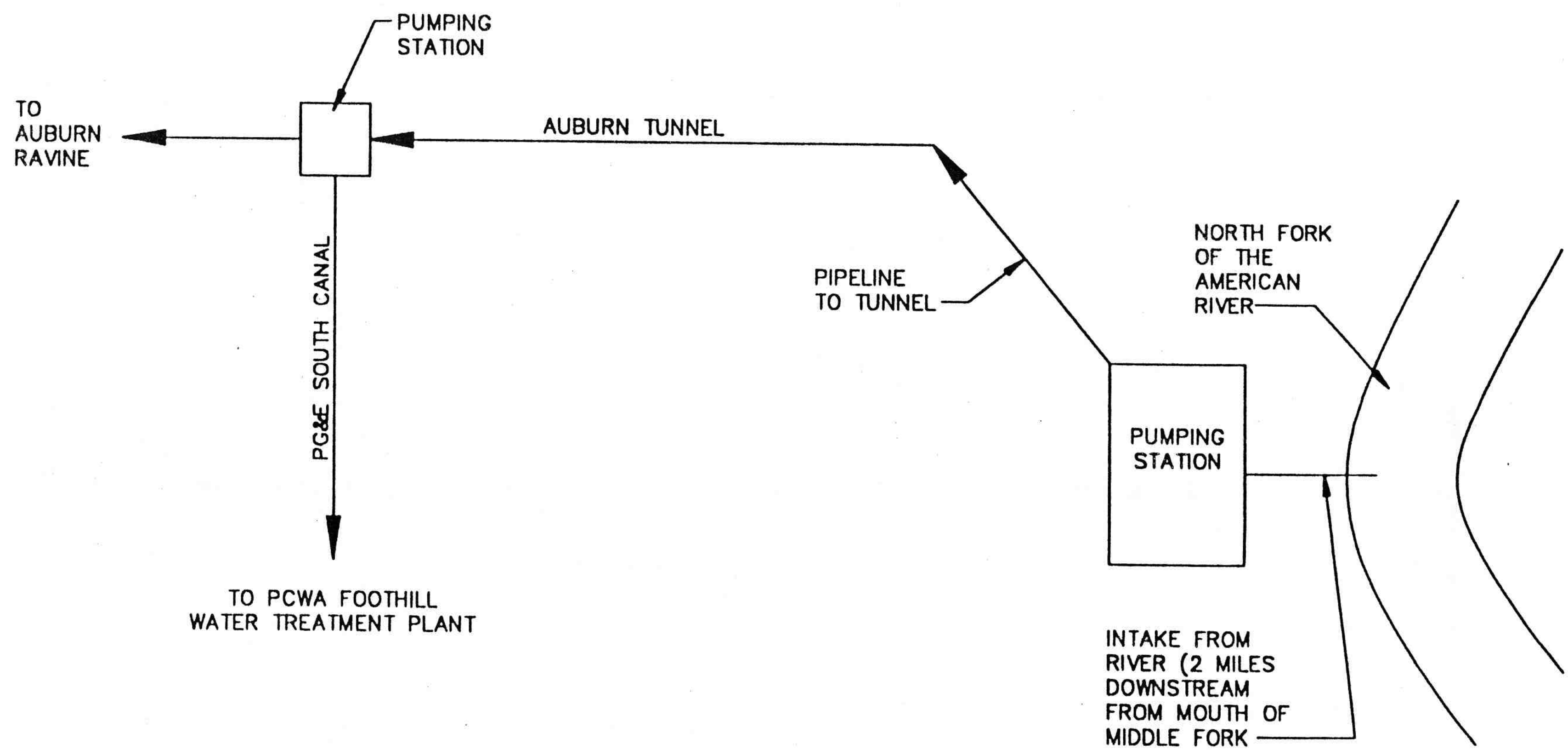

SCHEMATIC OF PCWA INTAKE SYSTEM

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Figure III-36

Commercial and Industrial, and Resource-based Categories (Timberlands, Agriculture, and Mining). A description of each of the general and more detailed land use categories follows:[7]

- Urban lands are those already designated for urban uses including the cities, and commercial and industrial uses.

- The incorporated designation includes areas designated outside the cities of Colfax and Auburn that have the existing or potential ability to support residential, commercial or industrial land uses and are already incorporated.

- The Residential designation includes urban and suburban areas of single family homes, multi-family housing, and mobile homes.

- The Commercial designation includes land used for offices, retail establishments, gas stations and highway oriented commercial use (including convenience stores and tourist oriented retail outlets.

- The Industrial designation includes light warehousing, industrial and heavy industrial sites utilizing heavy manufacturing equipment on manufacturing large items.

- The Agricultural designation includes irrigated row crop production, dry land farming, livestock grazing, poultry production, orchards and vineyards.

- The Resource based designation includes timberlands, mines, and quarries.

Figures III-37A and III-37B are maps of the North Fork American River sub-basin showing the distribution of the principal land use designations described above. Urban, Residential

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[7]Maps of these more detailed subcategories may be found in the Placer County General Plan. They have not been mapped for this report.

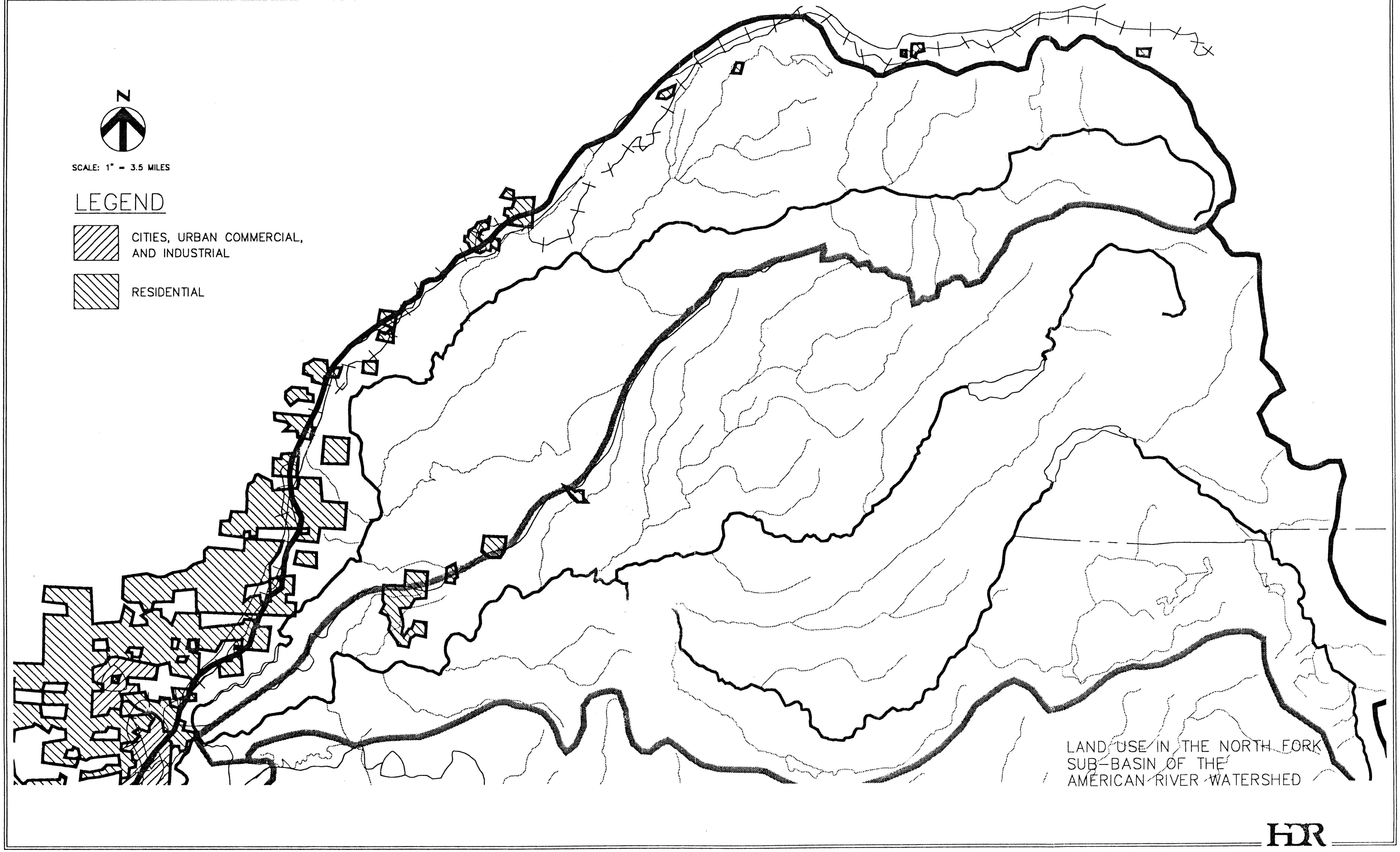


Figure III-37A

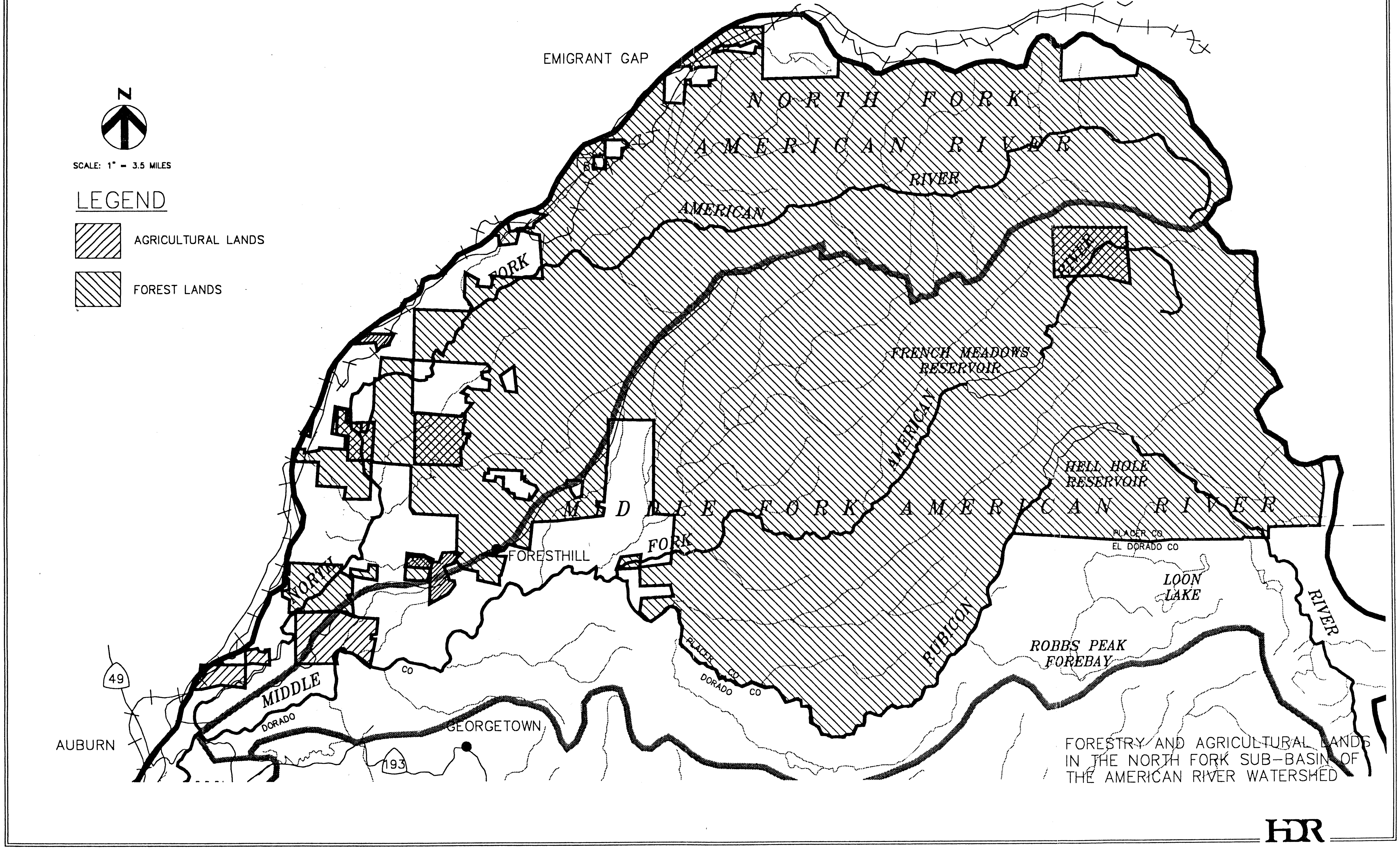


Figure III–37B

and Rural lands are shown in Figure III-37A and the Agricultural and Forest lands are shown in Figure III-37B.

The North Fork American River sub-basin contains a portion of the Tahoe National Forest. Land use decisions and resource management within the National Forest are outside the jurisdiction of Placer County. The U.S. Forest Service has developed a Resource Management Plan to control future land use which is summarized below.

- Grazing and timber harvest activities are to be maintained near present levels throughout the next ten to fifteen years. Timber production is proposed to be reduced after fifteen years.

- Existing ski areas and developed public recreation areas are proposed for expansion.

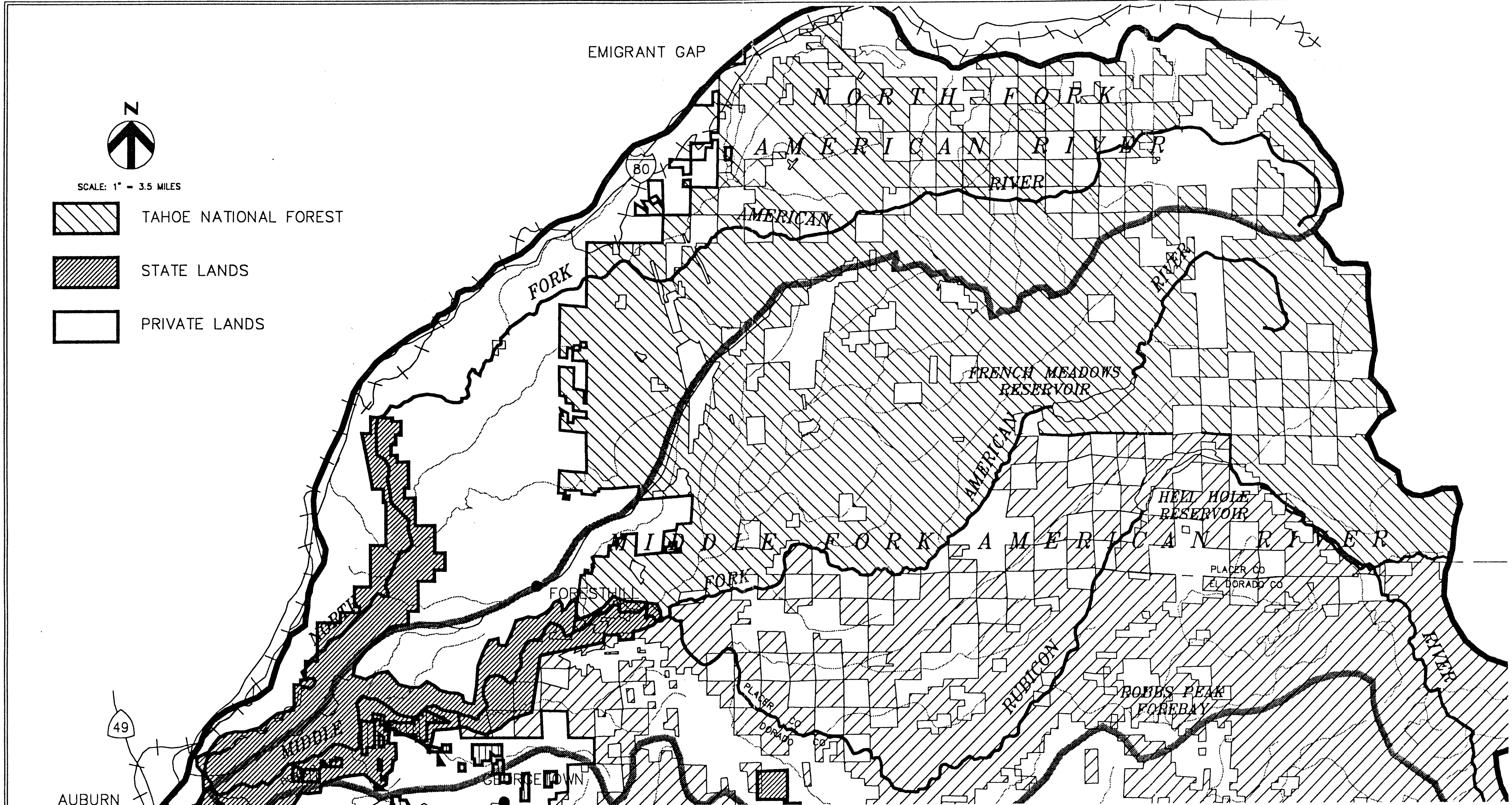
- Habitat protection areas are proposed for rare, threatened, and endangered species and about 18,700 acres is proposed for wilderness designation under the California Wilderness Act of 1984.

- The North Fork American River will be managed as a "Wild and Scenic River," which means that special management practices will be employed to preserve it in its natural state. The Resource Management Plan recommends study of the upper Rubicon River (in the Middle Fork American River sub-basin) for possible designation as "Wild and Scenic."

- Activities that diminish or degrade views from scenic roadways, wilderness areas, and other sensitive areas will be reduced or eliminated.

Land Ownership--

For the purposes of this report land ownership is divided between public and private ownership. Figure III-38 is a land ownership map of the watershed. The public lands within the North Fork American River sub-basin are owned by either federal, state or



NORTH FORK SUB-BASIN
LAND OWNERSHIP

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Figure III-38

local governments. These public lands may be used for federal wilderness areas, national forests, multipurpose water supplies, parks, transportation right-of-ways, schools, and public buildings. The most significant public land holdings within the sub-basin are subject to the jurisdiction of the U.S. Forest Service, Bureau of Reclamation, and the State of California Department of Parks and Recreation. These holdings are described below.

- The U.S. Forest Service manages the Tahoe National Forest (only the southern third is within the North Fork American River sub-basin) which contains about 1,175,000 acres with 794,000 acres under National Forest ownership and the remaining 381,000 acres under private ownership. Most of the privately owned lands are in an "alternate section," or checkerboard pattern, and are surrounded by National Forest lands. This ownership pattern has caused problems between the National Forest and the private owners due to incompatible land use goals and objectives. The National Forest is continuing a program to consolidate ownership within the boundaries of the Forest, with existing private ownership being phased out through purchases, exchanges, and donations.

- The Bureau of Land Management (BLM) is a federal agency within the U.S. Department of Interior. BLM administers many lands scattered along the foothills of the Sierras but outside of the National Forest. They consist of several thousand acres of riparian lands and some timberlands and water supply reservoirs. The BLM water supply reservoirs within the North Fork American River sub-basin include Lake Clementine and Sugar Pine Reservoir.

- The California Department of Parks and Recreation administers state park lands. Two of these state parks are located within the North Fork American River sub-basin: about half of the Auburn State Recreation Area and a small portion of the Folsom Lake State Recreation Area. The Auburn State Recreation Area is located at the confluence of the North and Middle Forks of the American River. Folsom Lake is owned by BLM while the recreational facilities are administered by the State Parks Department.

FOLSOM RESERVOIR AND LAKE NATOMA

Geography

Location--

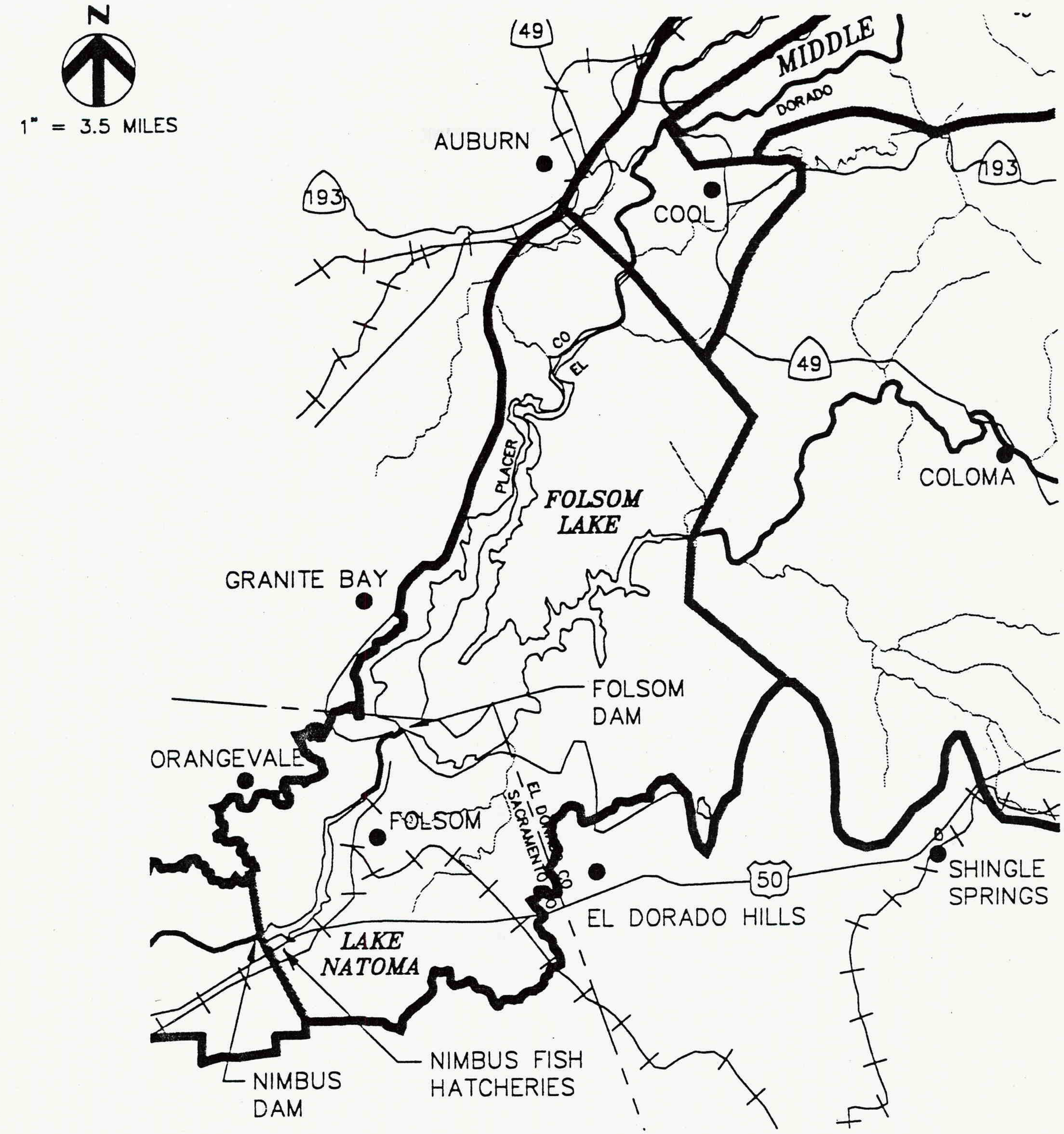
Folsom Dam is located on the American River at the topographic break in slope between the Central Valley and the west slope of the Sierra, midway between the communities of Folsom and Granite Bay. Its crest elevation is 480.5 feet (MSL) and the water surface level has fluctuated between 355 and 467 feet (MSL) over the last ten years. When full, Folsom Reservoir inundates 10,315 acres of federally owned lands in Placer, Sacramento and El Dorado counties, including the site of the historical confluence of the North and South Forks of the American River.

Nimbus Dam is located 4 miles downstream from Folsom, just upstream from the Hazel Avenue Bridge, which connects Orangevale with the City of Folsom. Its crest elevation is 130 feet and it forms Lake Natoma, the afterbay to Folsom Reservoir and forebay to the Nimbus power plant. Since it is a reregulating reservoir, Lake Natoma's water surface remains at a more constant level than Folsom. At full capacity it inundates 540 acres of federally owned land in Sacramento County.

The location of the Folsom Lake-Lake Natoma sub-basin in relation to the other sub-basins was shown in Figure III-1. Figure III-39 is a detailed map of the sub-basin.

Watershed Area--

Folsom Reservoir collects the outflows from the North, Middle and South Forks of the American River as well as from 52,120 acres immediately to the north, east, and south of the reservoir. Stored water is then released through the powerhouse and/or spillways into a short segment of canyon leading to Natoma Reservoir. In addition to Folsom's watershed, Lake Natoma collects runoff from 27,465 acres of adjacent land.



FOLSOM LAKE AND LAKE NATOMA
SUBBASIN OF THE AMERICAN RIVER
WATERSHED

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Figure III-39

Topography

The two reservoirs are located amongst the lowest of the Sierra Nevada foothills.

Topography around Folsom Lake is rolling, with numerous small incised ephemeral drainages. The reservoir has inundated the deeply incised canyon of the historical main stem American River and the lower portions of the North and South Fork Canyons. It extends upstream almost to Auburn on the North Fork and just beyond Salmon Falls Bridge on the South Fork.

The topography adjacent to Lake Natoma is somewhat rolling, grading into a slightly rolling plain to the south and west, with pronounced 100-foot bluffs close to the North Shore. The lake is surrounded by gravel bars and piles of placer tailings left from the mid-nineteenth century gold dredging. Elevations range from 270 feet at the top of the bluffs to 100 feet at the base of Nimbus Dam.

Elevations around the lakes range from 126 to 1,869 and slopes are from 0 to >75 percent.

Geology

Folsom Reservoir, the canyon immediately to its west, and Natoma Reservoir lie in the metamorphic belt of the western foothills of the central Sierra. The metamorphosed volcanic and sedimentary rocks range in age from 140 to more than 300 million years old. The strata have been faulted and folded in complex patterns, then eroded into a landscape of moderate relief. Volcanic and sedimentary rocks were then deposited over the old erosional surface. Regional uplift and western tilting formed the present drainage patterns, inducing erosion and canyon cutting. The Foothill Fault system is a series of subparallel, northwest trending, near vertical faults which includes at least two major fault zones. The easternmost is the Melones Fault zone, and the westernmost is the Bear Mountains Fault zone, which intersects the main body of Folsom Lake. This system is about 200 million years old; the last major movement occurred approximately 140 million years ago (USCE, 1992).

The canyon below Folsom Dam and valley below Lake Natoma are part of the Great Valley Geomorphic province of California. The broad valley was filled with erosional debris that originated in the surrounding mountains. These deposits consist of successive unconsolidated layers of clay, silt, and sand. Fresh alluvium was deposited with each floodflow event until the present surface was formed.

Sedimentation continues in the reservoir but the rates are relatively low due to limited upstream development, the general shallowness of soils, a low rate of upstream erosion, and numerous containment basins. Estimates of the annual sediment yield range from 0.1 to 0.3 ac-ft per square mile. Since the completion of Folsom Dam and Reservoir in 1955, only about 2 percent of the reserved sediment storage space has been filled (USACE, 1992).

Soils and Soil-Plant Associations

The soils of this region were formed from the sedimentary rocks and underlying metamorphics. They tend to be shallow and coarse, except in the valleys and swales where slopes are low and the organic component is high. Stream courses, gullies and the river banks along exposed sections of the canyon are lined with unconsolidated deposits of clay, silt, sand, gravel and cobbles.

Figure III-40 is a generalized soils map of this sub-basin. Descriptions of each soil unit follow:

Xerorthents--Xerorthents are very deep, excessively drained and somewhat excessively drained soils located in and on dredge material tailings near the American River. The soils formed in material containing high amounts of gravel and cobbles derived from mixed rock sources that were deposited as tailings during mining operations. Loose gravel or cobble layers are commonly interbedded with these soils. Slopes range from 0 to 50 percent.

Minor areas of the well drained Red Bluff and moderately well drained Redding soils occur on the high terraces of this unit. Red Bluff soils are very deep with a clay loam and gravelly

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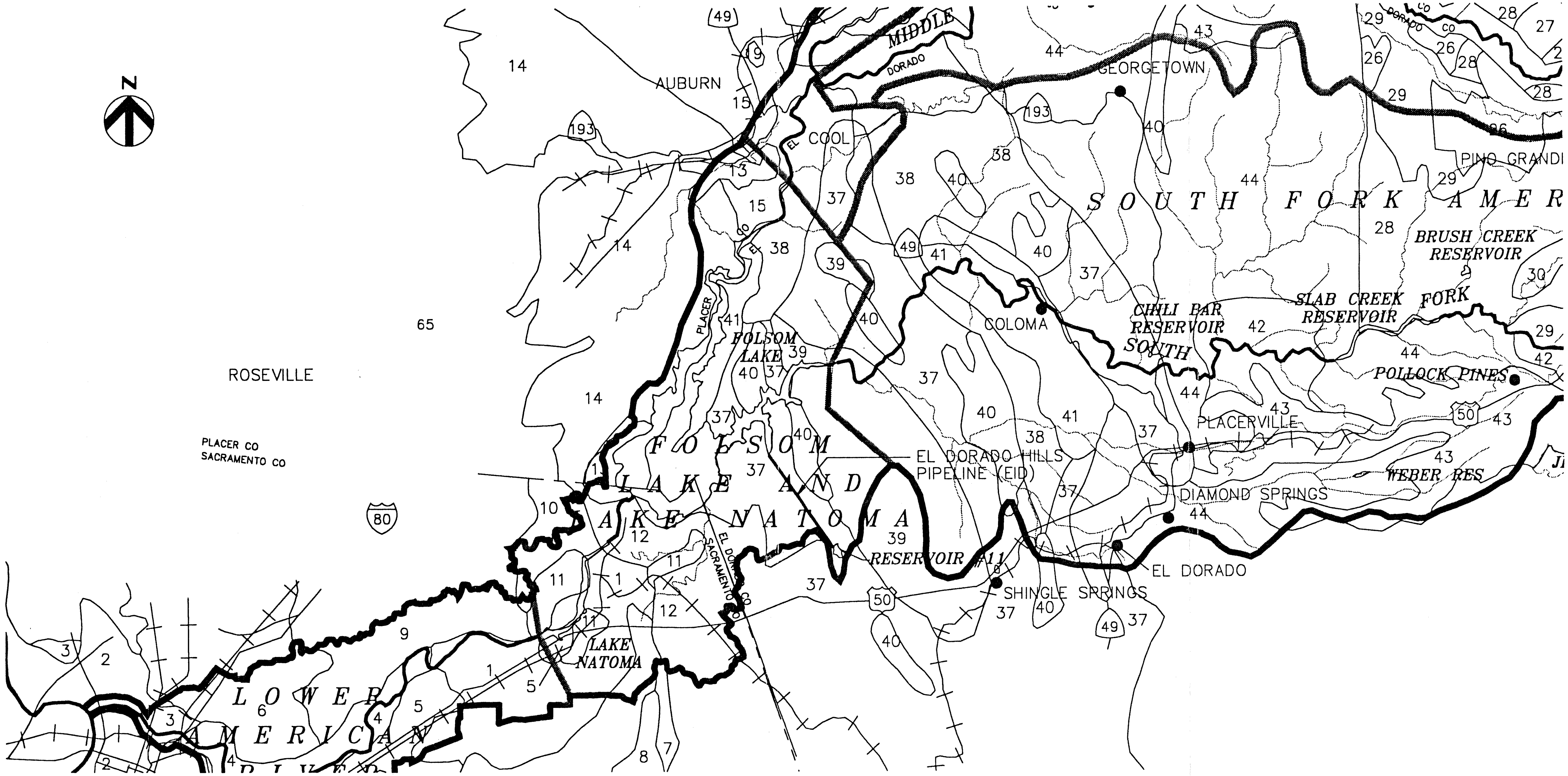

SOIL TYPES OF THE FOLSOM LAKE AND LAKE NATOMA SUB-BASIN

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Figure III-40

clay subsoil. Redding soils have a gravelly claypan and are moderately deep over a strongly cemented hardpan.

Areas of this unit are used mainly for wildlife habitat and urban development.

Where this unit is used for urban development, the main limitations are steepness of slope, rapid and very rapid permeability and the high content of gravel and cobbles. Extensive grading and leveling is required to prepare this unit for urban development. Because of the rapid and very rapid permeability, on-site sewage disposal systems may cause contamination of the groundwater. Cut banks of trenches and excavations are subject to sloughing. Topsoil is required for landscape plants.

Urban Land-Americanos-Natomas--Urban lands consist of areas covered by impervious surfaces such as roads, driveways, sidewalks, buildings, and parking lots.

Americanos soils occur on low stream terraces. They are deep to very deep and well drained. Typically, the surface layer and subsoil consist of silt loam underlain by a discontinuous, weakly silica-cemented sandy loam at a depth of 50 to 72 inches.

Natomas soils occur on low terraces. They are also very deep and well drained. Typically, the surface layer is loam underlain by a clay loam subsoil and a sandy loam substratum. Areas of this unit are used primarily for urban development; there are few limitations.

Orangevale-Fiddyment Soils--These are well drained, very deep or moderately deep soils over a cemented hardpan. They are formed in coarse alluvium derived from granitic rocks and in materials weathered from consolidated sediments of mixed rock sources. The sediments are weakly to moderately consolidated sandstones and siltstones. Slopes range from 2 to 25 percent.

Orangevale soils occur on high terrace remnants, dissected high terraces and on hills north of Lake Natoma. These soils are very deep and well drained. Slopes range from 2 to 25 percent. Typically, the surface layer is coarse sandy loam. The subsoil is sandy clay loam over coarse sandy loam.

Fiddyment soils occur on hills. They are moderately deep and well drained. Slopes range from 1 to 8 percent. Typically, the surface is fine sandy loam. The subsoil is a claypan underlain by a hardpan at a depth of 20 to 40 inches.

Areas of this unit are used mainly for urban development, limited by the moderate or high hazard of water erosion. The Fiddyment soils are limited by the low strength and very slow permeability of the subsoil, moderate hazard of water erosion and moderate depth to hardpan. Steep cut and fill slopes are susceptible to erosion and should be permanently protected by structural or vegetative measures.

Redding-Corning-Red Bluff Soils--These consist of moderately well drained, deep soils over a cemented hardpan, and well drained, very deep soils.

Redding soils occur on high terraces and terrace remnants. They are moderately deep and moderately well drained. Slopes range from 0 to 15 percent. The surface layer is usually gravelly loam and the subsoil is a gravelly claypan underlain by a hardpan at a depth of 20 to 40 inches.

Corning soils also occur on high terraces and terrace remnants and on smooth terrace sideslopes. They are very deep and well drained. Slopes range from 0 to 30 percent. Typically, the surface layer is gravelly, fine sandy loam and the subsoil is claypan. The substratum is stratified, gravelly, sandy clay loam and gravelly sandy loam.

Red Bluff soils occur on intermediate and high terraces. These soils are very deep and well drained. Slopes range from 0 to 5 percent. Typically, the surface layer is loam and the subsoil is clay loam, gravelly clay or gravelly clay loam.

Areas of this unit are used mainly as rangeland and wildlife habitat. A few areas are used for urban development.

The major soils in this unit are suited to the production of vegetation used for livestock grazing. Limitations of the Redding and Corning soils include low available water capacity and moderate fertility. Some areas of the Corning soils have a hazard of water erosion and should be protected from overgrazing.

Redding and Corning soils are limited by the very low permeability of the claypan, and Redding soils by the moderate depth to hardpan. The Red Bluff soil is limited by moderately slow permeability . The restricted permeabilities and depth to hardpan of these soils can cause failure of on-site sewage disposal systems if they are not adequately designed. Depth to hardpan and claypan will also cause restricted drainage for landscape plants.

Auburn-Whiterock-Argonaut Soils--Auburn soils are shallow to moderately deep and well drained. Slopes range from 2 to 30 percent. Typically, the surface layer and subsoil are loam underlain by fractured metabasic and metasedimentary rock at a depth of 10 to 28 inches.

The Whiterock soils are very shallow to shallow, and somewhat excessively drained. Slopes range from 3 to 30 percent. Typically, the surface layer is loam underlain by highly fractured and vertically tilted metasedimentary rock, at depths of 4 to 14 inches.

The Argonaut soils are moderately deep and well drained. Slopes range from 3 to 30 percent. Typically, the surface layer is loam. The subsoil is a claypan underlain by highly weathered meta-andesitic and metamorphic rocks at depths of 20 to 40 inches.

Areas of this unit are used mainly for rangeland, urban development and wildlife habitat. They are suited to the production of vegetation used for livestock grazing and are limited by the moderate hazard of water erosion. Other limitations include very low or low, available water capacity and shallow rooting depth in the Auburn soils, very low available water capacity and very shallow rooting depth in the Whiterock soils, and low available water capacity in the Argonaut soil.

This unit is also limited by the steepness of slope and moderate hazard of erosion. Steep cut and fill slopes are susceptible to erosion and should be permanently protected by structural or vegetative measures. On-site sewage disposal is limited by the steepness of slope and shallow soil depths. The Argonaut soils are also limited by the very slowly permeable claypan. Because of these limitations, effluents from sewage disposal system may seep from the surface at downslope locations.

The following soil series are characterized here and discussed in greater detail in the South Fork Watershed soils description:

Exchequer-Inks--This series consists of shallow, well drained to somewhat excessively drained soils over undulating to steep slopes on granitic rocks.

Andregg-Caperton-Sierra--This series consists of deep to shallow, well drained to somewhat excessively drained soils over undulating to steep slopes on granitic rocks.

Auburn-Sobrante--This series consists of shallow to moderately deep, well drained soils over undulating to steep slopes on metamorphic rocks.

Auburn-Argonaut Association--This unit consists of well-drained silt loams and gravelly loams formed in material weathered from basic rocks and metasedimentary rocks.

Boomer-Auburn Association--This unit consists of well-drained loams formed in material weathered from basic igneous rocks or metasedimentary rocks.

Rescue Association--This unit consists of well-drained sandy loams formed in material weathered from basic rocks.

Serpentine Rock Land-Delpiedra Association--This unit consists of excessively drained to somewhat excessively drained rock land and loams formed in material weathered from ultrabasic rocks.

Auberry-Ahwahnee-Sierra Association--This unit consists of well-drained coarse sandy loams and sandy loams formed in material weathered from granitic rocks.

Vegetation

Because this is a transitional sub-basin, between the foothills and the valley floor, there are frequent occurrences of vegetative communities representative of adjacent sub-basins.

Vegetation consists primarily of oak woodland, brush, and scrubland, and open grasslands. Patches of riparian woodland occur along the riverbanks, ephemeral and permanent stream courses, and adjacent to seasonal and permanent wetlands. Descriptions of these vegetative communities may be found in the lower American River and the South Fork American River sub-basin vegetation descriptions.

Climate

The period from May to October is generally dry, while rainfall is usually confined to the period from November to April. The climate of the area is characterized by cool, wet winters and hot, dry summers. Most of the seasonal rainfall occurs in only 2 or 3 of the winter months. Micro-climates are closely associated with elevation, the orientation of the topography to the land, and its proximity to water. Marked differences in precipitation can occur within short distances.

Temperatures in the valley canyons and low western foothills are high in the summer and moderate in the winter. The average frost free season extends from 250 to 285 days.

Precipitation ranges from 16 to 20 inches on the valley floor to about 30 inches on the higher foothills above Folsom Lake; 90 percent of the runoff-producing precipitation occurs from November through March. Precipitation almost always falls as rain, but snowfall can occur down to the 1,000 foot level a few times each season, and at rare intervals, as low as the valley floor. Thunderstorms are relatively infrequent, but can occur during any season, with associated episodes of torrential rains.

Peak wind velocities are generally associated with winter-type storm fronts whereas the strongest sustained winds occur in the summer during periods of maximum sunshine. The prevailing wind direction in this sub-basin is from the south and southeast during the months of April through September, and from the north during the months of October through March.

Hydrology

Since the earliest days of the California gold rush, numerous dams, canals and levees have been constructed on the American River and they have significantly altered the natural flow regime. At present, there are 13 major reservoirs in the American River watershed with a combined storage capacity of 1.75 MAF. Table III-5 lists these facilities as well as their storage capacities, the operators, and the years storage began. Completed in 1956, Folsom Reservoir is the largest, with a newly revised capacity of 975,000 ac-ft. The combination of Folsom Reservoir and Lake Natoma has by far the greatest effect on flows in the lower American River.

The operation of the upstream reservoirs affects lower American River streamflows through the release of stored spring runoff to generate hydro-electric power and meet consumptive use requirements. Thus, historic natural flows in the American River have been incrementally redistributed by the water resource developments that have captured, stored, and released water for inbasin use or export. The significance of these historical modifications was limited until 1956.

Table III-5. Major Reservoirs in the American River Watershed			
Name	Storage Capacity (TAF)	Operating Agency	Year Storage Began
Folsom Reservoir	1,010	USBR	1956
Union Valley Reservoir	277	SMUD	1962
Hell Hole Reservoir	134	PCWA	1965
L.L. Anderson (French Meadows) Reservoir	77	PCWA	1964
Loon Lake	77	SMUD	1962
Ice House	46	SMUD	1959
Caples Lake	22	PG&E	1917
Lake Edson (Stumpy Meadows)	20	GDPUD	1962
Slab Creek	17	SMUD	1967
Lake Clementine	15	CDC	1939
Silver Lake	12	PG&E	1922
Lake Valley Reservoir	8	PG&E	1911
Lake Natoma	8	USBR	1956

CDC - California Debris Commission
GDPUD - Georgetown Divide PUD
PCWA - Placer County Water Agency
PG&E - Pacific Gas and Electric Company
SMUD - Sacramento Municipal Utilities District
USBR - U.S. Bureau of Reclamation
Source: California State Water Resources Control Board, Technical Report, June 1988.

Table III-6 displays the total precipitation recorded at Folsom Dam on a monthly basis from 1971 to 1980. The variability of annual precipitation totals and distribution have been demonstrated in prior sections. All of these variables affect the operation of, and releases from, the Folsom/Nimbus complex and ultimately the flows in the lower American River.

Table III-6. Precipitation at Folsom Dam; 1971 to 1980 (inches)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1971	1.52	8.04	5.95	1.36	0.23	3.36	0.64	1.02	0.19	0.00	0.00	0.15	22.46
1972	0.72	2.07	5.55	1.02	2.44	0.62	2.59	0.49	0.23	0.00	0.00	1.45	17.18
1973	1.31	5.69	2.77	9.02	6.30	3.75	0.83	0.05	0.02	0.00	0.00	0.28	30.02
1974	2.79	7.40	5.66	4.63	1.38	5.80	2.49	0.00	0.47	2.14	0.00	0.00	32.76
1975	1.54	1.69	2.55	1.07	6.91	5.91	2.00	0.10	0.11	0.01	0.53	0.02	22.45
1976	2.00	0.95	0.90	0.48	1.35	1.19	1.42	0.00	0.04	0.00	1.15	1.61	12.09
1977	0.00	0.82	0.25	1.39	1.12	1.21	0.07	1.65	0.00	0.00	0.00	0.46	6.96
1978	0.18	2.01	4.87	11.03	4.67	6.87	4.28	0.00	0.11	0.00	0.00	0.87	34.89
1979	0.00	4.39	1.37	5.60	4.58	3.75	1.79	0.21	0.00	0.19	0.00	0.03	21.91
1980	2.92	2.27	3.93	7.47	7.40	3.84	1...29	0.61	0.04	0.84	0.00	0.00	30.65

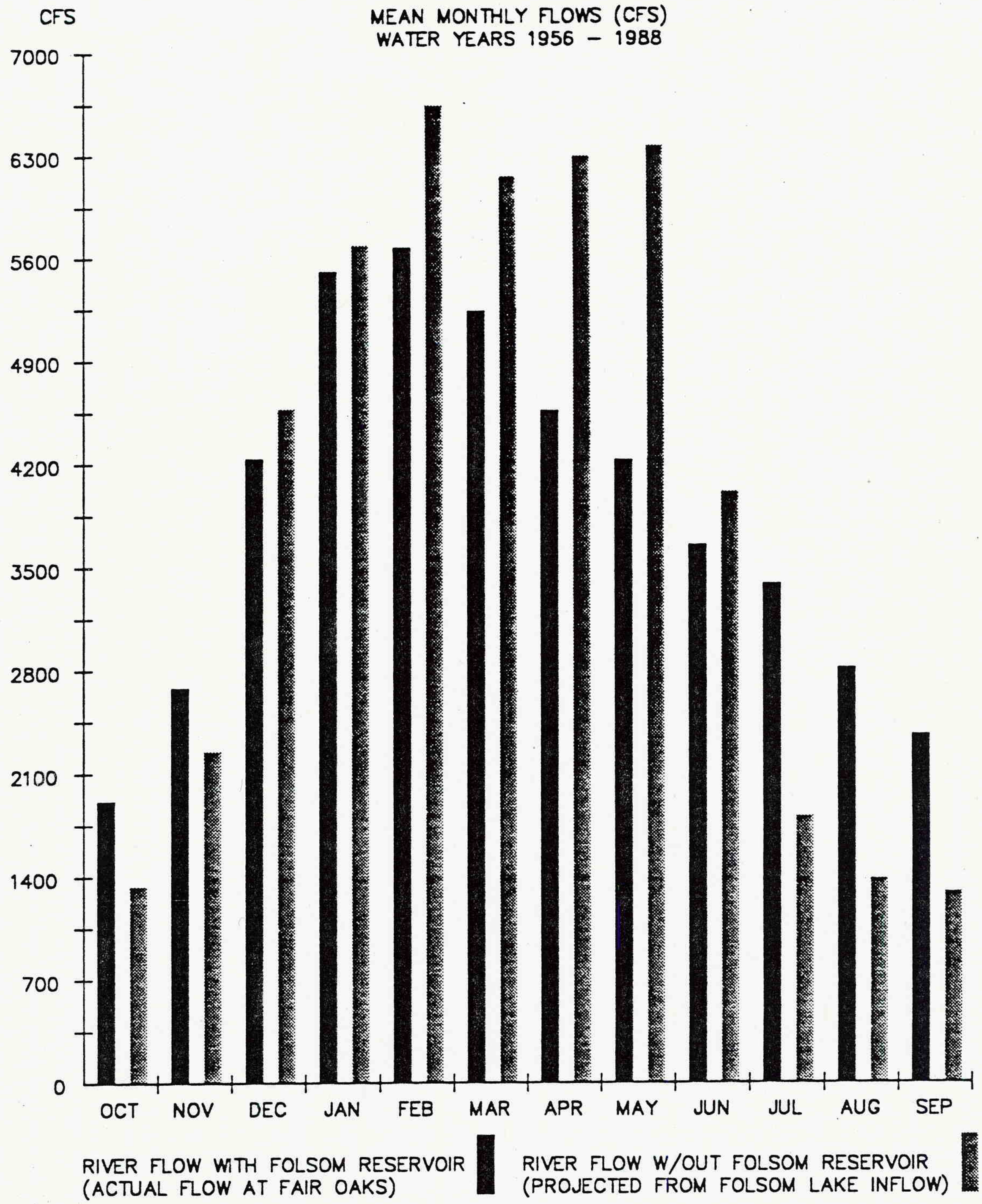
Source: California Department of Water Resources, "California Rainfall Summary" July 1981.

Runoff from the American River averages about 2.8 million ac-ft annually. Inflows to Folsom Lake vary greatly throughout the year ranging from a recorded maximum in excess of 900,000 cfs during the February 1986 flood to a minimum of 225 cfs during 1977. This wide range of variability could be extended in the future because the size of the 100-year flood event has been revised upward as a result of new calculations based on the single flood event of 1986. The resultant controversy over how Folsom should be operated during the peak flood season is due in large measure to the lack of any significantly large upstream reservoirs, especially on the North and Middle Forks. Folsom Dam and Reservoir is a multipurpose water project (the American River Division) constructed by the USCE and operated by the USBR as part of the Central Valley Project (CVP). Folsom Dam regulates runoff from about 1,875 square miles of drainage area. Folsom Reservoir has a normal full pool storage capacity of 975,000 ac-ft with a seasonally designated flood control storage space of 400,000 ac-ft (which may be upgraded to 600,000 ac-ft as a result of the Folsom reoperation study). Nimbus Dam/Natoma Reservoir provides another 8,000 ac-ft of storage, but it is mainly used for reregulating power releases from Folsom. The reservoir complex provides limited flood protection for the Sacramento area as well as water supplies for irrigation, hydropower, municipal, and industrial use. It also provides extensive water-related recreational opportunities, both in and downstream from the reservoirs. Releases are made for water quality control (primarily salinity repulsion in the Bay-Delta estuary), to meet project diversion requirements from the Sacramento-San Joaquin Delta, and to maintain anadromous fish runs and resident fish and wildlife populations in, and along the American River below the dam and in the Sacramento-San Joaquin Delta.

An additional feature of the American River Division of the CVP is the Auburn-Folsom South unit, which was authorized in 1965 to utilize and expand the resources made available by the Folsom Project. Elements of this project included Auburn Dam and Reservoir (2,500,000 ac-ft gross capacity) and Power Plant, Folsom South Canal, and smaller related features. The future of this project (or, more likely, State-funded elements) is extremely uncertain due to lawsuits filed to block its construction and the unwillingness of the federal government to appropriate funds to complete its construction. The USBR had estimated that if all elements of the American River Division of the CVP had been completed, the firm yield of the American River would have been 1,860,000 ac-ft.

Since construction of Folsom Dam, flows in the lower American River (Nimbus Dam to the mouth) have been modified substantially. By storing peak runoff for later discharge through operation of the Folsom/Nimbus facility, the Bureau of Reclamation has modified actual flows when compared to "natural, unimpaired flows" by decreasing, through storage, the winter and spring flows and increasing, through storage releases, the summer and early fall flows. Figure III-41 illustrates average monthly inflows (represented by "lower American River flows without Folsom Reservoir") versus average monthly releases (represented by "lower American River flows with Folsom Reservoir") to the lower American River.

Flood-producing runoff occurs during October through April and is most extreme during November through March. The rain-produced flood season is followed during April through July by a period of moderately high runoff from snowmelt. Such runoff generally does not result in flood-producing flows, but is ordinarily adequate to fill reservoir space maintained for flood control during the winter months. Water supply is in greatest demand from June through September. Thus, in years of normal or above normal snowmelt, flood control



LOWER AMERICAN RIVER FLOWS
WITH & WITHOUT FOLSOM RESERVOIR

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HDR

Figure III-41

operation does not interfere with the filling of the reservoir for subsequent deliveries. In other years with less runoff, the reservoir often does not fill to its maximum capacity.

After the 1986 storm, the unregulated rain-produced flood volume flow-frequency relationship at the Fair Oaks gauge was updated. This relationship reflects the flow data collected for the period from 1905 to 1954, and adjusted from 1955 to 1986 to account for the effects of Folsom, French Meadows, Hell Hole, Loon Lake, Union Valley, and Ice House Reservoirs. A revised peak flow-frequency curve for a regulated condition was then developed for the American River downstream from Folsom Dam in 1987.

Water Supply Systems

Diverters From Folsom Dam--

San Juan Suburban Water District, City of Roseville, City of Folsom and Folsom State Prison all divert water from Folsom Lake at the upstream face of Folsom Dam. Their common intake, with trash rack, is located at an elevation of 317 feet MSL (base of dam is at approximately 280 feet MSL). Flow from the intake to all four utilities, water treatment plants is normally by gravity. However, when the water level at Folsom Lake is low, the quantity of water that can flow by gravity is reduced and the Folsom Pumping Plant is used to lift water into the distribution system. Figure III-42 is a representative schematic of the entire water diversion system.

Service areas of the water purveyors diverting directly from Folsom Dam are shown in Figure III-43.

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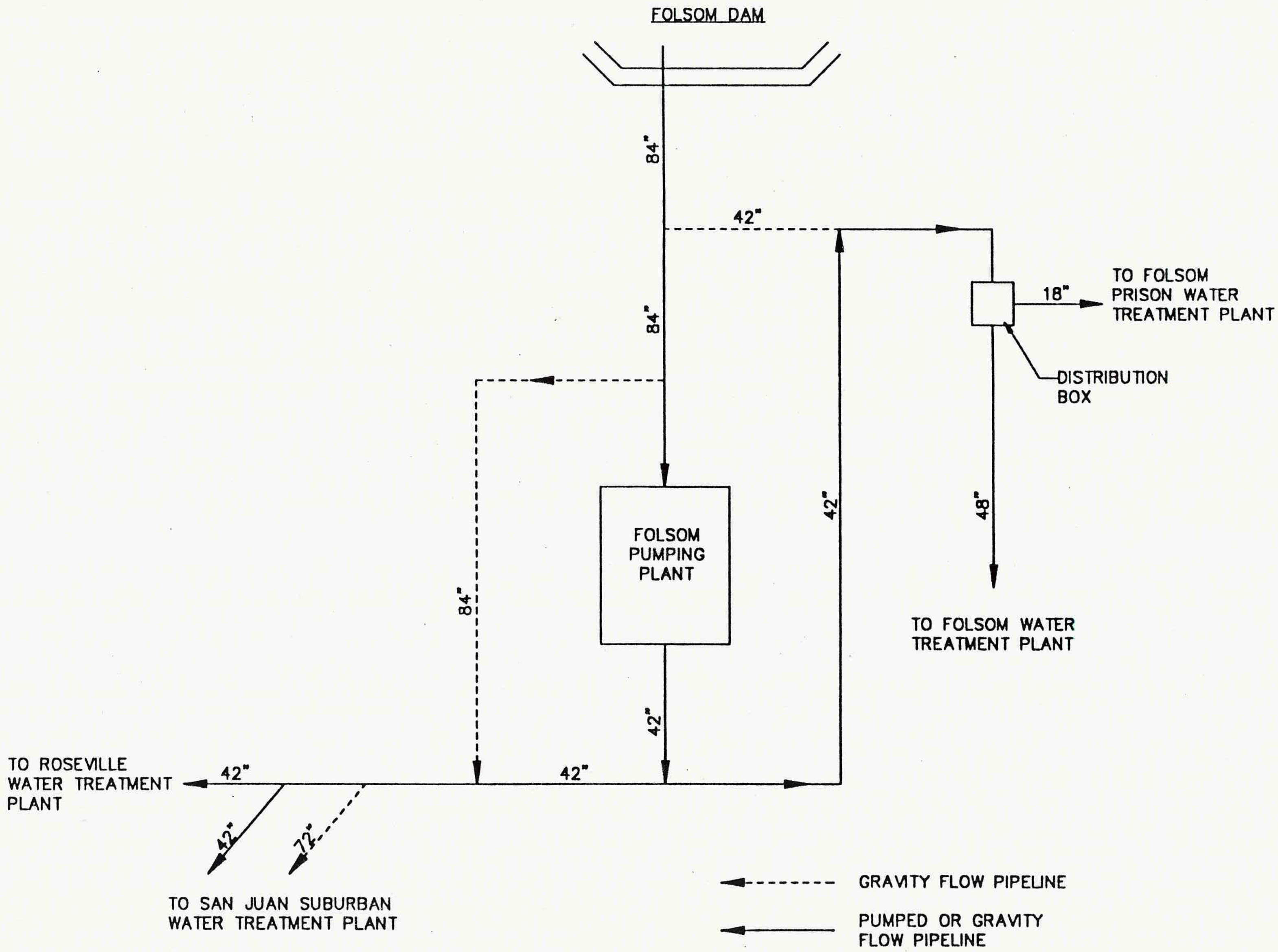
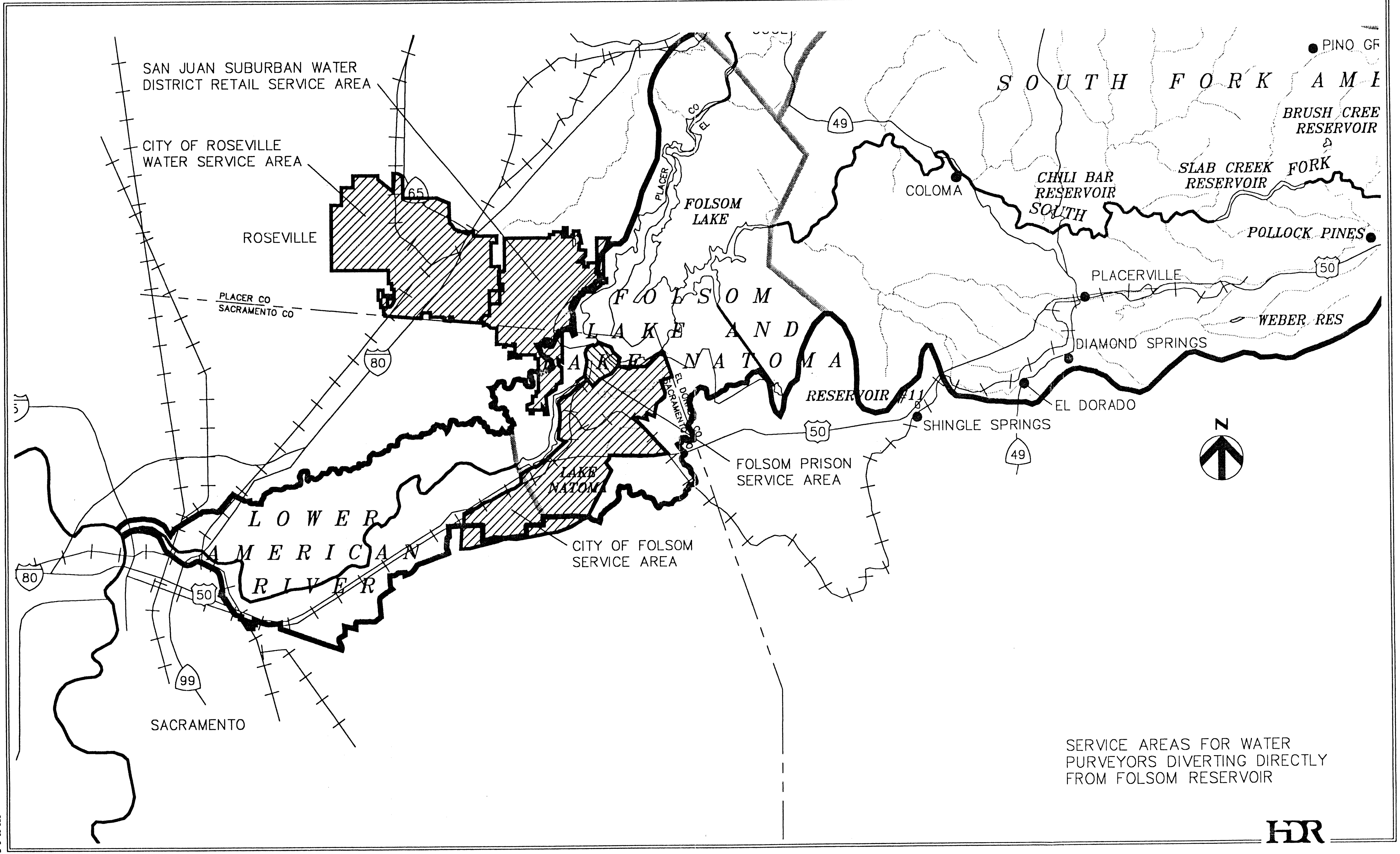


SCHEMATIC OF WATER DIVERSION SYSTEM FROM FOLSOM LAKE TO ROSEVILLE, SAN JUAN SUBURBAN, FOLSOM, AND FOLSOM PRISON INTAKES

HDR

Figure III-42



SERVICE AREAS FOR WATER PURVEYORS DIVERTING DIRECTLY FROM FOLSOM RESERVOIR

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Figure III-43

Folsom South Canal Users--

Southern California Water Company diverts its 10,000 ac-ft per year entitlement directly out of the Folsom-South Canal to serve the Rancho Cordova area. The Cordova District Service Area is shown in Figure III-44.

East Bay Municipal Utility District (EBMUD) also claims rights to American River flows or diversions made via the Folsom-South Canal. Unless Auburn Dam and the Folsom-South Canal are completed, however, EBMUD is faced with severe limits on its deliveries.

EID and El Dorado County Water Agency (EDCWA)--

EID has a contractual entitlement to divert up to 7,550 ac-ft/year of water from Folsom Lake as discussed in the South Fork American River section. Critical dry year deficiencies may exceed 50 percent as in 1977. The El Dorado Hills pipeline intake and route was shown in Figure III-15.

Recently enacted federal legislation designates some of the water stored in the Central Valley Project's Folsom Reservoir for municipal and industrial supply for EDCWA and other water agencies. Public Law 101.514 directs the Secretary of the Interior to enter into a water supply service contract with EDCWA for up to 15,000 ac-ft/yr. The contract would be subject to USBR imposed deficiencies under dry or critical conditions..

EDCWA proposes to make half of this water supply available to EID. The yield of the USBR entitlement to EID would be 5,625 ac-ft/yr, after deducting a 25 percent dry year deficiency. This water would be in addition to EID's existing 7,500 ac-ft/yr entitlement.

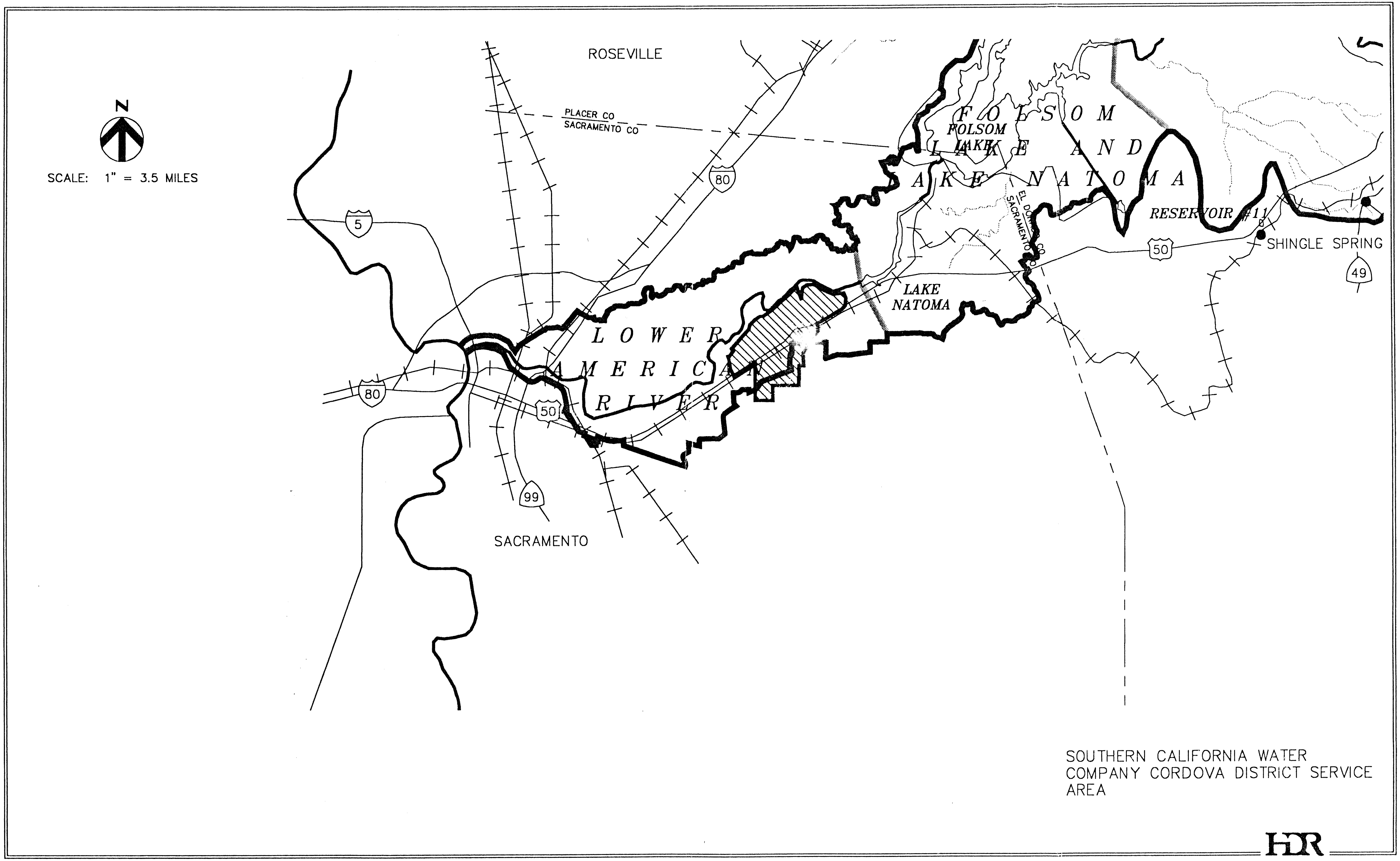

Figure III-44

The California Department of Parks and Recreation diverts water from Folsom Lake to serve its public campsites along the shoreline.

Land Use and Land Ownership

Land Use--

The primary use of the surface and shoreline of Folsom Reservoir and Lake Natoma is recreation. The state park and state recreation area combine with the American river Parkway and other county parks to comprise a continuous recreational parkway, complete with equestrian, bike and hiking trails, extending from the vicinity of Auburn to the mouth of the American River.

As one of the most popular units in the California State Park system and the most heavily used state recreation area in California, with shoreline in three different counties, Folsom's State Parks and Recreation Area have major regional and statewide significance. With up to 11,500 surface-acres of lake, water oriented recreation activities include sailing, water and jet skiing, and wind surfing. The upstream arms of the lake are designated slow zones for quiet cruising, fishing, and nature appreciation. Brown's Ravine Marina provides 680 berthing slips for year-round mooring, when reservoir levels permit, along with small craft rental and supplies.

Folsom Reservoir has up to 75 miles of undeveloped shoreline, depending upon reservoir surface elevations. The shoreline provides excellent quality sandy swimming beaches when surface water levels are adequate. Water surface elevations ranging between 435 to 450 feet MSL is the most beneficial to all users during the primary recreation seasons from May until Labor Day.

Lake Natoma, with its relatively stable surface elevation and shoreline, is reserved for nonpower boat use: sailing, windsurfing, canoeing, rowing and kayaking.

Other land uses in the watershed, as identified in the Sacramento, El Dorado and Placer County General Plans, include:

Agricultural: General agriculture and croplands, agricultural preserves and choice soils suitable for future agriculture.

Urban: High density urban core areas, commercial areas and offices, intensive and extensive industrial.

Residential: Medium and low density residential and agricultural residential.

Rural: Very low density (10-acre minimum parcel size).

Public and Quasi-public: Schools, hospitals, cemeteries and other public and quasi-public lands.

Figure III-45 is a delineation of the land use categories described above within the Folsom Lake-Lake Natoma sub-basin.

Land Ownership--
Land ownership within the sub-basin is depicted in Figure III-46.

LOWER AMERICAN RIVER WATERSHED

Geography

Location and Size--
The Lower American River extends approximately 23 river miles from the point of outflow of Natoma Reservoir at Nimbus Dam westward to its confluence with the Sacramento River. The watershed encompasses approximately 44,000 acres (70 square miles) as shown in Figure III-47, draining portions of the City of Sacramento and neighboring suburbs.

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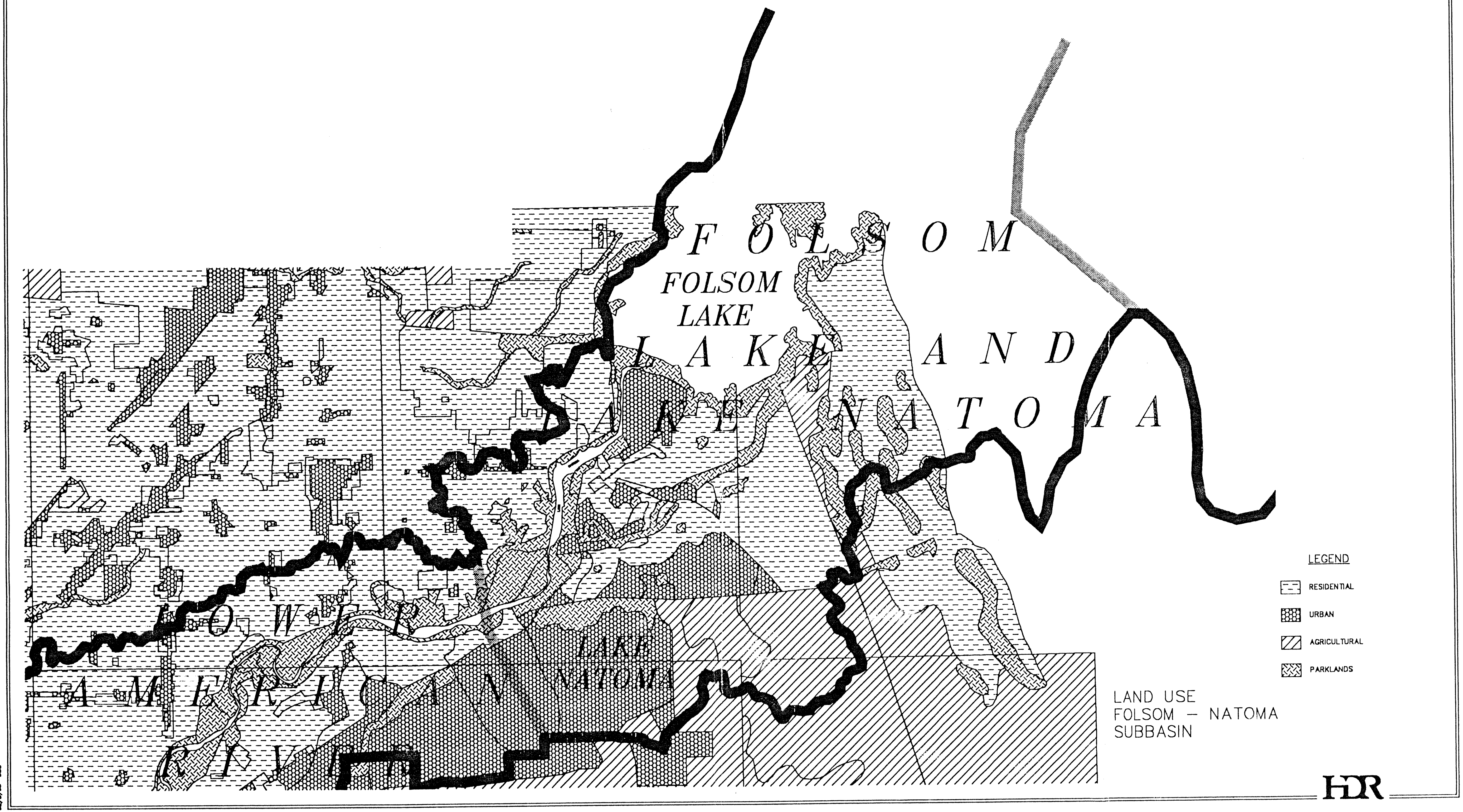

Figure III-45

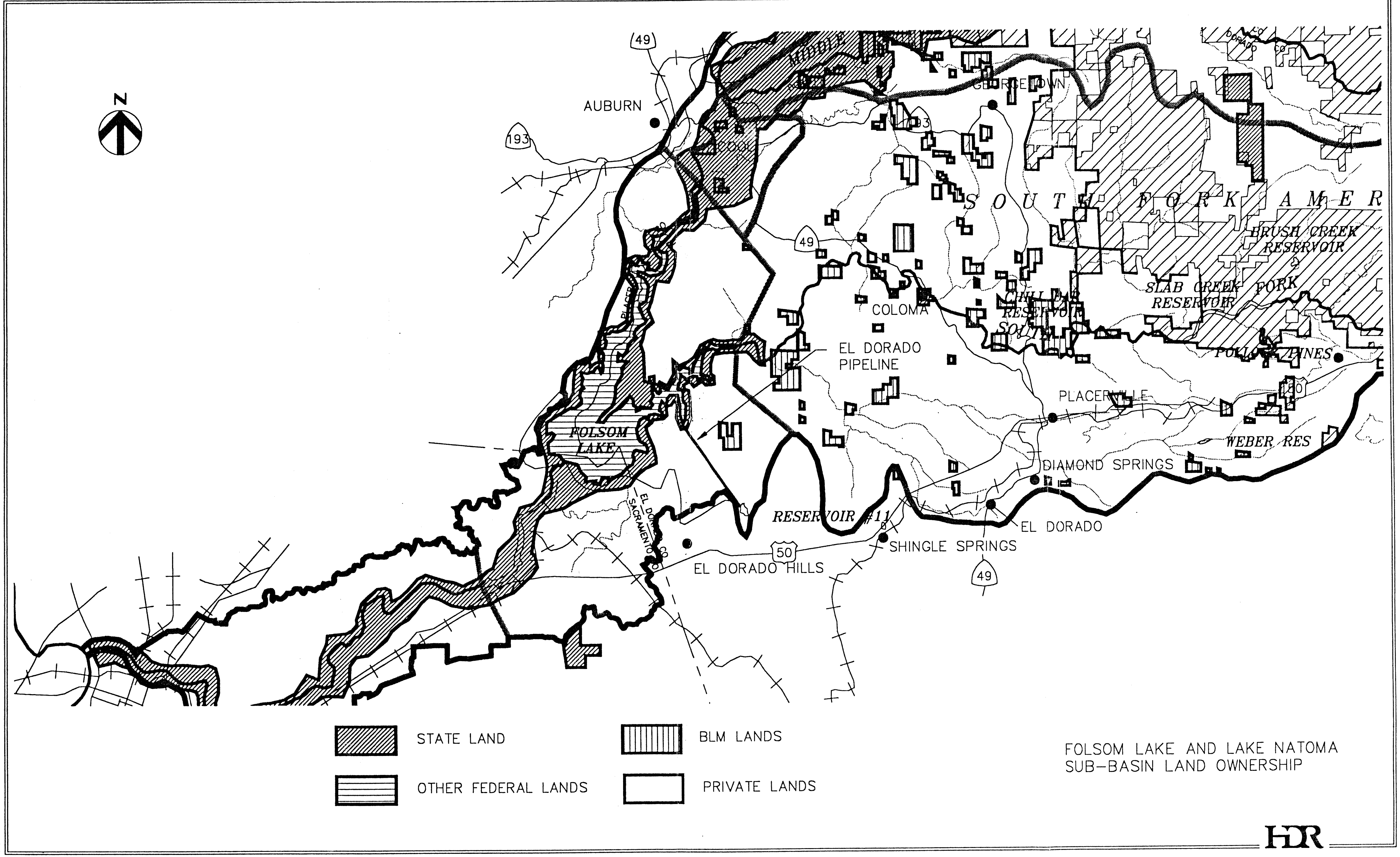

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Figure III-46

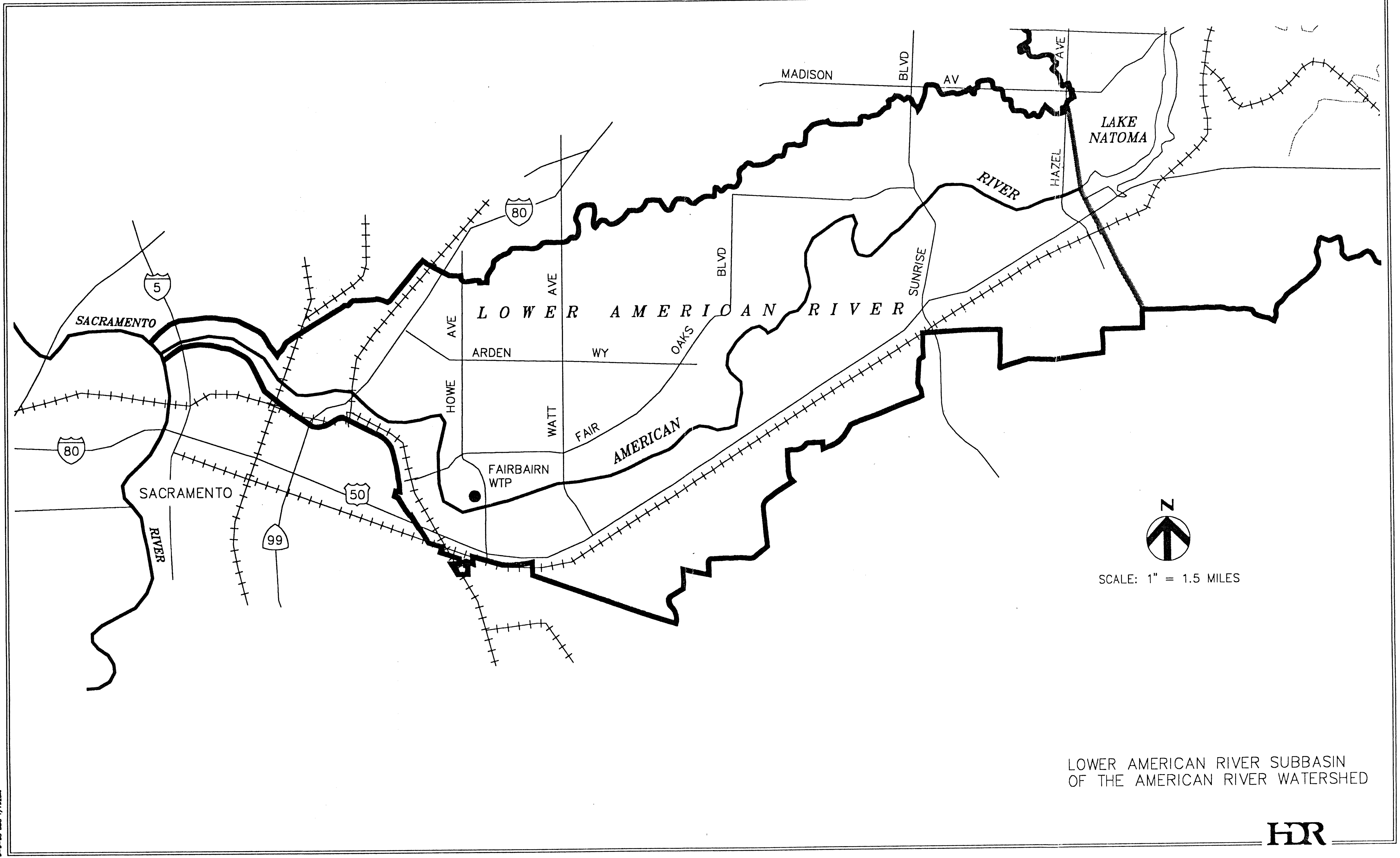


Figure III-47

Its position in relation to the neighboring sub-basins was shown in Figure III-1.

Topography

The topography in the vicinity of the City of Sacramento is virtually flat. The plain upon which it is located was formed from alluvial deposits that have accumulated over the last 100 million years. The plain lies at an average elevation of 20 feet and slopes gently toward the southwest. Linear low topographic rises originating from natural levees of the Sacramento and American Rivers are occasionally present along the river. The American River and other local drainages have downcut through the plain forming low, near vertical streambanks in some reaches. The topography has been modified by an extensive system of man-made levees and floodways which provide flood protection to the City of Sacramento and parts of the County. With the exception of these riverbanks and levees, ground slopes within the City do not exceed 8 percent, and in most cases, are between 0 and 3 percent.

Geology

The watershed area below Nimbus Dam is a continuation of the Great Valley Geomorphic province of California. The basic geologic structure of the Sacramento area was formed over 100 million years ago from successive layers of marine deposits left by a receding ocean, and from alluvial sediments deposited during floods originating in the Sierra Nevada, Klamath, Cascade and Coast Ranges.

Most of the deposits are recent alluvial floodplain soils consisting of unconsolidated deposits of clay, silt and sand. The alluvial deposits are fractured by a few inactive faults. Of these, only the Dunnigan Hills and Midland Faults west of Sacramento, and the foothill Fault System to the east, are located close enough to pose significant earthquake hazards.

Soils and Soil-Plant Associations

A general soils map for the lower American River sub-basin is shown in Figure III-48. Soils of this region are described below:

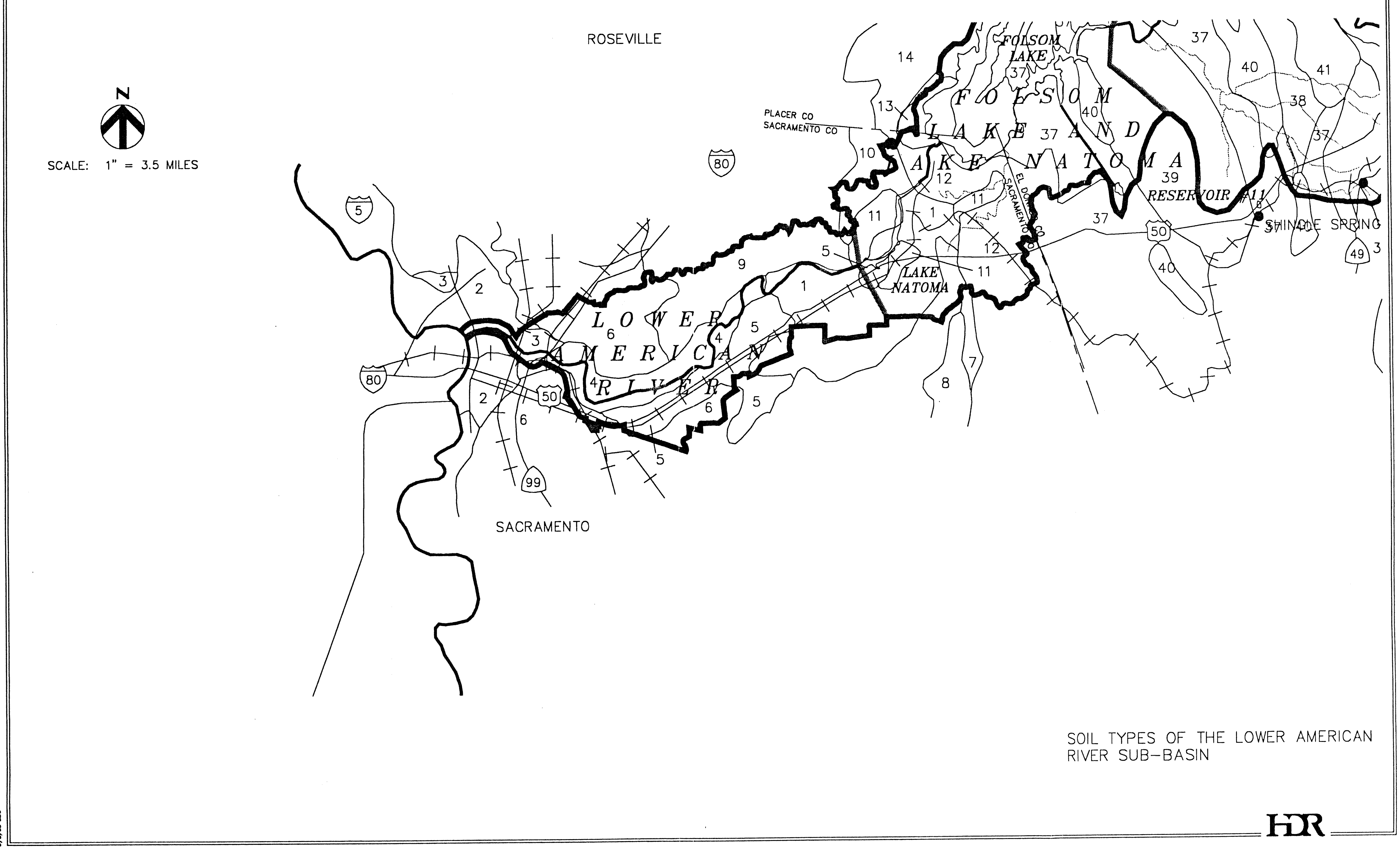
Sailboat-Scribner-Cosumnes--These are somewhat poorly drained soils that have a seasonal high water table and are protected by levees. They occur on natural levees, edges of backswamps and low flood plains adjacent to the American River near its confluence with the Sacramento River. The soils formed in alluvium derived primarily from mixed rock sources. This unit is protected from flooding by levees and upstream dams. Seepage from nearby channels causes a seasonal high water table during the winter and early spring months. Slopes range from 0 to 2 percent.

Sailboat soils occur on the natural levees of the low flood plains and are very deep. They are formed under somewhat poorly drained conditions. Typically, the surface layer is silt loam and the underlying material is stratified clay loam and loam. A seasonally high water table is maintained below a depth of 36 to 60 inches by pumping drainage water out. It is subject to rare flooding.

Scribner soils occur on the edges of backswamps. Typically, the surface layer is clay loam and the underlying material is stratified clay loam and sandy clay loam.

The Cosumnes soils occur on the low flood plain. Typically, the surface layer is silt loam. The underlying material is stratified, silty clay loam and clay. Soil depth, formation conditions, water table and flood frequency characteristics of the Scribner and Cosumnes soils are the same as for Sailboat soils.

Areas of this soil unit are well suited for irrigated crops and wildlife habitat. A few areas are used for urban development. Limitations include depth to seasonal high water table and moderately slow or slow permeability.



SOIL TYPES OF THE LOWER AMERICAN RIVER SUB-BASIN

HDR

Figure III-48

Columbia-Cosumnes--These are somewhat poorly drained soils that are subject to flooding unless protected by levees. They occur on the narrow, low flood plains just upstream from the mouth of the American River. The soils were formed in alluvium derived primarily from mixed rock sources. Slopes range from 0 to 2 percent.

Columbia soils occur on narrow, low flood plains. Typically, the surface layer is sandy loam and the underlying material is stratified sandy loam, silt loam and loam. Some areas are underlain by clay.

The Cosumnes soils also occur on narrow, low flood plains downstream from the Columbia soils. Both Columbia and Cosumnes soils are very deep, formed under somewhat poorly drained conditions, with depth to a seasonally high water table of about 72 inches, subject to occasional flooding except rare flooding where protected by levees. Typically, the surface layer is silt loam and the underlying material is stratified, silty clay loam and clay.

Areas of this unit are used mainly for irrigated crops, irrigated hay and pasture, and wildlife habitat. The main limitation is flooding. The Cosumnes soil and some areas of the Columbia soils are also limited by slow permeability which inhibits most perennial deep rooted crops. In areas that are not protected by levees, erosion, deposition and damage to crops can occur during periods of flooding.

Rossmoor-Vina--The soils in this group lie adjacent to the American River and other channels at elevations ranging from about 30 feet near Sacramento to about 200 feet near Lake Natoma. If not protected by levees or upstream dams they are subject to flooding. They are well drained. The soils formed in alluvial deposits derived from mixed and granitic rock sources. Slopes range from 0 to 2 percent.

Rossmoor soils occur on narrow high flood plains. They are very deep and well drained. Typically, the surface layer is fine sandy loam and the underlying material is a paler colored fine sandy loam. It is subject to rare flooding.

Vina soils occur on narrow high flood plains. They are very deep and well drained. Typically, the surface layer is fine sandy loam and the underlying material is weakly stratified loam and sandy loam. It is subject to occasional flooding where unprotected by levees.

The Rossmoor soils of this unit are used primarily for urban development, recreation and wildlife habitat. Other areas of this unit are used mainly for irrigated crops and wildlife habitat. Where the major soils in this unit are used for urban development, the main limitations are the rare to occasional flooding hazards. All common crops can be grown on these soils. However, in areas that are not protected by levees, erosion and deposition can occur with resultant damage to crops.

Urban Land-Americanos-Natomas--These soils are described in the Folsom Reservoir and Lake Natoma sub-basin section.

San Joaquin--These are moderately well drained soils that are moderately deep over a cemented hardpan. They occur on low terraces in the western and central parts of Sacramento County where they formed in alluvial deposits derived from mixed, but primarily granitic rock sources. Slopes range from 0 to 8 percent.

Typically, the surface layer is silt loam and the subsoil is a claypan underlain by a strongly cemented hardpan at a depth of 20 to 40 inches.

Areas of this soil unit are used mainly for irrigated crops, irrigated hay and pasture, urban development, rangeland and wildlife habitat. Limitations include moderate depth to claypan and hardpan, very slow permeability and low to moderate available water capacity. This soil is poorly suited to deep rooted crops or landscape plants requiring ample water and good drainage.

Vegetation

A very sizeable area of lowland riparian forest occurs along the American River from Nimbus Dam to its confluence with the Sacramento River. When combined with the Nimbus reach, this area represents the state's largest riparian forest that is completely surrounded by urban development. The natural vegetation of this stretch of the American River is described by six plant communities: Great Valley, Willow Scrub, Great Valley Cottonwood Riparian Forest, Great Valley Mixed Riparian Forest, Great Valley Oak Riparian Forest, Open Digger Pine Woodland, and Coastal and Valley Freshwater Marsh.

The structure and distribution of the riparian vegetation is determined by the river. The riparian vegetation along the river can be characterized according to three physical settings or zones, the (1) active zone, (2) border zone, and (3) outer zone. The vegetative communities (and soils) of these three zones are determined by the duration, intensity, and timing of flood flow incursions into the zone.

The active zone is adjacent to the low flow channels and is characterized by gravel bars with willow communities. When present, goldenrod and muhleygrass provide groundcover.

The border zone is farther away from the water's edge. Flooding of this zone is less frequent and intense. The canopy is taller and more complex; characteristic species include Fremont's cottonwood, white alder, and valley oak. The understory often features wild grape and elderberry.

The outer zone is located furthest back from the river and its species do not tolerate floods. The cool, moist microclimate supports species such as digger pine, western redbud occidentalis and deer brush. Vegetation of ponds and marshes is composed of species such as waterfern, tule and cat-tail. The riparian vegetation along the American River is described in more detail below.

Great Valley Willow Scrub is open to dense, broadleafed, winter-deciduous, shrubby streamside thicket dominated by willow species. Open stands have grassy understories that are usually dominated by introduced species. This community occupies the active zone.

Great Valley Cottonwood Riparian Forest is a dense, broadleafed, winter-deciduous riparian forest dominated by Fremont Cottonwood and black willow. Understories are dense with abundant young trees and California wild grape. This community occupies the border zones that are inundated yearly during the spring and have an annual input of nutrients, soil and seeds. The fine-grained alluvial soils associated with these sites provide subsurface irrigation even when the channel is dry.

Great Valley Mixed Riparian Forest is characterized by a tall, rather dense deciduous, broadleafed canopy composed of Fremont cottonwood, red, black and yellow willow, Hind's black walnut, western sycamore and California box elder. The understory consists of smaller specimens of these species along with Oregon ash, poison oak and valley elderberry. California wild grape and Himalaya berry are abundant in the upper and lower canopies. When herbaceous vegetation is present, it is dominated by grasses and horsetail. Great Valley Mixed Riparian Forest typically occurs on relatively fine-textured alluvial soils of the border zone that are not exposed to strong flood flows or erosion. This community has been reduced from its historical size by clearing for agriculture, flood control and urban expansion.

Great Valley Oak Forest is a medium to tall, broad leafed, deciduous, closed canopy riparian forest dominated by valley oak. The understory includes scattered oregon ash, Hind's black walnut, western sycamore and young valley oaks. California wild grape and Himalaya berry are present in the understory. This community is typically restricted to the outer zone where soils are better drained and less likely to remain saturated for extended periods. It is less extensive than Great Valley Mixed Riparian Forest and most often occurs on drier sites adjacent to or intergrading with it.

Open Digger Pine Woodland is a digger pine dominated, savannah-like woodland on the well drained soils of the outer zone. Spacing and canopy density are quite variable and understories are dominated by annuals. Characteristic species associated with this community include California buckeye, common busk brush, western redbud and snowberry.

Valley Freshwater Marsh is dominated by perennial, emergent monocot plants that often form closed canopies 4 to 5 1/2 feet in height. Typical species of this community include soft-flag, bur-red and slough grass. This community is found throughout the zones where soils are permanently flooded by quiescent freshwater bodies.

Climate

Topographic features strongly influence the passage of winds in the Sacramento valley. The prevailing wind direction in Sacramento is up-valley from the southwest, resulting from marine breezes through the Carquinez Strait. During winter, the ocean breezes diminish and down-valley winds from the north occur more frequently. However, the winds from the south still predominate. Atmospheric pressure gradients through the gap in the Coast Ranges at Carquinez Strait occasionally allow cool oceanic air to flow into the valley during the summer season. This markedly reduces temperatures temporarily throughout the Sacramento-San Joaquin Delta and up-valley to Sacramento.

Most of the rainfall occurs from November to April. The normal annual precipitation for the area is 17.68 inches with the bulk of it occurring between November and April. The annual mean temperature at Sacramento is 60.5 degrees F.

The potential for air pollution is high in Sacramento; the severity on any given day is determined by the amounts and types of emissions and the relative ability of the atmosphere to transport and dilute pollutants. Atmospheric variables include dispersion by winds and vertical mixing. Atmospheric inversions, whether subsidence inversions or surface inversions, have great potential to concentrate pollutants close to the ground, thereby intensifying effects. Both types occur frequently over Sacramento. The major product of photochemical smog, produced mainly in the summer when solar insolation is high, is ozone.

Hydrology

Since construction of Folsom Dam, flows in the lower American River (from Nimbus Dam to the mouth) have been modified substantially. By storing peak runoff for later discharge through operation of the Folsom/Nimbus facility, the Bureau of Reclamation has modified the natural "unimpaired"[8] flows by decreasing, through storage, the winter and spring flows; and by increasing, through storage releases, the summer and early fall flows. The benefits of summer and fall augmentations of the natural flows were particularly apparent during critical drought years like 1977.

Water Rights and Instream Flow Standards--
Since construction of Folsom Dam and development of the American River Parkway, public attention has been strongly focused on the fishery and recreational uses of the lower American River and their requirements. Several sets of instream flow standards have been developed to protect these and other instream uses. It is these standards, plus Bay-Delta standards, and hydrology, rather than hydrologic conditions alone, that control the flows of the lower American River during "balanced" conditions. A summary of recent SWRCB decisions and other decisions that presently control flows, or may control future flows in the lower American River, follows:

Decision 893--D-893 issued by the SWRCB in 1958, approved the Bureau of Reclamation (USBR) water right applications for Folsom Reservoir. D-893 requires that the USBR release sufficient quantities of water into the lower American River to meet minimum flow requirements. 250 cfs are required from January 1 through September 14, and 500 cfs are required from September 15 through December 31, from Nimbus Dam to the mouth of the American River for the propagation and preservation of fish life. Reductions below the required instream flow standards only may be made in the same proportion as reductions are made to deliveries for irrigation purposes. These D-893 requirements are the present, legally required minimum flow standards.

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[8]"Unimpaired" flows are the theoretical, calculated flows that would have occurred in a given hydrologic year had all water development projects and diversions been absent.

Decision 1400--In 1972, the SWRCB issued D-1400 approving the Bureau's water right applications for the proposed Auburn Dam and Reservoir. The flow standards in this decision were to be required only if and when Auburn Reservoir was built and operational. The decision would require the following flows:

For fish and wildlife "not less than 1,200 cfs from October of each year to the succeeding July 14, and not less than 800 cfs from July 15 to October 14." Reductions below these amounts only may be made in the same proportion as deficiencies are imposed on water deliveries to the Folsom-South service area.

For recreation "not less than 1,500 cfs is required from May 15 to October 14 of each year."

The flows required for the two purposes are not cumulative. In addition, no flows shall be required for recreation when any irrigation deficiencies are required in project (CVP) water delivered within the Folsom-South service area.

A graphic illustration of these instream flow standards is presented in Figure III-49.

Modified D-1400 Standards--The USBR has stated that its operations of Folsom Dam have attempted to meet the D-1400 schedule of flow standards, measuring them at the Howe Avenue Bridge instead of the mouth of the lower American River. Below Howe Avenue Bridge and the Fairbairn Water Treatment Plant diversion, only D-893 instream flow standards have been met. The State Board has taken no action to either approve or disapprove of this practice.

EBMUD Decision--A final decision was issued in May, 1990 by Judge Richard Hodge in the case of Environmental Defense Fund (EDF) vs. East Bay Municipal Utility District (EBMUD).[9] It states that EBMUD can take water from the lower American River at the Folsom South Canal under its water service contract with the Bureau of Reclamation only

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[9]Alameda County Superior Court Case No. 425955.

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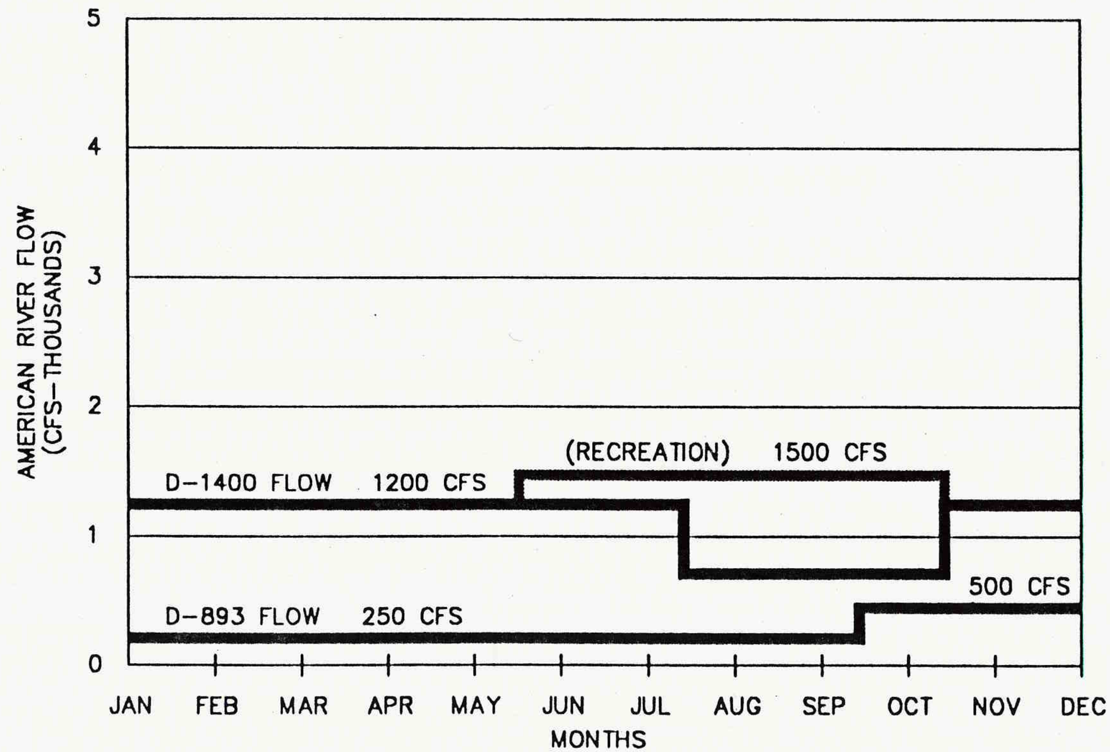


SOURCE: QUAD CONSULTANTS, 1990
REFERENCE: FAIRBAIRN WATER TREATMENT PLANT EXPANSION EIR, CITY OF SACRAMENTO, CALIFORNIA

COMPARISON OF D893 AND D1400 INSTREAM FLOW STANDARDS

HDR

Figure III-49

if the flows set by the court are not impaired by EBMUD's diversion. The case is binding only on EBMUD, not the City of Sacramento or any other diverters. The State Water Resources Control Board has authority to set appropriate flow standards which are applicable to other diverters and upstream beneficial use needs. The State Board has stated its intention to review Bureau of Reclamation and City of Sacramento water entitlements and determine appropriate flows for the American River under future conditions. However, it is likely to be several years before the Board completes its review and issues a decision.

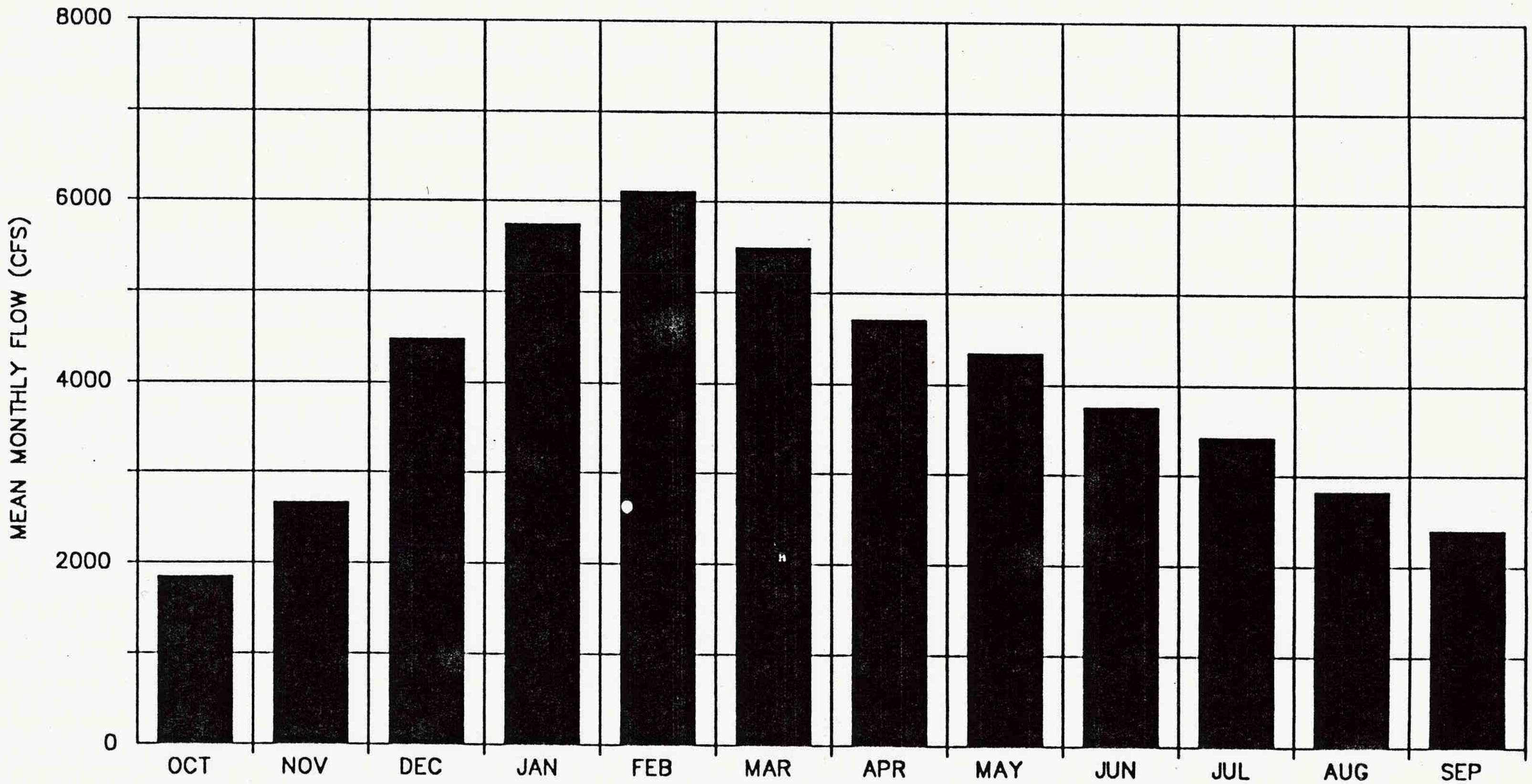
Actual American River Flows--American River flows are actually, on the average, significantly higher than those required by the above described minimum instream flow standards. This is because SWRCB standards for the Sacramento-San Joaquin Delta and San Francisco Bay, in combination with SWP-CVP delivery requirements via the Delta, generally are more demanding than the American River flow standards just described. Also, without Auburn Reservoir and with only partial development of the Folsom-South Canal, there is more uncontrolled water in the system during normal and wet years. Figures III-50 and III-51 depict the mean monthly flow hydrograph and annual flow duration curve, respectively, for the lower American River under present conditions.

Water Supply Systems

The primary water users of the lower American River are the City of Sacramento, the Carmichael Water District and Arcade Water District. Flows in excess of their needs satisfy those of downstream water rights holders, water quality (primarily salinity) control requirements, the export needs of the State and Central Valley projects, fish and wildlife requirements, Suisun Marsh salinity standards and San Francisco Bay outflow requirements.

City of Sacramento--

The City of Sacramento diverts one half or less of its municipal and industrial water supply directly from the American River adjacent to Sacramento State University. Its water right permits on the American River would allow the Fairbairn Water Treatment Plant to be expanded from its current capacity of 200 mgd (minimum of 91 mgd at low river stage) to



SOURCE: QUAD CONSULTANTS, 1990
FAIRBAIRN WATER TREATMENT PLANT EXPANSION EIR, CITY OF SACRAMENTO, CALIFORNIA

LOWER AMERICAN RIVER HYDROGRAPH

HDR

Figure III-50

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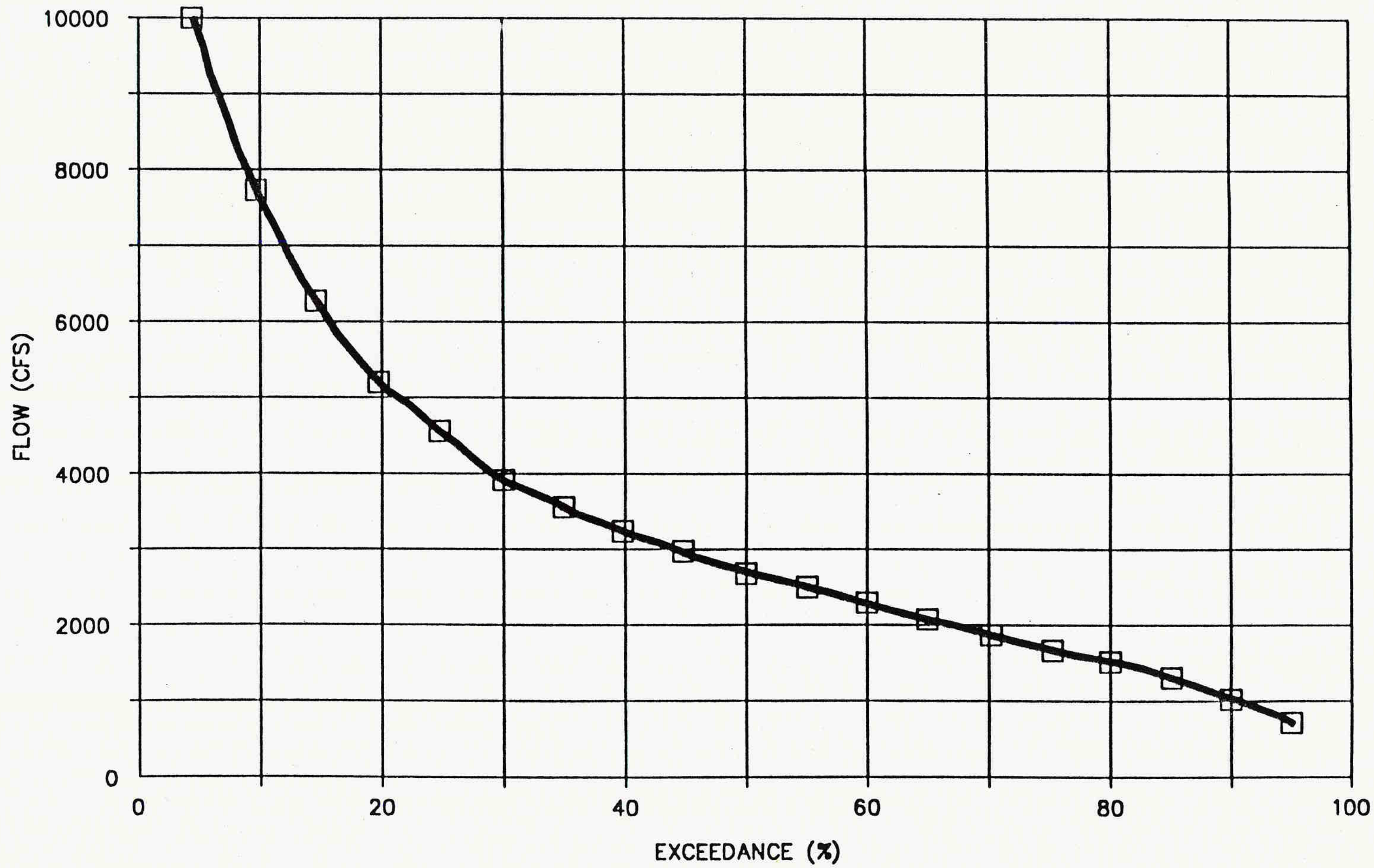


SOURCE: QUAD CONSULTANTS
FAIRBAIRN WATER TREATMENT PLANT EXPANSION EIR, CITY OF SACRAMENTO, CALIFORNIA

LOWER AMERICAN RIVER FLOW DURATION CURVE

HDR

Figure III-51

436 mgd (245,000 ac-ft/yr) at buildout in year 2030. SWRCB approval of the City's petitions for extensions of time to construct the additional facilities is necessary for them to permanently vest these rights in licenses. The City's authorized place of use for American River water is shown in Figure III-52. Table III-7 is a summary of the City's water rights.

Figure III-53 is a plan and cross section view of the City's intake to the Fairbairn Water Treatment Plant showing the surrounding bathymetry. The structure is sited approximately 80 feet from the water's edge in the main river channel. The intake structure is connected to the treatment facility by a concrete box culvert which conveys the raw water supply to the grit basin and the treatment plant.

River water is drawn into the intake structure by six vertical mixed flow pumps that are protected by intake screens. The screens are located on both sides of the intake with two screens serving each of the six pump stations. The function of the intake screens is to keep fish, as well as debris, out of the raw water supply. The screen material is 5/16-inch thick stainless steel perforated plate. The plate perforations are 3/8-inch in diameter drilled on 1/2-inch staggered centers. Cleaning of the intake screens is currently accomplished by back-flushing with water and by occasional cleaning with high pressure sprays.

Carmichael Water District--

Carmichael Water District possesses the following appropriative rights to American River surface waters:

Date of Application	Status	Licensed or Permitted Quantity
9/18/15	Licensed	15 cfs Jan 1 - Dec 31
8/22/25	Licensed	10 cfs May 1 - Nov 1
3/01/48	Permit	25 cfs Jan 1 - Dec. 31 For Municipal Supply Mar 15 - Oct 15 For irrigation

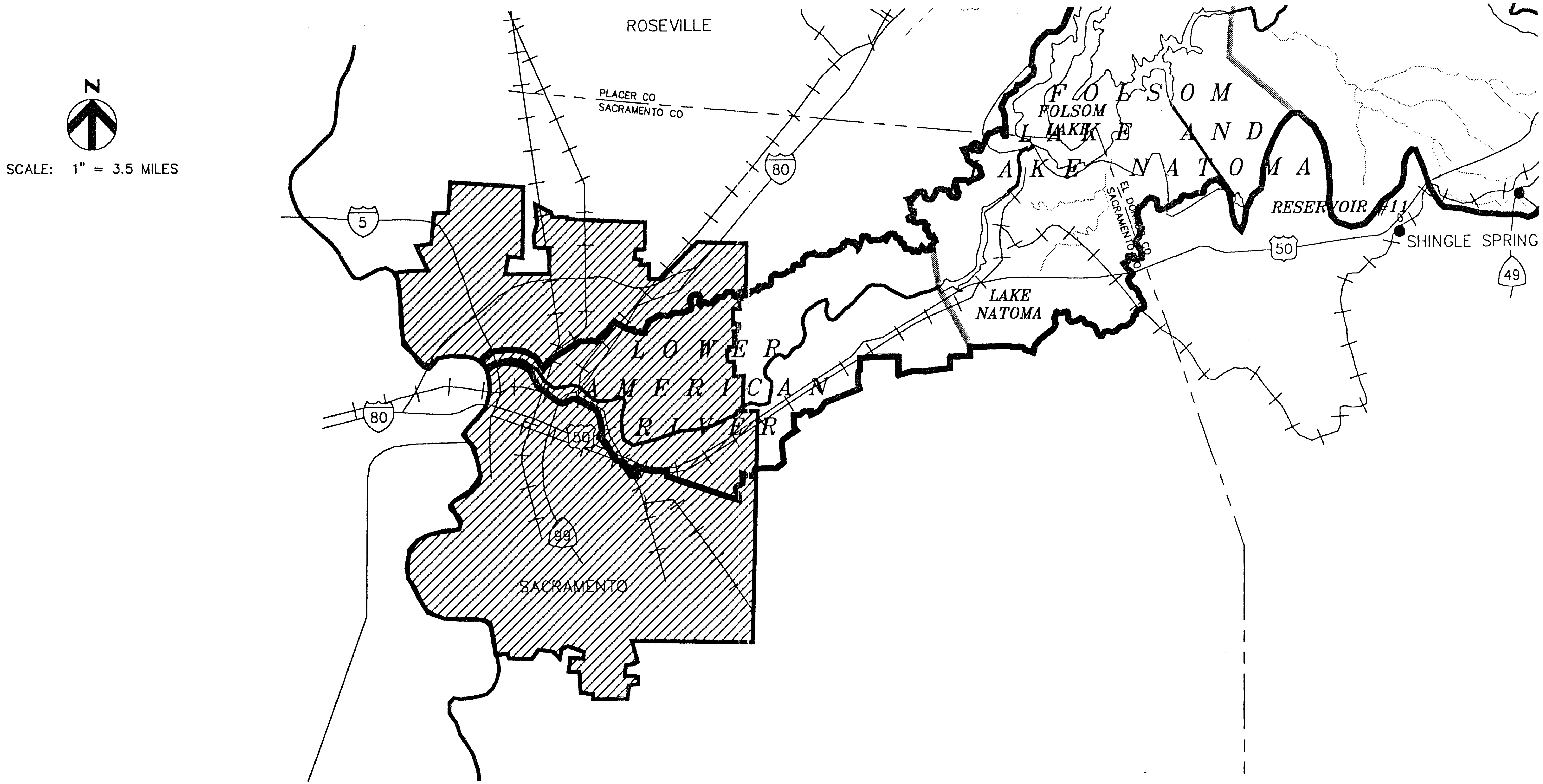
TABLE III-7

SUMMARY OF CITY OF SACRAMENTO WATER RIGHTS

Permit/Application	Source(s)	Diversion Rate (cfs)	Firm Supply (acre-feet/yr)	Diversion Season	Use(s)	Storage Reservoirs	Authorized Diversion Points
992/1743	Sacramento R.	225	81,800	Year-round	Municipal	None	Sac R. WTP Pioneer Resvr
11358/12140	American R.	675*	245,000*	Nov 1 - Aug 1*	Municipal Recreational*	None	Fairbairn WTP
11360/12622	American R. Tributaries (Rubicon R., Rockbound Creek, S. Fork Rubicon R., Gerle Creek					Rubicon Rockbound Loon Lake Gerle	Sacramento R. WTP
11359/12321	American R. Tributaries (Silver Creek, S. Fork Silver Creek)					Union Valley Ice House	Riverside WTP
11361/16060	American R.					None	
	Total:	900	326,800				

* - Combined benefits, permits 11358,11359,11360 & 11361

DRJ/ 1/22/93



CITY OF SACRAMENTO SERVICE AREA
FOR AMERICAN RIVER WATER

HDR

Figure III-52

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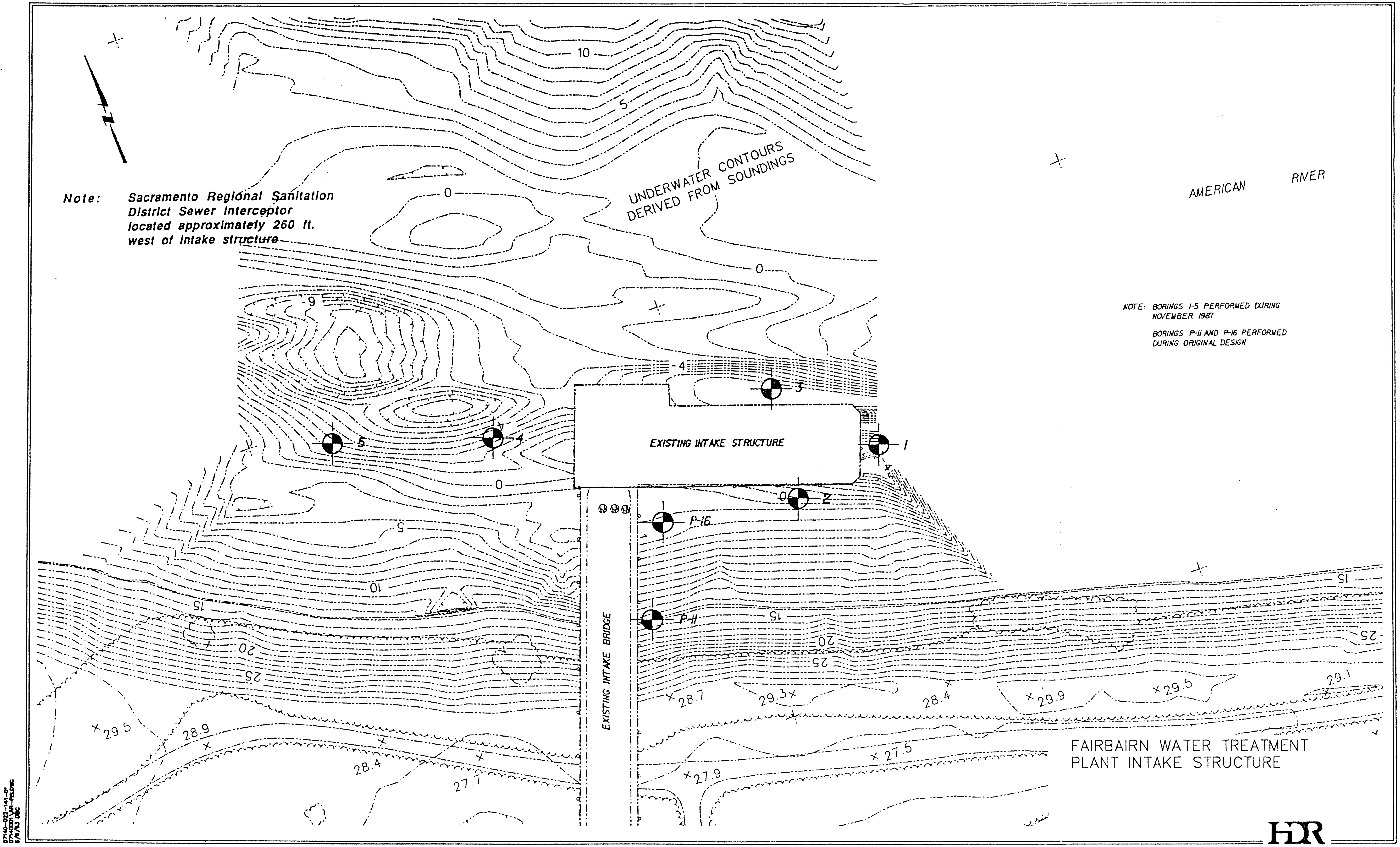

Figure III-53

The District has petitioned for an extension of time within which to develop the facilities and apply the permitted water to the proposed uses in order to vest its rights to the last 25 cfs. This petition was approved by the State Water Resources Control Board with the date to complete application of the water deferred until December 1, 1995. However, in 1988 the State Water Resources Control Board notified all riparian users and diverters holding permits and licenses within the Sacramento-San Joaquin Watershed that "Natural flows are available to appropriators only after all riparian demands have been satisfied." In drought years, the natural flow in the American River is not adequate to meet all the appropriative water rights, thus reducing the above listed quantities.

The District can increase its diversion rate beyond the total permitted diversion of 50 cfs (10,125 gallons per minute) as long as:

- The equivalent continuous flow allowance of the 50 cfs water right for any thirty (30) day period is not exceeded.
- There is no interference with other vested water rights.

However, the District is limited by the combined capacity of the four Ranney collectors[10] it uses, which have been rated at a combined flow of 23,100 gpm. This capacity can be impaired by river substrate clogging during extended periods of low flow (a minimum combined collector yield totalling 14,200 gpm has been measured). Recovery of collector capacity has been generally related to flood flows that scour the riverbed of clogging sediments and organic deposits.

The boundaries of the Carmichael Water District are shown in Figure III-54.

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[10]Ranney collectors are like large bore stilling wells sunken into the riverbank gravels. They intercept subsurface river flows at differing rates determined by river stage and minimum pumping elevation.

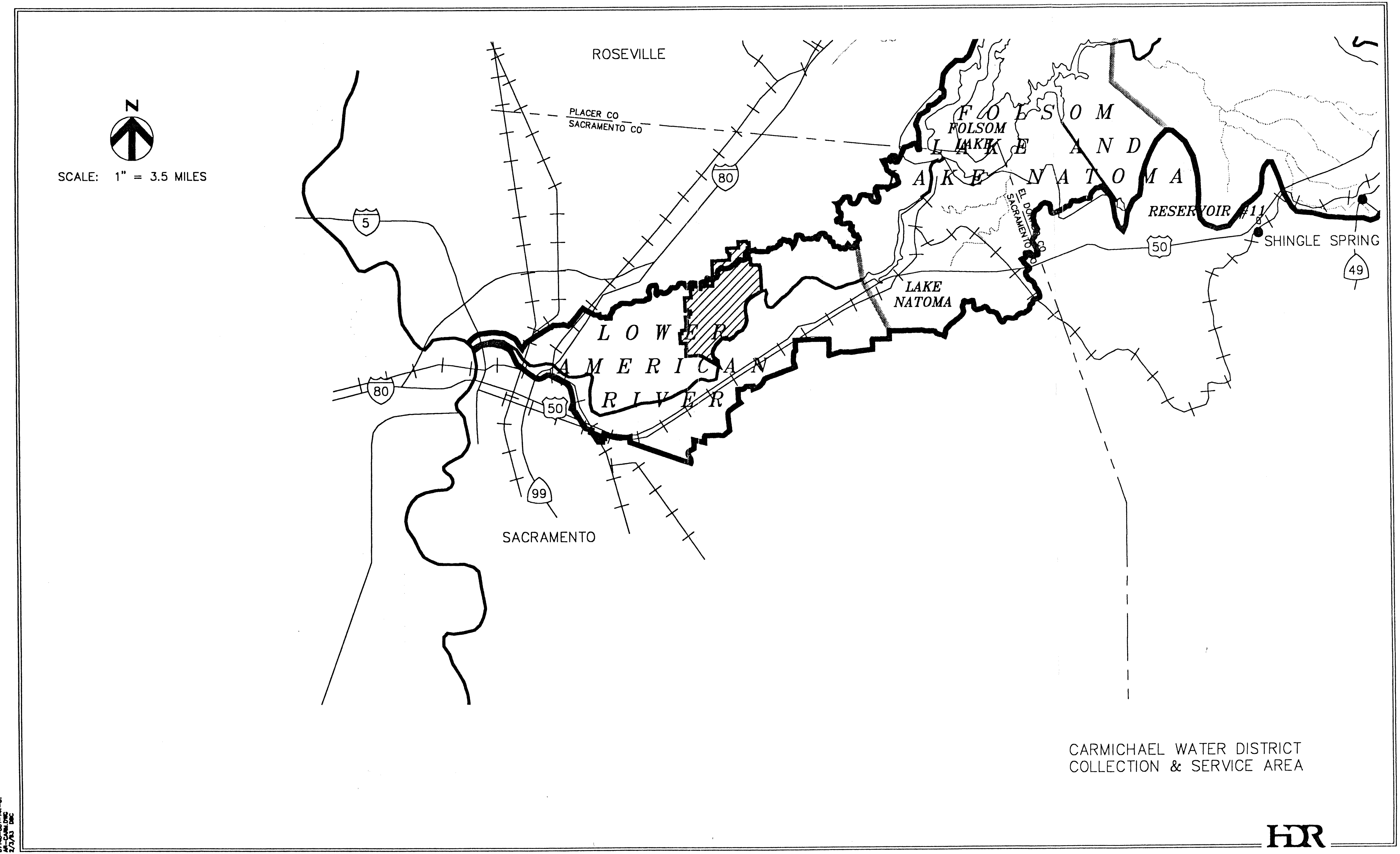


Figure III-54

Land Use and Ownership

Land Use--

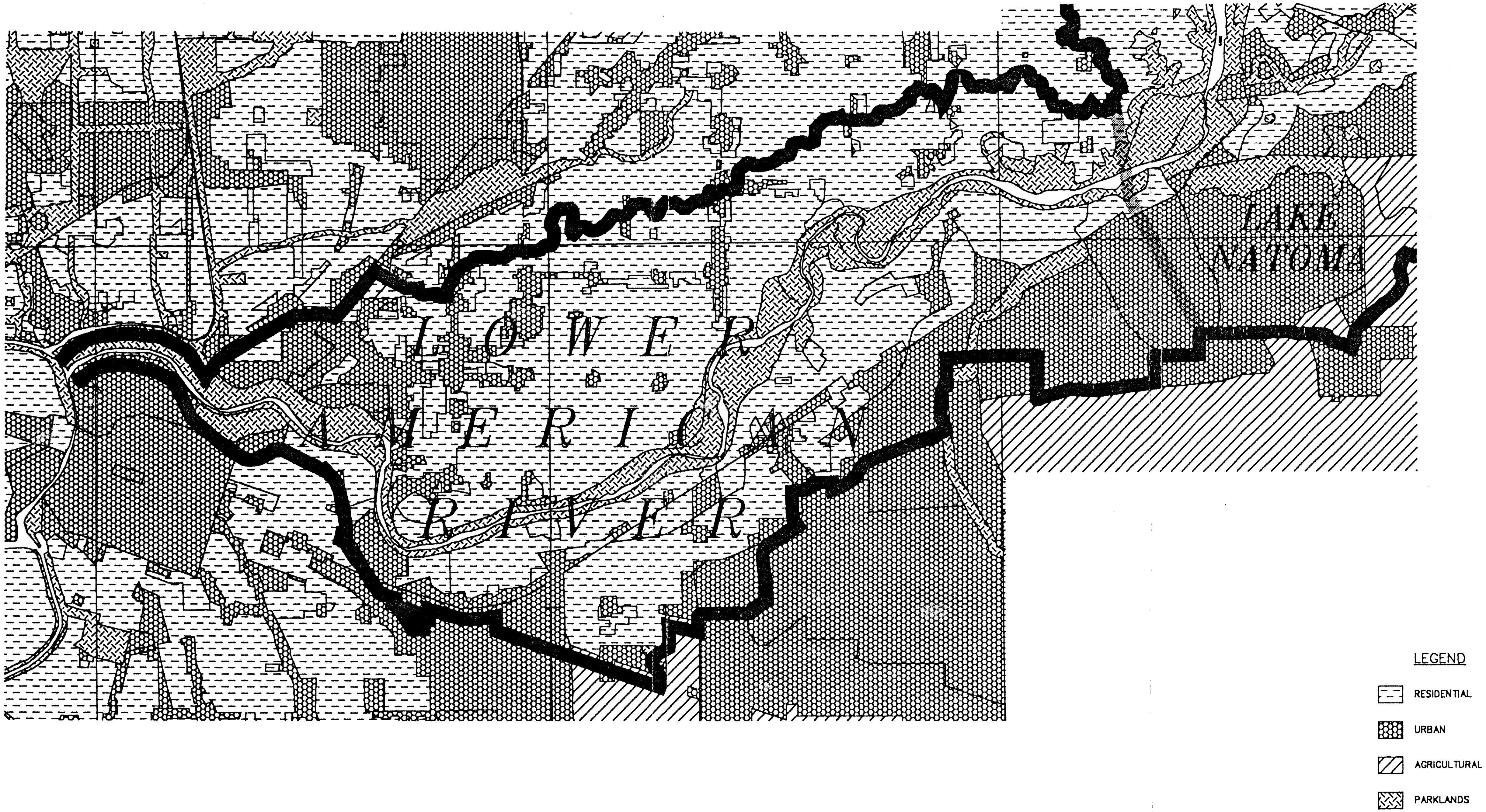
American River Parkway--The American River Parkway encompasses both sides of the river along the entire lower reach. It has a profound effect on land use activities that affect this reach of the river. Essentially, the parkway is an open space greenbelt which extends approximately 29 miles from Folsom Dam to the confluence of the American River with the Sacramento. The Parkway Plan, as adopted by the Sacramento City Council and the Sacramento County Board of Supervisors, and included in the City and County General Plans, provides a guide to land use decisions affecting the Parkway, specifically addressing its preservation, use, development and administration.

The plan includes goals, policies, and implementation measures for management of the "Parkway." The "Parkway" is a regional park crossing boundaries which demark the City of Sacramento, the County of Sacramento and Folsom State Recreational Area. The Parkway is shown in Figure III-55, the land use delineation for the lower American River sub-basin.

In addition to its recognition at the local level as a unique natural resource, both the California State Legislature and the U.S. Congress have separately included the lower American River in their respective wild and scenic river systems and classified it as a recreational river.

The parkway provides over 20 improved access points in the 23 mile stretch below Nimbus Dam (see Activities section). For much of this length the "wild" character of the river is reasonably well maintained, especially considering that the entire lower 23 miles passes through a major urban area.

High and low intensity recreational facilities are widespread within the American River Parkway. Bike trails run along both sides of the river along with pedestrian and equestrian trails.



LAND USE –
LOWER AMERICAN RIVER
SUBBASIN

HDR

Figure III-55

Land use policies contained in the Parkway Plan which are germane to watershed activities and water diversions include the following:

- Facilities and improvements shall not be installed within the Parkway unless consistent with an adopted area plan.

- Adverse impacts upon the Parkway caused by adjacent land uses and activities shall be eliminated or mitigated.

- Levees, landscaping, and other man-made or natural buffers should be used to separate the Parkway visually and functionally from adjoining land uses.

- Brush clearing, mowing of natural vegetation, fire breaks, or similar activities shall be prohibited in the Open Space Preserve Areas, Nature Study Areas, Protected Areas and Recreation Reserve Areas, unless a demonstrated need exists to protect the public health, safety, or welfare, as determined by the appropriate fire agency.

- Human developments and facilities including, but not limited to, buildings, fences, trails, sprinkler systems and gates shall be prohibited in the Open Space Preserve Areas, except as necessary to protect the public health, safety, and welfare.

- Facilities and other improvements in Protected Areas shall be limited to those which are needed for the public enjoyment of the natural environment. Extensive development is not appropriate.

Under the Implementation Program of the Parkway Plan it is recognized that certain existing uses within the Parkway are nonconforming uses. The plan acknowledges that "public facilities, such as the City of Sacramento's filtration plant, could constitute an obstruction to river flows or create other conflicts with the parkway. However, facilities such as this are considered necessary to promote the overall health, safety and welfare of the community."

Other Land Use--

The following general land use designations have been adapted from the Sacramento County General Plan:

Parklands: State, city and county parks including the River Parkway.

Urban: High density urban core areas, commercial areas and offices, intensive and extensive industrial.

Residential: Medium and low density residential and agricultural-residential.

Agricultural: General agriculture and agricultural croplands.

Public and quasi-public: Schools, hospital, cemeteries and other public and quasi-public lands.

Figure III-55 is a delineation of the areal distribution of these land use categories within the American River watershed.

Land Ownership--

Table III-8 summarizes the identified categories of land ownership within the sub-basin and Figure III-56 delineates their extent.

Table III-8. Summary of Water Right and Contractual Entitlements of Water Purveyors

Water Purveyor	Entitlement ac-ft/yr	Source	Basis	Provider	Deficiencies ac-ft/yr	System Capacity, cfs
San Juan Suburban WD	33,000 11,300 25,000[1] 69,200[3]	Folsom Lake Folsom Lake North Fork (via Folsom Dam)	Prior water right Contract Contract[2]	USCE USBR PCWA	12,500	186
City of Roseville	40,000 (max) equal exchange of treated for raw water	Folsom Lake North Fork (via Folsom Dam)	Contract Contract	USBR PCWA[2]	>31,700	65
City of Folsom	22,000	South Fork (via Folsom Dam and Folsom-South Canal)[4]	Water Right & Contracts	USBR	0	20 from Folsom South Canal when finished
Folsom Prison	4,000	American River (via Folsom Dam)	Comdemnation Judgement	USBR	Unknown	9

[1] This water may only be used to serve lands within Placer County.
[2] Wheeled by USBR.
[3] SJSWD has requested an additional 28,800 ac-ft/yr of contractual water from the Central Valley Project (USBR).
[4] Folsom's rights to Folsom Dam deliveries will be reduced by amount delivered via Folsom-South Canal.

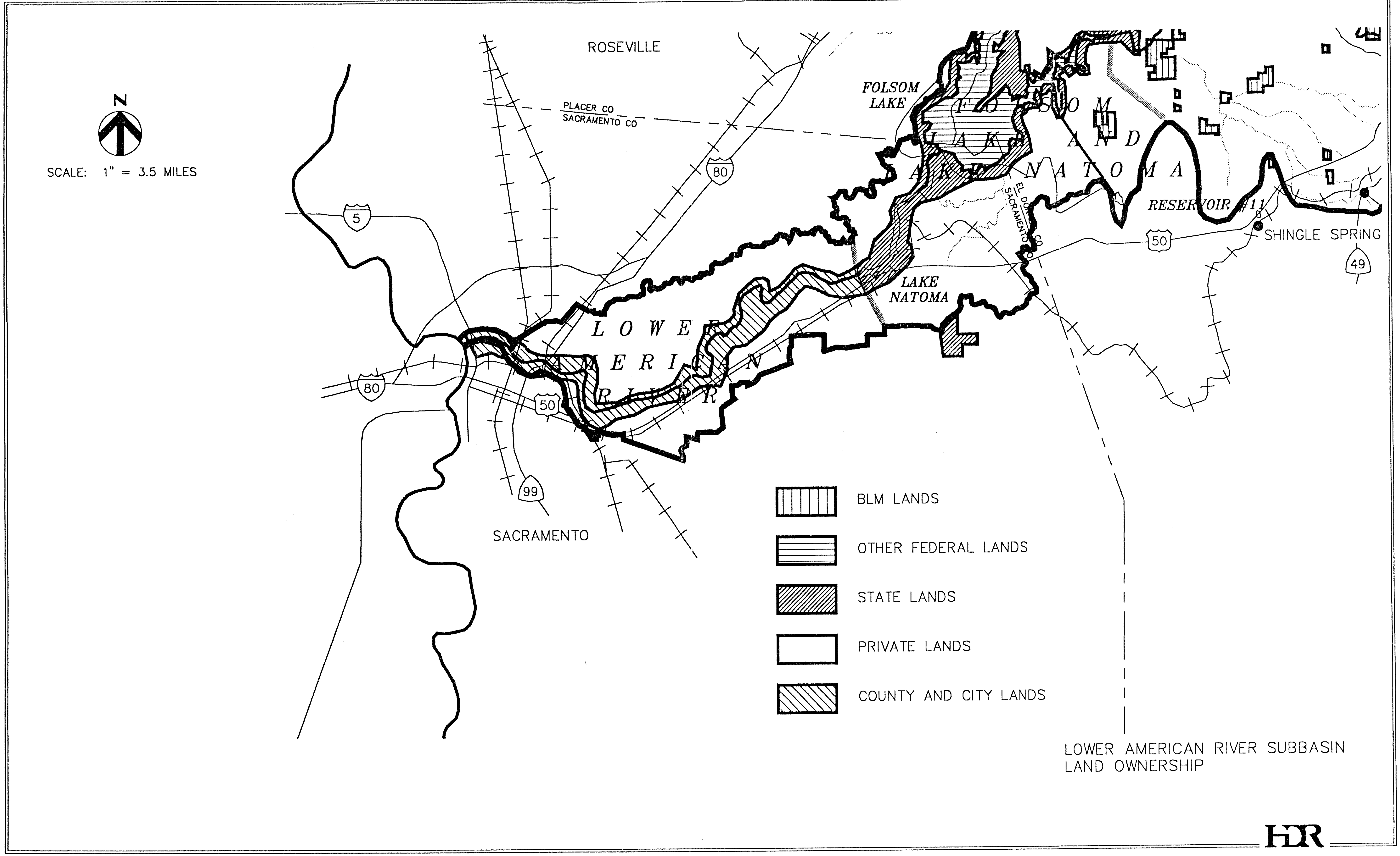


Figure III-56