

Federal Lands Permit

Attachment F1

WARP Technical Analysis

I. INTRODUCTION

The purpose of this document is to describe the methodology for establishing the Watershed Assessment and Recovery Program (WARP) annual treatment obligations per Administrative Unit. The intent of this methodology is to provide a fair accounting of relative treatment obligations across the various Administrative Units (AUs) of the three federal agencies regulated by the Federal Lands Permit (FLP), the United States Forest Service (USFS), Bureau of Land Management (BLM), and the National Parks Service (NPS). This methodology assists in quantifying treatment obligations, aggregated across Hydrologic Use Code (HUC) 12 watersheds, to provide a yearly expectation of work conducted across federal agencies to improve water quality conditions. The factors considered in this analysis fall into three broad categories: status of past and present management, current 303(d) listings for sediment/temperature/turbidity, and wilderness or roadless designations.

II. WARP INPUTS

The analysis proposes to calculate, from information sourced from geographic information systems (GIS) data, for each AU and for each HUC 12 watershed with some federal ownership, the following information:

1. Total Acres of AU Ownership
2. Total Acres of Roadless/Wilderness¹ area
3. Calculation (AU ownership minus Roadless/Wilderness area), to derive Acres of AU Managed Lands
 - a. If the Roadless/Wilderness area is greater than the AU Ownership, then the Managed Lands value is set to zero.
4. Acres of Grazing Allotments within Roadless/Wilderness areas, and those allotments' current status (Active/Inactive or Closed)
5. Acres of AU ownership within 303(d)-listed waterbodies for sediment, turbidity, and/or temperature.

¹ Roadless/Wilderness areas refer to federally-administered Wilderness Areas designed by the 1964 Wilderness Act (https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd645666.pdf), and USFS lands included in the 2001 Roadless Rule (https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5057689.pdf).

III. WARP CALCULATION

With these data aggregated by administrative unit and by HU, the analysis results in the following calculation:

$$\omega = \frac{\beta_M(A_U - A_W) + \beta_L A_L + \beta_G A_G}{A_{HU}} = \frac{\beta_M A_M + \beta_L A_L + \beta_G A_G}{A_{HU}}$$

where:

- ω = dimensionless obligation metric (omega); $\omega \in [0,1]$
- A_{HU} = HUC 12 watershed area
- A_U = Area of Administrative Unit ownership
- A_W = Wilderness or Roadless Area within AU ownership
- A_M = $A_U - A_W$; AU ownership minus wilderness/roadless area
- A_L = 303(d) listed watershed area within AU ownership; $A_L \leq A_U$
- A_G = grazing allotment within Wilderness/Roadless areas ; $A_G \leq A_W$
- β_M = coefficient/weight for managed lands area
- β_L = coefficient/weight for 303(d) listed area
- β_G = coefficient/weight for grazing allotments

In other words, the obligation metric ω (omega) is a weighted sum of federal land use within a given HUC 12 watershed normalized by the total HUC 12 watershed area. The values of the three coefficients are:

- Managed coefficient $\beta_M = 0.75$
- 303(d) listing coefficient $\beta_L = 0.25$
- Grazing allotment coefficient $\beta_G = 0.15$

A. Example Calculation

Etna Creek is an approximately 17,245 acre (A_{HU}) HUC 12 watershed in the Scott River Watershed. The USFS Klamath National Forest AU is the sole federal agency with any ownership in this watershed. Here are some details about this watershed:

1. Klamath National Forest administers approximately 9,582 acres in Etna Creek
 - a. Approximately 9,061 acres of the AU ownership is Wilderness or Roadless Area
 - b. Grazing Allotments within the Wilderness/Roadless Area comprise 8,585 acres
 - c. Within the AU ownership, approximately 9,571 acres are impaired for sedimentation/siltation and/or temperature
 - d. Coefficient values for β_M , β_L , β_G are 0.75, 0.25, and 0.15, respectively.

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Variable	Area Description	Acres
A_{HU}	HU12 Watershed	17,245
A_U	AU Ownership	9,582
A_W	Roadless/Wilderness	9,061
A_M $= A_U - A_W$	AU Managed Lands	521
A_G	Grazing Allotment	8,585
A_L	303(d) Listed	9,571

Given this information, the calculation for Etna Creek would be:

$$\omega = \frac{\beta_M A_M + \beta_L A_L + \beta_G A_G}{A_{HU}}$$

$$\omega = \frac{(0.75 \times 521) + (0.25 \times 9,571) + (0.15 \times 8,585)}{17,245}$$

$$\omega \approx 0.236 \text{ obligation}$$

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IV. WARP RESULTS

The WARP calculation was then run across each HUC 12 watershed in the North Coast Region using ArcGIS Pro and R. Each Administrative Unit’s WARP credit obligation may change over time because of alterations in land management activities (e.g., grazing in Wilderness allotments), incorporation or removal of land areas from an Administrative Unit, extensive CSDS treatments across a HUC 12 watershed, and/or changes in waterbody impairment statuses. Table 1 below summarizes the WARP credit obligation allocation and total acreages of the inputs by AU.

Table 1: Summary of WARP Results by Administrative Unit

	ADMINISTRATIVE UNIT	HUC 12 (#)	Σ Ω	TOTAL OWNERSHIP (AC)	MANAGED AREA (AC)	WILDERNESS / ROADLESS AREA (AC)	GRAZED WILDERNESS AND ROADLESS AREA (AC)	303(D) LISTED AREA (AC)
BLM	Arcata Field Office	65	6	202,238	109,373	92,865	68	164,149
BLM	Redding Field Office	55	6	96,591	96,560	31	0	89,835
BLM	Ukiah Field Office	25	4	36,990	36,990	0	0	35,977
NPS	Redwood National Park	15	3	95,095	95,095	0	0	81,285
USFS	Klamath National Forest	131	54	1,663,527	1,008,962	654,565	169,688	1,200,457
USFS	Mendocino National Forest	52	32	480,101	271,164	208,937	102,357	480,080
USFS	Rogue-Siskiyou National Forest	13	7	83,632	43,962	39,670	31,274	36
USFS	Shasta-Trinity National Forest	100	41	1,267,671	632,928	634,744	88,978	965,479
USFS	Six Rivers National Forest	71	28	978,250	649,605	328,646	75,765	653,932

Note that the AUs in the “dry quarter” of the North Coast Region, Modoc National Forest, the BLM Applegate Field Office, and Lava Beds and Tulelake National Monuments are all excluded from the WARP analysis. See Attachment F for additional details.

There may be slight variations in acreages across AUs, many of which are the result of “edge” cases. There is a small amount of “edge” cases that are removed from the analysis. “Edge” cases are defined as AU-HUC12 combinations where the AU ownership within a HUC12 is less than 1 percent of the HUC12’s area. Whiskeytown-Shasta-Trinity National Recreation Area and Fremont National Forest will be removed as their AU-HUC12 pairs can be considered “edge” cases and the overall area within

the North Coast Water Board is either very small or are a result of minute differences in the source dataset's boundaries leading to "slivers" of these AUs being appended to the North Coast Water Board boundary.

V. WARP ANALYSIS TECHNICAL DOCUMENTATION

The WARP analysis and calculation of the obligation metric ω is implemented in *R*, a computer programming language for statistics that has been widely adopted in the sciences, technology engineering, and mathematics disciplines. A detailed description of the analysis is available upon request from North Coast Water Board staff.

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