Chehalem Watershed Assessment

The Yamhill Basin Council • (503) 472-6403
Yamhill and Polk Counties, Oregon
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Watershed Assessment Project Manager
Jeffrey Empfield

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Ryan Dalton, Bureau of Land Management
Ted Gahr, resident
Jacqueline Groth, resident
Todd Anderson, Assistant Superintendent, Dundee Public Works
Denise Hoffert-Hay, Yamhill Basin Council
Alan Lee, Newberg Waste Water Treatment Plant
Doug Rasmussen, resident
Dean O'Reilly, Yamhill County SWCD
Peter Snow, resident fisherman
Bobbi Riggers, Oregon Plan Watershed Restoration Inventory
Kareen Sturgeon, resident
Robin Richard, resident
James Stonebridge, resident
Rob Tracey, Natural Resources Conservation Service
Gary Galovich, Oregon Department of Fish and Wildlife
Tom Currans, resident
Susan Mundy, Yamhill County Public Works
Janet Shearer, Oregon Department of Fish and Wildlife
Melissa Leoni, Yamhill Basin Council
Don Young, McMinnville Water Reclamation Facility
Francis Dummer, resident
Luella Ackerson, OSU Yamhill County Extension Office
Bill Ferber, Oregon Water Resources Department
Sam Sweeney, resident
Barb Mingay, Newberg Planning Division
Gail Meredith, resident
Ron Huber, Yamhill County Parks
Gordon Jernstedt, resident
June Olson, Confederated Tribes of Grand Ronde
Dave Hanson, resident
Stan Miller, SP Newsprint
Dawn Marshall, Oregon Dept. of Geology and Mineral Industries
Linda May, resident
Mark Charles, Department of Environmental Quality

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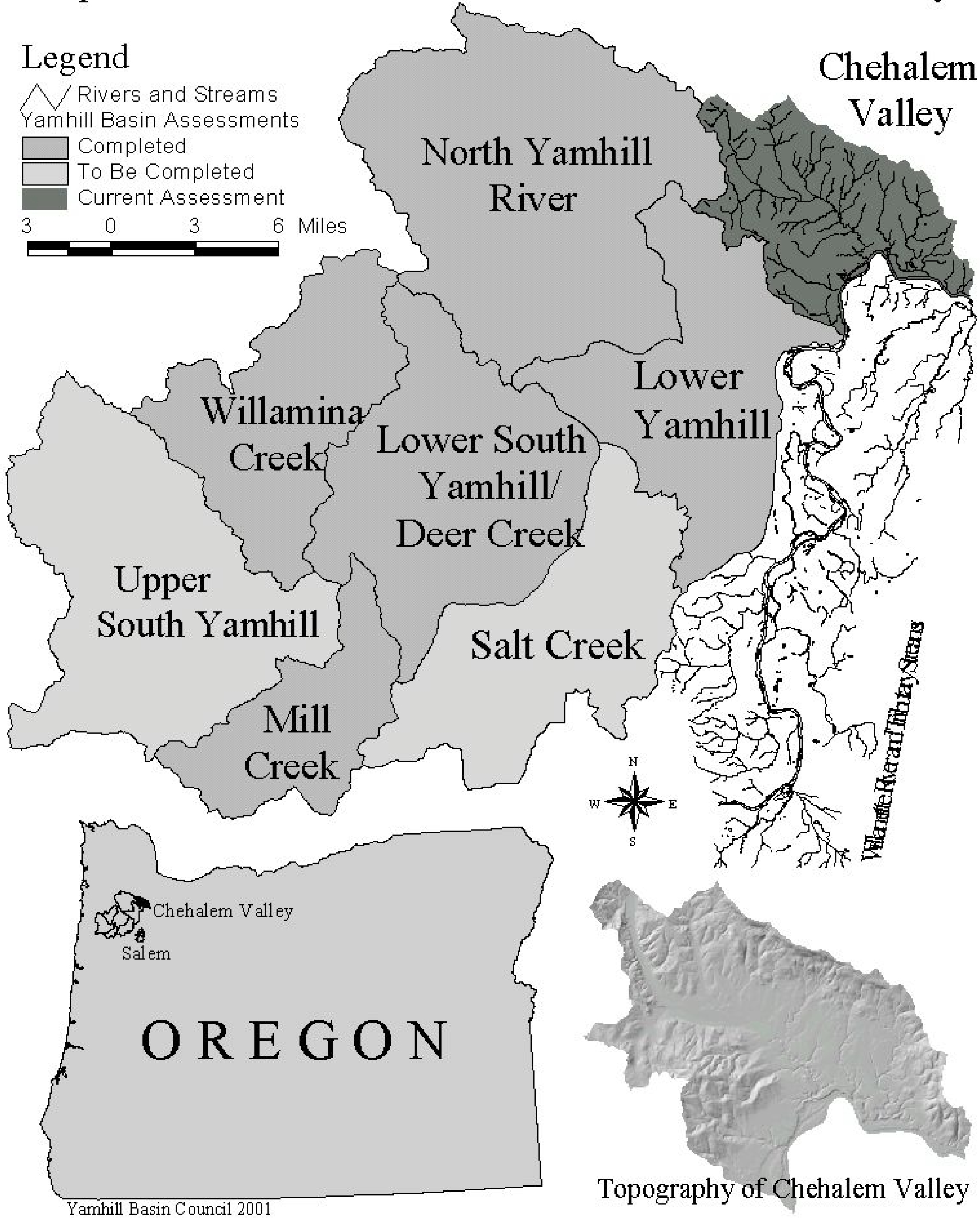
Abbreviations and Acronyms

BLM	Bureau of Land Management
CHT	Channel Habitat Types
CFS	Cubic Feet per Second
CREP	Conservation Reserve Enhancement Program
DBH	Diameter at Breast Height
DEQ	Department of Environmental Quality
DOGAMI	Dept. of Geology and Mining Industries
DO	Dissolved Oxygen
DSL	Division of State Lands
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
GIS	Geographic Information Systems
LCDC	Land Conservation and Development Commission
LTA	Long Term Agreement
LWD	Large Woody Debris
LWI	Local Wetland Inventory
NWHI	Northwest Habitat Institute
NWI	National Wetland Inventory
NRCS	Natural Resource Conservation Service
ODFW	Oregon Dept. of Fish and Wildlife
ODF	Oregon Department of Forestry
OSUES	Oregon State University Extension Service
OWAM	Oregon Watershed Enhancement Board
RM	River Mile
SCS	Soil Conservation Service
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
UGB	Urban Growth Boundary
URA	Urban Reserve Area
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WRD	Water Resources Department
WWTP	Waste Water Treatment Plant
WRP	Wetland Reserve Program
YBC	Yamhill Basin Council

Map 1. Yamhill River Basin and Chehalem Valley



Think wetlands. Think of restoring habitat with your own private hydric soils. Into bogs, swamps, peats, fens, marshes, swales—old names for increasingly rare places. Even "moss" originated as a placename, a wetland. As did "peat-moss"—a moist, productive place from which our ancestors learned to harvest.

Wetlands are places of life and mystery. Think of the bog-people sacrificed and preserved. Think of being alone in a swamp, a place of difficulty where water or wildlife might overwhelm you. Think of venturing into a "muskeg." That's the wilderness speaking.

A New World placename, "swamps" were too wet for cultivation by settlers but had rich soils with trees and plentiful vegetation. Ancient Germanic people said "swamp" when they meant sponge and before them the Greeks said "swombhos" (σομφοs) meaning spongy.

Hundreds of plants and animals are closely associated with wetlands and have marsh or bog or swamp in their name. There's swamp ash and swamp lantern. Marsh hawk, marsh wren, marshmallow. Bog Labrador tee. There's swamp blueberry, swamp blackberry, swamp gooseberry, and swamp dewberry. Swamp deer, swamp rabbit, swamp partridge, and even swamp wallaby. A swamp angel plays the flute of a wood thrush.

We can't have too much of restoring wetlands now. We are operating on a deficit. Of wetlands, of marshes—of meadows. Wetlands are meadows. Meadows are wet grasslands near a stream. Imagine saying "Welcome to our meadow."

CHAPTER 1

Introduction and Watershed Overview

The Chehalem watershed assessment is a publication of the Yamhill Basin Council (YBC) and is a reference tool for landowners, watershed residents, and council members. It contains factual and interpretive information about the condition of the watershed, both past and present. The overriding purpose of the assessment is to evaluate local water in terms of quality of life issues for basin residents. More specifically, it looks at how natural and human processes are influencing the watershed's ability to produce clean water and suitable habitat. It may serve as a baseline for designing restoration projects and will aid the Council and community members in developing monitoring plans for the Chehalem watershed. This document is a snapshot, of sorts, but it's also tied to an ongoing process of community-based land use planning; the information contained will need to be updated as needs and objectives evolve.

The guidance for this assessment came from a manual developed specifically for Oregon. The Oregon Watershed Assessment Manual (OWAM) provides information on the resources available for completing a local assessment, information on watershed functions in Oregon, and suggestions for approaching each aspect of the assessment. If you ever have the opportunity or inclination to assess your local surroundings using a manual like this, don't be put-off by the apparent immensity of the task. Understand that the authors were trying to give you as many tools as they could in terms of a broad working knowledge of water's role in your surroundings. Accomplishing any portion of an assessment is valuable.

In our scientific age we rely heavily on data analysis. This is because we're looking for direction in a complex world of public policy, local politics, economic forces, diminishing resources, religious and cultural traditions, rapid changes in technology, and our natural surroundings—all of which we understand imperfectly.

Data used in preparing this document came from a wide variety of sources. The Bureau of Land Management's Geographic Information System (GIS) "base layers" provided data for many of the maps on which this document is hinged. The Northwest Habitat Institute, the Oregon Water Resources Department, the Oregon Department of Forestry, The Nature Conservancy, and the Federal Emergency Management Administration also provided "projections" used in the maps. Additional field work and interviews with local residents and officials was also helpful.

In contrast to the personal knowledge many residents have of the area, specific scientific data is limited for the Chehalem Valley. Like the Yamhill River basin (including most of Yamhill County and the northern part of Polk County) this area has not been studied much by natural science researchers. This is noteworthy because our society has adopted scientific (and increasingly, ecological) management for our institutions, public lands, and natural surroundings. This approach demands scientifically derived statistics to serve as a basis for acceptable air and water pollution, wildlife habitat, and use of our natural resources. So it may surprise some readers that there is little documentation on historic and current fish populations, for example, or even on species surveys in the area. Only regional generalizations and some scattered stream and water quality data are available.

A lot of the information contained in the assessment comes from general databases for the Willamette Valley or for the state. Needless to say, there are opportunities for further investigation locally. Consequently, the Yamhill Basin Council began collecting stream temperature data in a number of locations in the watershed during the summer of 1999. Please contact the Council at (503) 472-6403 at the Yamhill County Soil and Water Conservation District if you are interested in water quality monitoring or forming a community group to do so.

It is difficult to draw definitive conclusions on the condition of the watershed without information of this kind. We should not be discouraged, though. We can still draw meaningful conclusions based on what we know and more importantly we can determine what level of health we want to set as a goal for our watershed and work towards that goal.

Table 1. Examples of GIS Data Layers

- Watershed boundaries
- Streams
- Roads
- Land-use
- Land ownership
- Urban growth boundaries
- Historic vegetation
- Current vegetation
- Geology
- Irrigation rights
- Wells
- Floodplain
- Debris flow risk
- Township, range, section lines
- Soil erodibility
- Wetlands, hydric soils

Geographic Information Systems

Computer software called ArcView provided the tools for producing the maps and many of the statistics included in this document. ArcView is one of several commercial brands available using Geographic Information System (GIS) technology. GIS allows maps to be produced from digitized information based on geographic coordinates—the map image is broken down into thousands of individual points and the computer remembers what each point represents. With this system, instead of drawing a line to represent a river the computer draws a number of dots that appear to form a line.

The significance of this technology is similar to the difference between a traditional camera and a digital camera. With a traditional camera (or map) we produce images that are somewhat inflexible; one can add to the image using various techniques but selecting, removing, or manipulating information from a film negative (or a traditional map) is difficult. The advantage of digitized information is that with a relatively simple personal computer, geographic information can be manipulated (selected, combined, removed, highlighted, differentiated, or correlated with other information) for specific, local purposes. For example, the wetlands, streams, and soils can all be displayed simultaneously to provide a better picture of the watershed's hydrologic conditions. Calculations and measurements can also be made using GIS. This versatility helps us answer many questions about the watershed and its features that otherwise might be prohibitively complex, expensive, or time consuming.

The assessment draws information from many sources in an effort to do preliminary footwork for interested residents. Additional data, maps, and explanations of water issues are available from public agencies, the library, and fellow residents. If you're interested in learning more about any of the topics in the assessment, a simple search on the internet (available free at the public library) will get you started.

Like all technological advances, GIS also contains weaknesses and represents a tradeoff with the advantages of the system it replaces. For example, the most basic limitation of GIS maps is the imperfect nature of the data on which they're based. The data comes from many sources of varying accuracy and should be read as interpretive in most cases. What you see on the map is an approximation of the actual conditions on the ground or in the water of your local surroundings. This is the case with all maps, satellite images, and even photographs.

A second limitation of the maps included here is the scale of presentation. You'd be surprised at how much more you can see in GIS when you look at a large format wall map or use a computer to zoom in on a specific area in ArcView. Unlike these larger formats, our watershed of approximately 43,000 acres is represented here on 8.5" x 11" pages. Consequently, even though we're looking at a relatively local area, a lot of detail is lost. The significance for watershed residents is that these maps are useful for gaining an understanding of the big picture of your immediate surroundings. Further investigation on the part of citizens is needed to determine locations and strategies for their water-related issues. These maps should help in approximating locations and conditions before you set out.

Another tradeoff is that computer-generated maps don't always compete on the human to human level of communication. Handmade maps of any kind (including quick sketches mapping out directions for someone) contain a human element that is lost in the process of making digitized maps. Handmade maps are like illustrations in guidebooks—they elucidate what's significant from a human point of view, seen through human eyes, and then processed by the big *Homo sapiens* brain. Images created with cameras or computers can sometimes be less helpful (or even reliable) than drawings. Although a surprising degree of the humanistic effect is likely retained by computer software that mimics pen and paper, we undoubtedly lose some of the human-to-human communication. We exchange this for the more standardized, quantified data available through GIS, as well as for the seductive presentation in bold colors.

Think of the information you find in this assessment as a new look at your surroundings rather than as the last word on things. Decide for yourself whether the neighborhood or countryside where you live is as healthy as you'd like it to be. Consider what you would like to see improve in your community or surroundings and how that might happen.

What is the Chehalem Watershed?

The Chehalem watershed is part of the Willamette River basin in the northwestern Willamette Valley. The 43,400-acre watershed is on the eastern side of the Coast Range. The entire watershed is within Yamhill County. In this case we use Chehalem Valley synonymously with watershed because the size and shape of the watershed approximates the boundaries of one recognizable valley. Other large scale watersheds contain thousands of distinct valleys. For instance the Columbia Basin is a huge watershed including much of the Pacific Northwest all the way to the western slope of the Northern Rockies and a large part of Canada. It's often more useful to use the idea of watershed in terms of the stream or river that is closest to your house, though. The area drained by each stream you see constitutes a watershed.

The major streams of the Chehalem watershed include Chehalem Creek of course, Hess Creek on the east side of Newberg and Spring Brook into which it flows, as well as the other Hess Creek near Dundee. There are many other perennial or "blue line" streams contained in the watershed that are tributaires to these major streams; some have official names while other's don't.[1] For the purpose of comparison, the Chehalem watershed can be further divided into sub-watersheds based on the guidelines set forth in the Oregon Watershed Assessment Manual (OWAM). Sub-watersheds can be identified by their major streams and help citizens group themselves locally for addressing issues they share in common. See Map 2.

Elevations in the watershed range from about 60 feet above sea level along the Willamette River to over 1400 feet on Chehalem Mountain. All of the higher elevations are found along the ridge of mountains to the east and north of the valley. Parrett Mountain rises to1,247 feet to form the eastern boundary of the watershed while the Chehalem Mountains rise to 1,414 feet and form the northern boundary. To the west, the Red Hills of Dundee separate the Chehalem Valley from the Yamhill River Basin and rise to 1,067 feet.

Population

Yamhill County has a population of approximately 84,000. Although nearly all areas of the countryside are occupied, the population density of the Chehalem watershed is concentrated mainly in the towns of Newberg and Dundee.

Table 2. Population of Yamhill County

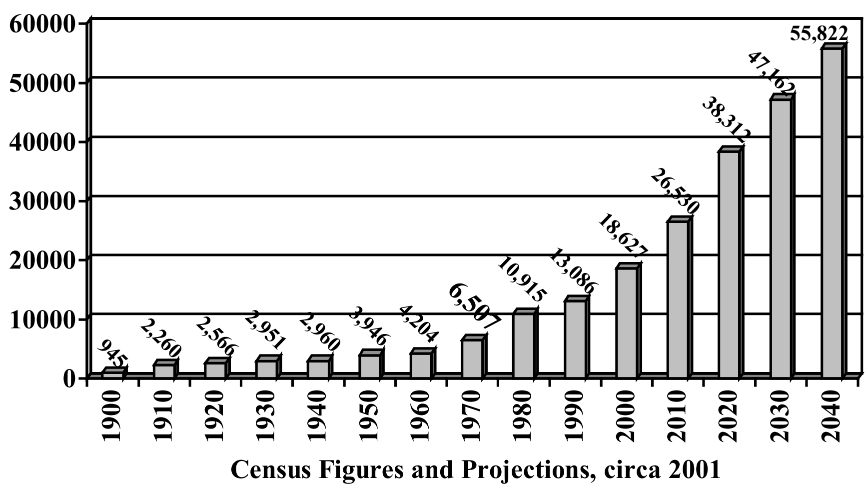
1900	13,400
1910	18,285
1920	20,529
1940	26,336
1950	33,484
1960	32,478
1990	65,551
2000	83,992

[1] Blue line refers to the streams recorded in blue on USGS topographical maps

Newberg is the economic and cultural heart of the valley and is located near the Willamette River. Signs as you come into town give the 1998 population of 17,355. The latest figure from the Portland State University Center for Population Research and U.S. Census Bureau lists the 2000 population at 18,064. This is a 38% increase since 1990. Dundee grew more than 56% in the past decade and now boasts 2,598 residents.

Current population figures are more revealing when viewed in terms of growth. During the 1990s, Newberg's growth rate varied from a low of 1.78% in 1992 to spikes of 4.52% in 1994 and 5.72% in 1996. The average annual growth rate was 3.6% and planners will use that average to project growth for the next several decades. Actual census figures for the decades 1900-2000 and projections for 2000-2040 are shown in Figure 1. Planning for services and infrastructure is adjusted on an ongoing basis according to actual population figures.

Figure 1. Population Growth of Newberg



Newberg developed population projections such as these in the early 1990s as part of establishing its Urban Reserve Area (URA). The URA takes urban planning a step further than Oregon's standard Urban Growth Boundary in preparation for the area's accelerating growth. The URA helps to figure out the amount of area needed to accommodate additional residents. It's the city's planning boundary for public facilities. Property owners in the URA can anticipate city services at some point in the next decade.

According to population projections, Newberg will grow at a rate of 3.6% through 2020, then at 2.1% to 2030, and finally at a rate of 1.5% to 2040. The decreasing rate is due to the fact that as population increases, the percentage of growth decreases for the same number of additional residents. Projections are based on recent growth and the best estimates for development pressure from the Portland area. For regional comparisons, the Newberg population over the past 20 years has increased by an average rate of 4.6% per year while the state average has been at 2%, Portland at 2.3%, and Yamhill County at 2.7%.

Urban Growth Boundary (UGB)

Thirty years ago, statewide concern about accelerating and haphazard growth led to passage of Senate Bill 100. It created the Land Conservation and Development Commission (LCDC) for state planning and for helping municipalities with their local planning. Another boost for comprehensive planning came in the early 70s when the Oregon Supreme Court found in two cases that when conflicts existed between zoning and comprehensive plans, that the latter took precedence. Urban Growth Boundaries (UGB) were established statewide in response to the 1980 Oregon Statewide Planning Act. It's part of an effort to set goals and guidelines for urban growth including plans for adequate infrastructure.

Newberg's current UGB—the hopeful limit of short-term urban growth—includes approximately 3,456 acres. Of these, 1911 are developed, 1275 are available, and roughly 270 acres are considered unbuildable. More specifically, 2,133 acres are designated residential with 1,228 acres already developed and 799 acres still vacant and suitable for housing. One hundred and six acres of the residential zone is considered unbuildable due to steepness, being in the floodplain, or for some other reason. In addition to the residential areas, Newberg has about 913 acres within the UGB that are industrial. By 1986, 264 acres were developed and 446 acres were vacant and buildable. By 2001, 367 industrial acres were developed while 295 remained vacant. Part of the discrepancy is due to different sources for these statistics. Agricultural land accounts for about 20% of the UGB and roughly 3% is forested. Officials report no wetlands remain within the planning area, though hydric soils exist within the city limits indicating wetlands were historically present. See Map 6.

According to current figures, 1275 acres remain within the current UGB on which future residences may be built. This acreage must also include amenities such as parks and schools. There are also some partially vacant residential acres that already have residences on them but that are large enough to accommodate additional development. Check with the planning department if you are interested in learning more about residential options such as "granny flats."

One of the issues facing planners is the question of how many additional dwelling units—houses and apartments—will be needed in the near future, say over the next 20 years. The question of how much land is needed to expand Newberg and Dundee's UGBs to meet this need (as well as for industrial and commercial development) has yet to be sufficiently answered. Creative solutions are needed. According to planners, the challenge is to establish residential needs through data analysis, public planning workshops, and public hearings. The solution will likely include a combination of expanding the UGB and adopting appropriate growth management measures such as revising zoning to allow additional residential options.

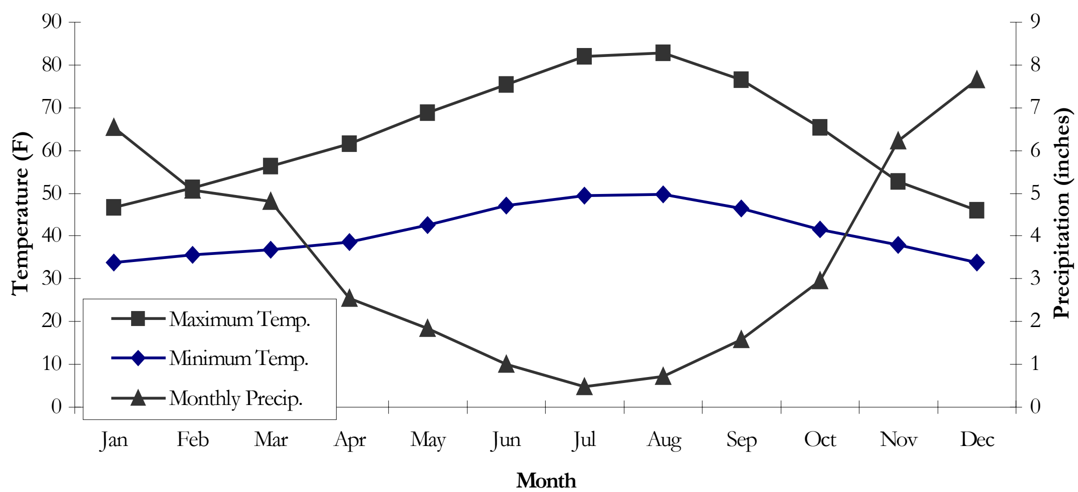
Climate and Topography

The Chehalem climate is marine-influenced with extended winter rainy seasons and hot, dry summers. Snow and ice do not accumulate often, even at the higher elevations of the watershed. As a result "rain on snow events"—where heavy snow accumulation is followed by intensive rains—are rare. When this does happen, it greatly increases the speed of runoff resulting in flooding. In 1964 and 1996, enough snow did accumulate in the Coast Range to contribute to the record flooding.

Average annual precipitation estimates are available from the Oregon Climate Service. Rainfall amounts vary in the watershed; the higher elevations of the Chehalem Mountains receive up to 60 inches of precipitation annually while the bottomlands receive about 40 inches annually.

As is typical for the west side of the Cascades, precipitation is not spread evenly over the calendar year but falls during the winter and spring months in a water year that runs from October to May or June. Figure 2 shows the average monthly temperatures and precipitation figures for McMinnville, just a few miles to the southwest of the Chehalem Valley.

Figure 2. Average Monthly Temperatures and Precipitation McMinnville 1961-1990



Geology and Soils

The geology of the Chehalem watershed is summarized in Table 3. This information helps us understand the topography and history of the landscape as well as the nature of the parent material that forms the soils. It also helps us understand how river channels formed in our area and how changes in the landscape my lead to stream bank erosion.

Chehalem Valley soils have both volcanic and sedimentary parent material—or raw material—out of which the soils form. A variety of volcanic basalts intermingle with marine sediments resulting in a complex geology in the Coast Range, Red Hills of Dundee, and on Parrett and the Chehalem Mountains. The valley floor has sedimentary rock with deep alluvial deposits overlaying it. The geology of the watershed is illustrated in Map 2.

The Soil Survey of Yamhill County lists six main soil associations for the Chehalem watershed. In-depth information on the soils and their characteristics and locations can be found in the soil survey.

Briefly: the soils along the Willamette River, especially near Dundee, are of the Chehalis-Cloquato-Newberg association and are well-drained silty clay loams, silt loams, and fine sandy loams. The soils along the larger, bottomland creeks such as the lower mainstem Chehalem as well as the lower portions of both Hess Creeks and Spring Brook have Woodburn-Willamette association soils. These are moderately well drained and nearly level silt loams and silty clay loams.

Table 3. Geology of the Chehalem Watershed

Geologic Name	Description by P-types	Location
Columbia River basalts	**Tc** (Miocene) A group of succeeding volcanic flows high in glass content. Subaerial basalt and minor andesite lava flows and flow breccia; submarine palagonic tuff and pillow complexes. Locally includes invasive basalt flows. Occurs principally in the Willamette Valley from Salem north to the Columbia and in the northern Coast Range.	The Red Hills of Dundee, Parrett and Chehalem Mountains
	Tcg Grande Ronde basalt (Middle and lower Miocene) Flows of dark-gray to black aphyric tholeiitic basalt. Potassium-argon ages mostly in the range of 15 to 17 Ma.	NE end Che Mt., Red Hills
	Tcw Wanapum basalt (Middle Miocene) Flows of gray to dark-gray medium grained, commonly plagioclase porphyritic basalt of Frenchman Springs petrochemical type. Generally exhibits blocky to platy jointing. Potassium-argon ages about 15 Ma.	Tops of Red Hills of Dundee.
Ridge-capping basalt and basaltic andesite	**Trb** (Pliocene and upper Miocene) Flows of breccia and basaltic andesite and Lesser diktytaxitic to intergranular olivine basalt. Includes some dense, aphyric flows. Low in section flows show some alteration to clays (nontronite and soponite), secondary silica minerals and calcite; pinkish brown glass in some flows unaltered. Potassium-argon ages date from 4 to 8 or 9 Ma.	Western ridgetop of Chehalem Mountain
Decomposed sediments	**QTs** (Pleistocene and Pliocene) Semiconsolidated lacustrine (associated with lakes) and fluvial (associated with rivers) ashy and palagonic sedimentary rocks, mostly tuffaceous sandstone and siltstone. May contain basaltic debris and pebble conclomerate.	Steep middle ridgetop of Chehalem Moutain
Willamette silt	**Qs** (Pleistocene) Lacustrine and fluvial light-brown silt up to 75 feet thick throughout the Willamette Valley. Unconsolidated and semi-consolidated clay, silt, sand, and gravel; in places includes mudflow and fluvial deposits and discontinuous layers of peat. Includes older alluvium and related deposits of Willamette silt, alluvial silt, sand and gravel that form terrace deposits.	Most of the level urban, agriculture, and industrial land in the southern half of the valley
Recent alluvium	**OW** (Holocene) Unconsolidated silt, sand, and gravel. Often covered by water.	Flood plain of the Willamette River
	Qal (Holocene) Alluvial deposits of sand, gravel, and silt forming flood plains and filling present and former channels of streams. In places includes soils containing abundant organic material and thin peat beds.	
Nestucca formation	**Tss** (Upper and middle Eocene) Very mixed: volcanic flows, tuffs, marine siltstone, and sandstone. Thick to thin bedded. Fine to coarse grained.	NW slopes of the Red Hills
Marine Sedimentary rocks	**Tsd** (Oligocene and upper Eocene) Sedimentary marine shale, siltstone, sandstone, and conglomerate, in places partly composed of tuffaceous and basaltic debris; interbeds of arkosic, glauconitic, and quartzose sandstone.	Northern half of Chehalem Valley floor

The upper portion of Chehalem Creek, where the valley narrows between the Red Hills and Ribbon Ridge, is characterized by Wapato-Cove association soils. These are poorly drained silty clay loams and clays.

The upper stretches of the valley's creeks flow over the Jory-Yamhill-Nekia and Willakenzie-Hazelair association soils. Jory-Yamhill-Nekia soils are usually well-drained, gently sloping to very steep clay loams over clay. They may also be silt loams over silty clay. They're typically formed in basaltic colluvium and in the Chehalem Valley they're found in the eastern Red Hills of Dundee and in the foothills of Parrett and Chehalem Mountains. Willakenzie-Hazelair association soils are gently sloping to steep silty clay loams formed over clay and siltstone.

Map 2. Chehalem Geology

Volcanic lava & ash, ocean & freshwater flooding, tectonic uplifting, and erosion have all helped form the Chehalem Valley. It's a complex and beautiful landscape with rugged uplands and rich bottomlands.

Subwatersheds (shown below) help landowners and groups of residents address local issues such as water shortages, flooding, habitat, and poor water quality.

These are more common in the northern part of the watershed in the northern Red Hills and in the rolling hills to the north and east of the upper Chehalem Creek.

The top of the Chehalem Mountains are characterized as Laurelwood association soils. In general these are well drained, gently sloping to steep silt loams over silty clay loams formed in mixed parent material.

Closely related to geology is the vegetation in the Chehalem watershed which varies a great deal depending on the location. In general, the hilly areas in the north, east, and west are forested but in recent years have had increasing acreages converted to vineyards. Meanwhile the more level valley bottoms are dominated by an impressive variety of agricultural crops ranging from annual and perennial grasses to row crops, berries, orchards, and vineyards. For a more detailed outline of the area's vegetation including current and historic conditions and noxious weeds see Chapter 3 on vegetation.

Fire History

For at least the past four thousand years and possibly as long as ten thousand years prior to Euro-American settlement, humans have systematically burned large sections of the Willamette Valley including the Chehalem Valley. Biological and anthropological researchers agree that this long-established practice played a major role in the evolution of valley ecosystems.

The indigenous Che-ahm-ill people of the "Yam Hills" area were a sub-group of the Kalapuyan culture. They occupied the valley at the time of Euro-American contact and for several decades afterward until their numbers dwindled and the few survivors were removed with other tribes' to reservations, primarily the Grand Ronde reservation in the Coast Range. The first white explorers to the valley in the 1820s reported large prairies, oak savannas, and thick smoke from widespread burning during the late summer. The newcomers reported that natives intentionally torched large portions of the landscape annually to hunt and encourage certain plant communities. Natives had developed a system of land management to help maintain favorable conditions for meeting their food and other needs. We know now that many of these areas otherwise would have supported the Douglas fir forests which have grown up in these areas over the past century and a half.

Natural and human-caused wildfires continued to shape the landscape after Euro-American settlement, but in different ways. In the 1850s, the Coast Range forests burned more than they had in previous decades while valley prairies and savannas had less fire and were either turned to field and pasture or began growing into forests. Euro-American settlers and their descendents have viewed fire control as necessary to protect timber and property in the region, an approach that continues to this day.

There were many fires in 1902 and 1910. In 1933 the infamous Tillamook burn covered nearly a quarter of a million acres. Since the 30s, fire suppression crews have become better trained and organized. Despite our best efforts, though, fires happen. In 1949, for instance, 18,000 acres of logged forestland burned in Yamhill County. In the 1950s a public education campaign through area newspapers urged residents to prevent forest fires. Through the later decades of the 20th century and currently, large fires continue to burn most years in various parts of the West.

Residential development in forested areas will likely experience fires at some point. A lack of fire-breaks surrounding buildings, limited water availability during the high-risk summer months, and fire suppression over the last 100 or more years contribute to a fire hazard in the forested hillsides of the watershed. Suppression of fire has contributed as much to the current vegetation pattern as historically intentional burning did. Of course there are differences between the two land use patterns. The most obvious difference is that the region has significantly more acres of Douglas fir and much less oak savanna and prairie since the end of intentional burning in the middle of the 19th century. See Maps 3 and 4 for indications of the area's historic and current vegetation.

Land Ownership and Land Use

The overwhelming majority of the watershed's 43,399 acres are privately owned. Land use reflects this in a varied mosaic of agriculture, industry, residential, and commercial development. Unlike much of the surrounding land where mountains and forest predominate, here the land is a patchwork of relatively small intensively managed parcels with a highly developed infrastructure.

Agriculture accounts for the lion's share of the acreage in the Chehalem Valley. Table 4 shows the acreage for various land use categories. The county and municipalities use different zoning categories than what is shown here. Information for more specific land uses (i.e. Ag-for, Mixed-EFU, etc) is available by contacting your local planning department.

Table 4. Land Use of the Chehalem Valley

Land Use	Acres	Percentage
Agriculture	23,688	54.58%
Forested	15,767	36.33%
Urban	2,975	6.86%
Water, gravel, sand	731	1.68%
Reed canarygrass	171	0.39%
Parks/Cemeteries	67	0.16%
Total	43,399	100%

Figures derived from ArcView analysis of BLM data from 1998.

Mining

Area quarries mine rock and gravel for road construction, fill, asphalt paving, or ready mix concrete. They are required to obtain permits from the Department of Geology and Mining Industries (DOGAMI). The Grant of Total Exemption Rule states that person(s) disturbing less than 5,000 cubic yards and/or less than one acre in a 12-month period need not apply for a permit with the state. That means that small amounts of earth can be moved legally without permit unless one is near a wetland or body of water. In that case, the Department of State Lands would need to be contacted for a permit.

Permits can be filed with the DOGMAI office in Albany, Oregon if more than 5,000 cubic yards are being disturbed. This permitting process became law in 1974, making records of mines and quarries before that date unknown or anecdotal. Nine quarries are shown on the USGS topographical maps of the watershed (updated most recently in the 60s and 70s). For further information on these quarries, contact the USGS office in Portland.

Table 5. Current Quarry Permits held in the Chehalem Watershed

Number	Status	Name of Quarry and Permit Holder	Type	Location
36-0005	Permitted	Timmons Quarry, Timmons Rock Co.	Basalt	3S 3W sec. 33
36-0009	Permitted	Rex Quarry, C.C. Meisel Company, Inc.	Basalt	3S 2W sec. 10,15
36-0018	Permitted	Renne Pit, A & R Spada Farms	Rock	3S 2W sec. 22
36-0019	Bond Pulled	Renne Pit, DOGAMI Fernwood Quarry (Flintstone) Project	Gravel	3S 2W sec. 22
36-0025	Permitted	Crabtree Pit, Crabtree Rock Co.	Basalt	3S 3W sec. 27,28,33,34
36-0056	New	Yamco Rock, LLC	Basalt	3S 2W sec. 22

(From DOGAMI records office in Albany, Oregon, 2001)

Agriculture

Since Yamhill County was organized in the 1840s, agriculture has been an important part of the culture and economy. In 1947 there were 276,000 farmer-owned acres in the county. By 1959 this had dropped to 229,137 acres—87.9% of the county. The dominant land use in the Chehalem Valley to this day is agriculture but development threatens this. Any approach to addressing the area's landscape-related issues must address the importance of agriculture.

Of course agriculture has great significance for the area's streams and rivers. Much of the area under cultivation in the watershed has been tiled and drained. The land has enough topography to provide outlets for drainage systems, unlike the central Willamette Valley, which is too flat to provide adequate drainage. Outlets for drainage systems allow water to be channeled off the surface and into streams making cultivation possible during the wetter part of the year. A side effect is that the area's hydrology is altered. Because agricultural issues pervade the landscape we will return often to them throughout the assessment.

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CHAPTER 2

Historical Conditions

This is an overview of cultural and natural factors that have helped shape Yamhill County. By looking at the area's environmental history—the mutual influence of nature and human contrivance over time—we can understand something about our current interdependence with the land. This information has bearing both for the area's growth and for our efforts to maintain or restore natural functions.

Timeline:

Before Europeans arrived, native Kalapuyan people, numbering in the thousands, occupied the Willamette Valley and used fire as a land-management tool. The Chehalem Valley was predominantly oak savanna and oak-fir savanna maintained through annual burning.

1782 Willamette Valley natives became exposed to smallpox and the population severely declined. Intentional burns subsequently decreased.

1812 Pacific Fir Company traders entered the Willamette Valley under the leadership of Donald McKenzie—this was the first documented contact between Kalapuyan and European people.

1831 Severe malaria plagued Kalapuyan people.

1840+ Wetland areas tiled and drained to make land available for agriculture and residential development

1841 Kalapuyan population estimated at 600 for the entire Willamette Valley. Malaria outbreaks continue. Open areas in the valley were now transitioning to forest as Indian burning decreased.

1843 Provisional Government established at Champoeg and regulated further settlement.

1846 United States gained sole claim of the Oregon Territory through a treaty with Great Britain.

1848 Nestucca fire burned area forestlands.

1849 Kalapuyan population dropped to only 60 individuals.

1847 Jacob and Susannah Shuck established a land claim of 640 acres in the Dundee area.

1850 The 1850 census indicates 243 houses in Yamhill County.

1855 Kalapuya, Umpqua, and Takelma peoples moved to the Grand Ronde reservation. Congress ratifies treaty with Confederated bands of Grand Ronde.

1861 Large flood on the Willamette River and its tributaries estimated to be comparable to 1964 flood levels.

1869 Settlement begins in the Newberg area, town named after Newberg Germany. Through the 1870s settlement continued mostly by Quakers.

1881 William Reid of Scotland built a large hotel and depot at "Dundee Junction" as part of his narrow gauge Oregonian Railway Company serving the Willamette Valley.

1887 The Southern Pacific Railroad began service shipping a high diversity of agricultural products including fruits. Prior to this only grains could be grown for distant markets; they were shipped by steamboat down the Willamette River.

1889 An act incorporating the town of Newberg was filed with the Oregon secretary of state on February 21, 1889. Another act establishing the City of Newberg with a charter was filed in 1893. The original charter of 1893 was revised in 1950 and expanded in 1982

1895 Dundee was incorporated as a city.

1900 First Italian Prunes planted in the Dundee area. Petit or French Prunes were also grown in the area. Most plantings were 10 to 20 acres in size, intended as a single-family orchard. Many growers built their own dryers; over 41 prune dryers were built in the Dundee area alone. Row crops, wheat, and hay gave way to a valley-wide orchard boom in the early 1900s. Largely clean cultivated, orchards tended to suffer serious erosion.

1911 First tractors began to replace animals for farming and gentle slope logging.

1923 Hydraulic sheave mounted to rear of tractors, allowed line logging on steep hillsides.

1929 Southern Pacific Railroad discontinued passenger service through Yamhill County.

1930s The Depression greatly affected agriculture and ended the production of prunes as a major crop. Hops farmers lost their market due to prohibition. The next big change in land use came in the 1930s with the development of the seed industry. Production of hairy vetch seed largely replaced grain production in the valley. Eventually perennial grass seed came into production, which alleviated erosion because the ground was covered year round (except during establishment when the ground is left bare or in ditches that are sprayed "clean").

1948 Tansy ragwort, an invasive and aggressive plant introduced from Europe, took root in the area. Tansy ragwort quickly colonizes areas of disturbance such as cut-over areas, roadside ditches, and overgrazed pastures.

1954 Officials began releasing hatchery coho salmon to area streams and continued into the 1980s.

1964 On December 22 and 23, tremendous floods damaged homes and businesses in low-lying areas. The flood did considerable damage to agricultural lands. An estimated 20 million tons of loose soil was washed into streams. Significant damage also occurred from the accumulation of logs and other logging debris on agricultural lands when the wood was washed into swollen streams and then deposited in fields as the water slowly subsided. Bridges were damaged or destroyed when log jams developed and brought the full force of the water against them.

1980s Stocking of hatchery coho salmon and rainbow trout discontinued after biologists began to question detrimental interactions between wild (native) and stocked species.

1996 Large-scale flooding throughout the Willamette basin (probably a 100+ year flood).

1998 Winter steelhead in the upper Willamette watershed were listed as threatened under the Federal Endangered Species Act.

2000 The Yamhill Basin Council began stream temperature monitoring on local streams.

Prehistoric Yamhill

When Lewis and Clark passed through the Columbia Gorge in 1805 they encountered a settled landscape of varied and interconnected native cultures. They noted a lively trade network across the region in spite of population losses to smallpox that had swept through after the initial European contact decades earlier—before many of its victims had even seen a white person. We can imagine the well-established system of trade, communication, and social organization that had evolved here over millennia. We can also imagine that native cultures were already experiencing the first stresses of decline.

Along the Columbia lived the head-flattening Chinook tribes whose activity and iconography focussed on the river and the bounty of food available there. Just south of the Chinook villages were the Tualatin people—the northernmost of the Kalapuya tribes living north of the Yamhill basin on the cultural fringe between the Willamette Valley and the Columbia River culture groups. As Kalapuyans, the Tualatins were one of several Penutian-speaking peoples that occupied the Willamette Valley at the time of European contact. The Kalapuya were an inland people whose territory included the Willamette Valley as far north as Willamette Falls (at Oregon City) and south including the headwaters of the Willamette and a small portion of the upper Umpqua River drainage.

Each of the 13 or so Kalapuyan tribes lived as an autonomous group within their own territory—better defined as an area of influence, possibly following watershed boundaries. Within their area the group had access to most of what they needed in plants, animals, and other resources. Archeologists theorize that within each sub-basin the tribe likely occupied several villages that shared access to resource and hunting areas. In addition to sharing resources, it is also plausible that each village had its own plant harvest areas "which may have been further divided into individual gardens or plots," according to archeologist David Stepp.

South of the Tualatin Valley and Chehalem Mountain was another valley of grass-covered hills occupied by the Che-am-ill Kalapuyans. Here in "Yamhill" country, population density was perhaps lower than along the Columbia or the coast, but still relatively high for western Native Americans. The economy was less centralized and relied more on plants and seasonal migration in contrast to the settled economy of salmon fishing along the Columbia and lower Willamette.

There are no known archaeological sites of these "Yamhelas" in the Chehalem Valley but no conclusive or detailed survey has ever been conducted. We are fortunate to have known sites nearby, though. Several time capsules from prehistoric times appear in dozens of graves in two burial mounds located along the South Yamhill River. Contained there were the skeletal remains of at least 66 individuals along with a variety of burial items. Excavated in 1941 and 1942, these mounds provide fascinating artifacts. The native people were as different from us as we can likely imagine but they also faced many of the same challenges we do today. What little we can learn about their economy, technology, and land use from these graves is an excellent point of comparison for what it means to live in the Chehalem watershed today.

The Fuller and Fanning Mounds provide the most diverse inventories of artifacts from any known archeological site in the Willamette Valley. "Exotic" artifacts suggest contact with coastal, Columbia River gorge, and interior plateau cultures. Examples of imported goods include ceremonial obsidian blades similar to ones from Gold Hill in southwest Oregon, whalebone salmon clubs from the coast, and a wood carving of staring owl eyes similar to ones found along the Columbia River and on the interior plateau. Another indication of contact outside the Basin is that nine of the 66 individuals studied from the mounds had some intentional forehead flattening.

We can understand something about how the groups interacted in the region by tracing the cultural practice of head flattening. Gradually deforming the fronto-occipital part of the scull was common with the Chinookan cultures for whom this type of head flattening is named (i.e. the "Chinookan" type of flathead). The Kalapuyans were influenced by the Chinookan cultures immediately to their north and consequently some practiced head-flattening. Central valley Kalapuyan tribes practiced cranial deformation less often than those to the north and southern Kalapuya show little Chinookan influence. Remarkably, in spite of our current high level of transportation, communication, and transience we can still identify patterns of culture and economy having similar geographical poles.

The burial items represent a fascinating variety of both utilitarian and symbolic items. They include tools such as elk-horn wedges, projectile points and scrapers, broken and complete mortars, pestles, bone awls, stone bowls, stone mauls, stone drills, whalebone clubs, a bone dagger, a large obsidian blade, antler digging sticks, and antler digging stick handles. They include symbolic and ornamental items like an owl's head carved in bone, shell beads and pendants, bone beads and pendants, antler labrets (lip discs) or ear plugs, feathers, and trade items such as copper pendants, copper bangles (ornamental bracelet or anklet), copper buttons, and glass beads. They also include more cryptic artifacts such as animal remains (bear penis bone, bird bills, cat claws, and fish vertebrae), a sandstone disc, cedar bark, wood fragments, and some corroded iron fragments. Of course the full significance of artifacts remains mostly buried in the past. We can glean some meaning from them, though.

Interestingly, there are differences in the mixture of items buried with deformed and non-deformed individuals. Archeologist David Stepp suggests this indicates either 1. a later arrival of cranial deformation practices (and possibly another cultural group) to the area, 2. possibly more than one culture group using the Fuller and Fanning sites, or 3. an elite class separation defined in part by artificial deformation of crania. Our interpretations must rely mainly on informed speculation.

Ultimately, we have to be satisfied with basic conclusions such as there was a deeply complex culture developed in this place over a time period lasting much longer than the current historic period. More significantly, the prehistoric system co-evolved with the local ecology, relied overwhelmingly on local, renewable resources, supported a large, relatively healthy population, and was rich in leisure time, craft, and both utilitarian and non-utilitarian art. In contrast, even the earliest white settlers relied on distant resources for many manufactured trade goods.

Anthropologist Lou Ann Speulda provides an interesting inventory of artifacts that illustrate this. The Champoeg town site, located only a few miles downstream from Newberg, was a center of European-American activity in the first 30 years of settlement starting about 1830. The history of Champoeg and the nearby Chehalem Valley includes the fur trade, pioneer settlement, and the provisional government of the Oregon Territory. Items found at Champoeg include clothing, buttons (loop shank and four-hole), fasteners, footwear, beads, tobacco pipes, alcohol bottles, a wine seal, marbles, floor coverings, flatware, ceramics, British, Scottish, and American (Ohio) earthenware, and porcelain from China.

For building materials settlers used local wood but also imported many materials such as "crown glass" from England manufactured before 1850, American or European "cylinder" glass manufactured after 1840, and brick imported after 1851. Machine-made, common-cut nails were the most common type of nails (imported to Fort Vancouver by the late 1840s) but there were also some hand wrought, wire drawn, and cast nails. Hinges, screws, keys, and door latches were also imported. Horseshoes, percussion caps, lead ball and shot, gunflint, cartridge casings, a gun barrel, a metal knife with wooden handle, and some blacksmithing stock iron also survive as artifacts.

In contrast, Native American building techniques used only local materials. Their winter houses and sweathouses (for both men and women) were semi-subterranean structures with a rectangular pole framework and bark or plank siding. Kalapuya inhabited permanent villages during the wet, cold season, but ranged through itinerant camps during the rest of the year from April or May to November. Summer shelters used while moving through seasonal hunting and gathering sites were often a natural or hand-built windbreak of brush or trees.

Surprisingly, plant foods accounted for more of their nutritional intake than meat did. Camas was the most important of their staples; they roasted it in pit-type ovens. Other nutritionally important plants were wapato, tarweed seeds, hazelnuts, and various berry species. We know that they cultivated Tobacco (*Nicotiana sp*.) White oak acorns were used but don't seem to have been a major part of their diet. Abundant wildlife was also utilized by the Kalapuya including deer, elk, small mammals, black bear, birds, fish, lamprey, and grasshoppers.

Finally, the Che-am-ill population of Kalapuya appears to have been in general good health. Very few pathologies can be detected in their skeletal remains. Most of the individuals, while being relatively short compared to modern populations, were "somewhat robust in musculature as evidenced by rugged areas of muscle attachment in the skeletal remains." These were well-adapted people. After thousands of years of settlement, the land appeared pristine to European eyes and supported more biodiversity than we enjoy today.

When Commodore Charles Wilkes visited the Willamette Valley in 1841 he found a well-cared-for landscape, though the significance of that was likely lost on him. Europeans had trouble seeing the value of Indian ways and like J.C. Cooper regarded the natives as "neither crafty nor cunning…a quiet, indolent people." Wilkes instead focussed on the land describing the "Yam Hills" as moderate, "the tops are easily reached on horseback, and every part of them which I saw was deemed susceptible of cultivation. The soil is a reddish clay, and bears few marks of any wash from the rains"—a telling observation by someone familiar with the effects of plowing. "These hills are clothed to the very top with grass, and afford excellent pasturage for cattle," Wilkes concluded, and soon they would be put to that purpose. Already in 1841 on their "route through the Yam Hills," Wilkes reported, "we passed many settlers' establishments."

Early History: 19th Century Yamhill

Yamhill County was home to many of Oregon's earliest white settlers who began arriving in significant numbers in the 1840s. The greatest proportion were Americans from the eastern states that had already moved to the Midwestern frontier. In many cases, they spent a few years in places such as Kentucky or Ohio before embarking on the Oregon trail in Missouri. A commonly held belief is that they "farmed out" one area and moved on. Undoubtedly many were enticed by lavish descriptions of the Willamette Valley and various offers of free or cheap land.

By 1850, Oregon had a population of 11,952. Many of these were Native Americans. As for pioneers, almost as many white children in 1850 had been born in Missouri as had been born in Oregon—about 2000 each. About 800 had been born in Illinois. Although there were no adults from the Rocky Mountains there were 25 children listed as being born in that region, presumably while their families traveled the Oregon Trail. There was a comparable number born in California under similar circumstances of immigration. Over 644 adult whites were from Kentucky. The other leading points of origin for adult Oregonians (in decreasing numbers) were Ohio, New York, Missouri, Virginia, Tennessee, Indiana, Pennsylvania, and Illinois. Significant numbers came from all regions of the United States, though, so no single agricultural tradition was transplanted to the Willamette Valley. Instead, the first settlers came up with a unique system of unprecedented high numbers of cattle and horses being held by each farmer. The relatively large land claims made this possible.

An early provision for distributing land was the "Donation Land Claim" system established in 1850 preceding the Homestead Act by more than a decade. Prior to this federal system, there were various rules of the provisional government aimed at limiting single family holdings to a reasonable acreage. Limits were needed because of land speculation. Indeed, some settlers came to Oregon specifically to get rich by speculating on land, a process they believed would take no more than 10 years. University of Oregon geographer Jerry Charles Towle writes that "[w]hatever the intention of Congress, there is little doubt that the settlers themselves intended to sell a portion of their grants, and hoped for extremely high returns." A high demand for these excess acres never developed in the 19th century, though. As late as 1899, for example, some 40,000 arable acres were still underutilized in southern Yamhill and northern Polk counties.

The 1850 Donation Land Law recognized "preemption" claims of those already settled and gave them free land as a reward for the hardships of pioneering. Immigrants to Oregon Territory who were citizens of the U.S., 18 years of age, and who arrived before December 1, 1851 could secure 320 acres if they lived on and cultivated the land for four years. If they married before December 1, 1851, the woman could also obtain 320 acres. The law was later changed: the age requirement went up to 21 and the deadline was extended first to 1853 and then to 1855 while the acreage was decreased to 160 acres each (320 total) for pioneer couples.

By the time of the Civil War, foreign immigrants began to arrive in the Willamette Valley. In the 1860s and 1870s Chinese-Americans worked in the area cutting oak firewood for the Portland market. Swedes and Germans came in the 1860s and established farms. Finnish people immigrated to the area between 1900 and 1920. In the early years following settlement, agriculture meant cattle and horse grazing and subsistence farming. During the first two decades of settlement, the valleys filled up rapidly with cattle herds pushed back into the hills.

Farmers grew wheat on the level land and it became the first field crop of any importance. The 1880 census reported that wheat, oats, and hay accounted for 99 percent of the agricultural production in the area. During the 1880s, farmers were so successful in growing clover that it became the dominant cash crop. By 1900 clover occupied 1,216 acres, wild grasses 250 acres, tame grasses 8,007 acres, and grain (which farmers cut green for hay) 3,033 acres. With an increase in clover production the livestock industry flourished. Hops also became a significant part of the local agricultural economy. The 1900 census reports 1,801 acres in hops production in Yamhill County alone.

Apparently land in the valley changed hands regularly from settlement time on. Some farmers went on to purchase additional farms and sometimes held over 500 or 600 acres. Area farms of the late-19th century were often over 200 or even 300 acres. This surprisingly large size was mostly dedicated to woodlots, however, with some field cropping and pasture for cattle, sheep, hogs, and horses. The historic prairie was well suited to growing wheat and for pasture.

The Past Century

From 1900 to 1910, the dairy industry gradually expanded in the area. Yamhill and Polk County dairies used primarily Jersey & Guernsey cows because there were breeders in the area. The Tillamook and Portland area dairies were primarily Holstein. Every farm had at least a few cows. They could sell the milk to the local "creamery." There were milk trucks that had regular routes and would stop and pick up milk cans on a daily basis. Dairymen made a modest living on only 20 or 30 cows. The increase in dairy cattle increased the production of clover, grasses, and hay. By 1909 clover production showed an increase of nearly 500% and acres of grain cut green for hay had increased by 600%. Fruit and nut production started around the turn of the century as well and contributed significantly to the agricultural economy by 1909. Production of hogs, sheep, goats, and poultry were important to the agricultural economy as well.

After 1919, wheat production decreased while dairy and prune production increased. By 1925 there were 2,864 farms in Yamhill County with an average size of 83.56 acres. The twenty-five year period 1925-1950 witnessed a drop in the fruit tree production of apples and pears while filbert production increased. Commercial production of berries came in following World War I. Loganberries, strawberries, raspberries, blackberries, and gooseberries comprised the initial mix with strawberries being dominant. "Franquette" walnuts also rose in importance.

During the 1930s the federal government encouraged the then innovative use of cover crops to help retain soil. Grass seed became important about 1935 and increased in acreage steadily. Field crops were primarily wheat, Austrian winter field peas, and red clover. They also grew malting barley because it paid a premium of $5 over the regular price, or $47/ton instead of $42. To get the premium, however, the farmers needed some rain in late June or early July and then no rain until threshing.

Yamhill County agriculture experienced a boom and bust pattern that has plagued farmers throughout the country over the past century. For example, in the summer of 1929 prune prices spiked and farmers enjoyed a large profit. One farmer was able to buy a 15' combine, a Caterpillar 22, and a John Deere Model D all from that one crop. In addition, he paid his farm workers through the 1934 season—all on the 1929 prune income. The 1930s brought falling prices, market collapse, and many foreclosures on area farms. World War II improved the farm economy somewhat through the 1940s. Yamhill County ranked first in Oregon in production of prunes and walnuts and was also strong in cherries, filberts, forage seeds, vegetables, flax, turkeys, and chickens.

Then in the 1950s agriculture prices took a nosedive in general. Farmers increasingly moved from mixed, small-scale operations to specializing in a few revolving cash crops. Hairy vetch and field peas held on longer than alfalfa as a viable crop in our area. There's still some common vetch being grown in the valley. Farmers turned to wheat and grew all the government would allow—it was one of the few profitable choices. These were still relatively small, mixed farms, though, by the standards of today. By the late 50s an agriculture depression set in due to production surpluses. This was just one step towards financial insecurity experienced by farmers nationwide. Common knowledge held that a farmer in 1900 needed only one good year in nine to remain solvent—they could then weather three bad and five or six so-so years. By 1950, though, farmers needed one good year in three due to being more mechanized and carrying debt.

When asked what else has changed about making a living on farm income, Gordon Jernstedt says that now we have many more expenses for consumer goods and luxuries in addition to increasingly expensive farm equipment. He added that farming is less physically difficult but more difficult in terms of financial management. One oft-cited result is the loss of family farms to consolidated corporate operations. Between Gordon's childhood school bus stop and Carlton there were 10 farms. In the same area now there are only three. The whole farm structure has changed, he says. Those three farms are much larger and spread out on rented land. There's also a lot of residential, non-farm land use mixed in. There are no longer many sheep and goats being raised in the valley; the gardens are smaller and there is little homegrown meat these days.

Area farmer Sam Sweeney agrees. Family farms in earlier times were much more diversified and self-sufficient than they are today he says. They had to be because a good farm economy was never guaranteed. "For family consumption," he says, "most farms kept chickens for the eggs and even hogs for bacon." Sam also confirms that livestock was a big part of the area's farm economy in the past. Sheep were valued for meat and wool and there were also horses for powering farm work. Sam's family kept a team of horses as late as the 1940s.

Horses were also important for logging. According to a 1947 Department of the Interior report, the forests of Yamhill County were "seriously depleted" and the number of jobs in forestry and wood products was expected to drop due to "reduced lumber production resulting from exhaustion of local timber supplies." In 1942 the forest service had classed 51% of the county as forestland, 48% agricultural, and 1% as waste. Nearly half of the forestland contained immature conifers in '47 while only one-fifth represented saw-timber; the rest was cut over or deforested by fire. Saw timber volume totaled 1.4 billion board feet that year, nearly all in Douglas fir.

Logs were still commonly floated to mills on the Willamette River. The minimum channel depth was 3.5 feet. The Willamette River Project of the U.S. Army Engineers aimed for a channel width of 150 feet and a minimum depth of 6 feet from Salem to Portland.

By 1962, Yamhill County's municipal water supply systems served 7,270 homes (23,371 people) with 1,226,000,000 gallons of water. Half of the consumption occurred during the three summer months and the utilities were already reporting shortages

Irrigation was becoming more common. In the 1940s alone, irrigated acreage had doubled reaching over 6,000 acres countywide. The bulk of the irrigated land in 1946 was on Grand Island. At least 95% was irrigated by sprinkler systems. Estimates of land that could be brought under irrigation ran as high as 67,000 acres by the National Resources Planning Board. Water for irrigation would be obtained by pumping from the Yamhill or Willamette Rivers and from creeks. Irrigated acreage increased over 500% in the Willamette Valley between 1945 and 1970.

Another issue was farmland being flooded. The land could not be intensively cultivated, everyone agreed, until drained and protected from inundation. Government agents recommended drainage systems be installed on 28,000 acres countywide or nearly half the total recommended for irrigation.

At the same time a "considerable proportion" of area farmland was suffering "seriously from erosion." Cultivation in orchards and on steep land more suitable for pasture was believed to be the main reason. Contour plowing, cover cropping, and switching from annual to perennial grasses and legumes were still new ideas being promoted by the SCS and county agents.

The 1947 report touts tourism as an important and growing part of the economy and important for quality of life. In addition to providing services for coastal traffic, Yamhill County supposedly held tourist attractions such as excellent mountain fishing streams and campsites.

Modern Times

Fifteen years later, the lumber and wood products industries in the county had declined further, agriculture was still losing jobs, and Yamhill County had just come through one of its toughest decades in memory. In March 1962, the County Court sat for the transaction of county business and set out to do something about it. They established a committee to participate in the Kennedy administration's Area Redevelopment Administration.

This committee was made up of one man from each town as well as three agriculture men and one representing labor. Together they identified the main factors contributing to economic decline in the county: "Several years ago employment in the logging and lumber industry declined quite markedly. Employment on the farms was gradually declining and several processing plants for poultry and other farm products left the area." They also agreed that as a subsidiary of the U.S. Area Redevelopment Administration, they were "to promote and develop industrial and economic interests for the county."

Throughout the rest of the year the committee developed an overall economic plan for the county. They found there did "not appear to be any catastrophic problems confronting the area. Housekeeping type of problems do exist. Better roads, improved transportation, sewer systems, pollution abatement and the elimination of flood damage and erosion along the streams."

In terms of tourism and recreational facilities, the committee wanted to see development of additional facilities at existing parks. They also wanted to acquire additional public land for access to streams, historical sites, an historical museum, convention facilities, and other possible development for water-related recreation.

For public health, education, and welfare, the committee called for a survey of the methods necessary to eliminate pollution from the county's rivers and streams. They wanted to study the feasibility of increasing the minimum flows in streams to abate pollution, enhance fish and wildlife, and create opportunities for recreation. Following the thinking of the time, they wanted to clear streams of debris to improve stream channels—we've since rejected this line of thinking in favor of the exact opposite: putting woody debris into streams. Rip-rapping and revetment work was also needed along streams, they said, to protect against flooding and erosion—again, the best information we have today is that this should be avoided whenever possible. Finally, they called for planning for the highest use of the available water to meet "all local needs."

By the beginning of 1963, just before submitting their report, the committee agreed to place more stress and importance on water resource development. They wanted storage of water for irrigation and flood control. Of course they also felt drainage practices should be continued and encouraged, which they were. But their support for building reservoirs was emphatic:

> One thing the committee wishes, however, to emphasize and place in the very highest priority, is the conservation and development of the water resources of the area. Conservation in this instance being used and intended to mean wise use of these resources. Yamhill County has an abundance of water both in quantity and quality and it is adjudged adequate for all foreseeable needs of the area. The problem which confronts the area is not new. It is the old story of too much when it is not needed and not enough when needed. Storage is the answer and we have adequate storage sites. In the years ahead there will be great competition among users for the available sites and water. All of these users are important to the economic well being of the area. Municipal, industrial, agricultural and recreational needs must be met if the area is to develop a sound economy.
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> Agriculture does have a large and important impact on the economy of the area and it will continue to be one of the dominant factors in any development of Yamhill County and it would appear that here lies the real opportunity for the creation of jobs…All of these activities make for more jobs both on farm and off farm. How many, depends on how fast and how extensive the development. The committee feels that it could not at this time make an estimate but it does feel that it would be very large and very substantial in it's impact on the area.

Agricultural employment had dropped from 26.5% of county workforce (3,180) to 16.5% (1,861) during the decade 1950–1960, though. Similarly, lumber and wood products manufacturing saw a decrease from 15.5% (1,861) to 10.3% (1,157) of county jobs through the fifties.[2] In the decade prior to 1964, the value of farm products increased despite a steady loss of farmland. As the number of farms decreased by 16.9% (417 farms) during that time the average size increased from 110.2 ac. to 124 ac., a 12.5% increase. "Commercial" farms averaged 213.7 acres while noncommercial ones averaged 30.9 acres during the same period.

Planning for the Future

Interest in improving the quality of life in Yamhill County mounted through the following years. In contrast to the problems of the past decades, things were looking up in 1964. The economy of the county seemed healthy finally and was growing after a lengthy period of recession. Likewise, after a population decline of 3% during the fifties, the county appeared to have more than recovered the losses over the past few years and was headed for further growth.

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[2] Put another way, in 1940, agriculture accounted for 33.8% of total county employment. In 1950, 42% of county employment was made up by agriculture, timber, and wood products. By 1960 these jobs had declined to 27% of the total and were declining further.

From 1954 to 1964 the value of vegetable sales increased by 108%. Field crops were still more important with 23.6% of total agricultural sales. During the same time "automobiles and better roads, which allow local citizens to shop in Portland and Salem" caused a decrease of total personal income being spent locally from 96.6% down to 91.1%.

"Several boat landings are in operation as at Dayton," officials wrote. Other recreational opportunities were rare, though. Several ponds were stocked with fish and public fishing was allowed. One fish hatchery had recently began operation. Several private holdings were leased for duck hunting. A few areas were reserved for youth fishing. County leaders found optimism in the increasing numbers of small county rest areas and parks along roads adjacent to streams. Unfortunately, hiking and horse riding trails were "scarce and only locally known" and there were remarkably few swimming holes available due to pollution and withdrawals from the streams. Today, these amenities still elude local residents.

Doubtless, officials had an eye to developing a tourist trade in the growing outdoor recreation industry that remains underdeveloped in Yamhill County. Historically the county has not emphasized establishing parkland. In 1966 we had 13 parks totaling less than 60 acres with a budget of $12,000. That's less than 40 cents per resident at a time when other counties in Oregon were spending over $3 per capita on parks.

Since then, the county has not created any additional parks, though the existing park acreage has increased to over 81 acres. The budget has increased to an estimated $110,000 annually through a complicated arrangement where the parks department is tacked on to the county corrections department. Ron Huber wears several hats as a corrections officer and the county park supervisor. He explains that the park system is like an "orphan" and could not be sustained without the maintenance labor of inmates and the managerial efforts of corrections employees like himself. Huber reports that the parks receive $68,000 from the county general fund and additional funding comes from building permits (~$1k), the state Marine Board (~$7k), and most significantly from an Oregon State Parks fund (~$35-40k) on an annual basis. Yamhill County's share of this fund is based on the number of RVs registered in the county and the number of public campsites available in the county. As a result of having campsites, several other counties in western Oregon have parks budgets running up to several million dollars. Not only do they collect fees from campers but their share of the State Park Fund increases for every campsite in the county. By contrast, Yamhill County has zero campsites.

A bright spot in the local parks picture is that work has just recently been completed at Roger's Landing Park. The Marine Board dollars coming into Yamhill County have been focussed there to improve recreational opportunities on the Willamette.

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CHAPTER 3

Vegetation

Historic Vegetation

Much of what we know about the native vegetation of the Willamette Valley comes from early written accounts of explorers, early newspapers, personal letters, and diaries. From these sources we know that the Willamette River floodplain was covered with a rather dense forest that included a lot of Douglas fir trees. Indian-set fires were common since at least 1647 but ceased after 1848 according to tree ring analysis or dendrochronology.

Early botanical analysis also helps. Writing in 1902, J. E. Kirkwood explained that in the 50 years since the first considerable immigration into western Oregon, most of the original forest had been cleared in the lowlands. Apparently this was not the case in riparian areas. Kirkwood pointed out that a "remnant of the forest remains along the banks of streams whose location and course may by this means be determined from a distance." Oak forests had already taken on the appearance they have today. "*Quercus* [oak] usually forms groves by itself," Kirkwood reported, "and does not grow so well in the open forest of *Psudotsuga* ["false fir," or Douglas fir, what Kirkwood called a Douglas spruce] as do some other deciduous trees." The swale areas "possess some peculiarities worth noticing"such as "a luxuriant undergrowth" of *Fraxinus, Crataegus, Spiraea, Amelanchier, Acer, Salix*, etc."

Kirkwood went on to recount the rapid reforestation that occurred throughout the valley after burning ended:

> It is said by the older inhabitants that before much immigration had taken place, considerable areas of land in the Willamette valley were covered only by large isolated tress and a luxuriant growth of grass, a condition, as they say, maintained by the Indians. As parts

> were fenced off by the settlers for cultivation, the rest was neglected and soon sprang up to undergrowth which one sees to-day as a forest of young trees fifty feet or more in height.
>
> A tract of land which was under the writer's own observation in 1884, was then almost entirely devoid of undergrowth, the growth having been cleared off and burned a few years previous. In the summer of 1901, however, this tract was…covered with an almost impenetrable growth mostly of *Psudotsuga*, about twenty feet in height.

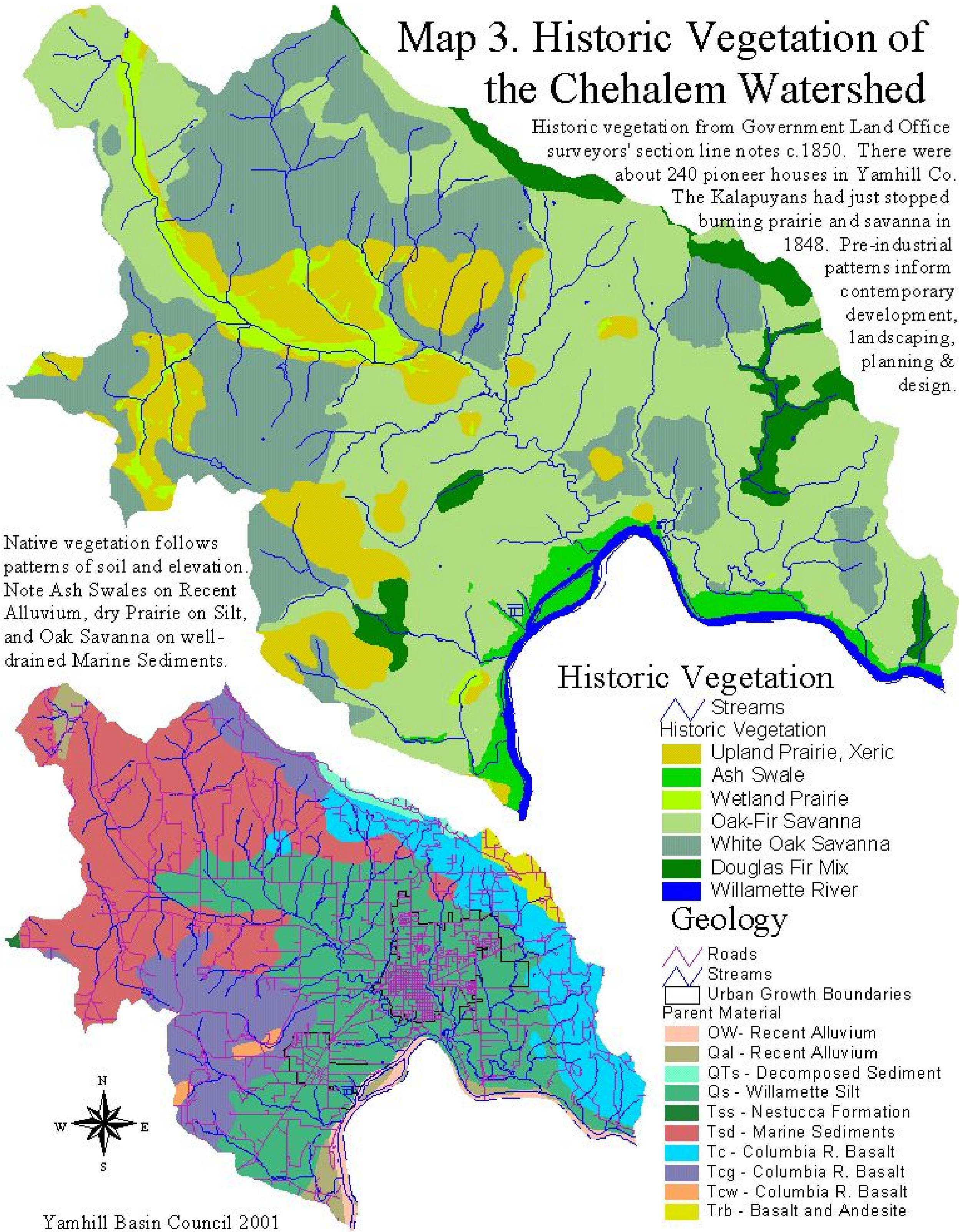
Similarly, Kirkwood suggested that small streams such as those in the Chehalem Valley may have previously had less dense riparian vegetation. "The valleys of streams tributary to the Willamette which head in the Coast Mountains," he wrote, "are flanked in their upper parts by forests." The significant thing about the upland riparian forests were that they had dense undergrowth dominated by Douglas firs with widely spread branches indicating open canopy or savanna-type setting when they were young trees.

An excellent indication of pre-settlement vegetation comes from the Government Land Office surveys conducted in the 1850s. At that time surveyors were establishing section lines and took notes on the landscape and vegetation they encountered as they crisscrossed the valley. Although some areas were homesteaded with fields planted to crops several years before the surveys began, most areas were surveyed before or concurrently with settlement. At the end of each mile, the surveyor was to provide a summary of the landscape making mention of the type of vegetation, soil, and geography of the previous mile of surveyed line. When they completed a township (divided into 36 sections), they wrote an overall description. Doug fir was the most common "witness tree" marking corners, though oak, pine, and maple were also used.

Map 3 shows the approximate vegetation of the watershed prior to Euro-American settlement based on these notes. The Nature Conservancy compiled the information contained in surveyors' descriptions kept at the BLM office in Portland. Although surveyors' botanical knowledge was imperfect and their note taking was not standardized, the descriptions allow us to reconstruct the historic patterns of vegetation. Table 6 provides examples of the kind of information available from the surveyors' notes in the Nature Conservancy database. Descriptions from the database that seemed to overlap were combined for the map. Map categories that do not appear in Table 6 (Upland Prairie, Xeric; Water) come directly from the database.

Table 6. Simplified Categories for Historic Vegetation Map of the Chehalem Valley c.1850

Mapped Category	Nature Conservancy Database Categories Combined in Mapped Category
Wetland Prairie	• Seasonally wet prairie. • Emergent wetland.
Ash Swale	• Ash swamp and ash swale, sometimes with alder. • Ash-mixed deciduous riparian forest with combinations of red alder and willow. • Ash-willow swamp, sometimes with ninebark and briars, "very thick." • White oak-ash riparian forest, sometimes with ponderosa pine.
Oak-Fir Savanna	• Scattering or thinly timbered Douglas fir-white oak woodland. • White oak-Douglas fir savanna, mostly herbaceous undergrowth.
White Oak Savanna	• "Scattering" or "thinly timbered" white oak woodland, brushy. • White oak forest, oak brush, or oak and hazel brush. • White oak savanna.
Douglas Fir Mix	• Douglas fir forest, often with bigleaf maple, grand fir. • Douglas fir woodland or "timber" often with bigleaf maple, alder.


Map 3. Historic Vegetation of the Chehalem Watershed
Historic vegetation from Government Land Office surveyors' section line notes c.1850. There were about 240 pioneer houses in Yamhill Co. The Kalapuyans had just stopped burning prairie and savanna in 1848. Pre-industrial patterns inform contemporary development, landscaping, planning & design.
Native vegetation follows patterns of soil and elevation. Note Ash Swales on Recent Alluvium, dry Prairie on Silt, and Oak Savanna on well-drained Marine Sediments.
Historic Vegetation
Streams
Historic Vegetation
Upland Prairie, Xeric
Ash Swale
Wetland Prairie
Oak-Fir Savanna
White Oak Savanna
Douglas Fir Mix
Willamette River
Geology
Roads
Streams
Urban Growth Boundaries
Parent Material
OW- Recent Alluvium
Qal - Recent Alluvium
QTs - Decomposed Sediment
Qs - Willamette Silt
Tss - Nestucca Formation
Tsd - Marine Sediments
Tc - Columbia R. Basalt
Tcg - Columbia R. Basalt
Tcw - Columbia R. Basalt
Trb - Basalt and Andesite
N
W
E
S
Yamhill Basin Council 2001

There are four main types of natural habitat in the Willamette Valley[3]—riparian forest, prairie (wet and dry), woodlands, and oak savanna. These habitats evolved under both natural conditions and human-caused fire and are currently evolving in response to fire suppression and heavy development over the last century.

Riparian Forests

Nearly all of Newberg and Dundee are built on class II soils that were previously prime agricultural lands. Draining these more level uplands are several tributary creeks of the Willamette River. The creeks are important natural open spaces. Although these areas no longer contain their full diversity of species, as "drainageways" they're the major remaining habitats for fish and wildlife in the urban areas of the watershed. Riparian vegetation returns oxygen to the air, a real benefit to urban areas. It's also important because it reduces the velocity of surface runoff while it filters the water before entering the streams. "The drainageways create continuous, narrow strips of open space running considerable distances through the Newberg area," explains Newberg's *Inventory of Natural and Cultural Resources.* "They create natural buffer zones between uses," officials wrote in 1981, "and would be capable of supporting simple trails and bikeways as well as parks in some of the wider areas."

In the past, Willamette Valley rivers had extensive floodplains with closed-canopy forests of deciduous Oregon ash, alder, black cottonwood, big leaf maple, and conifers such as Douglas-fir, grand fir, and ponderosa pine. Western red cedar may have been present occasionally but since it is very fire sensitive it would not have been common. Regular burning by natural and human-set fires would have affected riparian forests but the higher levels of soil and plant moisture likely made them resistant to intense burning. Generally these forests extended over large parts of the river's floodplain and transitioned into wet prairies which were more open.

Today, the bottomland areas have been intensively managed for agriculture, and bottomland forests are typically only narrow strips along stream banks and increasingly rare hedgerows. In many areas, non-native blackberry dominates, exasperating the problems of diminished biodiversity, habitat, and understory growth. Where large woody plants are present, the dominant species are usually red alder, big leaf maple, and willow sometimes intermixed with second or third-growth conifers.

Under natural conditions, streams in relatively flat valley bottoms develop a meandering pattern that changes from year to year and includes sections of complex braided channels. Where beavers are present, their dams slow the water and trap sediment. As beaver ponds fill in, new channels typically form carrying the current around the obstructing dam. This also leads to multiple side-channels and a variety of habitats. Other obstructions such as fallen trees slow and reroute the water forming multiple shallow channels. Log jams and dense riparian vegetation slow and dissipated floodwaters over the adjacent floodplain. Sediments then have time to settle out and accumulate on these floodplains. Their seasonal inundation also serves to recharge groundwater levels that are the main source for summer flows. These conditions are prevented in much of the watershed due to downcutting, straightening, and dyke building along streams.

[3] The Willamette Valley is a distinct "ecoregion" according to current thinking in the biological sciences. There are nine such regions in Oregon. They're useful for extrapolating knowledge and best management practices to areas with similar ecology or conversely for understanding how conditions differ from one region to another.

Historically in the hilly parts of the watershed, riparian tree species were alder, maple, and Douglas-fir. This is contrasted with the bottomland riparian forests of Oregon ash, black cottonwood, Douglas fir, and bigleaf maple. Steeper stream gradient and less frequent fires characterized the hilly areas where mixed-forest riparian corridors have been logged or cleared for agriculture and are now primarily red alder and other pioneer species that thrive on disturbance. Non-native vegetation dominates many stream banks in the watershed. Once non-native invasives such as Himalayan blackberry become established, it is very difficult to remove them and re-establish native vegetation. Even native species such as Reed canarygrass can become invasive when they have been altered through breeding programs.

Forested riparian areas, especially those with large conifers, provide shade to keep stream temperatures cooler as well as large woody debris for slowing the flow and increasing complexity of the stream. Unfortunately, these forests are absent from large portions of the watershed and the trees that now fill riparian corridors are often too small for creating adequate complexity in the stream channels. Animals such as the Columbia white-tailed deer have also been affected. White-tailed deer depended heavily on the original riparian forests but have been forced out of the area or *extirpated* and have remained absent since the 1800s.

Prairie, Wet and Dry

Prairies dominated the Willamette Valley in prehistoric times. Approximately one third of the prairie was described as “wet prairie” in surveyors’ notes. The tall perennial grass species tufted hairgrass (*Deschampsia cespitosa)* is a good example of a native prairie species; it is well adapted to both periodic fires and hydric soils—soils that are inundated for a significant part of the year. It was an important source of forage for animals. Today it remains only in isolated remnants of prairie and where it has been reintroduced in restoration projects.

Numerous species in the lily family co-evolved with Native Americans in the valley who cultivated them in semi-wild settings for centuries. In addition to benefiting from periodic weeding and selection, they were well adapted to the annual burning practices of the Kalapuyan people. The fires knocked back the more competitive grasses and released nutrients allowing the lilies to flourish. Although many members of the lily family were utilized, the primary edible species was camas (*Camassia quamash*). Camas forms bulbs that many Western Indians dug and stored as a staple.

A 1919 study of grasses in the Salem area reported 106 species with 55 introduced and 51 considered

The Kalapuya burned prairies throughout the valley and into the foothills of the Coast Range to elevations of 1000 feet. Robert Boyd has reconstructed a likely scenario for burning:
In late spring and early summer the Indians were probably concentrated at "primary flood plain" sites in the wet prairies, where root crops such as camas were collected and processed. There was no burning at this time. During midsummer (July and August) the focus shifted to the dry prairies, and "narrow valley plain" sites were more intensively occupied. Burning in July and August was apparently sporadic, most likely occurring after the harvesting of seasonally and locally available wild foods (grass seeds, sunflower seeds, hazelnuts and blackberries), in limited areas. The intermediate effect of the early burns would be a "cleaning up" process; the long-term result would be to facilitate the re-growth, in future seasons, of the plants involved. In late summer fire was used, on the high prairies, as a direct tool in the gathering of tarweed and insects. This was followed, in October, by firing of the oak openings after acorns had been collected. Finally, from the "valley edge" sites, the Kalapuya initiated large-scale communal drives for deer, which provided a winter's supply of venison. The sequence ended as they returned to their sheltered winter villages along the river banks. (Robert Boyd, *Strategies of Indian Burning in the Willamette Valley*.)

native. One of the dominant grasses of the valley's native dry prairies was red fescue (*Festuca rubra rommerii*).

In both wet and dry prairies, shrubs and small trees such as hazel, serviceberry, and cascara were present. Again, they're well adapted to burning which consumes their woody, above-ground structure encouraging a burst of sprouts the following spring. This re-growth, we believe, was a major source of fiber for Indian clothing, shelter, and baskets.

Conifer Forest

In prehistoric times, there was relatively little conifer forest in the Chehalem Valley. Map 3 indicates conifers along both Hess Creeks and on the ridge of Chehalem Mountain. Interestingly, many of the conifers were in pure bottomland stands and intermixed with broadleaf trees along rivers and streams. Today, conifers are still found in riparian areas but they have also spread into the hilly areas of the watershed where they're found intermixed with deciduous trees and in small pure stands.   Conifers now account for over 20% of the vegetation cover of the Chehalem watershed.

In upland conifer stands, common understory plants include sword fern, salal, Oregon-grape, and red huckleberry. These areas generally support less understory vegetation than Oak-dominated forests, though, because of the closed canopy of larger conifers and the high density of young trees established after cutting or disturbance.

Laminated root rot may be a factor in the conifer areas of the watershed. A native root fungus, *Phellinus weirii,* causes laminated root rot in Douglas-fir trees, and eventually kills them. Infected trees are vulnerable to "windthrow" or blowdowns due to weakened roots. This is a bigger problem in the more mountainous and heavily forested areas in the Coast Range.

Gaps in the canopy provide light and moisture for understory species such as shrubs, hardwoods, and herbaceous ground cover. Dead snags provide habitat for many plants and animals as well as coarse woody debris for streams. This is important in many of the larger bottomland riparian forests where many of the watershed's conifers are found.

Oak Forests and Oak Savanna

The Oregon white oak (*Quercus garryana*) is found everywhere in the Willamette Valley (covering about one million acres) and on drier soils throughout western Washington and Oregon in coastal mountains and halfway up the eastern slopes of the Cascade mountain range. It is slow-growing compared to other deciduous trees and thrives where conifers are limited by low soil moisture. Two growth forms of Oregon white oak occur: forest and savanna. The majority of existing trees developed under forest conditions. These "forest-form" trees are relatively tall, seldom exceed 60 centimeters in diameter measured at breast height (dbh), and have ascending branches clustered near the crown. Their crowns form a closed canopy. The average age of mature forest-form trees (in 1968) was 90 years with a range of 47-135 years.

Scattered through the forest and remaining in some fields are a few large relict *Quercus garryana* apparently developed under non-forest conditions. These "savanna-form" trees generally exceed 1 meter dbh and their boles are short in relation to the total height of the tree.

They have massive branches and spreading crowns and are usually spaced so the crowns do not touch. There is an average of 17 savanna-form *Quercus garryana* per hectare (2.471 acres) in remnant oak savanna forests of the region. In 1968, their annual growth rings indicated an age range of about 260—310 years. Other studies indicate Oregon white oak may live over 500 years and reach 90cm dbh at only 250 years of age.

Many areas of the Chehalem Valley currently have both oak and Douglas fir-dominated forests forming a patchwork. Pacific madrone, another dry-soil tree, often occurs in large stands within oak-dominated forests. Western poison oak is also common in the understory. Yamhill County has a higher ratio of Oregon white oak than many surrounding areas. Typical oak forest animals include acorn-loving western scrub jays and western gray squirrels.

Historically, oak savanna covered a large portion of the Willamette Valley. It remains today primarily in isolated remnants on wildlife refuges or in thin bands where more dense oak woodlands transition into agricultural and residential areas. Savanna is characterized by mixed grasslands covering rolling hills with large, spreading Oregon white oak as the dominant tree. Black cottonwood, red alder and Oregon ash are also sometimes present. Historically oak savanna was quite open with expanses of grass between trees. The canopy has closed in to create an oak woodland where management prevents fire from keeping young saplings in check.

Older, dead, or dying Oregon white oak trees provide more “cavity” habitat than any other type of vegetation in the area. Twenty-eight bird species including white-breasted nuthatch and black-capped chickadee seek out these cavities along with small mammals that don’t seem as well adapted to Douglas fir-dominated woods.

A newly discovered oak disease (“sudden oak death”) has been gaining attention for attacking a variety of oak species in northern California and southern Oregon. University of California—Davis plant pathologist David Rizzo believes a two-tailed fungus with an appetite for oak bark is probably to blame for the death of thousands of black and tan oak trees in coastal California. Rizzo's investigation showed that the culprit is a novel fungus related to the organisms that caused the Irish potato famine of 1845-50 and the modern deaths of Port Orford cedar trees in Northern California and southern Oregon. Contrary to some reports, the pathogen is not related to the oak wilt fungus (*Ceratocystis fagacearum*), a disease of oaks in the eastern United States.

Once in the tree, the fungus produces enzymes that dissolve the dead outer and living inner layers of bark. Oozing sores result as the cell walls break down. As the disease progresses past the bark and into the wood, the tree becomes so weak that it is vulnerable to bark beetles, which burrow into the tree and kill it by blocking its circulatory system. The fungi move around by spores that can easily travel in infected wood and soil, on bicycle and car tires, on hikers' shoes, and on animals' feet. "Preventing the movement of soil and wood will be critical to slowing the spread of the fungus to other oak woodlands," he says. "In particular, firewood and soil should not be moved from [potentially infected] areas." Any wood already moved elsewhere should be burned.

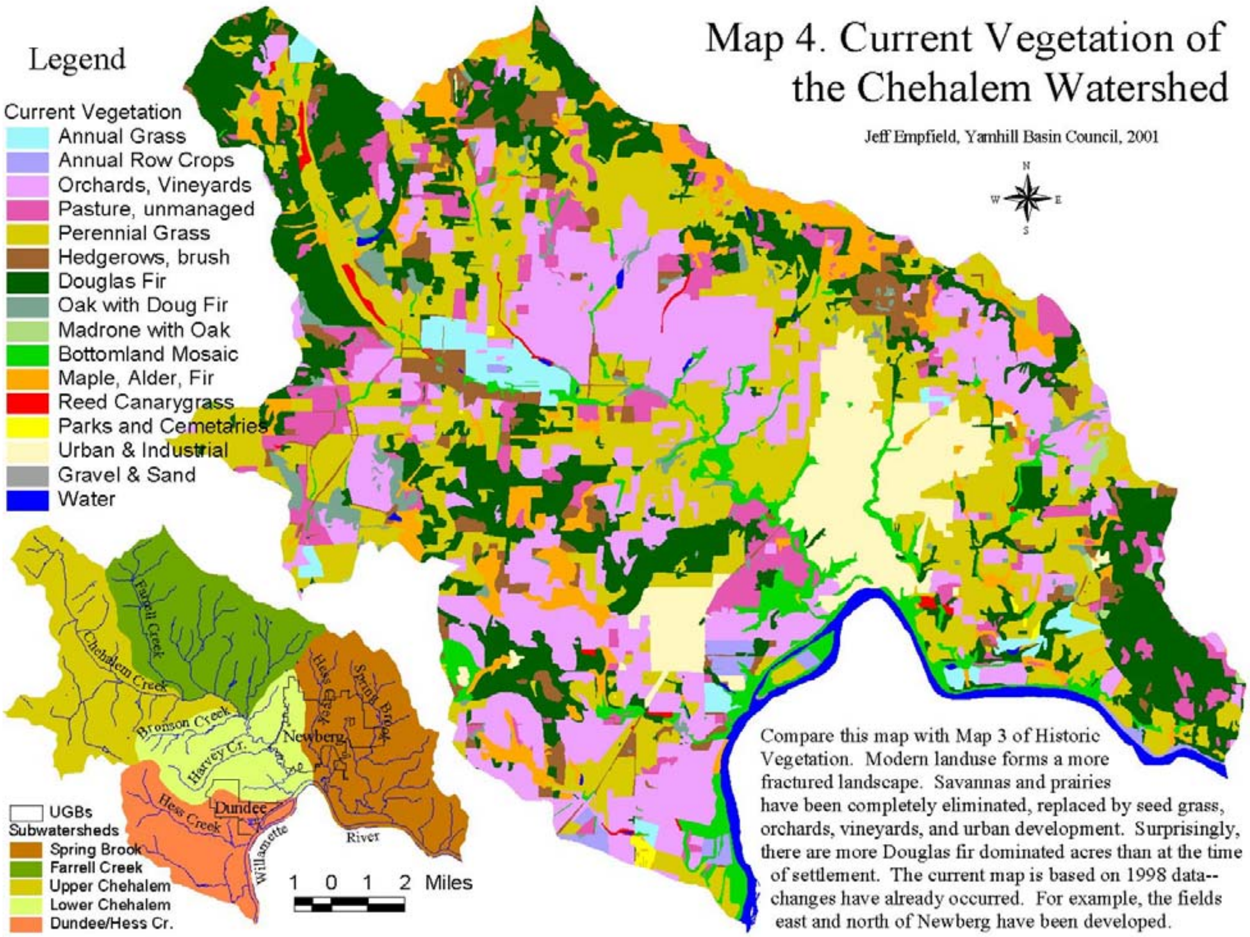
Current Vegetation

Map 4 shows the current vegetation of the watershed. The basis for this map is a 1998 study conducted by the Oregon Department of Fish and Wildlife (ODFW) Ecological Analysis Center

Table 7. Current Vegetation and Land Use in the Chehalem Valley

Vegetation/Land use	Acres	Percent of Watershed	Explanation of vegetation and land use classes
Row crops	343	0.79%	Farmland could be vegetables or herbs.
Annual grass	822	1.89%	Farmland for production of wheat, oats, barley, and rye. Generally, without irrigation.
Perennial grass	10,978	25.29%	Farmland for production of perennial grass especially grass seed and hay. Also without irrigation.
Orchards, berry farms, nurseries	8,951	20.63%	Farmland used for fruit trees, berries, Christmas trees, and nursery stock usually requiring a high volume of water for irrigation.
Unmanaged pasture	2,594	5.98%	Farmland that appears to have no active management such as fertilizer application, irrigation or weed control. Might be grazed. Land usually has been cleared and farmed intensively for some time.
Parks, cemeteries	67	0.16%	Too small to be seen on this map.
Urban & industrial zones	2,975	6.86%	Includes current areas of industry and housing in towns and subdivisions, not urban growth boundaries. It depicts actual land use at the time of mapping.
Water	728	1.68%	Only areas of water that have enough surface area to be seen at this scale are shown on the map.
Black hawthorn, riparian, hedgerows	1,965	4.52%	Many of these areas are too small to be seen clearly on the map at this scale.
Reed canarygrass	171	0.39%	Promoted as a forage grass, it now overwhelms many wetlands and riparian areas as an unwanted invasive. Native but altered through breeding.
Ash, cottonwood, maple bottomland	1,839	4.24%	This habitat is usually a seasonal wetland, bordering streams and standing water. These areas are sometimes too thin to be seen on the map at this scale. Expect trees, willow, and emergent wetland species.
Oak mostly w/ Douglas-fir	848	1.95%	Usually very diverse habitat with many species of forbs and grasses in the understory.
Oak, madrone	89	0.21%	Not possible to see easily at this scale.
Maple, alder, fir Hardwoods dominant	2,477	5.71%	Along streams typically in response to logging or fire where conifers weren't actively planted.
Douglas-fir	8,549	19.69%	In many areas in planted pure stands. Unharvested Christmas tree plantings likely got this classification too.
Gravel bars or sand	3	0.009%	Shows areas where there is commercial gravel and sand operations. Larger quarries are included in the urban and industrial category.
Total	43,399	100%	

and the Northwest Habitat Institute (NWHI). They mapped 90% of the landscape through field surveys and the remaining 10% using aerial photos. They estimate their accuracy for Yamhill County at 83%. Some uncertainty is due to the difficulty in differentiating between annual and perennial grasses—large fields of lawn regardless—but significant due to the loss of soil accompanying cultivation for annual grasses.



Like all maps, this one represents a moment in time and any changes in land use since the late 1990s is not reflected here. For our purposes there has been little change in the vegetation pattern in the watershed since the survey. Approximately 27,600 acres or 64% of the watershed is non-forested—lands under cultivation or development. On the forested land, conifers make up 30% of the mixed forest while hardwoods comprise 70%. Other analyses frame the Yamhill County proportion of hardwoods at about 20% of the total land coverage compared to the regional (northwest Oregon) average of only 7% hardwood coverage.

The current and historic vegetation maps are even more informative when compared with one another. It's interesting to locate an area with which you're familiar to see how accurate the current map is and what vegetation was likely there a hundred and fifty years ago. You may enjoy theorizing about what caused the changes and why. What is desirable about the current pattern of vegetation and what, if anything, is undesirable?

The value of knowing historic conditions is having a benchmark for the scale of change resulting from modern land management. "Wet prairie," for example, is virtually non-existent in the area now. Much of the valley's wetlands are now cultivated land and have been tiled, ditched, and drained over the past century. Conversely, the amount of forested land has increased. The lack of fire has allowed Douglas-fir, especially, to expand its range. Compare these maps with Map 10 for areas under irrigation for another major factor effecting vegetation and water.

Non-native Plants

Non-native species (also known as exotics) are species that have been introduced from other regions or, in many cases, from the other side of the globe. Oftentimes, exotics don't do well because they have evolved under different conditions and aren't adapted to the local climate. In other cases they do extremely well and become invasive. When this happens native species often have no adaptation to compete with the new invasive. There are now whole books documenting how agriculturists and land managers have relocated plants and animals around the world only to lose control of them causing unwanted and unforeseen consequences. It's interesting to note the definition of "weed" is simply an unwanted or problematic species. Further, many of today's "weeds" were intentionally introduced before we had a sufficient understanding of the interconnected nature of things. Human folly is never better illustrated than by introductions gone awry followed by additional introductions meant to correct the initial problem which then also become "weeds."

The Oregon Department of Agriculture (ODA) identifies noxious weeds as plants having the potential to cause economic losses. It is very costly to eliminate them once they're established and usually requires intensive herbicide application to manage the population. Some species have bio-control methods available, but these are the minority. The BLM identifies Scotch broom (*Cytisus scoparius*) and tansy ragwort (*Senecio jacobaea*) as two species of major concern. Scotch broom is listed due to its ability to over run land, and tansy ragwort is listed due to its toxicity to cattle.

Note that Reed canarygrass (introduced for livestock forage) covers over 170 acres of the Chehalem Valley—usually in already degraded streams and increasingly rare wetlands but also in the numerous small draws and irrigation reservoirs. Yamhill County farmer Sam Sweeney has an idea for how to increase beneficial shade on these reservoirs while at the same time suppressing Reed canarygrass. His idea is to deepen reservoirs in some areas while creating an island in the middle. On the island he suggests planting trees to shade the water. The deeper water resulting from excavation would prevent Reed canary from completely dominating the reservoir, Sam theorizes, as it thrives in shallow water.

The Native Plant Society of Oregon lists 37 noxious invasive species for the region. These species are sometimes cultivated by gardeners who aren't aware of the problem, being sold by local nurseries, or are introduced through some other means such as vehicle or animal transport. The current list of noxious weeds compiled by the Yamhill Soil and Water Conservation District includes two new additions: Himalaya blackberry and Reed canarygrass. The complete 2000/2001 noxious weed list appears below. These weeds typically invade disturbed areas and form monocultures making regeneration of native species very difficult.

English ivy is not on many weed lists yet but is increasingly recognized as a problem. It is one of the few exotics that can become established and grow in deep shade. English ivy forms thick carpets on the forest floor and chokes out native vegetation, including tree seedlings. It creeps up trees into the canopy, flowers and forms berries. Birds eat the berries and disperse seeds to other locations. Seedlings emerge and start new infestations. The vines weigh down tree branches causing them to break. English ivy is a threat to the integrity of area forests. To suppress it you can cut vines from trees. This will only kill the vines growing on the tree, though. To eradicate it, stems and roots on the ground must be pulled and then monitored for resprouts.

Table 8. Yamhill County Priority Noxious Weed List

Common Name	Scientific Name	ODA Class	List Date
High Priority For Control			
Italian Thistle	*Carduus pycnocephalus*	B	1-29-90
Meadow Knapweed	*Centaurea pratensis*	B	8-13-90
Purple Loosestrife	*Lythrum salicaria*	B	2-26-91
Gorse	*Ulex europaeus*	B, T	1-29-90
Spurge laurel	*Daphne laureola*	Not listed	May 2, 01
Important To Control *Agric.* - Denotes species that are primarily a problem in agricultural production.			
Milk Thistle – *Agric.*	*Silybum marianum*	B	11-13-89
Canada Thistle	*Cirsium arvense*	B	11-13-89
Tansy Ragwort	*Senecio jacobaea*	B, T	11-13-89
Scotch Broom	*Cytisus scoparius*	B	11-13-89
Field Bindweed - *Agric.*	*Convolvulus arvensis*	B	2-26-91
Large Crabgrass - *Agric.*	*Digitaria sanguinalis*	-	2-26-91
Blackgrass - *Agric.*	*Alopecurus myosuroides*	B	3-26-97
Velvetleaf - *Agric.*	*Abutilon theophrasti*	B	3-26-97
Field Dodder - *Agric.*	*Cuscuta pentagona*	B	3-26-97
Himalayan blackberry	*Rubus discolor*	B	5/23/00
Reed Canarygrass	*Phalaris arundinacea & aquatica*	Not on list	5/23/00
Puncturevine	*Tribulus terrestris*	A, B	3/03/93
English Ivy	*Hedera helix*	B	5 / 2 /01

ODA Classifications: (Yamhill County SWCD, Updated May, 2001)

"A" Weeds - a weed of known economic importance which occurs in the state in small enough infestations to make eradication/ containment possible; or is not yet known to occur, but its presence in neighboring states makes future occurrence in Oregon seem imminent.

"B" Weeds - a weed of economic importance which is regionally abundant, but which may have limited distribution in some counties and is important to control where found.

"T" Weeds - a priority noxious weed designated by the Oregon State Weed Board as a target weed species on which the Department will implement a statewide management plan.

The Meadow Knapweed Control Area

Meadow knapweed has become established in an area of about 200 acres north of Newberg in recent years. It's an aggressive weed that spreads rapidly and takes over fields, pastures, and roadsides. It loves open ground and crowds out more slow-growing native plants. Meadow knapweed is a native of Europe but is increasingly found in the Northwest from British Columbia to northern California. In Oregon, it is found in several locations west of the Cascades, especially in Douglas County where there are several extensive infestations. The knapweed found north of Newberg is the only known location of this particular invasive exotic in Yamhill County and presents a unique weed control opportunity.

Dean O'Reilly of the Yamhill County Soil and Water Conservation District identified it several years ago and has helped Chehalem Valley residents get organized to address the problem. The meadow knapweed control area includes properties on Herd Road, View Crest Court, Wilkerson

Way, Slope Lane, and Mountain Top Road. The best solution is to pull or dig out individual plants before they go to seed. Wear gloves, though, as some reports suggest knapweed is a carcinogen. With large areas, mowing or spraying may be the most realistic approach. Landowners are working together and individually to eradicate plants through a combination of mowing and spraying herbicides. Last year, six landowners hired commercial herbicide sprayers to spray approximately 28 acres in the control area while others shared hand-held herbicide sprayers for spot spraying their own land. There is a local citizen coordinator who distributes SWCD equipment and herbicides for landowner use. If you can avoid using chemicals then by all means do so. If you must use chemicals then use only what is required to accomplish the job. Also, don't spray chemicals in or near water.

Dean O'Reilly estimates that landowners were able to eliminate up to 90% of the plants in 2000. They are continuing with their efforts in 2001. If you think you may have meadow knapweed in your area or if you have any questions, call Dean at the SWCD office at (503) 472-6403.

Sensitive Species

The Federal or State government lists nine species native to the watershed as rare, threatened, or endangered. These species have been field-verified by the Oregon Natural Heritage Program (ORNHP, 1998). Additionally, the BLM lists 16 species as special status species and seven species as sensitive species that may be present in the watershed.

Historically, these species were much more widespread than they are today. The importance of preserving their habitat and working to ensure their future survival is important generally for preserving Oregon's natural heritage. Preserving biodiversity is significant for more specific reasons, as well, but these often become apparent only after we've lost something. With the loss of any species—whether it is plant, bird, fish, mammal, amphibian, insect, or soil bacteria—a valuable piece of the ecosystem in which we live is lost.

Often we hear about the loss of genetic diversity and think that it is inevitable, natural, or that we have no role in it. Strictly speaking, extinction is natural and inevitable over the course of millions of years with the number of species on earth. But humans currently have an unnaturally inflated influence on extinction due to our fossil-fuel-driven growth in population, technology, and consumption. We now threaten even our own extinction. It is simply enlightened self-interest to pay attention to the health of local species.

The following list gives the names of the species that are in danger of disappearing from this watershed. Please consult one of the following organizations to learn more about any of these species listed here.

The Oregon Natural Heritage Program
821 SE 14th Avenue
Portland, OR 97124-2531
(503) 731-3070 ext. 335 or 338
http://ocelot.tnc.org/nhp/us/or/index.html#mission

Bureau of Land Management
Salem District Office
1717 Fabry Road S.E.
Salem, OR 97306

Table 9. Threatened, Endangered, or Sensitive Species of the Chehalem Valley.

Threatened species listed by ESA and state of Oregon	
Sidalcea nelsoniana	Nelson's sidalcea
Lupinus sulphureus ss Kincaidii	Kincaid's lupine
Candidate for protection under ESA	
Icaricia icarioides fenderi	Fender's blue butterfly
Species of concern listed by ESA	
Cimicifuga elata	Tall bugbane
Megascolides macelfreshi	Oregon giant earthworm
Myotis evotis	Long-eared bat
Rhyacotriton variegatus	Southern seep salamander
State of Oregon candidate for listing as endangered or threatened	
Delphinium oreganium	Willamette Valley larkspur
Sidalcea campestris	Meadow checker-mallow

Table 10. Special Status Species Possibly Native to the Chehalem Valley.

Aneides ferreus	Clouded salamander
Brachyramphus marmoratus	Marbled murrelet
Haliaeetus leucocephalus	Northern bald eagle
Accipiter gentilis	Northern goshawk
Strix occidentalis	Northern spotted owl
Dryocopus pileatus	Pileated woodpecker
Arborimus longicaudus	Red tree vole
Myotis evotis	Long-eared Myotis
Myotis thysanodes	Fringed Myotis
Myotis volans	Long-legged Myotis
Lasionycteris noctivangans	Silver-haired bat
Rhyacotriton kezeri	Columbia torrent
Rhyacotriton variegatus	Southern torrent salamander
Rana Aurora	Red-legged frog
Ascaphus truei	Tailed frog
Phenacomys albipes	White-footed vole

Table 11. Sensitive Species Possibly Native to the Chehalem Valley.

Agrostis howellii	Howell's Bentgrass
Castilleja levisecta	Golden paintbrush
Cimcifug elata	Tall bugbane
Delphinium leucophaeum	White rock larkspur
Delphinium pavenaceum	Peacock larkspur
Filipendula occidentalis	Queen-of-the-forest

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J.E. Kirkwood, "The vegetation of Northwestern Oregon," *Torreya*, September, 1902.
Northwest Habitat Institute website.
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Dean O'Reilly, personal communication, March, 2001.
John F. Thilenius, "The *Quercus Garryana* Forests of the Willamette Valley, Oregon," *Ecology*, Autumn, 1968.
UC Davis Expert Identifies Oak-Tree Killer and Warns Public to Use Caution, UC Davis website.

CHAPTER 4

Riparian Areas and Wetlands

Riparian Conditions

"Riparian" is from the Latin *ripa* meaning "stream bank." Riparian areas generally include the stream or river and the land next to it. For certain purposes we use more specific definitions and say the riparian area includes everything within a certain distance of the water. This is somewhat arbitrary but serves some purposes. We can also base our definition on ecological conditions that indicate the effected area. By this more ecological definition, not only the stream and riverbanks are included but also wetlands or any part of the landscape with enough moisture to support the unique combinations of plants and animals typically found in the riparian zone. Riparian areas generally have higher moisture levels in the soil than the adjacent land. The elevated moisture level supports a more diverse and productive ecosystem.

Land managers often regard riparian areas as a buffer zone because the vegetation and soil functions as a filter and "buffers" the stream, hopefully, from pollutants picked up as rainfall flows over our roads, lawns, and fields.

The beneficial effects of riparian vegetation on aquatic life include cooling shade, balanced water chemistry, and nutrient assimilation and transformation from the surrounding soil. The absence of adequate vegetation results eventually in the depletion of aquatic nutrients. Large woody debris (LWD), which only a few decades ago we considered detrimental to stream health, is now recognized as integral to many functions essential to clean, cool water. For example, logs in the water will retain about half of the gravel and sediment where it is. This in turn helps to create terraces, meanders, larger riparian zones, a pool and waterfall pattern, and less powerful floods.

The Importance of Large Woody Debris

Throughout the Willamette Valley, logjams or "large woody debris" (LWD) are lacking from streams and rivers. Large trees that fall into streams are beneficial for a variety of reasons, not least of which because they're a natural source of in-channel habitat diversity. Land managers with a propensity for jargon refer to trees falling into streams as "LWD recruitment." Of course, trees need to be close enough to the stream to be "recruited" when they fall down. The size and diameter of the trees necessary to perform this function is directly related to the size of the stream. Streams with higher flows and wider streambeds need larger trees in order for the wood to remain in place during winter storms.

LWD lodged in the streambed slows down the water and causes sediment to settle creating gravel beds, sand bars, and silt terraces. The downstream side will often develop a scour pool due to the force of the water moving over or under the wood.

Riparian vegetation influences fish habitat and water quality in a variety of ways including:
- Shade, which helps prevent extreme daily fluctuations in water temperature and provides fish cover from predation.
- Stabilizes the stream banks, which decreases erosion and prevents downcutting of banks.
- Provides habitat for insects and macro-invertebrates, which are a food source for fish.
- Provides detritus or organic litter to the stream, which adds nutrients to the entire ecosystem.
- Riparian areas are also important sources of large wood for the stream system. Large wood is vital for fish habitat because it provides cover for fish, diverts channels and obstructs flows, which in turn increases channel and habitat complexity.

Farmers' Historical Use of Creeks

According to Dayton area farmer Sam Sweeney, landowners historically depended on creeks and riparian areas for several uses. Livestock grazing in the past was nearly always confined to the riparian areas, he explains. This was because farmers wanted to use the more level tillable acreage for grain and other cash crops. "Not wanting to waste tillable crop land," he says, farmers "would fence and keep their livestock in the riparian areas close to the creeks." These areas not only provided pasture and shade, but also drinking water.

Old property lines illustrate the widespread importance of access to bottomland areas for early farmers. Sam discovered this pattern when his family bought their farm on the east branch of Palmer Creek near Dayton. "I often wondered why the donation land claim was divided into different boundary configurations with each parcel having access to the creek," he says. When asked, the previous owner of the farm replied that the original landowner had given his daughters parcels of land and wanted them each to have access to the creek for their livestock

Sam estimates that approximately 60% to 70% of streams in the area were utilized this way. Why isn't this true today? The livestock industry has bypassed the small producer, Sam explains, and few mixed family farms remain. Livestock in Yamhill County is now kept primarily for recreation and fields previously reserved for cropping are now used for pasture.

Landowners also used riparian areas as a source of forest products. Wood lots would often be close to the creek or within the riparian areas. They were considered a "nest egg" that landowners could use during hard times or to meet a particular need for lumber. This is still true today, he points out. A significant difference was that in the past, the forest would reseed itself. "The area did not have the blackberries," Sam says, "that would take over and hold back the growth of the seedlings." People rarely took an active role in replanting trees, he recalls, until the 1940s when foresters introduced the idea.

Another common use of creeks in early times was for power and transportation for lumber or flour gristmills. People would be busy during the spring and summer months with planting and harvesting. But after winter rains began, they would have time to work in the mill and naturally there would be more flow in the creeks to drive a small mill. The area creeks were also used for transporting logs in the winter months during high water. To supply the mills with logs, trees would be felled, probably on the upper ground that would be later cleared for crops. The logs would be drug down to the creek bottoms with horses in the spring, summer, or fall. Then men would secure them with ropes, wait for high water, and float them downstream to the mills. Early settlers built saw mills as early as the 1840s or 1850s. Initially they used waterpower for sawing logs. Later, steam engines and internal combustion engines powered mills in the area.

Map and Photo Analysis

Map 5 indicates the dominant vegetation type for each section of stream in the watershed. It also gives an estimated width of the riparian zone as non-existent, 0-50 feet, or over 50 feet. The five dominant vegetation categories are brush, conifers, grass, hardwoods, and "mixed" which in our area is typically either brush or grass interspersed with broadleaf trees. The "non-existent" category indicates stretches of waterway where there is no riparian vegetation to speak of. In many cases the streambed itself has been altered beyond recognition.

Black and white aerial photographs on the scale of 1:660 (one inch equals 660 feet) from the Farm Service Agency in McMinnville served as the primary source for evaluating riparian conditions. Periodically the agency makes a new series of aerial photos covering the countryside. The most recent series for Yamhill County dates from 1994 and shows summer conditions. Summer vegetation photographed in black and white from ten thousand feet is sometimes difficult to differentiate—between hardwoods and conifers, for example. Aerial photos taken in the winter, done most recently in 1980, show standing water (possible historic wetlands with hydric soils) and more clearly contrast evergreen and deciduous vegetation. The Yamhill County Soil Survey and U.S.G.S. topographical maps helped in locating landmarks and stream channels in the photos.

It was not possible to differentiate between the left and right banks for any stream other than the Willamette River. Small streams are difficult to see on aerial photographs—they are often dry, or nearly so during the summer, and at other times they're obscured by vegetation. Where the actual channel was not visible but apparent because of the narrow band of vegetation (its riparian zone), it was sufficient to make estimates using the middle of the band of vegetation.

Current riparian conditions can be compared with what historically would have been found in the watershed. The scale of the historical vegetation map and the current vegetation map do not allow detailed ecological comparisons for each waterway. Rather, general conclusions about the historic conditions versus current conditions can be made.

The reaches represented on the map included here are approximations only and are not meant for use in determining precise locations for restoration or enhancement projects. More in-depth analysis of a specific area is recommended before proceeding. This information is meant to provide a starting point for identifying areas of concern, not to pinpoint specific locations. Please consult the YBC at (503) 472-6403 if you have specific questions.

Map 5. Riparian Conditions of the Chehalem Watershed

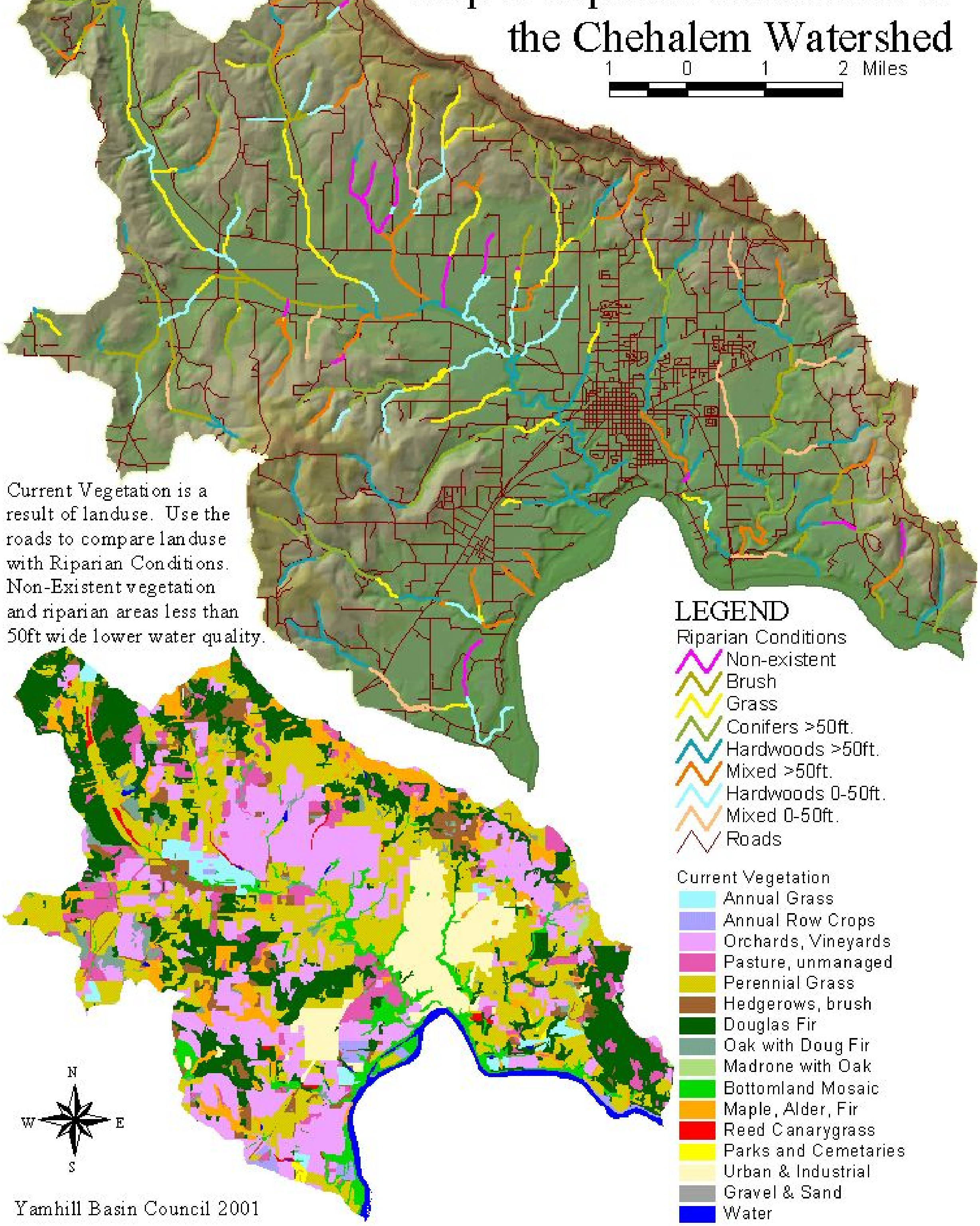

Table 12 gives the miles of stream in each riparian class. The majority of streams surveyed are bordered by either a narrow or wide band of hardwoods. It is important to note that more than 5% of the riparian areas surveyed are now non-existent due to industrial or agricultural development. By non-existent we mean they are shown on topographical maps but appear to no longer exist as natural waterways with riparian vegetation. Map 5 indicates riparian conditions with different colors. The hot pink segments indicate "Non-existent" streams with little or no vegetation and altered stream characteristics. These are areas of concern.

Table 12. Riparian Condition Units for the Chehalem Watershed

Riparian description	Length (miles)*	Percent of total
Non-existent	6.37	5.1%
Brush.	13.01	10.41%
Grass	18.53	14.82%
Conifers, >50 ft.	21.14	16.91%
Hardwoods, >50 ft.	26.37	21.09%
Mixed, >50 ft.	16.97	13.57%
Hardwoods, 0-50 ft.	15.1	12.08%
Mixed, 0-50 ft.	7.53	6.02%
Total	125.02	100%

* Includes all streams and in-stream reservoirs. These numbers exclude off-stream ponds and reservoirs as well as the Willamette River.

Ideally, riparian areas that contribute LWD should include some conifers. Hardwoods decompose more easily in moist conditions and do not provide structure and complexity in the stream for as long as conifers. Based on air photo analysis and field verification, it appears that conifers are lacking from many riparian areas in the watershed.

Wetlands

The Oregon Division of State Lands defines wetlands for removal-fill permits as:

> …those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

There are many different types of wetland, but they share three characteristics: water, saturated soil, and wetland plants.

1. An abundance of water from either high water table, rain water "perched" over impervious layers in the soil, frequent flooding, or groundwater seeps is necessary. However, there does not need to be visible water year round. This is the area of wetland determination that people find most difficult to understand. Water levels vary from year to year and season to season within a given year. That is why standing water is only one of three components that need to be examined.
2. Hydric soils that developed under mostly saturated conditions. Soil scientists have established criteria for identifying soils that have historically been saturated for a period of time on an annual basis. These are associated with wetlands.

3. A plant community called hydrophytes, plants with special adaptations for life in permanently or seasonally saturated soils.

Wetlands can be dry during summer months and still be a wetland, though we may call it something else. Sometimes we refer to wetlands as swamps, marshes, or bogs. They can also be called wet meadows, swales, seasonal seeps, and sometimes even ditches if there is standing water part of the time and other conditions are right to create wetlands.

To be considered a wetland for legal purposes, a piece of land must meet two of the three criteria. Agricultural areas are assessed on the basis of hydrologic conditions and soils since cultivation typically precludes wetland vegetation. The absence of wetland vegetation does make delineation more challenging, but if a piece of land meets the other two criteria, it can be reliably considered a wetland. A wetland does not have to be mapped by the state or otherwise designated to enjoy wetland protection under state and federal regulations.

Wetlands play numerous roles in the health of the watershed. Their benefits include:

- Connecting upland and aquatic ecosystems, necessary for many species.
- Connecting lakes, streams, rivers, and riparian areas with one another.
- Capturing sediment from erosion runoff.
- Consumption of nitrogen from agricultural runoff.
- Recharging groundwater by retaining water that percolates into the ground.
- Maintaining more steady flows to streams by slowing peak flows.
- Flood mitigation for the same reason.
- Providing habitat for wildlife including rare and endangered species.
- Open space, outdoor recreation, education, and aesthetics.

Of course not all wetlands provide all these benefits or provide them to the same extent. Each one has a unique setting and provides different functions as conditions fluctuate. It is safe to say that wetlands provide many benefits.

Several agencies are involved in the regulation and protection of wetlands including:

- Oregon Division of State Lands (DSL)
- State Department of Forestry under the Forest Practices Act
- U.S. Natural Resources Conservation Service (NRCS) under the Farm Bill
- U.S. Army Corps of Engineers under the federal Clean Water Act and the Harbors Act.

In seeking to understand wetland conditions in the Chehalem watershed, we need information on both current and “prior converted” wetlands. Prior converted—labeled PC on many photos and maps—means simply that these wetlands were converted to non-wetland uses such as pasture or cultivation prior to our current understanding of the importance of wetlands. Until passage of the 1985 Farm Bill we subsidized, encouraged, and facilitated draining of wetlands for cultivation. In ’85 there was a change in policy concerning wetlands ending these subsidies. Of course we continue to lose wetlands through a myriad of development pressures.

The location of prior-converted wetlands are identified by a variety of sources including:

- Soil Conservation Service soil surveys of Yamhill and Polk counties (1974, scale 1:20,000)
- National Wetlands Inventory (NWI) maps (1976, 1982, scale 1:24,000 and 1:62,500)

- USGS topographical maps (scale 1:24,000)
- Farm Service Bureau black and white aerial photos (1994 summer fly-over, scale 1:660).

Wetland Distribution and Trends

As part of a National Wetlands Inventory (NWI), the U.S. Fish and Wildlife Service mapped our remaining wetlands using color infrared aerial photographs at a scale of 1:58,000. Most wetlands on the map are not field-verified. The minimum acreage mapped is two acres so smaller wetlands do not appear, though many remain. Wetlands that are cultivated but not classified as prior converted for one reason or another are not included in NWI maps but may still be regulated. Further information is available from a series of DSL flyers called *Just the Facts....* These include guidance for how to identify, assess, and inventory wetlands. NWI maps are available in digital form through the NWI website. The data on Map 6 came from there.

Hydric soils—outlined on soil maps and elsewhere—are another indicator of current and historic wetlands. Hydric soils have formed under predominantly wet conditions as in a wetland. The locations of hydric soils in Yamhill County are available in digital format from the BLM and are shown in Map 6. For more information regarding the location or significance of these soils, contact the Yamhill Soil and Water Conservation District at (503) 472-6403.

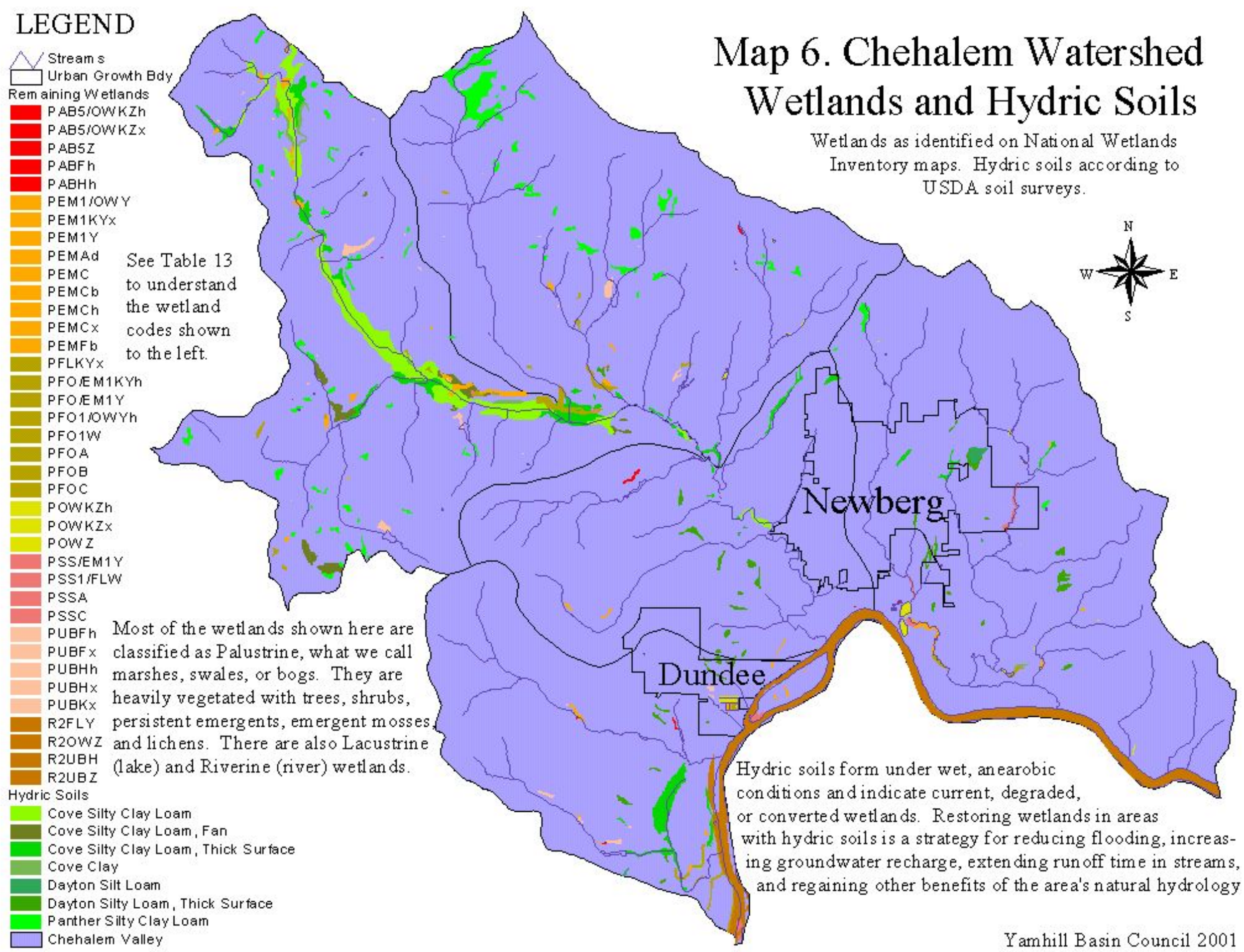

Table 13 shows the wetland classifications that apply to the Chehalem watershed. Each wetland marked on a NWI map has a code indicating whether it is palustrine (associated with standing shallow water), riverine (associated with flowing water) or lacustrine (lakes). Wetlands are described further by subsystem codes that describe their hydrology. The final level is the class level, which describes the vegetation or substrate. The classification system also includes "special modifiers" that can be used to describe human alterations to the wetland.

Table 13. Wetlands Descriptions

Ecological System

The First Character in the Wetland Label (i.e. **P**UBHx**)**

Palustrine (P) These are the freshwater wetlands commonly referred to as marshes, bogs, and swamps. Included are wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and some non-vegetated wetlands that do not meet the criteria for Lacustrine wetlands.

Riverine (R) River, creek and stream habitats contained within a channel, where water is usually, but not always flowing. Riverine systems are usually unvegetated but may include nonpersistent emergent vegetation; Palustrine (persistent vegetation) wetlands are often adjacent to Riverine system or contained within them as islands. R2 is Lower Perennial.

Laustrine (L) Lakes, Reservoirs, and deep ponds. Typically there is an extensive area of deep, open water and wave action.

Classes

The Middle Characters in the Wetland Label (i.e. P**UB**Hx)

Aquatic Bed (AB)
Wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season during an average year.

Unconsolidated Bottom (UB)
Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7cm) and a vegetative cover less than 30%.

Emergent Wetland (EM)
These wetlands have rooted herbaceous vegetation standing above the water or ground surface.

Open Water (OW)
Areas of open water or water with unknown bottom.

Scrub-shrub Wetland(SS)
Wetlands dominated by shrubs and tree saplings that are less than 20 feet high.

Forested Wetland (FO)
Wetlands dominated by trees that are greater than 20 feet high.

Unconsolidated Shore (US)
Unconsolidated substrates with less than 75% area cover of stones, boulders, bedrock; less than 30% area cover of vegetation other than pioneering plants; and any of the following: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, seasonal-tidal, temporary-tidal, or artificially flooded.

Modifiers

The Last Characters in the Wetland Label (i.e. PUB**Hx**)

Temporarily Flooded (A)
Saturated (B)
Seasonally Flooded/Well Drained (C)
Semipermanently Flooded (F)
Permanently Flooded (H)
Artificially Flooded (K)
Intermittently Flooded/Temporary (W)
Saturated/Seasonal (Y)
Intermittently Exposed/Permanent (Z)

Special Modifiers	
b Beaver **dd Partially Drained** **f Farmed**	**h Diked/Impounded** **r Artificial Substrate** **x Excavated**

The majority of wetlands in our area are long and narrow—too narrow to be mapped at this scale. Linear-shaped wetlands are characteristic of the Willamette Valley where wetlands have typically formed in abandoned river and stream beds or in low-lying draws between hills rather than in the classic manner of glaciated kettles or potholes.

The distribution and acreage of wetlands shown on the map only approximates actual wetlands. Again, it's important to remember that NWI maps are not very useful on a small scale for identifying local wetlands. Unfortunately there is no definitive source of information about all the area's wetlands or about specific parcels of land.

The area of hydric soils in the Chehalem Valley is larger than the area currently designated as wetlands. We have an inherent conflict because most wetlands occur in the lower, more flat parts of the landscape and these areas are also desirable for farmland. The vast majority of land under cultivation in the watershed, (greater than 50% and maybe up to 80%) is tiled to drain water from fields in order to improve access for large machinery earlier in the growing season. There has not been any monitoring to document this and records of tiling are not open to the public. Drainage tiles carry water away that previously would have remained in the ground and gradually percolated into aquifers and supplied springs and streams with year-round flows.

The Oregon Department of State Lands uses the Cowardin system of wetland classification as do the NWI Maps. This makes it easy to compare conditions across the state. More specific descriptions are used when developing Local Wetlands Inventories (LWI) which are usually completed as a partnership between the Oregon Division of State Lands and a local community.

Conclusions

Historically, wetlands were much more extensive in the valley than they are today. With European-American settlement, Kalapuya burning ended allowing woody vegetation to move in. Over the past century and a half wetland acreage has been significantly reduced through draining and tiling in order to make cultivation possible earlier in the growing season. Wet prairie is now almost non-existent in the watershed. It once played a significant role for providing habitat for aquatic wildlife, provided off-channel storage of floodwaters, and groundwater recharge to the system during low-flow summer months.

Wetland restoration and enhancement projects help restore some of these functions to the watershed. Converted wetlands in developed areas will likely not be reclaimed in the foreseeable future, though. So it's important to determine where the best opportunities exist to enhance, restore, and even create wetlands to mitigate or compensate for the net loss in wetland function in the area. A good place to start may be to complete local wetland inventories or to raise awareness of the problem simply by talking with your neighbors. Also, state and federal assistance may be available for landowners that want to enhance, restore, or create wetland functions on their land

For more information contact the Oregon Freshwater Assessment Methodology (OFWAM), Wetlands Program, Oregon Division of State Lands, 775 Summer Street NE, Salem, OR 97310

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CHAPTER 5

Channel Habitat Types

Channel Habitat Type (CHT) is a classification system for the physical characteristics of our streams. The Oregon Watershed Assessment Manual (OWAM) draws on several stream classification systems already in use to classify Oregon streams into one of 15 types of channel habitat.[4] The Yamhill Basin doesn't have coastal estuaries, high mountains, or desert environments so not all of the OWAM designations apply. For the current watershed assessment, we only needed to use seven.

CHT classifications are based on apparent conditions recorded in aerial photos and USGS 1:24,000 topographical quadrant maps. For this assessment, the maps were particularly important for estimating gradient, confinement, and size of floodplains. Only perennial streams (those with year-round flow) are included. Each stream is divided into segments according to their pattern of steepness, confinement, and size. Segments of at least 1,000 feet appear on Map 7 in the color corresponding to the likely CHT conditions present.

Stream channels in our area do not always fit clearly into one CHT category. This is due in part to the imperfect nature of all classification systems—they simplify things. It's also partly due to the altered physical condition of the area's streambeds because now they don't always follow the natural patterns that the categories aim to characterize.

Incision or Downcutting

Many of the stream beds in the Chehalem Valley are deeply incised or downcut meaning they have steep banks which greatly impact the stream's natural meandering and seasonal flooding. A natural bottomland stream is typically flooding regularly, creating new meandering channels, and depositing sediments. In their natural state, they are *Flood Plains* (FP1, 2, or 3).

[4] OWAM's CHT system synthesizes six other systems that focus variously on mountain and forest streams, Washington and Alaska streams, stream habitat, map-based surveying, physical geology, and geomorphology.

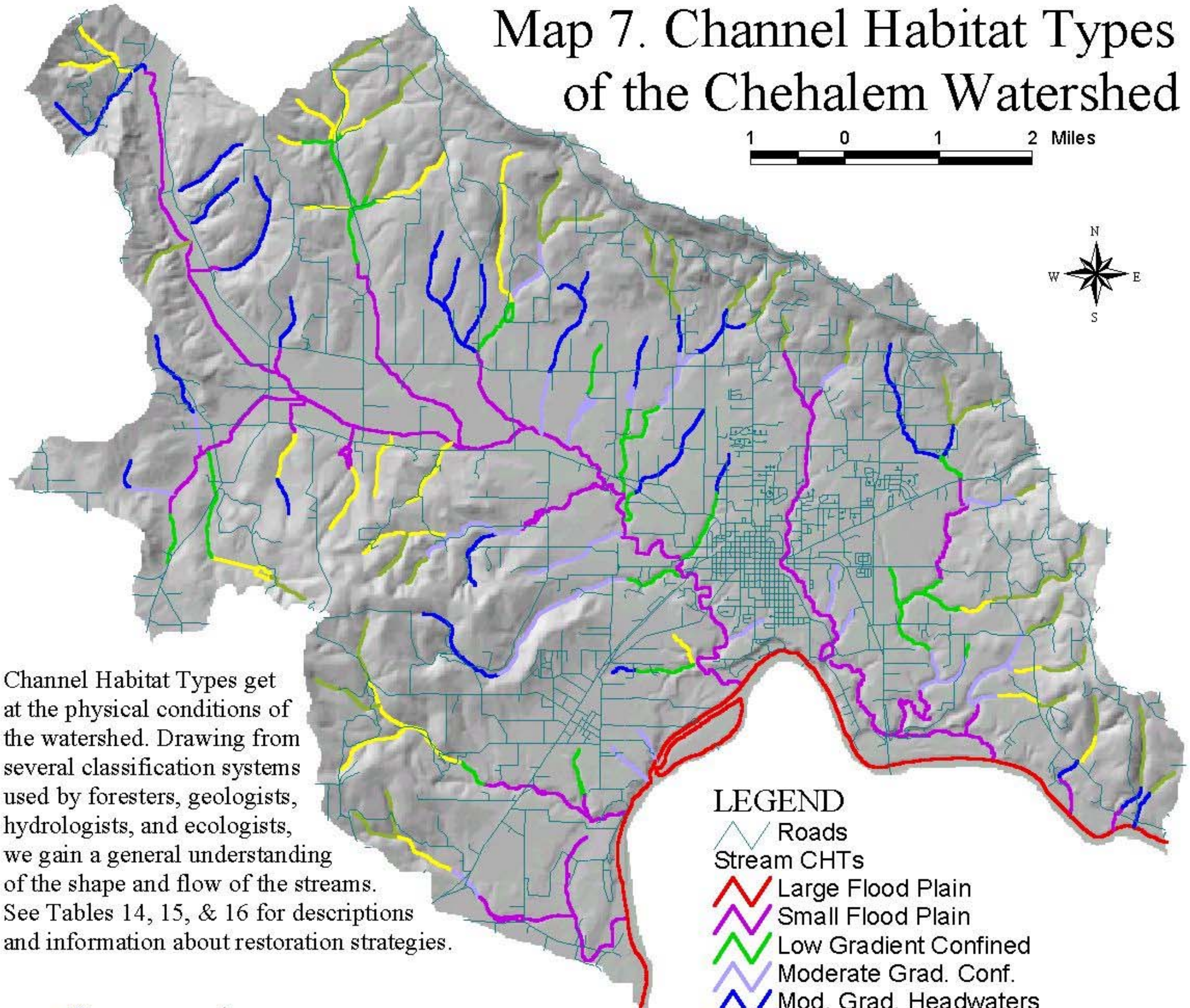
Table 14. Channel Habitat Type Descriptions

Channel Habitat Type	Description	Fish Utilization
Low Gradient Large Floodplain Channel **(FP1)**	Lowland and valley bottom channels of large watersheds. These have extensive valley floodplains and river terraces. Sloughs, oxbows, wetlands and abandoned channels are common. Numerous overflow side-channels, extensive gravel bars, avulsions, and logjams in forested basins are characteristic.	Anadromous: Potential steelhead rearing. Resident: Potential overwintering.
Low Gradient Small Floodplain Channel (**FP3**)	Located in valley bottoms and flat lowlands. Usually adjacent to toe of foot slopes or hill slopes within the valley bottom. May contain wetlands. Beavers can dramatically alter channel characteristics. Sediment from upstream temporarily stored in these channels and on the adjacent floodplain.	Anadromous: Potential steelhead rearing. Resident: Potential overwintering.
Low Gradient Confined Channel (**LC**)	Incised channels. Lateral migration is controlled by frequent bedrock outcrops, high terraces, or hill slopes along stream banks. Channels are often stable. High flows are often contained by the upper banks and move all but the most stable log jams downstream. Stream banks are susceptible to landslides in areas where steep slopes abut the channel.	Anadromous: Potential steelhead spawning and rearing. Resident: Potential spawning, rearing, and overwintering
Moderate Gradient Confined Channel (**MC**)	Flow through narrow valleys or are incised into valley floors. Hill slopes may lie directly adjacent to the channel. Bedrock steps, short falls, cascades, and boulder runs may be present. Moderate gradients, well-contained flows, and large-particle substrate indicate high stream energy. Landslides along channel side slopes may be a major sediment contributor.	Anadromous: Potential steelhead spawning and rearing. Resident: Potential spawning, rearing, and overwintering.
Moderate Gradient Headwater Channel (**MH**)	Common in plateaus in Columbia River basalts, young volcanic surfaces, or broad drainage divides. May be sites of headwater beaver ponds. Similar to LC channels, but exclusive to headwaters. Potentially above the anadromous fish zone.	Anadromous: Potential steelhead spawning and rearing. Resident: Potential spawning, rearing, and overwintering.
Moderately Steep, Narrow Valley Channel (**MV**)	Moderately steep gradient, confined by adjacent moderate to steep hill slopes. High flows are generally contained within the channel banks. A narrow floodplain, one channel width or narrower.	Anadromous: Potential steelhead spawning and rearing. Resident: Potential spawning, rearing, and overwintering.
Steep Narrow Valley Channel (**SV**)	Constricted valley bottom bounded by steep mountain or hill slopes. Vertical steps or boulders and wood with scour pools, cascades and falls are common. Channels are found in the headwaters of most drainages or side slopes to larger streams. May be shallowly or deeply incised into the hill slope. Channel gradient may be variable due to falls and cascades.	Anadromous: Lower gradient segments may provide rearing. Resident: Limited spawning and rearing.

(From the Oregon Watershed Assessment Manual, 1999)

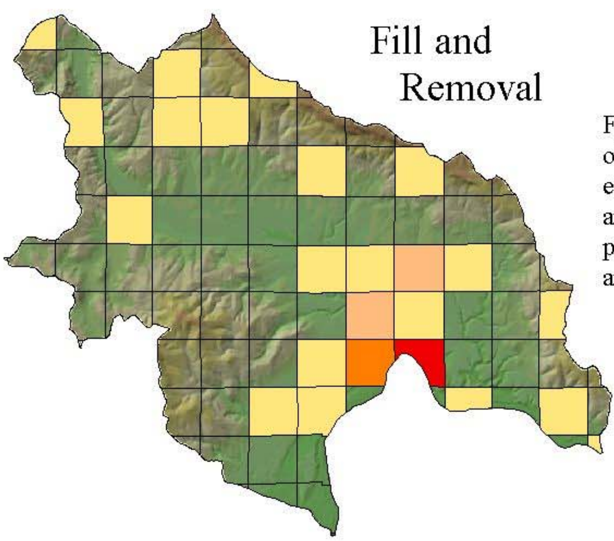
Many of the botttomland areas in our watershed, however, more closely fit the description of a *Low gradient, Moderately confined* stream. These channels do not meet the OWAM manual description of "variable confinement by low terraces or hill slopes" though. Instead, their confinement is due to downcutting of the stream banks. So for this assessment they are labeled

Map 7. Channel Habitat Types of the Chehalem Watershed



Channel Habitat Types get at the physical conditions of the watershed. Drawing from several classification systems used by foresters, geologists, hydrologists, and ecologists, we gain a general understanding of the shape and flow of the streams. See Tables 14, 15, & 16 for descriptions and information about restoration strategies.

Fill and Removal



Fill and Removal Permits are issued by the Division of State Lands. The number of permits issued in each Section provides some indication of the amount of Channel Modification that has taken place there. Problems of erosion and downcutting are reduced by minimizing the level of modification.

Jeff Empfield, Yamhill Basin Council, 2001

LC for *Low gradient, confined* streams. See Table 14 for descriptions. Needless to say, the conditions on the ground and in the streams are infinitely complex and do not always fit easily into a classification system. The important thing is to find some generalized indication of conditions on the ground and use that to identify problems.

Table 15 provides descriptions of the gradient, channel confinement, stream size, and the sensitivity of that channel to restoration. Stream gradient is the steepness of the channel. The gradient is generally highest in the headwaters and lowest in the valley. Of course, there are exceptions. Sometimes headwater valleys can be gently sloping and areas downstream can have steep gradients for a while.

Confinement describes the steepness and narrowness of the stream banks; it determines whether the stream is able to overflow onto its floodplain. Unconfined streams meander freely, flood during high flows, and occasionally create new channels. Confined streams become entrenched within steep walls that prevent lateral movement. A moderately confined stream has conditions somewhere between these two. Table 16 provides descriptions of the restoration potential associated with each CHT.

Table 15. Channel Habitat Type Parameters

Channel Habitat Type	Gradient	Channel Confinement	Stream Size	Responsiveness to Change
Low gradient large floodplain **(FP 1)**	<1%	Unconfined	Large	High
Low gradient small floodplain **(FP3)**	<1%	Unconfined	Small to medium	High
Low gradient confined **(LC)**	<2%	Confined	Variable	Low to Moderate
Moderate gradient confined **(MC)**	2-4%	Confined	Variable	Medium
Moderate gradient headwaters **(MH)**	1-6%	Confined	Small	Medium
Moderately steep narrow valley **(MV)**	3-10%	Confined	Small to medium	Medium
Steep narrow valley **(SV)**	8-16%	Confined	Small	Low

(From Oregon Watershed Assessment Manual, 1999)

Possible reasons for stream incision:

- A large proportion of the area's flood plains no longer function naturally by flooding during heavy precipitation and gradually draining over a period of hours or days. This is due to decades of dredging, dike building, straightening, damming, and wetland drainage projects aimed at making flood plains accessible year-round for agriculture and building sites. A consequence is that a larger volume of water is concentrated in the stream system during shorter periods of time causing higher velocities. These higher velocities carry more energy and they tend to erode banks and scour the channel.
- Settlers began removing woody debris from the area's rivers in the 19th century; and we continue to remove many large trees from the system. As late as the 1960s we cleared wood from streams because we mistakenly thought we were increasing the quality of fish habitat. We now know that log jams decrease velocity, increase storage capacity, and create habitat.

- Stream bank modifications such as hardening of the bank with rip-rap (rocks that hold the soil in place) or concrete prevent the stream from gradually changing its course through meandering. Meander patterns find the stream's natural curvature to best dissipate energy.

Table 16. Channel Habitat Type Restoration Potential

CHT	Riparian Enhancement Opportunities
Low gradient large floodplain **(FP1)**	Due to the unstable nature of these channels, the success of many enhancement efforts is questionable. Opportunities for enhancement occur where lateral movement is slow. Lateral channel migration is common and efforts to restrict this natural pattern will often result in undesirable alteration of channel conditions downstream. Side-channels may be candidates for efforts that improve shade and bank stability.
Low gradient small floodplain **(FP3)**	The limited power of these streams [i.e. low stream flows] offers a better chance for success of channel enhancement activities than the larger floodplain channels. While the lateral movement [i.e. meandering] of the channel will limit the success of many efforts, localized activities to provide bank stability or habitat development can be successful.
Low gradient confined **(LC)**	These channels are not highly responsive and in-channel enhancements may not yield intended results. In basins where water-temperature problems exist, the confined nature of these channels lends itself to establishment of riparian vegetation. In non-forested land these channels may be deeply incised and prone to bank erosion from livestock. As such, these channels may benefit from livestock access control measures.
Low gradient moderately confined **(LM)** *Note: although no sections have this designation in the Chehalem Valley watershed, this restoration characterization may apply to sections designated LC.*	Like floodplain channels, these channels can be among the most responsive of channel types. Unlike floodplain channels, however, the presence of confining landform features often improves the accuracy of predicting response and helps limit the destruction of enhancement efforts common to floodplain channels. Because of this, LM channels are often good candidates for enhancement efforts. In forested basins, habitat diversity can often be enhanced by the addition of wood or boulders. Pool frequency and depth may increase, and side-channel development may result from these efforts. Channels of this type in nonforested basins are often responsive to bank stabilization efforts such as riparian planting and fencing. Beavers are often present in the smaller streams of this channel type.
Moderate gradient confined **(MC)**	Same as LC and MV.
Moderate gradient headwaters **(MH)**	These channels are moderately responsive. In basins where water temperature problems exist, the stable banks generally found in these channels lend themselves to the establishment of riparian vegetation. In non-forested land, these channels may be deeply incised and prone to bank erosion from livestock. As such, these channels may benefit from livestock access and control measures.
Moderately steep narrow valley **(MV)**	Same as LC and MC.
Steep narrow valley **(SV)**	These channels are not highly responsive and in-channel enhancements may not yield intended results. Although channels are subject to relatively high energy, they are often stable. Where stable banks exist, opportunity for riparian enhancement. This may serve as a recruitment effort for large woody debris in the basin.

(From Oregon Watershed Assessment Manual, 1999)

Channels respond to change differently based on their position in the watershed. The headwaters of Chehalem Creek and Spring Brook, for example, are steep with low responsiveness to changes in channel pattern, location, width, depth, sediment storage, and bed roughness. The segments labeled moderate gradient confined (MC), moderate gradient headwaters (MH), and moderate steep narrow valley (MV) throughout the watershed are more likely candidates for successful enhancement projects.

Low gradient streams that are most responsive to change are also the ones in the most developed parts of the watershed where land is under cultivation. Refer to Map 4 for current vegetation. Each has significant amounts of stream length that could be enhanced. With current land use these areas would benefit most from riparian enhancement projects that may or may not encourage meandering or flooding but would at least improve the quality of bank vegetation.

Considering CHTs helps us understand the streams in our landscape by labeling them according to varying gradient, channel confinement, size, and likely substrate. This classification should be useful in combination with other characterizations in the assessment to estimate a given stream's sensitivity to restoration efforts. Of course, one needs to investigate the specific conditions on the ground before designing any restoration.

References:

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment,* Yamhill Basin Council, September, 2000.

Oregon Watershed Enhancement Board, *Oregon Watershed Assessment Manual*, July, 1999.

CHAPTER 6

Channel Modifications

The Oregon Watershed Assessment Manual (OWAM) describes channel modifications as any of the following: impounding, dredging or filling water bodies and wetlands, splash damming, hydraulic mining, stream cleaning, and rip-rapping or hardening of the streambanks. We can also include road crossings (bridges and culverts) and streams with "permanent discontinuity" due to the artificial effects of a roadbed being constructed near the stream.

Stream channels are normally dynamic systems that respond to physical conditions including climate. Human manipulation at times magnifies or eliminates the evolutionary changes that streams naturally undergo. This section examines how humans have impacted stream channel structure and consequently the aquatic habitats of the Chehalem Valley.

The channel modification section includes information from residents, fill and removal permits, dam records from the Oregon Water Resources Department (OWRD), aerial photos, and FEMA floodplain maps.

Historic Channel Modifications

Throughout history humans have modified the streams where they live both intentionally for irrigation, transportation, and drinking water and accidentally through a variety of landscape modifications. In the Yamhill Basin, for instance, residents dug a new channel for Mill Creek in 1900 using muscle and animal power. Over the past century the growth in our earth-moving technology fueled by fossil fuels has resulted in a much larger scale of channel modification.

In terms of area affected, agriculture has had the greatest effects on stream modification in the Chehalem Valley. It is now common for small drainages to be disked and plowed in cultivated fields, effectively eliminating the stream and wetland qualities. This, along with the installation of drainage tiles means standing water drains and soil dries faster allowing farmers to access their fields earlier in the season. Historical aerial photographs reveal different conditions near streams in the past. For example, photos from the mid-20th century not surprisingly show that rivers and streams were in roughly the same location as they are now. The interesting thing is that the land adjacent to streams historically contained wet oxbows and standing water, what we know today to be valuable wetlands. Many of these large wetland areas no longer exist. On aerial photos taken in 1994 some ghostly contours of the historic oxbows are still visible, though they are now drained and cultivated.

Our powerful technology associated with road building is another major cause of channel modification. In hilly areas road construction follows the path of least resistance that inevitably is right next to streams. To protect our investment in road infrastructure we have learned to use channel hardening or bank stabilization (rip-rap) to keep streams from undercutting our roads. Unfortunately this has harmful effects on the health of our streams by preventing natural channel movement. It creates problems in several ways. By restraining the flow to one channel we've taken away the stream's ability to meander. This keeps streams from evolving in ways that dissipate energy, sustains habitat, and recharges wetlands. When constrained, the stream cannot dissipate energy; during heavy flows it maintains a high velocity, erodes its channel, picks up sediment, and becomes incised.

Road crossings have similar effects. Because of the proximity of many roads to streams and our desire for relatively straight roadways, we design our roads to cross streams repeatedly. Bridges and culverts at stream crossings typically encroach into the floodplain and streambed and usually involve very permanent footings and backfill. Private residences and side roads require additional bridges or culverts to provide access. This further limits the movement of the stream. Roads placed next to streams also prevent the formation of side channels while they reduce or eliminate many needed functions associated with riparian areas. These include shade, a source of large woody debris, flood mitigation, and habitat complexity.

Other human interventions such as dam building, dredging and straightening of streams, and removing wood from streambeds have also contributed to the high level of modification in our streams. Even our straight property lines have an impact by orienting land use and development to imaginary boundaries rather than natural ones such as streams and ridgelines. Section line boundaries, for example, cross streams rather than respecting them as a natural boundary.

DSL Fill and Removal Permits

It is difficult to thoroughly assess the extent and location of historic channel modifications. Fill and removal permits on file at the Division of State Lands give some sense of the physical modifications that have taken place in the area over the past several decades, though. Permits were not required until the late 1970s, so little is known prior to that. A lot of the fill and removal permits apply to off-stream projects such as road building or reservoir construction. A lot of in-stream channel modification appear as well, though, and most of the off-stream work has direct or indirect effects on streams anyhow—by eliminating wetlands, for instance. The whole watershed is interconnected, after all.

Most fill and removal activity is either road-related or for reservoir construction. There is a lot of activity surrounding bridge replacement, bridge removal, straightening creeks, road crossings with culverts and earth fill, upgrading culverts, replacing culverts, extending culverts, highway widening, and filling in wetlands for "ingress and egress" from housing developments. There are also a lot of small earthen dams for watering stock and for irrigating vineyards. The rest are for things like installing pipelines, electrical lines, or sewer lines, constructing "outfall" for water treatment plants, and the rare construction of a boat launch.

Representing the Public Interest

Americans today are generally leery of "big government." Large scale and potentially harmful activity in or near public waterways underscores the need for some representation of the public interest, though. One example is a series of permits held by Newberg River Rock and partner companies from 1978 to the present. It involves mining gravel for commercial production of about 125,000 cubic yards of riverbed per year from several Willamette River locations near Newberg. In addition to in-stream activity, each mining location requires some riverbank clearing and leveling.

Another example comes from 1981 along Hess Creek on the eastside of Newberg. According to Stan Miller of SP Newsprint, years ago a culvert had been installed to carry the creek under one of the mill's sewage lagoons. Culverts don't last forever, though, so when this one collapsed under the lagoon all the sewage drained into Hess Creek and flowed several miles to the Willamette. SP Newsprint received a fill and removal permit to build a new tunnel to carry Hess Creek around the waste treatment pond instead of under it. This involved building inlet and outlet structures and a 12' diameter steel and concrete tunnel 1250 feet long. Another part of the design was to excavate an entirely new streambed, complete with rip-rapped banks, to carry Hess creek to and from the new tunnel. In an effort to avoid further sedimentation, excess soil was stored on high ground away from the flow of water.

In 1986, Newburg built a 24" submarine "outfall" line to the middle of the Willamette "to carry treated sewage and diffuse it to the river." This required digging a trench (3' wide x 10'deep x 145' long) down the riverbank and half way across the river bottom. Then they installed a two-foot diameter pipe and outlet structure and covered it all with rip-rap. The pipe carries Newberg's partially treated sewage to the mid-bottom of the river.

In addition to these large-scale projects, fill and removal permits for the area record instances where state oversight helped correct problems that arose from private efforts. In 1975, for example, an "after the fact" permit was issued to help prevent further erosion after a diversion ditch was built. The problem was that poor design of the ditch resulted in significant erosion and siltation at the confluence of Chehalem Creek and one of its tributaries.

Another "after the fact" permit was issued in 1978 to correct problems with the Newberg Garbage Dump where rip-rapping of the Willamette River had begun before applying for a permit with DSL. This involved the area just downstream of the mouth of Chehalem Creek. The fill material was concrete from the recently dismantled Burlington Northern RR Bridge in Wilsonville. This is a case study of why oversight is necessary sometimes. Originally there were large protruding chunks of concrete with tangled rebar sticking out and the bank slope was too steep with a more than 2:1 rise over run. DSL required the larger pieces of rubble to be removed and broken into smaller pieces and the protruding rebar to be cut off. They also required adding river gravel to help smooth the rip rap surface and then soil was placed at the top of the bank to make the surface smooth and uniform. Afterwards, they planted vegetation.

In the final analysis, these kinds of problems are the exception, not the rule. Most permits reflect common infrastructure activity such as rip-rapping bridge piers of an abandoned Newberg bridge, presumably to preserve it for future use. Other examples are temporary culverts for traffic detours while building a bridge over the East Fork of Chehalem Creek and rip-rapping along the Willamette just across the river from Champoeg Creek. Even when done well, though, our infrastructure has large impacts that as a people we are learning to mitigate.

Ecological Trends

There is an interesting trend toward more ecological awareness indicated by fill and removal permits. In 1978, new and disturbed dirt slopes were to be seeded and mulched at bridge and culvert installations. The work also included reshaping of slopes for stabilization and erosion control. When SP Newsprint wanted to build a boat ramp at Roger's Landing, they took pains to control erosion and siltation on the site by "barricading" day use areas and hydro seeding impacted areas. When builders wanted to remove fill material from Chehalem and Harvey Creeks to construct a new highway and bridge, their work in the flowing stream was done "behind berms, cribs, cofferdams." All disturbed areas were to be seeded and mulched and new grading was to be "blended into the existing adjacent ground." Likewise, the Yamhill County Road department worked to minimize the time disturbed soil was exposed to flowing water while they replaced a steel culvert on Chehalem Creek. They also minimized the disturbance of existing vegetation and reseeded the site afterwards.

By the 1990s there is more far-reaching ecological concern. Earthen dams for livestock watering and wildlife are now designed to have a limited footprint—the area of disturbance—by excavating from within the planned reservoir. Water is now piped to stock troughs outside fenced reservoirs or wetlands. Area residents are also excavating and building low dikes to restore wetlands on prior converted farmland for wildlife purposes. Some property owners manage primarily for wildlife purposes and plant diverse riparian forests and native prairie species such as tufted hairgrass. Another local idea is to build a shallow impoundment below a spring to create a small pond and wetland to provide year-round habitat for wildlife.

Growing ecological care is reflected in public works projects as well. In 1994, a bridge replacement on Chehalem Creek included a Wetlands Mitigation Monitoring Program. It was aimed at creating gradual stream banks to avoid scour, increasing runoff storage capacity in wetlands, improving wildlife habitat, temporarily reducing Reed canarygrass, and restoring the detour area to preexisting wetland conditions. More recently, a bridge replacement over Chehalem Creek on Sunnycrest Road included efforts to avoid impacting wetlands and mitigation for the wetland areas that were lost.

"Mitigation" means to mollify, to make less severe, or to temper one's impact. In Oregon if you have to damage or destroy wetlands you can mitigate that by creating new wetlands or by enhancing other degraded wetlands in the area. As scientific people, we now quantify impacts and the appropriate corresponding mitigation. In 2000, ODOT submitted plans to build in wetland areas adjacent to Hess Creek and Spring Brook while expanding Highway 99—work currently being done. A "realignment" of Hess Creek will permanently impact 567m2 of palustrine wetland (see Table 13) and 585m2 of open water. On Spring Brook there will be impacts on 636m2 of wetland and 640m2 of open water. Mitigation involves re-grading and planting native wetland species in the impact zone as well as building new wetlands at the standard ratio of 1.5:1 wetland acres lost. Replacing 50% more wetland area than you destroy presumably recognizes that artificial wetlands aren't as functional as natural ones. In this case they will construct wetlands nearby in Hoover Park.

Monitoring for success requires at least 70% survival of plantings after the first year and 50% survival after the second year. Monitoring normally ends after three years when hopefully there will be 90% coverage by "emergent hydrophylic vegetation." The overall design also includes a constructed wetland to improve the water quality of runoff from the Fred Meyer parking lot. Traffic pavement runoff contains sediment and pollutants such as antifreeze, oil, gasoline, tire rubber, and heavy metals from brake pads.

When Fred Meyer was built in 1991, they impacted the same area of Spring Brook and associated wetlands. Mitigation was needed for the site on Prior Converted farmland with some wetland designation. Their wetland delineation included analysis of the soils, vegetation, hydrology, impervious surfaces, and runoff water quality treatment.

Dams

Chehalem Valley reservoirs of various type, purpose, and size are noted in Table 17. Dam locations and dimensions are only given for those dams that meet the criteria to be monitored as such. According to Jon Falk of the Water Resources Department (WRD), only those dams that are 10 feet or greater in height and that store more than 9.2 acre feet are required to be engineered and recorded in a dam safety database. Smaller structures are not recorded although all storage projects require a reservoir permit. Falk notes that a structure less than 10 feet high could have a storage pond of 9.2 acre feet or approximately 3 million gallons of water.

The structures with a zero in the Drainage Area column are off-channel storage reservoirs. Those with a number in the Drainage Area column, representing the square miles being drained, are in-channel storage structures. In-channel storage is important to note because of its possible effects on streams such as non-native fish introduction, loss of spawning and rearing habitat, possible migration barrier, and water quality impacts. These dams need further investigation to determine if temperature or fish passage are issues that need to be addressed for any of them.

Table 17. Dam Locations and Descriptions for the Chehalem Watershed

Dam I.D. Number	Name	Year Comp-leted	Owner Type	Purpose	Dam Lgth (ft)	Dam Ht (ft)	Stor-age (acre /ft)	Surface Area (acres)	Drainage Area (sq. mi.)	Hazard
OR-00821	Unnamed dam on Williamson Creek	NA	Private	NA	NA	16	12	NA	NA	Low
OR-00939	Unnamed reservoir	NA	Private	NA	NA	21	10	NA	NA	Low
OR-00507	E. R. Baker Reservoir	1970	Private Earth	Irrigation	820	56	225	14	0	Sig-nificant
OR-00738	Dundee Sewer Project	1979	Munici-pal Earth	Waste Lagoon	4400	37	47	9	0	Low
OR-01894	Hays Reservoir	NA	NA	NA	NA	15	25	NA	NA	Low
OR-00231	Hickory Hill Farm Reservoir	1952	Private Earth	Irrigation	330	29	47	6	0	Sig-nificant
OR-00289	Walker Reservoir	1956	Private Earth	Irrigation	850	27	145	15	1	Sig-nificant

(Oregon Water Resources Department web page)

Flood Plains Flood

The Federal Emergency Management Agency 100-year-floodplain map is shown on Map 9. Not only is this map a different scale as the other maps allowing full coverage of Yamhill County, but the shape of the landscape is somewhat distorted. The larger rivers and streams in the area historically meandered and routinely flooded their banks, changed directions, and carved side channels. There is physical evidence of this in ghost channels, oxbow lakes, and wetlands.

Currently, many streams are restricted within steep banks, have lost many of their side channels, and no longer routinely flood. It is unlikely that we'll see the historic conditions return as long as we continue to build in the flood plain, make intense efforts to restrain floods, and rely on federal assistance when our efforts fail. The larger creeks of the Chehalem Valley flow through communities on their way to the Willamette and the land being farmed on their floodplain increasingly receives a built infrastructure incompatible with seasonal flooding. What can be done to accommodate the natural tendencies of the streams? There are immediate opportunities for enhancing the vegetation to provide more diversity. Where possible, owners with land that floods year after year could leave that land undeveloped and use it in flood-compatible ways. Area planning and zoning is already working in this direction. Such an approach will reduce flood damage and increase wetland area for wildlife and open space as well as for ground water infiltration. Streams can provide additional off-channel water storage during high flows.

References:

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment,* Yamhill Basin Council, September, 2000.
Division of State Lands fill and removal permit files.
Federal Emergency Management Administration (FEMA) 100-year floodplain data.
Oregon Watershed Enhancement Board, *Oregon Watershed Assessment Manual*, July, 1999.
Water Resources Department web page.

CHAPTER 7

Sediments

Sediments are a concern in the watershed due to their effects on water quality and aquatic resources. Major sources of sediment are cultivated fields, construction sites, landslides, roads, pavement, and insufficiently vegetated stream banks. Bank erosion potential is greatest in the lower elevation main channels where soils contain mostly fine materials that erode easily. This is also where stream entrenchment encourages lateral scour of stream banks.

Water draining from roads can move considerable amounts of sediment from drainage ditches and road surfaces. Road ditches sometimes fill in with sediment from *ravel*, sliding and erosion of the road cut slope. Ditches are designed to move water away from the roads; when the ditch has no vegetation, flowing water picks up sediment and carries it into streams. It is important to remember ditches are essentially an extension of streams because they drain directly to them.

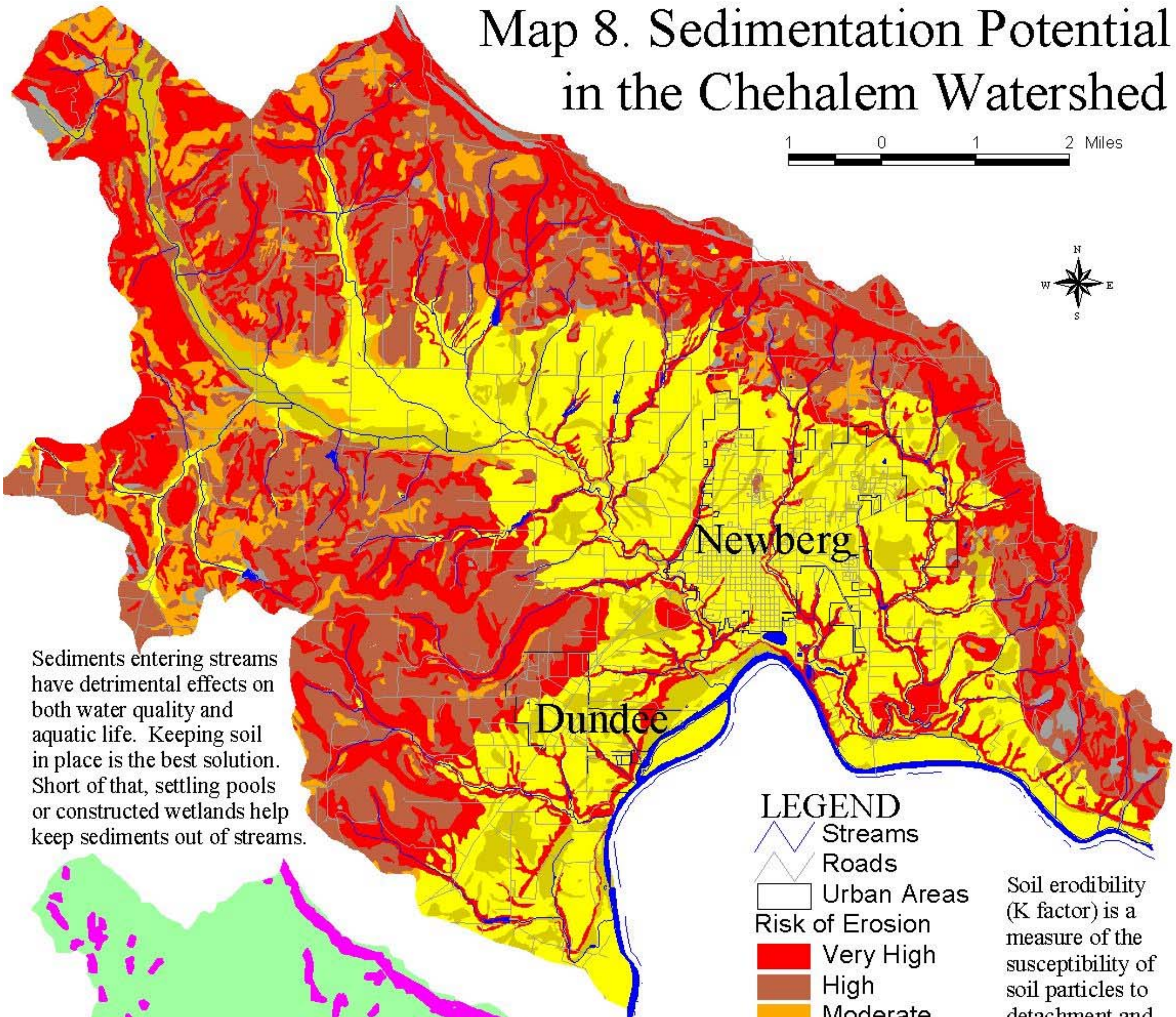
The amount of sediment potentially contained in runoff from any road is difficult to estimate because of variable conditions and the fact that conditions can change rapidly. A road surfaced with high-quality rock can be quickly reduced to a quagmire if water is allowed to pool during wet weather or if there is heavy traffic. Conversely, a road with a poor-quality surface may not degrade much at all if it is used mainly during dry weather. Paved roads prevent road surface erosion but exacerbate another set of problems related to chemical and petroleum-based contaminants and impervious surfaces that prevent surface water from soaking in to the ground.

Hilly areas classified as having a moderate or high potential for debris flows are a major concern. Debris flows are initiated by landslides on steep slopes that quickly transform into semi-fluid masses of soil, rock, and other debris. Typically they scour materials for a portion of their travel distance and move rapidly down steep slopes and confined channels. Landslides can become large debris flows; the debris flow inset on Map 8 does not indicate maximum potential size.

Decades of Erosion

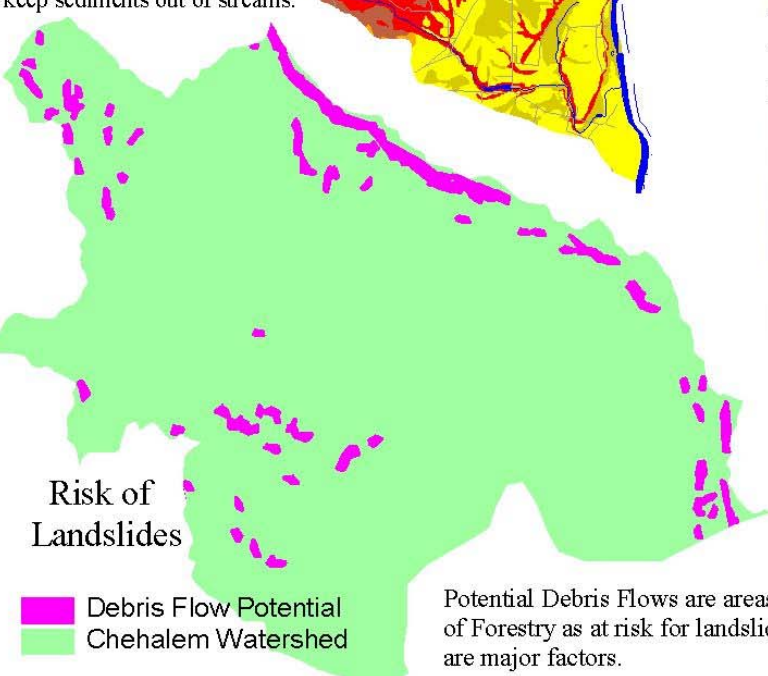
Over thirty years ago county officials identified stream bank erosion as the largest single soil erosion problem in Yamhill County. What's more, it was accelerating. According to the 1979 *Natural Resource Conservation Plan* of the Yamhill County Soil and Water Conservation District, the major causes were the removal of riparian vegetation, timber harvesting and urban development within riparian areas, agricultural cultivation, straightening of streambeds, and increased runoff due to agricultural drainage tiling.

Map 8. Sedimentation Potential in the Chehalem Watershed



Sediments entering streams have detrimental effects on both water quality and aquatic life. Keeping soil in place is the best solution. Short of that, settling pools or constructed wetlands help keep sediments out of streams.

Soil erodibility (K factor) is a measure of the susceptibility of soil particles to detachment and movement by rainfall and run-off. Properties of soil effecting erodibility include texture, percent of sand content, organic matter content, soil structure, soil permea-bility, clay minerology, and the presence of rock fragments. The Sedimentation map correlates erodibility and steepness to identify areas where disturbance of soil is a potential problem.



Potential Debris Flows are areas identified by the Oregon Department of Forestry as at risk for landslides. Land use, steepness, and rainfall are major factors.

Jeff Empfield, Yamhill Basin Council, 2001

Roadside erosion was also identified as one of the worst contributors of sediment to streams in 1979. At that time the Yamhill County Road Department identified 35 miles of "severe roadside erosion" in the county. Several factors contributed to the problem including narrow right-of-ways requiring steep road cuts, inadequate drainage ditches and culverts, siting roads in areas with highly slumping soils, and lack of soil-stabilization seeding and maintenance.

Soil erodibility (also called K factor) is a measure of the susceptibility of soil particles to detachment and movement by rainfall and runoff. Soil properties affecting soil erodibility include soil texture, percent of sand present greater than 0.1mm, organic matter content, soil structure, soil permeability, clay mineralogy, and the presence of rock fragments. Soil erodibility and steepness can be correlated to indicate relative risk for sedimentation. See Map 8.

Recognizing that rural roads contribute significant amounts of sediment to waterways, the Yamhill Basin Council helped form a Roadside Water Quality Committee that meets quarterly to collaborate on issues related to county roads. Currently, the members include representatives from the Yamhill Basin Council, Yamhill and Polk County Public Works Departments, Yamhill Soil and Water Conservation District, Oregon State University Extension, Oregon Department of Transportation, and local landowners and residents. They are working to improve the conditions of ditches through a seeding project that began in 1997. The goal is to improve the ability of the ditches to transport water while leaving the soil in place. This is accomplished through reshaping the ditch, preparing a good seed bed by eliminating weeds, and seeding a low growing grass such as creeping red fescue or the bluegrass "fowel" in the ditch.

Currently, Yamhill County maintains the vegetation in its ditches by mowing. However, Yamhill County does not mow all the ditches in the agricultural areas, only those where visibility is an issue. Regardless, mowing is preferable to applying herbicides because vegetated ditches hold sediments instead of letting them pass on to streams and chemicals sprayed in or near drainage ditches end up in streams.

Ditches in Yamhill County are re-graded on a 10-year rotation. Seven to eight years would be ideal but budget constraints prevent that schedule. Some areas have yearly maintenance and others only every twenty or so years. Ideally, re-ditching would be restricted to the driest months of the year to prevent sediment from the exposed surface from entering waterways. However, due to the workload, road ditching is scheduled year round. Most road grading occurs during the winter months when the road substrate has enough moisture to be reshaped.

If you would like further information on roadside seeding or other road-related issues contact the Yamhill Soil and Water Conservation District, 2200 SW 2nd St., McMinnville, (503) 472-6403 and ask for the "Roadside Vegetation Management" brochure.

Urban Runoff

Storm water runoff is drained both by pipe and natural open channels. It is piped primarily from central business districts. The developed areas of Newberg and Dundee lie on land that is sufficiently higher than the surrounding waterways and is generally unaffected by floods. This is an elevated alluvial floodplain of the Willamette River, though, which has little natural slope and impermeable soils that drain poorly. The remainder of urban development (and future development) is on the surrounding hills. Elevations range from 160 feet near downtown Newberg to 1300 feet along Chehalem and Parrott Mountain. Surface slopes range from 0 to 3%. The Newberg area slopes in a northerly direction averaging .8% from 160 to 250 feet.

In 1986, engineers and Newberg officials agreed that very few, if any, of the recommendations of the original stormwater drainage plan had been implemented since its adoption a decade earlier. They felt the reasons included lack of staff involvement in preparing the original plan and a corresponding lack of understanding and commitment to it. There was also inadequate funding for storm drainage improvements and changes in land use had outdated the old plan. Furthermore, many drainage systems were inadequate or improperly located. Frequent flooding and ponding at some sites was due to undercapacity storm drains and debris-blocked ditches in several areas. Upgrading, rerouting, and detention were prescribed alternatives to these ongoing problems. The estimated cost for the needed improvements was $4,000,000 in 1986 dollars.

Specific recommendations included installing larger capacity pipes, a new pipe route to divert flows from residential areas along Pioneer Street and Crestview Drive into Chehalem Creek at Columbia Road, and open channel improvements such as excavating ditches in drainage problem areas. Generally, engineers design public storm water drains for five or 10-year "frequency events." Designing for stormwater detention is another strategy. "The concept of runoff detention is simple," they wrote, "hold back the excess upstream runoff that would cause flooding problems downstream." This excess water can then be released slowly at a rate the system can handle. Detention can occur in ponds, underground, on rooftops, or in wetlands.

Within many Willamette Valley UGBs, there are drainage management sub-basins ranging in size from 30 to 60 acres in areas of dense development and larger than 60 acres in less developed areas. These sub-basins are used for storm water planning and for flood modeling by the Corps of Engineers. To better understand this, consider the fact that every square foot of land is part of a drainage basin. The smallest basins are ones that create puddles or rivulets. Dozens of these combine to form headwaters which in turn combine to form streams, then bigger streams, and finally rivers. We can recognize boundaries between basins by observing where there is high ground between drainages. The boundaries are physically determined by the lay of the land. The scale, however, is arbitrary depending on whether we want to address big problems common to the entire Willamette Valley or the drainage system of downtown Dundee.

Currently, there are no requirements by the U.S. Environmental Protection Agency (EPA) on storm water quality for cities the size of Dundee and Newberg. Such requirements will eventually be imposed, though. It is prudent, therefore, to consider the probable direction of those requirements and to act accordingly. Low cost or no cost options for improved storm water quality should be implemented including:

- Keeping natural channels open where possible in preference to installing storm drains. (Newberg has a Stream Corridor Ordinance that helps protect natural stream channels.)
- Adopting appropriate erosion control measures for construction activities.
- Adopting standards for the construction of water quality and detention facilities for major new industrial and commercial projects.

Impervious Surfaces

The amount of storm water runoff is increased substantially through development by increasing impervious surfaces. Impervious areas include all pavement such as streets, parking lots, sidewalks, and loading areas, as well as rooftops. Together they increase the volume of runoff by preventing water from soaking in to the earth. Further, these impervious surfaces tend to concentrate runoff into storm drains or ditches carry the runoff to the receiving stream more quickly. This in turn decreases the time of concentration for a given rainfall to enter the stream and generally increases peak rates of runoff downstream. Transforming agricultural lands to urban lands can increase the rates and volumes of storm runoff by a factor of two to four (2x-4x). Consequently, impervious area is very significant in the analysis of storm drainage systems.

Mapped Impervious Area (MIA) is a rating system for different degrees of impermeability. For residential areas the estimated MIA ranges from 40% to 65%, depending on housing density and the residents' propensity for building-on or paving their yard. For commercial areas it's 90% and for industrial areas it's about 80% due to the lack of vegetation and open ground. Of course open areas or "green spaces" have an MIA of zero.

Impervious surfaces in Dundee and Newberg are concentrated in the downtown and outlying commercial areas. The shopping centers, highway retail establishments, car dealerships, and warehouse sales operations are generally along Highway 99W. These areas are characterized for drainage purposes by large expanses of pavement. The downtown areas generally have small shops, office space, and institutional centers with smaller parking areas and less sprawl.

Runoff Contaminants

Inevitably, impervious surfaces and rural road ditches collect a lot of the oil and gas, exhaust particulates, rubber from tires, and anti-freeze that all our cars leave behind, as well as excess nitrogen running off our agricultural lands, and myriad pollutants originating with our industry and consumer products. What can be done to keep these sediments out of the streams? Of course it is easier to control contaminants at the source than to remove them downstream through some treatment process. Fortunately, there are several forms of remediation for reducing the impact of contaminants that get into our water.

Runoff contaminants are most effectively removed by passing runoff water through an area where plant uptake of the nutrients is significant and where heavy metals and toxins can either settle out or be consumed in a safe way before entering the stream. There are a variety of techniques being developed for this under the rubric of "bioremediation." These areas can be natural or man-made grassy swales, settling or detention ponds, or constructed wetlands. With each of these, the objective is to maximize the amount of surface contact and contact time with the remediation plants. For phosphorous this is a type of banking because phosphorous doesn't really leave the system unless the plant that takes it up is removed, harvested, or eaten.

For reducing soil sediments, in all cases, it is more effective to substantially reduce erosion at the source. This is one of the biggest challenges for farmers. The costs go beyond fertility of the land, though. All reservoirs have a limited life span before sediments fill them. In addition to cultivated fields, construction sites are sediment contributors because soil is generally left bare. Sediment catch techniques such as straw bales, silt fences, woven matting, detention ponds, and temporary swales can be used to clean storm water runoff to the extent that most of the transported sediments will remain on the site. Another technique is to require gravel on exit routes from work sites to remove most of the mud from vehicle tires prior to the vehicle leaving the site. This helps keep soil off the pavement and out of drains.

In general, natural draws and streams should be retained. A well-vegetated, slow-moving creek system can provide channel storage of runoff waters and can often assimilate contaminants prior to discharging water into the river. Wetlands are highly valuable in this respect.

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CHAPTER 8

Hydrology and Water Use

The hydrologic cycle is the circulation of water through plants and animals into the atmosphere, precipitation, surface water (streams, lakes, and oceans), and finally as groundwater before again entering plants, animals, and the atmosphere. It has distinct stages including precipitation, surface run-off, percolation, ground water, transpiration/respiration (plants animals expire water vapor), and evaporation. Human activities and technology influence all these stages. This chapter covers the hydrology of the watershed in terms of flood history, groundwater aquifers, and the extent that different uses of land and water affect stream flows.

"Peak Flow Events," a.k.a Floods

The earliest recorded floods in our region occurred in 1843, 1844, 1852, 1861, and 1890. The 1861 flood (likely a "100-year frequency event") is considered by some to be the largest flood in recorded history. It's difficult to know because there were no measurements of volume being taken at that time. The largest floods in the past century occurred in December 1955, December 1964, January 1965, January 1972, November 1973, January 1974, and January 1996.

The amount of precipitation is not the only factor that influences peak flows. They're also influenced by withdrawals for irrigation and drinking water, stream and wetland modifications, changes in land use and water-related technology, and the removal of vegetation. These factors not only affect the amount of water present in streams but also the rate of release of water into streams during a storm. For example, if a braided stream (multiple intertwined channels) is modified or restricted to one channel, that stream will act more like a flume than a slow moving reservoir for storm water concentrated from across the landscape. The flow will respond more rapidly and will move rain water downstream leaving less water upstream to gradually soak in or drain over a longer period of time.

When left in their natural state, streams drain slowly and provide a variety of benefits:
- Greater sinuosity (meandering) resulting in more stream-riparian contact, larger riparian areas, and slower flow velocities.
- Raised channels that reach the flood plain more often exchange water with wetlands, and transfer water to riparian areas more efficiently.
- Deeper flood plain soils for water storage and plant growth.
- Evolving channels that change in location and create backwaters and other aquatic habitat.
- More pools and deeper pools that fish, children, and the young-at-heart love.
- Natural disturbance of riparian areas that promote habitat complexity.
- Less fluctuation between low flows and peak flows resulting in less property damage.
- More frequent, minor, localized flooding and less frequent, major flooding downstream.

The opposite of peak flows are low flows. These are the lowest flow rates for a given stream over a given time period, usually recorded annually. Low flows contribute to increases in stream temperatures and decreased water quality conditions that adversely affect aquatic life. Low flows may also restrict water rights use, especially for junior users. Low flows are influenced by many of the same factors as high flows: precipitation, channel modification, wetland removal, ditching, and tiling. The two extremes of flow go together—if you have a stream that experiences extreme peaks, it will likely experience extreme dips at other times.

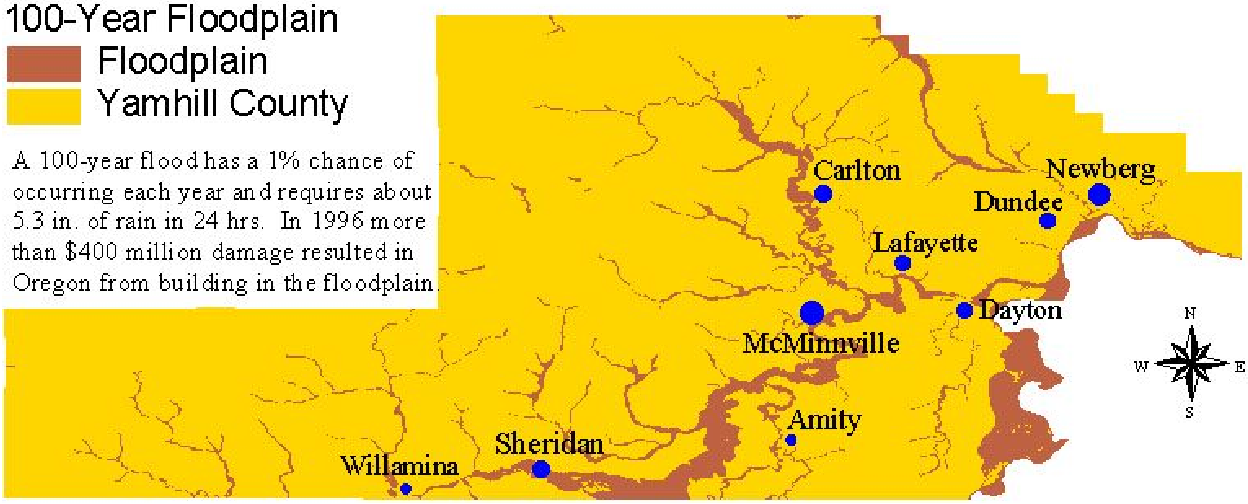
Predicting Flood Frequency

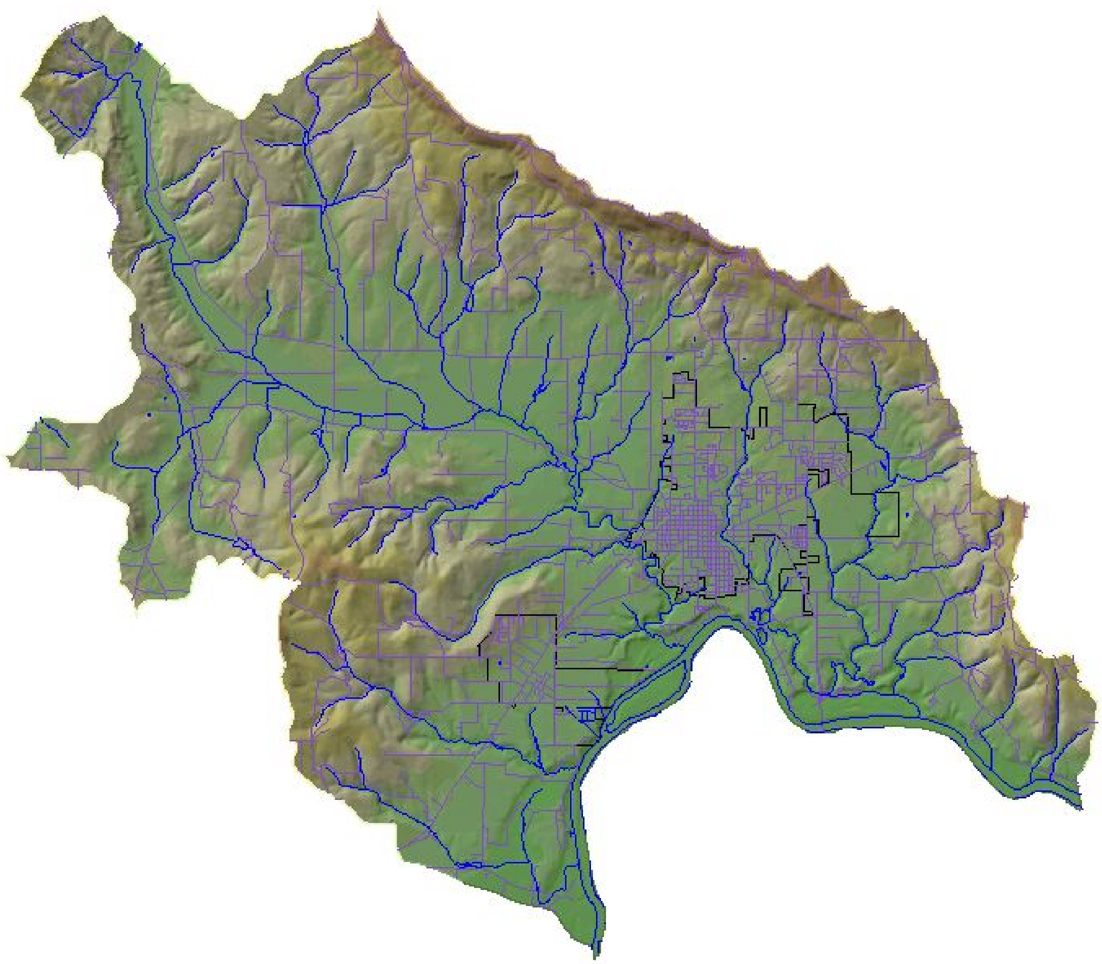
By looking at historic stream flow records it is possible to estimate likely flood recurrence and frequency. This gives us the probability of a given flood level occurring in a given year. It's not a forecast, though. For example, a 100-year flood has a 1 in 100 chance of occurring in any given year. Map 9 shows the 100-year flood plain for Yamhill County as outlined by the Federal Emergency Management Agency (FEMA). The100-year floodplain in the Newberg and Dundee area is about 90 or 92 feet above sea level. The 1968 Flood Insurance Act subsidizes property owners' purchases of flood insurance. The FEMA map is a Flood Hazard Boundary Map; it indicates flood-prone areas. A structure's risk is based on the elevation of its lowest floor.

Table 18. Precipitation Rate and Annual Probability for Various Levels of Flooding

Flood Frequency	Rate of 24 hr. Precipitation	Annual Probability
2 year	2.4 in	.50 (50%)
5 year	3.1 in	.20 (20%)
10 year	3.6 in	.10 (10%)
25 year	4.2 in	.04 (4%)
50 year	4.7 in	.02 (2%)
100 year	5.3 in	.01 (1%)

Map 9. Yamhill County One Hundred-Year Floodplain





Flow records are essential for establishing accurate local probabilities. Some flow records in Oregon date back about 100 years. Most areas have a much shorter record to examine, though. Models have been developed to examine the relationship between precipitation and various land uses to predict flood recurrence levels without actual flow data. They are not commonly used at this point, though. Even in areas where flow records exist, predicting floods is difficult.

The state climatologic service examines weather trends for Oregon and believes the state has a 20-year wet and 20-year dry cycle. The significance of this for flood information is that data collected from a stream for the past 30-year period may contain 20 years of relatively dry conditions so flood predictions will be different from data collected during a 20-year wet period.

Sources of Error in Determining Flood Levels:

1. The length of time records have been kept is significant because of long-term cycles and gradual changes over time. For a record-keeping period 25 years long, there is an 85% confidence level that the statistics will accurately represent expected flood levels.
2. Conditions in the watershed may change over time. For example, increasing urbanization tends to increase impervious surfaces and the intensity of flooding for the same amount of rain. This means the mapped 100-year flood plain may be out of date.

Groundwater

The Chehalem Valley is part of the rapidly growing metropolitan Portland area. Because of this rapid growth, water needs continue to increase. In addition, much of the area is not served by central water and sewage systems, so many homes depend on individual wells and septic systems. To obtain ample water supplies, wells commonly must be drilled to depths of several hundred feet. Even at these depths, though, some wells produce poor quality water.

The landscape consists of a series of uplands surrounded by low-lying plains and valleys which have implications for groundwater. The watershed is bounded to the west by the Coast Range, on the north by the Tualatin Valley and Chehalem Mountains, on the east by Parrett Mountain and the Willamette River, and on the south by the river and the Red Hills. Because of structural folding and localized faulting followed by weathering (erosion), the Chehalem Mountains and Parrett Mountain have considerable relief.

In the Chehalem Valley, the water table is generally highest beneath upland areas and lowest beneath the valley floor. In other words, the water table elevation somewhat follows the land surface elevation. There are also many local variations in groundwater, some of which reflect seasonal changes.

Parts of Chehalem Mountain are classified as a "Ground Water Limited Area" (GLA). Only certain uses of ground water are allowed in a GLA. The Chehalem Mountain GLA allows exempt uses (listed in ORS 537.545), irrigation, and rural residential fire protection systems. Water Rights Permits are required for fire protection and irrigation—it must be drip irrigation or something equally efficient. Permits may be issued for a period not to exceed five years and may be renewed. GLAs are established by rule and the ones for the Willamette basin are covered in OAR 690-502. OARs and ORSs are available through the OWRD website.

Lowland Aquifers

The valley bottom is narrow to the northwest and broadens as it extends into the lowland surrounding Dundee and Newberg. Both sides of the valley have foothills composed of marine rocks. Much of the valley has 10 to 25 feet of alluvial soils lying over marine sandstone, siltstone, and shale. Alluvial deposits can be water bearing where they are relatively thick, permeable, and in hydraulic contact with adjacent streams. This is generally rare, though.

The underlying marine rocks are quite permeable and wells tapping them reportedly yield 9gal/min to 200gal/min. The average yield is 52gal/min and the average specific capacity is about 1(gal/min)/ft. Wells drilled in the valley range in depth from 45 to 240 feet and have an average depth of 140 feet. Water levels in the Chehalem Valley are considered stable and have fluctuated within a seasonal range of about 25 feet in recent decades. The quality of the water produced by wells less than 100 feet deep drilled into marine rocks is suitable for most purposes. However, water-quality data and drillers' logs indicate deeper wells (depths of greater than 200ft) often produce water of undesirable quality.

The low-lying eastern half of Chehalem Valley (including the cities of Dundee and Newberg and areas east to the foothills of the Chehalem Mountains and south to the Willamette River) is covered with Willamette Silt. It's composed of thinly bedded layers containing lenses of fine sand and clay. Locally it contains scattered pebbles of granite and quartzite. In general, it ranges in thickness from a few feet to 50ft and is thickest adjacent to the Willamette River. At higher altitudes near Newberg, its thickness is only five to 10ft. Near Yamhill and Carlton, Willamette Silt is generally less than 30ft thick. Because the permeability of Willamette Silt is low, the formation yields water slowly to wells and only a few shallow wells are used in the area.

Some of the better wells in the area are adjacent to and extending south and east of the Red Hills of Dundee. Here, the lowland consists of marine sedimentary rocks and basalt called the Troutdale Formation. The sand, silt, and clay of the Troutdale Formation have a uniform thickness of about 60 to 70ft. The Troutdale Formation also underlies the lowland area near Newberg and is exposed in the bottoms of several ravines and creek beds near town. In most places, in fact, the formation is concealed beneath Willamette Silt or recent alluvium and is exposed only in the bottom of steep ravines and along the Willamette River from Newberg to Wilsonville. Yields of wells tapping the Troutdale Formation range from 4 to 360gal/min.

The Chehalem Mountains and Parrett Mountain consist of a series of northwest-trending uplands that reach altitudes of 1629ft on Bald Peak (outside of the Chehalem watershed) and 1247ft on Parrett Mountain. The uplands have been dissected by many small streams whose canyons range in depth from 300 to 500ft. The Chehalem Mountains are underlain by the Columbia River Basalt Group, which is overlain in places by silt that caps the ridges.

Basalt Group Aquifer

The most important aquifer in the area is the Columbia River Basalt Group. Groundwater from this aquifer is chemically suitable for most uses including drinking. Some of the wells drilled into the marine sedimentary rocks produce water that is too mineralized for general use.

Because many wells drilled in uplands penetrate isolated groundwater bodies perched high above the regional water table, they have a large range in depth, water level, and yield. Some of the wells have water levels of less than 50ft below land surface, whereas others drilled nearby or at lower altitudes have much deeper water levels. Where the basalt aquifer is heavily pumped, water levels have declined about 1 foot per year. This decline is not general throughout the Columbia River Basalt Group, though.

The basalt consists of a series of individual lava flows that are mostly blocky, jointed lava—each with a unique system of joints. Between some flows are zones of ash, soil, breccia, cinders, or broken rock that are porous enough to permit the movement of water. These are called "interflow zones" and are the main aquifers (water-bearing and water-yielding zones) in the basalt. The basalt group ranges in thickness from only a few feet in some places to 1000ft; individual flows can be up to 100ft thick. Because of this, wells drilled into the Columbia River Basalt Group are highly variable. Yields of wells drilled into the basalt range from about 15 gal/min in the upland areas to as much as 1000gal/min in some lowland areas.

The Red Hills of Dundee range in altitude from 200 to 1000ft. They're underlain by marine sedimentary rocks and are capped by the Columbia River Basalt Group. Well information indicates that the basalt is about 400ft thick on the eastside of the Red Hills. However, the basalt becomes thinner to the west and at the southern end of the hills.

Water from the basalt in the Red Hills occurs under unconfined conditions. In the higher parts of the hills, the main water table is generally more than several hundred feet deep. Therefore, some wells drilled at the higher altitudes must be drilled to considerable depths. However, many small bodies of perched ground water occur locally above the regional water table. These water-bearing zones yield water for many domestic uses and serve as outlets for many springs. Wells used for municipal supplies by Dundee produce 100 to 180gal/min. The chemical quality of water in the Red Hills is satisfactory for most uses. However, wells that penetrate the marine rocks beneath the basalt may produce water of undesirable quality.

The upland silt that overlies ridges and flatter parts of the Chehalem Mountains consists of micaceous sandy and clayey silt with occasional rounded basalt pebbles and generally has a thickness of 3 to 6ft. It lies directly on weathered basalt of the Columbia River Group, but in places it overlies the Helvetia Formation. Upland silt cannot be distinguished from weathered basalt in drillers' logs.

Groundwater Recharge

The aquifers of the area are recharged mostly during late autumn and winter—the season of greatest precipitation. Many of the aquifers in the lowland areas are of low permeability; consequently, recharge to these units is small. Besides permeability of the soil and rocks, recharge depends on factors such as slope, vegetative cover, attitude of rocks, and precipitation.

Recharge in the area is mostly from direct infiltration of precipitation. Aquifers in the lowlands also may receive some recharge from streams during periods when ground-water levels are lower than adjacent stream levels. However, water levels indicate that adjacent to most streams the water table is actually higher than the stream. Consequently, most streams gain water from the aquifers through springs. In the Newberg area, quick recharge from streams is unlikely because of the low permeability and yield of shallow deposits near the stream.

Groundwater levels of the Columbia River Basalt Group are subject to long-term water-level declines in some heavily pumped areas where use of groundwater is continually increasing. Although groundwater levels in the alluvium and Troutdale Formation fluctuate seasonally, they generally show no net change from year to year. The recovery of water levels each winter to approximately the same level indicates that these aquifers are supported by recharge from the direct infiltration of precipitation and that, in general, recharge balances discharge.

Municipal Needs

The population of Newberg over the past 20 years has increased by an average rate of 4.6% each year. This is high compared with the State average (2%), Portland (2.3%), or Yamhill County (2.7%). Dundee grew by 56% in the 1990s, the fastest rate in Yamhill County. This trend will continue for the foreseeable future raising concerns for the already-scarce supply of clean water.

Newberg developed four springs on Chehalem Mountain prior to 1900 and augmented them in 1933 by Otis Springs at the base of Rex Hill. Newberg owns water rights for 5.16 million gallons per day (mgd) from these springs but the yield from the original four springs has dropped to .25 to .4mgd and .4 to .5mgd for Otis Springs. The latter was shut down in 1987 due to potential contamination from surface runoff. Most of Newberg's water supply comes from a well field across the Willamette River. The first Newberg-owned Marion County well was constructed in 1948 with additional wells drilled through 1980. Current well production is 5.5mgd. The total city water supply with springs is 5.6mgd without any wells in reserve.

The Dundee water system is supplied by a variety of wells and springs. Five of the wells are in town. The Spring Area includes four wells located in the Red Hills. There are two Pruit wells. Another well is currently being constructed. "As far as any shortages it is hard to say," says Todd Miller, Assistant Superintendent of Dundee's public works department, "we have enough water to meet our needs at the time being."

Newberg's water treatment plant was originally constructed in 1953 primarily to remove iron from well water. It was last expanded in 1990 and treats water using sediment settling, filtration, and disinfection by chlorine (30 minutes required by the State).

Newberg residents consume about 80 gallons of water per capita per day for domestic uses. When considering the total demand, though, including industry, the actual total per capita demand is over 200 gallons per day. Industrial users are lead by SP Newsprint who in 1985 used about 3.06mg/month of municipal water. According to Stan Miller of SP Newsprint, the mill actually uses about 12mgd including water taken directly out of the Willamette.

In recent years the well field south of the Willamette and three perennial springs on Chehalem Mountain have been marginally able to meet peak summer demands. A recent study indicates the current well field draws a significant portion (25 to 92%) of its water from the river. The study also shows the percentage of river water pumped by the wells rises with pumping time.

Table 19. Chehalem Valley Municipal Water Statistics

City of Newberg Water Volume, circa 1997

Existing Water Rights: Springs 5.16mgd (million gallons per day), Wells 9.79mgd	*Potential Well Field Yield*: 10 to 11mgd

Well Capacity:
- #1 1.6 mgd
- #2 .8 mgd
- #3 abandoned
- #4 1.7 mgd
- #5 2.6 mgd
- #6 2.6 mgd

> Well flow rates are based on single well operating. Actual flow varies depending on which combination of pumps are operating and the current depth of the water table. For example, well #5 cannot be used during the summer since the pump is above the water table.

Demand (92-97 avg.)	*Total*	*Per Person*
Max Day 1996	5.3 mgd	330 gal
Ave. Day 1996	2.4 mgd	150
Winter Avg. 95/96	1.86 mgd	115
Summer Avg. 1994	3.14 mgd	195

Production (1992-1997 avg.)
Springs: .4 mgd (spring) .25 mgd (fall)
Well Field 6.7 mgd
Total (1996) 887,937,035 gal

City of Dundee Water Volumes, circa 2000

The Dundee water system is supplied by a variety of wells and springs. The only treatment the water receives is with chlorine. The following numbers are for 2000 and are reported in millions of gallons. For example, the total domestic water volume in 2000 was 127,327,000 gallons.

Domestic Water Volumes

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Spring Area	5.085	3.953	4.248	4.9363	5.773	6.970	7.939	8.141	4.699	6.539	4.734	4.968	67.987
Deep Wells	1.006	0.933	1.066	1.064	1.001	0.921	1.209	0.747	0.683	0.813	0.839	0.896	11.177
Well #10	2.474	2.269	2.466	2.380	2.392	2.024	2.043	2.132	1.658	2.214	2.085	2.216	26.352
Pruit Wells						4.922	7.292	6.438	3.140				21.793
TOTAL Millions of Gallons	8.566	7.155	7.779	8.380	9.165	14.837	18.484	17.476	10.181	9.566	7.657	8.080	127.327

Sewer Volumes

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Influent	17.765	15.056	14.840	9.724	9.341	7.704	6.494	6.171	6.255	6.187	6.661	9.709	115.906
Effluent	20.253	18.346	18.148	13.664	11.937		0.447	1.622	0.592		16.538	19.158	120.705

Dundee has three reservoirs with volumes of 400,000 gal, 200,000 gal, and 50,000gal.

Newberg City Manager Duane Cole wrote in 1998 that the "projected population increase creates the need for public investment in the water system either by the City's existing residents, or by new residents, who build in the City, or by both." A new reservoir with transmission system will cost about $3,480,000 while new wells in Marion County with engineering at Gearins Fery will cost about $1,335,000. Also, a new water treatment plant will run about $3,000,000 (in 1998 dollars). The current municipal water system also includes two 4 million-gallon reservoirs and 56 miles of water lines that require maintenance.

Conservation

Newberg's conservation policy provides a general conservation program and a protocol for curtailing service in case of an emergency. The city works with high volume users during critical hot summer days to conserve water. Residents also have conservation guidelines. The program costs approximately $225,000 annually.

Conservation means changing technology and habits to reduce per capita demand for water. The city is currently replacing older water meters to insure that customers pay for what they use and is replacing the older steel water lines that have substantial leaks. Modifications at the water plant will make treating water more efficient. Wells and pumps have also been rehabilitated to maximize pumping capacity; they're currently on a five-year rehabilitation program.

For individual consumers, water conservation programs take three approaches: education, technical assistance, and regulations. The first two are relatively easy to implement but take longer to impact demand, while the regulatory approach is much more difficult to pass. Newberg is a member of the Columbia-Willamette Water Conservation Coalition that deals with water conservation elements on a regional basis. This helps by sharing costs in developing brochures and education programs. Water rates can be used to reduce the peak demand during the summer. Inverted block rates charge higher rates for large users. With growing population densities, landscape regulations can be expected to reduce the future needs for peak water usage.

The Growth of Irrigation

As early as the 1960s supplies for irrigation water were becoming scarce. Yamhill County had an increasing demand for water and, according to community leaders, stream flow was "not going to be sufficient to provide water to everyone" who needed it. In 1964 it was reported that there had been a tremendous increase in just the last two years in water users on the South Yamhill. The amount of irrigated land in the region was relatively small but it was increasing quickly. The amount in the county had increased from 12,475 acres in 1954 representing 15.9% of all farms and averaging 31.8 acres per irrigated farm to 19,218 acres in 1964 representing 18.8% of all farms and averaging 49.8 acres per irrigated farm.[5]

Natural resource conservationists expected Yamhill County land to yield 15 inches of runoff in an average year meaning that each acre would produce 15 acre-inches or 1¼ acre-feet of runoff. "Without storage," they concluded, "this water is already passed onward toward the sea in great part when the irrigation season starts." Note that many of the dams listed in Table 17 were built soon after this.

It's interesting to juxtapose our needs and limits regarding water use. "The limitation on irrigation appears to be not so much a lack of usable land," community leaders wrote in the 60s,

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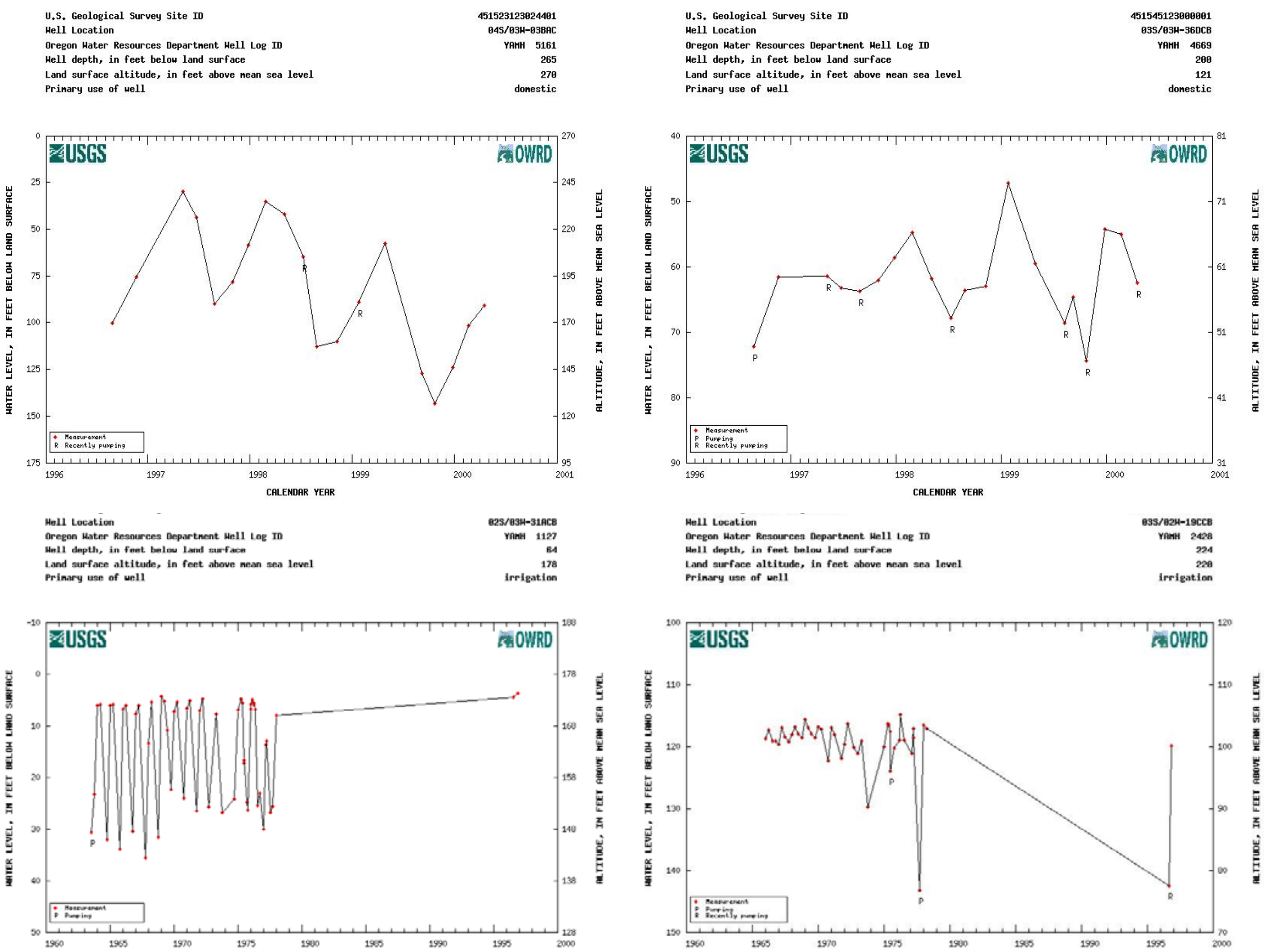
[5] Figures from another report show similar growth, though the totals vary. According to them, in 1959 irrigated acres in Yamhill County represented 9.2% of all county cropland but by 1964 it had increased to 13.7%.

"but limited number of dams, insufficient water, and possibly, the types of farming operations which can make irrigation economically feasible." They knew that there was about 20,000 acres irrigated in1963 and they felt that twice that amount would be needed by 1970. They also knew that in addition to developing reservoirs, we would need to adjust our needs. Current figures for irrigated acres in the county are not available. According to the OSU Yamhill County Extension Office, irrigated acreage is difficult to track because there is a lot of variability from year to year. Regardless, we have yet to resolve our various water needs with the reality of limited supplies.

As early as the 1970s *ecology* became a household word as ecological limits were becoming apparent. Concern in Yamhill County had extended to groundwater as withdrawals for irrigation, domestic, and public supplies had increased steadily in recent years. Because withdrawals were expected to continue in the future, information was needed "to aid in the orderly and efficient development of the ground-water resources of the area."

Figure 3. Hydrographs for Four Wells in the Chehalem Watershed



Well Data

Well information is available from the well log database maintained by Oregon Water Resources Department (OWRD) and is available in a variety of formats from the OWRD web site. The contractors who construct wells supply data to OWRD by submitting a well log. The well location on some well logs may only be to the closest 40-acre parcel. Water levels shown in Figure 3 indicate the approximate static water level below the surface. Measuring status codes from hydrographs in Figure 3:

The status of the site at the time the water level was measured:
- D, the site was dry (no water level is recorded);
- E, the site was flowing recently;
- F, the site was flowing;
- G, a nearby site was flowing;
- H, A site that taps the same aquifer had been flowing recently;
- I, injector site (recharge water being injected into the aquifer);
- P, the site was being pumped;
- R, the site was pumped recently;
- S, a nearby site was being pumped;
- T, a nearby site had been pumped recently;
- V, foreign substance was present on the surface of the water;
- W, the well was destroyed;
- Z, other conditions.

Measuring method:
- A, Airline measurement;
- B, Analog, graphic, or digital recorder;
- C, Calibrated airline measurement;
- E, estimated;
- G, Pressure-gage measurement;
- H, Calibrated pressure-gage measurement;
- M, Manometer measurement;
- R, Reported, method not known (generally by driller);
- S, Steel-tape measurement;
- T, Electic-tape measurement;
- V, Calibrated electric-tape measurement;
- Z, Other.
- --, no data.

The system used for locating wells is based on the rectangular section system. The position of a township is given by its north-south "Township" position relative to the baseline and its east-west "Range" position relative to the meridian. Each township is divided into 36 sections approximately 1-square-mile (640-acre) in area and numbered from 1 to 36. For example, a well designated as 01S/03E-33DCA is located in Township 1 south, Range 3 east, section 33. The letters following the section number correspond to the location within the section; the first letter (D) identifies the quarter section (160 acres); the second letter (C) identifies the quarter-quarter section (40 acres); and the third letter (A) identifies the quarter-quarter-quarter section (10 acres). Thus, well 33DCA is located in the NE quarter of the SW quarter of the SE quarter of section 33.

The Well Log ID shown on Map 10 are unique for each well and can help you find current data on the groundwater of your area. It is a four-letter county-code (“YAMH”) and a well-log number with up to 6 digits which is assigned to the well when a water well report is filed by the well driller with the OWRD. The information is recorded in the Ground Water Resource Information Distribution (GRID), a statewide computer database maintained by the OWRD. The USGS also maintains a national computer database of wells and may be able to provide additional information.

Water Rights and Stream Flow

Under Oregon law all water is publicly owned. Before water is consumed, a water right needs to be obtained. This applies to use of water from a creek, stream, or river even if the water is for domestic use. In some cases water rights are needed for ground water as well. Water rights are issued through an application process administered by the OWRD.

Water Rights are becoming increasingly important as seasonal water demands are exceeding supplies with growing frequency. Competition between in-stream and out-of-stream uses is intensifying according to the 1992 Willamette Basin Report. At present, issuance of water rights is very limited in the Yamhill and Chehalem basins. Generally, if water is desired for the period May 1 through October 31, new non-storage water right applications are being processed only for domestic use, commercial use for customarily domestic purposes not exceeding 0.01cfs (4.48 gal/min), livestock use, and public in-stream uses. Some stream basins are limited year round to only domestic, commercial uses for customarily domestic purposes not exceeding 0.01cfs (4.48 gal/min), livestock, and public in-stream uses. Use may be limited further in the future due to water availability, fish, and water quality concerns.

During the low flow time of year, rivers and streams of the Chehalem watershed are currently over appropriated. This means that the sum of water rights is greater than the estimated flow in the streams. If all the area's water rights were exercised simultaneously, the streams would be dry. This oversimplifies the hydrology of the watershed, though, because it does not take into account that some portion of the water removed for uses such as irrigation or domestic use theoretically flows back into the system. Another factor is the time of day that the water is used—this is not taken into consideration when calculating sum flow and appropriation.

Oregon water law states that water rights not exercised for five consecutive years are forfeited. Currently there is no system in place to monitor all water withdrawn by users or stream flows. Therefore, it is difficult to determine the amount of water actually being used.

Map 10 shows the land area with irrigation rights, as well as the points of diversion (surface water) and points of appropriation (wells). Points of diversion, points of appropriation, and place of use (irrigated land area) are shown based upon maps supplied by the applicant or from a final proof survey or court decree. The irrigated acreage polygons represent the areas with rights to both surface and ground water for irrigating that acreage. It does not mean those rights are being exercised and the land may not actually be irrigated.

Oregon water law is based on the prior appropriation doctrine—first in time is the first in right. When exercised water rights exceed the available flow (usually during the summer months) and water users are not able to get the amount of water they can beneficially use under the water right(s), water is distributed among users based upon the priority date of their water right. The priority date is set by court decree or the date the application is accepted by OWRD. Junior users can be told to stop using water if a senior user is unable to exercise his/her full right.

An online introduction to Oregon's Water Law and Water Rights System on the website for OWRD states,

> "Watermasters respond to complaints from water users and determine in a time of water shortage who has the right to use water. They may shut down junior users in periods of shortage.
>
> Watermasters work with all of the water users on a given water system to ensure that the users voluntarily comply with the needs of more senior users. Occasionally, watermasters take more formal actions to obtain the compliance of unlawful water users or those who are engaged in practices which "waste" water. The waste of water means the continued use of more water than is needed to satisfy the specific beneficial use for which the right was granted.

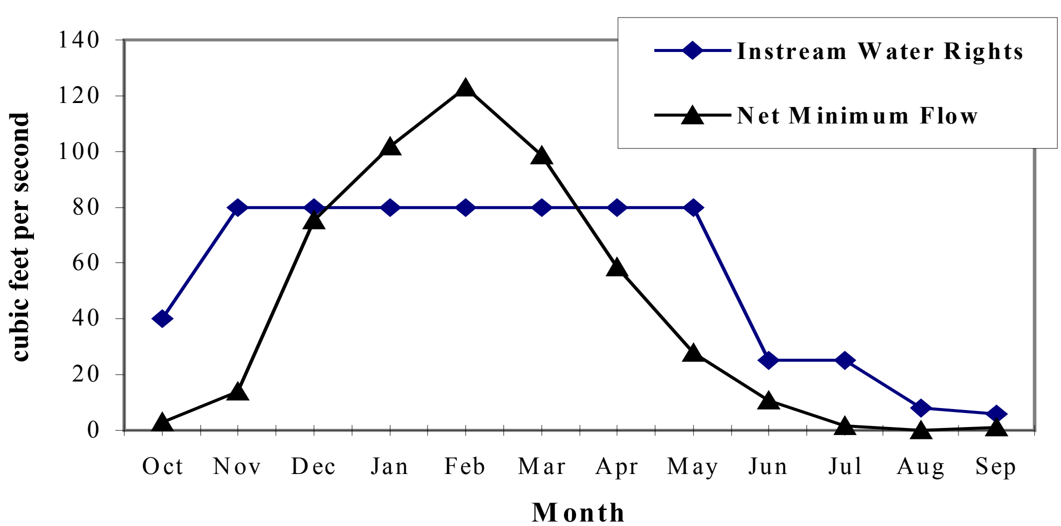
> Instream water rights are not guarantees that a certain quantity of water will be present in the stream. When the quantity of water in a stream is less than the instream water right, the Department will require junior water right holders to stop diverting water. However, under Oregon law, an instream water right cannot affect a use of water with a senior priority date (OWRD 1996)."

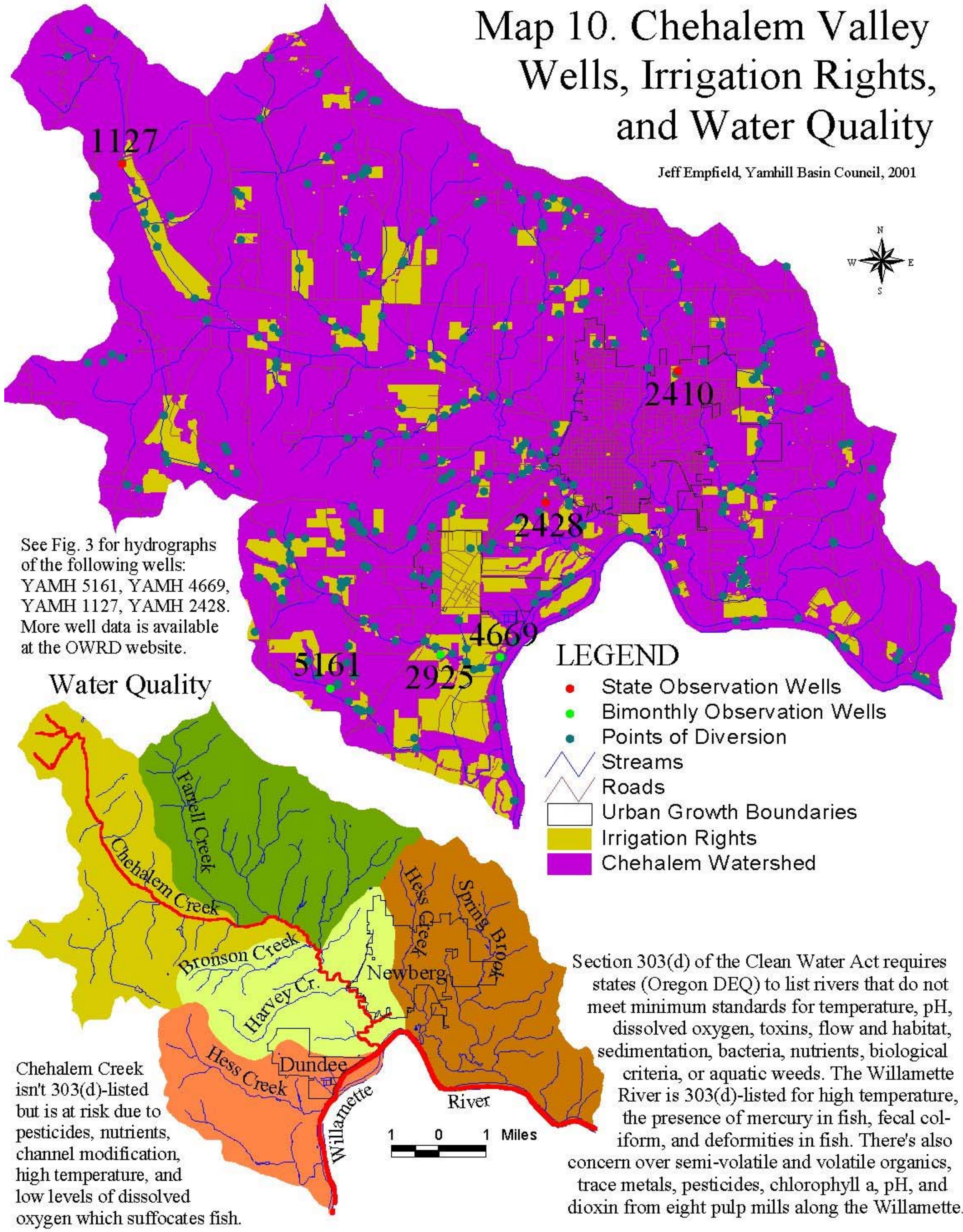
According to Bill Ferber, the OWRD watermaster for the area, conflict seldom happens. On paper streams appear over-allocated. In reality users have not yet been denied access to water in Yamhill County. How is this possible? Ferber has three hypotheses: 1) users are not exercising their full right since we have had more evenly distributed rain in recent years or 2) he suspects that much of the irrigation water eventually percolates through the water table and re-enters the stream or 3) users are not filing complaints. Another possibility is that users are not all taking the water from the stream at the same time of the day. Some may remove water at night or in the evening while others are removing water during the day.

The lack of sufficient streamflow to dilute pollutants and support aquatic life (including salmonids) is an issue throughout the Willamette basin. This is especially true during the summer when flows are naturally low due to the lack of precipitation in the valley during summer months and the absence of snow melt in the coast range. Consequently, the primary source of water during the summer is groundwater that enters the streams through seeps and springs. This condition is worsened by out-of-stream demands especially for irrigation.

At this time, there are no plans for the basin or the state to change the way water rights are allocated or to increase the enforcement of the "use it or lose it" policy. However, this discrepancy between available water and water rights has not been tested by a severe drought (necessitating that more users exercise their irrigation water rights) according to the area watermaster Bill Ferber.

Figure 4. Typical Net Flow Versus In-stream Water Rights




Map 10. Chehalem Valley Wells, Irrigation Rights, and Water Quality
Jeff Empfield, Yamhill Basin Council, 2001
N
W
E
S
1127
2410
2428
4669
5161
2925
See Fig. 3 for hydrographs of the following wells: YAMH 5161, YAMH 4669, YAMH 1127, YAMH 2428. More well data is available at the OWRD website.
LEGEND
State Observation Wells
Bimonthly Observation Wells
Points of Diversion
Streams
Roads
Urban Growth Boundaries
Irrigation Rights
Chehalem Watershed
Water Quality
Farrell Creek
Chehalem Creek
Bronson Creek
Harvey Cr.
Newberg
Hess Creek
Spring Brook
Hess Creek
Dundee
Willamette
River
1
0
1
Miles
Chehalem Creek isn't 303(d)-listed but is at risk due to pesticides, nutrients, channel modification, high temperature, and low levels of dissolved oxygen which suffocates fish.
Section 303(d) of the Clean Water Act requires states (Oregon DEQ) to list rivers that do not meet minimum standards for temperature, pH, dissolved oxygen, toxins, flow and habitat, sedimentation, bacteria, nutrients, biological criteria, or aquatic weeds. The Willamette River is 303(d)-listed for high temperature, the presence of mercury in fish, fecal coliform, and deformities in fish. There's also concern over semi-volatile and volatile organics, trace metals, pesticides, chlorophyll a, pH, and dioxin from eight pulp mills along the Willamette.

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CHAPTER 9

Water Quality

This chapter provides a screening level assessment of the water quality in the Chehalem Valley. This is a broad overview and addresses water issues not examined in the other sections including: temperature, dissolved oxygen, pH, nutrients, bacteria, and chemical contaminants.

In-stream water quality is desirable to protect "beneficial uses." These are legally defined for Oregon water quality standards. Beneficial uses for watersheds in the Willamette Valley are listed in Table 20.

Table 20. Beneficial Uses for Willamette River Tributaries

Beneficial Use
Public Domestic Water Supply
Private Domestic Water Supply
Industrial Water Supply
Irrigation
Livestock Watering
Anadromous Fish Passage
Salmonid Fish Rearing
Resident Fish and Aquatic Life
Wildlife and Hunting
Fishing
Boating
Water Contact Recreation
Aesthetic Quality
Hydro Power

Often, the most sensitive beneficial uses depend on maintaining water for the rearing and spawning of salmonids—including cutthroat trout. In the Chehalem Valley, cutthroat trout are one of the most important indicators of the overall health of a stream. If they are not present and healthy in areas where they were found historically, then the quality of that water is likely a problem. Salmonids need specific water conditions for spawning and rearing fry and juvenile fish. They are very sensitive to changes in water quality during early development.

Oregon is required to set standards of water quality under section 303 of the Federal Clean Water Act. When the standards are violated, the stream becomes listed under section 303(d) rules of the law. The stream sections currently listed from the Chehalem watershed are shown in Table 21 below. "Listing" means the water quality is not in compliance with the law and steps need to be taken to bring it into compliance. The Oregon Department of Environmental Quality (DEQ) administers the rules and manages the data that determines 303(d) listing.

Table 21. Water Quality Limited Streams—303(d) List for the Chehalem Watershed

Stream Location	Parameter examined	Criteria	Season of concern	Basis for Listing	Supporting Data
Willamette River, Willamette Falls to the Yamhill River	Toxics	Tissue - Mercury	Year Around	Health Division Consumption Health Advisory (1997)	Health Division Consumption Health Advisory issued for Mercury in fish tissue (.63ppm) based on data collected since 1969; Reference level (.35 ppm)
Willamette River, Willamette Falls to the Yamhill River	Bacteria	Water Contact Recreation (fecal coliform-96 Std)	Fall Winter Spring	DEQ Data; d1 in 305(b) Report (DEQ, 1994); NPS Assessment - segment 104 and 454: moderate, data (DEQ, 1988)	DEQ Data (2 Sites: 402007, 402010; RM 34.4, 48.6): 17% (7 of 41), 26% (17 of 66) FWS values respectively exceeded fecal coliform standard (400) with maximum values of 1600, 2400 between WY 1986 - 1995.
Willamette River, Willamette Falls to the Yamhill River	Temperature	Rearing 68 F (20.0 C)	Summer	DEQ Data; USGS Data; NPS Assessment - segment 104: moderate, observation (DEQ, 1988)	DEQ Data (2 Sites: 402007, 402010; RM 34.4, 48.6): 62% (23 of 37); 60% (36 of 60) Summer values exceeded temperature standard (68) with a maximum of 80.6 and exceedences measured each year between WY 1986 - 1995.
Willamette River, Willamette Falls to the Yamhill River	Biological Criteria	Fish Skeletal Deformities		Tetra Tech (5/1995)	Tetra Tech (5/95): The incidence of skeletal deformities (from 22.6 to 74%) in juvenile Squawfish collected between RM 25.5 - 51 in 1993 and 1994 were significantly higher than those measured in upper river or reference site, cause is unknown.

(Oregon Department of Environmental Quality website)

Sources of Pollution

National Pollutant Discharge Elimination System (NPDES) permits are required for point sources of pollution that are registered with the EPA. "Major" NPDES permits are for facilities that discharge more than one million gallons in any 24-hour period. In the Chehalem watershed, the city of Newberg Wastewater Treatment Plant (WWTP) and SP Newsprint hold major permits. Dundee holds a minor one. To put this in context, 33 major NPDES sites and 320 minor ones discharge effluent into the Willamette River or its tributaries. Relatively little is known about their nutrient content.

Stream flow influences the concentrations of both dissolved and suspended contaminants, but the relation between concentration and stream flow is not straightforward. For example, high flows can reduce concentrations by diluting point-source inputs, or, conversely, they can be associated with additional inputs such as non-point-source contaminants in surface runoff. Because flows vary among sites and at individual sites, their variability should be considered whenever concentrations are compared.

The period of greatest concern for pollution or "contaminant loading" of rivers in our area is during the summer months of July through September. This period is important because non-point source contaminants tend to accumulate between infrequent rainfall during the summer and are then washed into rivers with relatively low rates of flow. The low summer flow in the river limits the capacity of the river to dilute incoming contaminants.

Types of non-point source contaminants in storm water:

- Nutrients (such as phosphorous and nitrogen) act as fertilizer for aquatic plants like algea. They come from leaking septic tanks, domestic animal wastes, feedlots, fertilizer applied to lawns and cropland, detergents—especially those used outdoors (car washing) and rinsed into street drains, and from decaying plant debris.
- Sediment is considered to be a non-point source contaminant because it causes turbidity and damaging deposits of silt on gravel spawning beds. It also reduces flood storage volumes by filling in streambeds and pools. Sediment is caused by erosion at construction sites, along poorly protected banks of fast moving streams or drainage ditches, from agriculture fields, and from landscaped areas.
- Bacteria such as E. coli come from human and animal waste and serve as an indicator that waste is present. It means other harmful bacteria or pathogens may also be present. E. coli and fecal coliform are common in the environment but are not always dangerous; when they are found in high concentrations, though, there is likely a source of raw sewage that requires further investigation or treatment.
- Organic compounds and solvents such as benzene, oil, gasoline, and tri-chloro-ethane (TCE) can be soluble or not and either heavier than water or not. Light, floating solvents such as gasoline or oil will often be transported by surface "sheet" flow. Leaking underground fuel tanks can contribute to ground water contamination for years without detection. It will generally travel downward until it reaches the water table and then it will move laterally at the top of the water table. Heavier insolubles such as TCE will migrate downward through

soil horizons rather than being transported by either surface or subsurface water flow. Soluble organics such as anti-freeze are difficult to remove from storm water and will be transported downstream. Concerns: changing oil, steam cleaning, degreasing, industrial activities, underground fuel tanks, use of pesticides, use and disposal of household cleaners, paint, etc.

- Metals, primarily lead, cadmium, copper, and zinc are a concern because of their possible toxic effect on aquatic, animal, and human life. Metals can reenter the food chain through bottom feeding species and benthic organisms (like clams). Significant sources of trace metals are industry, leaded gas, and the wearing of brake shoes and tires.

Table 22 provides information from the DEQ database of reaches that have been considered for listing but for one reason or another were not placed on the 303(d) list. According to Mark Charles of DEQ, the Environmental Protection Agency is revising its requirements so that the decision whether or not to list will be simplified. Mark adds, though, that the stretches listed in Table 22 deserve more attention and will remain areas of concern for state agencies until shown otherwise.

Table 22. Chehalem Areas of Concern for 303(d) Standards

Stream Section	Criteria	Cause for Concern (These stretches are *not* 303(d) listed.)
Chehalem Creek, mouth to headwaters	Toxics, pesticides	NPS Assessment - segment 360: moderate, observation (DEQ, 1988).
	Nutrients	NPS Assessment - segment 360: moderate, observation (DEQ, 1988).
	Habitat Modification	NPS Assessment - segment 359: severe, observation (DEQ, 1988).
	Flow Modification	NPS Assessment - segment 359: severe, observation (DEQ, 1988).
	Dissolved Oxygen (DO)	NPS Assessment - segment 359: severe, observation (DEQ, 1988).
	Temperature	NPS Assessment - segment 359: severe, observation (DEQ, 1988).
Willamette River, Willamette Falls to Yamhill River	Toxics, PAHs, Semi and Volatile Organics (Sediment)	Willamette River Basin Water Quality Study Phase I and II, USGS data: Benzo(A)anthracene, Benzo(GHI)perylene, Benzo(K)fluoranthene, Benzo(A)pyrene, Bis(2Ethylhexyl)phthalate, Chrysene, Fluoranthene, and Pyrene were found in sediments,but below various guidelines or guidance values. No beneficial use impairment evaluations are available that show a toxicity problem. Benzo(B)fluoranthene, Di-n-butylphthalate and Indeno123-cdpyrene were found, however, there are no well established guidelines available for evaluating risks, nor have there been any beneficial use impairment evaluations. No other PAHs, Semi or Volatile Organics were detected. Did not meet listing criteria.
	Toxics, Trace Metals (Water)	Willamette River Basin Water Quality Study Phase I and II, USGS data: Copper, Manganese, Nickel, and Zinc were found in water, but levels were below the water quality standards Table 20 values. No other trace metals were detected.
	Toxics, Trace Metals (Sediment)	Willamette River Basin Water Quality Study Phase I and II, USGS data: Chromium, Copper, Manganese, Nickel, Zinc were found in elevated levels in sediments when compared to various guidelines or guidance values, however, sediment toxicity does not correlate well with sediment contaminant concentrations and is dependent on local conditions. To determine toxicity a demonstration of a beneficial use impairment is needed. No data on beneficial use impairment (e.g. bioassays) is available. For constituents in sediment there is no single type of sediment-quality guideline generally accepted in the scientific literature.

	PH	DEQ Data (2 Sites: 402007, 402010; RM 34.4, 48.6): 0% (0 of 38, 58) Summer values respectively exceeded pH standard (6.5 - 8.5) between WY 1986 - 1995.
	Toxics, Pesticides (water)	NPS Assessment - segment 104: moderate, observation (DEQ, 1988); Willamette River Basin Water Quality Study Phase I and II, USGS data: Atrazine, Diazinon, Metolachlor and Simazine were found but either do not have or were below any water quality standard, guidance level or criteria. No other pesticides detected.
	Toxics, Tissue and Water Column - 2,3,7,8-TCDD	TMDL Approved (2/25/91)Basis for Consideration for Listing: EPA (91); DEQ Data; 1994 304(l) list, Part A/B: Dioxin TMDL based on the loading capacity calculated from the water quality standard (0.013 ppq - established to protect human health), discharge estimates from 8 chlorine-bleaching pulp mills in the Columbia R Basin, and a design stream flow. Rationale for not Listing: TMDL has been established for dioxin, approved (2/25/91) and is being implemented
	Chlorophyll a	DEQ Data; d1 in 305(b) Report (DEQ, 1994); NPS Assessment - segment 104 and 454: moderate, data (DEQ, 1988): DEQ Data (2 Sites: 402007, 402010; RM 34.4, 48.6): 14% (5 of 37), 2% (1 of 55) Summer values respectively exceeded chlorophyll a (15 ug/l) with maximum values of 20, 17 between WY 1986 - 1995.

(Oregon Department of Environmental Quality website)

Nutrients

Total phosphorus is a way to measure the amount of phosphates in the water column and phosphorus in suspended organic material. Total nitrate is a way to measure the majority of nitrogen present in the water. Scientists identify the two as the major limits to plant growth. If there are excessive amounts of phosphorus and nitrates, plant growth increases and can be a problem in slow-moving water. Algae and other plants remove dissolved oxygen from the water, can interfere with recreation, and with certain algae, produce chemicals that are toxic to animals.

Fecal Coliforms

Fecal coliforms are microorganisms that indicate when feces (animal or human) is present in the water and warn us of the associated pathogenic health hazards. Sources of fecal coliforms include faulty septic systems, runoff from feedlots or other high concentration of domestic animals, leaking sewer pipes, overflows from sewers or wastewater treatment facilities, and wildlife. Fecal coliform bacteria are to be expected in all surface streams. In-stream concentrations less than 100 colonies per 100ml are considered acceptable but concentrations above 200 suggest a source of raw sewage and are cause for concern. The potential problem when levels are high is that other more dangerous pathogens may be present. In this respect, fecal coliform serves as an indicator that there is a source of raw waste entering the water.

The data for fecal coliform shown in Table 23 indicates "ambient" or preexisting levels—not the levels caused by a leak or overflow of sewage. Overflow readings are much higher. For ambient fecal coliform levels, readings of 200 or more suggest sources of raw sewage are polluting the stream. Failing household septic systems commonly contribute to this problem.

Table 23. Fecal Coliform in the Newberg Area

Figures indicate number of FC organisms/100mg of sample water. Numbers over 200 suggest a problem.

	WILLAMETTE RIVER				CHEHALEM CREEK		HESS CREEK (East of Newberg)				
DATE	Rogers Landing	Champoeg State Park	San Salvador Park (Marion Co.)	Other	Dayton Ave. Bridge	Ewing Young Park	Mountainview Drive	Villa Road	George Fox Univ.	Hoover Park	WWTP
7/3/89		10		17[1]							
7/5/89	6	5		9[1]							
7/6/89	10	7									208
7/7/89	41	3		2[1]							172
5/23/91											513
7/23/91				0[2]							
"				10[3]							
7/25/91	13										
7/26/91	10										
8/2/91					127						
8/5/91					53	84					
9/16/91					40						
2/27/92									430		
11/12/92											140
11/18/92									600	>1200	320
12/29/92					640	660	480			1545	
1/7/93							167			960	
1/22/93						100				1270	
1/26/93						117	350			864	
2/2/93						120	80			1020	
2/9/93							60			1240	
2/18/93							100			1480	
2/23/93							350	520	1120	1340	
3/3/93							180	480	700	1440	
12/14/93							700				
1/19/94					200	374					
2/25/94					500						
2/21/95					200	200					
5/18/95		200								800	
2/9/96										500	
2/14/96					91	91					273
8/30/96					500						
10/25/96	267				1000						
10/28/96						97					
5/27/97						0					
12/1/98					200						
12/3/98					267	133					
12/8/98					280	240					
12/29/98					545	591					
1/5/99	45				91	182					
1/26/99	273	64	83		309	200					
2/8/99					217	267					
2/19/99					267	250					
2/26/99	540				67	50					
3/15/99	233				183	150					
8/5/99	180	20	40								
8/12/99	73	45	54								

[1]at mouth of Spring Brook
[2]upstream of mouth of Chehalem Cr.
[3]at mouth of Chehalem Cr.

(City of Newberg Wastewater Treatment Plant, 2001)

According to Alan Lee of the Newberg WWTP, the only stream sampling they do at the WWTP is for fecal coliform, and then only when they have an overflow that reaches surface waters

(Chehalem or Hess Creeks or any tributary streams). They have some Willamette River data, but that is also limited. The city of Newberg and SP Newsprint are working with the USGS to install a permanent monitoring station on the Willamette in the Newberg vicinity. This station will monitor flow, temperature, and dissolved oxygen, and possibly other criteria, but there is no timeline for installation at this time. Of course, they keep extensive data on their effluent and monitor it to keep within standards.

According to the 1979 *Natural Resource Conservation Plan* of the Yamhill County Soil and Water Conservation District, failing septic systems are a significant source of pollution in the county. According to soil surveys, 93% of the soils in Yamhill County severely limit the functioning of septic systems. Consequently, this acts as a limitation for residential development. This is the case where there is too much clay for effluent to move through the soil at a sufficient rate, where winter standing water eliminates many potential septic sites, and conversely in foothills that are too steep for installing drainage fields.

Fecal counts as high as 10,000 have been recorded after sewer system overflows, with levels greater than 1000 common. The duration depends on the magnitude of the spill and the stream flow at the time. Coliform levels can return to normal in as little as 24 hours for small spills at high flows. For larger spills at lower stream flows, it can take a week or longer for the counts to return to ambient or pre-spill levels.

DEQ has recently changed the fecal indicator from the bacterial group of fecal coliforms to a subset of that group known as *Escherichia coli* (E. coli). The limit is a 30-day mean of 126 E. coli organisms per 100ml. This will also be Newberg's discharge limit when the new National Pollutant Discharge Elimination System (NPDES) permit is issued, replacing the 200 per 100ml fecal coliform limit. Therefore, 126 E.coli roughly equates to 200 fecal coliforms.

The change is intended to improve the accuracy of the standard. Standards will be established for the Yamhill Basin (including the Chehalem Valley) during the total maximum daily load (TMDL) process scheduled for 2007. This process will assess the "natural" or background concentrations of fecal pollution and then establish a threshold by which the watershed will be monitored. The DEQ water quality program website (http://waterquality.deq.state.or.us) has additional information. Another resource for learning more is to call the water quality program office at (503) 229-5279.

Sewage Treatment

Newberg's first sewage plant was built in 1949. It was updated in 1962 and again in 1971. The original facility was partially flooded by the 1964 flood. This, along with a pattern of frequent bypassing of raw sewage into the Willamette, indicated that the system was inadequate. By the early 1980s, Newberg's old sewage treatment plant repeatedly failed State water quality standards. The plant was experiencing structural problems, it was receiving higher volumes than it was designed to handle, and even when it worked well it was still located partly in the floodplain of the Willamette River. With the help of Federal funding acquired through the EPA, the city built the existing facility that began operating in September 1987.

The current wastewater treatment plant (WWTP) is an oxidation ditch type activated sludge secondary treatment plant with a dry weather design flow averaging 4.0 million gallons per day (mgd). During the wet season the plant is designed for an average of 6.5mgd with a peak capacity of 18mgd. Solids removed from the wastewater are "dewatered" and composted in a large concrete vessel—an innovative system. The liquid wastewater is disinfected with chlorine and then dechlorinated with sodium bisulfite prior to discharge to the Willamette. The plant is designed for a population of 27,000 plus an industrial population equivalent of 9,300. There are no plans for expanding the capacity or level of treatment at the plant but it was designed with future modular expansion in mind. The old WWTP was also an activated sludge secondary treatment plant with chlorine disinfection (no dechlorination) and anaerobic digesters for solids.

The new plant was designed to meet newer, more stringent effluent standards to try and avoid polluting the Willamette. In the winter when there is more water in the river the treated effluent can have up to 30mg/1 biochemical oxygen demand (BOD) and suspended solids (SS). When water and dissolved oxygen levels are lower in the summer, the standard is accordingly more strict at 10mg/1 BOD and SS. The design of the plant goes a long way towards simplifying the process in order to avoid using large quantities of expensive and problematic chemicals.

Ammonia is removed biologically by bacteria in the treatment system which metabolizes it. Instead of metabolizing phosphorous, bacteria incorporate it into their bodies, not unlike the carbon sequestration in trees currently being promoted as a treatment for greenhouse gases. The phosphorous can then be removed by taking out a portion of the bacteria to be used as fertilizer.

One of the most exciting features of the treatment process is that solids (in the form of sludge) are removed from the effluent, thickened, dehydrated, and then composted. This involves adding carbon in the form of sawdust to the "dewatered" sludge. The carbon balances the concentrated nitrogen already present and the two fuel a biological process that accelerates the breakdown of the sludge. It quickly eliminates the polluting characteristics of the waste and creates soil compost as a byproduct. The composting takes only about two weeks and then an additional two weeks to a month of curing results in a stable, environmentally safe fertilizer available to the public. Called "Newgrow," it exceeds all EPA and DEQ standards and is free of pathogens though it may have some low levels of heavy metals. According to the promotional literature, Newgrow may be used without restriction for any landscaping or gardening uses, including vegetables for human consumption. It provides a long-term slow release of nitrogen, phosphorous, and potassium and improves the quality of any soil. For more information on Newgrow call the City of Newberg Wastewater Treatment Plant at (503) 537-1254.

This same basic technique can be used by anybody on a small scale. In fact, it's the basis of many simple composting toilet systems. The essential thing is to add carbon material (preferably sawdust), put a roof over it, and give it some time to decompose. All plant material is high in carbon content and the carbon balances the nitrogen in animal (human) waste to promote efficient decomposition. In a relatively short time the combined material becomes soil, suitable for planting. If you want to try this but would like more information, you can learn everything you need to know from *The Humanure Handbook* available from Jenkins Publishing, PO Box 607, Grove City, PA 16127. To order, call 1-800-639-4099.

All treatment or decomposition systems involve bacterial growth—this is a useful tool for consuming nutrients under controlled conditions. In the environment, bacteria are everywhere and that is natural and good but certain bacteria can threaten the health of plants and animals, including humans. This is especially true of bacteria associated with human waste because as living organisms, these bacteria are constantly evolving and some of the ones that live inside humans evolve to be pathogenic to humans. A related variable is the volume of water in the Willamette River—where much of the region's wastewater goes—because it fluctuates widely during the year from huge winter storms to very little volume during late summer.[6] High flows effectively dilute discharges; during low flows discharges to the river have more of an impact.

Not only is the volume of the river higher in the winter, but so is the amount of wastewater coming into the plant. The reason is that some storm water still enters the system. The plant can handle up to 18 million gallons per day but sometimes levels exceed that during winter storms. To stay below this maximum capacity it is imperative that Newberg phase out combined storm/wastewater drainage and manhole covers with holes in them that drain storm runoff when streets become inundated. During heavy rainfall, the capacity of lift stations is sometimes exceeded and the excess overflows directly to area streams. Few things make less sense than mixing our sewage with fresh water and then trying to separate the two. The less fresh water we pollute, the better. Towards this end, new storm drain pipes discharge directly to creeks.

Another problem with old pipelines is that they leak and allow "I &I"—inflow and infiltration of groundwater during the winter when the water table rises. These same pipes allow some limited "exflow" of raw sewage when the water table drops during summer months. The city of Newberg does not have any combined sewers (stormwater + wastewater) but infiltration and inflow through leaky pipes has been a problem in the past. Pump station overflows have also been common in past years. This past winter that was not a problem because of the lack of rainfall but Newberg is also taking steps to avoid future overflows. The city has replaced two of its older and less reliable pump stations in the past year and has made improvements to the Dayton Avenue Pump Station, the largest pump station in the system. Newberg has also constructed a new sewer interceptor that has relieved some of the flow at Dayton Avenue. The Public Works crew also has an ongoing I & I program to identify and replace failing sewer lines and to seal leaking manholes.

Temperature

High temperatures affect native fish by stressing them in a variety of ways and even leading to death in many cases. Above their normal range of temperatures, salmon and trout experience an increased metabolism so that they cannot eat enough to maintain their body weight. Further exacerbating this for salmonids is the fact that they lose their appetites and become less competitive in catching food at abnormally high temperatures.

Figure 5 shows Yamhill Basin Council temperature monitoring data for the year 2000. Staff implemented a monitoring program in association with the Oregon Department of Environmental Quality (DEQ). The technique is to place special thermometers in area streams that record

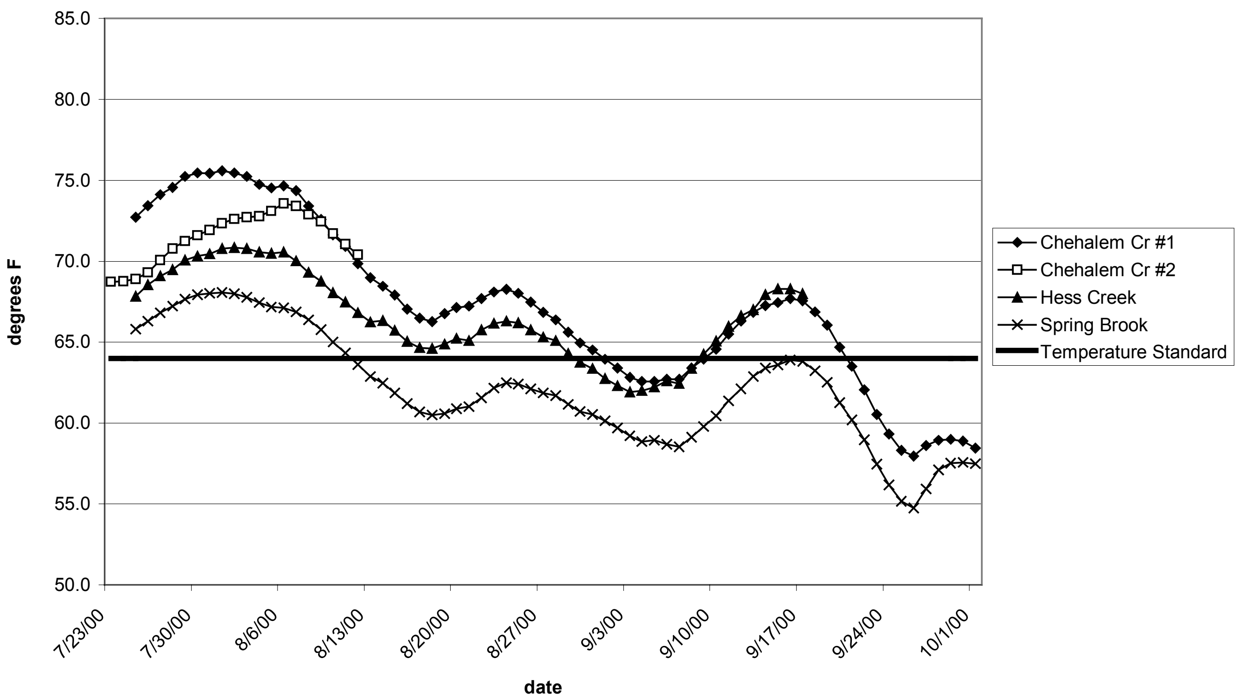
[6] Levels in the Yamhill River illustrate the seasonal fluctuation. Flows peaked at over 47,000 cubic feet per second (cfs) during the 1996 flood. In contrast, September flows typically drop to only ~10cfs or less.

temperatures every half hour and store the data on a computer chip for later analysis. A number of streams in Yamhill County experience their seasonal seven-day maximum around the same time (August 1).

The maximum seven-day average temperature standard for the Yamhill Basin is 64°F. This means that over any seven-day period, the average maximum daily stream temperature ideally will not exceed 64°F. All streams monitored in the Chehalem watershed exceeded this standard in the summer of 2000. During spawning season for winter steelhead, the seven-day moving average temperature is not to exceed 55°F in order to support salmon spawning, egg incubation, and fry emergence from the egg. These standards are widely debated because temperature cycles vary daily and seasonally and different life stages and species of fish exhibit different tolerances.

When DEQ begins working on the TMDLs ("Total Maximum Daily Loads") for the Yamhill Basin they will examine temperature and determine if 64°F is an attainable maximum

Figure 5. Chehalem Watershed 7 Day Ave Max Stream Temperatures (Yamhill Basin Council, 2001)



temperature for the region. Critics say that historically the area's waters exceeded 64°F under natural conditions. Unfortunately, there is no historic temperature data to confirm or refute this. There is no dispute that water temperature influences the aquatic ecosystem, including the composition of the biological community and the chemical behavior of the system. Most living organisms have adapted to and tolerate only limited temperature ranges. For example, water temperatures exceeding 20ºC are dangerous for salmonid species and temperatures exceeding 25ºC can be lethal.

Dissolved Oxygen

Temperature also influences the chemical behavior of many dissolved gases because they decrease in concentration with increasing temperatures. This effect is particularly important for dissolved oxygen (DO) and is one cause of the seasonal variation in the DO concentration.

Dissolved oxygen is important for supporting cold-water organisms such as salmon and trout. Throughout their lifecycle, these species have different dissolved oxygen demands. The Oregon Water Quality Standards specify the amount of dissolved oxygen to meet the needs of these species. For the screening level of this assessment, the level of DO that is desired is 8mg/L or above. In Yamhill County, samples range from 8.5mg/L to 13.5mg/L with the majority of the samples in the 9.0mg/L to 10.0mg/L range, which is also meets the standard.

pH

pH measures the hydrogen ion concentration in water which means it indicates the relative acidity or alkalinity. pH values greater than seven indicate alkaline conditions and those less than seven indicate acidic conditions. Knowing the pH of water tells us how available nutrients are and how toxic chemicals may be. Water chemistry and water quality are profoundly affected by the relative acidity of the water as hydrogen ions participate in many equilibrium reactions in water. Consequently, the pH can be used to indicate which chemical reactions predominate and can be very important when considering the toxicity of a weak acid or base. In the case of ammonia, for example, the non-toxic, ionized form is dominant when the pH is low (<9.3); but when the pH is high (>9.3) the toxic, neutral form is dominant.

The Oregon Water Quality Standards specify an acceptable pH range of 6.5 to 8.5 for basins west of the Cascades because water having a pH value outside of this range is toxic to freshwater organisms. Note that pH values vary during different times of the year based on natural conditions such as photosynthesis and respiration cycles of algae present in the water.

Turbidity and Suspended Solids

Turbidity is a measure of water clarity. It can be caused by runoff of sediment or by suspended material such as algae. Turbidity is measured by recording the amount of light that passes through a water sample. High values (>50 Hach FTU) indicate high amounts of suspended sediments or particles in the system. Sediment affects salmonids by damaging their gills and reducing their ability to see their prey. Sediments also clog gravels salmonids use for spawning.

No turbidity data is available for the Chehalem watershed. Data recorded by DEQ from 1986-88 showed turbidity levels in the South Yamhill River near the Whiteson gaging station between 1.0 to 34.0 Hach FTU. This is an area DEQ lists as needing more information.

Other Contaminants: Organic Compounds, Pesticides, and Metals

The literature concerning pesticides and other water quality contaminants is extensive. Many studies have been conducted in the Willamette basin. Most of the reports focus on the

Willamette River with occasional references to the Yamhill. There is little specific information for the streams in the Chehalem watershed.

In general, there are several different pesticides likely to exist in the streams and rivers of the Yamhill basin. The most common ones are atrazine, desethylatrazine, simazine, metolachlor, and diuron. Urban areas contribute significantly to the chemicals present in the watershed.

Given the dominant upland vegetation and crops present, there are likely to be a number of agricultural contaminants in the water. According to Susanne Aldrich Markham of the OSU Extension Service out of McMinnville, diuron and metolachlor are used on grass seed fields in the basin. Atrazine and simazine are used on Christmas tree farms. Atrazine is no longer used on grass seed fields. Aldrich-Markham says that glyphosate (Roundup) does not travel through the soil to reach the water table and thus doesn't pose problems for the watershed. However, according to a report by Oregon Pesticide Education Network:

> "Roundup, or glyphosate, has been publicized as an environmentally friendly herbicide that breaks down shortly after application. However, experiments have shown that glyphosate may persist in the environment for as long as 3 years (Torstensson et al., 1989). Its metabolite, AMPA, may persist even longer (World Health Organization, 1994). Glyphosate is typical of many pesticides in that its breakdown is dependent upon the environmental conditions in which it is used and that the toxicity of its breakdown products is equal to or greater than the toxicity of glyphosate itself. Pesticides may remain in the environment much longer than expected or claimed, and the breakdown products may also be toxic to organisms (Oregon Pesticide Education Network, 1999)."

Roundup is often applied by hand using backpack sprayers in limited quantities, however. According to Dayton area farmer Sam Sweeney, it is a concern in the region because of the larger volumes used to "clean up" fields prior to establishing grass seed fields. Even at limited volumes, there are some concerns associated with its use.

The volume of data available on pesticides is beyond the scope of this document and could not be easily summarized. Further information on effects of pesticides on aquatic life can be found by downloading the report found at: http://www.pond.net/~fish1ifr/salpest.htm

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CHAPTER 10

Fish Habitat and Barriers

The objective of this chapter is to identify historic and current fish populations in the watershed and to evaluate current fish habitat conditions. The Chehalem Valley and upper Willamette have several native anadromous species: winter steelhead, Pacific lampray, and spring chinook salmon. Upper Willamette winter steelhead and upper Willamette spring chinook salmon are listed as threatened species under the federal Endangered Species Act. These and other native species would benefit from restoration of water quality and habitat in the watershed.

Cutthroat trout are the most plentiful and widespread native salmonid in the Yamhill basin. Needless to say, they play an important role in the aquatic ecosystem. Since they're more widely distributed in the small streams of the Chehalem watershed than any other salmonid, the effects of habitat restoration programs can be more readily discerned by looking at the effects on trout. This makes cutthroat the best indicator species for water quality in the Chehalem watershed.

Fish History

There is a great deal of historical fish population information for the region, though there is little available specifically for the Chehalem watershed. What we do have, though, is a lot of local knowledge regarding fish. Anecdotal evidence suggests habitat and populations are decreasing in many area streams. Based on first-hand accounts, it is likely that prior to European American settlement fish populations were higher and possibly more diverse in the watershed.

Historically, in-stream habitat was different from present conditions. Log jams created diverse habitat, fish passage impediments such as culverts and dams were non-existent, water quality was higher, mature timber provided shade resulting in cooler water temperatures and greater dissolved oxygen, and stream meanders provided complex habitat with pools and riffles.

The area has supported large numbers of salmonids, though the variety of species has been influenced by Willamette Falls (at Oregon City) that has limited certain anadromous fish species to the lower Willamette and Columbia Rivers since time immemorial. In spite of this obstruction, many tributaries of the upper Willamette have a variety of salmonids, even some anadromous species such as steelhead and chinook. Significantly, we know that these populations are currently in decline indicating degraded water quality or habitat or both.

The list in Table 24 is a general fish list for Chehalem Valley. These are native species that are likely to be found in the streams of the watershed given the habitat, water quality, and what ODFW has found in other similarly sized streams. It is important to note that some of these species may only be present seasonally. The list is general and uses the most common names. Also, it doesn't include all commonly found species, only the native ones. For example, coho salmon, catfish, mosquitofish, large and smallmouth bass, and crappie are all common to the area but they are non-native, introduced species. There may be other introduced species, as well.

Table 24. Native Aquatic Species Likely to be Found in the Yamhill Basin

Aquatic species (common name)
Winter steelhead salmon
Cutthroat trout
Sculpin
Dace (speckled, longnose, etc.)
Redside shiner
Threespine stickleback
Pacific lamprey
Brook lamprey
Northern pike minnow
Sucker
Spring chinook salmon
Crayfish

It's interesting to note that as early as 1962 the Yamhill County Economic Development Committee found that all fish populations were decreasing in the County except "silver" (coho) salmon. They knew establishing minimum flows would help fish populations. However they erroneously thought that raising the water temperature by constructing reservoirs would also be beneficial. They called for eliminating industrial and other types of pollution. "The establishment of minimum flows and elimination of pollution are the most important things needed to increase the fish population," they wrote. They finally noted that "treatment of the waters with Rotenone and Toxaphine is about the only successful way to eliminate trash fish" whose populations were increasing.

Fish Hatcheries

The ODFW stocking program of the latter half of the 20th century aimed to establish new coho runs in the upper Willamette Valley (including the Chehalem Valley) and supplement the native coho population of coastal rivers. Coho salmon are not native above Willamette Falls, therefore these fish would not have been found in the area without stocking. Coho have historically been an important part of the Oregon economy and are also popular with ocean sport fishermen. It made sense to increase their range and numbers with stocking before adverse impacts to other species became apparent. Releases occurred from the 1950s to the 1980s, though not in the streams of the Chehalem Valley because they're generally too small. Stocking took place in headwater streams of the larger watersheds for reasons of water quality and habitat. Watershed-specific data for these releases appear in other 5th field assessments for the Yamhill basin.

Some hatchery fish may have found there way to the lower stretches of streams in the Chehalem Valley. All anadromous fish releases in the upper Willamette basin have potentially entered the Chehalem Valley, though spawning and other resident activity likely takes place elsewhere in larger, cooler, cleaner rivers and streams.

In the 1980s, concerns over the effect of coho on native cutthroat trout and winter steelhead led ODFW to reformulate their hatchery release plan for the region. Obviously, there are limits to how many fish an area can support. Short of exceeding the carrying capacity, though, there is the problem of non-native plants and animals displacing native species for a variety of reasons. ODFW did not want to risk further decreasing populations of native fish by continuing to introduce non-native coho. According to Gary Galovich, though, ODFW has documented adult coho returning and juvenile coho present in the upper Willamette basin after discontinuing hatchery releases. This means that introduced coho have been able to sustain themselves through natural reproduction and will possibly remain a factor in Yamhill County.

Table 25. Yamhill River Basin Stocking History Summary Table

Fish Species	A=Anadromous R=Resident	Native	Non-native	Stocking Notes
Winter Steelhead Trout (*Oncorhynchus mykiss*)	A-Winter/Spring spawn	X		No hatcheries present in watershed. Not many fish present historically, hatchery releases into the S.Yamhill River 1964-82 from Big Creek stock. Area may not have any indigenous stock. STEP fry releases in recent years.
Coho Salmon (*Oncorhynchus kisutch)*	A- Late Fall early Winter		X	No hatcheries in basin. Stocking from Bonneville, Oxbow, Eagle Creek, Cascade, and Sandy and in 1983, from Cowlitz Hatchery in WA. In 1980s, number of streams stocked decreased to minimize effects on steelhead and cutthroat. Many releases in 60s and 70s, to supplement Columbia River run.
Cutthroat trout (*Oncorhynchus clarki clarki)*	R	X		Neither currently nor historically stocked.
Rainbow trout (*Oncorhynchus mykiss)*	R		X	Hatchery rainbow trout released to create fishery. Early as 1920s, 30s. until 1980s. No evidence of natural reproduction.

Cutthroat Trout

Cutthroat trout are native in the Chehalem watershed and have never been stocked here. Although cutthroat are not listed as an endangered or threatened under the Endangered Species Act (ESA), it has been a candidate for listing and is being managed accordingly by ODFW. In general, cutthroat in Yamhill County live their entire life in one watershed. Some cutthroat populations are "fluvial," meaning they migrate within their river system, while others like those in Chehalem streams tend not to migrate.[7] Because of this, it is easier to determine if habitat restoration efforts are impacting the survival of native cutthroat. With anadromous fish such as winter steelhead, the journey from stream to ocean and back involves many unknown perils, making the effects of individual watershed restoration projects difficult to discern. Of course, juvenile populations and habitat surveys can still get at the question for anadromous species.

[7] "Anadromous" is used to describe species that live in the ocean and ascend rivers to spawn. "Fluvial" or "potamodrous" fish live in freshwater and migrate into small headwater streams to spawn. "Catadromous" species such as eels live in freshwater but migrate to the ocean to spawn.

Table 26. Summary of Fish Life History Patterns

Fish Species	Spawning	Interesting Notes
Winter Steelhead (*Oncorhynchus mykiss*)	Late January – late April Juveniles stay 1-2 yrs. Migrate to the ocean in spring where they stay 2-3 years. Return to spawn in winter. May spawn more than once in a season. Ocean distribution not well understood. It appears steelhead move further offshore than other salmonids (OSUES, 1998).	Prefer fast moving water, stream gradient >5%, cool waters, large woody debris important component for their habitat
Coho Salmon (*Oncorhynchus kisutch)*	Juveniles rear throughout watersheds, live in pools in summer. Juveniles migrate to ocean in Spring, rear just off OR coast. Adults return to rivers late fall/early winter. Spawn when 3 years old. Following spawning, they die.	Prefer gravel bars and upper watersheds.
Cutthroat trout (*Oncorhynchus clarki clarki)*	Variable spawning and migration. Potanadromous cutthroat migrate into small headwater streams in fall/winter, spawn, return to larger streams. Some do not migrate at all. Some migrate to estuaries.	Only native trout in basin. Prefer slow moving water, overhanging vegetation.

Peter Snow's Fish Records for Spring Brook

Longtime area resident Peter Snow provided the following records of fish caught in Spring Brook near Rex Hill north of Newberg. Peter fishes a section of stream about 500 yards long just north of Wilsonville Road. Downstream, is a large box culvert that carries Spring Brook under the road. Another four miles downstream is Spring Brook's confluence with the Willamette River, a point that is about a mile upriver from Champoeg State Park.

The information in Table 27 is taken from Peter's fishing journal. These are catch and release entries and provide a good idea of what mixture of species and sizes can be expected in the creeks of the Chehalem Valley. Peter indicates that there are cutthroat trout, redsided shiners, freshwater sculpin, an occasional salmon smolt and, until just a few years ago, a substantial population of crayfish in the stream. "The population of cutthroat trout seems to fluctuate with the water level and temperature," Peter says, "and higher populations occur during the winter and spring months when the water is higher." Peter explains that as the water level drops, the amount of food available in the stream also decreases while the temperature of the water rises making it harder for fish to breathe. This helps explain why there are fewer fish.

Gary Galovich of ODFW feels this account is very accurate. "We would expect to find resident and fluvial populations of cutthroat in all [Chehalem Valley] streams," Gary says. The resident populations would be found in those areas where water quality can support them while the fluvial (or migratory) fish would be present primarily during the fall, winter, and spring. Gary would also expect juvenile spring chinook salmon and juvenile winter steelhead. Steelhead can sometimes be mistaken for rainbow trout. Juvenile salmon use Spring Brook and other area streams for seasonal rearing and refuge during the fall, winter, and spring but primarily will be found in Chehalem waters during the winter and spring.

Table 27. Peter Snow's Fish Records for Spring Brook

Date	*Noteworthy Catch*
4-24-86	Three 8-inch cutthroat trout
4-25-86	One 10-inch, one nine-inch cutthroat trout
12-15-86	One 8-inch rainbow trout and two redsided shiners
1-9-87	One 12-inch cutthroat trout and one 6-inch salmon smolt
3-25-87	Two 10-inch cutthroat trout and two redsided shiners
3-26-87	Two 10-inch cutthroat trout
3-27-87	Two 10-inch cutthroat trout—These were not the same fish from the day before because they were different in sex and color
4-10-87	One 10-inch cutthroat trout
5-28-87	Three 9-inch cutthroat trout
6-1-87	Two 10-inch and one 8-inch cutthroat trout
2-20-88	Six 5-6-inch salmon smolt
5-1-90	Four 8-10-inch cutthroat trout
5-17-90	Four 7-10-inch cutthroat trout
1-8-97	Two 8-inch cutthroat trout
1-28-97	Three 9-10-inch cutthroat trout
2-7-97	Two 8-inch cutthroat trout
2-11-97	One 7 inch rainbow, one salmon smolt
2-12-97	Four 10-12-inch cutthroat trout
2-18-97	One 13-inch cutthroat trout, one 6-inch rainbow trout, four redsided shiners
3-1 to 3-31-97	Caught seven cutthroat trout ranging from 9-11 inches

Fish Habitat

According to the StreamNet website, Chehalem Creek is spring chinook habitat for rearing and migration. The lower five miles is the area most likely used by chinook. According to Gary Galovich of ODFW, this does not necessarily mean fish do not use other areas or would not use other areas if habitat were improved. ODFW has also recorded juvenile steelhead in the North Yamhill River and several of its tributaries. This suggests at least the possibility of transient winter steelhead in the larger streams of the Chehalem watershed.

Stream surveys done by ODFW in the 1980s did not find salmonids on streams in Yamhill County.[8] Again, Galovich cautions surveys performed at one point in time do not take into account the dynamics of fish life cycles. There is no continuous fish-monitoring program on any stream in the Chehalem Valley. If a species isn't found in a stream on a given day, that doesn't

[8] To survey a stream for spawning salmon, ODFW personnel walk the streams looking for evidence of fish presence and make notes on the condition of the habitat. They count live fish, spawned-out fish (mortalities), and "redds," or the gravel mounds created by fish at spawining sites.

mean it never uses the stream during some part of its lifecycle. Juvenile rearing is a very critical stage in salmonid development, and many streams support salmonids only for rearing.

Regardless, it's important not to focus only on restoring habitat for salmon—especially in areas such as ours that are not known primarily for salmon populations. A more appropriate goal is to improve stream health for all aquatic and terrestrial life (including people).

Fish Barriers

Fish barriers are either natural or human-created obstacles that impede the passage of fish and other organisms. Barriers include culverts, dams, waterfalls, logjams, and beaver ponds. They block the movement of anadromous fish as well as fluvial populations such as cutthroat trout. Actually, barriers can impact all aquatic species. Changes in habitat, population, or water quality conditions sometimes create pressure to relocate for more favorable conditions. Barriers can then create a significant problem for organisms that needs to move.

Culverts that act as fish barriers on state and county roads are reported in an ODFW database. The ones reported for the Chehalem Valley are classified as low or medium priority. They are described in Table 28 below. Numerous studies, including ones conducted in 1996 by the National Research Council, conclude that migration barriers have substantially impacted fish populations. The extent to which culverts impede or block fish migration appears to be substantial. During fish surveys conducted in coastal basins during 1995, nearly all of the barriers identified (96%) were culverts associated with road crossings.

Culverts reported in the database are found on fish-bearing streams and were evaluated against established passage criteria for juvenile and adult salmonids. Parameters measured or estimated and recorded include:

- Culvert diameter (inches) and length (feet);
- Culvert slope (percent); *Generally, non-embedded metal and concrete culverts are considered impassable if the slope exceeds 0.5 to 1.0 per cent. At slopes greater than this, water velocities within the culvert are likely to be excessive and hinder passage;*
- Presence or absence of a pool;
- Pool depth, if present, (in inches);
- Distance of drop (in inches) to the streambed or pool at outlet; *Conditions at the culvert outlet are evaluated for drop (distance from culvert invert to stream below) and the presence or absence of a jump pool. If a pool is present, its depth is recorded. The general criteria for pool depth is 1.5- to 2.0-times the height of the jump required to reach the culvert—the fish need a running jump, so to speak. Pools shallower than this depth are considered inadequate. If the height of the jump (pool surface to water level in the culvert) into a culvert exceeds 12 inches during the period of migration, the culvert is judged inadequate and included in the listing of culverts needing attention. If the jump is greater than 6 inches but less than 12, the culvert is judged to be a passage problem for juveniles only;*
- Whether the culvert is embedded in the streambed and contains substrate;
- Whether water runs beneath the culvert at the upstream end of the culvert; *this is a problem for downstream migration of juvenile fish in low water;*
- Fish size (juvenile, adult, or both) likely to be hindered.

Table 28. Fish Passage Barriers on Public Roads in the Chehalem Watershed

Location: Waterbody, Road, Approximate Road Mile (RM)	Priority	Comments
Unnamed Tributary of Chehalem Creek, Hwy 240, RM 3.95	NA	Not on straight-line chart.
Chehalem Creek, Road 275, RM 2.8	NA	Not in County Road log.
Chehalem Creek, Road 275, RM 3	Low	Not in Co Rd log. 0.35 miles from Rd 274. Possible velocity barrier.
Chehalem Creek, Road 275, RM 3.1	Low	Not in County Road log.
Unnamed Tributary of Chehalem Creek, Road 275, RM 3.3	Low	Not in Co Rd log. Step barrier; may only inhibit adults at mod/high flows.
Unnamed Tributary of Chehalem Creek, Road 4, RM 5.87	Low	1.05 miles west of Rd 113. Culvert OK except for 16" step out of culvert due to bedload.
Unnamed Tributary of Chehalem Creek, Road 11, RM 5.62	NA	NA
Unnamed Tributary of Chehalem Creek, Hwy 240, RM 4.76	Low	Straight-line chart lists as RCBC. 0.7 mi. west of Kuehne Rd.
Unnamed Tributary of Chehalem Creek, Hwy 240, RM 5.73	NA	NA
Unnamed Tributary of Chehalem Creek, Road 4, RM 4.66	Low	0.9 mi. west of Dopp Rd.
Unnamed Tributary of Chehalem Creek, Hwy 240, RM 6.3	Low	Not on straight-line chart. 0.75 mi. east of Kuehne Rd.
Unnamed Tributary of Chehalem Creek, Road 111, RM 2.4	Low	Not in Co Rd log. 0.75 mi. north of Calkins Rd.
Unnamed Tributary of Chehalem Creek, Road 111, RM 2.7	Low	Not in Co Rd log. 1 mile north of Calkins Rd. Last segment at downstrm end is detatched and tilted towards pool.
Unnamed Tributary of Chehalem Creek, Hwy 240, RM 6.9	Low	Not on straight-line chart. Culvert is 0.1 mi. below reservoir.
Hess Creek (near Dundee), Road 95, RM 1.46	Low	0.85 mi. east of Fairview Dr.
Unnamed Tributary of Chehalem Creek, Road 110, RM 2.6	NA	Not in County Road log.
Unnamed Tributary of Chehalem Creek, Road 110, RM 1.65	Low	Not in Co Rd log. Step estimated; downstream end inaccessible.
Bronson Creek, Road 72, RM 1.4	Low	Not in Co Rd log. 0.45 miles from Dudley Rd. Parameters estimated due to inaccessibility.
Bronson Creek, Road 72, RM 1.15	Low	Not in County Road log.
Harvey Creek, Road 75, RM 0.05	Low	Not in Co Rd log. Culvert slope estimated due to high flow. High velocity may be due to culvert size, suggest larger culvert.
Bryan Creek, Road 98, RM 0.32	NA	NA
Bronson Creek, Road 72, RM 0.65	Low	Not in County Road log.
Bronson Creek, Road 72, RM 0.26	NA	NA

Bronson Creek, Road 71, RM 0.43	Low	Juvenile step barrier. 0.6 mi. from Hwy 240. 0.05 miles below reservoir.
Unnamed Tributary of the Willamette River, Road 181, RM 0.05	Low	Not in Co Rd log. .05 mi. from Riverwood Rd
Hess Creek, Hwy 99, RM 27.08	NA	NA
Unnamed Tributary of Chehalem Creek, Road 4, RM 1.6	Low	Not in County Road log. 0.45 miles east of Stone Road. Possible velocity barrier.
Harvey Creek, Road 74, RM 0.8	NA	NA
Unnamed Tributary of Chehalem Creek, Hwy 240, RM 9.88	NA	Br. # OP042
Unnamed Tributary of Chehalem Creek, Road 169, RM 0.56	Medium	Juvenile step barrier and possible velocity barrier.
Unnamed Tributary of Chehalem Creek, Hwy 240, RM 10.2	Medium	Not on straight-line chart. Juvenile step barrier, possible velocity barrier.
Unnamed Tributary of Chehalem Creek, Road 70, RM 1.77	Medium	No access to downstream end. Log blocking upper end creates a 12" step out of culvert.
Unnamed Tributary of Chehalem Creek, Road 67, RM 3	Low	Step barrier.
Unnamed Tributary of Chehalem Creek, Road 67, RM 2.63	Low	Lower 20' of culvert has 7% slope. Flow signs missing in County Road log.
Unnamed Tributary of Chehalem Creek, Road 68, RM 1.05	NA	NA
Unnamed Tributary of Chehalem Creek, Road 62, RM 0.68	NA	NA
Unnamed Tributary of Chehalem Creek, Road 67, RM 2.33	Low	Slope and step estimated due to inaccessibility.
Unnamed Tributary of Chehalem Creek, Road 67, RM 1.8	NA	Not in County Road log.
East Fork Chehalem Creek, Road 70, RM 0.3	Low	12' slide at top, 10' chute at bottom w/ 8" step. Culvert sections coming apart. Slope varies throughout
Unnamed Tributary of Chehalem Creek, Hwy 219, RM 0.5	Low	Not on straight-line chart. No access to downstream end. Step barrier.
Hess Creek (near Newberg), Road 58, RM 1.3	Medium	Not in County Road log. Step barrier and possible velocity barrier.
Spring Brook, Road 46, RM 1.1	Low	Rootwad stuck in culvert creates 6" step within culvert.
Spring Brook, Road 5, RM 1.45	NA	NA
Spring Brook, Road 55, RM 0.3	Medium	Not in Co Rd log. Step barrier. Bad culvert below under train tracks. Bad culvert above on private property.
Spring Brook, Road 44, RM 1.63	Medium	20" step out of culvert due to debris jam.
Unnamed Tributary of Spring Brook, Road 54, RM 0.64	Low	Step barrier.
Spring Brook, Road 54, RM 0.09	NA	NA
Spring Brook, Hwy 99, RM 21.06	Medium	6' spillway 20' above culvert.
Unnamed Tributary of the Willamette River, Road 5, RM 5.2	Low	NA

(Fish Passage Culvert Database from ODFW)

The impacts of barriers on migratory species are obvious. The major impacts on resident, non-migratory populations are less obvious but include:

- Juvenile and resident adult fish must be able to move upstream and downstream to adjust to changing habitat conditions (i.e., temperature fluctuations, high or low flows, competition for available food and cover);
- Resident fish need continuity of stream networks to prevent population fragmentation which decreases gene flow and genetic integrity;
- Catastrophic events can displace entire populations. Barriers can prevent the escape or re-colonization of these habitats

Yamhill County Public Works Bridge Supervisor Susan Mundy reports that the county regularly checks and clears culverts. When they do so they also record information relating to fish passage in an effort to compile a local database on all county road culverts.

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CHAPTER 11

Restoration and Enhancement

Restoration is an effective and increasingly popular response to many of the issues raised in the previous chapters. Nearly all the ways we've considered water and water-related land use, economy, and planning can be understood as functions. The power of science lies in its ability to reduce nature down to its parts or functions. Ecology is valuable for once again regarding the whole system or at least many of its parts simultaneously and in relation to one another. Together, this enables watershed residents to understand how their surroundings work and to restore functions that are absent or degraded. Under our system of private property and with our cultural and ecological mandate for local determination, restoration is taking place in many independent projects across the region.

It is valuable to evaluate local efforts already underway when considering possible approaches to designing a project. Coordination, monitoring, and subsequent fine tuning will increase the likelihood of having a positive impact. This will also help generate new restoration designs and provide opportunities to increase awareness of the local issues.

One source of information concerning restoration efforts is first-hand accounts by landowners who report on a voluntary basis to the Oregon Plan Watershed Restoration Inventory. Unfortunately, few people are even aware of the existence of this database. Each year, though, the folks at the Oregon Watershed Enhancement Board (OWEB) publish a report summarizing restoration efforts statewide including Yamhill County. It is a valuable tool for anyone who wants to either encourage restoration by offering their project as a model or for those who are interested in examples before designing a project of their own. If you would like to learn more about this voluntary database, contact Bobbi Riggers at (541) 757-4263 or by e-mail at: Bobbi.Riggers@orst.edu. A great deal of relevant information including recent annual reports is available at www.oregon-plan.org.

The USDA Service Center in McMinnville is another excellent starting point for local residents. There you can tap into the resources and expertise of the U.S. Department of Agriculture, the Natural Resource Conservation Service (formally the Soil Conservation Service), and the local Soil and Water Conservation District. Advice, design consultation, plantings, and sometimes even partial funding can be garnered there. People from one or more of these agencies were involved in many of the projects reported in the database or described below. It's up to the individual landowners whether or not to contact the database, though, as government employees do not provide information on individual projects without the landowner's authorization.

For additional information on USDA program eligibility contact:

USDA Service Center
2200 SW 2nd Street
McMinnville, OR 97128
By phone: (503) 472-1474

Yamhill Soil and Water Conservation
2200 SW 2nd Street
McMinnville, OR 97128
By phone: (503) 472-6403

Passive and Active Restoration

Passive restoration can be the easiest thing in the world. It's as straightforward as letting nature alone to recover over time from disturbance through natural succession and evolution. Often our faith in human technology leads us down the path of more manipulation, often with further economic and ecological costs, even when the shortcomings of the very same technologies got us into trouble in the first place. The risk in active restoration is that we often treat only the symptoms of a problem or create a whole new set of unanticipated problems through further technological impacts. This often doesn't work. In most cases we can save time, money, and ecological integrity simply by identifying a problem and curtailing its causes.

Passive restoration involves simply ending disturbance and letting land heal with time. For example, where domestic animals have access to streams we can install off-stream watering for livestock and allow the stream to recover naturally. That's what Jim and Linda May and their neighbors did. When they noticed a herd of cattle was hanging out in the creek just upstream of their four-acre pond, they contacted their neighbors to work out a solution. The folks at The Trappist Abbey of Our Lady of Guadalupe agreed that it would be simple enough to water the cattle off stream and now they keep the cows fenced out of the riparian area.

In another area the Mays are pursuing active restoration by planting vegetation to stabilize the stream bank of Millican Creek. They were concerned about erosion taking place along the creek flowing through their property so they worked with Dean O'Reilly of the Yamhill Soil and Water Conservation District to plant appropriate riparian plants and stem the problem, so to speak. Native plants are better adapted to the climate and ecological conditions and consequently require less care to become established. Of course, planting native vegetation is also important because it reduces the potential of introducing noxious weeds.

Active restoration (or enhancement) efforts try to speed up the ecological recovery of a disturbed area by rebuilding natural functions that appear to be missing. For example, in our contemporary landscape of towns, housing developments, shopping areas, and fields there are large stretches of streams that have very little or no large woody debris. What's more, without adequate mature trees nearby, these streams will not receive debris in the foreseeable future. Consequently it is increasingly common for landowners and land managers to add tree trunks and root wads to streams that are downcut, eroding their banks, or lack habitat complexity. This is clearly an active approach.

Active solutions are far trickier than passive ones because of the complexity of our interactions with nature and the difficulty of identifying the causes instead of merely the symptoms. Done without adequate respect for nature's patterns, active restoration can do more harm than good. The potential for unanticipated negative results is directly related to the degree of manipulation. A low-tech activity such as planting native riparian vegetation is less likely to produce negative results than, say, reshaping the streambed with a bulldozer. Of course a bulldozers can be a great tool for certain jobs but greater care is needed when you harness that much power.

An example of the needed care comes from a fill and removal permit for the relocation of a Willamette & Pacific rail line. It reflects our society's growing awareness as we attempt to accommodate the complex interrelationships of water, land, flora, and fauna as we continue to build across the landscape. The following description of preexisting conditions was written by a biologist hired to help the company avoid a net loss of wetland functions:

> "An extensive emergent and shrub-scrub marsh lies on the south side of the railroad embankment. It occupies a broad swale about 25 acres in size which joins the South Yamhill River half a mile to the east. Hydrology is driven by groundwater discharge and runoff from adjacent industrial uses and irrigated fields. Soils are hydric and high in clay content with an organic surface layer. Vegetation consists mainly of typical emergent marsh species such as *Typha latifolia* (cattail), *Scirpus acutus* (hardstem bulrush), *Carex spp*. (sedges), *Juncus spp.* (rushes), and associated shrubs such as *Salix lasiandra* (Pacific red willow). There is some use by typical songbird species (warbler, red-winged blackbird), small mammals (raccoon), and deer. Sediment trapping is an important function of the wetland."

It is important to consider natural conditions (and their functions) in any restoration effort. This is particularly true with active restoration that changes land contours, hydrology, and vegetation cover. The reference to "hydric soils" here indicates that this area has been a wetland for quite some time. Hydric soils are known to have formed under wet conditions. They characteristically have high water tables, are ponded or flooded frequently, or are saturated for extended periods during the growing season. This knowledge can help guide project design including the shape of the land, hydrology, and plantings.

Design

For most active restoration projects, the costs of heavy machinery, labor, and infrastructure materials will largely determine the limits of what happens. This can be an advantage when viewed from a long-term evolutionary perspective. Restoring ecosystems slowly, incrementally, with an eye to how the ecosystem responds is preferable to a machinery-intensive makeover lasting only several hours.

In 1956 the distinguished systems theorist Herbert Simon coined the word "satisficing" to describe solutions that both satisfy and suffice. He observed that in nature "organisms adapt well enough to 'satisfice'; they do not, in general, 'optimize.'" Not all at once, at least. To optimize a solution in one fell swoop requires understanding and analysis "several orders of magnitude more complex" than that required for satisficing. Organic systems appear remarkably well designed but they reach that condition (and sustain it) through endless incremental changes and adaptations. When approaching a problem then, avoid the assumption that you will be able to solve it once and for all in one muscular effort. Instead, understand that only by fine tuning your use of the land and water repeatedly over a long period of time can you imitate evolution.

Allan Savory, a leading proponent of rotational grazing, has gained international recognition for identifying problems with conventional land use and for advocating an alternative he calls "holistic management." He says that in solving problems, such as that involved in natural resource management, we typically design a system and then put all our effort into defending and maintaining it. He points out that there are always problems, though, and suggests that we look for the weaknesses in our newly developed systems and work to redesign them from the beginning, on an ongoing basis.

In his book on the evolution of buildings called *How Buildings Learn*, Steward Brand points out that the advantage of make-do solutions is that they require more modest investments of time, resources, and money and they make it easier to improve or dismantle shortcomings later. Another advantage is that satisficing requires attention by the occupants of a place bringing an efficient directness and more awareness of the effects. Of course some of the watershed problems we have identified have large-scale causes that require relatively large-scale solutions. Much can be accomplished through small projects, though. The point is to set *improvement* as a goal during the design stage in hopes of avoiding additional problems through overkill.

A Pattern Language

A superb model for how to design restoration projects is a technique that mimics natural processes such as local determination and gradualism. The approach of the influential architectural theorist Christopher Alexander is to follow processes that have created beautiful, functional, evolving structures and towns throughout history. He anchors his philosophy on the idea that traditional builders use a shared language of patterns that orient design to actual results rather than symbolic facades or certain building products.[9] Alexander understands successful design is an organic process:

> In nature you've got continuous very-small-feedback-loop adaptation going on, which is why things get to be harmonious. That's why they have the qualities that we value. If it wasn't for the time dimension, it wouldn't happen. Yet here we are playing the major role in creating the world, and we haven't figured this out.

Design is good when in addition to big elements being gradually added it also plans for a continuous series of adaptations—small, very small, and tiny ones in ever larger quantities—so that there will be many opportunities to re-evaluate and fine tune things. At the scale of the individual residence this might mean a fence here, an undrained wet spot there, a tree, a couple of standing snags that provide habitat.

In his design for the campus of the University of Oregon described in *The Oregon Experiment* Alexander explains that:

> [L]arge-lump development is based on the idea of *replacement*. Piecemeal growth is based on the idea of *repair*. Since replacement means consumption of resources, while repair means conservation of resources, it is easy to see that piecemeal growth is the sounder of the two from an ecological point of view. But there are even more practical differences. Large-lump development is based on the fallacy that it is possible to build perfect buildings [or wetlands.] Piecemeal growth is based on the healthier and more realistic view that mistakes are inevitable. …Piecemeal growth is based on the assumption that adaptation between buildings [or landscapes] and their users is necessarily a slow and continuous business which cannot, under any circumstances, be achieved in a single leap.

Designers can't visualize exactly how a restoration project will work, nor can anyone else—no matter how well thought out or computer-enhanced the design—and so construction benefits from a process of trial and error. You will constantly learn more about the project's situation while constructing it and what you will find out is inherently and necessarily unpredictable. "You are watching a developing wholeness," Alexander says. Whether applied to buildings or restoration work, this approach is remarkable for mimicking nature by using nature's method—ruthless evolutionary selection.

In *A Pattern Language* Alexander and his colleagues provide specific patterns for use within this approach to design. Their technique is remarkably straightforward: pay attention to what is beautiful and functional in our surroundings, try to understand why—what is the essential quality that makes it good, and then mimic those qualities through design. We can use a similar approach for identifying watershed values we want to promote in our surroundings.

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[9] Stewart Brand says Alexander's *A Pattern Language* is the "one book that everyone dealing with buildings (or towns) should have." He says *The Timeless Way of Building* is a philosophy of design and buildings of great depth, savvy, and subtlety. In a sense, it is a treatise on evolutionary design. In another sense it is about the ethics of design. He lauds *The Oregon Experiment* for its principles of community planning, especially the idea of "piecemeal growth."

A Pattern Language is a highly successful attempt to identify universals—sources of the good life—that involve not only the built environment, but also the way we organize ourselves socially. The authors address the effects of design on human relationships in patterns such as "LIFE CYCLE," "CONNECTED PLAY," and significantly "THE FAMILY" and "OLD PEOPLE EVERYWHERE." *Human nature* means our deepest natural tendencies, after all, and interconnection between generations as well as the connection between people and their natural surroundings is fundamental to life. In regards to this, and of particular interest for watershed issues, are patterns such as "STILL WATER," "POOLS AND STREAMS," "ACCESS TO WATER," and "SITE REPAIR."

The list in the book is not the final word on patterns, though. On the contrary it is only the beginning—just as this assessment is only a tentative step in the process of identifying watershed patterns for the Chehalem Valley. We can all add to the list of desirable patterns. The assessment provides suggestions for the desirable qualities; they're seen in the chapter titles and section headings as well as in tables and text. For example, "RIPARIAN CONDITIONS," "WETLAND RESTORATION," and "WILDLIFE HABITAT" are watershed patterns that Yamhill County residents have been pursuing for years. Many other yet-to-be-named patterns are implicit in the qualities and problems identified in the previous chapters. For instance, channel modification in most cases has the potential for creating problems. This reality can be restated as a positive, desirable goal as "RIVER CHANNELS UNMODIFIED" or "RIVERS FREE OF RIP-RAP" perhaps. The idea of using desirable patterns to design your surroundings is a voluntary, constructive approach. The point is that we can recognize what is good about living where we do, we can agree on a great deal regarding this, and we can work both as individuals and with others to foster those things. It will require some planning and design. In many cases it will involve modifying things or building them differently the next time. Usually, though, all that is required is restraint based on our experience with past degradation.

Local Restoration Examples: On-going Design

A restoration project on the property of James Stonebridge and Kathleen Boeve serves to illustrate the evolving design process. It involves 15 acres of bottomland in the northwestern corner of Chehalem Valley that is not suited for agricultural uses. The original idea developed through the landowners' contact with Dean O'Reilly of the Yamhill County SWCD while he was designing an extensive drainage system for their new vineyard.

The Stonebridges had contacted the NRCS/SWCD office in the summer of 1988 to request assistance with developing a conservation plan for their recently acquired property. Dean inventoried the site and advised the Stonebridges on which portions of their property were suited to grape production. Hillside fields had seeps that would require drainage before planting vines.

Following a soils investigation, it was clear that one 15-acre field was not suited to grapes or even filberts, reports NRCS Resource Conservationist Rob Tracey. The clay soils present did not drain well enough to allow grape or nut production, he says. The site is also a low-lying frost pocket. At this time Dean asked the Stonebridges if they would be interested in establishing a wildlife habitat or wetland restoration in the field—additions he felt would be appropriate in their situation. They were not interested at that time, but they included the suggestion in their conservation plan as a future possibility.

In the summer of 1991, the Stonebridges read about the federal wetland reserve program (WRP) and again contacted the SWCD office to inquire about participating. At that time WRP was not available in Oregon but Rob and Dean agreed to investigate other sources of financial assistance since the Stonebridges were interested in restoring a wetland. They were envisioning "water to attract water fowl," according to James Stonebridge. The NRCS/SWCD office drew up a project plan before applying for Long Term Agreement (LTA) funds. In the fall of 1991, the Stonebridges received $13,000 in cost-share funding from the federal government.

In subsequent site investigations Dean discovered the original design would need to be modified in several ways due to conditions that were not immediately evident. One of the most dramatic changes was that a drainage ditch that was going to be inundated needed to remain open for a drainage system on the neighboring property. This meant that there would need to be two smaller ponds on either side of the ditch where initially Dean and the Stonebridges had envisioned one large pond. They also added two smaller seasonal ponds in areas where water was collecting at old drainage tile outlets. Throughout the process, Dean consulted with Steve Smith of the Oregon Department of Fish and Wildlife (ODFW) to maximize habitat values.

The final design involved six ponds, the larger four being hydrologically connected by a system of inlets and overflows that actually go underneath the road access and drainage ditch. These changes illustrate that projects start out with an ideal, a pattern such as "water to attract water fowl," and evolve from there. Changes in design occur according to economics and materials, the skills and preferences of the people involved, and physical conditions such as the soil, hydrology, vegetation, and existing infrastructure. Evolution over time is essential to getting a good result because local conditions ultimately determine the ecological response to projects.

The Stonebridge project is still being designed, in a sense, over seven years after its initial completion. On one edge of the project they planted Douglas fir and western red cedar in hopes of establishing a conifer forest. About midway in this strip of conifers the young trees died and on either side of the dead zone the surviving trees are stunted. Clearly, the growing conditions here do not favor these two tree species. Dean theorizes that the soil is poor in that one area and that some Willamette Valley ponderosa pines would do better. Elsewhere, he would like to interplant more native species that were not available commercially even a few years ago. They planted tufted hairgrass provided by ODFW on the dikes. Birdsfoot Trefoil and Switchgrass were also broadcast throughout the site for forage and nesting habitat.

Of course, landowners can choose their level of participation in this ongoing design process. There is always more that could be done in restoration if you pay attention to what seems to be working and what doesn't. If you would rather not continue with active efforts indefinitely, then shift your focus to passive restoration (by preventing major disturbance) and let the local natural conditions effectively redesign the site through evolution.

Patterns used in Dean's conceptual plan and final design include Conifer Forest, Deciduous Forest, Grass Meadow, Wildlife Food Plots, Shallow Water Pond, Water Diversions, Grassed Waterway, Low Dike, and Spoil Bank. Combining these allowed the Stonebridges to succeed with their goal of having water attracting waterfowl.

Incremental Restoration

In 1999 Doug Rasmussen decided he wanted to do something with his farm where he has lived all his life. He wanted to restore it for wildlife habitat and water quality protection. Doug contacted Rob Tracey of the NRCS for assistance. After numerous visits and development of various alternatives for protecting the site, Doug decided to apply for planning and financial assistance under the Conservation Reserve Enhancement Program (CREP).

For eligible acres—generally riparian corridors and associated wetland—CREP provides an annual rental payment for land removed from agricultural production. Many farmers find these rental payments more profitable than cropping. CREP also provides financial assistance for establishment of *conservation practices*—suggested land use patterns available in print through the NRCS/SWCD. Some forms of financial assistance require implementation of at least a few conservation practices. Aside from this incentive, though, "conservation practices" are a useful guide for anyone looking to improve agricultural or rural acreage.

Working together, Doug and Rob designed a restoration plan that included native trees and shrubs along a stream, destruction of the existing drainage system, shallow excavations for restoring wetland functions, and establishment of a wet prairie plant community throughout the area. "Installation of this restoration package insures this 46-acre parcel will no longer contribute to the degradation of water quality in the area," Rob feels. Instead it now serves to actually improve the quality of water cycling through the property, it provides valuable wildlife habitat, and provides an opportunity for the reintroduction of rare and endangered plant species.

Following completion of the CREP plan and after beginning the on-site restoration, Doug became so enthused by the process that he began making plans for other portions of his farm. He requested information on how to improve an additional 24 acres of upland that had been in continuous crop production for over 50 years. The fields were eroding and washing sediments into the river. Doug wanted to address the erosion by establishing permanent cover on the cropland, provide additional wildlife habitat, and begin to rebuild soil tilth. Following a planning process similar to that used on the wetland, Doug elected to apply for the Environmental Quality Incentive Program (EQIP) for technical and financial assistance. Doug was successful with his EQIP application and he and Rob subsequently designed a conservation program for the upland. Doug is now in the process of establishing shelterbelts around the crop fields and planting a mix of trees within the fields. These practices serve to increase infiltration of rainwater, provide wildlife habitat, reduce soil erosion, and ultimately provide high-value wood products.

Starting Small and Urban Options

County resident Ted Gahr is known for his expertise in creating wetlands. This is due to years of experimentation on his own property and through assisting with a number of neighbors' restoration projects. Ted learned how to run a bulldozer years ago when he was a rancher in California. Now he uses them to construct dikes for wetlands and ponds.

His experience in restoration work started years ago on his land in Muddy Valley almost by accident. He had placed some rocks in a stream on his land to make crossing the stream easier. He later noticed that during heavy rainfalls the stream overflowed its banks at that point and flooded part of his field. He liked the idea of having a little wetland there so he expanded the flooded area by digging a little diversion ditch to carry the floodwater further into the field. Ducks soon arrived. He continued to take small progressive steps like that, based on experimentation and common sense, to gradually increase the functioning and size of his restored wetland. Eventually he removed the drainage tiles from the field and now has a 15-acre constructed wetland. In all, he has about 30 acres of restored wetland on his land.

Ted found he could still grow oats and barley in the recently inundated fields as long as he planted in the spring. Winter wheat wouldn't have worked. A beneficial side effect was that the winter flooding killed the agricultural weeds as well as left over seeds from the previous crops—historically the field had vetch and ryegrass. For several years the field was essentially weed-free without any spraying or cultivation. Subsequently perennial wetland plants became established and now serve as "weeds" in terms of raising grains. This along with the drop in crop prices led Ted to discontinue cropping in his wetland.

He is now looking for wetland plants with wildlife or domestic feed value and high yields that could be used as wetland crops. One of his leading candidates is yellow vetchling from the pea family. It possibly could be used as chicken feed, he thinks, or as a legume in rotation with other wetland crops. Another possibility is leafy beggars tick (native) and tall beggars tick (non-native). Steve Smith of ODFW told Ted that beggars tick has a higher energy yield than the same acreage of corn. Elk and ducks both love it and seek it out around Ted's place.

Although not everyone will want to devote the time, acreage, and creative energy to restoration that Ted has, his initial, accidental flooding of Prior Converted wetland (drained for agriculture) serves as a model for small, low input restoration that almost anyone can follow. Check with the Water Resources Department and the Department of State Lands before getting started.

A similarly small-scaled, yet important example comes from McMinnville resident Kareen Sturgeon. Kareen is a professor of biology at Linfield College and has both a personal and a professional interest in wetlands. So when she heard of a program in Portland that paid homeowners to divert their gutter runoff away from storm drains, she was interested in learning more. This innovation has a variety of benefits such as easing the load on stormwater drains and increasing percolation into groundwater aquifers.

Although the financial reimbursement is not available in McMinnville, Kareen still liked the idea. She consulted Dean O'Reilly of the SWCD and they came up with a plan. The design was to dig a trench about 20 feet long with a very gentle slope away from the house. Next, she installed a pipe connected to her downspouts and "daylighted" it in her backyard. Water now filters through her lower yard where she has planted a variety of water-loving natives. There the water percolates slowly through the ground before reaching Cozine Creek. Her proximity to the creek made this alternative especially appropriate. Check with your local planning department before getting started with any similar changes.

One final example comes from homeowner Jacqueline Groth who has been gradually turning her small urban lot into an island of native vegetation over a number of years. As a new homeowner Jacqueline says she was “graced with the nightmares of cheap plants” put in places they didn't belong. She was driven to remove what was ugly and dying in her yard and find replacements. “Over the years, every original thing has been dug up and burned,” she says. Finding plants that both enhanced the landscape and were low maintenance were her initial objectives. Finding them proved to be a process of trial and error. She planted many things that were wrong for one reason or another. Then, Jacqueline explains:

> I discovered the Soil and Water Conservation District's Native Plant Sale by accident, by following my nose to the least expensive way to acquire my favorite Oregon plant when I was growing up spending summers in the Oregon woods—the Pacific Dogwood. I planted it and it proceeded to die. This irked me, so I proceeded to study native plants, to find out what I was doing wrong. It seemed to me that native plants should just GROW wherever they were planted. What an eye-opening experience studying native plants proved to be. Now, after 15 years, I can say that the information about native plants has increased to the point where even I can find and use it! Information that was not available five years ago will enable me to grow more native plants. I have become an addict. Why? Native plants in the Willamette Valley are special. They define this area botanically as distinct from all others. They give a sense of place and integrity. This is where we live and what we are responsible to maintain.

Jacqueline considers each homeowner to be as important as any wildlife biologist or forester in helping to restore the natural systems of the Willamette Valley. She points out that this is really enlightened self-interest because extinctions will come back to haunt us. Jacqueline feels that by planting native plants in her urban setting she is helping to preserve native species, creating corridors for wildlife, enhancing seed banks, and reducing degradation in the region. She’s not alone, either. Many area homeowners and even some new housing developments include native plants in their overall landscape design.

Jacqueline has several suggestions for getting started. The Native Plant Society of Oregon (NPSO) has a local chapter that is an excellent resource for homeowners because it involves networking with other people in the area who can share information. *Landscaping for Wildlife in the Pacific Northwest* by Russell Link (U. of Washington Press, 2000) is "state of the art" and *The Wild Lawn Handbook, Alternatives to the Traditional Front Lawn* by Steve Daniels (MacMillan, 1995) is another good source of ideas. Jacqueline says the NPSO's sale is “far and away the best way to acquire native plants because they are so cheap that you can make mistakes (which you will do) and keep trying, experimenting, and not experience buyer's remorse!” Commercial nurseries are another resource. Wally Hansen in Salem is expensive but he has everything. The Portland Nursery and Metro (Portland) have native landscape workshops for homeowners. Another option is to contact Jacqueline with your questions.

Economics of Restoration Projects

The cost for the Stonebridge project came to $23,000. Don’t be discouraged by that, though. There are several things to keep in. First, this was a relatively large, active restoration involving labor and materials that are not always necessary. Many valuable projects can involve smaller acreages and less complicated infrastructure for hydrology. These last examples show that watershed restoration can take place with little more than a good idea and a shovel. Remember that water rights and a Department of State Lands fill and removal permit may also be required.

Another important factor is that federal and state agencies provide partial funding through a variety of programs. In the case of the Stonebridges, assistance from the USDA and ODFW brought the landowner costs down to approximately $5,800. In addition to the $13,000 federal Wetland Reserve Program dollars, the ODFW was able to provide $5,000 cost-share for earth moving, planting, and the costs of securing the required water rights.

Cost analysis for landowners should also account for the potential production lost by establishing habitat keeping in mind that areas suited to restoration were often originally wetland, contain hydric soils, and are less well suited for agriculture anyway. A related consideration is the added value of property that has ponds and swales with their associated plants and animals, open space, and clean water. Although these values are often difficult to quantify in monetary terms, they can have real economic benefits for agriculturists pursuing direct marketing, on-farm retail, or public relations efforts in a world that is becoming increasingly conscious of environmental health.

The Stonebridges' project is a prime example of something that likely would not have happened without cooperation between landowners and several government agencies. The landowner was unable to expend all these funds and neither of the two agencies were able to fund the difference. By working together and each party providing a portion of the funding, they were able to create an enduring wetland habitat

The NRCS provides money each year in federal matching funds for conservation projects on farms and other privately owned land. Most projects require a 50% match by landowners, though this rarely means a dollar for dollar match. Instead, landowners can provide labor, materials, or equipment totaling the value of federal funding. For smaller projects, technical advice rather than funding will be the main service available through the SWCD.

We've mentioned a variety of funding programs throughout the assessment. Don't be deterred by not understanding them all. The folks at the USDA Service Center are there to advise you. Currently, many restoration and enhancement projects find support in the Environmental Quality Incentives Program (EQIP) established by the 1996 Farm Bill to provide a single, voluntary, conservation program for farmers and ranchers to address natural resource issues. Funding in Yamhill County through EQIP has been relatively high in recent years but is dropping. There are other possibilities such as the Conservation Reserve Enhancement Program (CREP) as well as state Oregon Watershed Enhancement Board (OWEB) grants.

CREP is a USDA program that targets "significant environmental effects" related to agricultural land. It is a voluntary program that pays landowners for entering into Conservation Reserve Program (CRP) contracts of 10 to 15 years duration. OWEB grants are available to anyone addressing altered watershed functions, water quality, and fish. The funding priorities include removal and remediation of human-caused alterations, projects that change land management, projects that involve collaboration between stakeholders and agencies, projects located closer to headwaters (rather than downstream closer to the mouth of the river), and peer education where landowners share information regarding their watershed. Further information on EQUIP, CREP, and OWEB funds are available by contacting the USDA Service Center, 2200 SW 2nd Street, McMinnville, OR 97128. Phone: (503) 472-1474. Ask for a copy of the "Guide for Using Willamette Valley Native Plants Along Your Stream."

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Watershed Conditions Summary

The Chehalem Valley is very similar to other areas of the Willamette Valley that have been impacted by urban development and agriculture. Private ownership of nearly all the land in the watershed leads to a wide variety of uses and restoration priorities. This document serves as a starting point for identifying ways to improve the water quality and habitat conditions in the watershed. Following is a summary of each chapter's major findings. Table 29 highlights sub-watershed conditions.

Chapter 1: Introduction and Watershed Characteristics

- The Chehalem Valley has approximately 43,000 acres and five sub-watersheds: Dundee/Hess Creek, Lower Chehalem, Upper Chehalem, Ferrell Creek, and Spring Brook
- The majority of the watershed is privately owned. Historically, fire played a very important role in the maintenance of oak savanna and prairie ecosystems.
- Agriculture has been and continues to be an important part of the watershed's economy. Agriculture is the dominant land use and accounts for over 54% of the acreage. While the variety of crops grown has ranged from plums to hops to grass seed, the acreage under cultivation has remained fairly constant. Over 25% of the watershed is currently under cultivation for perennial grass seed making it the largest single land use. The next largest land use category is orchards, berries, and nurseries at nearly 21% of the watershed.

Chapter 2: Historical Conditions

- Kalapuya Indians managed the watershed, in part, with summer burning. The majority of the Chehalem watershed was savanna and grassland in prehistoric times.
- The Fuller and Fanning Mounds near the South Yamhill River are one of the richest archeological sites in the Willamette Valley. They indicate that the native Che-am-ill group of Kalapuyan people in this area were part of a distinct upper Willamette Valley culture that had close ties to the people along the Columbia and some contact with coastal and southern Oregon cultures. The local native Americans relied heavily on plant foods and secondarily on meat, though surprisingly little on salmon. They were muscular and remarkably healthy.
- European settlement brought an end to the intentional burns resulting in many areas becoming more heavily forested, mostly by Oregon white oak and Douglas-fir dominated woodlands.
- Agriculture has been important to the area throughout history and produces an impressive array of food and other products. Over the past century, farms have decreased in numbers as larger operations grow ever larger and many small family farms go under. The larger farms are more specialized and less meat is raised in the area in general.

Chapter 3: Vegetation

- Vegetation in the watershed varies from being forested and in grapes in the hilly areas to a patchwork of residential development and agricultural crops in bottomland areas.
- Approximately 27,600 acres or 63.6% of the watershed is non-forested—lands under cultivation or development. On the forested land, conifers make up 30% of mixed forest while hardwoods comprise 70%.
- There are four main types of native habitat in the watershed—riparian forest, prairie (wet and dry), woodlands, and oak savanna. These habitats evolved with natural and human-caused fire and likely are now not present or they're evolving in response to fire suppression.
- The tall perennial grass species tufted hairgrass (*Deschampsia cespitosa)* serves as an example of a native prairie species that should be reestablished. It is well adapted to both periodic fires and hydric soils—soils that were inundated for a significant part of the year. Today it remains only in isolated remnants of prairie and where it has been reintroduced in restoration projects. There are only isolated patches of tufted hairgrass in the Chehalem watershed in places where it has been reestablished through planting.
- In prehistoric times, there was less conifer forest in the Chehalem Valley. Today, conifers are found in riparian areas and in hilly areas intermixed with deciduous trees and in small pure stands. Conifers, mostly Douglas fir, account for over 20% of the vegetation cover of the watershed.
- Current conditions show that farmed perennial grass is the dominant cover of the watershed. The next largest cover class is annual grass. Together, these two grass seed crops cover over a quarter of the watershed.

Chapter 4: Riparian Areas and Wetlands

- Riparian areas have been intensively managed for agriculture for a long time. Due to the economic pressures of agriculture, forested buffers along stream banks are typically narrow.
- The majority of riparian areas have some vegetation, although it is often hardwoods or brush with low potential for adding large woody debris to streams. Many riparian zones have no vegetation to speak of (5.1% of the watershed). The benefits of riparian vegetation include cooling shade, balanced water chemistry, and nutrient assimilation from the surrounding soil.
- Non-native plants compete vigorously with native vegetation, especially in stressed or disturbed areas and pose significant problems for landowners and managers.

- Hydric soils are those that have formed under wet conditions such as a wetland. They characteristically have high water tables, are ponded or flooded frequently, or are saturated for extended periods during the growing season.
- The majority of the wetlands in the watershed have been drained and tiled to make land available for agriculture, resulting in a loss of all but a tiny percentage of the native habitat.
- Wetlands play numerous roles in the health of the watershed. Their benefits include: connecting upland and aquatic ecosystems, lakes, streams, rivers, and riparian areas with one another, capturing sediment from erosion runoff, consumption of nitrogen from agricultural runoff, recharging groundwater by retaining water that then percolates instead of heading downstream, maintaining more steady flows to streams by slowing peak flows, and flood mitigation for the same reason, providing habitat for wildlife, open space, outdoor recreation, education, and aesthetics.

Chapter 5: Channel Habitat Types

- The majority of channels in the lowland areas of the watershed were once floodplain type channels and are now deeply incised channels that meet the criteria for low gradient, confined channels. These channels pose the greatest challenge to restoration efforts but also the greatest value for improving habitat.
- Channels respond to change differently based on their position in the watershed. The headwaters of streams like Ferrell Creek are steep, with low responsiveness to changes in channel pattern, location, width, depth, sediment storage, and bed roughness. The segments labeled moderate gradient confined (MC), moderate gradient headwaters (MH), and moderate steep narrow valley (MV) throughout the watershed are more likely candidates for enhancement projects.

Chapter 6: Channel Modifications

- Channel modification has for years included the following: impounding, dredging or filling water bodies and wetlands, splash damming, hydraulic mining, stream cleaning, and rip-rapping or hardening of the streambanks. We can also include our ubiquitous road crossings (bridges and culverts) and streams with "permanent discontinuity" due to the artificial effects of a roadbed having been constructed within 200 feet the stream
- The small dams constructed in the watershed for flood control or fire protection are likely not significant barriers to fish passage. In-stream reservoirs, as are common on Chehalem Creek, can be barriers to habitat and pose other problems such as high temperatures.
- In terms of area affected, agriculture has had the greatest effects on stream modification in the watershed. It is now common for small drainages to be disked and plowed in cultivated fields, effectively eliminating the stream and wetland qualities.
- Most fill and removal permits are related to roads. There is a lot of bridge replacement, bridge removal, straightening creeks, road crossings with culverts and earth fill, upgrading culverts, replacing culverts, extending culverts, highway widening, and filling in wetlands for "ingress and egress" from housing developments. An ongoing high volume removal is commercial gravel mining from a number of locations along the Willamette.
- There is an interesting trend toward more ecological awareness evident in permits. Some recent fill and removal permits reveal efforts specifically aimed at creating wildlife habitat or restoring wetlands

Chapter 7: Sediments

- Potential sources of sediment include of dirt roads and ditches and impervious surfaces, slope failure on steep ground, and erosion of disturbed soil.

- All ditches drain to a water body, usually a stream. Ditches of the county are being managed to decrease their sediment contribution through roadside seeding. Please mow, don't spray.
- The amount of storm water runoff is increased substantially through development, especially by increasing impervious surfaces. Impervious areas include all pavement such as streets, parking lots, sidewalks, and loading areas, as well as rooftops.
- Runoff contaminants are most effectively removed by passing runoff water through a constructed wetland where plant uptake of the nutrients is significant and where heavy metals and toxins can either settle out or be consumed in a safe way before entering the stream.

Chapter 8: Hydrology and Water Use

- Stream flows and ground water are influenced by precipitation, loss of wetlands, withdrawals for irrigation and municipal drinking water, stream channel modifications, changes in land use and water-related technology, and the removal of vegetation.
- Flooding has changed due to the clearing, straightening, hardening and deepening of the major stream channels.
- Streams and rivers in the watershed are over-allocated for water rights. This means that seasonal demands exceed the water supply. There has not been any conflict over this because most users are not exercising their full water rights.
- Extensive irrigation rights are held for land near the Willamette River as well as Chehalem Creek. Much of these areas were historically wetlands but are now drained and tiled.

Chapter 9: Water Quality

- The Willamette River is 303(d) listed for bacteria (fecal coliform), toxics (mercury), biological criteria (fish deformities) and high temperature. It is also at risk for pH, nutrients, sediment, toxics (PAHs, volatile organics, trace metals, 2,3,7,8,-TCDD), and chlorophyll.
- Chehalem Creek is at risk for flow, toxics (pesticides), nutrients, habitat modification, dissolved oxygen (DO), and temperature.
- The period of greatest concern for pollution or "contaminant loading" of rivers in our area is during the summer months of July through September. This period is important because non-point source contaminants tend to accumulate between infrequent rainfall and are then washed into rivers with relatively low rates of flow. The detritus from five weeks of heavy traffic on a huge parking lot suddenly washed into the local trout stream brings new meaning to "summer freshet."
- The Yamhill Basin Council has a stream temperature monitoring program.

Chapter 10: Fish Habitat and Barriers

- Based on first-hand accounts, aquatic populations were larger and more diverse in the past.
- Historical in-stream habitat was very different than the present. Log jams created diverse habitat, fish passage impediments such as culverts and dams were non-existent, water quality was higher, mature timber provided stream shade resulting in cooler water temperatures and greater dissolved oxygen, and stream meanders provided complex habitat with pools and riffles.
- Coho salmon were stocked nearby throughout the 1970s and 80s but this practice was discontinued due to concerns about the interactions between hatchery-stocked fish and native fish. Introduced coho have been able to sustain themselves through natural reproduction and will possibly remain a factor in the Yamhill Basin
- Cutthroat trout were once abundant in the watershed and their sizes and numbers have declined over the years according to anecdotal information.

- Cutthroat trout have the potential for abundance and are resident fish meaning they live in the watershed year-round. Native winter steelhead are threatened but use the Willamette and the lower Chehalem Creek for only part of the year and have the potential for many interactions away from the watershed. This makes cutthroat the best indicator species for salmonids and fish species in general in the Chehalem Valley.
- Scattered stream surveys exist but there's no comprehensive source of local information.

Chapter 11: Restoration and Enhancement

- There is a database available for landowners to be included in a statewide inventory of restoration and enhancement projects.
- Restoring ecosystems slowly, incrementally, and with an eye to how the ecosystem responds is preferable. Only by fine-tuning our use of the land and water repeatedly over a long period of time can we imitate evolution. We will learn more about a restoration project's situation while constructing it and what we find out is unpredictable.
- Design is good when in addition to big elements being gradually added it also plans for a continuous series of adaptations—small, very small, and tiny ones in ever larger quantities—so that there will be many opportunities to reevaluate and fine-tune things.
- Everyone can identify desirable patterns. The assessment provides suggestions for patterns of desirable watershed qualities such as Wetland Restoration and Rivers Free of Riprap. It is possible to design and build or better yet, avoid destroying, watershed qualities or functions.
- Residents are doing a variety of things to improve water quality and habitat in local streams including creating wetlands, improving riparian conditions, and planting native vegetation. They're also getting involved with local groups or helping out in their own way.

Table 29. Watershed Conditions Summary

Sub-Basin	Riparian Conditions	Wetland Conditions	Water Quality	Sediment Sources	Hydrology and Water Use
Spring Brook	Degraded riparian areas in varied settings from logging, to annual grass seed fields, to urban areas. Many areas with bare ground or short vegetation. Some areas with no vegetation or streambed remaining.	Many wetlands along the lower reaches of creeks. Only NWI mapped information available. No Local Wetland Inventory data available. Large acreage of drained hydric soils.	Willamette River 303(d) listed for temperature, the presence of mercury in fish, fecal coliform, and deformities in fish. Also at risk for pH, trace metals, dioxin, pesticides, semi-volatile & volatile organics, and chlorophyll a	Some debris flow hazard potential. Large areas of impervious surfaces, urban runoff non-point sources of pollution, construction sites, annual grasses, row crops, clean cultivated orchards and forestry.	Considerable irrigation along Willamette River and Spring Brook. Many domestic wells, some in-stream reservoirs. Many natural springs.

Farrell Creek	Has the valley's largest proportion of degraded stream bank conditions. Many orchard areas have no vegetation or streambed remaining. Other areas with narrow strip of trees or worse, only grass and brush in the riparian zone. Little shade.	Many wetlands along the lower reaches of creeks and Willamette. Only NWI mapped information available. No Local Wetland Inventory data available. Drained hydric soil areas in foothills provide good opportunity for wetland restoration.	Chehalem Creek is at risk for the presence of pesticides, high temperatures, nutrients, dis-solved oxygen, and channel modifications.	High debris flow hazard. Rural roads parallel to streams. Some impervious surfaces. Highly erodible soils with construction sites, annual grasses, row crops, clean cultivated orchards and forestry.	Heavily irrigated north of Chehalem Creek, especially in orchards. Many domestic wells. Many natural springs.
Upper Chehalem	Extensive areas with narrow strip of trees or worse, only grass and brush in the riparian zone. Insufficient shade and woody debris.	Many wetlands along Chehalem Creek. Extensive areas of hydric soils drained—these provide a good opportunity for restoration.	Chehalem Creek is at risk for the presence of pesticides, high temperatures, nutrients, dis-solved oxygen, and channel modifications.	Some debris flow hazard potential. Highly erodible soils with annual grasses, row crops, clean cultivated orchards.	Heavily irrigated along Chehalem Creek and along northern foothills of the Red Hills. Some domestic wells.
Lower Chehalem	Urban areas and Red Hills have good shade trees. Agricultural areas lack sufficient bank vegetation.	Only a few small wetlands remain. Hydric soils west of Chehalem Cr. would make good wildlife habitat wetlands near urban areas.	Chehalem Creek is at risk for the presence of pesticides, high temperatures, nutrients, dis-solved oxygen, and channel modifications.	Large areas of impervious surfaces, urban runoff non-point sources of pollution, construction sites, annual grasses, row crops, clean cultivated orchards.	Heavily irrigated in the Dundee area and elsewhere along the Willamette. Many domestic wells
Dundee/ Hess Creek	Orchard areas have eliminated some riparian zones. Urban areas and Red Hills have good shade trees. Agricultural areas lack sufficient bank vegetation.	Many wetlands along the lower reaches of creeks and Willamette. Only NWI mapped information available. No Local Wetland Inventory data available. Large acreage of drained wetlands suitable for restoration.	Willamette River 303(d) listed for temperature, the presence of mercury in fish, fecal coliform, and deformities in fish. Also at risk for pH, trace metals, dioxin, pesticides, semi-volatile & volatile organics, and chlorophyll a	Some debris flow hazard. Rural roads parallel streams. Large areas of impervious surfaces, urban runoff non-point sources of pollution. Highly erodible soils with annual grasses, row crops, clean cultivated orchards.	Largest acreage of irrigation in the watershed. Primarily near Dundee and south along the Willamette River. Also scattered throughout the Red Hills. Many domestic wells.