



# United States Department of the Interior

## FISH AND WILDLIFE SERVICE

Private Lands Office  
2233 Watt Avenue, Suite 375  
Sacramento, California 95825-0509

IN REPLY REFER TO:

July 2, 1996

Dave Anderson  
Redwood National Park  
P.O. Box 7  
Orick, California 95555

Subject: Coho Salmon Habitat Restoration Project, Prairie Creek, Humboldt County,  
California

Dear Mr. Anderson:

On April 16, 1996, we discussed a salmon habitat restoration project that the U.S. Fish and Wildlife Service will be funding this year through its "Partners for Wildlife" fish and wildlife habitat restoration program. We would like your review and input on any effects that the project may have on fish or wildlife inhabiting Redwood National Park.

The project is located immediately west of Highway 101 north of Orick in Humboldt County, California. Enclosed is an environmental assessment of the project prepared by the USDA Natural Resources Conservation Service that includes a project location map and description document entitled "Morphodynamic Investigation of Prairie Creek & Design Criteria for a Proposed Coho Rearing/Overflow Channel". The primary objective of the project is to provide juvenile coho salmon overwintering habitat. Chinook salmon, steelhead trout, cutthroat trout, red-legged frogs, western pond turtles, and a variety of other wetland and riparian-oriented fish and wildlife species will also benefit from the restoration of a historic side channel to Prairie Creek that has been mostly filled-in and currently provides only minimal wildlife habitat.

A component of the project that may result in a temporary impact to fish and wildlife inhabiting Prairie Creek will involve 1) removal of an earthen berm and placement of rock rip-rap along the toe of a 15 foot-wide section of the east bank of the creek at the side channel inlet, and 2) placement of bank stabilization material onto one or two eroding sections of the east bank of the Creek. Those actions are described in the enclosed document. We hope to start the project in late summer or early autumn 1996.

During our phone conversation you requested information on the Service's Partners for Wildlife private lands habitat restoration program. I have included some information on the program in the enclosed packet. I would be happy to discuss the program with you, and would be interested in hearing of any possible projects you may have in mind.

Please review the enclosed document and let us know if you have concerns about the project or would like to make recommendations regarding project construction. If you would like to discuss the project please give me a call at (916) 979-2085.

Sincerely,

A handwritten signature in black ink, appearing to read "Daniel Strait". The signature is fluid and cursive, with the first name "Daniel" and last name "Strait" clearly distinguishable.

Daniel Strait  
Partners for Wildlife

Enclosures

cc: (w/o enclosures)

Marilynn Friley, FWS-DHC, Portland

Tim Viel, USDA-NRCS, P.O. Box 1414, Weaverville, CA 96093

Mitch Farro, PCFW&WRA, P.O. Box 4574, Arcata, CA 95521

# **Prairie Creek Side Channel Restoration Project Environmental Assessment**

## **A. BACKGROUND**

The U.S. Fish and Wildlife Service (FWS) Partners in Wildlife Program offers technical and cost-share assistance to landowners who wish to restore wildlife habitat. The program focuses on the re-establishment of original natural communities. Projects given preference are those that will contribute to the survival of endangered, threatened, or candidate species.

In May of 1994 President Clinton declared a disaster for Pacific Northwest salmon fishermen and their coastal communities in northern California, Oregon, and Washington. The Office of Sustainable Development, U.S. Department of Commerce, put together a \$12 million relief package called the Northwest Emergency Assistance Program (NEAP) to help offset the the impact of this continuing disaster. The USDA Natural Resources Conservation Service (NRCS) was designated as the agency to oversee the Habitat Restoration Element of this disaster relief program. Six million dollars has been earmarked for the Habitat Restoration Element, of which 2.2 million dollars has been made available as grants to qualified applicants in four northern California counties (Del Norte, Humboldt, Mendocino, and Sonoma), to hire and train eligible, displaced commercial salmon fishermen to perform salmon habitat restoration work on private land.

The Salmon Stamp Restoration Fund began in 1979 and is a self-imposed tax by the commercial salmon industry to help pay for projects to increase freshwater production of young salmon. The program creates approximately \$1million/year to increase stocks through propagation and habitat improvement.

Together, the above three programs in conjunction with equipment and material contributions from Arcata Redwood Corp. and in-kind services of the landowner, Richard Byrns of Orick, provide the bulk of funding and services for the **Prairie Creek Side Channel Restoration Project**.

The sponsoring organization for the project is Pacific Coast Fish, Wildlife, and Wetlands Restoration Association of Arcata, Ca.

## **B. NEED FOR PROPOSED ACTION**

Numerous studies have documented the migration of juvenile coho salmon from summer rearing areas in the main channels of river systems into side channels and backwater areas to overwinter (Skeesick 1970; Peterson 1982; Cederholm and Scarlett 1982). Lack of overwintering habitat has been shown to be a limiting factor in coho salmon populations (Marshall and Britton 1990). Other research has documented the importance of abandoned channels, particularly with ponded areas, for the overwinter survival of juvenile coho salmon. Up to 20 to 25% of total smolts originated from such areas in some studies (Peterson and Reid 1984; Brown 1985).

Similar emigration into small tributaries has been observed, but is much less documented, in the coastal California portion of the coho's range. In early March of 1994, a CDF&G area biologist documented the presence of juvenile coho in a tributary channel (Skunk Cabbage Creek) to Prairie Creek. It is assumed that these juvenile fish had emigrated into this tributary since there is no suitable spawning gravels (Dave McCleod pers. comm.). This tributary is approximately two miles downstream of the proposed project location.

The primary objective of this project is to increase winter habitat for juvenile coho salmon. An abandoned and degraded channel of Prairie Creek will be restored to its original function as a side channel of Prairie Creek. Flows of an existing tributary will enter the restored channel and will be utilized to feed channel and ponded areas created by project actions. Placement of cover in the ponded and channel areas and planting of riparian vegetation will provide suitable low velocity overwinter habitat for juvenile coho salmon.

#### **C. ALTERNATIVES**

1. No Action

Under this alternative, the proposed side channel restoration project would not be undertaken.

2. Proposed Action

The proposed action is to carry out the side channel restoration activities of the project. A detailed description of the proposed work is presented in attachment 1.

#### **D. AFFECTED ENVIRONMENT**

Redwood National and State Parks, in a 1995 environmental assessment for a development plan for the area adjacent to the proposed project site, conducted a review of the affected environment which included climate and air quality; topography, geology, and soils; water resources; floodplains and wetlands; vegetation; wildlife and fisheries; federal and state threatened, endangered and candidate species; and cultural resources. A copy of this review is included in attachment 2. It is felt that this document adequately describes the affected environment for this project and is referenced for that use.

#### **E. ENVIRONMENTAL CONSEQUENCES**

**Alternative 1 - No Action** - there would be no significant short or long-term impacts to the environment.

**Alternative 2 - Proposed Action**

##### **General Impacts**

Implementation of the project would result in short-term localized impacts to the environment. Construction impacts would be of low intensity, narrowly confined and of short duration.

The newly constructed side channel resulting from this project will have positive cumulative affects on existing aquatic/wetland habitat due to the proposed conversion of a portion of pasture land to a riparian/wetland zone. An increase in plant and mammal species diversity is expected as a result of the more diverse and complex habitat to be created from the side channel construction and habitat enhancement activities.

##### **Air Quality**

There would be minor localized decreases in air quality resulting from construction. Temporary increases in dust and fumes may occur from operations, but no significant impacts are anticipated.

### **Soils and Vegetation**

Construction in riparian areas of Prairie Creek at the head or tail end of the side channel would occur during the dry season to avoid additional impacts to bank stability. No old growth trees or large snags would be removed. However, some alders and young conifers may be removed when breaching the side channel with Prairie Creek.

Areas disturbed by construction would be revegetated. Revegetation activities would be focused on the riparian areas as quickly as possible upon completion of side channel construction to minimize erosion of newly created and disturbed banks. All armoring at the head or tail end of the channel connection with Prairie Creek will be planted with appropriate riparian vegetation to enhance habitat.

Spoils from dredging the channel will be dispersed on site throughout landowner's property in a manner not to alter significantly the topography of the property. All spoil material and disturbed areas will be appropriately revegetated with endemic species upon completion of channel excavation.

The long-term impact to the vegetation of the project site would be enhanced through the revegetation component of the project. Riparian habitat will be created along the constructed side channel, and the armored sections of Prairie Creek would be planted with appropriate species to provide a more diverse, complex riparian zone.

### **Water Resources**

Runoff from soils disturbed by construction activities and through the newly constructed channel itself would increase turbidity of Prairie Creek on a short-term basis. Soil disturbance near Prairie Creek would be monitored and erosion control techniques employed to avoid water quality impacts.

Instream work to stabilize the points of entry on Prairie Creek with the side channel mouth and outlet would occur during low flow periods, between July and October, to minimize the amount of sedimentation and turbidity impacts resulting from construction. Instream sedimentation control methods, such as silt fences, would be employed if impacts surpassed base levels that result from storm events. The breaching of the side channel with Prairie Creek will not occur until revegetation measures to stabilize the newly constructed channel have been completed and established.

No long-term adverse impacts on water quality of Prairie Creek are anticipated from project implementation.

### **Floodplain and Wetland**

The proposed side channel would have no adverse impact to the current floodplain. It would increase the ability of the current floodplain to adequately carry floodwaters during high flow events. The fifty-year flood event on Prairie Creek is estimated to be 8500 cfs immediately downstream of project site at Davison Ranch.

Presently, the existing pasture where construction would occur is not designated wetland, but would be so designated upon completion of project.

### **Wildlife and Fisheries**

Short-term impacts due to construction noise and human activity may have an adverse impact to wildlife in the area. However, the site is immediately adjacent to Hwy. 101, and additional noise and activity is expected to be minimal. The construction site is predominantly pastureland and upon project completion available wildlife habitat will become more diverse.

The project's intent is to increase overwintering habitat for juvenile coho salmon, and by doing so, there will also be an enhancement of riparian wildlife habitat along the entire reach of the side channel.

### **Threatened and Endangered Species**

No listed or proposed threatened or endangered plant species are known to exist within the project area.

No significant impact would occur towards the marbled murrelet, northern spotted owl or critical habitat by the proposed actions. There is no suitable habitat for either species within a 1/4 mi. of project site.

With the proposed action, there may be a short-term adverse affect on riparian-dependent species, such as the recently listed Northern Red-legged Frog, due to construction disturbance within the present riparian zone where the restored side channel will connect with Prairie Creek. However, the long-term affects would be towards an increase in suitable habitat for riparian species once the restored side-channel and riparian zone is established.

There would be a significant, positive affect for the proposed coho and steelhead fish species. With project action, juvenile rearing habitat for both species would be enhanced in this reach of Prairie Creek.

There are no other threatened, endangered, or proposed species that would be significantly affected by the proposed action.

The USFWS has reviewed the proposed action and potential impacts on these species as part of their requirement as the major funding source for this project through their Partners for Wildlife Program. They are in concurrence with this E.A. towards any threatened or endangered species.

### **Cultural Resources**

The USFWS has conducted a cultural resource inventory as required by their Partners for Wildlife Program. The inventory concluded there would be no impacts to any archeological, historic, or ethnographic resources from proposed actions.

## **ATTACHMENT 1**

## **SALMONID HABITAT RESTORATION PROJECT SUMMARY**

**WATERWAY:** Prairie Creek

**COUNTY:** Humboldt

**NEAREST CITY:** Orick

**USGS QUAD:** Orick, CA, 1975

**LEGAL DESCRIPTION:** Township 11 North, Range 1 East, northwest quarter of Section 14

**SIZE OF PROJECT AREA:** Approximately 700 feet of an historic side channel to Prairie Creek

**CURRENT PROPERTY OWNER:** Richard Byrns, 125752 Highway 101, Orick, CA 95555

**RESOURCES TO BE BENEFITTED:** Coho salmon, a species proposed for listing as threatened under the federal Endangered Species Act, is the primary species targeted. Also benefitting will be chinook salmon, cutthroat trout, steelhead trout, red-legged frog (federally threatened), western pond turtle (federal species of concern), and other wetland and riparian dependent species, particularly neotropical migrant songbirds.

### **PROJECT DESCRIPTION:**

The landowner will excavate a series of ponded water areas connected by a flowing water channel in an existing side channel to Prairie Creek. The majority of the excavation will be for the purpose of enlarging areas to create ponded water habitat and to remove fill that has been placed in the channel during road construction and from agricultural activities in the past. Placement of a 6 ft. culvert under an existing road will reconnect a portion of the channel that is now isolated. Some of the excavated soil and gravel will be used to create a final contour to the ponds and channels. This will also provide a suitable soil medium for riparian vegetation restoration. Some of the excavated material will be placed in the channel to direct flows at high discharges. Rip rap and large woody debris will be used to armor the head, tail end, and other potential scour locations of the channel to protect the channel and provide cover for juvenile salmon.

The channel and ponds will be excavated during late summer or fall with a track mounted excavator to a depth approximately 1.5 feet below final elevation, with 3:1 bank slopes. A layer of clay material will be applied to the ponds and channel 4 to 6 in. deep and compacted with a sheep foot compactor. A geo-textile fabric will be used to seal log structures, the culvert, and the armored areas. Armoring and final contouring will be accomplished with a backhoe. Exposed soil will be straw mulched after construction.

The project area will be planted with big leaf maple, Sitka spruce, and other native trees and shrubs. Willow cuttings will also be placed along the restored channel. Plant introduction will be completed during the first winter after construction.

The berm at the north end of the historic side channel, which currently acts to isolate the channel from Prairie Creek, will be lowered to an elevation that will allow water during a 5-year rainfall event to top the berm and enter the channel. The excavation of the berm will not occur until one growing season has past in order to reduce the potential for erosion.

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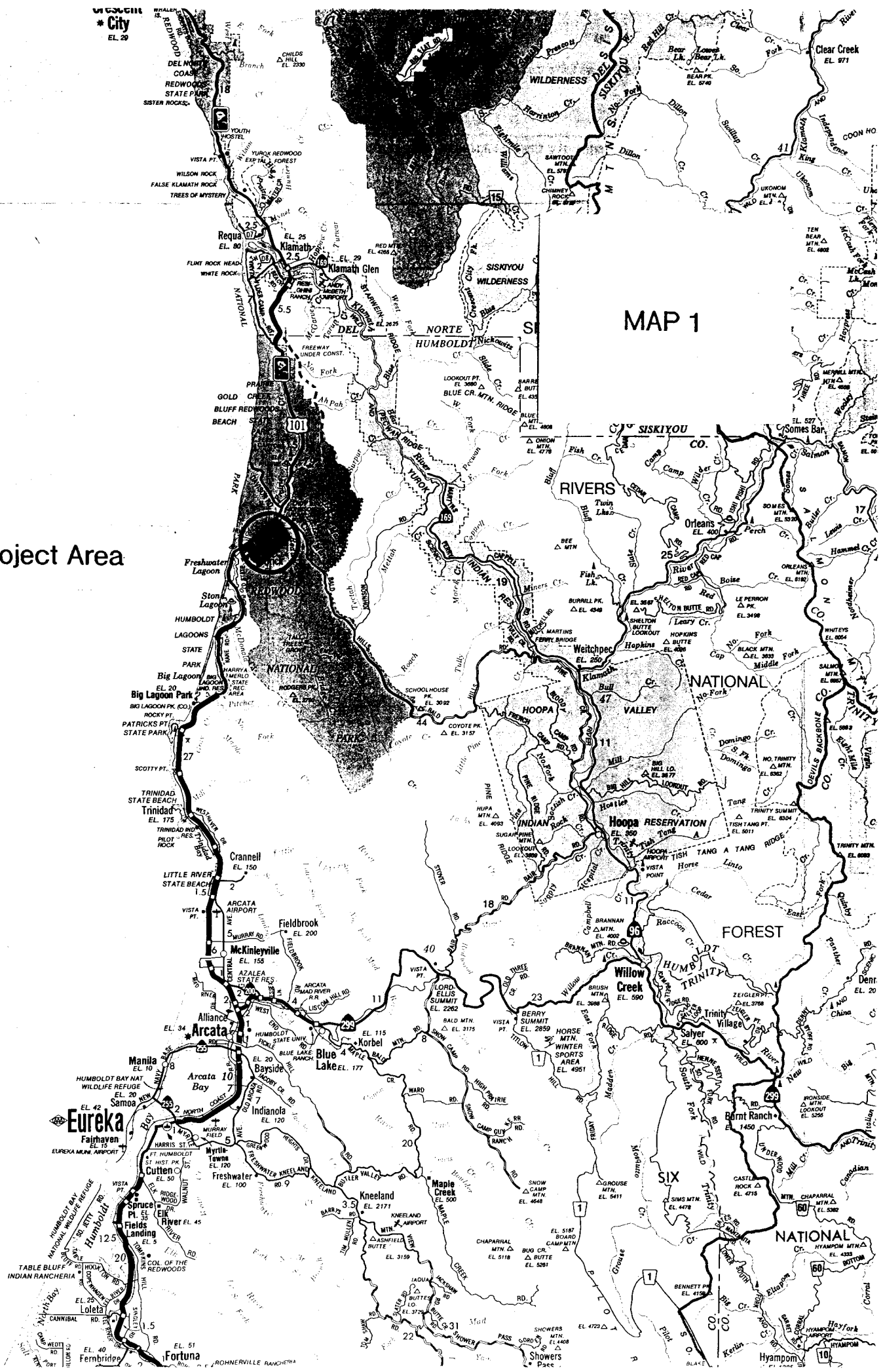
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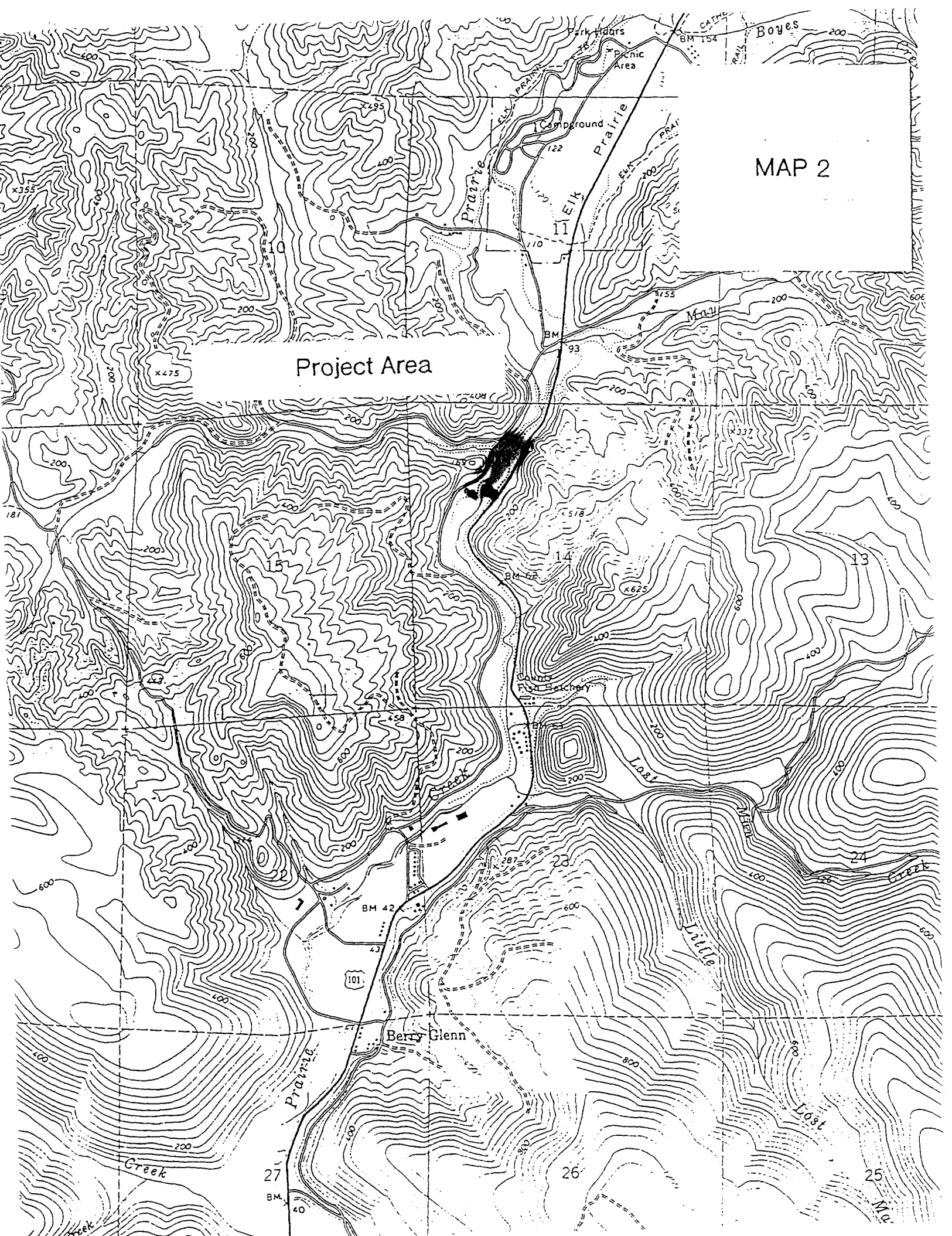
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Project Area

MAP 1





MAP 2

Project Area

Berry Glenn

Boyce

Campground

Little Creek

Lost Creek

Creek

26

25

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24

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11

## **ATTACHMENT 2**

MORPHODYNAMIC INVESTIGATION OF PRAIRIE CREEK &

DESIGN CRITERIA FOR A PROPOSED

COHO REARING/ OVERFLOW CHANNEL

Pacific Coast Fish, Wildlife & Wetland Restoration Association

by M.J. Scalici

June, 1996

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## **1.0 INTRODUCTION**

In 1996, Pacific Coast Fish, Wildlife & Wetland Restoration Association (Pacific Coast Restoration) received grant funding to enhance coho salmon rearing habitat by recreating an overflow channel on a terrace of Prairie Creek immediately downstream of the southern end of the US Highway 101 bypass. The project channel is being designed to meet two goals:

- 1) Enhance fishery habitat by creating a structurally complex channel adjacent to Prairie Creek with the following habitat types: one backwater, three pools and two riffles.**
- 2) Reduce peak flood stages at the project site by allowing discharges occurring every 3-4 years to flow through the project channel.**

Field investigations were conducted in 1994 and '96 to meet three objectives.

- 1) To characterize the topography of the project site.**
- 2) To evaluate the hydrologic and morphodynamic processes of Prairie Creek in the vicinity of the project site.**
- 3) To provide criteria for designing the proposed channel.**

The following report summarizes field data we compiled for the project and describes the design criteria for creating the channel.

## 2.0 METHODS

### 2.1 FIELD SURVEYING

Field surveys were conducted in 1993-'94 and in May, 1996 using level surveying techniques to characterize the topography of the project site, a terrace on the east side of Prairie Creek and Prairie Creek itself. Rebar or wooden pins were placed at select points around the site. Distance and compass bearings (Decl. 19°) of these pins to distinct geographic features were measured in the field.

### 2.2 CROSS SECTIONAL SURVEYS OF PRAIRIE CREEK AND ITS ADJACENT TERRACE

Cross sectional surveys along the adjacent length of Prairie Creek and both its terraces were conducted to identify channel morphology and relate it to hydrodynamic processes. In 1994 two cross sections were conducted. Redwood National Park also did cross sectional surveys along this reach of Prairie Creek (Dave Anderson, personal communication, 1996).

Two cross sections were done in 1994. We first placed rebar pins on the west-side terrace (HP) and stretched a calibrated tape from the HP to a pin on the east-side terrace on a line perpendicular to the channel's bankfull axis. Level surveying techniques were used to create a cross sectional graph of the channel. Slope, vegetation and substrate changes were used to identify rod placement.

By repeating these surveys in '96, following two winters of above average rainfall-runoff and four months after Prairie Creek witnessed a 12-15-year flood (R. Klein, Redwood National Park hydrologist, pers. comm., 1996), we were able to evaluate the geomorphic changes that occurred between the surveys. A total of six cross sectional surveys were performed in '96. Three more were placed downstream: two upstream of Pacific Coast Restoration's staff gage and fish trap, one downstream between the gage and the confluence of Streetlow Creek, and one at the lower end of the project site.

### 2.3 PRAIRIE CREEK LONGITUDINAL PROFILES & CRITICAL STAGE SURVEYS

Longitudinal surveys and critical stage surveys were conducted in May, 1996. Bankfull stage (BFL) was used for estimating the longitudinal energy gradient. The recent floods eroded some banks thereby erasing BFL at some locations, but enough remained to adequately the longitudinal gradient. Vegetation characteristics such as moss breaks on the creek banks and slope breaks were used as indicators of BFL. Indicators of other critical stages included scoured roots and undercut banks.

## 2.4 SOIL PROFILES

Five soil profiles were logged across the project site in March, 1994 using a 4-inch hand auger. Salient lithological characteristics were described and the depth to ground water and presence of wood was noted.

## 2.5 MAPPING

The site was mapped at a scale of 1 inch = 50 ft. (1:600), using an enlarged aerial photograph from Caltrans taken July 16, 1992. The original photo was a scale of 1:2400. The distance and compass bearings of the pins to mapped geographic features were transferred onto an acetate overlay to establish a base map. From this base map, topographic, geomorphic and design maps were created. Vertical error was +/- 0.05 ft while horizontal error was +/- 1 ft.

## 2.6 RELATING CREEK MORPHOLOGY TO CLIMATIC VARIABILITY

Decade-scale climatic variability exerts observable influences on stream morphology. Following several years of drought and relatively minor peak discharges, riparian vegetation may encroach on gravel bars and mature on the stream banks. The channel may downcut as sediment supply decreases. Large-scale floods may scour the bars and erode the encroaching vegetation, mobilize new sediment sources resulting in aggradation of some channel reaches, they may erode stream banks and undermine riparian trees causing them to fall into the stream and create debris jams.

Such was the case at the project site. Climatically, the '94 surveys were conducted following the 7th straight year that winter peak flows of rivers and streams throughout the region rarely exceeded bankfull discharge. Alder saplings began rapidly growing on the gravel bars and a pronounced thalweg was observed. The '96 surveys were conducted following 2 relatively wet winters and five months after Prairie Creek experienced a 12-15 year flood, the largest flood since 1986.

## 2.7 FLOOD STAGE DETERMINATION DURING A 12-15 YEAR FLOOD EVENT

On December 30, 1995, Prairie Creek witnessed a 12-15 year flood event (Randy Klein, personal communication, 1996) with peak stage at the project site lasting at least 5-6 hours. Mitch Farro took photographs of the project site between 10:00 and 12:00 that day. Robert Capriolo who visited the site around 5 a.m. reported similar stages as those shown in the photographs. The photos allowed us to survey the water surface elevations during this flood event and to recreate the hydrodynamic processes of the flood across the project site (See Figure 17a-f).

### 3.0 SITE DESCRIPTION

In this section, we will give descriptions of the project site and its location in the Prairie Creek watershed. The morphology of Prairie Creek around the project site will be described on a reach-by-reach basis and the results of cross section and long profile surveys given.

Descriptions of sites along Prairie Creek adjacent to the project site will be given as follows: Along a cross sectional transect, the distance, in feet, from the headpin (placed on the right or west bank) is identified as Sta. #. Thus, cross sections were graphed as though the observer is looking upstream. Longitudinal survey data was measured as the distance (in feet) downstream of Caltrans' west-side rip-rap and identified as L.Sta. #.

#### 3.1 THE PROJECT SITE

The project site is a 5-10 year flood terrace of Prairie Creek with a hydrologically disconnected overflow channel running southward through it. This channel was cut off several decades ago by the construction of an earthen levee on Prairie Creek's east bank. A bridge used to span this channel at the northern end of the project site and pilings from this bridge are still visible. A driveway, access for the land owner residing on the project site, forms a dike running perpendicular to the valley and creek axes. A small draw provides year-round water that flows under Hwy 101 through a 18-inch diameter culvert at the northeast side of the site. Elevations of the project site range from 63 feet to 70 feet above sea level.

Ownership is a private residence. A Caltrans right of way and U.S. Hwy 101 forms its eastern boundary and Prairie Creek forms its northern, western, and southern boundaries.

#### 3.2 PRAIRIE CREEK WATERSHED

Prairie Creek is a south-flowing, coastal tributary of Redwood Creek (Figure 1). The watershed is heavily forested with coast redwood (*Sequoia sempervirens*) and evergreen shrub understories dominating the hill slopes. Grassland prairies, grazed by Roosevelt elk, dominate the broad terraces that give Prairie Creek its name.

The total drainage area upstream of the project site is estimated to be 14.5 mi<sup>2</sup>. It is several hundred feet downstream of Redwood National Park's *Prairie Creek @Wolf Creek Bridge* gaging station (drainage area = 12.6 mi<sup>2</sup>). May Creek (dA = 1.88 mi<sup>2</sup>) drains into Prairie Creek a few hundred feet above the project site and Streetlow Creek discharges into Prairie Creek adjacent to it.

A report by Redwood National Park (1991), conducted as part of the highway bypass monitoring project was used to estimate flood discharges and their frequencies at the project site. These data were compared to estimates we calculated using our cross sectional surveys and the Manning equation. We then related these flood frequencies to the stage heights at the project site to obtain stage- discharge relationships (Table 1).

Table 1: Flood frequency estimates at the project site, drainage area 14.5 mi<sup>2</sup>.  $Q$  RNP '91 synthesized from RNP (1991),  $Q$  '94 and  $Q$  '96 calculated using the Manning equation and channel dimensions from surveys we conducted in March, 1994 and May, 1996, respectively. Stages based on survey data at T-1.

| Recurrence interval | 2-year (BFL) | 5-year | 10-year | 25-year | 50-year |
|---------------------|--------------|--------|---------|---------|---------|
| Stage (ft)          | 64.5         | 67.2   | 68.5    | ?       | ?       |
| $Q$ RNP '91         | 1,166        | 2,071  | 2,592   | 3,678   | 4,400   |
| $Q$ '94             | 914          | 1,834  | 2,471   | --      | --      |
| $Q$ '96             | 1,109        | 2,157  | 2,726   | --      | --      |

### 3.3 PRAIRIE CREEK UPSTREAM OF THE PROJECT SITE

The reach of Prairie Creek 300 feet upstream of the project site is a linear, low gradient riffle that runs parallel to Highway 101 at a compass bearing of 240° (Figure 2). This reach was extensively modified by Caltrans as part of the Hwy 101 Bypass Project beginning in 1988 (RNP, 1991). The east valley wall was a rock gabion, built by Caltrans in 1988 with three wing deflectors at its base.

A 30-40 foot wide thicket of 6-8 year old red alder (*Alnus rubra*), grows on a flood plain east of the channel separating it from the gabion wall. As this stand has matured, flood plain roughness on the east bank has increased, transferring the force of the creek during floods away from the gabion wall and toward the levee at the upper end of the project site.

Rip-rap was also placed by Caltrans on the west side of the channel to a point about 210 feet above the upper end of the project site (L.Sta. 0). The construction of this rip-rap has minimized the opportunity for flood water to dissipate energy above the project site, and transfers the force of flood waters downstream toward the leveed east bank at the upper end of the project site.

The eastern edge of the alder thicket was eroded 5 to 6 feet during the floods of 1994-'96, widening the channel by 10-20% in this reach.

**Bankfull channel width** was between **30** and **35** feet wide and had a **gradient** of **0.32%**. Its bed substrate was composed of gravels with sand and silt deposits on the downstream side of the east-side alder thicket. Table 2 shows the results of the bankfull stage surveys for this reach and calculated BFL energy gradient.

Table 2: Bankfull (BFL) stages over a 215-foot length of Prairie Creek upstream of the project site. The bankfull gradient in a 155-foot long Caltrans-engineered, low gradient riffle upstream of T-1 is 0.32%  $(63.9-63.4)/(175-20) = 0.0032$ .

| L.Sta. (ft) | BFL stage (ft) | Bank | Comment                                                                                  |
|-------------|----------------|------|------------------------------------------------------------------------------------------|
| 20          | 63.9           | West | -20 feet downstream from end of Caltrans rip-rap on right bank. Slope, vegetation break. |
| 80          | 63.7           | West | -Vegetation break.                                                                       |
| 175         | 63.4           | West | -40 feet upstream of T-1.                                                                |
| 215         | 64.5           | East | -At T-1. Water flow impinges on this bank as the channel deflects to the SW.             |
| 215         | ?              | West | -Recent slump blocks from eroded bank. masked evidence of BFL.                           |

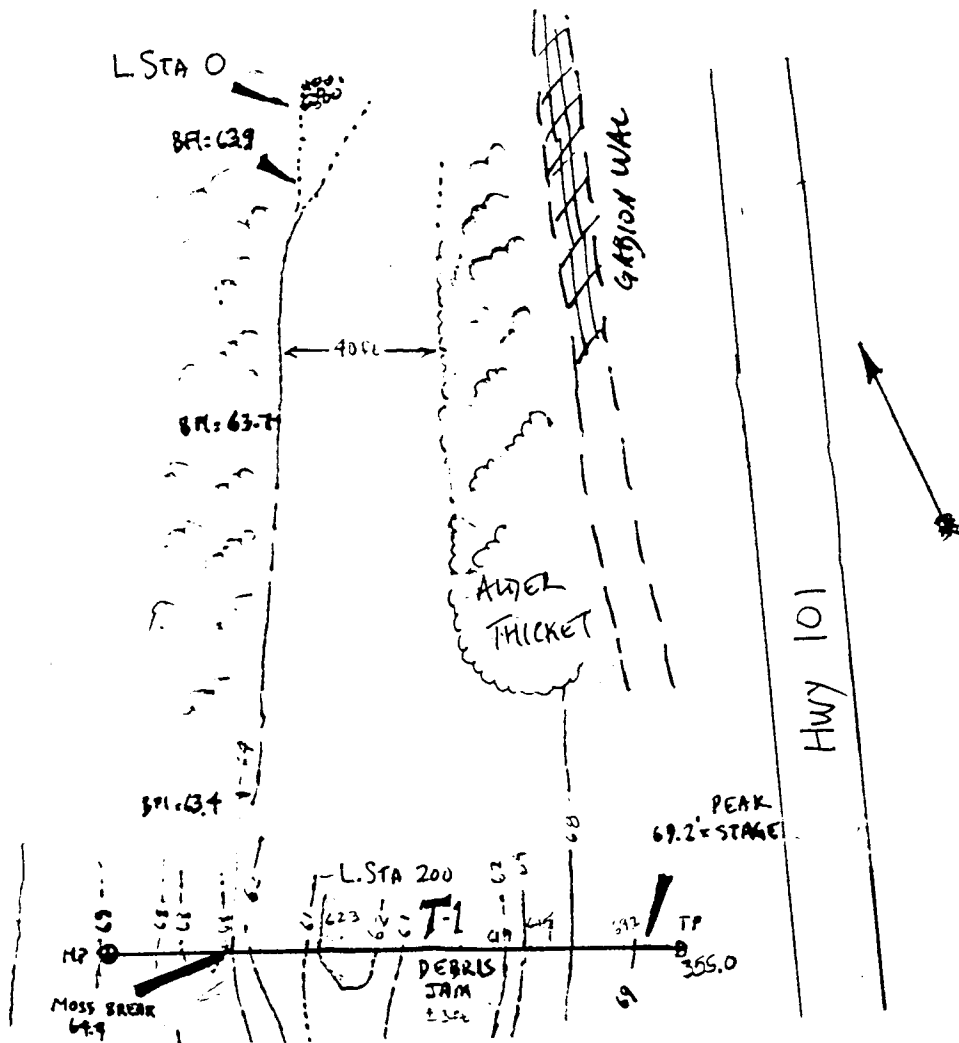


Figure 2: Map of Prairie Creek upstream of the project site to T-1 showing some topography and elevations of bankfull stages at various points along the channel. Survey conducted in May 1996.

### 3.4 PRAIRIE CREEK @ T-1 (Figures 2-5).

1994 Survey: A cross section survey transect was placed across Prairie Creek at the lower end of the Caltrans-engineered reach, representing a channel profile immediately upstream of the proposed overflow channel inlet (Figure 2). In March, 1994, a rebar pin (HP) was placed on the west-side terrace about half way to the west valley wall. The transect ran across the creek at a compass bearing of 72° to a small alder at the base of a rip-rap slope below Hwy 101. The first 38 feet of the transect (Sta. 0-38) ran across a 5-10-year flood terrace where the overstory consisted of 10-20 inch diameter red alder (*Alnus rubra*) with sword fern benches (*Polystichum munitum*), a scattered shrub layer of salmon berry (*Rubus parviflorum*), blackberry (*Rubus* sp.), and forbs such as bedstraw (*Galium triflorum*), stinging nettle (*Urtica* sp.) and horsetail (*Equisetum* sp.).

At Sta. 53 of our transect, a rebar pin, labeled 'LX3' and previously placed by Redwood National Park as a part of the Highway 101 Bypass Monitoring Study (Dave Anderson, personal communication), crossed our transect. In 1994, this pin was on the west terrace at an elevation was 64.3 ft. The **bankfull elevation** was identified at Sta. 54 at **64.1 ft.** The **bankfull width** spanned 59 feet (Sta.54-113) with a strong asymmetry to the channel (Figure 4, Appendix A). The east bank was composed of rip-rap placed by Caltrans, and the terrace was a graded gravel fill at elevations of 69-70 ft. The channel **thalweg** hugged the east bank (Sta.100) and was at an elevation of **59.14 ft.**

1996 Survey: Figure 3 shows the T-1 profile comparing the March 1994 survey with that of May 1996. The main **thalweg** migrated from the east side to the west side of the channel to Sta. 46, a site formerly 7 feet below the surface of the west-side terrace. The area around the former thalweg (Sta.100-106) **aggraded 2-3 feet** with sand and gravel. The **west-side terrace** was severely eroded across the transect, washing RNP's 'LX3' pin away. A gravel bar deposited over the west-side of the '94 channel to a depth of about **1.5 feet** across a width of 18 feet (Sta.57-75). Across the center of the channel (Sta.75-95), **0.7-0.9 feet** of gravel were deposited. A mix of gravel and fine sandy silt were deposited in front of a small **debris jam** between Sta.96-107 with as much as **3.9 feet of vertical aggradation** occurring at Sta.106. Based on frequent site visits by M. Farro and R. Capriolo over the two-year period, most of this change apparently occurred during the Dec.'95 flood.

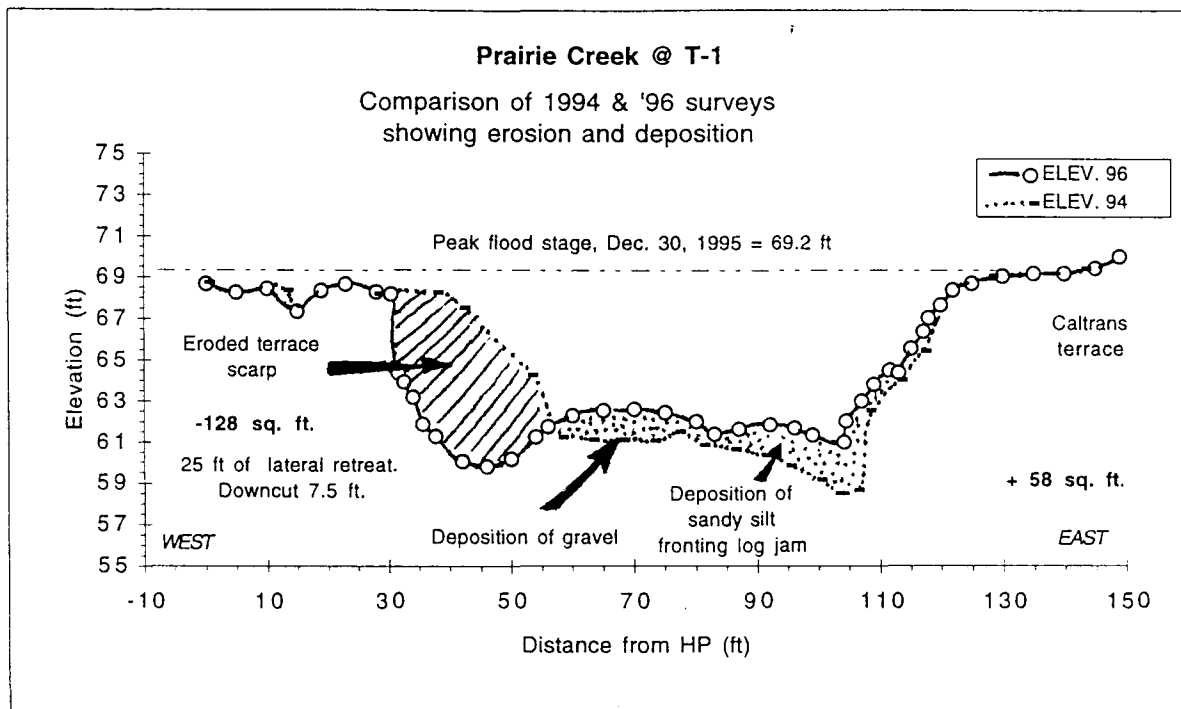


Figure 3: Prairie Creek @ T-1. Comparison of March 1994 and May 1996 surveys. The west-side terrace retreated laterally 25 ft as an estimated 128 ft<sup>3</sup>/ft of erosion occurred across this transect. About 58 ft of deposition occurred as gravel and sandy silt were deposited in the channel. Erosion exceeded deposition by 2.2 times (128/58).

Figures 4a and 4b show the May '96 channel profile at bankfull stage and at the 12-15-year flood stage (looking upstream). The west-side **bankfull elevation** was 64.4 ft, identified as a moss break on this bank, 5 feet upstream of the transect (L.Sta. 195). Based on photographs by M. Farro on Dec. 30 and subsequent surveying, the **peak flood stage** on the east-side terrace around T-1 was 69.2 ft. A similar stage was obtained on a 15-inch diameter alder on the west-side terrace also based on photographic evidence and subsequent surveying.

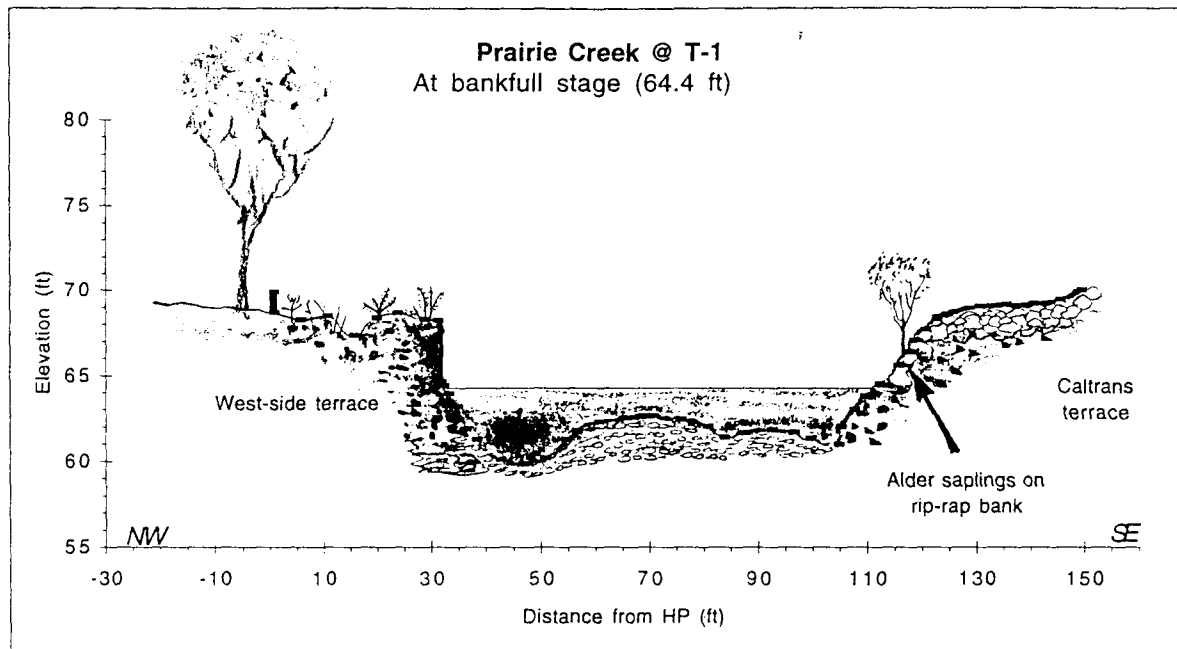


Figure 4a: Prairie Creek @ T-1 as surveyed May 3, 1996 showing bankfull stage of 64.4 ft. Assuming a  $Q_{BFL} = 1,000$  cfs,  $w = 78$  ft,  $d = 3$  ft, the average velocity at BFL =  $Q/(w*d) = 4.3$  ft/sec.

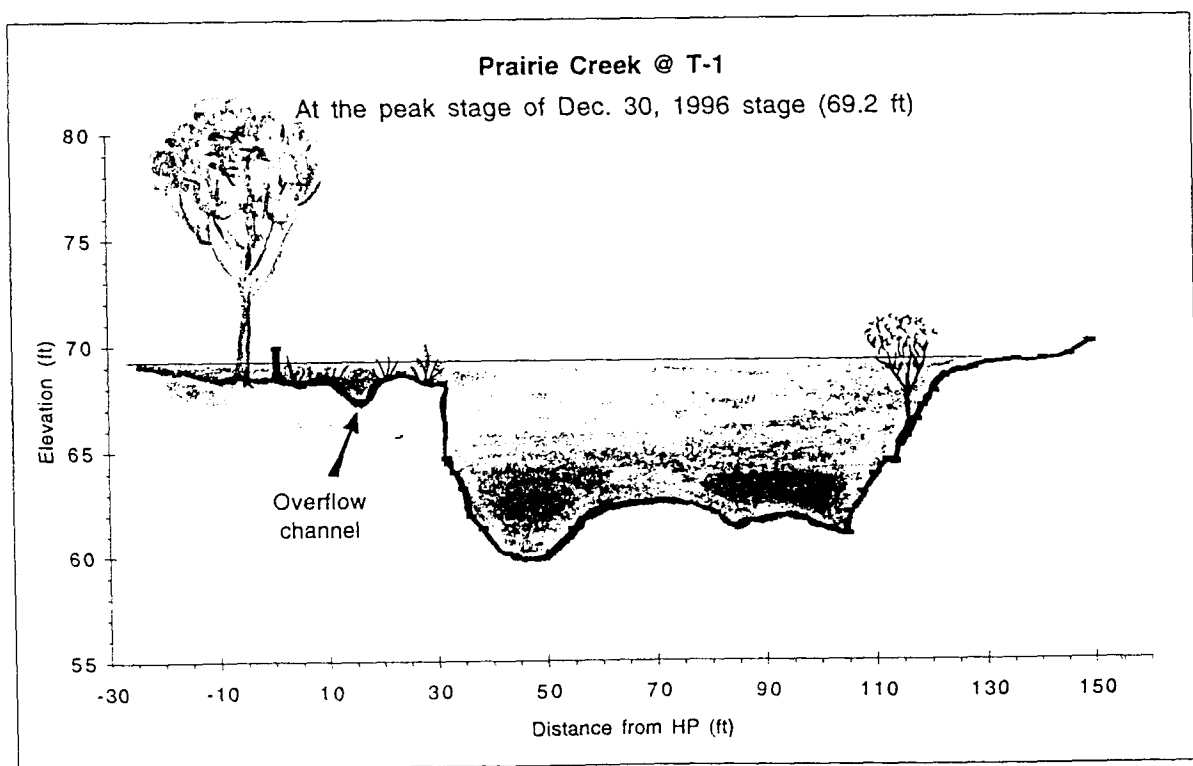


Figure 4b: Prairie Creek @ T-1 as surveyed May 3, 1996 showing the peak flood stage of Dec. 30, 1995, 69.2 ft.

Calculations of the areas eroded (-) and aggraded (+) show that twice as much erosion occurred as aggradation,  $-128 \text{ ft}^3/\text{ft}$  vs.  $+58 \text{ ft}^3/\text{ft}$ . The **area at bankfull stage** however remained virtually unchanged, calculated at  $178 \text{ ft}^2$  in 1994 and  $177 \text{ ft}^2$  in '96 (Figure 5).

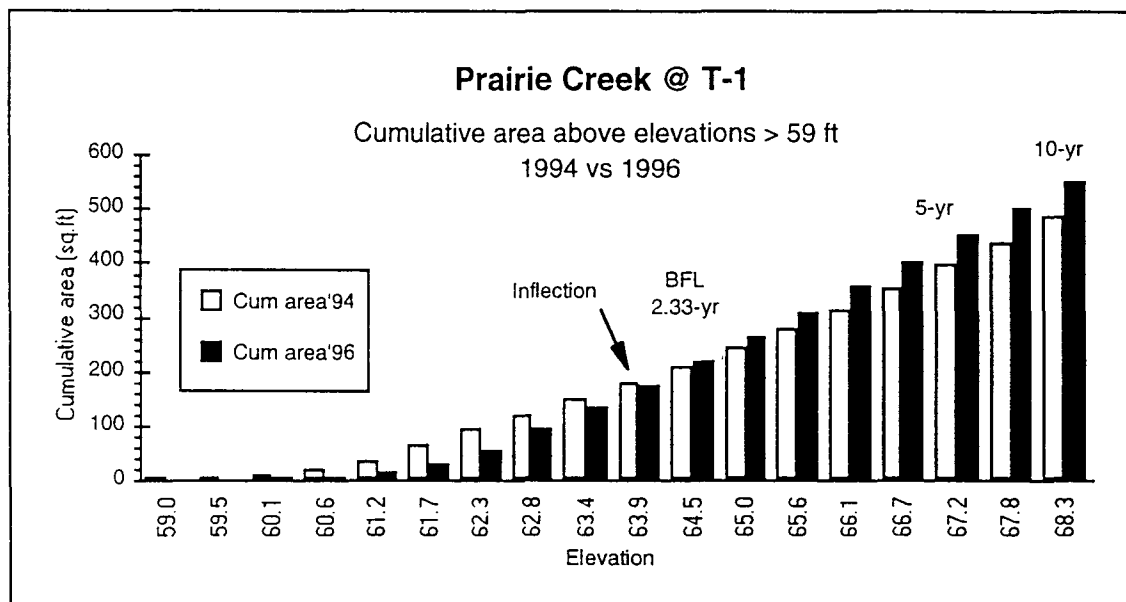


Figure 5: Prairie Creek @ T-1. Cumulative area above various elevations calculated over increments of 0.54 ft. Following the flood of 1996, aggradation in the channel reduced channel area below bankfull stage. An inflection point occurred around the bankfull stage (63.95-64.49 ft) so that the cumulative area above BFL was greater in '96. Severe erosion of the west side terrace enlarged channel area at the 10-year flood stage by 11%.

### 3.5 PRAIRIE CREEK, T-1 to T-2

Downstream of T-1, Prairie Creek deflects to the southwest at an angle of 32°. An old, earthen levee covered with a thicket of Himalayan blackberry and 6-8 inch diameter conifers forms the east (outer) bank of this meander. During the Dec. 30 flood, the base of this levee was eroded. On the west-side, the flood eroded the terrace bank, dropping several alders into the creek thereby encouraging the formation of a debris jam (Figures 6, 17a,b).

### 3.6 PRAIRIE CREEK @ T-2

1994 survey: Transect 2 was placed across Prairie Creek at the proposed overflow channel inlet (Figure 6). A rebar headpin was placed on the west-side terrace and the transect spanned the channel to the earthen levee at a compass bearing of 160°. The **bankfull elevation** was about **63.4 ft.** on the east bank and the **thalweg** was adjacent to the east bank at an elevation of **59.0 ft.**

1996 survey: Figure 7 compares the March 1994 survey with that of May 1996. This comparison shows that the thalweg **aggraded about 0.5 ft** and a **gravel bar** deposited across the center of the channel (Sta. 60-75) whose apex was 3 feet upstream at an elevation of **61.4 ft.** On the west-side terrace, a stringer of 10-16 inch diameter alders was observed at Sta.15-21. The elevation of the bases of these trees was about **66-67 ft.** At Sta. 21, **silty sand** was deposited behind these alders by the Dec. 30 flood at an elevation of about **66 ft** where the water was 3 feet deep at the height of the flood. Between Sta. 24.5 and 26.5, a layer of **medium to coarse sand** was deposited behind sword ferns at an elevation of **65 ft** where the water was over 4 feet deep at the height of the flood. At Sta.33.5, **sword fern roots were scoured** and exposed at an elevation of **64.4 ft** as the **bank retreated 3 to 5 feet.** This elevation is assumed to correspond to a 3-year flood stage.

Figure 8 shows the profile at T-2 as surveyed in 1996 at bankfull stage (8a) at the 10-year flood stage (8b).

Calculations of the areas eroded and aggraded show that erosion (-) and deposition (+) amounts were an order of magnitude lower than those measured at T-1, but at a similar ratio (**-16.5ft<sup>3</sup>/ ft** vs. **+9ft<sup>3</sup>/ ft**). The **area at bankfull stage** remained virtually constant, calculated at **155 ft<sup>2</sup> in 1994** and **158 ft<sup>2</sup> in '96** (Figure 9).

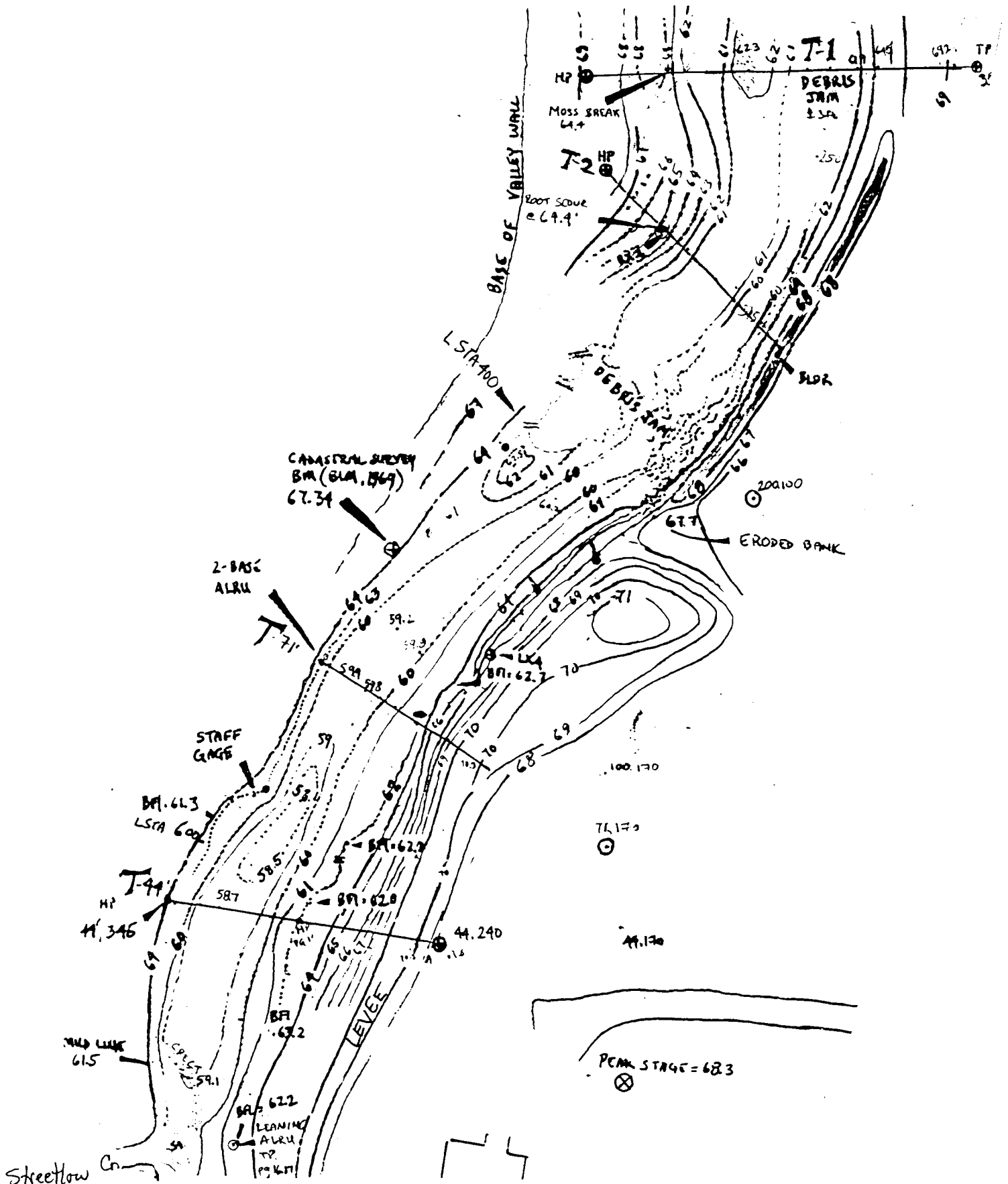


Figure 6: Prairie Creek from T-1 to Streetlow Creek showing general topography and critical stages at select sites from field surveys conducted in May 1996. Scale: 1 inch = 50 ft.

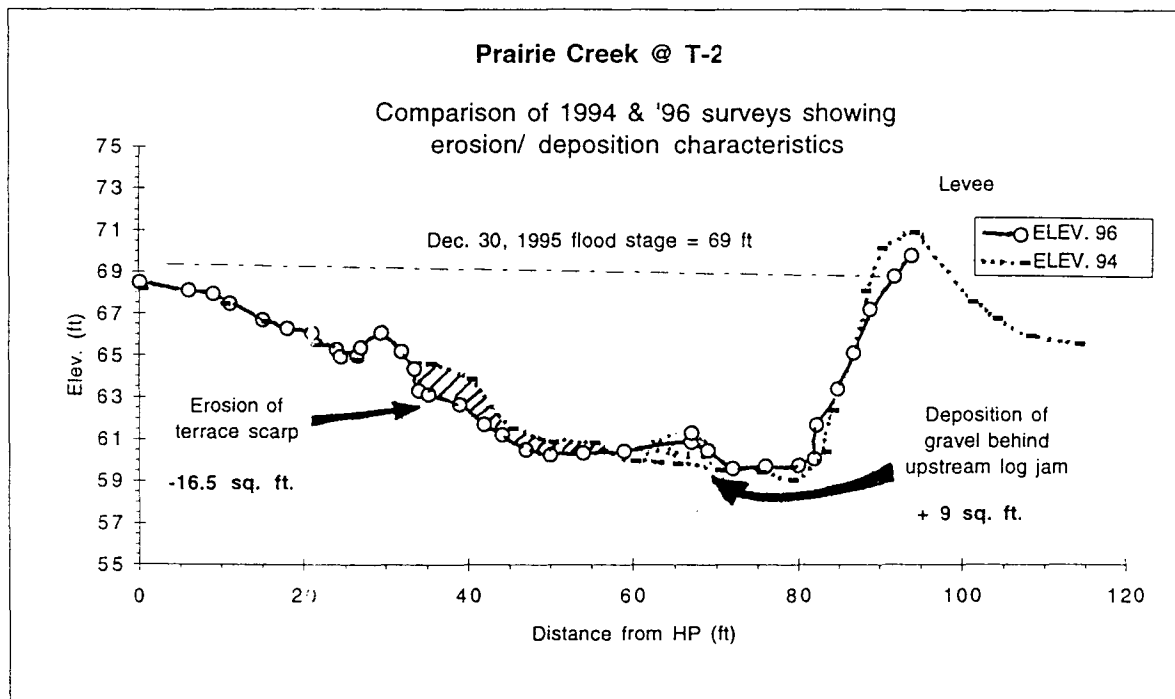


Figure 7: Prairie Creek @ T-2. Comparison of March 1994 and May 1996 surveys. While erosion and deposition values were an order of magnitude less than those observed at T-1, erosion exceeded deposition at a similar ratio (1.8 times).

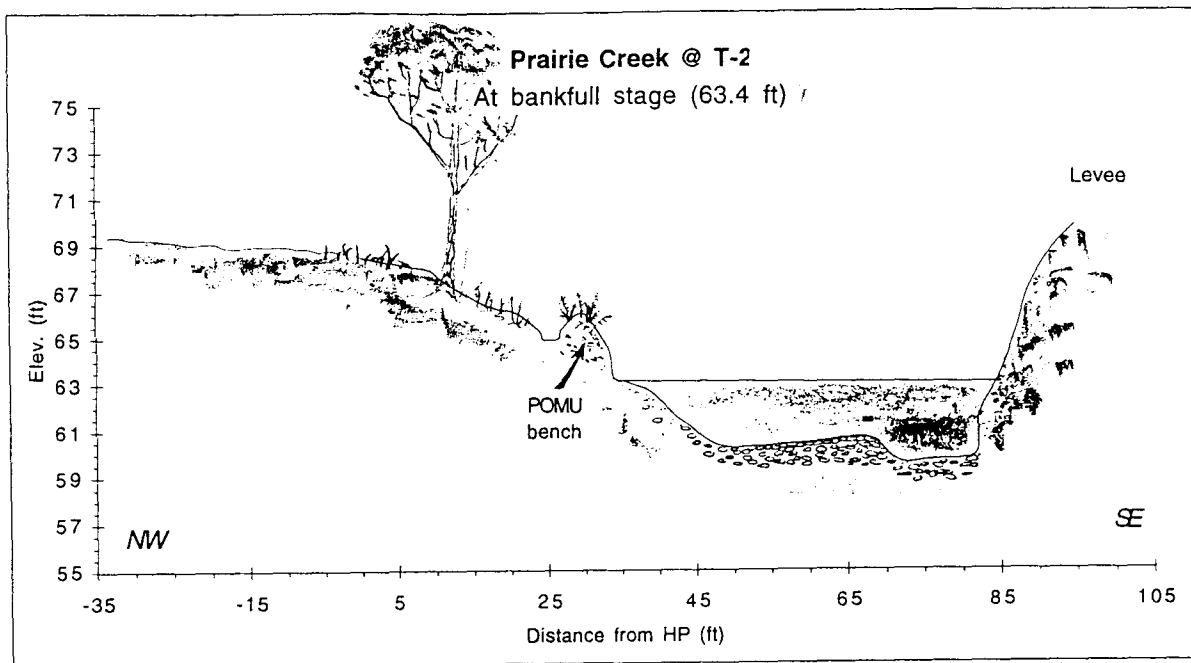


Figure 8a: Prairie Creek @ T-2 as surveyed May 3, 1996 showing bankfull stage of 63.4 ft. Assuming a  $Q_{BFL} = 1,000$  cfs,  $w=53$  ft,  $d = 3.5$  ft, the average velocity @ BFL =  $Q/(w*d) = 5.4$  ft/sec.

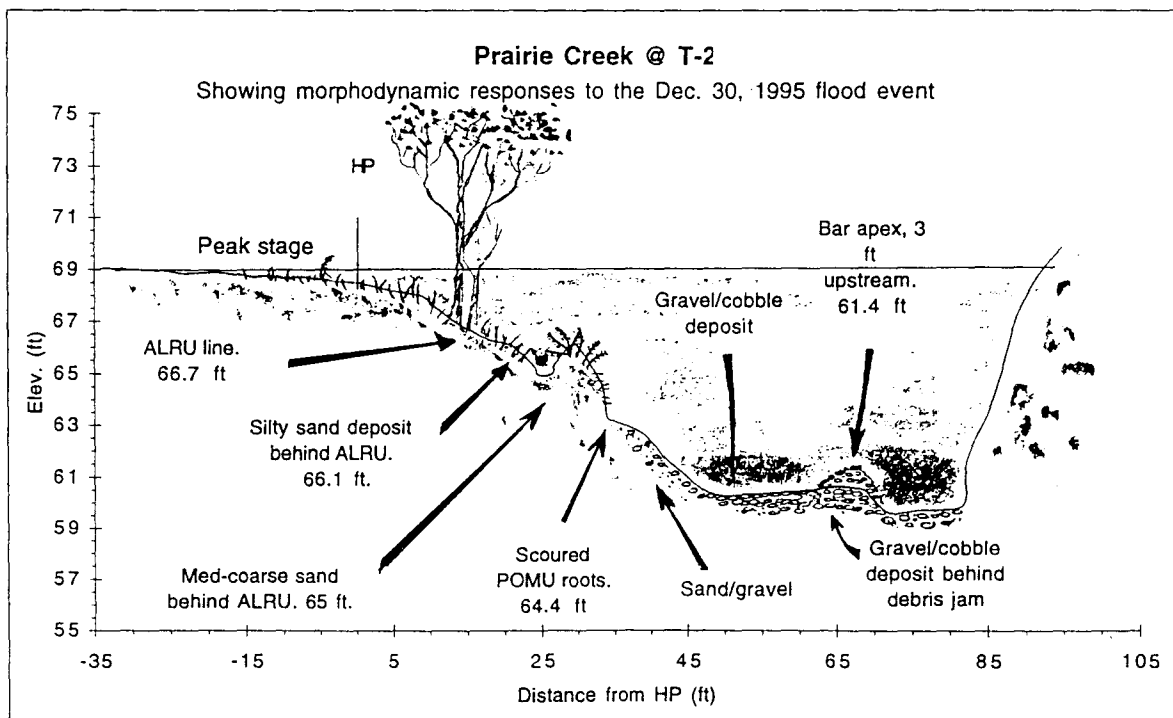


Figure 8b: Prairie Creek @ T-2 as surveyed May 3, 1996 showing peak flood stage of 69 ft and the morphodynamic responses to the Dec. 30, 1995 flood.

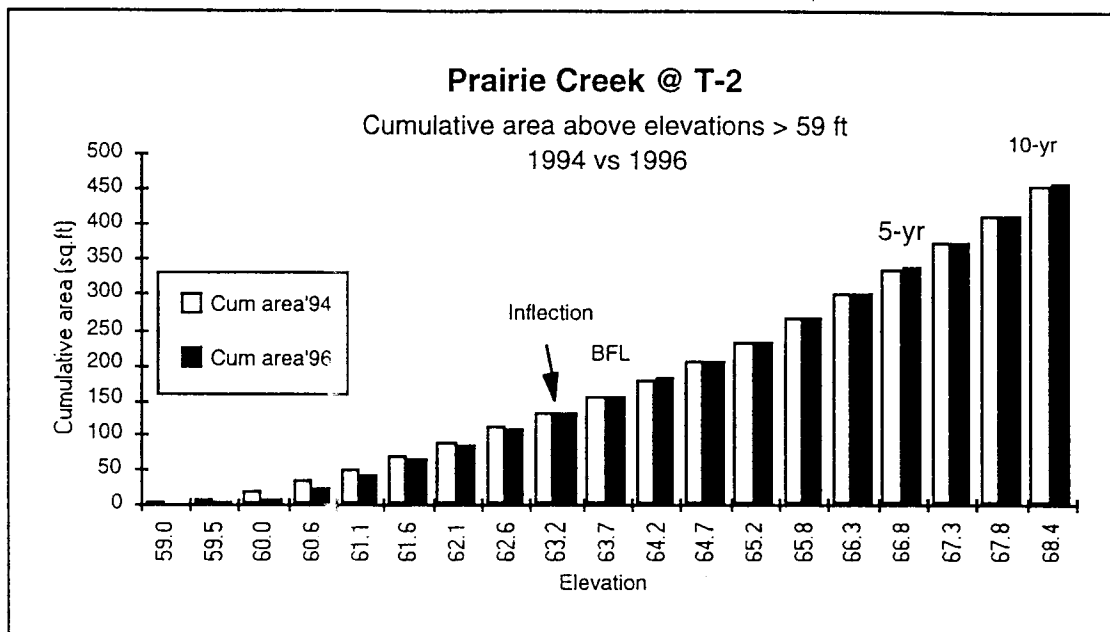


Figure 9: Prairie Creek @ T-2 showing cumulative flooded area calculated from 1994 and '96 survey data. Following the flood of Dec. 30, 1995, aggradation in the channel reduced channel area below bankfull stage of 63.4 ft. The relative area at bankfull stage was nearly identical. Moderate erosion on the west-side terrace scarp increased the size of the channel above bankfull stage.

### 3.7 PRAIRIE CREEK DOWNSTREAM OF T-2

Downstream of T-2, Prairie Creek is nearly linear for about 525 feet. Bankfull stage was identified at 7 locations along this reach (Table 3). The earthen levee forming the left bank was eroded considerably at the site shown in Figure 6 as a debris jam formed in the channel 50-60 feet downstream of T-2 forcing water to impinge on the bank and scour it. Field observations by M. Farro indicated that as flood stage dropped, water that had pooled in the northern end of the project area began to spill back into the channel at that site and further induced erosion of this bank. The elevation of the low spot adjacent to the eroded levee was surveyed in May '96 at 67.7 ft.

Table 3: Bankfull stages elevations over a 525 foot length of Prairie Creek from T-2 to 90 feet downstream of Streetlow Creek. The bankfull gradient in a 285-foot long reach from T-2 to near T-44' was  $(63.4-62.2)/(595-310) = 0.0065$  or **0.65%**. Note the bankfull indicator on the right bank downstream of Streetlow Creek was higher than those observed above it. It may be that the addition of discharge from this creek raises the bankfull stage indicator.

| <b>L. Sta (ft)</b> | <b>BFL elev.</b> | <b>Bank</b> | <b>Comment</b>                        |
|--------------------|------------------|-------------|---------------------------------------|
| 310                | 63.4             | Right       | T-2                                   |
| 410                | 62.5             | Right       | Moss break                            |
| 490                | 62.7             | Left        | Near RNP's LX4                        |
| 510                | 63.0             | Right       | At T-71'                              |
| 565                | 62.2             | Left        | 1 foot above leaning alder used as TP |
| 595                | 62.2             | Left        | 10 ft above T-44'                     |
| 835                | 62.7             | Right       | 90 ft downstream of Streetlow Creek   |

The Dec. 30, '95 flood deposited a large gravel bar behind the debris jam on the west side of the channel downstream of T-2 (Figure 6). The apex of this bar was at an elevation of 62.8 ft, nearly 2 feet high and 25 feet long. Bedrock was exposed along a 20-foot length on the west side of the channel.

Two more cross sectional transects were performed in May 1996, labeled T-71' and T-44'. Between the two transects was Pacific Coast Restoration's staff gage located on the west side of the channel.

### 3.8 PRAIRIE CREEK @ T-71'

T-71' was located about 205 feet downstream of T-2 (L.Sta. 510). Figure 6 shows the plan view of the transect and Figure 10 shows the profile (looking upstream). The tape was stretched from a rebar pin placed at Sta. 71+170 to the levee (compass bearing, 329°), then behind an east-bank alder and across the channel at a compass bearing 334° to a double-based alder tree on the west bank at Sta. 71'+ 299.5 .

The **west terrace** was covered with sword fern with a 1 foot deep **undercut bank**. Defining the east bankfull was a **leaning red alder** (Sta. 43.5). A 9-foot wide flood plain, largely devoid of vegetation and roughness elements formed the left bank to the base of the east-side levee. The bankfull channel was relatively wide and shallow, spanning a width of 47 feet, with an average depth of 1.8 feet. **Bankfull stage** was **63 ft.** A thin, fine sandy-silt bar was deposited by the Dec. 30 flood at the base of the levee at an elevation of 62.1 ft around Sta.45. This bank was eroded with alder roots exposed between Sta.46-50 at elevations of 62.3-64.4 ft that extended 20-30 feet up- and downstream. An **erosion scarp** was evident on the east bank at an elevation of **65.4 ft.**

### 3.9 PRAIRIE CREEK @ T-44'

T-44' was located about 95 feet downstream of T-71' at L.Sta. 605. Figure 6 shows the plan view and Figure 11 shows the profile (looking upstream). The tape was stretched from a rebar pin placed on the project site at Sta.44+240 to a nail placed in an alder tree on the west-side terrace scarp at Sta. 44'+345 (compass bearing = 315°).

The **west-side** was a steep and eroded terrace scarp. A muddy peat formed the bank. The channel **thalweg** was at Sta.18 with an elevation of **58.5 ft**. The **bankfull channel width** was about 4 feet narrower than at T-71', spanning **43 feet**, but deeper, with an average depth of **3.5 feet**.

On the east bank, an 8.5 inch-diameter red alder to which the fish trap was cabled, crossed the transect at Sta.50 at about bankfull stage. No flood plain was evident on the east bank as seen in T-71' as the levee tapered down to the bankfull level.

### 3.10 PRAIRIE CREEK DOWNSTREAM OF T-44'

In the 95-100 foot length downstream of T-44', a run-riffle sequence reached to the confluence of Streetlow Creek, located at LSta. 715. The tail of the riffle had an elevation of 59.1 ft (Figure 5). A 6-7- foot deep pool existed at the confluence, one of the deepest pools in Prairie Creek.

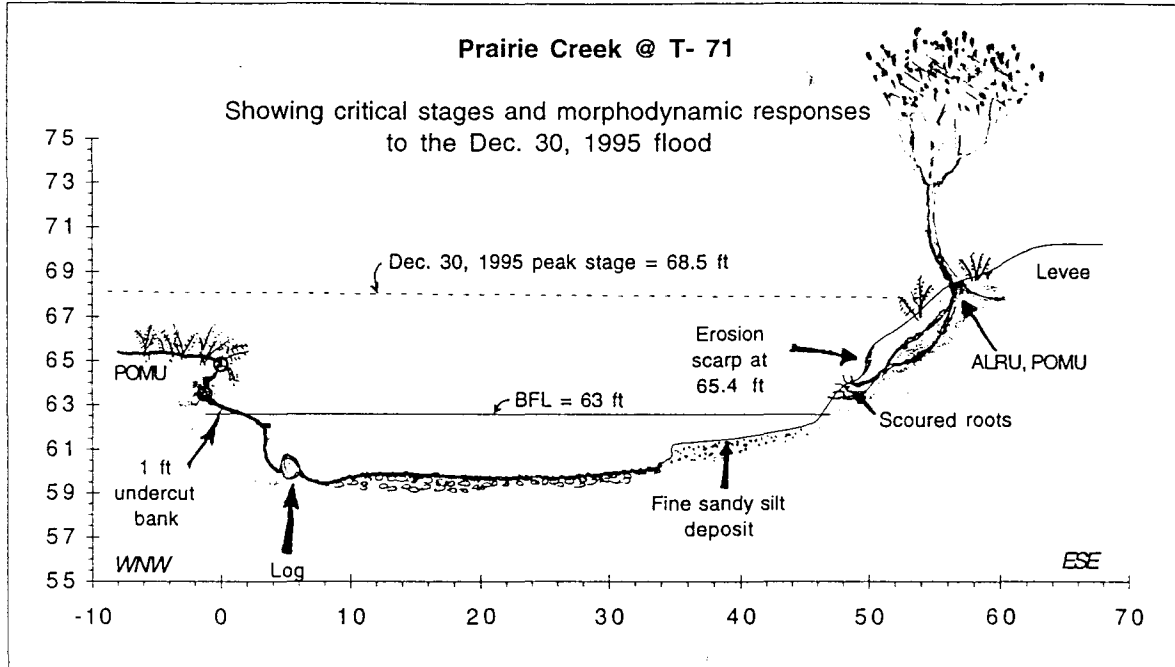


Figure 10: Prairie Creek at T-71' looking upstream. Note the undercut bank on the north-northwest bank, the scoured alder roots and erosion scarp on the southeast bank, and the sandy silt deposit on the base of the flood plain. Assuming a  $Q$  BFL = 1,000 cfs,  $w$  = 47 ft,  $d$  = 3 ft, average velocity at BFL:  $v = Q/(w*d) = 7.1$  ft/ sec.

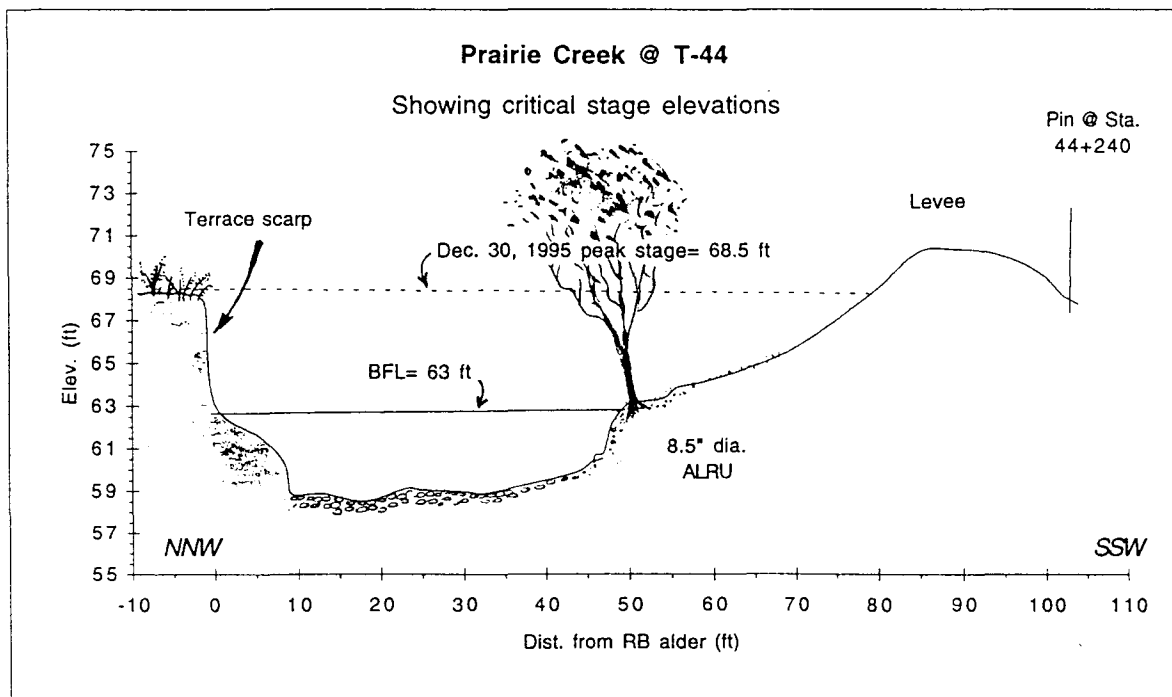


Figure 11: Prairie Creek at T-44' looking upstream showing bankfull stage and Dec. 30, 1995 peak stage. Assuming a  $Q$  BFL = 1,000 cfs,  $w$  = 43 ft,  $d$  = 3.5 ft, average velocity at BFL:  $v = Q/(w*d) = 6.7$  ft/ sec.

### 3.11 PRAIRIE CREEK DOWNSTREAM OF STREETLOW CREEK

Below Streetlow Creek (LSta.715), Prairie Creek deflects to the south in a linear riffle-run sequence. Critical stage measurements on the west bank between LSta. 740-800 showed **scoured sword fern roots** at elevations around **64 ft**. The bases of the alders growing on this bank and moss breaks, indicators of **bankfull stage**, were between **62.0-62.5 ft** (Figure 12). A large, fresh gravel deposit, nearly 100 feet long, was deposited by the Dec. 30 flood with an apex at an elevation of 62 ft (LSta. 1,075). The formation of this bar forced flood water to impinge on the east bank and scour the bank behind a large redwood log that had been buried in this bank for decades.

The bankfull surveys below Streetlow Creek showed a total drop of 2.6 feet over 605 ft giving a **bankfull gradient** of 0.0043 or **0.43%** (Table 4). A 20-foot long scarp was recently formed on the east bank between LSta. 1,250-1,270. Just downstream of that was a 15 foot long terrace slump with a cluster of alders growing on it.

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Table 4: Bankfull stages elevations over a 605 foot length of Prairie Creek from 25 feet below Streetlow Creek (LSta. 740) to T-520 (LSta. 1,345). The bankfull gradient was  $(62.7-60.1)/(1345-740) = 0.0043$  or **0.43%**.

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| L.Sta (ft) | BFL elev. | Bank  | Comment              |
|------------|-----------|-------|----------------------|
| 715        | --        | Right | Streetlow Creek      |
| 740        | 62.7      | Right | Base of alders       |
| 800        | 62.5      | Right | Base of alder        |
| 980        | 62.5      | Left  | Slope break in levee |
| 1,105      | 60.6      | Right | Moss break           |
| 1,120      | 60.6      | Right | Moss break           |
| 1,145      | 61.4      | Right | Slope break          |
| 1,160      | 60.7      | Right | Slope break          |
| 1,200      | 62.2      | Left  | Alder bench on bank  |
| 1,345      | 60.1      | Right | Slope break          |

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### 3.12 PRAIRIE CREEK @ T-520'

At LSta. 1,350, the downstream-most cross section was performed. The tape was stretched from a 15 inch diameter alder on the far west side of the valley, across to the southern end of the project site at Sta. -520+ 0. A temporary wooden stake was placed at this point.

Figure 13 shows the profile of this transect as surveyed in May, 1996 and critical stages identified during this survey. **Bankfull stage** was defined by a moss break on the east bank at an elevation of **60 ft**. The **5-year** flood stage was estimated at **63 ft** and the **Dec. '95 flood stage** was about **67 ft**. **Thalweg elevation** was at an elevation of **56.2 ft**. The width from terrace to terrace was 140 ft with the active channel on the far east side.

**Three overflow channels** were evident in the flood plain west of the active channel. All had thalweg elevations at or below bankfull stage. The Dec. '95 flood apparently mobilized much of the debris and loose vegetation on this flood plain and deposited sand and gravel in the overflow channels and behind the stringers of alders and sedges growing on this flood plain (Figure 14). The **1st** overflow channel (Sta. 60), had a **thalweg elevation** of **59.5 ft** and had a thin sand and gravel deposit. The **2nd** channel was on the far west side of the valley and had a **thalweg elevation** of **60.5 ft**. The **3rd** channel was adjacent to the main channel (Sta. 90) with a **thalweg elevation** of **60.6 ft** and was **aggraded** with a layer of **fresh gravel**. A bar graph showing the cumulative flooded area of each channel is shown in Figure 15.

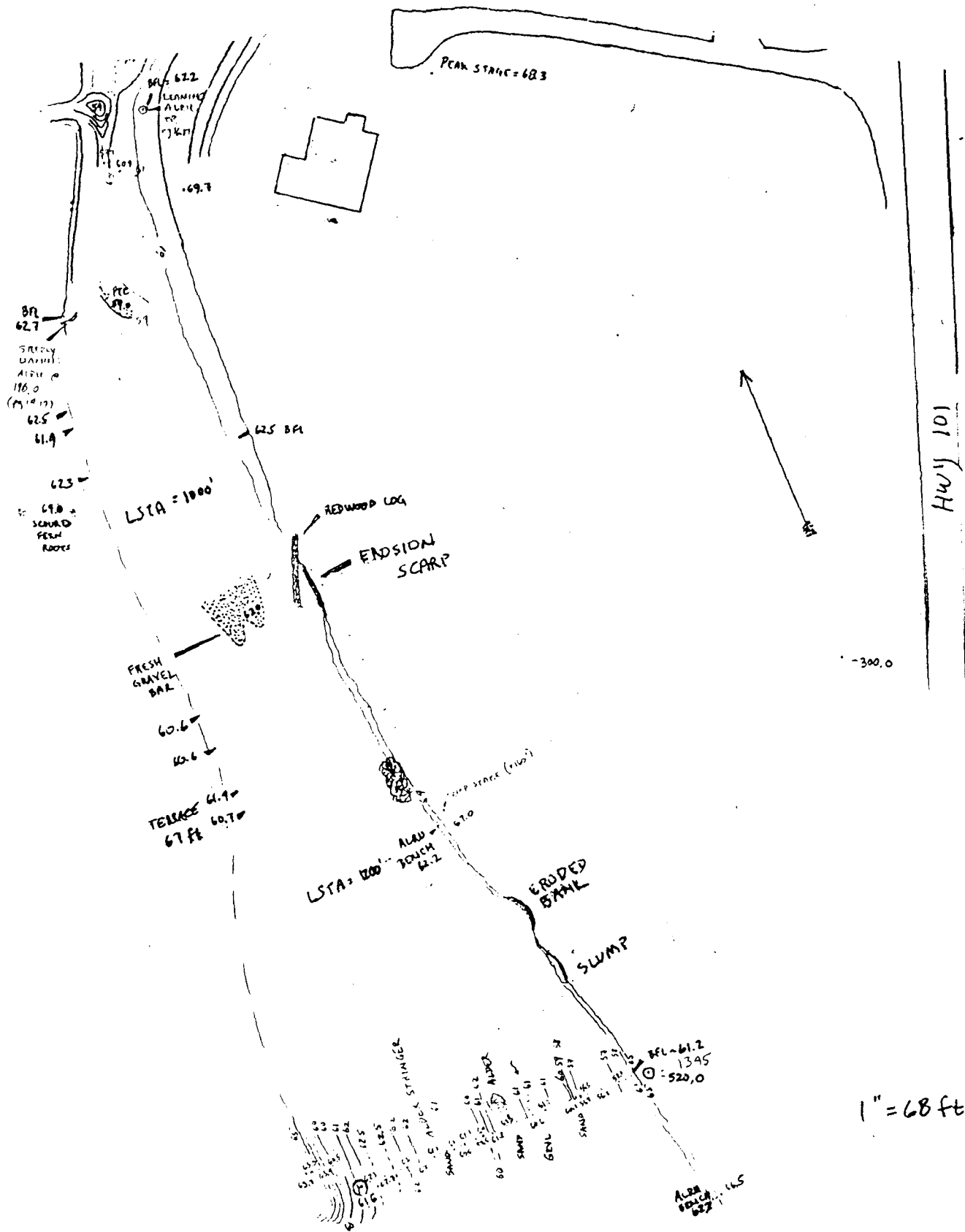


Figure 12: Plan view of Prairie Creek downstream of Streetflow Creek to the downstream-most transect of the project site (T-520').

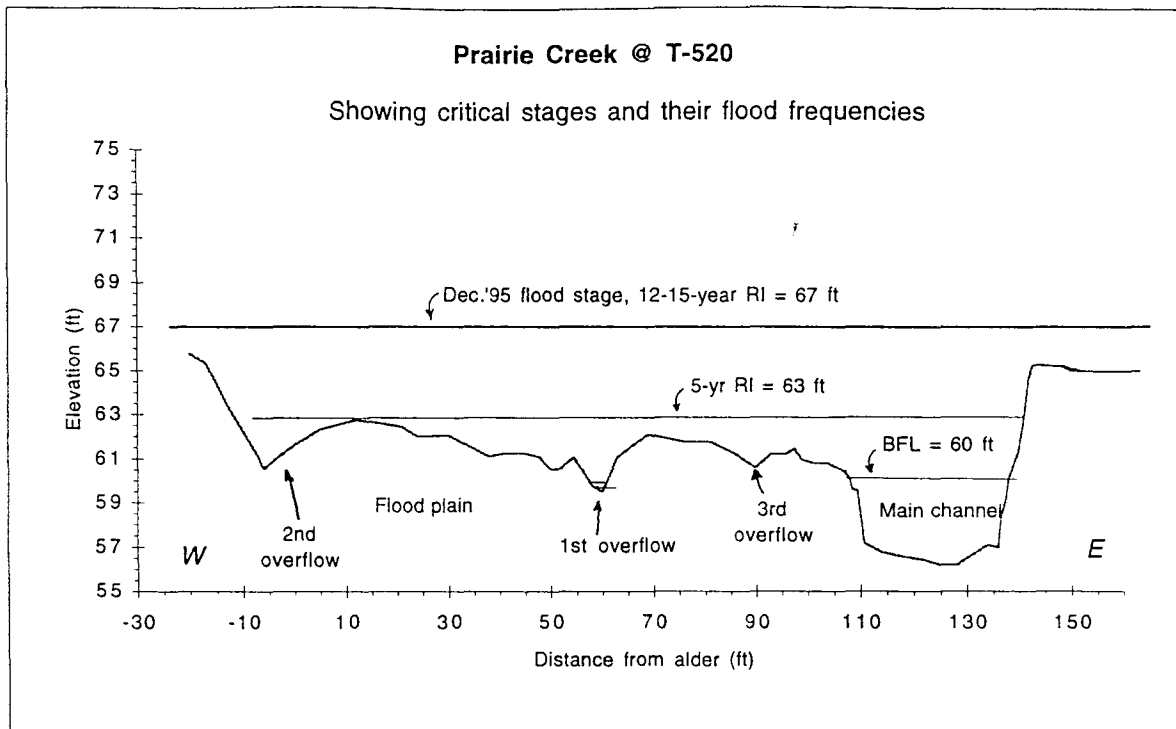


Figure 13: Prairie Creek at T-520' showing critical stages and various flood frequencies. The tape was stretched from a south-leaning alder tree on the far western edge of the flood plain and spanned across an alder and grass covered flood plain, across Prairie Creek at the lower end of the project site. In addition to the main channel, three overflow channels were identified.

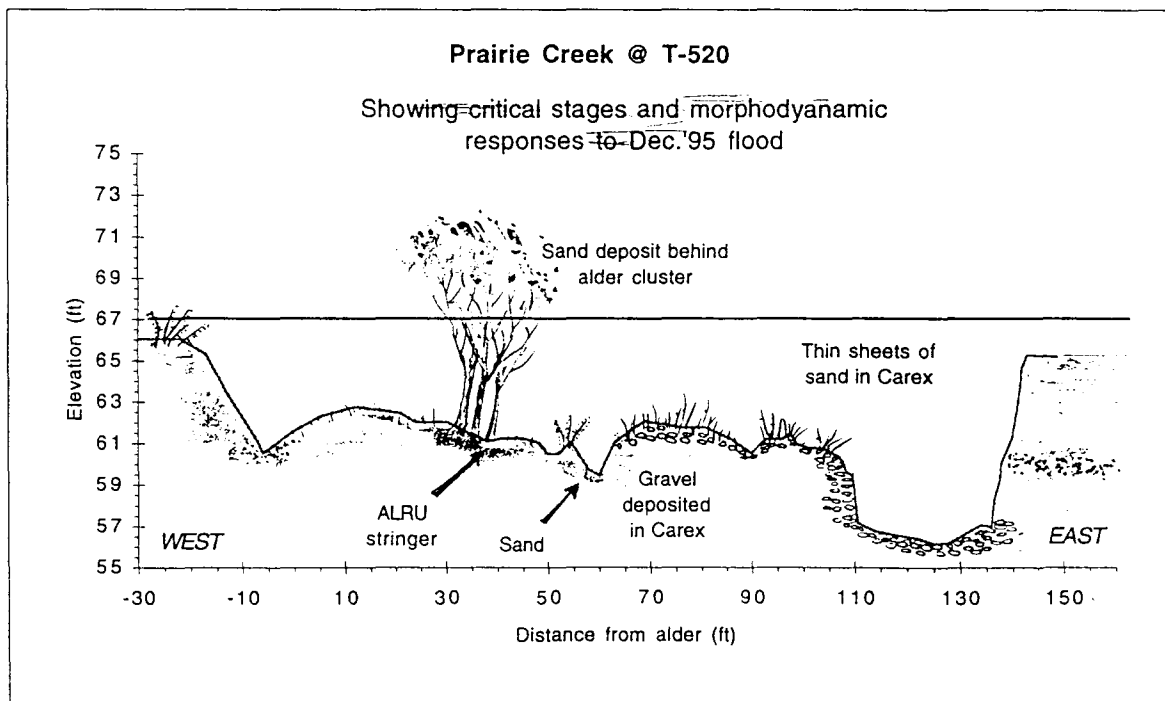


Figure 14: Prairie Creek at T-520' showing flood plain vegetation and deposits recorded in May, 1996.

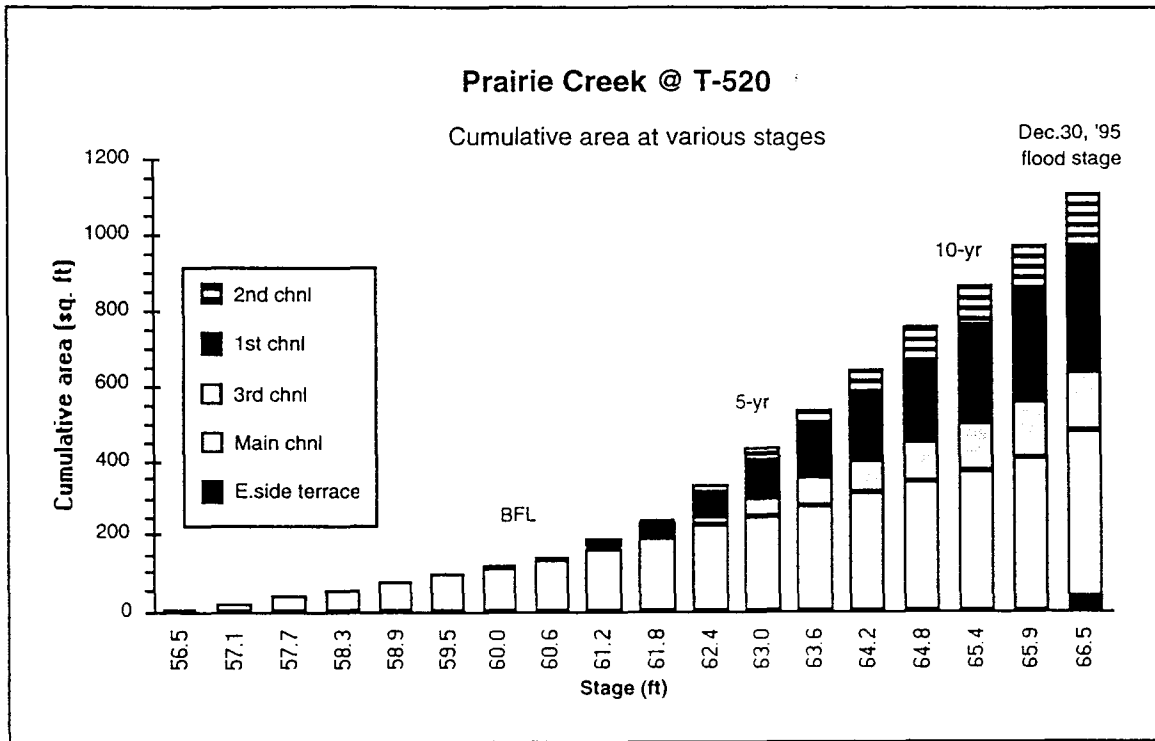


Figure 15: Prairie Creek @ T-520' showing the cumulative flooded area of each channel at various stages. Bankfull stage was about 60.1 ft. The 5-yr flood stage = 63 ft, the 10-yr flood stage = 65.4 ft and the Dec. 30, 1995 flood stage = 67 ft.

#### 4.0 WATER SURFACE ELEVATIONS DURING THE DEC. 30, 1995 FLOOD EVENT

Photographs and field observations during the Dec. 30, 1995 flood event allowed us to survey the water surface elevations at the project site during a 12-15 year recurrence interval flood. The estimated discharge was 3,000 cfs. Figure 16 shows a map of the inundated area with wavy lines indicating the direction of flow, surveyed water surface elevations and photo points of Figures 17a-f which are photographs taken by M. Farro between 11:00 and 12:00 during the height of the flood.

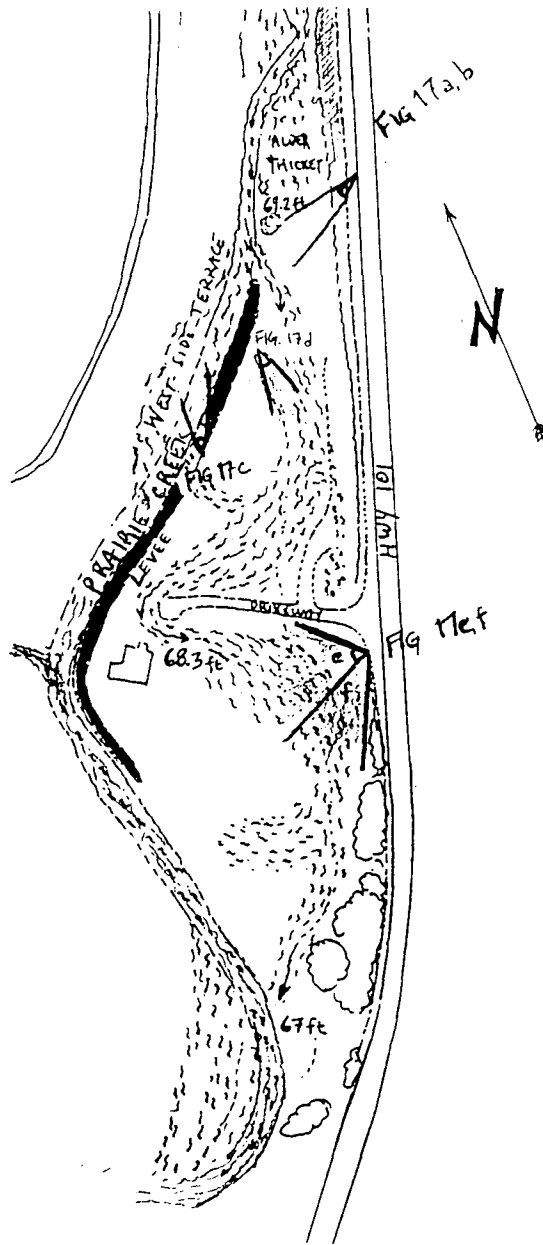


Figure 16: Water surface elevations, flood patterns during the Dec. 30, 1995 flood and photo points for Figures 17a-f.



Figure 17:a: Upper part of project site and Prairie Creek looking downstream (southwest) from the edge of Hwy 101. Note the water flowing over the Caltrans-engineered terrace, the debris jam fronting it and the tilted alder in the center foreground.



Figure 17b: Close up of the channel. In the center foreground, note the debris jam and tilted alder. In the center background, note the cluster of alders falling into the creek from the west-side terrace.



Figure 17c: Prairie Creek looking upstream at the height of the flood at the alders fallen from the west bank and the debris jam at L.Sta. 350-360.



Figure 17d: Project site above the driveway at the peak of the flood. view looking southeast.



Figure 17e: Project site below the driveway at the height of the flood, view looking southwest to west. The water flowed behind the truck, around the north side of the garage, toward viewer (east) and then through the swale in the foreground where it flowed left to right (south).



Figure 17f: Project site below the driveway at the height of the flood, view looking south. Water flowing away from viewer (south) through swale area (proposed backwater unit).

## **5.0 PROJECT DESIGNS- Descriptions and Computations**

The project, as proposed, entails modifying a 50 foot length of Prairie Creek's east bank, opening up an old overflow channel, and creating coho salmon rearing habitat in the form of a backwater that will be hydrologically connected to Prairie Creek at the lower end of the project site. A riffle will connect this backwater with upstream pools which will be maintained year-round by a small perennial draw and groundwater, and by occasional flood waters flowing through an inlet at the upstream end of the project site.

Several principles were incorporated in the design- hydraulics, hydrology, geomorphology and fishery habitat, collectively referred to as morphodynamics ecology. Some guidelines contained in the California Salmonid Stream Habitat Restoration Manual, 2nd edition (Flossi and Reynolds, 1994) were also used for project implementation.

This section will describe the project on a unit-by-unit basis starting from the upstream end where Prairie Creek's east bank will be modified and the overflow channel inlet created, down to the backwater unit at the lower end of the project site.

### **5.1 DREDGING AND MATERIALS REQUIREMENTS**

The project will require dredging 9,000- 10,000 yds<sup>3</sup> of soil. No more than 20% will likely be stored onsite. About 200 yds<sup>3</sup> of 1/2 ton quarry rock and woody debris of various sizes will be required. Most of this wood may be logging slash from nearby logging operations. Live, native vegetation will also be obtained for planting on site which may include redwood (*Sequoia sempervirens*), cascara (*Rhamnus purshiana*), blackberry (*Rubus vitifolius*), red alder (*Alnus rubra*) and hazel (*Corylus cornuta*). In addition, some of the vegetation removed by dredging will be planted along the banks of the project channel, particularly the sedges (*Carex* sp.) found in various locations on site.

Figure 18a shows the plan view of the design channel's topography. Figure 18b shows the excavation depths. Figure 19 shows the longitudinal profile along the project channel. Figures 20-22 show the longitudinal profile of the project channel at bankfull, 5-yr and 12-15-year flood stages.

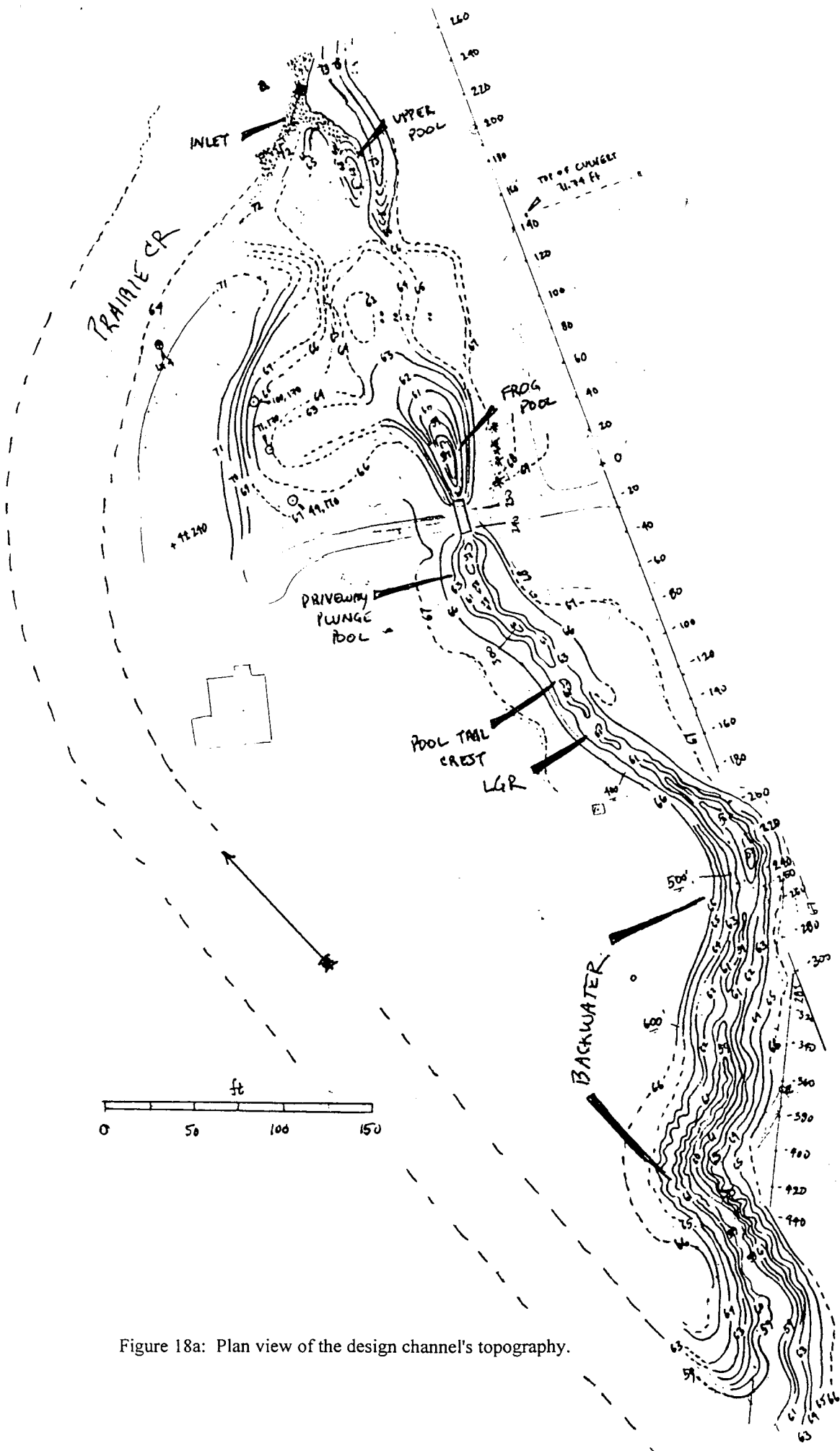


Figure 18a: Plan view of the design channel's topography.

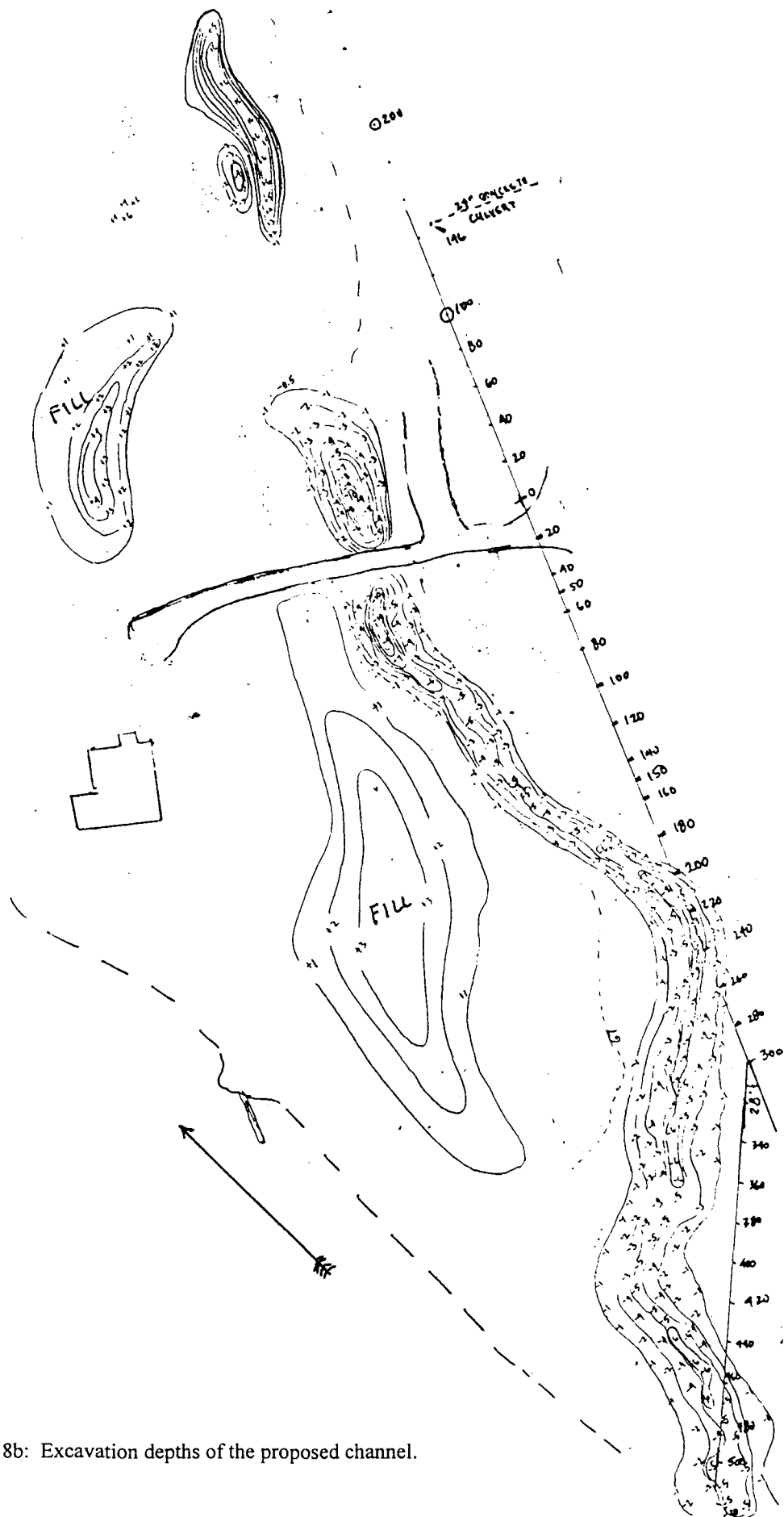


Figure 18b: Excavation depths of the proposed channel.

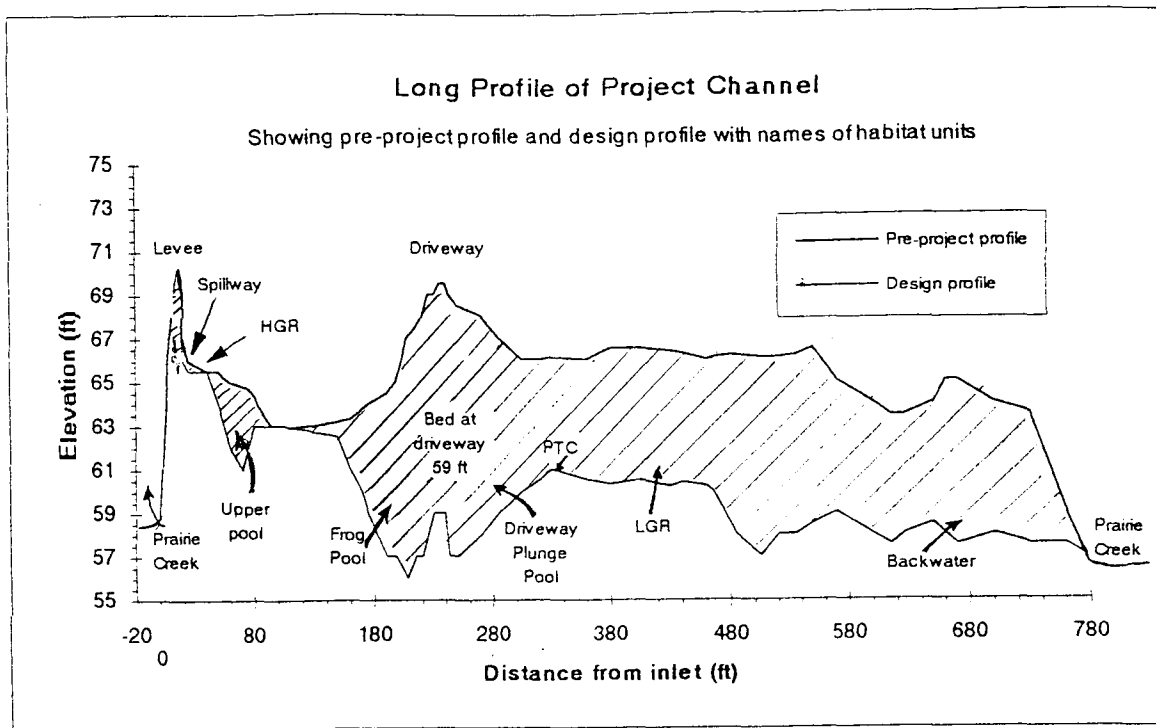


Figure 19: Longitudinal profiles along the thalweg of the project channel: Design profile overlaid on the pre-project profile. LGR = low gradient riffle. BFL = bankfull stage in Prairie Creek at the downstream end of the project site. PTC = pool tail crest.

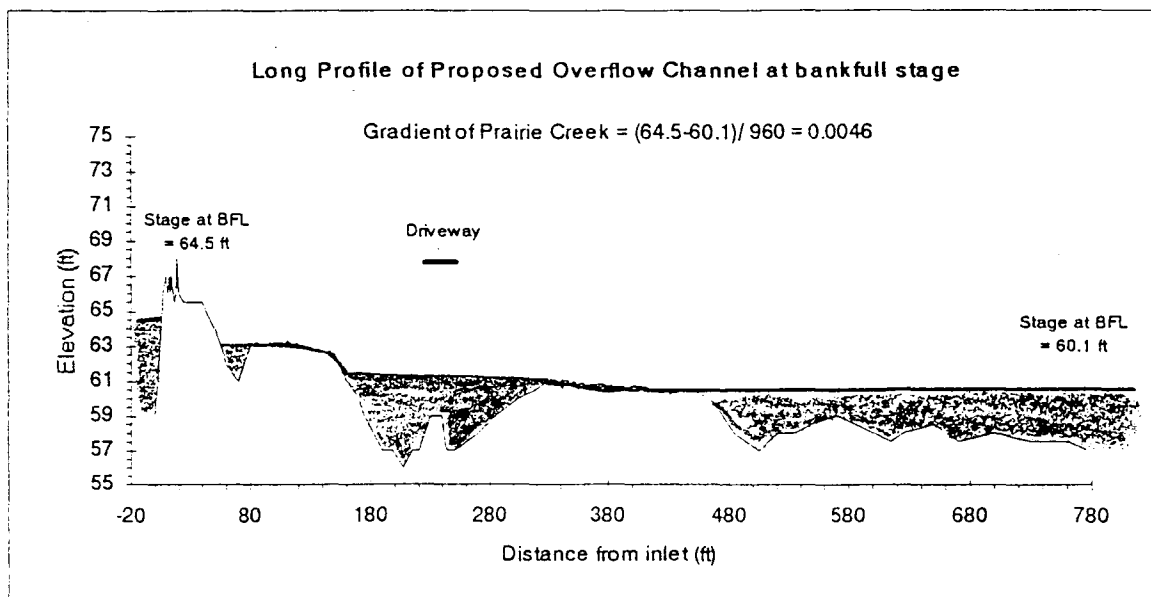


Figure 20: Longitudinal profile of the proposed channel at bankfull stage. The PTC of the the Driveway Plunge Pool at 400 feet will be designed at Prairie Creek's bankfull stage at the lower end of the project site. Thus, stages below BFL will not back up past the PTC and into the Driveway Plunge Pool.

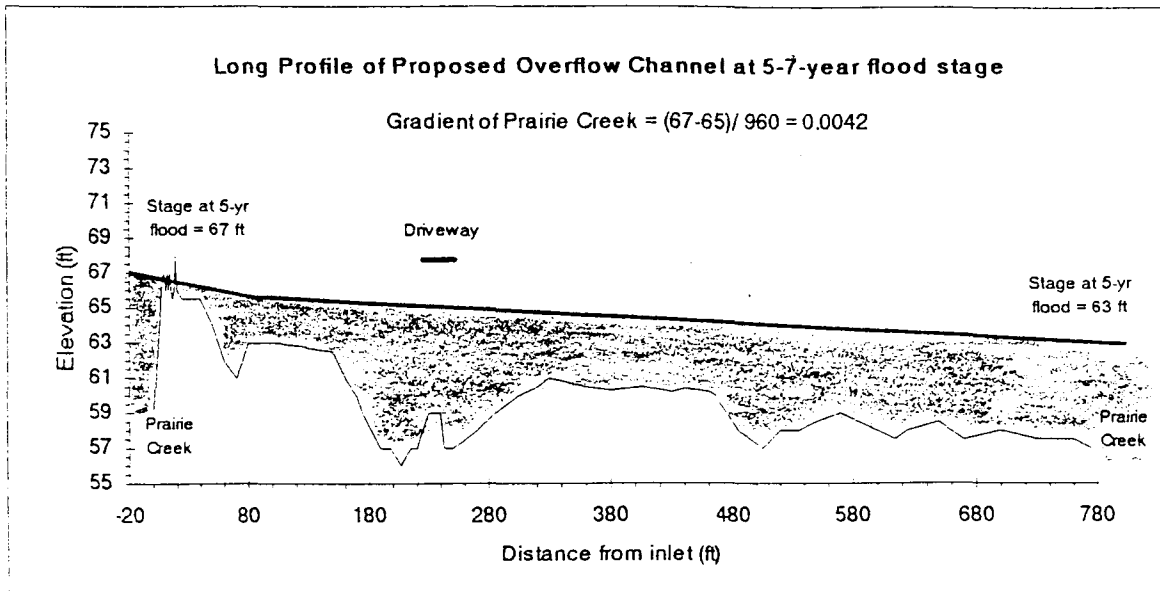


Figure 21: Longitudinal profile of the proposed channel at 5-7 year flood stage of 67 ft at the inlet. Stage will be 1.5 feet over the inlet elevation of 66 ft. The slope along the first 120 feet of the channel should be between 0.15 and 0.20 (1.5-2.0%) in order to dissipate the energy.

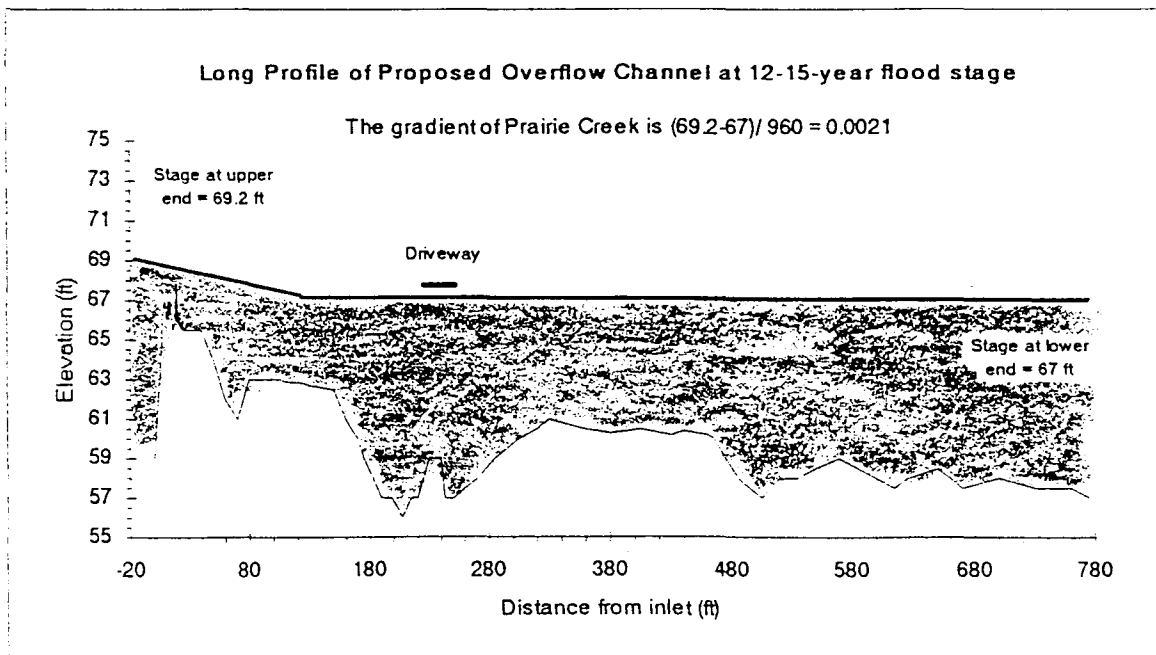
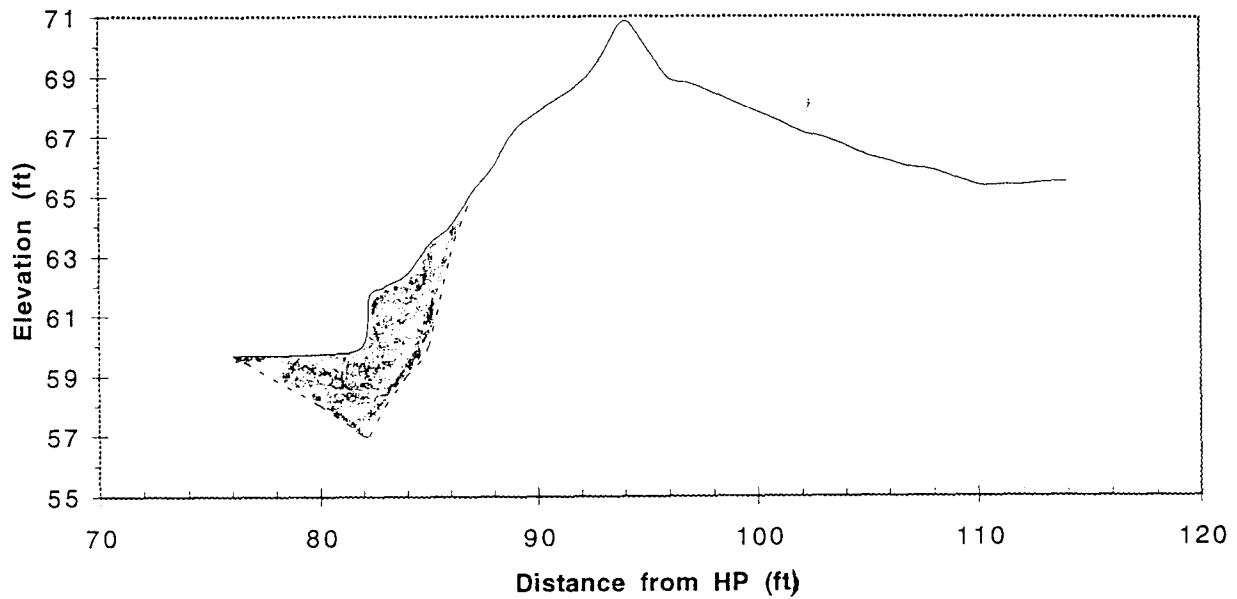


Figure 22: Longitudinal profile of the proposed channel at the 12-15-year flood. Stage at the inlet will be about 3 feet over the lowest elevation of the inlet (65) ft. The slope along the first 120 feet of the channel should be between 0.15 and 0.20 (1.5-2.0%) dropping water surface elevation at the driveway to about 67.5 ft. There should be at least 1 foot of clearance between the water surface and the driveway ceiling.

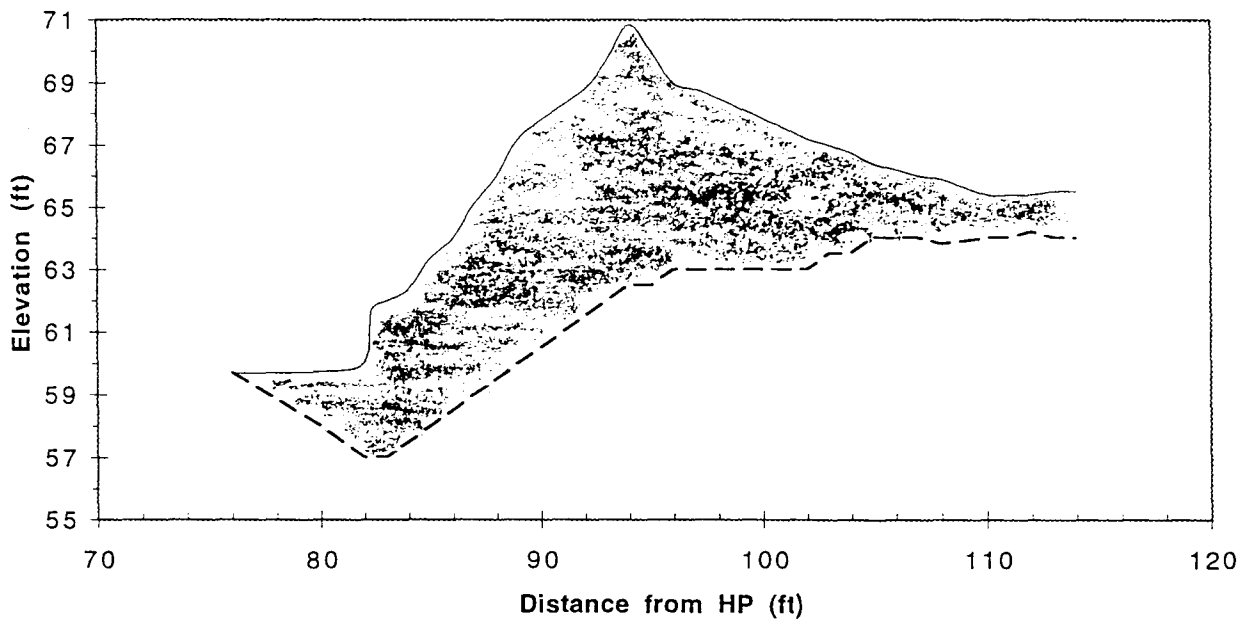
## 5.2 PROPOSED DESIGN OF THE PROJECT CHANNEL SPILLWAY & ITS SHORELINE (FIGURES 23 -26, TABLE 4).

The leveed, east bank of Prairie Creek at the northern or upstream end of the project site was severely eroded during the Dec. 30, 1995 flood event and will not likely withstand future floods. A 50-foot length of it will be modified as part of this project. Below is a step-by-step process that we are proposing to help stabilize this shoreline and create the overflow channel's inlet.

*STEP 1, EXCAVATION OF THE TOE OF THE LEVEE:* The toe of the levee will first excavated down to an elevation of 57 ft for a length of 50 feet as shown in 2-D in Figure 23. This excavation depth is 3 feet below the present elevation of Prairie Creek as suggested by Flosi and Reynolds (1994). While performing this work, the debris jam in Prairie Creek in this vicinity should be removed and set aside to be used as structural components elsewhere at the project site. A 15-foot length of the levee will be fully excavated to make way for the overflow channel's inlet. Any trees and shrubs excavated during this process should be removed with care so that they may be replanted later. This work will require about 130 yds<sup>3</sup> of excavation.



A.



B.

Figure 23: Profile of Prairie Creek's east bank in the vicinity of the proposed inlet. The existing and excavated profiles. The shaded zone is the area to be excavated. A) Excavation profile upstream and downstream of the inlet. B) Excavation profile along the 15-foot length of the proposed inlet

**STEP 2, PLACEMENT OF RIP-RAP:** Rip-rap will be placed along this excavated shoreline to an elevation of 65-66 ft as shown in Figure 24. Two single wing deflectors—one at the upstream end and one at the downstream end will extend into Prairie Creek as shown in Figures 25 and 26. The upstream end of the rip-rapped shoreline will be merged with that placed by *Caltrans* in 1989.

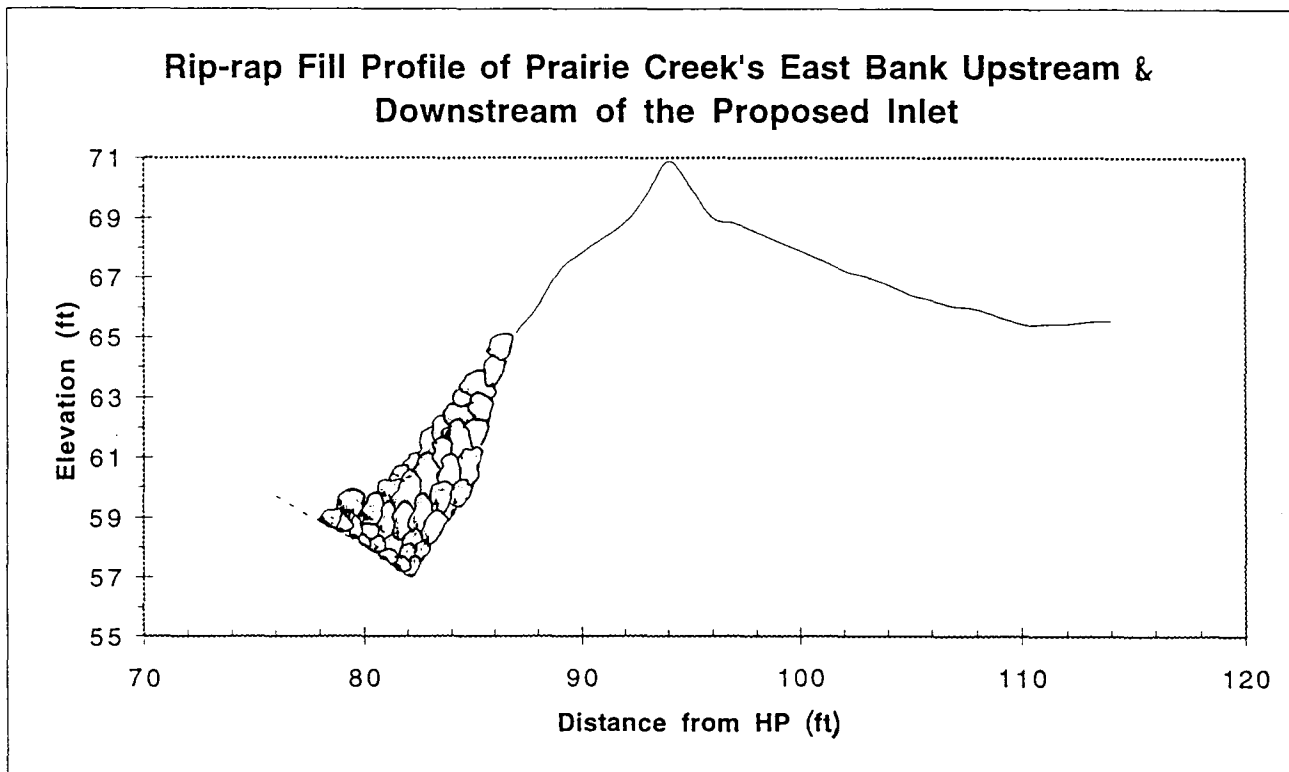


Figure 24: Rip-rap will be placed in the excavated area up to an elevation of 65-66 ft. The levee on both sides of the inlet will be brought back up to 71 feet along the redesigned shoreline with some of the previously excavated soil (200 yds<sup>3</sup>) and planted with vegetation.

### STEP 3, CREATION OF THE OVERFLOW CHANNEL INLET & WING

**DEFLECTORS:** Over the 15-foot wide segment of levee fully excavated, an inlet will be created in order to allow portions of floods recurring every 4-5 years to separate from the main channel and flow into the project channel. The inlet will be composed of rip-rap extending back from the spillway about 30 ft. Elevations of the inlet will range from 65 to 68 ft to maintain high roughness over the expected range of flows. Figure 25 shows the plan view of the inlet and Figure 26 a-c show the profiles at the sites indicated in Figure 25.

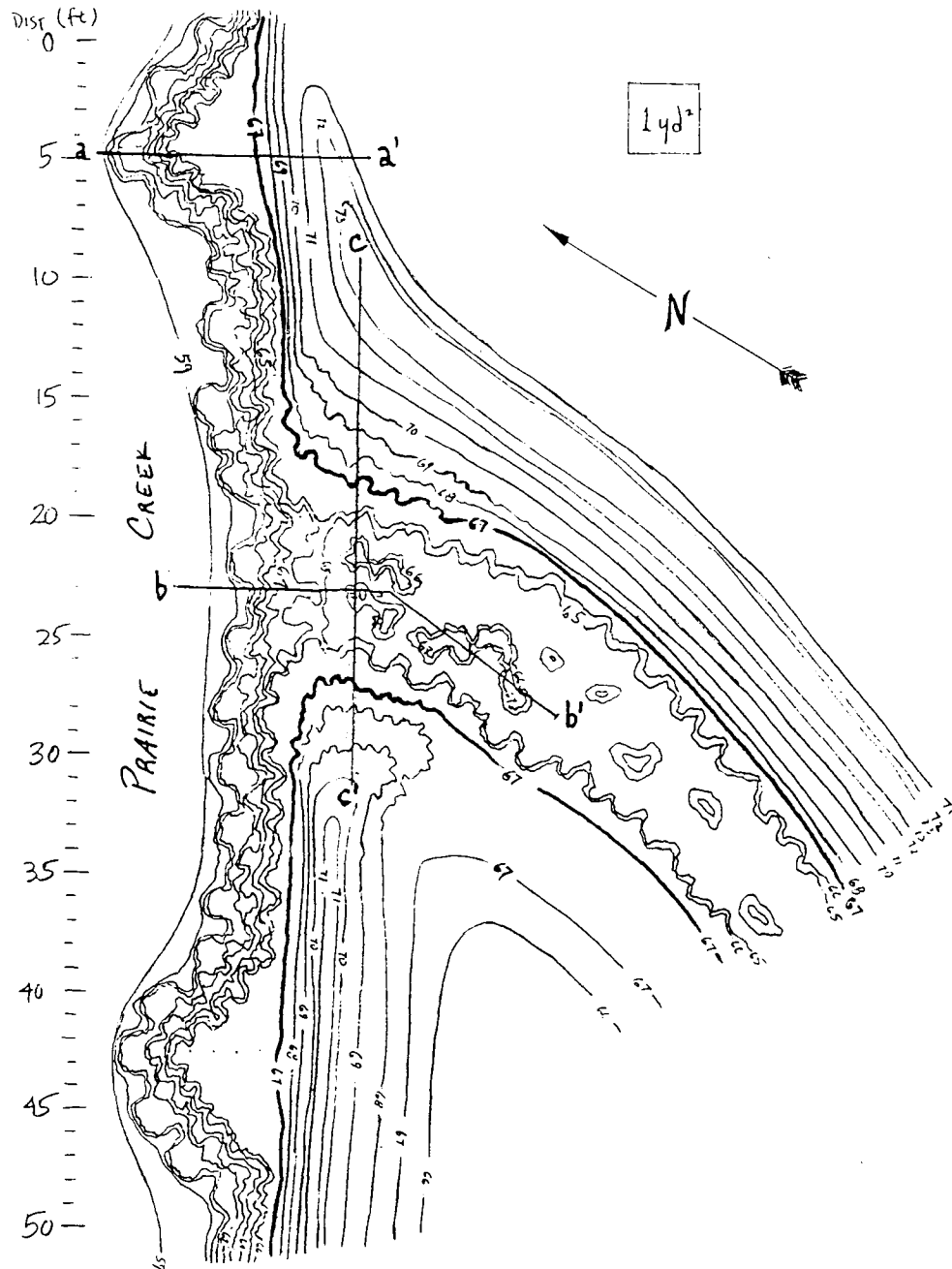


Figure 25: Contour map of Prairie Creek's east shoreline and the project inlet. Rip-rap is indicated by jagged contours. Profiles are shown in Figure 26.

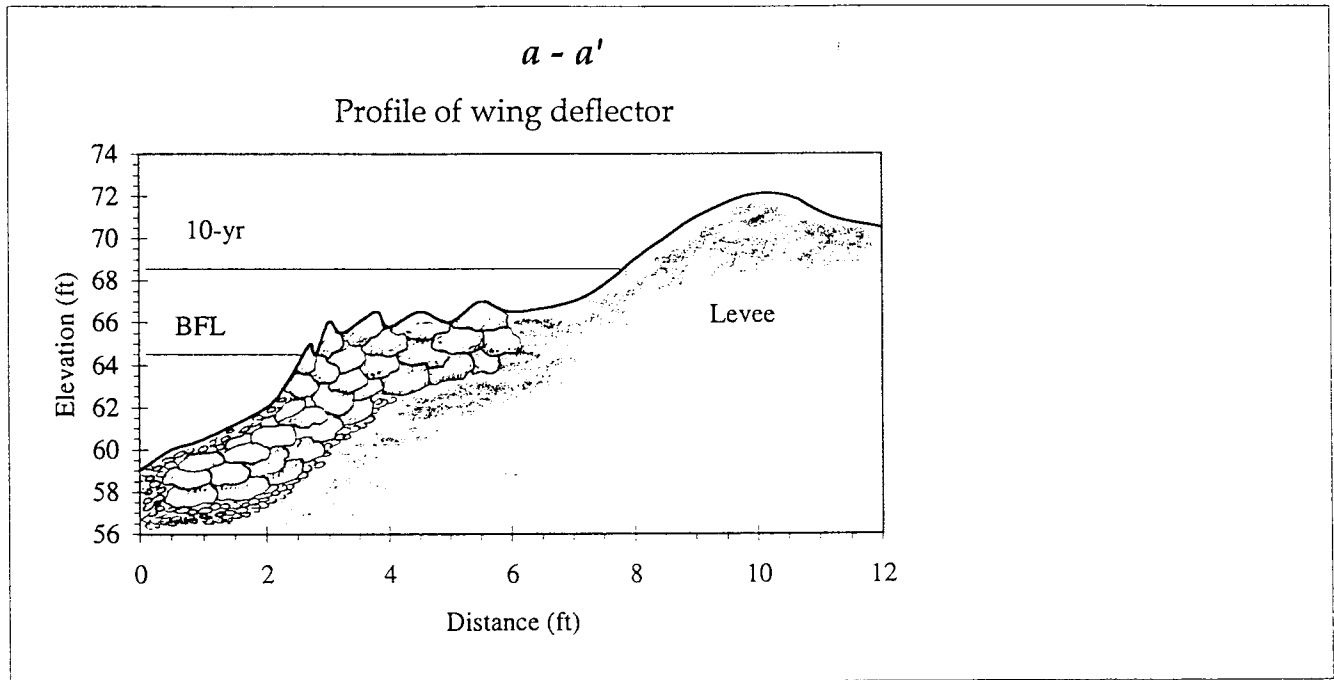


Figure 26A: Profile of the wing deflectors.

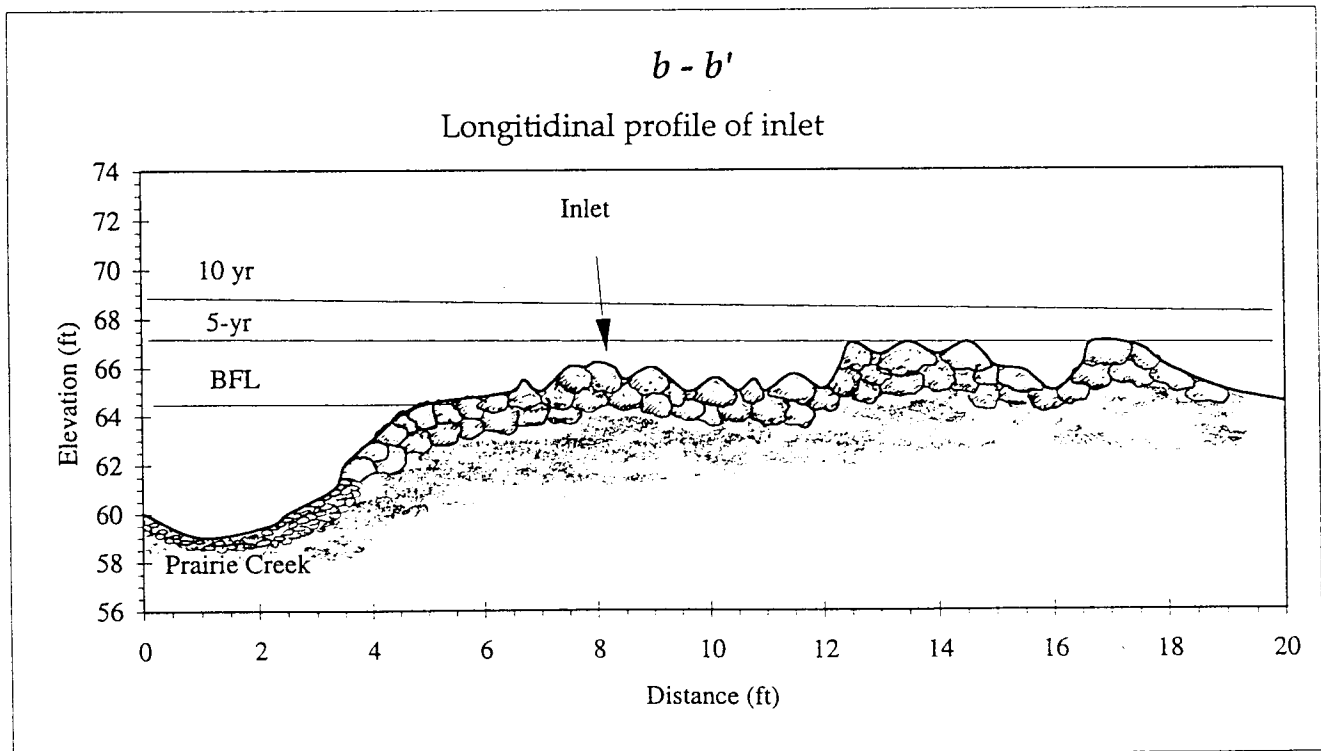


Figure 26B. Longitudinal profile of the inlet.

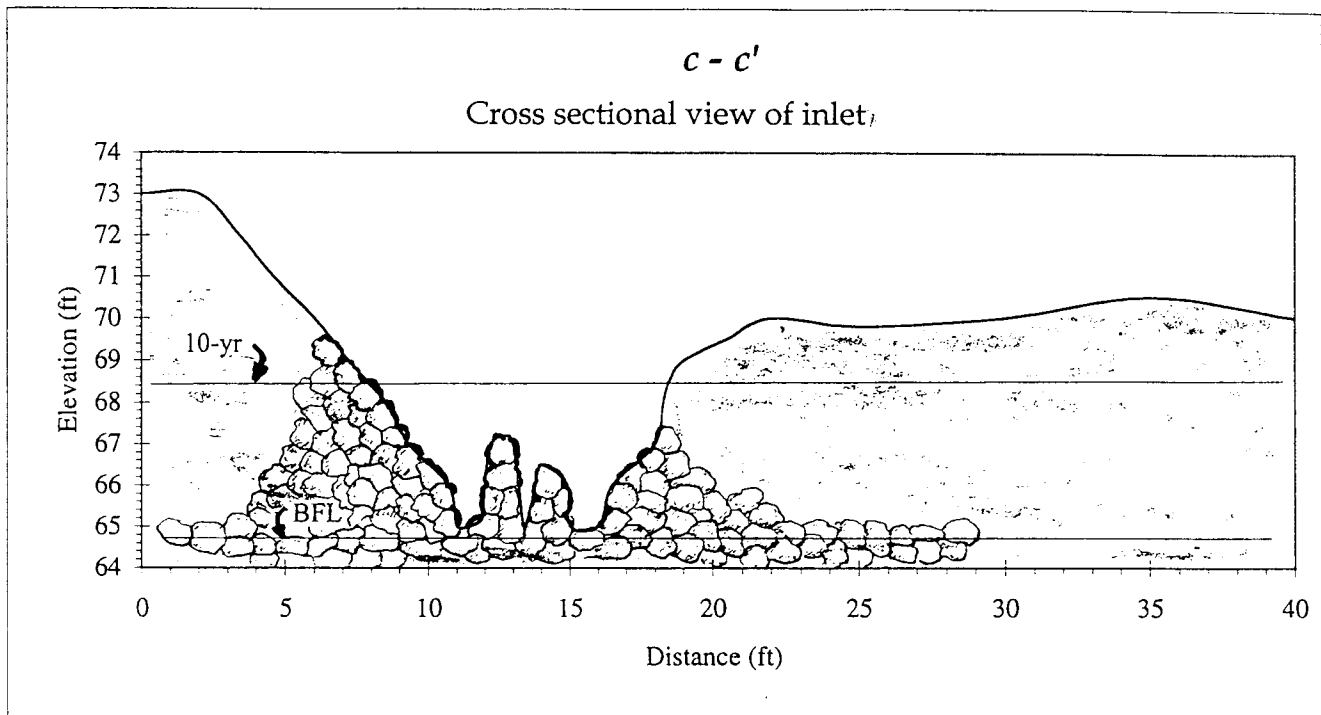


Figure 26C: Cross section of the inlet.

Table 5 shows the stage-discharge computations for the project channel inlet. Discharges were estimated using the Manning equation and are maximum restimates. The percent of the total discharge flowing down Prairie Creek at T-1 over stages reaching the 15-year flood were also calculated.

TABLE 5: Stage-discharge relationships for the project inlet compared with the total flow of Prairie Creek just upstream of the proposed inlet. The Manning equation was used for these

| RI (recurrence interval, years)          | 3.5   | 4     | 5     | 6.5   | 8     | 10    | 12    | 15    |
|------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| STAGE (ft)                               | 65.5  | 66.5  | 67.0  | 67.5  | 68.0  | 68.5  | 69.0  | 69.5  |
| A (Area flooded, sq.ft)                  | 2.5   | 5.5   | 10    | 17    | 25    | 34    | 44    | 50    |
| WP (Wetted perimeter, ft)                | 7.3   | 11    | 18    | 22    | 25    | 27    | 29    | 32    |
| R (hydraulic radius, WP/A)               | 2.92  | 1.96  | 1.78  | 1.28  | 1.01  | 0.79  | 0.65  | 0.64  |
| S (slope, %)                             | 0.02  | 0.02  | 0.02  | 0.02  | 0.02  | 0.02  | 0.02  | 0.02  |
| n (roughness)                            | 0.080 | 0.070 | 0.060 | 0.050 | 0.040 | 0.030 | 0.030 | 0.025 |
| Q across inlet (cfs)                     | 13    | 26    | 52    | 84    | 132   | 203   | 232   | 310   |
| Q total flowing down Prairie Creek (cfs) | 1,300 | 1,600 | 2,000 | 2,300 | 2,400 | 2,700 | 3,000 | 3,200 |
| Q (%)                                    | 1%    | 2%    | 3%    | 4%    | 6%    | 8%    | 8%    | 10%   |

$$\text{Manning equation: } Q = 1.486/n * A * R^{0.67} * S^{0.50}$$

---

HIGH GRADIENT RIFFLE: A 25-30 foot long, curving, boulder-dominated high gradient riffle will extend from the inlet to the Upper Pool. Rip-rap will be placed in a formation similar to that shown in Figure 25. As with the inlet, elevations will vary 2-3 feet to maintain high roughness over expected flood stages.

The gradient of the upper end of the spillway will be about 2% while the lower end will be 8% over 10 feet where it becomes the Upper Pool.

### 5.3 UPPER POOL

The Upper Pool will absorb much of the energy of flow spilling into the project channel. It requires an excavation volume of 75 yds<sup>3</sup>. This material will be placed on the east side to a maximum elevation of 73 ft (Figure 27). The pool will be excavated down to an elevation of 62 ft. Woody debris could be buried in the east bank if needed and it will be replanted with shrubs, such as cascara and blackberry and redwood trees.

Below the Upper Pool, there is a length of about 70 feet where there will be no excavation (Figure 19). The elevations here are about 63 ft and is where the old pilings exist and several alders grow.

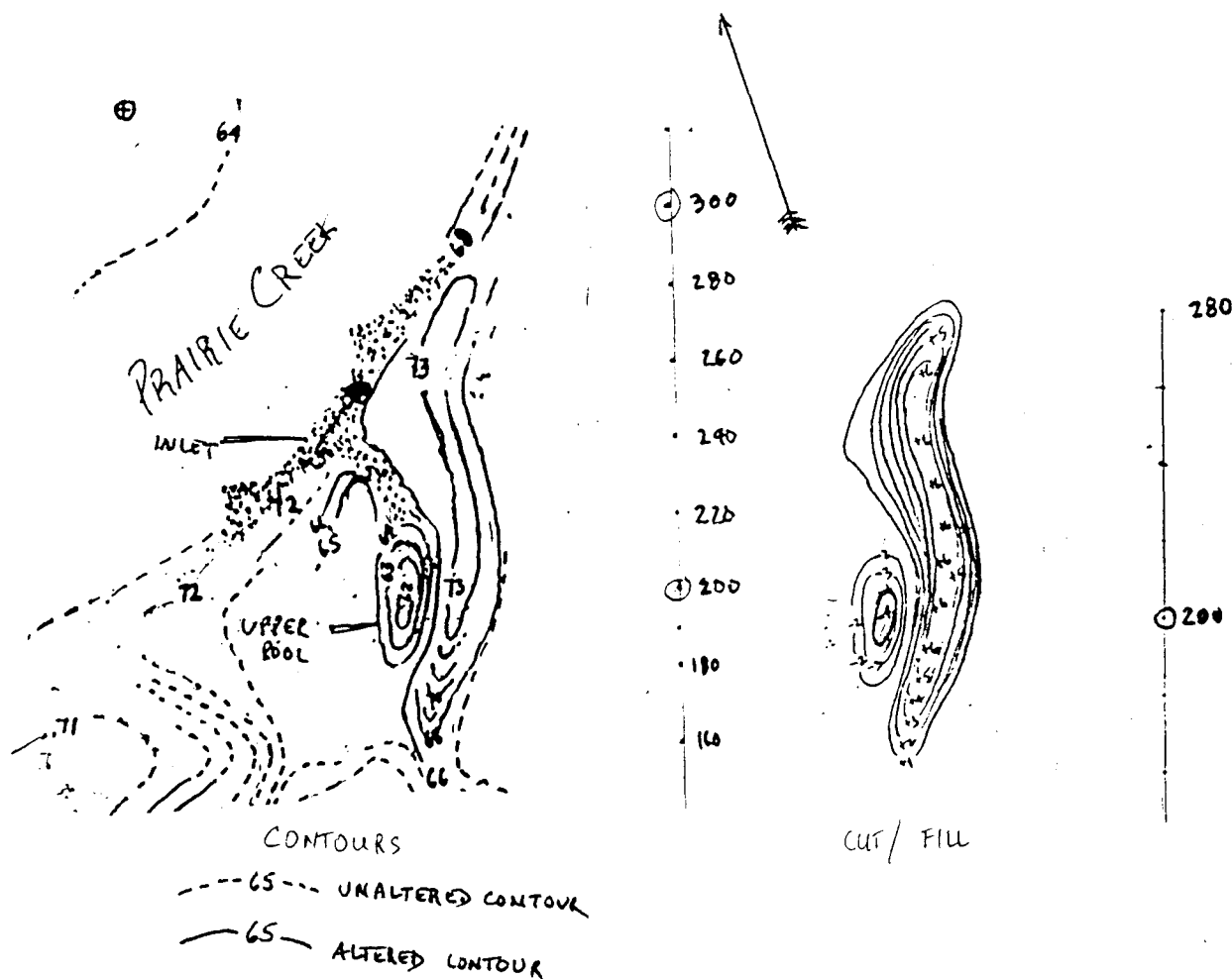


Figure 27: Upper Pool showing cut and fill.

## 5.4 FROG POOL

The Frog Pool is the pool at the upstream end of the driveway (Figure 28). It will be excavated to a maximum depth of 10 feet to bring the elevation down to 57 ft and will require about 1,500 yds<sup>3</sup> of excavation. Based on a stratigraphic profile conducted in 1994, the upper 5 feet here consisted of mostly fine sand and clay, with pea gravels and coarse sand at 5 feet (elevation, 60 ft). Gravel seemed to get coarser below this depth and we couldn't penetrate below this.

Some of the excavated material will be placed in the area west of the pool site and graded to 71 ft, maximum elevation of this area presently. Woody debris will be placed around the margins of this pool to create cover.

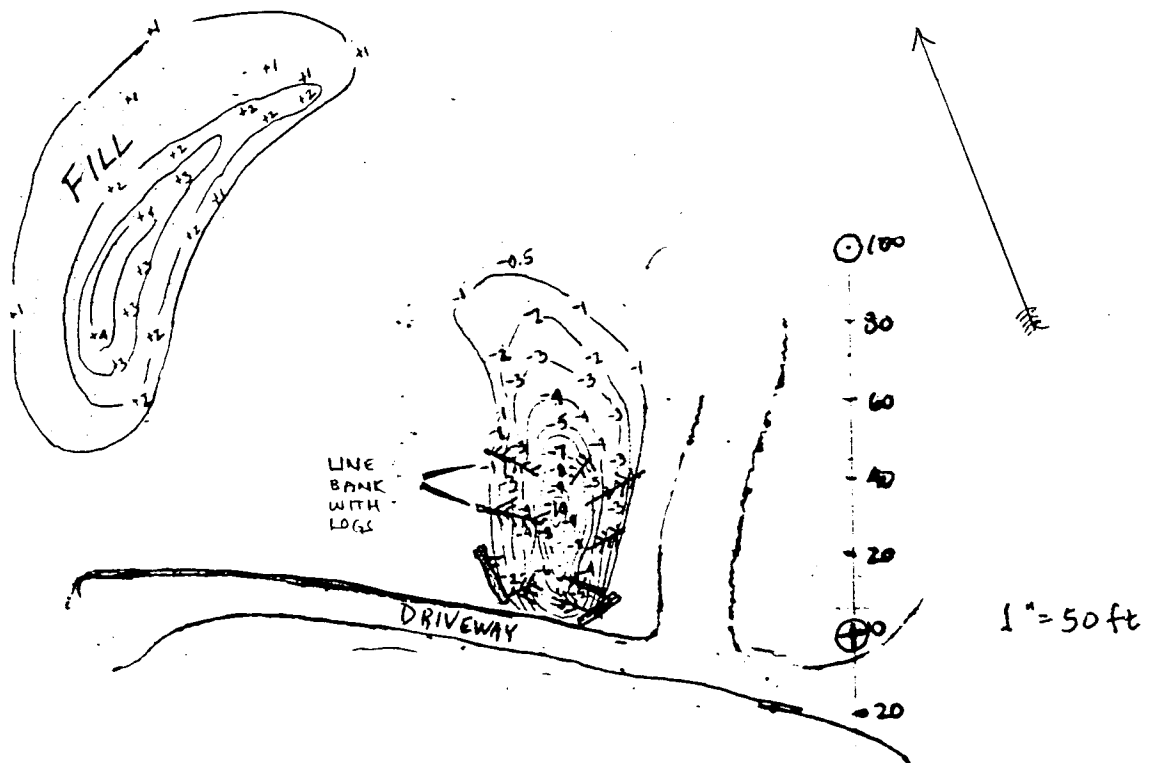


Figure 28: Frog Pool showing cut and fill, and placement of structural components.

## 5.5 DRIVEWAY CROSSING

Between the Frog Pool and Driveway Plunge Pool will be a crossing consisting of either a railroad car or a 10-foot diameter culvert. Whatever is used, the elevation between the two pools will be 59 feet, so that fish could access both pools year-round. In addition, the maximum discharge expected to flow through the design channel will not be constricted to allow water to flow freely below the driveway.

## 5.6 DRIVEWAY PLUNGE POOL & LOW GRADIENT RIFFLE

The Driveway Plunge Pool will require an estimated 1,000 yds<sup>3</sup> of excavation and will be dredged to a minimum elevation of 57 ft. The edges will be cut with pockets created by the excavator (Figure 29). In these pockets, woody debris will be placed. Soil and small boulders will be placed on top of the woody debris in order to anchor it in.

A Low Gradient Riffle will separate the Driveway Plunge Pool from the Backwater. The upstream end of this riffle is the pool tail crest (PTC) of the Driveway Plunge Pool. The riffle will be about 60 ft long and have minimum elevation of 60.5 ft, the bankfull elevation of Prairie Creek at the lower end of the project site.

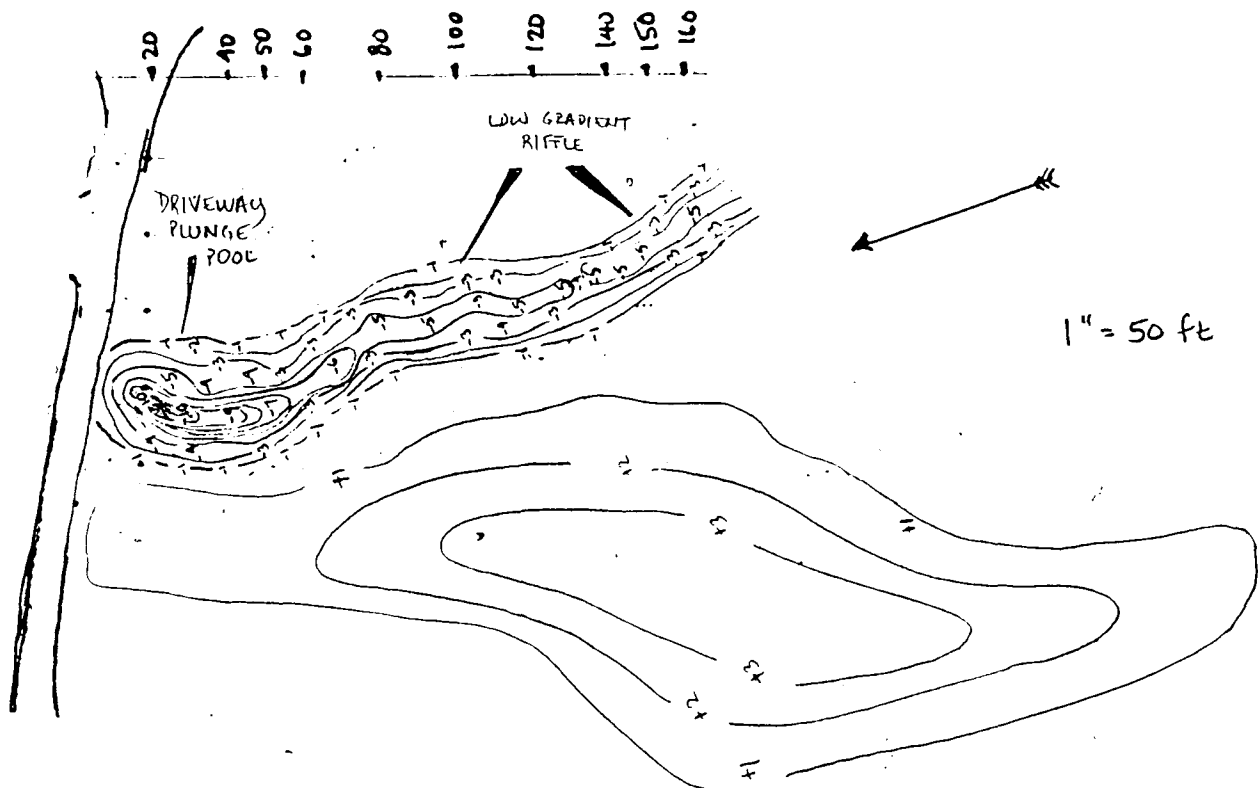


Figure 29: Driveway Plunge Pool and low gradient riffle showing contours and placement of structural components. The pool tail crest will be at an elevation of about 60.5 ft, equivalent to the bankfull elevation of Prairie Creek at the lower end of the project site.

## 5.7 BACKWATER

The Backwater will be excavated down about 1 foot below summer, low-flow water surface elevation at the lower end of the project site (58 ft). The volume of excavation is estimated at 6,500 yds<sup>3</sup>. There may be some buried woody debris encountered during excavation and it may be appropriate to leave it in place. Its thalweg should be relatively sinuous to allow for habitat complexity and for reducing water stagnation.

Once excavated, its bed will be lined with logs, small woody debris and scattered boulders. Its banks will be lined with small wood revetments tied together (Figure 30). It will run close to the forested area on the east side to take advantage of the canopy shade.

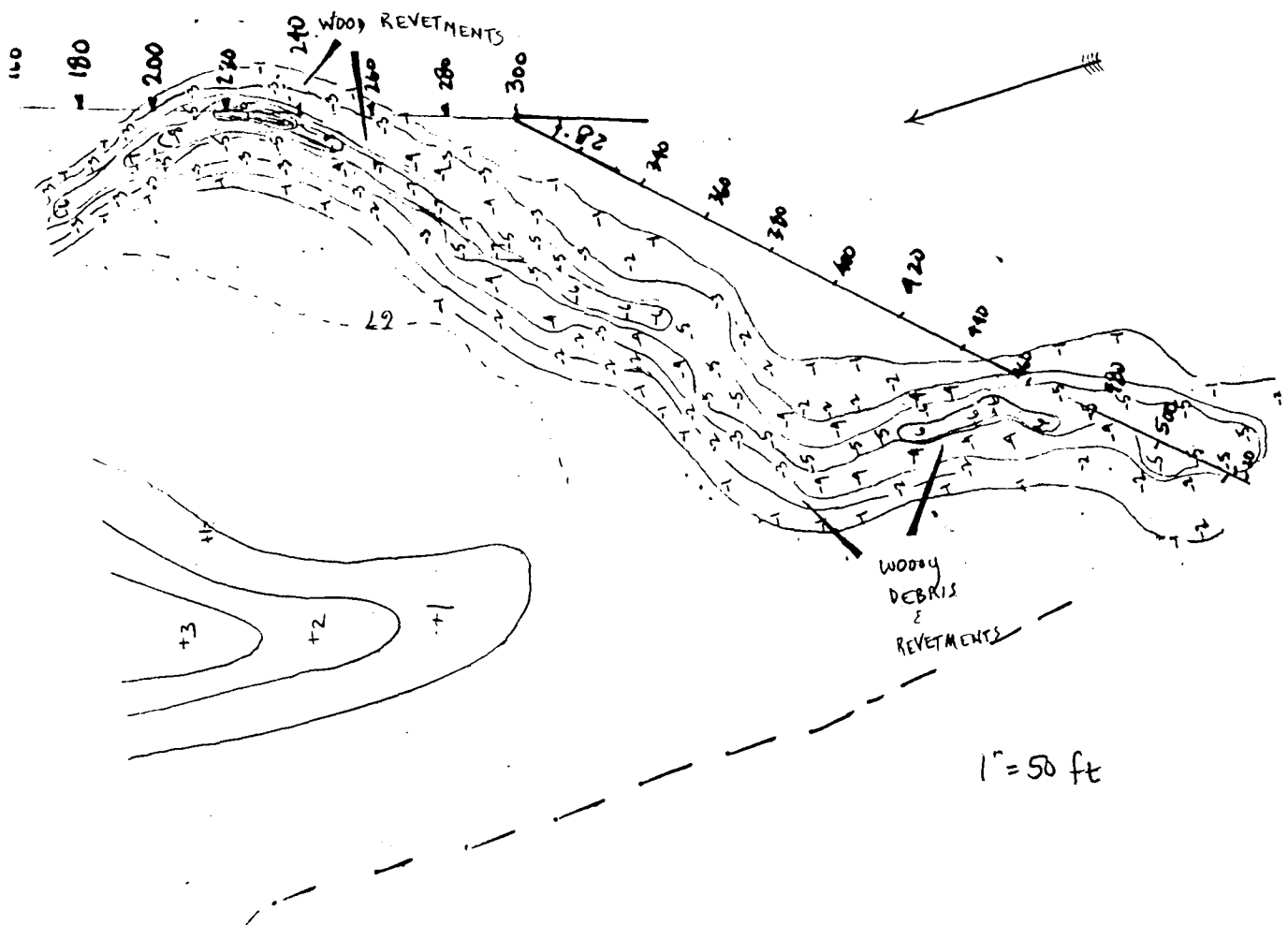


Figure 30: The backwater unit showing showing contours and placement of structural components

## 5.8 PREVENTING FURTHER BANK EROSION

The east bank of Prairie Creek in the vicinity shown in Figure 31 was eroded during the Dec. 30 flood, particularly behind the large redwood log partially buried in this bank. With formation of the large gravel bar adjacent to it, subsequent floods may further impinge on this bank and erode it. Should there be enough resources after the core project is implemented, some of the material excavated from the design channel and levee as well as some gravel, boulders or woody debris may be used to help stabilize the bank to minimize further erosion.

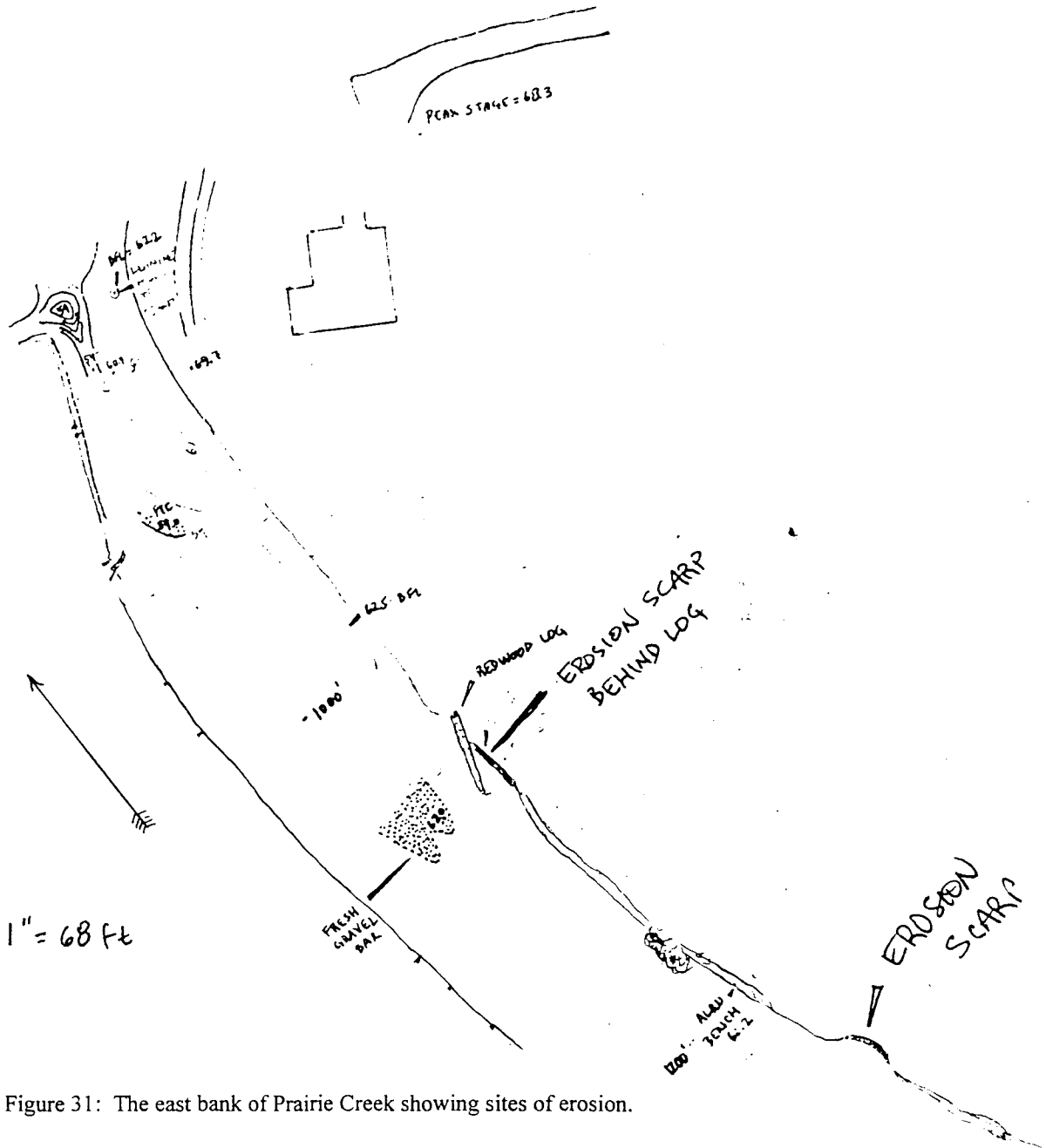


Figure 31: The east bank of Prairie Creek showing sites of erosion.

## **6.0 REFERENCES**

Flosi and Reynolds, 1994. California Salmonid Stream Habitat Restoration Manual, 2nd edition.

Redwood National Park, 1991. Monitoring the impacts and persistence of fine sediments in the Prairie Creek watershed: 1989-90.

## APPENDIX A

Channel cross section data

# APPENDIX A

## PRAIRIE CREEK @ T-1

Comparison of March 1994 & May 1996 Cross sectional surveys.

| Station | ELEV. 96 | ELEV. 94 | Diff | 96 COMMENT                                                       | 94 COMMENT                    |
|---------|----------|----------|------|------------------------------------------------------------------|-------------------------------|
| 0       | 69.9     |          |      | Top of HP                                                        | Top of HP                     |
| 0.1     | 68.7     | 68.8     | 0.0  | West side terrace                                                | West side terrace             |
| 5       | 68.3     |          |      |                                                                  |                               |
| 10      | 68.5     |          |      |                                                                  |                               |
| 13      |          | 68.4     |      |                                                                  |                               |
| 15      | 67.4     |          |      |                                                                  |                               |
| 19      | 68.4     |          |      |                                                                  |                               |
| 23      | 68.7     |          |      |                                                                  |                               |
| 28      | 68.3     | 68.2     | 0.1  |                                                                  |                               |
| 31      | 68.2     |          |      | Edge of terrace                                                  |                               |
| 31      | 64.7     |          |      | Base of terrace                                                  |                               |
| 32      | 64.4     |          |      | Moss break, 3 ft upstream. BFL                                   |                               |
| 33      | 64.0     |          |      | On slump blocks                                                  |                               |
| 34      | 63.2     |          |      | On slump blocks                                                  |                               |
| 36      | 61.9     |          |      | On slump blocks                                                  |                               |
| 38      | 61.3     | 68.3     | -7.0 | Base of right bank behind failure block                          | On west-side 5-7-year terrace |
| 42      | 60.1     | 67.6     | -7.5 |                                                                  |                               |
| 46      | 59.8     |          |      | Thalweg, water depth = 1.4 ft                                    |                               |
| 50      | 60.2     |          |      |                                                                  |                               |
| 53      |          | 64.3     | -3.5 |                                                                  | RNP's pin: LX3                |
| 54      | 61.3     |          |      | WSEL, May 3, 1996, 12:30                                         |                               |
| 56      | 61.8     |          |      |                                                                  |                               |
| 58      |          | 61.2     | 0.8  |                                                                  | In active channel             |
| 60      | 62.3     |          |      |                                                                  |                               |
| 63      |          | 61.1     | 1.3  |                                                                  |                               |
| 65      | 62.5     |          |      |                                                                  |                               |
| 68      |          | 61.1     | 1.5  |                                                                  |                               |
| 70      | 62.6     |          |      | Top of bar behind woody debris                                   |                               |
| 73      |          | 61.1     | 1.5  |                                                                  |                               |
| 75      | 62.5     |          |      |                                                                  |                               |
| 77      |          | 61.5     | 0.7  |                                                                  |                               |
| 80      | 62.0     |          |      | Gravel bar edge                                                  |                               |
| 81      |          | 60.9     | 0.9  |                                                                  | Edge of gravel bar            |
| 83      | 61.4     |          |      | Gravel bar                                                       |                               |
| 86      |          | 60.7     | 0.9  |                                                                  | WSEL                          |
| 87      | 61.7     |          |      | Gravel bar                                                       |                               |
| 91      |          | 60.3     | 1.4  |                                                                  |                               |
| 92      | 61.9     |          |      | Gravel bar                                                       |                               |
| 95      |          | 59.8     | 1.9  |                                                                  |                               |
| 96      | 61.7     |          |      | Sandy silt mud in front of log jam.                              |                               |
| 99      | 61.4     |          |      | WSEL in red algae covered backwater                              |                               |
| 100     |          | 59.1     | 2.1  |                                                                  | Thalweg                       |
| 103     |          | 58.5     | 2.7  |                                                                  | Against LB                    |
| 104     | 61.0     |          |      | In channel bottom                                                |                               |
| 105     | 62.1     |          |      |                                                                  |                               |
| 106     |          | 58.7     | 3.9  |                                                                  |                               |
| 107     | 63.0     |          |      |                                                                  |                               |
| 108     |          | 62.5     | 0.9  |                                                                  | On LB rip-rap/ ALRU           |
| 109     | 63.8     |          |      |                                                                  |                               |
| 112     | 64.5     |          |      | Base of rock. 5" dia. ALRU, SCMI. BFL                            |                               |
| 113     | 64.4     | 64.0     | 0.4  |                                                                  | On LB rip-rap/ ALRU           |
| 115     | 65.6     |          |      |                                                                  |                               |
| 117     | 66.4     | 65.4     | 1.0  |                                                                  |                               |
| 118     | 67.1     |          |      | ALRU saplings over rip-rap slope                                 |                               |
| 120     | 67.7     |          |      | ALRU saplings over rip-rap slope                                 |                               |
| 122     | 68.4     |          |      | ALRU saplings over rip-rap slope                                 |                               |
| 125     | 68.7     |          |      | Caltrans-constructed terrace                                     |                               |
| 128     |          | 69.1     | -0.2 |                                                                  | On terrace                    |
| 130     | 69.1     |          |      | Caltrans-constructed terrace                                     |                               |
| 135     | 69.2     |          |      | Caltrans-constructed terrace                                     |                               |
| 140     | 69.2     |          |      | Caltrans-constructed terrace                                     |                               |
| 143     |          | 69.4     | -0.1 |                                                                  |                               |
| 145     | 69.4     |          |      | Caltrans-constructed terrace                                     |                               |
| 149     | 70.0     |          |      | Base of Hwy 101 rip-rap. Tape wrapped around scaggy 2" dia. ALRU |                               |
| 151     |          | 69.9     |      |                                                                  |                               |

# APPENDIX A

T-2: Surveyed on May 3, 1996 by Migs & Curt  
See Migs notebook # 2, pg. 22-25.

IH = 73.11

| STATION | ELEV. 96 | FS    | COMMENTS                                                                     |
|---------|----------|-------|------------------------------------------------------------------------------|
| 0       | 68.5     | 4.63  | Terrace, nettle, horsetail, blackberry, bedstraw under red alder             |
| 6       | 68.1     | 4.99  | 7-10 year stage                                                              |
| 9       | 68.0     | 5.15  |                                                                              |
| 11      | 67.5     | 5.63  |                                                                              |
| 15      | 66.7     | 6.40  | Alder line, 5-7 year stage                                                   |
| 18      | 66.3     | 6.82  |                                                                              |
| 21      | 66.1     | 7.03  | + sword fern. Fine sandy silt deposit behind alder from Dec. 30, 1995 flood. |
| 24      | 65.3     | 7.80  |                                                                              |
| 25      | 65.0     | 8.15  | Medium to coarse sand deposit.                                               |
| 27      | 65.0     | 8.11  | Medium to coarse sand deposit.                                               |
| 27      | 65.4     | 7.70  | Surface of flood-bent sword fern.                                            |
| 30      | 66.1     | 7.00  | Top of sword fern bench.                                                     |
| 32      | 65.2     | 7.88  |                                                                              |
| 34      | 64.4     | 8.74  | Top of scoured roots. BFL.                                                   |
| 34      | 63.3     | 9.79  | Sand deposit                                                                 |
| 35      | 63.1     | 9.97  | Sand/ gravel                                                                 |
| 39      | 62.7     | 10.43 | Gravel                                                                       |
| 42      | 61.7     | 11.39 |                                                                              |
| 44      | 61.2     | 11.90 | WSEL                                                                         |
| 47      | 60.5     | 12.60 | Cobble/ gravel                                                               |
| 50      | 60.3     | 12.85 | Thalweg                                                                      |
| 54      | 60.4     | 12.76 |                                                                              |
| 59      | 60.5     | 12.66 | Gravel, cobble                                                               |
| 63      | 60.6     | 12.54 |                                                                              |
| 67      | 60.9     | 12.25 | At tail of upstream gravel bar.                                              |
| 67      | 61.4     | 11.74 |                                                                              |
| 69      | 60.5     | 12.65 |                                                                              |
| 72      | 59.6     | 13.50 | 1 ft upstream of 3 ft dia boulder                                            |
| 76      | 59.7     | 13.40 |                                                                              |
| 80      | 59.8     | 13.36 |                                                                              |
| 82      | 60.1     | 13.05 |                                                                              |
| 82      | 61.7     | 11.43 | Slope break                                                                  |
| 85      | 63.4     | 9.74  | Base of rock, BFL                                                            |
| 87      | 65.1     | 8.00  | Up levee slope                                                               |
| 89      | 67.2     | 5.90  | Up levee slope                                                               |
| 92      | 68.8     | 4.30  | Up levee slope                                                               |
| 95      | 69.8     | 3.29  | Next to boulder on top of levee                                              |

# APPENDIX A

## PRAIRIE CREEK @ T-2

Comparison of March 1994 & May 1996 Cross sectional surveys.

| Station | ELEV. 96 | ELEV. 94 | Differer 96 | COMMENT                                                                | 94 COMMENT                  |
|---------|----------|----------|-------------|------------------------------------------------------------------------|-----------------------------|
| 0       | 68.5     | 68.17    | 0.3         | Terrace. Veg.= nettle, horsetail, blackberry, bedstraw under red alder |                             |
| 6       | 68.1     |          |             | Terrace flooded by 7-10 year RI flood stages                           |                             |
| 9       | 68.0     |          |             | Terrace flooded by 7-10 year RI flood stages                           |                             |
| 10      |          | 67.45    | 0.3         | Terrace flooded by 7-10 year RI flood stages                           |                             |
| 11      | 67.5     |          |             | Terrace flooded by 7-10 year RI flood stages                           |                             |
| 15      | 66.7     | 66.61    | 0.1         | Alder line, 5-7 year stage                                             | Alder line                  |
| 18      | 66.3     |          |             | Terrace flooded by 2.5-5 year RI flood stages                          |                             |
| 21      | 66.1     | 65.50    | 0.6         | + sword fern. Fine sandy silt behind alder from 12/30/95 flood.        |                             |
| 24      | 65.3     |          |             |                                                                        |                             |
| 25      | 65.0     |          |             | Medium to coarse sand deposit.                                         |                             |
| 26      |          | 64.80    | 0.2         |                                                                        | Fern stringer               |
| 27      | 65.0     |          |             | Medium to coarse sand deposit.                                         |                             |
| 27      | 65.4     |          |             | Surface of flood-bent sword fern.                                      |                             |
| 30      | 66.1     |          |             | Top of sword fern (POMU) bench.                                        |                             |
| 31      |          |          |             | Crosses RNP's RX 2                                                     |                             |
| 32      | 65.2     |          |             |                                                                        |                             |
| 34      | 64.4     |          |             | Top of scoured roots. BFL.                                             |                             |
| 34      | 63.3     |          |             | Sand deposit                                                           |                             |
| 35      |          | 64.61    | -1.5        |                                                                        |                             |
| 35      | 63.1     |          |             | Sand/ gravel                                                           |                             |
| 39      | 62.7     |          |             | Gravel                                                                 |                             |
| 40      |          | 63.89    | -1.7        |                                                                        |                             |
| 42      | 61.7     |          |             |                                                                        |                             |
| 44      | 61.2     |          |             | WSEL                                                                   |                             |
| 45      |          | 61.48    | -0.6        | Cobble/ gravel                                                         | Gravel bar                  |
| 47      | 60.5     |          |             |                                                                        |                             |
| 50      | 60.3     | 60.83    | -0.6        | Thalweg                                                                |                             |
| 54      | 60.4     |          |             |                                                                        |                             |
| 55      |          | 60.81    |             |                                                                        |                             |
| 56      |          | 60.40    | 0.0         |                                                                        | WSEL                        |
| 59      | 60.5     |          |             | Gravel, cobble                                                         |                             |
| 60      |          | 59.91    | 0.5         |                                                                        |                             |
| 63      | 60.6     |          |             |                                                                        |                             |
| 65      |          | 59.77    | 0.9         |                                                                        |                             |
| 67      | 60.9     |          |             | At tail of upstream gravel bar.                                        |                             |
| 67      | 61.3     |          |             | At apex of gravel bar, 3 ft upstream of sta. 67                        |                             |
| 69      | 60.5     |          |             |                                                                        |                             |
| 70      |          | 59.51    | 0.5         |                                                                        |                             |
| 72      | 59.6     |          |             | 1 ft upstream of 3 ft dia boulder                                      |                             |
| 75      |          | 59.40    | 0.3         |                                                                        |                             |
| 76      | 59.7     |          |             |                                                                        |                             |
| 79      |          | 59.01    | 0.7         |                                                                        |                             |
| 80      | 59.8     |          |             |                                                                        |                             |
| 82      | 60.1     |          |             |                                                                        |                             |
| 82      | 61.7     |          |             |                                                                        |                             |
| 83      |          | 60.36    | 2.2         |                                                                        | Bank                        |
| 84      |          | 62.37    | 0.2         |                                                                        |                             |
| 85      | 63.4     |          |             |                                                                        |                             |
| 87      | 65.1     |          |             | Up levee slope                                                         |                             |
| 88      |          | 68.06    | -1.9        | Up levee slope                                                         |                             |
| 89      | 67.2     |          |             | Up levee slope                                                         |                             |
| 90      |          | 70.08    | -2.1        | Up levee slope                                                         |                             |
| 92      | 68.8     |          |             | Up levee slope                                                         |                             |
| 93      |          |          |             | Up levee slope                                                         | Base of pin on top of levee |
| 94      | 69.8     | 70.86    | -1.0        | Next to boulder on top of levee                                        |                             |
| 101     |          | 67.54    |             |                                                                        |                             |
| 104     |          | 66.75    |             |                                                                        |                             |
| 108     |          | 65.90    |             |                                                                        | Base of levee               |
| 114     |          | 65.52    |             |                                                                        | Wetland                     |

# APPENDIX A

**T-44': Surveyed on May 2, 1996 by Migs & Curt**

See Migs notebook # 2, pg. 12-15.

IH 1= 75.03

IH 2= 68.74

| STA' | STA   | ELEV | FS    | COMMENTS                     |
|------|-------|------|-------|------------------------------|
| 345  | -1.0  | 67.6 | 1.14  | Terrace IH2                  |
| 344  | 0.0   | 63.1 | 5.64  | Cut bank, steep slope        |
| 339  | 5.5   | 61.5 | 7.22  |                              |
| 336  | 8.0   | 60.5 | 8.23  | Muddy peat bank              |
| 335  | 8.7   | 59.8 | 8.9   | WSEL                         |
| 335  | 9.0   | 58.9 | 9.8   | Edge of channel              |
| 334  | 10.0  | 58.8 | 9.92  |                              |
| 331  | 13.0  | 58.9 | 9.85  |                              |
| 326  | 18.0  | 58.5 | 10.23 | Thalweg, depth 1.35 ft       |
| 321  | 23.0  | 59.1 | 9.62  |                              |
| 319  | 25.0  | 59.1 | 9.67  | Top of gravel bar            |
| 314  | 30.0  | 59.0 | 9.76  |                              |
| 312  | 31.7  | 58.9 | 9.86  |                              |
| 311  | 33.0  | 58.9 | 9.83  |                              |
| 306  | 38.0  | 59.3 | 9.42  |                              |
| 301  | 43.5  | 59.9 | 15.18 | WSEL IH 1                    |
| 299  | 45.5  | 60.4 | 14.68 | On gravel/ sand bar          |
| 298  | 46.0  | 60.7 | 14.34 | On log                       |
| 297  | 47.0  | 60.8 | 14.22 | Gravel bar                   |
| 296  | 48.0  | 62.2 | 12.81 | Channel side of alder        |
| 294  | 50.0  | 63.1 | 11.89 | On 8.5" dia alder root, BFL. |
| 293  | 51.5  | 63.2 | 11.81 |                              |
| 290  | 54.0  | 63.4 | 11.67 |                              |
| 289  | 55.5  | 63.8 | 11.21 |                              |
| 288  | 56.0  | 63.9 | 11.13 |                              |
| 285  | 59.0  | 64.2 | 10.88 |                              |
| 280  | 64.0  | 64.8 | 10.27 | On floodplain                |
| 275  | 69.0  | 65.5 | 9.52  | Levee base                   |
| 270  | 74.0  | 66.7 | 8.30  | Down west side of levee      |
| 264  | 80.0  | 68.5 | 6.56  |                              |
| 259  | 85.0  | 70.2 | 4.82  |                              |
| 255  | 89.0  | 70.3 | 4.69  | Center of levee              |
| 251  | 93.0  | 70.2 | 4.82  | East side of levee           |
| 247  | 97.0  | 69.7 | 5.30  |                              |
| 244  | 100.0 | 69.0 | 5.99  |                              |
| 242  | 102.0 | 68.2 | 6.81  |                              |
| 240  | 104.0 | 67.8 | 7.26  | Base of pin                  |

# APPENDIX A

T-71': Surveyed on May 6, 1996 by Migs & Curt

IH 1= 74.81

See Migs notebook # 2, pg. 33-35.

| STA'  | STA  | ELEV  | FS    | COMMENTS                                                 |
|-------|------|-------|-------|----------------------------------------------------------|
| 0.0   | 0.0  | 66.17 | 8.64  | Top of pin at Sta. 71', 299.5                            |
| 132.0 | -1.2 | 63.50 |       | Undercut bank, 1 ft deep                                 |
| 131.0 | 0.0  | 64.84 | 9.97  |                                                          |
| 128.9 | 3.1  | 62.07 | 12.74 | BFL                                                      |
| 128.6 | 3.4  | 61.15 | 13.66 | Scoured roots                                            |
| 128.3 | 3.7  | 60.33 | 14.48 | WSEL, 10:30                                              |
| 128.0 | 4.0  | 60.13 | 14.68 |                                                          |
| 127.5 | 4.5  | 59.99 | 14.82 | Next to log                                              |
| 127.0 | 5.0  | 60.79 | 14.02 | Top of log, L=6' x w=14"                                 |
| 125.0 | 7.0  | 59.54 | 15.27 |                                                          |
| 123.0 | 9.0  | 59.60 | 15.21 |                                                          |
| 121.0 | 11.0 | 59.88 | 14.93 |                                                          |
| 118.0 | 14.0 | 59.93 | 14.88 | Top of subaqueous bar                                    |
| 115.0 | 17.0 | 59.83 | 14.98 | Bar                                                      |
| 110.0 | 22.0 | 59.77 | 15.04 |                                                          |
| 105.0 | 27.0 | 59.77 | 15.04 |                                                          |
| 102   | 30.0 | 59.97 | 14.84 |                                                          |
| 98.5  | 33.5 | 60.11 | 14.7  |                                                          |
| 98.0  | 34.0 | 60.39 | 14.42 | WSEL, gage ht = 0.70 ft                                  |
| 97.2  | 34.8 | 60.71 | 14.1  |                                                          |
| 97.0  | 35.0 | 61.24 | 13.57 |                                                          |
| 93.0  | 39.0 | 61.46 | 13.35 |                                                          |
| 88.5  | 43.5 | 61.87 | 12.94 | Leaning ALRU upon which fish trap is tied, 3 ft upstream |
| 87.0  | 45.0 | 62.07 | 12.74 | Fresh fine sandy silt bar                                |
| 86.0  | 46.0 | 62.34 | 12.47 | Scoured roots                                            |
| 85.0  | 47.0 | 63.12 | 11.69 | Scoured roots                                            |
| 84.0  | 48.0 | 63.82 | 10.99 | Scoured roots                                            |
| 82.5  | 49.5 | 64.36 | 10.45 | Scoured roots                                            |
| 82.0  | 50.0 | 65.42 | 9.39  | Erosion line                                             |
| 81.0  | 51.0 | 66.00 | 8.81  |                                                          |
| 79.0  | 53.0 | 66.78 | 8.03  |                                                          |
| 76.0  | 56.0 | 68.36 | 6.45  | Sta. 71', 246.2                                          |
| 73.0  | 59.0 | 69.00 | 5.81  | ALRU, POMU, some roots exposed                           |
| 69.0  | 63.0 | 70.16 | 4.65  |                                                          |
| 64.0  | 68.0 | 70.25 | 4.56  | Middle of levee                                          |

Prairie Creek Coho Channel,  
Inlet Profiles

*a - a'*

| Dist | Elev |
|------|------|
| 0.0  | 59.0 |
| 0.5  | 60.0 |
| 1.0  | 60.5 |
| 2.0  | 62.0 |
| 2.3  | 63.0 |
| 2.5  | 64.0 |
| 2.7  | 65.0 |
| 2.8  | 64.5 |
| 3.0  | 66.0 |
| 3.2  | 65.5 |
| 3.5  | 66.0 |
| 3.8  | 66.5 |
| 4.0  | 65.8 |
| 4.5  | 66.5 |
| 5.0  | 66.0 |
| 5.5  | 67.0 |
| 6.0  | 66.5 |
| 7.0  | 67.0 |
| 7.6  | 68.0 |
| 8.0  | 69.0 |
| 8.5  | 70.0 |
| 9.0  | 71.0 |
| 9.8  | 72.0 |
| 10.5 | 72.0 |
| 11.2 | 71.0 |
| 12.0 | 70.5 |

*b - b'*

| Dist | Elev |
|------|------|
| 0    | 60.0 |
| 1.0  | 59.0 |
| 2.2  | 59.5 |
| 2.5  | 60.0 |
| 3.3  | 61.0 |
| 3.5  | 62.0 |
| 4.0  | 63.0 |
| 4.5  | 64.0 |
| 5.0  | 64.5 |
| 6.5  | 65.0 |
| 6.7  | 65.5 |
| 7.0  | 65.0 |
| 7.5  | 66.0 |
| 7.8  | 66.0 |
| 8.0  | 66.2 |
| 8.3  | 66.0 |
| 8.5  | 65.5 |
| 9.0  | 66.0 |
| 9.6  | 65.0 |
| 10.0 | 65.5 |
| 10.2 | 65.5 |
| 10.5 | 65.0 |
| 10.8 | 65.5 |
| 11.0 | 65.0 |
| 11.5 | 65.7 |
| 12.0 | 65.1 |
| 12.3 | 66.0 |
| 12.5 | 67.0 |
| 13.0 | 66.5 |
| 13.5 | 67.0 |
| 14.0 | 66.5 |
| 14.5 | 67.0 |
| 14.8 | 66.5 |
| 15.0 | 66.0 |
| 15.5 | 65.8 |
| 16.0 | 65.0 |
| 16.5 | 66.0 |
| 16.7 | 67.0 |
| 17.5 | 66.8 |
| 18.0 | 66.0 |
| 19.0 | 65.0 |
| 20.0 | 64.5 |

*c - c'*

| Dist | Elev |
|------|------|
| 0.0  | 73.0 |
| 2.0  | 73.0 |
| 3.4  | 72.0 |
| 4.6  | 71.0 |
| 6.0  | 70.0 |
| 7.2  | 69.0 |
| 8.5  | 68.0 |
| 9.3  | 67.0 |
| 10.7 | 66.0 |
| 11.0 | 65.0 |
| 11.4 | 65.0 |
| 11.9 | 65.2 |
| 12.0 | 66.0 |
| 12.2 | 67.0 |
| 12.8 | 67.2 |
| 13.0 | 67.0 |
| 13.2 | 66.0 |
| 13.4 | 65.0 |
| 13.8 | 66.0 |
| 14.0 | 66.5 |
| 14.9 | 66.0 |
| 15.0 | 65.0 |
| 16.0 | 65.0 |
| 16.5 | 66.0 |
| 18.0 | 67.0 |
| 18.3 | 68.0 |
| 18.5 | 68.5 |
| 19.0 | 69.0 |
| 20.5 | 69.5 |
| 22.0 | 70.0 |
| 25.0 | 69.8 |
| 30.0 | 70.0 |
| 35.0 | 70.5 |
| 40.0 | 70.0 |

## APPENDIX B

Subsurface stratigraphy data

## APPENDIX B: Subsurface stratigraphy

Five soil cores were performed in March, 1994 to evaluate subsurface stratigraphy at select locations on the project site. Figure 32 shows the locations of these core sites.

B1, located at the Upper Pool, showed silt and clay down to 46 cm (18 inches). Medium-course sands were encountered that coarsened to gravelly sand with depth, indicating stream deposits. Groundwater was encountered at 110 cm (43 in).

B2 was located in an elevationally low spot near the pilings. Clay covered the upper 50 cm (20 in) of the core. Fine to medium sands and rounded (stream) gravels were encountered below 55 cm (22 in).

B3 was located where the proposed Frog Pool will be excavated. Mostly fine or medium sands with layers of gray clay were encountered in the upper 160 cm (5.25 ft) of the core. Charcoal was identified at around 60 cm (2 ft). A layer of organic debris was found at 175 cm (5.75 ft) below which coarse, clean sand and gravels were found, indicating stream deposits. Groundwater table was at 157 cm (62 in).

B4 was located at the proposed Driveway Plunge Pool site. Below the surficial gravel fill was fine sands, small stringers of coarser sands with occasional gray clays- overbank deposits. Charcoal was encountered at about 125 cm (4 ft). Roots were found in gray clay down 205 cm (6.7 ft) below which refusal on what may have been a log occurred at 228 cm (7.5 ft). Groundwater was not recorded.

B5 was located near the proposed upper portion of the backwater unit. Fine sand with silt was found in the upper 56 cm (2 ft) with a few pebbles. Course-medium sand with charcoal was encountered at around 73-82 cm (2.4-2.7 ft). Below this was a layer of silt and clay with roots and charcoal and stringers of fine sand. At 220 cm (7.2 ft), medium sand with large woody debris, barck, cones, and pebbles were encountered, again clear indication of stream deposits. Groundwater table was recorded at 140 cm (4.6 ft).

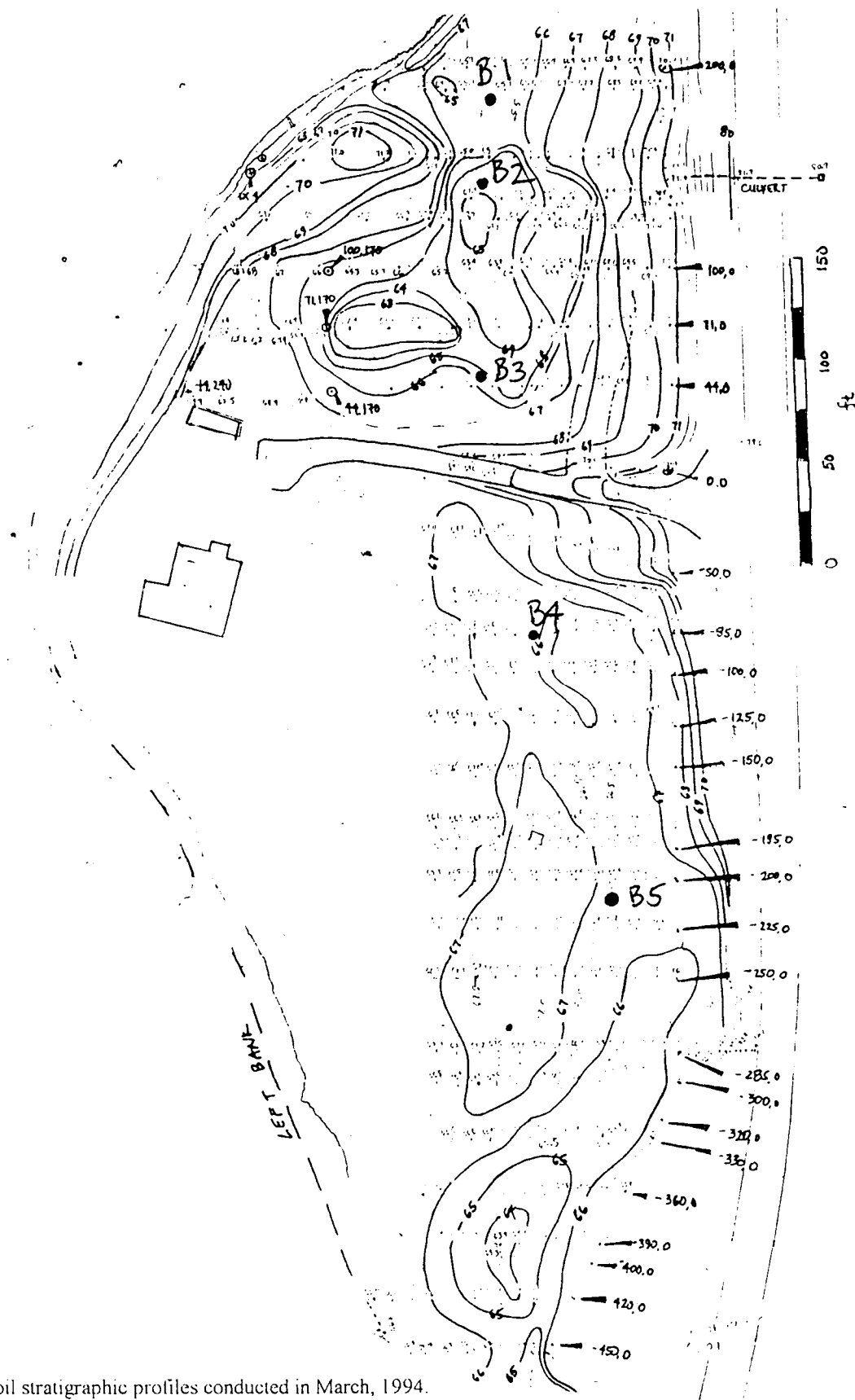


Figure 32: Sites of soil stratigraphic profiles conducted in March, 1994.

# Soils

Hole Log 1994

|           |                                |
|-----------|--------------------------------|
| Location  | Prairie Creek, Caho Slough     |
| Elevation | 65.5'                          |
| Date      | 3/27/94                        |
| Time      | 10:45 AM                       |
| Party     | Mike Sculici, Stan Thiesen     |
| Geologist | Stan Thiesen                   |
| Hole Type | Auger 4"                       |
| Purpose   | Determine former stream course |

| DEPTH<br>(cm) | LITHOLOGY<br>(sketch) | SIZE<br>(mm) | REMARKS                                             |
|---------------|-----------------------|--------------|-----------------------------------------------------|
| 0-20          |                       | < 1/8        | Silt & Clay, dark brown with roots                  |
| 20-30         |                       | < 1/8        |                                                     |
| 30-40         |                       | < 1/8        |                                                     |
| 40-48         |                       |              | 46 cm probably begins stream deposits               |
| 48-50         |                       | 64 → < 1/8   | 46 cm begin medium sand /                           |
| 50-71         |                       | 1/2 - 20     | 48 cm begin medium-coarse sand-gravel pebbles       |
| 71-80         |                       | 1 - 20       | Mostly coarse, clean sands, some gravel/pebble      |
| 80-93         |                       | 1 - 30       | ↓ + very coarse sand                                |
| 93-105        |                       |              | ↓ + more gravels & pebbles                          |
| 105-112       |                       |              | ↓ slightly coarser / GW ~ 110                       |
| 112-120       |                       |              | ↓ slightly coarser                                  |
| BOH.          |                       |              | Hole Caving                                         |
| 0-55          |                       | < 1/8 mm     | Brown clay with alder leaves & roots                |
| 55-60         |                       | 1/4 < mm     | ↓ + a few pebbles, possible minor sand              |
| 60-78         |                       | 1/8 → 20 mm  | Medium-fine sand, gravel & few pebbles clay         |
| BOH.          |                       |              | Found stream deposits                               |
| 0-25          |                       | 1/8 → 1/6 mm | Mostly fine sand, medium brown                      |
| 25-44         |                       |              | ↓                                                   |
| 44-60         |                       |              | ↓                                                   |
| 60-75         |                       |              | Some fine gray clay, roots, mottling?               |
| 75-80         |                       |              | ↓ + charcoal,                                       |
| 90-95         |                       | 1/4 → 1/6 mm | ↓                                                   |
| 95-113        |                       | 1/2 → 1/6    | medium sand, wetter, less clay, gray                |
| 113-130       |                       |              | some coarse sand, very gray                         |
| 130-140       |                       | 1/4 → clay   | begin gray clay                                     |
| 140-157       |                       | 1/4 → clay   | gray clay, fine / medium sand / organic roots, wood |
| 157-173       |                       | 1/4 → clay   | + more medium sand, wood frags ~ 10 mm or less      |
| 173-175       |                       |              | ↓ organic layer at base?                            |
| 175-190       |                       | 1/2 → 1/8    | begin coarse, clean sand, G.W.                      |
| 190-196       |                       | 1/8 → 20     | begin pebbles                                       |
| 196-203       |                       | 1/4 → 30     | pebbles & coarse sand                               |

BOH.

stream deposits too coarse to auger

Hole Log 1994

|           |                            |
|-----------|----------------------------|
| Location  | Prairie Creek, Cohe Slough |
| Elevation |                            |
| Date      | 3/27/94                    |
| Time      | 2:00 PM                    |
| Party     | Mike Saalici, Stan Thiesen |
| Geologist | Stan Thiesen               |
| Hole Type | Auger, 4"                  |
| Purpose   | Find stream gravels        |

B-4

South of  
Driveway  
near pond  
with tadpoles

3 ft

~6 ft

| DEPTH<br>(cm) | LITHOLOGY<br>(sketch) | SIZE<br>(mm) | REMARKS                                          |
|---------------|-----------------------|--------------|--------------------------------------------------|
| 0-8           | o.o.o.o.o             |              | gravel fill                                      |
| 8-24          | o.o.o.o.o             | 20-1/8       | brown, fine sand → gravel & pebbles, roots, wood |
| 24-40         | o.o.o.o.o             | 10-1/4       | clean medium sand, gravel on top, brown          |
| 40-50         | o.o.o.o.o             | 30-1/2       | mostly medium to coarse sand, few pebbles        |
| 50-62         | o.o.o.o.o             | 20-1/4       | finer sand, pebbles (contamination)              |
| 62-73         | o.o.o.o.o             | < 1/4        | brown sand                                       |
| 73-75         | o.o.o.o.o             | 1-1/4        | small stringer of clean coarse/medium sand       |
| 75-89         | o.o.o.o.o             | < 1/4        | brown medium/fine sand                           |
| 89-95         | o.o.o.o.o             | ↓            | ↓                                                |
| 95-102        | o.o.o.o.o             | < 1/4        | fine sand with gray clay, roots                  |
| 102-121       | o.o.o.o.o             | < 1/4        | more clay, some wood prongs                      |
| 121-130       | o.o.o.o.o             | ↓            | ↓ some charcoal                                  |
| 130-140       | o.o.o.o.o             | < 1/8        | finer, more gray clay                            |
| 140-160       | o.o.o.o.o             | < 1/8        | ↓ some sand stringers, wood prongs               |
| 160-180       | o.o.o.o.o             | 1/2 → clay   | more gray medium sand                            |
| 180-193       | o.o.o.o.o             | ↓            | ↓                                                |
| 193-205       | o.o.o.o.o             | 1/8 → clay   | gray clay with roots                             |
| 205-228       | o.o.o.o.o             | ↓            | ↓ small chunks brown fine sand                   |
| B.O.H.        |                       |              | Refusal on wood / log?                           |
| 0-17          | o.o.o.o.o             | < 1/4        | fine brown sand with silt with roots, grass      |
| 17-27         | o.o.o.o.o             | < 1/4        | fine/medium brown sand, roots                    |
| 27-40         | o.o.o.o.o             | ↓            | ↓ few pebbles                                    |
| 40-56         | o.o.o.o.o             | ↓            | ↓                                                |
| 56-73         | o.o.o.o.o             | 1/2-1/8      | coarse sand/medium sand, charcoal                |
| 73-82         | o.o.o.o.o             | ↓            | ↓                                                |
| 82-90         | o.o.o.o.o             | < 1/8        | slightly grayish silt & clay, roots, charcoal    |
| 90-110        | o.o.o.o.o             | 1/4-1/8      | fine sand & silt                                 |
| 110-140       | o.o.o.o.o             | 1/8 →        | ↓ more gray clay                                 |
| 140-160       | o.o.o.o.o             | 1/8 →        | ↓ more clay                                      |
| 160-185       | o.o.o.o.o             | 1/8 →        | ↓                                                |
| 185-210       | o.o.o.o.o             | 1/4 →        | ↓ + fine sand charcoal                           |
| 210-220       | o.o.o.o.o             | ↓            | ↓                                                |

220-235

B.O.H.

$$\frac{25.4 \text{ mm}}{1} = \frac{140 \text{ mm}}{x}$$

$$25 \overline{) 140}$$

brown  
gray &  
Gw table  
140