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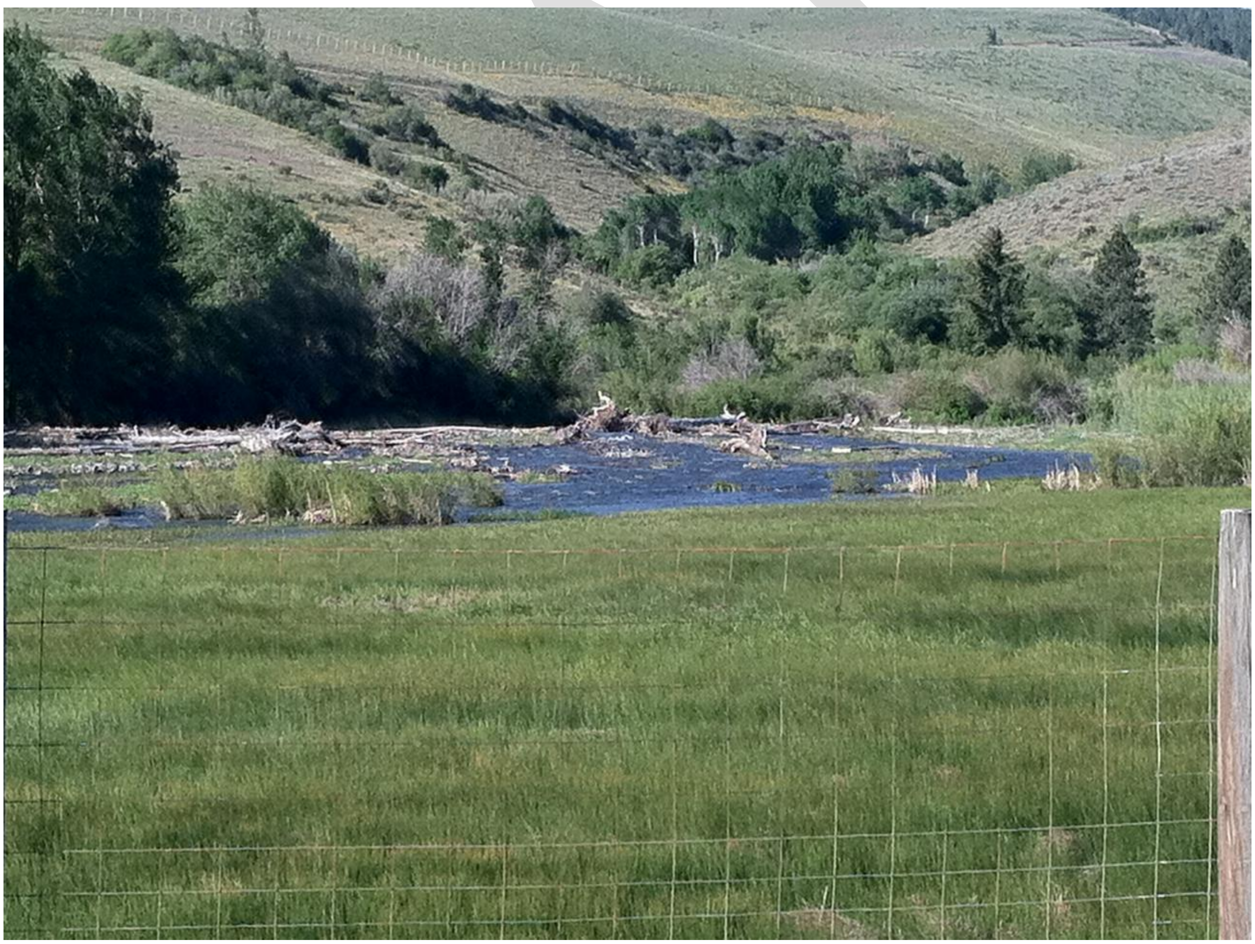
Kittitas County Critical Areas Ordinance – Critical Aquifer Recharge Areas

BEST AVAILABLE SCIENCE REVIEW AND CONSIDERATIONS FOR CODE UPDATE

Prepared for: August 2012

Kittitas County



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1.0 INTRODUCTION

Washington State's Growth Management Act (GMA) (RCW 36.70A) requires counties and cities to adopt development regulations that identify and protect critical areas, including "areas with a critical recharging effect on aquifers used for potable water. Protection of these critical aquifer recharge areas (CARAs) helps maintain public groundwater drinking supplies so that contamination events and their associated hardships and potential physical harm to people and ecosystems can be prevented.

Under the GMA implementing rules, counties and cities must classify aquifer recharge areas according to their vulnerability to contamination. Vulnerability is the combined effect of hydrogeological susceptibility to contamination and the contamination loading potential. High vulnerability is indicated by land uses that contribute directly or indirectly to contamination that may degrade groundwater, and hydrogeologic conditions that facilitate degradation. Low vulnerability is indicated by land uses that do not contribute contaminants that will degrade groundwater, and by hydrogeologic conditions that do not facilitate degradation. Hydrological conditions may include those induced by limited aquifer recharge. Reduced aquifer recharge from effective impervious surfaces may result in higher concentrations of contaminants than would otherwise occur (WAC 365-190-100).

The paper reviews the County's existing CARA regulations in Kittitas County Code (KCC) 17A.08 and offers considerations for how to incorporate the current scientific understanding of CARAs into development standards and regulations in Kittitas County. This paper was prepared as part of Kittitas County's effort to update its critical areas ordinance. The County may also use this information to update is shoreline master program under RCW 90.58. These two regulatory programs overlap, so the updates are being closely coordinated.

2.0 OVERVIEW OF INVENTORY

Aquifer recharge occurs where rainfall, snowmelt, infiltration from lakes, wetlands and streams, or irrigation water infiltrates into the ground and adds to the underground water supply. According to the GMA implementing rules (WAC 365-190-100), examples of areas with a critical recharging effect on aquifers used for potable water may include:

- Recharge areas for sole source aquifers designated pursuant to the Federal Safe Drinking Water Act;
- Areas established for special protection pursuant to a groundwater management program, chapters 90.44, 90.48, and 90.54 RCW, and chapters 173-100 and 173-200 WAC;
- Areas designated for wellhead protection pursuant to the Federal Safe Drinking Water Act;
- Areas near marine waters where aquifers may be subject to saltwater intrusion; and
- Other areas meeting the definition of "areas with a critical recharging effect on aquifers used for potable water".

There are no designated sole source aquifers in Kittitas County (EPA http://yosemite.epa.gov/r10/water.nsf/Sole+Source+Aquifers/ssamaps). No portions of the County are designated as a special groundwater management area and there are no designated wellhead protection zones.

Kittitas County has not undertaken a comprehensive study or assessment of aquifer susceptibility. As a result the location and extent of CARAs are not fully known. Identification and mapping of CARAs requires analysis and understanding of the physical characteristics such as:

- Depth to groundwater;
- Aquifer properties such as hydraulic conductivity, gradients, and size;
- Soil (texture, permeability, and contaminant attenuation properties);
- Characteristics of the vadose zone including permeability and attenuation properties; and
- Other relevant factors.

Vulnerability to contamination is assessed by considering:

- The contaminant loading potential;
- General land use;
- Waste disposal sites;
- Agriculture activities; and
- Well logs and water quality test results.

An initial attempt to classify areas of the County according to relative levels of susceptibility was conducted in support of this best available science review (see the March 2012 CARA map provided under separate cover). The goal of the mapping exercise was to determine areas where both: (1) recharge to a aquifer that provides potable water potentially occurs, and (2) where there are higher probabilities for surface land uses to occur that could impact that aquifer. The mapping identified areas with high, medium, or low aquifer susceptibilities. The general rational for each rating category is explained below in Table 1.

Table 1. Kittitas County CARA Mapping Rationale for Aquifer Susceptibility

Susceptibility Rating	Mapping Elements	Notes
High	The Roslyn and Kittitas Structural basins plus: Alluvial sediments (Qal); Outwash (Qao), alluvial fan (Qafo), Loess (Ql), outbursts (fs(t)). Continental sedimentary (Thorp gravel)	Will be variation between the two structural basins, but includes unconfined shallow aquifer and a higher density of human activity. Connect the two structural basins; may ignore bedrock.
Medium	Older bedrock in lower elevations [designated by alluvium and glacial drift Qad(e)]	Highest recharge rates, but modest volume of removal; lower potential for contamination due to lower degree of connection to surface activities, or much lower probability of surface activities that could impact the aquifer.

Susceptibility Rating	Mapping Elements	Notes
Low	CRBG at higher elevations; older bedrock at higher elevations.	Low levels of recharge with aquicludes between surface and water bearing strata. Very low population densities.

These coarse-scale delineations are general and preliminary, and the boundaries do not imply a physical change in the landscape. The boundaries have been developed with relatively few vertices which reflect the lack of precision in terms of the delineation.

3.0 GROUNDWATER RESOURCES IN KITTITAS COUNTY

Kittitas County is located in central Washington on the eastern slopes of the Cascade Mountains between the Cascade Crest and the Columbia River in the Columbia River basin. The underlying old basement sedimentary rocks, consolidated sedimentary rocks, interbedded Columbia River basalt flows, and relatively young unconsolidated (or weakly consolidated) materials have been structurally altered by ongoing tectonic forces. Structural basins formed by faulting and folding have typically been filled with unconsolidated or weakly consolidated materials which have supported the development of groundwater basins.

Groundwater is a substantial resource that is of critical importance to the residents and the agricultural industry. For the Yakima Basin in the year 2000, estimates suggest that 40,000 water wells withdrew about 312,284 acre-feet (Vaccaro and Sumioka, 2006). These widthdrawals support municipal, irrigation, commercial and industrial, livestock, fish and wildlife, non-municipal Group A and B systems, domestic, and groundwater claims.

Substantial investigations into the hydrogeology of the Yakima Basin have occurred to support an ongoing adjudication of surface water rights in the area (see for example Vaccaro et. al. 2009). This work covers the Yakima River basin, including the majority of Kittitas County. A portion of the County that drains directly to the Columbia River near Vantage is not directly included in this work, but geology and groundwater in the area are relatively consistent, dominated by Columbia River Basalts, and includes hydrogeologic units that are likely consistent with those described for the Yakima basin.

The USGS identified four categories of hydrogeologic units in the Yakima River basin:

- Unconsolidated basin fill units composed of Pliocene to Recent sediments;
- Semi consolidated to consolidated basin fill units composed of Miocene-Pliocene sediments;
- Miocene Columbia River Basalt Group (CRBG) and interbed units; and
- Paleozoic to Quaternary bedrock units.

All of these units are present within Kittitas County, with the older bedrock units dominating the higher elevations in the western portion of the county, basin-fills in the valleys surrounding Cle Elum and Ellensburg, and CRBG covering higher elevations in the eastern portion of the County. The basin-fill hydrogeologic units (1 and 2 in the list above) are of particular interest, as two structural basin fill units occur in Kittitas County (Roslyn and Kittitas), and they provide relatively shallow sources of groundwater that are often used for groundwater extraction. These units are not typically confined, meaning that there are pathways that can allow for interactions of surface land uses and the underlying aquifer.

While these units are generally similar in terms of overall structure, there is a substantial amount of variation within the basin fills in terms of materials and lateral and vertical hydraulic conductivities. The Roslyn basin includes more fine grained materials from lacustrine (lake) deposits which can have hydraulic conductivities that are many orders of magnitude less than adjacent alluvial or sand and gravel deposits. The Kittitas basin has fewer fine grained units than the Roslyn basin, but has more consolidated deposits.

The CRBG and older bedrock units also provide sources of groundwater in Kittitas County. The CRBG provides the most storage volume of the hydrogeologic units in the Yakima basin, and is engaged with deeper wells (100 to 500 feet deep) in the foothills east of Ellensburg. The older bedrock is also a routine source of groundwater in the higher elevations above Cle Elum, extending up the tributaries.

3.1 Yakima River Groundwater Study

The U.S. Bureau of Reclamation, Washington Department of Ecology, and the Yakama Indian Nation contracted with the USGS to study the groundwater system in the Yakima River Basin (USGS, 2011). The study includes data collection and mapping of hydrogeologic units and groundwater levels. As part of this effort, the USGS has completed a regional groundwater modeling study of the Yakima River basin which includes the majority of Kittitas County (USGS, 2011). The study examined groundwater data from October 1959 to September 2001. From this 41-year period, water budgets were evaluated for wet (1997), average (2000), and dry (2001) precipitation years to measure effects on outflows and inflows to the aquifer system.[1] These three years were selected to capture the hydrologic variability present and were found to be representative of existing conditions.

Groundwater recharge for the region, which drives the aquifer system, was found to range from about 3,200 cubic feet per second (cfs) in 2001 up to 9,700 cfs in 1997, a 200 percent increase between the dry and wet year (USGS, 2011). In 2000, recharge was within 3 percent of the mean annual recharge for the calibration period. Recharge to the system was found to be reasonably matched by the outflows from the aquifer system for the three example years (1997, 2000, and 2001). In 2001, less water flowed out of the groundwater flow system largely due to lower water levels. The next largest changes between years are inflows to the flow system from storage. In 1997 and 2000, inflows from storage are nearly the same, but inflows from storage in 2001 are about 600 cfs larger than in years 1997 and 2000. For the dry year (2001) with less recharge and additional effects of pumping, the inflow of water into the groundwater flow system from storage is clearly shown in the budget (determined from the outflow minus the inflow), where the 2001 difference is an inflow of about 2,900 cfs.

The next largest budget component is the drain flow, which is the boundary condition that accounts for the groundwater discharge which supports streamflow. The remaining factors affecting the groundwater budget include groundwater discharge to streams (stream leakage outflows), head-dependent boundary flows (lows into and out of the system dependent on groundwater levels where higher groundwater levels result in smaller inflows and vice versa), groundwater pumping wells, and contributions from the Columbia River boundary.

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[1] Outflows (e.g., groundwater well pumping) represent changes in groundwater volumes that move out of the aquifer system. Inflows represent groundwater that is moving into the aquifer system such as groundwater recharge.

The model that was developed for this study can be used for examining the effects of continued or increased pumping on the regional groundwater flow system to effectively manage groundwater resources. However, there are limitations to the use of the model which, for instance, is not effective for assessing effects of one or two individual new wells on the flow system. The model is more appropriate for such applications as estimating the quantity of pumpage in an area that leads to unacceptable groundwater-level declines and (or) streamflow capture (USGS, 2011).

3.2 Upper Kittitas County Groundwater Study

The United States Geological Survey (USGS) is conducting a study of the western Kittitas County groundwater-flow system to provide current, complete scientific information for future management of groundwater. The study is in response to concerns about potential impacts of groundwater withdrawals on tributary baseflows in the western portion of Kittitas County (Ecology, 2012). The 2011 USGS study indicated that groundwater and surface water are interconnected in the Yakima River basin. However the hydrogeologic framework and the potential impacts of groundwater withdrawals on tributary streamflow in the bedrock system are not as well known. Results of the Upper Kittitas Groundwater Study will be used to further define the hydrogeology of the area including groundwater occurrence and availability as well as the potential impairment resulting from well use (Ecology, 2012). Some of the work performed to date includes obtaining groundwater-level data from a field inventory to document the spatial distribution of water levels in the study area during spring 2011, and will be used along with the lithologic information from well drilling logs to develop a better understanding of the groundwater-flow system in the area (Fasser and Julich, 2011).

4.0 GROUNDWATER CONTAMINANT SUSCEPTIBILITY

The rate and distance a contaminant travels depends on a variety of factors including the natural setting and the chemical and physical characteristics of each particular contaminant. Because there are many different chemicals with varied characteristics such as solubility and specific gravity, it is difficult to assess all of the possible environmental fate scenarios. It is more feasible to characterize contaminant susceptibility. This involves determining the physical characteristics of the vadose zone, the area between and ground surface and the aquifer, and underlying aquifer.

Susceptibility to contamination can be used as a management tool to limit or prohibit the use of high-risk contaminants within areas determined to be high priority susceptible areas. The characteristics of the vadose zone can be a key factor in determining how easily a spill of a contaminant could get to the water table. Characteristics important for susceptibility assessment typically include depth to water, infiltration rate, permeability, chemical retardation factors, adsorption, and the presence or absence of an impermeable layer. Susceptibility factors include:

- **The vadose zone** consists of the unsaturated earth materials above an aquifer. Depth to water is the distance through the vadose zone a contaminant would travel to reach the water table. The deeper the water table, the longer the travel time.
- **Permeability** is a scientific measurement of the rate of infiltration in inches of water per hour. Infiltration rate is a measure of how fast water and pollutants can move downwards through the earth materials of the vadose zone. The more permeable the ground is and the faster water moves down through it, the more the underlying ground water is susceptible to contamination. Coarse sands and gravels allow water to pass through much more quickly than fine silts and clays.

- **Chemical retardation** is a measurement of how clays and organic matter react with some chemicals to slow their passage or change them chemically.
- **Adsorption** is a measurement of the tendency of ions dissolved in water to stick to particles of silt or clay. The particle size and the amount of organic matter affect the adsorption. Sand with no organic matter may not adsorb at all, while an organic silt or clay may adsorb well. In short, a contaminant can be captured or slowed down by sticking to clay.
- **Low permeability layers**, such as clay or glacial till, may occur between the ground surface and an aquifer, either within the vadose zone or within an aquifer system. These layers would restrict downward migration of contaminants and would provide a measure of protection to the aquifer.
- **Hydraulic conductivity** is a measure of how fast a quantity of water can move through an aquifer (for a given gradient through a unit area). The higher the hydraulic conductivity, the faster the flow.
- **Gradient** is the result of differences in elevation between two locations of the water table or the differences in pressure between locations in a confined aquifer. The higher the gradient, the faster the flow.
- **Groundwater flow direction** is determined by gradients, which in turn are influenced by pumping, discharge to surface water, topography, and geologic setting.
- **Groundwater flow rate** depends on the nature of the geologic materials water flows through along with the pressure on the water. Coarser materials allow faster flow, and higher pressures induce faster flow.

4.1 Vadose Zone/ Groundwater Levels

A USGS field inventory of 196 wells in the Upper Kittitas County study area was conducted in April to May of 2011 (Fasser and Julich, 2011). In August 2011, groundwater levels were measured again at a subset of 43 wells. These data and additional information including well construction and lithology from drilling logs are stored in the USGS National Water Information System (NWIS), Groundwater Site-Inventory (GWSI) database. The groundwater level data collected during this field inventory document the spatial distribution of water levels in the study area during spring 2011, and will be used along with the lithologic information from drilling logs to develop a better understanding of the groundwater flow system in the area. Preliminary reports show that depth to water throughout the upper Kittitas County varies significantly and can range from several feet to over 500 feet below ground surface (Fasser and Julich, 2011).

4.2 Soil Permeability

Soil permeability can be estimated by using data from the *Soil Survey of Kittitas County* (NRCS, 2010), which gives the drainage class for each soil type listed. The drainage class refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed (NRCS, 2010). Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained.* The soil survey also includes data in the form of saturated soil hydraulic conductivity for the various soil types listed. Saturated hydraulic conductivity is a measure of the ease with which pores of a saturated soil transmit water. Terms describing saturated hydraulic conductivity are *very high*, (14.17 or more inches per hour); *high*, (1.417 to 14.17 inches per hour); *moderately high*, (0.1417 inch to 1.417 inches per hour); *moderately low*, (0.01417 to 0.1417 inch per hour); *low*, (0.001417 to 0.01417 inch per hour); and *very low*, (less than 0.001417 inch per hour). However, the soil survey data only covers the upper 5 feet of soil and therefore may not accurately represent actual conditions especially where depth to water is much greater than 5 feet deep. In these cases, an understanding of the permeabilities and hydraulic conductivities of underlying geologic materials would be necessary.

4.3 Geologic Material Permeability

A determination of the permeability of the underlying geologic material is more challenging. The Ecology CARA manual calls for using well logs to determine the underlying geologic material permeability. However, the number of wells, as well as the lack of the well log data in digital format, makes that prospect unrealistic due to the number of well logs required to review, and the amount of time required to interpret the nonstandardized geologic descriptions on the individual well logs, to digitize the data, and to conduct the analysis. In general, geologic materials such as unfractured bedrock, particularly thick igneous or metamorphic deposits as well as clays, dense sandstone or hardpan deposits will have very slow permeabilities. Glacial till, fractured igneous and metamorphic rock as well as silts, clayey sands and weathered basalts will have slow permeabilities. Unconsolidated alluvial deposits will have moderate to rapid permeabilities depending on the degree of coarseness of the materials.

4.4 GROUNDWATER CONTAMINATION PATHWAYS

Regional groundwater quality issues are often tied closely with land uses. In Kittitas County, the land uses in higher elevations consist primarily of resource allocation in the form of timber harvesting, with some areas used for recreational purposes. Resource allocation is still predominant in the mid-elevations; however, residential development is increasing in these areas.

In the lower elevations agricultural activities are the main land use, with residential development intermixed in the area. Irrigated agriculture has occurred in the County for over 100 years, with farmers applying fertilizers and pesticides to attempt to maximize crop yields. Agricultural use also includes large dairy operations and feedlots which significantly increases the amount of nitrates present. For much of the past 150 years, people have depended on the aquifers for their domestic and stock water. Until fairly recently, well construction requirements and health and safety protections in place on those wells were fairly rudimentary.

The U.S. Congressional Office of Technology Assessment (USOTA) published a study related to the protection of groundwater as a potable water source, and outlined those uses that represent potential for contamination (USOTA, 1984). Many substances found in groundwater are widely used by industry, agriculture, commerce, and residential households. Potential contaminants can thus enter groundwater at numerous points. Many of these substances can cause biological injury, disease, or death under certain conditions of exposure. Listed below are some of the more common potential contaminant sources present in Kittitas County.

- Septic Tanks - Septic tank systems consist of a buried tank and drainage system designed to collect waterborne wastes, remove settlable solids from liquid by gravity separation, and permit percolation into the soil of clarified effluent. They are best suited for small volumes and periodic flows. Of all the sources known to contribute to groundwater contamination, septic tank systems directly discharge the largest volume of wastewater into the subsurface. Major factors affecting the potential of septic systems to contaminate groundwater in general are the density of systems per unit area, and hydrogeological conditions. Areas with a density of more than 40 systems per square mile are considered regions with potential for contamination.
- Landfills - Solid wastes deposited in landfills are generally classified either as hazardous or as nonhazardous. Considerations in the design of municipal landfills include the location, the area to be served, and plans for different stages in the filling process (e.g., land use upon completion of

the fill). Groundwater contamination can be minimized by proper design, construction, and operation and maintenance of a facility. Abandoned landfills (the locations of which are not usually known to regulatory authorities) often pose a threat to groundwater quality because geologic and hydrologic characteristics were not considered in the original site selection; the same may be true for some active landfills.

- Surface Impoundments - Surface impoundments are used by industries, agriculture, and municipalities for the retention, treatment, and/or disposal of both hazardous and nonhazardous liquid wastes. They can be either natural depressions or artificial holding areas (e.g., excavations or dikes). The term pit is commonly applied to a small impoundment used by industries, municipalities, agricultural operations, or households for special purposes (e.g., farm waste storage and sludge disposal). The wastewater in impoundments is treated by chemical coagulation and precipitation, by pH adjustment, by biological oxidation, by separation of suspended solids from liquids, and by reduction in water temperature.
- Underground Storage Tanks - Underground storage tanks are used by industries, commercial establishments, agricultural operations, and individual residences for storage and treatment of products or raw materials, for waste storage and treatment, and for piping systems. Industrial use is primarily for fuel storage but also for storage of a wide range of other substances, including acids, metals, industrial solvents, technical-grade chemicals, and chemical wastes. Commercial businesses, agricultural operations, and individual homeowners use underground storage almost exclusively for fuel storage. The most numerous underground storage tanks are those used for gasoline at service stations and for fuel oil at residences. Underground storage tanks are known to have caused many cases of groundwater contamination. In particular, old corroded gasoline storage tanks are frequently cited as sources of contamination. Such corrosion can be caused by impurities in the backfill, by faulty installation involving surface abrasions and failure to remove shoring, and by certain soil conditions. Many companies have installed new tanks near old ones. When they do, a new tank often acts as a sacrificial anode (i.e., metallic ions flow from the new tank to the old tank) and it rusts faster. In addition, dispensing pumps can develop leaks in couplings and hoses, and delivery lines can corrode or break. Although new underground tanks are usually coated with a protective or corrosion-resistant material if they are steel, or are made from relatively corrosion-resistant materials (e.g., fiberglass), they still are subject to corrosion-induced leakage. Fiberglass tanks can crack if installed incorrectly, and the polyester resins in fiberglass may be weakened by some alcohol-blend gasoline.
- Pipelines - Pipelines are used to transport, collect, and/or distribute both wastes and nonwaste products. The wastes are primarily municipal sewage, most often located in densely populated areas. The primary nonwastes are petroleum products and natural gas, but ammonia, coal, sulfur, and anhydrous ammonia are also transported. Nonwaste pipelines are located throughout the nation; maps of major pipeline networks are available from the Federal Energy Regulatory Commission. Although pipelines are designed to retain their contents and thus to pose no threat to groundwater, in reality they have leakage contamination potential. The major causes of leaks are ruptures, external and internal corrosion, incorrect operating procedures, and defective welds on pipes. Other causes were surges of fluid in pipelines, breakage or heaving of lines by tree roots or earthquakes, loss of foundation support, and rupture due to other loads.
- Animal Feeding Operations - Animal feeding operations can adversely affect groundwater if leachate enters the subsurface, either directly from feedlots or from waste piles and wastewater impoundments (see surface impoundments, above). The most important potential contaminant in manure is nitrogen, but bacteria, viruses, and phosphates are also of concern. The potential for groundwater contamination is greatest in areas with high densities of animals and a shallow water table. Data are insufficient to estimate the volume of leachate and runoff that actually reaches the

water table from large feedlots. In any case, because manure piles and feedlots often are near rural homes, domestic water supply wells are vulnerable.

- Stormwater Runoff - Urbanization expands impervious areas that intercept rainfall and thus increase the amount and rate of surface runoff. The runoff, in turn, is channeled by drainage networks and carries with it the contaminants associated with urban activities (e.g., automobile emissions, litter, deposited atmospheric pollutants, and sediments). The potential for groundwater contamination from urban runoff depends on where the runoff is discharged, its proximity to aquifers, and various hydrogeologic factors. A major source of contaminants is automobile emissions, which may contribute contaminants to surface runoff in some areas. The contaminants of most concern are suspended solids and toxic substances, especially heavy metals and hydrocarbons. Runoff can also contain bacteria, nutrients, and other oxygen-demanding loads, and petroleum residues.

5.0 REVIEW OF KITTITAS COUNTY CARA REGULATIONS

Kittitas County's existing critical areas code (KCC 17A.08) has minimal regulations for aquifer recharge areas. The code notes that no critical aquifer recharge locations have been identified in Kittitas County. KCC 17A.08 indicates that future classification of these areas will consider the degree to which the aquifer is used as a potable water source, feasibility of protective measures to preclude further degradation, availability of treatment measures to maintain potability, and availability of alternative potable water sources.

Kittitas County regulates proposals falling under the provisions of Section 17A.03.015 and which deal with hazardous materials that may contaminate ground or surface water by requiring compliance with all applicable federal and state laws and regulations. To the extent such proposals are not otherwise regulated under state and federal law, the applicant must submit a hazardous materials plan, developed in consultation with the Kittitas County environmental health department. The County can require secondary containment for wastewater, fuels, and other materials deemed by the County to pose a significant adverse impact on ground or surface water. The County can also require monitoring to ensure that the hazardous materials do not leak or contaminate ground or surface water. Other groundwater protection that the County may require include the use of settling ponds, setbacks for materials, restrictions on off-site discharge, biofiltration or other methods deemed necessary to prevent a significant adverse impact on ground or surface water.

6.0 CONSIDERATIONS FOR CODE UPDATES

Considering the limited nature of the existing regulations and the information presented above, there are several opportunities to improve the CARA regulations of KCC Title 17A to make them more consistent with scientific standards and commonly accepted management practices. Specific recommendations are as listed below.

6.1 General Recommendations

The protection of groundwater resources is vital for the future protection of public groundwater drinking supplies so that adverse conditions resulting from contamination can be prevented. Groundwater management strategies must also address hydraulic connectivity to streams and the Yakima River in light of the concerns about new wells affecting streamflows.

Contaminated water can cause illness and expose the public to ingestion of toxic chemicals or other harmful substances that may have acute or chronic effects. Once impaired on a regional level, remediation or reversal of conditions can be expensive and challenging to complete. Land uses that are some of the largest contributors to direct groundwater contamination involve subsurface disturbances, such as landfills, underground storage tanks, injection wells, and mining.

Other land uses such as application of agricultural fertilizers and pesticides or dairy/feedlot operations that cover large areas can also represent potential contributors to groundwater pollution. Prohibition of most land uses in areas that are determined to be highly susceptible to groundwater contamination is generally not practical. However, implementation of protection measures can be effective means of containing the contaminants to ensure against inadvertent introduction into the soil and ultimately the groundwater. Some examples of prevention requirements that could be more specifically referenced in KCC 17A.08 include:

Fertilization –

- Ensure that all fertilizers are applied at agronomic rates.
- Provide adequate setback from open water and residential wells.

Paints and Chemicals –

- Store on an impervious surface with a perimeter barrier capable of containing the amount of liquid being stored.
- Reuse spent cleaning solvents and/or send to a tank for periodic pumping. Do not allow to run down floor drains.

Underground Storage Tanks –

- Backfill with noncorrosive materials.
- Construct with noncorrosive materials. Reinforce the base of tank area to support the entire weight of the tank when full.
- Install with secondary containment features.

Vehicle Maintenance and Repair Shops –

- Collect all used fluids for recycling.
- Use non–solvent-based cleaners.
- Use drip pans to avoid contamination from leaks.

Low Impact Development Drainage Control –

- Require new development to incorporate drainage control features that encourage infiltration of stormwater runoff onsite such as bioswales, permeable pavement, use of planter boxes for roof drains, etc.
- Treat runoff from parking lots with vegetated swales.
- Incorporate landscaping into drainage control.

The above list is only a sample of proven ways contaminants can be prevented from entering groundwater and contaminating drinking water supply. Each use must be evaluated for its unique potential for groundwater contamination, and conditioned accordingly if necessary. The County could also require new developments in high susceptibility areas to conduct hydrogeologic assessments. The level of assessment could be calibrated based on the potential threat of contamination. A basic hydrogeologic assessment for conventional new developments could include:

- Available information regarding geologic or hydrogeologic characteristics of the site including the surface location of all critical aquifer recharge areas located on site or immediately adjacent to the site, and permeability of the unsaturated zone;
- Groundwater depth, flow direction and gradient based on available information;
- Currently available data on wells and springs within 1,300 feet of the project area;
- Location of other critical areas, including surface waters, within 1,300 feet of the project area;
- Historic water quality data for the area to be affected by the proposed activity; and
- Best management practices proposed to be utilized.

Larger scale or more intensive developments such as development that creates large impervious surfaces, divert, alter, or reduce groundwater, or use hazardous substances other than household chemicals, could be subject to additional assessment and reporting requirements. These more detailed assessment would describe:

- Historic water quality data for the area to be affected by the proposed activity;
- Groundwater monitoring plan provisions;
- Effects of the proposed project on the groundwater quality and quantity, including:
    - Predictive evaluation of groundwater withdrawal effects on nearby surface wells and surface water features; and
    - Predictive evaluation of contaminant transport based on potential releases to groundwater; and
- Provisions for regular inspection, repair and replacement of structures and equipment that could fail.

The County could also consider limiting or restricting certain land uses in areas of high susceptibility. Uses that would be restricted/prohibited w could include:

- Hazardous substance treatment, storage and disposal facilities;
- Solid waste and inert debris landfills, transfer stations, recycling facilities;
- Petroleum product pipelines;
- Class I, II, III, IV and V underground injection wells, except 5D2 storm drainage wells, 5G30 special drainage wells and 5R21 aquifer recharge wells as identified by the federal Safe Drinking Water Act;
- Mineral extraction.

The final element of the critical aquifer recharge protection pertains to adequate wellhead protection. The federal Safe Drinking Water Act requires every state to develop a wellhead protection program. The Washington Department of Health (DOH) administers the wellhead protection program in Washington. Washington's wellhead protection requirements are designed to prevent contamination of groundwater used for drinking water. The requirements apply to all Group A[2] public water systems that use wells or springs for source water, except those that purchase their water or get their water through interties. Public water systems must work with local governments and regulatory agencies to develop and implement their own local wellhead protection programs. In Washington, local wellhead protection programs must include:

- A completed susceptibility assessment.
- A delineated wellhead protection area for each well, well field, or spring.
- An inventory of potential contaminant sources in the wellhead protection area that could threaten the water-bearing zone (aquifer) used by the well, spring, or well field.
- Documentation showing the water system delineation and inventory findings was sent to required entities.
- Contingency plans for providing alternate drinking water sources if contamination occurs.
- Coordination with local emergency responders for appropriate spill or incident response measures.

The County should consider the need for a wellhead protection program. Further identification and evaluation of CARA protection strategies should be conducted by a licensed hydrogeologist in accordance with Ecology's Guidance Document for Critical Aquifer Recharge Areas.

[2] DOH uses the term "Group A" to designate public water systems that serve 25 or more people or 15 or more connections. More details can be located in WAC 246-290-020.

7.0 REFERENCES

Department of Natural Resources (DNR). 2012. Washington State, Earthquakes in Washington, available online at:

Fasser, E.T., and Julich, R.J., 2011, Groundwater levels for selected wells in Upper Kittitas County, Washington: U.S. Geological Survey Data Series 649.

Kittitas County, 2012, Kittitas County Hazard Mitigation Plan, April 2012.

Lasmanis, Raymond, The geology of Washington: Rocks and Minerals, v. 66, no. 4, p. 262-277, also available online at http://www.dnr.wa.gov/researchscience/topics/geologyofwashington/pages/columbia.aspx, 1991.

Lillquist, Karl. 2001. Mass Wasting in the Swauk Watershed.

Natural Resources Conservation S at: http://soils.usda.gov/survey/online_surveys/washington/WA637/KittitasWA.pdf.

United States Geological Survey (USGS). 2011. Numerical Simulation of Groundwater Flow for the Yakima River Basin Aquifer System, Washington, Scientific Investigations Report 2011–5155.

United States Office of Technology Assessment (USOTA). 1984. Protecting the Nation Groundwater From Contamination, U.S. Congress, Office of Technology Assessment, OTA-O-233. October, 1984. Washington, D.C.

Vaccaro, J.J., and Sumioka, S.S. 2006. Estimates of ground-water pumpage from the Yakima River Basin Aquifer System, Washington, 1960-2000. U.S. Geological Survey Scientific Investigations Report 2006-5205.

Vaccaro, J.J., Jones, M.A., Ely, D.M., Keys, M.E., Olsen, T.D., Welch, W.B., and Cox, S.E. 2009. Hydrogeologic framework of the Yakima River basin aquifer system. U.S. Geological Survey Scientific Investigations Report 2009-5152.

Washington Department of Ecology (Ecology). 2012. Upper Kittitas Groundwater Study, available at http://www.ecy.wa.gov/programs/wr/cro/ukgws.html, accessed July 25, 2012.