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Technical Memorandum

To: Amy Blain, PE – City of Longview, Washington

From: Larry Eaton, RG, LHG – GSI Water Solutions, Inc.
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Date: May 5, 2008

Re: City of Longview – Proposed Mint Farm Wellfield Area Environmental Review

Executive Summary

The City of Longview (City) has considered developing a sole-source, 20-million-gallon-per-day (mgd) water supply wellfield in the gravel aquifer below the Mint Farm Industrial Park in Longview, Washington. Hazardous chemicals used by industrial and commercial entities in the Mint Farm area could pose a potential risk to the proposed wellfield; however, a thick sequence of fine-grained silts and sandy silts that overlie the sand and gravel aquifer provides protection from potential surface contamination sources, but is not absolutely impermeable. GSI Water Solutions, Inc. (GSI) was retained by the City to conduct an environmental review of the area near the proposed water supply wellfield. The purpose of the review was to identify potential contaminant sources and evaluate the risk these potential sources pose to groundwater.

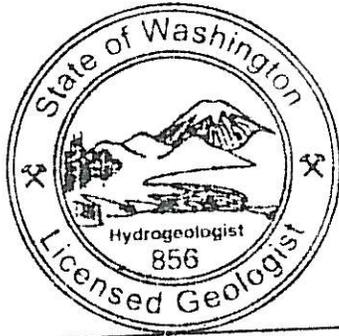
The risk assessment evaluated overall risk of contamination to the proposed Mint Farm Wellfield by weighing the factors that tend to reduce the risk of well contamination (i.e., fine-grained silts and sands that overlie the sand and gravel aquifer) against the factors that tend to increase the risk of well contamination (i.e., the types of hazardous chemicals used by industrial and commercial entities). The risk assessment involved three components:

- Evaluation of risk posed to the proposed Mint Farm Wellfield by industrial and commercial operations using a U.S. Environmental Protection Agency (EPA) priority setting approach (EPA, 1991).
- Evaluation of risk posed to the proposed Mint Farm Wellfield by existing groundwater contaminant plumes within 1 mile of the wellfield.
- Evaluation of risk posed to the proposed Mint Farm Wellfield by inadequate seals on existing water wells and geotechnical borings within 2 miles of the wellfield.

GSI makes the following conclusions and recommendations from the results of the environmental review:

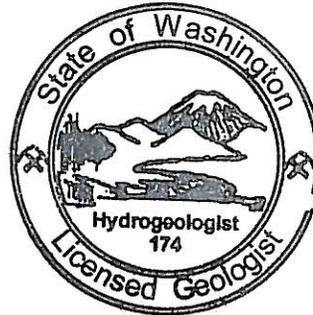
- The risk assessment discussed in this memorandum is a conservative approach to evaluating the risk posed to an aquifer by potential contaminant sources. Specifically, the approach did not consider influences of the possible pumping of nearby wells because the City has no control over their operation. Pumping of nearby wells reduces the area of influence of the proposed Mint Farm Wellfield; therefore, not including pumping of nearby wells is conservative.
- Based on the results of EPA's risk assessment protocol, most of the 17 potential contaminant sources in the proposed Mint Farm Wellfield Wellhead Protection Area (WHPA) pose only a low risk of wellfield contamination. Two potential contamination sources (Mt. Solo Landfill and the previous agricultural mint farm designated as the Old Mint Farm in this document) pose a medium risk of wellfield contamination, and one site (Weyerhaeuser Longview) has an overall risk that is very close to being considered "medium." GSI recommends that the City actively manage the risk from these three potential sources of contamination during development of the proposed Mint Farm Wellfield and the Wellhead Protection Plan (WPP).
- The medium risk sites (i.e., Mt. Solo Landfill and Old Mint Farm) and near-medium risk sites (i.e., Weyerhaeuser Longview) can be managed with additional data collection. Mt. Solo Landfill is located on the margin of the Mint Farm Wellfield WHPA. GSI recommends that the WHPA be refined to further evaluate whether the Mt. Solo Landfill is a potential metals contaminant source. Soil at the Mint Farm is contaminated with pesticides; however, these pesticides have limited mobility, and have not been detected in groundwater beneath the Mint Farm. GSI recommends that the production wells at the proposed Mint Farm Wellfield should be sampled for pesticides and that shallow soil be removed from each well site before well installation. The Weyerhaeuser Longview site is undergoing groundwater cleanup for mercury contamination, and continued use of chemicals at the facility has the potential to affect the proposed Mint Farm Wellfield. GSI recommends that wells at, or near, the Weyerhaeuser facility be instrumented and sampled as an early-detection system for migration of Weyerhaeuser chemicals toward the proposed Mint Farm Wellfield. Assigning a less conservative characterization of the unsaturated materials (i.e., using silt instead of silty sand) in the risk assessment would result in low risk levels for all sites.
- Three groundwater plumes have been identified within 1 mile of the proposed Mint Farm Wellfield (i.e., at Weyerhaeuser Longview, Reynolds Aluminum, and Prudential Steel). Currently, these groundwater plumes appear to be migrating away from the proposed Mint Farm Wellfield, toward the Columbia River. However, development of a 20-mgd wellfield in the Mint Farm area will reverse groundwater flow in the vicinity of the wellfield. This reversal in groundwater flow direction, particularly on the down gradient or river side of the wellfield, has the potential to induce contaminant plume movement toward the proposed wellfield and potentially affect the drinking water supply. GSI recommends installation of sentry wells between the groundwater plumes and the wellfield for early detection purposes, and instrumentation and routine sampling of existing monitoring wells at these sites to detect a hydraulic response from wellfield operation. GSI further recommends communication with the Washington Department of Ecology (Ecology) to ensure that remedial actions at each site are protective of the proposed wellfield.

- Water wells and/or geotechnical borings without adequate well seals within 2 miles of the proposed Mint Farm Wellfield were less than 50 feet deep, and did not penetrate the full extent of the silt and sandy silt. Therefore, inadequate wells seals pose a low risk of wellfield contamination at the proposed Mint Farm Wellfield.



Larry G. Eaton

Jerry L. Eaton
Expires 25-May-2008



KENNETH N. TROTMAN

Kenneth N. Trotman
Expires 5/09/09

1 Introduction

This memorandum outlines the results of an environmental review of the area near the proposed water supply wellfield located in the Mint Farm Industrial Park in Longview, Washington. The purpose of the review was to identify potential contaminant sources and evaluate the risk the potential sources pose to the groundwater resource. The memorandum was developed as outlined in GSI Water Solution's (GSI), December 3, 2007, scope of work, and includes:

- Background information about the proposed Mint Farm Wellfield (Section 2)
- A general discussion of geology and hydrogeology of the proposed Mint Farm Wellfield (Section 3)
- An evaluation of risk posed to the proposed Mint Farm Wellfield by:
 - Industrial and commercial operations (potential contaminant sources) in the 10-year time-of-travel Wellhead Protection Area (WHPA)
 - Existing groundwater contamination in the WHPA 1-year time-of-travel
 - Existing water wells with inadequate surface seals within 2 miles of the proposed wellfield (Section 4)
- Discussion of elements to include in a Wellhead Protection Plan (WPP) for the proposed Mint Farm Wellfield (Section 5)
- GSI's conclusions and recommendations (Section 6)

The objective of this work is to provide criteria that can be used by the City of Longview (City):

- Evaluate, from a wellhead protection perspective, the suitability of siting and developing a sole-source municipal water supply wellfield at the Mint Farm Industrial Park.
- Develop a strategy for managing risk from existing and potential sources of groundwater contamination.
- Establish the basic components of a WPP for the proposed Mint Farm Wellfield.

2 Background

Currently, the City water supply is from a surface water intake on the Cowlitz River. The City has a nearly 60-year-old raw water treatment plant that is in need of repair and updating, and in need of expansion to meet future growth demands. The river intake pumps fail frequently, and flocculation/residual basins and drying beds require frequent cleaning because of sediment loading from the river. For these reasons and more, the City has considered developing a new groundwater supply wellfield in the Mint Farm area, a 445-acre industrial park adjacent to industrial land to the west and south and commercial/residential land to the east and north, as shown in Figure 1 (PBJ, 2002).

Initial hydrogeologic investigations indicate that the aquifer below the Mint Farm area will support the City's need for a new wellfield. A Robinson, Noble & Saltbush, Inc. (2002, 2007), field testing program shows that a single well could yield up to 3,000 gallons per minute (gpm), and indicates that the wellfield could produce 20 mgd with reasonable well spacing. GSI has reviewed and supports the aquifer productivity findings by Robinson, Noble & Saltbush, Inc., but

reinforces the concern that the wellfield is to be sited in an industrial area that will continue to be developed for industrial purposes. Industrial and commercial properties in the Mint Farm Wellfield WHPA have used and continue to use hazardous chemicals that, if released to the environment in sufficient quantities, potentially could pose a risk to the aquifer below the Mint Farm area (GSI, 2007).

3 Geology and Hydrogeology

The general subsurface conditions in the Mint Farm Industrial Park consist of a valley eroded into underlying bedrock and filled in with sediments by the Columbia River over time. Specifically, clayey silt that becomes thicker near the Columbia River is present at the ground surface. The clayey silt is underlain by silt and sandy silt to approximately 175 feet below ground surface (ft bgs) and a sand and gravel aquifer (i.e., the target production aquifer) is encountered at about 175 ft bgs. Bedrock, which is encountered below the gravel and is present in the highlands, consists of low permeability shales and sandstones.

The sand and gravel aquifer is highly transmissive. Groundwater likely flows generally south and west and discharges to the Columbia River. Static water levels (potentiometric surface) are at or near ground surface in the sand and gravel aquifer, which indicates that the aquifer is under pressure (i.e., confined). Robinson, Noble & Saltbush, Inc. (2002, 2007), and GSI (2007) describe the subsurface conditions in more detail.

The Washington Wellhead Protection Program requires that the 1-, 5-, and 10-year time-of-travel zones be defined around a municipal groundwater source. For the purposes of this memorandum, GSI has designated the WHPA for the proposed Mint Farm Wellfield as the 10-year time of travel zone as simulated by WinFlow, an analytical groundwater model. Overall, the 10-year time-of-travel zone identifies the area of the aquifer that would contribute water to the wells during 10 years of continuous pumping. It is important to point out that the WinFlow model is based on several conservative, simplifying assumptions, which include (1) using a low groundwater hydraulic gradient, (2) no pumping occurs at nearby wells (e.g., Chinook Ventures and/or Weyerhaeuser), and (3) the aquifer is homogeneous and isotropic (e.g., ignores the bedrock features in the area). It may be advantageous, in the future, to take into account the hydrogeologic variabilities near the Mint Farm area to refine the Mint Farm Wellfield WHPA time-of-travel zones.

4 Risk Assessment

The proposed Mint Farm Wellfield is located in an industrial area zoned for commercial and industrial properties, some of which use and/or store hazardous chemicals (see Figure 1). Release of these hazardous chemicals potentially could pose a risk to the sand and gravel aquifer in the proposed Mint Farm Wellfield area because the overlying fine-grained sediments, although protective, are not absolutely impermeable. The risk of wellfield contamination is a function of several factors, including

- Thickness and lithology of soils above the aquifer
- Thickness and lithology of the aquifer
- Aerial recharge in the Mint Farm Wellfield WHPA
- The types and quantities of chemicals used at industrial/commercial properties in the WHPA

- The distance between the wellfield and the industrial/commercial properties where chemicals are used
- Extent and status of existing groundwater contamination
- Integrity of well seals in existing wells in the WHPA

As previously stated, the thick sequence of fine-grained materials above the sand and gravel aquifer in the proposed Mint Farm Wellfield tends to reduce the risk of wellfield contamination. However, the types of chemicals used at properties in the Mint Farm Wellfield WHPA (e.g., dense nonaqueous phase liquids at dry cleaners, pesticides at historic farms, etc.) tend to increase the potential risk of well contamination. As such, the risk assessment conducted as part of this environmental review evaluated overall risk to the proposed Mint Farm Wellfield by weighing the factors that tend to reduce the risk of well contamination against the factors that tend to increase the risk of well contamination.

The risk assessment involved three components. First, risk posed to the proposed Mint Farm Wellfield by industrial and commercial operations in the Mint Farm Wellfield WHPA was evaluated with an EPA (1991) priority setting approach (see Section 4.1). Both EPA and the Washington Department of Health (DOH) were contacted to ascertain if more recent risk evaluation methods were available; contacts were unaware of any updated methods. Second, risk posed to the proposed Mint Farm Wellfield by existing groundwater contaminant plumes within 1 mile of the wellfield was assessed (see Section 4.2). Third, risk posed to the proposed Mint Farm Wellfield by existing water wells within 2 miles with inadequate seals and geotechnical borings was evaluated (see Section 4.3). Each component of the risk assessment is discussed separately in the following sections.

4.1 Risk From Industrial and Commercial Operations

Risk from industrial and commercial operations in the Mint Farm Wellfield WHPA was evaluated with EPA's *Managing Ground Water Contamination Sources in Wellhead Protection Areas – A Priority Setting Approach* (EPA, 1991). Because the WinFlow-calculated WHPA does not include other possible pumping centers or aquifer boundaries that would alter groundwater flow near the Mint Farm area, this evaluation is considered a conservative approach to assess the risk of potential contaminant sources (i.e., the WHPA is conservatively large).

The EPA (1991) priority setting approach uses datasheets to classify wellfield hydrogeology and risk categories to better evaluate potential contamination sources. For the purpose of this memorandum, the EPA (1991) priority setting approach is described by four steps:

- **Step 1.** Wellfield geology and hydrogeology are classified on a Wellfield Datasheet.
- **Step 2.** Potential contaminant sources in the WHPA (i.e., commercial and industrial properties where hazardous chemicals are used) are identified and assigned to a risk category (e.g., storage tank, container storage and transfer, landfill, agricultural).
- **Step 3.** The likelihood of release and severity of a release of hazardous chemicals from the potential contaminant sources are evaluated using equations developed by EPA (1991).
- **Step 4.** A risk (i.e., high, medium, or low) is assigned to each potential contamination source based on Step 3, and the risk analysis results are presented.

The following sections discuss implementation of these steps for the proposed Mint Farm Wellfield.

Step 1: Classification of Wellfield Geology and Hydrogeology

The first step in the priority setting approach was to assign numeric values to geologic and hydrogeologic parameters at the proposed Mint Farm Wellfield. Specifically, planning period, depth to aquifer, aquifer thickness, infiltration, unsaturated zone hydraulic conductivity, saturated zone material, and groundwater velocity were assigned numeric values. Because the EPA (1991) approach does not provide an unsaturated zone hydraulic conductivity score for “sandy silt” (the lithology above the sand and gravel aquifer), the unsaturated zone hydraulic conductivity score must be taken from either a “silt” or a “silty sand” (lithologies for which unsaturated zone scores are provided). This risk assessment used “silty sand” for unsaturated zone material instead of “silt.” Using “silty sand” for the unsaturated zone material is a conservative approach because contaminants potentially can travel faster in silty sand than in silt. The effects of using “silty sand” are discussed in the risk assessment results section (see Step 4). Appendix A is the EPA (1991) Wellfield Datasheet, which lists the numeric values for geologic and hydrogeologic parameters. The justification for each numeric value is provided in footnotes on the Wellhead Datasheet.

Step 2: Identification and Classification of Potential Contaminant Sources

The second step in the priority setting approach was to identify and classify potential contaminant sources in the Mint Farm Wellfield WHPA (see Figure 1). As previously discussed, the WHPA was developed using conservative, simplifying assumptions to be more protective of the proposed wellfield. However, these conservative assumptions may be revised in the future as new information becomes available. Potential contaminant sources were identified from:

- Environmental Data Resources (EDR) radius map (EDR, 2007a)
- Historical aerial photos (EDR, 2007b)
- Conversations with Ecology (pers. communication, 2008a, 2008b)
- National Pollution Discharge Elimination System Permits (NPDES) (Ecology, 2008b)
- A file review conducted at the Washington Department of Ecology Southwest Regional Office on February 1, 2008

Potential contaminant sources were classified according to categories developed by EPA (1991). Table 1 shows the identified sites that were assigned to each category.

Specifically, more than 100 sites that use or store hazardous materials were identified by EDR (2007a, 2007b) and interviews with Ecology (pers. comm., 2008a, 2008b). Many of these sites were not included in the risk assessment because the facility was no longer operating, used a minimal quantity of chemicals, had received letters of No Further Remedial Action required from Ecology, or were not located in the Mint Farm Wellfield WHPA. In total, 34 sites were included in the risk assessment, and are shown in Figure 2. The sites were classified into the following categories based on EPA (1991) protocols:

- **Tanks.** This source category includes 12 active underground storage tank (UST) sites and 10 leaking underground storage tank (LUST) sites identified by EDR (2007a). The identified UST and LUST sites stored and/or used petroleum hydrocarbons. For the purpose of risk analysis, UST and LUST sites were grouped by distance from the proposed Mint Farm Wellfield. The grouping resulted in five potential contaminant

sources, as summarized in Table 1. Appendix B is the EPA (1991) Tank Source Datasheet that provides contaminant information and physical characteristics for the grouped UST and LUST sites.

- **Landfills.** This source category includes the Mt. Solo Landfill, which was identified on the Solid Waste Facility/Landfill Sites (SWF/LF) list by EDR (2007a). According to Shaw (2005) and Emcon (1999), groundwater beneath the landfill is contaminated with metals and is undergoing post-closure groundwater monitoring. Appendix C is the EPA (1991) Landfill Source Datasheet that provides contaminant information and physical characteristics of the Mt. Solo Landfill.
- **Container Storage and Material Transfer.** This source category includes 10 potential contaminant sources that store and/or use hazardous material, and were identified on the SQGs/LQGs, CERCLIS, CERCLIS NFRAP, CSCSL, CSCSL NFA, VCP, and ICR lists in EDR (2007a)¹ or from personal communications with Ecology staff (pers. communication, 2008a). Appendix D is the EPA (1991) Container Storage and Material Transfer Source Datasheet that provides contaminant information and physical characteristics for the facilities.
- **Agrichemical.** This source category includes the Mint Farm, which was identified on historical aerial photographs in EDR (2007b). Soil sampling at the nearby Flexible Foam site (GeoEngineers, 1999) indicates that pesticides DDD, DDE, DDT, Dieldrin, and Heptachlor Epoxide were used at the Old Mint Farm. Appendix E is the EPA (1991) Agrichemical Application Source Datasheet that provides contaminant information and physical characteristics for the Old Mint Farm.

After grouping UST and LUST sites by distance, and including landfills, container storage and material transfer, and agricultural operation sites, **17 potential sources of contamination were identified in the Mint Farm Wellfield WHPA.** The EPA source categories and site names corresponding to the 17 potential sources are summarized in Table 1.

¹ SQG = Small Quantity Generator
LQG = Large Quantity Generator
CERCLIS = Comprehensive Environmental Response, Compensation and Liability Information System
CERCLIS NFRAP = CERCLIS No Further Remedial Action Planned
CSCSL = Confirmed and Suspected Contaminated Sites List
CSCSL NFA = CSCSL No Further Action
VCP = Voluntary Cleanup Program
ICR = Independent Cleanup Response

Table 1
 Potential Sources of Contamination
 City of Longview – Proposed Mint Farm Wellfield

EPA Source Category	Site Name (Distance from Proposed Mint Farm Wellfield in parentheses)	Potential Contaminant Source
Tanks (Active)	Arco 5775 (1/2 to 1 mile) Ocean Beach Chevron (1/2 to 1 mile) FM Fuel Stop #185 (1/2 to 1 mile) Washington Way Market (1/2 to 1 mile) Minit Shop Texaco (1/2 to 1 mile) Beachway Gas (1/2 to 1 mile)	Active Tanks ½ to 1 mile
	Westside Shopper (1 to 2 miles) Miller's Market (1 to 2 miles) Mint Valley Golf Course (1 to 2 miles) Safeway Store #1078 (1 to 2 miles) Short Stop Store N Deli (1 to 2 miles) Yoon's Market and Deli (1 to 2 miles)	Active Tanks 1 to 2 miles
Tanks (Leaking)	Longview Fire Department (1/4 to 1/2 mile)	Leaking Tanks ¼ to ½ mile
	Ocean Beach Chevron (1/2 to 1 mile) Shell/Texaco Station (1/2 to 1 mile) Longview Aluminum (1/2 to 1 mile) Washington Way Market (1/2 to 1 mile)	Leaking Tanks ½ to 1 mile
	Arco Wakefield (1 to 2 miles) Miller's Market (1 to 2 miles) Rio West Restaurant (1 to 2 miles) Westside Shopper (1 to 2 miles) Monticello Garage (1 to 2 miles)	Leaking Tanks 1 to 2 miles
Landfill	Mt. Solo Landfill (1 to 2 miles)	Mt. Solo Landfill
Container Storage and Material Transfer	Flexible Foam Products (< 1/8 mile) Longview Auto Wrecking (1/8 to 1/4 mile) US DOE BPA Substation (1/2 to 1 mile) Camera Shop West (1/2 to 1 mile) Cleanery Longview (1/2 to 1 mile) Pollution Industrial and Env. (1/2 to 1 mile) Top Auto (1/2 to 1 mile) All Out Industrial and Env. (1/2 to 1 mile) Solvay Chemicals (1/2 to 1 miles) Weyerhaeuser Longview (1 to 2 miles)	Use or Storage of Hazardous Chemicals
Agrichemical	445-Acre Old Mint Farm (Site)	Historic Chemical Application

Step 3: Likelihood and Severity of Release Calculations

The third step in the priority setting approach was to estimate an overall risk that hazardous materials are released at each potential source of contamination and reach a production well in the proposed Mint Farm Wellfield. The overall risk was estimated through a series of risk assessment calculations developed by EPA (1991) based on information provided on the wellhead datasheet (Appendix A) and source datasheets (Appendices B through E). For a detailed discussion of the risk calculations, see EPA (1991). Only a brief description of the risk calculations is presented in this memorandum.

Specifically, the following values were calculated in Step 3:

- **Toxicity of the contaminant released (T).** T is a contaminant-specific value that is provided by EPA (1991).
- **Quantity of contaminant released (Q).** Q is defined as the sum of the volume score and concentration score at each potential contaminant sources.
- **Likelihood of a release at the site (L_1).** The variables involved in calculating L_1 depend on the source category (i.e., tanks, landfills, container storage and material transfer, or agricultural).
- **Likelihood of a contaminant reaching a well (L_2).** L_2 is the sum of the unsaturated zone likelihood score (L_U) (a function of hydraulic conductivity score, planning period, age of source and unsaturated zone time of travel category) and unsaturated zone likelihood score (L_S) (a function of velocity score and saturated zone time-of-travel category).
- **Attenuation during transport (A).** Attenuation during transport is the sum of the unsaturated zone attenuation (A_U) (a function of hydraulic conductivity score, contaminant persistence, and depth to aquifer score) and saturated zone attenuation (A_S) (a function of saturated zone material, distance score, velocity score, and contaminant persistence).
- **Likelihood of well contamination (L).** The likelihood that the potential contaminant source will contaminate a well is the sum of the likelihood of a contaminant being released at the site (L_1) and the likelihood of the contaminant traveling from the site to the well (L_2).
- **Severity of well contamination (S).** The severity of contamination from the source is calculated from the sum of the quantity of contaminant that could be released from the source (Q), attenuation of the contaminant during transport (A), and toxicity of the contaminant (T).
- **Overall risk.** Overall risk is calculated by summing L and S, and is provided on the Master Scoresheet (Appendix G).

Results of risk calculations are shown on the source datasheets in Appendices B through E (L_1 , T, Q), the transport worksheet in Appendix F (L_2 , A), and the Master Scoresheet in Appendix G (L, S, overall risk).

Step 4: Risk Scoring and Results Presentation

The fourth step in the priority setting approach was to use the overall risk scores calculated in Step 3 to assess risk at each site, and to present the results of the risk analysis. The assessed risk

for each potential contamination source fell into one of three categories: Low (overall risk less than -4.0), medium (overall risk between -4.0 and 0.0), or high (overall risk greater than 0.0), as shown in Table 2.

Table 2
Risk Assessment Results from EPA (1991) Approach
City of Longview – Proposed Mint Farm Wellfield

Site	Overall Risk	Risk Level
Mt. Solo Landfill	-2.2	Medium
Old Mint Farm	-3.4	Medium
Weyerhaeuser Longview	-4.1	Low
Camera Shop West	-7.0	Low
Solvay Chemicals	-7.9	Low
Cleanery Longview	-11.3	Low
Pollution Industrial and Environmental Supply	-18.4	Low
Longview Auto Wrecking	-102.8	Low
All Out Industrial and Environmental	-105.2	Low
US DOE BPA Longview Substation	-105.2	Low
Top Auto, Inc.	-105.2	Low
Leaking Tanks ¼ to ½ Mile	-106.7	Low
Leaking Tanks ½ to 1 Mile	-107.3	Low
Active Tanks ½ to 1 Mile	-107.8	Low
Flexible Foam	-110.2	Low
Leaking Tanks 1 to 2 Mile	-110.3	Low
Active Tanks 1 to 2 Mile	-110.8	Low

Appendix G is the Master Scoresheet, which shows the risk that each potential contaminant source poses to the proposed Mint Farm Wellfield and the location of each site is shown in Figure 2. Based on using the EPA (1991) risk assessment guidelines, the following conclusions are made:

- None of the potential contaminant sources poses a high risk of contamination to the proposed Mint Farm Wellfield.

- Fifteen of the 17 potential contaminant sources pose a low risk of contamination to the proposed Mint Farm Wellfield. However, one of those 15 low-risk potential contaminant sources (i.e., Weyerhaeuser Longview) has an overall risk of - 4.1, which is close to the criterion for being considered a medium risk (i.e., overall risk greater than - 4.0).
- Two of the 17 potential contaminant sources (Mt. Solo Landfill and Mint Farm) pose a medium risk of contamination to the proposed Mint Farm Wellfield.
- The Mt. Solo Landfill presents a medium risk of contamination to the proposed Mint Farm Wellfield because the associated contaminants (i.e., arsenic and iron) are highly mobile, moderately to highly toxic, and moderately to highly persistent. However, the Mt. Solo Landfill is located at the edge of the Mint Farm Wellfield WHPA, which was defined using conservative assumptions (see Figure 2). GSI recommends using a more robust modeling tool and refining the input parameters to better delineate the WHPA. As an example, if the modeling tool is refined by including Mt. Solo (a lower-permeability bedrock high) and/or using a less-conservative, albeit more realistic, groundwater gradient, then the Mt. Solo Landfill no longer may be located within the 10-year time-of-travel WHPA, suggesting that groundwater from beneath the Mt. Solo Landfill would not be captured by the proposed Mint Farm Wellfield. Because iron and arsenic were detected in the test well near the proposed wellfield, the new treatment plant will be designed to remove these metals.
- The Old Mint Farm poses a medium risk of contamination to the proposed Mint Farm Wellfield because of its proximity to the wellfield. However, the pesticides detected in Mint Farm soil (i.e., DDD, DDE, DDT, Dieldrin, and Heptachlor Epoxide) were not detected in shallow groundwater beneath the Mint Farm (GeoEngineers, 1999), which is consistent with the fact that DDD, DDE, DDT, Dieldrin, and Heptachlor Epoxide tend to adsorb to soil particles and are not readily transported to groundwater (CES, 2008; ATSDR, 2008). GSI recommends that the City manage risk from the Mint Farm by removing shallow soil at each production well location before well installation and monitor for pesticides as part of the routine water quality monitoring program.
- Because the Weyerhaeuser Longview site is marginally considered a low risk to the proposed Mint Farm Wellfield, GSI recommends that the City include Weyerhaeuser Longview in its risk management strategy. Risk management for the Weyerhaeuser Longview site is discussed in Section 4.2 below.

It is important to note that the results of the risk assessment summarized in Table 2 are based on the conservative characterization of the unsaturated zone material as silty sand. If the risk assessment was performed with the unsaturated zone material characterized as silt, which is present in the unsaturated zone at the Mint Farm, all risk levels in Table 2 would be categorized as low; including the Mt. Solo Landfill and the Mint Farm.

4.2 Risk From Identified Groundwater Contamination Undergoing Cleanup

The EDR radius map report (EDR, 2007a) lists three sites within 1 mile of the Mint Farm that have identified groundwater contamination and are undergoing cleanup under EPA or Ecology supervision. The EPA (1991) priority setting approach cannot be used to evaluate risk from existing groundwater plumes (except in the case of LUST sites and landfills, which are relatively straightforward). Therefore, risk from existing groundwater plumes was evaluated using best professional judgment instead of the EPA (1991) risk analysis procedure. Weyerhaeuser Longview was evaluated with both the EPA (1991) risk analysis procedure (to account for

currently used hazardous chemicals at the site) *and* professional judgment (to account for existing groundwater contamination).

The three sites with existing groundwater plumes, shown in Figure 3, are:

- **Weyerhaeuser Longview.** The Weyerhaeuser Longview facility is located approximately 1 to 2 miles southeast of the proposed Mint Farm Wellfield. Groundwater contamination at the Weyerhaeuser Longview facility resulted from mercury used in the paper bleaching process from 1958 until 1976 (CH2M HILL, 2004). Mercury has been detected in shallow groundwater at concentrations (1 milligram per liter [mg/L]) well above the EPA maximum contaminant level (MCL) of 0.002 mg/L (CH2M HILL, 1999; EPA, 2003). According to Ecology (2008d), remedial action at the Weyerhaeuser Longview facility is in progress.
- **Reynolds Aluminum.** The Reynolds Aluminum facility, also known as the Longview Aluminum facility and Chinook Ventures facility, is located approximately ½ to 1 mile southwest of the proposed Mint Farm Wellfield. Currently, the facility is being dismantled. According to Ecology staff (pers. comm., 2008b), shallow groundwater at the Reynolds Aluminum facility is contaminated with fluoride and cyanide that leached from spent potliner piles, which were stored in a field east of the facility until the early 1990s (The Daily News, 2004). Free cyanide has been detected in groundwater at concentrations up to 0.336 mg/L (above the EPA MCL of 0.2 mg/L), and fluoride has been detected at concentrations up to 2,470 mg/L (above the EPA MCL of 4.0 mg/L) (Anchor, 2007; EPA, 2003). Currently, the site is undergoing a remedial investigation/feasibility study (RI/FS) under Ecology's supervision.
- **Prudential Steel.** The Prudential Steel facility is located less than ½ mile west of the proposed Mint Farm Wellfield, and is currently the site of the Flexible Foam facility. Prudential Steel manufactured pipe until it closed in 2001. Shallow groundwater at the facility is contaminated with volatile organic compounds (VOC) including naphthalene, toluene, and 1,2,4 trimethylbenzene below Washington State Model Toxics Control Act (MTCA) Method A standards (PNG, 2004). The facility has been issued a letter of No Further Action (Ecology, 2005); however, shallow groundwater contamination remains at the site.

Table 3 summarizes the risk that the Weyerhaeuser Longview, Reynolds Aluminum and Prudential Steel sites pose to the proposed Mint Farm Wellfield. The risk levels presented in Table 3 are based on GSI's professional judgment and the fact that the DOH, Office of Drinking Water, has designated several Chinook Ventures' water supply wells as having a source susceptibility rating of "High." The source susceptibility rating is assigned to water supply sources under the Source Water Assessment Program and provides a measure of how susceptible the drinking water source is to contamination.

Table 3
 Risk From Existing Groundwater Plumes
City of Longview – Proposed Mint Farm Wellfield

Site	Risk Level	Rationale
Weyerhaeuser Longview	High	1. Mercury above MCLs 2. Close to wellfield
Reynolds Aluminum	High	1. Cyanide and fluoride above MCLs 2. Close to wellfield 3. Fluoride is highly mobile
Prudential Steel	Low	1. VOC concentrations are low (below MTCA A) 2. Detected VOCs (i.e., toluene, ethylbenzene, naphthalene) have “low” persistence in EPA (1991) 3. NFA letter awarded by Ecology

NOTES

MCL = Maximum Contaminant Levels
 VOC = Volatile Organic Compounds
 MTCA A = Model Toxics Control Act Method A
 NFA = No Further Action

Currently, the groundwater plumes at these sites appear to migrate away from the proposed Mint Farm Wellfield toward the Columbia River but this movement could be influenced by the operation of existing wells, if they were put into service. The operation of the proposed Mint Farm Wellfield (20 mgd pumping scenario) will reverse groundwater flow in the vicinity of the wellfield. This reversal in groundwater flow direction, particularly on the down gradient or river side of the wellfield, has the potential to induce contaminant plume movement toward the proposed wellfield and potentially affect the drinking water supply. To manage risk from these sites with known groundwater contamination, GSI recommends that the City:

- Monitor the cleanup status of these sites as the proposed Mint Farm Wellfield is developed.
- Communicate with Ecology and/or EPA project managers overseeing cleanup operations to ensure that the remedial action is protective of the proposed Mint Farm Wellfield.
- Inform EPA and Ecology of the City’s intent to develop a 20-mgd wellfield in the Mint Farm area.
- Install shallow and deep sentinel wells between the contaminated sites and the proposed Mint Farm Wellfield and, if possible, instrument the monitoring wells at the contaminated sites with water level monitoring equipment. The sentinel wells would be sampled once or twice per year for early-detection of contaminants from these three sites, and instrumented monitoring wells would be used to determine if wellfield operation creates a hydraulic response at the contaminated site. If the proposed Mint Farm Wellfield creates a hydraulic response at the contaminated site, then the potential exists for the wellfield to capture contaminated groundwater.

4.3 Risk From Inadequate Well Seals

GSI evaluated well seals in water wells, geotechnical borings, and decommissioned wells within 2 miles of the proposed Mint Farm Wellfield to determine whether wells could be conduits that allow contamination in the upper geologic unit (i.e., silt and sandy silt) to be transmitted to the lower water-bearing unit (i.e., gravel). Well construction was considered inadequate if:

- The well seal terminates at a depth of less than 18 ft bgs (as required by the State of Washington).
- The well seal appears defective and the well fully penetrates the upper fine-grained silt and sandy silt and is completed in the sand and gravel aquifer.

Driller's logs for wells within the Mint Farm Wellfield WHPA were obtained from Ecology's Web site (Ecology, 2008c). The search returned 416 driller's logs; the well seals of these logs were evaluated by GSI. Of the 416 driller's logs, 335 had seals more than 18 ft bgs, and are considered to have adequate seals. The 81 wells without adequate seals were less than 50 feet deep, and did not fully penetrate the upper fine-grained silt and sandy silt. The two deepest wells with inadequate seals (St. John Medical Center, 50 feet deep; Mary Palazzo, 36 feet deep) are shown in Figure 3. All other wells without adequate seals were less than 25 feet deep. Because all 81 wells without adequate seals do not fully penetrate the upper fine-grained silt, GSI considers these wells a low risk as a contaminant pathway to the sand and gravel aquifer; it is not necessary for the City to decommission these wells.

5 Wellhead Protection Plan

Because the proposed Mint Farm Wellfield would be the sole-source groundwater supply for a Group A water system, federal regulations require the City to develop a WPP. In Washington, the federal regulations for a WPP are enforced by the DOH.

The purpose of a WPP is to assist in prevention of wellfield contamination, and provide for contingency and emergency response procedures in case a primary source is lost (e.g., because of contamination). In the State of Washington, a WPP must contain the following elements (DOH, 1995):

- **A susceptibility assessment.** The susceptibility assessment can be completed by using information included in this memorandum.
- **A delineated WHPA for the wellfield.** The Mint Farm Wellfield WHPA initially was delineated by GSI (2007) and can be refined.
- **An inventory of all potential sources of contamination within the WHPA.** This memorandum presents the inventory of potential contaminant sources within the WHPA. The inventory may be refined if the WHPA is refined.
- **A contingency plan that provides for a backup source of water should the primary source of water become contaminated.**
- **Coordination with local emergency responders for spill response actions.**

Three of the five elements of a WPP for the proposed Mint Farm wellfield are near-complete or have been completed.

6 Conclusions and Recommendations

GSI makes the following conclusions and recommendations from the results of the environmental review:

- The risk assessment discussed in this memorandum is a conservative approach to evaluating the risk posed to an aquifer by potential contaminant sources. Specifically, the approach did not consider influences of the possible pumping of nearby wells because the City has no control over the operation of nearby wells.
- Based on the results of EPA's risk assessment protocol, most of the 17 potential contaminant sources in the Mint Farm Wellfield WHPA pose only a low risk of wellfield contamination. However, two potential contamination sources (Mt. Solo Landfill and Mint Farm) pose a medium risk of wellfield contamination, and one site (Weyerhaeuser Longview) has an overall risk that is close to being considered "medium." GSI recommends that the City actively manage the risk from these three potential sources of contamination during development of the proposed Mint Farm Wellfield and WPP.
- The medium risk sites (i.e., Mt. Solo Landfill and Mint Farm) and near-medium risk sites (i.e., Weyerhaeuser Longview) can be managed with additional data collection. Mt. Solo Landfill is located on the margin of the Mint Farm Wellfield WHPA. GSI recommends that the WHPA be refined to further evaluate whether the proposed Mint Farm Wellfield is a potential contaminant source. Soil at the Mint Farm is contaminated with pesticides; however, these pesticides have limited mobility, and have not been detected in groundwater beneath the Mint Farm. GSI recommends that the production wells at the proposed Mint Farm Wellfield should be routinely sampled for pesticides and soil should be removed from the well sites before well installation. The Weyerhaeuser Longview site is undergoing groundwater cleanup for mercury contamination, and continued use of chemicals at the facility has the potential to affect the proposed Mint Farm Wellfield. GSI recommends that wells at, or near, the Weyerhaeuser facility be instrumented and sampled as an early-detection system for migration of Weyerhaeuser chemicals toward the proposed Mint Farm Wellfield. A less conservative characterization of the unsaturated materials (i.e., using silt instead of silty sand) assigned in the risk assessment would result in low risk levels for all sites.
- Three groundwater plumes have been identified within 1 mile of the proposed Mint Farm Wellfield (i.e., at Weyerhaeuser Longview, Reynolds Aluminum, and Prudential Steel). Currently, these groundwater plumes are in steady state or flow away from the proposed Mint Farm Wellfield, toward the Columbia River. However, development of a 20-mgd wellfield in the Mint Farm area will influence groundwater flow, and has the potential to induce contaminant plume movement toward the wellfield. GSI recommends installation of sentry wells between the groundwater plumes and the proposed wellfield for early detection purposes, instrumentation of existing monitoring wells at the sites to detect a hydraulic response from wellfield operation, and communication with Ecology to ensure that remedial actions at each site are protective of the proposed wellfield.
- Water wells and/or geotechnical borings without adequate well seals located within 2 miles of the proposed Mint Farm Wellfield were less than 50 feet deep, and did not penetrate the full extent of the upper silt and sandy silt horizon. Therefore, inadequate wells seals pose a low risk of wellfield contamination at the proposed Mint Farm Wellfield.

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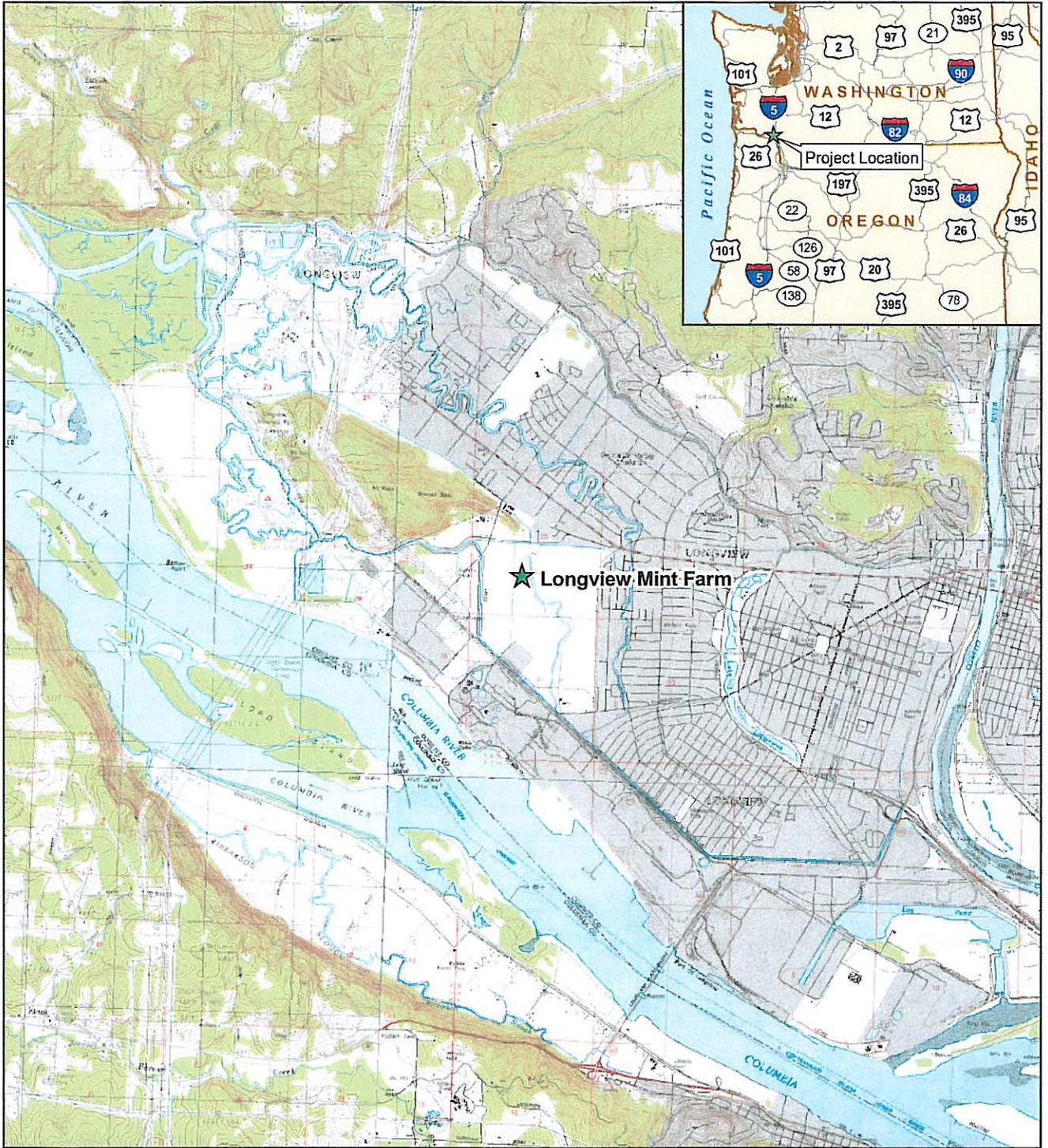
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LEGEND

★ Longview Mint Farm

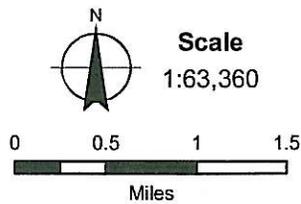


FIGURE 1

Site Location Map

City of Longview

MAP NOTES:
 Projection: Washington State Plane South Zone
 Datum: North American Datum of 1983
 Date: February 8, 2008
 Data Sources: USGS, ESRI



FIGURE 2
Mint Farm Wellhead
Protection Area
 City of Longview

LEGEND

Sites with Active or Leaking Tanks

- 1/4-1/2 Mile, Low
- 1/2-1 Mile, Low
- 1-2 Mile, Low
- Other Sites (Risk Level)

Particle Time of Travel

- 10 year
- 5 year
- 2 year
- 1 year

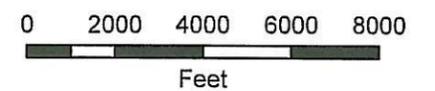
- Bedrock
- Proposed Wells
- Longview Mint Farm
- Freeways and Highways
- Roads
- Waterbodies

- Elevation**
- High : 1350 ft
 - Low : 0 ft

NOTE: Wellhead Protection Area (WHPA) developed by GSI (2007), and is defined as the 10 year particle time of travel.



Scale
 1:48,000



MAP NOTES:
 Projection: Washington State Plane South Zone
 Datum: North American Datum of 1983
 Date: May 5, 2008
 Data Sources: EDR, ESRI, USGS, City of Longview

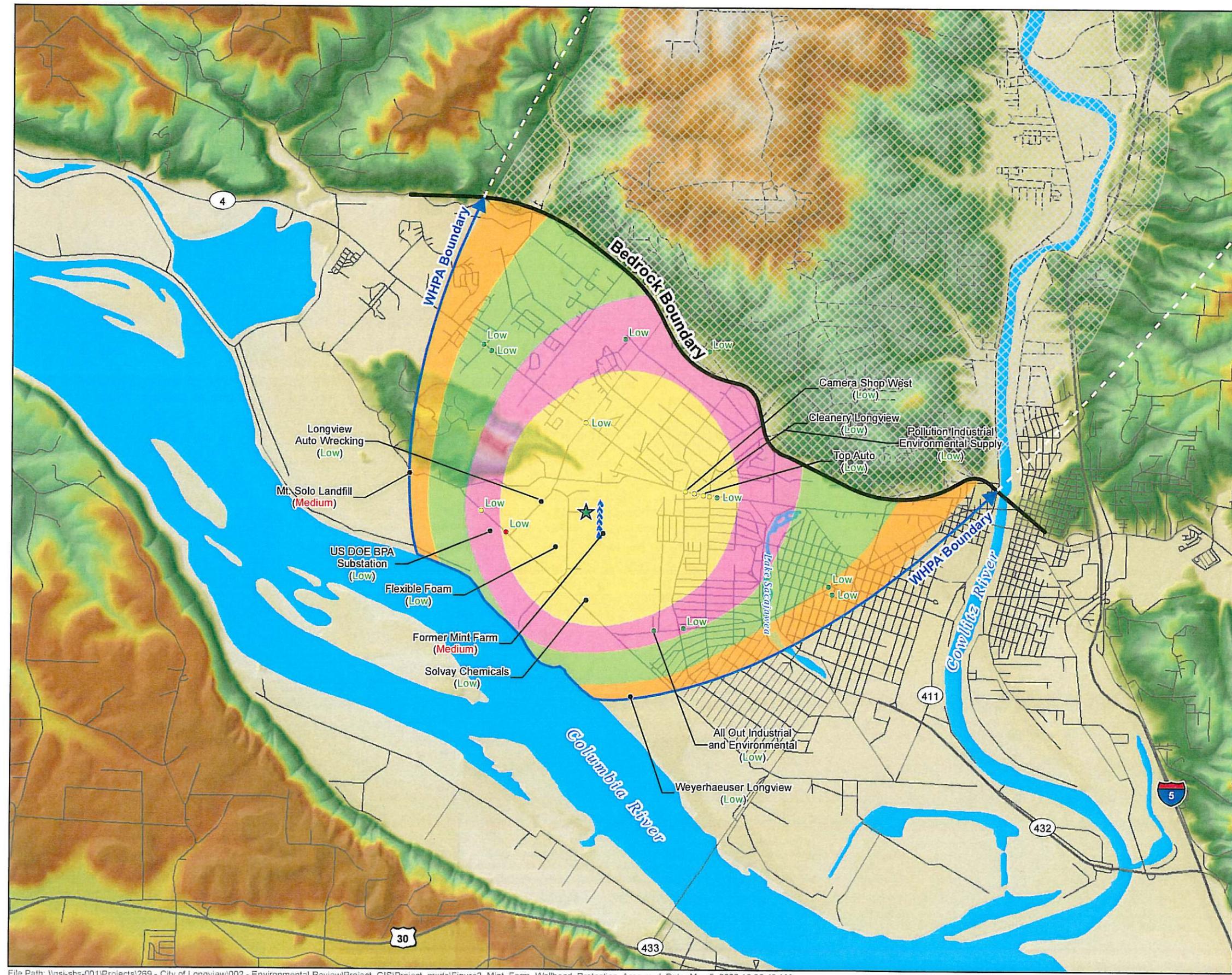
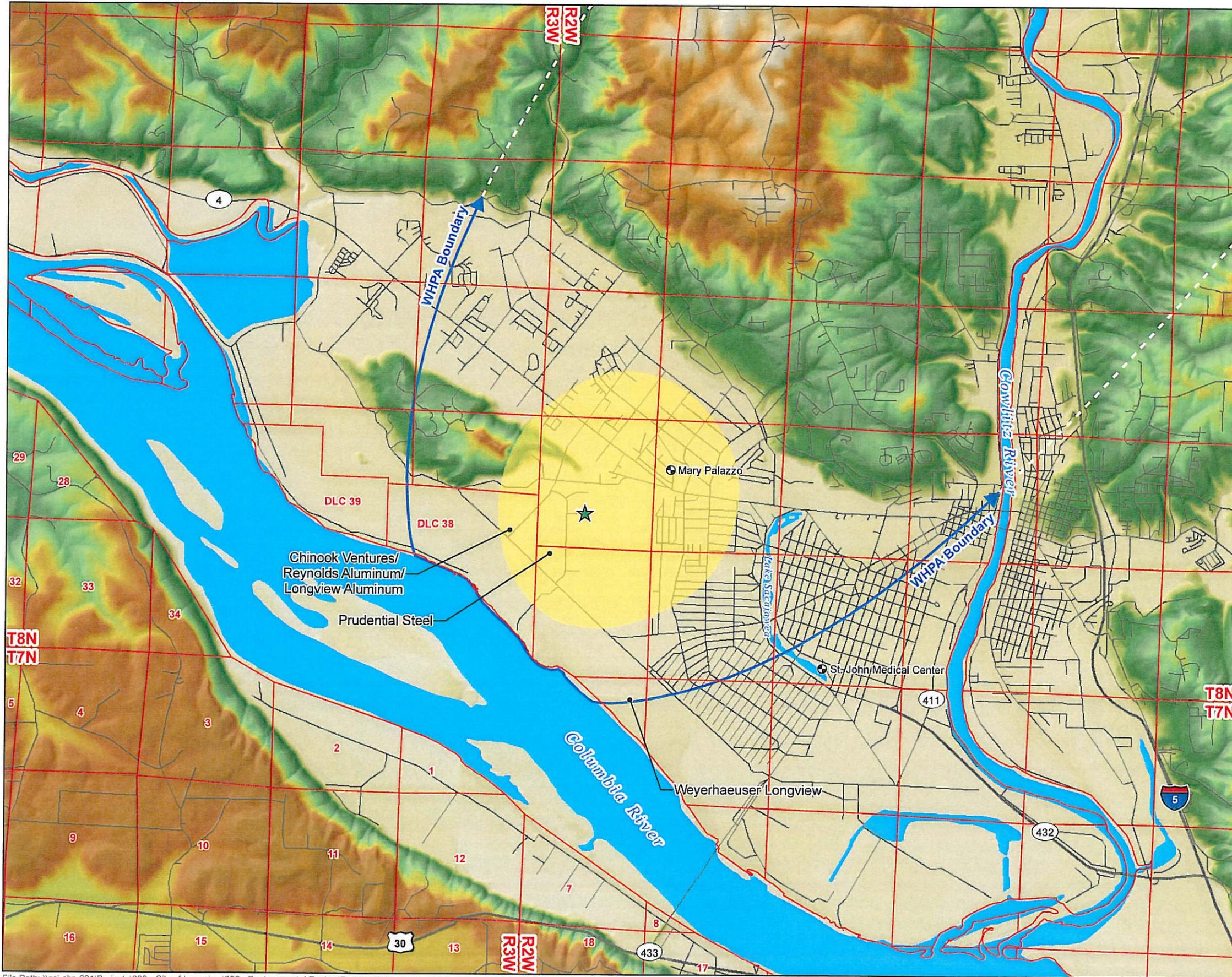


FIGURE 3
Wells with Inadequate Seals and
Sites with Existing Groundwater
Contamination
 City of Longview



LEGEND

- ⊙ Wells with Inadequate Seals
- 1 Year Particle Time of Travel Boundary
- ★ Longview Mint Farm
- ↗ Freeways and Highways
- ↘ Roads
- 🌊 Waterbodies

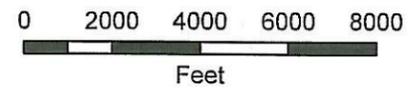
Elevation



NOTE: WHPA = Wellhead Protection Area



Scale
 1:48,000



MAP NOTES:
 Projection: Washington State Plane South Zone
 Datum: North American Datum of 1983
 Date: May 5, 2008
 Data Sources: EDR, ESRI, USGS, Washington Department of Ecology



Appendix A

Wellhead Datasheet

City of Longview - Proposed Mint Farm Wellfield

PARAMETER	PARAMETER ID	SCORE	UNITS
Planning Period	WD1	20	years
Depth to Aquifer Score ¹	WD2	2.2	dimensionless
Aquifer Thickness Score ²	WD3	1.5	dimensionless
Net Infiltration ³	WD4	20	inches
Unsaturated Zone Hydraulic Conductivity Score ⁴	WD5	3	dimensionless
Saturated Zone Material ⁵	WD6	Gravel	dimensionless
Groundwater Velocity Score ⁶	WD7	5	dimensionless

NOTES

- ¹ According to GSI (2007), aquifer depth ranges from 176 ft. bgs at Weyerhaeuser to 310 ft. bgs at the Weber Avenue Test Well
- ² According to Robinson and Noble (2007), aquifer thickness is 58 feet at the Weber Avenue Test Well
- ³ Default value for western Washington state in EPA (1991)
- ⁴ According to Robinson and Noble (2007), unsaturated zone material is sandy silt, which is not an option for the EPA (1991) unsaturated zone hydraulic conductivity score. The score used in this risk assessment is for a silty sand. See text for additional discussion of the unsaturated zone hydraulic conductivity score.
- ⁵ According to Robinson and Noble (2007), saturated zone material is gravel.

Appendix B
Tank Source

City of Longview - Proposed Mini Farm Wellfield

SOURCE DATASHEET								
Source #	Source Name ¹	Location	Number of Tanks (SD1)	Tank Size (SD2) ⁷	Tank Design (SD3) ⁸	Tank Age (SD4) ⁹	Distance Score (SDE)	Discharge to Conduit? (SDE)
2	Active Tanks, 1/2 to 1 mi. ²	1/2 - 1 mi.	20	MEDIUM	5	16.75	4	NO
3	Active Tanks, 1 to 2 mi. ³	1 - 2 mi.	15	MEDIUM	5	14.63	5	NO
4	Leaking Tanks, 1/4 to 1/2 mi. ⁴	1/4 - 1/2 mi.	1	MEDIUM	4	NA	3	NO
5	Leaking Tanks, 1/2 to 1 mi. ⁵	1/2 - 1 mi.	4	MEDIUM	4	NA	4	NO
6	Leaking Tanks, 1 to 2 mi. ⁶	1 - 2 mi.	5	MEDIUM	4	NA	5	NO

CONTAMINANT DATA TABLE (SD7)			
Source #	Contaminant/Mixture Score	Toxicity Score	Persistence Score
2	Benzene	2	L
3	Benzene	2	L
4	Benzene	2	L
5	Benzene	2	L
6	Benzene	2	L

SOURCE WORKSHEET		
L _i	Volume Score	Q
-0.4	0.7	-2
-0.4	0.7	-2
0	0.4	-2.3
0	0.8	-1.9
0	0.8	-1.9

NOTES

- Grouped by similar contaminants and distance from the well.
- Includes Arco 5775 (4 tanks), Ocean Beach Chevron (4 tanks), FM Fuel Stop #185 (3 tanks), Washington Way Market (3 tanks), Xinit Stop Texaco (3 tanks), and Beachway Gas and Grocery (3 tanks).
- Includes Westside Shopper (3 tanks), Miller's Market (3 tanks), Mint Valley Golf Course (1 tank), Short Stop Store and Deli (3 tanks), Yoon's Market and Deli (2 tanks), and Salsway Store #D78 (3 tanks).
- Includes Longview Fire Department (1 tank).
- Ocean Beach Chevron, Shell/Texaco Station, Longview Aluminum, and Washington Way Market.
- Arco Wakefield Property, Westside Shopper, Monticello Garage, Miller's Market, and Rio West Restaurant.
- Small is <5,000 gallons each, Medium is 5,000 - 30,000 gallons each, Large is > 30,000 gallons each. Tank size was provided by EDR (2007a).
- Prior to 1984, 85% of underground storage tanks were bare steel. By 1998, underground storage tanks were required to be cathodically protected (EPA, 2004). According to EDR (2007a), a significant number of tanks were installed prior to 1984 in the study area (i.e., were not required to be cathodically protected), and no active tanks are pre-1984 (i.e., bare steel construction); therefore, tank design score for active tank sites is from a "double-walled steel tank."
- Age or average age of tanks in the group.

Appendix D

Container Storage and Material Transfer Source City of Longview - Proposed Mint Farm Wellfield

SOURCE DATASHEET								
Source #	Source Name	Location	Throughput Score (SD1) ¹	Duration of Storage (SD2)	Storage Area Design (SD3)	Container Storage and/or Material Transfer Age (SD4) ²	Distance Score (SD5)	Discharge to Conduit? (SD6)
7	Cleanery Longview	1/2 - 1 mi.	2	Medium	Unpadded	25	4	No
9	Weyerhaeuser Longview	1/2 - 1 mi.	5	Medium	Padded	54	4	No
10	Camera Shop West	1/2 - 1 mi.	2	Medium	Unpadded	14	4	No
11	All Out Industrial and Environmental	1/2 - 1 mi.	2	Medium	Unpadded	25	4	No
12	US DOE BPA Longview Substation	1/2 - 1 mi.	2	Medium	Unpadded	25	4	No
13	Longview Auto Wrecking	1/8 - 1/4 mi.	2	High	Unpadded	25	2	No
14	Solvey Chemicals	1 - 2 mi.	3	Medium	Unpadded	25	5	No
15	Flexible Foam Products	< 1/8 mi.	1	Medium	Unpadded	7	1	No
17	Pollution Industrial and Environmental Supply	1/2 - 1 mi.	2	Medium	Unpadded	25	4	No
18	Top Auto, Inc.	1/2 - 1 mi.	2	Medium	Unpadded	25	4	No

CONTAMINANT DATA TABLE (SD7)					
Source #	Contaminant/Mixture	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
7	PCE	0.5	-1.3	M	M
	Chloride	2.4	1	H	H
	Zinc	-0.8	0.3	M	H
9	Benzene	2	2	M	L
	Chloroform	1.2	2	H	M
	2,4,6 Trichlorophenol	1.8	0.5	M	M
10	Silver	1	-0.5	M	H
11	Benzene	2	2	M	L
12	Benzene	2	2	M	L
13	Benzene	2	2	M	L
14	Naphthalene	-1.1	2	M	L
	Nitrates	-1.5	1.5	H	M
15	Toluene	-1	-1.3	M	L
17	Organics Mix - Ignitable Wastes	-0.4	2.5	H	L
18	Benzene	2	2	M	L

SOURCE WORKSHEET		
L ₁	Volume Score	Q
-1.6	-0.2	-1.5
-1.4	0.8	1.8
-1.4	0.8	1.1
-1.4	0.8	2.8
-1.4	0.8	2.8
-1.4	0.8	1.3
-1.5	-0.2	-0.7
-1.6	-0.2	1.8
-1.5	-0.2	1.8
-1.3	0.3	2.3
-1.6	-0.2	1.8
-1.2	0.2	1.7
-2.1	-0.7	-2
-1.5	-0.2	2.3
-1.6	-0.2	1.8

NOTES

- Based on the number of 55 gallon drums passing through the facility in 1 year. This number was estimated from generator classification (e.g., SDG or LQG) and references. For a PCE generating 50G (i.e., Cleanery Longview), the maximum number of drums would be approximately 36 drums per year. For a photo processing facility (i.e., Camera Shop West), Ecology (2008a) suggests a maximum of 1,55 gallon drum silver solution per month. For an LQG in excess of 1000 drums per year could pass through the facility.
- If the number of years that containers have been stored is not known, a default age of 25 years was used.

Appendix E
Agrichemical Application Source
City of Longview - Proposed Mint Farm Wellfield

SOURCE DATASHEET						
Source #	Source Name	Location	Age of Source (SD1) ¹ Years	Area of Application (SD2) ² Acres	Distance Score (SD3)	Discharge to Conduit? (SD4)
8	Mint Farm	0 - 1/8 mi	30	431	1	No

CONTAMINANT DATA TABLE (SD5)					
Source #	Contaminant/Mixture Score ³	Toxicity Score	Concentration Score	Mobility Score	Persistence Score
8	Aldicarb - Medium Irrigation	1.3	-0.6	H	M
	Other Pesticides - Corn Crop	-0.1	0.6	M	M
	Other Pesticides - Soybean Crop	-0.2	0.1	M	M

SOURCE WORKSHEET		
L _i	Area Score	Q
0	2.1	1.5
0	2.1	2.7
0	2.1	2.2

NOTES

- Number of years agrichemicals have been applied to the crop land. Aerial photographs indicate that the site of the proposed wellfield was used for agricultural purposes since at least 1970 (EDR, 2007b), and the Mint Farm operations ceased in about 2000 (PB, 2002).
- The area of the Mint Farm from 1970 aerial photo provided by EDR.
- Geoscientists (1999) indicates that pesticides DDD, DDE, DDT, Dieldren and Heptachloroepoxide are present in soil at the Mint Farm. It can be reasonably assumed that the presence of these pesticides is due to historical land use in the Mint Farm area. EPA (1991) does not provide toxicity, mobility, or persistence scores for DDD, DDE, DDT, Dieldren, or heptachloroepoxide; so generic pesticides documented in EPA (1991) (i.e., Aldicarb, other pesticides-corn crop, and other pesticides-soybean crop) were used for this risk assessment.

Appendix F
Transport Worksheet
City of Longview - Proposed Mint Farm Wellfield

Source #	Name	Timeframe ¹ (years)	Contaminant	Hydraulic Conductivity Score	Velocity Score	Unsaturated Zone TOT Category	Saturated Zone TOT Category	Unsaturated Zone Likelihood Score (L _U)	Saturated Zone Likelihood Score (L _S)	Likelihood of Reaching Well (L _r)	Unsaturated Zone Attenuation (A _U)	Saturated Zone Attenuation (A _S)	Attenuation Due to Transport (A)	
1	Mt. Solo Landfill	47	Arsenic	3	5	B	A	0	0	0	0	-6.9	-6.9	
			Iron	2	4	D	A	-0.9	0	0	0	-4.9	-4.9	
			Manganese	3	5	B	A	0	0	0	0	0	-6.9	-6.9
			Cadmium	2	4	D	A	0.9	0	-0.9	0	-0.1	-4.9	-4.9
			Mercury	2	4	D	A	-0.9	0	-0.9	0	-0.9	-4.9	-4.9
2	Active Tanks 1/2 to 1 Mile Distant	36.75	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-6.5	-106.5	
3	Active Tanks 1 to 2 Mile Distant	34.63	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-9.5	-109.5	
4	Leaking Tanks 1/4 to 1/2 Mile Distant	20	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-5.5	-105.5	
5	Leaking Tanks 1/2 to 1 Mile Distant	20	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-6.5	-106.5	
6	Leaking Tanks 1 to 2 Mile Distant	20	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-9.5	-109.5	
7	Cleanery Longview	45	PCE	2	4	D	A	-0.9	0	-0.9	-3.1	-4.7	-7.8	
8	Mint Farm	50	Aldicarb - Medium Irrigation	3	5	B	A	0	0	0	0	-6.2	-6.2	
			Other Pesticides - Corn Crop	2	4	D	A	-0.9	0	-0.9	0	-0.9	-4.2	-4.2
			Other Pesticides - Soybean Crop	2	4	D	A	-0.9	0	-0.9	0	-0.9	-4.2	-4.2
			Chloride	3	5	B	A	0	0	0	0	0	-6.7	-6.7
			Zinc	2	4	D	A	-0.9	0	-0.9	0	-0.9	-4.7	-4.7
9	Weyerhaeuser Longview	74	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-6.5	-106.5	
			Chloroform	3	5	B	A	0	0	0	0	0	-6.7	-6.7
			2,4,6 Trichlorophenol	2	4	D	A	-0.9	0	-0.9	0	-0.9	-4.7	-4.7
			Silver	2	4	D	A	-0.9	0	-0.9	0	-0.9	-4.7	-4.7
			Benzene	2	4	D	A	-0.9	0	-0.9	0	-0.9	-6.5	-6.5
11	All Out Industrial and Environmental	45	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-6.5	-106.5	
12	US DOE BPA Longview Substation	45	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-6.5	-106.5	
13	Longview Auto Wrecking	45	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-4.9	-104.9	
14	Solvay Chemicals	45	Naphthalene	2	4	D	A	-0.9	0	-0.9	-100	-9.5	-109.5	
			Nitrates	3	5	B	A	0	0	0	0	0	-6.9	-6.9
15	Flexible Foam	27	Toluene	2	4	D	A	-0.9	0	-0.9	-100	-4.2	-104.2	

Appendix F
Transport Worksheet
City of Longview - Proposed Mint Farm Wellfield

Source #	Name	Timeframe ¹ (years)	Contaminant	Hydraulic Conductivity Score	Velocity Score	Unsaturated Zone TOT Category	Saturated Zone TOT Category	Unsaturated Zone Likelihood Score (L _u)	Saturated Zone Likelihood Score (L _s)	Likelihood of Reaching Well (L _w)	Unsaturated Zone Attenuation (A _u)	Saturated Zone Attenuation (A _s)	Attenuation Due to Transport (A)
16	Pollution Industrial and Environmental Supply	45	Organics Mix - Ignitable Wastes	3	5	B	A	0	0	0	-12	-6.7	-18.7
17	Top Auto, Inc.	45	Benzene	2	4	D	A	-0.9	0	-0.9	-100	-6.5	-106.5

NOTES

TOT = Time of Travel

Appendix G
Master Scoresheet
City of Longview - Proposed Mint Farm Wellfield

BLOCK I			BLOCK II										BLOCK III							
IDENTIFY SOURCES			SOURCE ELEMENTS					TRANSPORT ELEMENTS					ESTIMATE RISKS AND RANK SOURCES							
ID	Category	Name	L ₁	Q	T	L ₂	L ₃	A	L ₁	Q	T	L ₂	L ₃	A	L	S	Risk	Overall Risk	Risk Level	
1	Landfill	Mt. Solo Landfill																		
			Asenic	0.2	3.7	0	0	-6.9												
			Iron	3.7	0.5	-0.9	-5													
			Manganese	1.95	-0.8	0	-6.9													
			Cadmium	1.4	1.4	-0.9	-5													
			Mercury	1.4	1.4	-0.9	-5													
2	Tanks	Active Tanks 1/2 to 1 Mile Distant																		
			Benzene	-0.4	-2	2	-106.5													
3	Tanks	Active Tanks 1 to 2 Mile Distant																		
			Benzene	-0.4	-2	2	-109.5													
4	Tanks	Leaking Tanks 1/4 to 1/2 Mile Distant																		
			Benzene	0	-2.3	2	-105.5													
5	Tanks	Leaking Tanks 1/2 to 1 Mile Distant																		
			Benzene	0	-1.9	2	-106.5													
6	Tanks	Leaking Tanks 1 to 2 Mile Distant																		
			Benzene	0	-1.9	2	-109.5													
7	Container Storage	Cleanery Longview																		
			PCE	-1.6	-1.5	0.5	-7.8													
8	Agricultural Application	Mint Farm																		
			Aldicarb - Medium Irrigation	0	1.5	1.3	-6.2													
			Other Pesticides - Corn Crop	0	2.7	-0.1	-7.3													
			Other Pesticides - Soybean Crop	0	2.2	-0.2	-7.3													
9	Container Storage	Weyerhaeuser Longview																		
			Chloride	-1.4	1.8	-2.4	-6.7													
			Zinc	-1.4	1.1	-0.8	-4.8													
			Benzene	-1.4	2.8	2	-106.5													
			Chloroform 2,4,6	-1.4	2.8	1.2	-6.7													
			Trichlorophenol	-1.4	1.3	1.8	-7.8													
10	Container Storage	Camera Shop West																		
			Silver	-1.6	-0.7	1	-4.8													

