FOREST MANAGEMENT PLAN

for the

SWANTON PACIFIC RANCH

Prepared by

BIG CREEK LUMBER COMPANY

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FOREST MANAGEMENT PLAN FOR THE SWANTON PACIFIC RANCH

1.0 Purpose and Procedure

In discussing the purpose of this management plan with Al Smith, he said that he had two main reasons for making his timberlands available to Cal Poly: 1) After years of caretaking the property, he was anxious to see it opened up and actively managed, and 2) He wanted to give Cal Poly students the chance to learn by working in a real forest. Based on Al's conviction that real world experience is the best teacher, the Plan approaches management of the Ranch timberlands on a pragmatic basis and assumes that there is great educational value in learning how manage the timber resource productively, sustainably, and economically. The plan delineates those areas where active forest management is economically viable, i. e., where the timber is of sufficient size, quality, and density, and where the site is both reasonably productive and loggable. To make the plan as useful as possible and because the timber varies so much from site to site, our evaluation is divided up by management units, which are primarily drainage specific. As stand and site conditions become more marginal, evaluation entails deciding whether the site merits investment in stand improvement operations or if it is preferable to abandon active timber management altogether. Similarly, educational opportunities vary from being timber management oriented to broader study of ecological relationships and vegetation dynamics.

2.0 Introduction

The forestlands of the Swanton Pacific Ranch are a complex interweaving of environmental and land use influences. Of the Ranch's roughly 3150 acres, only some 1300 acres are forested (1000 acres conifer dominated, 300 acres of hardwood) with the balance composed of approximately 150 acres of cultivated land, 1300 acres of grassland, and 400 acres of brushland. (Refer to Map #1, Vegetation Types). This diversity of vegetative types is mirrored by great diversity of forest types. There is riparian woodland of alder and willow, oak woodland of coast live oak, mixed evergreen hardwood with varying amounts of live oak, california bay laurel, madrone and tanoak, plus coniferous forests composed of coast redwood, Douglas-fir and Monterey pine. Each of the coniferous species occur in pure or nearly pure stands as well as mixed together in stands of varied composition. (Refer to Map #2, Timber Types.)

The overall floristic diversity and the variety of the forest types in particular reflect the tremendous variability of factors affecting growth on individual sites. The chief agent of this variability is the Ranch's rugged topography, which is dissected by numerous creeks of varying sizes. Working their way through and along geologic features such as the Davenport Syn-

cline, uplifted marine terraces of Santa Cruz mudstone, and springs emerging at the contact of the Cretaceous quartz diorite along the eastern boundary, these creeks define a complex array of slopes whose length, steepness and aspect have resulted in growing conditions that range from highly productive to nearly sterile.

Typical of forests in the Santa Cruz Mountains, trees on the Ranch occur in locations which offer some measure of relief from the droughty conditions of its Mediterranean climate. This relief is found on slopes which have more northerly aspects, receive some protection from ridges immediately to the south, or have springs or seeps that provide water well into the summer. The stands of Douglas-fir often mixed with Monterey pine found immediately east of Swanton Road from Archibald Creek north are something of an exception to this pattern, although they do benefit from the moderating climatic influences of being close to the ocean and the partial protection offered by the high tableland of the Rancho Agua Puerca between Highway One and Scott Creek.

Human activity has had a significant impact on the forests of the Ranch. Although indian occupation of the area seems to have been seasonal with no major concentrations of population, artifacts and indications of use are widespread from the mouth of Scott Creek until redwood timber closes in the river bottom north of the Ranch. The primary indian impact on vegetation was their frequent setting of fires to keep the valley opened up for good hunting and possibly to improve blackberry production. Frequent fires tended to favor grass and restrict spread of Douglas-fir and Monterey pine on more open slopes with south and west facing aspects. Since native american fire use at Scott Creek sites dates from nearly 2000 years ago and other nearby sites are even older, a fire adapted vegetation mosaic probably had time to become well established.

Keeping the area open and promoting grass growth was also the objective of the earliest white settlers, the Staub family and the successive owners of Rancho Agua Puerca y las Trancas. From the 1850s until tractors became available for brush clearing somewhere around 1930, fires remained the primary means of keeping both ranches open for cattle grazing. Douglas-fir and Monterey pine have increased in acreage since that time as clearing efforts have been sporadic. The effects of past timber cutting will be discussed in the Forest Management section which follows.

3.0 Forest Management

We have broken discussion of the Ranch timberlands into three parts: the Little Creek Unit, the General Smith Tree Unit, and the Satellite Stands. (Refer to Map #3, Management Units). Little Creek is the only area with timber and site quality typical of good tree farms in the Santa Cruz Mountains. The General Smith Tree Unit is a small area at the northern edge of the Little Creek

Unit which is discussed separately because access problems and the need to preserve old growth trees require a different management approach. The balance of the timbered acreage is treated on a stand by stand basis listed as units under the general heading, Satellite Stands. Douglas-fir, sometimes mixed with monterey pine, dominates these stands although patches of redwood occur in many of them.

3.1 The Little Creek Unit

Little Creek was the only part of the Ranch harvested during the Swanton area's primary phase of old growth logging, which lasted from just before the turn of the century into the 1920s. As a result, it is the only part of the Ranch with significant stands of merchantable sized second growth. It is in such second growth stands that most tree farming activity in the Santa Cruz mountains is concentrated. Therefore, the Little Creek timberlands will be considered a complete management unit whose primary educational purpose is to provide students with an active learning environment which demonstrates the forest management principles and practices essential to sustained yield timber production.

3.1.a. Logging History

The first cutting was done in 1907 by the San Vicente Lumber Company (originally organized as the Nibley-Stoddard Lumber Company) whose ownership on Little Creek began nearly three-quarters of a mile east of Swanton Road and included the best stands on the Ranch. It was clearcut and burn railroad logging which used two geared Shay locomotives especially designed for mountain logging. Trees were felled and then the woods set on fire in order to burn up the limbs and debris which blocked access to the logs. Although this type of cutting can be called a silvicultural method, it was not pursued with an eye to regeneration but to taking advantage of the best available log extraction technology. The best estimate is that San Vicente completed their logging of what are now Swanton Pacific lands by 1910. However, the San Vicente railroad logging operations lasted until 1923 on properties now owned by Lone Star and Lockheed, running to the headwaters of Little Creek and branching over into Big Creek.

Apart from the trees north of Little Creek which were logged when the San Vicente railroad was constructed, it is not clear exactly who cut what portions of the Little Creek timber west of the San Vicente Lumber property line. Probably most of it was cut by San Vicente Lumber Company during that same time period, but some was cut by a man named Clyde Adams, who had a sawmill in the creek bottom roughly 2000 feet east of Swanton Road. It might be possible to date and plot the extent of the two operations by taking increment cores in the vicinity of the Staub/San Vicente property line and work downstream toward the Adams mill location. To the best of anyone's memory, Adams cut after San Vicente had moved their operations upstream, probably in the years around

1920. In addition, the Staub family probably cut some trees during the course of settling the ranch and may well have worked some trees up for bolts or split them into shakes and shingles.

The only "modern" logging in Little Creek was done in the early 1960's when scattered residual old growth redwood and a good deal of second growth redwood was harvested from the flatter portions of the Staub ranch (then owned by Mr. Janes). This heavy cut has left very little merchantable sized timber in this 40+ acre area even today. The tractors used on this operation created a road and trail system which can be used again if reopened, although one stretch of truck road will have to be abandoned because it is too steep.

3.1.b. Current Conditions

With the exception of the small area logged in the 1960's, the old growth logging has created an even aged stand of redwood and Douglas-fir roughly 80 years old. The redwoods are predominantly of sprout origin, growing in clumps around the old growth stumps. While an individual stump may have supported as many as 20 or 30 sprouts within a few years after the original clear cut, competition has thinned their ranks so that now as few as one to as many as six or eight are still growing. Where Douglas-fir and redwood trees are growing together, the Douglas-firs are often dominant. Although tree heights are extremely variable, dominant and co-dominant redwoods are usually between 125 and 150 feet tall while dominant Douglas-firs are in the 145 to 180 foot range.

Tanoak is the primary understory tree and becomes the dominant tree species in a few areas, usually where soils are poorly developed and have low water holding capacity. Larger tanoaks are usually between 80 and 100 feet tall. Madrone, bay, big leaf maple, buckeye, coast and interior live oak are also present. Although conifer species are the dominant specimens, red alder is the most frequent tree species within riparian zones found along the main stem of Little Creek and its two forks nearly to the eastern property line. The zone is as much as 120 feet wide near Swanton Road, narrowing to little more than channel width of 15 feet on the upper portions of the forks.

The timber was type-mapped based on the classification system used in Region V of the U. S. Forest Service. The system relies on percent of area occupied by tree crowns by species and by tree crown size. To reflect the general tendency for stands with southern aspects to have lower volumes per acre, we have added an aspect factor to some of our timber types. To make the typing more descriptive, we have occasionally used more than two species characters in a single type. The following table gives our best estimate of conifer volumes by species in each timber type. The figures were developed by ocular estimation cross checked with the cruise data being developed by Cal Poly student interns and classes.

Table 1
Acreage and Volumes by Timber Type in Little Creek
(expressed in MBF)

TYPE	AC.	VOLUME/ACRE TOT (RW:DF)	VOLUME/TYPE TOTAL	RWD	DF
DFRW4G	43	55 (25:30)	2,365	1,075	1,290
DFRW4G/SA	27	35 (12:23)	945	324	621
RWDF4G	97	50 (33:17)	4,850	3,201	1,649
RWDF4G/SA	46	35 (25:10)	1,610	1,150	460
RWDFHB4G	48	27 (16:11)	1,296	768	528
DFRWHB3N	17	25 (12:13)	425	204	221
RWDFHBSX6S	38	8 (6: 2)	304	228	76
	316		11,795	6,950	4,845

Analysis of these figures yields a great deal of useful information about the productivity of the Little Creek timberlands. Subtracting the 38 acres harvested in the early 1960's where total volume is not a good measure of second growth productivity, 80 years of growth on 278 acres have produced roughly 6.7 million board feet of redwood and 4.8 million board feet of Douglas-fir for a combined total of some 11.5 million board feet of conifer timber, an average of about 41,300 board feet per acre. Therefore, growth over the eighty years expressed in board foot measure has averaged just over 500 board feet per acre per year. These estimates form the basis for designing a sustained yield timber management program.

3.1.c. The Regulated Forest - Long Term Growth and Harvest

Sustained yield and even flow lie at the heart of most approaches to timber management. While the concepts seem simple enough - growth should equal harvest and harvests of roughly equal volumes should occur at regular intervals - their application to an even aged 80 year old stand which you desire to change into an uneven aged stand using selection silviculture is not a simple matter at all. Under an even flow harvesting scheme, the period over which the second growth trees are harvested establishes the age, and therefore the size, of the trees to be harvested in the third generation. The liquidation period of the second growth becomes the harvest age of the trees in the third growth forest. Furthermore, the choice of a rotation age affects the volume that a given acre can grow. Knowing that the mean volume of redwood

and Douglas-fir grown per acre per year increases if the rotation period is extended from 80 to 100 years and beyond, a second growth liquidation period/third growth rotation age of 100 years seems appropriate. In theory, this choice means that the equivalent of 3.16 acres out of the 316 acre total must be regenerated each year of the 100 year period.

The total second growth volume available for harvest is the sum of the current timber inventory plus the volume of wood that will be grown by second generation trees as they are selectively harvested over a 100 year period to establish an uneven aged stand of third growth. Estimating volume growth for the next 100 years as the stand is being transformed from even aged second growth to all aged third growth by selective cutting is something of a shot in the dark. No reliable data is available because no such silvicultural program is more than 20 to 30 years into such a transition and experience has led to revisions of the marking guidelines and cutting practices judged most likely to succeed.

Projections of volume growth over the transition period cover a wide range and vary primarily according to what assumptions are made about how much standing volume can be left while successfully establishing and growing a third generation of trees. If regeneration needs dictate fairly heavy cuts during the first part of the transition period, total volume grown over the period will be lower than if more volume per acre can be carried into the latter stages of the transition. Response of the residual stand to release after harvesting is of interest, but has less impact on total volumes grown.

Following different sets of assumptions, estimates of growth over the transition period run from roughly six million board feet to over 12 million board feet. A model which assumes a 25 year cutting cycle (i.e., four entries over the 100 year transition), fairly heavy cutting on the first two entries, and release growth of 2 % produces an estimate of 6.2 million board feet. Area control models where final cuts are made of 180 year old even aged blocks yield the high end estimate. Adding the low end estimate of 6.2 million to the current inventory of 11.8 million gives an estimate of 18 million board feet of second growth available for harvest over the transition period. Dividing that total by the rotation length of 100 years produces an allowable cut figure of 180,000 board feet per year for the transition period. While that estimate may be unduly conservative, given the silvicultural uncertainties of the transition, it is difficult to be comfortable with growth projections that add more than another two million feet to that figure. Interestingly, even if the estimate of growth over the period is doubled to over 12 million board feet, the allowable cut increases only about 60,000 board feet to just over 240,000 board feet per year. Prudence suggests starting at the low end in the 180,000 to 200,000 board feet range and revising the figure as more experience and better data become available.

It should be noted that the allowable cut for the third generation of trees will be lower than the figures just discussed. Since the current 80 year old forest will be harvested over a 100 year period, the average age of trees harvested over that span will be 130. In the next generation, the average age would be 100 since that is the length of the rotation period. Projecting growth of the current stand for another 20 years, total volume per acre at 100 years is expected to be between 50,000 and 55,000 board feet. Using those figures to derive an average annual growth per acre of some 525 board feet for a 100 year rotation, allowable cut for the third generation would be roughly 160,000 board feet per year.

It remains to be seen whether or not the transition from even aged to uneven aged stands can be made following the even flow constraint. As implied above and discussed in the silviculture section to follow, the need to open up the stand significantly in order to permit successful regeneration may require initial harvests which exceed the even flow allowable cut figure. If that is the case, later harvests will likely fall below it.

3.1.d. Selection Silviculture

Silviculture is just forestry jargon for tree growing. Its goal is to base management activities on an understanding of tree physiology and ecology. In the predominantly urban counties of the Santa Cruz Mountains, State forest practice regulations require use of the selection silvicultural system because it preserves aesthetic values, protects ecological resources and fosters sustained yield by maintaining continuous forest cover.

Selection silviculture implements the principle of sustained yield by making periodic harvests of a portion of the stand to increase growth of the residual trees and to create growing space for young trees to replace those harvested. The logic behind selection silviculture is fairly straightforward. A forest can be harvested periodically over the long term only if it continuously produces harvestable sized trees. But a forest cannot continuously produce harvestable sized trees unless it always has pole sized trees ready to grow into harvestable sized trees. And saplings ready to grow into poles. And seedlings and sprouts ready to grow into saplings. In other words, a selection forest must have balanced numbers of trees of all sizes if the cycle is to keep growing smoothly.

Growing trees of all sizes at the same time on the same piece of ground is something of a balancing act. Because a selective harvest always leaves neighboring trees, young trees must grow up in a certain amount of shade, which is generally deepest at the forest floor. Unfortunately, the seedlings and sprouts of the young reproduction phase of the growth cycle need plenty of light to become well established. Shade is particularly deep in

redwood clumps, where trees of sprout origin grow unusually close together and depend upon peripheral light to maintain favorable growth rates.

On the other hand, although redwood is a fast growing species which does best with plenty of light, it is quite tolerant of shade once established and will respond to a major increase in light by dramatically increasing its growth rate. These are ideal characteristics for trees that must grow in the shade of larger nearby trees for most of their lives. The object of selective harvesting in redwood, then, is to let enough light down to the stumps to stimulate sprouting and release the growth of the smaller trees. Douglas-fir seedlings do well in partial shade but their shade tolerance decreases as they age, as does their ability to respond to release. Selection management for Douglas-fir requires larger openings for regeneration and maintenance in succeeding cuts of the larger amount of growing space needed for healthy crown development. The extent of the influence of hardwood shade on conifer growth is poorly quantified, but can be significant. Controlling hardwood influence on conifer growth by selective harvesting is discussed in the hardwood management section.

In addition to creating favorable growing conditions, harvesting must effect a change in stand structure from an even aged forest with a closed canopy dominated by large trees to an all aged forest with a variable enough canopy to grow balanced numbers of trees in all size classes. To begin the sustained yield pattern of cycling growth in an even aged stand, enough trees must be cut to break up the closed canopy and allow light down to the cut stumps to stimulate sprouting. Each harvest should help move the stand through the transition from an even aged stand to a more balanced all aged stand. Two different styles of selection silviculture, individual tree selection and group selection, have been developed to accomplish this transition and manage growth using harvesting to control light and spatial relationships.

3.1.d.(1) Individual Tree Selection

Individual tree selection attempts to uniformly increase growing space for residual trees by harvesting evenly throughout the stand. To produce widespread redwood regeneration under the individual tree selection method, experience has shown that 40 to 60 percent of the trees 18 inches in diameter and larger must be harvested. Such a harvest generally removes less than a third of the total number of redwoods on the site and less than a fifth of all the trees. After harvesting, growth of the forest canopy eventually reestablishes shady conditions which threaten the health of the sprouts and saplings created by the previous harvest. To maintain the cycling growth pattern, subsequent harvests must be timed to provide more light and growing space before the vigor of the overtopped trees is lost. In a very real sense, once

the individual tree selection system is begun, the biological needs of forest growth control the timing of all future harvests.

Individual tree selection methods have been widely practiced in the region over the last thirty years or so with reasonable success. In some cases, however, the transition from an even aged forest to an uneven aged forest has not been working smoothly. Even after harvesting, shade within some clumps remains deep enough to inhibit full sprouting and adequate growth of small trees. Where sprouting and growth are adequate, overhanging branches from larger adjacent trees may deform some of the smaller trees. To firmly establish all the young trees necessary for an all aged forest to cycle smoothly, a second and possibly a third harvest are projected at short ten to fifteen year intervals to maintain adequate light and prevent mechanical damage. The biological needs of forest growth require these relatively rapid reentries to promote the cycling pattern. Once a balanced mix of all sizes is achieved, selective cutting to release growth and promote regeneration is projected at roughly twenty year intervals.

3.1.d.(2) Group Selection

While pursuing the same growth objectives as individual tree selection harvesting, the group selection option offers greater flexibility of parameters such as cutting intensity and harvest interval because it removes nearly all overhead shade which might threaten the health of regeneration. In this method, a patchwork of tree groups up to 1/2 acre in size is identified and harvested, making sure not exceed the overall cutting limit of sixty percent. In theory, each harvested patch becomes an autonomous growth cell with more light for both regeneration and sapling growth. Local trials cutting groups 1/5 to 1/2 acre in size have been made over the last several years, and sprouts are exhibiting the greater vigor that was expected.

There are several potential advantages to the group selection method. Rather than being forced to harvest frequently to maintain healthy regeneration, harvest intervals can be greatly extended, or at least scheduled on a considerably more flexible basis. By assuring more vigorous early growth, group selection also represents the optimum method of maintaining good growth rates when harvesting at cutting intensities below the forty to sixty percent level. It may be possible to grow trees to a larger target size without facing a shading problem since regeneration and small trees are physically separated on a group by group basis from the larger trees. Finally, intermediate thinnings can be made to optimize growth within a clump with regeneration coming later when the entire group is harvested.

There are potential problems with group selection as well. Visual disturbance is greater in a just harvested group selection stand, particularly where group size is relatively large. The

concentrated removal of all redwoods in a group also tends to concentrate damage to hardwood trees surrounding the clump, magnifying the impact of the disturbed area. Also, stumpage prices may be slightly reduced on group selection sales because they tend to produce a higher percentage of small diameter logs. The potential advantage of maintaining good growth at lower cutting intensities is somewhat limited by the fact that, in practice, reducing cutting intensity too low tends to result in a loss of proper inventory control.

The distinction between individual tree and group selection is one of theory. Applied in the field, the two methods are simply opposite ends of a continuum which runs from cutting single trees through removals of two or three adjacent trees on one side of a clump on up to 1/2 acre clearcuts. In areas where appearance immediately after harvest is a major concern, it is logical to follow an individual tree or small group selection marking plan with minor variations to deal with specific tree configurations and growth patterns in a given clump. On the other hand, selection of larger groups is recommended where the tree farm objective is to maximize growth and somewhat more short term aesthetic impact can be tolerated. Indeed, on steep, more or less north facing slopes, group selection is probably the only way of getting enough light to the forest floor to stimulate adequate regeneration. As tree marking is subject to landowner approval, preferences and guidelines should be discussed before the work is done.

3.1.d.(3) Silvicultural Summary

To recapitulate the preceding silvicultural discussion, the following general principles guide uneven-aged management under selection silviculture:

1. Create and perpetuate a forest containing trees of all sizes.

2. Cut a portion of the larger trees periodically to:
   - increase the growth rate of the smaller trees, and
   - establish regeneration to replace the cut trees.

3. Best suited for trees which grow well in partial shade.

The following silvical characteristics of Santa Cruz Mountain forests affect implementation of uneven-aged forest management:

1. Existing stands are even-aged with closed canopies, have some diversity of tree sizes but are heavily dominated by larger trees. Little or no regeneration is present.

2. Sprouts and seedlings need lots of light.

3. Established trees can tolerate some shade, Douglas-fir being the less tolerant, redwood more tolerant, tanoak the most tolerant.

4. Depending upon crown development and degree of tolerance, shaded trees can increase their growth dramatically when given more light and growing space.

The following lists highlight some of the significant differences between individual tree and group selection harvesting:

Individual Tree Selection	Group Selection
- Cut individual trees at roughly even spacing.	- Cut small groups of trees at roughly even spacing.
- Shade and overhanging branches may inhibit stump sprouting and early growth. Sprout initiation and vigor tend to be erratic.	- Larger openings and little overhanging canopy mean more light to stumps. Sprouting and early growth more vigorous and uniform.
- Periodic harvesting at given intensities is needed more or less regularly to maintain the health of young trees.	- Choices of harvest intensity and timing are more flexible because young trees are more free to grow.
- Trees in the stand are more or less uniformly spaced. Tree sizes run from small to large within individual clumps and run significant risk of vertical stagnation. Slash is widespread throughout the stand.	- The stand has a patchwork appearance where dense clumps are interspersed with new, small openings. Tree sizes within individual clumps are are more uniform. Slash is more concentrated, more ground is undisturbed.

3.1.e. Coordinating Forest Regulation and Silvicultural Objectives

An even flow of harvest volumes from a sustained yield forest is a management objective that directly affects the biological factors which control forest growth and regeneration. Silviculture is the art of directing forest growth along lines that are both ecologically sound and managerially convenient. Regeneration is the key to coordinating the two. Area control following a group selection strategy is the simplest method of managing for even flow from the next generation of trees, but it will not produce even flow from selective harvests of the current even aged stand. Volume control which uses individual tree selection and is based on allowable cut calculations may produce even flow from an even aged stand, but is unlikely to be a successful regeneration strategy. There is no proven recipe for making the silvicultural transition and realizing the administrative objecti-

ves desired. The best method available at the present time for integrating these goals might be described as knowledgeable trial and error.

Based on experience with selection silviculture in the Santa Cruz Mountains to date, we recommend the following approach, which involves bouncing back and forth between area and volume control.

1. Start with a volume to be harvested, derived either as a target around which to lay out a unit or as a rough estimate of what will be harvested from an existing unit. Divide by the allowable cut to get the number of years worth of volume being removed. Multiply that number of years by 3.16 acres per year to get the number of acres that must be regenerated by the harvest in order to establish a regulated forest.

2. Since group selection appears to be the preferable method of establishing and growing the next generation of trees, mark and tally on a group selection basis enough area to meet regeneration requirements. Estimating the area marked for regeneration group cuts will be difficult and imprecise since it is the sum of numerous, irregularly shaped and physically isolated units. Make pacing estimates of area in marked groups or tally by using tree numbers or basal area as acreage estimators.

3. Group size should vary on a unit area control basis. The objective within the unit area is assurance of regeneration success. In an open grown location, it could be a single tree. Deep on a north facing slope, it may be as large as one-half acre. In selecting groups to cut, consider a) Is the group dominant enough to have negative impacts on the growth of surrounding tree groups if left? b) Is there enough large wood in the group to make cutting it economically attractive? c) Is the group healthy enough that it will grow well if left?

4. To keep field activities such as marking, falling and skidding coordinated and efficient, group cuts on the first cutting cycle that remove less than 20 to 25 % of the trees 18 inches in diameter and larger seem impractical. Group cuts of more than 40 % of conifer inventory may be excessive. Staying within these limits will create stands with three to five age/size classes and cutting cycles of 20 to 35 years.

5. Compare the volume tallied in the groups marked for regeneration with the allowable cut allocated for the harvest unit in #1. If there is volume leftover for harvesting, mark intervening clumps lightly for release. Principally look for a) single large trees dominating two or more smaller but healthy trees with good tops, or b) merchantable but defective trees which are adversely affecting growth of neighboring trees or which are likely to deteriorate or die before the next cutting cycle.

3.1.f. Hardwood Management

At present the only convincing reason for managing hardwoods in the Little Creek Unit is to minimize their negative impacts on conifer reproduction and growth. Fuelwood is the only product of significant value currently being made from local hardwoods, and yet local hardwood stumpage values are too low to justify managing the hardwood resource for fuelwood. The value of hardwoods for watershed and wildlife and the increased fire hazard and disposal problems associated with hardwood logging more than offset the ten to twenty dollar per cord return for cutting large volumes of hardwood from only the most favorable terrain. If hardwood values increase significantly in the future, silvicultural management may become viable.

The extent to which the presence of hardwoods decreases conifer growth is not well understood. At the present time, criteria for evaluating when, where and how much to cut are qualitative and fairly subjective. Research which quantifies the impacts of different hardwood stocking levels on conifer growth and the net costs of hardwood removal following different cutting strategies on a variety of terrain is badly needed. With that caution in mind, the following approach to hardwood control is recommended.

1. In the interest of maintaining forest diversity, try to limit hardwood cutting to those trees whose removal will significantly improve conifer growth and/or stocking. For example, we feel there is little point in cutting hardwoods to release conifers once conifers have enough gained dominance that their crown development and growth are not obviously restricted. Flexibility of approach is required as this recommendation often conflicts with economic efficiency in wood removal.

2. Because selective cutting leaves so many trees standing, hardwoods may need to be cut to improve regeneration success. Hardwood trees or areas to be cut should be marked at the time conifers are marked to assure coordination. Most attention should be paid to hardwoods on the south side of the regeneration site since they usually shade the site the most. Frequently hardwoods too small or too costly to skid are the ones that most need to be removed. Studies by Cal Poly students of the time and cost of such non-economic removals would be invaluable. Controlling tanoak sprouting after cutting is highly desirable. A study (Western Journal of Applied Forestry 2(2):41-45, April 1987.) suggests that 2,4-D, triclopyr, or picloram + 2,4-D applied directly to fresh cut stumps during the period from November to March provide effective control. Additional cost over just cutting was not discussed.

3. Attempts to convert hardwood sites to conifer stocking have met with limited success, are costly, are usually visual disasters and should be undertaken cautiously. Conversion should only be attempted on areas of good soil which can be kept relatively free of shrub and hardwood competition. Look for natural conifer seedlings in the understory. Sheltered live oak and sometimes madrone stands often seem to have good potential for planting. Local experience indicates that pure tanoak stands seem to have the least potential. Consider a shelterwood system of conversion.

4. Low product value is the factor which restricts viability of hardwood management. Although more difficult to mill successfully than the commercial conifers, tanoak products have been successfully milled in the past and accumulated research has led some people to promote tanoak lumber manufacturing as a promising field for the future. Available small-scale milling and drying technologies used on Ranch hardwoods might give them enough value to make silvicultural manipulations cost effective and would be valuable educational tools in and of themselves.

3.1.g. Sprouting, Planting and Timber Stand Improvement

Management of the Little Creek timberlands is to a great extent an attempt to manage the sprouting ability of redwood. While the second growth redwood forests of the Santa Cruz Mountains are abundant and vigorous demonstrations of sprouting success, it is worth monitoring and experimenting with redwood sprouts. Studies should attempt to quantify exactly how successful sprouting is at replacing selectively cut redwoods and what factors have the greatest influence on that success. Look for ways to encourage sprouting on the root crown at a distance from the stump in order to minimize the number of poorly seated sprouts. Consider using mechanical disturbance of roots as a planned means of vegetative propagation.

Since sprouting will be the primary mode of regeneration and major conversion of hardwoods is not recommended, planting opportunities will be limited. Because Douglas-fir is less well suited to selection management than redwood, some of the Douglas-fir harvested should be replaced with redwood, especially where planting openings are small or relatively shaded. Conifer stocking may be increased slightly by planting areas where felled conifers have knocked down adjoining hardwood trees. Do not plant too close to existing redwood clumps because growth in dense clumps may be partially dependent upon the availability of light and space at its perimeter.

Timber stand improvement operations should focus primarily upon assuring that sprouts are vigorous and thrifty. Immediately after harvesting, all old sprouts and suckers which could .pg; adversely affect the initiation and growth of new sprouts should be removed as close to ground level as possible. Avoid removing sprouts and suckers, regardless of defect, which will not adversely affect growth of desired stems or whose cutting will initiate sprouts that will not have enough room to grow. TSI should include lowering stumps which fallers had to leave high due to defect or grafting to adjoining trees. Thinning of healthy sprout groups to improve growth is not recommended in light of a study at Jackson State Forest by Dana Cole, although additional research into the matter for group selection conditions would be worthwhile. Wherever TSI was not done in redwood stands following a partial cut, such as the early 1960's Janes harvest and nearly all redwood harvested outside the Little Creek unit, TSI operations are highly recommended.

3.1.h. Forest Engineering and Harvest Operations

The principal objective is to establish access throughout the area while positioning roads so that they serve the most appropriate yarding method for the varied terrain and timber types. The original hope was to design a closed loop road system, but the South Fork of Little Creek is too deep and difficult to cross. Fortunately, much of the old railroad grade and the Staub Ranch waterline road were already in the right locations. With realignments and extensions, they form the core of the proposed road system. The principal change in the Staub Ranch road is its route to Swanton Road, which traverses the entire Swanton East satellite stand (see Satellite Stands section below), establishing good grade throughout that area for the first time while avoiding use of the improved driveway to Al Smith's house. The proposed road system is shown as part of Map #4, Roads and Facilities.

Several different yarding systems are recommended to match Little Creek's varied terrain and timber. Both skyline and swing yarding configurations are proposed for steep inner gorge areas while ground skidding covers the balance of the unit. For purposes of planning convenience, the Little Creek Unit has been broken down into four management units, each of which could make a logical Timber Harvest Plan, which could in turn be harvested in two or more operations done in different years. While some effort was devoted to devising units that made operational sense, they should not be thought of as fixed or complete, but should be altered or abandoned as new information or approaches become available. The management units and cable yarding areas are shown on Map #5, Little Creek Management Units. The units are broken down by acreage and volume in each timber type in the table below.

Table 2
Acreage and Volumes (in MBF) by Management Unit in Little Creek

Timber Type	Unit 1 Ac	Rwd	DF	Unit 2a Ac	Rwd	DF	Unit 2b Ac	Rwd	DF	Unit 3 Ac	Rwd	DF
DFRW4G	28	700	840	12	300	360	3	75	90			
DFRW4G/SA										27	324	621
RWDF4G	19	627	323	35	1155	595	31	1023	527	12	396	204
RWDF4G/SA							40	1000	400	6	150	60
RWDFHB4G	5	80	55							43	688	473
DFRWHB3N	10	120	130							7	84	91
RWDFHBSX6S	33	198	66							5	30	10
Totals	95	1725	1414	47	1455	955	74	2098	1017	100	1672	1459
Both Species		3,139			2,410			3,115			3,131	

The units are numbered in a logical harvesting sequence. A timber harvest plan (THP) for Unit 1 is being prepared in conjunction with this Management Plan. As proposed, harvesting of Unit 1 would occur in two steps. The first would be a tractor operation south of the South Fork of Little Creek in fall of 1989. The second phase would be a combined tractor/skyline operation which could be scheduled anywhere from 1990 to 1993. Harvesting of the succeeding units could similarly be done in two or more steps. If the 20 to 25 year cutting cycle proposed for the regulated forest is followed, the last harvest operation of the initial cutting cycle will occur in Unit 3 roughly around the year 2010. The units can be briefly characterized as follows:

Unit 1 - This initial unit was laid out to accomplish a number of different educational and administrative objectives. 1) It requires construction of the entire proposed road system, thus establishing access throughout Little Creek for educational purposes. 2) It demonstrates both cable (skyline) and ground skidding. 3) It permits harvesting under favorable market conditions of Douglas-fir with significant defect (probably largely the result of the 1948 fire) which is surpressing numerous redwood clumps. 4) It incorporates most of the heavily cutover unit from the early 1960's, thereby demonstrating rehabilitation cutting and opening up sites with the best planting potential in Little Creek as well as areas in which to demonstrate TSI operations.

Unit 2a - This small unit has ground skidding only and includes "Tranquillity Flats", two highly productive, spring fed landslide benches with the densest stocking in Little Creek. It is worth doing extensive inventory and growth studies of the flats before any operations are undertaken in order to better establish and understand the upper limits of productivity on the ranch. It is called Unit 2a because the limit of operations near the North Fork of Little Creek will be established by the tailhold locations used for the cable logging portion of Unit 2b.

Unit 2b - This is a combined tractor/cable unit that is almost entirely composed of productive, redwood dominated ground. Springs, seeps and landslides occur in both the tractor and cable operating areas. Cable harvesting is proposed for most of the inner gorge portion of the North Fork of Little Creek. Occasional patches of the upland timber may not be harvestable due to inaccessibility. It would be interesting to quantify the differences in size and form between the south facing timber and the north facing timber in this unit.

Unit 3 - This unit is the largest because it has the lowest average site quality and lowest average volume per acre. Because average tree size is smaller, it makes sense to do this unit last, giving the trees more time to grow into larger, more merchantable stems. Much of the unit south of Little Creek is very steep. Swing yarding is proposed as the most suitable harvesting method for this portion of the unit. North of Little Creek, slopes are very steep and rocky, making accessibility of the timber in various places subject to detailed field verification. Above the railroad grade, timber is scattered and is mostly low quality Douglas-fir. The combination of low timber value, low timber density and difficult terrain probably rules out using a cable harvesting system for this part of the unit. Indeed there is some question whether some sections in this area are commercially harvestable at the present time.

Al Smith has requested that normal management practices be altered in the immediate vicinity of the two cabins below the section of new road which will connect the upper and lower railroad grade segments. Rather than following the normal selection style of cutting where trees are always harvested when they reach a maximum size range, he would like to see a regime which favors growth and maintenance of large specimen trees which would only be cut if they become unacceptably hazardous. In this limited area, thinning from below to capture mortality and upgrade stand vigor is the recommended management technique.

3.2 The General Smith Tree Unit

This small unit includes the timber along the ridge which divides the Little Creek and Berry Creek drainages, and a corner of it reaches Berry Creek itself. The unit contains a number of large old growth trees, including the one from which it takes its name. There has been significant invasion of young growth trees along the ridge which provides an interesting example of forest succession. Al Smith has specifically requested that the old growth trees in this unit not be cut, but said that he would be happy to see the second growth managed. Road access is not currently suitable for log trucks and the second growth does not have sufficient value at this time to warrant trying to upgrade the road significantly.

The desire to preserve the old growth and the difficult access make management of this unit challenging. It warrants a special study to investigate the best ways of benefitting from its unique resources and constraints. Designing better road access to the unit would be a useful study exercise. One alternative to look into might be characterized as cost effective landscape management whose purpose would be to highlight the old growth trees by manipulating the second growth resource. Implementation of landscape design principles might be the overriding goal even as commercial forest products are developed which would offset the costs of managment and improving access. If large truck access cannot reasonably be established, second growth lumber might be manufactured on-site using mobile milling facilities such as those suggested for possible use with hardwoods. Other possible products might be firewood, fence posts or alaskan milled lumber. The unit is a good area to study plant succession in general and the effects of the 1948 fire in particular. An interesting old cabin used by Earl McCrary is located near Berry Creek at the uppermost NW corner of the property. Also considered a part of this unit but road inaccessible is a small patch of timber north of the Big Creek divide near the center of Section 8.

3.3 The Satellite Stands

The Ranch timberlands outside the Little Creek drainage are dominated by Douglas-fir often accompanied by Monterey pine with small pockets and stringers of redwood in more protected and moister sites. The timber breaks down into a number of individual units distinguished by drainage and continuity of timber, sometimes separated by significant through roads. Map #3, Management Units, and the following table of acreage by timber type in each unit give a good overview of the satellite stands.

Table 3
Acreage and Volumes by Timber Type in Satellite Stands
(:Ac MBF:)

Unit	DFRW 4G		RWDF 4G		DFRWHB 4G		RWHB 3G		DFMPRWHB 3N		MP Plant		Total	
Scott Creek	0		0		47	1410	9	180	150	3750	0		206	5340
Swanton E.	0		0		0		30	600	139	3475	40	0	209	4075
Pozzi	0		17	850	11	330	9	180	63	1575	0		100	2935
Mill Creek	10	400	0		0		0		39	975	0		49	1375
Archibald C.	0		0		0		27	540	0	0	0		27	540
Queseria Cr	0		0		0		0		17	425	0		17	425
No Name Dr.	0		0		0		0		13	325	0		13	325
All Units	10	400	17	850	58	1740	75	1500	434	10850	40	0	634	15340

Because so much of the timber is unmerchantable by present standards, board foot timber volumes are a somewhat misleading measure of stocking. Of the estimated 15,340,000 board feet growing in the satellite stands, probably a maximum of 20 % is of a quality and occurs in locations operable enough to be considered merchantable. Of that estimated merchantable volume of perhaps 3,000 MBF, only 1,000 to 1,500 MBF will be available for harvest over the next twenty years, and a portion of it will be lower grade Douglas-fir and monterey pine, which have low stumpage values.

A close reading of the table highlights the contrast between the Little Creek unit and the satellite stands. Acreage in medium sawtimber of good density (types ending in 4G) is only 13 % of the forested area in satellite stands versus 82 % in the Little Creek Unit. Good conifer sawtimber undiluted by significant hardwood canopy (the HB component in typing) was 67 % in Little Creek versus only 4 % in the satellite stands. Furthermore, the total of 85 acres of good sawtimber (the 4G component) is scattered about in four different units over five different access routes. This combination of factors severely limits the economic potential of harvest operations in the satellite stands.

On the other hand, the satellite stands have great educational potential because there is great need for remedial work such as sanitation/salvage, timber stand improvement, site preparation and planting operations to try and establish reasonably healthy stands with good stocking. There will be a tremendous variety of operations and techniques to be applied, many of which can be planned and done by students themselves if properly organized and trained. The need for upgrade operations is particularly acute in the DFRWHB4G and RWHB3G types, nearly all of which were hammered by cutting done from the late 1940's to the early 1960's. Similar operations are needed in the portions of the DFMPRWHB3N type which were harvested during the same period. Revenues generated by harvesting in the satellite stands should be reinvested in upgrading these stands. If that is done, net revenues from operations in the satellite stands are likely to be very low and sporadic in nature.

The fact that the DFMPRWHB3N timber type has four components indicates that it is something of a catch-all type and accounts for its prevalence throughout the satellite stands. Species composition is quite variable, including patches of pure Douglas-fir, pure monterey pine and riparian forest where all three conifer species are scattered through a mixture of red alder and bay. Site quality is generally site IV with only a few small areas reaching lower site III. Much of the type can be characterized as invasionary stands of Douglas-fir and/or monterey pine which are expanding into areas formerly in grass or brush when fires were frequent. In such stands, timber quality is usually too low to be sold profitably for dimensional lumber. The timber on much of the acreage in the type awaits the development of a good chip market to become merchantable.

Given the unusual mix of species and the response of the vegetation to changes in human use and impact, there is considerable educational value in study of the entire area, even if only a portion of it is chosen for active management. In light of the widespread low site and timber quality as well as the difficulty and cost of upgrading marginal stands and operating in a number of productive but small and sensitive sites, timber management in the satellite stands should be undertaken advisedly and only after evaluation on a stand specific basis. Some roads and trails used to harvest timber in the fifties should not be used again and more environmentally appropriate harvest methods may not be economic on such small volumes of timber. The table below summarizes our qualitative evaluation of each unit's suitability for timber management and is followed by a brief discussion of our findings.

Table 4
Summary Evaluation of the Satellite Stands

STAND	TIMBER		ROADS/TRAILS	COMMERCIAL	TSI
	Quality	Density			
Scott Cr.	low/mod	low/mod	recon/abandon	low/mod	yes
Swanton	low/mod	low/mod	realign/recon	low/mod	yes
Pozzi	mod/low	low/mod	recon/abandon	low/mod	yes
Mill Creek	mod/low	mod	reopen + new	low	yes
Archibald	low	low	realign/recon	no	yes
Queseria	low	low	recon/abandon	no	yes
No Name	low	low	not logged	no	no

(recon = reconstruct; abandon refers only to specific sections, not everything, and may require redesign and replacement by newly constructed access)

3.3.a. Scott Creek - The timber stands and topography are quite diverse. The portion of the unit south of the southernmost side draw is non-commercial and even sections of the redwood type in that side draw may be better left unmanaged. Portions of the steep slope are too steep to pretend to manage. The hydrology of the high tableland feeding springs at the head of several side draws would make an interesting study. The largest of the side draws breaks into two forks, both of which are deeply incised with slides and other inoperable sections.

On the other hand, there is one small but good patch of redwood just south of that largest draw, other even smaller but accessible redwood groups, and good opportunities for planting potentially productive ground between Scott Creek and the foot of the steep slope. Site prepping and planting that good ground is one of the best stand improvement options in all the satellite stands. There are also a couple small but fairly good looking stands of monterey pine and pine mixed with Douglas-fir near the top of the hill which might have enough quality stems to support a commercial harvest. A few other areas, in some cases now in grass, in others in an open stand of mixed conifer and hardwood, appear to have productive enough soil, gentle enough terrain and are far enough below the top of the ridge to be somewhat protected that they might make good sites for small, experimental plantations. Road access across Scott Creek is by stream fords at either end and could probably be handled by temporary culverted low water crossings.

3.3.b. Swanton East - This unit is also a mixed bag. Cutover stands of Douglas-fir mixed with monterey pine cover most of the area with a few patches of redwood thrown in, principally along Winter Creek. The redwoods need sanitation and TSI cuts. There has been some natural regeneration in the cutover fir/pine stands, but it is quite scattered and often not very healthy. Grass, forbs, vines, brush and hardwoods form a significant portion of

mixed vegetative cover in much of the cutover area. Some 40 acres of the better ground in the cutover were planted between 1979 and 1984, primarily with monterey pine including one small section with known clones which should be monitored. Pruning and precommercial thinning of these plantation sites are a high priority stand improvement operation for the satellite stands. Opportunities for spot planting or release of saplings from hardwood competition occur sporadically outside the plantation sites. In some cases, patch cut overstory removal may be the best means of readying a site for planting. An interesting option for portions of this unit, particularly where low productivity and difficult terrain combine to make economic management infeasible, might be to manage for wildlife habitat.

3.3.c. Pozzi - This unit has a little of everything. Below Swanton Road but west of Scott Creek is patch of less than 15 acres that definitely has some commercial conifer stems, but they are on a short, steep slope where breakage and skidding access could be problematic. In addition, there may not be a good low water crossing of Scott Creek on the property and permission would have to be sought from the adjacent owner for a reasonable crossing location.

The main area of interest is the draw east of the Purdy ranch road which has three major forks. A few acres next to the Rancho line at the back of the northern and middle draws have significant volumes of small old growth and released residual redwood. Both the Rancho line and viable new access routes need to be established before management of either can be undertaken. There is a nice picnic area at the junction of the forks and terrain near there has some opportunity for commercial management of all three conifer species in a mixed stand. The steeper slopes immediately east of the Purdy ranch road generally have little immediate commercial potential as they bear only scatterd, low quality Douglas-fir and pine.

3.3.d. Mill Creek - This small unit also has a few acres which might support limited commercial management of all three conifer species in a mixed stand. However, the slope is steep and short with high potential for breakage during falling. The merchantable volume is very small, and there is a powerline at the foot of the hill which complicates operations. It is worth looking at more closely but may not warrant active management.

3.3.e. Archibald Creek (the creek bottom and north facing slope to the Agua Puerca Rancho line) - Records indicate that this mixed stand of redwood and Douglas-fir was logged around 1950. There current stand needs a combination sanitation/timber stand improvement cut, but it is doubtful management of this stand is economically justifiable. Site and timber quality are both low as are stocking levels. In addition, the old skid roads feed out onto the road up Archibald Creek which is a paved road providing the sole access to the home of the owners of the neighboring

parcel. As a result, skidding and landing layouts have to be changed, an expense and impact not warranted for such a marginal stand. The site can be used for study of past logging practices and demonstrating timber stand improvement techniques which do not use heavy equipment.

3.3.f. Queseria Creek - This drainage has an east and a northeast fork, both of which would be classified as class II watercourses with flow persisting through the spring and wet spots into summer. Most of the conifer stocking is low quality Douglas-fir with redwood occurring almost exclusively in the damp draw bottoms. Logging was done in the vicinity of 1950 with access established both out the draw bottoms and, from the back portion of the northeast draw, up to the rangeland and out a ranch road past the corral on Swanton Road. Site productivity is limited by poor microclimate (poor aspect and direct marine influence), rocky slopes, and awkard access. The east fork can be written off for timber management entirely. The lower reach of the northeast fork was logged in the draw bottom over a skid trail which will have to be abandoned. Future vehicle access to the back end of the northeast fork requires reopening and upgrading of an existing trail from the old buildings at the edge of the rangeland above the draw. The site is good for demonstrating old logging practices and practicing timber stand improvement in redwood sprout groups. It is also notable for containing what may be the three or four southernmost members of the Ano Nuevo population of native monterey pine (Pinus radiata), and a nice patch of dogwood and gooseberry.

3.3.g. No Name Draw - Most of the timber in this stand is low grade, invasionary fir with a stringer of redwood along the draw at its steepest, wettest stretch. The stand has not been harvested and should not be, there being too little timber on difficult terrain to make economic sense. A ranch road crosses the draw at the top of the redwood stringer. The site is good for ecological niche instruction, possible wildlife management, and has a small patch of unusual forest type which could be called Douglas-fir/buckeye.

3.4 Management Summary

1. This Management Plan has devoted the majority of its attention to the Little Creek unit because from both the educational and economic perspectives, it is the primary forest resource on the Ranch. The first priority, therefore, is to establish the improved road system recommended in the Plan as rapidly as possible. The Timber Harvest Plan developed concurrently with this Management Plan addresses construction of the entire road system in detail. Road construction to access the initial harvest and CFIP areas, which are south of the South Fork of Little Creek, is scheduled for fall of 1989. If financially feasible, the remainder of the Little Creek road network should be completed in 1990.

2. Subsequent harvest operations in the Little Creek Unit should be timed to achieve the best balance of sustained yield goals, educational benefits and market opportunities. On average, Little Creek harvesting is likely to occur every third year. As much data as possible (harvest volumes, residual inventory, growth response, etc.) should be gathered as each harvest operation progresses with an eye to future Management Plan revisions.

3. Timing of management and educational activities in the General Smith Tree Unit and the Satellite Stands is at Cal Poly's discretion. This Management Plan makes a number of educational and operational suggestions for the various timber stands on the Ranch, but they should be followed up by site specific studies which propose more detailed management direction on a stand by stand basis. (Note: A discussion of possible forest improvement projects accompanies this Plan.) Because cost is likely to be a significant constraint on all the management and educational activities in these units, one way of approaching this educational inventory would be to do the stands with the greatest commercial potential first. The study might consist of a specific harvesting proposal, complete with 100% tallies of marked trees, planting and stand improvement operations, and the costs/revenues associated with each operation. As discussed in this Plan, portions of the Scott Creek, Swanton East, and Pozzi Units have the greatest commercial potential. Although it may have somewhat less attractive timber than the other two, the Swanton East Unit might be the best place to start since it is the most readily accessible. Depending upon the availability of students and professors, this educational inventory phase can probably be completed in two or three years.

4. The purpose of this Management Plan is to provide management direction for the Swanton Pacific Ranch, but it should be considered a working document subject to constant monitoring, revision and improvement. In about five years, timber and educational inventories will have been completed as well as two harvest operations, making it a good time to consider preparing a Management Plan Update which discusses in detail both the overall direction and a number of specific projects for the next five or ten year period. Detailed proposals regarding access to and harvesting of portions of the Satellite Stands should definitely be completed by that time.

MAPS

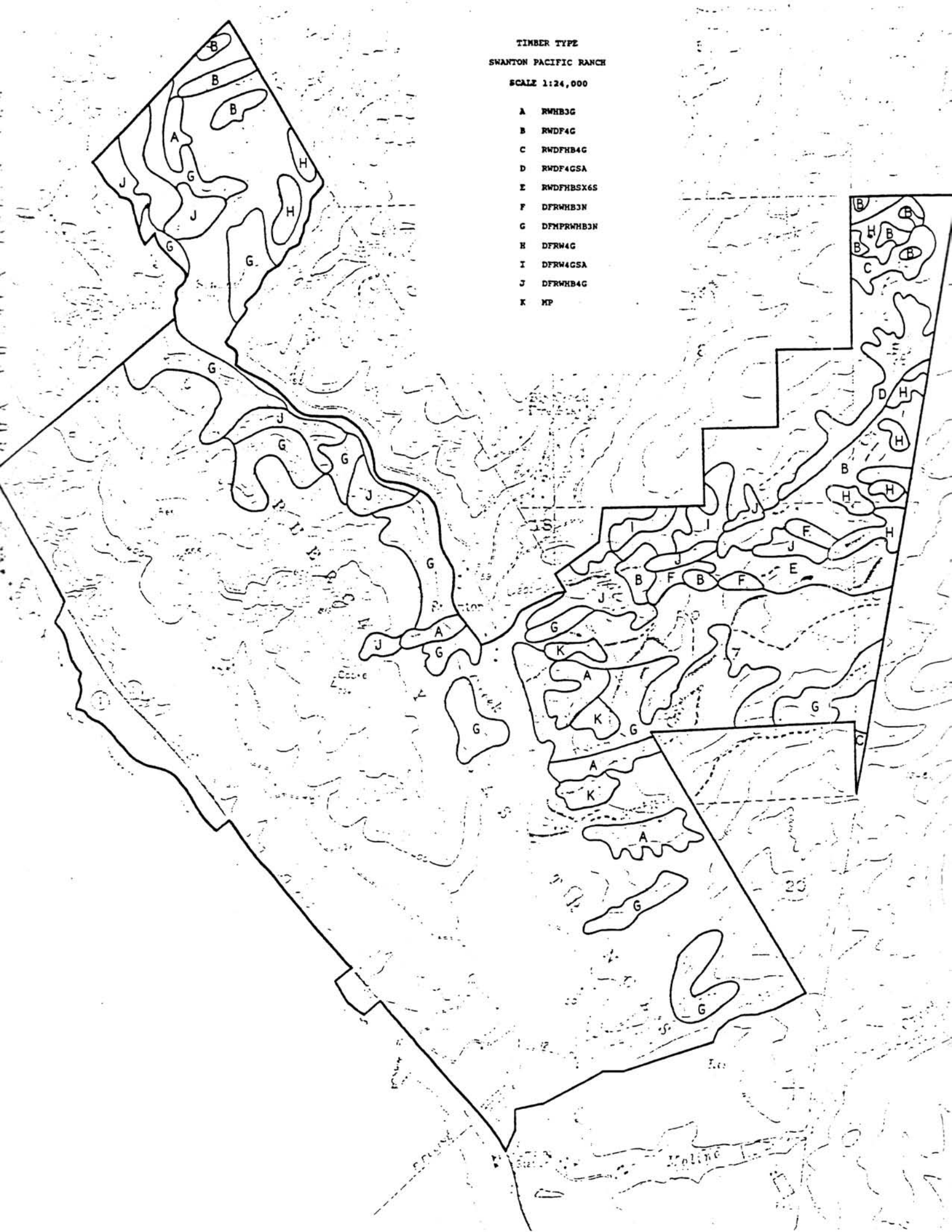
MAP 1

VEGETATION TYPE


VEGETATION TYPE
SWANTON PACIFIC RANCH
SCALE 1:24,000
CL CULTIVATED
CT CONIFER TIMBER
GX GRASSLAND
HA ALDER
HX HARDWOODS
KP KNOBCONE PINE
NB BARREN
NW WETLANDS
SX BRUSH
Bonside School
Big Creek Fire Sta.
Swanton
Cooke
Little
Archibald
Molino
Pumping Station
PIPELINE
Res
BM 101
BM 111

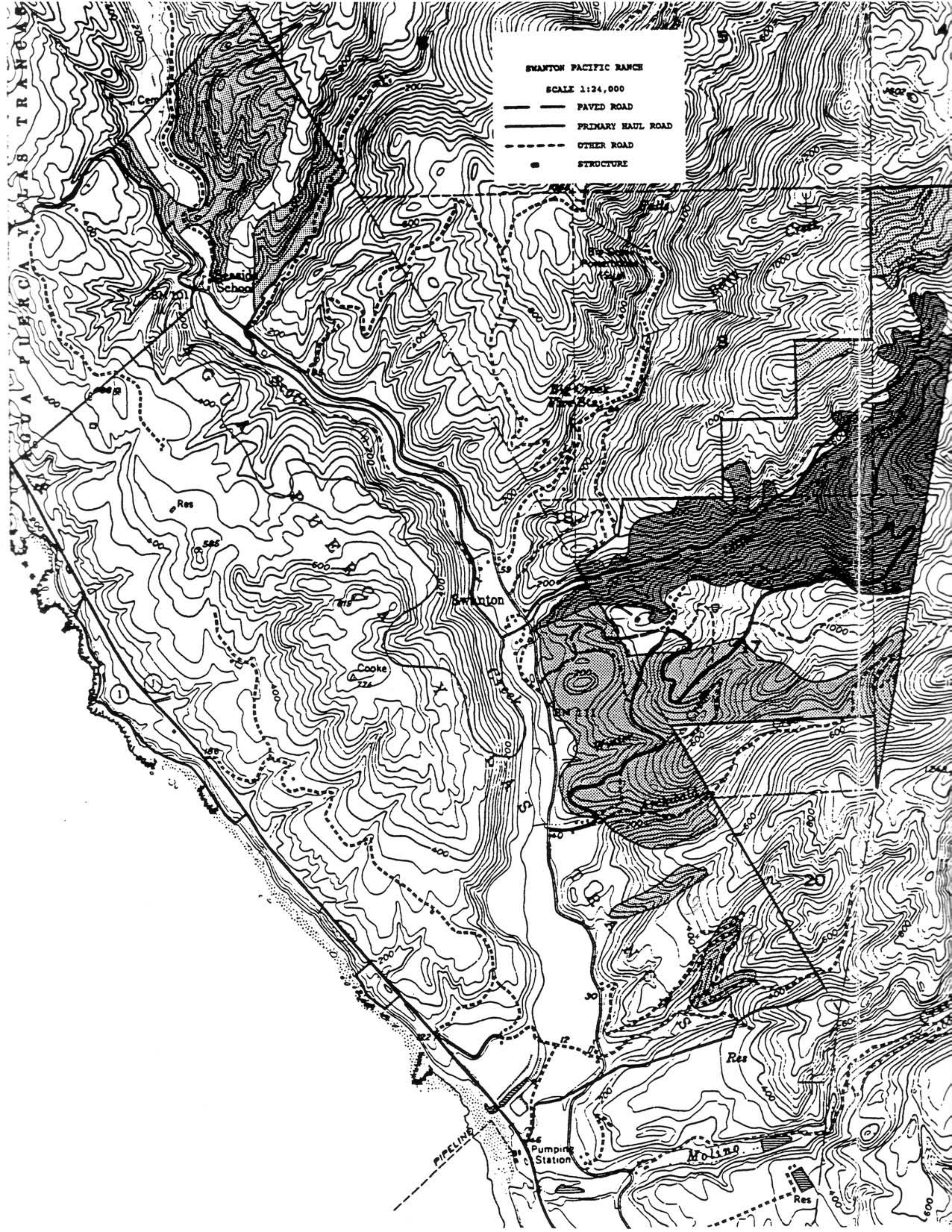
MAP 2

TIMBER TYPE


TIMBER TYPE
SWANTON PACIFIC RANCH
SCALE 1:24,000
A RWHB3G
B RWDF4G
C RWDFHB4G
D RWDF4GSA
E RWDFHBSX6S
F DFRWHB3N
G DFMPRWHB3N
H DFRW4G
I DFRW4GSA
J DFRWHB4G
K MP

MAP 3

MANAGEMENT UNITS


SWANTON PACIFIC RANCH
SCALE 1:24,000
PAVED ROAD
PRIMARY HAUL ROAD
OTHER ROAD
STRUCTURE
Swanton
Cooke
Res
Pumping Station
PIPELINE
Molino
Creek

MANAGEMENT UNITS

GENERAL SMITH TREE

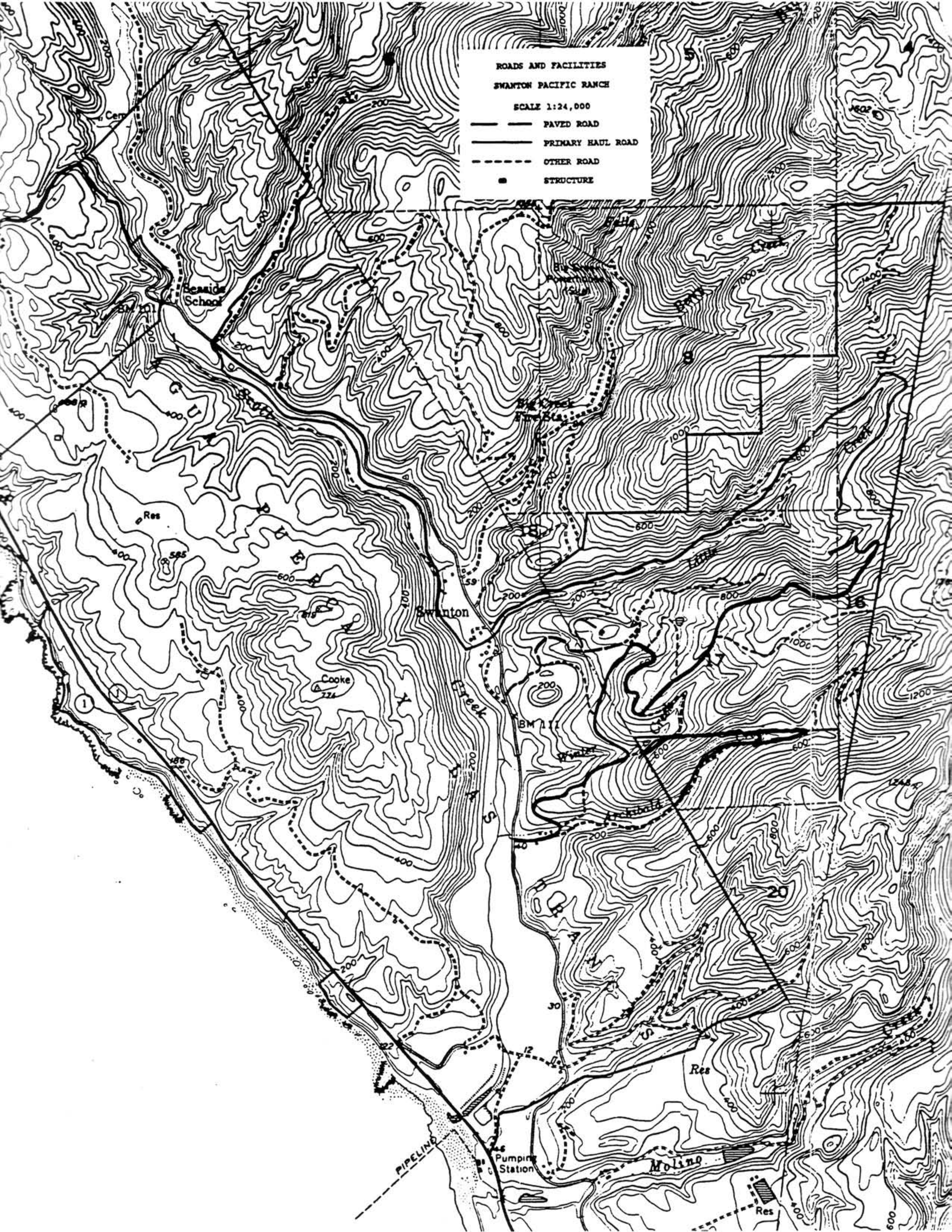
LITTLE CREEK

SATELLITE UNITS

1. POZZI
2. MILL CREEK
3. SCOTT CREEK
4. SWANTON EAST
5. ARCHIBALD CREEK
6. NO NAME DRAW
7. QUESERIA CREEK
8. 40 AC. TREE FARM PRESAC 1991

MAP 4

ROADS AND FACILITIES



ROADS AND FACILITIES
SWANTON PACIFIC RANCH
SCALE 1:24,000
PAVED ROAD
PRIMARY HAUL ROAD
OTHER ROAD
STRUCTURE
Seaside School
Swanton
Cooke
Big Creek Fire Sta
BM 111
Res
Pumping Station
PIPELINE
Molino
Little
Archibald
Creek

MAP 5

LITTLE CREEK MANAGEMENT UNITS


SWANTON PACIFIC RANCH
SCALE 1:24,000
PAVED ROAD
PRIMARY HAUL ROAD
OTHER ROAD
STRUCTURE
AGUA PUERCA Y LAS TRANCAS
Seaside School
BM 101
Scott Creek
Big Creek Powerhouse (Site)
Big Creek Fire Sta.
Falls
Swanton
Cooke
BM 111
Archibald
Res
Pumping Station
PIPELINE
Molino

LITTLE CREEK MANAGEMENT UNITS

MANAGEMENT UNIT 1

MANAGEMENT UNIT 2A

MANAGEMENT UNIT 2B

MANAGEMENT UNIT 3

PRIMARILY SKYLINE YARDING

PRIMARILY SWING YARDING

APPENDICES TO THE FOREST MANAGEMENT PLAN

FOR THE SWANTON PACIFIC RANCH

CONTENTS

Streams, Rainfall, and Floods

The main streams on the Ranch: Scott Creek, Mill Creek, and Little Creek - are all perennial, anadromous fish streams. Archibald Creek drains an area of nearly 900 acres and continues to flow well into the summer months in most years, but no one can recall seeing fish in it. The remaining watercourses and side draws are a wide ranging study in channel morphology and represent a great opportunity to acquaint students with the watercourse classification systems used in the State's forest practice regulations. Queseria Creek, No Name Draw, Winter Creek, and the two largest spring fed draws on the North Fork of Little Creek and on Scott Creek would all be classified as class II watercourses under that system. Watercourses requiring classification within the harvest area of the initial THP are shown on the THP map. The initial harvest will help students learn how to classify watercourses and assess stream protection measures directly.

Average annual precipitation varies from roughly 30 inches at the coast to over 50 inches at the highest elevations at the back of Little Creek. It is a mediterranean climate characterized winter rains and summer drought. More than 95 % of annual rainfall occurs during the seven months of October through April. Furthermore, rainfall totals vary greatly from year to year. Using precipitation records kept by the California Department of Forestry at the Big Creek Fire station, annual totals have ranged from a low of 21.03 inches (86/87) to a high of 49.65 inches (82/83). Although the average annual total at the station for the seven year period of records is about 32 inches, the closest any one year's total has been to that "average" is just over 5 inches, confirming the suspicion that there is no such thing as normal weather. Copies of the CDF rainfall records are attached.

Two major floods have occurred on Little Creek within the last fifty years. On February 29, 1940, high water and landslide debris came down Little Creek and knocked out the Swanton Road wooden bridge. WPA crews came in, cleaned up the debris and built the concrete bridge that is still in use. Unfortunately, on December 22, 1955 that concrete bridge caught a lot of landslide debris and diverted high water so that two houses below the bridge were damaged. The flood waters killed Mrs. John Shaw, who lived in one of those houses.

The 1980's have had several years of high water. The storm of January 4, 1982 did not hit the Swanton area quite as hard as it hit some other parts of the County. The storm total recorded at the CDF fire station came to 7.9 inches. Similar high flows occurred in 1983 when less intense but more prolonged storms came at intervals from mid-January through the end of March. In 1986 heavy rains in February and March caused some minor flooding, streambank failures, and alder log jams on Scott Creek, Big Creek and Little Creek. A large landslide occurred along the South Fork

of Little Creek that winter as well.

Soils and Geology

Lynn Moody's "Second Order Soil Survey for the Swanton Pacific Ranch," prepared March 4, 1987 for Dr. Ron Taskey's SS 501 provides a good treatment of the geology and soils of the Ranch. The geological report prepared for review of the initial Timber Harvest Plan is another good source of field oriented geological information.

Adjacent Parcels and Ownership

A comprehensive list of near and adjacent parcels and owners, complete with Assessor's maps, is available through Doug Piirto at Cal Poly.

Fire History

The management plan discusses fire occurrence and its influence on the Ranch's vegetative cover. Certainly the most dramatic fire event of recent times was the famous fire of 1948. Al Smith recalls that it burnt over a four to five week period during August and early September, starting with an intense burn of about four days, settling down for a three week period of creep, and then flairing up dramatically for another four or five days after that. It was during the last stretch that it came down far enough south to reach the Ranch, burning through the upper portion of Little Creek, across the ridge and into the upper end of Archibald Creek. Spirited resistance by the McCrary family and other local residents held the fire north of Ranch in Scott Creek and kept it from reaching Swanton Road anywhere, although it did singe the Big Creek Fire Station located on Big Creek where the Fish hatchery is now. A rough map based on recollections of Al Smith and Lud McCrary follows.

1948 FIRE


SWANTON PACIFIC RANCH
SCALE 1:24,000
PAVED ROAD
PRIMARY HAUL ROAD
OTHER ROAD
STRUCTURE
AGUA PUERCA Y LAS TRANCAS
Seaside School
BM 101
Scott Gulch
Res
Swanton
Cooke
Creek
BM 111
Big Creek
Little Creek
Big Creek Powerhouse
Pumping Station
PIPELINE
Molino
Res
Res

1948 FIRE

THE CROSSHATCHED AREA DEPICTS THE APPROXIMATE EXTENT OF THE 1948 FIRE.

Advisability of a Part or Full Time Forestry Staff Position for the Swanton Pacific Ranch

This question is best addressed by those involved with the practical realities of funding ranch activities and administering the educational program associated with the ranch timberlands. The preceding discussion of finances makes it clear that timber harvest revenues will not be adequate to cover expected maintenance, management and educational costs. Extensive field experience is the crucial requirement for anyone who will design and supervise forestry operations contemplated in the management plan. The size of the Ranch and its diverse management responsibilities and educational opportunities suggest that someone should be on-site at least part-time to coordinate matters. Administering a number of projects from a distance seems likely to create miscommunication and inefficiency. In addition, someone who is familiar with the Ranch on a continuing basis will be in the best position to direct use of the Ranch for maximum educational benefit.

Forest Improvement Projects

The logging which occurred on the Ranch from the 1940's into the 1960's has left many stands in need of planting and timber stand improvement operations. The following projects are listed and discussed more or less in order of priority and identified by their number on the accompanying map.

1. The initial Timber Harvest Plan for Unit 1 incorporates most of the area heavily cut for Janes in the early 1960's. Although stocking is expected to meet forest practice act standards after rehabilitation cutting for the timber harvest, considerable benefit can be gained by sanitizing existing sapling and pole stands and interplanting unstocked areas opened up by timber harvesting. This area probably has the most productive potential of the understocked areas on the Ranch. A California Forest Improvement Project (CFIP) application for the area will be submitted with this report.

2. The Swanton East Unit could benefit from several different kinds of improvement operations. The monterey pine plantations established from 1979 through 1984 need to be thinned and pruned. Competing vegetation needs to be controlled in them as well, probably through a combination of mechanical and chemical treatments. Areas where plantings failed should be reevaluated for suitability for spot replanting.

In areas not yet cleared and planted, the variety of practices recommended in the Management Plan - TSI in cutover redwood clumps, clean and release of overgrown seedling, sapling and pole

stands, site preparation and planting of unstocked sites of reasonable productivity and wildlife habitat improvement. The prescription will require detailed evaluation of the diverse field conditions, evaluation which may take several years to complete and coordinate. The advantage of working in this unit is that a great variety of practices wouold be fairly accessible.

3. As mentioned in the Management Plan, there are several areas of gentle ground between the existing dirt road along Scott Creek and the foot of the steep slope to the west that appear have good tree growing potential. Site preparation would be largely mechanical brush clearing although some hardwood removal, including some red alder, should also be done. Redwood would be the preferred species for planting. Ideally, the project would be done at the same time as selective harvesting of nearby mechantable stands, much the same as is proposed for the initial project.

As discussed in the Management Plan, there are numerous other opportunities for forest improvement projects, primarily in the Satellite Stands. However, these are best addressed as part of the site specific planning recommended for these stands in the Plan.

CFIP APPLICATION
RM-7 (8/88)

CALIFORNIA FOREST IMPROVEMENT PROGRAM
APPLICATION

CFIP Project Number

1. Enter the name(s) of all the landowners (use attachment if necessary).

a. Albert B. Smith, c/o California Polytechnic State University Foundation, Attn: Doug Piir Or Robert Griff
Name — Mailing Address: P.O. Box, Street
(805) 756-2968 — Cal Poly State University, San Luis Obispo, CA 93407
Phone Day/Evening — City, State, Zip

b. _____
Name — Mailing Address: P.O. Box, Street
Phone Day/Evening — City, State, Zip

2. Responsible person to be contacted (if different from above).

Doug Piirto, NRM Department, California Polytechnic State University
Name — Mailing Address: P.O. Box, Street
(805) 756-2968 — San Luis Obispo, CA 93407
Phone Day/Evening — City, State, Zip

3. (a) Does the landowner own 5,000 acres or less of forestland in California? Yes____ No XXX
(b) 20 acres or more of forestland? Yes XX No ____
(c) Is the total area proposed for each practice 5 acres or more (other than preparing a Management Plan)? Yes XXX No ____ N/A ____ (Wildlife/Conservation)
(d) Number of acres under the Management Plan Approximately 1,000 Total Ownership Size 3,200
(e) Project area timber site productivity is? I ____ II ____ III XXX IV ____ V ____
System? _____ (REF. CCR, Title 14, Article 4, Sections 1060).
(f) Has the project area been damaged by natural causes within the last 3 years? Yes ____ No XXX

4. How is the project area zoned? Circle one of the following and answer pertinent questions.
(TPZ) Agriculture Preserve, or Other.
(a) TPZ. Is a petition for rezoning from TPZ to other uses underway or contemplated for the period of time during which the grant is administered, 10 years? Yes.____ No XXX
If yes, explain _____
(b) Other. List all land uses permitted under this zoning. Indicate existing land uses on Management Plan map. List specific use(s): _____
(c) Will the landowner agree not to put CFIP land to any use incompatible with forest resource management for 10 years? Yes XXX No ____

5. Has any of the land proposed for CFIP funds been harvested subject to the 1973 Z'Berg-Nejedly Forest Practice Act? Yes____ No XXX If yes, list THP Number 1-89-539 SCR but will be in September/October 1989

6. Is there a previously prepared Forest or Land Management Plan for the area proposed for a CFIP project? Yes XXX No____ Should the plan be revised? Yes XXX No____
If Yes, list the CFIP Project Number 5-83/84-SCR-42

7. The project will be carried out by persons living in the county or in counties adjacent to the county where the project will take place? Yes ____ No ____ Unknown at this time

Complete the attached Application Project Summary. I certify that the above and attached is true and correct to the best of my knowledge. Executed on August 30, 1989 at Davenport CA 95017

_____
Applicant's Signature

Requires CDF foresters evaluation.
(a) The project is located in an area of high unemployment? Yes ____ No ____
(b) The project offers relatively more employment opportunities? Yes ____ No ____

APPLICATION/EXHIBIT B
PROJECT SUMMARY

NAME(S): Mr. Albert B. Smith - The Swanton Pacific Ranch - managed by Cal Poly State Uni

SUMMARY OF PRACTICES TO BE PERFORMED

PRACTICE	ACREAGE*	COST/ACRE**	TOTAL EST. PROJECT COST
Management Plan/Addendum	3200 total 1400 forested	$	$ 8,500
Site Prep	7	200	1,400
Trees and Planting	13	140	1,820
Follow-up	10	110	1,100
Release, chemical			
Release, non-chemical			
Pre-commercial thinning	50	240	12,000
RPF Supervision	80	20	1,600
Habitat Improvement			
Land Conservation			
Other			
Other			
		TOTAL	$ 26,420
			Box a

* Enter net acres work for partial practices (minimum of 5 acres of an individual practice except for land conservation and habitat improvement)

** Enter 100% contract cost/acre (not to exceed maximum allowable rate)

1. COST-SHARE RATE: 75 %

2. MAXIMUM REIMBURSEMENT:

75 % (rate from #1) x $ 26,420 (amount Box a) = $ 19,815 (maximum cost)

Location of the proposed project listed above. Provide maps (scale 15 min./7.5 min. USGS topographic are best) indicating areas to be treated. Use additional sheets if necessary.

For recording purposes at your local county recorder's office;

Sub. Sec.	Section	Township	Range	County	Assessor's Parcel #	Yes/No TPZ
Portions	16 & 17	10 S	3 W	Santa Cruz	57-121-10	Yes
					57-121-22	Yes

For non TPZ zoned lands described above a part of that real property more fully described in that certain deed from _____ to _____ dated _____ and recorded with the recorder of _____ County at Book _____, Page _____

CFIP PROJECT DESCRIPTION FOR SWANTON PACIFIC RANCH - 1989-90

1. Mr. Albert B. Smith
C/O California Polytechnic State University Foundation
Attn: Robert Griffin and Doug Piirto
Cal Poly State University
San Luis Obispo, CA 93407

2. Portions of Section 16 and 17, T 10 S, R 3 W, MDB&M.

3. The project area is within the harvest area to be harvested pursuant to THP 1-89-539 SCR. CFIP work will be done on a site specific basis within a 65 acre area. About half of the area was heavily cut in the early 1960's with predominantly redwood residual stocking with some Douglas-fir and a significant brush component. The other half of the area is an uncut stand of 80 year old second growth redwood and Douglas-fir which was burnt by a major fire in 1948.

A) Management Plan

A Management Plan plus site prep and tree planting work were done on the property under CFIP #5-83/84-SCR-42. Since that time, however, the ownership has expanded significantly through acquisition and its management has recently been given to California Polytechnic State University. As a result, the Management Plan needs to be completely rewritten for this now roughly 3,200 acre ranch to provide direction which will coordinate the combination of educational and commercial pursuits. Considerable field time must be spent checking timber typing and inventory estimates, assuring feasibility of a comprehensive road system, and evaluating terrain for application of various yarding systems. In line with the educational bent of the plan, the topics of sustained yield and forest regulation must be treated in considerable detail. Estimated cost for this essentially new plan is $8,500. (100 hrs. $50/hr. = $5,000 field work; 60 hrs. $50/hr. = $3,000 office work; clerical, typing, materials, reproductions and maps = $500).

B) Timber Stand Improvement

Highly defective, poorly seated and malformed redwood suckers occur in both stand types and need to be removed to promote healthy sprouting and vigorous growth of saplings and poles. Spacing and defect control are needed in redwood and Douglas-fir sapling and pole stands of seed origin as well. TSI is proposed subject to the following guidelines:

Sanitation Thinning - All damaged or defective stems shall be removed unless there is commercial wood potentially available in the next twenty years. Cuts shall be made as low as possible and may include cutting of larger, excessively high stumps.

Sprout Groups - Sprout stands shall be thinned so that a) defective stems up to 12 inches in diameter shall be removed before all others; b) no healthy stem greater than six inches in diameter shall be cut unless it is one of a group of more than three stems whose average spacing is eight feet or less, or it is immediately overtopped by a tree which will not be removed in the

next commercial harvest; c) no healthy stem of any diameter shall be cut which is more than 15 feet from another stem.

Seedling and Sapling Stands - 12" X 12" spacing is the standard with variability for best tree discretion. Trees should not be left less than 6 feet apart.

Stocking Following Thinning - This precommercial thinning will not reduce stocking levels significantly because the thinnings will be done in areas that are already overstocked and where the overstory usually already meets stocking standards. It will, however, provide suitable spacing in the understory to optimize crop tree development. Slash will be treated by lopping concurrently.

C) Trees and Planting

Desired planting sites occur irregularly within the much larger project area. Approximtely 15 acres can be interplanted with the greater portion being in the heavily cutover area. Planting acreage will be computed on a tree number equivalent bass - 400 trees per acre on an effective spacing averaging 10 feet. Spacing may be uniform to clustered depending on the site. Thus when 400 trees of stock have been planted at the desired spacing, an acre composed of a number of separate planting groups will have been treated. Stock will be from seed zone 097.5 as feasible.

D) Site Preparation

Because relatively little volume will be removed during harvesting of the cutover area, many areas now covered with brush and small hardwoods will not be disturbed and will therefore require site preparation for planting. Site prep will be done as much as possible by tractor crushing, keeping blading to the minimum required to expose enough soil for planting. Some handwork may be used to expand planting sites in both the cutover and 80 year old second growth stands. Leaving slash on site, treatment by crushing and/or hand lopping will minimize soil exposure and mitigate potential for soil erosion.

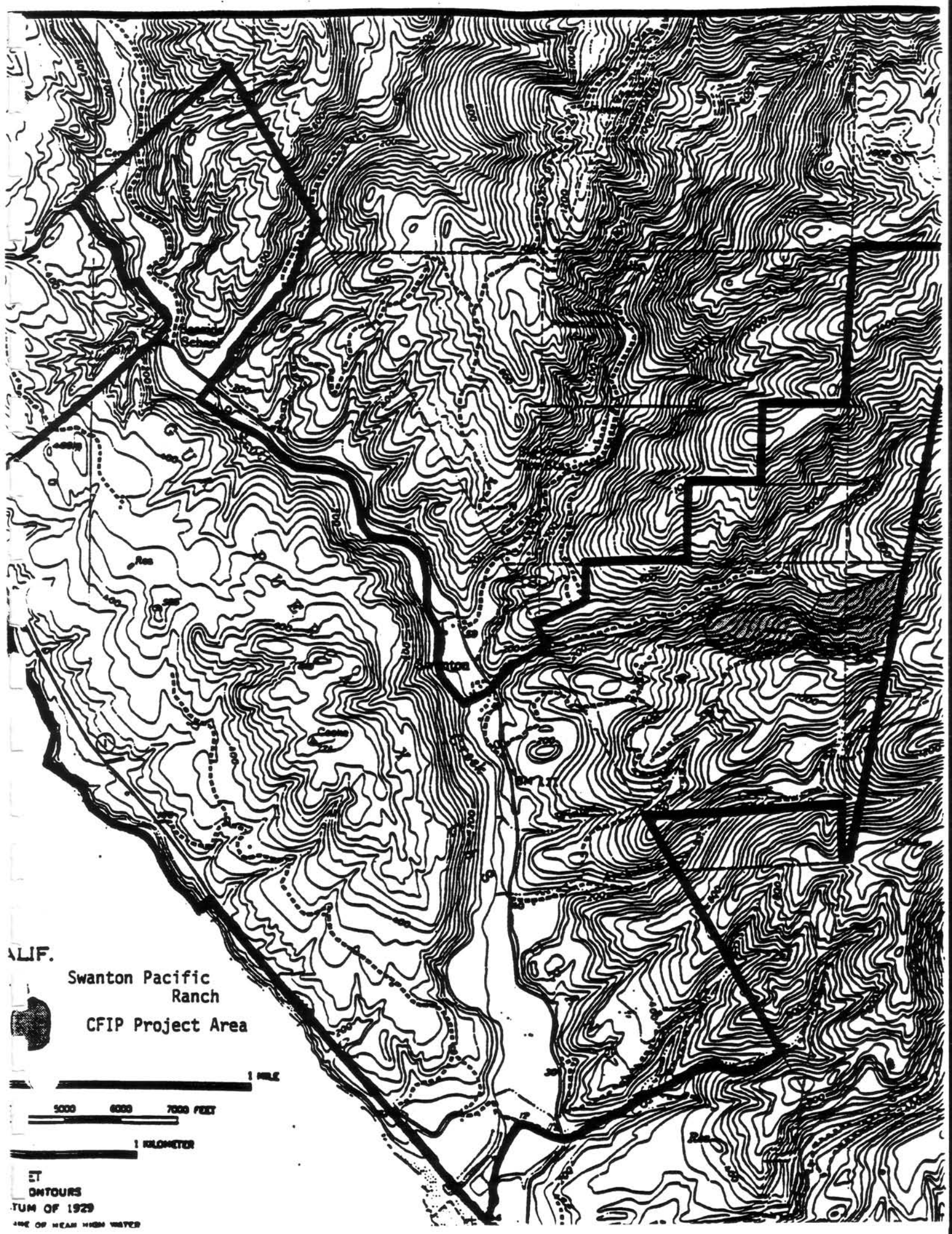
E) Follow Up

Hand or chemical vegetation control will be needed in planting areas heavily affected by hardwood and shrub competition, particularly from sprouting species. Timing of treatment will be based on field evaluation of the severity of the problem. Hand application of chemical veg control will mitigate potential adverse effects.

F) Supervision

Supervision of the above activities by a registered professional forester will help assure the successful implementation of this CFIP project.

4. With the exception of the Management Plan, all of the above activities will be conducted on lands currently subject to THP #1-89-539 SCR and all will be in compliance with all pertinent forest practice rules. The minor amount of equipment work proposed will be done on moderate terrain well removed from watercourses. There should be no conflicts associated with mitigating any of the effects specified in the Environmental Checklist.


ALIF.
Swanton Pacific
Ranch
CFIP Project Area
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1 KILOMETER
ET
ONTOURS
TUM OF 1929

STATE OF CALIFORNIA
CFIP ENVIRONMENTAL CHECKLIST
RM-8 (2/88)

CFIP Project Number

DEPARTMENT OF FORESTRY
AND FIRE PROTECTION

Check the appropriate effect and mitigation measures to be applied. Enter N/A where effect not applicable.

EFFECT	MITIGATION	
Water Quality		
XX 1. Soil deposition in streams caused by accelerated erosion due to use of heavy equipment to remove vegetation (PEIR pp. 59, 71).	1. a. Brush scalped off slopes will be windrowed along the contour and burned, leaving effective berms of residual soil to impede surface water flow (14 CCR 1545.3a).	XX
	b. No heavy equipment on excessively wet soils (14 CCR 1545.3b).	XX
	c. No heavy equipment within 50' of stream and lake transition line, therefore leaving buffer strip (14 CCR Section 1545.1c).	XX
NA 2. Landslides and slope failure due to heavy equipment operation on currently & potentially unstable lands (PEIR pp. 59, 71).	2. No heavy equipment on current or potentially active slide areas (14 CCR 1545.3c).	___
NA 3. Increased water temperatures due to removal of streamside shading (PEIR pp. 59, 44).	3. a. Leave riparian vegetation (14 CCR 1545a).	___
	b. Leave other vegetation as necessary to maintain stream temperature (14 CCR 1545e).	___
NA 4. Increased turbidity and sediment load in streams from clearing stream channels (PEIR p. 59).	4. Compliance with Fish and Game Code (14 CCR 1545.1d).	___
XX 5. Deposition of slash or debris in streams.	5. All streams below stream and lake transition line will be kept free of slash and debris. Accidental deposits will be cleared up (14 CCR 1545.1).	XX
XX 6. Accidental off-target deposition of herbicides due to spills and aerial drift (PEIR p. 69).	6. Compliance with Federal EPA. Cal. Food and Ag. Code, County ordinances as enforced by County Ag. Commissioners (14 CCR 1545.1). Applied by hand.	XX
NA 7. Effect on domestic water supplies from sediment deposits.	7. Establishment of Special Treatment Areas to protect domestic water supplies (14 CCR Section 1545.f).	___
NA 8. Unusual circumstances or project site conditions (e.g. soil type, slope, size of project, soil moisture) which could result in surface erosion effects not adequately mitigated by Resource Protection Guidelines.	8. Effects beyond the scope of the Program EIR will need additional review. (Please consult CDF Forester.)	___
NA 9. Siltation of stream gravels important for spawning by accelerating erosion after vegetation removal (PEIR p. 59).	9. See Mitigation for Significant Effect	___
XX 10. Impact to rare, endangered, or sensitive species habitat or wildlife as part of vegetation manipulation (p. 61).	10. The Department of Fish and Game's California Natural Diversity Data Base and the California Native Plant Society registers will be consulted for evidence of such occurrences in the project area. If likely, a (PEIR) field survey will be performed by a biologist. If such species are present, a Special Treatment Area will be designated and no forest improvement practice will be performed thereon unless they clearly benefit the protected species (14 CCR (Section 1545.8).	XX
XX 11. Contamination of game meat with herbicides.	11. Compliance with Federal EPA, Cal. Food and Agriculture Code, and County ordinances as enforced by County Agriculture commissioners (14 CCR 1545.5).	XX

Forest Insects and Disease

NA 12. Possible infestation of residual stands of three-needle pines with Ips and Dendroctonous beetles if slash from wet season precommercial thinning operations not adequately disposed (PEIR p. 75).

12. No precommercial thinning of three-needle pines between November 1 and May 15 unless risk of beetle infestation is reduced by chipping, burning, lopping, or otherwise treating thinning slash (14 CCR 1545.9.). —

NA 13. Infestation of pine stands with root rot pathogens after precommercial thinning (PEIR p. 75).

13. Allow application of borax on thinned stumps to qualify for cost share payments. —

NA 14. Particulates in air from burning brush (PEIR p. 60).

14. Compliance with Air Resources Board regulations and local ordinances (14 CCR 1545.4). —

NA 15. Contamination of air from aerial drifts of herbicides (PEIR p. 46).
Hand applied.

15. Compliance with Federal EPA, Cal. Food and Agriculture Code, and County ordinances as enforced by County Agriculture Commissioners (14 CCR 1545.5).

Archeological Historic, and Cultural Resources

XX 16. Disturbance of archeological, historic, and cultural resources when brush is removed to plant trees or habitat is removed (PEIR pp. 53-55, 58).

16. An archeological records search and project review will be made by the appropriate Information Center for the California Archeological Inventory. They will determine if known archeological or historical sites occur within or near the project area. In addition, if recommended by the Information Center, the project area will be thoroughly surveyed by a professional archeologist to determine if any undiscovered (unrecorded) resources are present which may be damaged by the project. Areas where such resources are identified will be designated Special Treatment Areas and no forest improvement practices will be performed thereon except where practices clearly benefit the protected resource as recommended by the professional archeologist (14 CCR Section 1545.8). A copy of the project map and a brief description of the project will be sent to the Native American Heritage Commission. Representatives of the NAHC will review the project for Native American concerns (PRC 21080.4, 14 CCR 1545.8, EPIC v. JOHNSON). XX

XX 17. Slash build-up after precommercial thinning increases fire hazard (PEIR p. 63).

17. Current state and local law and regulations as enforced by Area Fire Control Officer require slash disposal in high risk areas (14 CCR 1545.4). Plus local lopping regs. XX

NA 18. Risk of fire escaping (PEIR p. 62).

18. Compliance with all state and local laws and regulations (14 CCR 1545.4). XX

Other

NA 19. Project may result in significant environmental effects other than those listed in items 1 through 18 above.

19. Effects beyond the scope of the Program EIR will need additional review. (Please consult CDF Forester.) —

NA 20. Unusual circumstances or site conditions indicate that the project may result in unusually severe effects (other than those described in item 8 relating to water quality) which would not be adequately mitigated by the Resource Protection Guidelines.

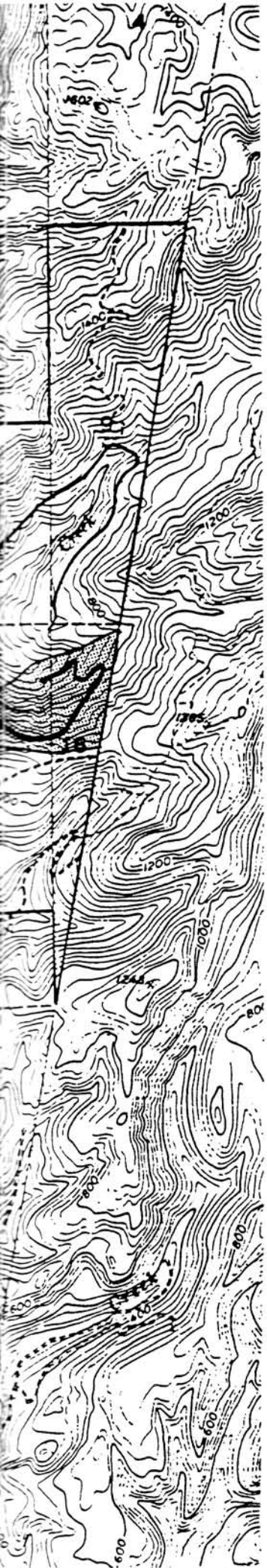
20. Effects beyond the scope of the Program EIR will need additional review. (Please consult CDF Forester). —

Signature of CDF Forester _____ Date _____

Signature of RPF or person preparing checklist _____ Date 8/30/89

FOREST IMPROVEMENT PROJECTS


SWANTON PACIFIC RANCH
SCALE 1:24,000
PAVED ROAD
PRIMARY HAUL ROAD
OTHER ROAD
STRUCTURE
SANTA CRUZ - SAN MATEO TRANSMISSION
Beaside School
Big Creek Powerhouse (Site)
Big Creek Falls
Big Creek Fire Sta.
Swanton
Cooke
Archbald
Molino
Pumping Station
PIPELINE
Res
Creek



FOREST IMPROVEMENT PROJECTS

PROJECT 1

PROJECT 2

PROJECT 3