U.S. Department of the Interior
Bureau of Land Management

Salem District Office
Tillamook Resource Area
4610 Third Street
Tillamook, Oregon 97141

March 1999

Dairy-McKay Watershed Analysis

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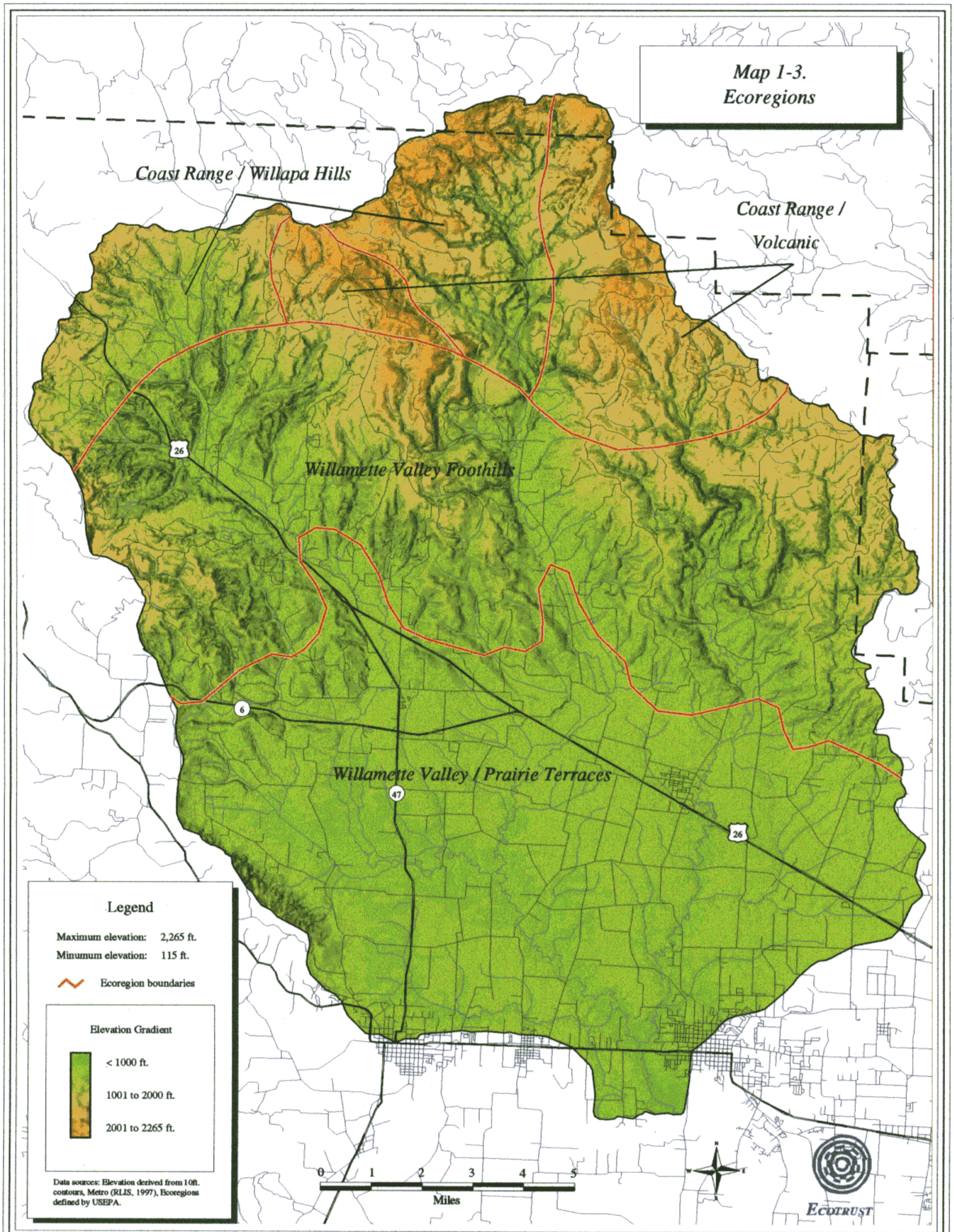

Map 1-3.
Ecoregions
Coast Range / Willapa Hills
Coast Range /
Volcanic
Willamette Valley Foothills
Willamette Valley / Prairie Terraces
26
6
47
Legend
Maximum elevation: 2,265 ft.
Minumum elevation: 115 ft.
Ecoregion boundaries
Elevation Gradient
< 1000 ft.
1001 to 2000 ft.
2001 to 2265 ft.
Data sources: Elevation derived from 10ft. contours, Metro (RLIS, 1997), Ecoregions defined by USEPA.
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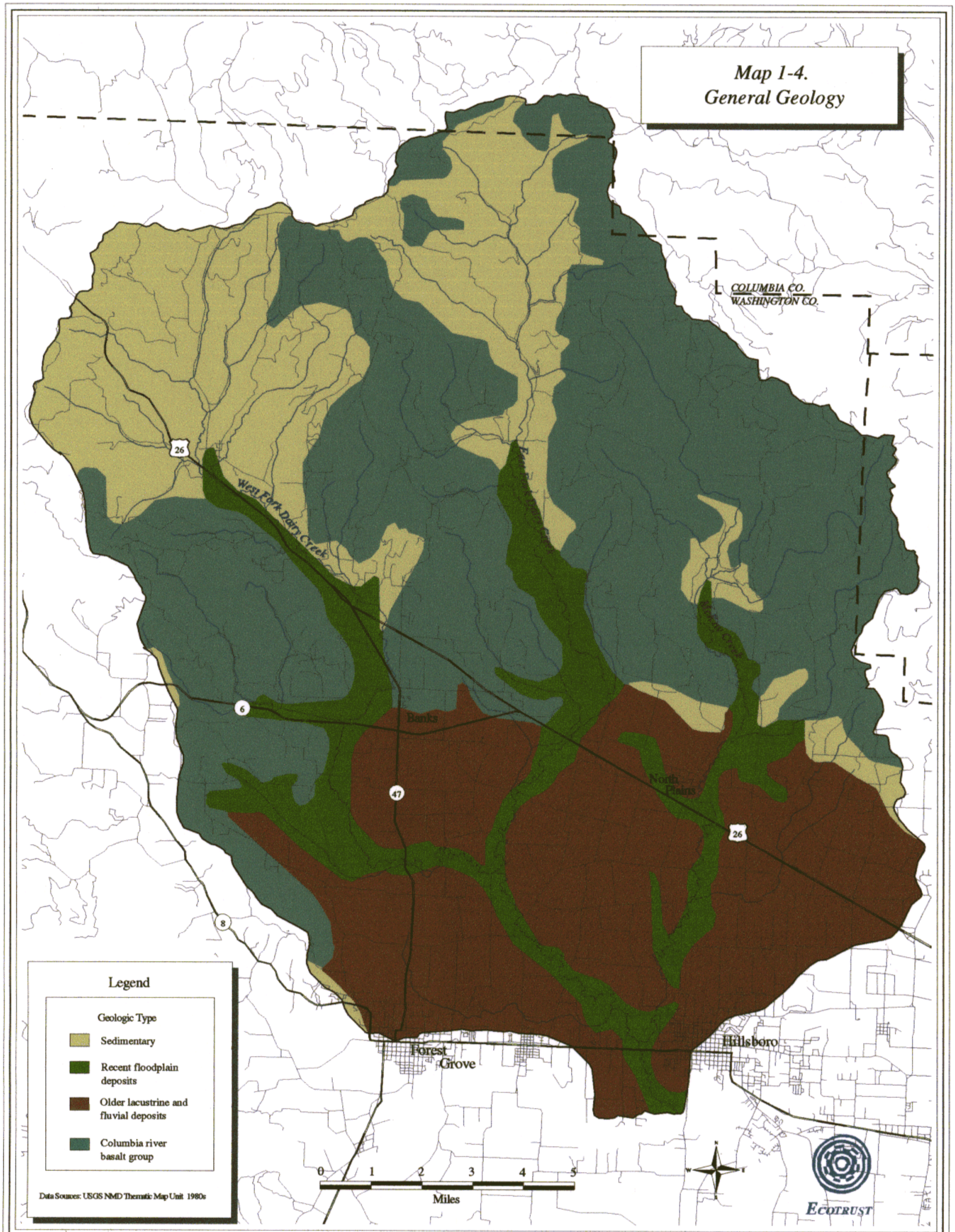

Map 1-4.
General Geology
COLUMBIA CO.
WASHINGTON CO.
West Fork Dairy Creek
26
6
47
8
Banks
North Plains
Forest Grove
Hillsboro
Legend
Geologic Type
Sedimentary
Recent floodplain deposits
Older lacustrine and fluvial deposits
Columbia river basalt group
Data Sources: USGS NMD Thematic Map Unit 1980s
0 1 2 3 4 5
Miles
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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Tillamook Resource Area Office
P. O. Box 404
4610 Third Street
Tillamook, OR 97141

IN REPLY REFER TO:

7300

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.

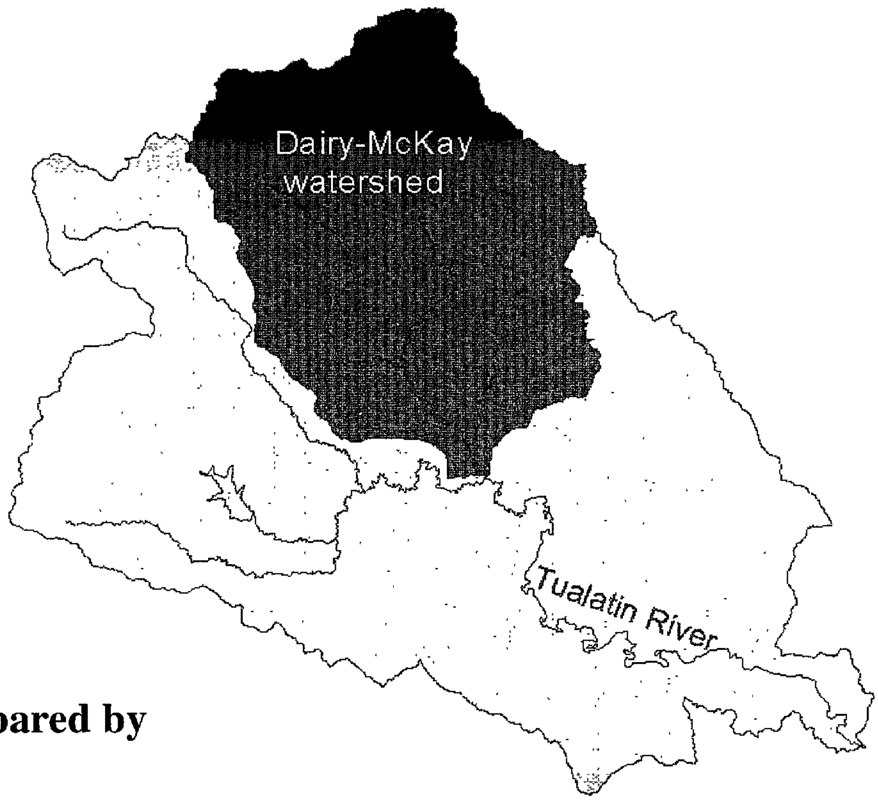
Watershed analysis is a continuing process. This document represents the first iteration of the analysis which will be updated in the future as additional information is obtained. Additional information and comments are encouraged and will be welcomed at any time on this watershed analysis. The information 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 Date: 5-26-99
Dana R. Shuford, Field Manager
Tillamook Resource Area

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

List of Tables

List of Figures

List of Maps

List of Appendices

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

Bob McDonald, BLM, GIS

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).

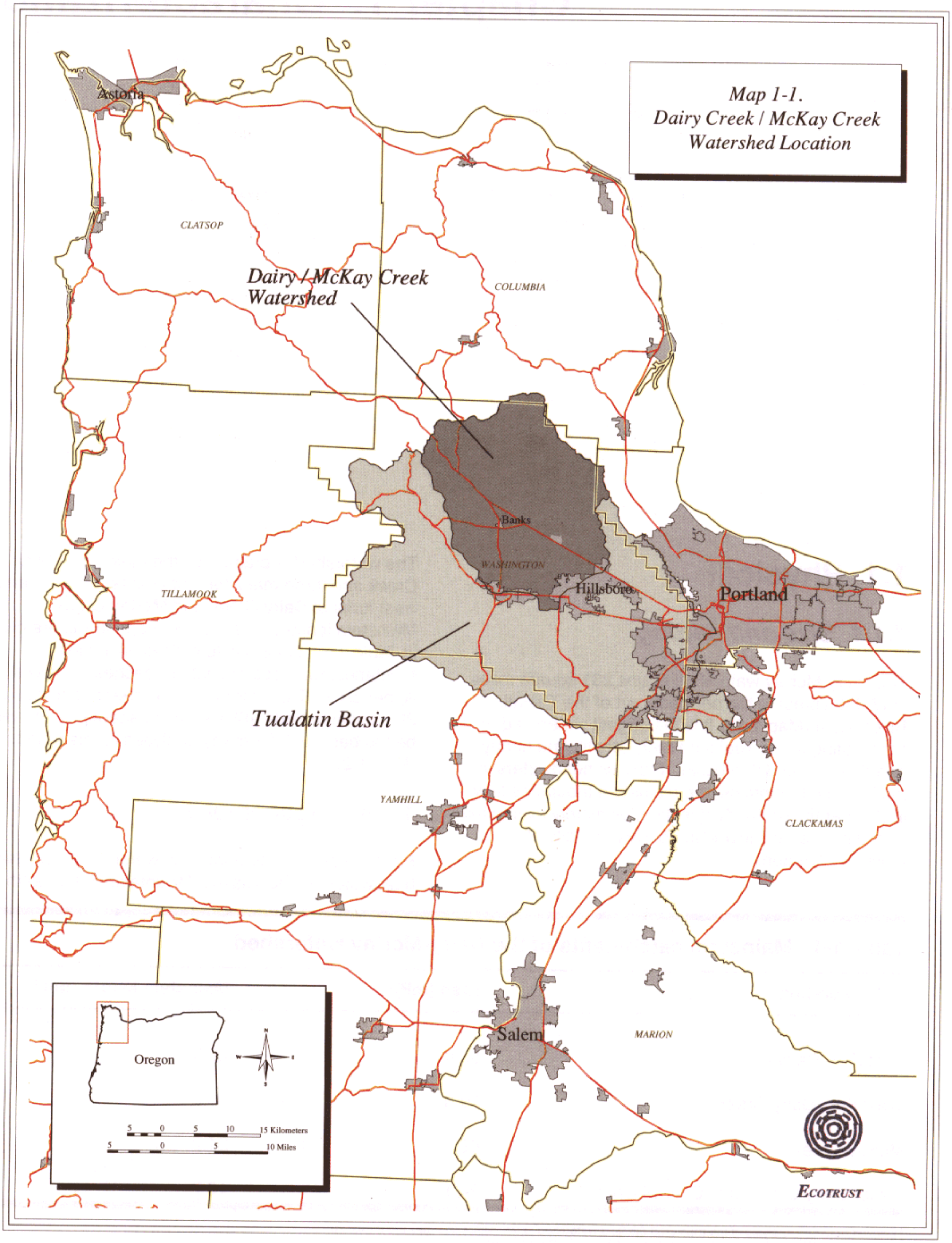
1.1.1.1 Topography

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

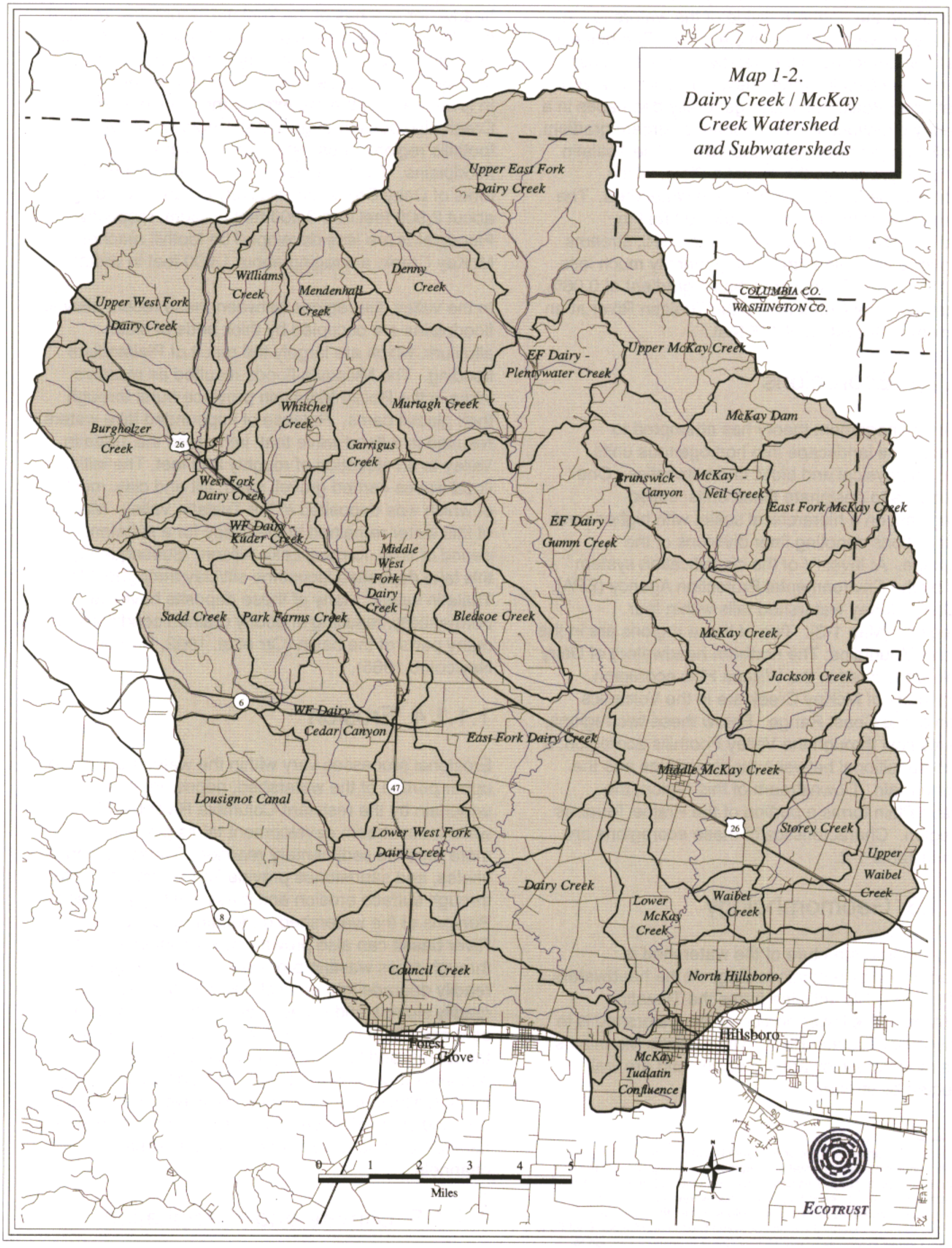
Table 1-1. Mainstem catchments of the Dairy-McKay watershed

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 bluelines 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


Map 1-2.
Dairy Creek / McKay Creek Watershed and Subwatersheds
Upper East Fork Dairy Creek
Upper West Fork Dairy Creek
Williams Creek
Mendenhall Creek
Denny Creek
COLUMBIA CO.
WASHINGTON CO.
Upper McKay Creek
EF Dairy - Plentywater Creek
Murtagh Creek
Whitcher Creek
Burgholzer Creek
Garrigus Creek
McKay Dam
Brunswick Canyon
McKay - Neil Creek
East Fork McKay Creek
West Fork Dairy Creek
WF Dairy - Kuder Creek
EF Dairy - Gumm Creek
Middle West Fork Dairy Creek
Sadd Creek
Park Farms Creek
Bledsoe Creek
McKay Creek
Jackson Creek
WF Dairy - Cedar Canyon
East Fork Dairy Creek
Middle McKay Creek
Lousignot Canal
Lower West Fork Dairy Creek
Storey Creek
Upper Waibel Creek
Dairy Creek
Lower McKay Creek
Waibel Creek
Council Creek
North Hillsboro
Forest Grove
Hillsboro
McKay Tualatin Confluence
26
6
47
8
0 1 2 3 4 5
Miles
ECOTRUST

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.

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 width[4].

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

[4] 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 Mountaindale; McKay Creek Brunswick Canyon to Jackson Creek. Width was calculated as polygon (area/length).

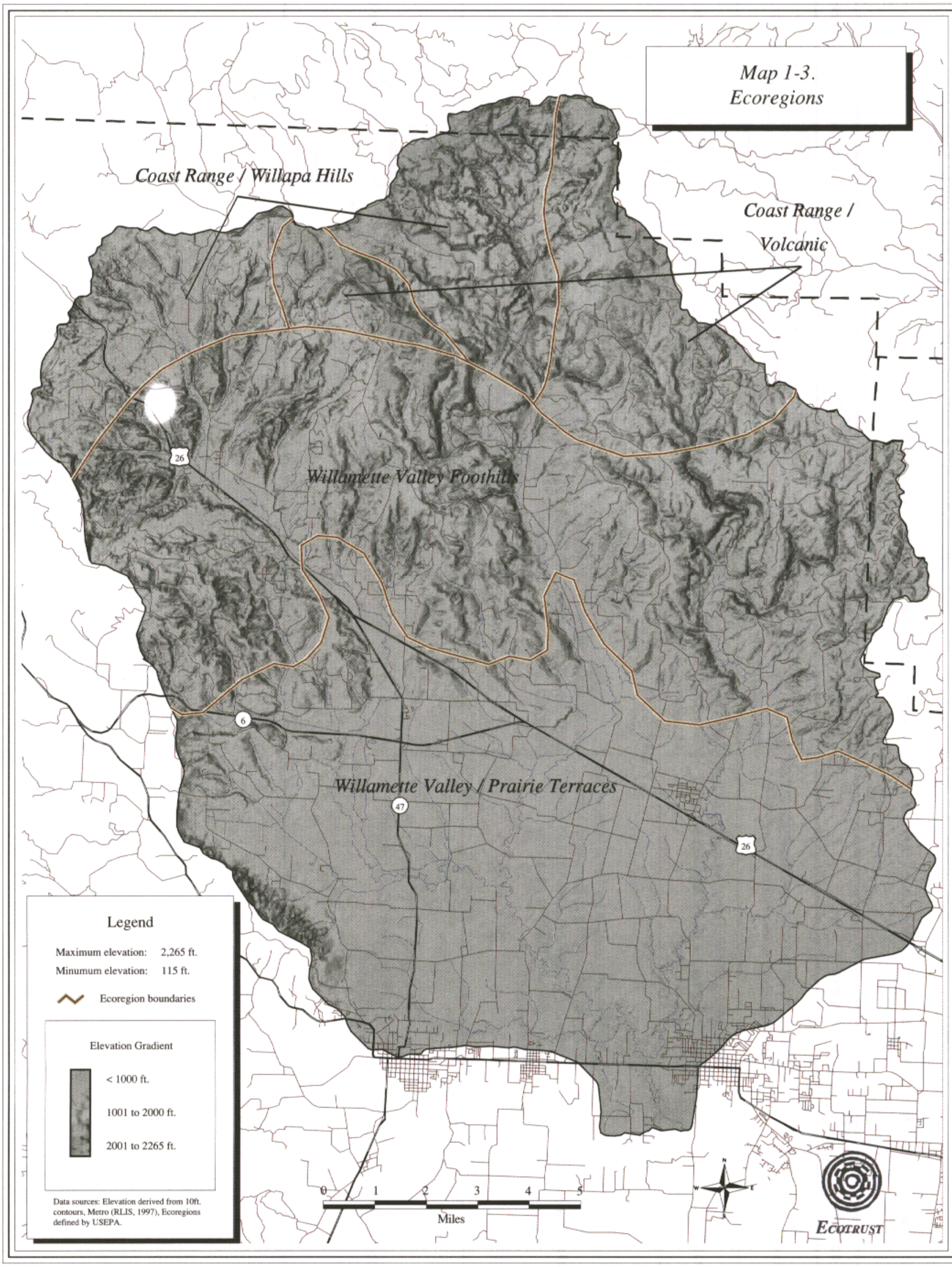

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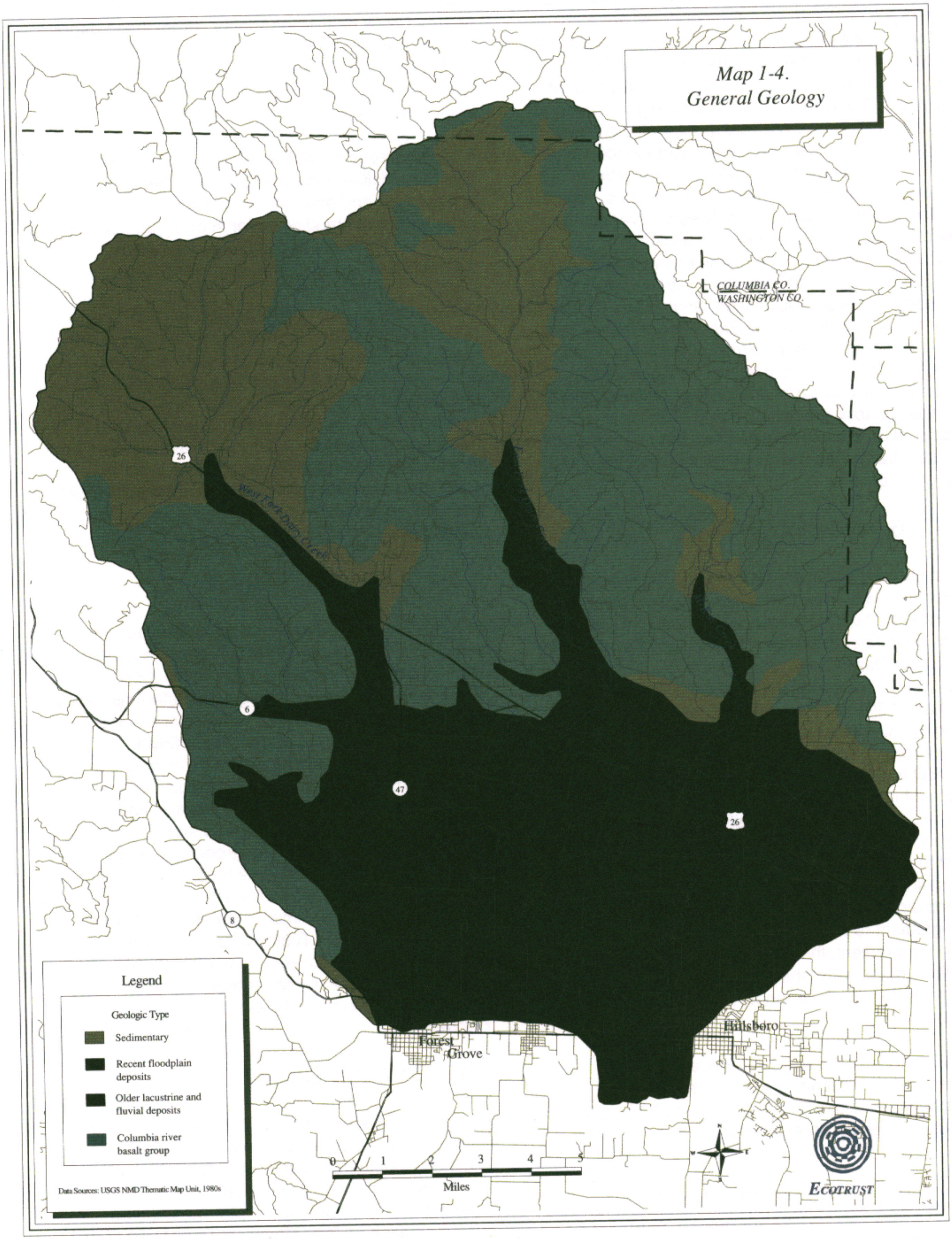
Table 1-2. Characteristics of EPA Level IV ecoregions in the Dairy Creek watershed. (Adapted from Pater et al. 1998, NRCS 1982)

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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Data Sources: USGS NMD Thematic Map Unit, 1980s
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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

Figure 1-1. Precipitation at Hillsboro 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 Mountaindale, 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

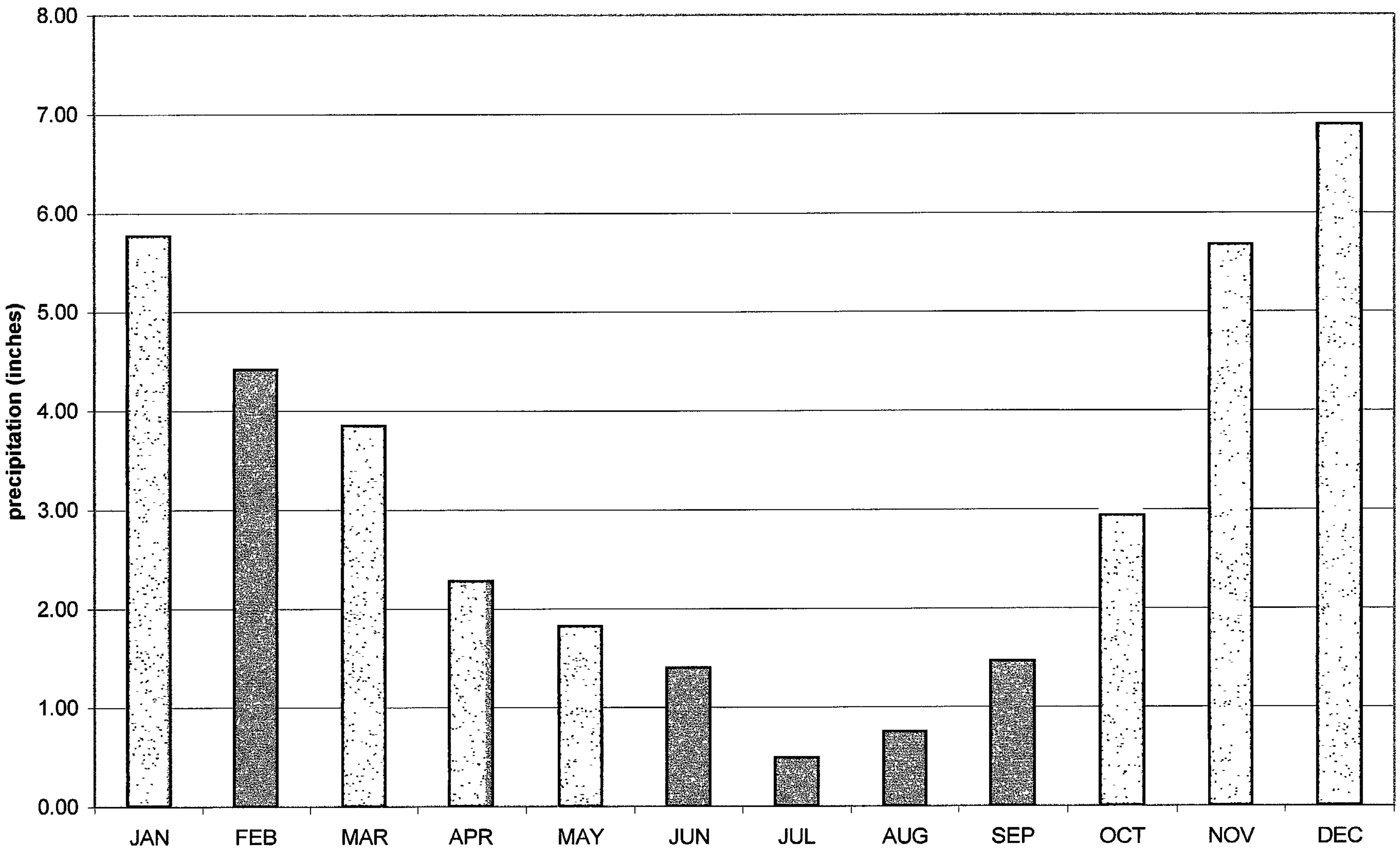
Stream channels vary with topography within the watershed. The upper stream reaches have relatively high gradients. Typical gradients within these reaches average 3-10%. These high gradient streams have a substantial capacity to carry sediments, and erosion and sediment transport are dominant fluvial 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 through-out 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).

[7] The 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.