

28 September 2010

To Lane County Planning Commission & Board of Commissioners
From Technical Advisory Committee
SUBJECT FINDINGS OF FACT AND RATIONALE FOR THE PROPOSED DRINKING WATER PROTECTION ORDINANCE

INTRODUCTION

The purpose of this memo is to provide findings of fact for the proposed *Lane County Drinking Water Protection Overlay Zone* (Lane Code 16.298/DWP-RCP). The purpose of this overlay zone is to promote the public health, safety, and general welfare of the residents of Lane County by minimizing public and private losses due to contamination of drinking water sources.

Specifically, the goals of the proposed ordinance are to protect surface and ground waters that provide sustainable sources of safe potable drinking water to Lane County residents, protect human life and health, minimize expenditure of public money for pollution remediation projects, and minimize interruptions to business and commerce. The newly defined overlay zone will serve to better protect Lane County's sources of public drinking water.

Technical Advisory Committee Mission and Charge

In late 2009, the Lane County Board of Commissioners appointed a Technical Advisory Committee (TAC) to assist the Lane Management Division (LMD) staff in drafting proposed revisions to the existing floodplain ordinance and preparing a new drinking water protection overlay zone. The objective of the TAC was to help LMD construct ordinances that would protect water quality, promote human health and safety and protect property, while providing reasonable limitations and exceptions to the code where necessary to protect private property rights.

In its deliberations, the TAC reviewed various practices in other jurisdictions, model ordinances prepared by the Oregon Department of Environmental Quality and other agencies, a recent study by the University of Oregon and other technical and scientific sources from agencies, a threat identification document prepared by LMD, and the relevant literature. References are cited in the documents prepared by the TAC. The Land Management Division is responsible for the final language that is presented to the Board of Commissioners. The TAC is not a stakeholder committee and the recommendations are not intended to reflect the views of stakeholders.

The members of TAC are:

Member	Affiliation
Amy Chinitz	Springfield Utility Board (SUB)
Jacqueline Fern	Oregon Department of Environmental Quality (DEQ)

Denise Kalakay	Lane Council of Governments (LCOG)
Joe Moll	McKenzie River Trust
Karl Morgenstern	Eugene Water and Electric Board (EWEB)
Bob Parker	University of Oregon Community Service Center
Larry Six	McKenzie Watershed Council
Eve Montanaro	Middle Fork Willamette Watershed Council

Membership on the TAC does not necessarily imply formal endorsement of the proposed ordinances by the agencies and organizations represented, although the objectives of the ordinances are consistent with the mission and goals of these organizations.

BACKGROUND

Sixty-seven community water systems provide the primary sources of drinking water for approximately 83% of the population in Lane County (ODHS, 2010). All of these community water systems have delineated drinking water source areas and have assessed the various pollution threats to water quality in these areas as required under the Clean Water Act (<http://www.deq.state.or.us/wq/dwp/swrpts.asp>). According to the U.S. Environmental Protection Agency, the leading cause of source water degradation is from nonpoint sources of pollution (NPS), which includes runoff from lawns, farms, forests, highways, and urban areas, as well as leachate from septic systems and landfills (U.S. EPA, 1998). Public water providers and community leaders in Lane County have been working to better understand and address the various threats to water quality in drinking water source areas with varying success. The following are examples of these efforts:

- Dune City: most Dunes City residents draw their drinking water from Siltcoos or Woahink Lakes. For years, Dunes city has been proactive in protecting their drinking water supply through a combination of regulatory and educational mechanisms. Dunes city prohibits detergents with phosphorous (Ordinance 190) and requires residents to have their septic systems periodically inspected to help reduce the risk to their water supply (Ordinance 173). Dunes City also has an erosion control ordinance (Ordinance 193) that requires site plans and erosion control for certain disturbances of soil (based upon size of disturbance and slope). Dunes City staff and volunteers are also long-term partners in ongoing project work to monitor and address blue-green algae issues.
- Florence: awarded an EPA grant to fund the Siuslaw Estuary Partnership project to better assess and protect natural resources including drinking water quality in their federally designated sole source aquifer.
- Heceta Water District is a partner in multiple drinking water protection grants including the Siuslaw Estuary Partnership project and a DHS grant to assess harmful algae blooms in mid-coast lakes. The water district also voluntarily tests for pharmaceuticals in their source water.
- Veneta: completed a drinking water protection plan in 2000. One of the goals in the plan is to “Form an Intergovernmental Agreement with Lane County”. The goal is

formed around the idea that collaboration with the County is important because “activities and actions within Lane County purview may adversely affect Veneta’s groundwater quality”.

- Springfield: developed a drinking water protection plan that was adopted in May 1999. Following the goals outlined in its plan, Springfield developed a drinking water protection overlay zone, which sets standards, prohibitions, and restrictions for the use of hazardous materials within those portions of Springfield’s groundwater source area that fall within the urban growth boundary. Springfield was also awarded a Dept. of Human Services grant in 2009 to coordinate with Veneta and Adair Village in implementing county-wide source water protection activities including public education and integration of drinking water protection with land use planning.
- Junction City and Coburg developed drinking water protection plans in 1997 and 1996, respectively, and are highly proactive in educating community members and reducing high-level risks to their city wells. Both municipalities are actively engaged in implementing strategies documented in the Southern Willamette Valley Groundwater Management Area Action Plan to reduce regional nitrate contamination.

The largest public water system in Lane County is the Eugene Water and Electric Board (EWEB) serving nearly 200,000 people. EWEB’s Drinking Water Source Protection Program has made a significant investment over the last nine years to collect baseline information with the U.S. Geological Survey (USGS) and other partners about water quality threats and impacts from forestry, agriculture, urban pollution, development, roadside vegetation management, operation of reservoirs and hydroelectric facilities, commercial and industrial pollution and hazardous material spills or releases (EWEB, 2000; EWEB, 2001a; EWEB, 2001b; EWEB, 2005a; EWEB, 2005b; EWEB, 2005c; EWEB, 2005d; EWEB 2005e; EWEB 2005f; EWEB, 2005g; EWEB, 2006a; EWEB, 2006b; EWEB, 2007; EWEB, 2009; USGS, 2009; Kraus, et. al., 2010; U of O CPW, 2009b; U of O CPW, 2009d; also see www.eweb.org and www.mckenziewaterquality.org). This information is being used to develop watershed models that will be used to help understand trends and predict future water quality based on changes in land use and the climate.

Recent studies by EWEB have focused on assessing the water quality impacts from septic system clusters areas (i.e., higher density areas) in close proximity to the river or tributaries on gravelly or highly permeable soils (EWEB, 2006a; EWEB, 2009). EWEB also engaged students at the University of Oregon Community Planning Workshop (CPW) to evaluate Lane County Development Code and determine what parts of the code were detrimental to source protection and what parts were beneficial. The CPW also assessed how the beneficial development code was implemented and enforced (CPW, 2009c). Based on these studies it appears increased development along the river poses a threat to Eugene’s sole source of drinking water in the following ways (EWEB, 2009; CPW, 2009b; CPW, 2009c; CPW, 2009d):

- Septic systems, especially those in higher densities or clusters, and/or located near the river in soils that are excessively permeable, pose a threat due to reduced treatment of domestic wastewater and short travel time to the river. Water quality monitoring from

samples collected downstream of septic system cluster areas indicated an increase in bacteria and nutrient concentrations in shallow groundwater and the McKenzie River when compared to upgradient or upstream samples (EWEB, 2009).

- Development removes riparian vegetation that can buffer impacts from runoff of pesticides, paint, wood treatment chemicals, fertilizer or other household chemicals during rainstorms. Riparian areas also provide critical habitat and shade the river to reduce water temperatures.
- Development in the floodplain poses a threat due to the potential inundation of homes, garages, sheds and businesses that store pesticides, paints, solvents, petroleum products, sewage (from septic tanks and drainfields), gasoline, oil, grease and other petroleum products during periodic floods.
- Development in areas where the river is actively meandering can potentially wash away structures, septic systems, drums, tanks, or other containers that store chemicals. In addition, landowners in meander areas often resort to using revetment to harden river banks to protect homes and other structures that are threatened. This leads to a straightening of the river, with higher water velocities and potential for downstream impacts.
- Lane County Code and permitting practices allow development in the riparian area, floodplain, floodway and/or meander zones that not only increases the threat to drinking water, structures and human safety, but increases County staff time and costs of government resources once the structures are built in these critical areas.

This data and information was presented to the Lane County Board of County Commissioners on June 2, 2009 and August 25, 2009. Because the CPW study focused on Lane Code and development patterns associated with that code the Commissioners directed staff to work on updating and expanding the existing floodplain management ordinance and a drinking water source protection overlay zone throughout Lane County. These ordinances are designed to better protect human health and safety and to safeguard community drinking water quality.

Protecting the water quality of Lane County community drinking water source areas (which include surface water and groundwater areas) is a crucial part of ensuring safe and clean drinking water for the vast majority of residents in Lane County both now and into the future. The terms “surface water” and “groundwater” refer to the same water, they merely clarify the location of the water at a particular point in time (Leopold, 1997).

Drinking water source protection overlay zone ordinances are used throughout the country as one of many different tools being employed to protect valuable community drinking water source areas. The main purpose of overlay protection zones is to restrict or prohibit activities like development, hazardous material use and storage and other disturbances that would directly threaten the long-term water quality and health of the people that rely on the drinking water source. By adopting a proactive ordinance, Lane County can better minimize expenditure of public money for pollution remediation projects by simply avoiding contamination in the first place (TPL, 2004).

The purpose of this memorandum is to provide the factual and scientific basis for the main elements of the proposed *Lane County Drinking Water Protection Overlay Zone* (Lane Code 16.298/DWP-RCP), which includes:

- Extent of drinking water protection buffer zones;
- Activities prohibited in protection buffer zones; and
- Groundwater protection zone delineation.

SUMMARY OF RESEARCH

The Economics of Source Protection

There are a number of purely financial reasons that exist for creating an overlay protection zone to help safeguard a community's drinking water source and reduce the likelihood that contamination will occur. Specific economic benefits include reduced costs for raw water treatment chemicals such as flocculent and chlorine, reduced water demand for backwashing, long-term economic viability of community, and reduced risk of contamination clean-up (TPL, 2004; NEIWPC, 2000).

The true value of clean water is hard to measure. The cost of drinking water is currently set by the cost of treatment and distribution to the customer, which makes water an extremely inexpensive commodity. However, the majority of people are willing to buy bottled water at a price of up to 1,000 times the cost of safe tap water (AWWA, 2005). The Harvard Law School developed a methodology to quantify the value of improvement in water quality. They found that a 1% improvement in water quality was worth \$22.40 per household (Magat, et. al., 2000). This type of valuation can also be used when assessing the worth of preventing water quality degradation.

Another way to assess the economics of source protection is to look at the cost of additional treatment should a water system become contaminated. Regardless of the type of water treatment technology used by a community water provider, the protection of public health and raw water quality requires the protection of the source water. Simply put, contamination isn't allowed to find its way into the public water supply in the first place, then society wouldn't have to pay the high price that goes with removing it (NEIWPC, 2000). Without source protection, raw water may degrade over time to the point where it is necessary to upgrade existing treatment technology at high capital costs. A few examples include:

- A lower bound on the economic benefits provided by watershed protection of the City of New York's water supply watersheds in the Catskill Mountains can be inferred from the estimated costs of \$6 to \$8 billion in capital investment and \$300 million annual operating and maintenance costs that would be needed for drinking water filtration facilities to replace the natural filtration of the City's water supply. To preserve these services, the City of New York is investing \$1.5 billion in the Catskill Mountain watershed for stream setbacks, stream fencing, and a range of best management practices to preserve the natural water filtration services of the riparian landscape (NRC, 2000; CRWPI, 2006).

- The 1996 flood had a significant effect on the quality and quantity of Salem’s water supply as the North Santiam River had extremely high turbidity and sediment loads. The city’s slow sand treatment system was quickly overwhelmed with sediment, forcing the city to drill emergency wells, purchase groundwater from neighboring communities and construct an emergency pre-treatment system at a cost of \$2,410,000 (TPL, 2004; NEIWPCC, 2000). Logging clear cuts and unmanaged roads that gave way to slides and erosion were cited as one of the main reasons for the high sediment load, as well as the proximity of urban and residential development, including a highway that parallels the city’s source of drinking water (U.S. GAO, 1998).
- Between 1996 and 1998 the City of Wilmington, North Carolina spent \$36 million to add ozonation and expand its treatment facility, in part as a result of an increase in industrial and agricultural runoff in their watershed (TPL, 2004).
- In 2000, Danville, Illinois invested \$5 million in a nitrate removal facility to deal with spikes in nitrogen resulting from agricultural runoff (TPL, 2004).
- In 2001, Decatur, Illinois, invested \$8.5 million in a new nitrate removal facility, also to deal with agricultural runoff (TPL, 2004).

The following table depicts the savings to communities that can be realized by investing in source water protection versus cleaning up the contamination after the fact. EPA estimates that on average, clean-up is 27 times more expensive than prevention and can be up to 200 times more expensive (U.S. EPA, 1996).

Community	Contamination Cost	Source Water Protection Cost	Overall Ratio of Contamination Cost to Source Water Protection Cost
Gilbert, LA	\$547,323	\$2,744	200:1
Norway, ME	\$545,904	\$101,014	5:1
Tumwater, WA	\$570,813	\$22,073	26:1
Gettysburg, PA	\$4,015,351	\$22,579	178:1
Dartmouth, MA	\$1,176,646	\$99,052	12:1
Middletown, OH	\$491,823	\$22,761	22:1

Another reason to pursue protection of community water systems is that some contaminants cannot be treated using known treatment technology, so even if society decided to just invest in treatment of contaminated water as opposed to preventing contamination, it would not be effective in protecting human health over time. A number of studies have shown that conventional treatment systems do little to remove contaminants such as pharmaceuticals, plasticizers, pesticides, steroids, flame retardants and detergents and even advanced treatment systems may not be effective in removing these compounds (Stackelberg, et. al, 2004; Stackelberg, et. al., 2007; TPL, 2004; NEIWPCC, 2000; Lubick, 2008; USGS, 2008). In fact, pesticides were detected at low levels in over 60% of the finished water samples (i.e., after treatment) from community water systems in the Clackamas River basin (USGS, 2008). With more than 100,000 synthetic chemicals manufactured and used in domestic, industrial and

agricultural applications it may not be possible to rely on simply treating the problem even if a community choose to go that route (Jorgensen, 2004).

To add to the complexity of addressing potential contaminants in a drinking water source area, scientists are starting to find that there can be synergistic toxicity effects when a number of organic compounds are present even at low concentrations. The U.S. Geological Survey (USGS) has conducted a number of studies across the country, including the Willamette Valley and Clackamas River Basin, that have found the majority of the water samples with detections from urban, agricultural and mixed-use streams contained two or more pesticides (Gilliom, 2007; USGS, 1996; USGS 1997; USGS, 1998a; USGS, 1998b; USGS, 2001; USGS, 2008; Laetz, et. al., 2009). The toxicological effects of these mixtures on aquatic organisms and humans are largely unknown. However, it is fairly clear that single-chemical risk evaluations are likely to underestimate the impacts of pesticide mixtures on salmon and other organisms (Laetz, et. al., 2009).

As already indicated, it is more cost effective to avoid the need for expensive technology for water treatment that may not be effective against a number of organic contaminants by protecting the quality of raw water (NEIWPC, 2000). Another benefit that is usually not considered (in fact is often cited as a reason not to pursue source protection) is the potential for increased property values resulting from land use controls within a source protection area (NEIWPC, 2000).

There are also a number of proven social, environmental and public health benefits associated with adopting a proactive drinking water ordinance. The following are benefits of proactive drinking water protection to the community (TPL, 2004; NEIWPC, 2000):

- Increased reliability and safety of the water source ensures consumer confidence
- Supports community values, e.g. good stewardship of resources; healthy environment
- Greater flexibility to adapt to changes/future water needs
- Reduced treatment chemicals = reduced health risks associated with disinfection by-products; less worker exposure to chemicals
- Improved water quality = reduced health risks
- No drinking water standards exist for many emerging contaminants, including pharmaceuticals and personal care products. These compounds have been detected in streams and groundwater nationwide (Kolpin, et. al., 2002; Barnes, et. al., 2008); pollution prevention provides added protection from health risks (and other environmental risks) associated with these contaminants; each year approximately 50 new drugs appear on the U.S. market
- Even state-of-the-art treatment plants cannot remove all contaminants; a USGS study showed that many drinking contaminants can pass through high-level treatment (albeit at low concentrations) (Blomquist, 2001)

- Improved aquatic habitat and in-stream flows; protecting other beneficial uses including swimming, fishing, shellfish harvesting, livestock watering, wildlife benefits, irrigation.
- Fewer chemicals/contaminants = higher quality effluent to receiving water bodies
- Greater forest cover = lower treatment costs; in a 2002 study of 27 water systems by AWWA and TPL it was found that for every 10% increase in forest cover in drinking water source areas, there was a 20% reduction in treatment and chemical costs (TPL/AWWA 2002 study).
- “Approximately 50-55 percent of the variation in treatment costs can be explained by the percent of forest cover in the source area.” (TPL/AWWA 2002 study)
- Trust for Public Land reports that a 1997 study by Dept. of Agricultural Economics at Texas A&M University of 12 water providers and 3 years worth of data found the following:
 - *“Suppliers in source areas with chemical contaminants paid \$25 more per million gallons to treat their water than suppliers in source areas where no chemical contaminants were detected.”*
 - *“For every four percent increase in raw water turbidity there is a one percent increase in treatment costs. Increased turbidity, which indicates the presence of sediment, algae and other microorganisms in the water, is a direct result of increased development, poor forestry practices, mining or intensive farming in the watershed.”*

Without proper proactive drinking water protection, costly contamination can occur, as depicted by examples both in Oregon and throughout the country. Contamination of two drinking water wells in a small community in Marion County, Oregon resulted in costs exceeding \$500,000 (ODEQ, 2010a). In the two-year interim between discovery of the problem and the installation of a treatment unit, residents had to use bottled water for drinking and cooking purposes. In contrast, the cost to develop a Drinking Water Protection Plan for a small community would be well under \$10,000 (ODEQ, 2010a).

In Milwaukee, Wisconsin, cryptosporidium in groundwater has cost the region \$89 million thus far. Furthermore, in Moses Lake, Washington, trichloroethylene in groundwater cost the region \$1.8 million to date on blending water and educating the public (Ainsworth and Jehn, 1996).

When water quality causes illness or even just an unusual taste, odor, or smell, the public quickly loses confidence in the safety of its supply. Loss of public trust costs both the supplier and the consumer and often leads to broader economic impacts (TPL, 2004).

Trust for Public Land states that “land use regulation and protection are crucial tactics for ensuring high quality drinking water in the region, but are often compromised for the short-term economic pay off of development. Land use decisions are often based on short-term (1-5 years) revenues and expense projections for local governments. The impacts of development on water quality and treatment costs are realized over the long run (5-10 years)” (TPL, 2004). In addition, once development occurs it is a permanent fixture on the landscape, unlike other land use activities such as agriculture and forestry (NRC, 2002).

In community drinking water source areas the cumulative impact of development in critical areas like along rivers and tributaries and in floodways can potentially have a long term negative economic impact on communities and property values, especially if the natural resources that attracted people in the first place are significantly altered or degraded (CWRPI, 2006). A 1997 survey conducted by Duke University revealed that randomly selected residents in Colorado and North Carolina were willing to pay significantly more for a residential property located on land with 'good' drinking water as opposed to 'poor' drinking water (TPL, 2004).

The effect of setback regulations on property values is uncertain. Setback regulations could create a development effect that either increases or decreases home and lot prices. While both river views and forest views are consistently shown to increase property values, Mooney and Eisgruber estimated the effect of Oregon's voluntary riparian buffer rules, requiring a 50 foot *forested buffer* - not just a setback - reduced property values approximately 3%, attributed primarily to the loss of river view. Setback regulations could also be expected to contribute positive amenity value from the preservation of scenic views and water quality protection, as seen in water clarity, in waterfront properties (Mooney and Eisgruber, 2001; CRWPI, 2006).

RATIONALE FOR KEY AMENDMENTS TO THE DRINKING WATER OVERLAY ZONE

The target of this ordinance is those areas that are the sources for community water systems as delineated by the Oregon DEQ as required under the federal Safe Drinking Water Act as delineated by Oregon DEQ and Department of Human Services (<http://www.deq.state.or.us/wq/dwp/swrpts.asp>).

Proposed Ordinance: Extent of Surface Water Protection Overlay Zone

Proposed Language: LC 16.298 4 Designation of Drinking Water Source Areas. This Drinking Water Protection Overlay Zone is comprised of two separate regulatory elements, which contain different standards and requirements related to the protection of either surface water source areas or groundwater source areas. The locations of the protected surface and groundwater source areas are generally depicted on the proposed Drinking Water Protection Overlay Zone Map for Lane County and are further described below:

(a) Surface Water Source Protection Areas: Include the areas adjacent to rivers, streams, lakes or reservoirs that serve as a source of public drinking water, or which are tributaries to a source of public drinking water. These areas extend inland 200 feet, measured perpendicularly, from the ordinary high water level of the source of public drinking water and from any tributary to a source of public drinking water. The Official Drinking Water Protection Overlay Zone Map identifies the surface waters to which these protection areas apply but does not depict the precise location of the ordinary high water level. Where development or vegetation removal is proposed near a surface water protection area, Lane County may require that a site visit be

conducted by staff to delineate and monument the location of the ordinary high water level and the boundary of the surface water protection area on a property by property basis.

Explanation: As noted in LC 16.298 4(a), Surface Water Source Protection Areas extend inland 200 feet, measured perpendicularly, from the ordinary high water level of the source of public drinking water including tributaries (see map at: <http://apps.lanecounty.org/LaneCountyPlanMaps/>).

Riparian buffer zones are land adjacent to waterbodies that have a significant role in controlling pollution and other impacts on water quality (NRC, 2000; NRC, 2002; CRWPI, 2006). The purpose of this 200 foot buffer is to prevent or minimize land use activities that may have a cumulative adverse impact on water quality over time in areas close to sources of public drinking water and provide increased treatment of overland runoff from nearby areas. According to the National Research Council (NRC), “Only if a setback is subject to management or natural preservation can it be considered a “buffer” that reliably insulates ecosystems and resources from nonpoint source pollution” (NRC, 2000). Lane Code 16.298 is designed effectively restrict activities that would impact the natural preservation within the 200 foot overlay zone to maximize the effectiveness of this area for treatment of nonpoint source pollution.

Rationale: Across the United States the majority of riparian forests have been converted to other land uses or have been replaced by development (NRC, 2002). This trend holds true for Lane County, where increased development of homes in floodways and within 100 feet of the river significantly impacts riparian forest (U of O CPW, 2009b; U of O CPW, 2009c). “Future structural development on floodplains should be placed as far from streams, rivers, lakes and other waterbodies as possible to help reduce its impact on riparian areas. Structural developments typically have significant and persistent effects on the size, character, and functions of many riparian areas. Thus, preventing unnecessary structural development in near-stream areas should be a high priority at local, regional, and national levels” (NRC, 2002). Lane Code 16.298 4(a) establishes that a buffer of 200 feet from the river or tributary stream is a reasonable setback distance for structural development to protect riparian forests in community drinking water source areas.

Because there are already substantial zoning ordinances already in place, the most effective way to protect riparian buffers is through an amendment that adds to the existing riparian overlay buffer zone (Wenger and Fowler, 2000). By increasing the buffer width, Lane County will decrease the extent of risk to drinking water posed by development adjacent to rivers, lakes and tributaries of source areas. Buffers can play a key role in the protection of drinking water sources. Riparian buffers are highly effective in removing a variety of pollutants from overland and shallow subsurface flow, as well as serving as stream flow regulators and bank and riverbed stabilizers; thus helping to improve water quality of a stream (ELI, 2008; Oregon, 2000; NRC, 2002; CRWPI, 2006; NRC 2002). A review of literature supports the need for riparian buffers, but recommendations provide a large range of buffer widths (NRC 2000; NRC 2002; May, 2003; USDA, 2003; Mayer, et. al., 2006; Palone and Todd, 1998) depending on:

- The value of the resource that riparian buffers are protecting (recreation, drinking water supply, habitat);
- The desired function of the riparian area (i.e., habitat improvement, pollution removal, flood control, bank stabilization, etc.);
- The magnitude and intensity of the adjacent land use (agriculture, development, timber harvest, roads, etc.);
- The characteristics of the riparian area and watershed such as steepness or slope of the adjacent upland area, climate and soil type.

The scientific literature suggests that common non-point source pollutants (i.e. nutrients, metals, pathogens) require a natural vegetated buffer of between 100-300 ft to attenuate those pollutants associated with land use development (NRC, 2000; CRWPI, 2006). Application of buffers to first and second order streams, as well as larger tributaries, has been shown to be essential to overall watershed water quality; thus buffer protection is extended to all perennial tributaries (NRC, 2002; CRWPI, 2006; Palone and Todd, 1998). Given varying natural buffer conditions, such as slope, soil type or land cover as well as the nature of the proposed land use, the buffer distances necessary to protect drinking water supplies may vary. The following is a summary of some examples of riparian setbacks adopted by other communities, counties and states.

- Three hundred feet is suggested as a buffer distance along the shoreline of a surface water drinking water supply as distance that would attenuate most common non-point source pollutants. A secondary buffer extending from 300 to 400 feet from the water supply's shoreline limits certain higher risk land uses (NHDES, 2008).
- In Washington State, the Legislature determined that "Shorelands" or "shoreland areas" means those lands extending landward for two hundred feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters for the purposes of designating critical areas for protection under the shoreline management act (WA, 2010).
- The United States Department of Agriculture (USDA) Forest Service handbook for establishing and maintaining riparian forest buffers in the Chesapeake Bay watershed, recommends the following minimum width ranges based on specific functions (Palone and Todd, 1998; CRWPI, 2006):
 - Bank stabilization and aquatic food web processes - 10ft to 40ft.
 - Water temperature stabilization - 10ft to 60ft.
 - Nitrogen removal - 30ft to 140ft.
 - Sediment removal - 50ft to 160ft.
 - Flood mitigation - 65ft to 225ft.
 - Wildlife habitat - 45ft to 255ft.
- In the Cuyahoga Valley National Park, the National Park Service has recommended that riparian setbacks range from 50ft to 120 ft depending on drainage area, plus an additional 2 ft for each 1% increase in slope (CVNP, 2002; CRWPI, 2006).

- The City of Everett, Washington conducted a review of riparian literature and, as applied to the riparian function requirements of their community, came up with the following buffer width recommendations (Everett, 2003; CRWPI, 2006):
 - Sediment Retention and Filtration – 100ft to 300 ft.
 - Bank Stability - 100ft to 125 ft.
 - Small Woody Debris - 250 ft.
 - Shade/Water Temperature – 35ft to 250ft.
 - Water Quality – 13ft to 600ft.
 - Wildlife Habitat – 30ft to 1000ft.
- The City of Renton, Washington conducted a similar review of riparian literature to provide the scientific support for their riparian buffer ordinance, and reported the following recommended minimum buffer widths for their community (Renton, 2003; CRWPI, 2006):
 - Pollutant Trapping – 50ft to 100 ft
 - Sediment Trapping – 50ft to 200 ft.
 - Provide Particulate Nutrients to Stream (detritus) – 50ft to 100 ft.
 - Microclimate Control – 100ft to 525 ft.
 - Shade and Temperature Control - 50ft to 250ft.
 - Human Disturbance Control – 25ft to 50ft.
 - Bank Stability- 40ft to 70ft.
- Massachusetts passed the Watershed Protection Act that designates two areas for protection in different ways.
 - Within 400 feet of the reservoirs and 200 feet of tributaries and surface waters (the "Primary Protection Zone"), any alteration is prohibited. "Alteration" includes a variety of activities, such as construction, excavation, grading, paving, and dumping. Generation, storage, disposal or discharge of pollutants is also prohibited in the Primary Zone.
 - Between 200 and 400 feet of tributaries and surface waters, and on land within flood plains, over some aquifers, and within bordering vegetated wetlands (the "Secondary Protection Zone"), certain activities are specifically prohibited. These include storage, disposal or use of toxic, hazardous, and certain other materials; alteration of bordering vegetated wetlands; more dense development; and other activities (MDCR, 2010; NRC, 2000).
- The EPA recommends a minimum width of at least 100 feet to provide adequate stream protection (U.S. EPA, 2005; Broadmeadow and Nisbet, 2004).
- The Oregon DEQ indicates in the "Model Ordinance: Protecting Surface Water Sources of Drinking Water" that a larger width of 200 feet would be most appropriate for protecting streams, rivers, and reservoirs that supply public drinking water (<http://www.deq.state.or.us/wq/pubs/factsheets/drinkingwater/DWPOrdinanceOverlay.pdf>).
- According to the Connecticut River Watershed Joint Commission, the minimum acceptable buffer width is 50 feet. However, value is added with each additional foot added (CRJC, 1998; Broadmeadow and Nisbet, 2004).

- To protect wildlife habitat, a buffer width of at least 300 feet is necessary. Although most pollutants can be filtered with a 100 foot buffer width, a 500-foot buffer is necessary in areas with clay soil (ELI, 2008).
- To ensure adequate water quality, the City of Portland (Oregon) recommends a buffer width ranging from 10 feet to 860 feet, depending on the soil, vegetation type, and topography (Portland, 2002).
- Summit County Ohio adopted buffer widths of 300ft or more to protect high quality wetlands (Broadmeadow and Nisbet, 2004).
- Baltimore County, Maryland requires nondisturbance buffers of up to 100-300 feet, but then further provides that residential buildings must be set back an additional 35 feet and commercial buildings an additional 25 feet from the edge of the buffer (ELI, 2008).
- In North Carolina, certain portions of watersheds that are designated by the state as water supply have buffer widths of up to 100 feet for streams and even wider for the permanent pool of reservoirs. The water supply buffers are implemented through overlay zoning, and over a large proportion of Durham County (Durham, 2010).
 - Fixed widths of 150 and 100 feet are required for perennial streams feeding the drinking water supply for cities of Durham and Raleigh (NRC, 2000).
 - To protect drinking water in Orange County, NC setbacks around University Lake range from 50-250 feet depending on slope and land cover (NRC, 2000).
- Newport News, Virginia requires 100 and 200 foot setbacks for intermittent and perennial streams, respectively (NRC, 2000).
- In Georgia, local governments are required to establish a 100-ft undisturbed riparian buffer in all small drinking water supply watersheds. In addition, the law requires a 150-ft impervious surface setback (100-ft undisturbed riparian buffer plus 50-ft setback), where development activities are limited and septic tanks and drain fields are prohibited (Champion, et. al., 2009).
- New York City has a range of setbacks from 100 to 1,000 feet along rivers, streams, lakes and reservoirs to protect the City's drinking water source depending on the waterbody type and activity that is regulated (i.e., hazardous material storage, septic system siting, pesticide applications, etc.) (NRC, 2000).

Furthermore, in the absence of site specific analysis, the Streamside Science and Inventory of Significant Riparian and Wetland Resources recommends a 100-300 foot buffer (Broadmeadow & Nisbet 2004). Buffer width depends on a number of factors, and there is no 'one size fits all' delineation for a proper buffer width (NRC 2002; CRWPI, 2006). The County's proposed standard of a minimum 200 foot buffer width reflects the range of variability in the references noted above, recognition of the diversity of landforms in Lane County, and recognition of landowner interest in private benefits of streamside development. Lane County choose to establish a simple ordinance that is easy to follow and implement, which would require a larger setback for natural preservation of the riparian area to be effective in removing pollution as opposed to smaller widths associated with site specific designed and managed buffers (NRC 2000; CRWPI, 2006; NRC 2002).

Proposed Amendment: Activities prohibited in buffer

Proposed Language: As noted in LC 16.298 (6) Surface Water Protection Requirements. The following standards shall apply within Surface Water Protections Areas:

- (a) New development is prohibited except for the following uses provided alteration and disturbances are kept to a minimum and native vegetation is used to replant disturbed areas after construction:
- (i) Development that is appurtenant to the production, supply, distribution, treatment, or storage of water by a public water supplier.
 - (ii) Public roads, main-line utilities and trails.
 - (iii) Private roads and driveways necessary to access buildable portions of a parcel where no alternative location is feasible.
 - (iv) Culverts, ditches and other stormwater management improvements carried out as a component of Lane County's stormwater management program.
 - (v) Wells and irrigation pumps, which may be housed in structures no larger than 25 square feet.
 - (vi) Replacement of existing structures provided a replacement location outside of the Surface Water Protections Area does not exist on the lot or parcel and the replaced structure is set back as far away as possible from the drinking water source or tributary to the drinking water source. Applications for replacement of existing structures within Surface Water Protection Areas shall be reviewed as ministerial land use decisions.
 - (vii) Water dependent uses on publically-owned land.
 - (viii) Development on public land carried out as part of an approved parks and open space plan.
 - (ix) Additions or alterations of existing lawfully established structures, including decks, stairs and landings attached to the structure, which do not cumulatively expand the footprint of the structure beyond 25 % of its size on the effective date of this ordinance.
 - (x) Fish passage channels, culverts and other similar structural ecological enhancement improvements conducted by a watershed council or soil and water conservation district (SWCD), or conducted by a land trust or private land owner working in consultation with a watershed council or SWCD.
- (b) Vegetation removal within Surface Water Protection Areas is prohibited except for the following uses and activities:
- (i) Commercial forest practices regulated by the Oregon Forest Practices Act.
 - (ii) Removal of dead or diseased vegetation that poses a safety or health hazard, excluding removal of root wads, provided a certified arborist or licensed forester provides a statement to the Land Management Division documenting the need for such removals.
 - (iii) Removal of vegetation necessary for the maintenance or placement of permitted structural shoreline stabilization.
 - (iv) Normal and accepted farming practices other than buildings or structures occurring on land zoned for exclusive farm use.

(v) Ecological enhancement projects replanted with native vegetation and conducted by a watershed council or soil and water conservation district (SWCD), or conducted by a land trust or private land owner working in consultation with a watershed council or SWCD.

(vi) Vegetation removal necessary to carry out development as permitted pursuant to LC16.298(6)(a)

(vii) Maintenance of existing primary fuel breaks required by Lane Code. New fuel breaks are not permitted within Surface Water Protections Areas.

(viii) Right-of-way vegetation management conducted in conformance with Lane Code 15.510.

(c) In addition to the development and vegetation removal standards of LC 16.298(6)(a) and (b), all new development within a Surface Water Protections Area shall also be subject to the Ground Water Protection requirements of LC16 298(7)(a) and (b) for Zone A.

(7) Ground Water Protection Requirements.

(a) Zone A Prohibited Uses. The following new uses shall be prohibited within Zone A of the DWP Overlay Zone:

(i) Storage, use, or production of hazardous materials, except as provided in LC 16.298 (7)(d).

(ii) Fueling facilities and automobile service stations, except as provided in LC 16.298 (7)(d).

(iii) Injection wells/dry wells/sumps except drywells for roof drainage.

(iv) Underground hazardous material storage facilities except those with spill, overfill, and corrosion protections in place.

(v) Disposal of hazardous materials.

(vi) Treatment of hazardous material, except remediation programs authorized by a government agency.

(vii) Disposal of septic sludge.

(viii) Automobile wrecking yards or activities, commercial or otherwise, that result in the accumulation of four or more non-operating vehicles.

(ix) Outside storage of eight or more nonfunctioning appliances.

(b) Any increases or alterations of non-conforming uses within Zone A as permitted under LC 16.251, must meet the requirements of LC 16.298(8). Non-conforming uses are uses otherwise prohibited by LC 16.298(7)(a)(i) that were in lawful existence on the date that LC 16.298 took effect.

Explanation: To ensure proper protection of community drinking water source areas, certain activities are prohibited within the 200-foot setback including new development, significant expansion of existing development, vegetation removal and storage/use of hazardous materials (NRC 2000; NRC 2002; CRWPI, 2006, ELI, 2008). As previously indicated, a setback can only be effective in removing nonpoint sources of pollution if it is subject to management or natural preservation (NRC, 2000). Lane Code 16.298 is designed effectively restrict activities that would impact the natural preservation within the 200 foot overlay zone to maximize the effectiveness

of this area for treatment of nonpoint source pollution. Exceptions are provided for each of these restrictions to attempt to minimize unexpected consequences.

Rationale: Land use controls such as zoning and subdivision requirements are the most powerful regulatory tools for protecting sources lands (TPL, 2004). Development near drinking water sources poses a significant threat to human health in the form of pollution runoff. Pollution from development is a cumulative impact from all homes built in the riparian area where runoff from lawn fertilizers, pesticide use, roadways and vehicle use, leachate from septic systems and other activities can degrade water quality over time (TPL, 2004; CRWPI, 2006; NRC, 2000). In addition, vegetation removal in the riparian area significantly reduces natural treatment of pollution runoff from upland areas (NRC, 2002). According to the US EPA, the leading cause of drinking water quality degradation is from nonpoint sources of pollution, such as agriculture, development and urban runoff (TPL, 2004; Banks and Wachal, 2002).

Previous sections provided information and references around the health risks and effects from contamination of drinking water supplies and the need to restrict activities adjacent to drinking water source areas that could lead to future contamination. This section of the code provides restrictions of these activities in riparian areas within the drinking water source protection overlay zone.

Proposed Amendment: Hazards materials

Proposed Language: As noted in LC 16.298 (3) Hazardous Material substances defined in any of the following:

- (a) Hazardous waste as defined in ORS 466.005(7).
- (b) Toxic substances as defined in ORS 465.003(9).
- (c) Any substance defined as a hazardous substance pursuant to Comprehensive section 101(14) of the federal Comprehensive Environmental Response, Compensation and Liability Act, P.L. 96-510, as amended, and P.L. 99-499.
- (d) Oil as defined in ORS 465.200(19).
- (e) Any substance that meets the criteria of ORS 465.400.

Explanation: Quantity limitations and/or management standards will apply to the storage, use, or production of hazardous materials that pose a risk to the drinking water source. Residential, rural home business, or home occupation use of hazardous material quantities greater than 110 gallons will be allowed provided the applicant submits a signed statement to Lane County asserting that all hazardous materials stored on site in excess of 110 gallons will be stored in secondary containment. New commercial uses of quantities greater than 110 gallons will be prohibited within Zone A and Surface Water Protection Areas, except where the exemptions apply. New uses of dense non-aqueous phase liquids (DNAPLs) will be prohibited. Certain land uses that pose particularly high risks in regard to potential release of materials are prohibited: (a) Injection wells/dry wells/sumps except drywells for roof drainage; (b) underground storage tanks except those with spill, overflow, and corrosion protections in place; (c) disposal of

hazardous materials; (d) treatment of hazardous material, except remediation programs authorized by a government agency to treat hazardous material present at a site prior to the adoption of this ordinance; (e) disposal of septic sludge; (f) automobile wrecking yards or activities, commercial or otherwise, that result in the accumulation of four or more non-operating vehicles; and (g) outside storage of eight or more nonfunctioning appliances.

Rationale: This portion of the code is triggered when the use, production, or storage of hazardous materials exceeds an aggregate quantity of 110 gallons. According to national estimates, the average household stores up to 8 gallons of hazardous materials on site, well under the aggregate threshold proposed by this ordinance (ODEQ, 2010b). The proposed Lane Code would not regulate standard household uses and instead focuses on the uses that involve greater quantities of hazardous materials.

The only exception to the 110-gallon threshold is the prohibition of new uses of DNAPLs, which are not allowed in any quantity. DNAPLs, also known as “sinkers,” pose a significant human health and ecological risk at low concentrations and are one of the greatest known chemical contamination risks to groundwater due to the difficulty of removal. In addition, some DNAPLs, such as polychlorinated biphenyls (PCBs), have been found in lake and stream sediments and can bioaccumulate in fatty tissue of fish and other animals (U.S. EPA, 2010). Most traditional uses of DNAPL chemicals are now available in alternative formulations, such as non-chlorinated strippers, brake cleaners, and other solvents (U of Mass, 2010). For example, dry cleaners can operate with alternatives to perchlorethylene, commonly referred to as “perc,” which is a carcinogenic contaminant and associated with at least twenty-five state environmental clean-up sites in Lane County (ODEQ, 2010c).

In some cases more than 110 gallons of hazardous materials will be allowed with the provision of secondary containment. Secondary containment is a secondary vessel or catchment system for a primary hazardous material container. Examples of secondary containment systems include double-walled tanks, 55-gallons drums on spill pallets, flammable chemicals stored in safety cabinets, or industrial cleaning supplies kept in plastic totes. The secondary containment is an insurance policy—if the primary container fails, the secondary containment serves to prevent a release of hazardous material. Consistent and proper use of secondary containment is a relatively simple and effective way to prevent the contamination of drinking water sources (U.S. EPA, 2001; TCBPP, 2004; ODEQ, 2001).

In addition to the prohibition of new uses of DNAPLs, the code prohibits other high risk activities, based on the understanding that prevention is the least expensive and most effective way to protect drinking water sources (U.S. EPA, 1995; ODEQ, 2010a; Ainsworth and Jehn, 1996). There are many documented cases of public drinking water contamination associated with spills or underground releases of hazardous materials, including cases in western Oregon (GPC, 2007; EPA, 2001). The prohibition of commercial uses of bulk quantities of hazardous materials (i.e., greater than 110 gallons) within the Zone A and Surface Water Protection Areas will prevent new large, industrial uses from establishing in the most sensitive areas, thereby reducing such risk.

Injection wells, pipes that allow water or other liquids to enter the ground, present direct pathways for contaminants to enter the groundwater, where they can also migrate to surface water (GPC, 2007). Injection wells are regulated by Oregon Department of Environmental Quality, thus, the ordinance language reinforces existing prohibitions. Underground storage tanks that lack adequate protective mechanisms also pose a risk of releasing hazardous materials directly into the sub-surface, where the contaminant may remain undetected (EPA, 2001; GPC, 2007). This ordinance would address risks associated with underground storage tanks that are not already addressed by the State. This would include home heating oil tanks, residential tanks holding 1,100 gallons or less of motor fuel used for noncommercial purposes; or tanks holding less than 110 gallons (ODEQ, 2008).

In Oregon, the Department of Environmental Quality issues and enforces permits for all septic sludge lagoons and treated sludge land application sites. This ordinance would prevent new sites from locating in the highest risk locations.

The ordinance also addresses impacts from automobile wrecking operations and storage of larger quantities of appliances. Contaminants released from automobile wrecking operations typically include petroleum-based chemicals; heavy metals such as mercury, cadmium and lead; other metals such as zinc and copper; battery acid; PCBs; Polycyclic aromatic hydrocarbons (PAHs), and solvents (EPA, 2009; CDPH&E, 2006, MPCA, 1995). In a comprehensive review of motor vehicle salvage facilities, Minnesota Pollution Control Agency found that waste oils and hydraulic fluids are major sources of these contaminants (MPCA, 1995). EPA reports many contaminants of concern that are associated with household appliances, including mercury, PCBs, and used oil (EPA online factsheet, last updated August 2010, <http://www.epa.gov/ozone/title6/608/disposal/household.html>). Prohibiting the outdoor storage of eight or more nonfunctioning appliances would reduce the risk of these contaminants reaching drinking water supplies.

Proposed Amendment: Vegetation removal

Proposed Language: As noted in LC 16.298 (3) Removal of Vegetation. The act of removing or fact of being removed by a person: i.e., to cut, thin or trim vegetation or to chemically treat vegetation which results in the loss of growth or health or the death of vegetation; to mechanically or manually disrupt or dislodge the root structure of vegetation resulting in loss of growth or health or causing the death of vegetation.

Explanation: Vegetation removal within Surface Water Protection Areas is prohibited (with exceptions) to maintain the natural benefits of a riparian area as previously discussed.

Rationale: Maintaining the ecological integrity of riparian areas can help protect and even enhance the quality of surface water. Riparian buffers can play an important role in removing pollutants and sediment, preventing erosion, slowing and controlling flood waters and providing critical habitat (NRC, 2002; CRWPI, 2006; NRC 2000). The slowing and dispersal of runoff and floodwater by riparian vegetation allows additional time for the water to infiltrate

and become purified before it reaches the stream (NRC 2002). However, “only if a setback is subject to management or natural preservation can it be considered a buffer that reliably insulates ecosystems and resources from nonpoint source pollution” (NRC, 2000). Lane Code 16.298 (3) effectively restricts activities such as vegetation removal that would impact the natural preservation abilities of the 200 foot overlay zone for treatment of nonpoint source pollution.

Removal of vegetation for development is often accompanied with an increase in impervious surfaces, such as roofs, driveways, and patios. Above 10-20 percent impervious surfaces, urban stream quality is consistently classified as poor (Wenger and Fowler, 2000). A stream’s water quality is affected when impervious surfaces exceed 12%, and is considered degraded when it exceeds 30% (Wenger and Fowler, 2000).

Keeping native vegetation ensures less soil erosion and improved water quality. Native plants are adapted to the climate and have deep root systems needed to react to changing soil and water conditions in a riparian area. Their deep roots hold the soil together, preventing erosion along stream banks and lakeshores and keeping sediments from clouding the water. Also, the roots of these plants and the bacteria in the soil are able to consume fertilizers and chemicals that flow into the water from adjacent areas (NRC, 2002; Pizzo, et. al., 2003). As the sediment and nutrients in the water are diminished, the water quality will improve (Pizzo, 2003; CRWPI, 2006; NRC 2002).

Other benefits of a healthy riparian forest include bank stabilization and slowing flood waters that help protect property and structures. “Not only does vegetation provide stability to banks directly via its root system, but its ability to dissipate stream energy along a reach is also an extremely important function. Floodplain vegetation (including canopies, branches, stems, roots, and litter) not only protects the soil from direct rainfall impact and reduces the velocity of overbank flows (thereby preventing scour), but it also promotes deposition of fine sediments. In years without floods, riparian vegetation becomes established on exposed areas of floodplains, providing stability to these areas and promoting the vertical accretion of sediment during subsequent floods” (NRC, 2002).

Proposed Amendment: Groundwater Zone Determination

Proposed Language: The updated 16.298 Drinking Water Protection Overlay Zone will create designated Groundwater Source Protection Areas. The location of the protected groundwater source areas are depicted on the Official Drinking Water Protection Overlay Zone Map for Lane County. These areas include the surface and subsurface area surrounding any water well, spring, or well field supplying a public water system through which contaminants have a potential to move toward and reach that water well, spring, or well field. Groundwater source areas include two separate protection zones:

Zone A: Include areas located within a time-of-travel zones of less than two (<2) years.

Zone B: Include areas within a time of travel zone between 2 and 20 years.

A property owner may request that the boundaries of the mapped Groundwater Source Protection Areas (Zone A and/or Zone B) be modified if those boundaries are believed to be incorrectly mapped. Such modifications would constitute a rezoning of the property and shall:

Be processed in accordance with Lane Code 16.252

Be accompanied by a letter and recertified source water assessment report from the Oregon Department of Human Services – Drinking Water Program, which clearly indicates that the boundaries of the source water area in question have been modified and officially recertified by DHS under the Administrative Rules that apply to Oregon’s EPA-approved Drinking Water Protection Program.

Explanation: The Groundwater Drinking Water Protection zones shown on the official map are those areas that have been delineated and certified by the Oregon Department of Human Services. The Drinking Water Protection Zones depict the area on the surface that directly overlies that part of the aquifer(s) that supplies groundwater to the wells. The time-of-travel zones indicate the amount of time it takes groundwater to move from that zone to the pumping well. It is within the drinking water protection areas that a contaminant, if released, could migrate down to the aquifer and travel to the well. The delineated areas allow the County to focus efforts on the area(s) where the most benefit to the drinking water resource will occur.

Rationale: The Oregon DHS Drinking Water Program is responsible for certifying groundwater delineations for all public water systems in the state (ODEQ and OHD). The proposed amendment relies on DHS-certified delineations and, in the case of proposed modifications, DHS delineation standards to be consistent with existing state and federal programs and regulations.

“Contaminants can reach a water body (groundwater, rivers, lakes, etc.) from activities occurring on the land surface or below it” (SDWPP, 1999). The delineations of groundwater source areas, which are based on hydrologic models that use local hydraulic conductivity data, illustrate the total land area that experiences drawdown when a particular well is operating, also referred to as the “zone of contribution” (ZOC). Land use activities within the entire ZOC have the potential to introduce contaminants to the drinking water source (Stewart and Nelson, 1996). Though the proposed amendment applies only to areas within the twenty-year time-of-travel zone (TOTZ), the ZOC can extend beyond a twenty-year TOTZ. For example, Springfield’s ZOC is delineated as a 99-year TOTZ (Springfield, 2010).

Regulatory protection programs determine how far to extend protections based on an analysis of where protection strategies will have the greatest impact (Stewart and Nelson, 1996). The City of Springfield’s drinking water protection overlay includes all areas within the twenty-year TOTZ, whereas the City of Portland extends its protections out to the thirty-year TOTZ (Springfield, 2010). In other cases the ten-year TOTZ captures the majority of the source area and suffices as a protection area (ODEQ and OHD).

Separating the protection area into two zones allows for the application of more stringent standards to the most sensitive areas where there is less time to detect and respond to a contamination before it reaches the well: “The area within the 2-year time-of-travel represents the ‘hot zone’ for the area: potential contaminant sources within this area will probably need extra attention because of their proximity to the well” (ODEQ and OHD).

References

- Ainsworth, Steve and Paul Jehn, 1996. *Source Water Protection: What's in It for You?* Public Management (vol 78, no. 2), International City/County Management Association. February 1996.
- American Water Works Association (AWWA), 2005. *The Value of Water: What it means, Why It's Important, and How Water Utility Mangers Can Use It.* Journal AWWA 97:4, April 2005, pg. 90-98.
- Banks, Kenneth and David Wachal, 2002. *Water Quality and Land Use.* Stormwater Journal, January/February 2002, p. 22.
- Barnes, Kimberlee K., Dana Kolpin, Edward Furlong, Steven Zaugg, Michael Myer and Larry Barber (Barnes, et. al.), 2008. *A national Reconnaissance of Pharmaceuticals and Other Organic Wastewater Contaminants in the United States – Groundwater.* Science of the Total Environment 402 (2008) 192-200.
- Blomquist, J. D., 2001. Transmittal of Preliminary Digital Data Sets from the USGS-USEPA Program "Pesticides in Water-Supply Reservoirs and Finished Drinking Water-A Pilot Monitoring Program." USGS, Baltimore, MD.
- Broadmeadow & Nisbet, 2004. *The effects of riparian forest management on the freshwater environment: a literature review of best management practice.* Hydrology and Earth System Sciences, 8(3), 286-305 (2004).
- Chagrin River Watershed Partners, Inc. (CRWPI), 2006. *Riparian Setbacks: Technical Information for decision Makers.* January 2006.
- Champion, Becky, Veronica Jarrin, Doug Baughman and Patrick Gervais (Champion, et. al.), 2009. *Proceedings of the 2009 Georgia Water Resources Conference.* April 27–29, 2009, University of Georgia.
- Colorado Department of Public Health and Environment (CDPH&E), 2006. *Automotive Salvage Yard Waste Management Practices in Colorado.*
- Connecticut River Joint Commissions (CRJC), 1998. *Riparian Buffers for the Connecticut River Watershed.*
- Cuyahoga Valley National Park (CVNP), 2002. *Riparian Buffer Plan for Proposed Agricultural Lands.* National Park Service. U.S. Dept. of the Interior.

Durham, City of, 2010. www.ci.durham.nc.us/departments/works/divisions/stormwater. City of Durham, North Carolina.

Environmental Law Institute (ELI), 2008. *Planners Guide to Wetland Buffers for Local Governments*. Washington DC. March 2008. ISBN 978-1-58576-137-1.

Eugene Water & Electric Board (EWEB). 2000. *Drinking Water Source Protection Plan*.

EWEB, 2001a. *Proposal for Implementation of the Drinking Water Source Protection Program*. Prepared By Karl Morgenstern. November 2001.

EWEB, 2001b. *Lower McKenzie River Watershed, Stormwater and Urban Runoff Monitoring Plan, Drinking Water Source Protection Program*. Prepared By Karl Morgenstern. November 2001.

EWEB, 2005a. *Agricultural Activity Assessment and Evaluation Plan for the McKenzie Watershed*. Prepared by Karl Morgenstern. February 2005.

EWEB, 2005b. *Forest Management Activity Assessment and Evaluation Plan for the McKenzie Watershed*. Prepared by Karl Morgenstern. February 2005.

EWEB, 2005c. *Septic System Assessment and Evaluation Plan for the McKenzie Watershed*. Prepared by Karl Morgenstern. February 2005.

EWEB, 2005d. *Construction Activity Assessment and Evaluation Plan for the McKenzie Watershed*. Prepared by Karl Morgenstern. February 2005.

EWEB, 2005e. *Supplemental Sampling and Analysis Plan for Commercial Forestry and Agricultural Activities*. Prepared by Karl Morgenstern. April 28, 2005.

EWEB, 2005f. *Supplemental Sampling and Analysis Plan for Assessment of Potential Impacts from Septic Systems*. Prepared by Karl Morgenstern. September 14, 2005.

EWEB, 2005g. *Supplemental Sampling and Analysis Plan for Assessment of Potential Impacts from Construction*. Prepared by Karl Morgenstern. September 25, 2005.

EWEB, 2006a. *Nonpoint Source Pollution Assessment and Evaluation Results for the McKenzie River Watershed, Oregon*. Prepared for the Oregon Department of Environmental Quality. April 2006.

EWEB, 2006b. *McKenzie Watershed Emergency Response Plan*. May 2006.

EWEB, 2007. *Agricultural Chemical Removal from Critical Watersheds, Final Report*. Prepared for the National Fish & Wildlife Foundation. August 2007.

EWEB, 2009. *McKenzie River Septic Assistance Project, Final Report*. November 2009.

<http://www.eweb.org/public/documents/water/septicFinalReport.pdf>

Everett, City of, 2003. *Use of Best Available Science in City of Everett Buffer Regulations: Non Shoreline Streams*. Prepared for the City of Everett, WA. By The Watershed Company, Kirkland Washington.

Ferguson, C., Charles, K., Deere, D. (Ferguson, et. al.), 2009. *Quantification of Microbial Sources in Drinking-Water Catchments*. *Critical Reviews in Environmental Science and Technology*, 39:1–40, 2009.

Gilliom, RJ, 2007. *Pesticides in U.S. Streams and Groundwater*. *Environmental Science and Technology Journal*, Vol. 41, No. 10, pg 3407-3413.

Groundwater Protection Council (GPC), 2007. *Underground Injection Control in Groundwater Report to the Nation: A Call to Action*. http://www.gwpc.org/CallToAction/finalpdfs/GWR_9.pdf

Jorgensen, S. 2004. *Pharmaceuticals in the Environment – Sources, Fate, Effects and Risk*. 2nd Edition., ed. Krummerer, K., 2004. Springer, 527 pp.

Koplin, Dana W., Edward Furlong, Michael Meyer, Michael Thurman, Steven Zaugg, Larry Barber, and Herbert Buxton (Koplin, et. al). 2002. *Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000: A National Reconnaissance*. *Environmental Science & Technology*. Vol. 36, No. 6.

Kraus, Tamara E.C., Chauncey A. Anderson, Karl Morgenstern, Bryan D. Downing, Brian A. Pellerin, and Brian A. Bergamaschi (Kraus, et. al.), 2010. *Determining Sources of Dissolved Organic Carbon and Disinfection Byproduct Precursors to the McKenzie River, Oregon*. *Journal of Environmental Quality*, 39:1–13 (2010), doi:10.2134/jeq2010.0030. Accepted for publish in 2010.

Laetz, Cathy A., et. al., 2009. *The Synergistic Toxicity of Pesticide Mixtures: Implications for Risk Assessment and the Conservation of Endangered Pacific Salmon*. *Environmental Health Perspectives Journal*, Vol. 117, No. 3, March 2009, pg 348-353.

Leopold, Luna B., 1997. *Water, Rivers and Creeks*. University Science Books, Sausalito, CA.

Lubick, Naomi, 2008. *Drinking Water Contamination Mapped*. *Nature*. December 17, 2008, 10:1038. <http://www.nature.com/news/2008/081217/full/news.2008.1310.html>

Magat, Wesley A., Huber, Joel and Viscusi, Kip W. (Magat et. al.), 2000. *An Iterative Choice Approach to Valuing Clean Lakes, Rivers and Streams*. Harvard Law School, Cambridge Mass, Discussion Paper No. 295, August 2000.

Massachusetts Department of Conservation and Recreation (MDRC), 2010. *The Watershed Protection Act*. <http://www.mass.gov/dcr/watersupply/watershed/wspa.htm>

May, Christopher W., 2003. *Stream-Riparian Ecosystems in the Puget Sound Lowland Eco-Region – A Review of Best Available Science*. Watershed Ecology, LLC.

Minnesota Pollution Control Agency (MPCA), 1995. *Motor Vehicle Salvage Facilities: A Report on the MPCAs Evaluation, Assessment and Outreach Effort*.

Mooney, S. and L.M. Eisgruber, *The influence of riparian protection measures on residential property values: The case of the Oregon Plan for Salmon and Watersheds*. *Journal of Real Estate Finance and Economics*, 2001. 22(2-3): p. 273-286.

Naiman, R.J. and R.E. Bilby, Editors. 1998. *River Ecology and Management: Lessons from the Pacific Coastal Ecoregion*. Springer Publishing, NY.

National Research Council (NRC), 2000. *Watershed Management for Potable water Supply: Assessing the New York City Strategy*. National Academy Press. 2000. ISBN 0-309-06777-4.

NRC, 2002. *Riparian Areas: Function and Strategies for Management*. National Academy Press. Washington DC 2002.

New England Interstate Water Pollution Control Commission (NEIWPC), 2000. *Source Protection: A national Guidance Manual for Surface Water Supplies*.

New Hampshire Department of Environmental Services (NHDES), 2008. *Innovative Landuse Planning Techniques: A Handbook for Sustainable Development*. October 2008.

Oregon Department of Environmental Quality (ODEQ), 2006. *Business and Industry Tips for Drinking Water Protection*. Factsheet.
<http://www.deq.state.or.us/wq/pubs/factsheets/drinkingwater/busindtips.pdf>

ODEQ, 2008. *Proper Care and Maintenance for Unregulated Tank Systems*. Factsheet.
<http://www.deq.state.or.us/lq/pubs/factsheets/tanks/hot/ProperCareMaintenance.pdf>

ODEQ, 2009. *Willamette Basin Rivers & Streams Assessment*. Laboratory and Environmental Assessment Division, June 30, 2009.

ODEQ, 2010a. *Introduction to Oregon's Drinking Water Protection Program*,
<http://www.deq.state.or.us/wq/pubs/factsheets/drinkingwater/IntroDWP10WQ020.pdf>

ODEQ, 2010b. DEQ Household Hazardous Waste Program,
<http://www.deq.state.or.us/lq/sw/hhw/>

ODEQ, 2010c. *Environmental Cleanup Site Information Database*,
<http://www.deq.state.or.us/lq/ECSI/>

ODEQ and Oregon Health Division (OHD). Source Water Assessment Plan: Implementation of the Safe Drinking Water Act 1996 Amendments.
<http://www.deq.state.or.us/wg/dwp/swap.htm>

Oregon Department of Human Services (ODHS) Drinking Water Program SDWIS Online, 2010.
(<http://170.104.158.45/index.html>)

Oregon State Programs (Oregon), 2000. *Oregon State Programs for Managing Riparian Resources*. Report By the Riparian Management Work Group. October 2000.

Palone, Roxane S. and Albert H. Todd, 1998. *Chesapeake Bay Riparian Handbook: A guide for Establishing and Maintaining Riparian Forest Buffers*. USDA Forest Service

Pizzo, Jack, Chris Hauser and Cory Ritterbusch, 2003. *Going Native*. Pizzo & Associates, Ltd.
<http://www.recmanagement.com/columns.php?fid=200304GC02>

Portland, City of, 2002. *Healthy Portland Streams, Summary of the Streamside Science and Inventory of Significant Riparian and Wetland Resources Discussion Draft*. January 2002.

Renton, City of, 2003. *Best Available Science Literature Review and Stream Buffer Recommendations*. Prepared for the City of Renton, by A.C. Kindig & Co., Bellevue, WA. and Cedarock Consultants, Inc. Woodinville, WA. 2003.

Smith, James and Perdek, J., 2004. *Assessment and Management of Watershed Microbial Contaminants*. Critical Reviews in Environmental Science and Technology, 34:109-139, 2004.

Springfield Drinking Water Protection Plan (SDWPP), 1999. Prepared for City of Springfield, Springfield Utility Board, and Rainbow Water District by Lane Council of Governments and Springfield Utility Board. Adopted May 17, 1999.

Springfield, City of, 2010. *Wellhead Protection Areas: Contaminant Source Area, Springfield, Oregon*.
http://www.ci.springfield.or.us/pubworks/gis_web_page/Images/img_std_map_wellheads.pdf

Stackelberg, Paul E; et. al., 2004. *Persistence of Pharmaceutical Compounds and Other Organic Wastewater Contaminants in a Conventional Drinking-Water-Treatment Plant*. Science of the Total Environment Journal, No. 329 (2004) pg. 99-113. Published by Elsevier B.V.

Stackelberg, Paul E; et. al., 2007. *Efficiency of Conventional Drinking-Water-Treatment Processes in Removing Pharmaceuticals and other Organic Compounds*. Science of the Total Environment Journal, No. 377 (2007) pg. 255-272. Published by Elsevier B.V.

Stewart, Sheree and Dennis Nelson, 1996. *Oregon Wellhead Protection Program Guidance Manual*. Oregon DEQ & Oregon Health Division.

The Trust for Public Lands and American Water Works Association (TPL/AWWA), 2002. *Protecting the Source: Land Conservation and the Future of America's Drinking Water*.

The Trust for Public Lands (TPL), 2004. *Land Conservation and the Future of America's Drinking Water: Protecting the Source*.

Thurston County Business Pollution Prevention Program (TCBPP), 2004. *Waste Management: Secondary Containment*. Hazardous Waste Update. October 2004, Vol. 3, No. 3.

University of Massachusetts-Lowell (U of Mass), 2010. *Toxics Use Reduction Institute*, http://www.turi.org/turi_lab/cleaning_research_projects/trichloroethylene_and_chlorinated_solvents_reduction/

University of Oregon (U of O CPW), Community Planning Workshop, 2009a. *EWEB Source Protection Project: Best Management Practices and Model Ordinance Review*. Prepared for the Eugene Water & Electric Board. June 2009.

U of O CPW, 2009b. *McKenzie River Basin: Development Risk Atlas*. Prepared for the Eugene Water & Electric Board. August 2009.

U of O CPW, 2009c. *EWEB Source Protection Project: Land Use Decisions Analysis*. Prepared for the Eugene Water & Electric Board. September 2009.

U of O CPW, 2009d. *EWEB Source Protection Action Plan Memorandum*. Prepared for the Eugene Water & Electric Board. October 30, 2009.

U.S. Department of Agriculture Natural Resource Conservation Service (USDA), 2003. *Where the Land and Water Meet: A Guide for Protection and Restoration of Riparian Areas*. CT-TP-2003-3. September 2003.

U.S. Environmental Protection Agency (EPA), 1995. *Clean Water Through Conservation*. EPA 841-B-95-002.

U.S. EPA, 1996. *Benefits and Costs of Wellhead Protection*. <http://info.ngwa.org/gwol/pdf/961161843.PDF>

U.S. EPA, 1998. *National Water Quality Inventory: 1998 Report to Congress*. EPA841-R-00-001.

U.S. EPA, 2001. *Managing Above Ground Storage Tanks to Prevent Contamination of Drinking Water. Source Water Protection Practices Bulletin.*

<http://www.epa.gov/safewater/sourcewater/pubs/ast.pdf> .

U.S. EPA, 2009. *Compliance assistance at work in auto salvage yards and auto recycling facilities (last updated July 2009)* <http://epa.gov/region9/enforcement/auto-compliance.html>.

U.S. EPA, 2010. *Contaminated Site Cleanup Information.*

[http://clu.in.org/contaminantfocus/default.focus/sec/Dense Nonaqueous Phase Liquids \(DNA PLs\)/cat/Overview/](http://clu.in.org/contaminantfocus/default.focus/sec/Dense+Nonaqueous+Phase+Liquids+(DNA+PLs)/cat/Overview/)

U.S. General Accounting Office (GOA), 1998. *Oregon Watersheds: Many Activities Contribute to Increased Turbidity During Large Storms.* GAO/RCED-98-220, July 1998.

U.S. Geological Survey (USGS). 1996. *Occurrence of Selected Trace Elements and Organic Compounds and Their Relation to Land Use in the Willamette River Basin, Oregon, 1992-94.* Water-Resources Investigations Report 96-4234.

USGS. 1997. *Distribution of Dissolved Pesticides and Other Water Quality Constituents in Small Streams, and Their Relation to Land Use, in the Willamette River Basin, Oregon.* Water-Resources Investigations Report 97-4268.

USGS, 1998a. *Water Quality in the Willamette Basin, Oregon, 1991-1995.* USGS Circular 1161. ISBN 0-607-89231-5.

USGS. 1998b. *Seasonal and Spatial Variability of Nutrients and Pesticides in Streams of the Willamette Basin, Oregon, 1993-95.* Water-Resources Investigations Report 97-4082-C.

USGS, 1999. *Pesticide Detections in Urban Streams During Rainstorms and Relations to Retail Sales of Pesticides in King County, Washington.* USGS Fact Sheet 097-99, April 1999.

USGS. 2001. *Pesticides in Selected Water-Supply Reservoirs and Finished Drinking Water, 1999-2000: Summary of Results from a Pilot Monitoring Program.* Open-File Report 01-456.

USGS, 2008. *Pesticide Occurrence and Distribution in the Lower Clackamas River Basin, Oregon, 2000-2005.* USGS Scientific Investigations Report 2008-5027.

USGS, 2009. *Evaluation of Passive Samplers for Long-Term Monitoring of Organic Compounds in the Untreated Drinking Water Supply for the City of Eugene, Oregon, September-October 2007.* Scientific Investigations Report 2009-5178.

Washington, State of, 2010. *RCW, Title 90, Chapter 90.58, Section 90.58.030.*

<http://apps.leg.wa.gov/rcw/default.aspx?cite=90.58.030>

Wenger, Seth and Fowler, Laurie, 2000. *Protecting Stream and River Corridors: Creating Effective Local and Riparian Buffer Ordinances*. Carl Vinson Institute of Government, The University of Georgia, 2000.