HERRERA

TECHNICAL MEMORANDUM

Date: June 30, 2021

To: Kimberly Swan, Clackamas River Water Providers

From: Jennifer Schmidt, Herrera Environmental Consultants

Subject: GIS Septic Systems Risk Analysis Results

INTRODUCTION

The Clackamas River is a source of drinking water for more than 300,000 people in Clackamas County and is an important resource for helping to meet future water demand in the region. The Clackamas River Water Providers (CRWP) represents five municipal surface water intakes on the Clackamas River: City of Estacada, Clackamas River Water, North Clackamas County Water Commission, South Fork Water Board, and City of Lake Oswego. Herrera Environmental Consultants (Herrera) was hired in 2011 to complete a series of geographic information system (GIS) analyses to help identify potential pathways for pollutant export to the Clackamas River from seven high-risk activity categories (Clackamas River Water Providers 2010):

- Septic Systems
- Agricultural Activities
- Forestry Activities
- Vulnerable Soils
- Urban Development
- Point-Source Pollutants
- Hazardous Materials

The goal of these GIS analyses was to map risk factors known to have a strong negative correlation with drinking water quality in the Clackamas River watershed. Mapped risk "hot spots" for each category provide a spatial context for both the geography and intensity of risk by activity that can be used by the CRWP to help prioritize mitigation efforts. In 2021, Herrera was hired to update these analyses to map changes that have may have occurred in the locations of risk "hot spots" in the watershed over the last decade based on new or updated GIS data. This memorandum focuses specifically on the results of the updated 2021 GIS Septic Systems Risk Analysis.

Potential Threats from Septic Systems

The CRWP have identified improperly maintained septic systems as being a significant source of risk to drinking water quality in the Clackamas River watershed. The primary threat to surface water from septic system malfunction is direct runoff from partially treated waste or from contaminated recharged groundwater. Some of the most serious contaminants that can be discharged into groundwater from malfunctioning septic systems include high concentrations of disease-causing pathogens, nitrates, organic matter, ammonia, nitrogen, phosphates, synthetic organics, toxic metals, PCPs, and pharmaceuticals (Clackamas River Water Providers 2010).

Approximately 10 to 25% of septic systems fail, often releasing untreated wastewater into the underlying groundwater and/or nearby surface water (U.S. EPA 2003; Schueler and Holland 2000). The risk of septic system malfunction increases: 1) with age; 2) where site conditions enhance the potential for pollutant movement such as rapidly draining soils, restrictive soils with slow permeability, or inadequate setbacks to surface water; and 3) in locations where a high density of septic systems on smaller lots are concentrated (Joubert et al. 2003).

GIS Septic System Risk Analysis

Herrera performed a GIS analysis to identify potential onsite septic systems and assess the risk of septic system failure to source water quality for all tax lots in the Clackamas River watershed. This methodology included gathering, ranking, and overlaying 5 datasets in GIS know to increase the risk of septic system failure:

- Septic system age
- Statistically significant septic system clusters
- Proximity to surface water and upstream distance from municipal surface water intakes
- Vulnerable soils
- Parcel size

The following sections provide more detailed information on this analysis, including objectives, methods for generating the septic system risk datasets, and data sources used and limitations.

Analysis Objectives

The primary objectives of the GIS septic system risk analysis were to:

1. Identify parcels in the Clackamas River watershed with potential on-site septic systems.

2. Assess the risk of septic system failure by mapping high-density septic system clusters, septic system age, proximity to surface water, vulnerable soils, and parcel size.

3. Rank, weight, and overlay each septic system risk factor to produce a map of cumulative risk to source water quality from septic system failure at the parcel level.

Data Source and Limitations

The primary GIS datasets required to assess septic system risk to source water quality are tax parcel boundaries, residential septic system age, non-residential septic system permits, sanitary sewer utilities, and vulnerable soils. The following sections describe these major datasets in more detail, including any major data limitations that are important to keep in mind when interpreting the GIS septic system risk analysis results. Documentation on all datasets used in the analyses can be found in Table 1. Herrera converted all GIS datasets used in the septic system risk analysis to the Oregon State Plane North HARN 83 map projection, with both the vertical and horizontal datum being in feet.

Tax Parcel Boundaries and Assessor Data

Herrera used tax parcel boundaries and property data records from the Clackamas County Assessor to help identify potential onsite septic systems and to estimate septic system age, density, and parcel size in the Clackamas River watershed. Tax parcel boundaries were obtained from the Oregon Metro Regional Land Information System (RLIS). RLIS provides an updated parcel boundary dataset in coordination with Clackamas County on a quarterly basis containing detailed information on parcel land use, building square footage, vacancy status, and other attributes helpful for predicting onsite septic system use.

Detailed records were obtained from the Clackamas County Assessor in May 2021 documenting the number of bedrooms, bathrooms, and building age for residential parcels in the Clackamas River watershed. Bedroom and bathroom data was used to help assess potential septic use and building age was used to calculate septic system age. One major limitation of using building age to predict the age of potential septic systems is that it does not consider potential repairs and replacements that may have occurred over time. Therefore, septic system age calculated based solely on building age may overestimate average septic system age in the watershed.

Vulnerable Soils

GIS soil data was obtained from Clackamas County from the United States Department of Agricultural National Resource Conservation Service (NRCS) website. Detailed information about each soil unit was obtained from the NRCS soil survey report for Clackamas County in 1985, and included attributes such as soil permeability, erosion hazard, runoff risk, slope percentage, typical land use by soil type, and specific risks for septic system construction and failure (NRCS 1985). This information was consolidated into a table and joined to the soil type polygons in GIS.

Septic System Permits and Locations

The Oregon Department of Environmental Quality (DEQ) issues Water Pollution Control Facilities (WPCF) permits for domestic wastewater for commercial and larger non-residential septic systems. Herrera obtained the locations of 7 issued WPCF domestic wastewater permits in the Clackamas River watershed from the Oregon Facility Profiler-Lite Interactive Viewer, which is a repository of DEQ regulated or permitted facilities and sites in Oregon.

An additional source of potential septic system locations came from four source water assessments completed by Oregon DEQ and the Oregon Department of Human Services with assistance from the Clackamas Basin Watershed Council in 2002-03. The purpose of these assessments was to identify surface water areas that supply public drinking water, identify sensitive areas, and potential contaminant sources that could adversely impact that source of water (Clackamas River Water Providers 2010). Over 1,200 potential contaminant sources (PCS) were identified in the Clackamas River Source Water Assessments and mapped in a GIS dataset, including 24 high-density septic system clusters in the Clackamas River watershed indicated as being of moderate to high risk to source water quality. Herrera extracted the septic system clusters from the overall PCS data for inclusion in the risk analysis.

Sanitary Sewer Utilities

Herrera obtained sanitary sewer mainline and lateral pipe data from Clackamas County Water Environmental Services (WES) for Clackamas County Service District (CCSD) #1 to help identify residences within treated sewer district boundaries that may not be connected to the sanitary sewer system. There are several limitations to using this data for predicting potential onsite septic system locations in the Clackamas River watershed that should be kept in mind when interpreting the septic system risk results within treated areas. First, sanitary sewer utility data was only readily available for CCSD #1 and not all sewered cities in the watershed. Second, the lateral pipe network data within CCSD #1 was not comprehensive. Finally, the presence of sewer laterals does not necessarily indicate that a residence is connected to the sewer main line.

Table 1. GIS datasets used to help assess the risk from septic systems to source water quality in the Clackamas River watershed.

Dataset Description	Source	Date
Aerial photography	United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP)	2019
Wastewater Domestic Permit Service Districts	Oregon Department of Environmental Quality (DEQ)	2020
Clackamas River watershed boundary	Oregon Metro Regional Land Information System (RLIS)	March 2021
Streams and waterbodies	Oregon Metro RLIS	March 2021
Taxlot boundaries	Oregon Metro RLIS	March 2021
Tax assessor table with building age, number of bathrooms, and number of bedrooms	Clackamas County Assessor	Obtained May 2021
Soil survey boundaries	United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)	Obtained March 2021
Sewer pipes and laterals	Clackamas County Water Environment Services (WES)	Obtained March 2021
Water Pollution Control Facilities permit (WPCF) locates for domestic wastewater	Oregon DEQ	Obtained May 2021
Potential Contaminant Sources (PCS)	Oregon DEQ	Obtained May 2021

Methodology

This section describes the GIS methods used by Herrera to 1) map potential on-site septic system locations and 2) assess potential septic system failure risk "hot spots" based on septic system age, density, parcel size, soil vulnerability, and proximity to surface water.

Mapping potential on-site septic system locations

Identifying parcels with potential on-site septic systems is the first step in assessing cumulative septic system failure risk to source water quality. Because no comprehensive dataset showing onsite septic system locations exists for the Clackamas River watershed, Herrera identified potential septic system parcels by overlaying several GIS datasets to predict where septic systems are most likely in use. This methodology was based on a decision-making flowchart provided to Herrera by the Oregon Department of Environmental Quality for assessing potential septic system impacts using GIS (DEQ 2011).

First, Herrera used tax parcel boundaries and assessor tables from the Clackamas County Assessor to identify parcels that are most likely occupied. Criteria used to determine whether a residential parcel is occupied included land use descriptions, the number of bedrooms, and the number of bathrooms. Occupied parcels with bathrooms or bedrooms were flagged as potentially having onsite septic system. Vacant parcels were removed from the analysis.

The next step was to overlay the remaining parcels with domestic wastewater permit service districts to identify parcels that are likely connected to a wastewater treatment system. This includes sewered areas like CCSD #1, City of Sandy, City of Gladstone, City of Estacada, City or Oregon City. The starting assumption was that all parcels within these boundaries are connected to wastewater treatment systems and are unlikely to be using onsite septic systems; however, a small number of parcels within treated areas may still be using septic systems. To identify potential septic systems within sewered areas, Herrera overlaid major sewer lines and sewer laterals where available with parcel boundaries and aerial photography. Occupied parcels not showing lateral pipe connections to the main sanitary sewer lines were flagged, and all other parcels within treated areas were removed from the analysis.

Approximately 9,670 potential onsite septic system locations were identified in this analysis. In addition to these parcels, Herrera included approximately 7 additional septic system locations to the analysis where Oregon DEQ has issued WPCF permits to larger non-residential facilities and approximately 20 septic system cluster locations identified in the 2002-03 Clackamas River Source Water Assessment. This information was first reviewed to ensure that duplicate data wasn't being included in this analysis. All potential septic system parcels mapped by Herrera are shown in Figure 1.

Estimating Onsite Septic System Age

More than half of the approximately 20 million septic systems used in the United States were installed over 30 years ago when on-site results were nonexistent or poorly enforced (U.S. EPA, 2003; Novotny and Olem, 1994). Herrera estimated septic system age for each potential parcel in this analysis using the effective year the property was built, which was obtained from the Clackamas County Assessor. Using this metric, approximately 80% of potential septic system parcels in the Clackamas River watershed are greater than 30 years old. Estimated septic system age for all parcels included in this analysis is shown in Figure 2.

Identifying High-Density Septic System Clusters

Septic systems clustered with other systems on small lots pose a significant threat to source water quality (U.S. EPA, 2003). Herrera mapped statistically significant clusters of small parcels with potential septic systems using the Anselin Local Morans I statistic based on parcel area. Approximately 4,650 of the 9,670 potential septic systems identified in the Clackamas River watershed are in clusters of small (<1 acre) parcels. These clusters are shown in Figure 3.

Calculating Proximity to Surface Water

Herrera calculated linear distance of each potential septic system parcel to the mainstem Clackamas River or its major tributaries. Then upstream distance to the closest surface water intake was calculated to account for pollutant attenuation in the surface water system.

Mapping Vulnerable Soils

Septic systems rely on the soil to remove harmful contaminants and pathogens from wastewater before the contaminants can affect source water quality. The soils that pose the highest risk to septic system failure are:

- **Dense or impermeable soils:** Water moves through these layers more slowly than it is applied to the soil surface as precipitation, so these restricting soil horizons become saturated with water (Lee et al. 2004).

- **Rapidly draining soils:** Wastewater is transmitted through the soil faster than the soil can treat it, placing groundwater supplies at risk. Examples of rapidly draining soils include coarse sand and gravelly layers commonly found near large rivers.

- **Bedrock:** Water-restricting bedrock zones result in saturated soils below septic system absorption fields, and often cause inadequate wastewater treatment. Bedrock layers cannot transmit natural rainfall, let alone the added effluent applies at rates two to seven times the normal precipitation rate.

Herrera NRCS soil survey for Clackamas County (NRCS 1985) to identify and map each of these vulnerable soil categories in the Clackamas River watershed.

Calculating Aggregate Septic System Risk

After Herrera mapped potential onsite septic systems and analyzed risk of septic system failure from septic system age, density, soil drainage, and water proximity, the next step was to rank and overlay the datasets together to determine aggregate risk from septic systems to source water quality in the Clackamas River watershed. To accomplish this, the attributes for each individual dataset were assigned a ranking scheme on a scale of 1 to 5, with a value of 1 indicating a low risk of septic system failure and a value of 5 indicating high risk.

As a final step, the scores were added together for each potential septic system parcel to calculate a total risk score. The results of this analysis showing cumulative risk from septic systems on source water quality in the Clackamas River are shown in Figure 4.

Table 2. Scoring criteria used to determine the risk from septic systems to source water quality in the Clackamas River watershed.

Dataset	Scoring Criteria	Score
Septic System Age	1 to 30 years	1
	31 to 50 years	3
	> 50 years (or unknown)	5
High-Density Septic System Cluster	Parcel is in a high-density septic system cluster	5
Distance to the Clackamas River or Major Tributary	0 to 0.25 miles	5
	0.25 to 0.5 miles	4
	0.5 to 1 mile	3
	1 to 2 miles	2
	> 2 miles	1
Upstream Distance to Surface Water Intake	0 to 0.5 miles	5
	0.5 to 1 mile	4
	1 to 2 miles	3
	2 to 5 miles	2
	> 5 miles	1
Vulnerable Soils	Very Slow to Moderately Slow Permeability	5
	Rapid Drainability	
	Bedrock Presence	
	Steep Slopes	

Results and Recommendations

Of the approximately 9,670 potential septic system parcels identified in the Clackamas River watershed, about 1825 were ranked as very low or low risk, about 4640 were ranked as moderate risk, and 3205 were ranked as high or very high risk. The most appropriate method for analyzing the risk analysis output is to focus on overall geographic risk trends rather than parcel-level results due to the potential for data anomalies. It is also important to keep in mind that the potential septic system parcels have not been field-verified. Verification of the presence, age, and condition of septic system parcels shown in high-risk clusters is an important next step to help focus septic system management strategies.

As indicated in Figure 4 the regions with the highest risk for septic system failure are located upstream of Estacada and Northeast of Oregon City / South of Highway 224. If future pollutant source tracking or modeling efforts identify septic systems as a potential pollutant source of concern, the systems located in these regions should be targeted first for system upgrades. If additional monitoring is implemented to try to identify pollutant sources in the watershed, the septic risk mapping data can be used to help select sites that could potentially isolate the water quality signal from septic systems. Additionally, if a modeling effort is developed to help quantify pollutant loading from various sources, the GIS septic system data will serve as a valuable model input. Herrera recommends that this analysis be repeated every 5 years to account for changes in septic system permit requirements, residential density, and potential septic system decommissioning.

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FIGURES

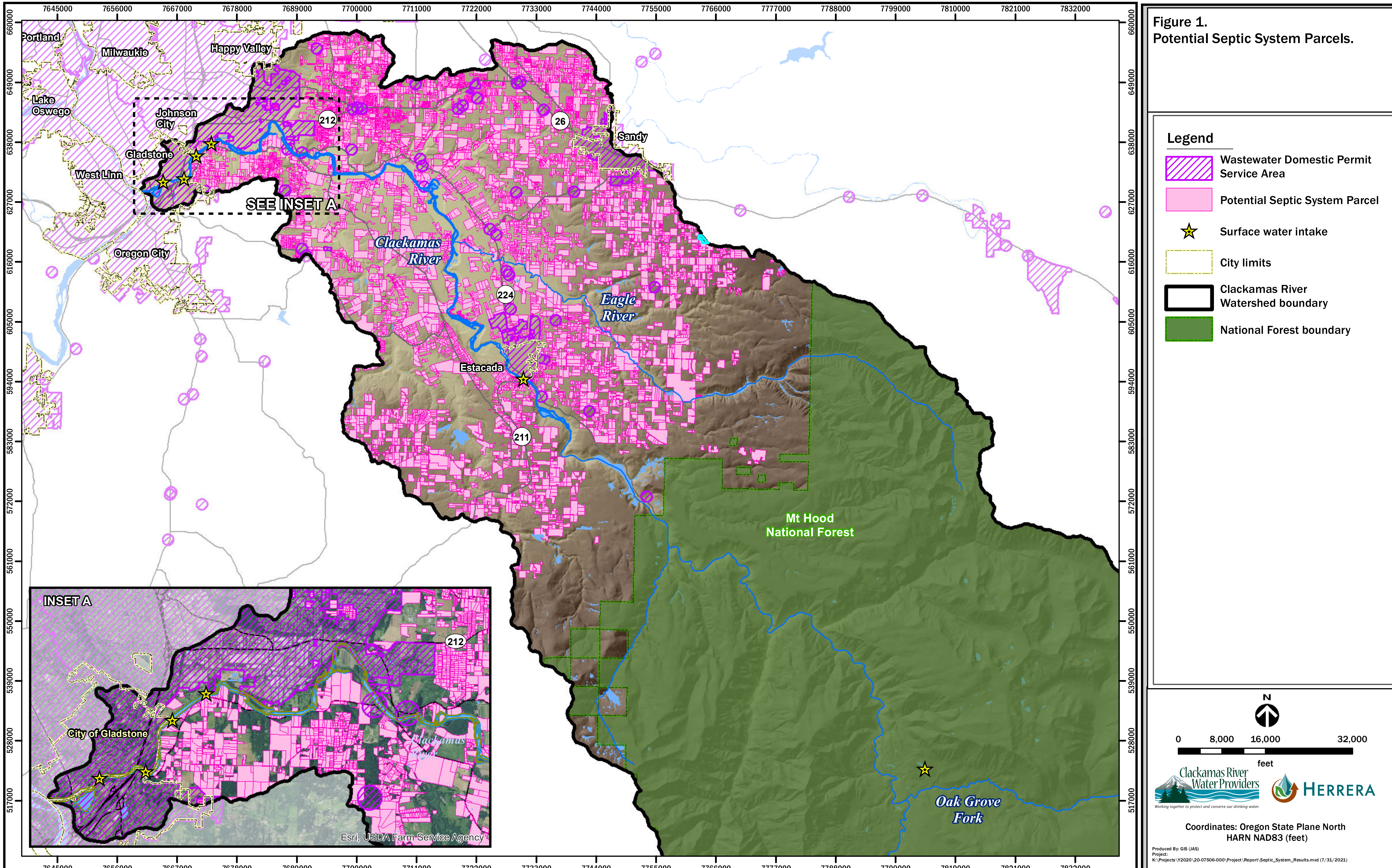
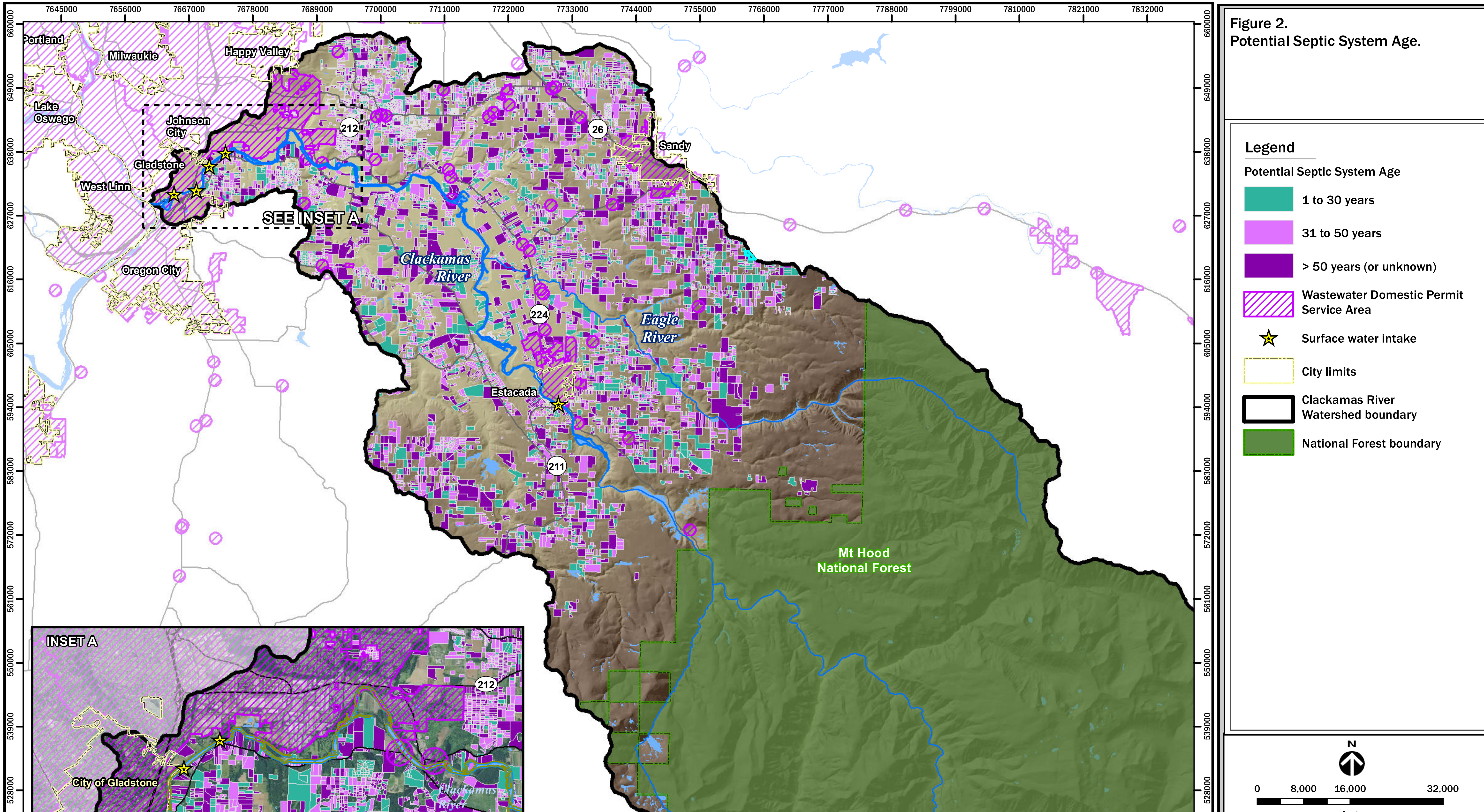


Figure 1.
Potential Septic System Parcels.

Figure 2.
Potential Septic System Age.



Clackamas River Water Providers
Working together to protect and conserve our drinking water.
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Coordinates: Oregon State Plane North
HARN NAD83 (feet)

Produced By: GIS (JAS)
Project:
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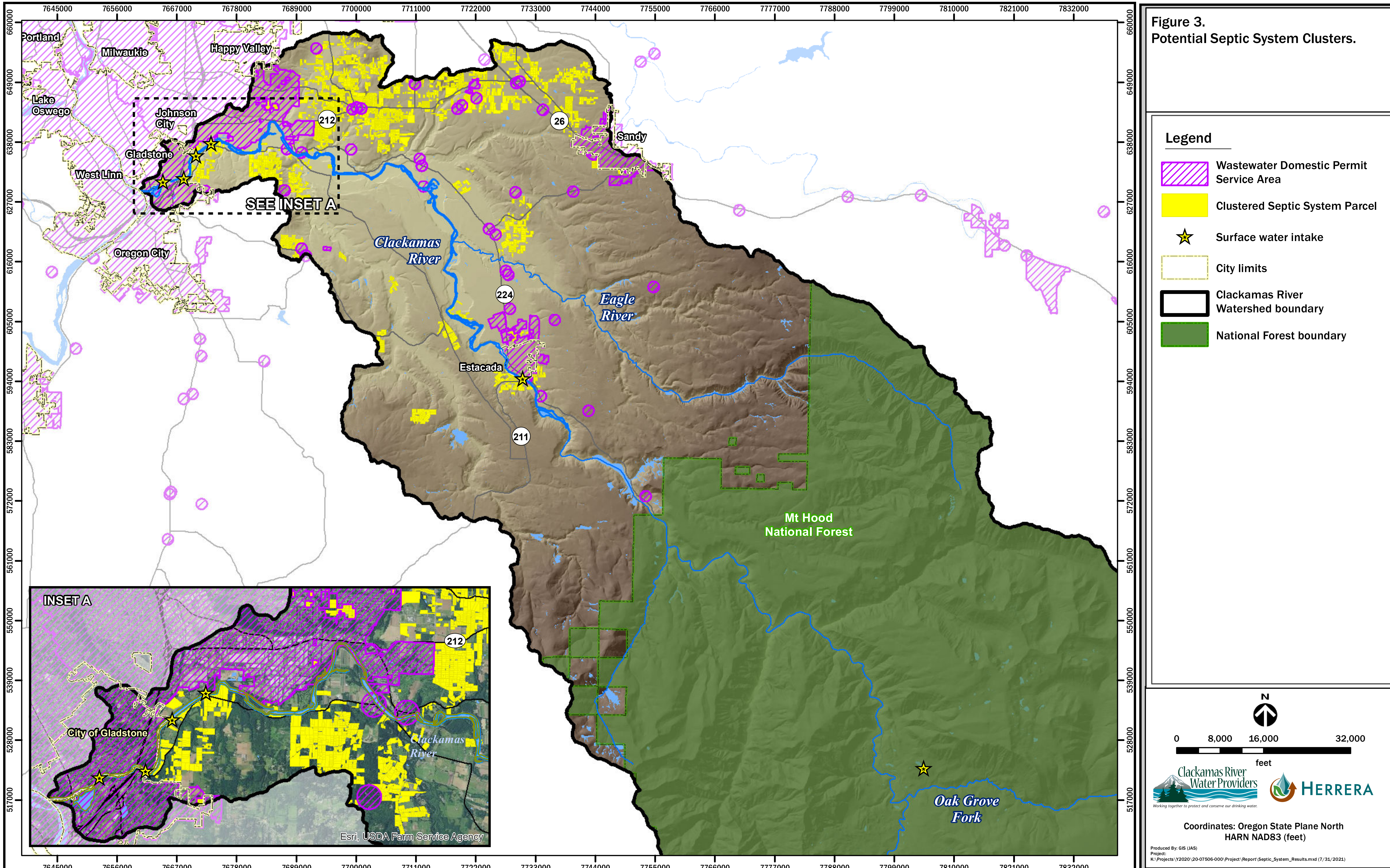

Figure 3.
Potential Septic System Clusters.

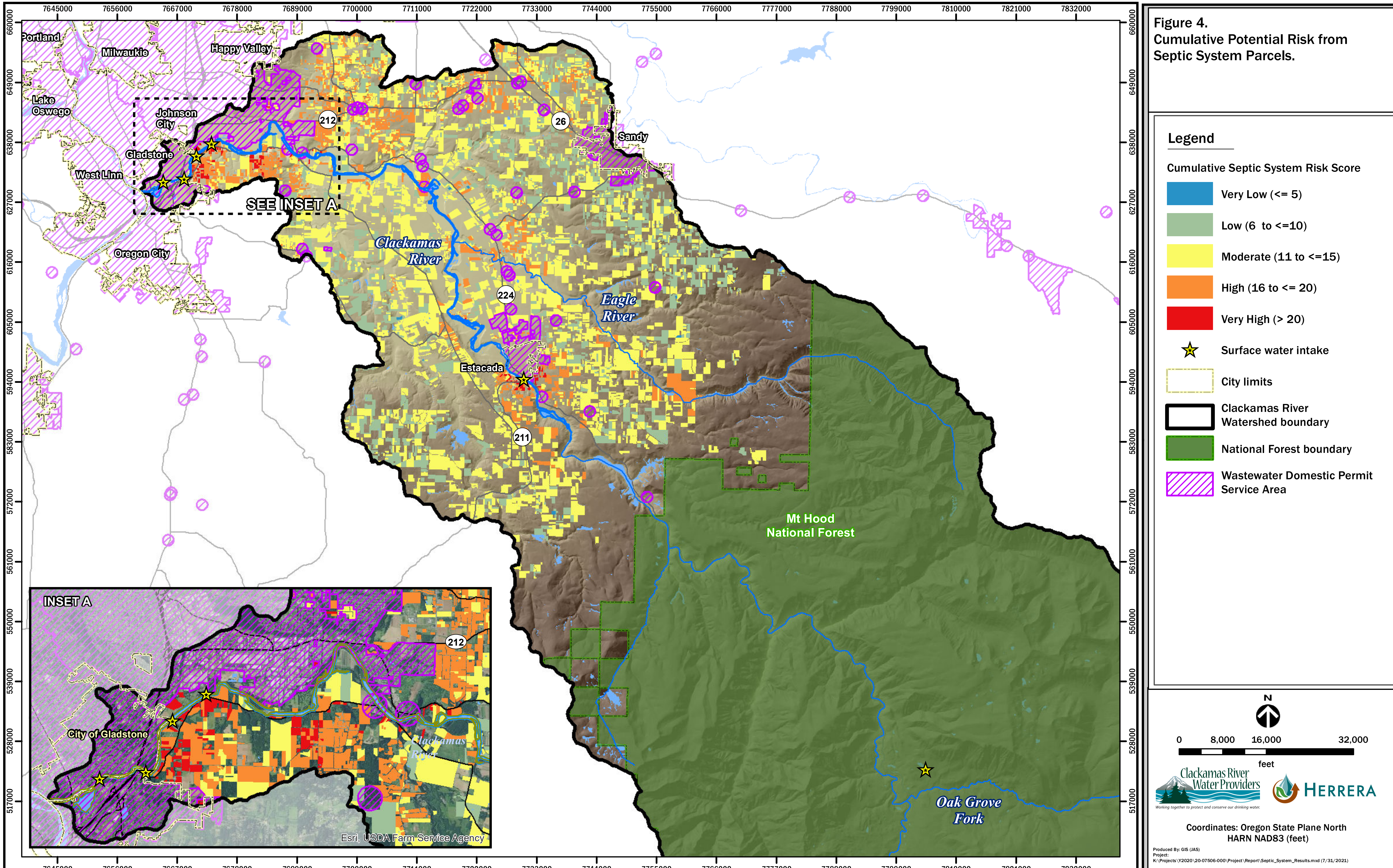

Figure 4.
Cumulative Potential Risk from Septic System Parcels.

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Coordinates: Oregon State Plane North HARN NAD83 (feet)

Produced By: GIS (JAS)
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