Water Quality Management Plan
Rogue River Basin
Illinois River Sub Basin

Siskiyou National Forest
Oregon Department of Environmental Quality, Medford Office

March 1, 1999

Watershed at a Glance	
Watershed	Sucker Creek (62,100 acres) USFS Ownership (42,000 acres) BLM Ownership (5,800 acres) Private Ownership (12,000 acres) State/County Ownership (300 acres) Caves National Monument (500 acres)
Stream Miles	Total (428 miles) Perennial (285 miles) Federal Ownership (353 total) (225 perennial) Private Ownership (75 total) (60 perennial)
Watershed Identifier	1710031103 (Hydrologic Unit Code)
303(d) listed Parameters	Temperature, Habitat, and Flow
Key Resources and Uses	Salmonids, Domestic, Agricultural, Industrial
Known Impacts	Mining, Timber Harvest, Roads, Water Withdrawals

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Statement of Purpose

This water quality management plan is prepared to meet the requirements of Section 303(d) of the 1972 Federal Clean Water Act.

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DEQ WQMP Element Location

A Table of Contents for location of the DEQ elements within the Sucker/Grayback WQMP is provided below:

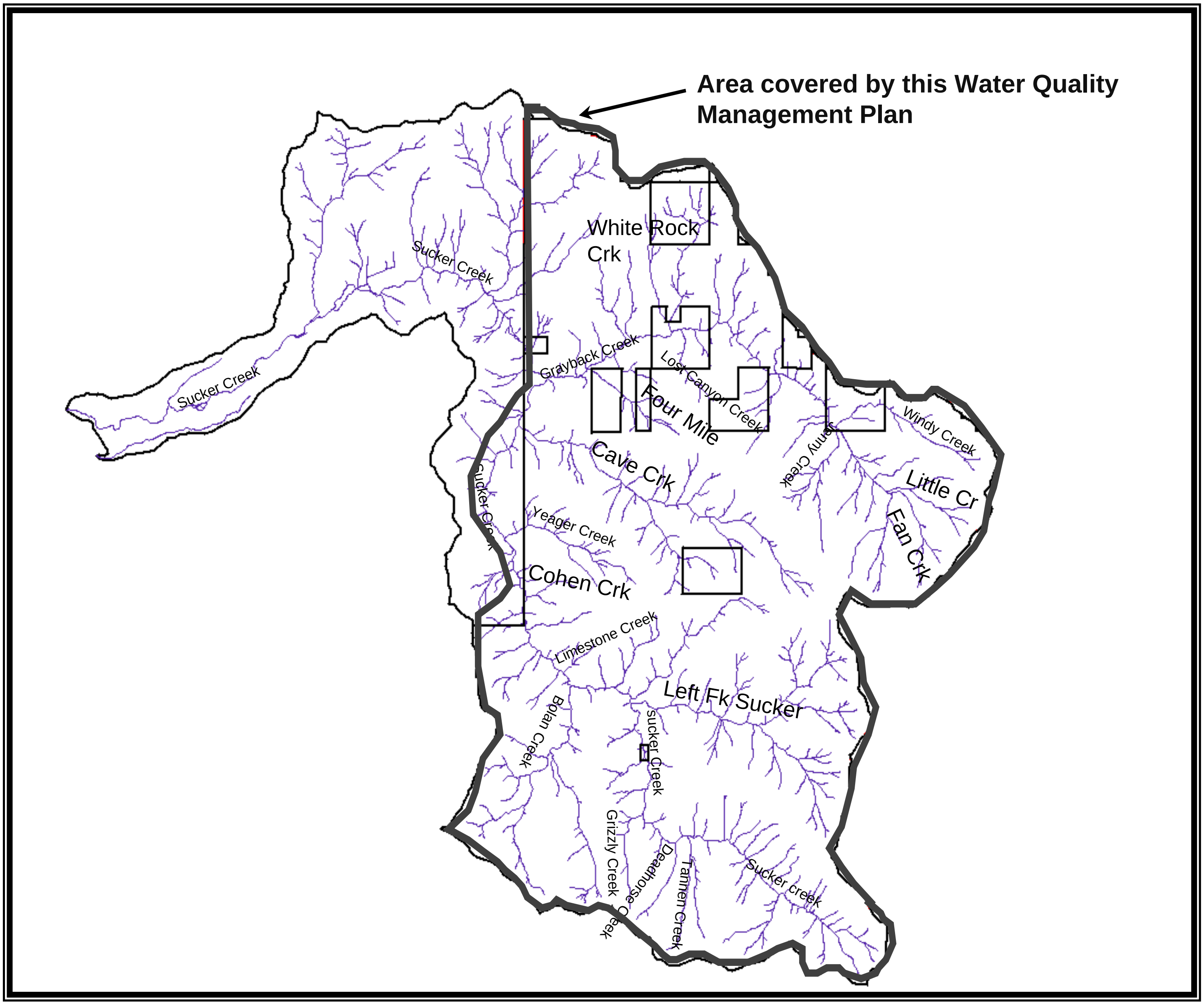

Figure 1. Sucker Creek Watershed

Chapter 1 - Project Overview

INTRODUCTION

Sucker-Grayback is a 62,100-acre watershed that is tributary to the Illinois and Rogue Rivers in SW Oregon.

Table 1

Ownership Boundary	Sucker Creek Watershed	Within USFS
USFS	62,000	42,000
BLM	5,800	
Private	12,000	2,890
State/County	300	
Caves National Monument	500	500

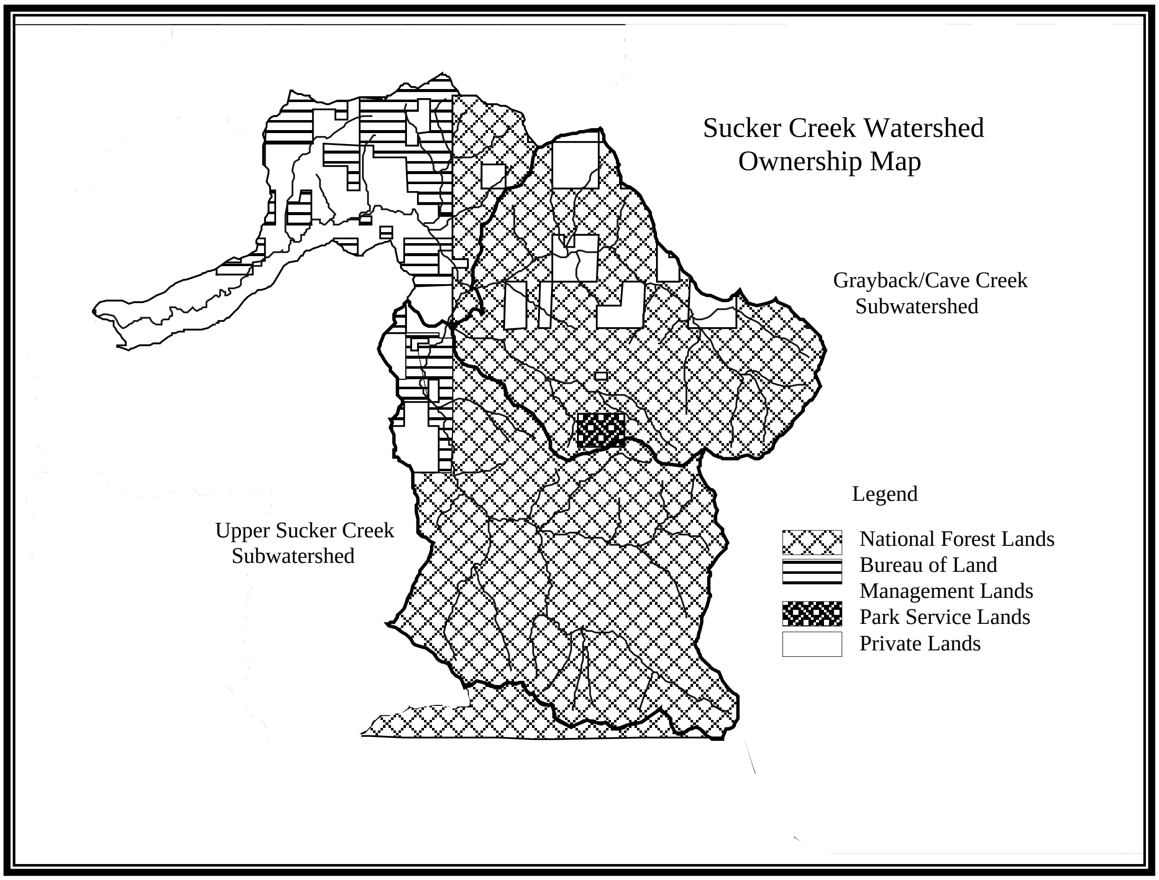

Figure 2. Sucker Creek ownership map.

The area covered by this plan includes land managed primarily by the U.S. Forest Service and BLM. It covers from the headwaters down to just below the confluence of Sucker-Grayback Creek at approximately RM 10.4 of Sucker Creek. This portion of Sucker-Grayback Creek is a key watershed as defined by the President's Northwest Forest Plan (1995, USDA, USDI). There are no point source discharges within the Sucker Creek watershed.

Inherently, Sucker Creek is a high value salmonid fish watershed. It is one of the few watersheds in the Siskiyou Mountains with substantive snowpack most years and good cold water flow. Despite the perturbances caused by mining, timber harvest, and downstream agriculture uses, Sucker Creek has good numbers of Coho salmon, Chinook salmon, and winter steelhead spawning during many years. Sucker Creek is a very high priority for protection and restoration, one of the most important anadromous fish watersheds in the Rogue River basin.

Private land within the area covered by this WQMP is managed under the Oregon Forest Practices Act. A subsequent Water Quality Management Plan will be written by Oregon DEQ to cover the remainder of the Sucker Creek watershed. The Sucker-Grayback WQMP covered in this current document is intended to be adaptive in management implementation. It allows for future changes in response to new information. Information generated during development of the private lands WQMP may cause modifications to this current plan for the federal lands.

Listing Status

Beneficial uses include domestic water supply, irrigation, livestock watering, industrial (mining), and cold water biota (salmonid). The Oregon Department of Environmental Quality placed this watershed on the 1994/1996 303(d) list for the following parameters identified in Table 3:

Table 2
303d Listing

Location	Parameter
Grayback Creek, Mouth to Headwaters	Habitat Modification
Sucker Creek , Mouth to Bolan Creek	Habitat Modification Flow
Sucker Creek, Mouth to Grayback Creek	Temperature
Lake Creek, Mouth to diversion	Temperature

Stream temperatures exceed the standard on Sucker Creek between June and September from the mouth upstream to the confluence with Grayback for the five years of record (1993-1997). The 1998 303(d) list approved by EPA to modified the temperature listing to read from the mouth of Sucker Creek to Grayback Creek. While the 1998 water quality limited status for temperature is below the Forest Service boundary, this analysis is relevant to answer the question regarding whether lands under Federal management are providing the coolest water possible to downstream uses. This document will show to what extent water is being warmed, and what factors are contributing to that warming.

Table 3
Grayback/Sucker Temperature Summary
Summer Water Temperatures Only - June to September

Water Quality Station	Years of Record	Average 7-Day High All Years	Average 7-Day High 1994 - 1997
Sucker Ck. @ Mouth Elevation 1360’	1993 -1997	71.9 F	72.3 F
Sucker Ck. blw. Little Grayback	1993 -1997	66.9 F	65.7 F
Sucker Ck. @ Bolan Ck.	1994 -1997	59.9 F	59.9 F
Sucker Ck. @ Tannen Ck.	1994 -1997	58.3 F	58.3 F
Grayback Ck. @ Mouth (1,840 feet elevation)	1991 -1997	61.9 F	61.6 F
Grayback Ck. below Mossback	1994 -1995	59.5 F	NA
Cave Ck. near Mouth	1977, 1980, 1994	62.9 F	NA
Bolan Ck. @ Mouth	1978-81,94-97	57.9 F	57.2 F
L.F. Sucker Ck. @ Mouth	1992-1997	58.9 F	59.0 F

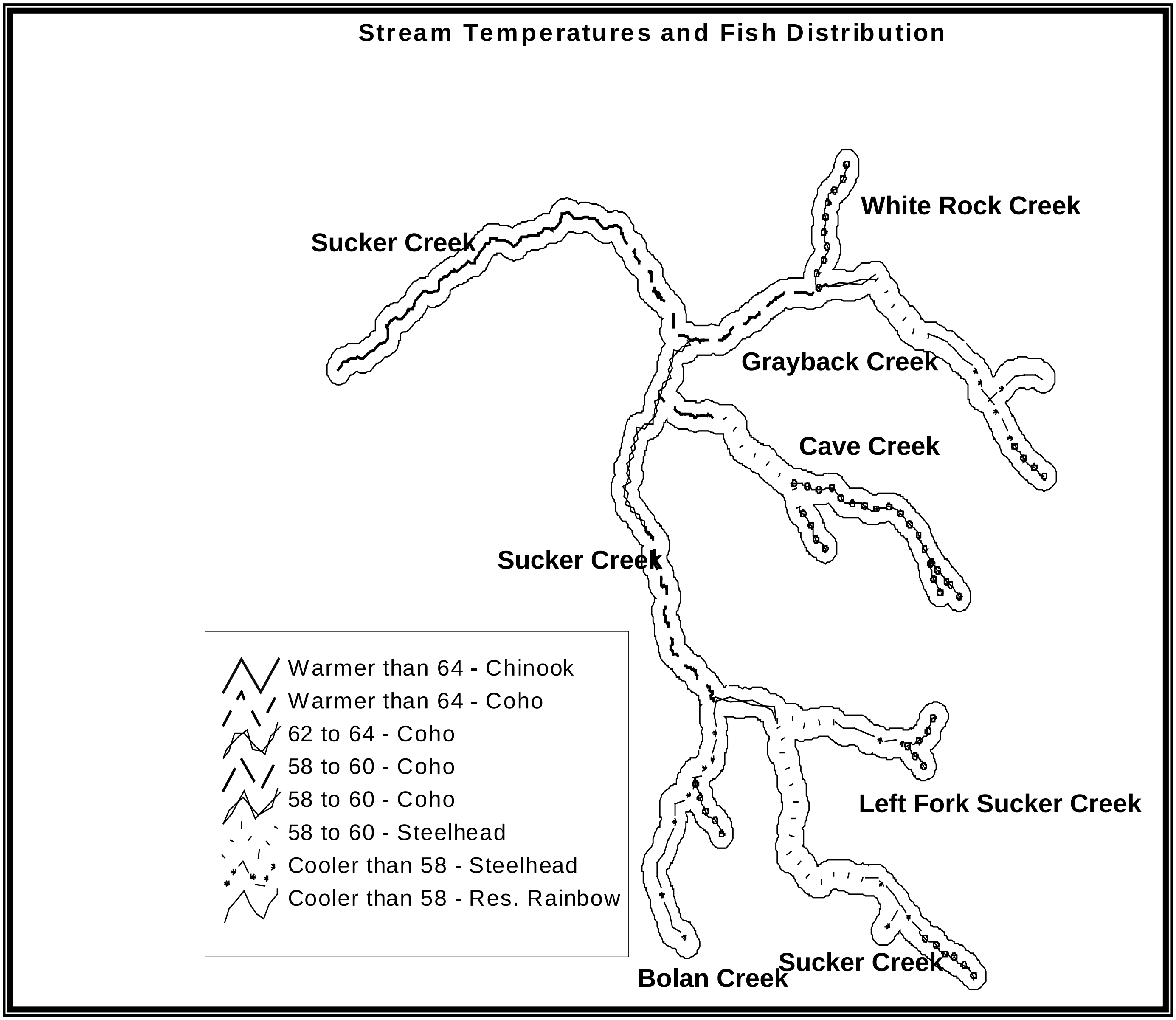

Figure 3. Stream Temperature and Fish Distribution

SEASONAL VARIATION IN TEMPERATURE AND FLOW

Section 303(d)(1) requires the TMDL's "be established at a level necessary to implement the applicable water quality standard with seasonal variations." Both stream temperature and flow vary seasonally and from year to year. Water temperatures are cool during the winter months, and only exceed the State standard between the summer months of June and September when stream flows are lowest and solar radiation is the highest.

Stream Flow

The 7-day low flows for the gage at Little Grayback Creek for the period of record from1942 to1990 have varied from 13 cfs in 1975 to 35 cfs in 1983. Low flows generally reflect annual precipitation levels with higher low flows in wetter years and lower summer flows in drier years. Variation in low flow from year to year is typical for this stream system.

Table 4
Stream Temperature

Name	**Period of Record**	**7 Day Max (F)**	**7 Day Max Range for Period of Record (F)**	**Day Over 64 F**	**Diurnal Flux (F)**
Sucker Creek at Forest Boundary	**1992**	**63.3**	**No range (data for 1992 only)**	**0**	**5.5**
Grayback Creek at Mouth	**1991 to 1997**	**61.9**	**4.2**	**0**	**6.0**

Responsible Parties

Participants in this plan for Federal lands include DEQ, BLM, and the USFS. The USFS is the lead agency in this plan, due to the large percentage of land in this watershed under Forest Service management. Federal land managers have worked out schedules for completion of WQMP's required on Federal lands. During those scheduling discussions, the Federal land managers agreed that the largest Federal landowner within the watershed would be the lead agency for plan completion, implementation, and management for the Federal lands.

A subsequent WQMP for the remainder of the watershed will be developed by DEQ and the Oregon Department of Agriculture. That WQMP will deal with private lands, including private forest lands within the Federal boundary, as well as non-resource lands and agricultural lands. The Agricultural WQMP is scheduled for completion in the fall of 1999. The private lands under DEQ responsibility are also scheduled to be completed in 1999.

The Oregon Department of Forestry (ODF) is the Designated Management Agency (DMA) for regulation of water quality on non-Federal forestlands. The Oregon Board of Forestry in consultation and with the participation and support of DEQ has adopted water protection rules in the form of BMP's for forest operations. These rules are implemented and enforced by ODF and monitored to assure their effectiveness. ODF and DEQ will jointly demonstrate how the FPA, forest protection rules (including the rule amendment process) and BMPs are adequate protection for water quality.

Oregon Water Resources Division (WRD) is a participant within the implementation and monitoring components of this plan. WRD will be doing flow measurements, and will also be trying to identify opportunities for converting consumptive uses to instream rights.

The Oregon Department of Geology and Mineral Industries (DOGAMI) is also a participant with respect to mining impact assessment and permit modifications. DOGAMI covers mining operations which exceed 1 acre of disturbance or 5000 cubic yards of production within a 12-month period. Operators are required to obtain an operating permit if they are located above the 2-year floodplain of creeks and rivers.

Public Involvement

This WQMP is a procedural step that focuses on Water Quality using elements of the Northwest Forest Plan (NWFP). It tiers to and appends the Grayback Sucker Watershed Analysis. Watershed analyses are a required component of the Aquatic Conservation Strategy under the NWFP. The Record of Decision (ROD) for the NWFP was signed in April of 1994, following extensive public review.

Public involvement was integrated into the development of the Grayback-Sucker Restoration Prioritization Plan (See Appendix A). This was a cooperative effort by the Illinois Ranger District to work with private citizens and watershed councils to restore lands in a multi-ownership watershed. Some of the restoration projects identified in the WQMP will be required to go through the NEPA process. These projects will require further public involvement.

In addition to ongoing communication with the Illinois River Watershed Council and the Illinois Valley Soil and Water Conservation District DEQ held a public hearing on this proposed WQMP on December 9, 1998. Public comment was solicited through a notice of public hearing issued by DEQ on November 24, 1998. Interested parties had the opportunity to submit comments through January 15, 1999.

Chapter 2 - Condition Assessment/Problem Description

PARAMETER 1. *STREAM TEMPERATURE* **(See Also Appendix G)**

For the listed parameter stream temperature, the beneficial uses affected are: Resident Fish & Aquatic Life, Salmonid Fish Spawning & Rearing. The standard for the Illinois Basin requires that the seven (7) day moving average of the daily maximum shall not exceed 64 degrees Fahrenheit. A stream is listed as Water Quality Limited when the rolling seven (7) day maximum average exceeds the standard.

Stream temperature is driven by the interaction of many variables. Energy exchange may involve solar radiation, longwave radiation, evaporative heat transfer, convective heat transfer, conduction, and advection (e.g., Lee 1980, Beschta 1984). While interaction of these variables is complex, certain of them are much more important than others (Beschta, 1987). For a stream with a given surface area and stream flow, any increase in the amount of heat entering a stream from solar radiation will have a proportional increase in stream temperature (Brown, 1972). Solar radiation is the singularly most important radiant energy source for the heating of streams during daytime conditions (Brown, 1984, Beschta, 1997) (See Appendix G).

Management activities can increase the amount of solar radiation entering a stream by harvesting riparian shade trees and through the introduction of bedload sediment resulting in increases in the stream's surface area. In addition to increases in solar radiation, water withdrawals during summertime may exacerbate maximum temperatures as demonstrated by Brown's equation (Brown, 1972). The Grayback/Sucker Water Quality Management Plan was developed addressing stream shade, changes in channel form, and flow as the three management factors contributing to water temperature problems.

Disturbance of the riparian area and stream channel from wild fires and storms can also lead to increases in summer stream temperatures. This is considered part of the natural processes, and are expected change agents considered in the Aquatic Conservation Strategy (FEMAT, 1993). Sucker Creek has a frequent fire history with return interval averaging 18 years (J.Agee, 1993, T. Atzet, 1988). Recovery of riparian vegetation in areas disturbed by fire and flood will most likely be offset by future events. The gain and loss of riparian vegetation by natural process will fluctuate within the range of natural variability for this watershed and is outside the scope of this assessment. This WQMP focuses on areas where Federal management activities have exacerbated natural disturbance and affected water quality.

TEMPERATURE FACTOR 1. Stream Shade

Without riparian shade trees, most incoming solar energy would be available to heat the stream. Riparian vegetation can effectively reduce the total daily solar heat load. The stream shade assessment determined where stream shade has been reduced by timber harvest and placer mining and calculated the resulting increase in total daily solar heat loading. To determine where shade problems exist and the magnitude of the problem, the stream network of both Sucker and Grayback Creeks were broken down into sections consisting of the main stem and its tributaries.

Tributaries contributing 5% or more of stream flow to the main stem, as measured at the point of confluence, were considered to significantly influence main stem temperatures and were included in the assessment. Shade values were estimated using shade curves generated from the shade model "SHADOW", see appendix B.

Target shade values represent the maximum potential stream shade in harvested or mined areas. This is a calculated value based on reaching site potential tree height and the resulting shade, given the stream channel characteristics for that area. Table 5 displays the existing and target shade values for the main stem Sucker Creek and its tributaries. Summarized values for Sucker Creek and its tributaries are shown in Table 6.

Table 5
Sucker Creek and its tributaries - current shade conditions and potential recovery

Location (2)	% Flow of Main Stem (1)	%Existing Shade	% Target Shade	Shade Loss	Type of Disturbance	Years to Full Site Potential Recovery
Main Stem		52 52	65 53	-13 -1	Mining Harvest	100 60
Tannen Ck	30	86	89	-3	Harvest	10
Deadhorse	15	77	86	-9	Harvest	45
Grizzly Ck	17	82	89	-7	Harvest	35
<u>LF Sucker</u>	**<u>30</u>**	**<u>69</u>**	**<u>85</u>**	**<u>-16</u>**	**<u>Harvest</u>**	**<u>50</u>**
Limestone	6	68	89	-21	Harvest	50
Bolan Ck	20	76	81	-5	Harvest	35
<u>Cohen Ck</u>	**<u>5</u>**	**<u>40</u>**	**<u>88</u>**	**<u>-48</u>**	**<u>Harvest</u>**	**<u>50</u>**
Yeager Ck	7	73	89	-16	Harvest	35
<u>Cave Ck</u>	**<u>20</u>**	**<u>73</u>**	**<u>85</u>**	**<u>-12</u>**	**<u>Harvest</u>**	**<u>50</u>**

Larger font and underline indicates areas of highest priority for recovery.

<u>Note:</u>
1. "% Flow of main stem" is at the point of confluence between the tributary and Main Stem. This represents of how much influence the tributary has on main stem temperatures.
2. Tributaries are listing in order starting from the headwaters down.

Table 6
Total shade values for Sucker Creek and its tributaries

Type of Disturbance	**% Existing Shade**	**Shade Loss by Disturbance**	**% of Target Shade**	**Years to Full Site Potential Recovery**	**Proposed Treatment**
SUMMARY Harvest & Mining	**68**	**-13**	**81**	**100**	**Silvicultural Work to Plant Trees, Increase Tree heights and Canopy Density -Increase Stand Vigor**

On the main stem of Sucker Creek, mining is responsible for the greatest reduction of stream shade. Mining operations include placer mining within the channel and floodplain of Sucker Creek. For the tributaries of Sucker Creek, the greatest loss of shade from management is due to harvest of trees in the riparian area. Considering both percent flow contribution and shade loss, the Left Fork Sucker, Cohen Creek and Cave Creek are highest priority to reach target shade values. Based on Brown's findings that an increase in solar radiation entering a stream (loss of stream shade) will have a proportional increase in stream temperature, a 13% loss of shade from human disturbance has had a small-to-moderate effect on increasing stream temperature on Sucker Creek above its confluence with Grayback.

Grayback Creek

Tables 7 and 8 display the existing and target shade values for main stem of Grayback Creek and its tributaries, and an overall summary for Grayback Creek.

Table 7
Grayback Creek and its tributaries - current shade conditions and potential recovery

Location (2)	**% Flow of Main Stem** (1)	**%Existing Shade**	**% Target Shade**	**Shade Loss**	**Type of Disturbance**	**Years to Full Site Potential Recovery**
Main Stem		44	57	-13	Harvest	45
Fan Ck	**20**	**41**	**86**	**-45**	**Harvest**	**45**
Little Ck	**30**	**30**	**86**	**-56**	**Harvest**	**45**
Jenny Ck	**30**	**53**	**79**	**-26**	**Harvest**	**50**
Windy Ck	25	65	78	-13	Harvest	50
Four Mile Ck	**27**	**27**	**58** (3)	**-31**	**Harvest**	**45**
White Rock	**15**	**63**	**86**	**-23**	**Harvest**	**50**
LostCanyonCk	5	54	69(4)	-15	Harvest	50

Bold and underline indicates areas of highest priority for recovery. Note:

1. "% Flow of Mainstem" is at the point of confluence between the tributary and mainstem. This represents how much influence the tributary has on mainstem temperatures.
2. Tributaries are arranged in order starting from the headwaters down.
3. The lower weighted target shade value for Four Mile Creek reflects damage to riparian areas from the December 1996 flood. USFS harvest units located on Four Mile Ck have a target shade value of 86%.
4. The lower weighted target shade value for Lost Canyon Ck is due to harvest on private land. USFS harvest units located on Canyon Ck have a target shade value of 86%.

Table 8
Total shade values for Grayback Creek and its tributaries

Type of Disturbance	**% Existing Shade**	**% Shade Loss by Disturbance**	**% Target Shade**	**Years to Target Shade**	**Proposed Treatment**
Harvest (USFS)	**49**	**-22**	**71**	**50**	**Silvicultural Work to Plant Trees, Increase Tree Heights and Canopy Density - Increase Stand Vigor**

For Grayback Creek, the greatest loss of shade from management is due to harvest of trees in the riparian area which caused a 22% increase in solar exposure. Grayback contributes 36% of the stream flow at the confluence of Sucker Creek. Considering flow and the amount of shade loss, Grayback does contribute to increases in stream temperature on Sucker Creek. For the tributaries of Grayback Creek, the highest priority to reach target shade values are Fan Creek, Little Creek, Jenny Creek, Four Mile Creek and White Rock Creek. Shade recovery on these tributaries will reduce summer temperature on the lower main stem of Grayback Creek.

Within the Forest boundary, 7% of the land is under private management. Because of different forest practices guidelines on Federal and private lands and the lack of information on future private management, target shade values do not include recovery of riparian vegetation on units under private management. (See appendix F and Margin of Safety, Timber Harvest on Private Land).

Summary and WQMP Targets

Table 9
Total shade values for Sucker Creek including Grayback Creek

Type of Disturbance	% Existing Shade	Shade Loss by Disturbance	% Target Shade	Years to Full Site Potential Recovery	Proposed Treatment
Harvest	**60**	**-14**	**74**	**60**	**Silvicultural Work to Plant Trees, Increase Tree Heights and Canopy Density. Increase Stand Vigor**

For Sucker Creek, including Grayback at the Forest boundary, management activities have increased solar exposure 14% by the removal of shade trees (Table 9). The highest priorities for shade recovery are four tributaries of Grayback Creek: Fan Creek, Little Creek, Four Mile Creek and White Rock Creek. Target shade value (or optimum shade recovery in managed areas) is expected to occur in a 60-year time period, much of the gain will be achieved by 2013. Shade gain over time is displayed in the Recovery Plan Section (Figure 8). Natural disturbance such as floods and wildfire can remove large areas of stream shade and offset any shade recovery in managed areas, as well as areas of past natural disturbance.

Solar energy is directly related to shade and can be used to give numeric value for a Total Daily Maximum Load (TMDL). A load value has been calculated based on existing and predicted shade values. While this loading does not have direct value to guide management strategies for temperature recovery, it is needed to satisfy 303(d) requirements as interpreted by EPA and DEQ. Table 10 displays the overall existing and target loading for the watershed within the Forest Service Boundary. Existing and target loading for each tributary and the main stem can be found in Table 5 of appendix G.

The target value is the load capacity (TMDL), and provides a reference for calculating the amount of pollutant reduction needed (solar energy). Target loading capacity is the average stream heat load value projected for site potential trees in managed stands.

Table 10
Target Solar Loading or TMDL

Existing Solar Loading	Target Solar Loading or TMDL	Reduction Needed
976 BTU/ftsq/day (3.07 Kwh/sqm/day)	**634 BTU/ftsq/day** (2.0 Kwh/sqm/day)	**342 BTU/ftsq/day** or 54% (1.07 Kwh/sqm/day)

TEMPERATURE FACTOR 2. **Channel Form**

Changes in sediment input and discharge can lead to a change in channel form (Leopold, et al., 1964; Megahan, et al., 1980). When sediment input increases over the transport capability of the stream, sediment deposition can result in channel filling, thereby increasing the width-depth ratio. An increase in channel width will increase the amount of solar radiation entering a stream. A wide, shallow stream will heat up faster than a narrow, deeper stream with the same discharge (Brown, 1972). During storm events, management-related sources can increase sediment inputs over natural, and contribute to channel widening and stream temperature increases.

The classification of rivers is an organization of data on stream features into discreet combinations (Rosgen, 1994). Rosgen stream classification system has eight stream types. For each stream type, a “most frequent range” of values is given for morphological descriptions, such as width-depth ratio. Rosgen’s stream classification system and width-depth ratios ranges by channel type can be used as an indicator of where increased stream width may result in increased solar radiation. Sucker and Grayback creeks were surveyed in 1997 using the Region 6, US Forest Service, Level II Stream Survey method. The stream survey collected width-depth ratios and did Rosgen stream typing. Figures 4 and 5 display the results of where channel widening may contribute to increases in solar radiation entering Sucker and Grayback creeks.

There has been considerable channel widening on Sucker Creek in the mining areas upstream of Grayback Creek to Yeager Creek. A meandering pool/riffle stream with connectivity to adjacent floodplains is characterized as a Rosgen “C” channel and is the expected channel form of this

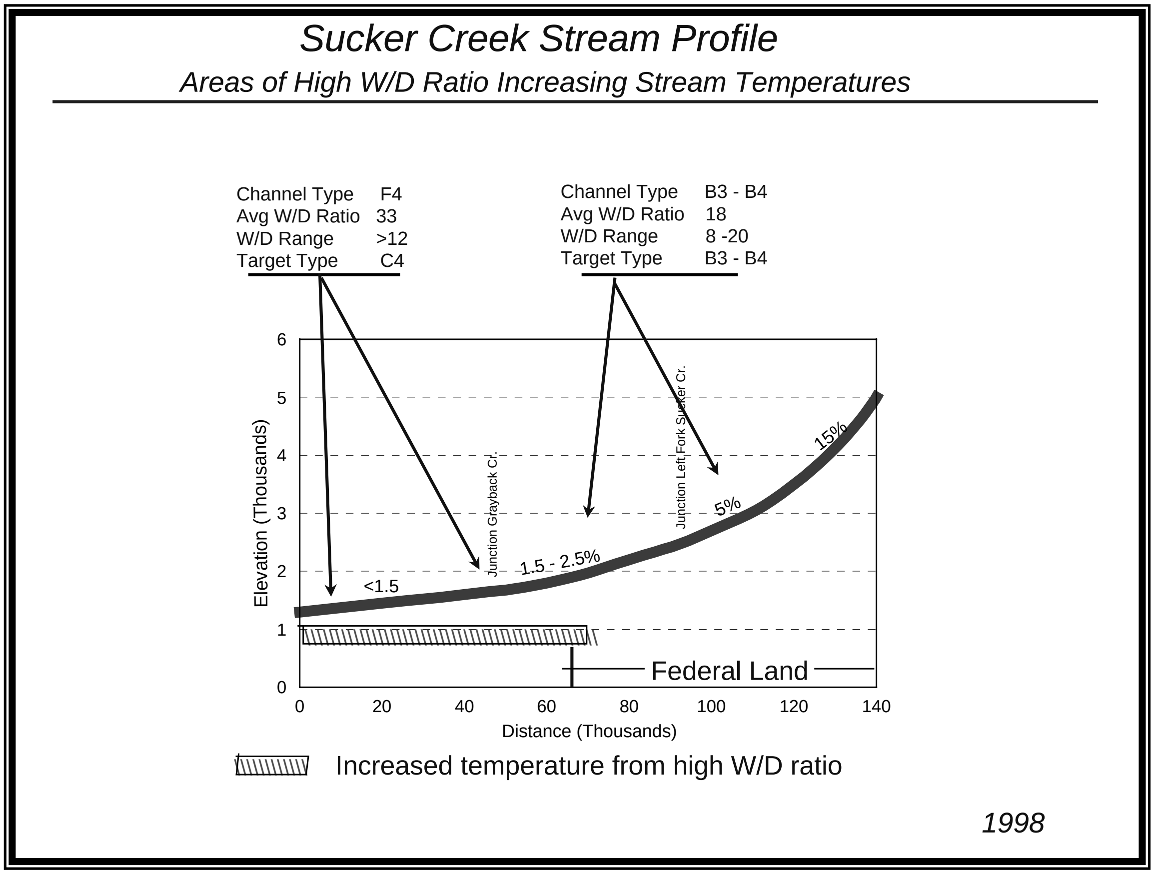

Figure 4. Longitudinal profile of Sucker Creek showing areas where channel widening has occurred.

stream segment. Aside from inclusions of more confined channel types, the dominant existing channel type is a “F4”. F4 channels are entrenched, meandering riffle/pool. An “F4” channel is extremely sensitive to disturbance and has a poor recovery potential (Rosgen, 1994). Changes in the channel probably occurred from natural disturbance, mining, and sediment sources in this stream segment. No other areas on Sucker Creek appear to have a channel width greater than expected.

The additional width has increased solar radiation in the “F4” stream section by 15%. The increased channel width is already figured into the existing shade values. The shade curves in Appendix B were used to estimate shade values in the WQMP. To estimate shade requires knowing the tree height and wetted stream width for each stream reach. Existing wetted widths are either measured or estimated from aerial photos and then used to determine stream shade. This method incorporated existing widths, which includes channels that are wider than expected because they are aggraded from sediment, into the shade section, and TMDL value.

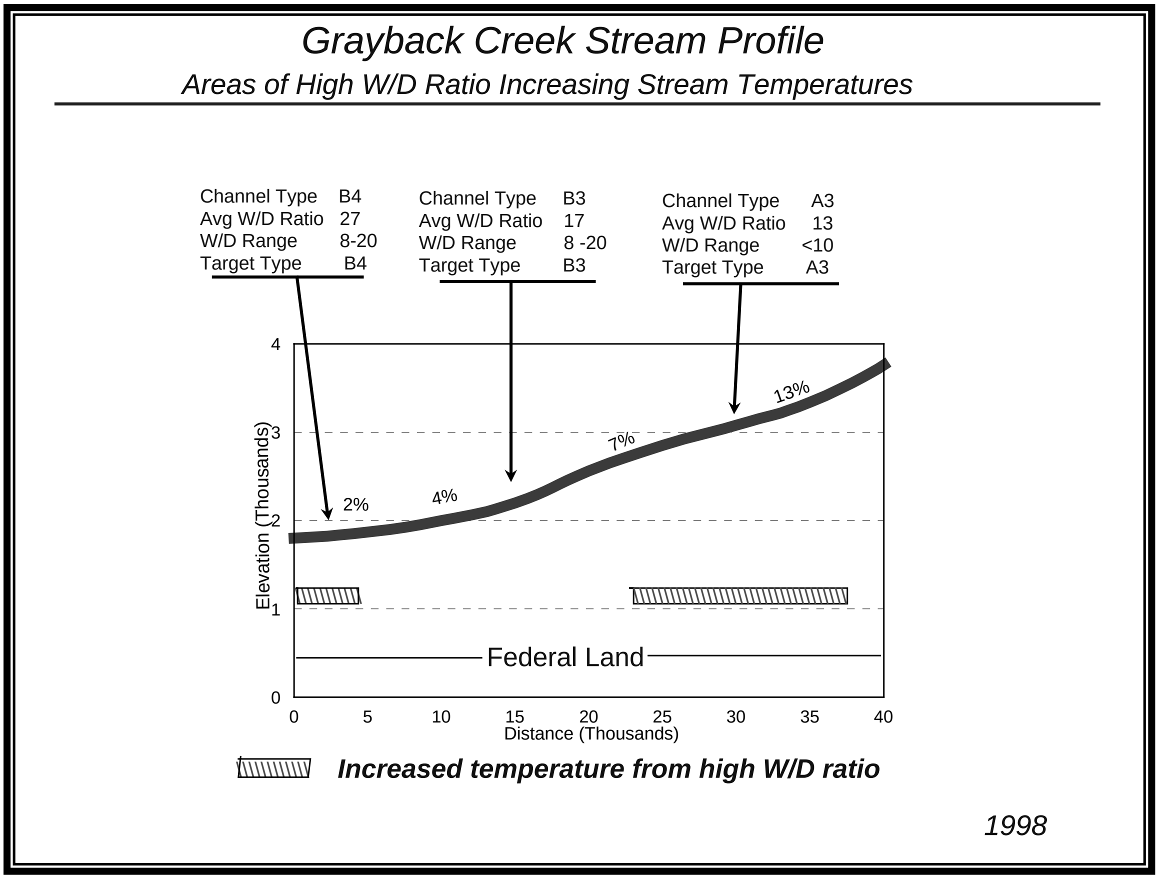

Figure 5. Longitudinal profile of Grayback Creek showing areas where channel widening has occurred.

On Grayback Creek there are two areas where channel widening may have occurred. In the upper reach from river mile 4.7 to 7.1, the channel is an "A3" steep, cascading step pool. In this area the w/d ratio exceeds expected by 3 units. The width-depth ratio values can vary by +- 2 units without showing a different morphology (Rosgen, 1994). During the storm of 1996, large amounts of sediment were introduced into the stream from natural and harvest-related landslides as well as road failures. Some widening may have occurred. The vegetation is of sufficient height in this area such that a small increase in stream width will not result in increases in solar radiation.

On Grayback Creek, from the confluence with Sucker Creek to river mile 0.75, stream widening is contributing to increases of solar radiation to the stream. The channel has increased in width approximately 10 feet from increases in flow and sediment. A "B4" channel is moderately sensitive to disturbance, and has an excellent recovery potential (Rosgen, 1994). The additional width has increased solar radiation to the lower 0.75 miles of stream by 7 percent. The increased channel width is already figured into the existing shade values as described in the Sucker Creek discussion.

Sediment Sources Potentially Contributing to Channel Widening

There are both natural and management related sources of sediment; these occurrences are episodic. In Sucker and Grayback creeks, sediment supplied during the January 1, 1997 storm has two primary sources: slope failures and road failures. The 1998 Forest Flood Assessment Report found that sediment supply from roads is greatest when culverts plug, and the flow is diverted outside of the original stream channel, figure 6. This is clearly demonstrated by the 63,000 cubic yards supplied to Grayback Creek as a result of the road diversion at Windy Creek.

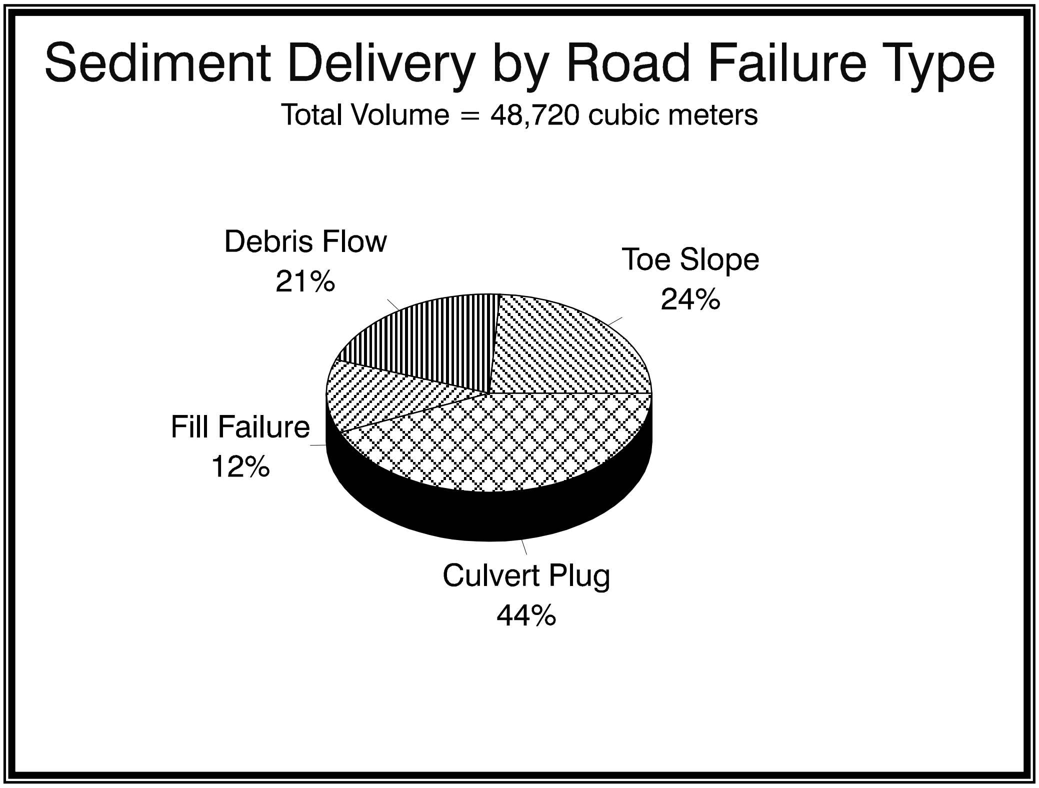

Figure 6. Sediment delivery by road failure type.

Secondly, large hillslope failures can contribute high amounts of sediment. Slope failures are observed to occur in both natural and created openings, sites which often lack large wood (USFS, IVRD, 1998). The effects of sediment delivery are less if large wood is simultaneously delivered to the channel. The principal processes that deliver sediment have been identified as slope failures, road failures, and streambank failures as the result of placer mining.

Volumes of sediment delivered during major storms provide an order of magnitude estimate. Review of air photos indicates that sediment pulses are linked to the 100-year recurrence interval: 1964 storm (280,000 cy) and the 25-year recurrence interval 1997 storm (214,000 cy). The relationship between large pulses of bedload sediment and channel widening are well- documented (Hagans and Weaver, 1987; Lisle, 1981; Kelsey, 1980).

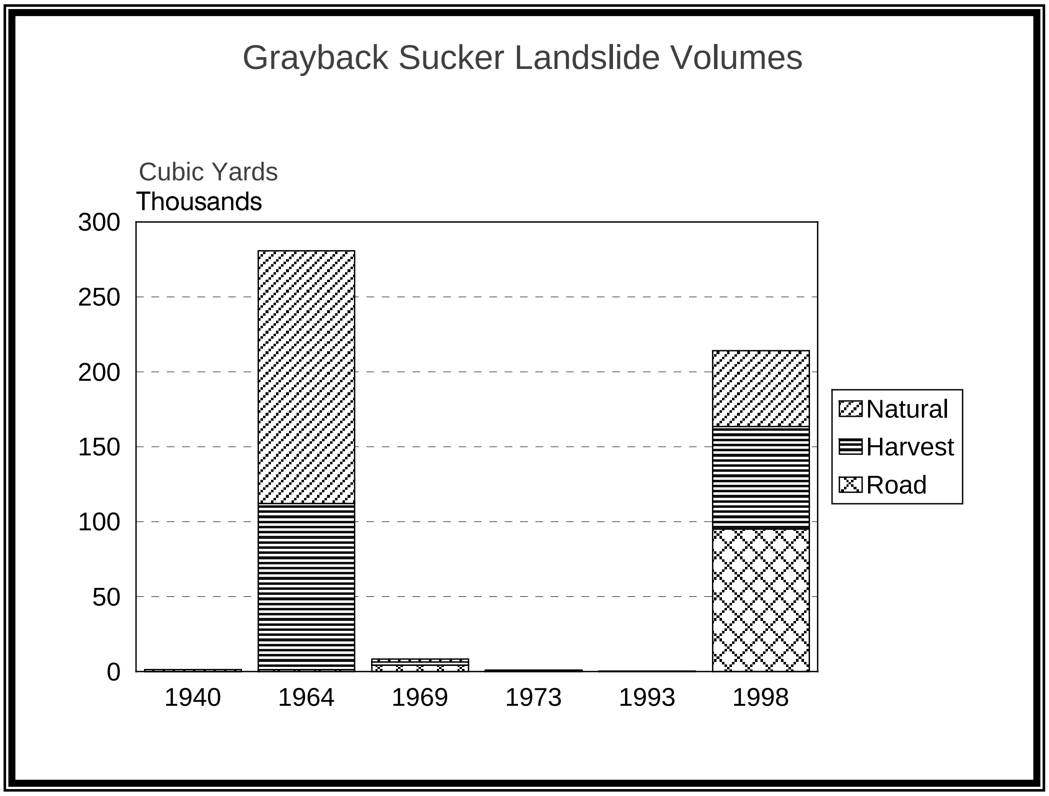

Figure 7. Grayback Sucker landslide volumes summary.

For the recent storms of 1996, the plugged culvert on Windy Creek accounted for 66% of the total sediment from roads. The Not You slide in the headwaters of Sucker Creek accounted for 50% of the total sediment from harvest units. It is not known if a 1980's shelterwood harvest unit triggered the Not You slide or if it was a natural occurrence.

In an attempt to understand the relationship between changes in sediment supply, sediment transport, and storage, changes in length of unvegetated bars adjacent to the channel were measured. In Sucker Creek above its confluence with Grayback, there has been a three-fold increase in the length over the photo period (1940 to 1997). Additionally, measured changes in sinuosity have declined from 1.22 to 1.08. In this same reach, there has been a decrease in riparian cover, especially conifers. An increase in unvegetated bars and loss of sinuosity supports the argument that there has been more sediment in the stream in recent decades.

The reduction of sediment supplied by management sources is critical for channel recovery on Grayback Creek, and can only help recovery on Sucker Creek. While linear recovery of channel form is possible, it is more likely to occur in association with channel changing storms whose recurrence interval is 25 years or more. Existing channel conditions will affect recovery rates.

Channel recovery on Sucker Creek near Cave Creek where mining is occurring will not begin until current mining practices are changed or stopped. Even then, channel recovery in an unstable "F4" channel type could begin or be set back in a storm event. Considering the poor recovery potential of the channel and the need for mature conifers to provide shade in this wide section, channel recovery could take over 100 years.

On lower Grayback Creek, there is good potential for recovery in the “B” channel type. With a reduction of management related sediment input, recovery could reasonably be expected over a 25- to 50-year time period

One mining claim, which makes up a small section of the mined reach on Sucker Creek, is no longer valid and is back under BLM management. BLM is in the beginning stages of planning a stream restoration project for this area. A cooperative effort between BLM, Forest Service, State agencies, Illinois Valley Watershed Council and interested public is underway.

DEQ works with current miners on water quality issues, (including fish passage, instream activities, riparian protection, and bank stability) under a permitting system. General permits for suction dredge operators and for small-scale mining operations are issued for a period of five years. Modifications to those general permits occur during the renewal process. (The general permit for suction dredge operators is currently under modification due to court action.) Modifications through the normal process are typically in response to issues and concerns that are identified during the life of the general permit. The modifications could include additional conditions addressing channel impacts. The next opportunity for modification occurs in the spring of 2002. DEQ also tries to educate miners individually as the permits are issued. DEQ and DOGAMI staff have a joint annual meeting to discuss coordination issues and whether any modifications to general permit conditions are warranted.

Individual permits for mining activity processing greater than 10,000 cubic yards of material can also be issued by DEQ. These types of permits are tailored to the individual site and operation. There are currently no DEQ individual mining permits on record for the Sucker/Grayback system.

***TEMPERATURE FACTOR 3.* Flow**

The temperature change produced by a given amount of heat is inversely proportional to the volume of water heated or, in other words, the discharge of the stream (Brown, 1984). A stream with less flow will heat up faster than a stream with more flow given all other channel and riparian characteristics are the same. Sucker Creek is listed as water quality limited by Flow Modification. The specifics of water withdrawal are addressed in the Flow Modification Section, *Parameter 3*. This analysis identified no Federal water withdrawals that are affecting stream temperature on Sucker or Grayback creeks. The issue of water rights is complex and outside of Forest Service and BLM authority. Both agencies are working in cooperation with DEQ, Water Resources Department, and private land owners to improve summer stream flows.

Temperature Findings

TMDL targets for temperature are based on a two-pronged approach to the temperature issue: shade and channel form. Temperature goals with this plan are to produce the coolest water possible in the shortest amount of time. Shade effects from historic harvest will largely recover in the next 15 years, but there are sites that will take considerably longer (100 years). The sites that have a 100-year target for shade recovery are also affected by changes in channel form. It is difficult to set an exact recovery path for channel form when the recovery process is storm dependent. Chapter 3, Recovery Goals and Plan details USFS expectations in this area.

PARAMETER 2, HABITAT MODIFICATION

The beneficial uses affected by Habitat Modification include Resident Fish & Aquatic Life, Salmonid Fish Spawning & Rearing. The standard that applies is: The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life, or affect the potability of drinking water, or the palatability of fish or shellfish shall not be allowed; or: Waters of the State shall be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities. A stream is listed as water quality limited if there is documentation that habitat conditions are a significant limitation to fish or other aquatic life.

No formal Load Allocation is proposed for the habitat modification parameter under discussion here. Habitat modification is not viewed as a water quality pollutant under the Clean Water Act although it is recognized that habitat modifications may cause Water Quality impairments which could lead to exceedance of WQ criteria. Measures to address the listed parameter causes are detailed in the goals and objectives portion of this document.

Determining overall channel conditions and the biological potential of fish-bearing stream segments from stream survey data has been ongoing for several decades in the Pacific Northwest. Analyzing stream survey data for the Sucker Creek Water Quality Management Plan concentrated on five attributes at the stream reach scale: riffle width, pool frequency, pool area, large wood, and riparian forest seral stage.

Except for riparian forest seral stage, the other attributes have been agreed to by Federal and State teams in Oregon as core attributes needed to assess stream conditions. These parameters are included on the "Interagency Aquatic Database and GIS," which is a compilation of stream surveys from various agencies in Oregon. These attributes are inventoried by the Forest Service, Bureau of Land Management, and the Oregon Department of Fish and Wildlife (ODFW) by protocols that are comparable. It was decided to include riparian forest seral stage in this discussion because of important relationships between aquatic and riparian functions.

To rate the five attributes as Poor, Fair, and Good, the ODFW benchmarks developed from hundreds of miles of stream surveys in Western Oregon were employed. These benchmarks are included in Appendix C as "Habitat Benchmarks, Table 1" and following the individual attribute discussion. Additionally, monitoring and watershed analysis information for these attributes on the Siskiyou National Forest was used to accommodate the unique stream and riparian conditions found in Klamath Mountain geology. The Poor, Fair, and Good ratings should be viewed as relative, with the diversity of conditions in Sucker/Grayback Creek, and helpful for a reference to compare across watersheds with similar ecological conditions. Table 11 shows the numeric values for the stream segments discussed in the Sucker Creek watershed.

The Sucker/Grayback Watershed Analysis documents human effects on instream and riparian habitat conditions. Placer gold mining started in the 1860s in mainstream Sucker Creek above Grayback Creek, and has continued to varying degrees since. This watershed is capable of growing large conifers; timber harvest and associated road development is widespread. Aquatic and riparian habitat has been greatly influenced by these activities, both directly and by the synergistic effects of human and natural events.

Individual Attribute Discussion:

Riffle Width: This attribute is the average wetted riffle width of the stream reach surveyed. Stream reaches in the USFS stream survey protocol range from ½ to 3 miles. Less observer bias is associated with wetted width than bankfull width per stream survey quality control monitoring. Riffle width was used here to calculate pool frequency.

Pool Frequency: Pool frequency was calculated by dividing the number of pools in the reach by the number of riffle widths in the reach length. Therefore, a pool frequency of 1/10 or 0.1 would translate to one pool per ten (10) wetted widths. A pool frequency of 0.1 or higher would be expected in a functioning low gradient reach (<3% gradient) with pool/riffle morphology. Some allowance was made in transport reaches where step/pool morphology forms more frequent and shorter pools.

Pool Area: Pool area is calculated by dividing the surface area of pool habitat by the total surface area of wetted habitat surveyed. Similarly to the discussion for pool frequency, some allowance must be made for the different morphologies of pool/riffle and step/pool stream reaches.

Large Wood Material: Large wood is included in this rating only if the dimensions are large enough to serve as a key piece to collect smaller pieces of wood in complexes. Diameters of these key pieces are equal to or greater than 24 inches, and the length is 50 feet or twice the bankfull width.

Riparian Forest Seral Stages: ODFW, BLM and Forest Service stream surveys measure the relative size of trees in the riparian zones along fish-bearing streams. The outer riparian zone, twenty-five feet (25') from the bankfull edge to one hundred feet (100') from the bankfull edge, was used here for rating the health of the riparian zones. The outer riparian zone is generally beyond the alder and hardwood buffer, as many stream channels have in Sucker/Grayback Creek. One would expect to find a large component of mature conifers and some hardwoods in this portion of the riparian zone. For comparative purposes, the expected condition of seventy-five percent (75%) large trees greater than twenty inches (20") diameter are designated as LT. Trees less than twenty inches in diameter are designated as small trees or ST. Sucker Creek watershed generally is a high site for conifer tree growth, capable of producing very large trees in most floodplains and terraces.

Below is an adaptation of ODFW's benchmarks for Sucker Creek and Grayback Creek:

Benchmarks for Evaluating Stream Survey Data
Sucker Creek – Siskiyou National Forest

	Poor	Good
Pools		
Pool Area (% of total surface area)	< 10%	> 30%
Pool Frequency (pools per channel width)	0.05	0.12

Source of Values: ODFW Benchmarks (1992/93), Siskiyou National Forest Monitoring
Source of Data: Interagency Aquatic Database and GIS CD, Stream surveys, monitoring surveys.

Large Wood Material

	Poor	Good
Wood Key Pieces/Mile (24 inches diameter X 50 feet in length or twice the active channel width in length)	<5/mile	20/mile

Source of Values: Applegate Sub-basin Assessment (1995), Siskiyou Mtns. Matrix of Factors and Indicators (1996), Siskiyou National Forest Monitoring.
Source of Data: Interagency Aquatic Database and GIS CD, Stream surveys, Monitoring surveys.

Riparian Vegetation

	Poor	Good
Percent of Trees in Seral Stage by Age Class (Small Tree, Large Tree)	<25% LT	75% LT
Outer Riparian Zone (Zone 2), Vegetation 25 feet to 100 feet from active channel margin. (Small Tree = <20 inches diameter, Large Tree = >20 inches diameter)		

Source of Values: Siskiyou National Forest Monitoring, Professional judgment
Source of Data: Forest Service, BLM and ODFW stream surveys, air photo interpretation, forest stand surveys.

Table 11
Key Stream Channel and Fish Habitat Attributes of Sucker/Grayback Creek – 1997 Stream Surveys

Stream Name	Reach No. & Function	Length (Miles)	Avg. Riffle Width	Pool Frequency – Pools per Riffle Width *(expected condition ≥ 0.1)*	Percent of Surface Area – Pools *(expected condition ≥30%)*	Wood Key Pieces ≥24 inches diameter/ Mile *(expected ≥25 /mile)*	Riparian Forest Seral Stage in Outer Rip. Zone (25 ft. – 100 ft.)
Sucker Creek	1 (low gradient)	14.0 miles	35 feet	0.06	11.5%	3.1	Pvt. = 100% small tree (ST); Public Lands = 43% ST, 57% large tree (LT)
Sucker Creek	2 (high gradient)	10.6 miles	25 feet	0.1	19.1%	5.1	30% ST 70% LT
Grayback Creek	1 (low gradient)	2.9 miles	20.2 feet	0.07	16.5%	3.1	44% ST 56% LT
Grayback Creek	2 (high gradient)	4.7 miles	17.9 feet	0.08	15.8%	7.5	74% ST 26% LT
Grayback Creek	3 (high gradient)	6.5 miles	12.2 feet	0.06	11.9%	4.6	36% ST 64% LT

In the upper stream reaches of both Sucker and Grayback Creek, the riparian and aquatic habitat are generally in fair to good shape. The exception is Reach 2 in Grayback Creek, where the riparian zone is in a very young seral stage and rated POOR. The low gradient response reaches, potentially high for biological productivity, are among the most altered by mining, harvest and flood repair work from past storm events. The aquatic habitat is considerably less than optimum for production of salmonids, particularly coho salmon, which require the full suite of freshwater habitat components. Coho salmon tend to inhabit low gradient stream reaches.

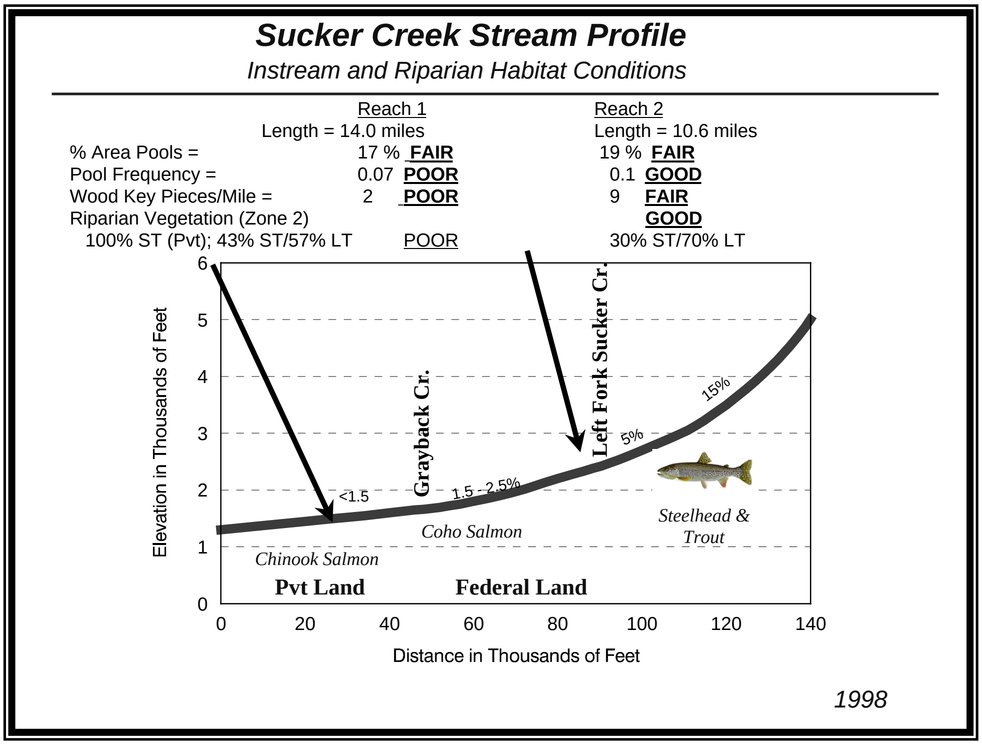

Figure 8. Habitat condition of Sucker Creek.

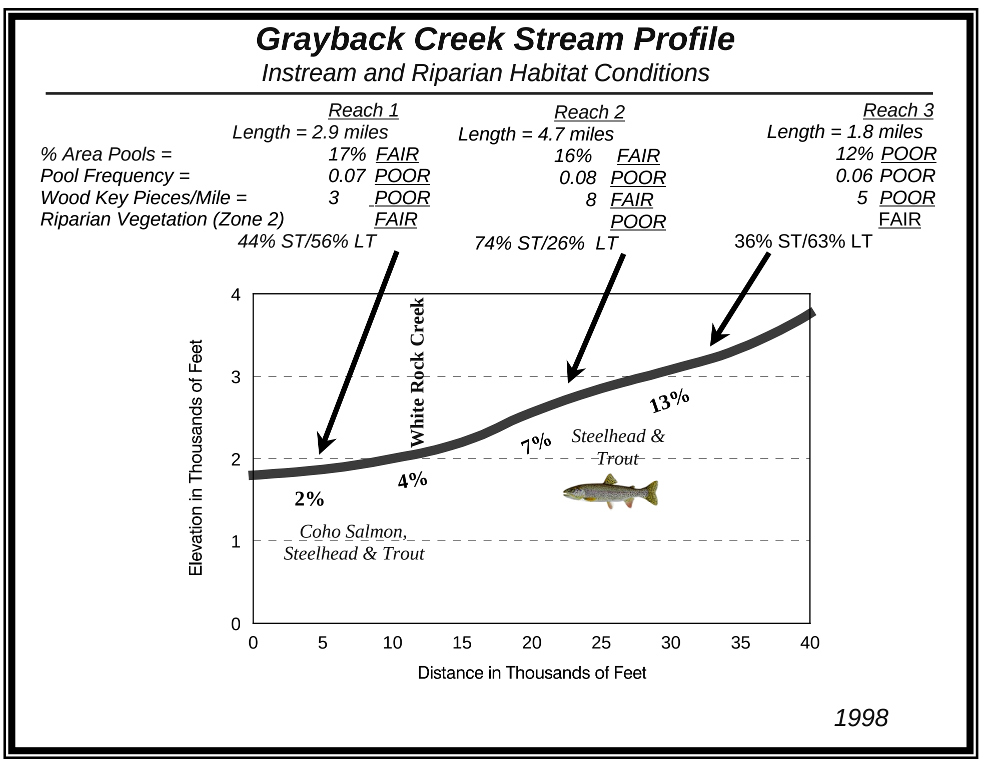

Figure 9. Habitat condition of Grayback Creek.

PARAMETER 3. FLOW MODIFICATION

Again, Resident Fish & Aquatic Life; Salmonid Fish Spawning & Rearing are the beneficial uses affected. Standards applicable are: The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish shall not be allowed; or, waters of the State shall be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities. A stream is listed as Water Quality Limited if flow conditions are documented that are a significant limitation to fish or other aquatic life. Flow modification is not considered a WQ pollutant but it is recognized that flow modifications may cause WQ impairments which could lead to exceedance of WQ criteria.

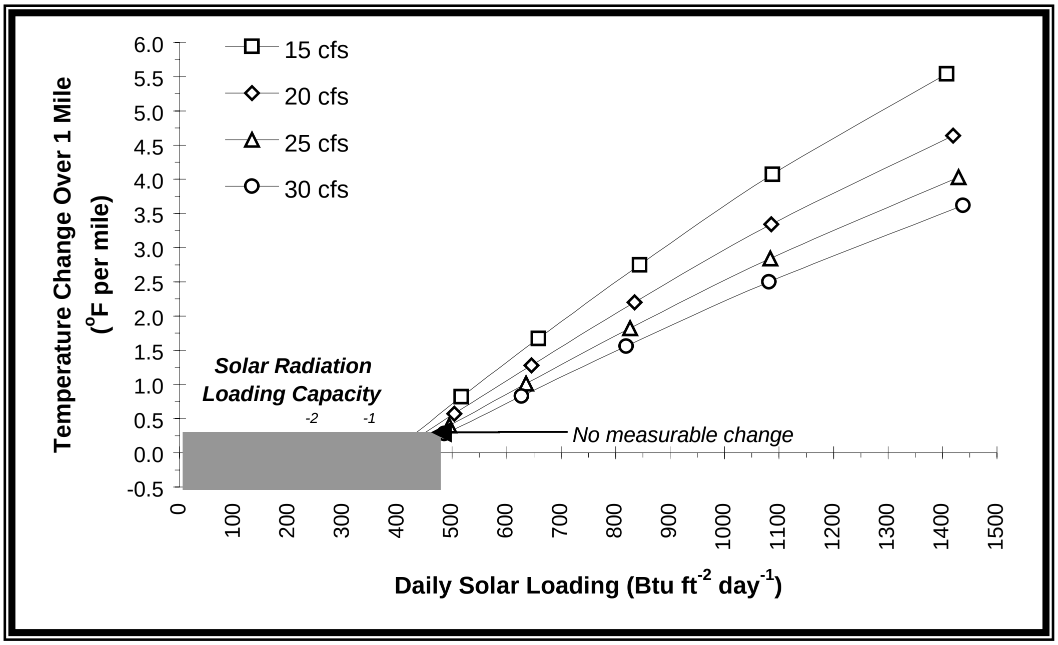

Figure 10. The effects of loss of flow on increasing stream temperature.

Summer low flow has been a long-term problem in the Sucker Creek watershed. Coho populations are depressed, and winter steelhead are declining as identified by Oregon DEQ 1994/1996 (Draft 1998), 303(d) lists of Water Quality Limited Water Bodies. Low flows due to water withdrawals have been identified as a water quality-limiting factor (ibid). Existing instream water rights are not often met at USGS gage 14375100 (located on Sucker Creek immediately below Little Grayback Creek). Low flows also have a direct affect on the temperature of streams. Stream temperatures tend to increase as flows decrease. The temperature listing issues for this system are discussed earlier in this document. Water rights were issued from 1853 until 1934, when the system was withdrawn from further consumptive use rights due to insufficient flow. Rights were still issued for mining and other non- consumptive uses, as well as for domestic use. Domestic uses fall in several categories, each providing for a slightly different use allowance. Approximately 113 cfs has been allocated on the main stem of Sucker Creek and its tributaries; a little over 50 cfs is for consumptive use.

While mining is considered a non-consumptive use, the mining water rights do allow for withdrawal. Current Department of Environmental Quality mining permitting requirements for small scale operations processing no more than 10,000 cubic yards of material per year do not allow for discharge of mining waters to a stream (General Permit #600). Off-stream placer mining is allowed under this general permit, as long as all wastewater is disposed of by evaporation and/or seepage with no readily traceable discharge to groundwater or surface water. Water withdrawn from streams is typically reused through holding ponds. The flow loss to the watershed system comes from evaporation at the holding ponds and during use. There are currently four operations on Sucker/Grayback under the #600 general permit. DOGAMI currently has three operating permits in their over 1-acre or 5000 cubic yards category (placer) within the Sucker Creek drainage. None of these three permits have been very active for the last year or so.

Individual permits for mining activity processing greater than 10,000 cubic yards of material can also be issued by DEQ. They can allow for discharge of water, but water quality requirements must be met. There are currently no DEQ individual mining permits on record for the Sucker/Grayback system.

Normally, in drier summers, water rights are cut back to the late 1800s. For instance, in 1994, a dry year, the water rights were cut back to 1865 priority date. This priority date allowed withdrawals of approximately 15 cfs (30% of the total consumptive rights allocated). Average summertime flow, according to the Josephine County Watermaster's office, is approximately 2 cfs at the lowest flow point, near river mile 2.6.

Minimum stream flows were identified for some Rogue Basin streams by the Oregon Department of Fish and Wildlife (ODF&W) beginning in 1959. In 1987 a new statute, ORS 537.346, was adopted by the State of Oregon, which converted all minimum perennial stream flows established on any waters of the State to in-stream rights. The Sucker/Grayback system did not have minimum flows adopted at that time, so none were converted to instream rights. Minimum stream flows, according to ODF&W, are flows necessary for fish passage.

The ODF&W applied for instream water rights for Sucker Creek from the confluence of Grayback to the mouth. From May 16 through June 30, the right is 80 cfs; July 1 through Oct. 31 the right is 54 cfs; November 1 through May 15 have a right of 135 cfs. The rights carry a 1989 priority date, so are relatively late, and cannot be considered to be protective of fish during dry years. There are also instream rights on Grayback creek from Windy Creek down to RM 2.6. The right varies monthly throughout the year, ranging from 9.8 cfs in July to 4.2 cfs in September. The Grayback rights have a 1991 priority date, and are also too new to provide much protection during dry years. As stated earlier, the instream rights are not often met.

Recommended optimum flows for fish life in the Rogue Basin were identified by ODF&W in 1972 (Lauman 1972). The instream rights allocated to ODF&W do not meet the optimum flows on Sucker Creek for September and October. On Grayback Creek, they fail to meet the optimum flows for June through November. Instream rights are only issued for flows up to the natural flow of the stream that is present 50 percent of the time. Optimum flows are those deemed adequate to maintain fish life at current levels and prevent further degradation.

Oregon Water Trust, a nonprofit private group that works to convert consumptive rights to instream rights, has permanent rights from the mouth of Sucker Creek to river mile 2.6 for 0.16 cfs. They also have a 0.16 cfs right on annual renewal, and 0.26 cfs on a two-year renewal at river mile 2.6. These rights have an 1857 priority date, so should be available even during drier years.

Table 12 provides a summary of water rights by use for the Sucker Creek watershed. Streams where the right is on Federal lands are indicated in bold type, as well as the portion of the right that is consumptive use.

Table 12

SUCKER	GRAYBACK	WATER	USE
STREAM SEGMENT	**USE**	**CFS ALLOTMENT**	**TOTAL**
Sucker Creek to E Fk Illinois	Irrigation Fish/Wi Agriculture Industrial Domestic	48.30 0.18 0.01 16.99 0.04	65.52
Bear Creek to Sucker Creek	Irrigation	1.37	1.37
Green Creek to Bear Creek	Irrigation	0.31	0.31
Nelson Cr to Sucker Cr	Irrigation	0.02	0.02
Unnamed Str to Sucker Cr	Domestic	0.01	0.01
Little Grayback to Sucker Cr	Domestic	0.02	0.02
Unnamed Str to Sucker Cr	Domestic	0.01	0.01
Lake Cr to Sucker Cr	Domestic	0.18	0.18
Grayback Cr to Sucker Cr	Irrigation Industrial	1.12 1.00	2.12
Little Jim Cr to Sucker Cr	Industrial	0.80	0.80
Cave Cr to Sucker Cr	Irrigation Industrial Recreation	0.05 11.50 0.01	11.56
Panther Cr to Lake Cr	Domestic	0.01	0.01
Johnson Cr to Sucker Cr	Industrial	4.00	4.00
Yeager Cr to Sucker Cr	Industrial	2.00	2.00
Mule Cr to Sucker Cr	Industrial Domestic	8.00 0.01	8.01
STREAM SEGMENT	**USE**	**CFS ALLOTMENT**	**TOTAL**
Unnamed Str to Sucker Cr	Industrial Domestic	7.99 0.01	8.00

Bolan Cr to Sucker Cr	Industrial	8.00	8.00
E Fk Bolan Cr to Bolan Cr	Industrial	2.00	2.00

TOTALS BY USE

Irrigation	Fish/Wild	Agriculture	Industrial	Municipal	Domestic	Recreational
51.17	0.18	0.01	62.28	0.00	0.29	0.01

Consumptive uses include irrigation, domestic, and recreational. On the Federal lands there are consumptive rights totaling 1.42 cfs (includes the unnamed stream rights).
Priority dates on the rights on Federal lands range December 31, 1907 to June 27, 1983.

Total cfs allocated by water right for the basin: 113.94 (approximately 51.5 consumptive).
Total cfs from Federal lands: 46.72 (approximately 1.42 consumptive).

See Appendix E for Individual Water Rights Information

Chapter 3 - Recovery Goals, Objectives and Restoration Plan (*Site Specific Restoration Plan - see Appendix A)*

All recovery goals and plans are strongly linked to the philosophy of maintaining those components of the ecosystem that are believed to be currently functioning, and to improving those sites that show the greatest potential in the shortest time frame. This philosophy maximizes recovery while minimizing expensive, extensive, and risky restoration treatments.

The objective of this plan is to eventually meet water quality standards by correcting through appropriate management practices the anthropogenic causes of water quality violations within this watershed. Those standards when met will protect the beneficial uses identified for the Rogue Basin under Oregon Administrative Rules (OAR) 340-41-362.

The recovery of habitat conditions in Grayback Creek and Sucker Creek will be dependent on implementation of the Siskiyou National Forest Land and Resource Management Plan and BLM Medford Resource Management Plan, as amended by the Northwest Forest Plan (NWFP). Paramount to recovery is adherence to the Standards and Guidelines of the NWFP to meet the Aquatic Conservation Strategy (ACS). This includes protection and culture of riparian areas as reserves and some silvicultural work to reach vegetative potential most rapidly. Some instream large tree placement may be beneficial where there exists conducive channel and riparian conditions.

Recommended Restoration Plan - *Proposed Management measures*:

The following standards and guidelines from the NWFP will be used to attain the goals of the Grayback-Sucker Water Quality Management Plan:

Stream Temperature - SHADE

Aquatic Conservation Strategy - B-9 to B-11, C-30
Standard and Guidelines for Key Watersheds - C-7
Riparian Vegetation - B-31
Riparian Reserves - B-12 to B-17 and ROD 9
Watershed Restoration - B-30

Stream Temperature - CHANNEL FORM

Aquatic Conservation Strategy - B-9 to B-11, C-30
Standard and Guidelines for Key Watersheds - C-7
Riparian Vegetation - B-31
Riparian Reserves - B-12 to B-17 and ROD 9
Watershed Restoration - B-30
Roads - B-19, B-31 to B-33

Flow Modification

Aquatic Conservation Strategy - B-9 to B-11, C-30
Roads - C-32

Habitat Modification

Aquatic Conservation Strategy - B-9 to B-11, C-30
Standard and Guidelines for Key Watersheds - C-7
Riparian Vegetation - B-31
Riparian Reserves - B-12 to B-17 and ROD 9
Watershed Restoration - B-30
Roads - B-19, B-31 to B-33
In-stream Habitat Structures - B-31

Adaptive Management, Review, Prioritization and Revision

Monitoring will provide information as to whether standards and guidelines are being followed, and if actions prescribed in the WQMP are achieving the desired results. In addition to the monitoring identified in the WQMP, Forest Plan monitoring occurs annually to assess implementation of standards and guidelines. Information obtained from both sources of monitoring will ascertain whether management actions need to be changed. The monitoring plan itself will not remain static, but will be evaluated periodically to assure the monitoring remains relevant, and will be adjusted as appropriate.

Maintenance of Effort Over Time

In the 1994 Record of Decision, the Secretary of Agriculture amended current land and resource management plans with additional land allocations and standards and guidelines of the NWFP. The Siskiyou National Forest Land and Resource Management Plan is included in the Land and Resource Management Plans. A revision of the Siskiyou Forest Plan will occur in the future, in which the standard and guidelines of the NWFP will be incorporated.

Assessing Potential for Recovery - Properly Functioning Condition Methodology

Recovery of riparian areas, stream channels, and aquatic habitat requires a base condition with adequate vegetation, channel form, and large woody debris to dissipate stream energy associated with high waterflows. The BLM/USFS methodology known as Properly Functioning Condition (PFC) assesses the physical capability of streams to withstand 30-year return interval storm events. This quick, interdisciplinary method is the first step in determining the feasibility of restoration and recovery. Representative sections of Grayback, the Left Fork of Sucker Creek, and Sucker above Grayback were surveyed in the spring of 1998.

Table 13
PFC Assessment for Sucker Grayback within the Forest Boundary

Location	**Miles**	**Properly Functioning**	**Functioning at Risk**	**Nonfunctional**
Sucker Creek (near Cave Creek)	2.0			**X**
Sucker Creek (above Johnson Gulch)	121	**X**		
Grayback Creek	69	**X**		

The entire system, exclusive of the Sucker above Grayback reach, meets the minimum requirements of the PFC methodology for restoration and recovery. Until there is adequate vegetation, channel form, and large woody debris to dissipate stream energy associated with high flows, the lower reach of Sucker Creek above the Forest boundary will remain unstable, and the recovery time is uncertain. PFC does not address biological or physical potential.

Restoration in Sucker Creek and Grayback Creek will be both active and passive. Growth of vegetation on floodplains is integral to recovery. The overall goal is to move the attributes considered in this assessment: pool/riffle ratio, pool frequency, large wood, and riparian forest conditions from the present "poor" and "fair" ratings to "good" and "fair", per ODFW benchmarks. These attributes are used to measure if and when the stream is nearing its biological potential for supporting dependent aquatic and riparian species, including anadromous fish. Natural variation will cause changes in stream and floodplain conditions and make allowance for some attributes being rated "fair". These attributes and benchmarks should be validated with subsequent inventory and monitoring work in the watershed, refining them to suit the range of conditions expected in the Sucker Creek as we learn more about the watershed.

Table 14
Recovery Goals - Active and Passive Restoration
(Detailed restoration plans are contained in Appendix A and in Tables 15 and 16)

Element	**Goals**	**Passive Restoration**	**Active Restoration**
<u>Temperature</u> *Shade Component*	Achieve maximum value possible per segment. Reduce BTU loading by 342 per sq.ft. per day in 60 years. Margin of Safety: Recognize wildfire and flood effects to riparian vegetation.	Let riparian vegetation grow to reach target value. See stream reaches highlighted in Fig. 2.	1. Rx's that increase growth rates. 2. Rx's that insure long term health.

Element	**Goals**	**Passive Restoration**	**Active Restoration**
<u>Temperature</u> *Channel Form Component*	Return channels to Rosgen type that existed historically, focusing on width-to-depth ratios. Decrease bedload contributions to channels during large storms. Increase wood-to-sediment ratio during mass failures.	Allow natural channel evolution to continue. Time required varies with channel type. Allow historic failures to re-vegetate. Follow Standards and Guidelines in the NW Forest Plan for Riparian Reserves, and unstable lands.	Rx's that actively manipulate form, only one location proposed at this point in time (Mined flat abv. Cave Creek, BLM lands). 1. Treat roads, esp. sites with Diversion Potential - See Appendix D 2. Minimize future failures through stability review and land reallocation if necessary. 3. Insure that unstable sites retain large wood to increase wood-to-sediment ratio. 4. Maintain and improve road surfacing. 5. Increase pipe sizes to 100-year flow size and/or provide for overtopping during floods.

Element	Goals	Passive Restoration	Active Restoration
Flow Modification *Withdrawals*	Maintain optimum flows for fish life. Maintain minimum flows for fish passage.		1. Purchase/lease water rights with a focus on high consumptive use and old priority date. 2. Improve efficiency of withdrawal systems (ditch to pipe) 3. Enforce existing regulations, including monitoring 4. Purchase/lease flood plain easements. 5. Educate water users on effective use and conservation
Habitat Modification	Increase size and number of wood pieces in channel. Increase depth, volume and frequency of pools. Restore connection of channel and floodplain, particularly in lower Grayback and Sucker above Grayback.	Allow large wood to remain in channel (no longer salvage).	1. Riparian Rx's that increase growth rates and vegetation diversity. 2. Place wood in channels where appropriate.

Table 15 further describes management measures and the restoration targets (Load Allocation) proposed with respect to specific sites and the specific factor affecting the limiting element.

Table 15

TMDL Organization in Grayback-Sucker WQMP					
Element	**Assessed Factors**	**Loading Capacity**	**Sources[1]**	**LA**	**Mgmt. Measures**
Temperature --Lack of shade--	Shade (%)	Solar loading 634 BTU/sf/dy	Harvest, gov. Mining Natural (65% BTU's)	Decrease current solar loading by 35 %	Treatments to increase growth and insure long term health in riparian areas
Temperature --Channel Form A3--	Rosgen type (W/D)	0 %	Harvest, gov. Road failures Natural background	NA – Maintain current condition	Upland sediment abatement.
Temperature --Channel Form B4 (0.75 stream miles)--	Rosgen type (W/D)	Decrease 7 % of BTU input by improving from B4 to B3 (Decrease W/D ratio)	Harvest, gov. Road failures Natural Background	Reduce width by 10'	Upland sediment abatement Introduction of Large Woody Debris
Temperature --Channel formF4 2.3 stream miles-	Sinuosity Rosgen type (W/D)	Decrease 15 % of BTU input by improving F4 to C4 (Decrease W/D ratio)	Mining Harvest, gov. Road failures Natural Background	Reduce width by 15-20'	Upland sediment abatement, mining permit modifications. Mining site reclamation, site manipulation
Temperature –Flow--	Federal withdrawals Seniority Dates Flow information	No effect (1.42 cfs+Fire)	Recreation (Campground & National Monument) Fire Protection Irrigation & Domestic	Maintain current condition. (Current consumptive uses on Fed. lands are not significant.)	Education of users regarding conservation. Enforcement of water rights laws.

Element	Assessed Factors	Loading Capacity	Sources	LA	Mgmt. Measures
Habitat modification --Lack of Channel Complexity--	Pool riffle ratio Pool area % Large Wood Pieces/mile Large riparian trees (%)	ODFW Benchmarks and Siskiyou NF Riparian Goals (Ref. 1998 Siskiyou WA)	Harvest, gov. Mining Flood damage Road Failures Natural	Move assessed factors from "poor and fair" ratings to "good and fair" per ODFW benchmarks.	Treatments to increase growth and insure long term health of riparian forest. Placement of wood in channel Upland sediment abatement, mining permit modifications. Mining site reclamation, site manipulation
Flow modification --Low flow condition--	Withdrawals Seniority Dates Flow information ODFW ISWR ODFW (Optimum Flows)	ODFW Instream flow expectation at forest boundary is 54 to 80 cfs during summer months.	Mining (0%) Domestic (17%) Irrigation (82%) Recreational (1%)	Increase summer flows by opportunity. (Consumptive uses within Federal lands accounts for only 2% of withdrawals from the watershed)	Seek to secure early priority consumptive rights for instream water rights. Educate users on conservation. Enforcement of existing water laws.

[1]Reserve and Margin of Safety were not discussed in terms of sources or allocations.

Restoration Prioritization and Funding

The amount of restoration funds distributed to the Forest depends on the amount of money appropriated each year by the Regional Office. The Siskiyou National Forest receives about a one million-dollar budget a year for watershed restoration. Annually, each of the five ranger districts submits a list of restoration projects prioritized by high, medium, and low to the Forest. The districts prioritize the projects based on if they are located in a key watershed and the benefits to the resources the project provides. The Forest evaluates the submitted projects, and then prioritizes the total group of projects at the Forest level using similar criteria. The amounts of funds distributed to the districts are based on priority. In addition to the appropriated restoration funds, timber sales provide restoration funds from the Knudsen-Vandenburg (KV) program. The Forest this year received a quarter of a million dollars from the KV program for watershed restoration. The limitation on this money is that it must be spent in the timber sale area that it was collected from.

The Sucker/Grayback watershed is a key watershed under the NWFP, and is therefore a high priority. Siskiyou National Forest will seek necessary funds for the implementation and monitoring components of the Sucker/Grayback WQMP as a high priority. However, due to the limitations of the Federal budget process, these funds cannot be guaranteed.

As part of the Clean Water Action Plan, Oregon has begun an interagency effort that identifies high priority watersheds in need of restoration and protection as part of the Unified Watershed Assessment. The Illinois sub-basin has been identified as a high priority watershed. It is possible that funding associated with the Clean Water Action Plan could be accessed to carry out protection and restorations actions in the Sucker Creek watershed

Recovery to Full Physical and Biological Potential

The present condition of stream and riparian habitat in Grayback Creek and Sucker Creek is discussed in previous sections. Generally, in transport or steeper reaches of both streams, the aquatic and riparian habitat are generally in fair to good shape in both these streams. These reaches are located mostly on National Forest lands. Downstream, in lower gradient stream reaches in both streams, aquatic and riparian habitat is in poor to fair condition. In Grayback Creek, these low gradient reaches are on National Forest land, and in Sucker Creek, these reaches are located on National Forest, Bureau of Land Management, and private lands.

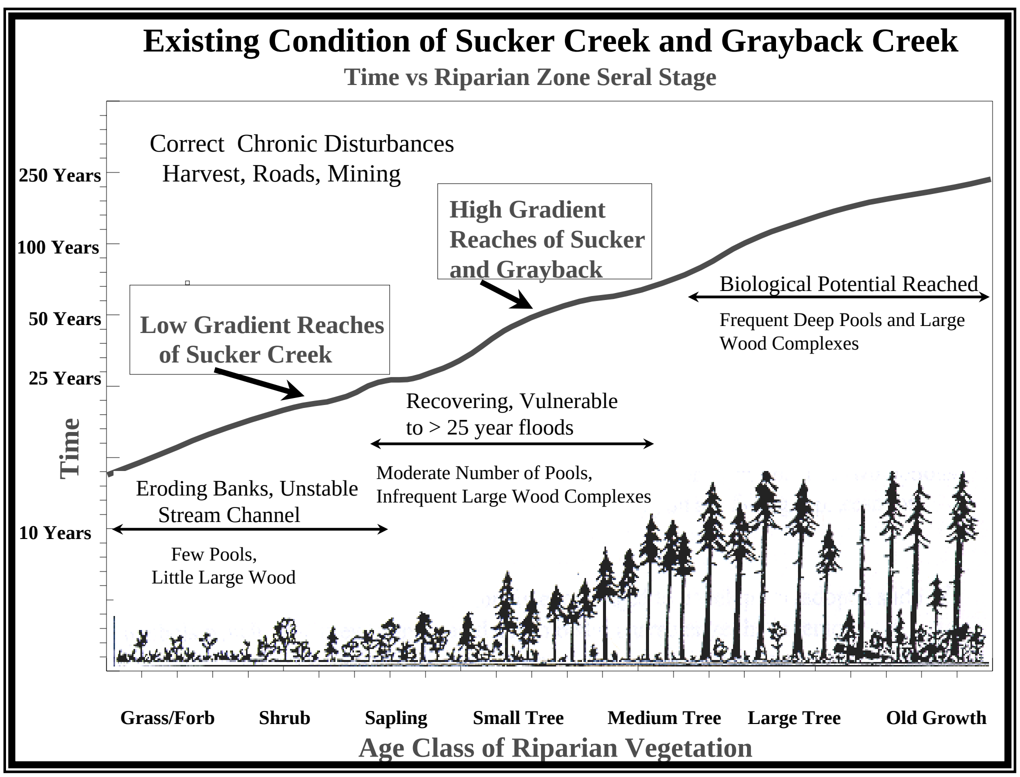

Figure 11. Existing condition of Sucker and Grayback Creek.

Most low gradient stream reaches in Sucker Creek are on private lands. Figure 11 shows the relative conditions of reaches in Sucker Creek as these areas move in a recovery direction.

Recovery of habitat conditions in Grayback Creek and Sucker Creek, to full biological potential, will take from 100 to 250 years. This time estimate accounts for some variability in recovery with "resetting" of aquatic and riparian conditions during floods. Where conditions are recovering as shown in Figure 12, e.g., transport reaches or headwater areas primarily on National Forest lands, recovery will take time.

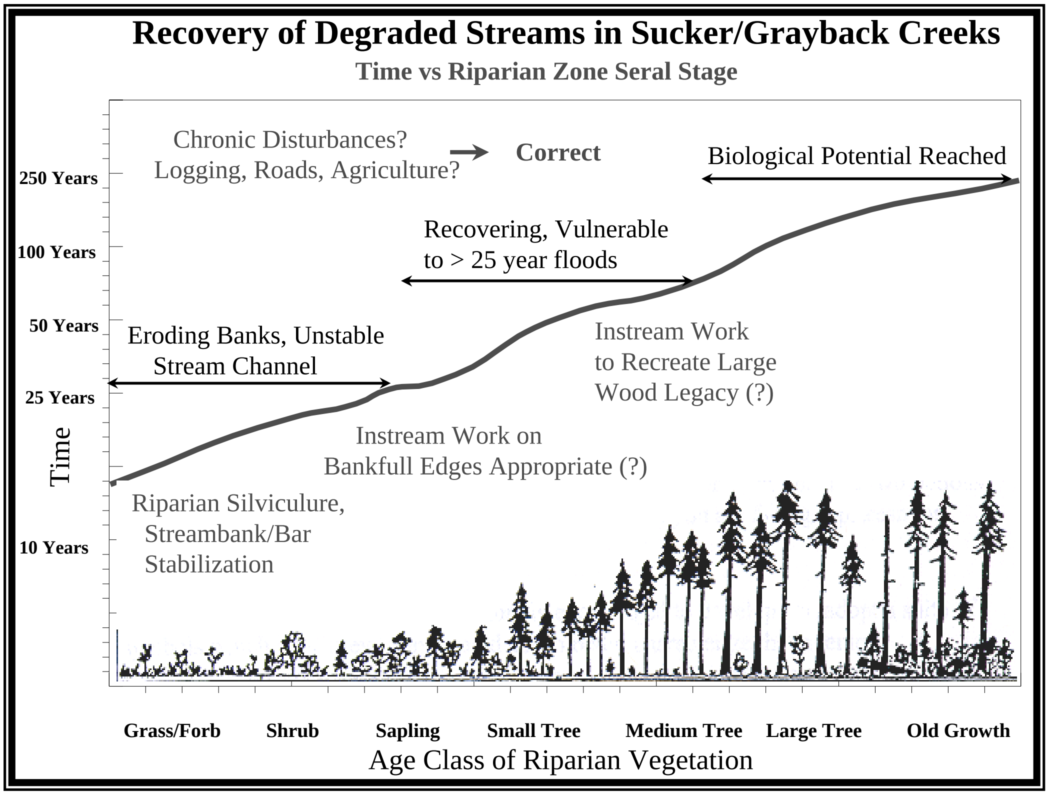

Figure 12. Recovery of Sucker and Grayback Creeks.

Interrelationships between riparian/floodplain vegetation, summer stream temperatures, sediment storage and routing, et cetera, and the complexity of habitats in the Sucker Creek watershed are many. It should be mentioned here that large mature conifers or hardwoods would continue to be rare on private lands, particularly agricultural lands, within the watershed unless major changes in land uses or land use regulations occur. This translates to a continuance of unrecovered conditions on private lands, largely due to agriculture activities. These low gradient areas have high biological potential for salmon as "grubstake habitat" (Frissell, 1993). In addition, recovery of large tree components on upstream public lands will not greatly benefit these habitats on private lands if these large tree lengths are not allowed to remain in the stream channel on private lands. An exception will be the anticipated decrease in sediment, fine and coarse. Less sediment production upslope and upstream may benefit these downstream aquatic and riparian habitats on private lands. Given these conditions, most high-quality salmonid habitat will be located on public lands in response reaches or headwater streams. These upstream areas will benefit certain species of salmonids, e.g., trout and steelhead, more than others, e.g., Coho and Chinook salmon.

Stream shade recovery will be realized more quickly than habitat recovery with the growth of hardwoods, e.g., alder, maple, ash, and cottonwood. Habitat recovery and associated sediment storage/routing in the channel will only recover to an optimum range of conditions with the recovery of riparian conifers to mature size. This will afford some added shade as these trees reach more height. Additionally, a mature riparian forest will increase bank and channel stability, cause the channel to narrow, and result in deeper pools in these sediment-rich channels of Grayback and Sucker Creeks. Lower summer water temperatures and creation of quality habitat conditions for trout and salmon are anticipated with maturation of riparian forests in these watersheds, addressing road-related problems in the watershed, and reduced timber harvest under the NWFP. Harvest related slope failure issues will be addressed through the adaptive management measures within the NWFP.

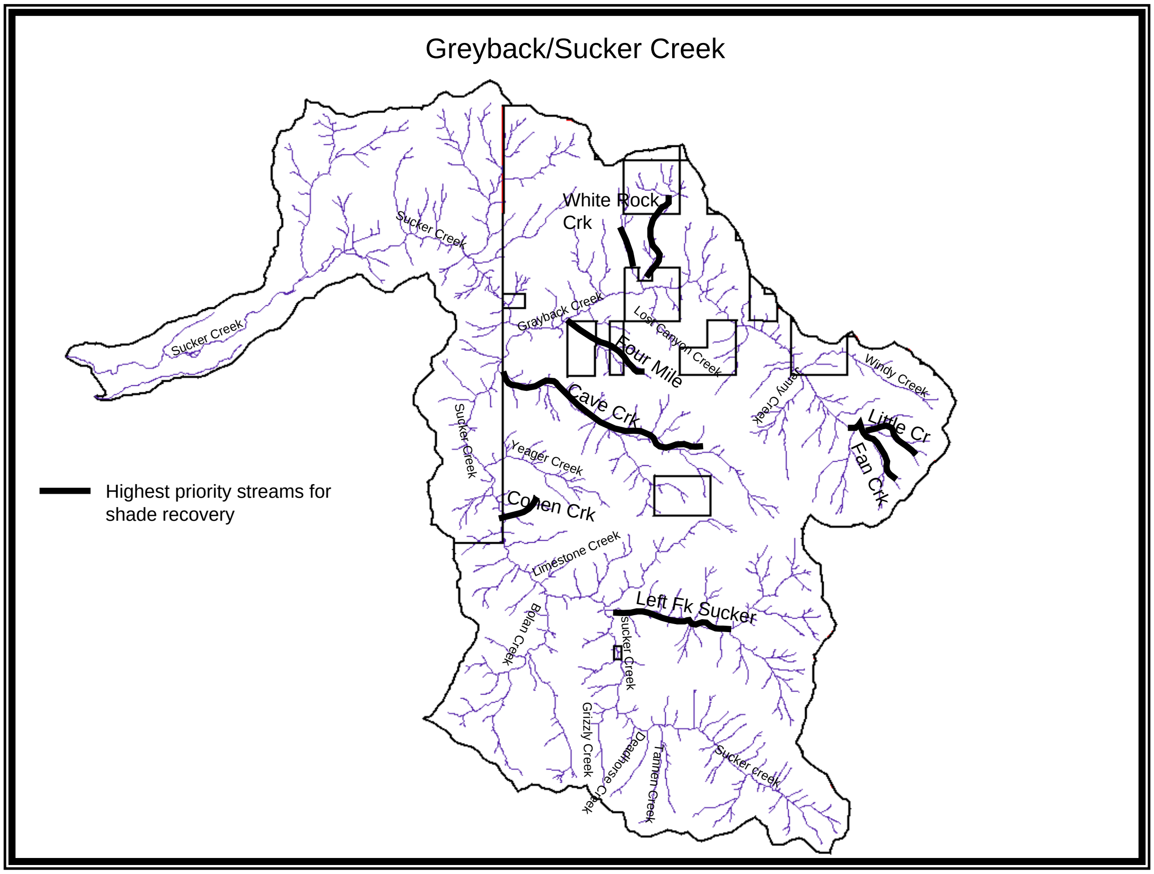

Figure 13. Highest priority streams for recovery.

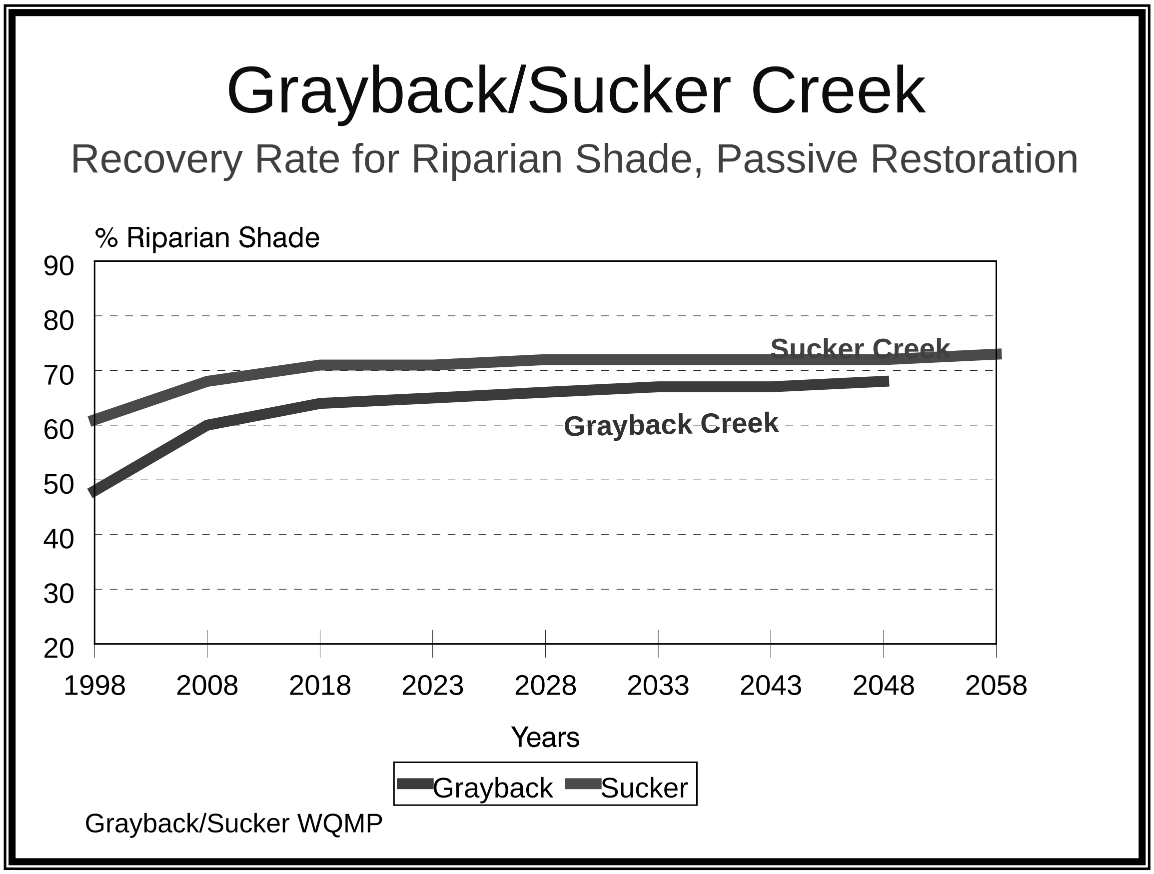

Figure 14. Shade recovery over time on Sucker and Grayback Creek.

MARGIN OF SAFETY

The Clean Water Act requires that each TMDL be established with a margin of safety (MOS). The statutory requirement that TMDLs incorporate a margin of safety is intended to account for uncertainty in available data, or in the actual effect controls will have on loading reductions and receiving water quality.

Assumptions

Natural Fire Disturbance - Sucker Creek has a frequent fire history with return interval averaging 18 years (J.Agee, 1993, T. Atzet, 1988). Recovery of riparian vegetation in areas disturbed by fire and flood will most likely be offset by future events. This is a conservative assumption, and does not account for fire suppression as a management tool. Fire suppression over the past decades has effectively reduced the acres burned by wild fire in riparian areas.

Channel Form Recovery - The channel form assessment identified areas on Sucker and Grayback Creek where channel width has increased, and is most likely contributing to stream heating. In projecting shade recovery values, credit is not given for channel recovery. Width/depth narrowing will decrease solar loading. It is also not accounted for in the shade recovery values, but is expected to occur. Through continued improved Federal management and restoration efforts, future sediment input into streams will continue to be reduced. In Grayback Creek, there is a high likelihood that the stream channel will recover in the projected time frame reducing stream heating. Management for "good" pool frequency condition will help to restore groundwater/stream flood plain connection and bolster groundwater/stream interactions with an expected expansion of cool water refugia. In addition, management for "good" Large Woody Debris conditions will reduce local flow velocity, and reduce local bed/bank shear stress. This can be expected to increase channel stability and bank building processes that will help to restore the desired channel width/depth conditions. Neither the temperature advantages nor the improved channel width component of these two management practices has been included in the shade recovery values. Because of the uncertainty of mining on the .75 mile section of Sucker Creek and the poor condition of the channel, this area is not considered part of the MOS.

Wind Speed - Wind speed is one of the controlling factors for evaporation, which is another cooling process for the stream. The shade recovery targets do not account for any cooling from evaporation due to wind speed.

Riparian Restoration - Riparian restoration will increase storage capacity for subsurface/ groundwater inflow. Benefits not included in the shade recovery values are twofold:
1. Groundwater inflow will cool stream temperatures directly – mass transfer of energy.
2. Groundwater inflow will increase stream flow and further prevent stream temperature change.

Timber Harvest on Private Land - Within the Forest boundary, 7 percent of the land is under private management for timber harvest. Because of the lack of information on private practices, no shade recovery was accounted for on private lands. As referenced earlier, the assessment of private lands in this watershed is underway. The shade recovery expected under current practices will be identified as well as the site potential for recovery. While Federal guidelines offer more protection for stream shade than State guidelines, State guidelines do offer some stream shade protection for trees that are recovering stream shade. The effect of not calculating any shade recovery for private lands requires a higher level of recovery on the remaining Federal lands. This is in effect a margin of safety for the Federal lands as there will be shade recovery on the private lands. As mentioned earlier, the Sucker-Grayback WQMP is intended to be adaptive in management implementation. It allows for future changes in response to new information. Information generated during development of the private lands WQMP may cause modifications to this current plan for the federal lands.

In addition, a statewide demonstration of FPA effectiveness in protection of Water Quality will address the specific parameters generally accepted to be affected by forest management practices (temperature, sediment and turbidity, aquatic habitat modification, bio-criteria). The schedule and other requirements for addressing these parameters are included in the DEQ/ODF Memorandum of Understanding (MOU) of May 16, 1998. For other requirements of the MOU, such as monitoring or watershed specific rules, see Appendix F.

The requirement on Federal lands to maintain two "site potential trees" for riparian reserve widths on fish bearing streams is based on protection of fish habitat and protection of other riparian dependent species and resources. The additional protection for the other species and resources provides an additional margin of safety for fish/stream protection.

Load allocations for private lands within the Sucker Creek Watershed are scheduled to be developed by the spring of 1999. Funding is in place, and assessment work is targeted for completion by the end of 1999. The Agricultural WQMP is also scheduled for completion in 1999.

Chapter 4 - Monitoring Plan

Reasonable Assurance of Implementation

Monitoring will provide information as to whether standards and guidelines are being followed, and if actions prescribed in the WQMP are achieving the desired results. In addition to the monitoring identified in the WQMP, Forest Plan monitoring occurs annually to assess implementation of standards and guidelines. Information obtained from both sources of monitoring will ascertain whether management actions need to be changed. Funding for annual monitoring is given as a percentage of the appropriated dollars allocated to each district or zone.

If changes are required, the District Hydrologist will present the problem to management for determination of appropriate actions. The monitoring plan itself will not remain static, but will be evaluated periodically to assure the monitoring remains relevant, and will be adjusted as appropriate.

Monitoring data will foster changes in management activities in three ways:

1. Iterative watershed analysis
2. Next revision of the Siskiyou Forest Plan/Decision memo process in the watershed
3. Independent issues raised

Temperature

The Siskiyou National Forest, with our cooperators, will continue to monitor stream temperatures throughout the Illinois River watershed and in Sucker-Grayback, specifically. We monitor to meet a variety of objectives, so site locations will vary over time. Our objectives are to monitor long-term temperature recovery, better understand the natural temperature variability, and to track potential project effects. There are five locations that are monitored annually during the summer months to establish long term records. The sites are:

Sucker Above Bolan
Bolan Creek
Left Fork at Mouth
Grayback at Mouth
Sucker at the gage below Little Grayback.

This program will be administered by the Illinois Valley Ranger District, principally the District Hydrologist. The estimated annual cost for these five stations is $1,500.

Temperature, Shade Component

Streamside shade will be directly monitored in the headwaters of Grayback Creek just downstream of the Fan, Elk, Little confluences, and on Sucker Creek near its confluence with Johnson Gulch (BLM lands). We will use a solar pathfinder to establish existing shade. Measurements will be taken every five years, beginning in 1998. This work will be used to track the interim shade goals. Estimated costs for these two stations is $250.

It is very likely that over the next few years the District will prescribe riparian stand treatments in stands located adjacent to perennially flowing water (active restoration). These stands will be surveyed using existing regional standards prior to and following treatment. Data should confirm that prescriptions are accelerating growth rates and/or maintaining stand health such that shade and large wood supply objectives are met.

Future iterations of watershed analyses will also provide a basin-wide context for the health of riparian stands such that our ability to maintain and/or improve shading and large wood supply is addressed.

Temperature, Channel Form Component

Channel form will be directly measured through the use of channel cross-sections and pebble counts (Potoyondy and Hardy, 1994; Bevenger and King, 1995). Cross-sections will be re-surveyed every three to five years, or following large, channel forming events. Cross-sections will be, or have been, established at the following locations:

Left Fork Sucker Creek (established 1997)
Sucker above Bolan (established 1997)
Grayback near Mouth (established 1995)
Sucker near Johnson Gulch (proposed for 1998)
Sucker at the gage below Little Grayback (established 1997)

Work will be administered by the Illinois Valley Ranger District at an estimated cost of $250 per cross section.

Bedload sediment storage and transport is reflected as channel form. Our efforts to reduce the anthropogenic sources of bedload will focus on reducing the number and effects of road failures, and in increasing the proportion of wood to sediment delivered during mass failures. We will monitor and report the miles of road decommissioned and the number of pipes treated for diversion potential on an annual basis. Because watershed restoration is an evolving science, we anticipate that other techniques will be introduced during the recovery period that this plan covers. Those new techniques will be included in this plan as appropriate. Bankfull width-to-depth and general Rosgen classification will be monitored on a 10-year basis with stream surveys.

Changes in channel form are anticipated as a result of road treatments. In general, reductions in road-derived sediment will result in narrower and deeper channel cross-sections over time.

Habitat Modification

Standard Level II and III stream surveys will be conducted on a recurring basis to document changes in channel morphology, distribution of fish habitat units, and pieces of large wood in our channels. Stream surveys will also monitor approximate densities of juvenile salmonids and riparian vegetation. Extensive surveys will survey whole watersheds or sub-watersheds during a summer (Level II surveys), with an average seven-year cycle.

More intensive surveys (Level III) will be done in low-gradient and less confined stream segments. These are anticipated to have measurable responses to changes in watershed conditions.

Sites to be monitored include:
Left Fork of Sucker (lower ½ mile)
Sucker above the FS Boundary (near Mule/Cohen Creeks)

Grayback Creek (lower ½ mile)

Flow Modification

US Geologic Survey has discontinued the Sucker Creek stream gauge because of lack of funding. The Oregon Department of Water Resources is currently operating the gauge, and takes additional flow readings at three additional sites in the watershed during dry months. The Oregon WRD will report any changes in water rights and uses to the Medford DEQ office.

***Properly Functioning Condition* (PFC)**

The BLM/USFS methodology known as Properly Functioning Condition (PFC) assesses the physical capability of stream to withstand 30-year return interval storm events. Representative sections of Grayback, the Left Fork of Sucker Creek, and the Sucker above Grayback were surveyed in the spring of 1998. These reaches will be reassessed if there are changed conditions in the Sucker Creek watershed.

Table 16 connects monitoring goals, frequencies, and interim benchmarks identified in this WQMP, with management measures and elements from Table 15.

Table 16

Interim Benchmarks and monitoring frequencies for Grayback-Sucker WQMP					
Element	**Site Identification**	**Management Measure**	**Interim Benchmarks**	[1]**Monitoring Parameter**	**Monitoring Frequency**
Temperature --Lack of shade--	See streams identified in Figure10	Passive – no treatment	Established stands continue to grow 10-50 years (See shade curves in Figure 11)	Shade % w/ solar pathfinder 2 Continuous temperature monitoring sites (dry weather)	Begin 1998 then @ 5 yr. Intervals Annually
Temperature --Lack of shade--	Sucker Creek Tribs.	Passive plus treatments to increase growth and insure long term health	2013 – solar radiation reduced by 10% 2043 – solar radiation reduced by 13 %	Stand surveys (growth and health) 2 Continuous temperature monitoring sites (dry weather)	Pre and post treatment 1998-2013 Annually

[1] QA/QC: DEQ protocol will be followed as close as possible where applicable (e.g. temperature monitoring). Region 6 Stand Examination Standards will be followed for stand surveys, and appropriate published protocol for Solar Pathfinder, Rosgen stream assessments, etc.

Element	Site Identification	Management Measure	Interim Benchmarks	Monitoring Parameter	Monitoring Frequency
Temperature **--**Lack of shade**--**	Grayback Creek Tribs.	Passive plus treatments to increase growth and insure long term health	2013 – solar radiation reduced by 10 % 2058 – solar radiation reduced by 14 %	Shade % w/ solar pathfinder Stand surveys (growth and health) Continuous temperature monitoring (dry weather)	Begin 1998 then @ 5 yr. Intervals. 1998–2013 Pre and post treatment Annually for main stem, intermittent for tribs.
Temperature **--**Channel Form A3**--**	Grayback RM 4.7-7.1	Upland Sediment Abatement	After two 25-year magnitude storm events (minimal impact on solar radiation)	Rosgen type (W/D) Miles road decommission Potential diversions corrected High priority road upgrades, decommission and stormproofing	Following large storms (25 yr magnitude) Annually
Temperature **--**Channel Form B4 (0.75 stream miles)**--**	Grayback (confluence w/Sucker to RM 0.75)	Upland Sediment Abatement	After two 25-year magnitude storm events Reduce solar radiation by 7 %	Rosgen type (W/D) Miles road decommission Potential diversions corrected High priority road upgrades, decommission and stormproofing	1 site @ 3-5 year intervals Annually
Temperature **--**Channel form F4 = 2.3 stream miles**--**	Sucker Creek u/s of Grayback to Yeager	Upland Sediment Abatement 2000 – DEQ, DOGAMI and USFS assess mining impacts. 2002 Address significant issues in 0600and 0700 NPDES and 401 certifications	100-year magnitude storm event[2] Alterations to mining general permits - 2002 401 certifications issued, changes in conditions.	Riparian Stands Rosgen type (W/D) NPDES permit modifications. Certifications issued, change in conditions	20 year cycle 3-5 year intervals 2002 and then @ 5 year intervals Annual

[2] Changes to historic mining practices and historic laws regulating mining activities will require a lonterm effort before measurable change is observed.

Parameter	Site Identification	Management Measure	Interim Benchmarks	Monitoring Parameter	Monitoring Frequency
Temperature --Channel Form Mining site reclamation--	Flat above Cave Creek	Channel manipulation project	Decrease W/D ratio by amount recommended by BLM interdisciplinary team. 1999	Rosgen type (W/D)	Pre Project Post Project (1999)
Temperature --Flow--	Federal ownership	Educate users regarding conservation	WSC to contact water users by 2000	Federal land Withdrawals Seniority Dates Flow information	Report educational efforts / 2-yr interval Bi-weekly during dry months[3]
Habitat modification --Lack of Channel complexity--	Reach 2 Grayback Creek	Treatments to increase growth and insure long term health 1998 Place wood in channel 1998	2098 – improved from fair to good (ODFW Benchmarks)	Level 2 stream survey Pool freq. (riff w/seg dist) Pool area (%) Large Wood (pieces/mile) Large riparian trees (%)	7-10 year intervals
Habitat modification -- Lack of Channel complexity--	Sucker Creek u/s of Grayback to Yeager	Reduce channel impacts from mining. Riparian forest management. Reduce upland sediment.	2X 25 year storm magnitude 2098 – improved from poor to fair[4]	Level 2 & 3 assessments. Pool freq. (riff w/seg dist) Pool area (%) Large Wood (pieces/mile) Large riparian trees (%) Sediment abatement (Roads decomm., etc.)	7 year intervals Level 3 biannually Annual
Habitat modification --Lack of Channel complexity--	Remaining Federal ownership	Passive – no treatment. ODF&W benchmarks plus Siskiyou Riparian goals	Percent of full biological potential	Level2assess. Pool freq. (riff w/seg dist) Pool area (%) Large Wood (pieces/mile) Lg Riparian trees (%)	7-10 year interval (See ODFW benchmarks in Table 11)

[3] Oregon Water Resources Department
[4]This area is in extremely poor shape and will require much time to recover.

Parameter	Site Identification	Management Measure	Interim Benchmarks	Monitoring Parameter	Monitoring Frequency
Flow modification -- Low flow condition--	Federal ownership	Seek to secure early priority consumptive water rights for conversion into instream water rights Educate users regarding conservation	Identify opportunities for conversion to instream rights. WSC to contact water users by 2000	Withdrawals Seniority Dates Flow information ODFW ISWR ODFW (Optimum Flows)	Report cfs converted to ISWR @ 2 year intervals Report educational efforts/ 2 year intervals

Implementation Monitoring and Adaptive Management

A biennial report outlining progress and tabulation restoration projects will be submitted to Oregon DEQ by the Illinois Valley Ranger District. Should monitoring reveal that interim goals are not on schedule, changes related to this Water Quality Management Plan will be made. These changes might include re-evaluation of assumptions, and/or new restorative treatments.

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APPENDIX A

Site Specific Restoration Plan

GRAYBACK SUCKER RESTORATION PRIORITIZATION

TEAM RECOMMENDATIONS SUMMARY

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Key Findings and Recommendations

1. The Team was able to gain consensus on objectives quite readily; consensus on treatments was a bit more elusive, but a great deal of common ground exists.

2. Vegetative treatments center on density management; key areas include previously treated stands located within or adjacent to habitat connectors and intact patches of interior habitat. Interior habitat maintenance is also an issue. Use of fire as a tool for density management was the preferred tool by some, and the last choice for others.

3. Lower Grayback Creek is the primary location identified for in-stream fish improvements, placement of whole trees is recommended. One member disagreed, all were concerned about environmental effects associated with the wood source. There are also some smaller opportunities in Bolan Creek and some diversion of high flow opportunities along the mainstem of Sucker near Cave Creek.

4. The road system is currently at high risk of damage associated with large storm events. Diversion potential correction is the preferred solution where obliteration is not feasible. Roads recommended for this are: 4611 (Grayback), 4611-070, 4611-079, 4612-098 (Upper Sucker), 4613 (Buck Pk), 4614-017 and 4614-024. 4612-080 past Left Fork is recommended for obliteration. There was no group consensus on the obliteration.

5. Vegetation treatments can be scheduled in a way that limits the need for high standard roads. There are many opportunities to complete commercial treatments that require lowboy access and then treat road template aggressively. (see list above).

6. The Team would like to see a moratorium on road-building, if this is not possible then minimize sediment production.

INTRODUCTION

This document contains the more detailed notes that accompany the November 15th memo addressed to the District Ranger regarding team recommendations and findings for the Grayback-Sucker restoration prioritization process. The document includes recommendations grouped by analysis areas, as well as some comments that cover the entire watershed.

SUMMARY OF APPROACH

Our group agreed that the best approach we could take in our attempt to prioritize restoration opportunities would be to focus on those activities which would best protect the ecological processes still functioning properly (or nearly so) in the watershed. This "protect the best" philosophy was a cornerstone for our work.

Secondly, while we recognized the interconnectedness of ecological processes, we felt that the only manageable way to work through this prioritization was to split into groups. We chose to focus on terrestrial processes, aquatic processes, and roads.

The terrestrial group used protection of large patches of interior habitat and the connecting land between those patches as the way to prioritize treatments. There is an accompanying document from that group that details their thoughts in more detail. Unfortunately, modeling of historic nor potential wild and/or prescribed fire was not included in this process. Therefore, risk of changed conditions due to this important process is not included in the prioritization. This will be addressed in the iteration of the Grayback-Sucker watershed analysis 1.1.

The Aquatic group identified five stream reaches that contained important habitat and populations as the focal areas to protect. Geomorphic processes that joined hill slopes to streams were identified, critical areas are highlighted on accompanying maps. Recommendations about roads were the by-product of discussions based on terrestrial and aquatic processes.

The lack of readily accessible data on private lands, and the non-conformity of BLM vs. FS data on federally managed lands made it difficult to extend our efforts off of the FS base. We made some small progress towards integration, most notably in sharing information about BLM roads and in brain-storming about processes in the lower, privately-owned portion of the watershed. Details regarding the lower portion of the watershed follow the sub-basin descriptions in this document.

DESCRIPTIONS OF THE SUB-BASINS

Each Sub-basin discussion is structured as follows: fish, gemorphology, vegetation, mining, land allocation, unique features, roads.

The District Ranger directed the group to document those areas of consensus and those areas of disagreement. In general, the statements listed below are those around which there was consensus. One team member asked to go on record as disagreeing with any road decommissionings. Several team members disagreed about the cutting of trees larger than 20" in any situation, others disagreed with the removal of any wood from either previously managed stands or unmanaged lands.

Main stem Sucker, Fehley Gulch to Left Fork

This reach supports winter steelhead and trout. It is characterized by high sediment transport and no instream structures for fish habitat improvement are recommended.

Due to the presence of granitics and steep slopes, especially in the Tannen, Grizzly, Deadhorse drainages and on the ridge between Sucker and the Left Fork, there is a high mass failure potential in this sub-basin.

The Tannen, Grizzly, Deadhorse drainages contain the patches of vegetation identified as the highest priority to protect; there are few opportunities to treat vegetation to improve mature and older forest characteristics.

Land allocations are mixed, both matrix and late-successional reserves are present.

Mining claims are present along the Main stem and several tributaries.

Road 4612-098 has a large number of pipes with diversion potential. Data also indicates that the spacing between drainage pipes (stream crossing and ditch relief) is high (widely spaced).

The group recommended that a physical scientist and an engineer review potential side cast conditions on 4612-098 immediately above the first bridge.

Left Fork Sucker

This reach supports primarily winter steelhead and trout, with some coho salmon in the lower reaches. There are no instream structures recommended in this reach.

This sub-basin has the highest percent of land at risk for mass failure in the Grayback Sucker watershed.

There are several plantations that are contained in and/or adjacent to mature forest patches that are high priorities for treatment. Some of these stands are of commercial size, some are pre-commercial. There is good consensus that it would be best if the stands were encouraged to grow larger trees more quickly. There was some concern about the use of fire due to smoke and potential health effects. There was also some disagreement about considering the removal of commercial sized trees from plantations as restoration. The group did agree that cutting of trees would spur others to grow, but some members preferred to leave the wood on site.

There are a fair number of Port Orford Cedar trees which are currently uninfested on the Main stem of the Left Fork. Some group members advocated closing the 4612-080 road as the best way to protect these trees from infestation. There was no consensus on this.

There are some mining claims along the lower portions of the Left Fork.

The land allocation includes matrix and late seral reserves.

Road 4612-080 has few pipes with diversion potential, but pipes are widely spaced. Placement of additional pipes should be considered. Road 4614-048 has 50% of its stream crossing pipes with diversion potential and widely spaced ditch relief pipes. Road 4612-080-472 has 33% of its stream crossing pipes with diversion potential.

Bolan

This stream does not support high numbers of fish, although it does support some winter steelhead and trout. Its most important feature is that is supplies clear, cool water to downstream reaches. It also appears to observers that it supplies a lot of water relative to other drainages of similar size.

This sub-basin has a low overall risk of mass failures with the exception of a high risk location in deep metamorphic soils where the two forks of Bolan join.

There is a large interior patch in this sub-basin. There are three stands that are high priority for treatment.

There is a stand of Port Orford Cedar near the bottom of Bolan Creek that some team members felt would be best protected if the road that crosses lower Bolan was closed. Some team members believe that road is no longer driveable and felt there would be little trouble meeting this suggestion.

The land allocation is a mixture of partial retention matrix and late successional reserve.

There is a mining claim along lower Bolan.

There was no field data collected on the roads in Bolan creek, nor were any culvert spacing calculations performed. In general, the roads in this drainage perform well during storm events and there was little emphasis given to this watershed in regards to the road network.

Main stem Sucker, Left Fork downstream to Johnson Gulch

High numbers of winter steelhead and trout in this reach, with marginal coho and chinook habitat and populations. The upper portions of this reach are best. Water quality is good, the reach is dominated by bedload transport and the presence of bedrock outcrops.

Mass failure potential is fairly low, Yeager Creek has a few locations with higher risk of failure.

There are several stands suggested for treatment within this sub-basin, including those along the riparian of Yeager Creek. These riparian stands are of especially high value due to the rarity of opportunities for low to mid elevation stands adjacent to mature forest patches.

Land is this sub-basin is managed by both the BLM and the FS, a mixture of LSR and matrix lands are present.

Mining occurs along Main stem Sucker in this reach.

The group recommended that the road system in upper Yeager be reviewed for opportunities to limit the risk of spread of POC root disease.

Main stem Sucker, Johnson Gulch to Grayback

This reach has the highest concentration of spawning coho in the Rogue. There is good potential for additional fish numbers, but habitat is heavily impacted from mining. *The team recommends that we try to influence mining operation designs such that activity is confined to small portions that are subsequently reclaimed prior to moving to a new area to mine. An opportunity to create a low flow channel was also identified, the location is shown on accompanying map. Flood plain revegetation with hardwoods was recommended.*

There are very few acres that are considered to be at a high risk of mass failure in this reach.

There are two low elevation stands adjacent to a large mature and old growth patch that are a high priority for treatment.

The land allocations are late seral reserve on FS-managed lands and matrix on BLM-managed lands.

Road 4612-013 was damaged in the January 1995 storm. There is no known on-going damage, but the road is not passable for its full length.

Cave Creek

Coho are present in the first 0.5 mile of Cave Creek, steelhead use the creek beyond this point. No anadromous fish habitat improvement work is recommended.

There are a few acres of high risk of failure ground in Cave Creek. Cave Creek has been subject to debris torrents in 1964 and in 1997.

There are numerous stands that are high priorities for treatment located along roads 4614-017 and 4614-024. These roads are also a high priority for road treatment as they have many plugged pipes and are located on soils that pose a high erosion risk (decomposed granitics). *The team recognized this area as a point of contradiction where two resource areas had strong needs that did not compliment each other.* Road storm proofing is planned for these roads in 1998.

There are also large stands that connect patches "e" and "g" (see map) that are a high priority for treatment.

POC occupies a fairly long, continuous, currently uninfested portion of the riparian area in upper Cave Creek. There is an infestation that includes the first tributary on the west facing bank downstream from the campground, and goes down Cave Creek from there.

Land allocation in Cave Creek is late seral reserve.

The Cave Creek Campground and the Caves National Monument are two unique features.

Roads 4614-017 and 4614-024 have already been discussed. Additionally road 4611-070 from Pepper Camp to Bigelow Lakes is mapped as a high risk road. Failures have occurred here in past storms. There are 7 sites associated with the January 1, 1997 event. *Subsequent to the team process, the hydrologist proposed that rather than repair the road, that it be decommissioned and turned into a trail. This proposal went out for public comment in January 1998.*

<u>Grayback</u>

There are Coho present in Grayback in the lower reaches below Whiterock, they are occasionally seen up to Mossback. Steelhead occupy the channel all the way to the Fan, Elk, Little junctions, and use lower portions of Whiterock. *The team recommends that the fish passage barrier (culvert) at Windy Creek be changed to a pipe arch to open up habitat. Instream bundles for fish cover are also recommended. Large wood is also considered to be of value in lower Grayback. One team member disagreed; concerned largely about the source of such wood and bridge safety.*

Some local miners have agreed to use their suction dredges to clear the recently deposited silt out the previously excavated coho alcove in the lower floodplain.

Riparian Meadows along lower Grayback: some of these are seeding in and will go back to trees. There are some opportunities to plant trees along the stream side edge.

The headwater drainages of Elk, Fan, Little and Jenny Creeks contain the land with the greatest risk of mass failure in the Grayback watershed. Numerous failures have occurred here in large storm events, January 1997 was no exception.

There is a very high percentage of Whiterock Creek in lands that are considered to be at high risk of mass failure. Limited field reconnaissance in this watershed indicates that much of the basin is occupied by large deposits from ancient failures, these sites are very productive in terms of growing vegetation.

There are MANY stands that are a high priority for treatment in the upper Grayback area. The team reviewed these on a road by road basis as part of our objective in this area was to look for opportunities to reduce road mileage or alter road templates in a way that reduced effects and costs associated with large storm events.

> <u>4611-988</u>. Most stands have been treated and it is estimated that it will be 20 years until the next commercial opportunity. *The team recommends that this area be carefully reviewed by a silviculturist for opportunities*. This road has a low watershed risk, but a high value for closure/ mitigation due to POC.
>
> <u>4611-079.</u> Road 988 comes off of this road, so any treatments needed there should be considered in conjunction with this road. There is a large stand, 40020066, located along this road. This is a very high treatment priority. There is one moderate priority stand 40020063 and a low priority stand 40020079. There is a strong need to remove or storm proof this road from a physical science perspective, 70% of the pipes on this road have diversion potential. Some team members felt road closure was very important for POC, others disagreed as the road is blocked for travel during much of the wet season due to snow drifts.
>
> <u>4611-070.</u> This road traverses ground that includes habitat connections whose land allocation is matrix. This makes treatment here a lower priority from a wildlife perspective as we will not be able to maintain mature and old-growth conditions on these sites over long periods of time. Stand 40010004 is presently available for commercial thin. The remaining stands accessed by this road are of moderate priority. This road is the primary escape route in case of a fire in the Caves N’tl Mon. 95% of the pipes on this road have diversion potential, making it a very high priority from a physical science perspective. *However, because the road is needed, the team recommends storm proofing (diversion protection most likely).*
>
> <u>4611-063.</u> The majority of the stands along this road are 10-15 years away from commercial treatment. The bottom of stand 40050064 was originally accessed using the 063 road, and the

road may be needed again to treat those acres. *The team recommends that a logging engineer review this site*. This road is a high priority from a physical science standpoint due to a high number (83% of pipes) of potential diversions, past (and present) failures, and a large distances between drainage pipes.

4611-063-970. This spur road accesses the heart of the connectivity in Grayback. There are 3 large stands ready for commercial entry: 40050005, 40010027, & 40010028. These stands are highly dissected by stream channels. *The team recommends field review of these units by an IDT as soon as feasible.*

4611-078. This road accesses stand 40010017 which is a high priority for commercial treatment. Once this treatment is complete, the team sees little reason for this road in terms of forest management for 20 years or so. The risk analysis does not indicate a high potential for failure, but Dave Patton, a long time employee, has seen failures on this road in the past. *The team recommends field review as soon as feasible.*

4611-085. This road had little interest from any team member.

4611-079 out to Williams. There are no vegetation treatments recommended along this stretch of road, aside from planting the deposit portion of the debris avalanche from the January 1, 1997 storm. There are a high number of historic failures on this road. *Storm proofing is recommended as the road is a connector and access matrix and therefore decommissioning did not appear to be an option.*

4611-955. There are no vegetation treatments recommended along this road. *The team recommends that this road be field reviewed for possible hydrologic and stability concerns.*

4611-019. Stand 40050039 is a high priority for treatment, stands 40050034, 40050032, 40050035 are moderate priority for treatment, and stands 40050127 and 40050079 should be considered for potential for pine restoration. If all of these stands are treated shortly, then the road could be heavily storm proofed. Decommissioning was not seriously considered as the road accesses privately owned timber land. POC would benefit from road closure or other mitigations.

4613-015. There are several stands who would benefit (moderate priority) from a pre-commercial treatment. There would then be a 30 year period where the road was not needed for forest management and could be heavily storm proofed. Decommissioning was not discussed as the road does not rate as a high risk to watershed resources. The stream crossing pipes on this road are covered with very little fill (flat ground at crossing). This may be a good opportunity to pull pipes so that during the 30 year hiatus we could reduce maintenance costs. It would be relatively inexpensive to put pipes back in when needed.

4613. There are 3 high priority stands along this road; 40050341, 40050069, 40050051. Stand 40050116 is of moderate priority.

4613-953. Stand 4005022 is of moderate priority. This road traverses private ground.

4611. This main road accesses much of the basin, including private land. The team discussed the potential for decommissioning. There was strong support for decommissioning due to location of the road in the riparian zone. The realities of decommissioning such a large, heavily invested and heavily used road, however, precluded this recommendation from being made in any formal way. There was no consensus on decommissioning. There are existing funds collected through KV (timber sale) to storm proof this road.

Little Grayback

There are coho in the lower reaches of Little Grayback and steelhead up further.

There are few acres in Little Grayback that pose a risk of mass failure.

There are two stands in the habitat connector that goes up Lake Creek, 40050043 and 40050019, these need to be field reviewed, but appear to be high priority through this analysis.

There were no Forest Service road segments reviewed in this watershed for this analysis. The BLM is contemplating, pending permittee contact, obliteration of 0.5 miles of road and upgrade of approximately 1.5 miles in this watershed.

Bear

Coho are present along Lower Bear Creek, this area has been field identified as very critical. *There is a diversion ditch that has no screen that the team recommends the local watershed council consider aiding the landowner in design and installation.*

There were no stands identified for treatment in this watershed due to incompatibilities between FS and BLM data.

The BLM is contemplating, pending permittee contact, obliteration of approximately 3.5 miles of road in Bear Creek.

ECOMMENDATIONS TO PRIVATE LANDS

The team did not systematically review the existing situation on private lands. Local experience of team members, however resulted in the following list of critical considerations as society looks for opportunities to improve watershed conditions on privately-held lands.

Pine-Oak Savanna. Much of the valley flat was historically dominated by this fire-dependant plant association. These plants are easily out-competed by vegetation that is more effective at gaining access to limited summer-time moisture (firs, cedar, brush). Restoration of these species on appropriate sites is desired.

Slow Water Habitats. The low gradient reaches of Sucker (below Grayback) offer unique habitat for fish and other aquatic organisms. Most critical are those channels that offer slow moving water during periods of high flow, these locations often offer cool, complex habitat during low flow also. Preservation and expansion of this habitat component in Sucker Creek is crucial.

Riparian Forests. The riparian forests of Sucker Creek have not been systematically inventoried. A more thorough understanding of their extent and character would aid in management of this outstanding resource. It is likely that due to fire exclusion, opportunities exist to treat these stands in order to ensure their long term health and productivity.

Port Orford Cedar is an important and unique species in our riparian forests. The area downstream of Grayback Creek is infested with the root rot disease that attacks this species. POC sanitation and other techniques may preserve individual trees.

Non-native Vegetation. There are locations where aggressively growing non-native vegetation is out-competing native trees and other vegetation on the valley flat. Control of this non-native vegetation, including noxious weeds, is recommended.

Roads. Diversion of natural stream courses by privately or county-owned roads is believed to occur throughout the watershed. Correction of these problems such that channels are in equilibrium with the historic water balance is desirable.

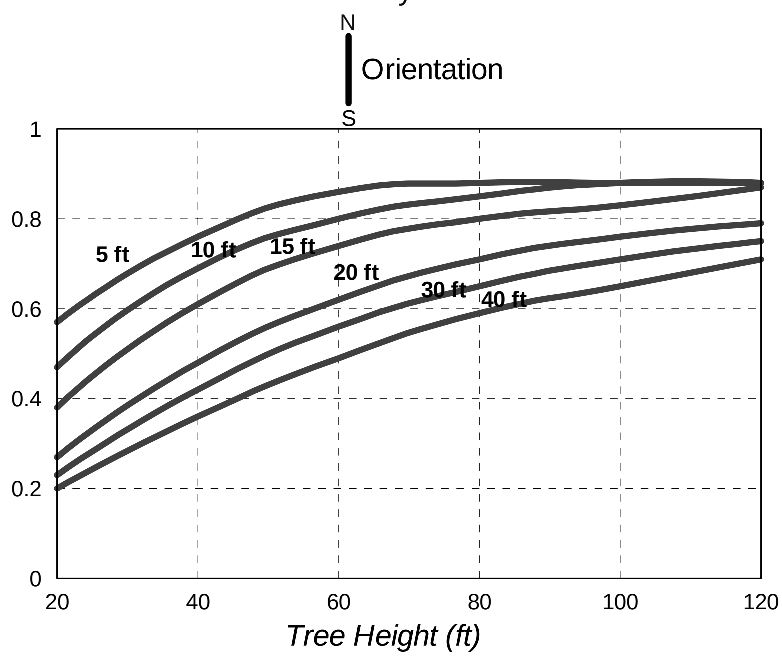
Erosion of fine-grained sediments and subsequent delivery to channels is believed to occur throughout the watershed. Road drainage improvement such that this erosion is minimized is desirable.

Mining. Mining along the floodplain of Sucker Creek above Grayback could potentially be conducted in a manner that disturbed small portions at any given time. The feasibility of this approach would have to be decided in concert with the mine operator and the Division of Geology and Minerals Industry.

APPENDIX B

Shade Estimation

Stream Shade by Wetted Width *42 Degrees Latitude*

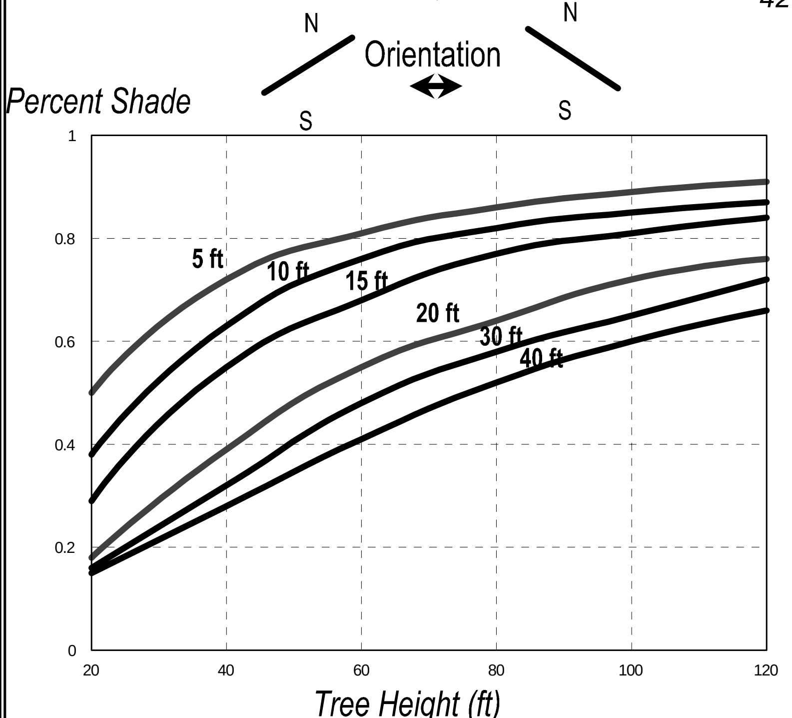


Shade Density	Correction Factor
70	-.03
60	-.06
50	-.09
40	-.15
30	-.23
20	-.34

SHADOW Shade Model

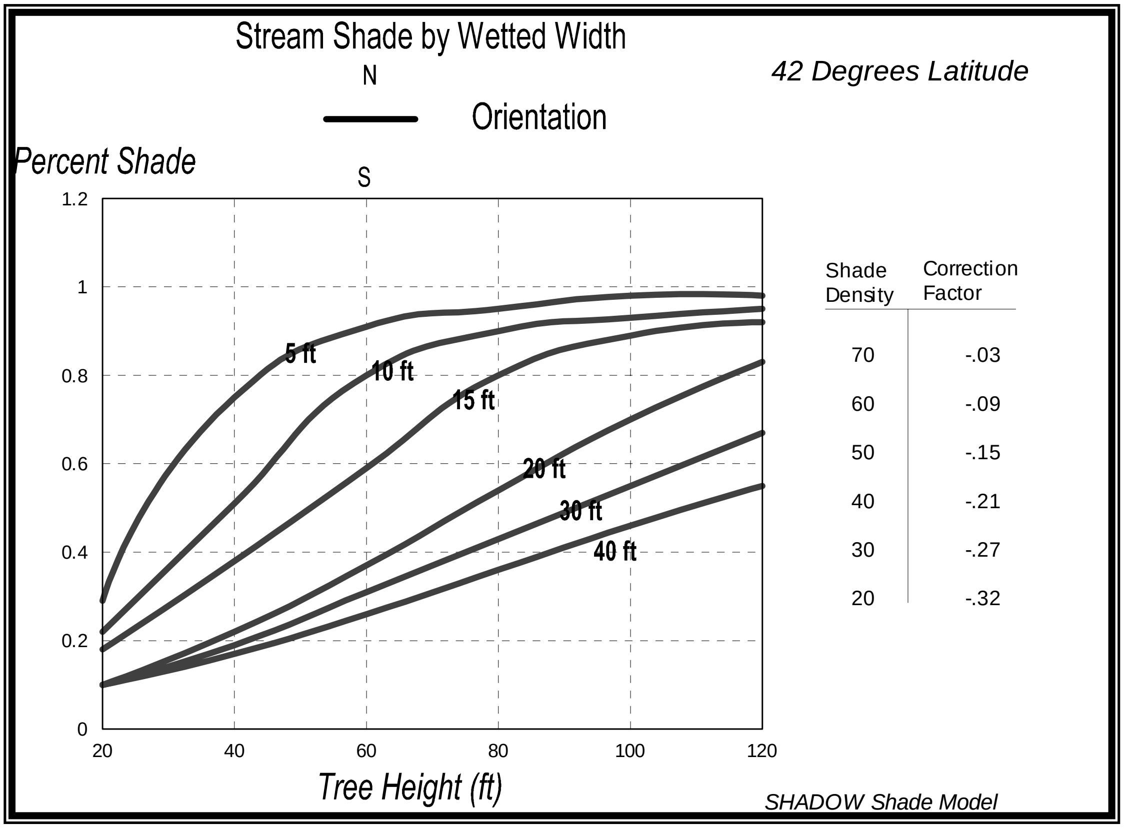
Stream Shade by Wetted Width

42 Degrees Latitude



shade Density	Correction Factor
70	-.02
60	-.04
50	-.09
40	-.16
30	-.24
20	-.34

SHADOW Shade Model



Stream Shade by Wetted Width
N
Orientation
S
42 Degrees Latitude
Percent Shade
1.2
1
0.8
0.6
0.4
0.2
0
20
40
60
80
100
120
Tree Height (ft)
5 ft
10 ft
15 ft
20 ft
30 ft
40 ft
Shade Density
Correction Factor
70 -.03
60 -.09
50 -.15
40 -.21
30 -.27
20 -.32
SHADOW Shade Model

APPENDIX C

Habitat Benchmarks

ODFW: AQUATIC INVENTORY PROJECT: HABITAT BENCHMARKS

TABLE 1

	POOR	GOOD
POOLS		
POOL AREA (%)	<10	>35
POOL FREQUENCY (Channel Widths)	>20	<8
RESIDUAL POOL DEPTH		
LOW GRADIENT-SMALL	<0.2	>0.5
HIGH GRADIENT-LARGE	<0.5	>1.0
RIFFLES		
WIDTH / DEPTH RATIO		
EASTSIDE	>30	<10
WESTSIDE	>30	<15
SILT-SAND-ORGANICS (% AREA)		
NORTHWEST/COLUMBIA	>25	<10
NORTHEAST	>20	<8
CENTRAL/SOUTHEAST	>25	<12
SOUTHWEST	>15	<5
GRAVEL (% AREA)	<15	>35
SHADE (Reach Average, Percent)		
STREAM WIDTH < 12 meters		
WESTSIDE	<70	>75
NORTHEAST	<60	>70
CENTRAL - SOUTHEAST	<40	>50
STREAM WIDTH >12 meters		
WESTSIDE	<55	>60
NORTHEAST	<40	>60
CENTRAL - SOUTHEAST	<30	>40
LARGE WOODY DEBRIS (15cm x 3m minimum piece size)		
PIECES / 100 m STREAM LENGTH	<10	>20
VOLUME / 100 m STREAM LENGTH	<20	>30
"KEY" PIECES (> 50 cm dia. & > ACW long)/100m	<1	>3
RIPARIAN CONIFERS (30m FROM BOTH SIDES CHANNEL)		
NUMBER >20in dbh/1000ft STREAM LENGTH	<150	>300
NUMBER >35in dbh/1000ft STREAM LENGTH	<75	>200

"Good" habitat conditions based on values from surveys of reference areas with known productive capacity for salmonids and from the 65th percentile of values obtained in surveys of late successional forests. "Poor" habitat conditions based on values associated with known problem areas and from the lower 25th percentile of combined data for each region.

APPENDIX D

Road Flood Damage Assessment

ROAD DAMAGE

KEY FINDINGS

Diversions

1. Diversion potential exists at many mid- & upper slope road/stream crossings. Diversion of intermittent or ephemeral streams resulted in some of the most extensive damage features.

2. Diversions greatly increase the effects of road failure sites. Comparison of three watersheds showed that diversions increased sediment delivery an average of 2 to 3 times over sediment that is delivered if the water is not diverted and erodes only the road fill at the crossing.

3. Ditch flow and diversions are often carried long distances where the road surface angle dips toward the cutbank. Some diversions were up to 1400 meters long.

4. Existing treatments aimed at preventing diversions may not be totally effective. One diversion with major effects occurred at a site where the road had a broad-based dip. A debris flow deposited material in the dip, and the flow diverted around it and down the road.

Debris Flows

1. Repair designs should account for future movement of landslides and reactivation of debris dams at many impacted sites.

2. Roads prisms often stop or significantly reduce the size debris flows. Inlet basins are typically completely filled with debris and sediment and the road fill eventually is eroded. Large wood was often captured at road crossings and was not delivered downstream.

Road Design, Maintenance, and Reconstruction Factors

1. Most forest roads have not been adequately storm proofed or armored to prevent severe erosion.

2. Several repairs made immediately after the storm were simple replacements of what failed and did nothing to prevent the likelihood of future failure (i.e. same size culvert, no diversion prevention measures). Many of the damage sites exposed old buried culverts at a lower elevation in the road fill, indicating that the sites had failed in previous storms.

3. There are ephemeral channels on each district that have no drainage structure where they intersect a road. Some of these caused road failures; others contributed to failures at larger stream crossings.
4. Small pieces of wood commonly initiated debris plugging of culverts[1].

1

5. Both number and size of failures increase with lower hillslope position.
6. Relatively few road failures can be attributed to inadequate maintenance. Where maintenance-related failures did occur, they were caused by rusted out pipes or live vegetation blocking culvert inlets or outlets [2].

Stream Channels

1. Road failures greatly increased storm effects on some channels, but left no visible effects on others.

2. Sediment delivery to streams from road damage varied by site from none to 100 percent. The average amount delivered was 75% of the total failed volume.

3. On Gold Beach and Chetco Districts little sediment was delivered directly into fish bearing streams. On the Powers District, 36 percent of sediment was delivered directly into fish bearing streams.

RESULTS & DISCUSSION

FAILURES:

The high flows generated by intense rainfall over a two-day period mobilized in channel sediment and wood, scoured stream banks, and triggered landslides that added more sediment and wood to the flows. As these high flows traveled downstream and encountered road crossings, they either passed through the drainage structure, exceeded the hydraulic capacity, or plugged culverts with sediment and/or woody material. Hydraulic exceedence and culvert plugging resulted in ponding behind the road fill, overtopping and eroding the road fill, saturating the fill and causing it to fail, or diverting of the flow and its transported material along the road. These mechanisms occurred at damage sites singly and in a variety of combinations. The effects of these “failed” crossings were road erosion, greater storm effects to downstream channels, diversion gullies, other damage sites downstream or down road, and landslides.

Where roads were constructed along the valley floor of larger streams, the high storm flows undercut the toe of road fills. The intense rainfall also saturated soils in road cutbanks and fills and caused failures that damaged roads.

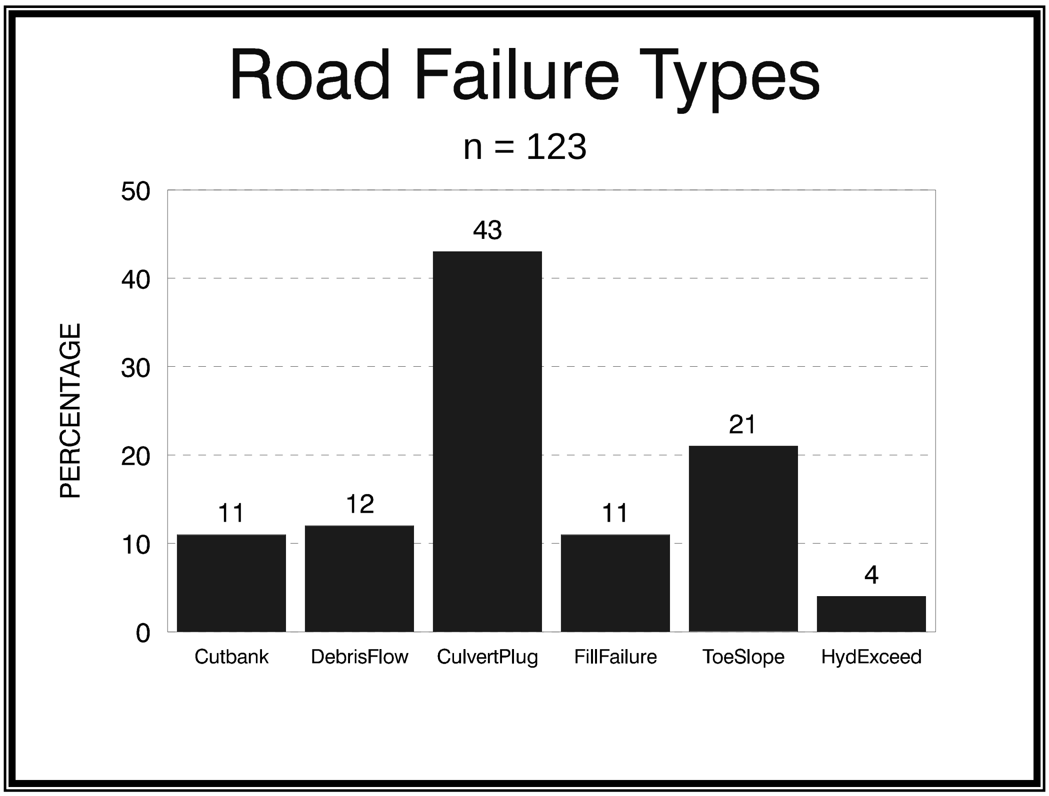
Causes:
Road damage was typically caused by one of the following:

Cutbank failure
Pipe plugging by debris flow
Pipe plugging by sediment and/or woody debris
Saturated fill failure
Fill failure from stream scour at toe
Hydraulic exceedence

[2] Finding consistent with Region 6 “Pacific Northwest Floods of 1996" conclusions.

The vast majority of road damage sites were associated with culverts and stream crossings. At sites not associated with culverts, fill failures and cutbank failures were typically caused by saturated ground conditions and removal of toe support by either road construction (cutbanks) or stream scour. The failure types for the study area are shown in Figure 9.

The most common failure type was culvert plugging by sediment and/or woody debris (43%). The other common failure types were fill failure from scour by streams at the toe (21%), plugging by debris flow (12%), fill failure not associated with stream crossings (11%), and cutbank failures (9%).



Only 4% of culvert failures were attributed to hydraulic exceedence. However, hydraulic exceedence may have been the cause of more site failures than reported. Personnel on site during the storm reported that there was no material at the inlet of some culverts that they attempted to unblock with heavy equipment, but the flow was more than the culvert could handle. When they returned to the sites after the storm, material had been deposited on the falling limb of the hydrograph making it appear that sediment had blocked the inlet.

Another observed cause was ephemeral channels that crossed the road with no drainage structure. One ephemeral stream caused a road damage site; in other cases flow from ephemeral channels diverted and contributed to failures at larger stream crossings.

Factors Contributing to Failure:
Culvert plugging by debris, especially sediment, caused the most resource damage of all failure types (see Effects Section). In addition to the volume and size of sediment and woody debris

relative to the size of the stream channel and culvert, culvert plugging appears to be related to a number of design factors.

Examination of 35 of the sites found that 60% of failures by plugging had a significant break in slope between the upstream channel and the culvert and/or inlet basin. The decreased gradient of the pipe/inlet basin appears to induce sediment deposition and eventual plugging.

Pipe inlet configuration (protruding, beveled, etc.) and inlet basin configuration play a significant role in the plugging potential from both wood and sediment. Beveled inlets increase the inlet efficiency of the culvert and reduce the potential for wood to jam at the inlet. Funnel-shaped inlet basins increase the capacity of the culvert to transport flows, sediment, and woody material. A circular basin will create eddies that cause head scour, and align wood across the inlet, trapping sediment and plugging the culvert. Most culverts measured had inlet basins several times the width of the culvert, which would have contributed to their plugging.

Road fill failure from scour at the toe by streams was the most common failure type in watersheds with arterial roads paralleling streams. These type of failures are recurring on low elevation roads along the larger rivers and streams. The encroachment of the fill prism into the river valley eventually leads to erosion during infrequent, large storm events. For the arterial road in Elk River, similar failures were experienced in previous floods of 1955 and 1964.

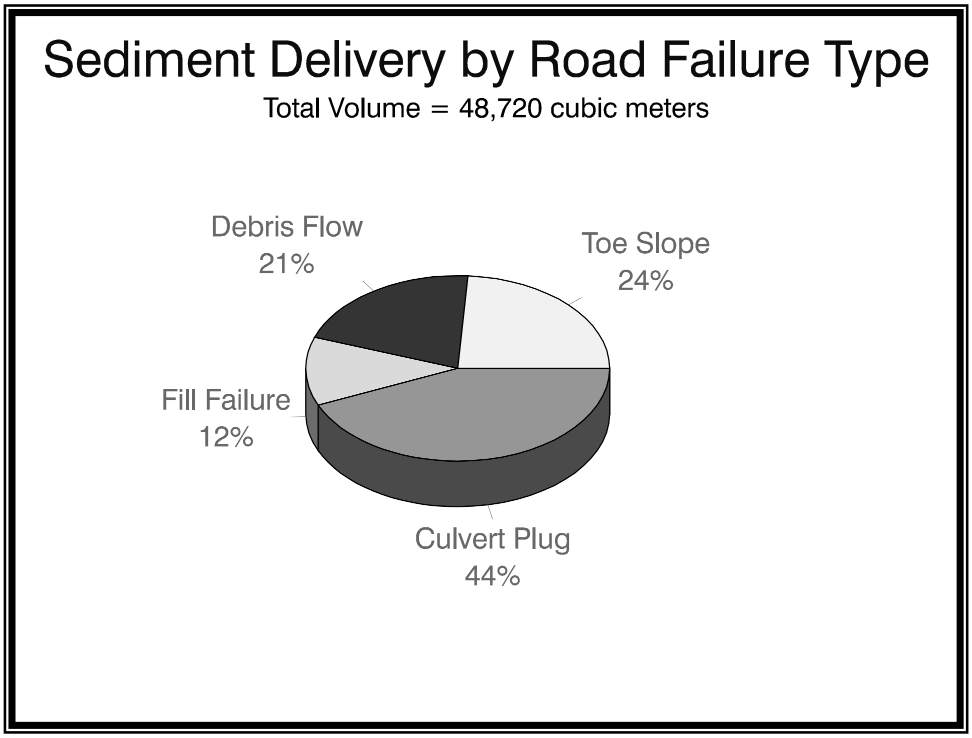
> Road construction on steep slopes within inner gorges creates high cutbanks which tend to become saturated and fail in large storm events or extended wet periods. However, no cutbank failure delivered significant sediment volume to any stream.

Failure Distribution:
At the watershed level, considerable variation occurred in failure causes and effects. A total of 123 sites were evaluated in the Powers, Gold Beach, and Chetco study area. Topographic position of the roads appears to have been a factor in both damage occurrence and extent. Nearly 50% of all failures were located within the lower hillslope position, primarily on roads constructed along major rivers such as the Elk and the South Fork Coquille. Road densities, failure locations, and slope positions will be analyzed in more detail when GIS data is available.

Diversions:
Diversions typically resulted in multiple plugging of ditch relief culverts, ditch scour, and landslides or hillslope gullies at the exit points, substantially increasing sediment delivery. Examination of the data within three of the watersheds showed that diversions increased sediment production an average of 2 to 3 times over the amount produced if the water is not diverted and erodes only the road fill at the crossing. Road crossings that survived debris flows with least damage had paved surfaces and no diversion potential. Paved surfaces minimized the amount of erosion caused by water flowing over the fill after the crossing overtopped. Lack of diversion minimized failure consequences by isolating damage to the fill prism at the stream crossing.

EFFECTS:

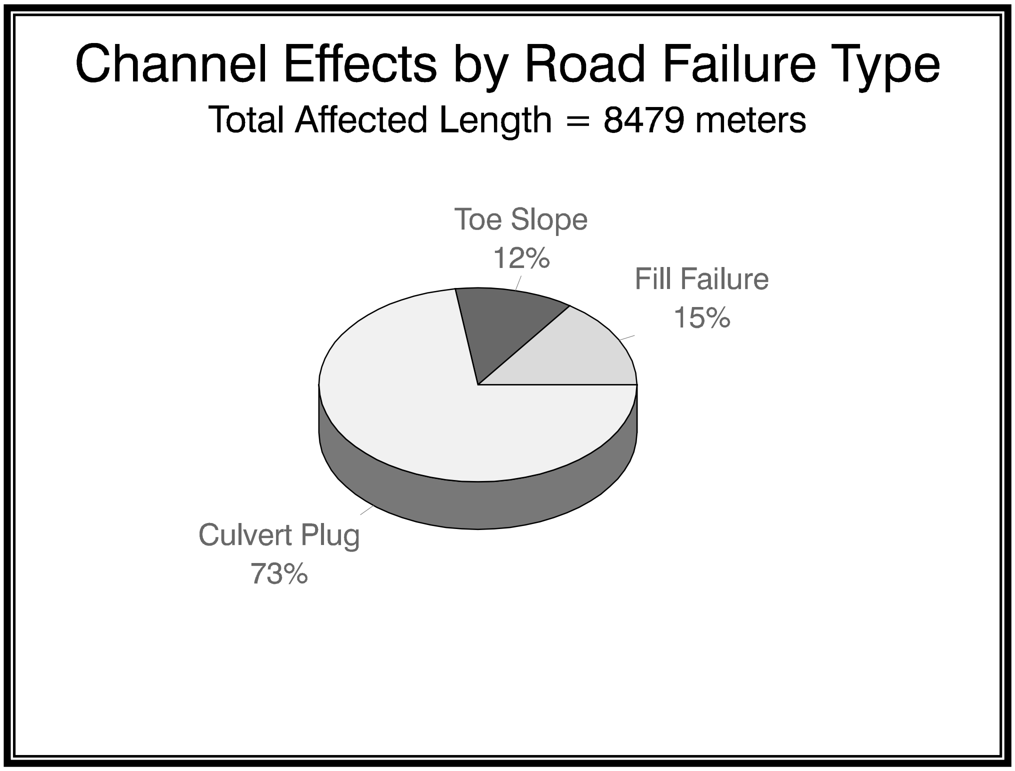
Sediment Delivery:
Road failures within the study area resulted in nearly 50,000 cubic meters of sediment being delivered to stream channels. On the Powers Ranger District, approximately 65 percent was deposited directly into small intermittent or perennial streams while the remaining 35 percent entered directly into high order fish bearing streams. On Gold Beach and Chetco Ranger Districts, little sediment was delivered directly into fish bearing streams.



Effects to Stream Channels:
Most of the sediment delivered to these streams was transported downstream from the point of delivery. Some was deposited behind log jams or wood complexes, some in gravel bars or terraces, some behind downstream road crossings. At all sites assessed, channels were surveyed as far downstream as the effects continued. Road crossing failures in the study area caused damage to nearly 8500 meters of small intermittent and perennial streams immediately below the failures. The stream types recording effects are relatively small, steep, non fish-bearing reaches that typically transport or temporarily store most sediment inputs with eventual deposition at lower gradient reaches in larger channels.

Upper Pistol, Quosatana, and Shasta Costa watersheds, none of the channels showed effects continuing downstream to the next larger flow category (i.e. intermittent to perennial, or perennial to fish-bearing). Undoubtedly, smaller material was transported to larger flow category streams, and some may have been deposited in flatter gradient reaches of these larger streams, and may have affected fish habitat. The storm triggered many natural landslides and inner gorge bank failures that contributed large volumes of sediment to streams. The relative contributions of road-related sediment and naturally generated sediment is unknown.

Damage to stream channels included degradation, aggradation, removal of riparian vegetation, bank scour, and initiation of stream bank slides. Effects varied considerably depending on the failure size, channel gradient, width, streamflow and bed features. As the stream gradient and depth of high water increased, so did the amount of channel degradation. At the same time, the amount of large woody material retained in the channel, either in complexes or scattered pieces, decreased. Figure 11 shows that the majority of channel effects (73%) were the results of plugged culverts. Measured response reaches in higher order fish bearing streams saw decreases in maximum depth and pool volume. See Fish Section.



Cascades:
An initial cause can affect another site, which in turn causes an effect at one or several additional sites, which become causes of effects at further sites. This type of chain reaction is referred to as "cascading effects" or "cascades." The characteristics of sites that experienced a complex series of causes and effects:

- Located within the high storm intensity or snowmelt areas.
- Steep hillslope (quantify after the field surveys are completed)
- More than one road on the hillslope
- Upper road generated debris flow by:
  - Drainage structure failed to pass bedload./wood transported by channel
  - Road cutbank failure
  - Road fill failure in headwall position
- Soils in streambanks and/or road cutbanks susceptible to undercutting by channelized flow

An example of a cascading failure is in the Rock Creek sub-watershed. A small landslide near the ridge entered an intermittent channel and plugged a 600 mm (24 inch) culvert. The stream diverted 60 m down the road, causing a large landslide to fail back into the channel. This landslide initiated a debris flow that destroyed two downstream road crossings, one of which diverted over 500 meters down the road and caused three other road fill failures. A schematic of the failure is shown in Figure 12. Erosional consequences are shown in the following table.

Length of Affected Channel	Delivered Landslide Volume	Delivered Road Erosion	Gully Erosion	Total Erosion **	Estimated Repair Cost
2020 meters	7000 cu.m.	4200 cu.m.	1900 cu.m.	13100 cu.m.	$363,000

** Erosion estimate does not include volume scoured from channel within debris flow track.

RECOMMENDATIONS:

Stream Crossings

1. Install driveable dips to eliminate diversion potential at road/stream crossings. Use ditch dams to further reduce the likelihood of diversions.

2. Upgrade undersized pipes to pass the 100-year recurrence interval discharge along with associated debris while minimizing adverse effects of eventual failure.

3. Reduce the magnitude of potential failures by decreasing fill size where appropriate.

4. Armor down stream fillslopes at crossings, where appropriate, to help prevent fill erosion during road overtopping.

5. Minimize the change in channel width at inlet basins. Narrow inlet approaches tend to align debris; wider basins set up lateral currents and encourage debris plugging.

6. Align pipes with the channel (horizontally and gradient).

7. Bevel pipe inlets to conform to the fill slope to transport streamflow and floating debris more efficiently.

8. Consider the potential for future debris flows or high sediment/debris loading when designing new stream crossings.

9. Consider wet fords in place of fill-intensive stream crossings with culverts.

10. Place culverts at all ephemeral channel crossings.

Erosion Control

1. Identify and treat unstable landing and sidecast road fills.

2. Prioritize storm proofing treatments in the upper watershed to reduce the likelihood of cascading failures.

3. Prevent long distance diversions, ditch flow and concentration of water by outsloping, where appropriate.

Location

1. Consider treating stacked road systems to reduced likelihood of cascading failures.

2.Design roads in the lower hillslope position recognizing the potential for more and larger failures.

APPENDIX E

Water Rights Information

SUCKER	GRAYBACK	WATER	USE
STREAM SEGMENT	**USE**	**CFS ALLOTMENT**	**TOTAL**
Sucker Creek to E Fk Illinois	Irrigation Fish/Wi Agriculture Industrial Domestic	48.30 0.18 0.01 16.99 0.04	65.52
Bear Creek to Sucker Creek	Irrigation	1.37	1.37
Green Creek to Bear Creek	Irrigation	0.31	0.31
Nelson Cr to Sucker Cr	Irrigation	0.02	0.02
Unnamed Str to Sucker Cr	Domestic	0.01	0.01
Little Grayback to Sucker Cr	Domestic	0.02	0.02
Unnamed Str to Sucker Cr	Domestic	0.01	0.01
Lake Cr to Sucker Cr	Domestic	0.18	0.18
Grayback Cr to Sucker Cr	Irrigation Industrial	1.12 1.00	2.12
Little Jim Cr to Sucker Cr	Industrial	0.80	0.80
Cave Cr to Sucker Cr	Irrigation Industrial Recreation	0.05 11.50 0.01	11.56
Panther Cr to Lake Cr	Domestic	0.01	0.01
Johnson Cr to Sucker Cr	Industrial	4.00	4.00
Yeager Cr to Sucker Cr	Industrial	2.00	2.00
Mule Cr to Sucker Cr	Industrial Domestic	8.00 0.01	8.01
Unnamed Str to Sucker Cr	Industrial Domestic	7.99 0.01	8.00
Bolan Cr to Sucker Cr	Industrial	8.00	8.00
E Fk Bolan Cr to Bolan Cr	Industrial	2.00	2.00

TOTALS BY USE

Irrigation	Fish/Wild	Agriculture	Industrial	Municipal	Domestic	Recreational
51.17	0.18	0.01	62.28	0.00	0.29	0.01

Total CFS 113.94

APPENDIX F

Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING BETWEEN THE OREGON STATE DEPARTMENT OF ENVIRONMENTAL QUALITY AND THE OREGON STATE DEPARTMENT OF FORESTRY

I. Introduction and Statement of Purpose

A. Introduction

1. The Environmental Quality Commission (EQC) and the Oregon Department of Environmental Quality (DEQ) are responsible for implementing the Federal Clean Water Act in Oregon, ORS 468B.035, including adoption of water quality standards. The DEQ has adopted and the U.S. Environmental Protection Agency (EPA) has approved Oregon's water quality standards and its 1994/1996 303(d) list. DEQ intends to update and resubmit its 303(d) list to EPA in 1998 and subsequent years as required by federal regulations. DEQ is setting priorities for TMDL preparation.

2. Subsection 303(d) of the Federal Clean Water Act (the Act), 33 U.S.C. §1313(d), requires states to identify waters for which effluent limitations or other pollution control requirements required by local, State, or Federal authority are not stringent enough to implement applicable water quality standards, 40 C.F.R. §130.7 (b). These water bodies are referred to as "water quality limited." For each water on the 303(d) list that is not removed from the list by findings of water quality impairment due to natural conditions or best management practice (BMP) effectiveness, the state must establish a total maximum daily load (TMDL) allocation at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. A TMDL is the sum of the individual wasteload allocations for point sources and load allocations for non-point sources and natural background, 40 C.F.R. §130.2(i).

3. TMDLs must be incorporated into the continuing planning process required by Section 303(e) of the Act and the continuing planning process must be included in the state's water quality management plan. Sections 208 and 319 of the Act, 33 U.S.C. §1288 and §1329, require the state to prepare non-point source management plans.

4. ORS 527.765 requires the Oregon Board of Forestry (the Board), in consultation with the EQC, to establish Best Management Practices (BMPs) and other rules applying to forest practices to ensure that to the maximum extent practicable non-point source discharges of pollutants resulting from forest operations do not impair the achievement and maintenance of water quality standards established by the EQC. The Oregon Department of Forestry (ODF) is the Designated Management Agency (DMA) by DEQ for regulation of water quality on nonfederal forestlands. Forest operators conducting operations in accordance with ODF BMPs are considered to be in compliance with Oregon's water quality standards.

5. The Board in consultation and with the participation and support of DEQ, has adopted water protection rules in the form of BMPs for forest operations, including, but not limited to, OAR Chapter 629, Divisions 635-660. These rules are implemented and enforced by ODF and monitored to assure their effectiveness. DEQ participates in the design and implementation of these monitoring efforts. The EQC, DEQ, the Board and ODF determined that pollution control measures required as BMPs under ORS 527.765 will be relied upon to result in achievement of state water quality standards.

6. The EQC, DEQ, the Board, and ODF are all committed to restoring salmon and meeting water quality through the Healthy Streams Partnership and Oregon Plan for Salmon and Watersheds, 1997 Oregon Laws, Ch. 7.

B. Purposes of MOU

The purposes of this memorandum of understanding:

1. To further define the respective roles and responsibilities of the EQC, the DEQ, the Board, and ODF in preventing, controlling and reducing non-point source discharges to achieve and maintain water quality standards;

2. To explain the process for determining whether (a) forest practices contribute to identified water quality problems in listed water quality limited streams; (b) if so, to determine whether existing forest practice rules provide sufficient control to assure that water quality standards will be met so that waters can be removed from the 303(d) list;

3. To describe the process for interagency coordination in revising forest practice rules, if necessary, to assure the achievement of water quality standards; and

4. To encourage the use of voluntary and incentive-based regulatory solutions to achieve and maintain water quality.

II. Forest Practice BMPs and Water Quality Standards

Since ODF is the DMA for water quality management on nonfederal forestlands and ODF's BMP's are designed to protect water quality, ODF and DEQ will jointly demonstrate how the Forest Practices Act (FPA), forest practice rules (including the rule amendment process), and BMP's are adequate protection pursuant to ORS 527.765. This demonstration of the ODF BMP program adequacy will be done at the statewide scale with due consideration to regional and local variation in effects including non-anthropogenic factors that can lead to water quality standard violations.

Water quality impairment related to aquatic weeds, bacteria, chlorophyll a, dissolved oxygen, flow modification, many nutrients, total dissolved gas, or toxics are generally not attributable to forest management practices as regulated by the FPA. However, it is generally accepted that forest management practices have in some cases caused documented changes in temperature, habitat modification, sedimentation, turbidity, and bio-criteria. Therefore, this statewide demonstration of FPA effectiveness in protection of water quality will address these specific parameters and will be conducted in the following order:

a. temperature (draft report target completion date Spring, 1999),
b. sedimentation and turbidity (draft report target completion date Summer, 1999),
c. aquatic habitat modification (draft report target completion date fall 1999),
e. bio-criteria (draft report target completion date end 1999), and
f. other parameters (draft report target completion date spring 2000).

The analyses will be presented in a format compatible with EPA region 10 guidance (pages 4-6, dated November 1995) regarding BMP effectiveness determinations, and will include:

a. "Data analysis of the effectiveness of controls relative to the problem": analyze relevant data and studies on the parameter and known control methods,
b. "Mechanisms requiring implementation of pollution controls": give a clear exposition of the rules/programs that are designed to provide for protection,
c. "Reasonable time frame for attaining water quality standards": discuss expected recovery times which may be long for some parameters because the ecological processes that bring recovery are long-term, and
d. "Monitoring to track implementation and effectiveness of controls": describe the scope and extent the effectiveness and implementation monitoring program and how they tie back to program changes for adaptive management.

In addition, these analyses will address attainment of state anti-degradation policy. These demonstrations will be reviewed by peers and other interested parties prior to final release. While analysis is being conducted and unless or until changes are made in accordance with ORS 527.765, the FPA and implementing rules will constitute the water quality BMP program for forestlands. These sufficiency analyses will be designed to provide background information and techniques for watershed based assessments of BMP effectiveness and water quality assessments for watersheds with forest and mixed land uses.

III. ODF and DEQ coordination for listed waterbodies (i.e., 303(d) list)

A. Waterbody Specific Coordination

The following coordination will occur between ODF and DEQ regarding the TMDL process and water quality management plans:

(a) For basins where agreement is reached that water quality impairment is not attributable to forest management practices (Figure 1), the forest practice rules will constitute the water quality compliance mechanism for forest management practices on nonfederal forestland. ODF will not participate in the development of the TMDL or water quality management plan except as requested to assist DEQ as ODF budgeted resources permit. If the basin associated with a listed waterbody is entirely or almost entirely on federal land or non-forestland ODF will have little or no involvement (Figure 1).

(b) For basins where water quality impairment is attributed to the long-term legacy of historic forest management and/or other practices, but ODF and DEQ jointly agree that the forest practice BMP's are now adequately regulating forest management activities and not adding to further degradation of water quality, the forest practice rules will be designated in the water quality management plan as the mechanism to achieve water quality compliance for forest operations. ODF will participate with the other DMAs in developing the water quality management plan as necessary.

(c) For basins where water quality impairment may be attributable to forest management practices and ODF and DEQ cannot agree that the current BMPs are adequately regulating forest management activities (Figure 1), the current forest practice rules will be designated in the water quality management plan as the mechanism to achieve water quality compliance for forest operations. However, ODF will design and implement a specific monitoring program as part of the basin plan to document the adequacy of the best management practices. The schedule and scope of the monitoring program will be jointly agreed to by DEQ and ODF. During the interim, while monitoring is being conducted, the current rules will constitute the water quality compliance mechanism. If the monitoring results indicate that changes in practices are needed in a basin, the DEQ and the Board will use OAR 629-635-120 to create watershed specific protection rules or use other existing authority to ensure that forest management activities do not impair water quality.

(d) For basins where both ODF and DEQ agree that there are water quality impairments due to forest management activities even with FPA rules and BMP's, the DEQ and the BOF will use OAR 629-635-120 to create watershed specific protection rules or use other existing authority to ensure that forest management activities do not impair water quality.

In deciding between conditions (a)-(d) above, the statewide rule sufficiency analysis (described in II) will be critical in determining which situation exists. If the practices and impairments are found by DEQ and ODF to be regional or statewide in nature the BOF will create or modify statewide or regional rules or design other effective measures to address the impairment.

B. Removal or Reclassification of Waterbodies

DEQ will propose removal of waterbodies (Figure 1) on the 303(d) list when:

(a) additional data indicates that the waterbody is not in violation,

(b) water quality parameters are found to be in violation for reasons other than human activities,

(c) TMDL's, or water quality management plans or their equivalents, have been established in compliance with the Clean Water Act §303, or

(d) the FPA, forest practice rules and BMP's are found to be adequate for a given water quality parameter in a given basin via the statewide demonstration or watershed based demonstration (see section II above) and all land affecting the listed waterbody is deemed forestland that is regulated under the FPA. Forest basins that have water quality impairment due to legacy conditions that will not be corrected by the current BMPs alone, remain listed with their present status until voluntary or incentive based actions are implemented that are intended to restore watershed conditions such that water quality standards can be met.

IV. Voluntary and Incentive-Based Approaches

DEQ and ODF will work jointly with landowners and watershed councils, as resources permit, to use innovative approaches to resolving water quality problems. DEQ and ODF will use other pollution control requirements when appropriate to restore watershed conditions such that water quality standards can be met in waterbodies listed under Section 303(d) of the Clean Water Act. These pollution programs include but are not limited to the following:

1. Oregon Laws 1997, ch. 553, The Green Permits Act,;

2. Oregon Laws 1995, ch. 413, The Forest Stewardship Act,;

3. Oregon Laws 1997, ch. 7, Healthy Streams Partnership and the Oregon Plan for Salmon and Watersheds;

4. DEQ's Environmental Management Systems Incentives Project;

5. Habitat Conservation Plans adopted and approved under the Endangered Species Act;

6. Project XL agreements with the EPA; and

7. Pollution Prevention Partnership agreements with the EPA.

Some of these alternative approaches will become critical and complementary to the forest practices program when attempting to restore water quality in streams with significant legacy conditions caused by past actions such as channel simplification from splash damming and stream cleaning.

V. Other key coordination points for DEQ and ODF

There are two other issues that will require special coordination between DEQ and ODF These coordination issues regard:

1. Outstanding Resource Water designations and management measures, and
2. Coordination between the two agencies when there is a land use conversion.

Both agencies agree to open discussion on how to coordinate on these issues but they are separate issues that are not covered by this particular MOU.

VI. Signatures

Signed: James E. Brown
James E. Brown, State Forester
Oregon Department of Forestry

Date: 4/16/98

Signed: Langdon Marsh
Langdon Marsh, Director
Oregon Department of
Environmental Quality

Date: 4-17-98

APPENDIX G

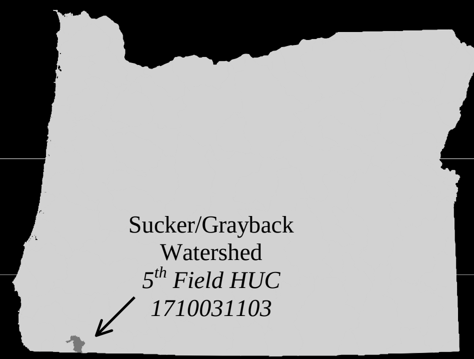
Supporting Documentation for Development Of Temperature Load Allocation

Prepared by
Siskiyou National Forest – Chris Park
Oregon Department of Environmental Quality - Matthew Boyd
March 1999

TABLE OF CONTENTS

Watershed at a Glance

Basin:	Rogue
Sub-Basin:	Illinois
Watershed:	Sucker/Grayback
Key Resources:	Chinook and Coho Salmon
	Steelhead Trout
Uses Affected:	Salmonid Spawning & Rearing
Impairment:	Water Temperature Increase
Pollutant:	Heat Energy (Solar Radiation)
Sources Considered:	NPS – Forest Practices, Mining



DOCUMENT ORGANIZATION

Preparation of the Sucker/Grayback Watershed TMDL considers a number of issues regarding surface water temperature and the relationship to requirements of 303(d). These issues have been divided into topic areas which include target identification (quantified end-points that will lead to attainment of water quality standards), source identification (a description of hazards areas that contribute to the problem), allocations designed to reduce pollutant inputs to those waters exceeding State water quality standards, and a margin of safety. In order to provide a framework for discussing these issues, this TMDL development document is organized into the following sections:

- ✓ Introduction
- ✓ Source Assessment – Stream Heating Processes
- ✓ Target Identification
- ✓ Deviation from the Target – Current Condition
- ✓ Source Assessment
- ✓ TMDL / Allocations
- ✓ Margin of Safety
- ✓ Seasonal Variation

Highlights of each TMDL development document section are summarzed in **Table 1**.

Table 1. Sucker/Grayback Watershed TMDL Components

State/Tribe: Oregon
Waterbody Name(s): All streams within the 5th field HUC (hydrologic unit code) 1710031103 – Sucker/Grayback watershed, RM 10.4 to headwaters. (See figure 1 page 7 of WQMP)
Point Source TMDL:_____ Nonpoint Source TMDL: __X__ (check one or both)
Date: March 1999

Component	***Comments***
Pollutant Identification	Stream temperature is an expression of *Heat Energy per Unit Volume* and is expressed in English Units as Btu per cubic feet. $$\text{Temperature} = \frac{\text{Heat Energy}}{\text{Volume}} = \frac{\text{Btu}}{\text{ft}^3}$$ *Pollutant:* Heat Energy *Anthropogenic Contribution:* Excessive Solar Energy Input
Target Identification *CWA 303(d)(1)* *40 CFR 130.2(f)*	*Applicable Water Quality Standards* **Temperature: OAR 340-41-365(1)(b)(A)** The seven day moving average of the daily maximum shall not exceed the following values unless specifically allowed under a Department-approved basin surface water management plan: **64°F (17.8°C)** or- **55°F (12.8°C).** Where **55°F (12.8°C)** applies during times and in waters that support salmon spawning, egg incubation and fry emergence from the egg and from the gravel. *Loading Capacities* • No more than 488 $\text{Btu}\cdot\text{ft}^{-2}\cdot\text{day}^{-1}$ solar loading as an average measured value over perennial stream length, or site potential (climax) solar radiation loading.
Existing Sources *CWA 303(d)(1)*	*Anthropogenic sources of thermal gain from riparian vegetation removal:* • Forest management within riparian areas *Anthropogenic sources of thermal gain from channel modifications:* • Mining, Timber Harvest, Roads
Seasonal Variation *CWA 303(d)(1)*	*Condition*: Based on USFS data (1992 to 1997) *Flow*: Low flow associated with maximum stream temperatures *Critical Conditions*: Increase desirable riparian vegetation to site potential (climax) conditions. *Inputs*: Solar ration increased by more exposed stream surface area as a result of decreased effective shade and increased channel width.
TMDL/Allocations *40 CFR 130.2(g)* *40 CFR 130.2(h)*	*WLAs*: None (There are no point sources within this watershed.) *LAs:* Effective shade levels of 80% as measured by solar pathfinder for summer months, or site potential (climax) shade conditions.
Margins of Safety *CWA 303(d)(1)*	Margins of Safety demonstrated in critical condition assumptions regarding groundwater inflow, wind speed and air temperature.
WQS Attainment Analysis *CWA 303(d)(1)*	• Statistical demonstration of temperature related to current shade conditions. • Analytical assessment of simulated temperature change related to allocated solar loading.
Public Participation *40 CFR 25*	See page 11 of the WQMP and Section 8 of Appendix G

1. INTRODUCTION

The Sucker/Grayback Watershed, part of the Rogue River basin, is home to productive forested lands and has the distinction of containing streams with historically abundant salmonid populations. Valuable contributions from forestry and fisheries in the Rogue River Basin have prompted extensive data collection and study of the interaction between land use and water quality. The knowledge derived from these data collection efforts and academic study, some of which is presented in this document, will be used to design protective and enhancement strategies that address water quality issues.

Recently several agencies have been mandated to take proactive roles in developing management strategies in the Rogue River Basin. In the near future water quality management plans will be developed for forested, agricultural and urban lands that address both nonpoint and point sources of pollution. It is imperative that these plans consider the relatively robust data that describe water quality, instream physical parameters and landscape features. The impending management efforts (*see* **EXISTING WATER QUALITY PROGRAMS**) demand that stakeholders, land managers, public servants and the general public become knowledgeable with water quality issues in the Rogue River Basin.

A Total Maximum Daily Load (TMDL) has been developed to address fisheries concerns For Sucker Creek and Grayback Creek and all tributaries on BLM and USFS lands. The TMDL builds upon the Northwest Forest Plan and Forest Ecosystem Management Assessment Team (FEMAT) protection/restoration measures.

The data review contained in this document summarizes the varied, yet extensive, data collection and study that has recently occurred in the Sucker/Grayback Watershed. It is hoped that water quality programs will utilize this TMDL to develop and/or alter water quality management efforts. In addition, this TMDL should be used to track water quality, instream physical parameters and landscape conditions that currently exist. In the future it will be important to determine the adequacy of planned water quality improvement efforts. Looking back at this TMDL, written in November 1998, it will be possible to track the changes that have occurred in water quality, instream and landscape parameters that affect fish, as well as people, in the Sucker/Grayback Watershed.

Excessive summer water temperatures in several tributaries and Sucker Creek and Grayback Creek may be reducing the quality of rearing habitat for chinook and coho salmon, as well as steelhead trout. Primary watershed disturbance activities which contribute to surface water temperature increase include past forest management within riparian areas, timber harvest in sensitive areas outside the riparian zone and instream mining practices. As a result of water quality standards (WQS) exceedances for temperature, waters in the Sucker/Grayback watershed are on Oregon's 1996 303(d) list. This TMDL and Water Quality Management Plan (WQMP) also address habitat and flow modifications. Specific management prescriptions designed to reduce input of pollutants into streams within the Federal lands covered by this TMDL are:

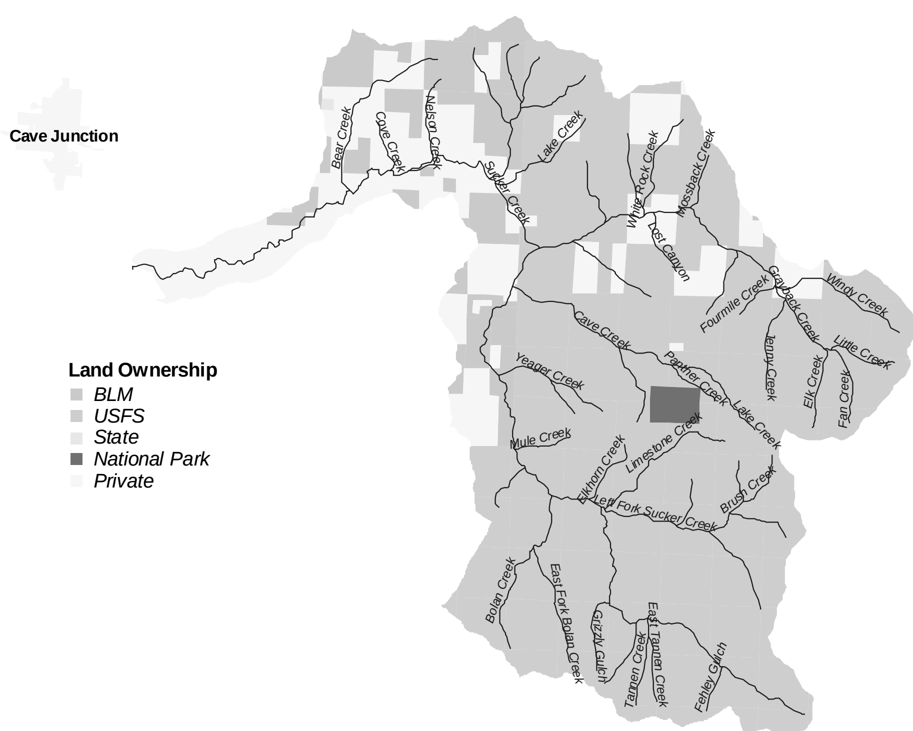
- Riparian conservation reserves that promote targeted shade levels
- Riparian conservation reserves that promote targeted channel morphology
- Riparian conservation reserves that promote targeted instream habitat goals
- Aquatic conservation strategy

Surrogate Measures (*"other appropriate measures"*) are used in conjunction with heat **Load Capacity** targets to address water temperature increases. Namely, *percent effective shade* is an effective measure of anthropogenic heat contributions and a descriptor of riparian condition. In essence, the **Surrogate Measure** (percent effective shade) is **Allocated** as a translation of the developed solar radiation **Loading Capacities**.

SCOPE

This TMDL builds upon the protection/restoration measures prescribed by the Northwest Forest Plan. The area covered by the TMDL and WQMP includes land managed primarily by the U.S. Forest Service (USFS) and Bureau of Land Management (BLM) (headwaters to the confluence of Sucker and Grayback Creeks). This portion of the Sucker/Grayback Creek is a key watershed as defined by the President's Northwest Forest Plan (1995, USDA, USDI). Private forested lands are managed under the Oregon Forest Practices Act (FPA). A subsequent TMDL and WQMP will be written by the Oregon Department of Environmental Quality (DEQ) to include non-Federal lands within the Sucker/Grayback Watershed. Land ownership is displayed in **Image 1**. Of the 62,100 acres within Sucker/Grayback Watershed, 42,500 are managed by USFS, 5,800 by BLM and the remaining 13,800 acres are private or State lands.

Image 1. Land Ownership in the Sucker/Grayback Watershed



As a result of water quality standards (WQS) exceedances for temperature, Sucker Creek is included on Oregon's 1998 303(d) list. In addition, this TMDL addresses potential temperature water quality impairment conditions for streams within the USFS and BLM managed lands that are not currently on Oregon's 303(d) list.

Table 2. USFS and BLM Managed Lands 303(d) listed Segments and Applicable Water Quality Standards	
• Sucker Creek Temperature, mouth to Grayback Creek (RM 10.4 to Confluence with Grayback is within the USFS and BLM managed Lands)	*OAR 340-41-365(2)(b)(A)*

EXISTING WATER QUALITY PROGRAMS

Oregon's Total Maximum Daily Load Program

The quality of Oregon's streams, lakes, estuaries and groundwaters is monitored by the Department of Environmental Quality (DEQ). This information is used to determine whether water quality standards are being violated and, consequently, whether the *beneficial uses* of the waters are being threatened. *Beneficial uses* include fisheries, aquatic life, drinking water, recreation and irrigation. Specific State and Federal plans and regulations are used to determine if violations have occurred: these regulations include the *Federal Clean Water Act* of *1972* and its amendments 40 *Codified Federal Regulations* 131, and *Oregon's Administrative Rules* (**OAR Chapter 340**) and *Oregon's Revised Statutes* (**ORS Chapter 468**).

The term *water quality limited* is applied to streams and lakes where required treatment processes are being used, but violations of State water quality standards occur. With a few exceptions, such as in cases where violations are due to natural causes, the State must establish *a Total Maximum Daily Load* or *TMDL* for any waterbody designated as *water quality limited*. A *TMDL* is the total amount of a pollutant (from all sources) that can enter a specific waterbody without violating the water quality standards.

The total permissible pollutant load is allocated to point, nonpoint, background, and future sources of pollution. *Wasteload Allocations* are portions of the total load that are allotted to point sources of pollution, such as sewage treatment plants or industries. The *Wasteload Allocations* are used to establish effluent limits in discharge permits. *Load Allocations* are portions of the *Total Maximum Daily Load* that are attributed to either natural background sources, such as soils, or from nonpoint sources, such as agriculture or forestry activities. *Allocations* can also be set aside in reserve for future uses. Simply stated, *allocations* are quantified measures that assure water quality standard compliance. The *TMDL* is the integration of all developed *allocations*.

Northwest Forest Plan

In response to environmental concerns and litigation related to timber harvest and other operations on Federal Lands, the United States Forest Service (USFS) and the Bureau of

Land Management (BLM) commissioned the Forest Ecosystem Management Assessment Team (FEMAT) to formulate and assess the consequences of management options. The assessment emphasizes producing management alternatives that comply with existing laws and maintaining the highest contribution of economic and social well being. The "backbone" of ecosystem management is recognized as constructing a network of late-successional forests and an interim and long-term scheme that protects aquatic and associated riparian habitats adequate to provide for *threatened species* and *at risk species*. Biological objectives of the Northwest Forest Plan include assuring adequate habitat on Federal lands to aid the "recovery" of late-successional forest habitat-associated species listed as threatened under the Endangered Species Act and preventing species from being listed under the Endangered Species Act.

Oregon Plan

The State of Oregon has formed a partnership between Federal and State agencies, local groups and grassroots organizations, that recognizes the attributes of aquatic health and their connection to the health of salmon populations. The Oregon Plan considers the condition of salmon as a critical indicator of ecosystems (CSRI, 1997). The decline of salmon populations has been linked to impoverished ecosystem form and function. Clearly stated, the Oregon Plan has committed the State of Oregon to the following obligations: an ecosystem approach that requires consideration of the full range of attributes of aquatic health, focuses on reversing factors for decline by meeting objectives that address these factors, develops adaptive management and a comprehensive monitoring strategy, and relies on citizens and constituent groups in all parts of the restoration process.

The intent of the Oregon Plan is to conserve and restore functional elements of the ecosystem that supports fish, wildlife and people. In essence, the Oregon Plan is distinctly different from the traditional agency approach, and instead, depends on sustaining a local-state-federal partnership. Specifically, the Oregon Plan is designed to build on existing State and Federal water quality programs, namely: Coastal Zone Nonpoint Pollution Control Programs, the Northwest Forest Plan, Oregon's Forest Practices Act, Oregon's Senate Bill 1010 and Oregon's Total Maximum Daily Load Program.

WATER QUALITY IMPAIRMENTS

Monitoring has shown that water quality in the Sucker/Grayback Watershed often does not meet State water quality standards. The narrative and numeric standards for *temperature, flow modification* and *habitat modification* are not achieved in the mainstem reaches of the Sucker/Grayback Watershed.

Section 303(d) of the Federal Clean Water Act (1972) requires that water bodies that violate water quality standards, thereby failing to fully protect *beneficial uses*, be identified and placed on a 303(d) list. Following further assessment, *Total Maximum Daily Load* (TMDL), will be implemented to restore water quality. In addition to watershed condition assessment and problem statements, a water quality management plan (WQMP) requires identification of water quality goals and objectives, designation of responsible parties, implementation of the management plan (TMDL), some measure of assurance that the plan (TMDL) will actually be implemented, and a monitoring of feedback loop (DEQ WQMP guidance 1997).

Temperature+

Location:	• Sucker Creek (mouth to Grayback Creek)
Time Period:	• Rearing: June 1 through September 30 • Spawning Through Fry Emergence: October 1 through May 31 or waterbody specified as identified by ODFW biologist.
Supporting Data:	• USFS (1992 – 1997)

Flow Modification+

Location:	• Sucker Creek (mouth to Bolan Creek)
Time Period:	• All time periods
Supporting Data:	• USGS, OR DWR

Habitat Modification+

Location:	• Sucker Creek (mouth to Bolan Creek) • Grayback Creek (mouth to headwaters)
Time Period:	• All time periods
Supporting Data:	• USFS • ODFW

Oregon Administration Rules (**OAR Chapter 1, Division 41, Table 19**) lists the designated beneficial uses for which water is to be protected. The beneficial uses occurring in the Sucker/Grayback Watershed are presented in **Table 3**.

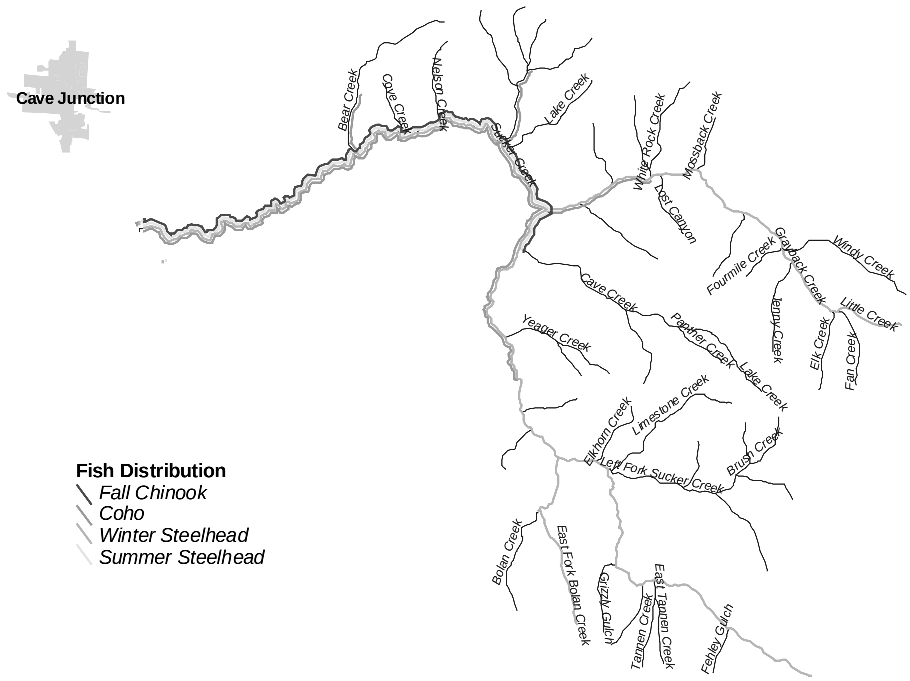
Table 3. Beneficial uses occurring in the Sucker/Grayback Watershed

Beneficial Use	***Occurring***	***Beneficial Use***	***Occurring***
Public Domestic Water Supply	✓	Anadromous Fish Passage	✓
Private Domestic Water Supply	✓	Salmonid Fish Spawning	✓
Industrial Water Supply	✓	Salmonid Fish Rearing	✓
Irrigation	✓	Resident Fish and Aquatic Life	✓
Livestock Watering	✓	Wildlife and Hunting	✓
Boating	✓	Fishing	✓
Aesthetic Quality	✓	Water Contact Recreation	✓
Commercial Navigation & Trans.		Hydro Power	

Numeric and narrative water quality standards are designed to protect the most sensitive *beneficial uses*. In the Sucker/Grayback Watershed, resident fish and aquatic life and

+ 1996 303(d) listed water quality parameter salmonid spawning and rearing are designated the most sensitive *beneficial uses*. Sensitive *beneficial uses* (salmonid migration, spawning and migration) are presented in **Image 2**.

Image 2. Sensitive Beneficial Uses – Salmonid Migration, Spawning and Rearing



POLLUTANTS

Water temperature is an expression of heat energy per unit volume:

$$\text{Temperature} = \frac{\text{Heat Energy}}{\text{Volume}} = \frac{\text{Btu}}{\text{ft}^3}.$$

Anthropogenic increase in heat energy is derived from solar radiation as increased levels of sunlight reach the stream surface and raises water temperature. The pollutant (solar heat energy) is a source of stream temperature increase that is within management measures and is targeted in this TMDL.

SURROGATE MEASURES - DEFINED

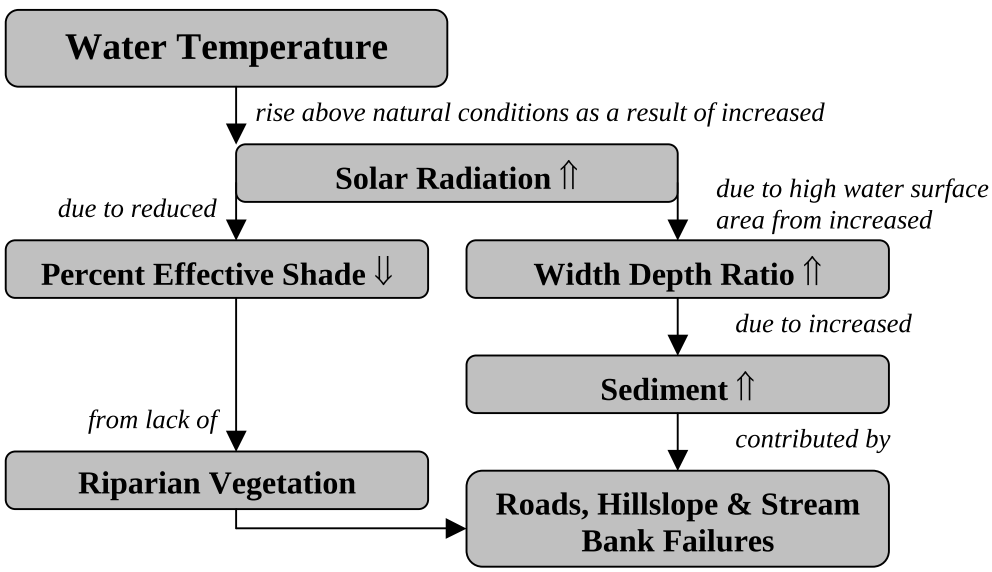
The Sucker/Grayback TMDL incorporates measures other than "*daily loads*" to fulfill requirements of 303(d). Although a loading capacity for heat is derived [e.g. 488 British Thermal Units (Btu) per square foot per day], it is of limited value in guiding management activities needed to solve identified water quality problems. In addition to heat loads, the Sucker/Grayback TMDL allocates "*other appropriate measures*" (or surrogates) as provided under EPA regulations [40 CFR 130.2(i)]. The specific surrogate used is *percent effective shade* (as defined in **SOURCE ASSESSMENT**).

2. SOURCE ASSESSMENT

STREAM HEATING PROCESSES

Decreased effective shade levels result from lack of adequate riparian vegetation available to reduce sunlight (e.g. heat from incoming solar radiation). Human activities that contribute to degraded water quality conditions in the Sucker/Grayback Watershed include improper timber harvest, roads and instream mining. Wider channels also increase the stream surface area exposed to heat transfer from solar radiation. The relationship between the percent effective shade (surrogate) and factors that impact stream temperature are described in **Figure 1**.

Figure 1. Factors that Impact Water Temperature



Note: Boxes depict measured or calculated key indicators

Riparian area and channel morphology disturbances have resulted from past timber management and mining land uses. These nonpoint sources of pollution primarily affect the water quality parameter (temperature) through increased solar loading by: (1) increasing stream surface solar radiation loading and (2) increasing stream surface area exposed to solar radiation loading. Although timber harvest and mining continue in the Sucker/Grayback Watershed, altered management practices that comply with surrogate measures (allocations) presented in this document are intended to ameliorate pollutant delivery.

Riparian vegetation, stream morphology, hydrology, climate, and geographic location influence stream temperature. While climate and geographic location are outside of human control, the condition of the riparian area, channel morphology and hydrology can be affected by land use activities. Specifically, the elevated summertime stream temperatures attributed to anthropogenic causes in the Sucker/Grayback Watershed result from the following listed conditions:

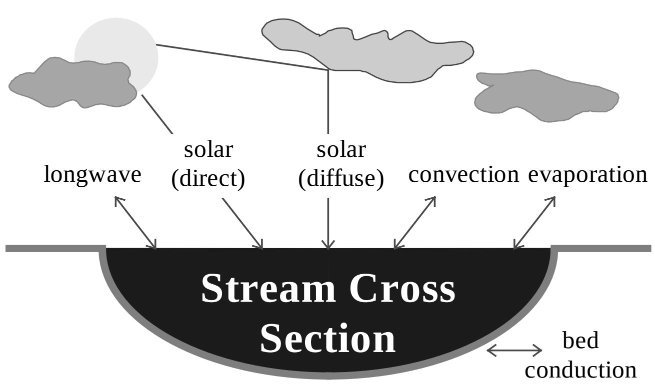
1. *Channel widening (increased width to depth ratios) that increases the stream surface area exposed to energy processes, namely solar radiation,*
2. *Riparian vegetation disturbance that compromises stream surface shading, riparian vegetation height and density (shade is commonly measured as percent effective shade),*
3. *Reduced summertime base flows that result from instream withdrawals per instream water rights.*

Analysis presented in this TMDL will demonstrate that developed loading capacities will ensure attainment of State water quality standards. Specifically, the link between shade surrogate measures (allocations) for solar radiation loading capacities and water quality attainment will occur via two processes:

1. *Remove human (anthropogenic) solar radiation contributions from temperature dynamics in the Sucker/Grayback Watershed, and*
2. *Restore riparian reserves that function to protect stream morphology and encourage bank building processes in severe hydrologic events.*

Stream temperature is an expression of heat energy per unit volume, which in turn is an indication of the rate of heat exchange between a stream and its environment. The heat transfer processes that control stream temperature include solar radiation, longwave radiation, convection, evaporation and bed conduction (Wunderlich, 1972; Jobson and Keefer, 1979; Beschta and Weatherred, 1984; Sinokrot and Stefan, 1993; Boyd, 1996). With the exception of solar radiation, which only delivers heat energy, these processes are capable of both introducing and removing heat from a stream. **Figure 2** displays heat energy processes that solely control heat energy transfer to/from a stream.

Figure 2. Thermodynamic (heat transfer) processes that heat or cool water.



When a stream surface is exposed to midday solar radiation, large quantities of heat will be delivered to the stream system (Brown 1969, Beschta et al. 1987). Some of the incoming solar radiation will reflect off the stream surface, depending on the elevation of the sun. All solar radiation outside the visible spectrum (0.36μ to 0.76μ) is absorbed in the first meter below the stream surface and only visible light penetrates to greater depths (Wunderlich, 1972). Sellers (1965) reported that 50% of solar energy passing through the stream surface is absorbed in the first 10 cm of the water column. Removal of riparian vegetation, and the shade it provides, contributes to elevated stream temperatures (Rishel et al., 1982; Brown, 1983; Beschta et al., 1987). The principal source of heat energy delivered to the water column is solar energy striking the stream surface directly (Brown 1970). While exposed to summertime midday solar radiation, large quantities of heat energy will be imparted to the stream. Exposure to direct solar radiation will often cause a dramatic increase in stream temperatures. When shaded throughout the entire duration of the daily solar cycle, far less heat energy will be transferred to the stream. The ability of riparian vegetation to shade the stream throughout the day depends on vegetation height, density and position relative to the stream.

Water Temperature ⇑

Rise above natural conditions as a result of increased

Solar Radiation ⇑

Both the atmosphere and vegetation along stream banks emit longwave radiation that when received by the stream surface has a warming influence. Water is nearly opaque to longwave radiation and complete absorption of all wavelengths greater than 1.2μ occurs in the first 5 cm below the surface (Wunderlich, 1972). Longwave radiation has a cooling influence when emitted from the stream surface. The net transfer of heat via longwave radiation usually balances so that the amount of heat entering is similar to the rate of heat leaving the stream (Beschta and Weatherred, 1984; Boyd, 1996).

Evaporation occurs in response to internal energy of the stream (molecular motion) that randomly expels water molecules into the overlying air mass. Evaporation is the most effective method of dissipating heat from water (Parker and Krenkel, 1969). As stream temperatures increase, so does the rate of evaporation. Air movement (wind) and low vapor pressures increase the rate of evaporation and accelerate stream cooling (Harbeck and Meyers, 1970).

Convection transfers heat between the stream and the air via molecular and turbulent conduction (Beschta and Weatherred, 1984). Heat is transferred in the direction of warmer to cooler. Air can have a warming influence on the stream when the stream is cooler. The opposite is also true. The amount of convective heat transfer between the stream and air is low (Parker and Krenkel, 1969; Brown, 1983).

Depending on streambed composition, shallow streams (less than 20 cm) may allow solar radiation to warm the streambed (Brown, 1969). Large cobble (> 25 cm diameter) dominated streambeds in shallow streams may store and conduct heat as long as the bed is warmer than the stream. Bed conduction may cause maximum stream temperatures to occur later in the day, possibly into the evening hours. The instantaneous heat transfer rate experienced by the stream is the summation of the individual processes:

$$\Phi_{Total} = \Phi_{Solar} + \Phi_{Longwave} + \Phi_{Evaporation} + \Phi_{Convection} + \Phi_{Conduction}\ .$$

Solar Radiation (Φ_{Solar}) is a function of the solar angle, solar azimuth, atmosphere, topography, location and riparian vegetation. Simulation is based on methodologies developed by Ibqal (1983) and Beschta and Weatherred (1984). *Longwave Radiation* ($\Phi_{Longwave}$) is derived by the Stefan-Boltzmann Law and is a function of the emissivity of the body, the Stefan-Boltzmann constant and the temperature of the body (Wunderlich, 1972). *Evaporation* ($\Phi_{Evaporation}$) relies on a Dalton-type equation that utilizes an exchange coefficient, the latent heat of vaporization, wind speed, saturation vapor pressure and vapor pressure (Wunderlich, 1972). *Convection* ($\Phi_{Convection}$) is a function of Bowen's Ratio (1926) and terms include atmospheric pressure, and water and air temperatures. *Bed Conduction* ($\Phi_{Conduction}$) simulates the theoretical relationship ($\Phi_{Conduction} = K \cdot dT_b / dz$), where calculations are a function of thermal conductivity of the bed (K) and the temperature gradient of the bed (dT_b/dz) (Sinokrot and Stefan, 1993). Bed conduction is solved with empirical equations developed by Beschta and Weatherred (1984).

MECHANICS OF SHADE

Stream surface shade is a function of several landscape and stream geometric relationships. Some of the factors that influence shade are listed in **Table 4**. Geometric relationships important for understanding the mechanics of shade are displayed in **Figure 3**. In the Northern Hemisphere, the earth tilts on its axis toward the sun during summertime months allowing longer day length and higher solar altitude, both of which are functions of solar declination (i.e. a measure of the earth's tilt toward the sun). Geographic position (i.e. latitude and longitude) fixes the stream to a position on the globe, while aspect provides the stream/riparian orientation. Riparian height, width and density describe the physical barriers between the stream and sun that can attenuate incoming solar radiation (i.e. produce shade). The solar position has a vertical component (i.e. altitude) and a horizontal component (i.e. azimuth) that are both functions of time/date (i.e. solar declination) and the earth's rotation (i.e. hour angle). While the interaction of these shade variables may seem complex, the math that describes them is relatively straightforward geometry, much of which was developed decades ago by the solar energy industry.

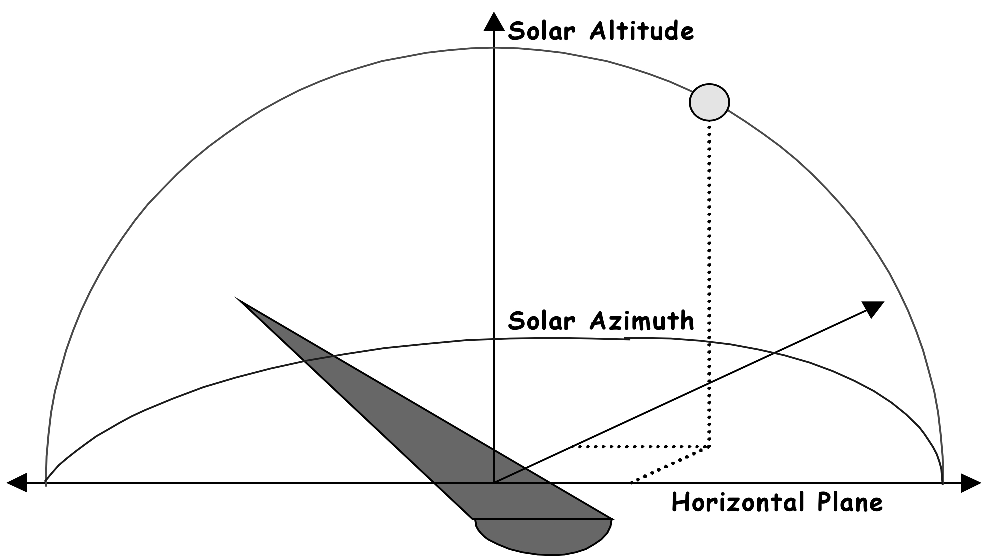
Table 4. Factors that Influence Stream Surface Shade

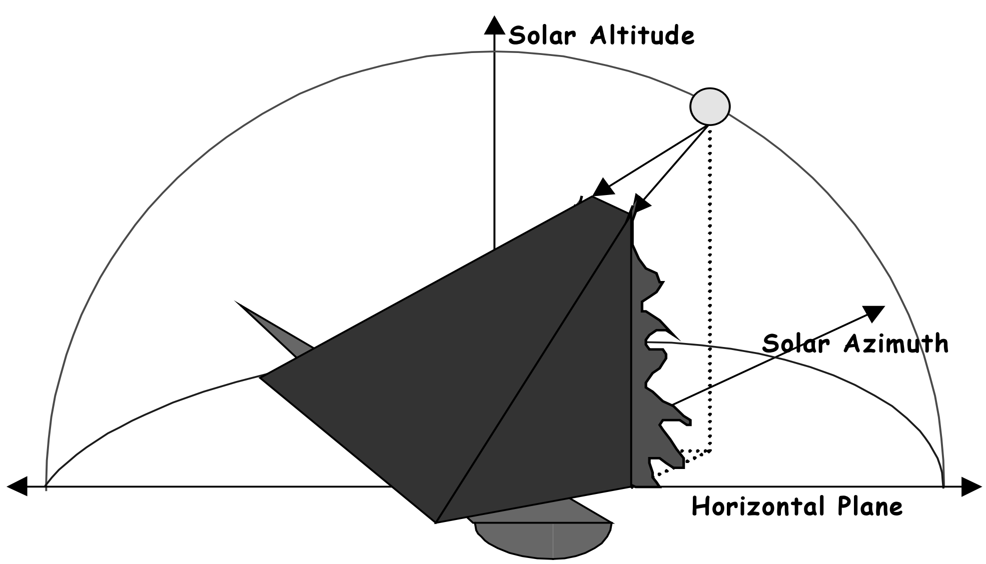
Description	Measure
Season	Date
Stream Characteristics	Aspect, Bankfull Width
Geographic Position	Latitude, Longitude
Vegetative Characteristics	Buffer Height, Buffer Width, Buffer Density
Solar Position	Solar Altitude, Solar Azimuth

Figure 3. Geometric Relationships that Affect Stream Surface Shade

Solar Altitude and **Solar Azimuth** are two basic measurements of the sun's position. When a stream's orientation, geographic position, riparian condition and solar position are known, shadeing characteristic can be simulated.

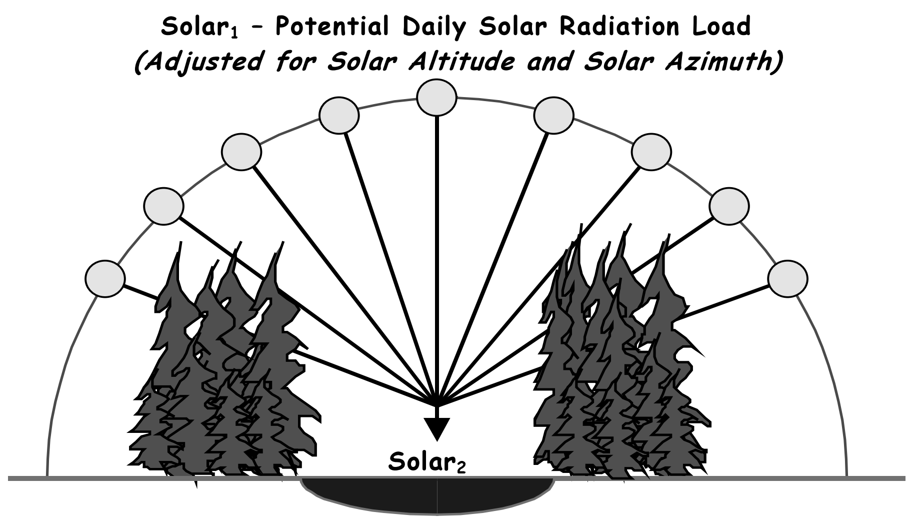
Solar Altitude measures the <u>vertical</u> component of the sun's position
Solar Azimuth measures the <u>horizontal</u> component of the sun's position





The percent effective shade is perhaps one of the easiest and straightforward stream parameters to monitor/calculate and is most helpful in directing water quality management and recovery efforts. **Figure 4** demonstrates how effective shade is monitored/calculated. Using solar tables or mathematical simulations, the *potential daily solar load* can be quantified. The *measured solar load at the streams surface* can easily be measured with a Solar Pathfinder© or estimated using mathematical shade simulation computer programs (Boyd, 1996 and Park, 1993).

Figure 4. Effective Shade Defined



Effective Shade Defined:

$$\text{Effective Shade} = \frac{(\text{Solar}_1 - \text{Solar}_2)}{\text{Solar}_1}$$

Where,

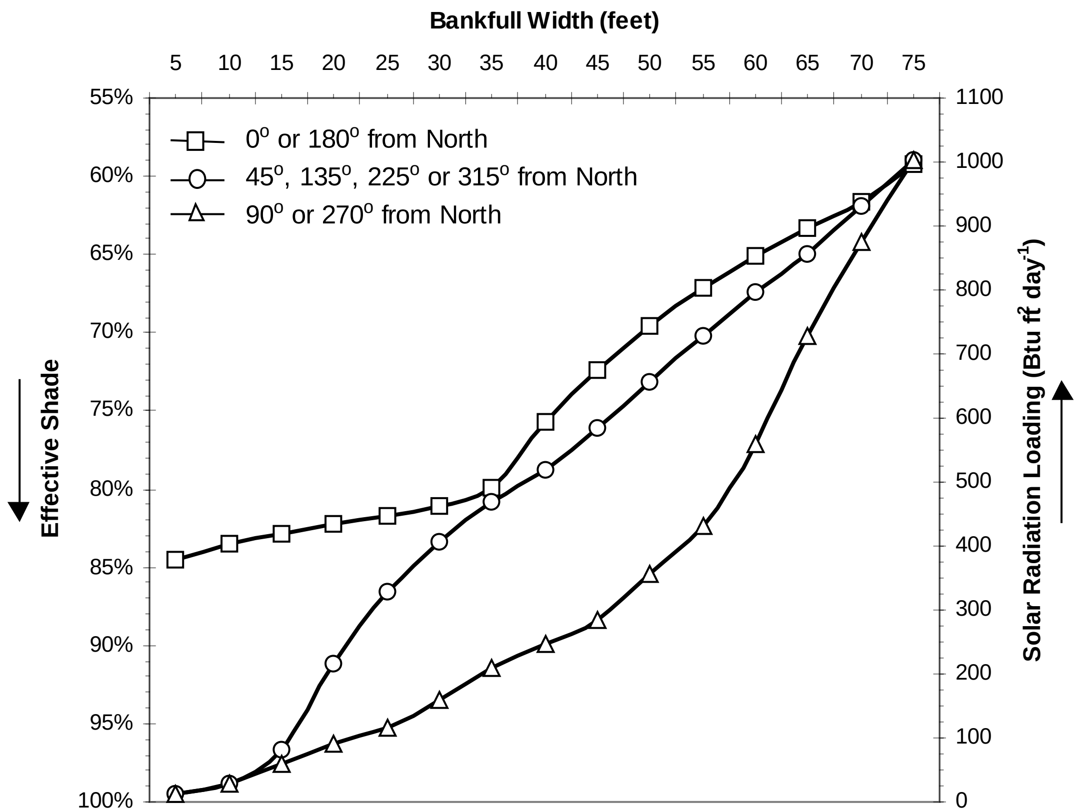
Solar$_1$: Potential Daily Solar Radiation Load

Solar$_2$: Measured Daily Solar Radiation Load at Stream Surface

Site potential effective shade and solar radiation loading were simulated for various channel widths (bankfull). Site potential vegetation is assumed to be late seral Douglas fir. In the Sucker/Grayback Watershed, undisturbed riparian areas generally progress towards late seral woody vegetation communities (mixed hardwood, but conifer dominated). Few, if any, riparian areas in the Sucker/Grayback are unable to support either late seral woody vegetation or tall growing herbaceous vegetation. Further, the climate and topography are well suited for growth and maintenance of large woody vegetative species in the riparian areas. **Figure 5** shows the simulated percent effective shade (as defined in **Figure 4**) and solar radiation load that result when site potential riparian conditions are achieved.

Figure 5. Site Potential Effective Shade and Solar Radiation Loading Based on Bankfull Channel Width and Stream Orientation (Aspect) for Late July and Early August

Site Potential Riparian Vegetation
Buffer Height: 120 feet
Buffer Width: 200 feet
Buffer Density: 65%



3. TARGET IDENTIFICATION - APPLICABLE WATER QUALITY STANDARDS

The Oregon Environmental Quality Commission has adopted numeric and narrative water quality standards to protect designated *beneficial uses*. In practice water quality standards have been set at a level to protect the most sensitive uses and seasonal standards may be applied for uses that do not occur year round. Cold-water aquatic life such as salmon and trout are often the most sensitive *beneficial uses* in Sucker/Grayback Watershed. In this forested watershed, concerns related to the effects of excessive water temperatures on rearing of salmonid fish been well documented.

Temperature: OAR 340-41-365(1)(b)(A)
The seven day moving average of the daily maximum shall not exceed the following values unless specifically allowed under a Department-approved basin surface water management plan:

64°F (17.8°C) June 1 – Sept. 30
-or-
55°F (12.8°C). October 1 – May 31

Where **55°F (12.8°C)** applies during times and in waters that support salmon spawning, egg incubation and fry emergence from the egg and from the gravel.

Habitat and Flow Modification: OAR 340-41-365(2)(i)
The creation of tastes of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish shall not be allowed.

4. DEVIATION FROM TARGETS – EXISTING CONDITIONS

OBSERVED LONGITUDINAL STREAM HEATING

Generally, stream temperatures follow a longitudinal (downstream) heating pattern, where smaller tributaries are cooler than the mainstem reaches of Sucker Creek and Grayback Creek. **Figure 6** displays stream heating as a function of measured perennial stream distance from headwaters. Headwater temperatures are near groundwater temperatures (51°F to 53°F) and warm roughly 20°F over the 25 miles of perennial stream length to the Sucker Creek/Illinois River confluence.

Image 3. Sucker/Grayback Stream Temperature *(1992 to 1997)*

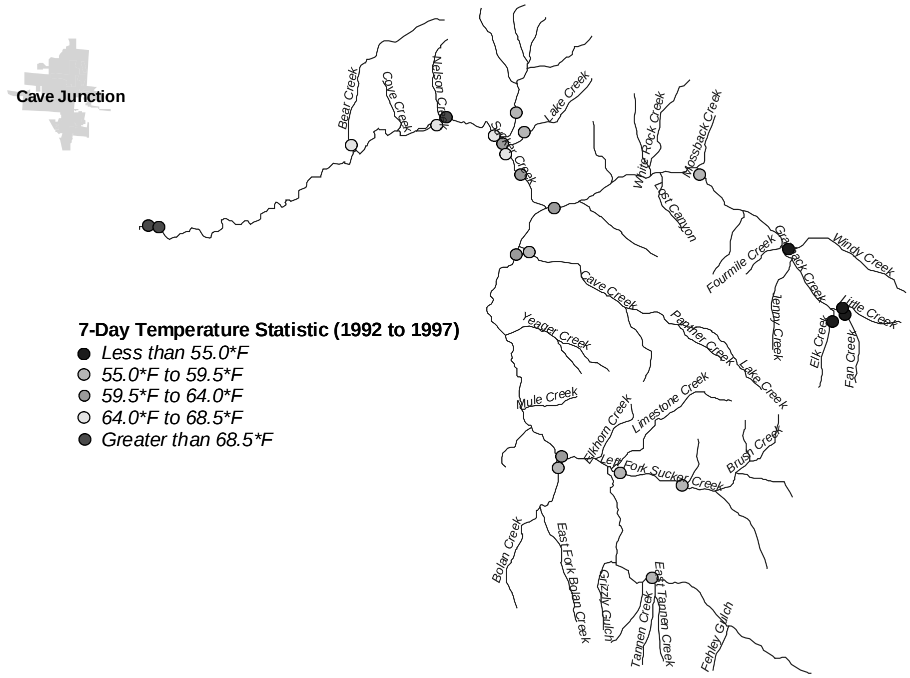
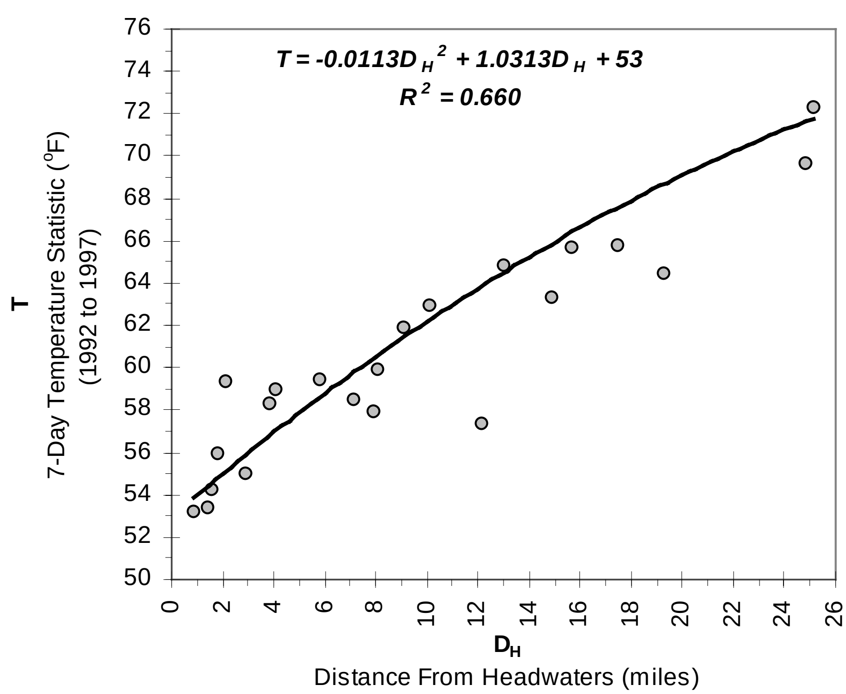


Figure 6. Longitudinal Stream Heating Curve – Seven Day Statistic Values Related to Distance from Headwaters
(1992 to 1997)

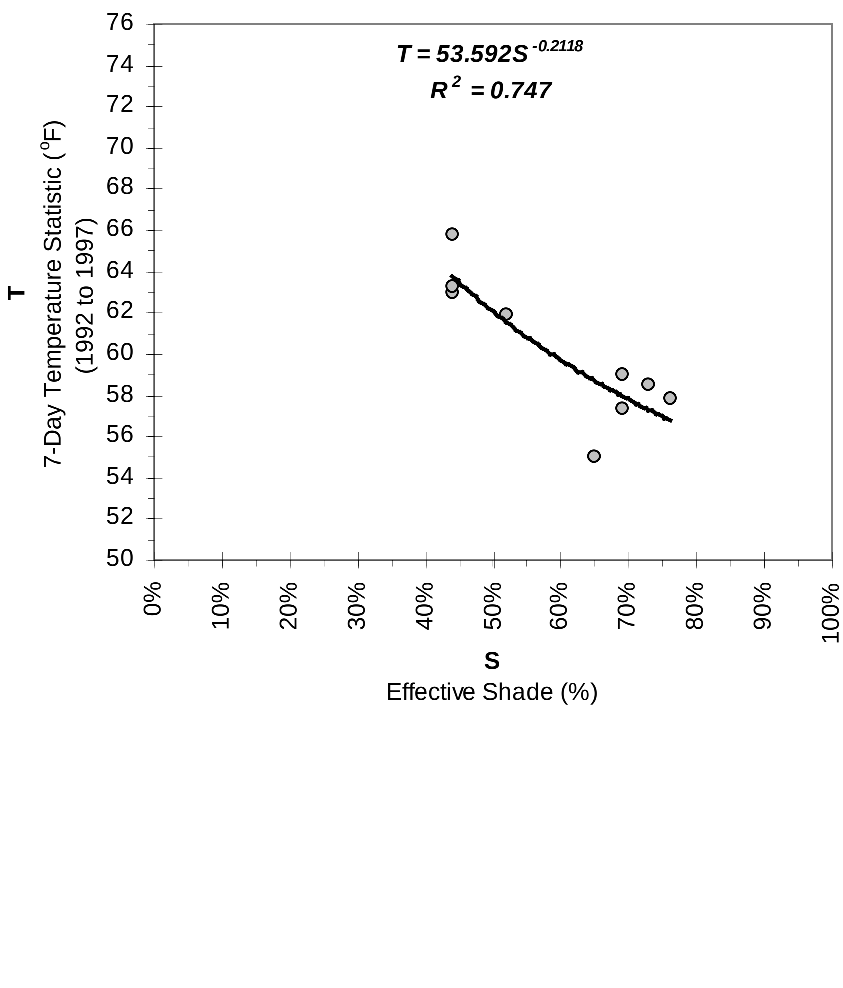


SHADE RELATED TO OBSERVED LONGITUDINAL STREAM HEATING

Longitudinal heating is a natural process. However, rates of heating are dramatically reduced when high levels of shade exist and solar radiation loading is minimal. The overriding justification for the solar loading reduction (loading capacity) is to minimize longitudinal heating. A limiting factor in reducing longitudinal stream heating is the site potential effective shade level (see **Figure 5**).

Statistical analysis of the temperature data that fall within stream reaches that have known effective shade levels (n=10) demonstrates an inverse relationship is apparent. High effective shade levels correspond to cooler 7-day stream temperature values (**Figure 7**). Stream temperature may also exhibit a threshold condition in which slight reductions in effective shade allow considerable stream heating. Dramatic stream temperature increase is possible when the stream surface moves from a highly shaded condition to partial shade.

Figure 7. Effective Shade and Observed Stream Heating (1992 to 1997)



5. <u>TMDL</u> – LOADING CAPACITIES AND SURROGATE MEASURES (ALLOCATIONS)

LOADING CAPACITIES

Regulatory Framework

Under the current regulatory framework for development of TMDLs, identification of the loading capacity is an important first step. The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with standards. By definition, TMDLs are the sum of the allocations [40 CFR 130.2(i)]. Allocations are defined as the portion of a receiving water loading capacity that is allocated to point or nonpoint sources and natural background. EPA's current regulation defines loading capacity as "*the greatest amount of loading that a water can receive without violating water quality standards*."

Solar Radiation Loading Capacities

Loading capacities in the Sucker/Grayback Watershed are heat from incoming solar radiation expressed as Btu/ft^2 per day. Analysis of heat transfer processes indicate that water temperatures increase above natural daily fluctuations when the heat load from solar radiation is above 488 Btu/ft^2 per day. Recognition of site potential has been given. Streams in which climax solar loading has been determined are allocated site potential solar loading capacities. **Table 5** lists the site potential loading capacities for the Sucker/Grayback Watershed. Streams that are not listed in **Table 5** do not have a site potential analysis completed, and therefore, are assigned the 488 Btu/ft^2 per day solar radiation loading capacity. **Figure 5** (site potential effective shade and solar radiation loading based on bankfull channel width and stream orientation for late July and early August) can be used to determine site potential loading capacity and effective shade conditions for those streams in the Sucker/Grayback Watershed lacking a site potential analysis.

In terms of water temperature increases, the principle source of heat energy is solar radiation directly striking the stream surface. **Figure 8** illustrates the total energy budget for Sucker/Grayback streams in the *reach averaged* current condition (Current Solar Loading = 976 $Btu \cdot ft^{-2} \cdot day^{-1}$) and the targeted loading capacity condition (Solar Loading Capacity = 488 $Btu \cdot ft^{-2} \cdot day^{-1}$). Note that the targeted solar loading capacity condition results in significant diurnal heat energy reductions. **Figure 8** clearly shows solar radiation is the predominant heat energy process in the current condition simulation. The simulated loading capacity (targeted condition) is also displayed in **Figure 8**, where a significant reduction in the diurnal (daily) solar radiation load is apparent.

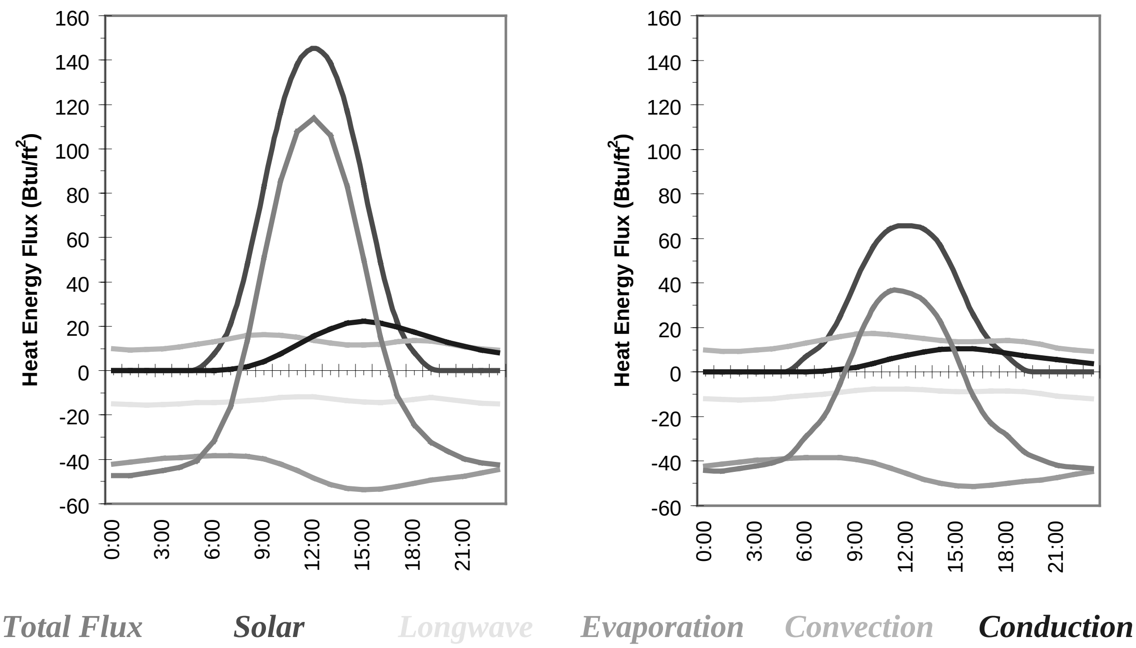
Table 5. Loading Capacity – Summertime Solar Radiation Loading						
			Loading Capacity			
Perennial Stream Reach	*Contributing Flow (%)*	***Current Condition*** *Solar Load* *(Btuft^{-2}day^{-1})*	***Site Potential*** *Solar Load (Btuft^{-2}day^{-1})*	*Required Solar Load Decrease (%)*	*Nonpoint Source of Pollutant*	*Time for Load Capacity Attainment (years)*
Sucker Creek	N/A	1171	1147	2%	Harvest	60
Sucker Creek (Grayback to Yeager)	N/A	1171	854	34%	Mining	100
Tannen Creek	30	342	268	27%	Harvest	10
Deadhorse Creek	15	561	342	64%	Harvest	45
Grizzly Creek	17	439	268	64%	Harvest	35
LF Sucker Creek	30	756	366	107%	Harvest	50
Limestone Creek	6	781	268	191%	Harvest	50
Bolan Creek	20	586	464	26%	Harvest	35
Cohen Creek	5	1464	293	400%	Harvest	50
Yeager Creek	7	659	268	145%	Harvest	35
Cave Creek	20	659	366	80%	Harvest	50
Grayback Creek	N/A	1366	1049	30%	Harvest	45
Fan Creek	20	1440	342	321%	Harvest	45
Little Creek	30	1708	342	400%	Harvest	45
Jenny Creek	30	1147	512	124%	Harvest	50
Windy Creek	25	854	537	59%	Harvest	50
Four Mile Creek	27	1781	1025	74%	Harvest	45
White Rock Creek	15	903	342	164%	Harvest	50
Lost Canyon Cr.	5	1122	756	48%	Harvest	50
All other tributaries*	N/A	N/A	488	N/A	N/A	N/A

* Streams without site potential analysis.

Figure 8. Simulated Daily Heat Energy Balance

Current Condition
Reach Averaged Solar Loading
(Current Solar Loading = 976 Btu·ft^{-2}·day^{-1})

Load Capacity* – *Targeted Condition
Reach Averaged Solar Loading
(Targeted Solar Loading = 488 Btu·ft^{-2}·day^{-1})



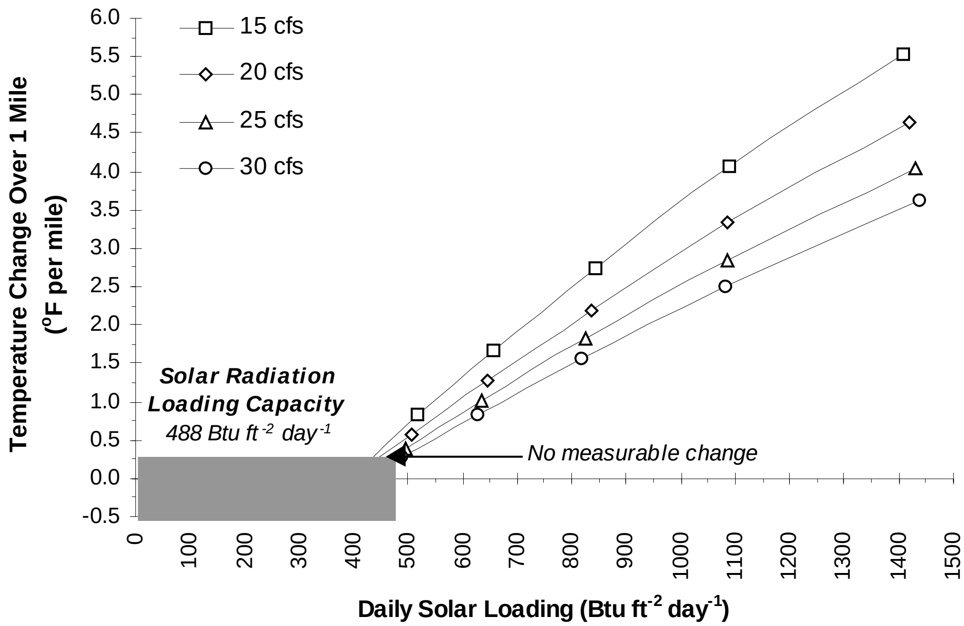
Water Quality Attainment - Temperature Change Related to Solar Loading Capacities

Using mathematical relationships, the rate of change in water temperature over one mile of stream length can be estimated (Boyd 1996). Relationships include both the total energy transfer rates to the stream (i.e. the sum of heat energy transfer processes) and the response of water temperature to heat energy absorbed. Heat transfer processes considered in the analysis include solar radiation, longwave (thermal) radiation, convection, evaporation and streambed conduction. This analysis has been developed using typical streamflows and channel characteristics commonly found in the Sucker/Grayback Watershed as well as conservative assumptions described in the margin of safety discussion.

Figure 9 displays simulated stream temperature change results. No measurable increase in stream temperature occurs when solar radiation loads are less than the loading capacity (Targeted Solar Loading = 488 Btu·ft^{-2}·day^{-1}). As demonstrated by simulation results, stream heating is a function of streamflow. Lower flows correspond to increased stream heating. Solar radiation loading of 488 Btu·ft^{-2}·day^{-1} represents a reasonable starting point for defining loading capacity (i.e. the greatest amount of loading that surface waters can receive without violating water quality standards). Average flat plane solar radiation loads above the riparian canopy in late July to early August are on the order of 2440

Btu·ft^{-2}·day^{-1}. This 80% reduction in potential solar radiation load delivered to the water surface defines another target (*or "appropriate measure*") which can be used for TMDL development.

Figure 9. Effect of Solar Radiation Loads on Water Temperature



SURROGATE MEASURES (ALLOCATIONS)

Regulatory Framework

The Sucker/Grayback TMDL uses measures other than "*daily loads*" to fulfill requirements of 303(d). Although a loading capacity for heat energy is derived (488 Btu·ft^{-2}·day^{-1}), it is of limited value in guiding management activities needed to solve identified water quality problems. In addition to heat energy loads, the Sucker/Grayback TMDL uses "*other appropriate measures*" (or surrogates) as provided under EPA regulations [40 CFR 130.2(i)].

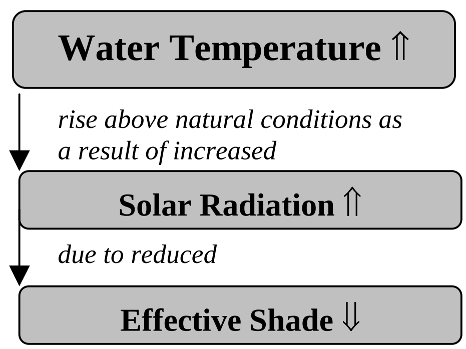
The *Report of Federal Advisory Committee on the Total Maximum Daily Load (TMDL) Program"* (FACA Report, July 1998) offers a discussion on the use of surrogate measures for TMDL development. The FACA Report (Appendix G) indicates:

> *"When the impairment is tied to a pollutant for which a numeric criterion is not possible, or where the impairment is identified but cannot be attributed to a single traditional "pollutant," the state should try to identify another (surrogate) environmental indicator that can be used to develop a quantified TMDL, using numeric analytical techniques where they are available, and best professional judgment (BPJ) where they are not. The criterion must be designed to meet water quality standards,*

including the waterbody's designated uses. The use of BPJ does not imply lack of rigor; it should make use of the "best" scientific information available, and should be conducted by "professionals." When BPJ is used, care should be taken to document all assumptions, and BPJ-based decisions should be clearly explained to the public at the earliest possible stage.

If they are used, surrogate environmental indicators should be clearly related to the water quality standard that the TMDL is designed to achieve. Use of a surrogate environmental parameter should require additional post-implementation verification that attainment of the surrogate parameter results in elimination of the impairment. If not, a procedure should be in place to modify the surrogate parameter or to select a different or additional surrogate parameter and to impose additional remedial measures to eliminate the impairment."

As discussed, water temperature warms as a result of increased solar radiation loads. A loading capacity for heat (i.e. incoming solar radiation) can be used to define a reduction target. This reduction target forms the basis for identifying surrogates. The specific surrogate used is percent effective shade (expressed as the percent reduction in potential solar radiation load delivered to the water surface). The decreased effective shade is the result of a lack of adequate riparian vegetation available to reduce sunlight (i.e. incoming solar radiation).



Because factors that affect water temperature are interrelated, the surrogate measure (percent effective shade) relies on restoring/protecting riparian vegetation to increase stream surface shade levels, reduce stream bank erosion and stabilize channels. Likewise, narrower channels still require riparian vegetation to provide channel stability and shade, thus reducing heat loads (unless confined by canyon walls or shaded by topography).

Effective shade screens the water's surface from direct rays of the sun. Highly shaded streams often experience cooler stream temperatures due to reduced input of solar energy (Brown 1969, Beschta et al 1987, Holaday 1992, Li et al 1994). Stream surface shade is dependent on topography as well as riparian vegetation type, condition, and shade quality. Over the years, the term shade has been used in several contexts, including its components such as shade angle or shade density. For purposes of this TMDL, shade is defined as the percent reduction of potential solar radiation load delivered to the water surface. Thus, the role of effective shade in this TMDL is to prevent or reduce heating by solar radiation.

Effective Shade Surrogate Measures (Allocations)

Allocations in the Sucker/Grayback Watershed TMDL are derived using heat loads. Percent effective shade (surrogate measure) can be linked to specific areas and, thus, to management action needs to solve problems that cause water temperature increases (Park 1993). Sucker/Grayback Watershed allocations are listed in **Table 6**.

Perennial Stream Reach	*Contributing Flow (%)*	***Current Condition*** *Effective Shade (%)*	**Allocated**[**] ***Site Potential*** *Effective Shade (%)*	*Required Increased Effective Shade (%)*	*Nonpoint Source of Pollutant*	*Time for Surrogate Measure Attainment (years)*
Sucker Creek	N/A	52	53	1	Harvest	60
Sucker Creek (Grayback to		52	65	13	Mining	100
Tannen Creek	30	86	89	3	Harvest	10
Deadhorse Creek	15	77	86	9	Harvest	45
Grizzly Creek	17	82	89	7	Harvest	35
LF Sucker Creek	30	69	85	16	Harvest	50
Limestone Creek	6	68	89	21	Harvest	50
Bolan Creek	20	76	81	5	Harvest	35
Cohen Creek	5	40	88	48	Harvest	50
Yeager Creek	7	73	89	16	Harvest	35
Cave Creek	20	73	85	12	Harvest	50
Grayback Creek	N/A	44	57	13	Harvest	45
Fan Creek	20	41	86	45	Harvest	45
Little Creek	30	30	86	56	Harvest	45
Jenny Creek	30	53	79	26	Harvest	50
Windy Creek	25	65	78	13	Harvest	50
Four Mile Creek	27	27	58	31	Harvest	45
White Rock Creek	15	63	86	23	Harvest	50
Lost Canyon Cr.	5	54	69	15	Harvest	50
All other tributaries[*]	N/A	N/A	80%	N/A	N/A	N/A

[**] Sites < 80% based on optimum management practices to achieve maximum site potential
[*] Streams without site potential analysis.

Image 4. Effective Shade - Current Conditions

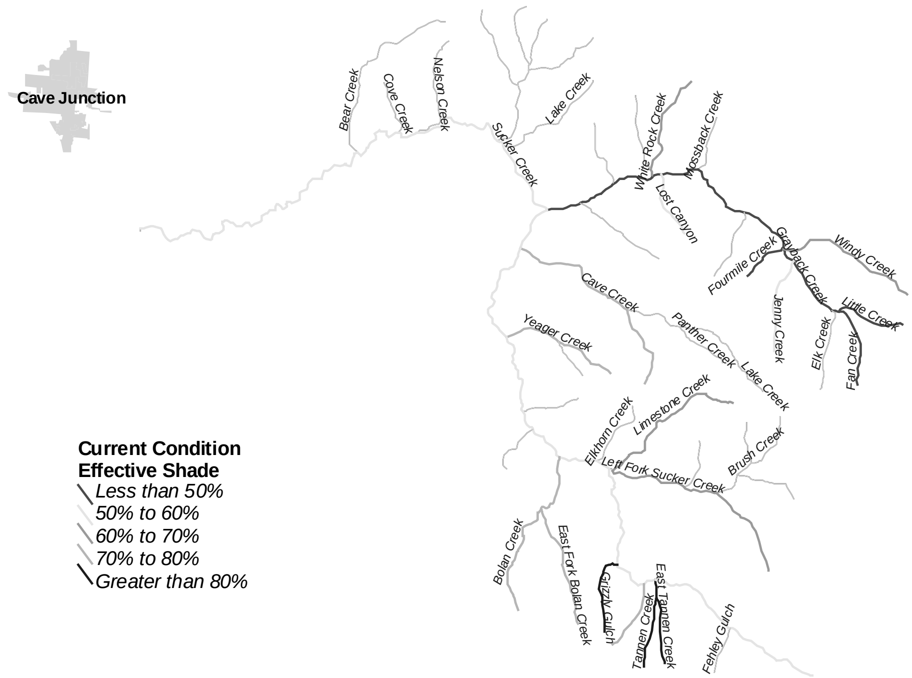
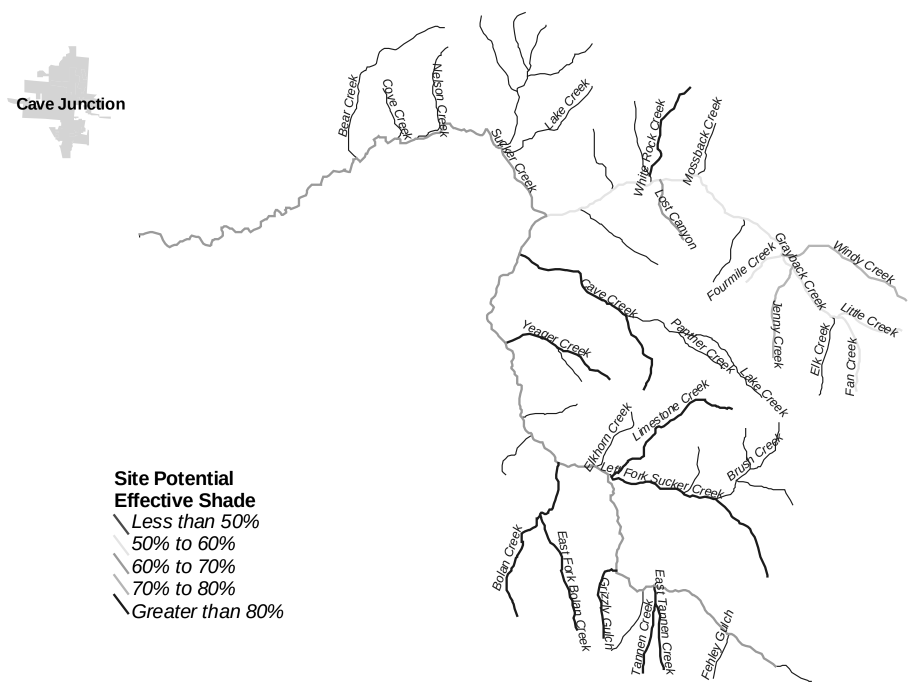


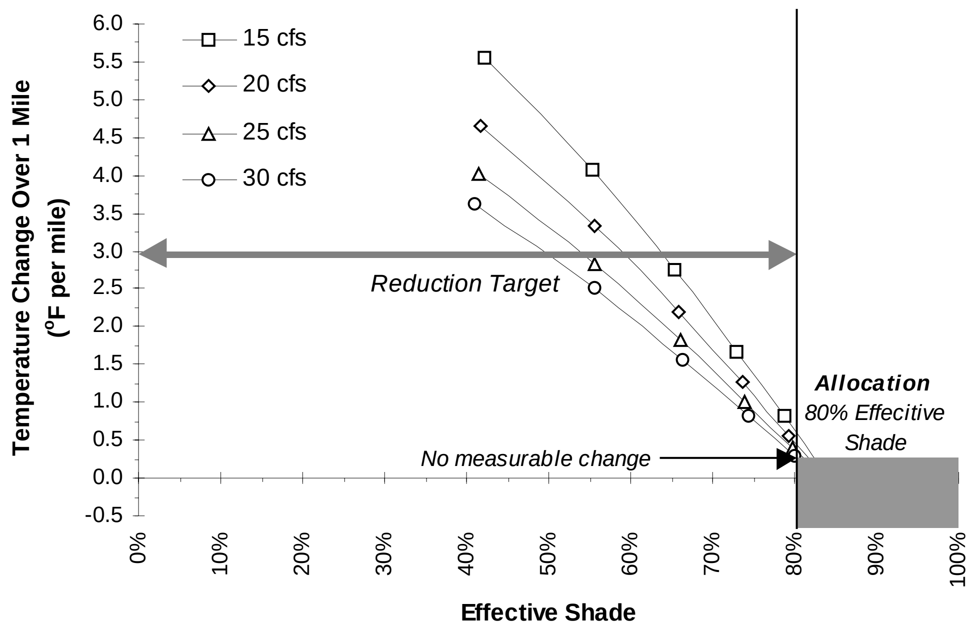
Image 5. Effective Shade - Site Potential



Water Quality Attainment - Temperature Change Related to Shade Surrogate Measures

Figure 10 illustrates the same concept discussed earlier regarding the effect of solar radiation loads on stream temperatures. However, the information is presented in a manner consistent with the definition of effective shade in this TMDL (i.e. the percent reduction of potential solar radiation load delivered to the water surface). This provides an alternative target (or surrogate) which relates to stream temperatures, in this case, an 80% reduction in potential solar radiation delivered to the water surface (i.e. 80% effective shade).

Figure 10. Effective Shade (Allocation - Surrogate Measure) and Water Temperature Change



Stream temperature simulation results, presented in **Figure 10**, clearly demonstrate that decreasing levels of solar radiation can have a drastic stream cooling effect. Language that is more precise would describe the effect of decreased solar loads as preventing stream temperature increases. Simulation results suggest that thermal conditions in the Sucker/Grayback Watershed can have vastly different temperature regimes when adequate riparian protection measures are implemented. This conclusion is consistent with *all* temperature modeling efforts for other waterbodies in the Pacific Northwest (Brown, 1969; Beschta and Weatherred, 1984; Sullivan and Adams, 1990; Boyd, 1996;).

It should be noted that this modeling exercise solely focused on solar radiation as a function of riparian vegetation and the shade it provides the stream. Additional parameters that are related to riparian vegetation that affect stream temperature are wind effects and possible summertime flow augmentation by increasing the volume of water stored in riparian areas (see **MARGIN OF SAFETY**). In essence, excluding wind effects and flow changes as they relate to riparian vegetation condition almost certainly underestimates the cooling attributed to allocated riparian restoration scenarios.

6. MARGIN OF SAFETY

The Clean Water Act requires that each TMDL be established with a margin of safety (MOS). The statutory requirement that TMDLs incorporate a margin of safety is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A margin of safety is expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions).

The margin of safety may be implicit, as in conservative assumptions used in calculating the loading capacity, WLAs, and LAs. The margin of safety may also be explicitly stated as an added, separate quantity in the TMDL calculation. In any case, assumptions should be stated and the basis behind the margin of safety documented. The margin of safety is not meant to compensate for a failure to consider known sources. **Table 7** presents six approaches for incorporating a margin of safety into TMDLs.

Table 7. Approaches for Incorporating a Margin of Safety into a TMDL

Type of Margin of Safety	Available Approaches
Explicit	1. Set numeric targets at more conservative levels than analytical results indicate 2. Add a safety factor to pollutant loading estimates 3. Do not allocate a portion of available loading capacity; reserve for MOS
Implicit	4. Conservative assumptions in derivation of numeric targets 5. Conservative assumptions when developing numeric model applications 6. Conservative assumptions when analyzing prospective feasibility of practices and restoration activities.

The following factors may be considered in evaluating and deriving an appropriate margin of safety:

- ✓ The limitations in available data in characterizing the waterbody and the pollutant and addressing the components of the TMDL development process.
- ✓ The analysis and techniques used in evaluating the components of the TMDL process and deriving an allocation scheme.
- ✓ Characterization and estimates of source loading (e.g., confidence regarding data limitation, analysis limitation or assumptions)
- ✓ Analysis of relationships between the source loading and instream impact.
- ✓ Prediction of response of receiving waters under various allocation scenarios. (e.g., the predictive capability of the analysis, simplifications in the selected techniques)
- ✓ Expression of analysis results in terms of confidence intervals or ranges. Confidence may be addressed as a cumulative effect on the load allocation or for each of the individual components of the analysis.
- ✓ The implications of the MOS on the overall load reductions identified in terms of reduction feasibility and implementation time frames.

ADAPTIVE MANAGEMENT

Establishing TMDLs employs a variety of analytical techniques. Some analytical techniques are widely used and applied in evaluation of source loading and determination of the impacts on waterbodies. For certain pollutants, such as heat, the methods used are newer or in development. The selection of analysis techniques is based on scientific rationale coupled with interpretation of observed data. Concerns regarding the appropriateness and scientific integrity of the analysis have been defined and the approach for verifying the analysis through monitoring and implementation addressed. Without the benefit of long term experience and testing of the methods used to derive TMDLs, the potential for the estimate to require refinement is high.

A TMDL and margin of safety, which is reasonable and results in an overall allocation, represents the best estimate of how standards can be achieved. The selection of the MOS should clarify the implications for monitoring and implementation planning in refining the estimate if necessary (adaptive management). The TMDL process accommodates the ability to track and ultimately refine assumptions within the TMDL implementation-planning component.

The Sucker/Grayback TMDL is intended to be adaptive in management implementation. This plan allows for future changes in loading capacities and surrogate measures (allocations) in the event that scientifically valid reasons demand alterations. It is important to recognize the continual study and progression of understanding of water quality parameters addressed in this TMDL/WQMP (stream temperature, habitat and flow). The Sucker/Grayback WQMP addresses future monitoring plans. In the event that data show that changes are warranted in the Sucker/Grayback TMDL or WQMP, these changes will be made by Oregon DEQ, USFS and BLM.

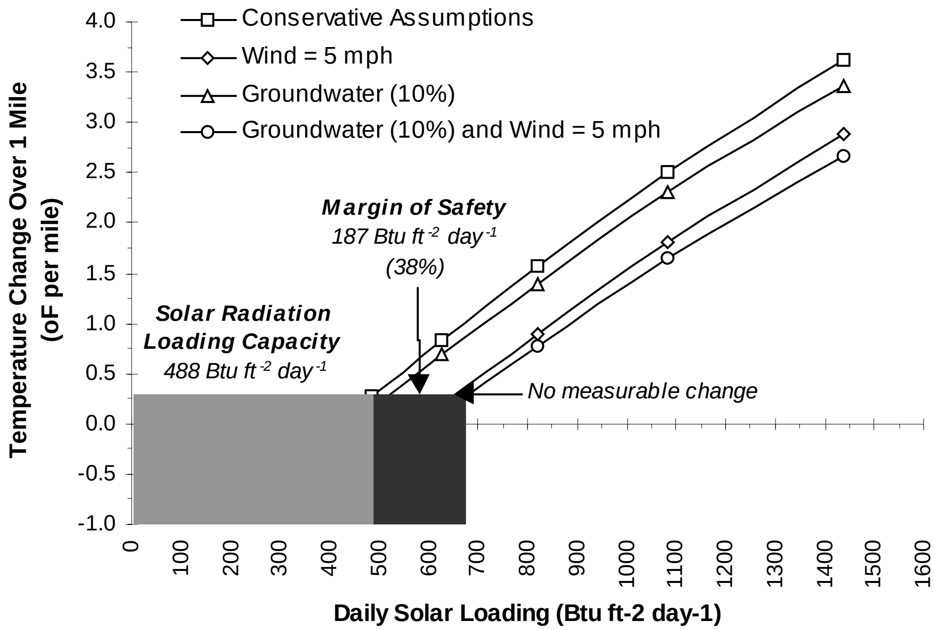
ASSUMPTIONS

Description of the margin of safety for the Sucker/Grayback Watershed TMDL begins with a statement of assumptions. A margin of safety has been incorporated into the temperature assessment methodology. Conservative estimates for groundwater inflow and wind speed were used in the load capacity and surrogate measure (allocation) temperature simulations. Specifically, zero groundwater inflow and zero wind speed (mph). Recall that groundwater directly cools stream temperatures via mass transfer/mixing. Wind speed is a controlling factor for evaporation, a cooling heat energy process. To calculate a numeric margin of safety, additional stream temperature change simulations have been performed and results are presented in **Table 8** and **Figure 11**.

Table 8. Margins of Safety

Potential Source of Cooling	*Allowable Solar Radiation Loading Capacity*	*Margin of Safety*
Conservative Loading Capacity	488 Btu ft^{-2} day^{-1}	0%
Groundwater Inflow (10% of Streamflow)	525 Btu ft^{-2} day^{-1}	8%
Wind Speed (5 mph)	650 Btu ft^{-2} day^{-1}	33%
Groundwater Inflow (10% of Streamflow) *-and-* Wind Speed (5 mph)	675 Btu ft^{-2} day^{-1}	38%

Figure 11. Stream Temperature Change for Margins of Safety



7. SEASONAL VARIATION

Section 303(d)(1) requires this TMDL to be "established at a level necessary to implement the applicable water quality standard with seasonal variations." Both stream temperature and flow vary seasonally from year to year. Water temperatures are coolest in winter and early spring months. Winter water temperature levels decrease dramatically from summer values, as river flows increase and available solar energy is at an annual minimum. Stream temperatures exceed State water quality standards in summer and early fall salmonid rearing months (June, July, August and September). Warmest stream temperatures correspond to prolonged solar radiation exposure, warm air temperature, low flow conditions and decreased groundwater contribution. These conditions occur during late summer and early fall and promote the warmest seasonal instream temperatures. The analysis presented in this TMDL is performed during summertime periods in which controlling factors for stream temperature are most critical.

8. PUBLIC PARTICIPATION

Public participation is covered in the WQMP, see page 11. Below is a copy of the notice of public hearing for the draft plan issued November 24, 1998.

A responsiveness summary document (copy submitted with this document) was prepared by DEQ in reply to comments received at the public hearing and written comments received within the comment period.

Notice Of Public Hearing

Oregon Department Of Environmental Quality

Notice Issued: November 24, 1998
Close Of Comment Period: January 15, 1999

Sucker-Grayback Water Quality Management Plan

PUBLIC PARTICIPATION:

Public Hearing
The public hearing will be held in Cave Junction, Or at 7:00 PM on December 9, 1998 in the County Office Building, 102 S. Redwood Hwy.

Written comments:
Written comments on the proposed water quality management plan (WQMP) must be received at the Oregon Department of Environmental Quality (DEQ) by 5 p.m. on January 15, 1999. Written comments should be mailed to Oregon Department of Environmental Quality, Attn: John Blanchard , 201 West Main, Suite 2-D, Medford, Oregon 97501. ***People wishing to send comments via e-mail should be aware that if there is a delay between servers or if a server is not functioning properly, e-mails may not be received prior to the close of the public comment period.*** People wishing to send comments via e-mail should send them in Microsoft Word (through version 97), WordPerfect (through version 6.x) or plain text format. Otherwise, due to conversion difficulties, DEQ recommends that comments be sent in hard copy. E-mails should be sent to: sucker.tmdl@deq.state.or.us

WHO IS PROPOSING AN ACTION	Oregon Department of Environmental Quality 811 SW 6th Avenue Portland, Oregon 97204-1390
AREA COVERED BY ACTION	The Sucker Creek Watershed, including Sucker Creek, Cave Creek, Grayback Creek and several other tributary creeks, within Siskiyou National Forest and the BLM Medford District in Southwest Oregon.
WHAT IS PROPOSED:	DEQ proposes to submit the Sucker-Grayback WQMP to the U.S. Environmental Protection Agency (EPA) for approval as a total maximum daily load (TMDL) for federal lands within the Sucker Creek Watershed. EPA approval would remove water quality limited streams covered by the WQMP from DEQ's "303d" list of impaired waterbodies. The Sucker-Grayback WQMP is based on the Siskiyou National Forest Land and Resource Management Plan and the BLM Medford Resource Management Plan as amended by the Northwest Forest Plan. *This public hearing addresses only the WQMP that is being submitted to EPA.*
WHO IS AFFECTED:	Local public and private land managers, people interested in water quality and fisheries, and people interested in DEQ's implementation of Section 303(d) of the federal Clean Water Act.
NEED FOR ACTION:	Section 303(d) of the federal Clean Water Act requires development of TMDLs for waterbodies included on a state's "303(d)" list. EPA must approve TMDLs submitted by a state.

WHERE TO FIND DOCUMENTS:

The WQMP is available for examination and copying at DEQ's Medford Office at Oregon DEQ, 201 West Main, Suite 2-D, Medford, Oregon 97501 and at DEQ's Headquarters Office at Oregon DEQ, Water Quality Division, 811 S.W. 6th Avenue, Portland, OR 97204. Documents are also available on DEQ's web site at http://www.deq.state.or.us. Click on "water quality" then on "water quality program public notices".

While not required, scheduling an appointment will ensure documents are readily accessible during your visit. To schedule an appointment in Medford contact John Blanchard at 541-776-6010, ext. 240 or TTY at 541-776-6105. For an appointment in Portland call Donna Kelly at 503-229-6962 (toll free at 1-800-452-4011) or DEQ's TTY at 503-229-6993. To request copies of the WQMP call John Blanchard or Donna Kelly at the above numbers.

In addition, copies of the WQMP can be found at the following locations:

> Siskiyou National Forest Illinois Valley Ranger District at 26568 Redwood Highway, Cave Junction, Oregon 97523. Judy McHugh (541-592-2166) is the Forest Service contact for this location.
>
> Illinois Valley Soil and Water Conservation and Watershed Council office at 102 S. Redwood Highway, Cave Junction, Oregon 97523. Corky Lockard 592-3731 is the contact at this location.
>
> DEQ Grants Pass Office, 510 NW 4th Street, Grants Pass, Oregon 97526. Sherry Brierty 471-2850 is the contact at this location.

Questions on the proposed WQMP should be addressed to John Blanchard at the above phone number or to Dave Powers at 503-229-5988.

WHAT HAPPENS NEXT:

DEQ will review and consider all comments received during the public comment period. Following this review, the WQMP may be sent to U.S. EPA for approval as a TMDL or may be modified prior to submission. You will be notified of DEQ's final decision is you present either oral or written comments during the comment period. If you do not comment but wish to receive notification of DEQ's final decision, please call or write DEQ at the above phone numbers/addresses.

ACCOMODATION OF DISABILITIES:

DEQ is committed to accommodating people with disabilities. Please notify DEQ of any special physical or language accommodations you may need as far in advance of the hearing date as possible. To make these arrangements, contact Ed Sale at 503-229-5766 or by calling toll free within Oregon at 1-800-452-4011. People with hearing impairments can call DEQ's TTY at 503-229-6993.

ACCESSIBILITY INFORMATION: This publication is available in alternate format (e.g. large print, Braille) upon request. Please contact DEQ Public Affairs at 503-229-5766 or toll free within Oregon 1-800-452-4011 to request an alternate format. People with a hearing impairment can receive help by calling DEQ's TTY at 503-229-6993.

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