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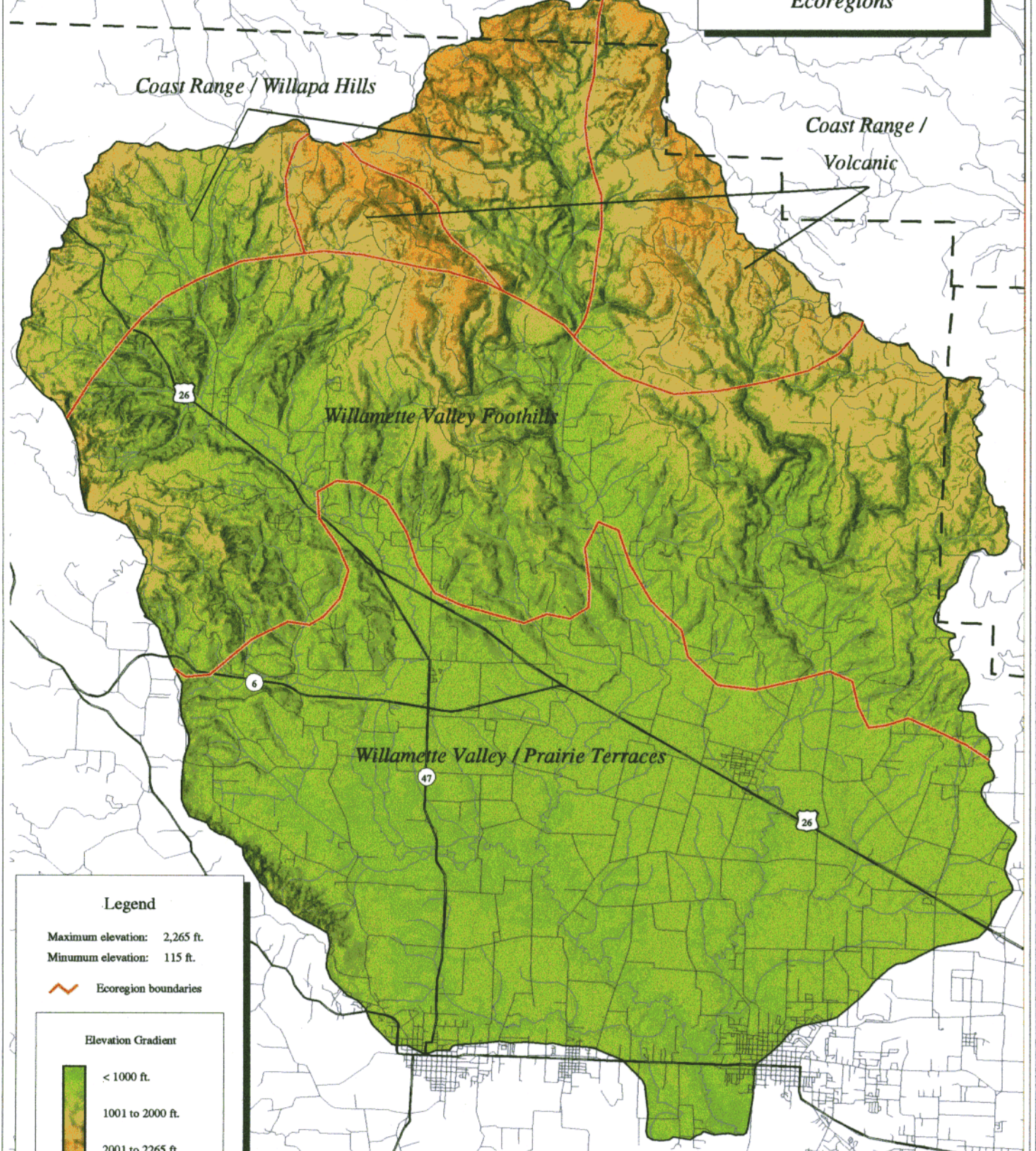
March 1999

Dairy-McKay Watershed Analysis

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

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**Map 1-3.
Ecoregions**

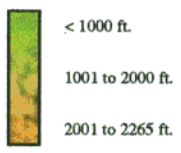


Legend

Maximum elevation: 2,265 ft.
Minimum elevation: 115 ft.

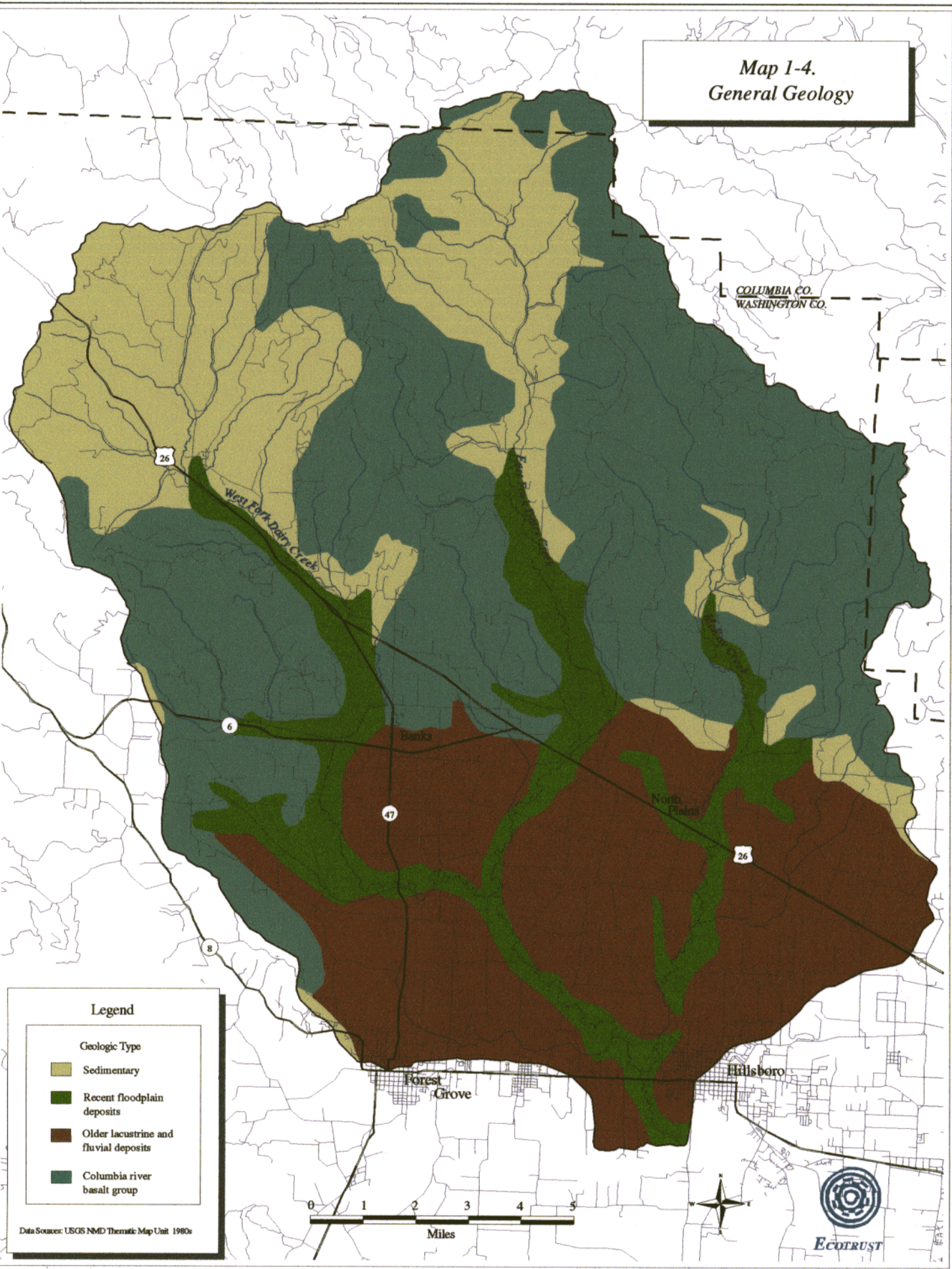
 Ecoregion boundaries

Elevation Gradient



Data sources: Elevation derived from 10ft. contours, Metro (RLIS, 1997), Ecoregions defined by USEPA.

Map 1-4.
General Geology



Legend

- Geologic Type
- Sedimentary
 - Recent floodplain deposits
 - Older lacustrine and fluvial deposits
 - Columbia river basalt group

Data Sources: USGS NMD Thematic Map Unit 1980s





United States Department of the Interior

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May 26, 1999

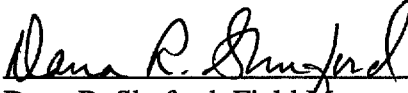
Attached is a copy of the Dairy-McKay Watershed Analysis prepared through a partnership between Washington County Soil and Water Conservation District and the Bureau of Land Management. The following acknowledgments page demonstrates the breadth of cooperation and valuable assistance received during this effort.

This watershed analysis is a combination of current inventory data provided by a BLM interdisciplinary team and information gathered by the principal author John Hawksworth, of Washington County SWCD. The purpose of this watershed analysis is to provide reference information that is used in project planning. The information in this document is the most current data available.

Watershed analysis is a continuing process. This document represents the first iteration of the analysis which will be updated in the future as additional information is obtained. Additional information and comments are encouraged and will be welcomed at any time on this watershed analysis. The information will be retained with the analysis, used accordingly and eventually evaluated and incorporated into future iterations.

If you have any questions, please contact Katrina Symons at the above address or phone 503-815-1100.

Sincerely,


Dana R. Shuford, Field Manager
Tillamook Resource Area

Date: 5-26-99

DAIRY-McKAY WATERSHED ANALYSIS



Prepared by

**John Hawksworth, principal author
Washington County Soil and Water Conservation District**

**In cooperation with
United States Bureau of Land Management
United States Fish and Wildlife Service**



February 1999

Table of Contents

CHAPTER 1: CHARACTERIZATION	1
1.1 PHYSICAL.....	1
1.1.1 <i>Size and setting</i>	1
1.1.1.1 Topography.....	1
1.1.1.2 Ecoregions.....	4
1.1.1.3 Geomorphology.....	4
1.1.1.4 Erosion.....	4
1.1.1.5 Climate and Precipitation.....	4
1.1.1.6 Hydrology.....	8
1.1.1.7 Stream Channel.....	8
1.1.1.8 Water Quality.....	8
1.1.1.9 Soils.....	10
1.2 BIOLOGICAL.....	13
1.2.1 <i>Vegetation characteristics</i>	13
1.2.2 <i>Species and Habitat</i>	13
1.2.2.1 Species.....	13
1.2.2.2 Habitat.....	14
1.3 SOCIAL.....	16
1.3.1 <i>Population</i>	16
1.3.2 <i>Ownership</i>	16
1.3.3 <i>Allocations</i>	19
1.3.3.1 BLM Allocations.....	19
1.3.4 <i>Human Uses</i>	19
1.3.4.1 Forestry.....	19
1.3.4.2 Agriculture.....	20
1.3.4.3 Urban.....	20
1.3.4.4 Recreation.....	20
CHAPTER 2: CORE TOPICS AND KEY QUESTION	21
2.1 AQUATIC.....	21
2.11 <i>Erosion issues</i>	21
2.12 <i>Hydrology and water quantity issues</i>	21
2.13 <i>Stream channel issues</i>	22
2.14 <i>Water quality issues</i>	22
2.15 <i>Aquatic species and habitat issues</i>	22
2.2 TERRESTRIAL.....	23
2.21 <i>Vegetation issues</i>	23
2.22 <i>Species and habitat issues</i>	23
2.23 <i>Forest resources issues [BLM only]</i>	24
2.3 SOCIAL.....	24
2.31 <i>Issues related to human uses</i>	24
2.32 <i>Road-related issues</i>	24
CHAPTER 3: CURRENT CONDITION	27
3.1 AQUATIC.....	27
3.1.1 <i>Erosion processes</i>	27
3.1.1.1 Overview of erosion and sedimentation processes.....	27
3.1.1.2 Mass wasting.....	27
3.1.1.3 Surface and streambank erosion.....	28
3.1.1.4 Human impacts on erosion processes and sediment production.....	30

3.1.1.5 Prohibited conditions	31
3.1.2 <i>Hydrology and water quantity</i>	31
3.1.2.1 Hydrologic characteristics	31
3.1.2.2 Water quantity and water rights	32
3.1.2.3 Flooding	34
3.1.2.4 Groundwater	35
3.1.2.5 Human impacts on hydrology	37
3.1.3 <i>Stream channel</i>	37
3.1.3.1 Stream morphology and sediment transport processes	37
3.1.3.2 Effects of human influences upon stream morphology	39
3.1.4 <i>Water quality</i>	41
3.1.4.1 Beneficial uses	41
3.1.4.2 General indicators of water quality	41
3.1.4.3 Streams on the 303(d) list	41
3.1.4.4 Parameters of concern	43
3.1.4.5 Water quality trends	46
3.1.4.6 Superfund sites	46
3.1.5 <i>Aquatic species and habitat</i>	46
3.1.5.2 Survey and manage mollusks	46
3.1.5.3 Amphibians	60
3.1.5.3 Other Riparian and wetland-dependent species	51
3.2 TERRESTRIAL	51
3.2.1 <i>Vegetation</i>	51
3.2.1.1 Array and landscape pattern of vegetation	51
3.2.1.2 Exotic/Noxious Plants	53
3.2.2 <i>Species and habitat</i>	54
3.2.2.1 Abundance and habitat of terrestrial species	54
3.2.2.2 Effect of ownership upon habitat management opportunities	61
3.2.2.3 Current distribution and density of snags and down wood	61
3.2.3 <i>Forest resources</i>	61
3.2.3.1 Forest productivity, diseases, and other pathogens	61
3.2.3.2 Late Successional Reserves/ Big Canyon	62
3.3 SOCIAL	62
3.3.1 <i>Human uses</i>	62
3.3.1.1 Economic Uses	62
3.3.1.2 Recreational opportunities	66
3.3.1.3 Cultural Resources	66
3.3.2 <i>Roads</i>	66
3.3.2.1 High risk areas for road-related slope failures	68
3.3.2.2 Road density	68
3.3.2.3 Stream crossings, bridges and culverts	70
3.3.2.4 Access to BLM lands	70
CHAPTER IV: REFERENCE CONDITIONS	71
4.1 Introduction	71
4.2 Erosion	71
4.3 Hydrology and water quantity	72
4.3.1 <i>Tualatin Mountains</i>	72
4.3.2 <i>Tualatin Plain</i>	72
4.3.2.1 Extent of wetlands in the early Dairy-McKay watershed	73
4.4 Stream Channel	73
4.5 Water Quality	73
4.6 Aquatic Species and Habitat	74
4.6.1 <i>Fish</i>	74
4.6.2 <i>Wetland and riparian dependent species</i>	75
4.7 Vegetation	75
4.7.1 <i>General regional characteristics</i>	75

4.7.2	<i>Vegetational characteristics of the Tualatin Mountains</i>	76
4.7.3	<i>Vegetational characteristics of the Tualatin Plain</i>	76
4.7.4	<i>Wetland vegetation</i>	76
4.7.5	<i>Sensitive plant species</i>	76
4.7.6	<i>Terrestrial Species and Habitat</i>	77
4.8	Human	77
4.8.1	<i>Historical changes in landscape pattern</i>	77
4.8.1.1	Human uses prior to European settlement	77
4.8.1.2	European settlement and agricultural conversion	78
4.8.1.3	Timber operations	78
4.8.1.4	Wetland conversion	78
CHAPTER 5: SYNTHESIS		81
5.1	AQUATIC	81
5.1.1	<i>Erosion issues</i>	81
5.1.1.1	Changes in erosion processes following settlement	81
5.1.1.2	Management impacts on erosion, Tualatin Mountains	81
5.1.1.3	Management impacts on erosion, Tualatin Plain	82
5.1.2	<i>Hydrology and water quantity issues</i>	83
5.1.2.1	Management effects on hydrology	83
5.1.2.2	Water rights allocations	84
5.1.3	<i>Stream channel issues</i>	84
5.1.3.1	Management effects upon stream morphology	84
5.1.4	<i>Water quality issues</i>	85
5.1.4.1	Management effects on water quality	85
5.1.4.2	Factors leading to high aquatic phosphorus levels.	86
5.1.4.3	Temperature	86
5.1.4.4	Streams on the Oregon 303(d) water quality limited list	86
5.1.4.5	Effects of water quality on recreation	87
5.1.4.6	Prohibited conditions	87
5.1.4.7	Superfund sites	88
5.1.5	<i>Aquatic species and habitat issues</i>	88
5.1.5.1	Fisheries	88
5.1.5.2	Wetlands: Management Impacts.	88
5.1.5.3	Riparian habitat: Management impacts	89
5.1.5.4	Impacts of wetland and riparian changes upon species	89
5.2	TERRESTRIAL	89
5.2.1	<i>Vegetation issues</i>	89
5.2.1.1	Post-settlement effects on landscape characteristics.	89
5.2.1.2	Potential vegetation management strategies	90
5.2.1.3	Noxious and exotic plants	90
5.2.1.4	[BLM only] Potential management strategies within the Riparian Reserves	91
5.2.2	<i>Species and habitat issues</i>	91
5.2.2.1	Factors affecting the distribution of sensitive species.	91
5.2.3	<i>Forest resources issues [BLM-specific]</i>	92
5.2.3.1	Management of snags and down wood	92
5.2.3.2	Laminated root rot	92
5.2.3.3	Management of hardwood stands	93
5.2.3.4	Achievement of late-successional goals in Big Canyon	93
5.2.3.5	Management on Connectivity lands	93
5.3	SOCIAL	93
5.3.1	<i>Issues related to human uses</i>	93
5.3.1.1	Agriculture	93
5.3.1.2	Timber	93
5.3.1.3	Urban uses	94
5.3.1.4	Rural interface	94

5.3.1.5 Recreation	94
5.3.2 Cultural Resources	95
5.3.3 Road-related issues	95
5.4 DATA GAPS	95
CHAPTER 6: RECOMMENDATION	97
AQUATIC	99
<i>Erosion issues</i>	99
<i>Hydrology and water quantity issues</i>	101
<i>Stream channel issues</i>	101
<i>Water quality issues</i>	102
<i>Aquatic species and habitat issues</i>	103
TERRESTRIAL	106
Vegetation issues	106
Noxious/Exotic Plants	107
<i>Species and habitat issues</i>	107
SOCIAL	108
<i>Issues related to human uses</i>	108
Recreation	108
Cultural resources	108
Road Related Issues	108
RECOMMENDATIONS ON BLM LANDS	109
AQUATIC	109
<i>Erosion issues</i>	109
<i>Stream channel issues</i>	109
<i>Water quality issues</i>	109
<i>Aquatic species and habitat issues</i>	110
TERRESTRIAL	110
Vegetation issues	110
Noxious/Exotic Plants	110
<i>Species and habitat issues</i>	110
<i>Forest resources issues [BLM only]</i>	111
SOCIAL	113
<i>Issues related to human uses</i>	113
Rural interface	113
Recreation	114
Road-related issues	114
BIBLIOGRAPHY	117

List of Tables

Table	Description	Page
1-1	Mainstem catchments of the Dairy-McKay watershed	1
1-2	Characteristics of EPA Level IV ecoregions in the Dairy-McKay watershed	6
1-3	Threatened/endorsangered/sensitive plant species potentially found in the Dairy-McKay watershed	15
3-1	Total surface water rights by subwatershed	33
3-2	Total surface water rights by type of use	35
3-3	Minimum perennial streamflows (cfs) as regulated by instream water rights in the Dairy-McKay watershed	35
3-4	USA monitoring sites in the Dairy-McKay watershed	42
3-5	Anadromous and resident fish known to inhabit the Dairy-McKay watershed	47
3-6	Size classes of forested lands of all ownerships	54
3-7	Age classes of forest on BLM lands	54
3-8	Survey and Manage fungi and lichen species found in the Dairy-McKay watershed	58
3-9	Agricultural statistics for farms in five zip codes surrounding and including the Dairy-McKay watershed	65
3-10	Roads within the Dairy-McKay watershed	68
6-1	Priority sites for preservation, restoration, and renovation of riparian and wetland conditions	98

List of Figures

Figure	Description	Page
1-1	Precipitation at Hillsboro	9
1-2	Mean flow on the East Fork of Dairy Creek, 1940-1951	11
1-3	Mean flow on McKay Creek, 1940-1955	12
3-1	Population growth of cities entirely or partially within the Dairy Creek watershed	63
3-2	Timber harvest within the Dairy Creek watershed, 1962-1995	67

List of Maps

Map	Description	Page
1-1	Dairy Creek-McKay Creek watershed location	2
1-2	Dairy Creek-McKay Creek watershed and subwatersheds	3
1-3	Ecoregions	5
1-4	General geology	7
1-5	Population density, 1990	17
1-6	Major land ownership	18
3-1	Steep slopes	29
3-2	Floodplains and wetlands	38
3-3	Stream reach types	40
3-4	Water quality and water supply	44
3-5	Fish distribution	48
3-6	Land use and land cover, non BLM lands	55
3-7	Age class of forest vegetation, BLM lands	56
3-8	Roads and road crossings	69

List of Appendices

Appendix	Description	Page
1	Stream miles indices for Dairy Creek and major tributaries	121
2	Streamflow and water temperature tables and graphs	127
3	Oregon Administrative Rules 603-095	135
4	Location and characteristics of BLM lands in the Dairy-McKay watershed	153
5	Channel habitat typing tables from the draft 1997 GWEB assessment manual	157
6	Analysis of riparian vegetation	163
7	Summary of the culvert survey conducted by Washington County	171
8	Land cover and size classes of forested land, by subwatershed	175
9	The Oregon Department of Agriculture noxious weeds list, 1998	179

Abbreviations and Acronyms

BA	Bureau Assessment
BLM	Bureau of Land Management
BMP	Best Management Practice
BOD	Biological Oxygen Demand
BS	Bureau Sensitive
CD	Compact Disk
CERCLA	Comprehensive Environmental Response Compensation and Liability act of 1980
cfs	cubic feet per second
DBH	Diameter at Breast Height
D.O.	Dissolved Oxygen
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEMAT	Federal Ecosystem Management Assessment Team
FSA	Farm Service Agency
FT	Federal Threatened (under the ESA)
GFMA	General Forest Management Area
GIS	Geographic Information System
gpm	gallons per minute
GWEB	Governor's Watershed Enhancement Board
IBI	Index of Biotic Integrity
LSR	Late Successional Reserve
LSRA	Late Successional Reserve Assessment
LWD	Large Woody Debris
Metro	Metropolitan Service District
NFP	Northwest Forest Plan
NRCS	Natural Resources Conservation Service
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODSL	Oregon Division of State Lands
OED	Oregon Employment Department
OGI	Oregon Graduate Institute
OSU	Oregon State University
OWRD	Oregon Water Resources Department
O&C	Oregon and California Railroad
RM	River Mile
RMP	Resource Management Plan
ROD	Record of Decision
ROS	Rain on Snow
SB1010	Senate Bill 1010 (Agricultural Water Quality Mgmt. Area Plan)
SWCD	Soil and Water Conservation District (Washington County)
S&M	Survey and Manage
SV	Sensitive Vulnerable species designation (State of Oregon)
TAC	Technical Assistance Committee
TCOD	Total Chemical Oxygen Demand
TMDL	Total Maximum Daily Load
TRWC	Tualatin River Watershed Council
TVID	Tualatin Valley Irrigation District
UGB	Urban Growth Boundary
USA	Unified Sewerage Agency of Washington County
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WPA	Works Progress Administration
WQI	Water Quality Index

Introduction

The concept of watershed analysis is built on the premise that management and planning efforts are best addressed from the watershed perspective. Better decisions are made, and better actions taken, when watershed processes and other management activities within a watershed are taken into consideration. Issues related to erosion, hydrologic change, water quality, and species are not limited to a specific site. Changes to watershed processes at one site often have effects that extend downstream and elsewhere in the watershed. By addressing these issues at the watershed level, we take the interconnected nature of watershed processes into account. We are thereby enabled to synthesize approaches to planning and management that preserve ecosystem functions. Where these functions have been diminished from reference conditions, we are able to plan activities to restore these functions.

In keeping with the principle of ecosystem analysis at the watershed scale, the Bureau of Land Management (BLM) has formed a partnership agreement with the Washington County Soil and Water Conservation District (SWCD) to prepare the Dairy-McKay Creek Watershed Analysis. The United States Fish and Wildlife Service (USFWS) also participated in production of this watershed analysis. The missions of these agencies are complementary. The BLM manages lands that are mostly in mountainous, forested portions of the watershed. The BLM is charged with several management duties by the people of the United States. As part of its stewardship role, the BLM is mandated to maintain ecosystem functions and processes. This includes maintenance of wildlife habitat. The USFWS has the mandate to protect terrestrial wildlife, aquatic species, and their habitat. As part of its mission, the SWCD works with farmers to conserve the soil resources of the valley, and to protect water quality within the watershed. The Washington County SWCD is mostly active within lower portions of the watershed. Together these agencies cover many of the interests within the watershed. This watershed analysis report is designed to address questions of interest to these agencies. However, in recognition that diverse interests exist in the watershed that are not covered by these agencies, this watershed analysis is also designed to be consistent with the interests of the Tualatin River Watershed Council, as expressed by the Tualatin River Basin Action Plan. Within the time and financial limitations of this report, it has done so.

The framework of this watershed analysis is built according to the requirements of *Ecosystem analysis at the watershed scale: a federal guide for watershed analysis* (REO 1995). This watershed analysis methodology is built up of six complementary parts. The first chapter is a watershed **characterization**, defining the characteristics that distinguish the watershed. The background laid out in this chapter leads to a set of **core topics and key questions** that have to do with watershed processes and their specific interactions with management activities. In response to these questions, the third and fourth chapter are constructed. The third chapter describes the **current conditions** within the watershed, while the fourth chapter reconstructs watershed processes and conditions under **reference conditions** (usually prior to European settlement). Based on the information provided in these chapters, we are able to synthesize the changes in watershed process that have been caused by various management activities. The results of this **synthesis** are included in the fifth chapter. Based on this synthesis, **recommendations** for current management and restoration are formulated. As a level one analysis using the federal methodology, this watershed analysis report relies heavily upon data collected by other agencies and private sources. This particular watershed analysis report has relied extensively upon GIS analysis of publicly available data compiled by Interrain/ECOTRUST as part of the Tualatin Basin compact disk that was prepared on behalf of the Tualatin River Watershed Council. These data have facilitated the analysis from these reports. However, they are not intended to replace field-based data for site-specific decisions. The data were analyzed for obvious flaws. However, no intensive review was performed on any data used in this report. There may be flaws in the source data and/or analysis performed in this report. This report should be used for general guidelines to point the direction to more site-specific studies.

Acknowledgements

Successful completion of the Dairy Creek watershed analysis report required the contribution of experts in many disciplines. The following primary team members contributed technical assistance, provided editorial review, and in many cases authored paragraphs specific to their fields of expertise.

Mike Allen, BLM, Project coordinator

Steve Bahe, BLM, Wildlife

Julie Fulkerson, USFWS, Wildlife

Walt Kastner, BLM, Silviculture

Gregg Kirkpatrick, BLM, Recreation

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Dean Moberg, NRCS, Soils and agriculture

Andy Pampush, BLM, Survey and Manage species

Dave Roché, BLM, Silviculture

Larry Scofield, BLM, Vegetation

Lynn Trost, BLM, Roads

Warren Villa, Fire management

Matt Walker, BLM, Fisheries

Cindy Weston, BLM, Fisheries

Greg White, Tualatin River TAC, Fisheries

Dennis Worrel, BLM, Hydrology

People outside the primary team also made substantial contributions to the watershed analysis. Through his efforts, John McDonald, SWCD, facilitated the partnership between BLM and the SWCD that made this cooperative watershed analysis possible. Tracy Breinlinger and Fran Gray provided volunteer fieldwork. Jacqueline Dingfelder, formerly coordinator for the Tualatin River Watershed Council, provided assistance with watershed issues and supplied materials useful for preparation of the analysis. Finally, experts from many agencies provided information useful to the preparation of this report. Many thanks to all of these people for their assistance with the preparation of this watershed analysis report.

John Hawksworth

February 16, 1999

Chapter 1: Characterization

1.1 Physical

1.1.1 Size and setting

The Dairy-McKay watershed drains 231 square miles (147,956 acres) in the northern part of the Tualatin River basin (Map 1-1). It is the largest watershed contributing to the Tualatin River, constituting nearly one-third of the entire basin. From its headwaters in the Tualatin Mountains, the mainstem tributaries flow in a generally southerly direction, ultimately joining the Tualatin River at River Mile 45, near the city of Hillsboro, Oregon.

The watershed is drained by the mainstem Dairy Creek and three mainstem tributaries; the east and west forks of Dairy Creek and McKay Creek. Mainstem lengths and their drainage areas are given in Table 1-1. Stream mile indices, including tributaries, for these mainstem reaches are given in Appendix 1. The watershed is further subdivided into 38 subwatersheds (6th field watersheds), which will be the basic unit for many analyses in this report (Map 1-2).

1.1.1.1 Topography

Most major streams within this watershed have their headwaters in the Tualatin Mountains to the north and

Table 1-1. Mainstem catchments of the Dairy-McKay watershed

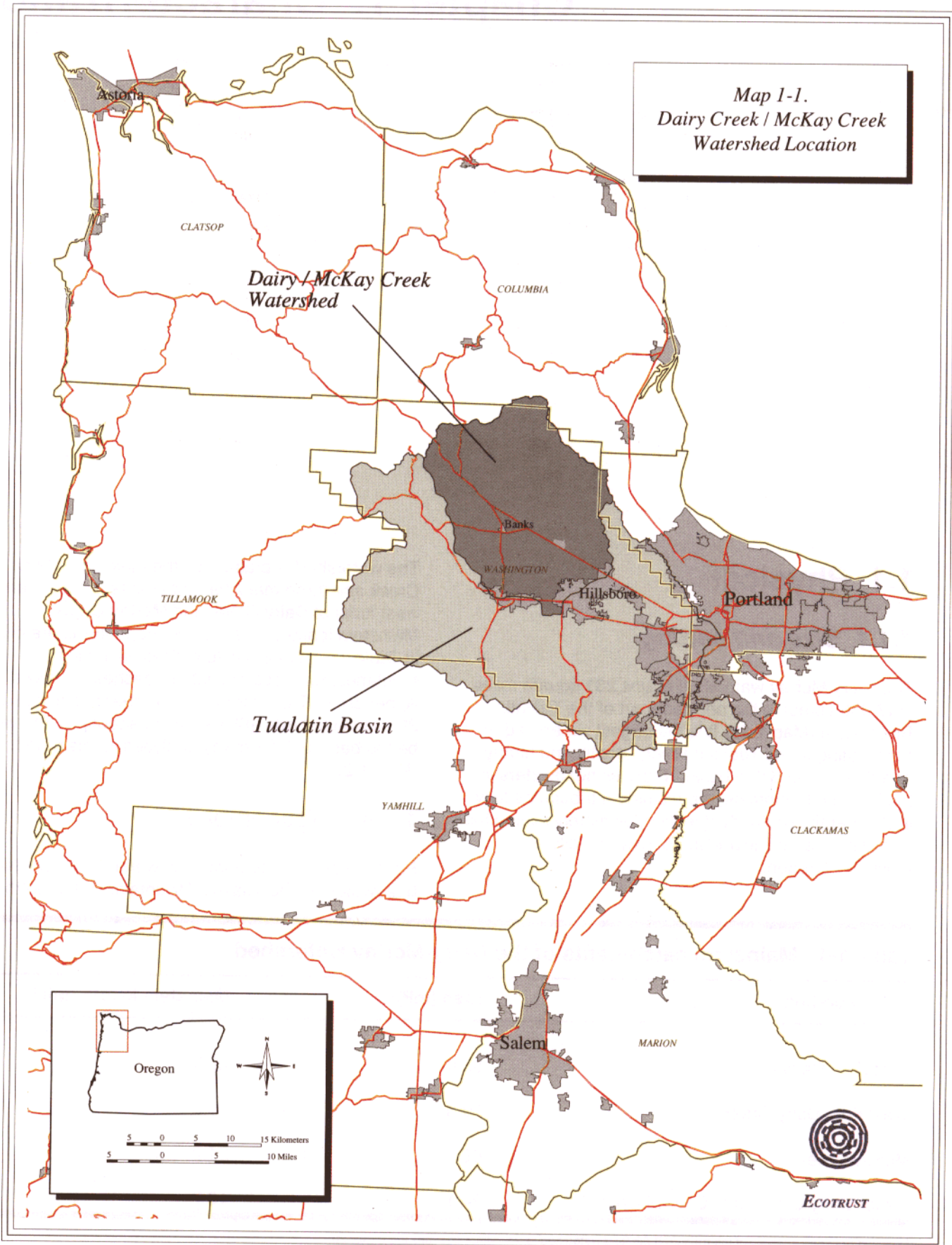
Subwatershed	Area (mi ²) ¹	Mainstem length (mi) ²
East Fork Dairy Creek	58.9	22.9
West Fork Dairy Creek	79.5	25.6
McKay Creek	68.5	24.2
Lower Dairy Creek (inc. Council Creek)	24.1	10.7

¹ Derived from GIS analysis of Interrain draft 6th field watershed layer. Minor changes are expected.

² Derived from GIS analysis of Interrain's digitized 1:24,000 stream layer.

³ Measured from blue lines on USGS 1:24,000 topographic maps. The BLM GIS layer contains additional low-order streams not displayed on the USGS maps. Gradients of these tributaries are often greater than 10%.

Map 1-1.
Dairy Creek / McKay Creek
Watershed Location





flow in a southerly direction through dissected terrain. Peaks along the northern divide of the watershed are generally above 1,500 feet in elevation. The highest elevations are found in the headwaters of the East Fork of Dairy Creek, where elevation reaches 2,265 feet at Long Peak. Elevation generally decreases in a southerly direction. In the mountains, stream gradient typically ranges between 3 and 10%³. The Tualatin Mountains grade into the Tualatin Plain, which constitutes the southern 30% of the watershed. The vast majority of this plain is below 200 feet in elevation. Over this part of the watershed, streams flow over a very slight gradient, generally much less than 1%. Lower Dairy Creek has a gradient of 0.06%. Ultimately, Dairy Creek meets the Tualatin River at an approximate elevation of 115 feet.

1.1.1.2 Ecoregions

Recent management theory has attempted to subdivide the landscape into homogenous units based on physical and biotic characteristics. One approach is to designate these units, called ecoregions, on a hierarchical scale, with higher level classifications denoting finer divisions of the landscape. At level IV of the classification system used by the Environmental Protection Agency (EPA), the Dairy-McKay watershed falls within four ecoregions (Map 1-3). Two of these regions are in the Tualatin Mountains: The northern headwaters of Dairy Creek are located in the Willapa Hills ecoregion. Headwaters of McKay Creek are in the Volcanics region of the Coast Range. Below these two regions, streams flow through the Valley Foothills ecoregion, a region transitional between the mountains and the Tualatin Plain. Downstream of this region, the Tualatin Plain forms a portion of the Prairie Terraces ecoregion. Characteristics of these ecoregions are given in Table 1-2.

1.1.1.3 Geomorphology

The geological structure of the watershed is characterized by tectonic folding. At the headwaters, the Portland Hills anticline forms the Tualatin Mountains. The lower portion of the watershed is in the synclinal Tualatin Plain. The Tualatin Mountains slope moderately toward the valley, and are well dissected by streams.

³ Derived by GIS analysis of Geology layer (Tualatin compact disk). For the analysis, floodplains were defined as stream-adjacent regions underlain by Quaternary Alluvium (Qal). This area varies from the 100 year floodplain. The foothills region was defined as that portion where these stream floodplains were bordered by bedrock lithology, rather than alluvium. On the West Fork, this was roughly the reach between Buxton and Banks; East Fork, Meacham Corner to Mountindale; McKay Creek Brunswick Canyon to Jackson Creek. Width was calculated as polygon (area/length).

Lithology varies within the watershed (Map 1-4). In headwater reaches of the Tualatin Mountains, most of the West and East forks of Dairy Creek are underlain by Tertiary Marine sedimentary formations, while McKay Creek is underlain by Columbia River basalt. In lower parts of the mountains, the forks of Dairy Creek also pass through basalt lithology. In the foothills regions, these streams develop alluvial floodplains. The floodplains of the West and East forks of Dairy Creek are relatively broad, averaging about 2,900 feet and 3,900 feet in width, respectively. Floodplains are less developed on foothill reaches of McKay Creek, averaging about 1,900 feet in width⁴.

In the valley, the regions between these recent alluvial floodplains are occupied by thick beds of older alluvium, which are largely the result of Pleistocene flooding. The Missoula floods resulted as massive lakes in the Rocky Mountain province burst through their glacial dams. Release of impounded lake waters resulted in a flood wave that immersed the Tualatin Valley to an elevation of roughly 250 feet. The initial flood waves carried gravel, sand, silt and clay, much of which was deposited in the Tualatin Valley. Much of this water remained in the valley for a substantial period of time, forming Lake Allison. Subsequently, this lake deposited lacustrine silt/clay throughout the Tualatin valley. Many of these deposits have low permeability, resulting in poorly drained conditions in many parts of the basin (Orr et al. 1992, Hart and Newcomb 1965).

1.1.1.4 Erosion

Erosional processes vary within the watershed. In the upper portion of the watershed, ridges are often underlain by the resistant Columbia River basalt, while most stream development takes place in the more erodible sedimentary reaches. These siltstones, shales, and sandstones provide fine sediments, both through surface erosion and mass wasting processes. Portions of the watershed underlain by Columbia River basalt can also provide substantial sediments through mass wasting processes. These basalts readily degrade into an unstable lateritic soil, which readily slumps and slides. Landslides are especially common along the steep inner gorges of streams. In the foothill and terrace regions, streambank erosion becomes a dominant process, as fluvial action erodes the soft alluvium of the banks. However, the cohesive silts and clays of these regions provide resistance to bank erosion, leading to deep, narrow, stream channels.

1.1.1.5 Climate and Precipitation

The Tualatin basin lies in a region of moderate

Map 1-3.
Ecoregions

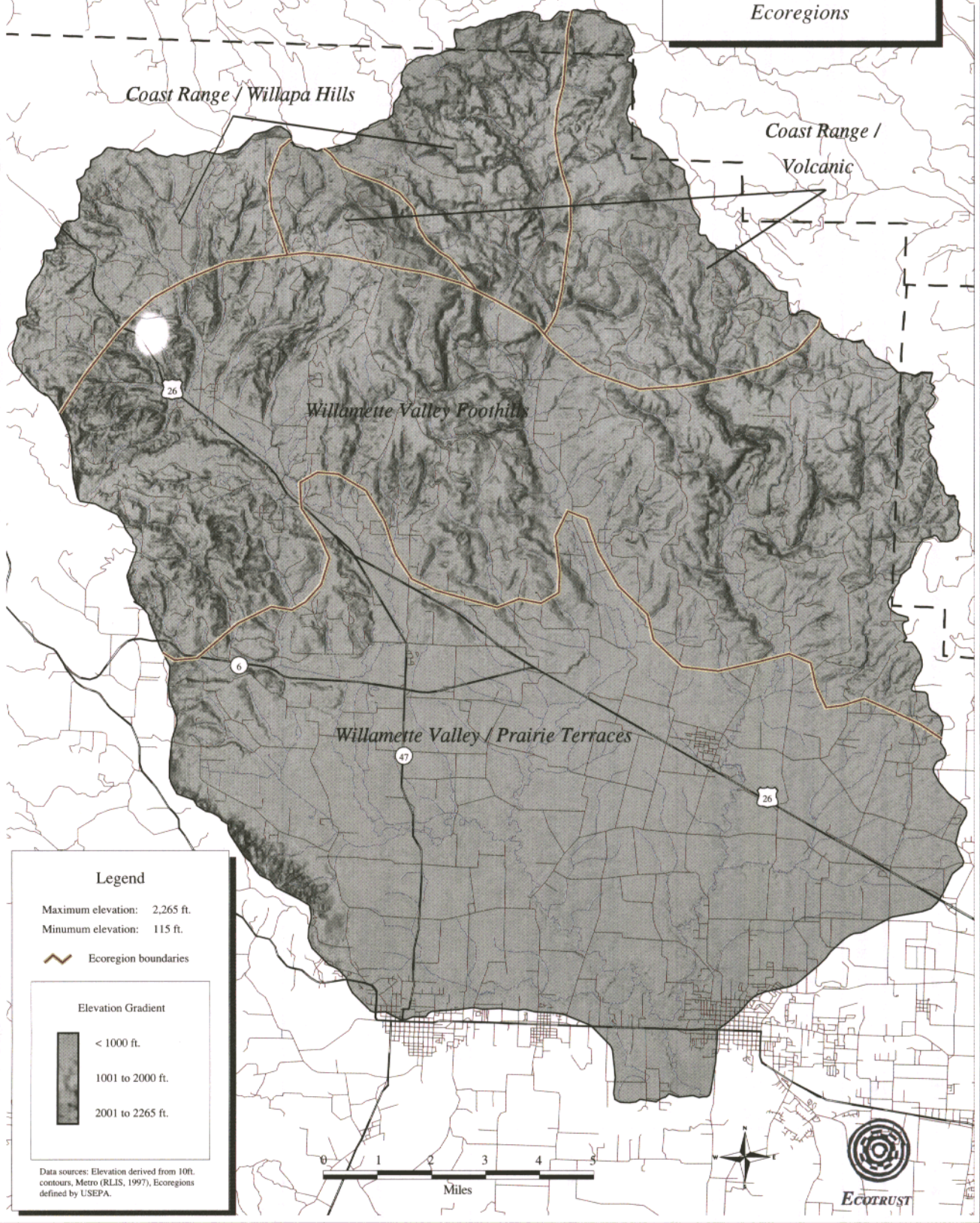
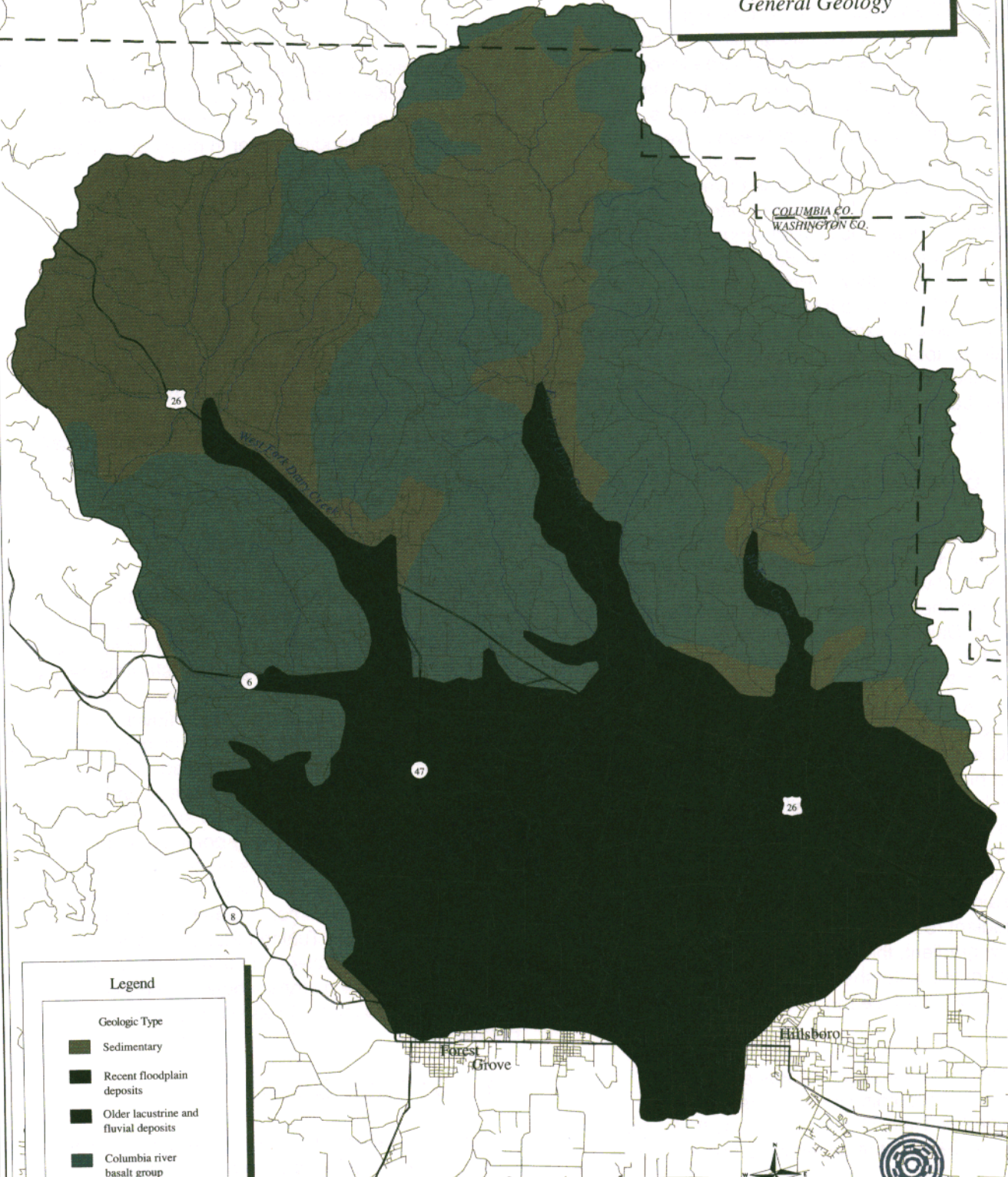


Table 1-2. Characteristics of EPA Level IV ecoregions in the Dairy Creek watershed. (Adapted from Pater et al. 1998, NRCS 1982)





Level IV ecoregion	Elevation (feet)	Physiography	Lithology	Soil orders	Common soil series	Potential natural vegetation	Land use	Climate
1d. Volcanics	400-2,200	Steeply sloping mountains. Moderate to high gradient streams with stable summer flow.	Columbia River basalt. Minor inclusions of sedimentary rock.	Andisols, Ultisols	Cascade, Cornelius, Goble, Saum, Delena	Western hemlock, western redcedar, Douglas-fir	Forestry, rural residential development, recreation.	Mesic/Udic
1f. Willapa Hills	500-2,300	Low, rolling hills and mountains with medium gradient, sinuous streams and river. Low drainage density.	Tertiary marine sedimentary rocks, mostly sandstone and siltstone.	Andisols, Ultisols, Inceptisols	Olyic, Melby, Pervina, Knappa, Tolke, Udifluvents	Western hemlock, western redcedar, Douglas-fir	Forestry, rural residential development, pastureland.	Mesic/Udic
3c. Prairie Terraces	115-200	Nearly level to undulating fluvial terraces with sluggish, meandering streams and rivers. Historically, seasonal wetlands and ponds were common. Many streams now channelized.	Pleistocene lacustrine and fluvial sedimentary deposits.	Alfisols, Mollisols, Inceptisols	McBee, Chehalis, Wapato, Verboort, Cove, Labish, Woodburn, Quatama, Willamette, Aloha, Amity, Dayton	Oregon white oak, prairies. In wetter areas: Oregon ash, Douglas-fir.	Agriculture. Also urban/ rural residential development and some forested riparian zones.	Mesic/Xeric
3d. Valley Foothills	200-1,800	Rolling foothills with medium gradient, sinuous streams.	Miocene andesitic basalt and marine sandstone.	Alfisols, Ultisols, Mollisols, Inceptisols	Chehalis, Cornelius, Kinton, McBee, Melbourne, Saum	On drier sites: Oregon white oak. In moister areas: Douglas-fir more common. Some western redcedar.	Rural residential development, pastureland, coniferous and deciduous forests, forestry, vineyards, Christmas tree farms, orchards.	Mesic/Xeric

Map 1-4.
General Geology



Legend

Geologic Type

-  Sedimentary
-  Recent floodplain deposits
-  Older lacustrine and fluvial deposits
-  Columbia river basalt group

Data Sources: USGS NMD Thematic Map Unit, 1980s



ECOTRUST

climate. Summers are warm and generally dry, while winters are cool and wet. Temperatures are moderated by the moist climate. In the Tualatin Valley, the freeze-free growing season averages 180 days, and the temperature falls below freezing 65 days out of the year (SCS 1982). Mountainous regions have shorter growing seasons and greater incidence of freezing temperatures than those experienced in the valley. Weather is often cloudy, but precipitation is generally concentrated in the winter months. Roughly 72% of precipitation occurs between November and March (Figure 1-1)⁵. Generally speaking, precipitation is greatest in the headwaters regions of the Tualatin Hills, and decreases with decreasing elevation. Annual precipitation ranges from 67 inches near the headwaters of the East Fork of Dairy Creek to 38 inches at Hillsboro. Precipitation is generally light, with little raindrop intensity. Although the mountain regions experience higher precipitation than the valleys, total precipitation and intensity of precipitation are low relative to western portions of the Tualatin basin, such as those drained by Gales and Scoggins creeks.

1.1.1.6 Hydrology

Most streams within the Dairy-McKay watershed are perennial. However, flow is seasonal, with high peaks in winter and very low flows in summer. The period from November to March accounts for 79% of flow in East Fork Dairy Creek, and 87% in McKay Creek (Figures 1-2 and 1-3)⁶. Unlike Gales Creek, the Dairy-McKay watershed does not contribute extensively to flood peaks on the mainstem Tualatin (ODEQ and USA 1982). Several factors mitigate against high runoff. This watershed lacks high mountains and intense rainfall, and rain on snow events are rare. Additionally, forested portions would tend to reduce surface runoff through interception and infiltration. Flood peaks are further attenuated by floodplain storage during their long journey through low-gradient reaches in the Tualatin Plain. Due to their low gradient, the alluvial areas at the lower portions of the watershed do not contribute appreciably to surface runoff, except near stream channels.

Few long-term hydrologic records exist for the watershed. A recording gage is seasonally maintained on Dairy Creek at Highway 8. During the 1940s and 1950s, staff gages were maintained on

East Fork Dairy Creek near Mountindale, and on McKay Creek near North Plains. From these gages, a mean annual discharge of 107 cfs was calculated for the East Fork Dairy site, and 70 cfs for the McKay site. However, differing periods of record limits comparison between these two gages.

Flooding frequently occurs in the alluvial portions of the Dairy-McKay watershed. During rainfall events, low gradient and poor infiltration combine to create large bodies of standing water in many portions of the alluvial plain. Some of these areas provided substantial wetlands in historical times.

Both unconfined and confined aquifers provide groundwater to the Dairy-McKay watershed. For the most part, the area lacks large aquifers, although some groundwater units are locally important for municipal and irrigation purposes. The most significant aquifers occur in the Columbia River basalt. Interspersed sand layers in the Hillsboro area provide important unconfined aquifers (Orr et al. 1992, Hart and Newcomb 1965). Additionally, locally perched water tables occur on clay lenses in the watershed.

1.1.1.7 Stream Channel

Stream channels vary with topography within the watershed. The upper stream reaches have relatively high gradients. Typical gradients within these reaches average 3-10%. These high gradient streams have a substantial capacity to carry sediments, and erosion and sediment transport are dominant fluvial processes. Under high flow conditions, only the larger sediment fractions are deposited. These reaches tend to have a cobble substrate, and previous surveys have found pools and riffles to be well distributed within the upper portions of the watershed. When the streams reach the alluvial plain, gradient decreases. The streams become less competent to carry sediments, and finer sediments are deposited. In the Tualatin Plain, the dominant substrate gradually converts to fine sand, silt, and clay. Generally, the boundary between cobble and fine substrates follows an East-West line north of Highway 26.

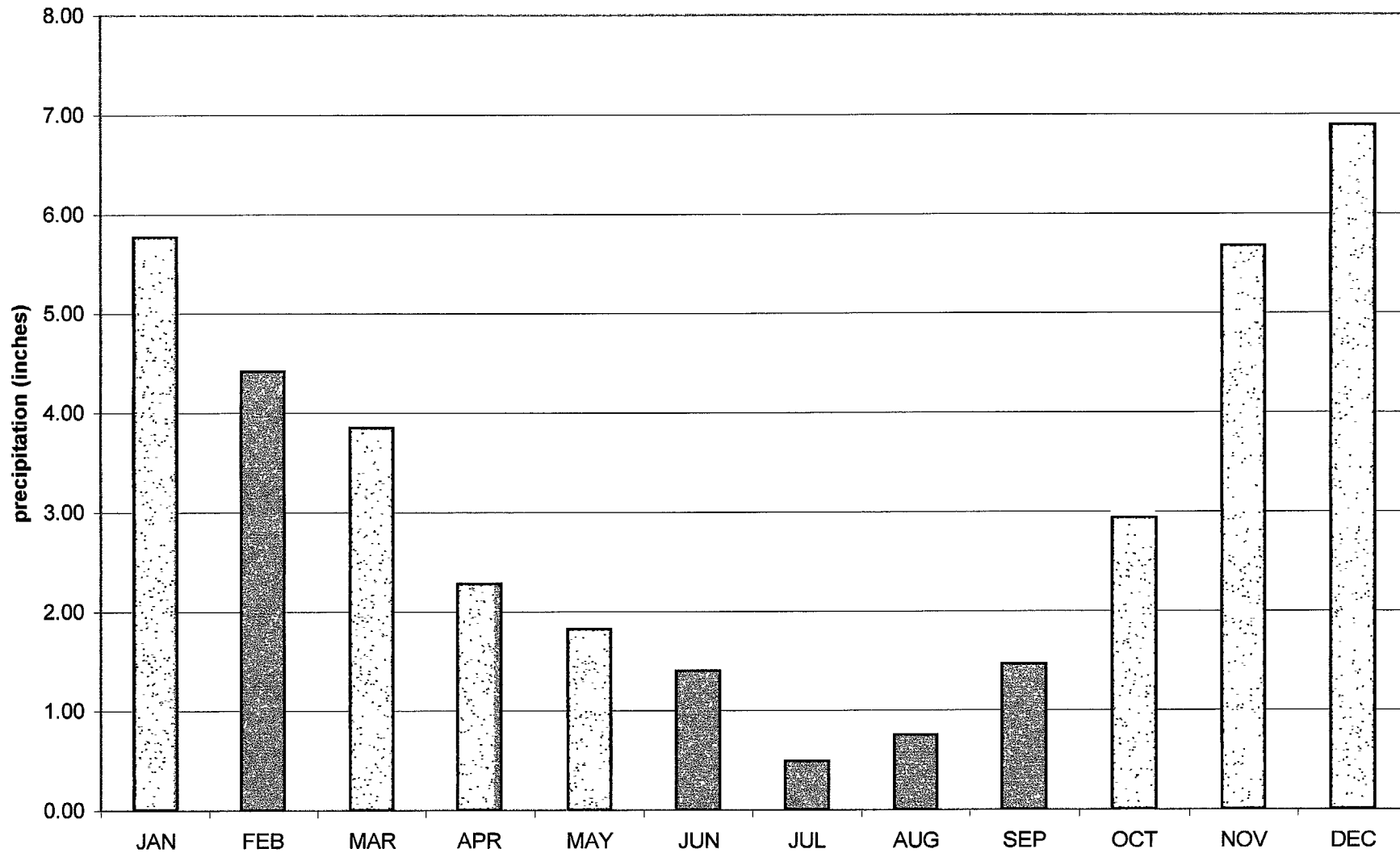
1.1.1.8 Water Quality

Recently, increased attention has been focused on water quality in the Tualatin River watershed. Legislation, both on the state and federal level has mandated improvements in water quality. For example, the Federal Clean Water Act requires implementation of Total Maximum Daily Load (TMDL)

⁵ Based on precipitation records at Hillsboro and Forest Grove

⁶ Based on ODWR estimates from a very short period of record. Records for McKay Creek were taken 1940-1943, and 1948-1956. Records for E.F. Dairy from 1941-1951.

Figure 1-1. Hillsboro: Rainfall distribution by month



standards for parameters limiting water quality. In 1987, TMDL standards were implemented in the Tualatin Basin for ammonia nitrogen and phosphorus. More recently, Senate Bill 1010 prohibited certain conditions leading to diminished water quality (Appendix 3). Implementation of environmental legislation, has required monitoring of water quality. Monitoring by the Oregon Department of Environmental Quality (ODEQ), Unified Sewerage Agency (USA), and several other public agencies and private organizations has been conducted at many locations within the watershed.

In response to the requirements of the Federal Clean Water Act, the state of Oregon produced the 303(d) list, which identifies streams with water quality limitations potentially impacting beneficial uses. Several streams in the Dairy-McKay watershed are on this list. These include

- Council Creek, where dissolved oxygen is considered limiting to cool water aquatic life from May to October;
- Dairy Creek below the confluence of the east and west forks. This reach of Dairy Creek has excessive *E. coli* counts year-round, and has summer temperatures which are limiting to cool-water aquatic life;
- East Fork Dairy Creek, from the mouth to Whisky Creek, where summer pH is frequently lower than the desired range of 6.5-8.5. In 1998, summer water temperature was also found to be limiting to cool-water aquatic life on this stream;
- West Fork Dairy Creek, which has high *E. coli* counts in summer. In 1998, summer water temperature was also found to be limiting to cool-water aquatic life on this stream;
- McKay Creek, from the Mouth to East Fork, summer water temperatures are a concern. Additionally, high *E. coli* levels prevail throughout the year.

Many of these streams also were considered for listing due to pesticide levels and sedimentation. Due to insufficient data, these factors did not cause any streams to be added to the 1998 list. As additional information becomes available, sediment and pesticide levels may become the source of future listings.

There is evidence that water quality in streams above these 303(d) listed reaches is generally good, although water temperatures may exceed the 17.8C

cool-water standard for salmonids periodically during the summer. In 1975 and 1976, B. Sutherland, ODEQ, performed a macroinvertebrate study on upper McKay Creek and the East Fork of Dairy Creek and found high species diversity, including species sensitive to water quality conditions (Sutherland 1976). Although these surveys are 20 years old, it is likely that the current water quality supports similar populations, as the Water Quality Index (WQI)⁷ for these streams has improved over that period.

1.1.1.9 Soils

The soils of the Dairy-McKay watershed are largely influenced by their parent material. In the Tualatin mountains, the sedimentary formations typically produce Alfisols and Inceptisols. These soils are typically fine grained with a large silt component. Texturally, they are typically moderately to very deep loams.

The Columbia River basalt typically produces Andisols and Ultisols. Texturally, these soils occur in a wide variety of loams. In Oregon's moist climate, the Columbia River basalt readily decomposes into a deep, red, lateritic, erodible, unstable soil (Hart and Newcomb 1965). This soil is readily erodible, resulting in a dissected terrain (Orr et al. 1992). Such dissection is particularly notable in the McKay Creek drainage.

Soils in the Tualatin Plain are typically made of fine alluvium in the silt and clay classes. Coupled with low slopes, this often leads to areas of poor drainage. Historically, large wetlands occupied many of these areas.

Some soils in the valley are rich in phosphorus. In some cases, high phosphorus levels may indicate accumulation over many years from agricultural use. However, groundwater phosphorus levels in the Tualatin Valley are naturally quite high, potentially resulting in high soil phosphorus levels (TAC 1997). Similarly, soil phosphorus levels in forested regions tend to reflect natural groundwater content (Wolf 1992). Forest soils developed on sedimentary lithology, in particular, have naturally high phosphorus content (Miller and McMillen 1994).

⁷The WQI was developed by ODEQ as a composite index of water quality. The component parameters of the WQI are temperature, dissolved oxygen, five-day biochemical oxygen demand, pH, total solids, ammonia +nitrate nitrogen, total phosphorus, and fecal coliform. A description of the procedure for determining WQI is found in Aroner 1998.

Figure 1-2. Mean Discharge, East Fork Dairy Creek at Mountaindale, October 1940-September 1951

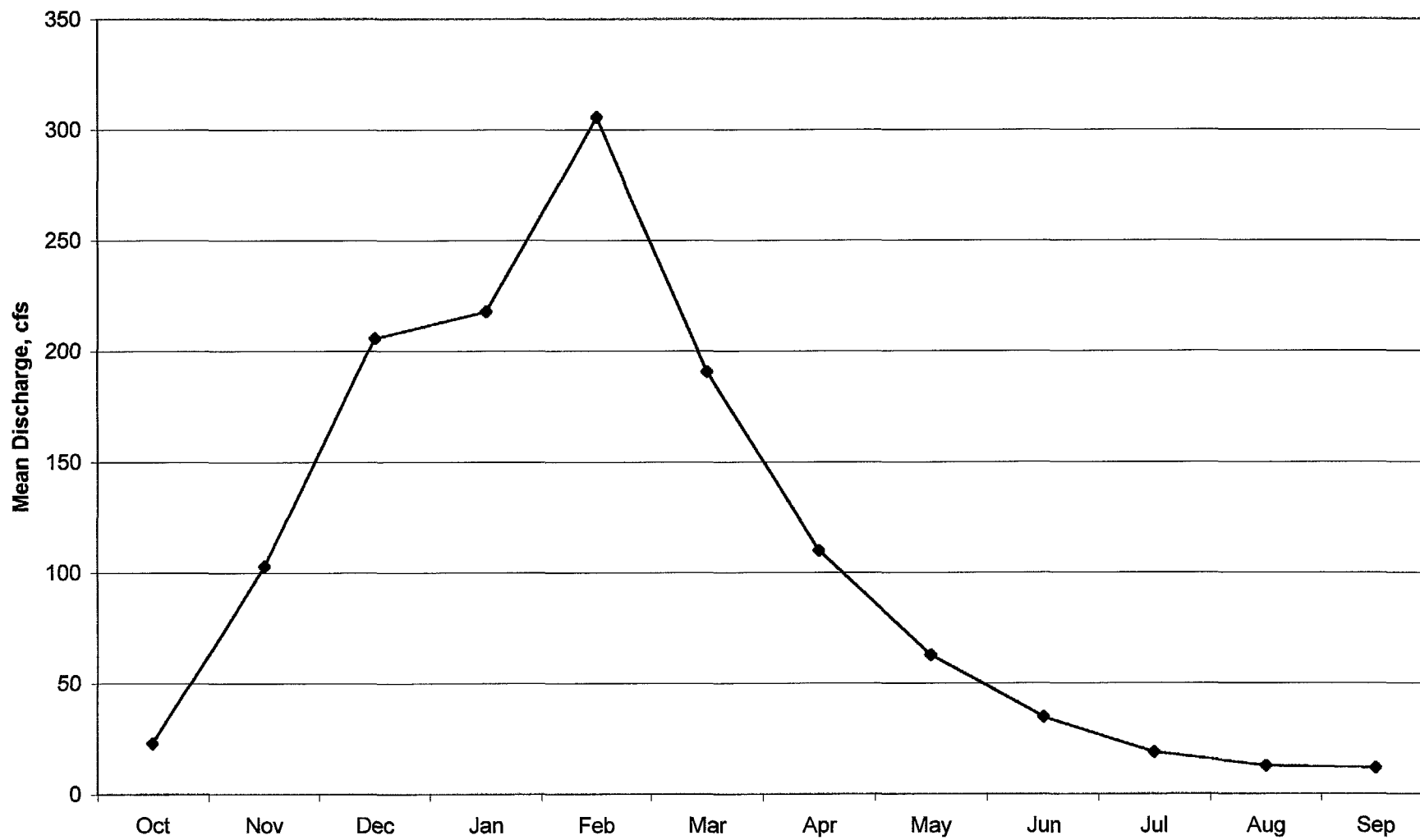
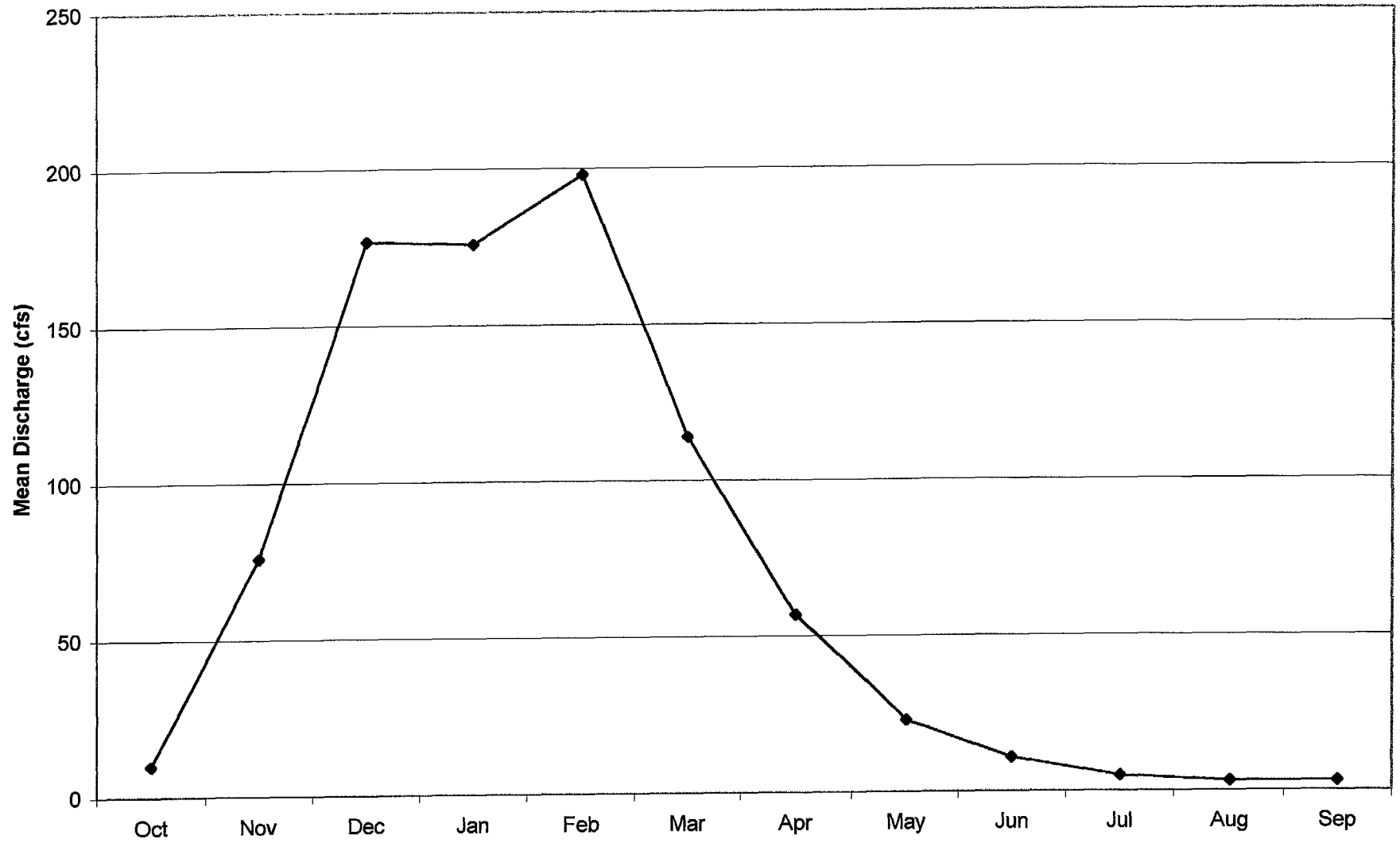


Figure 1-3. Mean Discharge, McKay Creek near North Plains, October 1940-September 1956.



1.2 Biological

1.2.1 Vegetation characteristics

Vegetation in the mountains is dominated by conifers, typically Douglas-fir (*Pseudotsuga menziesii*). Associated conifers include western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*). Hardwoods stands dominated by red alder (*Alnus rubra*) are common in riparian areas. Red alder is also common on disturbed sites. Bigleaf maple (*Acer macrophyllum*) is typically abundant on canyon walls, and often occurs as a minor stand component in upland Douglas-fir forests and drier portions of riparian forests. Similar species occur in the foothills, with Oregon white oak (*Quercus garryana*) becoming present in drier locations. The Tualatin plain itself is primarily used for agriculture. The vegetation consists mainly of wheat, orchards, and row crops.

Occasional patches of Douglas-fir and Oregon white oak, along with grasslands, are interspersed with the agricultural areas. Riparian zones in the lower reaches of the Dairy-McKay system are often dominated by Oregon ash (*Fraxinus latifolia*). Where riparian tree species do not provide an overstory, the streambanks are often dominated by shrubs such as the native red-osier dogwood (*Cornus stolonifera*) and the introduced invasive Himalayan blackberry (*Rubus procerus*).

Weed species present problems in many parts of the watershed, particularly in disturbed areas. The species of greatest abundance is Himalayan blackberry, which is nearly universal in ruderal habitats and along disturbed portions of streambank. Reed canarygrass (*Phalaris arundinacea*) is also abundant in moist, disturbed areas in the watershed. Other species of concern include Scotch broom (*Cytisus scoparius*) and various thistle species.

Several vegetational species bear special concern under BLM guidelines. Some of these species have a limited range, while others are diminished from their original numbers. Sensitive botanical species likely to inhabit the Dairy-McKay watershed are listed in Table 1-3. Additional discussion of sensitive species is found in section 1.2.2.1.1.

1.2.2 Species and Habitat

1.2.2.1 Species

1.2.2.1.1 Economically important and ecologically sensitive species

Dairy and McKay creeks are home to diverse animal species. Some of these species attract extra attention due to biological, recreational, or economic factors. These include game species, such as deer and elk, which are important for recreational hunting.

The Northwest Forest Plan (NFP) directed federal agencies to devote special management attention to certain plant and animal species on federal lands⁸. These included species listed as Endangered or Threatened under the Endangered Species Act (ESA), as well as those species considered to be sensitive under state or BLM guidelines.

A large number of the Special Attention Species fall within the Survey and Manage directive of the NFP. Of the over 1000 species whose viability was assessed through the federal Scientific Analysis Team and Forest Ecosystem Management Assessment Team (FEMAT) efforts, it was determined that slightly more than 400 of those species would benefit from extra management provisions. Thus, the Survey and Manage standards and guidelines were developed and adopted as part of the Forest Plan to reduce the possibility of loss of population viability of those species of concern through the implementation of federal actions.

There are four components to the Survey and Manage standards and guidelines and each species is assigned to one or more of the component categories. The component categories are:

1. *Manage known sites.* This component, which went into effect in 1995, requires federal agencies to acquire and use information on known sites of Component 1 species when planning and implementing projects. The most appropriate action in most cases is the protection of relatively small sites but in the case of a few species the protection of fairly extensive areas may be warranted.

⁸ A list of these Special Attention Species is given in the *Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl* (SEIS) of the NFP.

2. Survey prior to ground disturbing activities.

There are 77 Component 2 species that require surveys prior to implementing activities that may disturb the habitat of those species. Survey protocols for these species were to have been developed and surveys completed for projects to be implemented in Fiscal Year 1999 or later. Due to the difficulty of developing field survey protocols for some species, not all protocols are in place as of the beginning of Fiscal Year 1999. There are 32 of the 77 species that cannot be readily identified and/or do not fruit often enough to be adequately surveyed for in a single year. The federal agencies are currently undertaking an effort to reclassify these species into either Component 3 or Component 4 categories, where other survey schedules or techniques may prove more effective for those species.

3. *Extensive surveys.* Broad surveys would be conducted to find high-priority sites for species management. This component is primarily for species whose life histories are such that they may only be found or can be identified when specific climatic conditions exist. Protocols would be developed for these species and surveys for some species would be underway by 1996.

4. *General regional surveys.* The objective of this component is to survey to acquire additional knowledge of poorly understood species and to determine necessary levels of protection. The species intended to benefit from this standard and guideline are the arthropods, bryophytes, lichens, and those fungi species that were not classed as rare and endemic.

1.2.2.1.2 Aquatic species

Several native salmonid species inhabit the watershed, including steelhead trout (*Oncorhynchus mykiss*) and cutthroat trout (*O. clarki*). Although coho salmon (*O. kisutch*) is not native, they have been introduced and now spawn naturally within the watershed and are considered an important species.

Much of Dairy and McKay creeks contain salmonid habitat. Fisheries surveys conducted by the Oregon Department of Fish and Wildlife (ODFW) found salmonids in most surveyed streams in the watershed. Resident cutthroat trout, in particular, are distributed throughout much of the watershed. The amount of habitat available to anadromous salmonids is more limited.

Abundance of salmonid species is a matter of concern. Steelhead trout within the Upper Willamette Evolutionarily Significant Unit (ESU), which includes the Tualatin Basin, are proposed for listing as threatened under the federal Endangered Species Act (ESA). Additionally, coastal cutthroat trout are a candidate species for listing under the ESA. These species are also on ODFW sensitive species lists.

Many native non-salmonid species are present in the watershed, including sculpin, lamprey, and dace. The torrent sculpin (*Cottus rhotheus*), a species particularly intolerant to poor water conditions, was found in 1994 in the East Fork of Dairy Creek near Little Bend, indicating generally good water quality (Ward 1995).

1.2.2.2 Habitat

1.2.2.2.1 Wildlife Habitat (terrestrial)

Wildlife habitat has changed along with changes in the vegetation of the basin. Most vegetation in the Dairy-McKay watershed is predominantly in early and mid-successional seral stages, and structurally quite fragmented. Late seral habitat exists in very small patches. The patchiness of the current landscape is favorable to production of game species, such as deer, and other "edge" species.

On the other hand, these changes have created less favorable conditions for species dependent upon late-successional vegetation. Many of these species require habitat elements most commonly found in old-growth forest, such as snags and down wood. Bats, for example, use snags and down wood for roosting sites. Changes in forest structure have reduced the availability of these habitat elements. The effect of these changes varies by species. The watershed is no longer suitable for production of species with large home ranges, such as spotted owls. Other species, such as the marbled murrelet, have also experienced greatly diminished habitat, but remaining small patches of forest bearing late-successional elements can provide suitable habitat for these species.

Riparian habitat has become degraded in many parts of the watershed. The ability to provide large woody debris has been reduced, resulting in a reduction of the number and size of pools. Many of the large trees that formerly surrounded streams have been cleared, resulting in reduced canopy and increased summer water temperatures. The weedy shrub species, such as Himalayan blackberry, that have replaced these trees in many sites are unable to provide adequate stream shading.

Table 1-3. Threatened/endangered/sensitive plant species potentially found in the Dairy-McKay watershed.

Listed under ESA

<i>Sidalcea nelsoniana</i>	Nelson's checkermallow
<i>Howellia aquatilis</i>	Howellia
<i>Lomatium bradshawii</i>	Bradshaw's lomatium

Bureau Sensitive (BLM Manual 6840)

<i>Agrostis howellii</i>	Howell's bentgrass
<i>Castilleja levisecta</i>	Golden paintbrush
<i>Cimicifuga elata</i>	Tall bugbane
<i>Delphinium leucophaeum</i>	White rock larkspur
<i>Delphinium pavonaceum</i>	Peacock larkspur
<i>Filipendula occidentalis</i>	Queen-of-the-forest
<i>Lupinus sulphureus ssp. Kincaidii</i>	Kincaid's lupine

Assessment Species (BLM Manual 6840)

<i>Carex livida</i>	Pale sedge
<i>Carex retrorsa</i>	Retorse sedge
<i>Dryopteris filix-mas</i>	Male fern
<i>Fritillaria camschatcensis</i>	Indian rice
<i>Isopyrum stipitatum</i>	Dwarf isopyrum
<i>Lycopodium complanatum</i>	Ground cedar
<i>Polystichum californicum</i>	California sword fern
<i>Wolfia borealis</i>	Dotted water meal

Tracking Species (BLM Manual 6840)

<i>Bergia texana</i>	Texas bergia
<i>Elodea nuttallii</i>	Nuttall's waterweed
<i>Eriophorum polystachion</i>	Many-spiked cottongrass
<i>Euonymus occidentalis</i>	Western wahoo
<i>Hieracium canadense</i>	Canadian hawkweed
<i>Juncus kelloggii</i>	Kellogg's dwarf rush
<i>Lathyrus holochlorus</i>	Thin-leaved peavine
<i>Lycopodium annotinum</i>	Stiff club moss
<i>Montia diffusa</i>	Branching montia
<i>Poa laxiflora</i>	Loose-flowered bluegrass
<i>Poa marcida</i>	Weak bluegrass
<i>Sidalcea campestris</i>	Meadow sidalcea
<i>Trillium parviflorum</i>	Small-flowered trillium

Note: Additionally, there are many "Survey and Manage" plant species that could be found on these watersheds. These species are listed in Appendix J2 of the Northwest Forest Plan and the Salem District Resource Management Plan.

1.2.2.2 Aquatic Habitat

The suitability of aquatic habitat for sensitive cold water species is quite variable. Fine substrate, high temperatures, and low dissolved oxygen limit the ability of the lower mainstem of Dairy Creek to provide suitable summer rearing habitat for salmonids. Tributary reaches in the Tualatin Plain bear similar concerns.

In the foothills and mountains, salmonid habitat improves. In ODFW surveys conducted in the 1980's, McKay Creek and both forks of Dairy Creek were found to have suitable spawning gravels for salmonids (SRI 1989). Habitat surveys conducted by BLM in 1994-95 found fair to poor salmonid habitat in the upper reaches of Dairy Creek. No habitat surveys have been conducted subsequent to the flood events of 1996.

1.2.2.3 Special Habitats

Certain habitat types in the watershed have special significance through their rarity in the watershed and their importance to sensitive species. One such habitat type is forest with late-successional characteristics⁹. This habitat type can be found in patches, mainly distributed in headwater reaches of the watershed. On federal lands, the Big Canyon Late Successional Reserve (LSR) has the greatest contiguous stand of this habitat type.

Another important habitat type is wetland habitat. In the Tualatin Mountains, wetland types are generally represented by small ponds built by beavers. Larger wetlands are located in the Tualatin Plain. Most of these wetlands are located near the West Fork of Dairy Creek. Portions of Jackson Bottom, south of Hillsboro, also fall within the watershed boundaries. Although none of these wetlands fall into preserves, they provide important habitat for a number of aquatic, amphibian, and avian species.

1.3 Social

1.3.1 Population

Population within the Dairy-McKay Creek watershed is concentrated in the urbanized southern portion of

the watershed (Map 1-5). Incorporated cities wholly or partially within the Dairy Creek drainage (with estimated 1997 population) include Hillsboro (58,365), Forest Grove (15,965), North Plains (1,655), Cornelius (7,845) and Banks (625). The growth of the Portland metropolitan area and increasing employment in high technology contributed to rapid population growth within the watershed. To accommodate the increased population, an urban growth boundary (UGB) has been designated. If the present urban growth boundary remains constant, most future development will take place along the Highway 8 corridor in Hillsboro, Cornelius, and Forest Grove, and is most likely to affect Council Creek and the lower portions of Dairy and McKay creeks.

The present urban growth boundary encompasses 10.79 square miles within the watershed, an increase of 34% over 1997 city limits¹⁰. As these cities grow, most new development will take place on lands that were traditionally agricultural.

1.3.2 Ownership

Land in the Dairy-McKay watershed is primarily privately owned (Map 1-6). About 95% of the watershed is in private ownership: 27,400 acres (18.7%) is private industrial timberland, and 112,700 acres (76.2%) in other private lands¹¹.

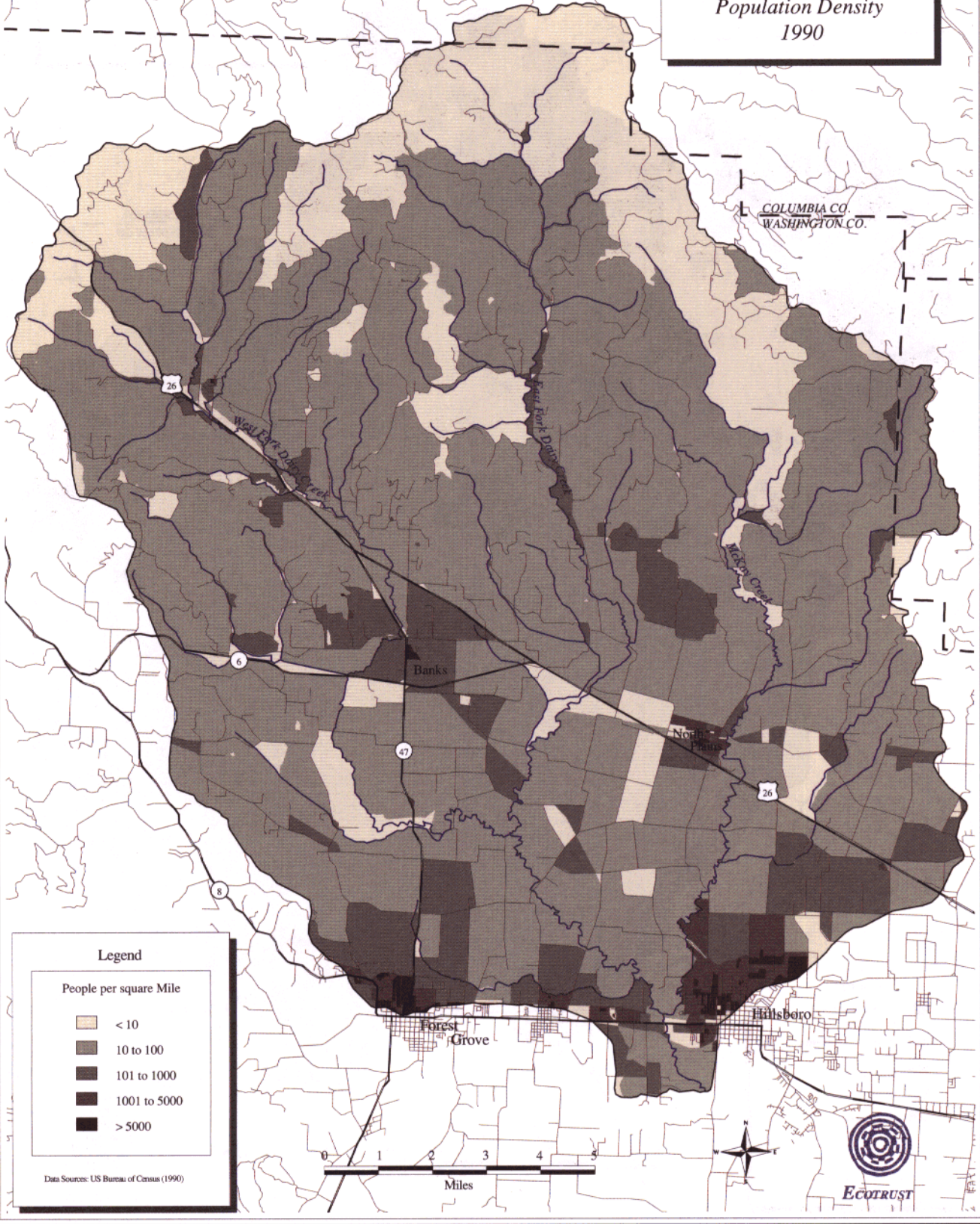
Public land managed by the Bureau of Land Management (BLM) makes up most of the remaining land within the Dairy-McKay watershed. BLM holdings comprise 6,521 acres of forested land, roughly 4.4% of the watershed. Most of these lands are Oregon and California Railroad (O&C) lands. Due to this legacy, these lands are distributed in a patchy fashion, rather than a single block. federal statutes direct the BLM to manage O&C lands for sustained yield forestry in a manner consistent with federal environmental objectives. Other public lands are managed by the State of Oregon, Washington County, and various municipalities.

⁹“Four major structural attributes of old-growth Douglas-fir forests are: live old-growth trees, standing dead trees (snags), fallen trees or logs on the forest floor, and logs in streams. Additional important elements typically include multiple canopy layers, smaller understory trees, canopy gaps, and patchy understory.” (NFP page B-2)

¹⁰ Derived from GIS analysis of Metro's 1997 UGB and City boundary coverages. If the UGB were to be completely developed, it would also represent a 70% increase over 1996 watershed development levels. However, these numbers are not directly comparable, as the 1996 data contain developed areas outside the UGB.

¹¹ Derived from GIS analysis of the 1995 OSU layer showing timberland ownership.

Map 1-5.
Population Density
1990



Legend

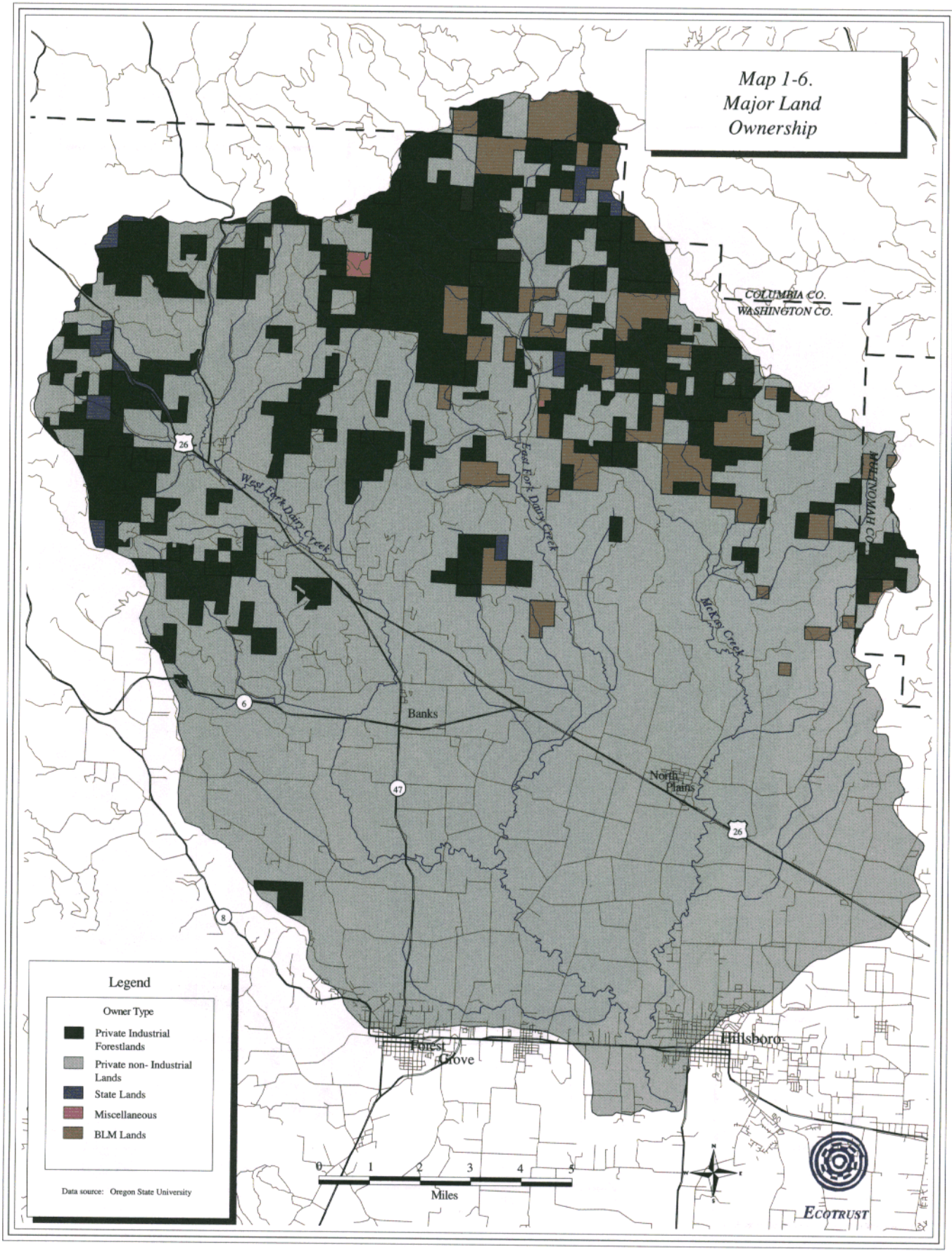
People per square Mile

Lightest Gray	< 10
Light Gray	10 to 100
Medium Gray	101 to 1000
Dark Gray	1001 to 5000
Darkest Gray	> 5000

Data Sources: US Bureau of Census (1990)



Map 1-6.
Major Land
Ownership



Legend

Owner Type

- Private Industrial Forestlands
- Private non-Industrial Lands
- State Lands
- Miscellaneous
- BLM Lands

Data source: Oregon State University



1.3.3 Allocations

1.3.3.1 BLM Allocations

1.3.3.1.1 Matrix

Roughly 45% of the BLM land in the Dairy-McKay watershed is allocated within one of two “Matrix” classifications: 1). General Forest Management Allocation (GFMA) or 2). Connectivity/ Diversity. According to the Salem Record of Decision (ROD), the objectives of Matrix lands are to produce timber at sustainable levels, provide habitat for a variety of organisms associated with diverse stands types, maintain stand structural diversity, and provide for organism dispersal. Connectivity blocks have the additional objective of providing connectivity between late successional reserves, and are designed to provide corridor habitat for upland species. Within the watershed, one 520 acre parcel of land (T2N, R3W, S1) is allocated for connectivity (Appendix 4). A minor portion of another connectivity block (T3N, R3W, S13) also falls within watershed boundaries.

1.3.3.1.2 Riparian Reserve

Riparian Reserves constitute 3,166 acres, approximately one-half of all federal lands in the watershed. Riparian Reserves are typically adjacent to streams, ponds, wetlands, and nearby areas of unstable topography. The extent of these reserves varies based on ecological and geomorphic factors. As a rule of thumb, they extend for a width of two site potential tree heights (usually about 400 feet) from each bank of fish-bearing streams. On other streams, the reserves typically extend for 1 site-potential tree (about 200 feet) from each stream bank.

In these reserves, management is centered on preservation of riparian-dependent resources. Other management activities must be conducted in such a manner so as not to conflict with this primary objective. Many species are dependent upon the habitat provided by Riparian Reserves. Additionally, Riparian Reserves assist in maintenance of the aquatic system by providing shade to regulate stream temperature, contributing woody debris to improve structure and diversity of aquatic habitat, and filtering sediments and nutrients supplied by adjacent upland sources.

1.3.3.1.3 Late-Successional Reserve

Late-successional reserves (LSRs) are designed to “protect and enhance the conditions of late-successional and old-growth forest ecosystems” (Salem ROD). These ecosystems provide habitat for many sensitive species, including the spotted owl and the marbled murrelet.

In the Dairy-McKay watershed, one 280-acre block of land has LSR designation. This site, located at Big Canyon (T2N, R3W, S5, South 1/4) has been the focus of past educational and scientific activities.

1.3.3.2 Private Zoning

The Dairy-McKay Creek watershed is in a rapidly urbanizing region of Washington County. In order to restrict urban sprawl and to preserve historical land uses, the Washington County Comprehensive Plan was created. This plan divides the watershed into zones of forestry, agricultural, and urban uses. As now, forestry uses will be centered in the mountainous portions of the watershed, while agriculture will dominate much of the central and lower portions of the watershed. Urban use will expand around the present urban centers in the lower watershed.

Current zoning regulations provide for 48.6% of the watershed in forest use, 31.6% in agricultural use, and 4.5% for urban uses. The vast majority of forest and agricultural lands are zoned for large parcels.

1.3.4 Human Uses

1.3.4.1 Forestry

Forestry is the dominant activity over the northern 50% of the watershed. Of this land, 27,402 acres (38%) is industrial forestland. BLM owns 6,521 acres (9%), and state lands amount to 673 acres (1.6%). Private non-industrial interests own the remaining 53% of forested land in the watershed. Management emphasis varies between these entities, but the vast majority of the land has been harvested within the past 80 years.

In addition to timber harvest, forestry entails related support activities, including fertilization, herbicide application, and road construction. Road density is particularly high in the West Fork of Dairy Creek. However, due to high stream densities, density of road crossings is also very high in the East Fork drainage. In McKay Creek, densities of roads and

road crossings are both relatively low, probably because the rugged terrain does not lend itself to road building activities.

1.3.4.2 Agriculture

Agriculture has traditionally been the predominant land use in the Tualatin Valley and continues to be economically important in the Dairy-McKay watershed. Agriculture also carries with it activities that may affect stream water quality. These include tillage, manure storage, fertilization, application of herbicides and pesticides, and encroachment upon the riparian zone. The USDA Natural Resources Conservation Service (NRCS) and Washington County Soil and Water Conservation District (SWCD) work with agricultural land owners to minimize effects of their operations upon streams.

1.3.4.3 Urban

Most urbanized lands in the watershed occur around Council Creek and lower McKay and Dairy creeks. Rapid development continues to occur in these areas. As these subwatersheds urbanize, pressures on water and land resources increase. This gives rise to

potential conflicts with aquatic life, agriculture, and other beneficial uses for these resources. These urban reaches also potentially contribute to stream-related problems, such as changed hydrologic conditions and contribution of pollutants through the storm drain system.

1.3.4.4 Recreation

Many recreational activities are supported within the watershed. These include activities that are directly supported by the streams, such as fishing. In the past, upper Dairy and McKay Creeks were known for supporting an excellent cutthroat and steelhead fishery. Other recreational activities supported by natural resources within the watershed are hiking, camping, hunting, birding, bicycling, and touring. Developed recreation is also popular and includes golf and model airplaning. Several developed urban parks exist within the watershed. Most recreational activities in rural lands are found in undeveloped areas, including BLM lands and private timberlands. It has been the policy of some timberland owners, including Longview Fibre, to allow public access to their lands for activities that are consistent with company operations.