dips at piers 3 and 4, located in the deepest part of the old Pit River channel. The elevation of the top of piers 3 and 4 is at 1067 feet, the height of the joint-use water surface elevation in the existing reservoir. The ledge supporting the support bearings of the truss section at Abutment 2, located at the southern end of the bridge, is at elevation 1088.03 (top of rail tie elevation shown at 1099.33). These elevations govern the extent to which Shasta Dam can be raised without relocating the bridge. A crest elevation of 1084 (4 feet below the hinge at Abutment 2) was selected as the maximum height the dam could be raised without requiring replacement of the bridge.

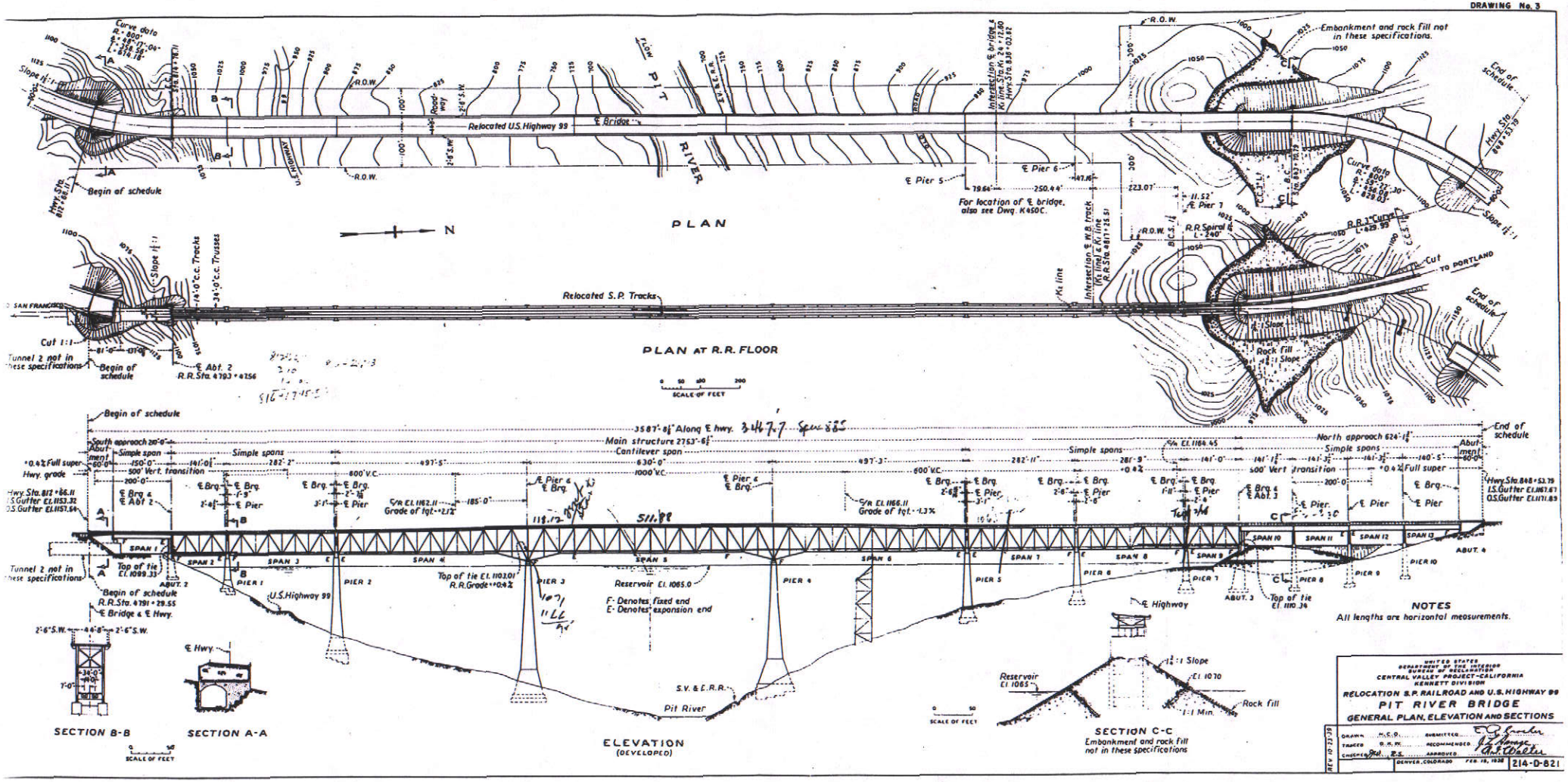
In the Low Option, the maximum water surface elevation of 1075.5 would still minimally inundate the truss structure at piers 3 and 4. In the Low Option, to account for this, the truss and support bearing components at piers 3 and 4 would be specially treated to withstand infrequent inundation for short periods of time. This floodproofing would provide protection against corrosion when the water surface elevation went above 1067. In addition, in the Low Option, the structure at piers 3 and 4 would be protected against the potential for floating debris. Protection against floating debris would be provided by installation of steel trash deflectors. Also, even under a flood condition where flood surcharge storage space is used, in the Low Option, there would be a minimum of 14 feet of clearance under the truss section, except in the immediate vicinity of the lower truss sections at piers 3 and 4, to allow passage of recreational houseboat traffic. These minimal measures were deemed adequate for the Low Option, given the frequency and duration at which they would be inundated.

For any enlargement options above elevation 1084, replacement of the bridge is necessary. In past studies of this bridge replacement, two sites have been considered. Two designs, a suspension and a through-truss design, have been considered for an alignment located west of the existing bridge structure. In addition, in past investigations, a suspension design has been examined for an eastern alignment. In this appraisal evaluation, a suspension bridge that carries both the highway and railroad traffic on the eastern alignment has been considered. This proposed eastern crossing site is located 200 feet east of the existing bridge.

The new bridge is proposed to be designed to higher standards, including six traffic lanes, inside and outside shoulders for each direction, a center median, and sidewalks, for a total deck width of 110 feet. The width of the existing bridge deck is less than 52 feet. A railroad bridge deck with a 35-foot width would be provided beneath the highway deck (as for the existing bridge). The bridge piers would be constructed in the dry, with the reservoir at or below elevation 1010. The high dam raise option would require a suspension bridge with a main span of 2,700 feet and end spans of 900 feet at deck elevation 1360.

There have been very few suspension bridges built that carry both rail and vehicular traffic. In earlier studies carried out in the 1980s, the only known suspension bridge that also carried rail traffic was built in Lisbon, Portugal. Now, however, a suspension or cable-stayed bridge having the required dimensions is considered within the

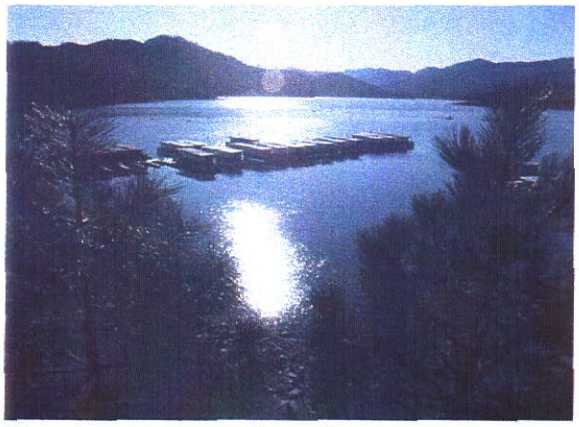
Figure 5


DRAWING No. 3
PLAN
PLAN AT R.R. FLOOR
ELEVATION
(DEVELOPED)
SECTION B-B
SECTION A-A
SECTION C-C
Embankment and rock fill not in these specifications.
Relocated U.S. Highway 99
Relocated S.P. Tracks
Pit River
For location of ℄ bridge, also see Dwg. K450C.
Main structure 2753'-6½"
Cantilever span
Simple spans
Reservoir El. 1065.0
F- Denotes fixed end
E- Denotes expansion end
NOTES
All lengths are horizontal measurements.
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT-CALIFORNIA
KENNETT DIVISION
RELOCATION S.P. RAILROAD AND U.S. HIGHWAY 99
PIT RIVER BRIDGE
GENERAL PLAN, ELEVATION AND SECTIONS
DENVER, COLORADO
214-D-821

current engineering state-of-the-art. The Akashi Kaikyo suspension bridge, with a 95-foot-wide highway deck above and a light rail line below, opened for use on April 5, 1998, in Japan. It has a main span of 6,527 feet and a total length of 12,825 feet. The Golden Gate Bridge in California has a main span of 4,200 feet and a deck width of 90 feet.

Recreational Facility Relocations

There has been extensive development of rural recreational facilities around Shasta Lake. Most facilities are near the existing shoreline, although private fly-fishing clubs are known to be operating on the McCloud River in potentially inundated areas. Table 9 shows a list of most of the recreational features found around the lake. This list was developed from the best available information. Figures 6 through 8 show the location of these facilities. Recreation facilities include campsites, picnic sites, swimming beaches, boat ramps, and several historic fly-fishing club lodges. Relocation of recreation facilities and appurtenant facilities includes roads, power and telephone utilities, bridges, administrative buildings, resorts, special use permit recreation residences, and other recreational support facilities.



Houseboat marina on Shasta Lake.

Most recreation facilities lie above elevation 1085, with the exception of some buildings associated with fly-fishing clubs. Consequently, the Low Option raise to elevation 1084 (joint-use water surface elevation 1075.5) reduces substantially any need for relocation of recreational facilities. Some modifications to existing facilities may still be required at some sites, but complete relocation will not be required for the most part. For all options above elevation 1085, recreational facilities will be adversely affected and, to the extent possible, will need to be relocated. The portions of the McCloud River, the Upper Sacramento River, Squaw Creek, and the Pit River that will be subject to reservoir inundation would no longer be suitable for fly-fishing during those times when inundated. Raising the lake to any of the proposed elevations is not likely to affect Shasta Caverns, other than possibly limiting expansion plans under the highest elevations of opening caverns below elevation 1271.5. Shasta Caverns is a highly visited tourist attraction in the area. A privately operated company conducts tours of the caverns.

The entrance to Samwell Cave, however, is at elevation 1270. Filling of the reservoir will likely adversely affect this cavern, since most of the cave is below the entrance. Other caves below elevation 1271.5 will potentially be flooded.

Community Relocations

Two small communities at Lakehead and Lakeshore would be affected by the Intermediate and High Option enlargements. Detailed topographic surveys need to be completed, but preliminary information indicates that these communities would be only minimally affected, if at all, under the Low Option, where the joint-use water level is at 1075.5. Several other smaller communities and developments would also be affected by the higher raise options. These include the communities or developments at Delta, Vollmer, and Antler, among others. These communities would have to be relocated.

Table 9.—Summary list of recreational features around Shasta Lake

Sacramento River Arm
Dry Creek Trail
Fisherman's Point Picnic Area
Centimundi Boat Ramp
Digger Bay Marina
Shasta Marina
Gooseneck Cove Campground
Old Man Campground
Lakeshore Resort
Beehive Point
Sugarloaf Resort and Marina (boat ramp)
Sugarloaf Cottages
Taesdi Resort
Shasta Lake Trails Resort
Gregory Beach
Gregory Creek Campground
Antlers Campground
Antlers Trailer Resort
Antlers Resort
Salt Creek
Lower Salt Creek Resort
Nelson Point Campground
Upper Salt Creek Resort
Salt Creek Picnic Area
Salt Creek Point Campground
Oak Grove Campground
McCloud River Arm
Bailey Cove Campground
Wintoon Campground
Shasta Caverns
Holiday Harbor Resort
Lakeview Marina Resort
Greens Creek Campground
Hirz Bay Day Campgrounds
Dekkas Rock Picnic Area and Campground
Moore Creek Campground
Ellery Creek Campground
Samwell Cave Nature Trail
Pine Point Campground
McCloud Bridge Campground
Bollibokka Fly-Fishing Club
Pit River Arm
Packers Bay Boat Ramp
Bridge Bay Resort
Ski Island Boat Camp and Marina
Silverthorn Marina
Mariners Point Campground
Rocky Ridge Campground
Jones Valley Campground
Upper Jones Valley
Lower Jones Valley
Jones Valley Resort
Jones Valley Boat Ramp
Rend Island Campground
Arbuckle Flat Boat Camp

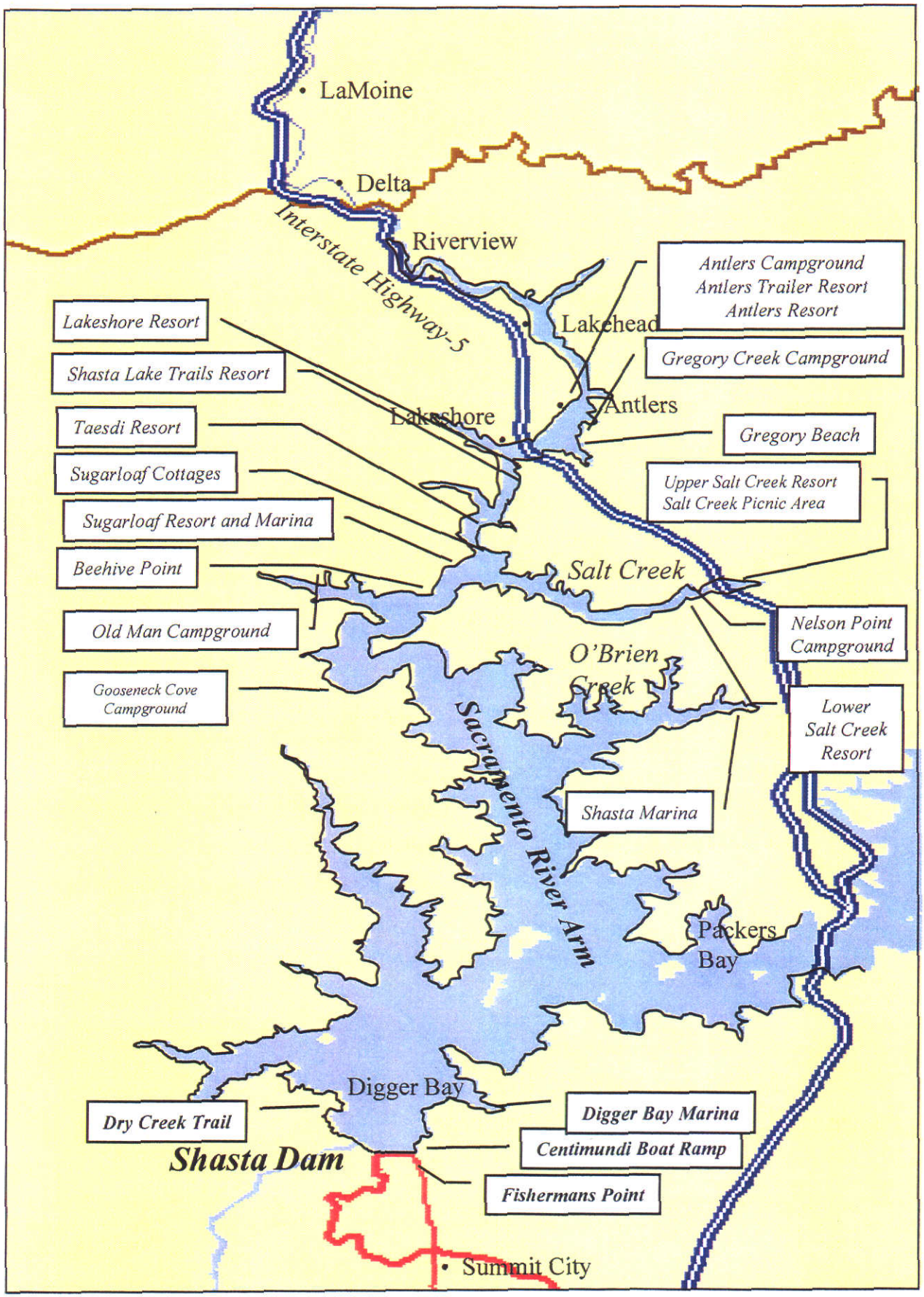


Figure 6 Recreation Facilities Sacramento River Arm

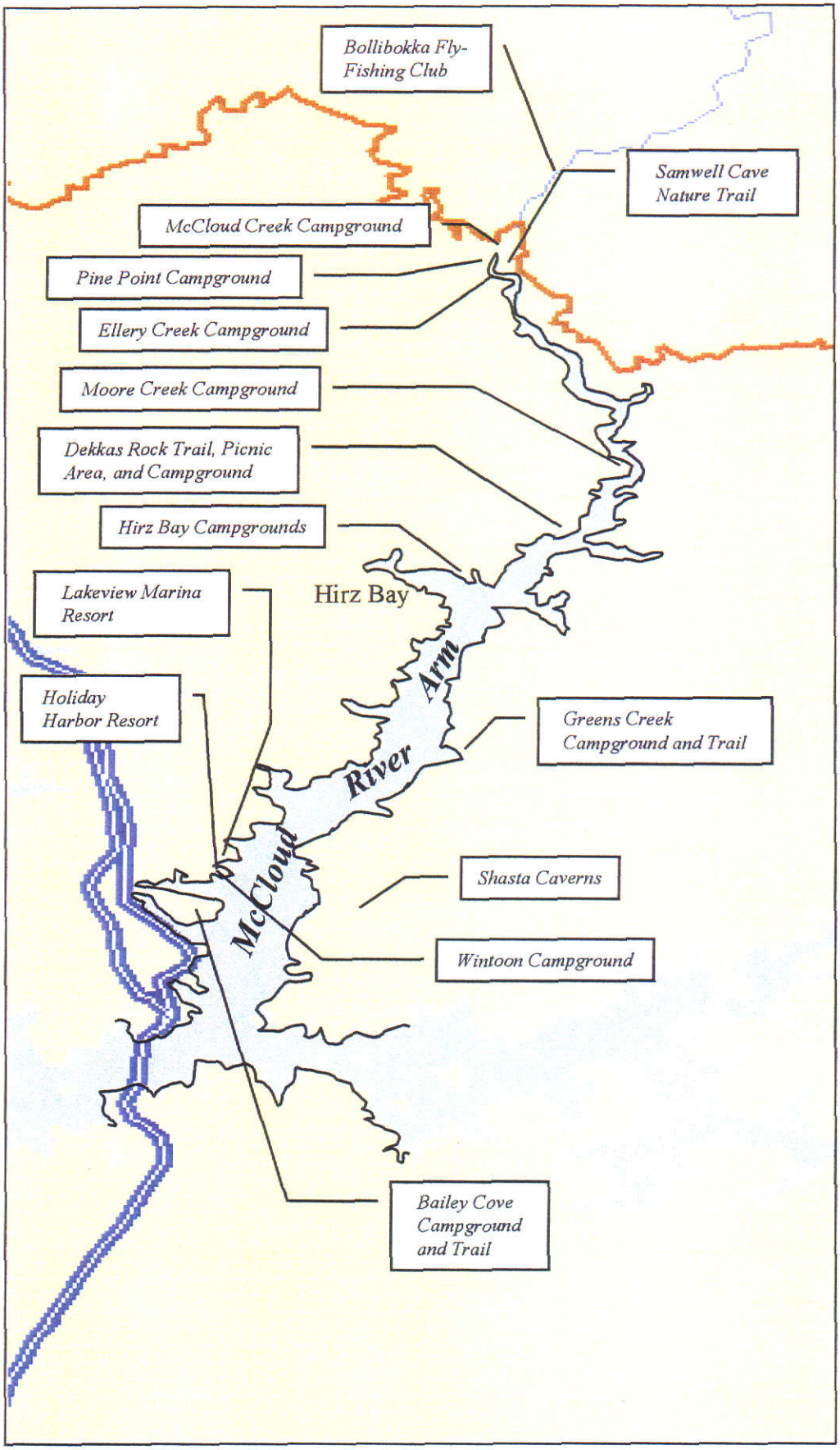


Figure 7 Recreation Facilities McCloud River Arm

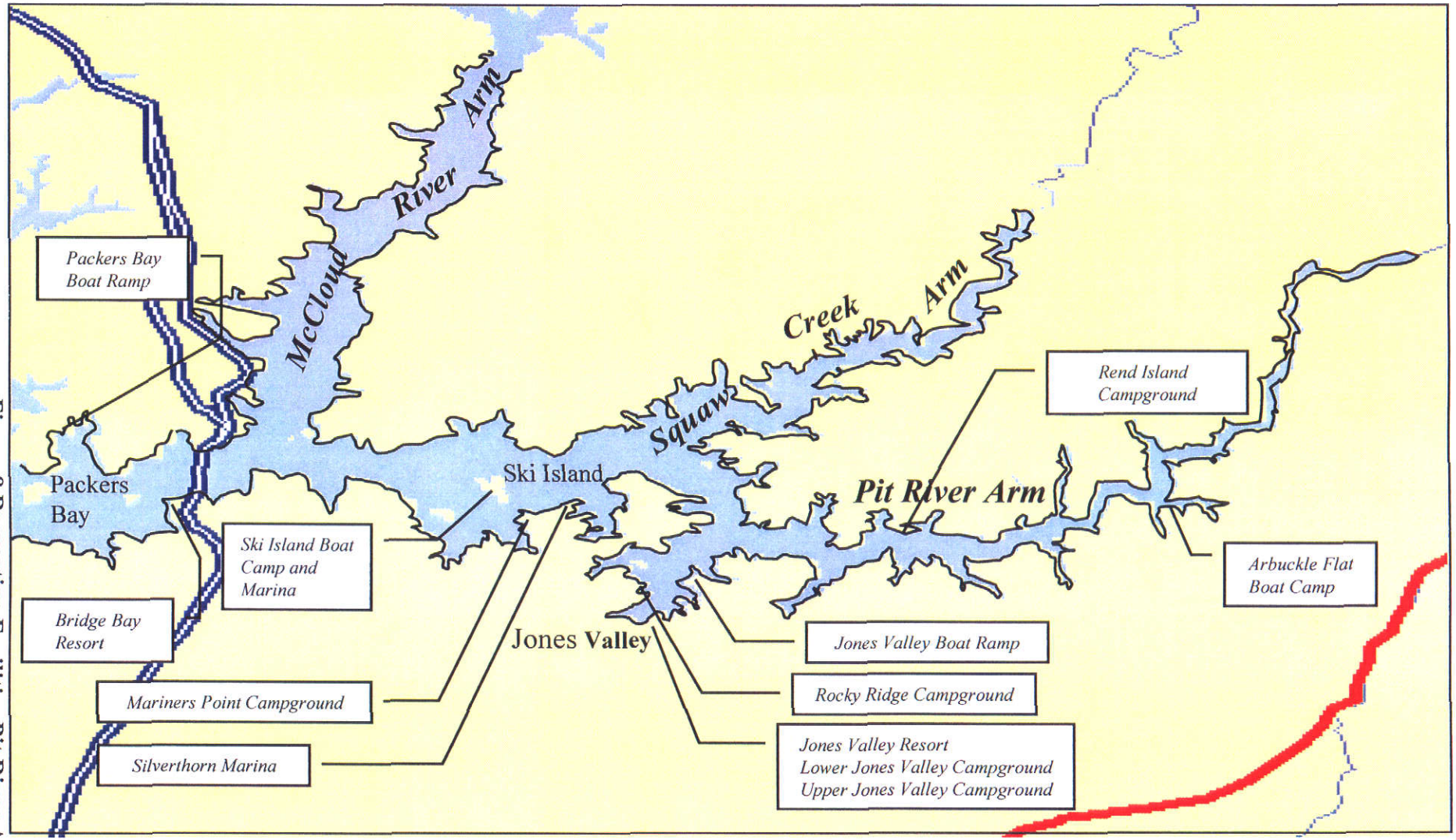
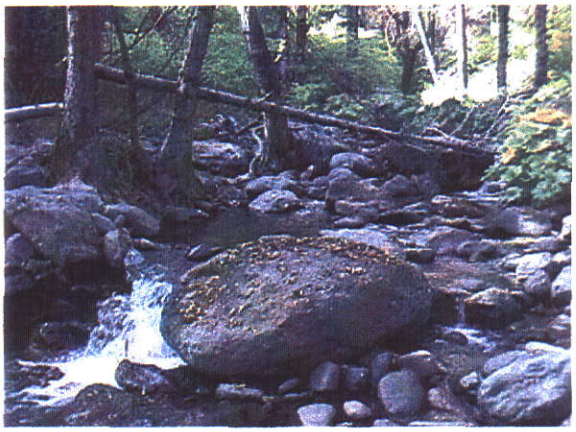


Figure 8 Recreation Facilities Pit River Arm



A small creek in the upper watershed above Shasta Lake.

Shasta Dam, due to its reservoir size and strategic location at the north end of the Central Valley, is an important component of California's complex water system. The size and location of the dam and reservoir allow significant operational flexibility to meet the water requirements for environmental and instream flow demands, as well as the traditional water supply demands. This water is also being touted as a mitigation source for proposed actions on the American River and areas further downstream. With increased stress on the water resources of the State, reliance on Shasta Lake for meeting ecosystem demands is likely to become even more important in the future.

Geographically, fish and wildlife issues directly associated with any proposed enlargement extend from the Sacramento-San Joaquin Delta to the headwaters of the Sacramento River and its tributaries above Shasta Lake. Indirectly, the issues extend further because increased water storage at Shasta would facilitate operational changes in the delta and San Joaquin Valley that would benefit fish and wildlife. While there would be certain adverse environmental effects associated with raising the dam, the increased storage also affords opportunities to better manage an already highly manipulated water resource.

The role any proposed enlargement of Shasta Dam and Shasta Lake may play in maintaining ecosystem values is described below, along with potential adverse effects of raising the dam.

The Role of Shasta Dam in Maintaining Ecosystem Values

Ecosystem demands on the water resource developed at Shasta Dam include: (1) meeting Bay-Delta water quality standards, (2) meeting requirements for the endangered winter-run chinook salmon and delta smelt, (3) meeting water temperature standards in the Sacramento River, (4) providing flows for dilution of acid mine drainage originating in the Spring Creek watershed, and (5) meeting instream flow requirements of the Central Valley Project Improvement Act.

The ecosystem standards that have been developed for the Bay-Delta and the Sacramento River have been deemed necessary for restoration of many aquatic and terrestrial species and their associated habitat. In California's highly managed water system, Shasta Dam is a critical feature in providing a reliable source of cold water for fishery restoration goals in the Sacramento River, as well as providing

volumes of water necessary to maintain water quality standards in the Sacramento-San Joaquin Delta.

In December 1994, the Bay-Delta Plan Accord established an interim agreement that provided for the Central Valley Project and the State Water Project to meet the water quality goals of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. The purpose of this accord is to contribute to the protection of beneficial uses in the estuary, including municipal and industrial, agricultural, and fish and wildlife objectives. Fish and wildlife water quality objectives are established for dissolved oxygen, salinity, delta outflow, riverflows, export limits, and delta Cross Channel gate operation. The Sacramento River flow objectives are to provide attraction and transport flows and suitable habitat for the various life stages of aquatic organisms, including delta smelt and chinook salmon. Under the Coordinated Operations Agreement, the operations of California's State Water Project and the Federal Central Valley Project are to be coordinated for sharing the obligation to meet the standards established for the delta. Shasta Lake is the primary facility on which the Federal Central Valley Project relies to meet these water resource demands.

In 1990 and 1991, the State Water Resources Control Board issued Water Rights Orders 90-5 and 91-01. These orders established a daily average water temperature objective of 56 degrees Fahrenheit in the Sacramento River at the Red Bluff Diversion Dam. The Central Valley Project attempts to maintain these temperatures within the winter-run salmon spawning grounds below Keswick Dam from April through September. In 1993, the National Marine Fisheries Service also issued a biological opinion that called for minimum instream flows in the Sacramento River of 3,250 ft^3/s below Keswick Dam from October 1 through March 31. Again, the water resources developed at Shasta Lake are critical in meeting these requirements. Interbasin water transfers from the Trinity River Basin are also vital in meeting temperature requirements, but as pressure increases to reduce the amount of interbasin transfers from the Trinity River Basin to the Sacramento River Basin, the demand on Shasta facilities for temperature control will continue to increase.

Another ecosystem value the water resource of Shasta Dam protects relates to dilution of acid mine drainage originating in the Spring Creek watershed. Spring Creek flows into Keswick Reservoir downstream from Shasta Dam. Acid mine drainage from abandoned mines in the upper Spring Creek watershed leach heavy metals into the watercourses. These heavy metals, under lower flow conditions, flow into Spring Creek Reservoir for a regulated release into Keswick Reservoir. During flood conditions, Spring Creek Reservoir occasionally fills and spills into Keswick Reservoir. Unless dilution water can be supplied from Shasta Lake or Spring Creek Powerplant, a high concentration of heavy metals can move downstream into the lower Sacramento River. This acid mine drainage is very toxic to fisheries, and water is required to dilute acid mine drainage runoff and prevent fishkills. Typically, water diverted from the Trinity River Basin into the Sacramento