Part 5

TRYON CREEK ENVIRONMENTAL BASELINE CONDITIONS;

Prepared for:
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INTRODUCTION

This report is part of an on-going watershed assessment and action planning process for Tryon Creek, a small stream system in northwestern Oregon. Tryon Creek enters the lower Willamette River near the City of Lake Oswego. Tryon watershed includes land in Lake Oswego and the City of Portland. The watershed has experienced rapid housing and other urban development during the past twenty years, particularly in the last five years.

Tryon Creek is one of the few remaining streams in the Portland metropolitan area that supports a run of anadromous steelhead trout (*Oncorhynchus mykiss*). The steelhead are part of the Lower Columbia River Steelhead Trout Evolutionarily Significant Unit (ESU), and they are listed as a threatened species under the Endangered Species Act (ESA). There is growing concern that development-related changes in the condition of the watershed, and especially degradation of the fish habitat, will lead to the loss of the steelhead trout and other important natural values of the creek system.

Within the past several years a number of studies have been conducted within the Tryon Creek watershed that provide information useful for assessing the present status of the watershed and fish habitat within the creek. These studies include a report on fish assemblages and distribution for the Tryon Creek watershed which was prepared by the City of Portland Endangered Species Act Program (CoP ESA Report 2001); an Oregon Department of Fish and Wildlife analysis of creek conditions (ODFW Habitat Assessment 2000); a riparian wetland "Properly Functioning Condition" assessment prepared by the National Riparian Service Team (NRST--PFC Report 2001), and several educational field study projects conducted by students at Lewis and Clark College (Ault 1994) and Portland State University (PSU macroinvertebrate sampling 2000-01).

Reports on a macroinvertebrate assessment for the watershed (Klatte 2001), a preliminary hydrologic evaluation of the upper watershed (PWA 1999), and a preliminary hydrogeologic assessment of the Tryon Creek basin (NRMG 2001) also provide insights into existing conditions.

In this study, we used available information in conjunction with our own survey data to develop both a watershed level and a reach-specific assessment of existing fish habitat conditions in Tryon Creek. In the reach-specific assessment, emphasis was placed on identifying limiting factors for anadromous salmonids such as steelhead trout and sea-run cutthroat trout (*Oncorhynchus clarki clarki*).

BASIN OVERVIEW

The Tryon Creek Watershed is approximately 4,200 acres, and is divided between the City of Portland (about 75 %), the City of Lake Oswego (about 10 %), and unincorporated rural residential land in Clackamas and Multnomah Counties. The watershed is entirely within the Metro urban growth boundary. It is bounded to the east by the Palatine Hills, to the north and west by Portland's west hills, and to the southwest by Mt. Sylvania.

The Tryon Creek watershed is decidedly urban although the most significant feature of the watershed is Tryon Creek State Park, a 640-acre Oregon State Park shared by the cities of Portland and Lake Oswego. Tryon Creek is approximately seven stream miles long, originating in Mt. Sylvania (970 feet msl) and flows southeasterly into the Willamette River (10 feet msl). Tryon Creek is one of the major remaining free flowing tributaries that drains Portland's West Hills. The Creek's major tributaries include: Arnold Creek, Falling Creek, Park Creek, and Nettle Creek (Figure 2).

Fish species known to occur in Tryon Creek include coho salmon (*Onchorhynchus kisutch*), steelhead trout, cutthroat trout, and sculpins (*Cottus spp.*). Tryon Creek is one of the few remaining streams in the Portland metropolitan area that still supports a small run of steelhead trout.

Methods

To provide a watershed level assessment of existing fish habitat in the Tryon Creek watershed, we used the National Marine Fisheries Services (NMFS) Matrix approach for evaluating baseline conditions for anadromous salmonid habitat (NMFS 1996). This approach evaluates a list of environmental pathways and indicators that are known to be important in determining the suitability of freshwater habitat to anadromous salmonids. For each indicator a determination is made as to whether it is "properly functioning", "at risk", or "not properly functioning". The NMFS' "Matrix of Pathways and Indicators" (Appendix A) provides criteria for making these determinations at the watershed scale. For example, water temperature (an indicator of water quality) is considered to be properly functioning if it is within the range 50-57^0 F, at risk if in is in the range 57-60^0 F during spawning or 57-64^0 F during rearing, and not properly functioning if it is >60^0 F during spawning or >64^0 F during rearing. Similar criteria are available for each of the indicators shown in the checklist of pathways and indicators (Table 1).

Some of the criteria in the NMFS' matrix are based on quantitative measurements and some are based on professional judgment, especially when applying the criteria to a urban watershed. We used available information as well as observations made during habitat surveys of the Creek conducted in October and November, 2001 to make the determinations for each indicator. James Turner (NMFS Fisheries Biologist) and Bernard Klatte (Consulting Fisheries Biologist) conducted the October 17 survey. During this survey, the criteria in the Matrix of Pathways and Indicators were discussed and evaluated relative to their application in urban watersheds. On November 30, 2001 Bernard Klatte returned to Tryon Creek to evaluate selected environmental indicators in the creek under higher flow conditions.

A reach-specific limiting factors analysis also was conducted to identify key problem areas for salmonid fish species that historically have used the watershed. This analysis was conducted using the Washington Conservation Commission (WCC) criteria established in "Salmonid Habitat Condition Rating Standards for Identifying Limiting Factors". The WCC criteria are very similar to the NMFS' watershed criteria and employ a similar matrix approach. However, the WCC criteria or more appropriate for evaluating limiting factors in specific reaches of a stream rather than the entire watershed. The WCC matrix lists each potential limiting factor and provides a rating of "good", "fair", or "poor" based on a quantifiable range for each parameter (Appendix B).
The study area for this survey is based on the reach map established by ODFW, 2000, Habitat Inventory Survey (see preceding report this publication, by ODFW).

Limiting Factors Analysis

In conducting the Limiting Factors Analysis, information was gathered from local, state and federal agencies and other sources including the gray literature (files and unpublished data). Many of the contacts providing information identified additional sources for review. Documents were evaluated for relevance to the Limiting Factor Analysis in Tryon Creek and are summarized in an annotated bibliography (Appendix C). The annotated bibliography lists the author, year, title, location and a brief description of the contents. We also used site-specific survey data gathered during the October 17 and November 30 surveys discussed above. The site-specific data included measurements of channel width, pool depth, riffle/pool frequencies, substrate condition, and bank condition in each of four reaches of mainstem Tryon Creek.

Study Reaches
The four study reaches (Figure 3) in Tryon Creek were initially established by ODFW (ODFW 2001) as part of their Aquatic Inventory Project for Oregon streams. We used the same reaches during our survey of the creek. The following is a general description of the boundaries of each reach:

Reach 1: Begins at the confluence of Tryon Creek with the Willamette River and ends at the west side of the State Route 43 stream crossing (culvert) (392 meters).

Reach 2: Begins at the west side of State Route 43 stream crossing and ends at the confluence of Nettle Creek with Tryon Creek in the Tryon Creek State Park (junction of Iron Mt. Bridge trail with Red Fox Bridge trail) (1,309 meters).

Reach 3: Begins at the confluence of Nettle Creek with Tryon Creek and ends at the confluence of Arnold Creek with Tyron Creek, just upstream from SW Boones Ferry Road stream crossing (culvert) (2,621 meters).

Reach 4: Begins at the confluence of Arnold Creek with Tryon Creek and ends at the confluence of Falling Creek with Tryon Creek just upstream with SW Lancaster Road (2,157 meters).

RESULTS

Watershed Evaluation

Results from the watershed-level evaluation (NMFS Matrix and Checklist) indicate that the Tryon Creek watershed is no longer properly functioning with respect to nearly all of the environmental parameters important to salmonid fish species (Table 2).

Water quality is degraded throughout the majority of the basin. Water temperatures during the summer often are greater than 64^0 F and Tryon Creek has been added to the 303(d) list of streams not in compliance with federal water temperature guidelines. Fine sediments blanket the lower ends of several of the tributary streams and comprises from 27 to 44 percent of the substrate in mainstem Tryon Creek riffle habitat.

No information was available to us on the occurrence of toxic chemicals or nutrients in Tryon Creek. However, it is possible that storm water runoff from paved areas in the upper watershed could be contributing oils and grease and possibly trace metals to the creek. Also drainage from lawns and gardens in the upper watershed could be contributing pesticides and plant nutrients.

Several physical barriers to fish migration were identified in the watershed and will be discussed below relative to limiting factors for salmonids. Habitat elements (i.e., substrate, large woody material, pool frequency, pool quality, off-channel habitat, and refugia) were all found to be "not properly functioning". Tributaries and mainstem habitat in the upper reaches of the watershed tended to be in the worst shape with respect to habitat elements.

These are the areas where most of the development has occurred in the watershed. Large woody material is generally in low abundance throughout the watershed although recruitment potential in Tryon Creek State Park is fair to good. Deep pool habitat (i.e, >1 m deep) is generally lacking throughout mainstem Tryon Creek and its tributaries. A few deep pools are present in Tryon Creek State Park.

Channel condition was evaluated with respect to width/depth ratio, streambank condition and floodplain connectivity. According to the NMFS' matrix criteria, width/depth ratios <10 are recommended for properly functioning forested, small salmonid streams. The width/depth ratio for mainstem Tryon Creek ranged from 11.1 to 16.2 with most of the values falling within the "at risk" category (i.e., 10 to 12). Streambank conditions were variable. Banks in the upper reaches of the watershed are often highly modified due to housing developments and high densities of paved streets. Within Tryon Creek Park, there are localized areas of bank erosion due to overuse by park visitors and failing cross drains.

Floodplain connectivity is very poor in the upper reaches of the watershed where much of the stormwater runoff is channeled through ditches or conveyed by storm drains. Many of the tributary stream channels in the upper reaches of the drainage basin show downcutting and a general loss of channel complexity. The section of Tryon Creek that passes through Tryon Creek Park is better connected with its flood plain but still shows degradation due to down cutting. The lower end of the creek (between the mouth and State Route 43) has been confined due to filling and bank stabilization. Head cutting is occurring within this reach.

Flow/Hydrology has been substantially modified due to runoff from impervious surfaces in the upper watershed and a complex network of storm drains and ditches that convey runoff water within the basin. Peak flows and an increased frequency of high flow events represent pronounced changes in hydrology relative to an undisturbed watershed of similar size, geology and geography. In addition, there has been a significant increase in the drainage network density due to roads in the upper portions of the watershed and the previously-mentioned complex network of storm drains and ditches.

General watershed conditions were evaluated with respect to road density and location, disturbance history and riparian reserves. Road density is >3 miles of road per square mile of watershed, which is the criterion for a not properly functioning condition. Although much of the lower mainstem of Tryon Creek lies within relatively protected State Park lands, the majority of the upper watershed has undergone extensive disturbance due to development of residential and commercial property and extensive street development.

The rate of development has increased substantially within the last 10 to 15 years, which has intensified problems in the small headwater tributaries that feed Tryon Creek. Disturbance history was given a "not properly functioning" rating due to the relatively large percentage of the watershed that has been disturbed. Riparian reserves in the Tryon Creek basin are fragmented and poorly connected in the majority of the upper watershed. Riparian reserves in Tryon Creek Park are in better condition and provide shade and limited refuge habitat for sensitive species such as steelhead and cutthroat trout. Overall, riparian reserves were given a "not properly functioning" rating.

Table 1. Results of properly functioning condition analysis for the Tryon Creek watershed.

PATHWAYS Indicators	SOURCE	ENVIRONMENTAL BASELINE		
		Properly Functioning	At Risk	Not Properl Functioning
▪ Temperature	303(d) ODEQ 1996			■
▪ Sediment	27% - 46% fines, ODFW 2001			■
▪ Chemical		Unknown	Unknown	Unknown
▪ Physical Barriers	ODFW 2001			■
▪ Substrate	ODFW 2001			■
▪ Large woody	16.1- 49.0/mi, ODFW 2001			■
▪ Pool Frequency	12.9 - 17.9/mi, ODFW 2001			■
▪ Pool Quality	1.1- 6.3/mi, ODFW 2001			■
▪ Off-Channel Habitat	0.24 - 4.9/mi, ODFW 2001			■
▪ Refugia	0, ODFW 2001			■
▪ Width/Depth **Ratio	11.1 - 16.2, ODFW 2001		■	■
▪ Streambank	31% - 58%, ODFW 2001			■
▪ Floodplain	ODFW 2001			■
▪ Peak/Base Flows	BES 1997			■
▪ Drainage Network	BES 1997			■

▪ Road Density & Location	> 3, BES 1997			[redacted]
▪ Disturbance History	>15% , BES 1997			
▪ Riparian Reserves	<70%, ODFW 2001			

Reach-Specific Limiting Factors Analysis

The WCC Limiting Factors Analysis matrix utilizes many of the same indicators as the NMFS matrix. However, Technical Advisory Group members, including local citizens, state and federal agency biologists, specialists and planners, developed the WCC matrix specifically for evaluating limiting factors for anadromous salmonids (G. Wade, pers. comm. 2001).

The LFA matrix ranked each of the four reaches on the mainstem Tryon Creek similarly, with all reaches receiving an overall average of *"poor"* (Table 3). Reaches 2 and 3, which are primarily located within Tryon Creek State Park, received *"fair"* scores for several limiting factors.

All four reaches in Tryon Creek have various levels of limiting factors to fish production. The major limiting factors are addressed in the following paragraphs:

Fish Passage Barriers: Access to spawning and rearing habitat in the basin is a major limiting factor to anadromous fish production. Access to anadromous salmonid spawning and rearing habitat upstream of Reach 1 appears to be limited due to a culvert under State Route 43. The culvert is a concrete box culvert, which has been retrofitted with baffles to improve passage of adult anadromous salmonids. However, the culvert still appears to represent a partial barrier, particularly to fall-spawning coho salmon. Historically, adult coho salmon spawned throughout the mainstem of Tryon Creek. Since the culvert was installed under State Route 43, no adult coho have been observed above this culvert. Recent electrofishing surveys in Tryon Creek have found juvenile coho salmon only downstream of the culvert. Since Reach 1 lacks spawning habitat suitable for coho salmon, the juveniles observed were probably spawned elsewhere in the Willamette River system and were probably using the lower reach of Tryon Creek for rearing. Adult steelhead trout have not been documented above the State Route 43 culvert for several years (ODFW 2001).

However, steelhead runs have been low in the Willamette River basin during the past several years and numbers returning to small streams such as Tryon Creek would be expected to be small. Juvenile rainbow/steelhead trout were captured during electrofishing surveys conducted by the City of Portland in 2001 in Tryon Creek State Park (Reaches 2 and 3), which indicates that some successful steelhead spawning has probably occurred above the State Route 43 as recently as the spring of 2000. Steelhead return to spawn in the winter and spring, when flow conditions in the creek are relatively high. Higher flows through the State Route 43 culvert may allow steelhead better access than the coho salmon, which typically spawn during relatively low flow conditions in the autumn.

Access is also a problem at the culvert under S.W. Boons Ferry Road (upper end of Reach 3). This is a long (over 100 ft), sloped, culvert. Juvenile salmonids would not be able to move upstream through the culvert under any flow conditions and adult upstream migration is more than likely limited to a relatively narrow range of flow conditions.

Detailed analyses of the limiting conditions at culverts in the watershed were not one of the objectives of this study. Further studies would be necessary to specifically identify the limiting conditions for salmonid migration at each culvert.

Fine Sediment: Excessive fine sediment concentrations represent a serious limiting factor for successful spawning of salmonid fish species in Tryon Creek. We found that most of the potential spawning areas (i.e., shallow riffles and pool tailouts) contained gravel that was heavily embedded in fine sediments. Fine sediments have been shown to reduce the flow of oxygenated water to incubating embryos and thereby reduce survival of embryos. Also, excessive fine sediment deposition on salmonid redds can seal the substrate and block alevins from moving out of the gravel. Sediments appear to be entering the system from headwater tributaries as well as from localized bank erosion.

Large Woody Debris: Large woody debris was in low abundance throughout all four of the study reaches. However, Reaches 2 and 3, which lie primarily within Tryon Creek State Park, contained over twice as many pieces of large woody debris per unit length of stream than either Reach 1 or Reach 4. The number of pieces per mile in all four reaches was well below the number recommended for a healthy anadromous salmonid stream. The low number of deep pools, lack of backwater areas and off-channel habitat in Tryon Creek can be related to the absence of large wood. Large wood (key pieces) provide cover, create pools, and provide habitat diversity and complexity for fish. Instream wood is important in reducing flood flow energy and storing sediment. The potential for large wood recruitment to the creek appeared to be substantially higher within the boundaries of Tryon Creek Park than in areas outside the Park.

Water Temperature: Summer water temperatures exceed recommended maximum levels throughout all four reaches. This is an important limiting factor because steelhead trout, sea-run cutthroat trout, and coho salmon rear for one or more years before migrating to the ocean. Juveniles of these species, therefore, are subjected to temperature conditions during the summer that can increase stress and potentially increase susceptibility to diseases. Summer temperatures are apparently not reaching lethal levels for salmonids as indicated by the presence of a resident population of cutthroat trout. The summertime warming appears to be caused by lack of adequate riparian shading in headwater streams and low summer flow conditions throughout the watershed.

Floodplain Conditions: A large part of the Tryon Creek watershed is disconnected from its active floodplain due to streambank hardening, channelization, and channel incision. In a functioning system, the width of a floodplain acts as a buffer during flood events (storage). It dissipates stream energy allowing suspended sediments to deposit on the banks, providing access to habitat for fish during flood flows, and recharges groundwater. The disconnection in Tryon Creek can be attributed to the increase in higher flows from impervious runoff and lack of instream large woody debris (LWD) to reduce the stream energy. The increase in water in the confined channel creates an increase in stream energy and down-cutting occurs to the channel bed (incision).

In summary, Tryon Creek is suffering from a variety of problems that are limiting its suitability for production of anadromous salmonids. Protection of riparian habitat provided along the lower mainstem by Tryon Creek State Park is probably the primary reason that salmonids are still present in the system.

Table 2. Limiting Factor Analysis for four reaches of Tryon Creek .

Limiting Factor	Score			
	Reach 1	*Reach 2*	*Reach 3*	*Reach 4*
Fish Passage Barriers	Poor	No barrier	Poor	Poor
Floodplain Connectivity	Poor	Fair	Fair	Poor
Loss of Floodplain Habitat	Poor	Fair	Fair	Poor
Fine Sediment	Poor	Poor	Poor	Poor
Large Woody Debris	Poor	Poor	Poor	Poor
Pool Quality	Poor	Poor	Poor	Poor
Pool Quantity	Poor	Fair	Fair	Poor

Streambank Stability	Poor	Fair	Fair	Poor
Side Channel Habitat	Poor	Poor	Poor	Poor
Sediment Supply	Poor	Poor	Poor	Poor
Road Density	Poor	Poor	Poor	Poor
Riparian Condition	Poor	Fair	Fair	Poor
Temperature	Poor	Poor	Poor	Poor
Dissolved Oxygen	Fair	Fair	Fair	Fair
Nutrients (Carcass)	Poor	Poor	Poor	Poor
Flow	Poor	Poor	Poor	Poor
AVERAGE SCORE	Poor	Poor	Poor	Poor

DISCUSSION AND CONCLUSIONS

The present degraded condition of Tryon Creek is symptomatic of many urban streams that have excessive amounts of impervious surface in their watersheds. Research conducted in King County, Washington (metropolitan Seattle area) sheds light on how stormwater runoff from developed basins effects stream channel stability and structure (King County 1990 a, b; Booth 1991).

Before discussing the King County studies, a brief review of the natural hydrological process in a watershed will help clarify how urban and suburban development is altering the natural process. Typically, only a fraction of the total precipitation falling on a basin actually reaches the stream channel. The remainder: 1) never reaches the ground and is evaporated off the surfaces of vegetation; 2) enters the ground but is transpired by plants or evaporated from the soil; or 3) percolates deeply to the regional groundwater system, with any subsequent entry to subsurface channels significantly delayed. Of the fraction that reaches the channel, its time of arrival is controlled by whether it flows primarily through the subsurface or over the surface, how quickly it is collected into open channels, and whether it is detained in reservoirs (Booth 1991).

Disruption of a stream channel by very high flow is a natural process that occurs erratically but with characteristic time scales. During such events, the channel form itself is affected-streambanks erode, large cobbles and boulders are moved, woody debris is repositioned or flushed from the system, pools are filled, and bars are scoured. Although the form of the channel is disrupted and the quality of the aquatic habitat degraded, effects are temporary. The "disturbance" ultimately results in a reformed, rejuvenated environment that continues for many years in a state of relative stability (Booth and Baker 1998). In the Pacific Northwest and other humid environments, channel disruptions are caused by flows larger than the 5-year flood event (Carling 1998, Sidle 1988).

Salmonid populations in the Pacific Northwest have evolved under conditions of episodic disturbances. Under natural conditions, rates of disturbance and subsequent recovery varied widely, even between streams of the same watershed. Habitat elements were altered but had periods of stability that lasted from a decade to century, or more (Booth 1991).

The runoff studies conducted by King County show that hydrologic changes imposed by urban development profoundly affect the disturbance frequency in developing basins. Using a continuous hydrologic computer model (HSPF), Booth (1991) determined the occurrence between 5-year flood events in a sample basin under completely forested conditions and fully urbanized conditions (40 percent impervious surface), using the same 40-year precipitation record for both simulations. The simulation for the forested watershed resulted in seven floods at or above the predevelopment 5-year discharge, with as much as 14 years between floods. In contrast, the same precipitation in the simulated urbanized watershed had only one year without a predevelopment 5-year flood event. Since Booth's initial modeling work, additional studies have been conducted that indicate as little as 10 percent impervious surface in some watersheds may result in development of unstable stream channels.

Booth (1991) reported that channel changes from increased flows and altered corridors have a characteristic "look" to them. Their beds are uniform, with few pools or developed riffles; channel banks are near vertical and exposed to erosion; woody debris is small and sparse; and aquatic organisms are nearly absent. These conditions often occur throughout all the streams of an urban drainage. They are maintained in this sterile condition by the high frequency of 5-year or greater flood events.

The changes in steam habitat resulting from urban development may be detrimental, long term and, to an extent, irreversible. Many urban streams in King County have already reached a point where rehabilitation is unlikely (Booth 1991). Compensation for the effects of increases in impervious surfaces in urban watershed generally involves the use of detention basins. Detention basins can reduced the rate of runoff, but they also can block migration routes for anadromous salmonids.

As documented by this study, Tryon Creek is suffering from many of the same effects described by Booth (1991) for developed King County urban streams. Impervious surfaces in the Tryon Creek watershed amount to approximately 30 percent of the surface area, which is approaching a fully built out condition. Even so, there are some encouraging signs with respect to the current condition of Tryon Creek. Stream banks in the lower and mid mainstem of the creek are relatively in tact and benthic macroinvertebrate densities were recently found to be in the moderate range for similar size undisturbed streams (Klatte, 2001). A resident population of cutthroat trout is still present and some spawning and rearing of steelhead trout appears to be occurring.

The solutions for reducing rates of surface runoff are complex and expensive. A carefully designed management plan and widespread, long-term cooperation among landowners and local governing bodies will be required to stop further degradation of fish habitat from surface water runoff. The most important short-term steps to improve use of the area by anadromous salmonids include:

1) upgrading fish passage at problem culverts,

2) reducing fine sediment loading from headwater tributaries,

3) lowering summer water temperature through enhancement of riparian shade in the upper basin,

4) creating more deep pool habitat that can be used as winter refuge for juvenile salmonids.

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PERSONAL COMMUNICATION

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PART 6

Overview of Existing Conditions, Data Gaps and Recommendations for the Protection and Restoration of Aquatic Resources

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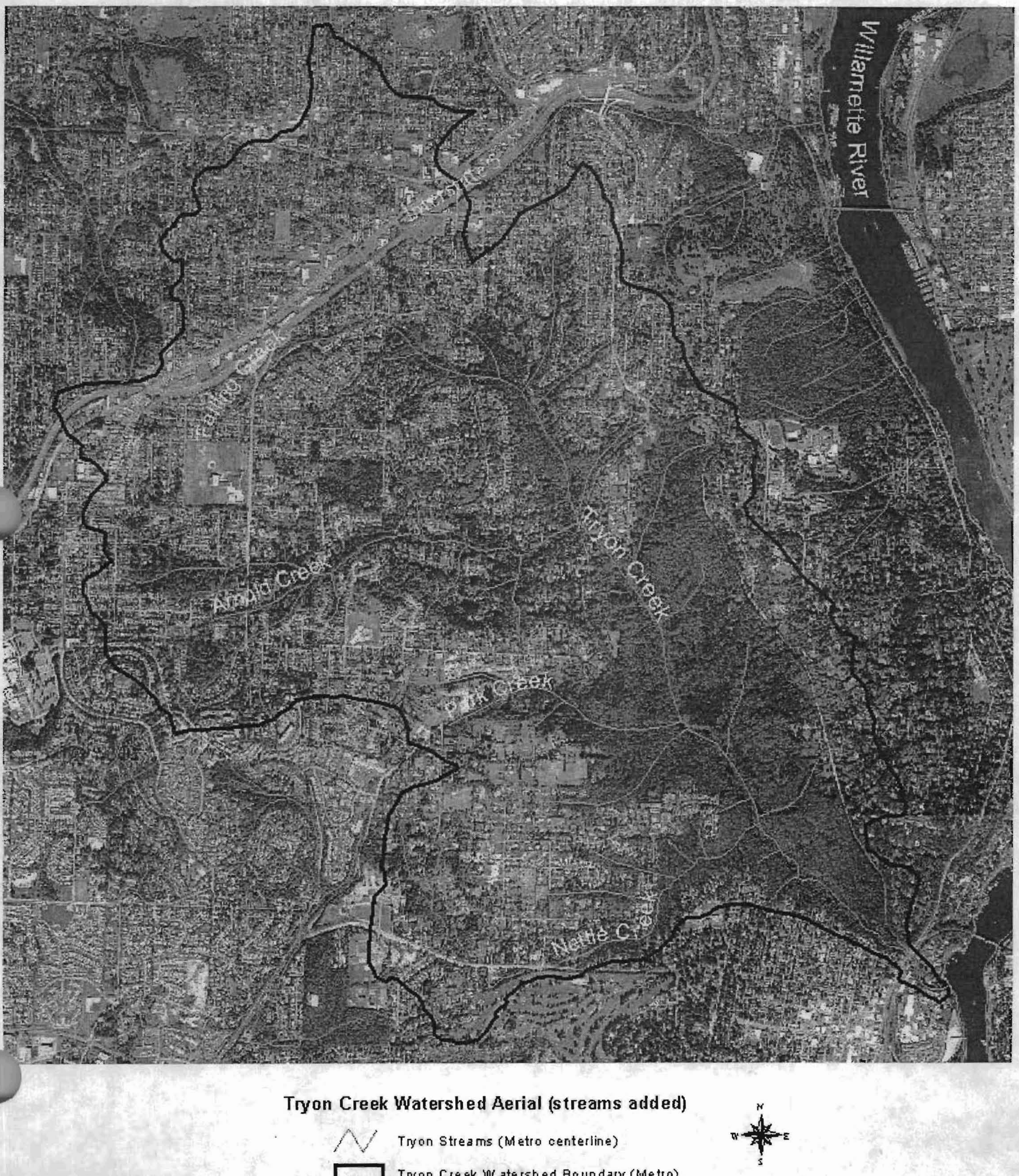
Map 1--Tryon Creek Watershed
Source: Stream centerline is from METRO RLIS data, 2001. Watershed boundary--black outline; stream centerline--blue line. Tributaries highlighted: Falling, Arnold, Park and Nettle.



Introduction

This report provides an overview and description of existing watershed and stream conditions in Tryon Creek, based on previous assessments and information. This report also describes the effects of existing watershed conditions on stream conditions, water quality, and the survival of salmonids in Tryon Creek. Based on this overview, this report identifies existing data gaps in the information on the condition of the Tryon Creek watershed and its embedded aquatic resources. It also briefly describes potential monitoring to fill those data gaps and determine trends in these conditions. Last, the report provides recommendations to protect and restore aquatic resources in the watershed, based on available information.

Physical Setting and Land Use

Tryon Creek is a tributary of the Willamette River, with a watershed area of about 4,200 ac. Elevations in the watershed range from about 970 feet above mean sea level at Mt. Sylvania to about 10 feet above mean sea level at the confluence with the Willamette River.

Annual average precipitation is about 36.3 inches. Almost all precipitation falls as rain. Winters are wettest: on average, almost 57% of the average annual precipitation occurs from November to February. On average, there is less total precipitation from June through September period than typically occurs in monthly November, December, or January. These precipitation patterns strongly shape streamflows. Flows are typically highest from November through May in response to rain events. Flows typically are lowest in July-September.

The area was historically forested. It appears that by the 1920s the area had been largely deforested by logging, fire, and clearing (PWA, 1997).

The watershed has been extensively and intensively urbanized, with the major exception being the 640-acre Tryon State Park in the lower central watershed (**See Map 1**). There are also several smaller city parks with a total area of about 45 acres scattered in the upper watershed. Impervious areas are estimated to occupy about 23% of the total watershed area, based on city estimates of the surface coverage by buildings, parking lots, and roads. Much of the upper watershed is urbanized so actual impervious area is likely higher than 25%, since imperviousness computations do not include driveways and sidewalks. Further, "effective" impervious area is still higher, because areas converted to lawns or where forest cover have been removed significantly increase runoff, acting as less permeable areas that contribute to the total "effective impervious area" (Booth and Jackson, 1997; Booth et al., 2002).

Salmonid Species

Tryon Creek provides habitat for steelhead trout *(Oncorhynchus mykiss)* included within the Lower Columbia River Evolutionary Significant Unit (ESU) as designated by NMFS. It also provides habitat for coastal cutthroat trout *(O. clarki clarki)* which are part of the Southwest Washington/Columbia River ESU that had been considered for listing under the Endangered Species Act (ESA). Although coastal cutthroat trout have declined widely and their habitat is severely degraded throughout the ESU (Federal Register, 1999; Johnson et al., 1999), in June 2002, the U.S. Fish and Wildlife Service opted not to list this ESU under the ESA (Federal Register, 2002). The stream also provides habitat for coho salmon (*O. kitsuch*), chinook salmon (*O. tsthwayscha*), and chum salmon (*O. keta*) (Klatte and Ellis, 2002). Currently, steelhead and cutthroat trout and coho salmon are found in Tryon Creek (STREAMNET, 2000; City of Portland, 2001). Coho salmon are a candidate species for listing under the ESA (City of Portland, 2001; Federal Register 1999).

Watershed Conditions and Effects on Aquatic Resources

Land use in Tryon Creek has had profound effects on watershed hydrology, sediment flux, and channel conditions. In aggregate, these effects have degraded the aquatic system and watershed function, resulting in increased peakflows, reduced low flows, elevated sediment delivery to streams, increased channel erosion, degraded fish habitat reducing the survival and production of salmonids, and reduced water quality. Several recent assessments of Tryon Creek conditions all indicate that stream conditions are significantly degraded (ODFW, 2001, Klatte and Ellis, 2002; Anderson, 2001; Portland BES, 1997), consistent with a considerable body of knowledge on the effects of urbanization on aquatic resources (e.g., Hammer, 1972; Graf, 1975; Dunne and Leopold, 1978; Booth and Reinelt, 1993; Moscrip and Montgomery, 1997, Trimble, 1997; Booth and Jackson, 1997; Booth et al., 2002). It is notable that the recent assessments of conditions in Tryon Creek used different methods, but still arrive at the same general conclusions, providing a strong indication of the veracity of the results.

Historic logging and conversion of forest to other vegetation assemblages has contributed to this existing situation, however, urbanization has had the greatest impacts on these aquatic resources and is currently the primary cause of existing degradation in Tryon Creek. The impacts of urbanization are almost impossible to correct or limit once significant urbanization occurs (Booth and Jackson, 1997; Booth et al., 2002). The only effective approach to limiting continued degradation is to avoid additional damage to the watershed and watershed function from the effects of on-going urbanization (Booth et al., 2002).

Alteration of Streamflows

Although streamflow records are lacking, urbanization has undoubtedly altered streamflows quite significantly in Tryon Creek. **(See Map 2)** Impervious areas significantly increase both the volume and duration runoff during storms (Hammer, 1972; Graf, 1975; Dunne and Leopold, 1978; Booth and Reinelt, 1993; Moscrip and Montgomery, 1997; Trimble, 1997; Booth and Jackson, 1997; Booth et al., 2002). Based on previous studies in other areas, it is likely that urbanization in the watershed has at least doubled peak streamflow in Tryon Creek. Previous studies in other areas indicate that urbanization increases peak flow rates by 2 to 5 times the pre-development flows (Booth and Reinelt, 1993).

It is also likely that duration of high flows in response to rain have been increased by urbanization. Previous studies have indicated that high flow duration is increased by a factor of 5 to 10 by urbanization (Booth and Jackson, 1997). Urbanization also increases the frequency of flows that are large enough to transport sediment, erode channels, and degrade habitats (Booth and Reinelt, 1993; Moscrip and Montgomery, 1997; Trimble, 1997; Booth and Jackson, 1997; Booth et al., 2002). These interrelated changes in high flows all combine to increase stream channel erosion and significantly alter a wide variety of channel conditions (Hammer, 1972; Graf, 1975; Dunne and Leopold, 1978; Booth and Reinelt, 1993; Moscrip and Montgomery, 1997; Trimble, 1997; Booth and Jackson, 1997; Booth et al., 2002).

Peakflow elevation from urbanization significantly affects salmonid populations and habitats. Montgomery and Moscrip (1997) found that the increased frequency and duration of flood flows in urbanized watersheds was associated with a decline in salmon numbers in the Puget Lowlands, Washington. They concluded that their data indicated a link between the decline in salmonids and increased flood frequency or related changes in salmonid habitat conditions.

While impervious areas primarily cause these increases in peakflows, several other factors contribute to elevate runoff and peakflows. These factors include rapid delivery of runoff from storm drains, removal of native vegetation, conversion of land to lawns, soil compaction, stream and floodplain encroachment, and accelerated soil loss from the combined effect of increased surface runoff and change in vegetation.

It is estimated that there are a total of 170 storm drain outfalls within the Tryon Creek watershed. Of these, 134 are from the City of Lake Oswego and 36 are from the City of Portland. It appears that 19 of the City of Portland outfalls and 13 of the Lake Oswego outfalls are within 50 ft. of identified streams. **(See Map 3)**

Map analysis indicates that almost all of the Portland outfalls and about half of the Lake Oswego outfalls drain directly into Tryon Creek or its tributaries (pers. comm., J. Robison, West Multnomah SWCD). However, these numbers have not yet been verified by the responsible agencies in the cities. Currently, the catchment areas for each outfall are unknown, as are the outfall dimensions and likely volume and capacity. Although there are gaps in information on the specifics of the storm drains, storm drain outfalls have undoubtedly increased the duration and magnitude of peakflows by rapidly shunting runoff from impervious surfaces to the stream system.

Although the effects of soil loss on streamflows are often overlooked, these effects are not trivial. The loss of 1 inch of soil over 1 square mile results in the loss of more than 813,120 cubic feet of available water storage in the soil profile.

Soil compaction further reduces available water storage in the remaining profile. Both compaction and accelerated soil loss inevitably occur as a result of urbanization. Reductions in water storage in the soil profile cause the same type of effects on peak streamflows as impervious areas: increased peakflows, increased duration of high flows, and increased frequency of sediment-transporting flows. Although soil loss and compaction causes these effects to a lesser degree than impervious areas, all of these effects on flows are additive. While not all of this lost soil water storage is converted directly to flow, it still contributes significantly to peakflow elevation, especially during intense or prolonged storms.

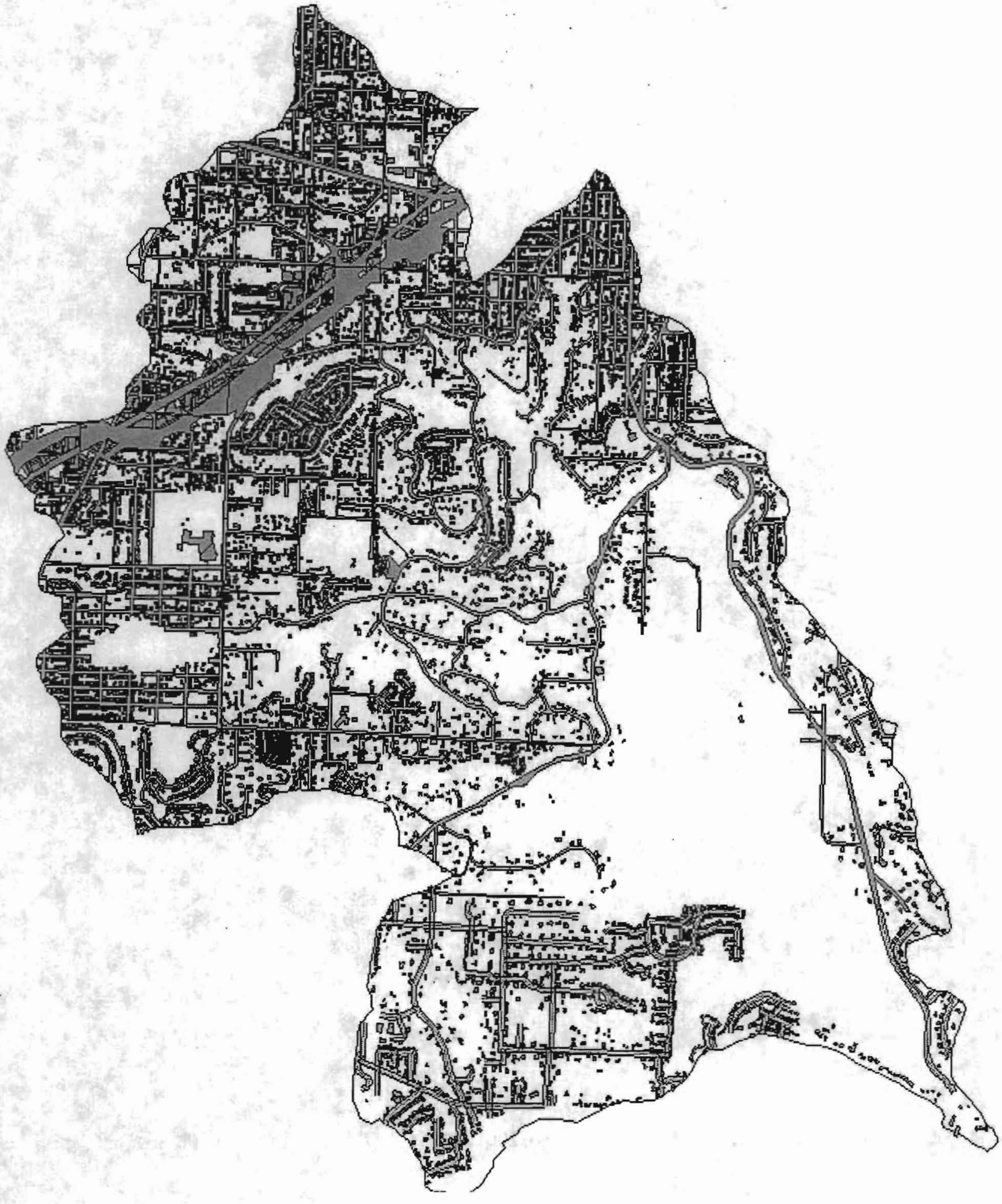
Infrastructure in riparian areas also increases peak stormflows by reducing water storage in the near-stream environment. The losses of water storage in the near stream soil environment and resultant increases in the magnitude and duration of peakflows are not trivial. For instance, a pipe with a diameter of 1 foot causes a loss of 4,145 ft^3 of water storage in riparian soils per mile of pipeline, while a 2-foot diameter pipe causes a loss of about 16,580 ft^3 of water storage in riparian soils per mile of pipeline. This loss of water storage translates to increased peakflows and adds to the increases caused by soil loss, soil compaction, and impervious areas.

Much of the near-stream environment in Tryon Creek has sewer lines running along the stream (**See Map 4**). Currently, it estimated that in Tryon Creek there are about 20,900 ft of pipelines within 50 ft of stream channels within the City of Portland and another 7,070 ft within 50 of stream channels from Lake Oswego. This results in a total of about 5.3 miles of pipeline within 50' of channels within the watershed. The pipelines within the City of Portland vary in diameter from 0.25- 3.5 ft; the diameter of pipelines within 50 ft. of streams in Lake Oswego is currently unknown. (The weighted average of pipeline diameter data was used to estimate the diameter of pipelines that did not have associated diameter data.) Based on the length of pipelines within 50 ft. of streams and pipe diameter information, pipelines within Tryon Creek have caused the loss of about 40,200 ft^3 of potential water storage within riparian soils. This loss of potential water storage adds to increased peakflows.

The severity of contributions to increased peakflows caused by these factors tends to increase with proximity to the stream. Impervious areas, soil loss, compaction, and infrastructure within riparian areas tend to have more pronounced effects on peakflows then the same impact outside of riparian areas.

The same watershed impacts that increase peakflows also decrease lowflows. Impervious areas, storm drain outfalls, soil loss and compaction, and pipelines all reduce low flows by reducing the water storage in soils, reducing infiltration, and rapidly shunting runoff to the stream system instead the soil system where it can be captured, stored, and ultimately released during the low flow period. Pipelines near streams may also reduce flows by acting as a barrier to subsurface flows to streams. Based on existing conditions, it is clear that lowflows in Tryon Creek have been decreased by cumulative watershed impacts and, especially, urbanization.

Map 2--Tryon Creek Impervious Surfaces
Darkened areas indicate impervious surfaces. Data includes only buildings, streets and large parking lots.
Sources: City of Portland, City of Lake Oswego, 2001.



Map 3 Tryon Creek Composite: Streams and Municipal Storm Drain Outfalls;
Dots indicate municipal storm drain outfalls within 50 feet of mapped streams. All data need field checking.

Data Sources: Cities of Portland and Lake Oswego, 2001.

Lowflows are also reduced by channel incision caused by increased channel erosion. The increased channel erosion has been triggered by increased peakflows combined with the loss of riparian vegetation, as commonly occurs in urbanized environments (Booth and Reinelt, 1993; Trimble, 1997). Significant channel incision already occurs in much of Tryon Creek (Portland BES, 1997; Anderson, 2001). Channel incision reduces lowflows by lowering the shallow watertable near the stream, which ultimately reduces groundwater contributions to lowflows (Ponce and Lindquist, 1990).

Reduced low flows can have serious negative impacts on salmonids via several mechanisms. Reductions in low flows can create migration barriers and reduce the area of usable habitat, which can limit the survival of salmonids. Summer water temperatures also increase as lowflows are reduced (Beschta et al., 1987; Rhodes et al., 1994). Increased summer water temperatures reduce salmonid survival (McCullough, 1999).

Sediment dynamics

Urbanization greatly increases erosion and subsequent sediment delivery to streams. Erosion and sediment delivery are particularly high during construction of infrastructure (Dunne and Leopold, 1978), but remain significantly elevated thereafter. These increases are caused by soil compaction and soil loss, increased runoff, increased channel erosion, and removal of native vegetation and groundcover (Booth and Jackson, 1997; Booth et al., 2002). The net result of these changes at the watershed scale can increase sediment yield by several orders of magnitude (Trimble, 1997; Booth and Jackson, 1997; Booth et al., 2002). Soil loss, impervious areas, increased runoff, and removal of native vegetation and groundcover have even greater impacts on sediment loads when they are in close proximity to the stream.

Riparian areas

A significant amount of the riparian area within the Tryon Creek has been affected by historic logging and urbanization (Portland BES, 1997; Klatte and Ellis, 2002). As discussed, these activities contribute significantly to elevated peakflows and sediment loads. However, impacts within riparian areas also have several other adverse effects on stream channels. The removal of riparian trees and vegetation has decreased bank stability in Tryon Creek, and made the channels more vulnerable to increased channel erosion. Together with elevated peakflows, this has contributed to greatly increased channel erosion in much of the creek.

The removal of riparian trees has also reduced the supply of large woody debris to the channel. Large woody debris (LWD) provides a number of important functions vital to the maintenance of desirable fish habitat and stream conditions (USFS et al., 1993; Rhodes et al., 1994). These functions include sediment detention, moderation of channel erosion, and pool formation.

The removal of riparian vegetation also removes stream shade and microclimatic regulation in the riparian environment. Both of these functions are critical to moderating water temperatures to levels that are conducive to salmonid survival and production (USFS et al., 1993). The loss of riparian vegetation within Tryon Creek has undoubtedly contributed to increased water temperatures.

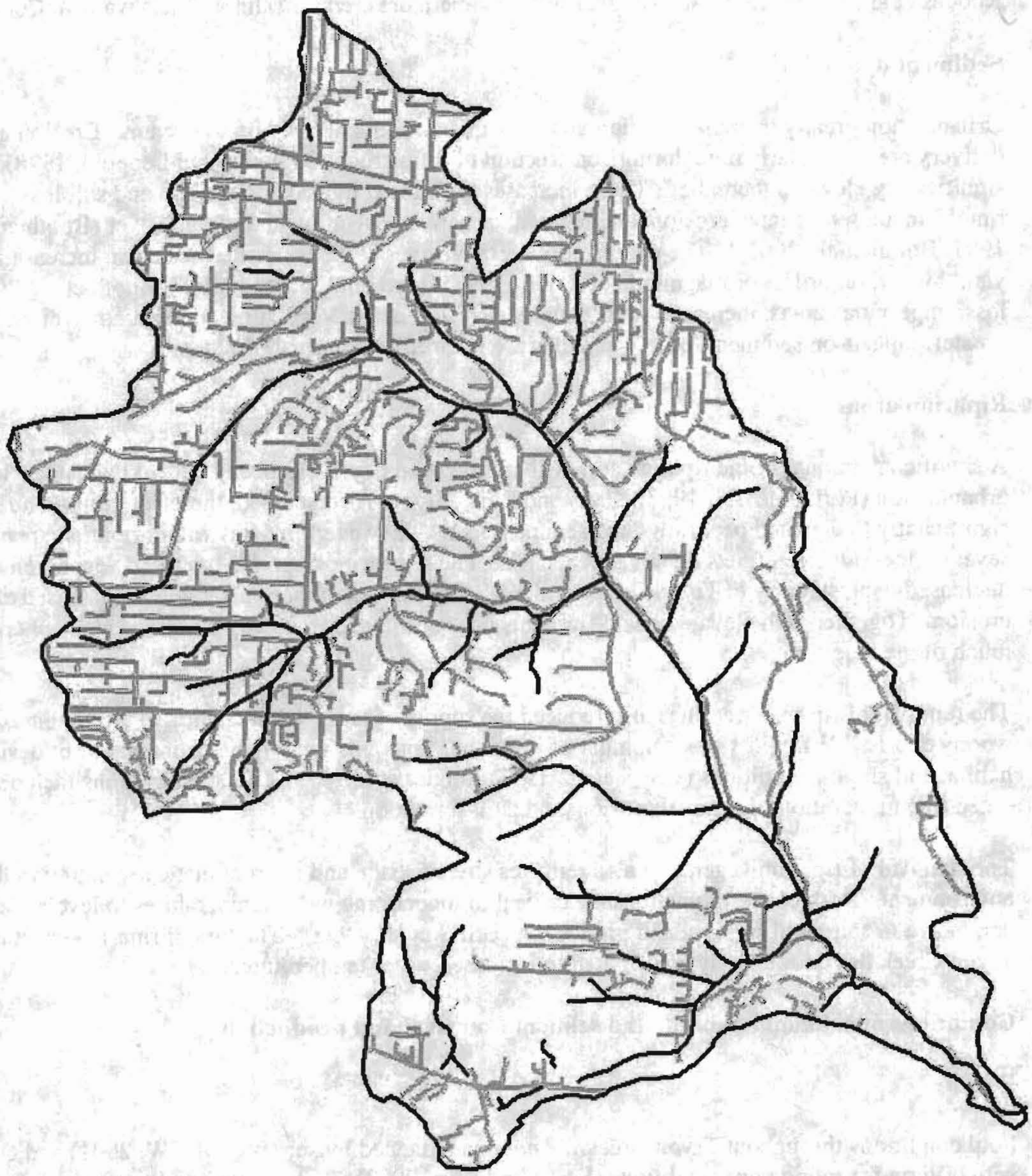
Conditions of salmonid habitat, and salmonid survival and production

Pools

Pool conditions throughout Tryon Creek are *poor* as indicated by surveys (ODFW, 2001) and comparison with criteria for rating pool conditions (Klatte and Ellis, 2002). These poor conditions are due to several combined factors, including increased sediment delivery and peakflows, loss of LWD, and low bank stability (ODFW, 2001; Klatte and Ellis, 2002). Individually, these impacts cause the loss of pool frequency, quality, depth, and volume (Rhodes et al., 1994; Murphy, 1995; Buffington et al., 2002). In Tryon Creek, all of these impacts have combined to produce poor stream habitat conditions.

Stream banks have also been riprapped and rock gabions have been added to the channel. These impacts have also contributed to poor pool conditions by preventing stream meandering and the development of pools at meander bends and undercut banks. Riprap also often results in increased bank erosion at downstream reaches, adding to the sediment load that contributes to the degradation and loss of pools.

Map 4 Composite: streams with municipal sanitary sewer pipes.
Data Sources: Stream centerline—Metro. Pipe data--City of Portland and City of Lake Oswego, 2001; Streams are in black, sewer pipes are in gray.



The loss of pools has likely contributed to the decline of salmonids in Tryon Creek. Pools are vital to all of the salmonids currently found in Tryon Creek (USFS et al., 1993; Murphy et al., 1995; Reeves et al., 1997). Pool loss caused by watershed impacts is believed to be one of the primary reasons for the long-term loss of coastal cutthroat trout in impacted watersheds (Reeves et al., 1997). This damage is especially significant in light of available data indicating that coastal cutthroat trout populations are unable to recover for long periods of time after the degradation of freshwater habitat (Reeves et al., 1997). For these reasons, arresting the degradation of pools is one of the prime needs to stem the on-going loss of salmonids in Tryon Creek.

Protection and restoration of pools is most effectively and sustainably accomplished by addressing the causes of pool degradation (Buffington et al., 2002). Research in urbanized areas, with climate and hydrology similar to Tryon Creek, has shown that LWD additions in degraded streams have generally been ineffective in improving stream conditions or forming pools (Larson, 1999). Treatment of the symptoms of degradation is typically ineffective and costly (Reeves et al., 1991; Booth and Jackson, 1997; Kauffman et al., 1997; Booth et al., 2002). The avoidance of additional damage is the most effective and efficient approach to stream and habitat restoration logistically, biologically, and financially (Rhodes et al., 1994; Kauffman et al., 1997). Therefore, the protection and restoration of pools within Tryon Creek will require avoiding increases in sediment delivery, peakflow, and riprap and avoiding any additional loss in LWD recruitment and bank stability (Buffington et al., 2002).

LWD

Large woody debris conditions are *poor* throughout Tryon Creek (Anderson, 2001; ODFW, 2001; Klatte and Ellis, 2002). These poor conditions are primarily to due to the removal of riparian trees from both urbanization and historic logging. Elevated peakflows may have also contributed by de-stabilizing LWD through channel widening and rafting out of channels during high flows. The loss of LWD has contributed to the poor quality pool conditions throughout the watershed. It has also exacerbated channel erosion and incision and the loss of bank stability in response to increased peakflows.

The loss of LWD is probably another factor that has contributed to the decline of salmonid populations in Tryon Creek. Besides providing important functions that are critical to pool formation and the maintenance, LWD also provides cover for salmonids, which is an essential aspect of their habitat. It is well documented that coho and steelhead numbers are positively correlated with the amounts of LWD. LWD levels recover slowly (Murphy, 1995). Therefore, it is critical to fully protect all sources of LWD recruitment as part of efforts to protect and restore Tryon Creek.

Fine Sediment

Fine sediment conditions are *poor* throughout Tryon Creek based on surveys and fine sediment criteria for salmonid habitat (ODFW, 2001; Klatte and Ellis, 2002). Macroinvertebrate data also indicate that high levels of fine sediment occur throughout much of the Tryon Creek. Macroinvertebrates that are tolerant of high levels of fine sediment are common to abundant at most sampled sites in the stream (pers. comm., B. Wisseman, Aquatic Biology Associates, Inc.)

Elevated sediment delivery has contributed significantly to the high levels of fine sediment throughout the watershed. It is well documented that elevated sediment loads cause elevated levels of fine sediment (Rhodes et al., 1994). Urbanization and its consequences are the primary source of elevated sediment delivery, based on existing watershed conditions and information on urbanization effects on sediment loads.

High levels of fine sediment have likely been a major contributor to the decline of salmonids in Tryon Creek and their depressed state. Elevated fine sediment levels have a wide variety of negative effects on salmonid habitat and salmonid survival (Meehan, 1991, Rhodes et al., 1994). High levels of fine sediment significantly reduce survival from egg to emergence from the channel bottom (Meehan, 1991; Rhodes et al., 1994).

Bed scour is more frequent, intense, and extensive in channels beds with high levels of fine sediment than in channels with coarser bed sediments (Booth and Jackson, 1997; Booth et al., 2002). Scour can wash the incubating eggs of salmonids out, resulting in high levels of mortality. Elevated rates and frequency of the scouring of salmonid eggs in the channel bed is of great concern, because elevated peakflows increase the frequency, magnitude, and extent of this significant impact to salmonid survival. Montgomery and Moscrip (1997) documented that elevated frequency and duration of flood flows caused by urbanization was associated with declines in salmon abundance in the Puget Lowlands of Washington. They concluded that their work indicated a link between the decline in salmonids and increased flood frequency or associated changes in habitat structure. Macroinvertebrate sampling data indicate that frequent channel bed disturbance from scouring is occurring in Tryon Creek (pers. comm., B. Wisseman, Aquatic Biology Associates, Inc.)

Reduction in fine sediment levels is a major need for the restoration and protection of salmonid habitats and populations. However, significant reductions in fine sediment levels may not be possible under current land use in Tryon Watershed. This makes it all the more critical to prevent any increases in sediment loading within the watershed.

Width/Depth

The channel width/depth ratios are *poor to fair* throughout the watershed (ODFW, 2001; Klatte and Ellis, 2002). These degraded conditions have been caused by the combined effects of loss of riparian vegetation, unstable banks, and, especially, elevated sediment loads and peakflows.

Degraded width/depth ratios have several negative effects on salmonids. In particular, poor width/depth conditions contribute to elevated water temperatures. It will be necessary to prevent additional increases in sediment delivery and peakflows in order to prevent continued degradation of width/depth ratios. It will also be necessary to avoid losses of riparian vegetation and bank stability to prevent degradation of width/depth conditions.

Bank Stability

Bank conditions throughout the watershed are *poor to fair* (ODFW, 2001; Klatte and Ellis, 2002). Bank stability in Tryon Creek only ranges from about 31-58% lineal length, while healthy streams have bank stability of at least 80% (Rhodes et al., 1994). Elevated peakflows, elevated sediment delivery, loss of LWD, and loss of riparian vegetation all combine to reduce bank stability (Rhodes et al., 1994; Booth and Jackson, 1997).

Low bank stability has several negative effects on salmonid habitat and survival. Unstable banks contribute to fine sediment levels and sediment loads. Unstable banks contribute to poor width/depth ratios and impede pool formation. Armoring channels with riprap and gabions does not effectively treat bank stability because it addresses the symptoms, rather than causes, of bank instability. Hardening banks and channels with riprap often causes increased bank and channel erosion downstream (Dunne and Leopold, 1978; Schmetterling et al., 2001); it can also prevent the development of overhanging banks and pools (Schmetterling et al., 2001). Because riprap and gabions often elevate downstream channel erosion, they contribute to channel incisement and widening, which can exacerbate downstream bank instability. The most effective approach to avoiding additional degradation of bank conditions is to avoid additional increases in peakflow and sediment loads and any additional losses of riparian vegetation.

Water Temperature

Water temperature conditions are *poor* throughout the watershed (Klatte and Ellis, 2002). Tryon Creek is currently listed as water quality limited with respect to temperature (ODEQ, 1996). Macroinvertebrate data corroborate that water temperatures are generally high because there are no cold water taxa present at any of the sampled sites, indicating that summer water temperatures must be high enough to preclude their establishment (pers. comm., B. Wisseman, Aquatic Biology Associates, Inc.)

Elevated water temperatures reduce the production and survival of salmonids through several mechanisms, even when temperatures are below levels that cause direct mortality (McCullough, 1999). These mechanisms include reduced egg viability, increased competition and displacement by warm-water tolerant species, and increased virulence of disease (McCullough, 1999). It is likely that elevated water temperature in Tryon Creek have contributed to the decline of salmonids and is a major factor preventing recovery of these depressed fish populations.

The loss of riparian vegetation, reduced lowflows, poor width/depth conditions, and bank instability all contribute to elevating water temperatures (Beschta et al., 1987; McCullough, 1999). Urbanization and impervious areas have contributed to all of these conditions affecting water temperatures. Summer runoff from impervious surfaces also increases temperatures (GAO, 1990). Riprap and gabions can also increase water temperatures by absorbing radiation and transferring the energy to water as heat.

Preventing additional increases in summer water temperature is a critical protection need. Key measures to prevent any additional increases in water temperature are to avoid any increases in sediment delivery, peakflow, and runoff from impervious surfaces during the summer and prevent additional losses of bank stability and riparian vegetation.

Macroinvertebrates

Macroinvertebrate data provides an integrated assessment of general stream conditions (Klatte and Ellis, 2002). The macroinvertebrate data indicate that water quality and stream conditions are largely *poor* throughout the watershed (pers. comm., B. Wisseman, Aquatic Biology Associates, Inc.; Klatte and Ellis, 2002). Only 3 sites out 15 sampled sites had macroinvertebrate assemblages that were in "fair" condition. These three sites were located within areas that appear to have a slightly lower percentage of the upstream area occupied by urbanization and impervious areas (Klatte and Ellis, 2002). The macroinvertebrate data also indicate low habitat complexity (few pools), frequent channel disturbance from scour, high levels of fine sediment, and warm water temperatures (pers. comm., B. Wisseman, Aquatic Biology Associates, Inc.).

These results are entirely consistent with physical stream survey data (ODFW, 2001; Klatte and Ellis, 2002), assessment of watershed conditions (Klatte and Ellis, 2002), and salient research. (Booth et al., 2002) documented a progressive decline in biotic conditions with increasing imperviousness in urbanized watersheds in Puget Sound lowlands in Washington; they noted that significant degradation of biotic conditions can occur at any level impervious cover. Biological indicators, such as macroinvertebrates, do not appear to have a threshold for responding negatively to impervious cover, but rather exhibit a continuous negative response to impervious areas within a watershed, even when the amount of impervious area is relatively low (Booth et al., 1997).

Data Gaps

There are several gaps in data for conditions in Tryon Creek. Better and more complete information would aid in refining the diagnosis of conditions and trends in the watershed and how these have been affected by watershed impacts. While filling these data gaps will refine the diagnosis, it would not fundamentally change the conclusions drawn from available information. Available watershed-specific data and general scientific information amply indicate that Tryon Creek has been significantly degraded, primarily by urbanization, to the detriment of stream conditions, water quality, and salmonids. This degradation will increase unless measures are taken to prevent an increase in their causes, as can be concluded from available information on the conditions of Tryon Creek (Anderson, 2001; ODFW, 2001; Klatte and Ellis, 2002) and the effects of urbanization on streams and their aquatic habitats (e.g., Hammer, 1972; Graf, 1975; Dunne and Leopold, 1978; Booth and Reinelt, 1993; Moscrip and Montgomery, 1997; Trimble, 1997; Booth and Jackson, 1997; Larson, 1999; Booth et al., 2002).

While better information will not change the condition of Tryon Creek, filling the following data gaps will aid in refining information on the causes and symptoms of aquatic degradation:

- Comprehensive assessment of all impervious surfaces within the watershed including driveways and sidewalks. Areas with significantly reduced infiltration and water holding capacity caused by compaction and conversion of native vegetation should also be assessed and converted to an equivalent impervious area via reasonable coefficients in order to fully assess effects of land use on runoff.

- Comprehensive assessment of the extent of riparian areas occupied by impervious surfaces and converted from native vegetation.

- Comprehensive, accurate, and consistent mapping of stream locations, including intermittent tributaries. Currently, there is considerable inconsistency among the various map sources in the location of streams.

- Comprehensive and accurate assessment of storm drains and outfalls. This assessment should include the location of these drains, their catchment areas, and the volume of runoff contributed by these outfalls.

- Comprehensive survey of the location and extent of riprap and gabions within the Tryon Creek stream system.

- Periodic survey of key stream and habitat conditions in order to determine trends in channel conditions. Surveys should be conducted at least every 2-5 years and include monitoring of pool conditions, LWD levels, fine sediment, bank stability, and water temperature. Additionally, stream surveys should also be conducted after major flood events, in order to increase the accuracy of trend data and gain information on the magnitude of channel alteration caused by major flow events. Water temperature should also be monitored continuously during critical periods in the summer and fall during lowflows when temperatures are likely to be most limiting for salmonids. Habitat conditions in urbanized watersheds often undergo significant and rapid change in response to the increased frequency, duration, and magnitude of peakflows (Booth et al., 1997). Therefore, relatively infrequent stream surveys can miss important changes in stream conditions and reduce the accuracy and usefulness of trend data (McCullough and Espinosa, 1996). Annual monitoring of stream conditions is recommended where accurate trend data on habitat conditions are important (McCullough and Espinosa, 1996).

Protection Recommendations

As mentioned, despite some data gaps, there is ample information to diagnose aquatic conditions, the cause of these conditions and the critical protection needs. Data from Tryon Creek generated by different methods all lead to the same conclusions: Tryon Creek has been significantly degraded by land use impacts, especially urbanization, and especially by these impacts in riparian areas. This degradation is manifested in poor stream and aquatic habitat conditions that will be slow to recover even if all necessary measures are taken. These data and assessments are consistent with the findings of other studies. Degradation in the Tryon watershed will increase unless measures are taken to insure that the causes of degradation do not expand or increase.

The common threads that run through all of the symptoms of watershed and stream degradation from urbanization effects are: damage to riparian areas, increased runoff and sediment loads and reduced lowflows. If these causes of watershed and aquatic degradation are not addressed, additional degradation of aquatic resources is assured, regardless of expensive attempts to mitigate the damage (Booth and Jackson, 1997).

The following recommendations are minimum protection measures needed to avoid further damage to Tryon Creek watershed's aquatic resources:

Riparian protection—Fully protect all vegetation and soils within at least 300 ft. of all streams from additional removal and damage

Virtually all credible assessments of watershed protection needs have concluded that adequate riparian protection is essential to avoiding additional significant damage to aquatic resources (e.g. USFS et al., 1993; Rhodes et al., 1994; Murphy, 1995; NRC, 1995; Spence et al., 1995; Rhodes, 1995). A wide variety of studies in a wide variety of locations have concluded that the aquatic degradation will increase unless riparian areas are fully protected. Notably, most of these assessments have been based on the need to protect aquatic systems from degradation from forestry activities. But they are certainly applicable to Tryon Creek, although more extensive protection of riparian areas in Tryon Creek is merited due to the intensity of the effects of urbanization on watersheds and stream conditions. The adverse effects of urbanization on aquatic resources are far more severe and much more persistent than forestry activities (Dunne and Leopold, 1978; Booth and Jackson, 1997; Booth et al., 2002); the adverse impacts of urbanization are much less amenable to reduction via mitigation (Booth and Jackson, 1997; Booth et al., 2002). This makes riparian protection an even more pressing need in urbanized environments such as Tryon Creek than in areas subject only to forestry activities.

Riparian areas provide functions that shape habitat conditions that strongly influence salmonid survival and water quality, including provision of LWD, thermal regulation, bank stability, hydrologic regulation, and sediment detention and storage (USFS et al., 1993; Rhodes et al., 1994). While some of these functions are shaped by conditions throughout the watershed, riparian area conditions exert a primary influence due to their proximity. Water quality and fish habitat cannot be protected without protecting riparian areas. Although upland ecosystems must also be protected, there are no measures that can serve as a surrogate for adequate riparian protection.

The <u>entire</u> channel network must be adequately protected if fish habitat and water quality are to be protected. While some approaches have provided greater protection along larger streams or those reaches containing fish habitat, the implicit premises for such approaches are not valid for several reasons. Smaller streams are typically more susceptible to damage from upland and riparian disturbance than larger streams, making the protection of riparian vegetation even more critical on smaller tributary streams (Rhodes et al., 1994; Erman et al, 1996). Smaller tributary streams also typically comprise 70-90% of the channel network by length in most watersheds and their conditions have a strong effect on water temperature, streamflow timing and magnitude, and sediment loads that strongly affect downstream water quality and habitat. Affording inadequate protection to tributaries in the channel network will likely result in cumulative degradation in downstream salmon habitat over time. For these reasons, smaller tributary streams should receive protection equal to or greater than larger streams, especially when sediment loads are of concern as they are in Tryon Creek (Rhodes et al., 1994; Erman et al., 1996; USFS and USBLM, 1997).

Riparian reserves must be wide enough to fully protect all riparian functions important to the maintenance of salmon habitat and water quality: water temperature regulation; sediment routing; LWD recruitment; and bank stability (NRC, 1995; Spence et al., 1995). Ample information exists to delineate the widths of protected vegetation needed to protect ecological functions such as stream shading, bank stability, and LWD recruitment (USFS et al., 1993; Rhodes et al., 1994). Full protection of riparian vegetation and soils within a slope distance of <u>at least</u> 300 feet (or to the nearest divide) from all streams is needed to protect these vital riparian functions and prevent aquatic degradation.

Notably, these distances do not fully eliminate degradation caused by elevated runoff and sediment delivery caused by impacts at the watershed scale, but they aid in ameliorating these impacts (Rhodes et al., 1994; Erman et al., 1996). Maintenance of stream shading, alone, does not prevent water temperature increases in urbanized environments. Reductions in lowflows, summer runoff from impervious areas, channel incision and poor width/depth ratios caused by the combined effects of urbanization increase water temperatures even where the shade from vegetation is maintained (Rhodes et al., 1994; McCullough, 1999).

Eliminate increases in impervious areas

Impervious surfaces in the watershed are already at levels that have degraded water quality and fish habitat. Available data indicates that impervious areas cover more than 23% of the area of the Tryon Creek watershed. Based on the data in Booth and Jackson (1997) this equates to effective impervious area (EIA) of at least 18.8%. Areas converted to lawns or where native forest has been removed also contribute to EIA (Booth and Jackson, 1997), but currently data is lacking on the amount of such areas in the Tryon Creek watershed. However, the data generally indicates that sizable areas are in such a condition, and this further increases the actual EIA for the watershed. Booth and Jackson (1997) research indicates that in areas such as Tryon Creek, an EIA exceeding 10% causes "...demonstrable, and probably irreversible, loss of aquatic-system function." While Booth and Jackson (1997) and Booth et al. (2002) found significant aquatic damage at levels of EIA lower than 10%, it was consistent and measurable in a wide variety of systems at EIA levels above 10%. The Tryon Creek watershed is well above this threshold of impervious area that causes severe degradation of stream and salmonid habitat degradation. All data from a variety of methods indicate that Tryon Creek stream conditions are significantly degraded. Available information indicates that the effects of impervious areas are contributing significantly to these conditions. As stated in PWA (1997), more impervious area results in more runoff. This will translate to yet more stream damage in already severely damaged areas. For these reasons, it is absolutely essential to take measures to prevent any increase in impervious areas within the watershed.

Eliminate further reductions of forest cover, and increase reforestation efforts

Loss of forest cover increases erosion, sediment delivery, and peakflows (Booth et al., 2002), all of which are major causes of the degraded conditions in Tryon Creek. Booth et al. (2002) noted that maintenance of at least 50% of the watershed area in a forested condition is an essential component of preventing severe stream degradation in urbanized environments in the Pacific Northwest. Although exact data are lacking, Tryon Creek likely has considerably less than 50% of the watershed in a forested condition. For these reasons, additional removal of forest cover should be eliminated and efforts should be taken to allow reforestation to occur in areas where this is possible.

Eliminate increases in discharge from storm drain outfalls to the stream system and reduce existing discharges from these outfalls

Storm drain outfalls that are connected to the stream system greatly increase peakflow by rapidly shunting runoff to the stream network, further exacerbating peakflow elevation generated by impervious surfaces and other urbanization impacts on runoff. While eliminating increases in impervious areas can do much to prevent additional increases in peakflows and sediment loads and consequent stream degradation, increasing the transmission of runoff to the stream system from storm drain outfalls can result in additional degradation.

Locate new pipe infrastructure outside of the stream environment, and explore options for relocating the existing infrastructure outside of the stream environment

As noted, pipeline infrastructure has had negative effects on Tryon stream conditions by increasing peakflows and flooding, while also decreasing lowflows. However, there are several other reasons to locate such infrastructure outside of the stream environment.

First, as is well documented, infrastructure in streams and floodplains is transient due to the effects of streamflows during flood events. During floods, pipelines are often damaged. In the case of sewer lines, this typically results in considerable water pollution in addition to the costs of repairs. These repairs often involve significant disturbance in the stream, resulting in acutely elevated sediment loads and streambank de-stabilization. All this will occur again in the next major flood for as long as the infrastructure remains in the stream environment.

It also is well known that building in floodplains is not prudent. It is time to recognize that attempts to maintain infrastructure in the stream environment is also imprudent. Over the long run, locating public infrastructure outside of the stream environment is likely to be more cost-effective than attempting to maintain it in such environments, even without including the environmental costs.

Forego any additional attempts to harden banks and bed, and remove gabions and riprap

Although it is tempting to try to address elevated channel erosion and bank instability by treating symptoms with riprap and gabions, instead of addressing the causes at the watershed scale, such efforts are both counter-productive and costly. Downstream damage caused by bank and bed hardening can be difficult to effectively treat, and recovery is typically slow. Since the downstream damage typically involves the same symptoms treated by gabions and riprap -- incisement and bank instability -- there is a strong tendency to treat yet more of the stream with further gabions and riprap (Dunne and Leopold, 1978).

Even when riprap and gabions do not aggravate downstream damage, they can thwart stream and habitat recovery processes within affected reaches. Riprap on banks prevents meander development (Schmetterling et al., 2001). This is counterproductive because the development of meanders reduces channel gradient which can aid in ameliorating channel erosion. Meander development also can encourage pool development (Rhodes et al., 1994). Riprap also prevents the development of overhanging banks that are vital aspects of fish habitat (Schmetterling et al., 2001). Riprap also thwarts revegetation on treated banks (Schmetterling, 2001). For these reasons, the practice of adding riprap and gabions to the stream should be abandoned.

Gabions and riprap additions have already caused negative impacts on Tryon Creek by increasing channel and bank erosion downstream of gabions and riprap and by preventing meandering and the development of overhanging banks. For these reasons, a program for removing riprap and gabions should be implemented.

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PART 7

Project Manager's View of the Past and Current Watershed Concerns

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Watershed Issues

By: Elizabeth Callison

Urbanization

There are strong pressures on Tryon watershed property owners to subdivide and urbanize to greater densities. At the same time, there are no practical incentives to landowners to preserve riparian lands as forest or greenspace. Even stream corridors and wetlands are frequently developed for housing and commercial structures or city utility infrastructures. Many headwaters and smaller wetlands have been drained into pipes and paved over, particularly in Arnold and Falling Creek sub-watersheds and in upper Tryon Creek near Taylor's Ferry Road and Barbur Blvd. City of Portland data on the Falling Creek sub-watershed, for example, indicates impervious surface coverage is well over 40%.

Economic Use of Streams by Utilities

City sewer departments enjoy stream management status invested in them by the Oregon Department of Environmental Quality (ODEQ). Lake Oswego's and Portland's use of creeks as storm water and wastewater conveyances--utilizing the stream corridors as free right-of-ways--is certainly contributing to the environmental problems evident throughout the watershed.

In Portland nearly $1 million in storm water fees is collected annually by the Portland Bureau of Environmental Services (BES) from Tryon watershed residents. It is not clear how much BES actually reinvests in the watershed per year in the form of conservation projects, staff time, stream stabilization, culverts, sewer pipes, and/or other facilities. Preliminary information from BES indicates that from $250,000 to $1 million has been spent annually during the past five years (Portland Office of Financial Management Memo to Portland Public Utility Review Board, 2002). It seems to Elizabeth Callison, Baseline Assessment Project Manager, that there needs to be more public awareness and oversight of sewer/storm water facilities and expenditures in the watershed. Despite BES's continuing investments in the stream corridors for sewer and storm drain infrastructures and in bank-anchoring projects, the area may be in current violation of the federal Clean Water Act (CWA) and Endangered Species Act (ESA).

Water Management and Stream Pollution

Portland sewage overflow records for Tryon Creek watershed list only three sewage spills into the creeks during the period of 1996 to 2002 (BES, 2002). BES's water sampling data, however, appear to indicate chronic stream pollution from harmful bacteria such as e-coli, fecal coliform, and enterococcus--possibly the result of leaking or overflowing sewage pipes set too closely into creek channels. Bacterial sources may include seepage from residential septic tanks, as well as surface water runoff into streams from streets, parking lots, landscaped areas, and swales. Many streets, roads, and driveways were built in the steep ravines in the Tryon watershed. Much of the runoff from streets and commercial areas is routed via municipal storm drainpipes into ditches or culverts that exit directly into stream banks. Maps of the drainpipes, culverts, and sewer pipe infrastructure, as well as results Portland's sampling of stream water quality are included in this Summary. The maps and water quality graphs provided in this Baseline Report are based on Metropolitan Service District (Metro), Portland, and Lake Oswego data.

Stream segments enclosed in culverts years ago to enable construction of roads or driveways across creeks have in some locations outgrown their pipes, resulting in the occasional stagnant, storm water-collecting pond that may flood up onto the adjacent road bank or backyard. Exposed sewer pipes stand in creek channels--a result of the strong floods of storm water runoff that rush through the creek system during rain events and incrementally wash away portions of the banks (see photo, next page). Very fine clay soils are characteristic of the Tryon watershed. Eroding into creek waters, these suspended colloidal sediments can be especially harmful to salmon and trout: clouding and darkening the waters, blanketing redds, harming gills, and compromising respiratory and immune system functions.

Photo: Frequent flooding of storm water runoff erodes stream banks and exposes sewer pipes.
This moss-covered sewer pipe and manhole are located in lower Tryon Creek State Natural Area--formerly named Tryon Creek State Park. First installed during the period of 1968-70, the cement sewer mains are approx. 4 ft. in diameter and run along the creek to the Tryon Creek Wastewater Treatment Plant in the Lake Oswego portion of the watershed.
When blocked with roots or other debris, these pipes may surcharge raw sewage into the creeks, given their proximity. Occasionally Portland also utilizes a toxic chemical foam to dissolve tree roots that have worked their way into the pipes. Some pipe protection/bank-anchoring was funded by USDA Natural Resources Conservation Service under its EWP (Emergency Watershed Protection Program) between 1997-99, as a result of severe 1996-97 flooding. Portland BES was the local sponsor and recipient of NRCS-EWP funds
photo, 2001, NRST-PFC Survey

Condition of Parklands
Portland, Lake Oswego, and Metro parks include approximately 50 acres of greenspace throughout the watershed. A state park encompasses approximately 640 acres in the lower watershed. Recently renamed the Tryon Creek State Natural Area, it is unique as the only Oregon state park located within an urban area. The eroded, incised streams within the state park demonstrate the end result of urbanization and questionable storm water management in the upper watershed. The park has been a frequent site for research studies such as the 1987, 1995-97, and 2001 fish population surveys conducted by the Oregon Department of Fish and Wildlife (ODFW). ODFW conducted fish population surveys because it had a stocking/student hatchbox program. (See StreamNet data, this Report, and the West Multnomah Soil and Water Conservation District's (WMSWCD) website (westmultconserv.org). Pacific Habitat Services performed a study of the creek system within the state park in 1997.

Student Research Projects in State Park

Several professors from neighboring Lewis and Clark College bring their students to the state park and numerous other sites on tributaries outside the park to study the geology, soils, and water quality. Professor Kip Ault and his graduate students performed a stream habitat survey in 1994 in cooperation with Portland BES staff Patrice Mango (protocol: Environmental Protection Agency [EPA] Streamwalk). This survey and the later Portland BES 1997 Upper Tryon Creek Corridor Assessment have been important sources of information about channel conditions, even though they include only selected portions of the system. Other instructors, notably Professors Liz Safran and Paulette Bierdzychudek, and their students from Lewis and Clark College regularly study the area's geology and water quality. Portland State University (PSU) research on the *hanta virus* was conducted in the state park during 2002-03; another PSU research study documented the presence of infected mice in the state park.

Riparian Protection and Enhancement

Although there are a few acres of stream land per year that are cleared of invasive ivy and blackberries and revegetated by public agencies, Portland and Lake Oswego rely mainly on local environmental regulations to protect Tryon's remaining forests, wildlife habitat, and streams. Portland BES had four small revegetation projects on Tryon creeks within 2002-03. One revegetation project site—a greenspace owned by Metro ("Foley-Balmer")—has been the scene of at least three publicly funded riparian enhancement projects in the past five years. In 1997, the Tryon Watershed Resource Council (TWRP) conducted a riparian enhancement planting project on the property, including a landscape design, invasives/debris clean-up, plantings by Salmon Corps crew, county alternative community service crews, and volunteers (the project was funded by ODFW's Restoration and Enhancement Program). More recently, there was a BES Revegetation Program (2002-03) project in the same area. Neither Metro nor the Cities seem to track such revegetation projects, or know whether certain areas are being repeatedly replanted by various groups; there is no central log or record. Considering the scarcity of public lands, and the scarcity of funds for restoration and enhancement projects, how frequently should the same plot of public land be revegetated? WMSWCD hopes that this Report will not only offer Metro and the Cities an example of how data can be gathered/presented, but will become a usable and widely accessible repository of data on restoration and other environmental issues.

Status of Environmental Zoning Regulations

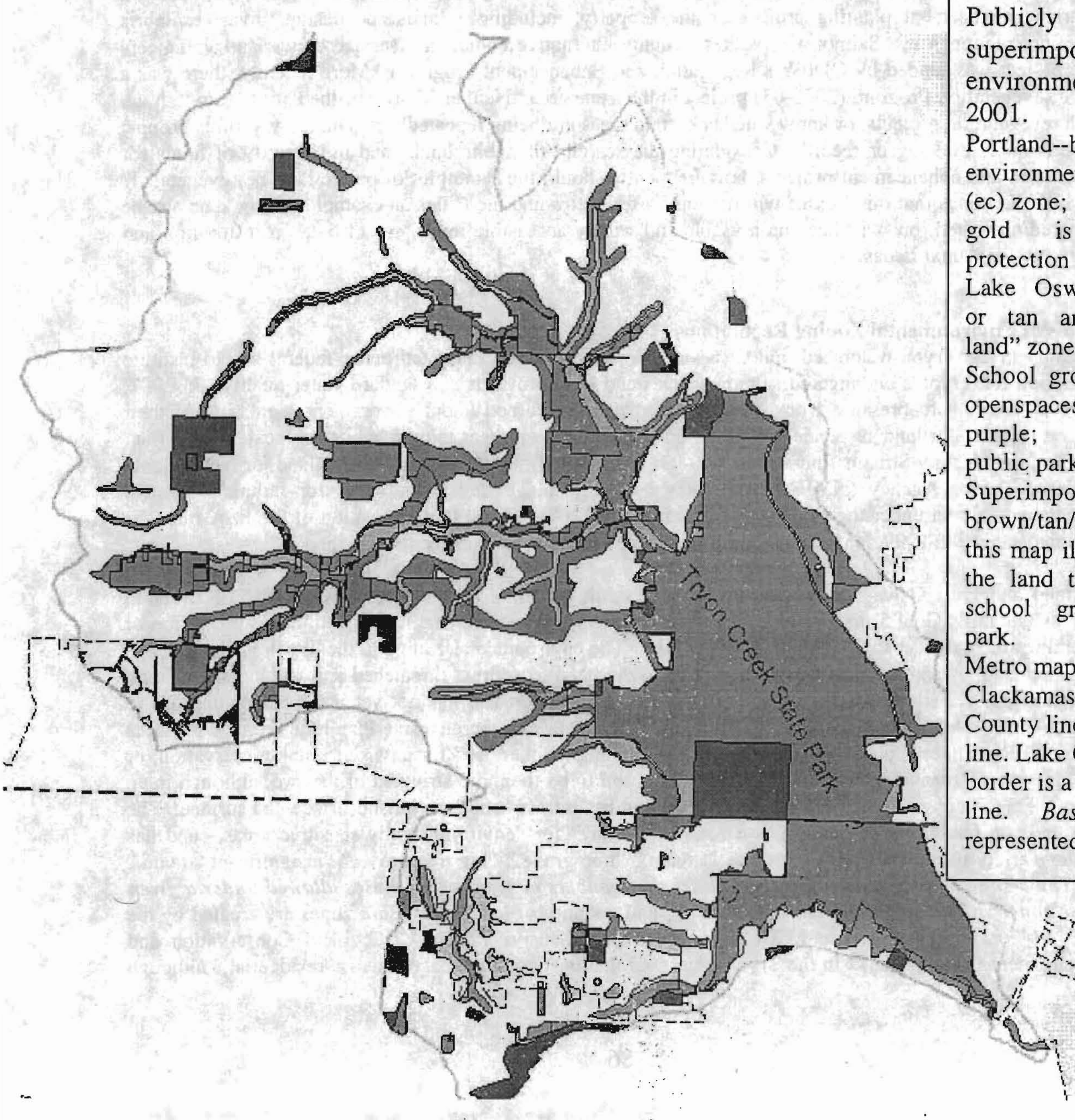
Not only in the Tryon watershed, but City-wide, Portland remains obligated under federal law to institute protection for Tryon's endangered salmon species and to improve its substandard water quality. In 2002, however, bowing to pressure from a group of citizens concerned about government regulation of their property rights, Portland suspended its proposed regulations to protect salmon habitat in local streams (i.e., the Portland Healthy Streams Initiative, 2000-02: not adopted). Thus the City of Portland, or the National Marine Fisheries Agency (NMFA) itself, may be vulnerable to legal challenges for failure to protect endangered salmon under the Endangered Species Act (ESA). Given that imposition of the ESA rules for salmon occurred in 1999, NMFS seems so far to have chosen not to enforce its own directive.

Portland and Lake Oswego originally instituted systems of "environmental zoning overlays" in order to address Oregon's Goal 5 mandate for local jurisdictions to provide for the identification and protection of natural resources under their Comprehensive Plans. The environmental zoning in the Tryon watershed was instituted by Portland more than a decade prior to the need to address threatened and endangered salmon listings (NMFS, Federal Register, 1999). As noted above, Portland has not yet instituted regulations to protect endangered salmon species. As far as meeting its state Comprehensive Plan requirements for Goal 5 Natural Resources, Portland has "environmental zoning"--either "ec" for environmental conservation, or "ep" for environmental protection. The ep is supposed to be the more stringent of the two, although in ep zones there are considerable numbers of municipal utility infrastructures, both subsurface and surface. The City of Lake Oswego also designates a zoning "overlay" for "environmentally sensitive areas," and has greater variety in its terminology such as "stream," "tree grove," "big tree grove," "insignificant stream," etc. ***The e-zone overlay does not restrict either the numbers or types of land uses allowed under a given "base zone."*** The *base zone* dictates the types and quantity of land uses. Base zones are created by the local city or county under an LCDC-approved Comprehensive Plan (LCDC: Land Conservation and Development Commission). In the Tryon watershed the most common base zone is "residential," although

Lewis and Clark College is in an "institutional" zone, while the zoning is "cg" commercial/general or commercial/mixed use/high density along arterials such as Barbur Blvd. (State Highway 99) and portions of Taylors Ferry Road and Terwilliger Blvd.

In any case, environmental zoning overlays have been insufficient to protect either salmon or water quality. Neither Portland nor Lake Oswego has any system for tracking or monitoring the urbanization of environmental zones. The subject is addressed in this Baseline Assessment Report for the first time by any agency.

Environmental Zoning of Parks
City parklands in environmentally sensitive areas are typically designated by Portland with an "environmental zone" (either "ec" or "ep") overlaid on an "open space" base zone. Tryon-area parks are owned by either Portland, Lake Oswego, the State parks system, or Metro, in some cases in joint ownership. Portland BES also has a few joint ownerships with Metro in the watershed. Metro parks holdings are maintained by the Portland Parks and Recreation Department through an intergovernmental agreement. As noted, there are more acres of public environmentally zoned (e-zoned) land than private e-zoned land. In the Tryon watershed, more than half of Portland's e-zoned land is public land--notably the 650-acre state park (see map). Even public lands have encroachments in environmental zones, particularly by both Portland and Lake Oswego utilities.

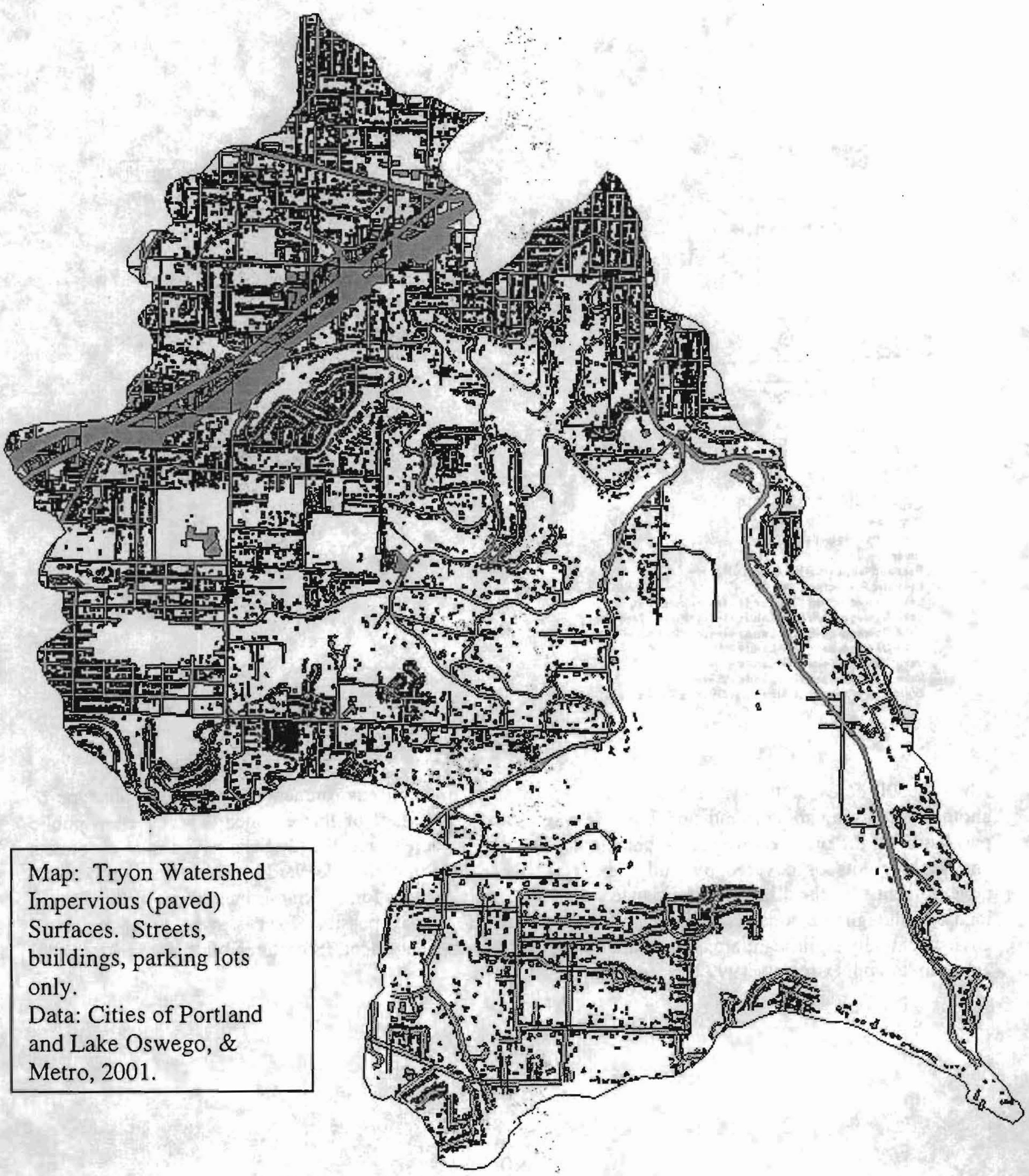


Publicly owned lands superimposed on environmental zoning. 2001.
Portland--brown is environmental conservation (ec) zone;
gold is environm[ental] protection (ep) zone;
Lake Oswego--light brown or tan are for "sensitive land" zone overlay.)
School grounds and similar openspaces are shown as purple;
public parks shown as green. Superimposed onto the brown/tan/gold areas. As this map illustrates, much of the land that is e-zoned is school ground or public park.
Metro map: Clackamas/Multnomah County line is a dotted green line. Lake Oswego/Portland border is a dotted brown line. *Base zones* are not represented on this map.

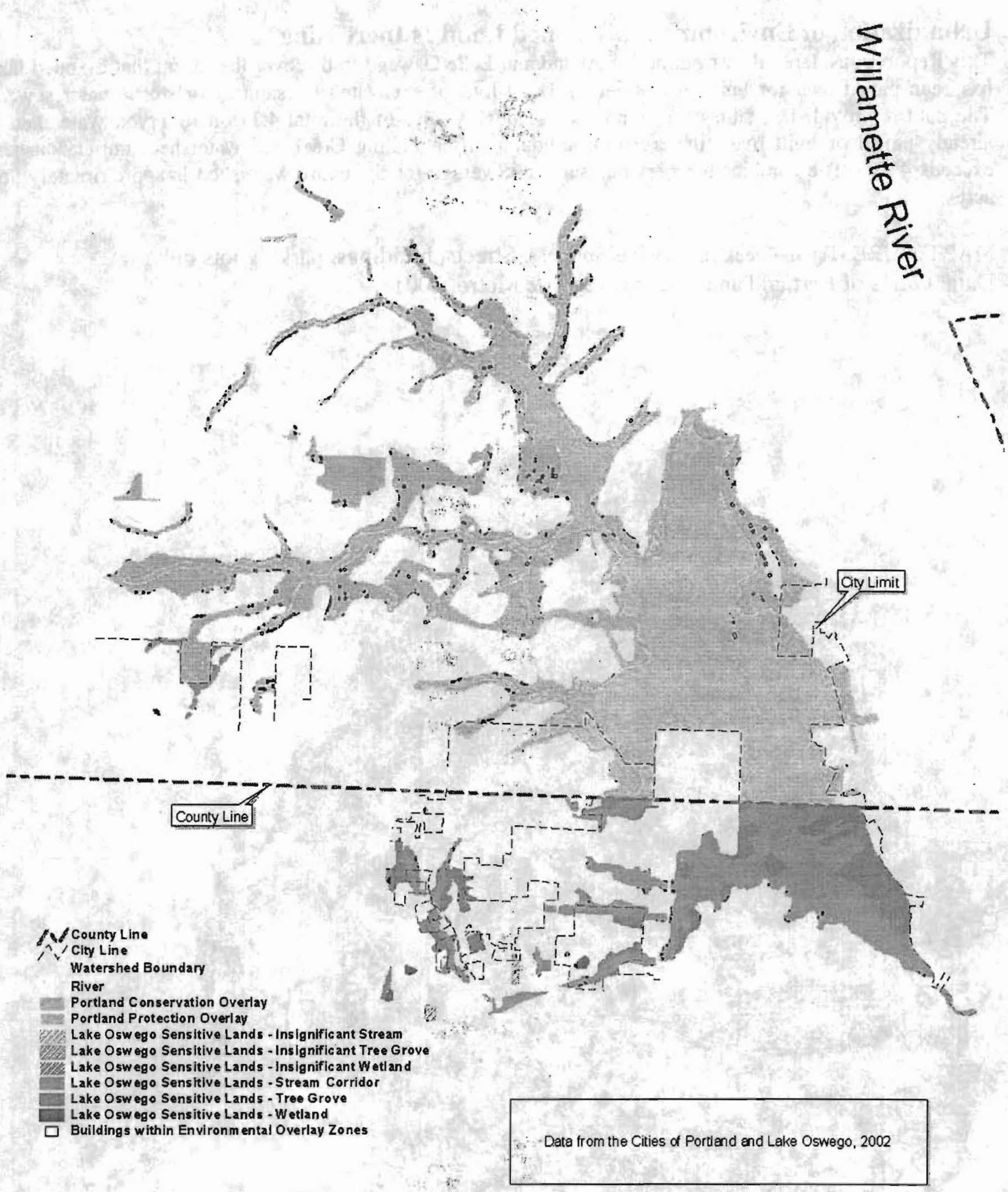
Urbanization of Environmentally Zoned Land Is Increasing

This Report considered data from both Portland and Lake Oswego to discover the extent that e-zoned land has been paved over for buildings, streets, parking lots, or excavated for sanitary or storm water sewers. The data is provided in tables for comparison. Roughly 23% of the total 4,178-acre Tryon watershed is already paved or built over (impervious), although in the Falling Creek sub-watershed, imperviousness exceeds 43%. The combined impervious surface coverage for the entire watershed is approximately 964 acres.

MAP FIGURE. Tryon Creek Impervious Surfaces. Streets, buildings, parking lots only.
Data: Cities of Portland and Lake Oswego, & Metro, 2001.



Map: Tryon Watershed Impervious (paved) Surfaces. Streets, buildings, parking lots only.
Data: Cities of Portland and Lake Oswego, & Metro, 2001.



About 1,300 acres of the watershed's total 4,178 acres have an environmental overlay of one type or another, according to Portland and Lake Oswego data. Over half of this e-zoned acreage is in public parkland. Of the privately owned e-zoned lands, at least 675 acres have already been paved over for streets and parking lots or covered by buildings. This figure does not include yards, driveways, and similar development. Portland lacks performance standards or benchmarks for tracking urbanization of its e-zoned lands. Although the local environmental zoning regulations may possibly have slowed urbanization of environmentally significant areas, they are having little permanent effect. Structures built in environmental zones up to approximately 1999 are provided in map form.

"Hypothetical" Riparian Setback (Stream Buffer)

There are some remaining acres of vacant private land along creeks in the Tryon watershed; however, there has been no effort by either Portland or Metro to purchase or set aside stream corridors as permanent greenways. WMSWCD District Administrator Jim Robison utilized Portland BES data on infrastructure and imperviousness to calculate encroachments within a "hypothetical" 50-ft. stream buffer and within a "hypothetical" 300-ft. stream buffer along Tryon Creek. A "hypothetical" 300-ft. stream buffer was selected because it is the basic minimum stream setback for salmon-bearing streams recommended by the U.S. Fish and Wildlife Service (USFWS). Another 50-ft. "hypothetical" stream buffer was selected because, given map data variations, it is likely the minimum lateral area typically occupied by the waterway, allowing for moderate flooding and meandering.

A. Estimating Urbanization of Riparian Areas

Since there is no riparian corridor inventory as such, the first hurdle in estimating stream encroachments was to decide which of the various stream maps to use. Ironically, the Portland BES watershed "ditch" maps appeared to be the most complete inventory of streams, although field-checking is needed to separate the many runoff gullies, roadside ditches, or constructed swales from natural creeks, since BES designates virtually all of them as "ditches."

Until Portland and Metro eventually agree on where the stream centerlines are, District Administrator Robison used the existing Metro stream centerline, to contrast with the National Wetlands Inventory (NWI) centerline. Following this discussion are tables of comparison as well as composite maps to illustrate graphically the existing encroachments within environmental zones, as well as within a "hypothetical" 50- or 300-ft. riparian buffer. (Note: As of February/March 2003, the City of Portland and Metro staff were meeting to coordinate their stream maps.)

B. Factors in comparing existing buildings, utility pipes, and streets within e-zoned lands vs. a "hypothetical" riparian corridor:

1) The three local governments (Metro, Portland, Lake Oswego) have no designation for a stream corridor, as such. As already noted, local environmental zoning rules (also including Metro's Title 3 water quality overlay zone) were applied without regard for streams as a complete linear resource. That is, e-zone overlays were applied according to planners' arbitrary landscape units; therefore some sections of streams, particularly the smaller headwaters and associated wetlands, were missed or excluded. Upper Tryon Creek tributaries (orphans) above Barbur Blvd. are examples of areas that were mostly excluded from e-zoning. Oregon Division of State Lands (ODSL) seems to bow to local stream designations in deciding whether state excavation/fill permits are needed. Also, there seems to be no agreement among the various agencies about whether to include culverted (piped) sections of stream in maps or local inventories. United States Geographical Service (USGS) topographic maps may not identify whether a particular section of stream is in a pipe.

2) The NWI streams in the Tryon system include only Park, Nettle, and Falling Creeks and part of the Tryon mainstream. This is a total stream mile length of only 7.9 miles, about a third of the Metro stream miles. (Note: Only about 5 stream miles are included in the StreamNet Library inventory of areas where salmonids have been noted for official records.) Federal and state agencies' enforcement of removal/fill regulations seem tied to whichever inventory map that federal agency happens to acknowledge, or whether some local agency has brought a proposed instream development to their attention. Given this shortcoming, one would expect that at least 7 stream miles should have been scrutinized under state or federal removal/fill regulations. By using even the very limited federal NWI map, the reader can see which in-stream encroachments should have triggered a federal regulatory permit. In fact, Robison calculated that within 50 feet of NWI streams (total area: 96 acres), there were approximately 14,500 lineal ft. of sanitary sewer pipes, 3,500 lineal ft. of storm drain pipes, and 23 culverts. Yet—except for one outfall for one storm drain in Lake Oswego—there was no permit information from the Army Corps of Engineers on these municipal infrastructures.

3) Total encroachments into a "hypothetical" 50-ft. riparian buffer were contrasted with total encroachments into environmental zones along both the NWI and the Metro streams. Encroachments into environmental zones should have triggered a local land use review process. Elizabeth Callison, Project Manager, asked the Portland BES to produce file information on its projects in the Tryon watershed, but BES was unable to locate any storm drain or sewer pipe permits--local, state, or federal--except for the one culvert/outfall project previously mentioned. (See Appendices for correspondence.)

4) Federal fish and wildlife agencies advise a 200- to 300-ft. riparian "no-cut" buffer (or setback) for salmon streams. Since Tryon is a salmon stream, Mr. Robison then compared the two streams (Metro and NWI) in relation to impervious surface and subsurface encroachments within a 300-ft. "hypothetical" riparian buffer.

5) For the Metro stream (20.8 stream miles in length), Mr. Robison mapped municipal utility encroachments within a hypothetical 50-ft. buffer width. This hypothetical 50-ft. buffer comprises 251 acres. There are already 36,000 lineal ft. of sewer pipes, 8,300 lineal ft. of storm drainpipes, and 115 culverts within this riparian "buffer," according to Portland BES data. **Note:** If WMSWCD had utilized the more comprehensive *"major and minor ditches"* map from Portland BES, the total stream miles would have been considerably greater than the Metro stream, increasing as well the total number and area of encroachments.

6) This Report stresses the need for more consistency in the various agencies' stream maps, as well as the need to address possible non-permitted encroachments by municipal utilities into the stream environment.

C. Permit-Related Questions

As the tables of comparison indicate for Portland, the number of existing utility infrastructures and the total area of impervious surfaces within an adequate hypothetical 300-ft. stream setback is substantial. There seemed to be almost no permit records available from regulatory agencies for the extensive municipal infrastructures. (See The Question of Riparian Protection, this Summary)

Water Quality and Fish Habitat Issues

Natural Resource Agencies

State

The state agency responsible for fish and wildlife is the Oregon Department of Fish and Wildlife (ODFW); the state agency responsible for stream water quality is the Oregon Department of Environmental Quality (ODEQ).

Federal

Both the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) seem to rely on information from the ODFW for guidance, but ODFW, to the best of WMSWCD's knowledge, has not analyzed existing stream water sampling data, nor has the ODEQ, even though Tryon and its tributaries were listed by ODEQ in 1996 as critically impaired for elevated summer temperatures (303 (d) list).

Due to dwindling fish populations, by 1997 ODFW had restricted fishing in Tryon Creek to "catch and release." Years earlier, in the 1970s and 1980s, ODFW staff occasionally stocked the creek with salmon eggs or fry in "hatchpen" educational projects involving several local middle-school groups (Caldwell, ODFW). In the late 1980s, and for several years in the mid-1990s, ODFW staff supervised electroshock surveys to count fish in the lower creek system. They found a few salmonids, including rainbow or steelhead and cutthroat trout (Caldwell, ODFW).

However, in the opinion of Project Manager Elizabeth Callison, ODFW could improve its habitat restoration strategy. For example, it has not yet requested that the Water Resources Department reserve water in-stream to improve fish habitat. Nor has ODFW analyzed data on potential culvert barriers or macroinvertebrate sampling results. This Baseline Report will be sent to ODFW for its review of available data on culverts that may be obstructing fish passage, as well as in-stream water reservation and macroinvertebrate survey results.

In 2000, on a contract with the City of Portland, ODFW-Corvallis Habitat Assessment staff surveyed creek conditions for a limited portion of the stream (mid- to lower-Tryon mainstream and mid- to lower-Arnold Creek). In cooperation with the local ODFW staff, the City of Portland ESA Team (Endangered Species Act-Response staff) performed electroshocking and fish netting in a number of sections of the lower creek (2000-02--Smith, Reed, Portland ESA Team). Due to the depressed salmonid population, however, this activity in itself may be responsible for killing fish.

Both Portland and Lake Oswego have constructed numerous storm drain outfalls that pour untreated runoff from streets, parking lots, and commercial development directly into stream corridors. (Private property owner outfall data was not available, although some households allegedly drain their hot tubs or swimming pools into adjacent creeks.)

Four foot-diameter sanitary (wastewater) sewer mains run parallel with and frequently cross Tryon Creek and several tributaries. These large wastewater pipes can become blocked, back up, and pour raw sewage into the creek. Toxic chemicals are occasionally used to flush sewer mains in order to dissolve tree roots that work their way into the joints of the large cement sewer pipes. Portland BES reported only three occurrences of sewage spills in the Tryon watershed between 1996 and 2002; however, City sampling data since 1994 show a number of instances of bacterial contamination of the stream water. This Baseline Report includes graphs of the sampling data, but all the data needs further review.

Excavated in the topographical low-point along creeks, large-diameter cement sewage pipes can collect substantial surface water runoff, which may be creating sewage pipe-capacity problems. It is probable though not documented that the pipes surcharge and overflow into the creeks during heavy rain events. Also, Portland owns and operates the Tryon Creek Wastewater Plant, a sewage treatment facility on Tryon's south bank where the creek meets the Willamette River. It is likely that the chlorinated effluent (secondary level treatment) that pours into Tryon's confluence with the Willamette River may be repelling many salmonids from entering the creek system to spawn. The effluent may also be killing other aquatics. Besides being within an Evolutionarily Significant Unit (ESU) for salmonids, the Tryon area has several endangered species of plants (USFWS and National Wildlife Federation data base reference).

Permitting Agencies

Federal and State: U.S. Army Corps of Engineers(Corps), Oregon Division of State Lands (ODSL)
The Corps and ODSL are responsible for issuing permits for stream and wetlands fill and excavation projects. These agencies, however, sometimes appear to work together less than effectively in developing an organized enforcement and monitoring process for stream and wetlands development. There is no watershed-wide (or geographically based) data base for recording significant changes over time. This is possibly one of several unintended consequences of the inconsistencies in stream inventories among the various agencies. Streams included on local inventories often do not appear on federal or state maps (for example, see NWI, StreamNet, and ODEQ 303 (d) maps).

Not organizing regulatory permits by geographical area--and not tracking them over time--has also resulted, or so it seems to this Project Manager, in some agencies apparently enjoying an exempt status which may not be warranted under either the Clean Water Act (CWA) or Endangered Species Act (ESA). Moreover, the natural resources ***consultation*** agencies such as the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and ODFW do not seem to keep records of the consultations they write regarding local, Corps, or ODSL land use permit applications.

(As an example, a staff notation surfaced in a Corps file regarding a BES 1999 application for a permit for 1,500 ft. of bank stabilization in upper Tryon/Playhouse Creek. According to the notation, NMFS questioned BES' proposal; BES then withdrew its permit application from the Corps. NMFS's original letter to the Corps was missing from the Corps' file, and NMFS staff had no record of the correspondence. BES had no copy of the NMFS letter although BES's decision to withdraw its application seemed to be related to the contents of the NMFS letter.)

Most of the Tryon watershed area--about 85%--is within the City of Portland, with much smaller portions in the jurisdictions of the City of Lake Oswego and unincorporated Clackamas and Multnomah Counties. Portland has intergovernmental agreements with various state resource agencies (for example, the Oregon DEQ) that allow it significant storm water management authority.

Stream "Modification" History
Regulatory permit data is very sketchy. It is difficult to track the history of even large-scale channel modifications. The Corps seems to not maintain records of permits for in-stream construction of municipal utilities. There is no monitoring of in-stream modification/development activities over time. The Corps was not able to provide permit information regarding streets built in stream corridors, or the culverts under for driveways, parking lots, etc. Unintentionally or not, both Cities have avoided permit review and revision for large infrastructure projects--their in-stream wastewater and storm water pipe systems. As mentioned, toxic chemicals are occasionally used to flush sewer mains to dissolve the tree roots that choke sewer pipes located within wet, low-lying riparian areas. Adverse impacts from the construction and operation of sewer and storm drainage utilities in the creek system have resulted in hazardous environmental conditions for both wildlife and humans. (Note: Data from the Corps, DSL, BES, etc. files are included in Appendices to this Baseline Assessment Report.)

Map-Related Regulatory Inconsistencies
As noted above, problematic inter-agency communication has resulted in inconsistency stream maps. Examples include: the National Wetlands Inventory (NWI) map, the United States Geological Service (USGS) topographic map, the Metro Regional Land Information System (RLIS) data files, and maps by Portland and Lake Oswego developed for use by their environmental engineers. Not surprisingly the NWI maps are the least comprehensive; the Metro-RLIS maps are somewhat inaccurate and the USGS topographical streams maps are similar to the Metro maps. Portland BES's "major and minor ditch" inventory seems to be the most complete inventory of waterways, at least for Portland's portion of the watershed, though the "ditch" appellation, unfortunately, and possibly (unintentionally or not) to the benefit of permit-seekers, is applied mistakenly and indiscriminately to man-made ditches as well as to life-supporting natural waterways.

Watershed Hydrological Problems Indicated in Condition of Creeks
Streams in the Tryon basin are in trouble. The small outer tributaries, particularly, are torn up, eroded, or even paved over. Although in the mid- to lower-watershed there are sections that appear to offer good habitat and functionality, the waters often appear grey-brown with an oily, bluish sheen. Portland water sampling tests for the past six years appear to violate state minimum standards for water quality. Storm drains spill runoff from streets, buildings, and parking lots into the waterways. There are numerous sections of creek that have been culverted and therefore likely obstruct passage for aquatic species, including migratory salmon. Macroinvertebrate sampling surveys during the baseline period showed that there are few examples of aquatic life in any of the creeks, with the exception of the most pollution-tolerant species.

Most of the huge old cedars and firs in the Tryon watershed were logged by the end of the 1900s; recent urban housing, institutional, and commercial developments have forced clear-cutting of even the second-growth forests. Portland and Lake Oswego utility bureaus typically remove logs and other woody debris from stream corridors while excavating, constructing, or maintaining their sewer and storm drain infrastructure. There is not much large woody structure left in the creeks and banks. Even in the state park there was little apparent beaver activity. (These last items were noted in both the ODFW Habitat

Inventory Report and the National Riparian Survey Team-Properly Functioning Condition [NRST-PFC] Report, included in Part 1 of this Baseline Report.)

Water Sampling

In 1996 Tryon Creek received a 303 (d) listing from the ODEQ for failure to meet the state standard for water temperature. Portland BES has been conducting a water-sampling program in several locations in the watershed since 1995; however, the Project Manager could find no evidence that the ODEQ ever reviews the results. BES cooperated with WMSWCD requests to provide their sampling data for this Baseline Report. The sampling data indicates several chronic water quality problems besides elevated temperature. Tryon Baseline Project intern, Bradlee Mertz, graphed Portland's sampling data. The Project Manager has requested that ODEQ review the BES data.

Local Environmental Regulations

In 1992, Portland instituted an "environmental overlay zone" for much of the Tryon area to protect high-value natural resources under Oregon's Goal 5 environmental mandate. Lake Oswego also instituted a zoning overlay plan similar to Portland's. Unfortunately (to the best of WMSWCD's knowledge), it appears that neither zoning overlay program is monitored for its effectiveness. Since Portland's jurisdictional area is far greater than any other unit of government in the watershed, WMSWCD used Portland data to track the amount of building, paving, and in-stream structures currently built within Tryon Creek's environmental zones. Portland's environmental zoning maps lack stream locational data. That is, the Portland Planning Department has not been including the creeks within its environmental zone overlay maps, but apparently is relying on Metro's or BES's (inconsistent) stream map data on an as-needed basis. Lake Oswego Planning Department also waits until a proposed development application appears to confirm stream locations.

Note: According to Portland Planning Department staff, the problem of inconsistent stream maps is now undergoing review. A joint Metro/Portland staff committee may be able to agree on a stream centerline map by early 2003, according to Portland Planning staff person D. Stein, 2/03. Not being addressed, however, are the discrepancies among federal or state agency stream maps and the local maps.

Impacts to Streams by Utilities

This Report reviews existing data on stream corridor encroachments by large-scale surface and subsurface infrastructures such as culverts and pipes for wastewater sewage and storm water runoff. These combined utility infrastructures appear to have had devastating effects on the stream corridors. The chronic effects not only include water pollution, soil erosion, fish and wildlife degradation, and hydrological disruption, but there have been significant indirect impacts as well. For example, locating sewer mains in the steep Tryon ravines likely increases the costs and risks for their maintenance and repair.

Large-scale utility projects having the potential to impact stream corridors or wetlands are supposed to undergo several levels of regulatory review. Complicating this process are:

- the lack of centralized permit-monitoring and record-keeping,
- inadequate coordination among regulatory agencies,
- incorrect or inconsistent stream/wetlands inventory maps used by the various agencies.

The considerable underground pipe systems of both Portland and Lake Oswego within the stream corridors should be under regulatory permit at the local, state, and federal levels. However, as noted, permit data for these infrastructures at the relevant regulatory agencies are nearly non-existent.

This Report shows the extent to which impervious surfaces (streets, buildings, parking lots, and large pipelines) already encroach within a "hypothetical" 300-ft. riparian buffer, as contrasted to encroachments within the "environmental zones." Again, it is important to note that the environmental zoning overlay does not restrict the type or number of buildings allowed under the "base zone." In the outer watershed, most lands have been zoned for commercial/general use or high-density mixed uses along Barbur Blvd. (Highway 99) and the I-5 freeway. In most instances the headwaters and small wetlands in those areas are still being paved over. Even where an area has an environmental zoning overlay, which is in itself rare in the outer watershed, the environmental zoning overlays do not stop any of the uses allowed in the "base zone," but merely guide the placement of structures and deal with certain environmental "mitigation" issues.

As far as the utility infrastructure is concerned, subsurface pipes and culverts are disruptive to hydrological and other watershed functions. In the cases where this is even acknowledged, Portland and Lake Oswego management policy is to approve "mitigation" for riparian degradation by revegetating the area of disturbance. Mitigation policy at every level seems to avoid addressing subsurface problems, such as loss of groundwater recharge capacity, or potential water contamination caused by sewer pipe seepage and surcharge.

As urban land uses increased and intensified over the past few decades, Portland and Lake Oswego planners and engineers encouraged use of streams for storm water runoff conveyance. The results of this policy decision thus far have been: severely channelized streams, chronic soil erosion, abnormally low summer flows and water pollution. Given the combination of ever-increasing impervious surfaces and shortsighted storm water management throughout the Tryon watershed, both the winter peak flows and the summer low flows are becoming more extreme. The Tryon system is normally fed by springs and seeps of clean cold water. But when rain events occur, the (often-over heated) runoff from streets, parking lots, and landscaped yards can quickly overwhelm creeks with water-borne contaminates.

Tree Canopy
Metro data on tree canopy-cover within the entire watershed as well as within stream corridors and environmental zones is provided in this Section. The tree canopy map was based on aerial photography.

Summary: Finding the Streams

Because of substantial discrepancies among stream maps of the various agencies, this Baseline Report compared stream corridors for two different streamlines: based on current Metro and NWI data. Each of the respective stream corridors was then depicted with two "hypothetical" buffer widths. This Report then contrasted existing impervious surface, subsurface, and structural inventories within the two "hypothetical" (50- and 300-ft.) buffer widths. The results of these queries were then contrasted with Portland's and Lake Oswego's data for their environmentally zoned lands.

The Question of Riparian Protection

As mentioned above, there are inconsistencies in stream mapping between the various governmental agencies. Compounding this problem are the vagaries of Oregon's land use regulatory system. For example, although statewide Goal 5 (protection of natural resources) does allow for a local jurisdiction to restrict building on steep slopes, earthquake prone areas, riparian corridors, and environmentally significant areas, among others, it does not require that the full length of streams be protected. Portland's inventory and protection scheme is applied to areas rather than being stream-specific. For example, Portland does not protect a stream as a *complete linear resource*, but instead applies an "environmental overlay zone" according to an area's "functional resource values." Ironically, as an area becomes more urbanized, the state's Goal 5 system tends to decrease protection for it. In the opinion of the Project Manager, it is a sad example of the failure of regulatory oversight in the Tryon area that the more abused and derelict an area appears, the more degraded it is therefore encouraged to become. Tryon's degraded and polluted upper tributaries inevitably impact the state park's officially protected stream corridors in the lower watershed.

Besides inconsistencies in the land use system, there is also the question of federal and state regulatory agencies' enforcement of water quality and endangered species laws. For example, the Cities of Portland and Lake Oswego both installed large sewer systems and storm water runoff drainpipe infrastructures in many of Tryon's stream channels. Much of the bank erosion and water pollution likely result from the proximity of these wastewater and storm sewer infrastructure systems, yet the problem seems to go unnoticed by federal and state regulatory agencies. The in-stream utility infrastructures are supposed to be under Army Corps of Engineers and/or Division of State Lands permits, yet these agencies' lack of permit records would seem to indicate that they have either never required the permits, or they have not been doing appropriate monitoring or revision. (A summary of the few records that were made available appear in an Appendix to this Report.)

Recommendations: The in-stream utility infrastructures are supposed to be under the Army Corps of Engineers and/or Oregon DSL permits, yet the permit records for both entities are woefully incomplete, a situation that needs to be corrected and improved before inevitable population and pollution increases further degrade the waterways in the area. (See Corps and Oregon DSL records in an Appendix to this Report.)

Local utilities appear to have enjoyed virtually free use of stream corridors as right-of-ways. Besides the problem of lax federal and state permitting processes, the inadequacy of maps and inventories is likely a contributing factor. For example, if the federal or state agency is utilizing incomplete stream and wetlands maps, its staff will not be aware when a permit or permit revision should be required of the property developer--including the Cities' own utility bureaus.

The tables on the following pages show calculations of data for two contrasting stream centerlines from the National Wetlands Inventory and Metro, respectively. Also included are calculations for Falling Creek--the most urbanized sub-watershed, and Park Creek--the least urbanized sub-watershed. For each of the stream types, several items are compared in the tables:

- Length of stream. The NWI stream map has the least stream length. In fact, for the entire Tryon system, NWI acknowledges only 7.9 stream miles, in contrast to the Metro stream map, which acknowledges 20.8 stream miles;

- Amount of construction of various types already built within two "hypothetical" riparian buffer widths, a "hypothetical" 50-ft. buffer and a "hypothetical" 300-ft. buffer. The 200- to 300-ft. stream setback is the minimum no-cut width recommended by federal fish and wildlife agencies for salmonid-bearing streams. This is contrasted with the amount of construction of various types already built within the City of Portland's "environmental" zones.

Table: National Wetlands Inventory Stream Centerline vs. Metro Stream Centerline with encroachments. Comparison of data for areas under Portland Environmental Zone Overlay vs. Two "Hypothetical" Stream Buffers, showing current encroachments for each width.

(Note: These computations were based on Portland data. They require field confirmation. Some categories were not available.)

	Entire Tryon Watershed		*Falling Cr. Sub-watershed*		*Park Cr. Sub-watershed*	
	NWI stream	Metro stream	NWI stream	Metro stream	NWI stream	Metro stream
Stream Length (All branches, in stream miles)	**7.9**	**20.8**	**0.8**	**1.1**	**0.9**	**1.7**
Area of Basin (As defined by Metro)	4,177.9 acres		371.1 acres		247.6 acres	
Area included in 50' Buffers (acres)	95.9	251.2	9.7	14.0	10.6	20.9
(percent)	2.3%	6.0%	2.6%	3.8%	4.3%	8.5%
Area included in 300' Buffers (acres)	565.5	1,475.9	60.1	90.2	63.1	122.9
(percent)	13.5%	35.3%	16.2%	24.3%	25.5%	49.6%

Impervious Surfaces within 300' Buffer – Buildings (acres)	24.5	79.4	6.7		0.7	
(percent)	0.6%	1.9%	1.8%	%	0.3%	%
Impervious Surfaces within 300' Buffer - Roads (acres)	38.9	141.8	13.2		3.3	
(percent)	0.9%	3.4%	3.6%	%	1.3%	%
Impervious Surfaces within 300' Buffer - Total (acres)	63.3	221.2	19.9		3.9	
(percent)	1.5%	5.3%	5.4%		1.6%	
Impervious Surfaces within 50' Buffer – Buildings (acres)	3.0	4.8	1.1		0.2	
(percent)	0.1%	0.1%	0.3%		0.1%	
Impervious Surfaces within 50' Buffer - Roads (acres)	3.4	14.8	1.8	0.0	0.0	0.0
(percent)	0.1%	0.4%	0.5%	0.0%	0.0%	0.0%
Impervious Surfaces within 50' Buffer - Total (acres)	6.4	19.5	2.9	0.0	0.2	0.0
(percent)	0.2%	0.5%	0.8%	0.0%	0.1%	0.0%

Table: Stream Comparisons con't:

Contrast the NWI-stream (left) vs. Metro-stream (right) for selected encroachments within two "hypothetical" stream buffer widths.

Lineal feet of Sanitary Sewer pipes within hypothetical 50-ft. Buffer	14,524.3ft.	35,854.3ft.
Lineal feet of Storm Drain pipes (excludes culverts) within hypothetical 50-ft. buffer	3,480.4ft.	8,326.9ft.
Lineal feet of culverts within hypothetical 50-ft. buffer (Portland only)	1,177.5ft.	7,734.2ft.
Number of culverts within hypothetical 50-ft. buffer (Portland only)	23	115
Lineal feet of sanitary sewer pipes within hypothetical 300-ft. buffer	68,183.5ft.	163,857.6ft.
Lineal feet of storm drain pipes (excludes culverts) within hypothetical 300-ft. buffer	19,355.6ft.	57,373.7ft.
Lineal feet of culverts within hypothetical 300-ft. buffer (Portland only)	11,604.3ft.	33,675.7ft.
Number of culverts within hypothetical 300-ft. buffer (Portland only)	138	411
Lineal feet of abandoned pipes within hypothetical 300-ft. buffer (Portland only)	496.1ft.	1,595.2ft.
Lineal feet of abandoned pipes within hypothetical 50-ft. buffer (Portland only)	.	232.6ft.

PORTLAND'S ENVIRONMENTALLY- ZONED LANDS AS CURRENTLY BUILT OR PAVED. 2002.

Total Acreage in e-zones (Tryon watershed/Portland only)	1,298 acres
Total Acreage in Impervious surfaces in e-zones (Buildings)	15 .0 acres
Total Acreage in Impervious surfaces in e-zones (Roads)	59.2 acres
Total Acreage in impervious surface in e-zones (buildings and roads)	**74 .2 acres**

Note: Total impervious surface for the watershed is estimated at 41,992,035 square feet, or 964 acres. Impervious surface as a percentage of the watershed area is roughly 23% of the total 4,178 acre watershed. (All estimates computed by WMSWCD based on Portland BES data (2001-02).

Recommendations

Considering the stalemate in environmental protection, both Cities need to reconsider their strategies for addressing the Clean Water and Endangered Species Acts, not to mention significant public health and safety issues. Currently, Portland encourages increases in density of residential, commercial, mixed, or industrial uses. And thus far neither Portland nor Lake Oswego facilitates incentive funding available for individual landowners to preserve or restore stream property. Most landowners are not aware they may be eligible for federal funding for wildlife habitat preservation and water quality improvements, as well as partial property tax exemptions available under state law.

For example, the federal Department of Agriculture (USDA-NRCS) has a financial incentive program called the Wetlands Reserve Program (WRP), which offers qualified landowners remuneration via a 15-year or 30-year contract to help restore their wetlands and stream habitat. The landowner keeps all property rights. WRP is supposed to be open to both urban and rural landowners equally. However, property owners of streams and wetlands would need specialized zoning such as farm or forest zoning to help them qualify. The Cities of Portland and Lake Oswego could facilitate this type of funding for landowners in several ways. The Cities could designate the *farm/forest base zone* for the riparian section of the property, at the landowner's request. This zoning could then be combined with a *voluntary conservation easement*, to strengthen the landowner's eligibility for environmental restoration incentive funds from either a public agency or private foundation. The facilitation of the WRP or similar programs could bring new sources of funds into the urban area--which would likely be popular with landowners while helping to improve habitat for fish and wildlife.

Board Conclusions, Other Important Studies, and Future Collaboration

The West Multnomah Soil and Water Conservation District board is grateful to Liz Callison for bringing all this information together and creating the beginnings for public dialogue. The board recognizes that there have been severe impacts to the stream in the past. Local government actions are a reflection of citizens and the amount of time and money that can be directed to solve problems. Some problems cited such as not knowing where the centerline of the stream is or what the best map to use is are not seen as a priority issue. The City of Portland representative on the Tryon Creek Watershed Council (TCWC) states that for the last 7 or 8 years, when there are actual local environmental decisions on construction or redevelopment, that the City always sees the project on the ground. Buffers, where required by City code, are established based on physical knowledge. We agree that when one attempts determine, using computer technology, the extent of impervious surfaces within hypothetical 50 or 300 foot buffers that information on the stream centerline is important. We can not say how more accurate the estimates of impervious surfaces in buffer zones would be if stream centerlines were more accurate, but we feel that it was important to attempt to portray this subject.

We hope this report is used and will be a tool for discussions on priority environmental concerns. As of this writing we have been told at the May TCWC meeting that there is a City of Portland priority on addressing storm water issues. The TCWC has a seat on that local storm water committee.

There are several recent studies that are not included with this report, but we will collaborate with the TCWC to find the best way to insure that we have the means to insure that the most recent information is available whenever we are re-examining technical issues. As a result of the City of Portland's ESA Program, ODFW has written a report "**Distribution of Fish in Portland Tributary Streams**". J. Graham & D. Ward, November 2002 and another report is due in six months. The public may be surprised to learn of the cutthroat fish populations in Tryon Creek. A study that produced macro-invertebrate data in several Portland area streams was part of a Portland State University study done by Yangdong, Walker, Hoy, Weilhoefer, and Sampere 2001. "**Bioassessment of Urban Streams**" Portland, OR. Another macro-invertebrate study was conducted by Laurie Hennings, in Tryon and other urban streams. The report is a draft but data and conclusions are available to the public. Trying to interpret the results of macro-invertebrate populations and their ultimate effect on fish is difficult, especially since fish benefit from a large supply of terrestrial insects that also are a significant food source.

The board is not convinced there is agreement on the severity of some problems, but we are committed to working with the (TCWC). We have focused some attention on getting more large woody debris in Balch Creek in the past and agree that this matter should be seriously addressed in Tryon Creek. We see the potential problems at culverts would need to be addressed by trash racks. Hopefully, the health of Tryon Creek is seen in a positive light so that the box culvert under highway 43 can be removed. An open stream at this location may be a large step in the right direction. We have been meeting monthly with the TCWC assessment committee to help us find ideas and support on future study and also with TCWC on how citizens and government can be more productive at recognizing and addressing problems. The Cities of Lake Oswego and Portland work with the council and the assessment committee to this end.