



ARCATA REDWOOD COMPANY

DIVISION OF ARCATA NATIONAL CORPORATION
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November 6, 1969.

Mr. Bruce Black
U. S. Department of Interior
National Park Service
450 Golden Gate Avenue
San Francisco, California

Dear Mr. Black:

Enclosed is a copy of the J. D. Sinclair watershed
conditions report dated January 1966. As I remember it,
this is the report that Gene Hofsted indicated he would
forward to you.

Yours very truly,

L. J. Chapman / L.P.

L. J. Chapman
Vice President & Treasurer

LJC:lp
Encl.

REPORT OF WATERSHED CONDITIONS
OBSERVED ON LANDS OF THE ARCATA REDWOOD COMPANY

HUMBOLDT COUNTY, CALIFORNIA
JANUARY, 1966

J. D. SINCLAIR
WATERSHED MANAGEMENT CONSULTANT

This report is based upon an examination of watershed conditions on Arcata Redwood Company properties, made under the guidance of Forester Eugene A. Hofsted on January 6 and 7, 1966. The examination was made to appraise the effects of timber harvesting and subsequent land management on soil stability and sedimentation, and to offer recommendations.

The time of this visit was opportune because 9.16 inches of rain had been recorded at the Arcata Redwood Company's Mill B near Orick during the preceding five days. (Annual rainfall here averaged 66.70 inches from July 1, 1954 to July 1, 1965.) This major storm caused severe flooding on most of the rivers and widespread damages in northwestern California. Orick was partially submerged on January 6 by flood waters from Redwood Creek. Flows in this stream as well as in Prairie Creek and its principal tributaries (Streelow, Mae, Lost Man, and Little Lost Man Creeks) were still high and muddy on January 7.

Timber Harvesting

The Arcata Redwood Company began operations in 1945 on lands it has held fee title to since 1906. Harvesting of timber on this 22,500-acre ownership has been limited to 1-1/2 to 2% of the area per year on a sustained yield basis. Selective cutting was practiced in earlier years but the loss of residual trees by wind throw was heavy and the salvage of down timber was difficult and costly. This experience led to re-logging the remaining

timber on selectively cut areas and, since 1959, to a program of clean logging followed by aerial seeding. Thus, the history of forest harvesting here over a period of twenty years provides an opportunity to observe soil stability and the effects of natural forest regrowth on areas selectively cut in earlier years and later re-logged, as well as watershed conditions on areas clean logged and seeded each year since 1959.

Physical Features

The cutover areas observed range from about 200 to 1500 feet in elevation and drain into tributaries of Prairie Creek. Main ridges are generally broad and rounded. Upper slopes are of less gradient than the steep side slopes, and the latter are usually dissected by numerous small drainages. The resulting terrain is very broken.

Soils are generally deep, well drained and underlain by sedimentary rocks. Secondary soils predominate, consisting mostly of Empire series, a sandy loam with some clay; and Hely series, a sandy gravelly loam with little clay. Primary soils include limited amounts of Hugo and Melbourne series, both of medium to fine texture; some Orick series derived from schist; and very small amounts of Atwell series, an unstable black graphitic soil.

Forest site quality is above average to excellent. The natural forest is dominated by dense stands of old-growth coast redwood with Douglas fir, Sitka spruce, and some western hemlock as the principal associates. Understory vegetation is dense.

It includes some hardwood species such as tan oak, California laurel, and big leaf maple, with numerous ferns and shrubs. Red alder occurs along stream channels.

Summary of Observations

Areas were examined in several drainages where dates of timber harvest ranged from 1946-48 to 1965. Streamflow and channel conditions were also observed at the mouths of four other drainages.

A summary of these observations follows:

<u>Drainage</u>	<u>Company Ownership</u>	<u>Logging History</u>
B Line Creek	462 acres	None
300 Road Creek	270 "	Logged 1949-50, re-logged 1963
Davison Creek	138 "	Logged 1945-49
Shop Creeks	122 "	Logged 1945-47

At the mouths of the above drainages, stream channels were stable and banks protected by understory vegetation. Streamflow was clear in B Line Creek and slightly cloudy in the others, due to suspended sediment or organic matter. Flow from 300 Road Creek did not show [?]any effects of the 1963 re-logging in that drainage. *Amazing*

<u>210 Vista Creek</u>	<u>110 acres</u>	<u>Logged 1946-48</u>
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Slopes along road appeared stable and well protected by re-generation of trees and undergrowth 17 to 19 years after logging.

<u>230 Road Creek</u>	<u>194 acres</u>	<u>Logged 1948-58, re-logged 1961</u>
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Stream channel and banks at 230 Road crossing appeared stable and flow was clear.

Upper slopes examined near the end of the 230 Road show effects of logging in 1961. The area is stocked with numerous tree seedlings and regrowth of other vegetation but this young

growth does not cover the soils exposed during logging. There is detailed evidence of soil movement on the rough ground surface where the soil surrounding small rocks has been washed away leaving the rocks on pinnacles of soil, and where eroded soil has been deposited in depressions or on the up-slope side of stumps and logging debris. Surface washing has also created small gullies in some places. Much of this soil movement probably occurred during the first two or three years after logging. There was little evidence of erosion during the recent major storm.

Water bars or barriers constructed on tractor trails in the area have prevented gullying, though some surface washing had occurred between bars.

Mae Creek

1,015 acres

Logged 1950-63

The five areas observed in this drainage had been logged between 1950 and 1959. Progressive changes in the natural regrowth of vegetation as well as the stability of slopes with time since logging are evident. Soils on slopes logged in 1950 are protected by the re-growing forest and well developed ground cover. Minor stream courses appear stable and flows in them were clear.

Tributary streams from areas logged in 1952 and 1954 were also flowing clear and channels appeared stable. There was no evidence of recent soil movement on the slopes which are generally well protected by forest regrowth.

Natural forest reproduction observed on a tributary of

Mae Creek logged in 1956 was dense and 5 to 6 feet high. There was no evidence of recent erosion on the slopes and runoff from them was clear. The surface of an access road with medium gradient, constructed on sandy subsoil, was trenched and the road drains had formed gullies due to inadequate diversion of surface runoff.

An area clean logged in 1959, the Company's first operation of this type, supports a rapidly growing young forest. There was evidence of some soil movement on steep slopes with incomplete soil cover. Flows in small tributary streams from the area were clear, but Mae Creek below the area was colored with suspended sediment. This colored flow was found to come from one fork with drainage from a road above. The sediment could have originated from washing along the road, stream bank erosion, or channel scour.

Streelow Creek

1,320 acres

Logged 1950-64

Areas observed in this drainage had been logged in:

(1) 1950-56; (2) 1957 and re-logged clean in 1960; (3) 1962; and (4) 1964.

Slopes logged between 1950 and 1956 are well protected with the re-growing forest. Channel of the stream draining the area appeared stable and flow in it was clear.

Young trees and other vegetation on the area re-logged clean in 1960 do not provide complete soil coverage, but the soil surfaces still exposed appear quite stable. Runoff from the area was clear.

Slopes logged in 1962 were viewed from a distance. Rapid

forest regrowth is providing partial but obviously not complete protection on the slopes. No gullying or land slides were visible.

Soil movement was evident on moderate to steep slopes in an area clean logged in 1964. Most of the surface soil had been disturbed and the ground left very rough by the logging operations. Soil surfaces are partially covered with natural regrowth and the sites examined are well stocked with small seedlings of forest species as the result of aerial seeding. Runoff in minor drainages on the slopes was clouded with suspended sediment.

Wolf Creek

84 acres

Logged 1957-62

Regrowth of tree seedlings and other vegetation is vigorous and providing good soil protection though not a complete cover. There was little evidence of soil erosion on sites examined. P

Numerous Douglas fir seedlings had been pulled out of the ground by browsing elk at one site.

400 Landings Creek

281 acres

Logged 1960-61

Rapid regrowth of young trees and other vegetation was observed on areas logged in 1960 and 1961 in the vicinity of the Forest Renewal Exhibit. Soil surfaces are only partially covered by this young growth but there is little evidence of recent soil movement on moderate slopes. Some erosion is occurring on steep slopes, from unstable stream banks and where small gullies have been formed by runoff from access roads. Stream courses are sandy but no large deposits of sediment were

observed. Flows in the small streams were almost clear, though the flow in a larger southern tributary logged in 1961 was cloudy.

The largest slide and one of few observed, is in this drainage. It is on a very steep slope traversed by a tractor road on considerable gradient. The slide appears to have been started by construction of the road or runoff from it. Surface of the slide directly below the road is very steep and will probably continue to erode. However, the lowest part or toe of the slide and vegetated slope below it are not as steep and appear stable. This stability prevents material from the upper part of the slide from moving on down the slope.

<u>Lost Man Creek</u>	<u>3,327 acres</u>	<u>Logged 1964-65</u>
(North Fork)	(1,157 ")	(203 acres)

Medium high flow in the North Fork of Lost Man Creek was muddy, probably due to sediment from an area in the headwaters clean logged in 1965. A distant view of this logged area was obtained from Mae Creek but examination was prevented by blowdown trees on the North Fork access road.

<u>Little Lost Man Creek</u>	<u>1,015 acres</u>	<u>Logged 1962-65</u>
		(97 acres)

A recently logged area in the northernmost part of this drainage was observed from Lost Man Creek Road. Some soil sloughing or sliding had occurred on very steep slopes but the material appeared to have lodged on lower segments of the slopes and had not moved into the main stream channel.

A North Creek

232 acres

Logged 1962-64

Gradient of upper slopes is generally moderate but most side slopes are very steep. Ground surface is rough and most of the soil disturbed due to logging. Numerous tree seedlings were observed but regrowth is too young to provide soil protection. Some soil movement was observed, especially on steeper slopes, and minor drainages contain deposits of silt and sand. Runoff was slightly cloudy.

Most of the water bars constructed on the tractor trails were effectively protecting the trails from washing. Ponding of surface runoff had occurred behind some of the bars with inadequate lateral drains and when over-topped, the bars had failed, usually at the side of the trail.

A South

263 acres

Logged 1964-65

Conditions observed on steep slopes along a road in this drainage are comparable to those in the adjacent A North area. Runoff in the minor drainage channels was clouded with suspended sediment. Streamflow from the entire drainage at a culvert on A Line Road was muddy due to suspended material probably washed from the recently logged area, or from erosion of stream banks and channels.

Bald Hills Road Areas

Drove through an area logged in 1954. The slopes are well protected with forest regrowth and are stable.

Examined three areas farther south along the main road that had been clean logged in 1962, 1964, and 1965 respectively. These areas have similar topography. Upper slopes along the

main ridge have gentle to moderate gradients but most side slopes are very steep and are broken into small drainages.

Logging has left much of the surface soil disturbed and ground very rough. Evidences of soil movement, washing in some places and deposition in others, were observed here similar to conditions on other recently logged areas. However, there is very little evidence of erosion on soil surfaces that were not disturbed during logging. This is probably due to higher infiltration capacity or intake of rain water and corresponding lower runoff on the undisturbed soil, compared to the soil that had been disturbed. Deposits of sand, silt, and finer textured material were observed in some of the basins formed by fills where access roads cross small drainages. These deposits are small in relation to the size of the drainage and indicate that soil material moving from these logged slopes into the streams is less than might be expected; further, that eroded material leaving the areas consists mostly of fine soil particles in suspension.

So, what's new?

Some bank sloughing and washing in drains along access roads had occurred but most roads were in very good condition after the recent storm. Water bars had been constructed on tractor trails in the areas and most of the bars had functioned satisfactorily.

Numerous small tree seedlings and other plants are growing on the areas logged in 1962 and 1964, regrowth on the former being more advanced. These areas were seeded to forest species after logging. The area logged in 1965 was to be seeded as soon as weather would permit.

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Discussion

1) Efficient harvesting of old-growth redwood forest is an extremely difficult operation. Any method of harvesting necessarily changes the appearance of the terrain and conditions on the ground. The Arcata Redwood Company has found from experience that carefully conducted clean logging followed by burning of the inflammable logging trash to reduce fire hazards, then aerial seeding of desired forest species are the most effective methods of harvesting and regenerating the forest on its lands.

2) Clean logging affects watershed conditions and functions in several ways. However, the magnitude of these effects diminishes in time with regrowth of the forest and stabilization of the surface soil.

A) Removal of the forest eliminates rainfall interception and loss by evaporation from the vegetation. This increases the amount and changes the distribution of rain reaching the ground. Fog condensation on the vegetation and drip from it also are eliminated. After logging, some rain is still intercepted by tree stumps and logging debris on the ground. Further, clear cutting the forest eliminates water loss from the soil through transpiration of the vegetation. This is offset in part by increased evaporation from exposed soil surfaces. Specific quantities of water involved in these changes under local conditions are unknown, however research elsewhere indicates that removal of

the forest increases the amount of water available for surface runoff or underground flow.

B) Disturbance of the forest litter and the soil during clean logging is extensive but unavoidable. Access roads and tractor trails must be constructed. Special beds of loose soil are prepared, upon which large trees are felled as a means of reducing breakage. Use of heavy equipment is required to remove the logs from the site.

During these operations much of the forest floor is disturbed, surface soils are mixed with subsoils, and soil structure is changed by movement or compaction. The infiltration capacity and permeability of the disturbed soil are probably reduced, thus causing increased surface runoff and erosion.

Surface of the ground after logging is usually very rough and protected only by unburned logging debris. This surface roughness may have both beneficial and detrimental watershed effects. The numerous depressions retard surface runoff, induce infiltration of water into the soil, and trap soil moving down the slopes. On the other hand, runoff may be diverted and concentrated by the depressions or by the ridges of soil causing soil washing, the formation of gullies, and increased erosion.

C) Evidences of surface runoff and soil movement were observed on slopes clean logged in recent years, and streams draining some of these areas were carrying suspended sediment, as reported earlier. Although local measurements are not available, erosion of the bared soils generally appeared to be much less than might be expected after harvesting the forest. It was also evident on other slopes that their stability increases with time after logging as the forest re-grows. Further, it appears that most soil movement takes place during the first three or four years after logging and that normal stability on the slopes can be expected within about ten years. The amounts of sediment in streams draining the areas should follow the same diminishing trends after forest harvesting. However, the effects of harvesting on runoff may continue longer until the infiltration capacity and permeability of the disturbed soil have been restored.

3) Some practices employed by the Arcata Redwood Company help to reduce soil erosion and sedimentation resulting from harvesting the forest.

A) Main access roads are very well planned and constructed. Drainage is generally good and the roads are well surfaced with rock. As a result, erosion from the roads is reduced to a minimum.

B) The construction of water bars or barriers on tractor trails as soon as logging has been completed is an effective means of preventing surface erosion and the formation of gullies by concentrations of runoff on the trails. Most of the bars observed had functioned well but some had washed out due to inadequate lateral drains, and surface washing had occurred between bars on some trails with steeper gradients.

4) When logging has been completed, the controlled burning of debris to reduce fire hazards and the probability of forest regrowth being destroyed by future fires is beneficial from the standpoint of watershed protection as well as forest management. However, the burning of organic matter and trash remaining on the surface of the soil may cause some increase in runoff and erosion.

5) Land slides are not an important source of soil movement in the areas observed. Only one moderate slide, probably resulting from road construction, was seen, and material from it had not moved beyond the stable slope below the slide.

6) Although the natural regrowth of vegetation is rapid after timber harvesting, the aerial seeding of forest species aids in the development of a well distributed forest cover on the watersheds.

Recommendations

From the watershed management standpoint all feasible means should be taken to minimize potential erosion hazards after clean logging. The current practice of constructing water bars on tractor trails is an excellent example. Most of the bars observed were effectively preventing surface erosion and gullyng on the trails. Some bars had been partially washed out when over-topped by ponded runoff due to inadequate lateral drainage from the bars. Lateral drainage from each bar is needed to divert runoff from the trails onto adjacent slopes or into natural stream channels. Some hand work may be required to accomplish this, but bars that fail may cause more erosion than would have occurred without them. Water bars at more frequent intervals on trails with steep gradients are also recommended to reduce surface washing between bars.

Terracing the slopes as commonly practiced on agricultural lands and on some wildlands is not considered practical here due to roughness of the terrain where erosion hazards are greatest, and to the problem of unburned logging debris left on the ground.

Seeding of a rapid-growing but temporary cover crop to protect the bare soil surfaces from erosion after clean logging is recommended on a trial basis. The results of hand seeding trials on plots might be used as a basis for aerial seeding after logging, at the same time that tree species are seeded. Plants recommended for trial are domestic annual rye grass (Lolium multiflorum) and Montana Trieste or Indian mustard (Brassica juncea). They might be tried separately and as a mixture. Rye grass should be broadcast alone at 6 to 8 lbs. per acre, and mustard at about 5 lbs.,

or both as a mixture of 4 lbs. each per acre. Seed of both plants is comparatively inexpensive. Mustard is a pest to the stockman and the grain farmer but it has been used for years as a cover crop in orchards. It grows rapidly from seed and the broad basal leaves soon provide protection to the soil. Annual rye grass grows slower than mustard but the mature grass provides a better soil cover than the dry mustard plants at the start of the second rainy season. Both plants grow well as associates so trial of the mixture is suggested.

The proposed temporary cover crop would compete with tree seedlings for moisture and light. However, soil moisture may not be a critical factor in the humid areas being considered, and light also may not be a critical factor in the growth of the tree seedlings. The cover crop when dry would also increase fire hazard. This factor should be evaluated by someone experienced in that field.

Forest harvesting should be done by the smallest units feasible to distribute and minimize the effects on runoff and erosion. Clean logging by the "patch" method is desirable from the watershed management standpoint. In other words, the total potential effects from 10 patches of 50 acres each, surrounded by undisturbed forest, would probably be less than the effects from 500 acres clean logged as a single unit. This is due to several factors including the effects of increased runoff and erosion from the longer slopes in the larger units. The patch method may not be considered feasible by the Arcata Redwood Company but any reduction in the size of the forest units

harvested would be beneficial in reducing erosion and sediment hazards.

Some suspended sediment sampling in local streams has been done recently by the Company to obtain information concerning the effects of forest harvesting on sediment yields. This information is badly needed but it must be based upon an adequate plan of sampling and use of recognized techniques in obtaining and analyzing the data if the results are to be considered valid. Sediment samples should be obtained that can be related to rates of streamflow before and after logging. This is a sizable task requiring more than one year of observations. If not done properly the effort involved will probably be wasted. A cooperative project with an agency working in the field of sedimentation might be the most efficient means of obtaining the desired information.

I wish to acknowledge the assistance received from Mr. Hofsted in the field and in providing maps and other information used in the preparation of this report.

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