Chapter 3: Current Conditions

3.1 Aquatic

3.1.1 Erosion processes

3.1.1.1 Overview of erosion and sedimentation processes

Dominant erosion processes within the Middle Tualatin-Rock Creek watershed roughly correspond to ecoregion boundaries. The Chehalem Mountains, Tualatin Mountains, and Cooper Mountain fall into an erosion regime roughly corresponding to the Valley Foothills ecoregion. Thus, the term foothills will be used to refer to this region. The Tualatin Plain is mostly a depositional area within the Prairie Terraces ecoregion.

In the foothills, both slumping and shallow landsliding are potentially important. These regions are typically comprised of interbedded sedimentary layers overlain by Columbia River Basalt. Thick layers of silty soil cap this basalt layer. These factors, along with steep slopes, contribute to slope instability. Landslides are especially common along the contacts between different rock types.

The fine-grained particles produced from erosion in the incised middle to upper-middle portions of the foothills are often delivered to streams. This is an especially important process in first and second-order reaches, where steep canyon walls often expedite the delivery of eroded material to the streams.

The geology of the watersheds has a strong influence on the amount and size of stream channel gravel deposits. Streams draining soft sedimentary rock tend to have less gravel and a higher proportion of fine sediments in stream channels than those drained from more resistant rock. This occurs because sedimentary formations tend to break down relatively quickly into fine-textured particles.

In the Tualatin Plain, slopes are generally low. Where soils are exposed to rainfall energy, they are readily detached. However, the ability to transport eroded soils to stream systems is limited by the low gradient of the valley floor. Where erosion takes place far from stream channels and roadside ditches, eroded soils are usually deposited prior to delivery to the streams. Localized erosion and delivery to streams occurs on both terraces and streambanks.

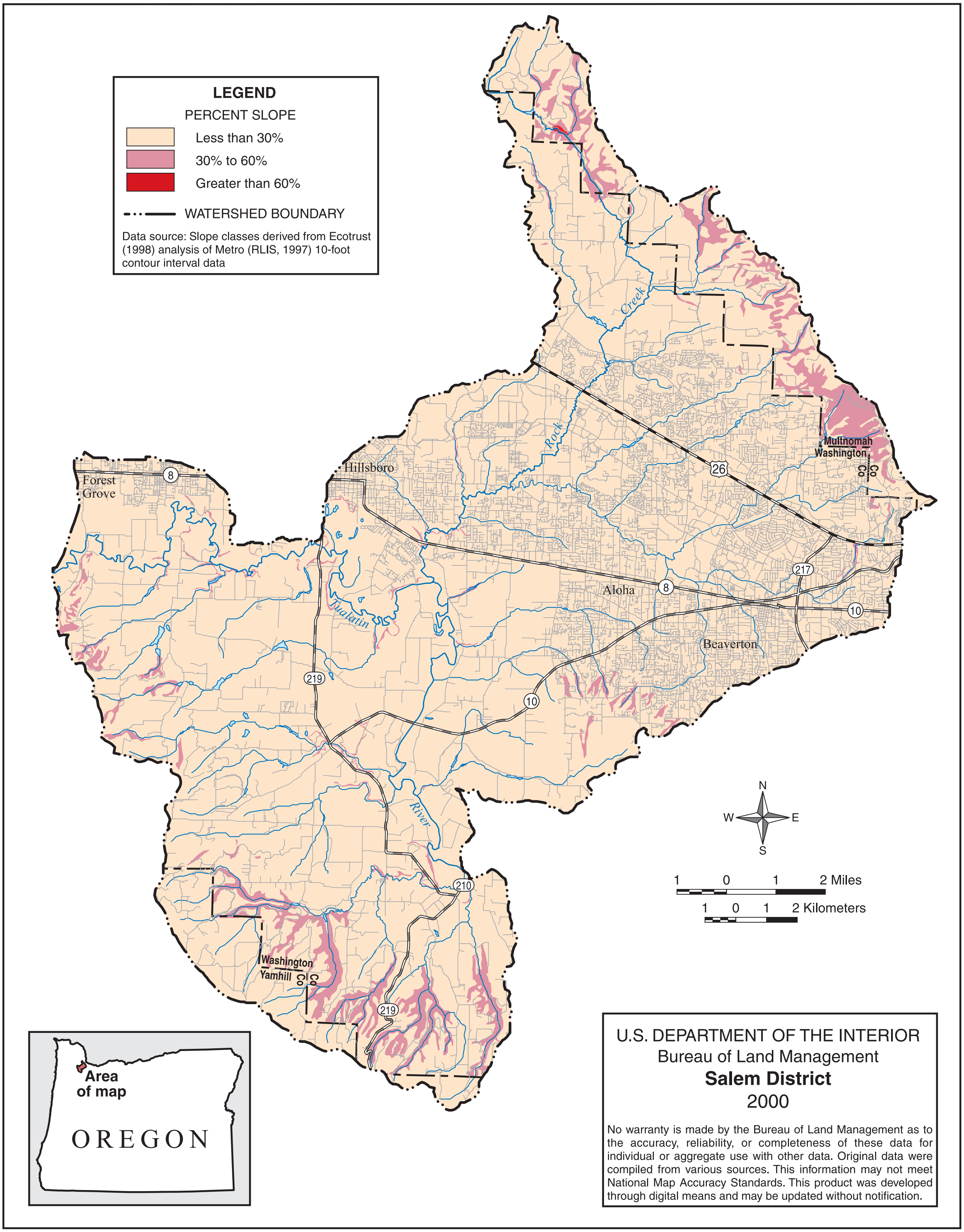
3.1.1.2 Mass wasting

Mass wasting (landsliding and related processes) provides substantial sediment inputs to the stream system. Earthflows and large rotational slumps have been identified as the most frequent mass wasting mechanism in the foothills (Burns et al. 1998). Large, rotational slumps are also important in the foothills. There are several indicators for determining risk of mass wasting.

Slope is an important indicator of landslide susceptibility within the watershed. During a inventory of landslides associated with the 1996 storm events, Burns et al. (1998) found that 92% of slides in the Portland Metropolitan Area occurred on slopes exceeding 60% (30 degrees). Virtually all other landslides occurred on slopes exceeding 30% (15 degrees). Mass wasting potential is low where slope does not exceed 30%. (Dave Michael, ODF, Personal communication).

Topographic maps and GIS layers are often useful for performing a preliminary screening of risk of slope failure. However, it should be noted that decisions should not be made using these tools alone. Due to generalization, maps are typically insensitive to local changes in topography. GIS slope layers often share this insensitivity, and in many cases have errors in the source data. The results of this slope analysis are to be taken as general indicators of landslide susceptibility and are not to be used for site-specific assessments.

Map 3-1 shows areas in the watershed falling into the various slope classes. Steep slopes are relatively uncommon within the Middle Tualatin-Rock Creek Watershed. Slopes exceeding 30% comprise 6,270 acres, or six percent of watershed area. About 1/5 of this total, or 1,331 acres, are comprised of slopes exceeding 45%. Slopes exceeding 60% are virtually nonexistent at the map scale. (However, it should be noted that steep slopes occur at a finer scale than that expressed on the map, particularly where human activities have altered slope characteristics.) The steepest slopes are found along canyon walls adjacent to streams, particularly in the Abbey Creek, Cedar Mill Creek, and Upper Rock Creek subwatersheds of the Tualatin Mountains, and the McFee Creek and Heaton Creek subwatersheds of the Chehalem Mountains.



Map 3-1 -- Slope Classes of the Middle Tualatin-Rock Creek Watershed.

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Lithology plays an important role in determining mass wasting susceptibility. Burns et al. (1998) found that the Portland Hills Silt was extremely susceptible to landslides. This geologic unit, which caps the upper portion of the Tualatin Mountains, quickly loses strength when saturated (Burns et al. 1998). Although the landslide inventory did not extend to the Chehalem Mountains, it should be noted that a similar silt loess unit caps this area, as well.

In conjunction with Metro, the Portland State University (PSU) Geology Department identified several areas within the watershed as having an enhanced landslide hazard. These landslide hazard maps can be accessed at the Metro website (www.metro-region.org). Subwatersheds with areas of enhanced landslide hazard include Abbey Creek, as well as headwater portions of Upper Rock Creek, Bronson Creek, Cedar Mill Creek, and Upper Beaverton Creek. The hazard was highest in canyons adjacent to streams. Moderate landslide hazard was also identified along stream gorges on Cooper Mountain. Although the PSU effort did not extend to the Chehalem Mountains, slope and geology suggest that similarly enhanced landslide hazard exists in this area, as well.

Urban and rural residential development is proceeding rapidly in the foothills of the watershed. These construction projects can potentially contribute to slope destabilization in these naturally unstable regions. Steep cutslopes reduce the strength of the hillslope, while poorly consolidated fills are weak and place an additional burden on the slopes below. Burns et al. (1998) identified human activities as contributing to 76% of landslides inventoried in the Portland Metropolitan area. Cutbanks for roads and driveways were most commonly implicated. Fills and poor runoff management were also identified as contributing factors.

Roads near streams and at stream crossings can provide a ready sediment delivery mechanism to streams. Analysis of roads within the watershed found that 22.4 miles of road occurred on slopes exceeding 30% slope. Most of these roads were located near McFee Creek and its tributaries, as well as Upper Rock Creek and Cedar Mill Creek subwatersheds (Table 3-1). Of these roads on steep lands, 5.9 miles lay within 200 feet of streams. These road segments would have the highest potential for contributing sediment to streams.

Table 3-1. Subwatersheds with a high incidence of roads on steep slopes and/or rural roads near streams.

Subwatershed	Area (Acres)		Road Length (Feet)			
	Total	Slopes >30%	Slopes >30%	Near Streams (Rural)	Near Streams (Urban)	Slopes >30% and Near Streams
McFee Creek	7,603	965	20,833	39,720	---	9,493
Heaton Creek	4,005	664	14,570	21,122	---	6,890
Upper Rock Creek	6,014	673	7,369	25,828	---	4,896
Baker Creek	2,026	376	12,069	5,518	---	2,638
Jaquith Creek	2,147	345	5,174	9,844	---	2,407
Christensen Creek	6,365	132	3,569	34,294	---	1,982
Cedar Mill Creek	2,365	761	17,113	---	---	
Blooming Creek	2,737	169	2,628	13,448	---	868
Bronson Creek	3,164	340	4,277	---	29,214	2,652
Abbey Creek	3,074	681	12,069	---	5,909	2,260
Middle Rock Creek	2,911	35	2,209	---	11,275	1,533
Johnson Creek (S)	3,408	127	2,759	---	37,927	1,262
Upper Beaverton Creek	5,489	42	2,093	---	59,371	995
Willow Creek	3,272	0	0	---	34,812	---
Butternut Creek	3,249	74	1,388	---	29,214	335
Johnson Creek (N)	2,439	44	2,675	---	25,442	---

3.1.1.3 Surface and streambank erosion

In the Middle Tualatin-Rock Creek watershed, the underlying lithology strongly affects the erodibility of the soils. Although the degree of resistance varies, most rock types within the watershed are fine-grained and weather to fine particles. Once this weathering has taken place, these particles are readily erodible.

Most subwatersheds within the Middle Tualatin-Rock Creek experience extensive disturbance of vegetation, either through construction, residential uses, or agriculture. This disturbance, along with soil compaction, can contribute to significant degrees of soil loss and stream sedimentation. In these cases, slope, climate, lithology and soil erodibility affect the relative magnitude of surface erosion.

The Tualatin Valley is underlain by alluvium of Quaternary age. Most erosion in this area is through streambank, sheet, rill and gully processes.

Streambank erosion occurs throughout the watershed, but is most significant along higher order streams that are not confined by valley walls. Although streambank erosion occurs under natural conditions, the magnitude of erosion has been increased due to altered hydrology, channelization and destruction of riparian vegetation by grazing livestock and other anthropogenic factors.

The Tualatin River has developed natural levees along its course within the watershed. During flooding events, sediment is deposited, resulting in increased elevation of streambanks. In many places, during peak flow, the stream water is higher in elevation than the surrounding floodplain. These streams often overtop the bank and flow into the floodplain. Where this occurs, the hydraulic energy of the floodwaters erodes the streambank and portions of the nearby floodplain. In an effort to combat this erosion, landowners and public works agencies repair breaches in the streambank and conduct streambank protection projects using resistant materials such as riprap. Further, bridges form hard barriers containing the channel at stream crossings. The result is that a system of artificial, resistant, levees has developed along many reaches of streams.

Sheet, rill, and gully erosion in the lower foothills and valleys of the watershed, however, probably pose more important threats to water quality and long-term agricultural productivity than does streambank erosion. While streambank erosion occurs throughout the soil profile, the topsoil layers eroded through sheet, rill, and gully processes are the most likely to be enriched with nutrients and pollutants. Also, topsoil losses due to sheet, rill, and gully erosion represent a more significant resource loss to agriculture than does soil loss from streambank erosion.

Soils classified as “Highly Erodible Land” (HEL) by NRCS have steep slopes and are mostly located on foothill slopes. Rolling lands in valley landscapes, however, are also prone to sheet, rill, and gully erosion. Most HEL within the watershed is found in the Chehalem Mountain subwatersheds. (It should be noted, however, that HEL data were not available for Multnomah County.) More than 75% of the subwatershed area contributing to McFee Creek is classified as HEL. Thus, McFee Creek and its associated aquatic resources, such as winter steelhead, are especially sensitive to land use practices.

3.1.1.4 Prohibited conditions

Under the Tualatin River Subbasin Agricultural Water Quality Management Area Plan, certain conditions potentially resulting from landowner management activities were specifically prohibited (OAR 603-095). Such prohibited conditions include excessive sheet and rill erosion, excessive gully erosion, lack of ground cover in riparian areas, summer discharge of irrigation water to streams, and placement of wastes where they would be likely to enter streams. An effort is currently underway to evaluate the existence and extent of these prohibited conditions. (Also see section 5.1.4.6.) These survey efforts, however, have not been systematically performed within the Middle Tualatin-Rock Creek watershed. Spot checks and complaint investigations have identified prohibited conditions related to waste management, erosion, and unvegetated streambanks. The Washington County SWCD and NRCS are working with several landowners to address these conditions.

Landowners have the option of developing a Voluntary Water Quality Farm Plan in conjunction with the SWCD, delineating an approach to protect water quality on their land. If such a plan is not adopted and a prohibited condition occurs, the Oregon Department of Agriculture (ODA) can take enforcement actions.

3.1.2 Hydrology and water quantity

3.1.2.1 Hydrologic characteristics

The precipitation regime of the Middle Tualatin-Rock Creek watershed is rainfall dominated. Snowfall is not a major source of precipitation. Precipitation is seasonal, with most rain falling between November and March (Figure 1-1). Precipitation intensities in this watershed are light related to those prevailing in western portions of the Tualatin subbasin. The 2-year, 24-hour precipitation event in the watershed ranges from 2.3 to 2.5 inches. Precipitation intensity is highest in the Chehalem Mountains and Upper Rock Creek watershed and decreases in the Tualatin Valley (OCS 1997).

Due to the lack of storage as snow and groundwater, discharge is seasonal and largely follows the precipitation cycle. Flows are very high in winter and fall to very low levels between July and October. Although these summer flows get quite low, most streams within the watershed are perennial[12]. Only the smallest streams dry up in the summer.

In the Middle Tualatin-Rock Creek watershed, the gage on the Tualatin River at Farmington Bridge (RM 33.3) provides the only long-term discharge records. This gage was operated by the United States Geologic Survey over two periods: Water years (WY) 1941-58 and WY 1979-84. The U.S. Army Corps of Engineers has maintained that gage since WY 1993. Other gages, with shorter periods of record, are maintained by the Oregon Water Resources Department (OWRD) and provide continuous and seasonal monitoring (Table 3-2).

Table 3-2. Stream flow gages in the Middle Tualatin-Rock Creek Watershed.

Stream	RM	Location
Tualatin River	51.5	Golf Course Road
	38.4	Rood Bridge Road
	33.3	Farmington
Johnson Creek (South)		Davis Road
Rock Creek	1.3	Highway 8
Dawson Creek	0.7	Brookwood Road
Bronson Creek	5.1	Saltzman Road
	2.1	Bronson Road

Figure 3-1 shows average flow characteristics of the Tualatin River at the Farmington gage site between the 1941 and 1958 water years, the period prior to flow regulation by Scoggins Dam. During this period, 84% of discharge passing the Farmington gage occurred during the November to March rainy period. Mean monthly February discharge was 3,943.8 cfs, while the mean August discharge was 52.5 cfs. The minimum recorded daily flow over this period was 1.0 cfs.

Figure 3-1 also displays the changes in discharge at the gage site following flow regulation. Between 1979 and 1984, the total flow was radically reduced from unregulated conditions. Total annual flow at this gage was 14% of the flow during the 1940-1958 unregulated period. Management practices improved radically subsequent to that time, as reflected by the 1993-1999 flow averages (based on OWRD measurements). Flow during the 1993-1999 period is 134% of that measured during the unregulated period. The current flow distribution pattern is similar to that occurring prior to regulation. Mean February discharge is 4,830 cfs, while mean August discharge has been augmented to 182 cfs.

An interesting fact is that the 1993-1999 figures exceed the unregulated flow throughout the year. This may reflect a reduction in upstream withdrawals, or may be a result of additional inputs from such sources as the USA Rock Creek Plant and Barney Reservoir.

3.1.2.2 Water quantity and water rights

Lack of summer streamflow is an important concern in the Tualatin subbasin. In summer, discharge is naturally quite low. Diversion during these natural low flow periods can create conditions where beneficial uses are not met. Additionally, natural drought cycles lead to a decreased natural pool of available water. Decreased stream volume can have adverse impacts, both to instream life and to human uses. These impacts include higher water temperature, decreased residual pool depth, decreased dissolved oxygen concentrations, and other detrimental impacts to aquatic life. Inadequate streamflow also leads to decreased availability for human uses, and can lead to aesthetically unpleasant water. In the Middle Tualatin-Rock Creek watershed, these concerns vary between the Tualatin River mainstem and tributaries. During the summer months, the Tualatin River mainstem receives additional flow from Henry Hagg Lake for water quality and irrigation purposes. Tributary streams do not receive this additional flow, and the local lack of summer water is a major concern. Based on the 80% exceedance flow[13], the OWRD has determined that surface water rights are overallocated in several parts of the watershed (Table 3-3). In the Water Availability Basin[14] comprising the Tualatin River upstream of West Linn, OWRD has restricted new water rights allocations for direct diversion between June and November. Water is even less available for direct diversion in McFee Creek above Gulf Canyon, where new water rights allocations are unavailable throughout the year. In most cases, consumptive uses contribute substantially to the lack of available water (Table 3-4). Consumptive uses exceed one-tenth of the 80% exceedance streamflow throughout the May-November period. The demand is greatest between July and September, when consumptive uses are greater than the 80% exceedance streamflow at most sites[15]. On McFee Creek above Gulf Canyon, the lack of available water between November and May is also the result of natural discharge insufficient to meet instream water rights.

Figure 3-1. Tualatin River at Farmington: pre- and post-regulation discharge

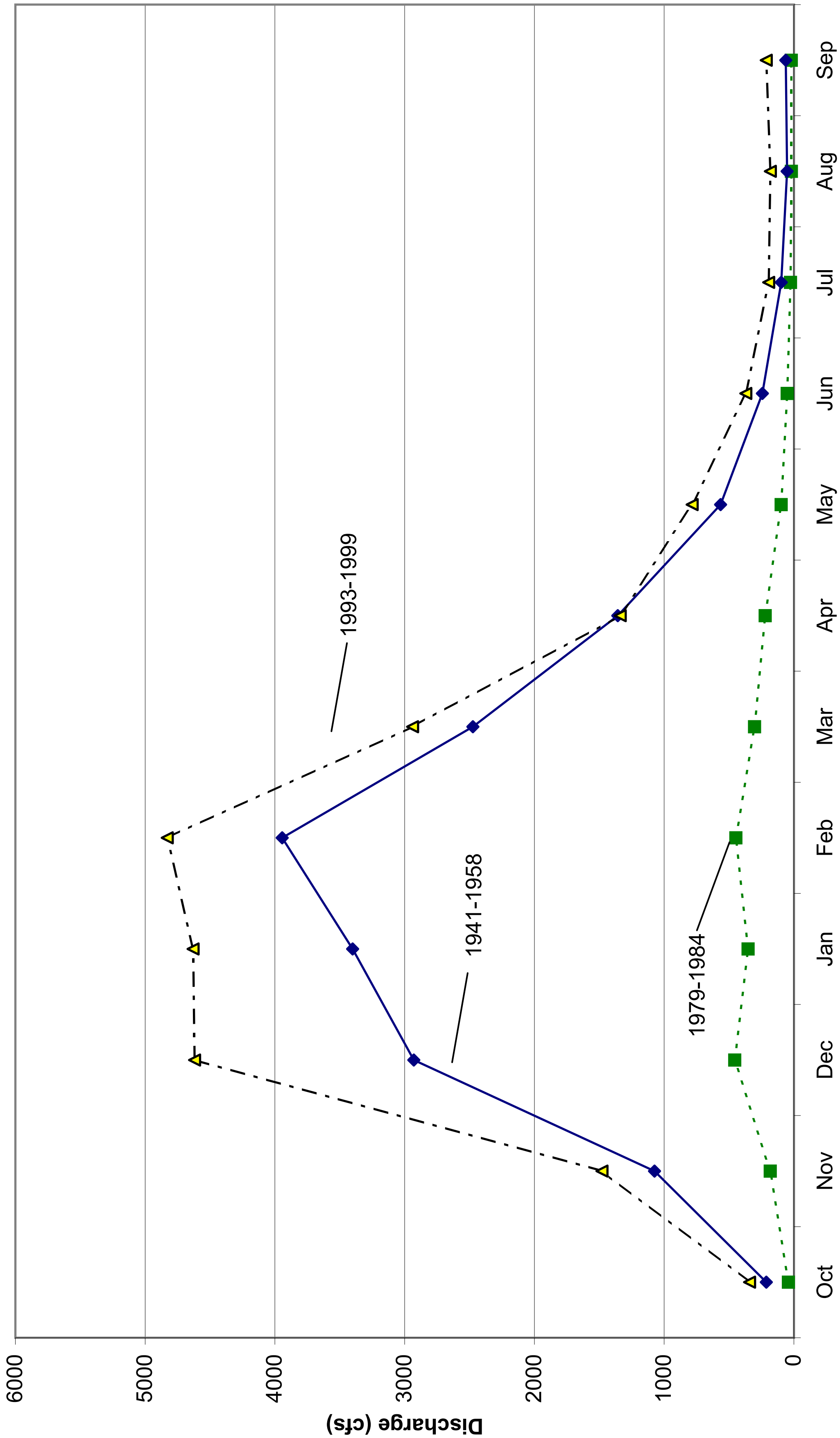


Table 3-3. Water availability summary for sites in or near the Rock Creek-Middle Tualatin Watershed. Based on OWRD WARS database.

	Monthly Net Water Available (cfs) at 50% exceedance level											
Water Availability Basin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Willamette R. at Mouth	48,800	43,800	36,000	30,300	24,400	12,600	4410	2170	2780	6350	22,300	50,600
Tualatin R. at Mouth	3020	2890	2010	1040	237	-15.9	-174	-209	-132	-17.8	221	2650
Tualatin R. at West Linn	3020	2890	2010	1040	237	-15.6	-172	-207	-131	-16.7	221	2660
McFee Cr. at Mouth	72.7	72.3	51.3	31.7	12.9	1.8	-3.21	-4.1	-2.18	0.07	12.1	66.3
McFee Cr. above Gulf Cyn	-14.9	-15	-20.7	-26.2	-32.1	0.28	-1.39	-5.45	-4.59	0.36	-32.8	-16.8
Tualatin R. at Farmington	2350	2800	1840	989	308	46.6	-105	-134	-72.6	-1.08	367	2250
Rock Cr. At Mouth	262	395	217	117	28.2	11.2	0.13	-1.94	0.9	7.01	12.4	258

	Monthly Net Water Available (cfs) at 80% exceedance level											
Water Availability Basin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Willamette R. at Mouth	25,200	24,700	22,100	19,300	16,800	7810	2710	1530	1970	3950	10,600	22,600
Tualatin R. at Mouth	971	1210	963	501	46.7	-116	-230	-231	-190	-81.8	-109	654
Tualatin R. at West Linn	971	1210	963	501	48	-115	-228	-229	-188	-80.7	-108	654
McFee Cr. at Mouth	31.4	36.8	29.6	17.5	6.23	-0.58	-4.27	-4.41	-2.79	-1.02	1.94	20.2
McFee Cr. above Gulf Cyn	-26.2	-24.6	-26.8	-30.1	-34.0	-0.28	-1.66	-5.55	-4.70	0.19	-35.1	-29.2
Tualatin R. at Farmington	975	1180	996	535	180	-13.6	-142	-169	-104	-37.7	46.7	642
Rock Cr. At Mouth	100	136	110	55.9	18.5	6.27	-4.85	-4.00	-1.04	1.83	1.01	43.2

Table 3-4. Consumptive use summary for sites in or near the Rock Creek-Middle Tualatin Watershed. Based on OWRD WARS database.*

	Consumptive Use as a Percentage of 50% Exceedance Streamflow											
Water Availability Basin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Willamette R. at Mouth	1.47	7.73	*11.45*	*12.81*	8.49	*10.66*	*25.94*	*33.58*	*25.52*	6.35	2.43	1.32
Tualatin R. at Mouth	2.10	5.41	3.60	6.07	*18.47*	*60.81*	**149.80**	**219.66**	**136.72**	*29.16*	8.13	2.17
Tualatin R. at West Linn	2.06	5.37	3.54	5.99	*18.28*	*60.70*	**148.99**	**218.34**	**135.57**	*28.22*	7.93	2.12
McFee Cr. at Mouth	3.50	3.51	3.74	4.50	*16.23*	*44.73*	**117.40**	**163.24**	*87.60*	*14.05*	5.81	3.56
McFee Cr. above Gulf Cyn	0.71	0.71	0.91	1.30	*24.47*	*84.95*	**271.60**	**437.21**	**247.50**	*23.40*	3.56	0.73
Tualatin R. at Farmington	1.59	4.99	2.89	5.17	*16.45*	*46.17*	**120.95**	**159.97**	*93.65*	*14.79*	4.05	1.49
Rock Cr. At Mouth	0.65	0.53	0.80	1.39	8.48	*20.52*	*65.21*	*88.28*	*39.50*	2.46	3.31	0.65

	Consumptive Use as a Percentage of 80% Exceedance Streamflow											
Water Availability Basin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Willamette R. at Mouth	2.74	*12.65*	*17.04*	*18.36*	*11.61*	*15.32*	*32.96*	*37.98*	*29.72*	8.90	4.67	2.81
Tualatin R. at Mouth	5.44	*10.96*	6.51	*10.05*	*27.09*	*92.64*	**243.86**	**291.06**	**303.82**	*65.06*	*22.79*	6.66
Tualatin R. at West Linn	5.33	*10.88*	6.40	9.92	*26.77*	*92.48*	**242.54**	**289.31**	**301.26**	*62.94*	*22.19*	6.51
McFee Cr. at Mouth	7.46	6.48	6.11	7.45	*25.38*	*64.44*	**158.61**	**186.04**	**114.72**	*22.11*	*16.85*	*10.08*
McFee Cr. above Gulf Cyn	1.51	1.30	1.49	2.17	*38.25*	**122.48**	**407.41**	**569.70**	**341.38**	*36.67*	*12.00*	2.02
Tualatin R. at Farmington	3.59	*10.68*	5.02	8.63	*22.79*	*61.64*	**176.42**	**284.92**	**148.60**	*22.59*	*12.16*	4.65
Rock Cr. At Mouth	1.65	1.50	1.55	2.80	*11.93*	*28.70*	**191.09**	**155.15**	*60.33*	5.25	*12.69*	3.63

*Months where consumptive uses exceed total streamflow are denoted in **bold**.
Months where consumptive uses exceed 10% of streamflow are *italicized*.

Table 3-5 shows the magnitude, by subwatershed, of permitted water rights for direct diversion from streams within the Middle Tualatin-Rock Creek watershed. By far, the largest rate of diversion from streams occurs within the Middle Tualatin subwatershed. Most of this diversion takes place at the Joint Water Commission water treatment plant on Springhill Road, which has a permit to divert up to 93 cfs. Other than the Middle Tualatin, the subwatersheds with the greatest potential diversion were Middle Tualatin-Cornelius, Middle Tualatin-Jackson Slough, Middle Tualatin-Rosedale Creek, Heaton Creek, and Christensen Creek. This does not include the diversion of water transferred from Henry Hagg Lake, which accounted for an estimated 46 cfs within the watershed[16].

Municipal uses and irrigation are of roughly equivalent magnitude, and account for virtually all surface water diversion within the watershed (Table 3-6). Altogether, these water rights add up to 265 cfs. If all of these rights were applied during low flow season, stream resources could become seriously overtaxed.

Agricultural water rights usually have a maximum cumulative annual withdrawal of 2.5 acre-feet per acre of irrigated land. However, this maximum is not typically fully utilized. In 1987, annual irrigation demand from the Washington County Water Resources Management Plan was estimated at 27,532 acre-feet distributed over 25,491 acres, or 1.08 acre-feet per acre (that is, a mean depth of 13 inches). A more recent study indicates that Tualatin Valley Irrigation District (TVID) provided 0.9 acre-feet of water for every acre that it serviced (WMG 1998).

In 1956, about 18 inches (1.5 acre-feet/acre) of irrigation water per growing season was considered necessary for optimal growth (Hart and Newcomb 1965). However, only about two-thirds of this total was available at the time, resulting in sub-optimal irrigation for growth. Based on current irrigation figures, it appears that actual water use per acre of land has not changed appreciably since the 1950s. However, it is likely that modern farms are deriving more productivity per acre-foot of water. Some additional benefit could be attained by implementing Best Management Practices designed for water conservation.

Under Oregon law, conflicts over water rights are resolved under the doctrine of prior appropriation (OWRD 1997). In effect, water rights obtained first have first priority to available water. For this purpose, each water right permit is assigned a priority date, which is usually the date of the application for the permit. Water rights with earlier dates, thus higher priority, are termed “senior water rights”.

On the Tualatin River and several tributary streams, water rights have also been assigned for instream uses. These rights are granted to promote sustenance of fish and wildlife. A list of minimum instream water rights is given in Table 3-7. The largest instream water right occurs on the Tualatin River mainstem. Above Farmington, a variety of certificated instream rights are applicable, resulting in cumulative rights ranging from 75 cfs in January to 93.6 cfs in November. Downstream of Farmington, instream water rights range from 94.5 cfs (September) to 250 cfs (November to March) as measured at West Linn gage. The water rights during the November to May period allocate additional water for spawning and migration of salmon and steelhead trout. Instream water rights are also regulated for McFee Creek and Rock Creek.

Although these instream water rights are designed to benefit aquatic resources, their effectiveness is limited by their relatively junior priority dates. The priority date for the McFee Creek rights and the most senior of the mainstem Tualatin River rights is May 25, 1966, while the instream right for Rock Creek has a priority date of August 5, 1993. Water rights holders with priority dates earlier than this date would have priority over these instream rights. Because of the large number of senior rights on these streams, instream water rights are subject to loss of regulatory protection from OWRD. In 1998 and 1999, relatively wet water years, instream water rights in the watershed upstream of Dairy Creek were ineffective after June 18 and June 14, respectively. The Tualatin River mainstem below Dairy Creek retained a portion of its instream water rights throughout the low-flow season. Many of the more recent water rights permits restrict withdrawals between November and March, with the purpose of ensuring adequate water remains instream for salmonids.

Through its instream leasing program, OWRD offers incentives for water rights holders to lease their rights for instream uses. This program is particularly useful for rights holders who temporarily do not expect to use their full allocation of water. The holder’s water rights are protected throughout the period of the lease. Minimum lease period is two years.

Table 3-5. Total surface water rights by subwatershed.

Subwatershed	# of rights	diversion cfs	Hagg Lake*	Total cfs.
Abbey Creek	2	0.06		0.06
Baker Creek	5	0.36		0.36
Beaverton Creek	6	0.76		0.76
Bethany Creek	1	0.66		0.66
Blooming Creek	5	3.03	6.15	9.18
Bronson Creek	8	1.14		1.14
Burris Creek	5	1.57	0.51	2.08
Butternut Creek	5	0.34		0.34
Cedar Mill Creek	10	2.48		2.48
Christensen Creek	34	11.10	0.90	12.00
Cornelius	14	9.95	7.19	17.14
Davis Creek	23	18.28	1.68	19.95
Dawson Creek	4	1.13		1.13
Golf Creek	27	4.11		4.11
Gordon Creek	24	9.76	0.51	10.27
Gulf Canyon	29	7.39	0.06	7.44
Heaton Creek	17	11.45	0.41	11.86
Holcomb Creek	4	1.11		1.11
Jackson Bottom	16	8.25	11.48	19.73
Jackson Reservoir	6	2.97	0.13	3.10
Jackson Slough	30	15.03	3.96	19.00
Jaquith Creek	8	1.08		1.08
Johnson Creek North	16	1.36		1.36
Johnson Creek South	2	0.17		0.17
Lower Beaverton Creek	22	1.45		1.45
Lower-Middle Tualatin	10	4.13	3.12	7.24
Middle Rock Creek	24	3.04		3.04
Middle Tualatin	31	135.98	7.08	143.06
Reedville Creek	3	0.43		0.43
Rock Creek	7	0.54		0.54
Rosedale Creek	34	13.77	2.82	16.59
Upper Rock Creek	8	0.87		0.87
Willow Creek	5	0.59		0.59
Total	445	274.32	45.97	320.29

Source: Analysis of OWRD point-of-use water rights information (February, 2000).

Adjusted for approximate apportionment of permit number S 35792 between multiple diversion sites.

*The 228 cfs water right at Hagg Lake is apportioned between subwatersheds within the Rock-Middle Tualatin watershed, and other watersheds, based on TVID irrigated acres.

Table 3-6. Total surface water rights by type of use.

USE		number of water rights	Average (cfs)	Cumulative (cfs)	% of total
AG	Agriculture	1	0.05	0.05	0.02%
AS	Aesthetic	3	0.30	0.91	0.33%
DI	Domestic	4	0.10	0.41	0.15%
DN	Domestic	1	0.01	0.01	0.00%
DO	Domestic	6	0.11	0.64	0.23%
DS	Domestic/stock	3	0.03	0.10	0.04%
FI	Fish	8	0.12	0.95	0.35%
FP	Fire protection	2	0.51	1.01	0.37%
I*	Irrig.,domestic,stock	1	0.20	0.20	0.07%
IC	Irrigation	2	11.70	23.40	8.54%
ID	Irrigation and Domestic	1	0.48	0.48	0.18%
IR	Irrigation	381	0.29	111.02	40.52%
IS	Supplemental Irrigation	3	3.01	9.04	3.30%
LV	Livestock	8	0.01	0.09	0.03%
MU	Municipal	3	40.33	121.00	44.17%
NU	Nursery Use	1	1.72	1.72	0.63%
PW	Power	1	1.00	1.00	0.37%
RC	Recreation	9	0.21	1.91	0.70%
WI	Wildlife	3	0.01	0.03	0.01%
	Total	441		273.97	100.00%

Source: Analysis of OWRD point-of-diversion water rights information.
Date of source GIS layer is February, 2000.

Table 3-7. Minimum perennial streamflows (cfs) as regulated by instream water rights in the Middle Tualatin-Rock Creek watershed.*

Stream Name	Above	OCT	NOV 1-15	NOV 16-30	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL 1-15	JUL 16-30	AUG	SEP
Tualatin R	West Linn	100	250	250	250	250	250	250	250	250	130	100	100	100	94.5
Tualatin R	Farmington	91.4	93.6	93.6	79.8	75	91.6	84.3	81.9	77.1	82.1	80.3	80.3	86.8	78.1
McFee Creek	Mouth	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
McFee Creek	Gulf Cyn	0	36	36	36	36	36	36	36	36					
Rock Creek	Mouth	2.5	2.5	2.											

3.1.2.3 Flooding

Flooding is another important concern within the watershed. Although flooding is a natural part of a stream's hydrologic regime, it potentially conflicts with extensive agricultural development within the floodplain. Flooding is largely a function of watershed topography. Poorly drained alluvial silts and clays underlie much of the Tualatin Plain. Altogether, these soils cover 19 square miles, roughly 12% of the total watershed area. Although these poorly drained soils tend to concentrate near streams, they are distributed throughout lowland portions of the watershed.

Extensive portions of the watershed lie within the 100-year floodplain (Map 3-2). Most of these areas are in rural portions of the watershed. Flooding in these areas would mostly affect agricultural and rural residential uses. However, broad floodplains do occur in rapidly expanding urban portions of the watershed. The broadest of these floodplains lie along the Tualatin River south of Cornelius. As pressure rises for infill, it will be important to maintain land uses in these floodplains that are compatible with the flooding regimes of these areas. Additionally, urbanization has increased peak flows in northern parts of the watershed, likely resulting in an expanded 100-year floodplain. In recognition of the fact, USA is currently undertaking research to model the 100-year floodplain under current and planned urbanization.

Retention of floodwaters in floodplains helps to moderate flood peaks downstream on the Tualatin River. Stream channelization and drainage projects such as drain tiling have reduced the amount of time that water is detained at these floodplain sites. Nevertheless, floodplain storage continues to contribute to flow moderation.

3.1.2.4 Groundwater

Both confined and unconfined aquifers provide important sources of groundwater in the Rock Creek-Upper Tualatin watershed. The most productive confined aquifers are found in the Columbia River basalt. Wells tapping this aquifer sometimes produce several hundred gallons per minute. However, this aquifer has a limited storage capacity, and in areas of heavy usage, withdrawal can exceed recharge (Hart and Newcomb 1965, Schlicker 1967).

Such depletion has occurred in the area surrounding Cooper Mountain. The Cooper Mountain/Bull Mountain Critical Groundwater area includes the watershed from Butternut Creek South to the Tualatin River. Within these boundaries, groundwater withdrawals from the basalt aquifer are only permitted for domestic uses. On parcels of 10 acres or more, up to _ acre of lawn or garden may be irrigated.

West of this area, the Chehalem groundwater limited area includes all of the McFee, Burris, and Christensen Creek subwatersheds, as well as that portion of the Davis Creek subwatershed that lies west of Highway 219. In addition to irrigation, water may be withdrawn from the basalt aquifer for purposes of rural fire protection, and by permit, water-efficient irrigation.

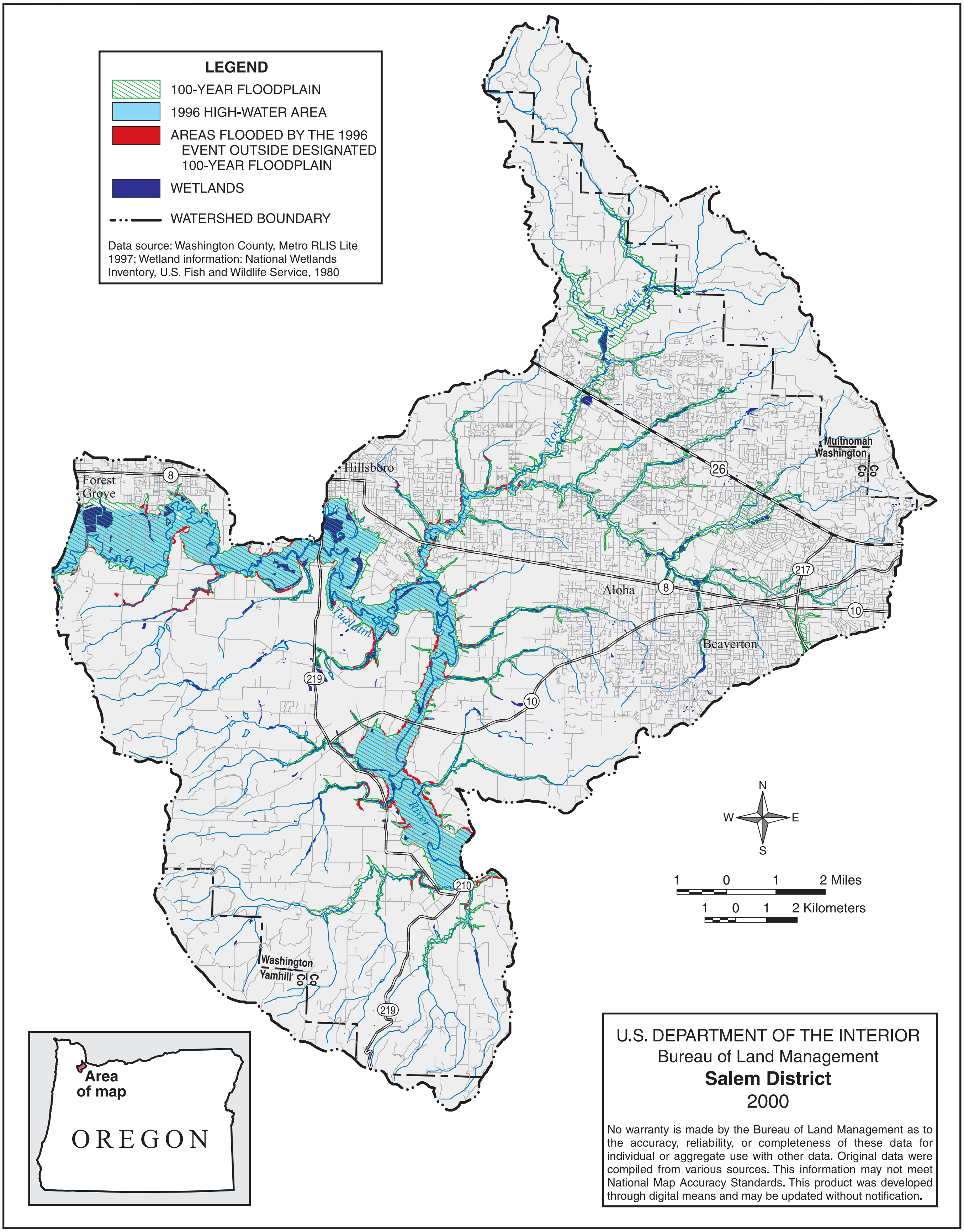
Seasonally high recharge can lead to circumstances where the water table rises to the surface, particularly in December and January. At these times, seasonal wetlands become flooded. Much of the valley is underlain by soils of low permeability, which contributes to wetland flooding.

3.1.2.5 Human impacts on hydrology

The natural flow regime has been altered through several anthropogenic influences. These include:

1. Decreased infiltration rates. Extensive urbanization in the eastern and northern portion of the watershed has resulted in increased area covered by impervious surfaces such as pavement and rooftops and decreased vegetative cover. Similarly, agricultural areas are subject to decreased soil organic matter and decreased vegetation cover relative to the natural condition. These factors all increase peak runoff rates and may decrease low flow rates in the summer.

2. Channelization. Many tributary streams in urbanized and agricultural portions of the watershed have undergone extensive channelization for drainage and flood control. Although modified channels are common throughout urbanized portions of the watershed, surveyors noted a particularly high incidence of "ditched" channels in the Butternut Creek subwatershed (USA unpublished data, 2000). Map analysis indicates that the course of Johnson Creek (North) is also visibly straightened. Among the rural areas, Christensen Creek appears to have undergone more straightening than other streams. Potential effects of channelization include hydrologic separation of the stream from its floodplain, reduced water detention, and increased downstream flooding. Stream cleaning and straightening associated with channelization reduce resistance to flow and locally increase the stream gradient, resulting in increased



Map 3-2 -- Flood Plains and Wetlands of the Middle Tualatin-Rock Creek Watershed.

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velocity and erosion. Additionally, channel straightening tends to destroy riparian vegetation, and reduces the length and diversity of instream and riparian habitats .

3. Diversions. As discussed earlier in this section, water diversions are distributed throughout the Tualatin Plain. Impacts of these diversions include reduced discharge, which in turn leads to increased summer water temperatures and decreased instream habitat for aquatic life. Where these diversions are unscreened, they also pose a hazard to fish populations by diverting fish onto agricultural fields.
4. Vegetation changes. Removal of vegetation and large wood from channels reduces resistance to flow, thus increasing the velocity of stream discharge. Although this has the potential benefit of reducing local flooding, it increases the prospect of downstream flooding, reduces the quality and diversity of available riparian and aquatic habitat, and increases erosion.
5. Flow regulation. The Tualatin River project, including Scoggins Dam, has altered flows in the watershed. Summer flows have been augmented along the mainstem. Winter peak flows have been reduced in western portions of the watershed. However, by Farmington, mean monthly flow appears to be above unregulated levels, even in winter. The effects of flow regulation become diminished downstream. Flow augmentation from Henry Hagg Lake and Barney Reservoir has contributed to improved water quality as far downstream as Rock Creek. Although many of these changes are positive for water quality and human interests, care must be taken not to create negative impacts to aquatic life and other beneficial uses.
6. Drainage. Surface and subsurface ("tile") drains provide drainage to agricultural areas throughout the watershed. This has increased peak winter flows and decreased summer flows in the Tualatin River and its tributaries. This flow alteration can lead to increased streambank erosion and channel sedimentation, decreasing habitat diversity, quantity, and quality.

3.1.2.6 Relative importance of human management factors to hydrologic change.

The OWEB methodology was used to determine the relative effects of each land use upon watershed hydrology (WPN 1999). The separate analyses, along with their limitations, can be found on the Washington County SWCD website (http:\\www.swcd.net). The results are as follows.

Agriculture. Enhanced peak flow from agricultural activities was estimated at 0.4 to 0.5 inches. Using the OWEB criteria, this was considered to provide a low flow enhancement potential. However, the calculations did not consider antecedent conditions.

Forest and rural roads. Forest and rural roads were found to occupy less than 4% of subwatershed area in each subwatershed. Using the OWEB criteria, this indicates that peak flow enhancement potential from these road types is low within the watershed.

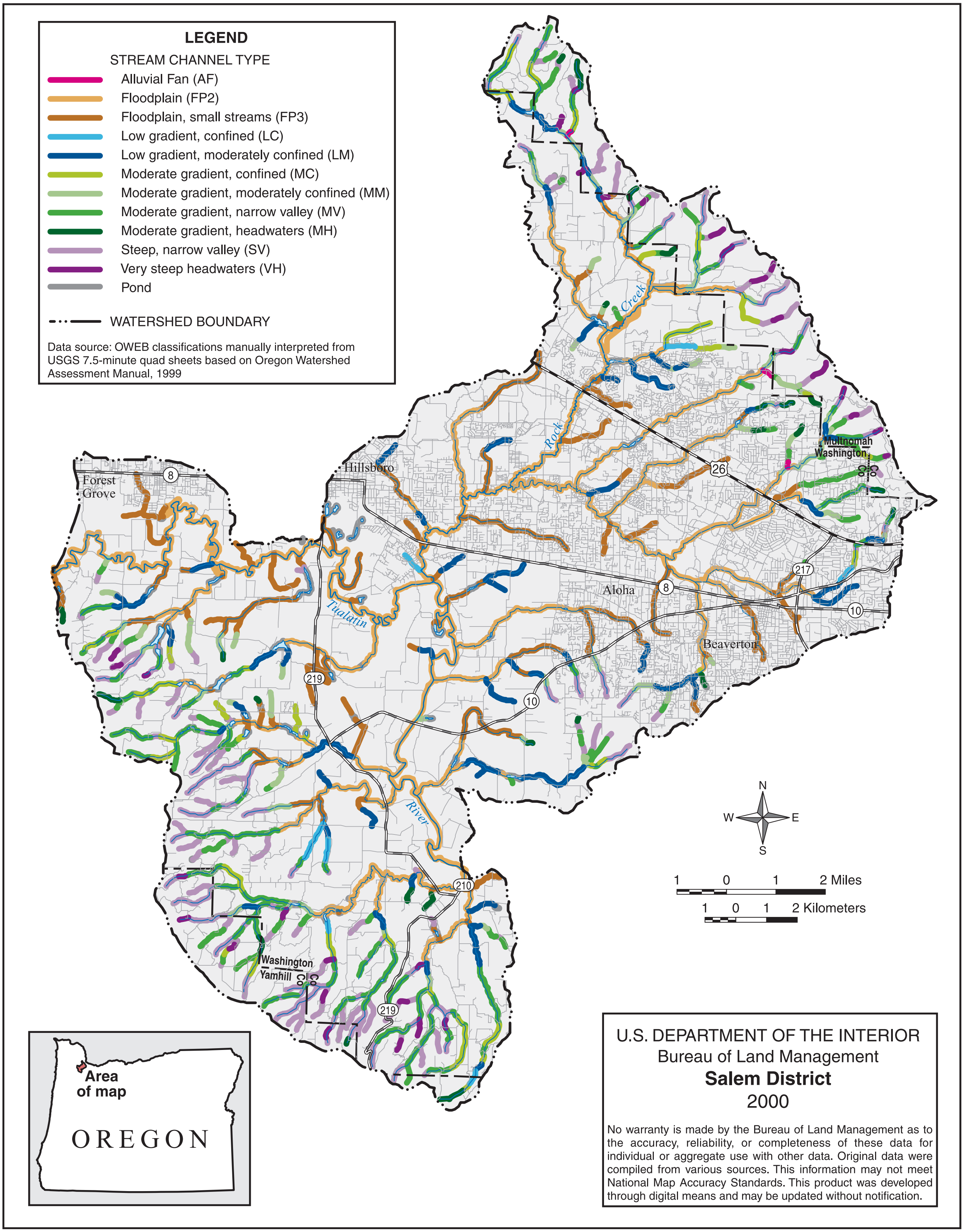
Urban and rural residential uses. The OWEB methodology includes an option where road density is used as a surrogate for total impervious area. (Subwatersheds with less than one square mile of urban or rural residential area were not included in the analysis.) Urban portions of all subwatersheds were found to have road density exceeding 10 miles road per square mile of land surface area. According to the OWEB criteria, the potential for peak flow enhancement from urban land uses was very high. Rural residential areas also seemed to produce a greater risk of peak flow enhancement than agriculture and forestry activities. However, definitive conclusions were difficult to draw because of the small extent of individual rural residential areas.

3.1.3 Stream channel

3.1.3.1 Stream morphology and sediment transport processes

Major streams in the watershed were channel typed according to size, gradient, and confinement characteristics (Map 3-3)[17]. In order to characterize the channel structure within the watershed, a channel typing methodology patterned after the Oregon Watershed Enhancement Board[18] (OWEB) approach was employed (WPN 1999). This approach offered the advantage that the assessment could be performed rapidly using topographic maps, as contrasted with other methods that require more intensive fieldwork. Office-based channel typing using the OWEB methodology is useful for rapid stratification of watershed stream reaches for characterization and preliminary planning. However, field study should precede any site-specific project planning.

Limited ground reference data was collected, and reports analyzed, to determine the character of channels within the watershed (Tables 3-8 and 3-9). The analysis revealed recurring stream characteristics.



Map 3-3 -- Stream Channel Types in the Middle Tualatin-Rock Creek Watershed.

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Table 3-8. Stream drainage characteristics of subwatersheds of the Middle Tualatin-Rock Creek watershed. (Based on GIS analysis using Tualatin River Watershed Information System).

Subwatershed	Area (miles^2)	Stream Length (miles)	Drainage Density (mi/mi^2)
Abbey Creek	4.81	11.15	2.32
Baker Creek	3.17	5.43	1.71
Beaverton Creek	4.15	4.86	1.17
Bethany Creek	3.13	6.87	2.19
Blooming Creek	4.28	12.74	2.98
Bronson Creek	4.95	9.92	2.00
Burris Creek	6.71	15.25	2.27
Butternut Creek	5.08	7.86	1.55
Cedar Mill Creek	3.70	9.02	2.44
Christensen Creek	9.95	28.01	2.82
Davis Creek	5.73	15.37	2.68
Dawson Creek	3.87	4.20	1.09
Gordon Creek	4.11	9.60	2.34
Heaton Creek	6.26	17.74	2.83
Holcomb Creek	4.82	8.62	1.79
Jackson Bottoms	4.11	11.03	2.68
Jackson Reservoir	6.76	12.41	1.84
Jackson Slough	4.86	11.34	2.33
Jaquith Creek	3.35	9.79	2.92
Johnson Creek	3.81	7.18	1.88
Johnson Creek (S)	5.32	8.83	1.66
Lower Beaverton Cr	3.48	7.22	2.07
Lower Middle Tualatin	2.35	3.41	1.45
McFee Creek	11.80	30.31	2.57
Middle Rock Cr	4.55	6.73	1.48
Middle Tualatin	4.05	12.73	3.14
MT-Cornelius	5.12	9.01	1.76
Reedville Cr	1.82	2.39	1.31
Rock Creek	4.12	7.41	1.80
Rosedale Creek	5.30	9.36	1.77
Upper Beaverton-Golf Cr	8.58	11.22	1.31
Upper Rock Creek	9.40	24.00	2.55
Willow Creek	5.11	8.00	1.57
Watershed Total	168.61	359.01	2.13

Table 3-9. OWEB channel types in the Middle Tualatin-Rock Creek watershed.

Channel Type	Description	Length (Miles)	% Type	Confirmed Fish Use	LWD	Fine Sed	Coarse Sed	Peak flow
AF	Alluvial Fan	0.45	0.14%	27.1%	Very High	Mod-High	High	Mod-High
FP2	Large to Medium Floodplain	111.73	34.48%	65.8%	High	Moderate	High	Low
FP3	Small Floodplain	47.89	14.78%	5.0%	High	Mod-High	High	Low
LC	Low Gradient Confined Channel	3.16	0.98%	15.6%	Low-Mod	Low	Moderate	Low-Mod
LM	Low Gradient Moderately Confined	26.21	8.09%	18.5%	Mod-High	Mod-High	Mod-High	Moderate
MC	Moderate Gradient Confined	12.83	3.96%	36.4%	Low	Low	Moderate	Moderate
MH	Moderate Gradient Headwaters	5.03	1.55%	25.0%	Moderate	Moderate	Mod-High	Moderate
MM	Moderate Gradient Moderately Confined	16.98	5.24%	25.4%	High	Moderate	Mod-High	Moderate
MV	Moderate Gradient V-shaped	41.40	12.78%	33.9%	Moderate	Low	Moderate	Moderate
SV	Steep Gradient V-Shaped	52.36	16.16%	13.5%	Moderate	Low	Low-Mod	Low
VH	Very Steep Headwaters	5.94	1.83%	14.0%	Moderate	Low	Low-Mod	Low
Total		323.99	100.00%	35.1%				

Most headwater streams in the Tualatin and Chehalem Mountains have "steep narrow valley channels" (OWEB SV classification). This channel type comprises 15% of total channel length in the watershed. This channel type is a sediment source region. In the Middle Tualatin-Rock Creek watershed, this channel type has a variety of potential substrates. Gravel or larger substrates generally dominate these channel types. However, many of the first order streams of this channel type have substantial inputs of fine, colluvial sediments.

Downstream of the headwater reaches, most streams transition into "moderately steep, narrow valley channels" (OWEB type MV). This channel type represents about 13% of total stream length within the watershed. Although they are loosely termed as transport reaches, the narrow canyon walls provide a ready source of debris flows and colluvial sediment to the stream channel. Stream channels are confined by these channel walls and thus tend to have a low sinuosity.

On middle reaches of some streams, the canyons widen and the channel type often changes to "moderate gradient confined channel" (OWEB type MC). Reaches with this channel type tend to be rather short, and Type MC streams represent only 4% of total watershed stream length. Another transport reach, these reaches are less susceptible to direct colluvial inputs than are higher gradient streams. These reaches also have low sinuosity, as hillslopes continue to constrain the channel.

As stream gradient decreases, MV and MC channels tend to grade into "moderate gradient, moderately confined channels" (Type MM) and "low gradient, moderately constrained channels" (Type LM). Together, these channel types represent 13% of watershed stream length. In these channels, both deposition and streambank erosion can be important, depending on factors such as sediment supply.

The moderate gradient channel types provide a transition between coarse, gravelly substrates and fine silts and clays. Although the moderate gradient channel types generally are dominated by gravel, clay-dominated substrate is found along several streams, including Johnson Creek (North) and streams draining Cooper Mountain (USA unpublished data, 2000).

In the lower portions of the watershed, low gradient streams with broad floodplains (OWEB types FP2 and FP3) dominate the channel forms. Large and medium streams are included under the FP2 type designation, while smaller tributaries are designated as FP3. Together, the floodplain types comprise 50% of the total stream length in the watershed. Under natural conditions these streams generally have a high sinuosity and are dominated by depositional processes. Sediments produced in the source and transport reaches are likely to be deposited for long periods of time in the floodplain type reaches, where they will affect channel morphology and substrate characteristics. Typically, clay and silt substrates dominate the floodplain channel types. Streambank erosion is an important process in these reaches. Where bare soils occur near channels, sheet, rill, and gully erosion are also important contributors of sediments to streams.

3.1.3.2 Effects of human influences upon stream morphology

Anthropogenic influences have had several effects upon stream morphology. Most notably, channelization has straightened naturally sinuous streams in the alluvial portion of the watershed. This has reduced floodplain and riparian area, and resulted in a general loss of habitat for aquatic and riparian-dependent species. Additionally, channel straightening reduces stream length, thereby increasing local stream gradient and potentially increasing downcutting. In the Tualatin subbasin, Ward (1995) attributed the lack of undercut banks to the effects of channelization.

Riparian buffers along many of the streams in the watershed have been diminished. In several areas, including the Tualatin River mainstem and Holcomb Creek, thin riparian buffers appear to be associated with accelerated bank erosion. When sediments produced by such erosion are redeposited, they often change stream morphology by embedding gravels and contributing to pool fill. Clearing of riparian vegetation also removes the amount of wood and other roughness elements available to the stream, thus limiting the stream's ability to develop pools.

3.1.4 Water quality

3.1.4.1 Beneficial uses

The beneficial uses of water in the Tualatin subbasin include:

Public domestic water supply;
Private domestic water supply;
Industrial water supply;
Irrigation;
Livestock Watering;
Anadromous fish passage;
Salmonid fish rearing;
Salmonid fish spawning;
Resident fish and aquatic life;
Wildlife and hunting;
Fishing;
Boating;
Water contact recreation;
Aesthetic quality; and
Hydropower.

The water quality parameters that these beneficial uses are dependent on include water temperature, nutrient levels, suspended sediment/turbidity levels, dissolved oxygen and bacterial levels.

3.1.4.2 General indicators of water quality

Generally speaking, the best water quality occurs in headwater streams within the watershed. Streams are relatively well shaded and cold. However, headwater streams within the Middle Tualatin-Rock Creek watershed have less continuous forest cover than is the case for watersheds further west in the Tualatin subbasin. Temperature monitoring indicates that streams rapidly warm as they descend from the Tualatin Mountains. Other water quality problems also develop quickly in this area. Although the most severe water quality problems occur south of West Union Road, field observations and monitoring data indicate substantial degradation of water quality prior to this point. This indicates that rural issues need to be dealt with to achieve water quality objectives. Although monitoring is less intensively performed in the rural Chehalem Mountain subwatersheds, it is likely that many water quality problems here also develop prior to reaching the valley floor.

The most severe water quality issues develop in urban portions of the watershed, particularly Rock Creek and its tributaries. These urban portions of the watershed are subject to thermal loadings and polluted runoff from impervious surfaces.

To address water quality problems, ODEQ, USA, TVID, and the Oregon Graduate Institute (OGI) are conducting a cooperative study of pollution sources and water quality in the Tualatin subbasin (Table 3-10). Over the course of the monitoring, the ODEQ water quality index (WQI) has been determined for numerous sites in the Middle Tualatin-Rock Creek watershed. Water quality at all sites has been found to range from poor to very poor. By far, the worst water quality was found during 1991 and 1992 at the Burris Creek and Christensen Creek monitoring sites. (Average WQI at each site was 19 and 24 out of a possible 100, respectively). Due to lack of subsequent monitoring, however, it is uncertain whether these measurements represent current conditions. Among recently monitored sites, the worst WQI measurements have occurred on South Johnson Creek at Glenbrook and on Beaverton Creek (Aroner 1998).

During monitoring efforts performed between the 1986 and 1995 water years, ODEQ and USFWS computed WQI for streams on the lower Willamette Basin (ODEQ 2000). Three streams in the Middle Tualatin-Rock Creek watershed were included in these computations. These included two sites along the Tualatin River, Rood Bridge, and at Highway 210 (Scholls), and Beaverton Creek at 216th Avenue (Orenco). Using the WQI criteria, ODEQ found water quality to be poor at the Rood Bridge site, and very poor at the Scholls and Orenco sites. However, water quality at each of these sites improved significantly over this time period. ODEQ attributed this improvement in water quality to improved management practices. In particular, the removal of phosphorus from the Rock Creek WWTP effluent was credited with large improvements in water quality at the Scholls site.

Table 3-10. USA tributary water quality monitoring sites in the Middle Tualatin-Rock Creek watershed. Adapted from Aroner 1998.

USA location code	EPA Code	Stream	Location	Samples per year																	
				1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3820012	3820015	Rock Creek	Hwy 8	1	1	1	1	1	1	17	15	12	34	32	68	104	77	39	40	36	25
3820047		Rock Creek	Quatama											25	26	26	32	39	40	5	
3820056		Rock Creek	Hwy 216																	30	24
3820078		Rock Creek	Rock Creek Blvd											25	25						
3820092		Rock Creek	West Union										19	13	16						
3821012		Beaverton Creek	216th										27	25	26	26	32	39	40	35	25
3821050		Beaverton Creek	170th											25	25	25		9		25	12
3821059		Beaverton Creek	Millikan Blvd											25				7			12
3821062		Beaverton Creek	Millikan Way															9			
3822002		Butternut Creek	River Road												25	25					
3822014		Butternut Creek	229th											25							
3822033		Butternut Creek	192nd											25							
3822070		Butternut Creek	Bany															4	13	3	
3823009		Cedar Mill Creek	d/s Jenkins Rd																	23	12
3823011		Cedar Mill Creek	Jay Street											25	25	25		9			
3823035		Cedar Mill Creek	119th										27	25							
3824001		Bronson Creek	205th											25				32	24	21	12
3824015		Bronson Creek	Walker Road															32	19	22	11
3824018		Bronson Creek	185th															31	27	22	12
3824020		Bronson Creek	Cornell Road															32	24	22	12
3824032		Bronson Creek	West Union/158th											25					19	22	12
3824050		Bronson Creek	143rd Road															30	19	22	12
3824071		Bronson Creek	Laidlaw Road															32			
3824072		Bronson Creek	Saltzman Road																14	22	12
3825004		Willow Creek	185th & Baseline											25				9			
3825023		Willow Creek	Cornell & 158th											25							
3826001		N Johnson Creek	Walker Road											25							
3826010		N Johnson Creek	Butner Road											25							
3826024		N Johnson Creek	Leahy Road											25							
3827002		S Johnson Creek	Hwy 8											25	25						
3827011		S Johnson Creek	Glenbrook Road												25			31	40	28	12
3827014		S Johnson Creek	Davis Road															31	40	28	8
3827024		S Johnson Creek	Hart Road															31	40	28	12
3827026		S Johnson Creek	Bridlehills/Hart											25	25						
3829007		Hall Creek	110th & Canyon											25	25	25				25	12
3830018		Christensen Creek	Hwy 219											1	25	25	7				
3831005		Burris Creek	Hwy 219											1	25	25	7				
3854004		T-Beaverton Creek	Shaw near 170th														23				
3859001		Bannister Creek	Laidlaw Road																24	22	12
3859010		Bannister Creek	124th																		12
3850006		Dawson Creek	Brookwood Road																		12
3850017		Dawson Creek	Airport RC																		8
3850023		Dawson Creek	Shute Road																		12

Non USA monitoring sites

Station	Agency	Stream	Location	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3804012	MUL	Abbey Creek	d/s Horse Ranch												2	5	9	8	7	7	6
3804020	MUL	Abbey Creek	u/s Horse Ranch																	5	6
3808010	MUL	Abbey Creek trib.													2	5	8				
3811010	ODA	McFee Creek	Hwy 219															12	13	12	13
3813001	ODA	Baker Creek	Hwy 210															12	13	12	13
3820145	MUL	Rock Creek													2	5	9	8	7	7	6
3820165	MUL	Upper Rock Creek													2	5	8				
3823045	POR	Cedar Mill Creek	Cornell											8	5	3		7	12	12	12
3824072	MUL	Bronson Creek	Saltzman															8	7	7	6
3830018	ODA	Christensen Creek	Hwy 219															12	13	12	13
3831005	ODA	Burris Creek	Hwy 219															12	13	12	13
402147	ODEQ	Rock Creek	Hwy 8							43	26	9	3		1						
402150	ODEQ	Beaverton Creek	216th	1			1	1		36	28	9	9	15	14	9	14	13	12	9	11

3.1.4.3 Macroinvertebrate sampling in the Middle Tualatin-Rock Creek watershed

Macroinvertebrate surveys provide an excellent indicator of water quality, sedimentation, habitat diversity, and biodiversity. In connection with monitoring efforts by USA, Alaska Biological Research, Inc. (ABR) conducted macroinvertebrate surveys in streams of the Tualatin subbasin (Cole 2000). Macroinvertebrates were sampled at 44 sites, 22 of which were within the Middle Tualatin-Rock Creek watershed. These included 14 urban sites in Rock Creek and its tributaries, as well as Butternut Creek. Additionally, eight rural sampling sites were chosen on Christensen, Burris, Heaton and Baker creeks. Generally speaking, the most degraded conditions were found in the urban streams. Within the watershed, the greatest degree of impairment was found at the Middle Beaverton Creek and lower Johnson Creek (South) sites. Species diversity and the proportion of pollution-intolerant species were much lower at this site than at the other sites.

Of additional note is the relatively impaired condition of macroinvertebrate populations on upper Rock Creek. Although this stream is classified as an urban stream, the upper site is well above the urban growth boundary and is in a zone dominated by rural land uses. The fact that this site scored relatively poorly indicates that issues involved with rural land uses must be dealt with to improve conditions on Rock Creek.

Although rural streams appeared to be less impaired than the urban streams, few sites within the watershed had macroinvertebrate communities comparable to the best sites, which were on Upper Dairy Creek, upper Chicken Creek, and Roaring Creek. The exception was Burris Creek, which scored slightly below these reference streams. Christensen, Baker and Heaton creeks scored substantially lower than did rural streams outside the watershed. The relatively poor performance of these streams, together with upper Rock Creek, may reflect the fragmented land use patterns, together with the natural erodibility of the steep lands within these regions.

3.1.4.4 Streams on the 303(d) list

The Middle Tualatin-Rock Creek watershed has the largest extent of 303(d) listed streams of any watershed in the Tualatin subbasin. An estimated 103 stream miles in this watershed are on the ODEQ 303(d) water quality limited list (Map 3-4). These streams are listed in Table 3-11. The most common criteria for listing include high levels of bacteria and high water temperature. Low dissolved oxygen, poor fish diversity, and high levels of chlorophyll *a* are also criteria for listing in some streams. Draft Total Maximum Daily Load allocations (TMDLs) have been developed for temperature, bacteria, dissolved oxygen, and chlorophyll *a*. Streams will be removed from the 303(d) list for these parameters once the TMDLs are fully in place. As of December, 2000, ODEQ tentatively planned to have the allocations in place by mid-2001 (G. Geist, ODEQ, personal communication).

3.1.4.5 Parameters of concern

3.1.4.5.1 Bacteria

E. coli is an important indicator of inputs of fecal bacteria to stream systems. High bacteria levels can cause disease, and restrict the beneficial uses of water for humans, such as water contact recreation. Studies by USA indicated that elevated bacteria levels in rural areas are largely the result of livestock farms with inadequate manure storage, manure management, or grazing management (Aroner 1998). It is possible that poorly placed septic systems may also contribute to the problem.

Bacterial impairment was widespread within the watershed. Generally, bacterial concentrations were the highest during the May-October sampling season (Table 3-12). The degree of bacterial impairment was the greatest on Johnson Creek South near Glenbrook Road, Cedar Mill Creek at Cornell Road, Bronson Creek at Kaiser Road, Hall Creek at Canyon Road, and Baker Creek at Highway 210. Additionally, the Cedar Mill Creek site was severely impaired by bacteria during the winter sampling season.

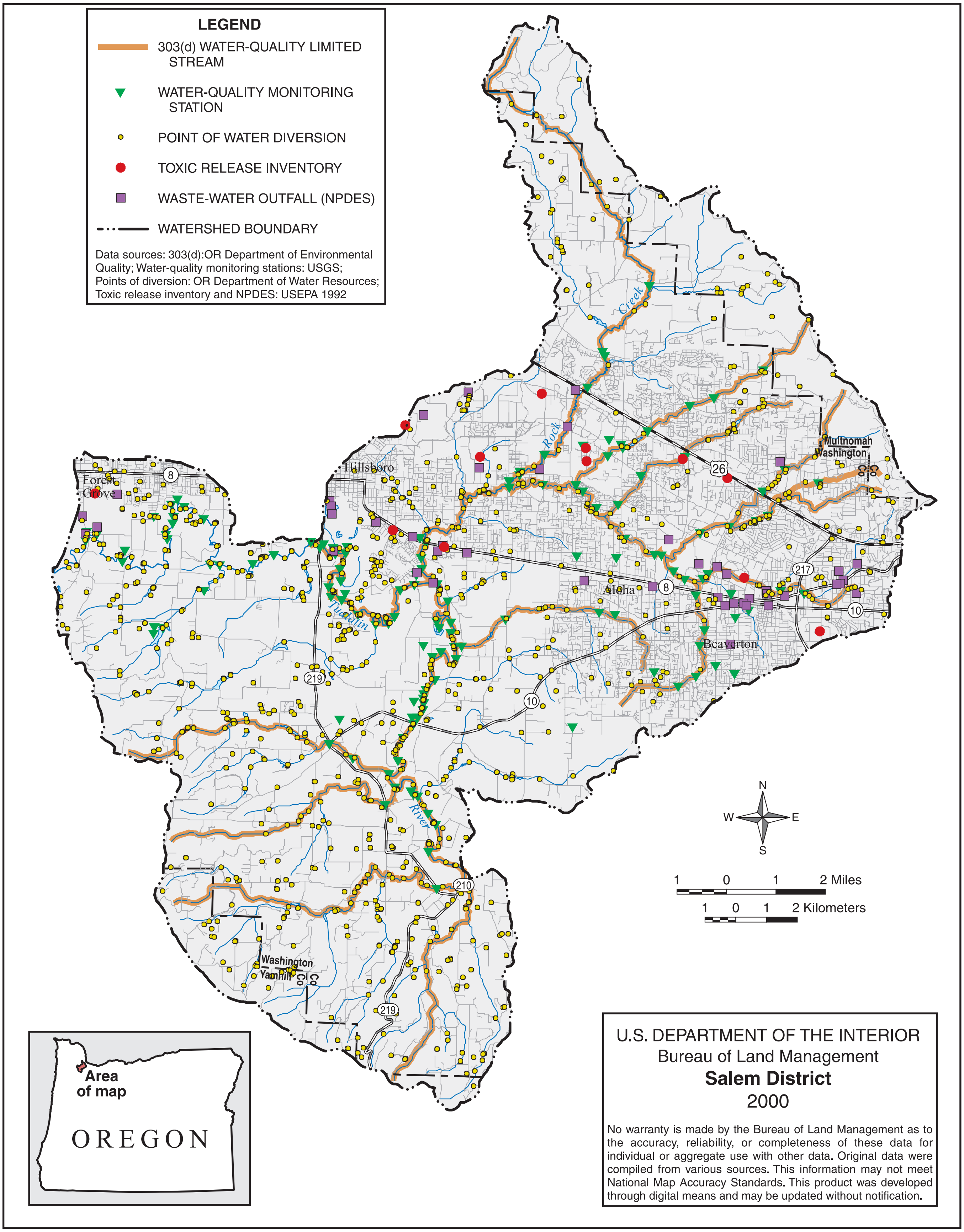
3.1.4.5.2 Dissolved oxygen

High levels of dissolved oxygen are essential for most cold-water aquatic species. Dissolved oxygen levels are affected by temperature, aquatic growth, nitrification, and oxygen demand imposed by decomposition of organic material. High water temperature reduces the amount of dissolved oxygen that can be stored in the water column. Decomposition of organic matter consumes oxygen, leading to low levels of instream dissolved oxygen[19]. As gases are often most easily transferred in turbulent waters, lack of turbulence, with accompanying pool stratification, can also lead to low dissolved oxygen levels.

In the past, high ammonia levels contributed to decreased dissolved oxygen levels. Oxygen was required to convert the ammonia to nitrates (that is, through nitrification). Additionally, ammonia posed a toxicity problem to aquatic life. These problems have been greatly reduced since the implementation of upgraded wastewater treatment processes by USA. Presently, ammonia is considered a minor contributor to dissolved oxygen reductions within the watershed (ODEQ 2000).

During recent studies related to TMDL establishment, ODEQ determined that high temperature and SOD were the primary contributors to dissolved oxygen deficits in streams in the watershed. In some cases, the other factors were potentially significant contributors, particularly in urban streams. The lowest dissolved oxygen levels were found on upper Beaverton Creek downstream of downtown Beaverton, and on Johnson Creek (South) near its confluence with Beaverton Creek. Dissolved oxygen levels improved downstream on Beaverton Creek (ODEQ 2000).

Different levels of dissolved oxygen (D.O.) are needed for successful spawning and fish rearing. Higher dissolved oxygen levels are necessary for successful fish spawning than for rearing. This is because high interstitial levels of dissolved oxygen are necessary to facilitate oxygen transfer and waste removal in gravel redds.[20] Where this oxygen supply is impaired, decreased survival, deformities, and altered hatch timing often result (Bjornn and Reiser 1991). Within the Middle Tualatin-Rock Creek watershed, portions of McFee and Rock creeks support spawning of winter steelhead trout. Additionally, several streams support spawning of resident



Map 3-4 -- Water Quality and Water Supply for the Middle Tualatin-Rock Creek Watershed.

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Table 3-11. Streams on the 1998 ODEQ 303(d) list.

Stream	Location	Parameter	Affected Beneficial Use	Period	WQ standard
Beaverton Creek	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	406 *E. coli*
		Biological Criteria	Fish		30 IBI
		Dissolved Oxygen	Cool-water aquatic	May-October	6.5 mg/L
		Temperature	Salmonid rearing	May-October	17.8 C
Bronson Creek	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	406 *E. coli*
		Biological Criteria	Fish		30 IBI
		Chlorophyll a		May-October	15 ug/L
		Dissolved Oxygen	Cool water aquatic	May-October	6.5 mg/L
		Temperature	Salmonid rearing	May-October	17.8 C
Burris Creek	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	61 enterococcus
		Chlorophyll a		May-October	15 ug/L
		Dissolved Oxygen	Cool water aquatic	May-October	6.5 mg/L
		Temperature	Salmonid rearing	May-October	17.8 C
Cedar Mill Creek	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	400 fc
		Biological Criteria	Fish		30 IBI
		Temperature	Salmonid rearing	May-October	17.8 C
Christensen Creek	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	61 enterococcus
		Dissolved Oxygen	Cool water aquatic	May-October	6.5 mg/L
Hall Creek	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	61 enterococcus
		Dissolved Oxygen	Cool water aquatic	May-October	6.5 mg/L
Heaton Creek	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	61 enterococcus
Johnson Creek N	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	400 fc
		Temperature	Salmonid rearing	May-October	17.8 C
Johnson Creek S	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	406 *E. coli*
		Biological Criteria	Fish		30 IBI
		Dissolved Oxygen	Cool water aquatic	May-October	6.5 mg/L
		Temperature	Salmonid rearing	May-October	17.8 C
McFee Creek	Mouth to Headwaters	Dissolved Oxygen	Cool water aquatic	May-October	6.5 mg/L
		Temperature	Salmonid rearing	May-October	17.8 C
Rock Creek	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	
		Biological Criteria	Fish		30 IBI
		Chlorophyll a		May-October	15 ug/L
		Dissolved Oxygen	Cool water aquatic	May-October	6.5 mg/L
		Temperature	Salmonid rearing	May-October	17.8 C
Tualatin River	Mouth to Dairy Creek	Bacteria	Water contact recreation	Year round	406 *E. coli*
		Temperature	Salmonid rearing	May-October	17.8 C
Willow Creek	Mouth to Headwaters	Bacteria	Water contact recreation	Year round	400 fc
		Dissolved Oxygen	Cool water aquatic	May-October	6.5 mg/L

Table 3-12. Percent of time water quality was exceeded at monitoring stations in the Middle Tualatin-Rock Creek watershed, 1998. Source: Aroner 1999.

USA location code	EPA Code	Stream	Location	Year Round Temperature	Year Round Dissolved Oxygen	Year Round pH	Year Round Bacteria	Year Round Chl a	Summer Temperature	Summer Dissolved Oxygen	Summer pH	Summer Phosphorus	Summer Bacteria	Summer Ammonia	Summer Chl a	Winter Dissolved Oxygen	Winter Bacteria
3820012	3820015	Rock Creek	Hwy 8	*10%*	*10%*	0%	*25%*	0%	*25%*	*25%*	0%	**100%**	*10%*	0%	0%	0%	*10%*
3820047		Rock Creek	14.5			0%		0%			0%				0%		
3821012		Beaverton Creek	216th	*10%*	*25%*	0%	*25%*	1%	**50%**	*25%*	0%	**100%**	*10%*	0%	1%	0%	*25%*
3821050		Beaverton Creek	170th	*25%*	*25%*	0%	*10%*	*10%*	**50%**	**50%**	0%	**100%**	0%	**50%**	*10%*	*10%*	*25%*
3823009		Cedar Mill Creek	Cornell	*10%*	0%	0%	**50%**		*25%*	0%	0%	**50%**	**50%**	0%		0%	**50%**
3824001		Bronson Creek	205th	*25%*	*10%*	0%	*10%*	1%	*25%*	*25%*	0%	**100%**	*25%*	0%	*10%*	0%	0%
3824015		Bronson Creek	Walker Road	*25%*	*25%*	0%	*10%*	*25%*	**50%**	**50%**	0%	**100%**	*10%*		*10%*	0%	0%
3824018		Bronson Creek	185th	*25%*	1%	1%	*10%*	*25%*	**50%**	*10%*	10%	**75%**	*10%*	1%	*25%*	0%	*10%*
3824020		Bronson Creek	Park	1%	*10%*	0%	*10%*	0%	*10%*	*10%*	0%	**100%**	*10%*		0%	0%	0%
3824032		Bronson Creek	West Union/158th	1%	*10%*	0%	*25%*	0%	*10%*	*10%*	0%	**100%**	*25%*		0%	0%	0%
3824050		Bronson Creek	Kais	0%	*25%*	0%	*25%*	*10%*	0%	**50%**	0%	**100%**	**50%**		*10%*	0%	0%
3824072		Bronson Creek	Saltzman Road			0%		0%				**100%**			0%		
3827011		S Johnson Creek	Glenbrook Road	*10%*	*25%*	0%	**50%**	1%	**50%**	**75%**	0%	**100%**	**75%**	**50%**	1%	*10%*	*25%*
3827014		S Johnson Creek	Davis Road	*25%*	*25%*	0%	*25%*	*25%*	**50%**	**75%**	0%	**100%**	*25%*	0%	*10%*	*10%*	*10%*
3827024		S Johnson Creek	Hart Road	*10%*	1%	0%	*25%*	*10%*	*25%*	*10%*	0%	**100%**	*25%*	0%	*10%*	0%	*10%*
3829007		Hall Creek	110th & Canyon	*10%*	1%	0%	*25%*	0%	*10%*	*10%*	0%	**100%**	**50%**		0%	0%	*10%*
Non USA monitoring sites																	
Station	Agency	Stream	Location														
3804012	MUL	Abbey Creek	d/s Horse Ranch			0%		0%			0%	**100%**			0%		
3804020	MUL	Abbey Creek	u/s Horse Ranch			0%		0%			0%	**100%**			0%		
		Beaverton Creek	216th (DEQ)	*10%*		0%	*10%*	0%	*25%*	*25%*	0%	**100%**	*25%*	*10%*	0%		0%
3808010	MUL	Abbey Creek trib.															
3811010	ODA	McFee Creek	Hwy 219	*10%*	*10%*	0%	*25%*		*10%*	*10%*	0%	**50%**	*25%*	**75%**			
3813001	ODA	Baker Creek	Hwy 210	*10%*	0%	1%	**50%**		*10%*	0%	1%	**50%**	**50%**	**75%**			
3830018	ODA	Christensen Creek	Hwy 219	1%	**50%**	0%	*25%*		*10%*	**50%**	0%	**100%**	*25%*	**75%**			
3831005	ODA	Burris Creek	Hwy 219	1%	*25%*	0%	*25%*		*10%*	*25%*	0%	**100%**	*10%*	**75%**			

Note: Aroner (1999) reported these monitoring data in terms of an exceedance range: 0, 0-25%, 25-50%, 50-75%, 75-100%, and 100%. Numbers reported here represent the lower extent of that range. Numbers given in bold represent severe stream impairment. Numbers given in italics represent moderate stream impairment.

cutthroat trout. Thus, these streams should receive special attention to ensure their ability to maintain high dissolved oxygen levels during the appropriate seasons.

Within the watershed, most recorded dissolved oxygen levels below federal standards occurred between May and October, when salmonid rearing was the most likely beneficial use to be affected. Only the sites on Beaverton Creek and South Johnson Creek recorded low dissolved oxygen levels during the November to April period (Table 3-12). Although spawning of steelhead trout would not be affected on these streams, cutthroat trout spawning could potentially be affected on South Johnson Creek.

3.1.4.5.3 Phosphorus

In many natural aquatic systems, phosphorus is the limiting nutrient to aquatic growth. When streams are enriched by phosphorus inputs, it can lead to algal blooms, decreased dissolved oxygen concentrations, fish kills, and bad odors.

Phosphorus is a major parameter of concern within the Middle Tualatin-Rock Creek watershed. Phosphorus levels exceed TMDL standards in monitored streams throughout the watershed (Table 3-12). During 1997, the highest median May-October phosphorus concentration occurred on Bronson Creek at Saltzman, Rock Creek at Highway 8, and Beaverton Creek at 216th Avenue. The highest recorded maximum phosphorus measurements, however, occurred along rural portions of Bronson Creek. The Bronson at Kaiser and Bronson at West Union sites had recorded maximum phosphorus concentrations more than double those of any other site (Aroner 1998, TRFMTC 1999).

3.1.4.5.3.1 Potential sources of phosphorus

Both urban uses and agriculture are important sources of phosphorus to aquatic systems. Conversion of forest to these land uses generally results in increased fertilizer use and soil destabilization (Wolf 1992). Where these fertilizers and soils are able to reach an aquatic system, they often transport a phosphorus load to the stream.

Urban and rural residential land uses, as well as agriculture, often implement practices that contribute organic material to streams. Contributions of easily decomposed organic matter (e.g. manure, straw, leaves, grass clippings) increase the sediment oxygen demand. This can lead to anaerobic conditions in the stream bottom during the summer, which tends to chemically mobilize phosphorus that has been adsorbed to iron and aluminum oxides in sediment.

3.1.4.5.4 Stream temperature

In the Tualatin Basin, concern over water temperature generally relates to the fitness of streams to provide suitable conditions for cold-water aquatic species, such as salmonids. For most streams in the basin, the salmonid rearing/migration standard of 17.8 C (64∞ F) is applied. This standard is applied based on a seven-day moving average of daily maximum temperatures (OAR 340-41-006).

In conjunction with monitoring efforts, USA and ODA measured water temperature at many urban and rural sites within the watershed (Table 3-12). In 1997, most monitored sites routinely exceeded the 17.8 C standard during the May to October period (Aroner 1998). This standard was most frequently exceeded at the Beaverton Creek sites, on South Johnson Creek between Davis and Glenbrook Road, and on Bronson Creek between 185th and Walker Road.

The Tualatin Basin Watermaster maintains constant summer temperature measurements at three mainstem Tualatin River sites in the watershed. These monitoring sites are located at Golf Course Road (RM 51.5), Rood Bridge (RM 38.4), and Farmington (RM 33.3). The first two sites are upstream of Rock Creek. The Rood Bridge site reflects inputs from Dairy Creek, while the Farmington Bridge includes inputs from Rock Creek and the Rock Creek WWTP. In 1999, the Golf Course Road site did not record a 7-day running mean maximum temperature exceeding the 17.8 C standard. This standard was exceeded on two days at the Rood Bridge site, and on 49 days at Farmington (TRFMTC 2000).

In 1999, ODEQ conducted an intensive monitoring study of several streams within the Tualatin subbasin, including Rock Creek. This study found that all sampled sites on Rock Creek and its tributaries exceeded the 17.8 C water temperature standard at some point over the summer sampling period. The maximum 7-day average temperature ranged from 17.9 C at the Rock Creek at Cornelius Pass Road site to 23.5 C at Bronson Creek near its mouth. In general, the length of time that stream temperature exceeded 17.8 C increased downstream. However, the headwater Rock Creek site (at 220th) had a longer period in excess of 17.8 C than any other site north of Highway 26. An examination of the graph at this site indicated high fluctuation in temperature. Conversations with ODEQ personnel indicated that observed high temperature measurements were a result of low water volume coupled with clearcuts upstream of the monitoring site (Rob Burkhart, ODEQ, personal communication 2000).

Among the monitored sites, Bronson Creek and Beaverton Creek displayed the greatest impairment due to temperature. Over the course of the monitoring period, stream temperatures at each of these sites exceeded 21.1 C for more than 200 hours. The longest total duration of excess, 419 hours, occurred on Beaverton Creek at 185th. Two Rock Creek sites, at Highway 8 and at Amberwood, also had recorded temperatures exceeding 21.1 C. Additionally, these streams, along with Willow Creek, spent more than 1,000 hours of the total monitoring period above 17.8 C.

In many reaches, streams are exposed to large amounts of summer heating because of impaired riparian canopy. Recent surveys conducted in connection with the Watersheds 2000 effort found that the vast majority of Rock Creek and its tributaries had riparian buffers less than 25 feet in width (USA, unpublished Watersheds 2000 data). Aside from headwater streams, most surveyed streams had less than 60% canopy coverage.

Analysis of RLIS Lite digital aerial photography showed that substantial portions of rural subwatersheds lacked riparian vegetation and/or provided insufficient shade. Many tributary reaches lacked riparian vegetation. The mainstem Tualatin River, on the other hand, usually had a forested buffer, but the river was often too wide to provide complete shade. Subwatersheds where shading seemed exceptionally low were Blooming Creek, Middle Tualatin-Jackson Bottom, and Christensen Creek. Lower portions of Burris Creek had low shading potential, but upper portions were outside the photo coverage.

3.1.4.5.5 Other parameters of concern

Through evaluation of 1993 monitoring data, the United States Geologic survey (1998) found Beaverton Creek at Cedar Hills Boulevard to be more contaminated by organic compounds than any other sampled site. It was noted that USEPA Tier two screening values were exceeded for 21 out of 22 chemicals. These chemicals covered a wide spectrum of pollutants, including heavy metals, pesticides, polyaromatic hydrocarbons (PAH), phenols, and phthalates. This high level of pollution appeared to have severe biological effects. Few fish were found at this location, and half of the fish that were found had physical abnormalities, including white tumors. Additionally PCBs were found in fish tissue at this site.

3.1.4.6 Water quality trends

The USA study, (Aroner 1998), found several notable water quality trends in the Tualatin Basin. Those shared by streams within the Middle Tualatin-Rock Creek watershed include:

- Declining phosphorus (May-October, all streams)
- Increasing temperature (May-October, Baker, Christensen, Rock, Beaverton)
- Decreasing chemical oxygen demand (Rock)
- Decreasing ammonia concentrations (November-April, all streams except Burris and Baker)

Baker Creek displayed a trend for increasing ammonia concentration.

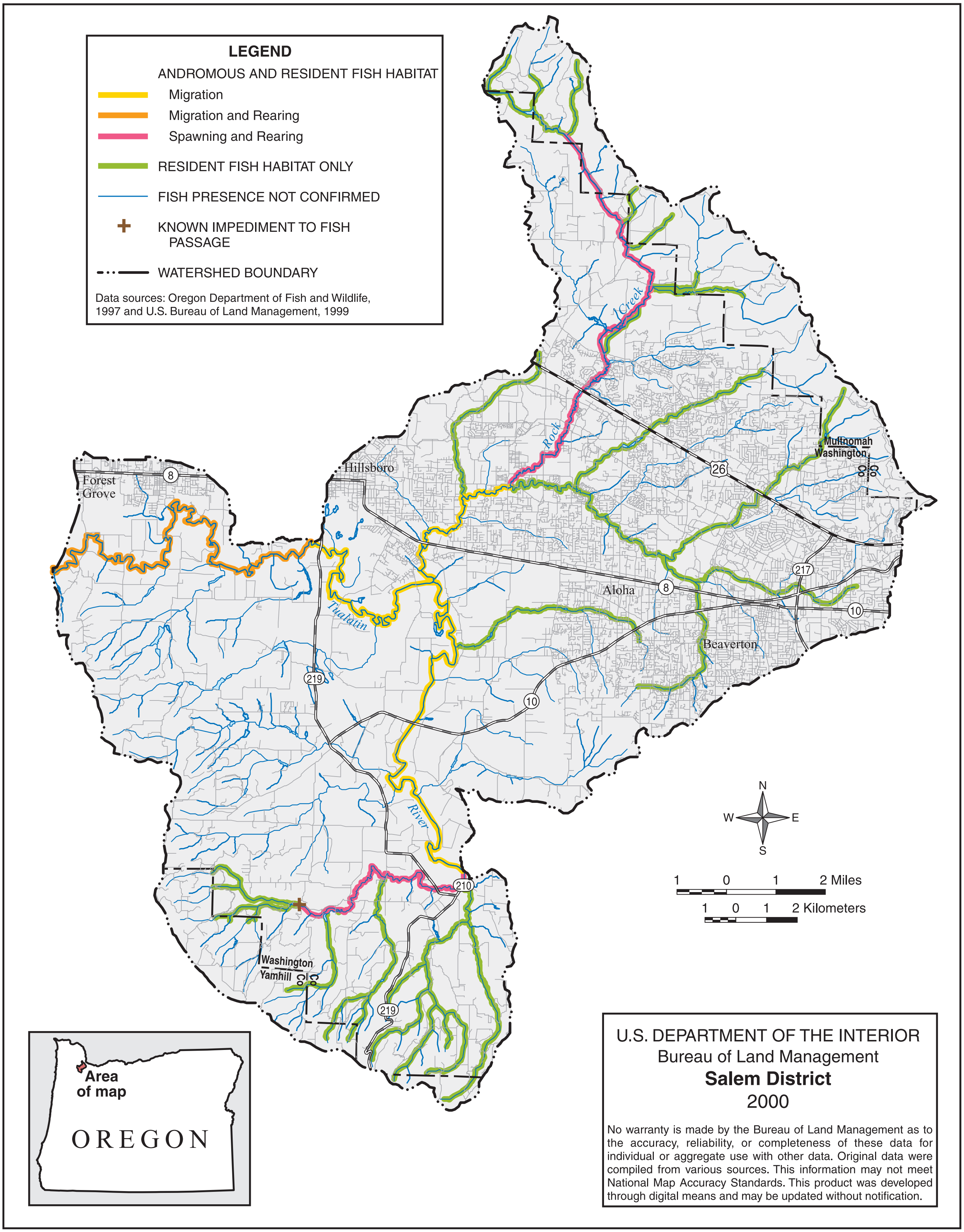
3.1.5 Aquatic species and habitat

3.1.5.1 Cold-water fish

3.1.5.1.1 Distribution and life history

Rock Creek and McFee Creek are considered to contain important habitat for spawning and rearing of anadromous steelhead (Map 3-5). Additionally, these streams and their tributaries support resident cutthroat trout and coho salmon. Cutthroat trout and steelhead trout are native to the system. Coho salmon were first introduced in the 1920’s and have since become naturalized (ODEQ and USA 1982). Common native non-salmonids include dace and sculpin. Pacific lamprey and brook lamprey are also present. A list of fish species within the watershed is given in Table 3-13.

Steelhead trout are considered to spawn and rear in Rock Creek between the headwaters and Beaverton Creek, and in McFee Creek below Finnegan Hill Road (ODFW database, 1999). Additionally, the mainstem Tualatin River and lower Rock Creek provide migratory corridors for these fish. The mainstem Tualatin River above Dairy Creek is considered to provide some steelhead rearing opportunities (ODFW 1999).



Map 3-5 -- Fish Distribution in the Middle Tualatin-Rock Creek Watershed.

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Table 3-13. Anadromous and resident fish known to inhabit the Middle Tualatin-Rock Creek watershed.

Anadromous Fish		Resident Fish	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Coho salmon	*Oncorhynchus kisutch*	Cutthroat trout	*Oncorhynchus clarki clarki*
Steelhead trout	*Oncorhynchus mykiss*	Western brook lamprey	*Lampetra richardsoni*
Pacific lamprey	*Entosphenus tridentatus*	Reticulate sculpin	*Cottus perplexus*
		Largescale sucker	*Catostomus platyrhynchus*
		Redside shiner	*Richardsonius balteatus*
		Speckled Dace	*Rhinichthys osculus*
		Northern pikeminnow	*Ptychocheilus oregonensis*
		Largemouth bass	*Micropterus salmoides*
		Bluegill	*Lepomis macrochirus*
		Warmouth	*Lepomis gulosus*
		Yellow perch	*Perca flavescens*
		Crappie	*Pomoxis sp.*

Although survey data are limited, it is likely that cutthroat trout spawn in Rock Creek and its tributaries above Abbey Creek, as well as McFee Creek (ODEQ 2000). Rearing of cutthroat trout occurs in lower Rock Creek, Beaverton Creek, Cedar Mill Creek, and the Tualatin mainstem.

Additionally, the Tualatin River provides a migratory corridor for chinook salmon. These fish infrequently utilize the Tualatin subbasin.

Winter run steelhead trout migrate into the Willamette basin between February and May. Spawning occurs April through June, with peak spawning occurring in May (Busby et al. 1996). Juvenile steelhead trout rear in streams for two years prior to smolting. Most trout rearing takes place in tributaries. Some migration to mainstem reaches may take place in fall and winter (Ward 1995). After smolting, they migrate to the ocean between April and June. Steelhead trout typically spend two years in the ocean prior to returning to their natal streams to spawn. Steelhead trout do not necessarily die after spawning, but may go back to the ocean and return in subsequent years to spawn again.

Coho salmon migrate into the upper Willamette basin in fall. Spawning occurs in November and December. Juvenile coho salmon rear in streams for one year prior to smolting, with outmigration taking place from March through May. In summer, most rearing takes place in tributaries. Some migration to mainstem reaches may take place in fall and winter (Ward 1995). After smolting, they migrate to the ocean. Coho salmon typically spend three years in the ocean prior to returning to their natal streams to spawn. Following spawning, they die.

In this watershed, cutthroat trout exhibiting both resident and potamodromous life histories are present[21]. Potamodromous migration occurs between the Middle Tualatin-Rock Creek watershed and the Willamette River. Additionally, localized movement will occur in an attempt to find superior habitat conditions. Although cutthroat trout can be found spawning most times in the year, their peak spawning season in the Tualatin subbasin is from February to April (G. White, fisheries biologist, personal communication 2001).

Life history of Pacific lamprey is complex. They typically migrate into the Willamette basin between April and September, and spend one winter in fresh water prior to spawning. Spawning occurs in June and July in stream reaches with abundant gravel. After hatching, lamprey spend four to six years in the larval, or ammocoete, stage. Ammocoetes migrate downstream to lowland reaches with mud substrates, where they remain until attaining juvenile stage. This stage, which is marked by physiological changes including the development of eyes, usually takes place between July and October, and is usually marked by a migration to stream reaches with fast flow and gravel substrate. As juveniles grow to adulthood, they outmigrate to the ocean, usually between late fall and spring. Off of the Oregon Coast, adult lamprey spend 20-40 months in the ocean prior to returning to fresh water to spawn. They die three to 36 days after spawning (Close et al. 1995).

3.1.5.1.2 Potential hazards

The greatest hazard faced by salmonids is generally considered to be the lack of quality habitat. For anadromous fish, in particular, habitat is limiting. There is an estimated 16 miles of spawning habitat in the Middle Tualatin-Rock Creek watershed that is accessible to anadromous fish (ODFW 1999). Most of the best rearing habitat also lies within the reaches used for spawning. Since the amount of habitat is so limited, any degradation is significant. Threats to salmonid habitat in the watershed include loss of habitat diversity, diminished water quality (including elevated water temperatures and low dissolved oxygen), and low summer and fall streamflow. Further discussion of streamflow and water temperature characteristics occurs in the Hydrology and Water Quality sections (Sections 3.1.2 and 3.1.4).

Migratory impediments, stream diversions, predation, and competition are other factors affecting salmonid populations. Poorly sized and placed culverts, in particular, can impede migration by creating jumps and velocity barriers (See Section 3.1.5.1.6). Stream diversions can entrain migrating and rearing salmonids and remove them from the stream system, often resulting in fish mortality in nearby upland habitats. While predation and competition are natural ecological processes in aquatic systems, human activities can increase pressures from these sources by reducing the amount and diversity of available habitat, accidental predator introduction, and planting of hatchery fish.

3.1.5.1.3 Planting of hatchery salmonids

Steelhead trout were released in the Middle Tualatin-Rock Creek watershed between 1984 and 1989 as mitigation for loss of habitat due to construction of Scoggins Dam. In 1984, 9,733 steelhead trout fry were planted in Rock Creek. In 1989, 14,611 fry were planted in McFee Creek. These numbers represent a very small proportion of the steelhead trout that were planted in the Tualatin subbasin over this period. In 1999, ODFW discontinued planting steelhead trout in the Tualatin subbasin. This change of policy resulted from the listing of upper Willamette steelhead trout as threatened under the Endangered Species Act (ESA).

Coho salmon were planted in the watershed between 1980 and 1985. Over this period, 369,800 coho salmon fry were released into Rock Creek, while 113,100 fry and 55,700 pre-smolts were released into McFee Creek. In 1999, ODFW discontinued planting coho salmon in the Tualatin subbasin in response to steelhead trout listings under the ESA.

3.1.5.1.4 Prospects for salmonid populations

The Middle Tualatin-Rock Creek watershed falls within the upper Willamette Evolutionarily Significant Unit (ESU) for steelhead trout. In March 1999, steelhead trout within this ESU were listed as threatened under the ESA. Through genetic analysis, the National Marine Fisheries Service (NMFS) determined that the steelhead trout in the Tualatin basin are of native stock, and therefore were included in the ESA listing. Although Nehlsen et al. (1991) did not consider these steelhead trout stocks to be at risk, more recent trends indicate a possible decline in population. Wide population fluctuations make trends difficult to determine. However, low populations indicate a possible risk of extinction (Busby et al. 1996).

On April 5, 1999 coastal cutthroat trout within the upper Willamette ESU were determined by the National Marine Fisheries Service (NMFS) to be "Not Warranted" for listing under the ESA (Federal Register 16397). However, the USFWS now has authority over cutthroat trout and are currently reviewing their status. Population trends for cutthroat trout within the Middle Tualatin-Rock Creek watershed are unknown.

3.1.5.1.4.1 Non-salmonid populations and trends.

Little population information is available on cold water non-salmonid fish species in the watershed.

3.1.5.1.5 Distribution of habitat

Coho salmon, steelhead trout, and cutthroat trout vary in their seasonal habitat utilization but all require structurally diverse channels for the maintenance of healthy populations. In general, coho salmon occupy middle stream reaches while cutthroat and steelhead trout occupy upper reaches. During high flow periods associated with winter and spring, juvenile coho salmon, steelhead and cutthroat trout depend on the low velocity habitats provided by pools, backwaters, and off-channel alcoves. Adult salmon and trout also use pools and wood structure for shelter from predators and for resting. During low flow periods zero to one year old steelhead and cutthroat trout inhabit higher velocity areas associated with riffles, while coho salmon continue to use pools. Two year and older steelhead and cutthroat trout generally prefer the deepest pool habitat.

In Coast Range streams, large wood pieces and accumulations play a vital role in maintaining channel complexity and fish populations. Large woody debris (LWD) creates scour, recruits and maintains spawning gravel, creates rearing pools and increases channel complexity. Although limited habitat surveys exist, most existing data indicate that LWD is far below optimal levels throughout the watershed. According to the OWEB manual, ODFW benchmarks for streams in forested basins indicate that less than 10 pieces of LWD (10 feet minimum length by 6 inch width) per 100 meters (328 feet) channel length are undesirable (WPN 1999). Although the majority of the Rock Creek watershed is not currently forested, these values provide a useful basis for comparison. Recent riparian surveys along Rock Creek and its tributaries, as well as Butternut, Gordon, and Rosedale creeks found that only one site exceeded 1 piece of LWD per 100 meters. Counts at ground reference sites on the Tualatin River were somewhat higher, ranging from 3.83 to 15.36 pieces per 100 meters.

The current characteristics of riparian vegetation further indicate that LWD recruitment potential is poor in most parts of the watershed. Once again the Tualatin River had somewhat higher recruitment potential than most tributaries, as many ash trees in the 12-24 inch dbh class were found interspersed among trees of smaller diameter classes.

Lowland reaches typically have eroding banks, low pool density, high stream turbidity, and fine-textured substrates. In most tributaries and the Tualatin mainstem below Rock Creek, summer water temperature often exceeds 17.8 C. These characteristics generally reduce their suitability for salmonid rearing habitat. However, a limited amount of suitable salmonid rearing habitat may occur within these lowland streams. Surveys conducted in summer and fall of 1999 found that small numbers of cutthroat trout were using sites along lower Rock Creek. However, these surveys were conducted at times when water temperature was well below 17.8 C (Hughes and Leader 2001).

3.1.5.1.5.1 Habitats for non-salmonid species

As described in section 3.1.5.1.1, Pacific lamprey have diverse habitat needs. They prefer cool water temperatures at all life stages. Substrate needs vary by life stage: During the ammocoete stage they utilize stream reaches with mud substrates. On the other hand, juveniles and adults need gravel substrates and flowing, well-oxygenated water. Thus, potential habitat concerns for lamprey involve both foothill and valley stream reaches in the Middle Tualatin-Rock Creek watershed.

3.1.5.1.6 Migration barriers

Barriers to fish passage include both natural and anthropogenic factors. On most of the smaller tributaries, stream size, gradient, and naturally occurring low flows are the limiting factors. In most other cases, migration impedance is partially or wholly due to human activities. Diversions can reduce stream depth, block upstream passage, and/or divert fish from the streams. Stream crossings can block fish passage, either through improperly placed culverts, or in some cases a lack of culverts.

The Oregon Department of Transportation (ODOT) performed a survey of 61 culverts within the watershed. Of these culverts, 5 were found to be structurally inadequate because of poor culvert condition, migratory impediment, or inadequate passage of high flows. Although none of these deficient culverts occurred on streams used by anadromous steelhead, these culverts were considered to provide potential barriers to migration of resident fish. All of these culverts were considered to be a low priority for replacement.

3.1.5.2 Warm-water fisheries

Warm water fish are present in the mainstem Tualatin, the lower reaches of Rock Creek and other tributaries, and in ponds (Murtagh et al. 1992, SRI 1990, JWC unpublished data). These include game species such as smallmouth bass, largemouth bass, and yellow perch, as well as non-game species such as yellow and brown bullhead. Below Rock Creek, fish communities are dominated by these species (SRI 1990).

3.1.5.3 Amphibians

Many amphibians depend on riparian and wetland habitats. Worldwide, the reduction in area of such habitats has resulted in a corresponding reduction in amphibian numbers. Additionally, native frogs in western states have largely been outcompeted by the introduced bullfrog (*Rana catesbiana*). For example, the bullfrog has been implicated in the extirpation of the spotted frog (*Rana pretiosa*) from the Willamette Valley (Leonard et al. 1993). Riparian-dependent amphibian Special Status Species[22] in the Middle Tualatin-Rock Creek watershed include the red-legged frog (*Rana aurora aurora*), Northwestern salamander (*Ambystoma gracile*), Dunn's salamander (*Plethodon dunnii*), tailed frog (*Ascaphus truei*), Columbia torrent salamander (*Rhyacottriton kezeri*), and the western toad (*Bufo boreas*). The clouded salamander also has special status, but it generally is associated with upland forested habitat, specifically snags, fallen trees, and rotten logs.

Northern red-legged frog (*Rana aurora*) (BS)

The red-legged frog is known to occur at numerous sites within the Middle Tualatin-Rock Creek watershed. These frogs generally breed in marshes, small ponds and slow-moving backwater areas. During the non-breeding season they are highly terrestrial, commonly venturing into forested uplands. Past management practices that altered cool, moist riparian and forest floor habitats may have adversely impacted the quality and quantity of red-legged frog habitat within the watershed (Csuti et al. 1997).

Cope's giant salamander (*Dicamptodon copei*) (BS)

This amphibian may be present within the watershed.

Pacific giant salamander (*Dicamptodon tenebrosus*) (No federal status)

These amphibians are infrequently observed in the Tualatin Hills Nature Park.

Tailed frog (*Ascaphus truei*) (BA, SS)

Tailed frogs may be present in this watershed.

Important habitat types for tailed frogs include cold streams with rocky substrate and adjacent riparian forests. In portions of its range, this frog has experienced a severe decline in population. Increased stream temperatures and stream sedimentation from timber harvest and road building activities have been suggested as possible causes for this decline (Csuti et al. 1997).

Columbia torrent salamander (*Rhyacottriton kezeri*) (BS, SS)

Columbia torrent salamanders may be present in this watershed.

Western Toad (*Bufo boreas*) (SS)

Western toads may be present within the watershed. This toad adapts to many habitat types, so it could be found in any aquatic or wetland setting. Although this amphibian is abundant in Oregon, it has been extirpated from many areas (Csuti et al. 1997).

3.1.5.4 Reptiles

Western pond turtle (*Clemmys marmorata*) (FC, SS)

This reptile occurs within the watershed. Populations in the Willamette Valley have experienced steep declines. Introduced predators including the bullfrog, red eared sliders, box turtles, and snapping turtles have been implicated in these population declines (Csuti et al. 1997).

Important habitat includes quiet water habitats, such as ponds, marshes, and slow moving floodplain streams. Pond turtles need basking sites, such as logs and rocks, adjacent to these aquatic habitats (Csuti et al. 1997).

3.1.5.5 Other riparian and wetland-dependent species

Riparian and wetland areas provide habitat for many bird species in the Middle Tualatin-Rock Creek watershed. These include migratory songbirds, as well as wood ducks and mallards, which nest in riparian areas. Seasonal flooding and farm ponds add to the available habitat for waterfowl. Species using such habitats include Canada geese, whistling swan, mallard, wood ducks, American widgeon, ring-necked duck, lesser scaup, green-winged teal, pintail, and American coot (ODEQ and USA 1982).

3.2 Terrestrial

3.2.1 Vegetation

3.2.1.1 Array and landscape pattern of vegetation

3.2.1.1.1 Vegetation in the Tualatin Plain and lower portions of the foothills

The watershed's valleys and adjacent foothills are within the interior valley zone described in Franklin and Dyrness (1973). Historically, the valley floors in this zone were dominated by overstories of Oregon white oak (*Quercus garryana*). Interspersed with the white oak were other tree species including bigleaf maple and Douglas-fir. Common understory plants included western hazel (*Corylus cornuta*), swordfern (*Polystichum munitum*), Saskatoon serviceberry (*Amelanchier alnifolia*), mazzard cherry (*Prunus avium*), common snowberry (*Symphoricarpos albus*), and Pacific poison oak (*Rhus diversiloba*). These hardwood forests were often interspersed with prairies, some of which were created through human actions such as burning. Under natural circumstances, riparian communities in this zone are often forested, with dominant vegetation consisting of bigleaf maple, black poplar, and various willows.

In the foothills, the oak woodlands of the valleys naturally grade into conifer forest. Douglas-fir is naturally a dominant component of the Willamette Valley foothills conifer forest, and under natural conditions, grand fir (*Abies grandis*) and bigleaf maple are also important components (Franklin and Dyrness 1973).

Currently, most of the eastern portion of the watershed has been urbanized. These urban portions comprise roughly 38% of the watershed[23]. Where urbanization has progressed, much of the native vegetation has been removed and replaced with buildings and impervious surfaces. Many exotic species have been introduced into these areas, resulting in a landscape dominated by a mélange of native and exotic species. The best chance for finding native communities in these areas is in special reserves such as the Tualatin Hills Nature Park where effort has been made to eradicate exotic species.

Most of the remainder of the Tualatin Plain and a portion of the adjoining foothills are in agriculture. These agricultural areas comprise roughly 48% of the watershed[24]. Much of the natural vegetation has been removed from these areas. Where such vegetation exists in upland zones, it is typically comprised of small stands of Oregon white oak and Douglas-fir. The riparian zone is generally narrow and patchy, with vegetation types varying from riparian forest to herbaceous. The riparian forests are generally dominated by Oregon ash, black poplar and large willows, while riparian shrublands are dominated by Himalayan blackberry, red-osier dogwood (*Cornus sericea*), wild rose (*Rosa nutkana*) and willows. Smaller tributaries and highly disturbed reaches are often vegetated with reed canarygrass and other herbaceous vegetation.

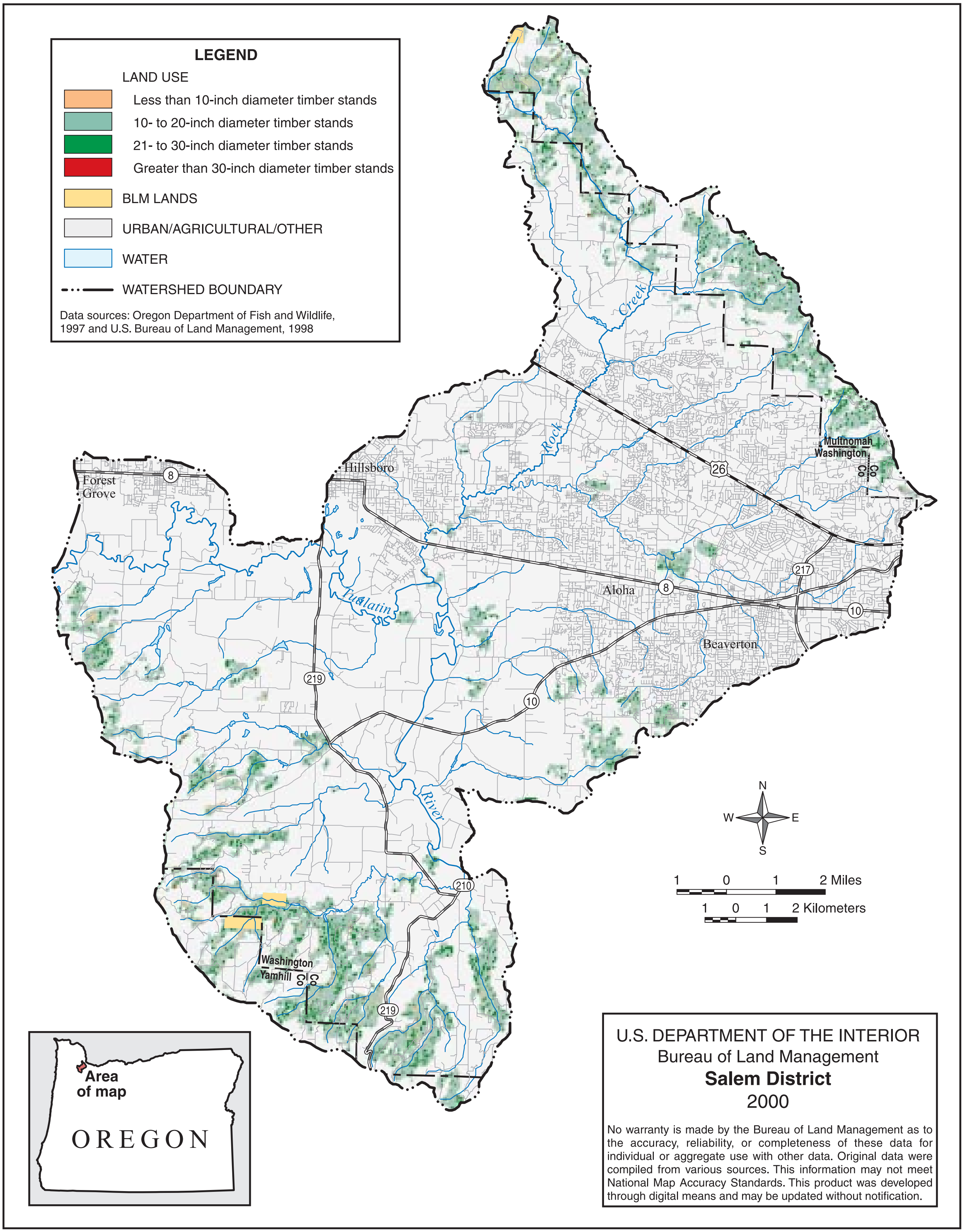
Width of the riparian buffer in the valleys is usually quite limited (Risley 1997). Surveyors connected with the Watersheds 2000 project collected riparian data within urban streams and adjacent rural streams. Sites surveyed within the watershed included Rock Creek, Butternut Creek, Gordon Creek, Rosedale Creek, and their tributaries. Most sites along these streams had buffers less than 25 feet in width (USA unpublished data).

The buffer along the Tualatin River is somewhat wider than along most tributaries. Aerial photographic analyses performed for the Watersheds 2000 project indicated that the vast majority of the river was bordered by mixed or deciduous forest. Mean buffer width was between 50 and 75 feet, although a quarter of the analyzed stream length was bordered by riparian forest greater than 200 feet in width. In most cases, these wide forested areas occurred on the inside of meander bends. Less than five percent of the riparian area along the mainstem was less than 25 feet in width.

3.2.1.1.2 Vegetation in the Tualatin and Chehalem Mountains

Upper portions of the watershed's foothills show characteristics transitional between drier portions of the western hemlock zone and the Willamette Valley foothill conifer forest described by Franklin and Dyrness (1973). Although portions of the watershed are mapped within the western hemlock zone, precipitation is generally below that considered necessary to sustain western hemlock forest. Thus, it is likely that Douglas-fir likely constitutes a major part of the climax vegetation of these mountains, although grand fir may originally have been a more significant component of the vegetational landscape than is currently the case. Riparian and frequently disturbed areas are commonly occupied by hardwood species, including red alder and bigleaf maple.

Stand condition in the watershed is shown in Table 3-14 and Map 3-6. The vast majority (90%) of lands are classified as nonforested (WODIP 1999)[25]. Only 1.5 percent of land area is occupied by stands in the mature



Map 3-6 -- Land Use and Land Cover for non-BLM Lands in the Middle Tualatin-Rock Creek Watershed.

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structural stage (that is, dominated by trees 20-29 inches diameter at breast height (dbh)). A minute portion (0.01%) of stand area is occupied by trees greater than 29 inches dbh, indicating that stands in the mature/old growth condition are extremely uncommon. These small stands are scattered throughout the watershed. The largest of these stands (about two acres apiece) are found in the McFee Creek, Heaton Creek, and Upper Rock Creek subwatersheds. The lack of mature, large-diameter stands limits the ability of forested lands to provide snags, down wood, and instream large woody debris for ecological purposes (Section 3.2.2.3). Younger structural stages dominate forests in the watershed, comprising 9% of total watershed area. These stands are mainly in the small tree stage.

Table 3-14. Size classes of forest stands within the Middle Tualatin-Rock Creek watershed.

Size class (inches)	Total area (acres)	percent of watershed
0 to 9	303	0.3%
10 to 19	9,125	8.5%
20 to 29	1,607	1.5%
over 29	12	0.0%
urban/agriculture	93,038	86.2%
other nonforested	3,788	3.5%
Total	107,872	100%

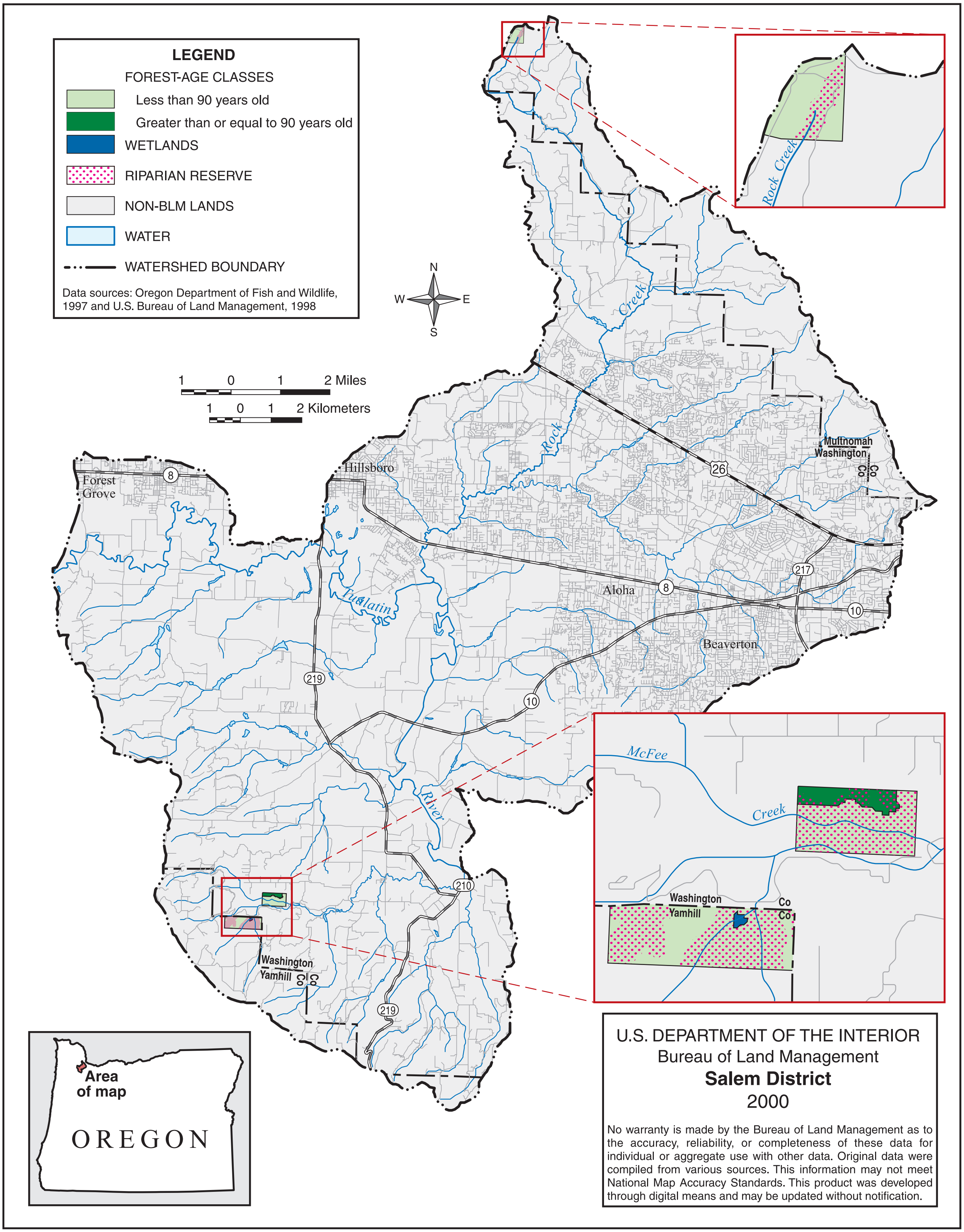
Currently, Douglas-fir dominates most forested stands in the foothills. These Douglas-fir stands are generally quite fragmented, being separated by residential developments and agricultural plots. The largest contiguous stands are along canyons in the subwatersheds contributing to McFee Creek. Forest stands also occur in the upper portions of the Tualatin Mountain subwatersheds. These stands are potentially important when considered together with stands along the north face of the Tualatin Mountains (which lie outside the watershed). Forest stands are generally well-stocked, with 85% of these stands exceeding 70% canopy cover.

The distribution of BLM stand types is given in Table 3-15 and Map 3-7. Virtually all BLM lands in the watershed are forested. As is the case with other forested lands in the watershed, small trees represent the dominant stand condition on BLM lands. Stands are comprised of Douglas-fir and red alder ranging between 50 and 70 years of age. Approximately 20 acres of BLM land within the Gulf Creek subwatershed (T2S, R3W, S13) consists of timber in the 90-year age class. Most of this mature timber lies outside the Riparian Reserve.

Table 3-15. Age classes of forest on BLM lands.

Age Class (years)	Total area (acres)	Percent of BLM
0 to 20	-	0.0%
30 to 50	118	48.5%
60 to 80	106	43.4%
90 to 110	18	7.5%
nonforested	2	0.7%
Total	244	100.0%

During project planning exercises, stands on all BLM-managed parcels were observed to be overstocked. Additionally, some stands on parcels in the Gulf Creek subwatershed were observed to be inconsistent with their mapped types.



Map 3-7 -- Age Class of Forest Vegetation on BLM Lands in the Middle Tualatin-Rock Creek Watershed.

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3.2.1.2 Exotic/Noxious Plants

Exotic weeds have become established throughout the watershed. Such species tend to outcompete native species, resulting in diminished populations of these species and reduced diversity. They tend to be aggressive colonizers on disturbed soils, and typically are found in fields, waysides, and similarly disturbed habitats. Eradication of these exotics is often difficult. In the Middle Tualatin-Rock Creek watershed, common exotic plant pest species include Himalayan blackberry (*Rubus discolor*), reed canarygrass (*Phalaris arundinacea*), purple loosestrife (*Lythrum* salicaria), Scotch broom (*Cytisus scoparius*), English Ivy (*Hedera helix*), and thistles (*Cirsium sp.*).

These weed problems are pervasive throughout the watershed. Himalayan blackberry often forms the dominant vegetation in riparian zones. Reed canarygrass is also common in riparian zones, and is particularly pervasive in wetlands. Purple loosestrife is a potential wetland invader. Scotch Broom is common in disturbed areas throughout the watershed, while English Ivy is mostly concentrated around the more urbanized portions of the watershed.

In agricultural areas, certain exotic species are determined to be toxic to livestock, or otherwise have a substantial detrimental effect to agricultural operations. The Oregon Department of Agriculture (ODA) designates many such plants as noxious weeds. Listed weeds of particular concern in the Middle Tualatin-Rock Creek watershed include Scotch broom (*Cytisus scoparius*), tansy ragwort (*Senecio jacobaea*), and spotted knotweed (*Polygonum sp.*). Although gorse (*Ulex europaeus*) has not been found in Washington County, patches have been found in Columbia, Tillamook, and Clackamas counties. As gorse is an ODA Target (priority) noxious weed, any sightings should be brought to the attention of ODA personnel.

Numerous groups are involved in weed control. ODA provides funds to finance special weed abatement projects and provide cost-share assistance to private landowners. Municipal authorities also sponsor weed abatement grants. These groups, together with OSU extension and the Washington County SWCD provide educational material related to weed control. Finally, community groups such as SOLV and the Tualatin Riverkeepers organize weed-abatement projects.

3.2.2 Terrestrial species and habitat

3.2.2.1 Abundance and habitat of terrestrial species

3.2.2.1.1 Economically important species

Urbanization and forest fragmentation limit the available habitat for big game species. Riparian corridors within the watershed provide habitat for black-tailed deer (SRI 1990).

3.2.2.1.2 Special status and special attention species

3.2.2.1.2.1 Botanical Species

Special status species include federally listed species and those species listed by the Oregon Natural Heritage Program (ONHP). The ONHP lists species that are of concern because of diminished population or habitat. Those ONHP-listed botanical species potentially found in the Middle Tualatin-Rock Creek watershed are displayed in Table 3-16. Additionally, the NFP mandates that special attention be given to certain species that do not currently have special status. Several special status and special attention species are known to live within the watershed on lands managed by the Tualatin Hills Parks and Recreation District (Ralph Cook, THPRD, personal communication). These include the lichen *Lobaria pulmonaria*, as well as meadow sidalcea (*Sidalcea campestris*) and the Willamette Valley bittercress (*Cardamine penduliflora*). Comprehensive botanical surveys would likely find other such species.

In the Middle Tualatin-Rock Creek watershed, special habitats for sensitive species are found both on BLM and private lands. These include wetlands[26]. The values for wetland habitats are especially important because they are a critical source of biological diversity. Wetland types include relatively large lowland marshes and forested wetlands of the valleys, as well as small ponds in the foothills. The location of wetlands identified under the National Wetland Inventory (NWI) is displayed in Map 3-2. Characteristics of these wetlands are summarized in Table 3-17. The NWI represents a conservative estimate of wetland area, as many valley bottom lands that are regularly inundated are not included. Although these wetlands potentially provide habitat for sensitive botanical species, that potential has been reduced in the valley wetlands because of extensive modification related to human uses. In particular, species composition has been altered and exotics such as reed canarygrass have replaced much of the native vegetation.

Table 3-16. List of Oregon Natural Heritage Program listed species that may be found within the Middle Tualatin-Rock Creek watershed.

Fungi

Scientific Name	Common name	Federal status	ODFW status	ONHP schedule
Amanita novinupta	fungus	□	□	3

Vascular plants

Scientific Name	Common name	status	status	schedule
Cimicifuga elata	tall bugbane	SC	C	1
Delphinium leucophaeum	white rock larkspur	SC	LE	1
Erigeron decumbens var. decumbens	Willamette daisy	PE	LE	1
Horkelia congesta ssp. congesta	shaggy horkelia	SC	C	1
Lupinus sulphureus ssp. kincaidii	Kincaid's lupine	PT	LT	1
Montia diffusa	branching montia	□	□	4
Sidalcea campestris	meadow sidalcea	□	C	4
Sidalcea nelsoniana	Nelson's sidalcea	LT	LT	1

Insects

Scientific Name	Common name	Federal status	ODFW status	ONHP schedule
Acupalpus punctulatus	marsh ground beetle	□	□	3*

Fish

Scientific Name	Common name	Federal status	ODFW status	ONHP schedule
Lampetra tridentata	Pacific lamprey	SC	SV	3
Oncorhynchus clarki clarki	coastal cutthroat trout		SV	3*
Oncorhynchus kisutch	coho salmon	C	SC	1*
Oncorhynchus mykiss	steelhead trout	FT	SV	1*

Amphibians

Scientific Name	Common name	Federal status	ODFW status	ONHP schedule
Aneides ferreus	clouded salamander	□	SU	3
Ascaphus truei	tailed frog	SC	SV	3*
Bufo boreas	western toad	□	SV	3
Rana aurora aurora	northern red-legged frog	SC	SV	3
Rana pretiosa	Oregon spotted frog	C	SC	1*
Rhyacotriton kezeri	Columbia seep salamander	□	SC	3*

Reptiles

Scientific Name	Common name	Federal status	ODFW status	ONHP schedule
Chrysemys picta	painted turtle	□	SC	2*
Clemmys marmorata marmorata	Northwest pond turtle	SC	SC	2*

Birds

Scientific Name	Common name	Federal status	ODFW status	ONHP schedule
Branta canadensis leucopareia	Aleutian Canada goose (wintering)	LT	LE	1*
Branta canadensis occidentalis	dusky Canada goose (wintering)	□	□	4
Chordeiles minor	common nighthawk (SC in WV)	□	SC	4
Contopus cooperi	olive-sided flycatcher	SC	SV	3
Empidonax traillii brewsteri	little willow flycatcher	SC	SV	3
Eremophila alpestris strigata	streaked horned lark	□	SC	3*
Haliaeetus leucocephalus	bald eagle	LT	LT	1*
Icteria virens	yellow-breasted chat (SC in WV)	□	SC	4
Melanerpes foricivorous	acorn woodpecker	□	□	3
Pooecetes gramineus affinis	Oregon vesper sparrow	□	SC	3*
Progne subis	purple martin	□	SC	3*
Sialia mexicana	western bluebird	□	SV	4
Strix occidentalis caurina	northern spotted owl	LT	LT	1*
Sturnella neglecta	western meadowlark	□	SC	4

Mammals

Scientific Name	Common name	Federal status	ODFW status	ONHP schedule
Arborimus albipes	white-footed vole	SC	SV	3
Corynorhinus townsendii townsendii	Pacific western big-eared bat	SC	SC	2*
Lasionycteris noctivagans	silver-haired bat	□	SU	3
Myotis evotis	long-eared bat	SC	SU	4
Myotis thysanodes	fringed bat	SC	SV	3*
Myotis volans	long-legged bat	SC	SU	3*
Sciurus griseus	western gray squirrel	□	SU	3

Table 3-17. Characteristics of NWI wetlands in the Middle Tualatin-Rock Creek watershed. (Source GIS analysis of data on Tualatin River Watershed Information System).

System	Acres	%Type	Class	Acres	%Type	Water Regime	Acres	%Type	Modifiers	Acres	%Type
Lacustrine	71.7	3.52%	Aquatic Bed	58.7	2.88%	Permanently flooded	178.4	8.76%	Natural	1502.9	73.81%
Palustrine	1881.7	92.41%	Emergent	719.9	35.35%	Semipermanently flooded	47.7	2.34%	Beaver	4.4	0.22%
Riverine	82.8	4.07%	Forested	681.4	33.46%	Intermittently exposed	390.5	19.18%	Diked/Impounded	313.1	15.38%
			Open Water	162.1	7.96%	Seasonally flooded	661.7	32.50%	Excavated	173.6	8.53%
			Scrub-shrub	118.5	5.82%	Temporarily flooded	97.0	4.77%	Partially Drained/Ditched	42.117	2.07%
			Uncon. Bottom	283.3	13.91%	Saturated	2.3	0.11%			
			Uncon. Shore	12.5	0.61%	Artificially flooded	245.2	12.04%			
						Sat/Semiperm/Season	413.2	20.29%			
Total	2036.2	100.00%		2036.2	100.00%		2036.2	100.00%		2036.2	100.00%

The Beaverton Local Wetland Inventory (LWI) identified 58 wetlands within its jurisdiction and performed an OFWAM assessment to determine the remaining functionality of these wetlands. All wetlands except a site on Cedar Mill Creek were considered to provide limited support for wildlife. Virtually all wetlands that had formerly supported fish habitat had lost all or a portion of that function. Hydrologic storage, however, was somewhat better supported. Forty-one of these wetlands were considered to have retained this function. Prospects for restoration for most of these wetlands ranged from moderate to low.

Current efforts to restore wetland habitats have largely been focused on Jackson Bottom, Fernhill Wetlands, and the Tualatin Hills Nature Park. Additionally, numerous small wetland restoration activities have taken place, usually in parks or as mitigation projects within the Urban Growth Boundary (UGB). Given willing landowners, there may be potential for wetland restoration outside the UGB. Agencies and organizations such as NRCS and Ducks Unlimited work with landowners to restore and enhance wetlands. However, certain obstacles exist. The cost of permits for wetland projects is often high. Additionally, these projects often require a high degree of maintenance if natural plant communities and wildlife support are desired functions.

Although ponds and other wetland areas in the foothills are generally quite small, they are potentially important sites for sensitive botanical species. These habitats are fragile and comprise an extremely small percentage of the public lands administered by the BLM. Wetland habitat protection is featured in BLM programs[27].

A small (approximately 2 acres) wetland is located on BLM land in the McFee Creek subwatershed (T2S, R3W, S23). During a brief visit to this site, no sensitive wetland-dependent species were observed. However, several exotic species were observed at this site, including Himalayan and cut-leaf blackberry, nightshade, and reed canarygrass. Scotch broom was observed around the wetland margins.

Other sensitive habitat types for botanical species include the few areas containing vegetation with late successional characteristics. On BLM land, this is restricted to northern portions of the parcel located at T2N, R3W, S13.

3.1.5.3 Survey and manage mollusks

Of the eight mollusk species potentially found within the Tillamook Resource Area (BLM), none are known to inhabit the Tualatin subbasin. However, due to the limited knowledge of the range of many mollusk species the Resource Area does conduct surveys of project areas within the watershed. The eight species thought to occur in the Tillamook Resource Area are:

Cryptomastix devia	Puget Oregonian
Derocerus hesperium	evening fieldslug
Hemphillia burringtoni	keeled jumping slug
Hemphillia glandulosa	warty jumping-slug
Hemphillia malonei	Malone jumping-slug
Megomphix hemphilli	Oregon megomphix
Prophysaon coeruleum	blue-gray tail-dropper
Prophysaon dubium	papillose tail-dropper

3.2.2.1.2.2 Amphibians

Clouded salamander (*Aneides ferreus)* (BS)

Clouded salamanders are terrestrial amphibians that inhabit large decaying logs, stumps, and snags. Although their presence has not been verified, it is very likely they occur within the watershed. Current management strategies on private lands involve short timber harvest rotations, which could limit the long-term maintenance and/or development of habitat for clouded salamanders on these lands. Management of federal lands within the Middle Tualatin-Rock Creek watershed provides for development of late-successional habitat within Riparian Reserve and allocations. Current timber harvest standards and guidelines mandate retention of green trees, snags, and down wood. These policies should provide for the long-term maintenance and/or development of habitat for clouded salamanders on federal lands.

3.2.2.1.2.3 Birds

<u>Northern bald eagle</u> (*Haliaeetus leucocephalus*) (FT)

Habitat- Bald eagles utilize snags for roosting and nesting, and prefer sites near open water to ensure food availability. Snags are not abundant in the Middle Tualatin-Rock Creek watershed. Fragmented land use patterns will continue to limit the development of habitat for bald eagles within the watershed. Management of federal lands within the Middle Tualatin-Rock Creek watershed given the Northwest Forest Plan's land allocations (Riparian Reserve and AMA) and Standards and Guidelines could provide for some long-term benefit to bald eagles. The long-term benefits to eagles resulting from federal management practices may include the improvement of foraging opportunities as salmonid stocks of concern improve or the development of roosting and nesting habitat on federal lands. The actual significance of these potential benefits is questionable given the small percentage of federal ownership within the watershed and adjacent lands.

Sites-Bald eagles are known to nest at a site in the Jackson Bottom Reserve.

<u>Pileated woodpecker</u> (*Dryocopus pileatus*) (BA)

Pileated woodpeckers are known to exist within the watershed. During a field visit to the a BLM-managed parcel in the Gulf Creek subwatershed (T2S, R3W, S23), pileated woodpecker use was observed by researchers associated with this watershed analysis. Pileated woodpeckers have also been observed at other sites, including the Jackson Bottom Reserve and the Tualatin Hills Nature Park.

Pileated woodpeckers are dependent on some components of older forests such as large snags for drumming, roosting, nesting and foraging and a good supply of large snags and down wood for foraging. These woodpeckers are often observed foraging in young stands or even clearcuts if large stumps, snags or down wood are present. Current management strategies on the majority of private lands involve shorter timber harvest rotations, which could limit the maintenance or development of habitat for pileated woodpeckers on these lands and potentially lead to local extinction. Management of federal lands within the Middle Tualatin-Rock Creek watershed given the Northwest Forest Plan's land allocations (Riparian Reserve, and AMA) and Standards and Guidelines (green tree, snag and down wood retention) should provide for some long-term benefit to pileated woodpeckers. These long-term benefits include the improvement of foraging and nesting habitat on federal lands.

3.2.2.1.2.4 Mammals

<u>NFP Bats</u>

One of the leading factors in the decline of worldwide bat populations is the destruction of roost sites and hibernacula. Most bat species occurring in the Pacific Northwest roost, reproduce, and hibernate in protected crevices that fall within a narrow range of temperature and moisture conditions. There is a strong concern that the loss of snags and decadent trees from the widespread conversion of old-growth forests to young, even-aged plantations, human disturbance and destruction of caves and mines, old wooden bridges and buildings have significantly reduced the availability of potential roost sites.

The NFP (Northwest Forest Plan) identifies five species of bats that would benefit from additional habitat protection. Four of these five species have potential of being located within the watershed. These species include the fringed myotis, long-eared myotis, long-legged myotis, and the silver-haired bat. All of these bat species are known to inhabit immature coniferous forest and may forage near riparian areas, open areas, and along forest edges. In addition to caves, mines, and abandoned wooden bridges and buildings, large hollow trees may be used for roosting, hibernating, and maternity colonies. Surveys for these species are required if caves, mines, or abandoned wooden bridges and buildings are within or near a proposed project area.

There is little or no information concerning the population health or distribution of these species within the watershed. However, based upon the low abundance of suitable roosts they are expected to be present in low numbers or even absent from the watershed. There are no known sites within the watershed although there are a few specific areas that seem to have potential for occupancy.

During a recent survey, bats were found to be roosting under 18% of Washington County bridges (WCDLUT 2000). However, it is not clear whether any of these bats belonged to species covered by the NFP.

Long-eared myotis (*Myotis evotis*), Fringed myotis (*Myotis thysanoides*) and Long-legged myotis (*Myotis volans*)

These three NFP species potentially found in the Middle Tualatin-Rock Creek watershed are small nonmigratory, crevice-roosting bats with widespread distributions that use snags, decadent trees, buildings, bridges and caves for roosting and hibernating. All three are also identified as Bureau Sensitive (BS) under BLM Special Status Species Policy.

Silver-haired bat (*Lasionycteris noctivagans*)

The silver-haired bat is a relatively large, migratory, widely-distributed snag and decadent tree-roosting bat, although it may occasionally use buildings and caves for roosting.

3.2.2.1.3 Exotic pest species

Several exotic animal species that were introduced to the Tualatin subbasin have created difficulties to ecological systems and/or economic efforts within the watershed. Nuisance species that occur within the Middle Tualatin-Rock Creek watershed include the bullfrog and the nutria.

Bullfrog predation has been responsible for the reduction of populations of many species throughout the western United States. In Oregon, affected species include the Western pond turtle and the spotted frog, which has been extirpated from the Willamette Valley. Outside of the Tualatin subbasin, bullfrogs have been found to be associated with declines in waterfowl production (Leonard et al. 1993).

Nutria (*Myocastor coypus*) were introduced to the United States by fur ranchers between 1899 and 1940. Their diet normally consists of a variety of wetland plants. In the Willamette Valley, they have become a nuisance to farmers by devouring crops and by burrowing into drainage canals. They also devour riparian plantings, thus complicating riparian and wetland revegetation efforts (CSE 2000).

3.2.2.2 Effect of ownership upon habitat management opportunities

Due to the limited and fragmented extent of federal ownership in the Middle Tualatin-Rock Creek and surrounding watersheds, the character of the landscape pattern is strongly influenced by management practices on private lands. While agricultural and urban patterns dominate in the Tualatin Plain, the remaining forested lands in the foothills are strongly dominated by early and mid-seral stage habitats. As a result, the few patches of mature forest in the watershed are dominated by high contrast edge habitat, with the watershed providing virtually no interior late-successional forest habitat. With increased urbanization, this pattern is likely to be perpetuated (and further fragmented) by intensive management on private lands.

As a result of the general landscape pattern the ability of species dependent upon late-successional habitat to disperse within the watershed and the adjacent landscape has been limited. For these species, this has created a high degree of regional isolation.

Successful habitat management depends upon cooperation between landowners. However, partnership efforts are complicated by a fragmented ownership pattern. The presence of many owners with differing management emphases complicates coordination of management efforts and contributes to habitat fragmentation.

3.2.2.3 Current distribution and density of snags and down wood

Snags and down wood are characteristically produced by forest stands in mature/old-growth condition. Very few of the timber stands in the Middle Tualatin-Rock Creek watershed are in this condition. Incidence of snags and down wood in the watershed appears to be correspondingly low. However, dead ash trees were observed adjacent to the Tualatin River during field surveys. These trees may provide some snag habitat. It is anticipated that many of these trees will eventually fall into the river, where they will provide instream large woody debris.

As with the rest of the watershed, lands managed by BLM have low snag densities. Generally, speaking, the quantity of down wood was not considered to be sufficient for habitat management purposes. An exception was at the BLM parcel at T2S, R3W, S23, where the smaller size classes of down wood were quite abundant. Large logs up to 65 inches in diameter were also noted. Present federal timber harvest practices promote retention of snags and down wood, so abundance of these habitat elements is expected to improve in the future.

3.2.3 Forest resources

3.2.3.1 Forest productivity, diseases, and other pathogens

Laminated root rot, caused by the fungus *Phellinus weirii*, is widespread and has a major influence on the character of many Douglas-fir stands in the watershed. *P. weirii* readily infects and kills highly susceptible conifer species such as Douglas-fir and grand fir. Western hemlock is considered intermediately susceptible and western redcedar is thought to be resistant to the disease (Hadfield 1985). All hardwood species are immune. Tree-to-tree spread is through root contacts with infected roots or stumps (Hadfield et al. 1986). Affected trees are often windthrown when their decayed root systems are no longer able to provide adequate support (Thies 1984). Other trees often die standing. Douglas-fir beetles often attack and kill infected trees weakened by the disease. This disease, therefore, results in production of snags and down wood.

P. weirii infection centers often appear as openings in the forest containing windthrown, standing dead, and live symptomatic trees, along with a relatively well-developed shrub layer (Hadfield 1985). Centers may also contain hardwoods and less-susceptible conifers. Disease centers range in size from less than one acre to several acres in size. Centers expand radially at the rate of about one foot per year. Douglas-fir timber productivity levels in *P. weirii* infection centers are generally less than one-half of those in uninfected areas (Goheen and Goheen 1988). Timber losses in diseased stands may double every 15 years (Nelson et al. 1981). High levels of *P. weirii* infection (>25 percent of the area infected) generally preclude commercial thinnings in Douglas-fir stands, especially if disease centers are not well defined.

Insects also have the potential to threaten the health of forest stands. The Douglas-fir bark beetle, *Dendroctonus pseudotsugae*, causes most of the insect damage in the Middle Tualatin-Rock Creek watershed. This beetle typically attacks trees that have been weakened by other factors (USDA and USDI 1997). Beetle infestations may reach levels of concern at sites where large amounts of relatively fresh dead wood are present.

3.3 Social

3.3.1 Human uses

3.3.1.1 Economic Uses

3.3.1.1.1 Urban/Rural residential

Washington County is the fastest growing county in Oregon in terms of population. Rapid growth has characterized Washington County throughout the latter half of the 20th Century. Between 1960 and 1999, county population grew by 338% (PSU 2000). Much of this growth has taken place within the Middle Tualatin-Rock Creek watershed. This growth trend is anticipated to continue, generating additional demands upon watershed resources.

Approximately 38% of the watershed is presently developed and/or zoned for urban uses. Urbanization within these portions of the watershed will continue to alter the region's hydrology and place new demands on infrastructure.

Most growth in southwestern portions of the watershed is expected to be associated with rural residential uses. About ten percent of the land in the watershed is zoned for rural residential uses. Most such land is located in the Chehalem Mountain subwatersheds, particularly Jaquith Creek, Baker Creek, Burris Creek, and McFee Creek. Although land use is less intensive than is the case with urban uses, rural residential uses provide their own challenges. In some cases, they can lead to accelerated erosion and mass wasting. Additionally, rural residential uses typically rely on septic systems, which, if faulty, can contribute to water quality problems.

3.3.1.1.2 Agriculture

Agriculture is the major economic activity in the watershed's valleys and adjacent hillslopes. In 1999, the total value of crops in Washington County was estimated at $169,701,000, with livestock activities adding $13,291,000 in value (Preliminary data from OSU extension economic information office). As the Middle Tualatin-Rock Creek watershed contains about 30% of the agricultural land in Washington County, it is reasonable to believe that the watershed produces about $55,000,000 in agricultural products annually.

Economically, nursery crops were the leading agricultural product in Washington County, with 1999 sales of $76 million. This represented 41% of total agricultural sales. Christmas trees and small woodlots, which were grouped together, had 1999 sales of $20 million (11%). Grain and legume seeds were close behind with sales of $19 million (11%). Small fruit and berries ($18 million, 10%) and tree fruit and nuts ($12 million, 7%) were also important contributors to the economy (OSU Extension 1999).

The 1997 agricultural census summarized land area devoted to crop production for Washington County. These figures showed that the most cropland was devoted to wheat (17,020 acres), with hay (14,539 acres), orchard crops (8,403 acres), and vegetable production (8,167 acres) being the most widespread crops. Wheat and vegetables tended to be grown on relatively large farms, with mean plot sizes of 85 and 66 acres, respectively. Hay and orchard crops were typically raised on smaller farms. Twice as many farmers raised these crops as raised wheat, but mean plot sizes for hay and orchard crops averaged 33 and 18 acres, respectively. Although similar information was not summarized for the Middle Tualatin-Rock Creek watershed, it is likely that farm characteristics in the watershed would be similar to those for Washington County as a whole.

3.3.1.1.3 Forestry

Forestry occurs on a relatively small portion of the Middle Tualatin-Rock Creek watershed. Only 5% of the watershed is zoned for forestry. An additional 15% is zoned AF (agriculture/ forestry). An undetermined amount of this land is used for forestry.

The majority of forestry activities take place in small woodlands. The economic importance of these activities is hard to determine because harvest from small woodlands is grouped with Christmas tree production for reporting purposes. Together, these two activities are responsible for estimated 1999 sales of $20 million (OSU extension 1999. See section 3.3.1.1.3). The forest products produced on these lands include timber, firewood, and miscellaneous products such as posts and poles. Additionally, these lands can provide values for habitat, watershed protection, and aesthetics.

3.3.1.1.4 Mining

The most important mineral resource within the watershed is crushed rock. Both basalt and sandstone are quarried, and are commonly used for construction and road maintenance. According to the Oregon Department of Geology and Mineral Industries (DOGAMI) GIS coverage of Oregon mineral resources (contained in Ecotrust 1998) there are currently eighteen active quarries in the Middle Tualatin-Rock Creek watershed (Table 3-18). Additionally, there are a number of abandoned rock pits (Table 3-19).

Table 3-18. Current quarries in the Middle Tualatin-Rock Creek watershed.

Subwatershed	Site	Product	Lat	Long
Upper Rock	Skyline Blvd Bauxite	Bauxite, Iron	45-38-56N	122-54-12W
Holcomb	Bauxite (Tualatin Mountains)	Bauxite, Iron, Titanum	45-36-42N	122-54-04W
Upper Rock	Krueger Quarry	Stone (Basalt)	45-36-26N	122-52-25W
Upper Rock	Hoyt Quarry	Stone (Basalt)	45-36-07N	122-50-51W
Upper Rock	Rock Creek Quarry	Stone	45-35-29N	122-52-11W
Golf Creek	Grabhorn Quarry	Stone	45-28-54N	122-48-00W
Blooming Creek	Willamette Industries-Hergert Quarry	Stone	45-28-07N	123-04-44W
Blooming Creek	Plant #2, Quality Rock company	Stone	45-28-03N	123-04-41W
Christensen Creek	John Mathews Quarry	Stone	45-27-39N	122-58-39W
Davis Creek	Vandecoevering Quarry	Stone	45-27-39N	122-58-00W
Rosedale Creek	Aloha Quarry, Quality Rock company	Stone (Basalt)	45-27-03N	122-53-53W
Rosedale Creek	Farmington Quarry	Stone (Basalt)	45-27-24N	122-53-59W
Johnson Creek S.	Murray Road Quarry, LH Cobb	Stone	45-27-27N	122-49-38W
Johnson Creek S.	Murray Road Quarry, Progress Quarries	Stone (Basalt)	45-27-27N	122-49-40W
Jackson Reservoir	Beaverton Quarry, LH Cobb	Stone (Basalt)	45-27-02N	122-53-31W
Jackson Reservoir	Farmington Pit	Stone	45-26-50N	122-55-33W
Burris Creek	Laurel Quarry	Stone	45-24-57N	123-00-49W
LM Tualatin	Scholls Tile Company	Clay	45-25-03N	122-55-24W

Source: DOGAMI data on Tualatin River Watershed Information System.

Table 3-19. Historical quarries in the Middle Tualatin-Rock Creek watershed. Source, Schlicker 1967.

T	R	Sec	Subsec	Subwatershed	Site name	Product
1S	2W	26	N1/2	MT-Rosedale	Baker Quarry	Basalt
2S	3W	26	SE1/4	McFee Creek	Bald Peak Quarry	Basalt
1N	1W	7	NE1/4, SW1/4	Upper Rock Cr	Berger Quarry	Basalt
1S	2W	30	NW1/4,SW1/4	Davis Creek	Burkhalter Quarry	Basalt
1N	1W	27	SW1/4	Willow/Cedar Mill		Basalt
1S	1W	22	NW1/4	Johnson Cr S	Cutbank Quarry Prospect	Basalt
1S	1W	3	SE1/4, NE1/4	Johnson Cr N	Daniels Quarry Prospect	Basalt
1S	3W	34	NW1/4, NE1/4	Christensen Cr	Dober Quarry Prospect	Basalt
1N	2W	12	NE1/4	Upper Rock Cr	Fuegy Quarry	Basalt
1N	2W	2	NE1/4, SW1/4	Holcomb Creek	Hill Prospect	Basalt
1N	2W	1	SW1/4, SE1/4	Holcomb Creek	James Quarry Prospect	Basalt
1S	3W	23	SE1/4, SW1/4	Jackson Bottom	Johnson Quarry Prospect	Basalt
2S	3W	11	NE1/4	Burris Creek	Laurel Quarry	Basalt
1N	1W	27	NE1/4, NW1/4	Willow Creek	Perrine Quarry Prospect	Basalt

3.3.1.1.5 Conflicts between BLM and the public

In the Middle Tualatin-Rock Creek watershed there are potential and existing conflicts between public use and federal land management activities. The greatest potential problems exist in the Upper Rock Creek watershed, because the McFee Creek parcels are not publicly accessible. In project planning surveys, evidence of dumping was observed in one of the BLM parcels in the Upper Rock Creek watershed (T2N, R2W, S15).

3.3.1.2 Recreational opportunities

Recreational opportunities vary between urban and rural portions of the watershed. Urban areas typically have developed recreation opportunities, both indoor and outdoor. Sites supplying outdoor opportunities include parks and golf courses.

Metro sponsors an extensive parks and greenspaces program within urban areas. Administration of these lands is divided between Metro and several municipal authorities. Collectively, the Tualatin Hills Parks and Recreation District, the City of Hillsboro, and the Unified Sewerage Agency (USA), and Metro administer 2,940 acres of parkland within the watershed. Another 590 acres are administered by smaller municipal authorities. Metro and individual municipalities are seeking additional opportunities for greenspace preservation in the face of continuing urbanization. As part of this effort, Metro has purchased several tracts outside of the urban growth boundary, including large tracts near Spring Hill Road and adjacent to Scholls. Metro sponsors the Greenspaces Technical Advisory Committee (GTAC), which is currently evaluating and prioritizing lands for future acquisition.

Recreational activities afforded by these parks vary with the size and type of the park. The Tualatin Hills Nature Park, for example, affords opportunities for hiking, bicycling, and education in a relatively natural setting. On the other end of the spectrum are small neighborhood pocket parks that provide picnicking and limited sporting activities. Developed facilities within the watershed, such as Hillsboro Stadium, afford opportunities for organized sporting activities.

Recreational opportunities in rural portions of the watershed are less common and typically dispersed. Such activities include nonconsumptive activities such as bicycling, walking, jogging, and wildlife viewing. These activities should generally offer low impacts, although there is potential for wildlife disturbance and localized soil compaction. Additionally, the scenery of the area offers opportunities for pleasure driving. This activity places the same demands and risks upon the watershed as other driving activities. BLM lands offer limited potential for these activities. The Rock Creek parcels are not developed for recreation, while public access does not exist to the McFee Creek parcels.

3.3.1.3 Cultural resources

Numerous discoveries of Native American artifacts have been recorded throughout the watershed. However, no specific cultural resources issues have been identified in conjunction with this watershed assessment.

3.3.2 Roads

3.3.2.1 Road density

There are approximately 1,286 miles of roads within the Middle Tualatin-Rock Creek watershed, as listed on the roads layer of the Tualatin River Watershed Information System ((TRWIS) Ecotrust 1998). Road density provides an indication of the degree of habitat fragmentation caused by roads, as well as potential road-related mass wasting and sedimentation problems. For the watershed as a whole, mean road density was 7.6 miles road per square mile of watershed area. The density of roads varies among the subwatersheds, ranging from 17.3 mi/mi^2 in the Upper Beaverton Creek subwatershed to 2.29 mi/mi^2 in the Middle Tualatin-Jackson Bottom subwatershed (Map 3-8). These figures were determined through use of GIS. Due to legacy roads and new roads, actual road density may be somewhat higher than the numbers cited.

These roads are mostly concentrated in the urbanized watersheds draining to Rock and Butternut creeks. It is expected that most new road construction will take place in and around these watersheds as infill takes place within the UGB and rural residential construction occurs adjacent to the UGB. This is of particular concern in the watersheds of the Tualatin Mountains, where increased urbanization occurs on steep, unstable slopes.

Most issues related to roads are addressed in the report sections devoted to erosion and sedimentation, hydrology, and aquatic species and habitat.

3.3.2.2 Stream crossings

Stream crossing density provides an indicator of the potential for road-related sediment delivery to streams. The TRWIS identifies 688 stream crossings within the watershed[28]. For the watershed as a whole, mean stream crossing density was 4.1 crossings per square mile of watershed area. High stream crossing densities were concentrated in the urbanized subwatersheds draining to Rock and Butternut creeks. The highest density of stream crossings, 11.31 crossings per square mile, was found in the highly urbanized Upper Beaverton Creek subwatershed.

3.3.2.3 Legacy roads

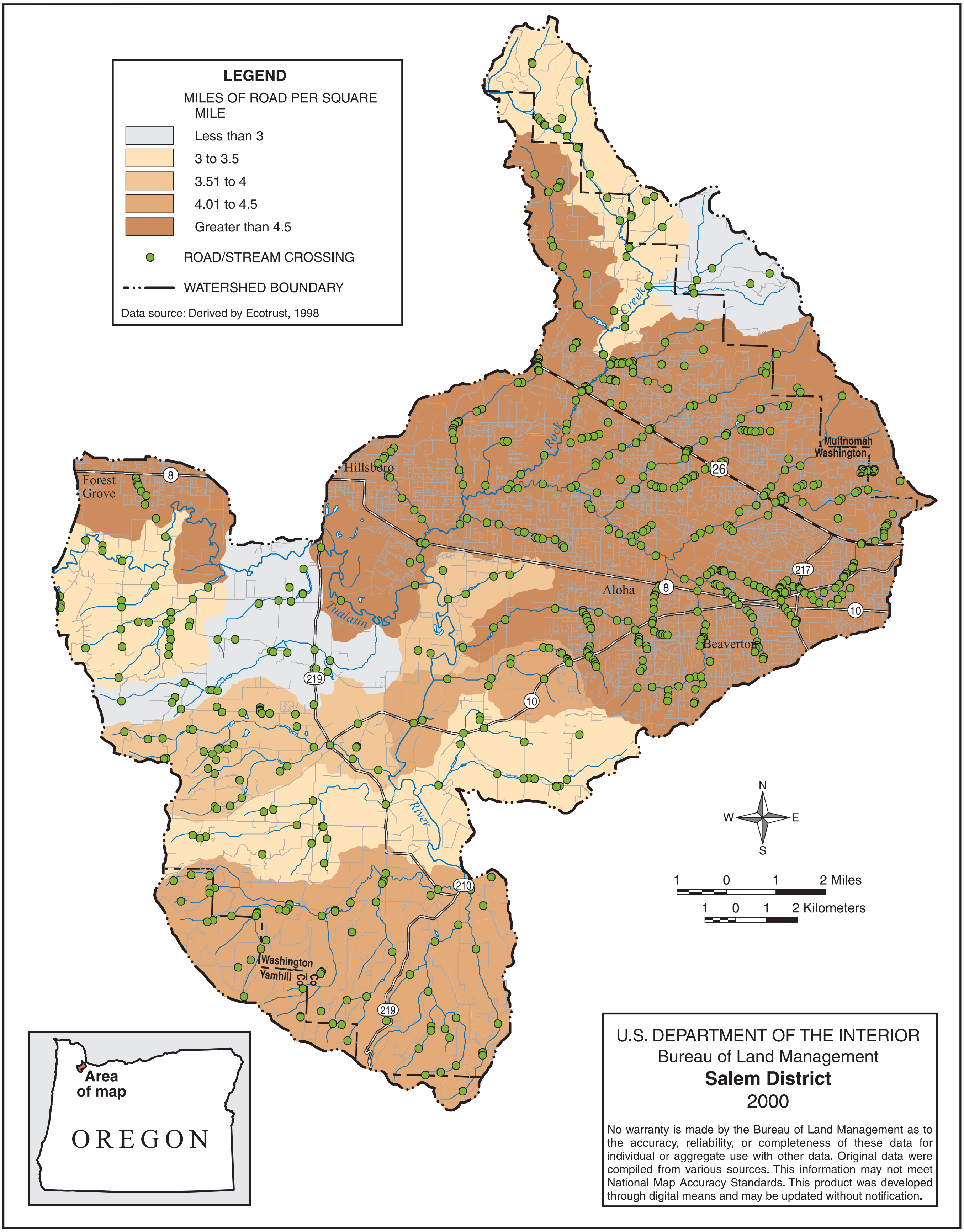
Among the roads potentially posing challenges to watershed management are old, discontinued roads known are legacy roads. These roads are generally not on mapping systems; thus contributing to a discrepancy between road networks displayed on GIS systems and actual road networks. These roads may be located by examination of old maps, timber sale records, and aerial photography. On aerial photographs, they often can be detected from visual cues such as linearly oriented alder trees.

3.3.2.4 Condition of roads on BLM lands

Very little road mileage exists on BLM lands. BLM road 2-3-13 provides legal access to one BLM parcel in the McFee Creek subwatershed (T2S, R3W, Section 13). Due to the lack of management activities in this parcel, this road is not actively maintained by BLM.

3.3.2.5 Access to BLM lands

The BLM parcels in the Upper Rock Creek subwatershed (T2, R2, Section 15) and one McFee Creek parcel (T2S, R3W, Section 13) have road access. The other McFee Creek parcel (T2S, R3W, Section 23) lacks access.



Map 3-8 -- Road Density and Road/Stream Crossings in the Middle Tualatin-Rock Creek Watershed.

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