PACIFIC groundwater GROUP

CITY OF BATTLE GROUND
WELLHEAD PROTECTION PLAN
2012 UPDATE

March, 2013

CITY OF BATTLE GROUND
WELLHEAD PROTECTION PLAN
2012 UPDATE

Prepared for:

City of Battle Ground
109 SW 1st ST, STE 122
Battle Ground, WA 98604
http://www.cityofbg.org/

Prepared by:

Pacific Groundwater Group
2377 Eastlake Avenue East, Suite 200
Seattle, Washington 98102
206.329.0141
www.pgwg.com

March 18, 2013
JM9904.15
BG WHP 2012 Final.doc

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1

1.1 FINDINGS 1
1.1.1 Hydrogeology and Existing Water Quality 1
1.1.2 Wellhead Protection Area Delineations 2
1.1.3 Contaminant Inventory 2
1.1.4 Source-Loss Analysis 3
1.2 RECOMMENDATIONS 3
1.2.1 Public Education and Technical Assistance 3
1.2.2 Contaminant Source Management 3
1.2.3 Monitoring and Data Management 3
1.2.4 Land Use and Regulatory Controls 3
1.2.5 Regional Coordination 3
1.2.6 Planning Strategies 4

2.0 INTRODUCTION 5

2.1 SCOPE 5
2.2 STUDY AREA PHYSIOGRAPHIC FEATURES 6
2.3 CLIMATE 6
2.4 WATER-SUPPLY SOURCES 6

3.0 HYDROGEOLOGIC FRAMEWORK 7

3.1 RECENT ALLUVIAL DEPOSITS 7
3.2 PLEISTOCENE ALLUVIAL DEPOSITS 8
3.3 BORING LAVA 8
3.4 TROUTDALE FORMATION 8
3.4.1 Upper Troutdale 8
3.4.2 Upper Confining Unit 9
3.4.3 Lower Troutdale 9
3.4.4 Lower Confining Unit 9
3.4.5 Sand and Gravel (SGA) 9
3.5 UNDIFFERENTIATED FINE-GRAINED UNIT 9
3.6 BEDROCK 10
3.7 GROUNDWATER FLOW 10

4.0 WATER QUALITY 11

4.1 SAMPLING FREQUENCIES 11
4.2 EXCEEDANCES 11
4.2.1 Iron and Mangenese 11
4.2.2 Volatile Organic Compounds 11

5.0 WELLHEAD PROTECTION AREA DELINEATIONS 13

5.1 CAPTURE ZONE ANALYSIS METHODS 13
5.2 CAPTURE ZONE DELINEATIONS 14

6.0 RISK ASSESSMENT 15

6.1 LAND-USE DATABASE & WINDSHIELD SURVEY 15
6.2 FACILITY/SITE DATABASE 16
6.3 OTHER POTENTIAL SOURCES 18

7.0 CONTINGENCY PLANNING 20

7.1 ANALYSIS OF SYSTEM CAPACITY, WATER RIGHTS, AND SOURCE LOSS 20
7.1.2 Source-Loss Analysis 21
7.2 OPTIONS FOR INCREASED CAPACITY UNDER EXISTING WATER RIGHTS 22
7.3 EMERGENCY PROCEDURES FOR LOSS OF A SOURCE 22
7.3.1 Emergency Notification Procedures 23
7.3.2 City's Chain-of-Command for Spill Response 23
7.3.3 External Emergency Notification 23
7.4 EMERGENCY PHONE NUMBERS 23

8.0 SPILL RESPONSE PLANNING 25

8.1 RESPONSIBILITIES FOR SPILL PREVENTION AND RESPONSE 25
8.1.1 The Responsible Party 25
8.1.2 Environmental Protection Agency 25
8.1.3 Department of Ecology 25
8.1.4 State Patrol 25
8.1.5 Emergency Management Division of the Washington Military Department 25
8.1.6 Local Emergency Planning and Emergency Management 26
8.2 SPILL ASSESSMENT AND RESPONSE PROCEDURES ON CITY PROPERTY 26
8.3 SPILL CONTAINMENT/CLEANUP PROCEDURES ON CITY PROPERTY 26
8.4 INSPECTIONS AND RECORDS 27
8.5 TRAINING 27

9.0 IMPLEMENTATION STRATEGIES 28

9.1 PUBLIC EDUCATION/TECHNICAL ASSISTANCE STRATEGIES 28
9.2 CONTAMINANT SOURCE MANAGEMENT STRATEGIES 28
9.3 MONITORING AND DATA MANAGEMENT STRATEGIES 29
9.4 LAND-USE CONTROLS AND REGULATION STRATEGIES 29
9.5 REGIONAL COORDINATION STRATEGIES 29
9.6 PLANNING STRATEGIES 30

REFERENCES 31

TABLES

Table 1: Summary of Source Capacity and Water Rights
Table 2: Battle Ground Water Supply Wells
Table 3: Battle Ground Interties
Table 4: Parcels of Concern
Table 5: Environmental Sites Identified from the Facility/Site Database
Table 6: Supplemental Information Regarding Cleanup Sites
Table 7: City's Chain of Command for Spill Response

FIGURES

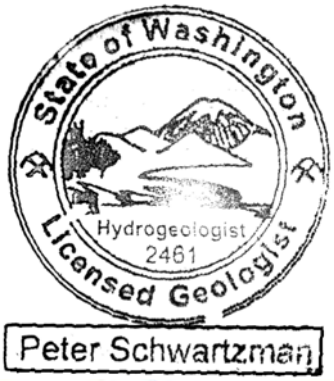
Figure 1: Map of Study Area Showing Battle Ground Supply Wells, Surficial Geology, Cross-Section Alignment and Groundwater Flow Patterns
Figure 2: Hydrogeologic Profile A-A'
Figure 3: Calculated Capture Zones
Figure 4: Buffered Capture Zones and Parcels of Concern
Figure 5: Buffered Capture Zones and Environmental Sites
Figure 6: Source Loss Analysis

APPENDICES

Appendix A: Documentation of Notifications

SIGNATURE

This report, and Pacific Groundwater Group's work contributing to this report, were reviewed by the undersigned and approved for release.



Peter Schwartzman
Principal Hydrogeologist
Washington State Hydrogeologist #2461

Dan Matlock
Principal Hydrogeologist
Washington State Hydrogeologist #714

1.0 EXECUTIVE SUMMARY

The City of Battle Ground has updated its wellhead protection plan (WHPP), which was originally issued in 2000. The purpose of the plan is to help prevent the City's groundwater supply sources from becoming contaminated, and to develop contingency and emergency response procedures in case one or more sources is lost because of contamination. The plan meets the requirements of Washington Administrative Code (WAC) 246-290-135(3). Work for this project included:

- Characterizing the hydrogeology of the Battle Ground area to identify aquifers that supply water to the City's wells and aquitards that protect water supplies from near-surface contamination;
- Updating groundwater quality characterization for the City's supply wells based on data managed by Washington Department of Health (WDOH);
- Updating delineation of wellhead protection area (WHPA) capture zones for select supply wells. WHPA capture zones were previously defined for some wells by the Clark County Water Quality Division;
- Updating inventories of confirmed and potential sources of contamination, particularly those that lie within the wellhead capture zones, and evaluating the risks associated with these sources;
- Updating contingency planning for provision of water supplies in case one or more wells are impacted by contamination and emergency response planning for spills that might affect the well sources; and,
- Updating implementation strategies to educate the public and manage the contaminant sources in the Battle Ground area.

The findings and recommendations of this work are discussed below.

1.1 FINDINGS

The City of Battle Ground currently owns eight wells that supply water to the municipality. Four of these (Wells 1, 2, 4, and 5) produce water from a shallow aquifer and four (Wells 6, 7, 8 and 9) produce water from a deeper aquifer. Groundwater withdrawals from the deep wells are emphasized because their yields are significantly higher than those of the shallow wells. In addition, the City also obtains backup supplies from an intertie with Clark Public Utilities (CPU). Intertie capacity will be increasing over the next 20 years.

1.1.1 Hydrogeology and Existing Water Quality

The major hydrogeologic units in the area include sediments deposited by modern rivers and by the ancient Columbia River. The Upper Troutdale and Sand and Gravel Aquifer (SGA) form the primary aquifers in the region. The SGA, a deep aquifer, is overlain by the fine-grained sediments of the Lower Confining Unit and, in some areas, the Upper Confining Unit. These two aquitards limit the movement of contaminants to the SGA from the surface and overlying aquifers. Consequently, wells completed in this unit are better protected from the threat of contamination.

Groundwater flows in the shallow Upper Troutdale Aquifer (QTu) is to the west-southwest in the study area, which covers 41 square miles surrounding Battle Ground. Groundwater discharges to features such as Salmon Creek and the East Fork of the Lewis River after traveling laterally from the upland areas, where much of the recharge occurs. The Columbia River serves as a primary discharge point for the deeper SGA system.

In general, the quality of groundwater from the City wells is good. In 1998, a few volatile organic compounds (VOCs) were detected in Wells 1 and 2, which are completed in the QTu. However, concentrations were well below drinking-water standards, and these compounds have not been detected in recent analyses. These historical detections may have been related to nearby contaminant sources along Main Street. The City monitors VOCs in these wells annually and biannually in all other wells.

In addition, iron and manganese exceedences have been noted in all of the City's wells, as is common for many areas of Clark County. Iron and manganese concentrations in the City's deeper (SGA) wells are sufficiently high to require treatment. Although these constituents do not threaten public health, they exceed secondary Maximum Contaminant Levels, which are based on aesthetic considerations.

1.1.2 Wellhead Protection Area Delineations

WHPA capture-zone delineations were prepared by Clark County and Pacific Groundwater Group for the City's wells. These delineations represent the extent of the capture zone for each well under average pumping conditions. Capture zones were defined for 0.5, 1, 5 and 10 year travel times within the groundwater flow system. The capture zones are represented in two-dimensions, and additional travel time is required for contaminants to travel from the land surface to the production aquifer, particularly for the City's SGA wells. PGG connected the capture zones for multiple wells to define "extended capture zones" and defined a 1000-foot buffer around the 10-year capture zone to compensate for possible inaccuracies in the locations of sites of potential groundwater contamination.

1.1.3 Contaminant Inventory

A range of potential contaminant sources was inventoried using a Geographic Information Systems (GIS) approach. Potential sources associated with land-use activities and septic system locations were identified based on data from Clark County, and potential sources associated with environmental sites and facilities using/storing hazardous materials were identified based on data from Washington Department of Ecology (Ecology). City staff also performed a windshield survey to identify possible activities on "parcels of concern" where land-use categories could include potential sources of contamination.

PGG ranked the priority of land-use parcels of concern based on contamination potential. The highest ranked parcels were associated with facilities with gasoline pumps and tanks, dry cleaners, car washes and auto parts dealers. Other facilities that could potentially contaminate groundwater but were outside the 5-year capture zone (e.g. car repair, gasoline pumps, etc) were assigned lower priorities. A few septic systems lie within the 1- and 5-year extended capture zones for the SGA wells. These septic systems should not pose a significant risk to these deep groundwater sources.

Ecology's database showed the occurrence of state cleanup sites under the State Model Toxics Control Act (MTCA), hazardous waste generators, underground storage tanks and leaky underground storage tanks (USTs and LUSTs), dairies, enforcement sites and stormwater generating operations within the capture zones. Within the capture zones there are 14 cleanup sites, 11 sites associated with hazardous materials, 14 sites associated with UST, 10 sites associated with LUST, and 1 stormwater site. PGG ranked cleanup sites as highest concern. Among the 14 cleanup sites, 3 are reported as requiring no further action and 2 are reported as cleaned up under MTCA, and 3 are located within defined 1-year capture zones.

Other potential sources of contamination include transportation-related spills along SR-502 and SR-503, and unused and improperly constructed wells.

The City will notify all owners/occupants of parcels and sites of concern that they are within WHPA capture zones and will notify the agencies regulating these parcels/sites of the potential contaminant inventory. Per WDOH wellhead protection guidance, the City should update its contaminant inventory every 2 years.

1.1.4 Source-Loss Analysis

A source-loss analysis completed for the Battle Ground wells indicates that the City has the ability to manage both short and long-term losses to the system. The system would be most impacted if Wells 7, 8 or 9 were taken off line, since they are the City's primary sources. Loss of these sources during high water demand months could lead to short-term rationing to achieve demand reductions of up to 23 percent, while the City either corrects an equipment failure or drills an additional well.

1.2 RECOMMENDATIONS

The following recommendations are based on the results of work completed for wellhead protection planning. These implementation strategies focus on public education, contaminant source management, monitoring, data management, and land use and regulatory controls. Wellhead protection can also be effected by coordination with other regional agencies and by emergency response and contingency planning, as discussed below.

1.2.1 Public Education and Technical Assistance

Strategies for public education include: increasing awareness and providing technical assistance for entities using hazardous materials within WHPAs, developing school programs and other educational materials for City residents (e.g. Annual Water Quality Report).

1.2.2 Contaminant Source Management

Businesses within designated WHPAs should be inventoried every two years to assess potential contaminant sources and waste handling practices. USTs that were not identified through this study should also be inventoried, including residential home heating oil USTs. Other strategies for managing possible contaminant sources include: encouraging Ecology to expedite cleanup actions; encouraging inspection of hazardous waste generators; reviewing stormwater management practices to identify areas of concern for groundwater quality; and encouraging residents to connect to sewer systems where possible. The City should request and/or encourage the cooperation of agencies such as Ecology and the Southwest Washington Health Department (SWWHD).

1.2.3 Monitoring and Data Management

Water-quality and other data that could assist in wellhead protection should be collected via cooperative programs with Clark County, CPU, and SWWHD and reviewed. These data should then be integrated into a database management system.

In addition to continuing with annual sampling for VOCs in Wells 1 and 2, the City may want to identify domestic wells for additional monitoring in high-risk areas.

1.2.4 Land Use and Regulatory Controls

Strategies related to land-use and regulatory controls include encouraging and supporting County ordinances related to wellhead protection and water quality, including Clark County's Critical Aquifer Recharge Areas (CARA) ordinance (Chapter 13.70) and Clark County's Water Quality ordinance (Chapter 13.26A).

1.2.5 Regional Coordination

The City should continue to communicate with other purveyors in Clark County to coordinate WHP planning activities and water-supply planning and development issues such as contingency planning and expansion of interties.

1.2.6 Planning Strategies

Developing strategies for emergency response and contingency planning is essential to wellhead protection. Such strategies include notifying emergency response organizations on the location of WHPAs, establishing communication protocols with first-responders, and preparing a contingency plan that covers short- and long-term responses if one or more sources are lost.

Given that source-loss analysis indicates that there will be times over the next 20 years when existing interties are insufficient to offset impacts to total system capacity if certain well sources are lost, the City may want to consider planning for installation/development of backup wells. Should backup wells be constructed, we recommend targeting the (deep) SGA aquifer due to its greater degree of inherent protection from contamination introduced to the land surface, its consistently higher well yield, and because current capacity is 300 gpm less than existing water-right allocations

2.0 INTRODUCTION

This document provides an update to the City of Battle Ground's Wellhead Protection Plan (WHPP) which was prepared in 2000 (PGG, 2000). The updated WHPP has been prepared to meet requirements of Washington Administrative Code (WAC) 246-290-135, which mandates that purveyors of water systems using groundwater sources shall develop and implement a wellhead protection program. The goal of such a program is to prevent these sources from becoming contaminated. This updated WHPP was prepared according to the Washington State Department of Health's Wellhead Protection Program Guidance Document (WDOH, 2010). The WHPP must contain, at a minimum, the following elements:

- Wellhead capture zone delineations for the 6-month, 1-, 5-, and 10-year times-of-travel for each water-supply source based on a WDOH-approved method;
- An inventory of known and potential contaminant sources ranked for groundwater contamination hazard;
- Documentation that the City has notified owners and operators of known and potential contaminant sources/sites, as well as the regulatory agencies and local governments that regulate these sources/sites;
- Contingency plans for alternative sources of drinking water if any of the primary sources become threatened;
- Documentation that the City has coordinated with emergency spill responders regarding WHP areas, the contingency plans, and other results of this WHP investigation

2.1 SCOPE

This report covers wellhead protection measures for Wells 1, 2, 4, 5, 6, 7, 8 and 9, which supply water for the City of Battle Ground. Work for this WHP assessment included:

- Characterizing the hydrogeology of the Battle Ground area to identify aquifers that supply water to the City's wells and aquitards that protect water supplies from near-surface contamination;
- Updating groundwater quality characterization for the City's supply wells based on data managed by Washington Department of Health (WDOH);
- Updating delineation of wellhead protection area (WHPA) capture zones for select supply wells. WHPA capture zones were previously defined for some wells by the Clark County Water Quality Division;
- Updating inventories of confirmed and potential sources of contamination, particularly those that lie within the wellhead capture zones, and evaluating the risks associated with these sources;
- Updating contingency planning for provision of water supplies in case one or more wells are impacted by contamination and emergency response planning for spills that might affect the well sources; and,
- Updating implementation strategies to educate the public and manage the contaminant sources in the Battle Ground area.

In accordance with WDOH requirements, the City of Battle Ground has completed and submitted wellhead susceptibility forms for all its water supply sources. Some of these forms will be updated in the near future.

2.2 STUDY AREA PHYSIOGRAPHIC FEATURES

The WHP study area is shown on **Figure 1**. It covers about 39 square miles surrounding the City of Battle Ground. The northern portion of the study area lies within the East Fork Lewis River basin and the southern portion lies within the Salmon Creek basin. The major population center is concentrated in Sections 34 and 35 of T.3 N., R.2 E., and Sections 1 and 2 of T.3 N., R.2 E. The study area extends as far south as the community of Meadow Glade.

The central part of the study area slopes gently to the southwest and ranges in elevation from about 260 to 310 feet above mean sea level (msl). Tukes Mountain lies directly to the northeast of the City and attains an elevation of more than 620 feet. Woodin (Weaver) Creek, a tributary of Salmon Creek, is the principal surface-water drainage in the Battle Ground area; its headwaters lie in the northern part of the City. The upper reaches of Mill Creek drain the western portion of the study area.

2.3 CLIMATE

Battle Ground lies in the central portion of Clark County, which has a marine warm-temperate climate, with relatively warm, dry summers, and typically mild, rainy winters. Approximately 75 percent of the total annual precipitation occurs from October through March; the remaining 25 percent occurs from April through September (Mundorff, 1964). Average annual precipitation at Battle Ground was about 52.6 inches for the 30-year period from 1981 through 2010 (http://www.wrcc.dri.edu).

2.4 WATER-SUPPLY SOURCES

The City of Battle Ground depends entirely on groundwater to meet the water demands of approximately 16,710 residential customers and 2,500 non-residential customers at 5,923 connections. Groundwater is withdrawn at an average rate of about 945 gpm (1.36 mgd) from eight water-supply wells based on historic 2004-2011 water use, and the rated capacity of these sources totals 1,660 gpm (2.39 mgd) (**Table 1**). The locations of these supply wells are shown on **Figure 1**. Construction details and other pertinent data for Wells 1, 2, 4, 5, 6, 7, 8, and 9 are presented on **Table 2**.

Wells 1, 2, 4, and 5, the "shallow wells", are less than 150 feet deep. These wells were constructed in the 1950s and 1970s and have limited capacities — less than 200 gpm. Wells 6, 7, 8 and 9, the "deep wells", were constructed between 1995 and 2004 and range from 299 to 438 feet deep. Original testing of the wells showed capacities ranging from 350 to 1000 gpm; however, current well capacities are somewhat lower due to partial clogging of the well screens with iron bacteria. The original well capacity estimates are summarized on **Table 2** whereas current operational capacities are summarized on **Table 1**.

Wells 7, 8 and 9 have the largest capacities and are used the most extensively. In addition to their production wells, the City of Battle Ground obtains water for peaking from a 500-gpm capacity intertie with Clark Public Utilities (CPU). The intertie also functions as an emergency source. The City is developing a new intertie with CPU that will replace the current intertie in 2013 and will have an initial capacity of 1,000 gpm. Improvements to this new intertie are available that would increase its capacity to 1,750 gpm (slated for 2017) and ultimately to 3,000 gpm (estimated for 2021). A summary of the City's interties is presented on **Table 3**.

3.0 HYDROGEOLOGIC FRAMEWORK

The regional geology of Clark County is commonly divided into older rocks and younger sediments (which are semiconsolidated or unconsolidated). The older rocks crop out in the foothills and mountains in the north and east portions of the County but occur at depths greater than 600 feet in the Battle Ground area. The sediments crop out on the terraces and plains that cover most of the study area and contain the principal aquifers. The sedimentary units, from youngest to oldest, consist of:

- Recent alluvial deposits
- Pleistocene alluvial deposits
- Troutdale formation

These units are described below and shown on Hydrogeologic Cross Section A-A′ (**Figure 2**). Surface outcrops for these units are shown on **Figure 1**, along with the location of the cross section. In addition to the sedimentary and older bedrock units, the Boring lava, a relatively young bedrock unit, crops out near Battle Ground.

All of the coarse-grained sedimentary units described below form the prevalent aquifers beneath Clark County.

3.1 RECENT ALLUVIAL DEPOSITS

Alluvial deposits occur in the study area along the rivers and streams. They include:

- Alluvial fans
- Terrace deposits
- Recent alluvium

The alluvial fans, terraces, and basin-fill deposits were deposited by tributaries of the Columbia River, which include the east Fork of the Lewis River and Salmon Creek. These sediments interfinger with the Pleistocene alluvium of the ancestral Columbia River.

The alluvial fans are coarse and gravelly in the terraces and at their apexes, but grade to fine sands and silts at their margins. One of the largest fans in Clark County occurs near Battle Ground.

Terraces occur along the stream channels upstream of the fans. The terraces north of Battle Ground along the East Fork of the Lewis River are generally much coarser than the alluvial fans, comprising very coarse gravel in a sandy matrix.

Within the Battle Ground study area, the Recent alluvium is confined to the floodplains of the East Fork of the Lewis River and Salmon Creek. It forms a thin veneer over the Troutdale formation and Pleistocene alluvial deposits. The alluvium typically consists of coarse sand and gravel along the lower portions of Salmon Creek and the East Fork of the Lewis River.

The Recent Alluvium contains a shallow, highly productive aquifer along streams such as the East Fork of the Lewis River and communicates hydraulically with these streams. Well yields from the aquifer can be relatively high, ranging between 500 and 1,000 gpm, although this aquifer is not a major supply source near Battle Ground.

3.2 PLEISTOCENE ALLUVIAL DEPOSITS

During Pleistocene time, the ancestral Columbia River deposited a great deltaic fan emanating from the Gorge because of a series of catastrophic events known as the "Missoula floods." The resulting alluvium is exposed on broad plains and terraces in the southwestern part of Clark County. It crops out in the southern third of the study area. The deposits are only 20 to 40 feet thick in the Battle Ground area, where they comprise primarily silt and clay according to local driller's logs.

The Pleistocene alluvial deposits form a highly permeable, productive aquifer in the southern part of Clark County, yielding more than 1,000 gpm to wells located in and near the cities of Vancouver, Camas, and Washougal. In the Battle Ground area, the deposits are too fine-grained and thin to yield significant quantities of water, and the aquifer is used solely for domestic purposes. In addition, only the lower few feet of the deposits are saturated in some areas, resulting in small well yields.

3.3 BORING LAVA

The Boring lava consists of fine-grained, vesicular basalt of Pliocene and early Pleistocene ages. The lava generally overlies the Troutdale formation, although evidence suggests simultaneous deposition. It crops out north and east of Battle Ground. Battle Ground Lake, a popular recreational site, lies in the crater of an old lava vent. The Boring lava forms a minor aquifer that can be productive within pyroclastic deposits and vesicular, scoriaceous interflow zones.

3.4 TROUTDALE FORMATION

The Troutdale formation underlies the Pleistocene alluvial deposits and comprises unconsolidated and semiconsolidated clay, silt, sand, and gravel. The unit crops out along the East Fork of the Lewis River, around Tukes Mountain, and in some areas west of town. The Troutdale formation contains three coarse-grained units that are separated by finer-grained confining units. The coarse units are:

- Upper Troutdale
- Lower Troutdale
- A deeper sand and gravel unit known as the "SGA"

These are the principal aquifers in the study area and their geologic characteristics are discussed below. The Upper Confining Unit separates the Upper and Lower Troutdale Aquifers, and the Lower Confining Unit separates the Lower Troutdale Aquifer and the SGA. The Upper Troutdale and SGA supply most of the groundwater in the Battle Ground area.

3.4.1 Upper Troutdale

The Upper Troutdale comprises the upper 100 feet of the Troutdale formation in the Battle Ground area. It consists of gravel in a matrix of coarse sand and silt, and includes sand lenses and stringers. The unit is often cemented. The Upper Troutdale appears to be continuous and underlie all of the study area.

The Upper Troutdale forms what has historically served as the most productive and important aquifer in the study area. The base of the aquifer lies between 80 to 150 feet msl in the Battle Ground vicinity. Despite its cementation, the Upper Troutdale Aquifer is permeable enough to produce high well yields in the

southern part of Clark County. In the Battle Ground area, however, yields from the Upper Troutdale are relatively low. Wells 1, 2, 4, and 5 only produce a few hundred gpm.

3.4.2 Upper Confining Unit

The Upper Confining Unit consists of fine sand, silt, and clay. It is typically about 50 feet thick and separates the Upper and Lower Troutdale in the western half of the study area. The unit may be absent in the eastern portion of the study area.

3.4.3 Lower Troutdale

Like the Upper Confining Unit, the Lower Troutdale is not continuous in the study area. The unit consists mostly of fine sand and typically attains thicknesses of about 50 to 80 feet where it has been penetrated by wells near Battle Ground. The Lower Troutdale occurs in the western portion of the study area but pinches out before reaching Well 6.

The Lower Troutdale Aquifer supplies many wells throughout Clark County, yielding from 300 to 1,000 gpm. The aquifer is not important in the Battle Ground area, however, because it does not contain sufficient coarse-grained zones and it is not continuous enough to produce significant quantities of water.

3.4.4 Lower Confining Unit

The Lower Confining Unit consists of fine sand, silt, and clay. It is typically on the order of about 50 feet thick in the study area, where it appears to be continuous between the Lower Troutdale and the SGA. The surface of the Lower Confining slopes to the west-southwest.

3.4.5 Sand and Gravel (SGA)

A deep sand and gravel unit (the “SGA”) lies beneath the Lower Confining Unit. It has been identified along the Sandy River in Oregon, at the City of Portland wellfield, at Ellsworth Springs, at Vancouver’s Well Station 7, and at the Vancouver fish hatchery. Logs for deep wells in the Meadow Glade and Pioneer vicinities indicate that the SGA probably extends continuously from the Portland wellfield to the East Fork of the Lewis River (Pacific Groundwater Group, 2008). The unit consists predominantly of fine- and fine-to-medium sand, with local lenses of silty sand and clay. It also contains sand and gravel horizons in the southern part of the county. This unit is on the order of 150 to 200 feet in thick in the Battle Ground vicinity.

The SGA supplies water to Wells 6, 7, 8 and 9, Battle Ground’s most productive sources, which have yielded up to 1,000 gpm of water. This aquifer dips to the west-southwest. Its base is estimated to lie at elevations between about 50 feet above msl and 300 feet below msl in the study area.

3.5 UNDIFFERENTIATED FINE-GRAINED UNIT

Undifferentiated fine-grained sediments underlie the SGA. These sediments consist mostly of silt and clay. In the Battle Ground area, the unit ranges in thickness from about 200 to more than 420 feet at Wells 7, 8, and the Keyser Nursery well. The undifferentiated fine-grained sediments overlie the older bedrock.

3.6 BEDROCK

Older bedrock crops out in the foothills and mountains in eastern and northern portions of Clark County and underlies the sedimentary deposits in the Battle Ground area. The rocks range from Miocene to Eocene age. They are primarily igneous in origin and include andesite, basalt, granodiorite, pyroclastics (breccia, tuff, and agglomerate), conglomerate, and shale. The rocks occur at depths of 500 feet or more in the study area and are generally hard and compact because of Miocene deformation.

The older bedrock units generally form poor aquifers because their permeability is low. Small domestic yields can be obtained in many areas where wells intercept fractures. Reasonable yields are possible where fractures are abundant and unobstructed, although such yields are not common or expected.

3.7 GROUNDWATER FLOW

Groundwater in the study area occurs under unconfined, semiconfined, and confined conditions. Unconfined conditions are observed in shallow aquifers such as the Pleistocene and Recent Alluvium. Semiconfined conditions occur in the cemented portions of the Upper Troutdale Aquifer, and confined conditions occur in the Lower Troutdale Aquifer and the SGA.

Groundwater flow patterns in the shallow aquifers are reasonably well defined because water-level data are relatively abundant. Groundwater elevations in the study area range from about 300 feet msl in the eastern portion (along the foothills) to about 200 feet near Meadow Glade. Water-level contours for the Upper Troutdale are presented in **Figure 1**; these contours are based prior wellhead protection characterization performed by Swanson (1995). The illustration shows that groundwater in the aquifer generally flows from the northeast to southwest. Regional groundwater flow patterns are influenced by the major drainages in the area, which include Salmon Creek and the East Fork of the Lewis River.

Water levels and groundwater flow within the SGA are poorly defined since only a few wells are completed in this aquifer. Groundwater elevations within most of the SGA wells are typically around 75 feet msl in the study area, and flow is generally to the west-southwest, based on water levels measured in local wells. Groundwater movement is influenced by regional drainage features such as the Columbia River and the lower portions of the East Fork of the Lewis River. PGG estimated a southwestern groundwater flow direction (-160 degrees relative to east, as shown on **Figure 1**) and a hydraulic gradient of 0.018 ft/ft based on water-level data from Battle Ground Wells 7, 8, TW-1, and TW-2, CPU's Well 32 and the Keyser Nursery well.

4.0 WATER QUALITY

The City of Battle Ground collects samples from its supply wells to ensure compliance with WDOH drinking-water requirements. Sampling frequencies, exceedances, and treatment of water from these wells are discussed below.

4.1 SAMPLING FREQUENCIES

WDOH provides a water-quality monitoring report to the City in October of each year. This report identifies the City's requirements for compliance monitoring. WDOH requires that the City collect inorganic compound (IOC) samples annually. Volatile organic compound (VOC) sampling is required annually in Wells 1 and 2; and every two years in Wells 4, 5, 6, 7, 8, and 9.

The City must test annually for nitrate levels and once every 4 years for radionucleides. Battle Ground is currently operating under a sampling waiver for semivolatile organic compounds (SOCs) which expires in 2013.

4.2 EXCEEDANCES

Water from the City's wells is of good quality and that it meets all primary State and Federal drinking water standards. PGG reviewed reported water-quality standard exceedences reported on the WDOH database and water-quality data from other sources. Exceedences and detects are summarized below:

4.2.1 Iron and Mangenese

The Sentry database indicates that Wells 1, 2, 4, 5, 6, 7 and 8 have exceeded the secondary MCL for iron (0.3 mg/l) and Wells 1, 2, 6, 7 and 8 have exceeded the secondary MCL for manganese (0.05 mg/l). The exceedences in Wells 1 and 2 were noted in 1995, were only slightly above MCL's, and have not continued in recent years. Although these metals do not pose a threat to public health, they are considered "nuisance constituents" since they tend to stain laundry and plumbing fixtures. Although not listed in the Sentry Database, Well 9 also exhibits elevated iron and manganese.

The City treats water from Wells 6, 7, 8 and 9 using a filtration method at Wells 7, 8 and 9 and a sequestering agent at Well 6. The filtration system at Wells 7, 8 and 9 features twelve 4-foot-diameter tanks that are configured into two separate filtration units of six tanks each. Each tank contains 3 feet of pyrolusite media. Depending on the demand for water, one or both of the filtration units may operate. Chlorinated water from Well 6 is treated with sodium silicate, a sequestering agent, to help reduce the effects of high levels of iron and manganese, which discolor water as they are oxidized by air or chlorine. Sequestering agents help prevent iron and manganese from precipitating in the water distribution system.

4.2.2 Volatile Organic Compounds

Annual and semi-annual sampling for VOC's have generally shown no detections; however, detections were encountered for a short duration approximately 15 years ago. Specifically, low concentrations of the following VOCs were detected in Well 1 in June 1998:

- Trichloroethylene (TCE) - 1.1 ppb
- Perchloroethylene (PCE) - 0.8 ppb
- 1,2,3-trichlorobenzene - 4.0 ppb

The Maximum Contaminant Level (MCL) for TCE and PCE is 5 ppb. Since 1,2,3-trichlorobenzene is unregulated, there is no MCL for this compound. These detections were believed to be related to nearby contamination sources along Main Street (PGG, 2000), which are now remediated.

5.0 WELLHEAD PROTECTION AREA DELINEATIONS

This section documents the methods used to delineate wellhead protection areas (WHPA's) and presents the results of the delineation analyses. Analytical modeling methods, developed based on PGG's understanding of the groundwater flow system, were used to delineate WHPA's. These methods are consistent with recommendations in WDOH's Wellhead Protection Guidance and with prior delineations based on existing susceptibility assessments of the City's wells. Also, as recommended in the WDOH Guidance, this section includes consideration of vertical components of potential contaminant transport pathways

WHPA delineations for Battle Ground's older wells (Wells 1, 2, 4 and 5) are based on analytical modeling work completed for a County-wide project by the Clark County Water Quality Division (Swanson, 1995). These delineations are considered to be conservative in that they likely overestimate WHPA sizes, since pumping at the older wells has reduced over recent years and is not expected to increase back to older rates. Analytical modeling was also used to generate new delineations for Wells 6, 7, 8 and 9.

Time-related "capture zones" were estimated for each supply well for 6-month and 1-, 5- and 10-year travel times. A capture zone is the area that supplies groundwater recharge to a pumping well—in other words, its "zone of contribution." In natural systems, capture zones are not circular but elongated, with most capture occurring from areas that lie upgradient of the wellhead. Each capture zone has a stagnation point—the maximum "point of capture" downgradient of the wellhead. A time-related capture zone is the area that supplies groundwater recharge to a pumping well within a specified period. The capture zone encompasses portions of the aquifer that surround the well.

Capture zones are defined in two dimensions within the aquifer in which the well is completed. Mapped capture zones are projections of capture areas defined within the completion aquifer up to the land surface. It should be recognized that additional travel time is often required for contaminants originating at the land surface to reach completion aquifers. This is particularly true for deep aquifers, where downward vertical transport can take decades or centuries.

Time-related capture zones provide a basis for developing monitoring plans, land-use inventories, and data collection plans. They are used in conjunction with the results of the aquifer vulnerability assessment.

5.1 CAPTURE ZONE ANALYSIS METHODS

Wells 1, 2, 4 and 5 are completed in the Upper Troutdale Aquifer. Swanson (1995) developed WHPA delineations with the EPA's "WHPA" model (EPA, 1991). The WHPA model is widely used for this purpose because it suits many hydrogeologic settings. The simpler WHPA module was used, which assumes a confined aquifer of infinite aerial extent, a uniform hydraulic gradient, and uniform transmissivity (i.e. the product of thickness and hydraulic conductivity). PGG updated the WHPA delineations prepared by Swanson by adding 6-month capture zones within the 1-year capture zones. The 6-month capture zones were assumed to have roughly the same shape and orientation as the 1-year capture zones, but were scaled to the volume of water captured over a 6-month pumping period using comparative fixed radius calculations. Given the close proximities between Wells 1 and 2 (60 feet apart) and between Wells 4 and 5 (50 feet apart), Swanson treated each well pair as a single pumping location (or wellfield).

Wells 6, 7, 8 and 9 are completed in the SGA. Capture zones for these wells were delineated using "GFLOW", a two-dimensional analytical element model (Haitjema, 2007). GFLOW also assumes steady-state conditions where flow rates, pumping stresses, and head gradients are in continuous equilibrium. It assumes an aquifer with constant thickness, infinite aerial extent, a uniform head gradient, and a uniform transmissivity. All wells were simulated as pumping simultaneously, such that capture zones are affected by pumping from neighboring wells. Given the close proximity of Wells 7 and 8 (25 feet), these wells were modeled as a single pumping location (wellfield).

Input to the models for the SGA wells included the following parameters:

- Pumping rate
- Aquifer transmissivity
- Aquifer porosity
- Hydraulic gradient and flow direction

Pumping rates modeled for the SGA wells were set to the 2004-2011 average withdrawals (Well 6: 112 gpm; Wells 7 and 8: 397 gpm, Well 9: 147 gpm).

Aquifer transmissivity was set to 10,600 ft^2/day based on an aquifer thickness of 100 feet and a hydraulic conductivity of 106 ft/day. The hydraulic conductivity was derived from values obtained from testing Wells 6, 7, and 8. The aquifer thickness was derived from drillers and/or lithologic logs and hydrogeologic cross-sections, and generally includes all significant water-bearing media encountered in the well while drilling through the aquifer. A constant aquifer porosity of 0.20 was used for the entire modeling analysis.

Since reliable water level data for the SGA are limited, water-level contour maps have not been developed for this system (Section 3.7). Based on water levels in local wells, PGG estimated a flow direction of -160 degrees (relative to east) and a hydraulic gradient of 0.018 ft/ft as input to the model.

GFLOW simulates pumping water levels and drawdowns in the completion aquifer. Based on estimated groundwater flow patterns, GFLOW employs particle tracking routines to trace groundwater flow patterns upgradient from the pumping well. PGG delineated capture zones within GFLOW by plotting out particle traces associated with specified travel times within the aquifer (e.g. 0.5, 1, 5 and 10 years).

5.2 CAPTURE ZONE DELINEATIONS

The results of the capture-zone analysis are shown on **Figure 3** and discussed below. In addition to the calculated capture zones, PGG included supplemental buffers around the capture zones. These buffers add an additional factor of safety to the risk assessment presented in Section 6.

Figure 3 shows calculated capture zones for wells completed in both the Upper Troutdale Aquifer (1, 2, 4 and 5) and the SGA (6, 7, 8, 9). Capture zones for the Upper Troutdale Aquifer Wells were estimated by Swanson (1995), with supplemental 6-month capture zones developed by PGG. Capture zones for each Upper-Troutdale pumping center are mapped with solid fill. Capture zones for the SGA wells were estimated based on particle traces defined with GFLOW. Modeled particle traces are segregated by travel time by color on **Figure 3**.

Buffers were created between wells by expanding the boundaries of calculated capture zones where these capture zones approached one another. **Figure 3** shows how the various calculated 0.5-, 1-, 5- and 10-year capture zones were expanded to create “extended capture zones”. In addition, PGG added a 1000-foot buffer around the extended 10-year capture zone to compensate for possible inaccuracies in the locations of sites identified as having potential to contaminate groundwater, as described in Section 6.

It is again worth noting that the capture zones shown on **Figure 3** are defined for the aquifers in which the wells are completed. Actual travel times from the land surface to the capture zones associated with (deep) SGA wells will be significantly longer than travel times defined within the aquifer itself. Although wells completed in the Upper Troutdale Aquifer are shallower than SGA wells, additional travel time is also required for contaminants to migrate from the land surface through the silt/clay Pleistocene Alluvial Deposits to this aquifer.

6.0 RISK ASSESSMENT

Contaminant sources that overlay the capture zones for Battle Ground's wells were investigated and mapped using three databases that were imported into the project GIS. Data regarding land-use and septic system locations (per zoning parcel) were obtained from Clark County and data regarding environmental sites and facilities using/storing hazardous materials were obtained from Department of Ecology. The three databases were plotted in the project GIS was used to assess whether existing and potential contaminant sources were located within the capture zones for Battle Ground's wells.

Once parcels and sites of concern were mapped in the project GIS, PGG provided these maps and associated lookup tables to the City of Battle Ground. City staff performed a windshield survey to confirm the parcels/sites identified by PGG and look for other sites that may not have been included in the databases referenced above (none were identified). Finally, PGG assigned relative priority rankings to potential contamination sites/sources based on the types of activities/contaminants associated with each site and their possible effects on the City's drinking water sources.

6.1 LAND-USE DATABASE & WINDSHIELD SURVEY

Clark County's database contains a description of the current land use within each parcel in the study area. A GIS analysis was used to identify land uses that could pose a risk to groundwater within the capture zone for each supply well. Parcels where such land uses were identified were designated "parcels of concern." (POC's) This approach provides a way to assess potential sources of contamination. The POC's include those where the following activities are practiced:

- Bio-filtration swales/ponds within 6-mo capzone
- Botanical gardens and conservatories
- Convenience stores with pumps & tanks
- Drive through car washes
- Dry cleaners (free standing building)
- Farm buildings for equipment
- Fleet operation centers & storage
- Funeral services & crematories
- General repair & service garages
- Food Manufacturers
- Manufacturers of rubber & plastic products
- Railroad right of way
- Service repair shops
- Service stations with tanks, pumps, card locks
- Tires, batteries, parts & accessories dealers
- Health clinics (if using septic systems)

City staff reviewed health clinics (medical, dental, veterinary) and office buildings, and confirmed that all were on sewer. In addition, City staff assessed activities associated with office buildings, retail buildings, neighborhood "strip centers" (no anchor), community shopping centers (with anchors), and storage warehouses during their windshield survey and did not identify activities posing significant concern for groundwater contamination.

The identified POC's are shown on **Figure 4** and listed on **Table 4**. In addition, PGG reviewed POC's previously identified in the City's 2000 Wellhead Protection Plan (PGG, 2000) and found that all previously listed POC's are still included on **Table 4**; however, one parcel (1716 W Main St) was previously an automotive services site but is now a building supply store.

Clark County's zoning includes parcels zoned for agriculture, golf courses, and parks. These land uses may include the use of fertilizers, pesticides and herbicides; some of which are mobile in the subsurface and can potentially contaminate groundwater. Current zoning does not show any such categories within

the City's capture zones (**Figure 4**), although the City has a "Central Park" on 414 E Main St (listed in the land use database as "botanical gardens and conservatories") (**Table 4**). Zoning documented in the City's 2000 Wellhead Protection Plan shows several parcels in the "agricultural/forestry" category within the City's capture zones, but did not identify associated land uses. Current land uses for these parcels include RC ("regional center intended for commercial development) and mixed use residential. While the City's park was not identified in the 2000 parcel analysis, aerial photography from Google Earth suggests the park has been in existence since at least 1990.

Table 4 includes priority rankings for POC's based on associated land-use activities and capture zone locations. The ratings are relative within a low-medium-high continuum. Because no particularly high risk land uses were identified within the 1-year capture zones, only "medium" ratings were assigned to these POC's . "Medium" ratings were assigned to all the POC's within the 1-year capture zones of the Upper Troutdale wells and "low" ratings were assigned to all POC's within the 1-year capture zones of the (deeper) SGA wells. All POC's within 5-year capture zones were associated with Upper Troutdale wells and their moderate risk land-use activities yielded "medium" ratings. All POC's outside the 5-year capture zones were assigned low ratings due to the relatively high response time available should a spill occur.

The City will notify all owners of parcels of concern identified in **Table 4** that they are located in a well-head protection area. An example letter and a list of contact information for parcel owners is included in **Appendix A**.

6.2 FACILITY/SITE DATABASE

Ecology's Facility/Site Database (http://www.ecy.wa.gov/fs/index.html) includes information about the following environmental sites and activities of concern:

- State Cleanup sites
- Federal Superfund sites
- Hazardous Waste Generators
- Solid Waste Facilities
- Underground Storage Tanks (LUST & UST)
- Dairies
- Enforcement
- Stormwater (Industrial, Municipal & Construction)

The database includes site locations; however, PGG has found that locations can contain slight inaccuracies. Buffers added to the calculated capture zones, discussed above, may compensate for potential location inaccuracies. Information for cleanup sites located within the capture zones was supplemented with more detailed information from Ecology's Cleanup Site Search Database (fortress.wa.gov/ecy/gsp/SiteSearchPage.aspx) and its ISIS database (https://fortress.wa.gov/ecy/tcpwebreporting/). PGG also researched sites within the capture zones associated with the "enforcement" category of the Cleanup Site Search Database and found that all sites were labeled "Non Enforcement Final". PGG contacted Ecology to determine the nature of these sites, all of which pertained to filling of wetlands and were not considered to be pertinent to wellhead protection concerns. Finally, for stormwater sites listed in the Cleanup Site Search Database, only industrial sites and municipal sites within 1-year capture zones were included in the inventory. Construction sites were not included due to their short-term nature.

Figure 5 shows the locations of environmental sites identified by the Facility/Site Database. **Table 5** summarizes the sites identified within the capture zones and notes whether a site is associated with hazardous materials, underground storage tanks (UST), leaky-underground storage tanks (LUST), cleanup activities, or stormwater. **Table 6** provides supplemental information regarding cleanup sites.

Table 5 shows that within the capture zones there are 14 cleanup sites, 11 sites associated with hazardous materials, 14 sites associated with UST, 10 sites associated with LUST, and 1 stormwater site. Cleanup sites can be associated with LUST contamination or other sources of contamination and there is frequent duplication between UST and LUST sites. Cleanup sites are considered to be of highest concern. Among the 14 cleanup sites, 3 are reported as requiring no further action and 2 are reported as cleaned up under MTCA (**Table 6**). Three cleanup sites are located within defined 1-year capture zones:

- The Sholund Family Farm is a cleanup site that requires no further action on MTCA. Metals have been remediated from the soil and groundwater and petroleum product has been remediated from the soil. The site is located within the 6-month capture zone of Well 6.
- The CFM Site is awaiting cleanup under MTCA. LUST notifications were issued in 1991 and 1996, and an initial investigation was performed in 2005. Petroleum contamination is confirmed above cleanup levels in the soil and suspected in groundwater. The site is located within the 6-month capture zone of Wells 1 and 2.
- Battle Ground School District 119 is being cleaned up under MTCA. The cleanup is supervised/conducted by Ecology. A LUST was identified in 1990 with a number of reports received thereafter. A discovery/release report was filed in 2010. Petroleum contamination is confirmed above cleanup levels in the soil and groundwater. The site is located within the 1-year capture zone of Wells 1 and 2.

It should be noted that the WDOH guidance states that "chemicals capable of contaminating groundwater must not be stored or used in Zone 1" (i.e. the 1-year capture zone). Two additional cleanup sites are located within 5-year capture zones. Union 76 is a LUST site that requires no further action. Petroleum products were confirmed in the groundwater and soil. Grace Cleaners is currently being cleaned up under MTCA. Halogenated organics have been remediated from soils, but phenolic compounds have been confirmed above cleanup levels in soils. All other cleanup sites are within the 10-year capture zones or within the 1000-foot buffer to the 10-year capture zone.

Whereas cleanup sites and LUST sites have known or suspected contamination, a number of other site categories included in Ecology's Facility/Site Database are included due to their potential to cause contamination.

- *UST* sites are associated with underground storage tanks; however, having such a tank does not provide evidence of a leak or contamination.
- *Hazardous Materials* sites are associated with the storage of hazardous materials; however, such storage does not provide evidence of a leak or contamination. The Williams Gas Northwest Pipeline crosses over the 0.5- and 1-year capture zone of Well 9, which is completed relatively deep in the SGA.
- *Stormwater* sites were limited in consideration to just industrial and municipal sites within 1-year capture zones. The single stormwater site located in the capture zones is also a dairy, designated in the industrial stormwater category.

PGG compared the environmental sites listed on **Table 5** with sites listed in the City's 2000 Wellhead Protection Plan (PGG, 2000). We found that the sites listed in 2000 are all listed on **Table 5** except for two sites that appear to be incorrectly located[1].

Table 5 includes priority rankings for facilities/sites based on their categories described above and associated capture zone locations. The ratings are relative within a low-medium-high continuum. Of the 3 sites identified within 1-year capture zones, all were cleanup sites, and 2 were assigned "high" risk (due

[1] One site had an address that does not exist in Battle Ground the other is in Elma WA.

to ongoing cleanup) whereas the third was assigned “low” risk (due to “no further action” designation. Within the 5-year capture zones, the two cleanup sites were assigned “medium” and “low” ratings (the low rating associated with no further action), and the remaining 3 sites were assigned “low” ratings due to their association with storage rather than contamination. All facilites/sites outside the 5-year capture zones were assigned low ratings due to the relatively high response time available should a spill occur.

The City will notify all owners/occupants of environmental sites with the delineated capture zones along with the agencies administering cleanup and LUST sites that they are within WHP capture zones. An example letter and a list of contact information for parcel owners is included in **Appendix A**.

6.3 OTHER POTENTIAL SOURCES

A number of other land uses not mentioned above have the potential to contaminate groundwater:

- On-site septic systems
- Unused and improperly constructed wells
- Transportation corridors

On-Site Septic Systems

On-site septic systems pose a risk to a groundwater where they are relatively high in density and/or where hazardous wastes are discharged to them. Potential contaminants from septic systems include pathogenic organisms (bacteria and parasites), toxic substances, and nitrogen compounds. Clark County maintains a GIS coverage of on-site septic system locations based on information provided by the Southwest Washington Health Department. The locations of the septic systems are plotted on **Figures 4** and **5**. In general, very few septic systems are located within the City’s WHP capture zones. A few septic systems lie within the 1- and 5-year extended capture zones for the SGA wells. These septic systems should not pose a significant risk to these deep groundwater sources.

The extent to which pathogens are transported in the subsurface away from a septic drain field depends on the type of pathogen and the chemical and physical conditions in the subsurface. In general, if a septic system is properly sited, constructed, and maintained, the transport of microorganisms will be limited. Household hazardous chemicals such as cleaners, polishes, waxes, and paints can be transported to groundwater can via a septic system. Homeowners can improperly apply or dispose of chemicals because they do not understand the threat they pose to groundwater quality. In some areas, business and commercial facilities may still use on-site septic systems for sewage disposal. While businesses and commercial facilities associated with land uses potentially risky to groundwater were identified in Section 6.1, some categories (e.g. office buildings and medical clinics) were considered to be in the “gray zone” as they could pose a risk to groundwater via septic discharge. City staff reviewed associated office and clinic parcels, and confirmed that they are all connected to sewer lines.

Septic systems add nitrate to groundwater. Nitrate is regulated, since ingestion can result in methemoglobinemia, or “blue baby” syndrome. Other sources of nitrate include fertilizers, feedlots, and natural mineral deposits. Background concentrations of nitrates in groundwater are typically less than 1 milligram of nitrogen per liter (mg-N/L). The MCL for nitrate is 10 mg-N/L. In 1990, CPU conducted a nitrate study involving 4,200 private wells to assess the distribution of nitrates in Clark County. As discussed in the City’s 2000 Wellhead Protection Plan, nitrate concentrations in the vicinity of the City’s WHP capture zones are generally below 5 mg-N/L.

Unused and Improperly Constructed Wells

Well casings can provide a conduit between the ground surface and underlying aquifers. Improperly constructed or abandoned wells pose several potential problems. In wells with no surface seal, contaminants introduced near the wellhead can move downward outside the casing to underlying aquifers. Many older wells that were constructed before the implementation of WAC 173-160 have no surface seal. Unused wells that have not been properly abandoned are left uncapped in many cases, posing a special risk because contaminants can be introduced directly into the aquifer. Unused wells also pose a risk when they are damaged during site redevelopment. Any of these situations can provide a conduit for contaminant movement.

Clark County (1993) estimated that there may be more than 10,000 private wells in the county (Swanson & McCarley, 1993). Since many of these wells were constructed before drilling standards were adopted, the likelihood that some are improperly constructed is high. In addition, since there has been no inventory of the number or location of these wells, some of these wells may have been abandoned properly.

Transportation Corridors

Vehicles transporting hazardous material can be a source of groundwater contamination through accidents and resultant chemical spills. Hazardous materials are transported through Battle Ground on a daily basis via SR-502 (Main Street) and SR-503 (10th Avenue) **(Figure 3)**. These routes are downgradient of the capture zones for the City's shallower wells (1, 2, 4, 5) and but occur within the mapped capture zones of the City's deeper SGA wells (6, 7, 8, 9). The depth of the SGA and overlying aquitards provides some measure of protection to these wells, including additional travel time from the land surface to the completion aquifer.

7.0 CONTINGENCY PLANNING

The purpose of this section is to develop a contingency plan identifying measures to be taken in case the City's largest production well is lost. This section is consistent with WDOH guidance on WHP planning and includes:

- An analysis of system capacity, water rights, and source loss
- Options for expansion within the City's existing sources of supply and water rights
- An analysis of existing and potential interties
- An analysis of potential future water supplies
- A description of emergency procedures to be taken if a source is lost
- A description of emergency notification procedures

7.1 ANALYSIS OF SYSTEM CAPACITY, WATER RIGHTS, AND SOURCE LOSS

7.1.1 System Capacity and Water Rights

In 1994, the City of Battle Ground's water sources consisted of four wells, three interties to CPU, and one supplemental well source from Battle Ground High School. Well 6 was installed in 1995, Wells 7 and 8 were installed in 1999, and Well 9 was installed in 2004. The City no longer receives water from the High School well and currently has only one active intertie with CPU. The rated capacity of all wells combined is currently 1,660 gpm (2.39 mgd), and the sum of water rights is 2,375 gpm (3.42 mgd) instantaneous (Qi) and 1,912 af/yr annual volume (Qa) (**Table 1**). The active intertie has a capacity of 500 gpm (0.72 mgd) (**Table 3**).

7.1.1.1 Wells 1 and 2

As originally constructed, Wells 1 and 2 had individual capacities of approximately 250 gpm. Over the years, the capacity of these wells diminished as water levels and well efficiencies declined. The current capacity of Well 1 is approximately 180 gpm and the current capacity of Well 2 is approximately 80 gpm, resulting in a combined capacity of 260 gpm or (0.37 mgd)[1]. The aquifer is capable of supplying this capacity on a continuous basis.

Water rights for Wells 1 and 2 are 350 gpm Qi and 270 af/yr Qa (Groundwater Certificate 2605C, priority date June 3, 1954). A portion of Qa on this water right (207 af/yr) was listed as a supplemental (non-additive) allocation for Wells 7 and 8 under Permit G2-29477 (priority date August 13, 1986) which was later expanded to include the City's Well 9 and CPU's Well 35 when Permit G2-29477 was divided between Battle Ground (G2-29477(A)) and CPU (G2-29477(B)). The combined Qa for Wells 1 and 2 is subject to reduction if associated non-additive water rights are used at either CPU Well 35 or Battle Ground Wells 7, 8 and 9.

7.1.1.2 Wells 4 and 5

The combined capacity of Wells 4 and 5 is 125 gpm or 0.18 mgd. The aquifer is capable of supplying this capacity on a continuous basis.

Water rights for Wells 4 and 5 are 250 gpm (0.36 mgd) Qi and 269 af/yr Qa (Water Right Certificate G2-23122, dated August 30, 1974).

7.1.1.3 Well 6

The current capacity of the well is 200 gpm or 0.29 mgd. The aquifer is capable of supplying this capacity on a continuous basis. The water right for Well 6 provides 500 gpm (0.72 mgd) Qi and 430 af/yr Qa (Permit G2-29208, priority date August 13, 1986).

7.1.1.4 Wells 7, 8 and 9

The current combined capacity of Wells 7 and 8 is 650 gpm and the current capacity of Well 9 is 425 gpm, resulting in a combined capacity of 1,075 gpm (1.55 mgd). The City's water rights for Wells 7 and 8 were originally issued under water right permit G2-29477, and Well 9 was subsequently added to the permit as an additional point of withdrawal. Water-right permit G2-29477 originally had a Qi of 2,000 gpm and a Qa of 2,150 af/yr, of which 1,943 af/yr was primary and 207 af/yr was non-additive from Wells 1 and 2. The primary Qa was reduced to 943 af/yr (certificate 29477-A) when 1,000 af/yr was transferred to CPU (certificate 29477-B). The combined Qi was also reduced to 1,375 gpm (1.98 mgd) at this time.

7.1.1.5 Interties

A summary of the City's interties is presented on **Table 3**. The City currently uses its sole intertie with CPU as a source of peaking and emergency supply. The intertie was installed in 1995, is 4-inches in diameter and can supply up to 500 gpm. The City is developing a new intertie with CPU that will replace the current intertie in 2013 and will have an initial capacity of 1,000 gpm. Improvements to this new intertie are available that would increase its capacity over time. The source-loss analysis presented below assumes that intertie capacity will be increased to 1,750 gpm in 2017 and to 3,000 gpm in 2021.

7.1.2 Source-Loss Analysis

This source-loss analysis considers what would happen if the City lost supply from any of its wells due to contamination or well failure. The City currently relies on its intertie with CPU for peaking capacity, and as water demand increases, the City will become increasingly reliant on current and future interties. **Figure 6** presents:

- Preliminary estimates of the City's projected annual and maximum daily demand[2];
- The total Qa water right for the City's wells (converted into an average daily pumping rate) and the total Qi water right;
- The City's projected instantaneous water-supply capacity over time based on its total well capacity plus capacity from existing and future interties; and,
- The City's instantaneous capacity with the loss of each of its key well sources (or source pairs, where two wells are located close together such that contamination would affect both)

While the City can meet the projected average daily demand (ADD) with its allocated Qa through 2017, comparison of projected maximum daily demand (MDD) to combined well capacity shows that the City cannot meet its current or future MDD without use of the interties. After 2017 the City will also need to rely on interties to meet portions of both its peaking demand *and* its ADD.

The combined source capacity curve (shown in cyan) can be compared to the projected MDD to evaluate the City's capability to meet MDD with all sources operating. **Figure 6** suggests that MDD can be met with the City's combination of wells and interties (although this comparison suggests a shortfall in 2012, this did not occur accept when Well 9 was temporarily inoperable due to pump outage).

[2] These numbers are from a draft version of the City's 2012 Water System Plan, currently under preparation (personal communication, Ginter, 2012).

Comparison of projected MDD to the City's instantaneous capacity curves with loss of specific well sources suggests that prior to 2017, loss of Well 9 or Wells 7 and 8 (combined) could have a notable affect on the City's ability to meet its MDD. For instance, in 2016, loss of Well 9 would mean that the City could supply only 86 percent of its MDD, and loss of Wells 7 and 8 would mean that the City could supply only 77 percent of its MDD. Between 2017 and 2029, loss of any individual well source (or source pair) would have little or no affect on the City's ability to meet its MDD. This is largely due to the contribution of interties from CPU. After 2029, loss of Well 9 or Wells 7 and 8 would again have a notable affect on the City's ability to meet its MDD.

It should be noted that while Wells 7, 8 and 9 have the largest capacity of all the City's sources, these wells are less vulnerable to contamination than Wells 1, 2, 4, 5 and 6 (Section 6.4). The latter group of wells have shallower completions in the Upper Troutdale Formation (**Table 2**), and are therefore more vulnerable to contamination at the land surface than the deeper SGA wells. It should also be noted that due to the proximity between wells situated in pairs and completed in the same aquifer (i.e. Wells 1 & 2, 4 & 5, 7 & 8), if contamination were to reach one of the paired wells, it would likely affect both wells – either removing them from service or requiring treatment before distribution.

7.2 OPTIONS FOR INCREASED CAPACITY UNDER EXISTING WATER RIGHTS

Current well capacities are sufficient to exceed the City's water-right Qa. However, the rated capacities of all of the City's wells are less than associated water-right Qi allocations (**Table 1** and **Figure 6**). The disparity between well capacity and Qi has increased as many of the City's wells have experienced reduced capacities due to clogging by iron bacteria. Additional wells could be added to the vicinity of each of the City's sources (under Ecology's "Showing of Compliance") to support withdrawals up to the allocated water-right Qi's. This would increase the City's internal capacity to meet its MDD, thus reducing reliance on interties. Specifically:

- An additional 90 gpm could be developed in the vicinity of Wells 1 and 2;
- An additional 125 gpm could be developed in the vicinity of Wells 4 and 5;
- An additional 200 gpm could be developed in the vicinity of Well 6; and
- An additional 300 gpm could be developed in the vicinity of Wells 7, 8 and 9.

In all, the unused capacity of these wells would provide 715 gpm of additional instantaneous capacity. Furthermore, if the City were prepared to drill new wells, it could potentially target the SGA and transfer water rights from its shallow wells to new deeper wells, thus effectively increasing protection from contamination to its well sources. However, because both the Upper Troutdale Aquifer and the SGA have shown a history of clogging due to iron bacteria, the City may prefer to emphasize interties to meet its instantaneous demand requirements.

7.3 EMERGENCY PROCEDURES FOR LOSS OF A SOURCE

Over the 20-year projection period addressed in this Wellhead Protection Plan, the impact of losing a single source (where two wells immediately adjacent are also considered a single source) is unlikely to require reductions in supply of more than 25 percent of MDD. During significant portions of the 20-year time period (i.e. 2018 to 2028), loss of a single source would not impact to the City's ability to meet MDD. Were a source loss to occur during a time when the combined capacity of all the City's wells was needed to meet demand, the City would likely need to institute short-term rationing and pursue drilling additional wells.

As discussed above, the City's well capacity could be increased without exceeding existing water rights by drilling new wells. The decision as to where to drill a new well would depend on the reason for source

loss. If source loss is due to well failure, a replacement well could be drilled near to the original well under "showing of compliance". Showing of compliance does not require water-right processing, and can be performed without significant administrative delay. It is reasonable to expect that several months (or longer) may be needed to contract and drill a new well, and connect the well to the distribution network.

If source loss is due to contamination, we would advise the City to either seek a new well location for the existing water right or increase groundwater development from an existing (different) location. In the first case, moving the point of withdrawal would require water-rights processing which would likely require months to years to complete[3]. However, because the City is not making full use of water rights from all of its sources, it could develop additional capacity at other source locations under showing of compliance and potentially offset lost capacity in a period of months. This is particularly relevant to loss of the City's shallow well sources, where available additional capacity in the deep sources exceeds the current capacity of the shallow sources. However, if the City were to lose a deep source to contamination, available additional capacity from shallow sources is insufficient to replace deep source capacities. In this case, water rights processing would be required for a new well location. Fortunately, the potential for contamination of deep sources is significantly less than the potential for contamination of shallow sources.

Should contamination be detected in one of the City's wells, emergency responses would be conducted, as described below.

7.3.1 Emergency Notification Procedures

In case of a spill of any magnitude within the WHPA, Ecology must be notified at (360) 407-6300. In addition, the following City Personnel should be notified:

- Scott Sawyer, City Engineer, (360) 342-5075
- Cal Newton, Public Works Superintendent, (360) 342-5365

7.3.2 City's Chain-of-Command for Spill Response

The City's Chain-of-Command response team is summarized in **Table 7**.

7.3.3 External Emergency Notification

In case of a spill that cannot be contained, Ecology's should be contacted at its 24-hour number, (360) 407-6300. Safety Kleen, a cleanup contractor, should also be contacted at (503) 655-5798. If a spill can be contained, it should be pumped into a containment tank. If there is no containment tank on site, Baker Tanks should be contacted at (503) 775-7211 to provide one.

7.4 EMERGENCY PHONE NUMBERS

The following is a list of contacts and telephone numbers in case of an emergency:

Police:	911
Ambulance:	911
Fire:	911
Hospital:	(360) 256-2000 (Peace Health Southwest Center)

[3] Months might be required under Ecology's Cost Reimbursement program; otherwise, years are often required.

Fatal injuries and accidents in which two or more employees are hospitalized must be reported immediately to the Washington State Department of Labor and Industries, Division of Consultation and Compliance (800) 423-7233.

8.0 SPILL RESPONSE PLANNING

8.1 RESPONSIBILITIES FOR SPILL PREVENTION AND RESPONSE

Many organizations have responsibilities for spill prevention in Washington State. This section briefly summarizes those responsibilities.

8.1.1 The Responsible Party

The primary responsibility for assessing, responding to, and containing an oil spill or discharge falls upon the individual, agency, and/or company responsible for the spill incident. The Responsible Party (RP) is responsible for containing and cleaning up the spill, disposing of contaminated debris, restoring the environment, and paying damages regardless of whether there is an approved contingency plan. State and federal law specifically require that the removal of a discharge of oil or hazardous substance should be immediate.

If the spiller is unknown or fails to respond, or if the State or Federal On-Site Coordinator (OSC) considers the response inadequate, the agency with jurisdiction may take over the response and recover expenses from the spiller (RCW 90.48.335).

8.1.2 Environmental Protection Agency

The EPA has primary responsibility for land spills and spills that occur on inland U.S. waters that are not under US Coast Guard jurisdiction. In the past, EPA has delegated authority for certain spill-response activities to Ecology.

8.1.3 Department of Ecology

Ecology is the lead agency for environmental pollution response in Washington. As such, it has predesignated the OSC and the Incident Commander (IC) for many spills occurring in the State's jurisdiction. If a spill occurs on a State highway, Ecology coordinates with the Washington State Patrol (WSP). The WSP then assumes responsibility as IC and leads the cleanup. The key responsibilities of Ecology include:

- Providing 24-hour emergency response to reported spill incidents
- Identifying the source, cause, and responsible party
- Assuming responsibilities of RP if a spiller cannot be located or is unresponsive
- Ensuring that containment, cleanup, and disposal are carried out in a timely and adequate manner

8.1.4 State Patrol

The Washington State Patrol (WSP) acts as the designated IC for incidents on Interstate and State highways and on other roads and jurisdictions as delegated. When a spill occurs on a State highway, Ecology joins the Unified Command and leads the cleanup response.

8.1.5 Emergency Management Division of the Washington Military Department

The Emergency Management Division of the Washington Military Department (http://www.emd.wa.gov/) provides disaster assistance for public agencies and recognizes hazards such as chemical (hazardous materials), pipelines, radiological, terrorism and transportation. Their assistance primarily addresses the repair and restoration of public facilities, infrastructure, or services which have been damaged or destroyed.

8.1.6 Local Emergency Planning and Emergency Management

The City of Battle Ground has developed a Local Emergency Planning Committee (LEPC) to facilitate planning efforts. LEPCs are responsible for creating emergency response plans. General requirements for local response plans are contained in Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). Generally, local agencies, particularly fire districts and law enforcement agencies, can be activated to provide emergency response services when there is a threat to life and property. Emergency response services may include:

- Investigating and documenting fire and explosion controls
- Establishing perimeter controls, evacuation routes, and traffic controls
- Containing or removing the spilled material, depending on the nature of the incident

The responsibilities of local government's Emergency Management Unit include:

- Developing and maintaining a hazardous material "annex" (supplement or appendix) to the State Comprehensive Emergency Management Plan. The responsibilities and actions of local, State, and Federal agencies should be defined.
- Assisting local agencies in preparing their standing operation procedures for hazardous materials incidents.
- Coordinating the various local emergency organizations and serving as the local liaison to Washington State EMD when that agency is involved.
- Contacting local landowners (may also be performed by local Health Department)
- Developing training programs and conducting exercises for local response agencies.
- Participating as a member of the Washington Wildlife Rescue Coalition.
- Establishing a Joint Information Center (JIC).
- Coordinating and interfacing with local governmental units (fire, medical, public works, sheriff, and law enforcement).
- Communicating with local government and industry.

8.2 SPILL ASSESSMENT AND RESPONSE PROCEDURES ON CITY PROPERTY

A spill of any magnitude that occurs within the WHPA and is not contained must be reported to Ecology and the City. After the spill is contained to the extent possible using on-site equipment, City personnel, Ecology, and a cleanup contractor should be notified.

8.3 SPILL CONTAINMENT/CLEANUP PROCEDURES ON CITY PROPERTY

If the spill can be contained, the following procedures should be followed:

1. Contain the spill with adsorbent materials. Neutralize with soda ash if the material is an acid.
2. Report the spill according to chain-of-command procedures.
3. Start the cleanup operation.

The spilled material should be pumped into an on-site tank for treatment, if possible. If it cannot be pumped into a tank, a cleanup contractor such as Safety Kleen should be contacted to contain the spill.

8.4 INSPECTIONS AND RECORDS

To the extent possible, the City should inspect the inventoried contaminants annually for proper containment. The facilities should also be checked to insure that the facility owners and operators are properly trained in spill prevention. The City staff should be responsible for inspection and record keeping for the spill prevention procedures. Records should be maintained for reference and recommendations should be made to correct deficiencies found by inspection.

Material Data Safety Sheets (MSDS) should be collected as part of the inspection process. These MSDS sheets must be available at each facility. The fire department also maintains copies of MSDS sheets for many facilities.

8.5 TRAINING

All City engineering, planning, and public works personnel should be trained in spill prevention at appropriate levels. For example:

- Engineering staff should be trained to identify proper spill containment and handling facilities when reviewing plans
- Planning staff should be trained to minimize potential contamination problems through changes in long-term zoning,
- Public works staff should be trained in spill response and field inspection procedures

City staff should be thoroughly familiar with the procedures outlined in this plan. City personnel can significantly impact spill prevention as part of their overall duties. This plan will be revised periodically to ensure that proper techniques are put to the best benefit.

Training should focus on safety, spill prevention, emergency response, evacuation, first aid, and hazardous waste first response.

9.0 IMPLEMENTATION STRATEGIES

Strategies for implementing the City of Battle Ground's WHP plan focus on several key issues:

- Public education and technical assistance
- Contaminant source management
- Monitoring and data management
- Land use and regulatory controls
- Regional coordination
- Planning

Each of these strategies is discussed below.

9.1 PUBLIC EDUCATION/TECHNICAL ASSISTANCE STRATEGIES

Public education and technical assistance strategies are required to teach City residents and businesses about practices that could impact the quality of groundwater in the WHPAs. These strategies include the following:

- Notifying all businesses that store and handle hazardous materials within the designated WHPAs about the importance of proper waste handling and disposal (addressed in **Appendix A**). Performing audits and making technical assistance available for small businesses within designated WHPAs.
- Developing educational materials that can be distributed to City residents to teach them how they can help protect groundwater. The Annual Water Quality Report can be used to inform customers about topics such as the location of WHPA boundaries and the importance of the proper use and disposal of lawn chemicals, household wastes, and other potential contaminants.
- Developing school programs to educate youth on groundwater protection.

9.2 CONTAMINANT SOURCE MANAGEMENT STRATEGIES

Strategies for managing contaminant sources are required to prevent contamination from point sources such as spills and USTs, as well as from regional sources such as septic systems. These strategies include the following:

- Regularly updating inventories of all businesses and potential contaminant sources within designated WHP capture areas. WDOH guidance states that inventories should be updated every two years (WDOH, 2010).
- Inventorying and locating USTs that were not identified through this study, including residential home heating oil USTs.
- Encouraging Ecology to expedite cleanup actions at confirmed contamination sites.
- Encouraging Ecology and the County to inspect the facilities of RCRA hazardous waste generators.
- Reviewing existing and proposed stormwater management practices to identify areas of concern for groundwater quality. The City should coordinate with Clark County as required.
- Requesting that the SWWHD focus its septic maintenance program on designated WHPAs.

- Encouraging residences that are currently served by septic drain fields within WHPAs to connect to the sewer system where possible. The City might consider financial incentives or other means of enticing residents to change.

9.3 MONITORING AND DATA MANAGEMENT STRATEGIES

Groundwater monitoring data provide a method for assessing trends in groundwater quality, on both regional and local scales. Regional data are available from sources such as the County, CPU, and SWWHD. Recommended strategies for monitoring and data management include:

- Collecting and analyzing water-quality, water-level, production, land-use, and other data that could assist in wellhead protection. This could be accomplished through cooperative programs with Clark County, CPU, and SWWHD.
- Integrating this data into a database management system to facilitate future analyses related to wellhead protection and water-resource issues.
- Applying a higher sampling intensity to the shallower, more vulnerable supply wells (wells 1, 2, 4 and 5).
- Reviewing logs for existing wells in high-risk areas to identify possible locations for monitoring.

9.4 LAND-USE CONTROLS AND REGULATION STRATEGIES

Wellhead Protection Guidance (WDOH, 2010) notes that public water systems owned and operated by local governments have clear authority to protect groundwater through zoning decisions, building and operating standards, land use controls, public health ordinances and other measures. The City can adopt zoning ordinances or codes that limit activities around water-supply sources, set design or operating standards for facilities in WHPA's, or other regulatory approaches. The following strategies related to land-use and regulatory controls could be implemented to protect water quality in WHPAs:

- Developing zoning overlays and adding performance standards to conditional use permits. However, because such strategies may be difficult and expensive to implement, it may be more practical to relocate the high-risk sources to areas where land-use conditions are not as critical.
- Encouraging and supporting the implementation of Clark County's Critical Aquifer Recharge Areas (CARA) ordinance (Chapter 13.70), which regulates activities within WHPAs and promotes the use of Best Management Practices (BMPs) to safeguard groundwater. Updated capture zone maps should be submitted periodically to the County for incorporation into the CARA process.
- Encouraging and supporting the implementation of Clark County's Water Quality ordinance (Chapter 13.26A), which is designed to reduce and control discharges of contamination to surface water and groundwater through BMPs and technical assistance programs.

9.5 REGIONAL COORDINATION STRATEGIES

Coordinating with other local purveyors in Clark County could enhance the effectiveness of wellhead protection efforts. Regional coordination strategies would include:

- Establishing a "steering group" with other local water purveyors and Clark County to coordinate WHP planning activities. This group should focus existing and future programs related to water quality and water resources on the designated WHPAs.

- Coordinating with other Clark County purveyors on water-supply planning and development issues. These issues include contingency planning and expansion of interties.

9.6 PLANNING STRATEGIES

Developing strategies for emergency response and contingency planning is essential to wellhead protection. Recommended action items related to such planning include:

- Notifying the appropriate emergency response organizations on the location of WHPAs and establishing formal communication protocols with the first-response emergency units.
- Preparing and distributing an emergency response contingency plan that covers short- and long-term responses if one or more sources is lost.
- Completing a hydraulic assessment of the distribution system to ensure that the contingency plans adequately address major losses of supply or storage capacity.

The City's Community Development Department should ensure that wellhead protection programs are integrated into overall community planning. Declaring a WHPA a critical aquifer recharge area, subject to local regulations and policies, is a useful part of a local Wellhead Protection Program.

Given that source-loss analysis indicates that there will be times over the next 20 years when existing interties are insufficient to offset impacts to total system capacity if certain well sources are lost, the City may want to consider planning for installation/development of backup wells. Should backup wells be constructed, we recommend targeting the (deep) SGA aquifer due to its greater degree of inherent protection from contamination introduced to the land surface and because current capacity is 300 gpm less than existing water-right allocations.

REFERENCES

EPA (U.S. Environmental Protection Agency), 1991. *A Modular Semi-Analytical Model for the Delineation of Wellhead Protection Areas, March 1991*.

Haitjema, H. 2007. Gflow version 2.1.2. Haitjema Software Inc.

Mundorff, M.J., 1964. *Geology and Groundwater Conditions of Clark County Washington, with a Description of a Major Alluvial Aquifer along the Columbia River*. U.S. Geological Survey Water-Supply Paper 1600.

Pacific Groundwater Group, 2008. Technical information in support of Clark Public Utilities South Lake Wellfield water right application G2-30381. Consultants report by Pacific Groundwater Group to Clark Public Utilities, January 8 2008.

Pacific Groundwater Group, 2000. City of Battle Ground wellhead protection plan. Consultants report prepared for the City of Battle Ground by Pacific Groundwater Group. June, 2000.

Swanson, R., 1991. *Unpublished Water Level Map for Clark County*. Intergovernmental Resource Center.

Swanson, R., and McCarley, C., 1993. *Wellhead Protection Area Inventory Using a Geographic Information System*. Clark County Water Quality Division and Department of Assessments and GIS, September, 1993.

WDOH (Washington Department of Health), 2010. Washington state wellhead protection program guidance document. DOH 331-018 (Revised). June 2010.

Table 1
Summary of Source Capacity and Water Rights

Well	Pumping Rate (gpm)			Annual Volume (acre-feet)		
	Historic Average[1]	Rated Capacity[2]	Rights (Qi)	Historic Average	Capacity[4]	Rights (Qa)
#1 and #2	171	260	350	276	420	270[5]
#4 and #5	118	125	250	190	202	269
#6	112	200	400	181	323	430
#7, #8, #9	544	1,075	1,375[3]	878	1,735	943[6]
Total	**945**	**1,660**	**2,375**	**1,525**	**2,680**	**1,912**

[1] Historic average from 2004-2011.

[2] Personal Communication, Cal Newton 2012.

[3] Qi for wells 7, 8 and 9 (combined) was reduced from 2,000 gpm to 1,375 gpm due to a 625 gpm water-right transfer to Clark Public Utilities (CPU) as documented in Certificates 29477-A and 29477-B.

[4] Instantaneous capacity pumped continuously over one year.

[5] Qa for wells 1 and 2 is subject to reduction if associated non-additive water rights are used at either CPU Well 35 or Battle Ground wells 7, 8 and 9.

[6] Original water-right certificate 29477 had a total Qa of 2,150 af/yr of which 1,943 af/yr was primary and 207 af/yr was non-additive from wells 1, 2, 4, 5 and 6. The primary Qa was reduced to 943 af/yr (certificate 29477-A) when 1,000 af/yr was transferred to CPU (certificate 29477-B).

Table 2 - Battle Ground Water Supply Wells

Battle Ground Well Number	WDOE Unique Well ID	WDOH Source ID	Local Number	Completed Aquifer	Well Diameter	Driller	Construct. Date	Altitude (ft-MSL)	Well Depth (ft)	Completion Interval Top (ft-bgs)	Bottom (ft bgs)	WL Depth (ft)	WL Date	Well Yield (gpm)	Specific Capacity (gpm/ft)	Estimated Transmissivity (gpd/ft)
WELL 1	AFP601	1	3N/2E-03AB	QTu	8	Bottner	3/30/1954	284	144	99	136	48.1	3/30/1954	180	7.9	
WELL 2	AFP603	2	3N/2E-03AB	QTu	12	Bottner	9/15/1954	284	152	116	144	54	9/15/1954	80	7.7	
WELL 4	AFP603	3	3N/2E-03DA	QTu	12	Hansen	6/25/1975	280	141	105	135	61.6	8/22/1975	75	3.3	
WELL 5	AFP604	4	3N/2E-03DA	QTu	12	Hansen	8/22/1975	280	140	105	135	59.7	8/22/1975	75	2.2	
WELL 6	ABT804	8	3N/2E-04AD	SGA	10	Hansen	9/17/1995	275	299	259	289	197.2	8/16/1995	350	9	46,000
WELL 7	ABB112	9	3N/2E-04-DB	SGA	12	Holt	1/15/1999	265	437	349	432	205	1/8/1999	1000	28.2	73,800
WELL 8	ABB118	10	3N/2E-04-DB	SGA	12	Holt	2/26/1999	265	438	350	435	202	2/22/1999	1000	23.8	73,800
WELL 9	AKW137	11	NW, SE, Sec 4, T3N/R2	SGA	12/8	Holt	2004	265	425	320	411	213.1	2004	500	21	70,000

NOTES:
Completion aquifers include Upper Troutdale aquifer (QTu) and sand and gravel aquifer (SGA).
Static water levels, well yields and specific capacity based on original driller's reports and represented well condition at time of drilling.
Transmissivity estimates referenced from hydrogeologic reports on file with City of Battle Ground.

Table 3
Battle Ground Interties

Location	Size (inches)	Maximum Capacity (gpm)	Status
NE 199th Street at Maple Grove School	4	500	Installed in 1995. WDOH Source #6. Will be used for emergencies only when 1000 gpm becomes available at NE 219th St.
NE 219th St and NE 92nd Ave	16	1000	Available in 2013.
	16	1750	Likely available in 2017 with installation of additional booster pump.
	18 and 24	3000	Assumed availabble in 2021. Requires installation of larger diameter pipes and larger booster pumps.

Table 4 - Possible Parcels of Concern

Map ID	Owner	Land Use Description	Site Address*	Capture Zone Location	Septic	Priority Ranking
114	City Of Battle Ground	Bio-Filtration Swales/Ponds	n/r	6-Month Zone, Wells 7 & 8		low
115	City Of Battle Ground	Bio-Filtration Swales/Ponds	n/r	6-Month Zone, Wells 7 & 8		low
9	West Main Llc	Drive Through Car Wash	512 W Main St	6-Month Zone, Wells 1 & 2		medium
10	West Main Llc	Tires (includes retread tires), batteries, parts & acces, dealers	510 W Main St	6-Month Zone, Wells 1 & 2		medium
112	City Of Battle Ground	Bio-Filtration Swales/Ponds	2509 SW 11th Circle	6-Month Zone, Well 9		low
108	City Of Battle Ground	Bio-Filtration Swales/Ponds	n/r	6-Month Zone, Well 6		low
55	Song Simon S & Song Renee J	Convenience Store - w/ pumps & tanks	13 E Main St	5-Year Zone, Wells 1 & 2		medium
31	Patel Alkesh R & Patel Bindiya A	Dry Cleaners, laundries (single tenant - free standing bldg.)	100 E Main St	5-Year Zone, Wells 1 & 2		medium
61	Hussey Properties Inc	Tires (includes retread tires), batteries, parts & acces, dealers	213 W Main St	5-Year Zone, Wells 1 & 2		medium
27	Brown Robert P & Brown Ruth I	Convenience Store - w/ pumps & tanks	1912 W Main St	10-Year Zone, Wells 7 & 8		low
43	Washington State	Farm Bldgs for Equipment	2411 W Main St	10-Year Zone, Wells 7 & 8		low
45	Morse Properties Llc	General repair & service garages	1713 W Main St	10-Year Zone, Wells 7 & 8		low
130	Mcnair Richard S & Mcnair Jacquelin	SERVICE REPAIR SHOP	1806 W Main St	10-Year Zone, Wells 7 & 8	Yes	low
48	Les Schwab Tire Centers Wa	Tires (includes retread tires), batteries, parts & acces, dealers	1719 W Main St	10-Year Zone, Wells 7 & 8		low
89	Andersen Ronald A	Fleet Operation Centers & Storage	103 S 3rd Ave	10-Year Zone, Wells 1 & 2		low
66	Ferraro Miguel A	General repair & service garages	403 E Main St	10-Year Zone, Wells 1 & 2		low
64	Andersen Ronald	Mfg - Food	305 E Main St	10-Year Zone, Wells 1 & 2		low
105	Krause Steven R	SERVICE REPAIR SHOP	n/r	10-Year Zone, Wells 1 & 2		low
106	Krause Steven R	SERVICE REPAIR SHOP	303 S Parkway Ave	10-Year Zone, Wells 1 & 2		low
46	Morse Properties Llc	General repair & service garages	n/r	10-Year Zone, Well 9, Wells 7 & 8		low
15	Frontier Equities Llc	Convenience Store - w/ pumps & tanks	16 NW 13th Ave	10-Year Zone, Well 9		low
126	Levy Esther Trustee	Convenience Store - w/ pumps & tanks	907 W Main St	10-Year Zone (Smoothed)		low
3	Jmf Investments Iv Llc	Drive Through Car Wash	105 NW 12th Ave	10-Year Zone (Smoothed)		low
145	Fred Meyer Stores Inc	Service Station w/ Tanks & Pumps or Card Lock Station	1205 NW 1st St	10-Year Zone (Smoothed)		low
20	City Of Battle Ground	Botanical gardens and conservatories.	414 E Main St	1000-foot Buffer		low
35	City Of Battle Ground	Botanical gardens and conservatories.	n/r	1000-foot Buffer		low
141	Dickinson Daniel & Dickinson Annette	Convenience Store - w/ pumps & tanks	409 E Main St	1000-foot Buffer		low
24	Laynes Funeral Home Inc	Funeral services and crematories.	16 NE Clark Ave	1000-foot Buffer		low
29	Laynes Funeral Home Inc	Funeral services and crematories.	n/r	1000-foot Buffer		low
2	Punks Mufflers Llc	General repair & service garages	212 NE Grace Ave	1000-foot Buffer		low
86	Bertsch Robert G	General repair & service garages	715 SE 1st St	1000-foot Buffer		low
140	Ek Properties Llc	General repair & service garages	508 SE 1st St	1000-foot Buffer		low
142	Ek Properties Llc	General repair & service garages	n/r	1000-foot Buffer		low
16	Andersen Ronald A	Mfg - Rubber & Plastic Products	15 NE Grace Ave	1000-foot Buffer		low
146	Clark County General Services - Railroad	Railroad right-of-way	215 S Grace Ave	1000-foot Buffer		low
23	Laynes Funeral Home	Small retail building (<10,000 s.f.)	n/r	1000-foot Buffer		low

See **Figure 4** for parcel locations. *All parcel addresses are in Battle Ground, WA 98604.

Table 5 - Summary of Environmental Sites within Wellhead Protection Capture Zones

Map ID	Facility Site ID	Cleanup Site ID	Facility Name	Cleanup Site	Hazardous Materials	UST	LUST	Storm Water	Capture Zone Location	Priority Ranking
35	71217895	3703	Sholund Family Farm	Y					6-Month Zone. Well 6	low
36	73713224	7120	CFM Site	Y		Y	Y		6-Month Zone, Wells 1 & 2	high
37	81695495	10621	Battle Ground School District 119	Y		Y			1-Year Zone, Wells 1 & 2	high
39	86416754	578	Graces Cleaners	Y	Y				5-Year Zone, Wells 1 & 2 AND 10-Year Zone, Well 6	medium
1	1051	4980	Union 76	Y		Y	Y		5-Year Zone, Wells 1 & 2	low
25	7256537		Andersen Dairy Inc		Y			Y	5-Year Zone, Wells 1 & 2	low
32	37223232		Cenex Harvest States Old Station		Y	Y			5-Year Zone, Wells 1 & 2	low
43	99375277		QWEST Communications Battleground CDO		Y	Y			5-Year Zone, Wells 1 & 2	low
30	31157289		Village Mart			Y			10-Year Zone. Well 9	low
4	4282	11627	Vancouver Clinic Battle Ground	Y	Y				10-Year Zone, Wells 7 & 8	low
19	1577475		Williams Gas Pipelines Northwest Pipeline		Y				10-Year Zone, Wells 4 & 5	low
24	7134825		Battle Ground School District 119		Y		Y		10-Year Zone, Wells 1 & 2	low
31	32749129	5875	Battle Ground Farm & Home	Y		Y	Y		10-Year Zone, Wells 1 & 2	low
34	64531412		Parkway North Health Care Nurs		Y				10-Year Zone, Wells 1 & 2	low
38	82713854	10658	Draper Cf Dba Drapers City Cleaners	Y		Y	Y		10-Year Zone, Wells 1 & 2	low
33	58523474	9812	Jacksons Food Stores 500	Y	Y		Y		10-Year Zone (Smoothed)	low
17	23782	5228	Battle Ground Chevron	Y		Y	Y		1000-foot Buffer	low
21	3506334		Albertsons 592		Y				1000-foot Buffer	low
27	9977600	5509	Battle Ground Mini Mart 805	Y		Y	Y		1000-foot Buffer	low
28	15491331	5582	Battle Ground Utility Trench Scott Bros	Y		Y	Y		1000-foot Buffer	low
29	25875197		Lewis Rock & Redi Mix Inc Main St			Y			1000-foot Buffer	low
40	89645195	3708	WA DOT Battle Ground	Y					1000-foot Buffer	low
41	90426683	11004	Battle Ground Inn	Y		Y	Y		1000-foot Buffer	low
42	92132423		Dorsey Bus Service Inc Main St E		Y	Y			1000-foot Buffer	low

See **Figure 5** for site locations. See Table 6 for supplemental information about cleanup sites. "No further action" (NFA) cleanup sites receive low priority rankings for risk of contamination

Table 6 - Summary of Cleanup Sites within Wellhead Protection Capture Zones

Map ID	Facility Site ID	Cleanup Site ID	Facility Name	ISIS Site Summary Report
1	1051	4980	Union 76	This site requires no further action under MTCA. Petroleum products are reported as confirmed in the groundwater and soil.
4	4282	11627	Vancouver Clinic Battle Ground	This site requires no further action under MTCA based on an initial investigation. Petroleum products in the soil were remediated to below cleanup levels.
17	23782	5228	Battle Ground Chevron	The site is being cleaned up under MTCA, an Ecology supervised/conducted cleanup has been started. A routine cleanup was performed in 1995-96, but the site was reopened in 2000 due to LUST contamination. Halogenated organics and PAH's have been remediated in the soil, but petroleum products are currently confirmed above cleanup level in the soil and groundwater.
27	9977600	5509	Battle Ground Mini Mart 805	The site is being cleaned up under MTCA, an Ecology supervised/conducted cleanup has been started. A LUST was identified in 2001, a site characterization perforemed in 2003. Petroleum contamination is confirmed above cleanup levels in the soil and groundwater, and PAH contamination is confirmed in the groundwater and suspected in the soil.
28	15491331	5582	Battle Ground Utility Trench Scott Bros	The site is being cleaned up under MTCA, an Ecology supervised/conducted cleanup has been started. A LUST was identified in 1996 and notice of a cleanup site issued in 2005. Petroleum contamination is confirmed above cleanup levels in the soil and groundwater.
31	32749129	5875	Battle Ground Farm & Home	The site is being cleaned up under MTCA, an Ecology supervised/conducted cleanup has been started. Priority pollutant metals and petroleum products are currently confirmed above cleanup level in the soil and groundwater.
33	58523474	9812	Jacksons Food Stores 500	This site is reported cleaned up under MTCA. The site has a history of LUST reports received between 1993 and 2009. Ecology performed an initial investigation in late 2011. Petroleum products were detected below cleanup levels in groundwater and soil. Non-halogenated organics were confirmed above cleanup levels in groundwater. A no further action notice has not been issued for this site.
35	71217895	3703	Sholund Family Farm	This site requires no further action under MTCA. Metals have been remediated in the soil and groundwater, and petroleum product has been remediated from the soil.
36	73713224	7120	CFM Site	The site is awaiting cleanup under MTCA. LUST notifications were issued in 1991 and 1996, and an initial investigation was performed in 2005. Petroleum contamination is confirmed above cleanup levels in the soil and suspected in groundwater.
37	81695495	10621	Battle Ground School District 119	The site is being cleaned up under MTCA, an Ecology supervised/conducted cleanup has been started. A LUST was identified in 1990 with a number of reports received thereafter. A discovery/release report was filed in 2010. Petroleum contamination is confirmed above cleanup levels in the soil and groundwater.
38	82713854	10658	Draper CF DBA / Drapers City Cleaners	This site is reported as cleaned up under MTCA. Petroleum (gasoline and other) products are below cleanup levels in the soil, and diesel contamination is reported as suspected inthe soil. A no further action notice has not been reported for this site.
39	86416754	578	Graces Cleaners	This site is being cleaned up under MTCA and the voluntary cleanup program. Contamination occurs in the soil. Halogenated organics are reported as remediated and phenolic compounds have been confirmed above cleanup levels.
40	89645195	3708	WA DOT Battle Ground	The site is being cleaned up under MTCA, an Ecology supervised/conducted cleanup has been started. Metals and petroleum products are confirmed above cleanup levels in the soil.
41	90426683	11004	Battle Ground Inn	This site is reported as cleaned up under MTCA. Diesel and other petroleum products were remediated below cleanup levels from the soil. A no further action notice has not been issued for this site.

Table 7
City's Chain-of-Command for Spill Response

Title	Name	Email	Phone	Cell/Pager
1. On Duty Battalion Chief (Clark Co. Fire & Rescue)	Variable	n/a	360-887-4609 (CCF&R)	360-607-3255
2. City Engineer & Public Works Director	Scott Sawyer	scott.sawyer@cityofbg.org	360-342-5075	360-608-0567
3. Public Works Foremen	Cal Newton	cal.newton@cityofbg.org	360-342-5365	360-798-7044
4. Maintenance Worker	Shawn Scott	shawn.scott@cityofbg.org	360-342-5364	360-798-7822

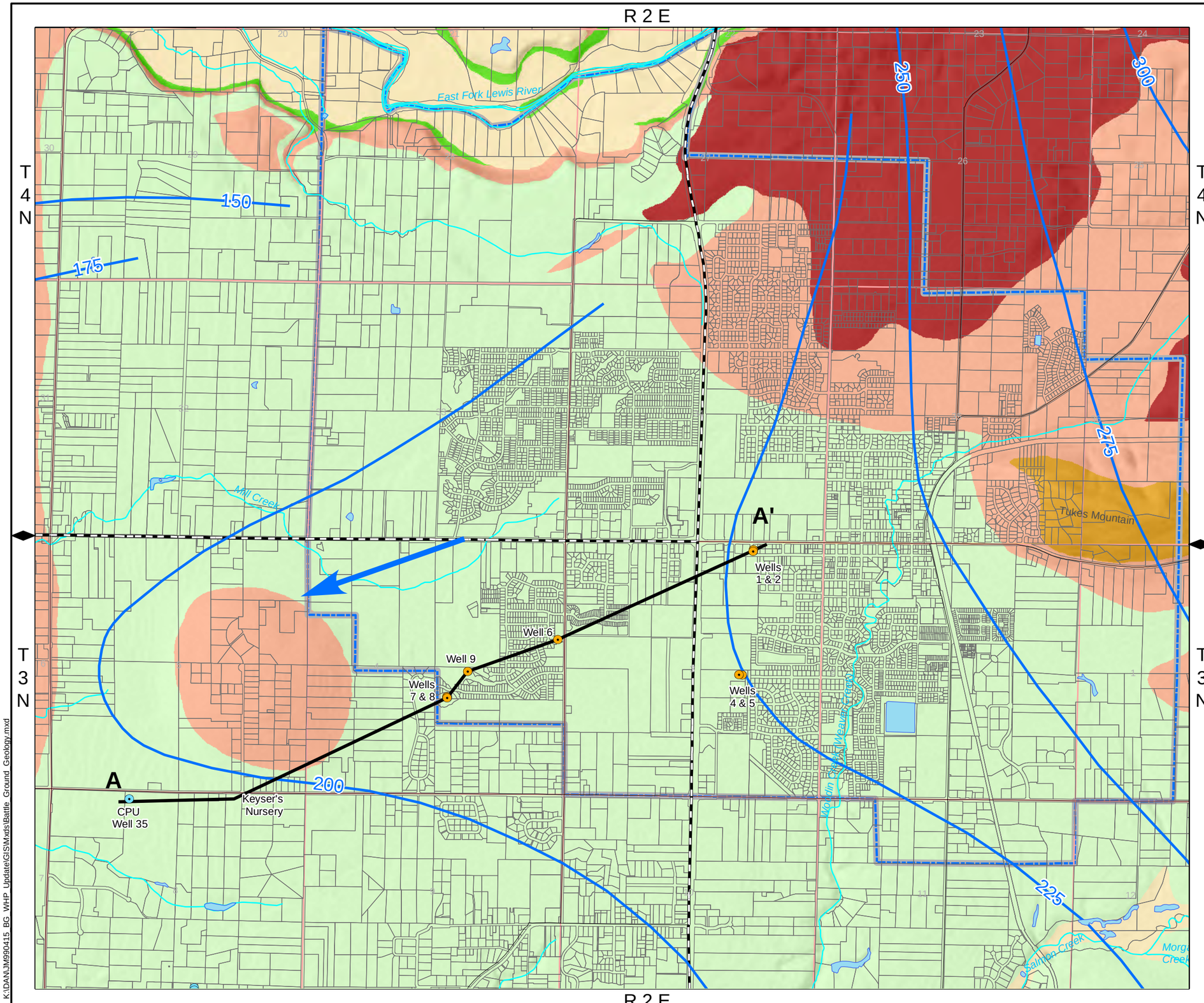


Figure 1
Surficial Geologic Map and Cross Section Alignments

Prepared for
City of Battle Ground

Prepared by
Pacific Groundwater Group

- Battle Ground Supply Well
- Other Wells
- Cross Section Allignment
- Water Service Area Boundary
- Taxlot Outlines
- Water Feature

Groundwater Levels

- Upper Troutdale Aquifer Water Level Contours*
- Estimated SGA Groundwater Flow Direction

Surficial Geology**

- Recent Alluvial Deposits
- Pleistocene Alluvial Deposits
- Upper Troutdale Formation
- SGA (Sand & Gravel Aquifer)
- Boring Lava
- Bedrock

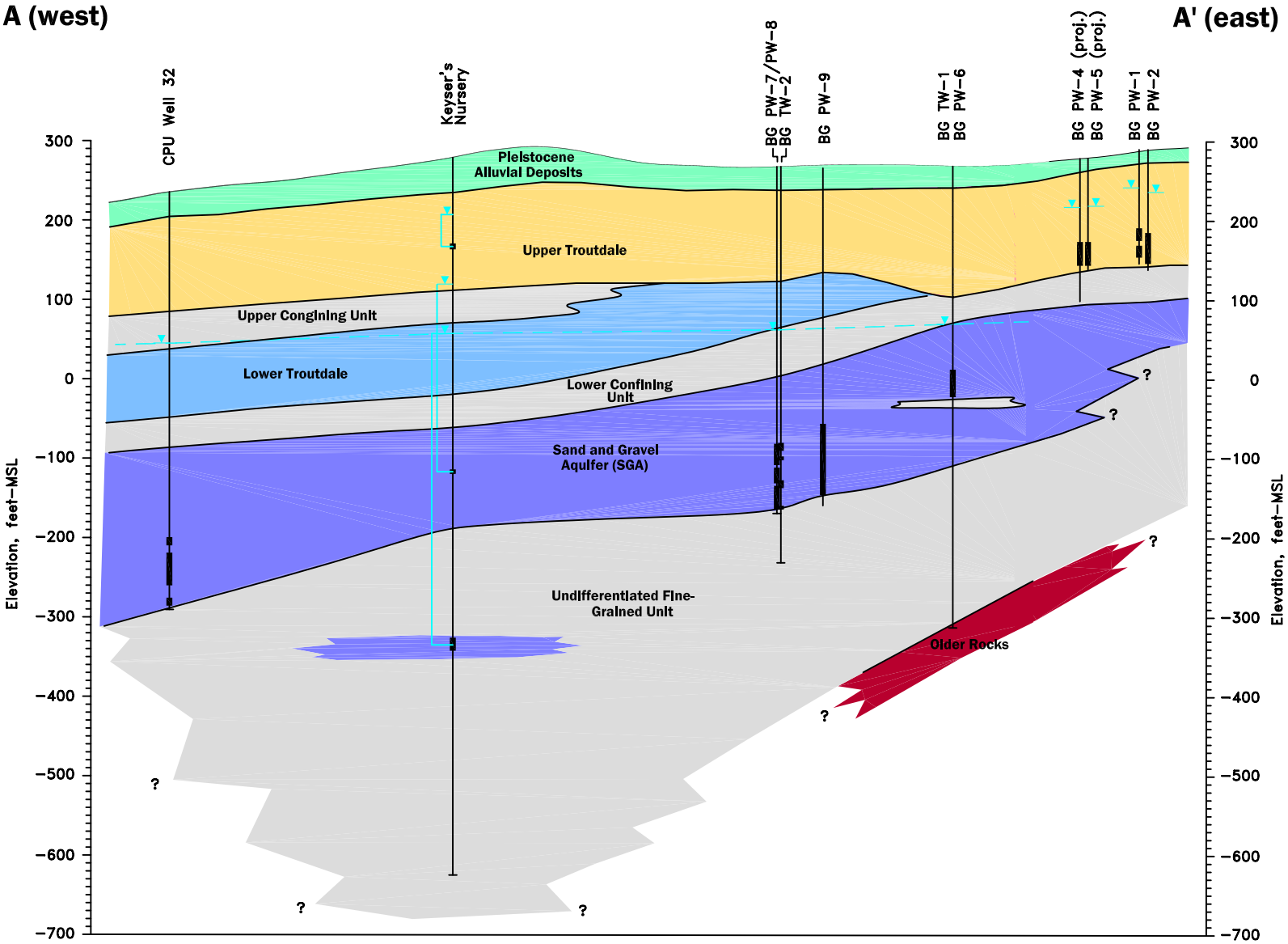
* From Swanson et al, 1993

**Modified from Howard 2002, Geologic Map of the Battle Ground Quadrangle, USGS MF-2395

0 2,000 Feet

Map Projected in Washington State Plane, South Zone, NAD83 Datum

K:\DAN\JM990415_BG_WHP_Update\GIS\Mxds\Battle_Ground_Geology.mxd



LEGEND

- Pleistocene Alluvial Deposits
- Upper Troutdale Aquifer
- Lower Troutdale Aquifer
- Sand and Gravel Aquifer (SGA)
- Confining Units
- Older Rocks

Well Completion Details

- Static Water Level
- Open Interval

Piezometric Surface for Sand and Gravel Aquifer

Vertical Scale in Feet
0 100 200
0 1000 2000
Horizontal Scale in Feet

Figure 2
Hydrogeologic Profile A-A'

Battle Ground
Wellhead Protection Plan - 2012

JM9904.08, xseca1.DWG, June/2004

PgG

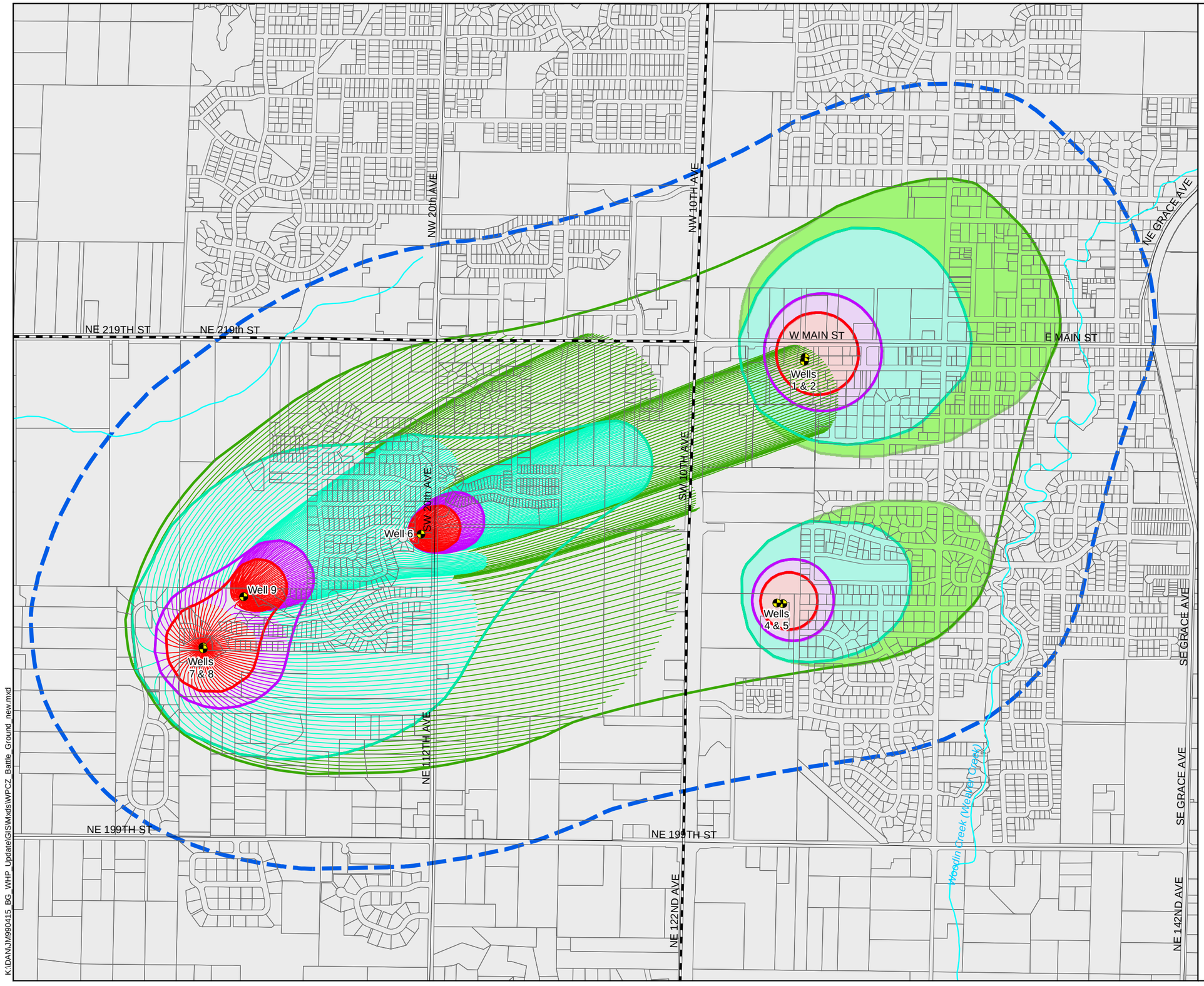


Figure 3
Wellhead Protection Capture Zones

Prepared for
City of Battle Ground

Prepared by
Pacific Groundwater Group

Battle Ground Supply Well
Taxlots

SGA Capture Zone Modeling
0 to 6 Month Particle Trace
6 to 12-Month Particle Trace
1 to 5-Year Particle Trace
5 to 10-Year Particle Trace

Upper Troutdale Aquifer Modeling (Swanson, 1993)
6 Month Capture Zone
1 Year Capture Zone
5 Year Capture Zone
10 Year Capture Zone

Extended Wellhead Protection Capture Zones
6 Month Capture Zone
1 Year Capture Zone
5 Year Capture Zone
10 Year Capture Zone
1000-foot Buffer

0 1,000 Feet

Map Projected in Washington State Plane, South Zone, NAD83 Datum

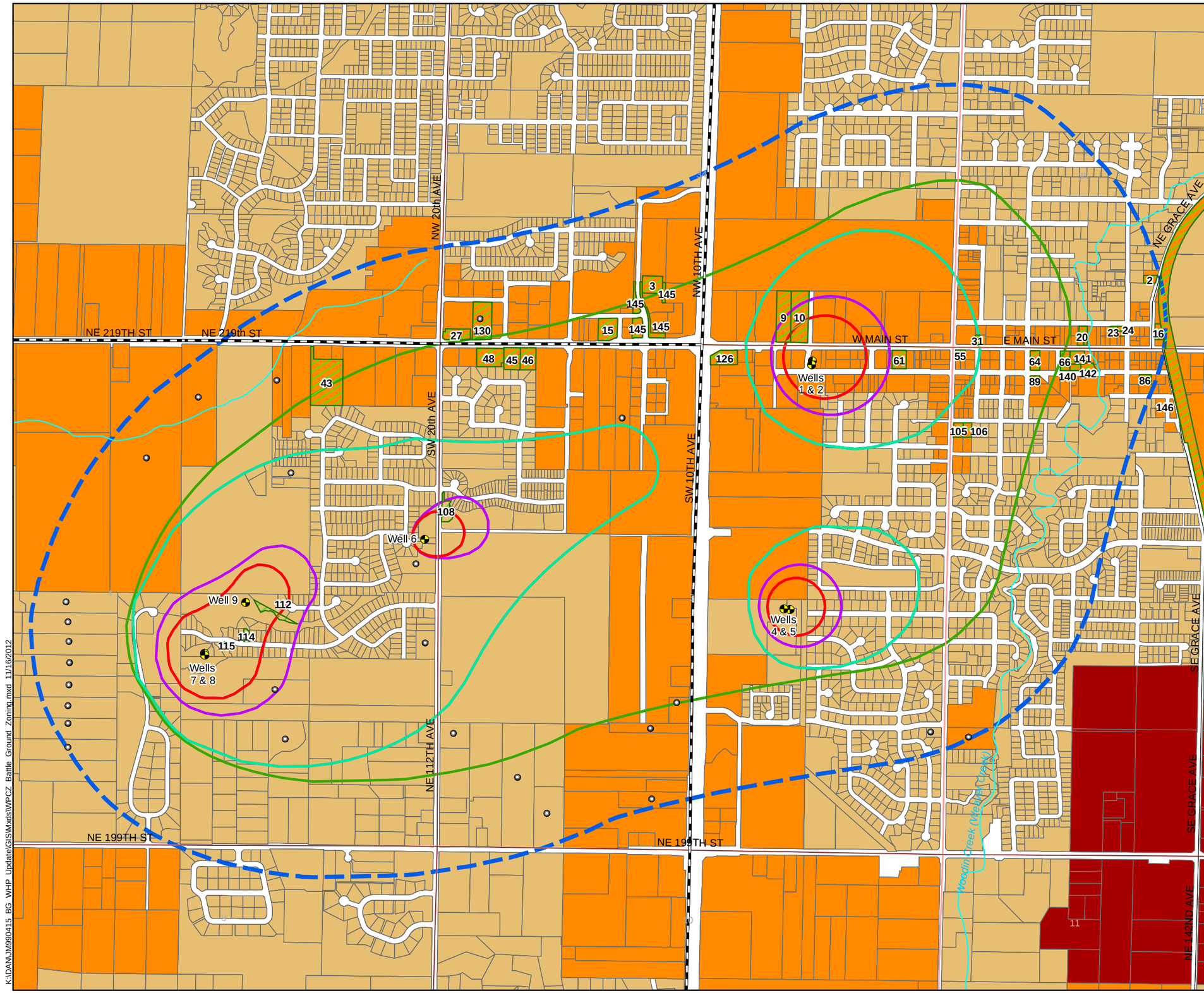


Figure 4

Zoning and Parcels of Concern

Prepared for
City of Battle Ground

Prepared by
Pacific Groundwater Group

Battle Ground Supply Well

86 Parcels of Concern

Septic Systems (from County)

Zoning Categories

- Industrial
- Residential
- Commercial
- Park/OS/Public

Extended Wellhead Protection Capture Zones

- 6 Month Capture Zone
- 1 Year Capture Zone
- 5 Year Capture Zone
- 10 Year Capture Zone
- 1000-foot Buffer

0 1,000 Feet

Map Projected in Washington State Plane, South Zone, NAD83 Datum

K:\DAN\M990415_BG_WHP_Update\GIS\Mxds\WPCZ_Battle_Ground_Zoning.mxd 11/16/2012

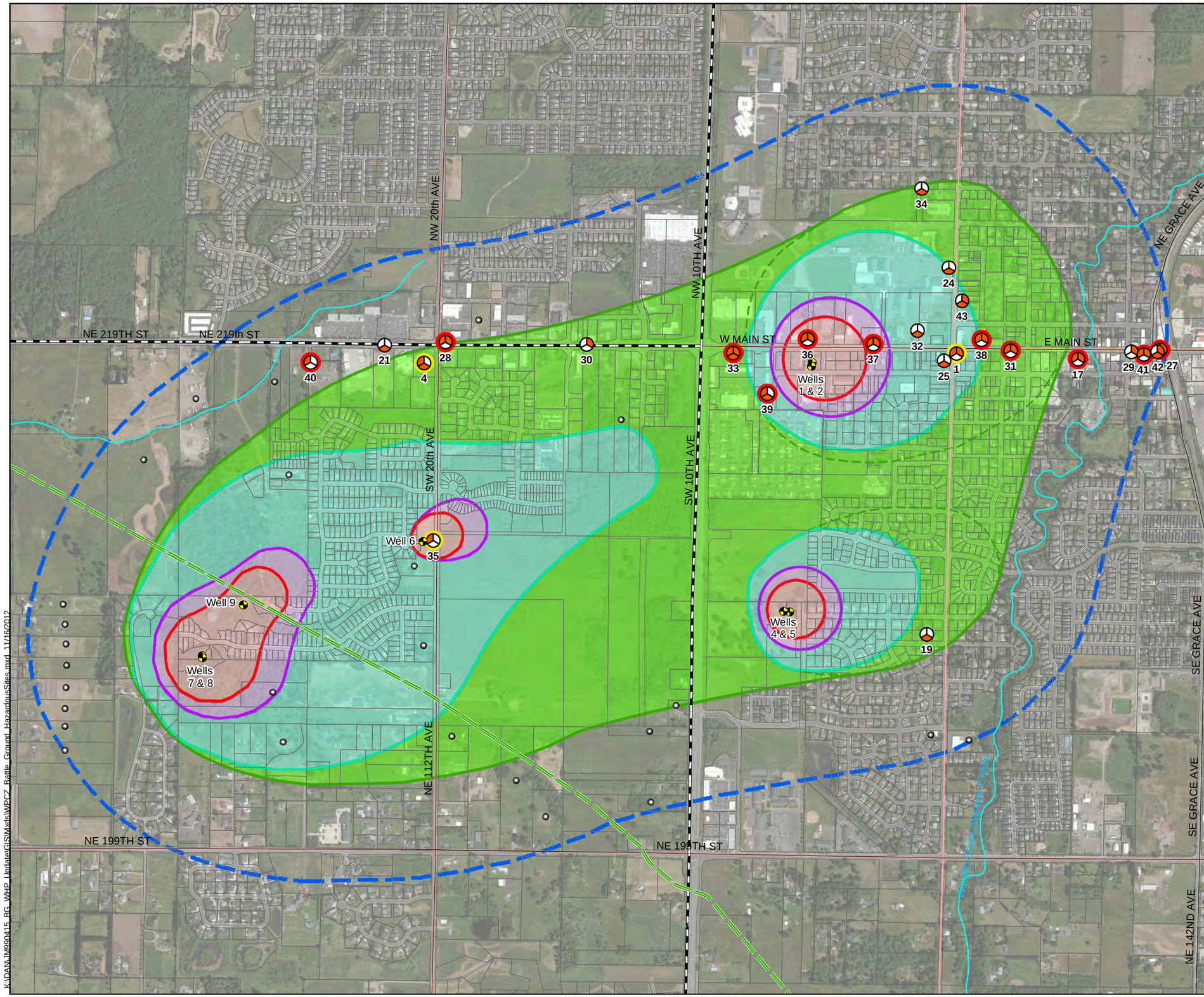


Figure 5

Environmental Sites within Wellhead Protection Capture Zones

Prepared for
City of Battle Ground

Prepared by
Pacific Groundwater Group

Battle Ground Supply Well

DOE Sites of Concern

Known Release

Known Release (No Further Action)

Table 5 ID → 11

Cleanup Site

UST/LUST

Hazardous Materials

Refer to Section 4.3 and Table 5 for description.

Septic Systems (from County)

Gas Transmission Pipelines

Wellhead Protection Capture Zones

6 Month Capture Zone

1 Year Capture Zone

5 Year Capture Zone

10 Year Capture Zone

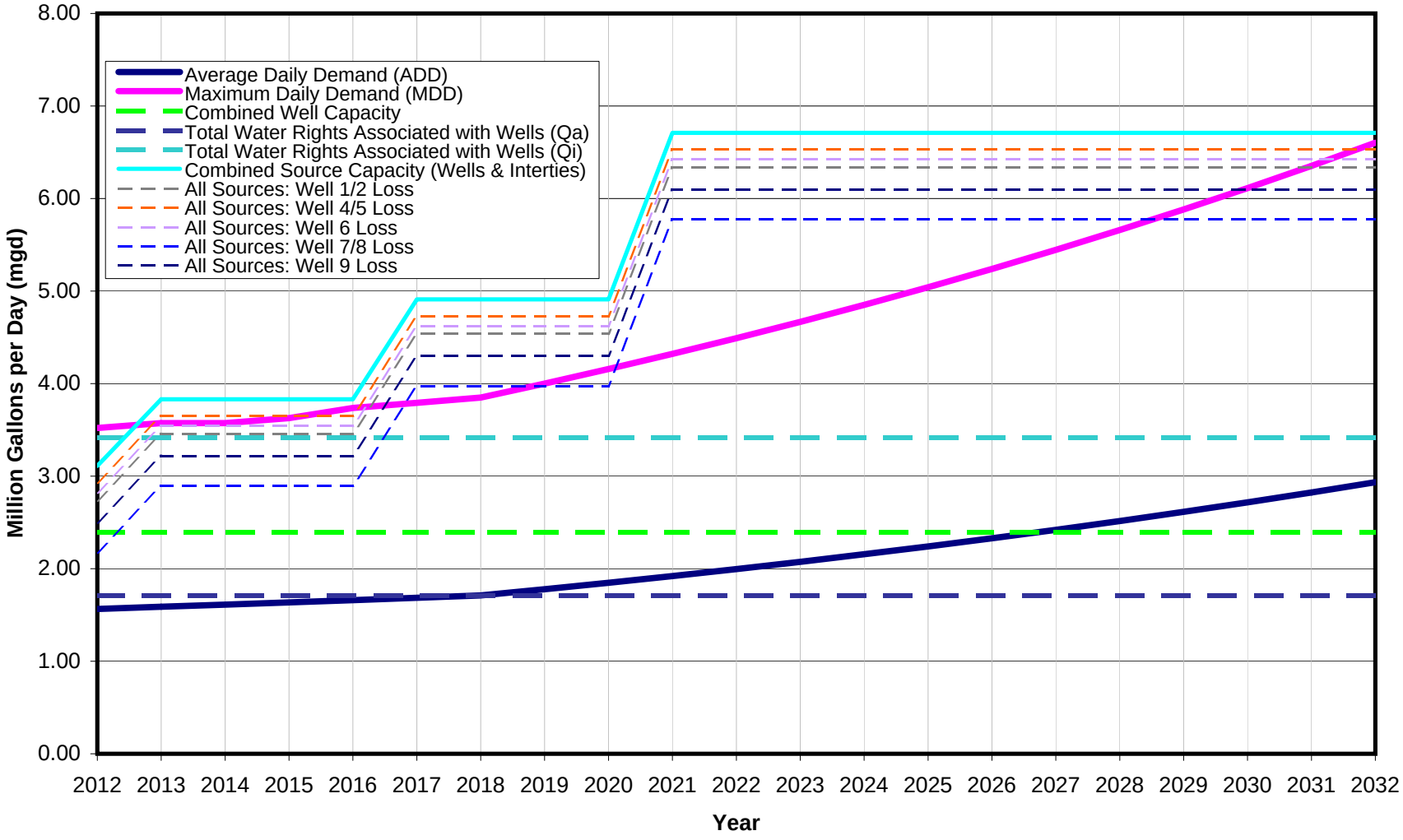
1000-foot Buffer

0 1,000 Feet

Map Projected in Washington State Plane, South Zone, NAD83 Datum

K:\DAN\IM990415_BG_WHP_Update\GIS\Mxds\WPCZ_Battle_Ground_HazardousSites.mxd 11/16/2012

Figure 6
City of Battle Ground
Source of Supply Scenarios vs. Demand



APPENDIX A
DOCUMENTATION OF WELLHEAD PROTECTION PROGRAM NOTIFICATIONS

[

Wellhead Protection Guidance (WDOH, 2010) states that within one year after defining the wellhead protection area boundaries, the water system must notify the identified potential contaminant sources—and the agencies or jurisdictions that regulate them—that they are in the wellhead protection area. Notification must be in writing. The water system must maintain documentation of the required notifications.

PGG recommends that the City send letters out to all "parcels of concern" listed on **Table 4** (addresses are included on the Table), all environmental sites listed on **Table 3** (addresses are listed on **Table A-1**), and relevant agencies. A sample letter for the parcels of concern and the environmental sites is included below, followed by sample letters for Ecology, the Police Department and the Fire Department. Letters to these three agencies should be accompanied by the map of environmental sites (**Figure A-1**). The letter to Ecology should also be accompanied by **Table A-1**.

Sample Letter to Potential Source Owners/Operators:

Date

Address of local business (*see Table 4 or Table A-1*)

Re: City of Battle Ground Wellhead Protection Plan

To Whom It May Concern:

The City of Battle Ground has developed a Wellhead Protection Plan to help maintain drinking water quality for our city residents. The Plan is based on Washington Department of Health WAC 246-290-135(3) regulations. As part of the Plan, maps were prepared that show the areas around each city drinking water well where a chemical spill on the ground may cause contamination of the well/aquifer. These areas are Wellhead Protection Areas (WHPA). The Plan also requires an inventory of potential sources of groundwater contamination within these wellhead protection areas.

The primary purpose of this letter is to notify you that your facility is located within our WHPA. Since your business or the activities conducted at your facility may involve the use of chemicals (e.g., gasoline, underground storage tanks, hazardous waste, etc.), and the potential exists that a chemical spill from your facility may adversely impact the city drinking water supply, please notify the City of Battle Ground immediately if a chemical spill occurs at your facility. All spills should be reported by dialing 911 and requesting that the City of Battle Ground Fire Department and Southwest Washington Health Department be contacted.

Thank you for assisting us in protecting our water supply and groundwater resources. If you have any questions, please contact me at (360) 772-1283.

Sincerely,

Elaine Huber, P.E.
Operations Manager
City of Battle Ground

Sample Letter to Ecology:

Date

Department of Ecology
Southwest Regional Office
PO Box 47775
Olympia, WA 98504-7775

Re: City of Washougal Wellhead Protection Plan

Dear Department of Ecology:

The City of Battle Ground has developed a Wellhead Protection Plan to help maintain the drinking water quality for our city residents. The Plan is based on Washington Department of Health WAC 246-290-135(3) regulations. As part of the Plan, maps were prepared that show the areas around each city drinking water well where a chemical spill on the ground may cause contamination of the well/aquifer. These areas are Wellhead Protection Areas (WHPA).

The enclosed map depicts the WHPA boundary, source wells, and identified potential contaminant sources. Also enclosed is a table with names and location information for each site. Please review the map and use it as a reference when inspecting and permitting the storage, use, and disposal of hazardous material within our WHPA.

Please note that the City of Battle Ground has sent notices to each of these properties informing them of their location within the WHPA boundary. The City has also sent similar letters to properties with land uses that could contaminate groundwater quality.

Thank you for your attention in this matter. If you have any questions or would like a copy of the wellhead protection plan, please contact me at (360) 772-1283.

Sincerely,

Elaine Huber, P.E.
Operations Manager
City of Battle Ground

Sample Letter to Police Department:

Date

Bob Richardson, Police Chief
Battle Ground Police Department
507 S.W. 1st St.
Battle Ground, WA 98604

Re: City of Battle Ground Wellhead Protection Plan

Dear Chief Richardson:

The City of Battle Ground has developed a Wellhead Protection Plan to help maintain the drinking water quality for our city residents. The Plan is based on Washington Department of Health WAC 246-290-135(3) regulations. As part of the Plan, maps were prepared that show the areas around each city drinking water well where a chemical spill on the ground may cause contamination of the well/aquifer. These areas are Wellhead Protection Areas (WHPA).

As part of this Plan, the city must provide wellhead protection information to agencies responsible for incident/spill response procedures. It is important that you are aware of where potential contaminant releases could adversely impact the quality of our communities drinking water supply.

A map of the wellhead protection areas and adjacent transportation routes is enclosed for your review. An acknowledgement of receipt of this information or a response from your office as part of our wellhead protection plan documentation would be appreciated.

In the event of a spill or contaminant release, we would ask that you notify immediately us and the Department of Ecology, so that we can take appropriate measures to deal with the problem.

Thank you for your attention in this matter. If you have any questions or would like a copy of the wellhead protection plan, please contact me at (360) 772-1283.

Sincerely,

Elaine Huber, P.E.
Operations Manager
City of Battle Ground

Sample Letter to Fire Department:

Date

Chief Dennis Mason
Clark County Fire District No. 11
21609 NE 72 AVE
Battle Ground, WA

Re: City of Battle Ground Wellhead Protection Plan

Dear Chief Mason:

The City of Battle Ground has developed a Wellhead Protection Plan to help maintain the drinking water quality for our city residents. The Plan is based on Washington Department of Health WAC 246-290-135(3) regulations. As part of the Plan, maps were prepared that show the areas around each city drinking water well where a chemical spill on the ground may cause contamination of the well/aquifer. These areas are Wellhead Protection Areas (WHPA).

As part of this Plan, the city must provide wellhead protection information to agencies responsible for incident/spill response procedures. It is important that you are aware of where potential contaminant releases could adversely impact the quality of our communities drinking water supply.

A map of the wellhead protection areas and adjacent transportation routes is enclosed for your review. An acknowledgement of receipt of this information or a response from your office as part of our wellhead protection plan documentation would be appreciated.

In the event of a spill or contaminant release, we would ask that you notify immediately us and the Department of Ecology, so that we can take appropriate measures to deal with the problem.

Thank you for your attention in this matter. If you have any questions or would like a copy of the wellhead protection plan, please contact me at (360) 772-1283.

Sincerely,

Elaine Huber, P.E.
Operations Manager
City of Battle Ground

Table A-1: Environmental Site Mailing List for Wellhead Protection Area Notification

Map ID	Facility/Site ID	Cleanup Site ID	Facility/Site Name	Address	City	State	Zip Code	Latitude	Longitude
21	3506334		Albertsons 592	2108 W MAIN ST	BATTLE GROUND	WA	98604	45.780538	-122.560522
25	7256537		Andersen Dairy Inc	305 E MAIN ST	BATTLE GROUND	WA	98604-4501	45.780508	-122.537692
17	23782	5228	Battle Ground Chevron	409 E MAIN ST	BATTLE GROUND	WA	98604	45.780648	-122.53223
31	32749129	5875	Battle Ground Farm & Home	106 MAIN ST E	BATTLE GROUND	WA	98604-4516	45.78084	-122.53499
41	90426683	11004	Battle Ground Inn	711 E MAIN ST	BATTLE GROUND	WA	98604	45.78083	-122.52955
27	9977600	5509	Battle Ground Mini Mart 805	813 W MAIN ST	BATTLE GROUND	WA	98604	45.780972	-122.528889
24	7134825		Battle Ground School District 119	300 NORTH PARKWAY	BATTLE GROUND	WA	98604	45.783163	-122.537596
37	81695495	10621	Battle Ground School District 119	204 MAIN ST W	BATTLE GROUND	WA	98604-9109	45.78093	-122.54059
28	15491331	5582	Battle Ground Utility Trench Scott Bros	1912 W MAIN	BATTLE GROUND	WA	98604	45.78067	-122.55804
32	37223232		Cenex Harvest States Old Station	210 SE 1ST ST	BATTLE GROUND	WA	98604-8316	45.781343	-122.538806
36	73713224	7120	CFM Site	510 W MAIN	BATTLE GROUND	WA	98604-0458	45.78102	-122.54328
42	92132423		Dorsey Bus Service Inc Main St E	1017 MAIN ST E	BATTLE GROUND	WA	98604-4549	45.780917	-122.528998
38	82713854	10658	Draper Cf Dba Drapers City Cleaners	114 MAIN ST E	BATTLE GROUND	WA	98604-0417	45.78113	-122.53619
39	86416754	578	Graces Cleaners	717 W MAIN	BATTLE GROUND	WA	98604	45.780563	-122.545009
33	58523474	9812	Jacksons Food Stores 500	917 W MAIN	BATTLE GROUND	WA	98604	45.78057	-122.5463
29	25875197		Lewis Rock & Redi Mix Inc Main St	915 MAIN ST E	BATTLE GROUND	WA	98604-0100	45.780897	-122.530058
34	64531412		Parkway North Health Care Nurs	404 N PARKWAY	BATTLE GROUND	WA	98604	45.7854	-122.53879
43	99375277		QWEST Communications Battleground CDO	BEACH ST BTWN 1ST & MAIN	BATTLE GROUND	WA	98604	45.78223	-122.53702
35	71217895	3703	Sholund Family Farm	20806 NE 112TH AVE	BATTLE GROUND	WA	98604-7409	45.774999	-122.558333
1	1051	4980	Union 76	13 E MAIN ST	BATTLE GROUND	WA	98604-4522	45.78072	-122.53719
4	4282	11627	Vancouver Clinic Battle Ground	2005 W MAIN ST	BATTLE GROUND	WA	98604	45.780055	-122.558897
30	31157289		Village Mart	16 NW 13TH AVE	BATTLE GROUND	WA	98604-4379	45.780707	-122.552288
40	89645195	3708	WA DOT Battle Ground	10707 NE 219TH ST	BATTLE GROUND	WA	98604	45.77999	-122.56352
19	1577475		Williams Gas Pipelines Northwest Pipeline	2513 SW 11TH ST	BATTLE GROUND	WA	98604	45.77269	-122.53811

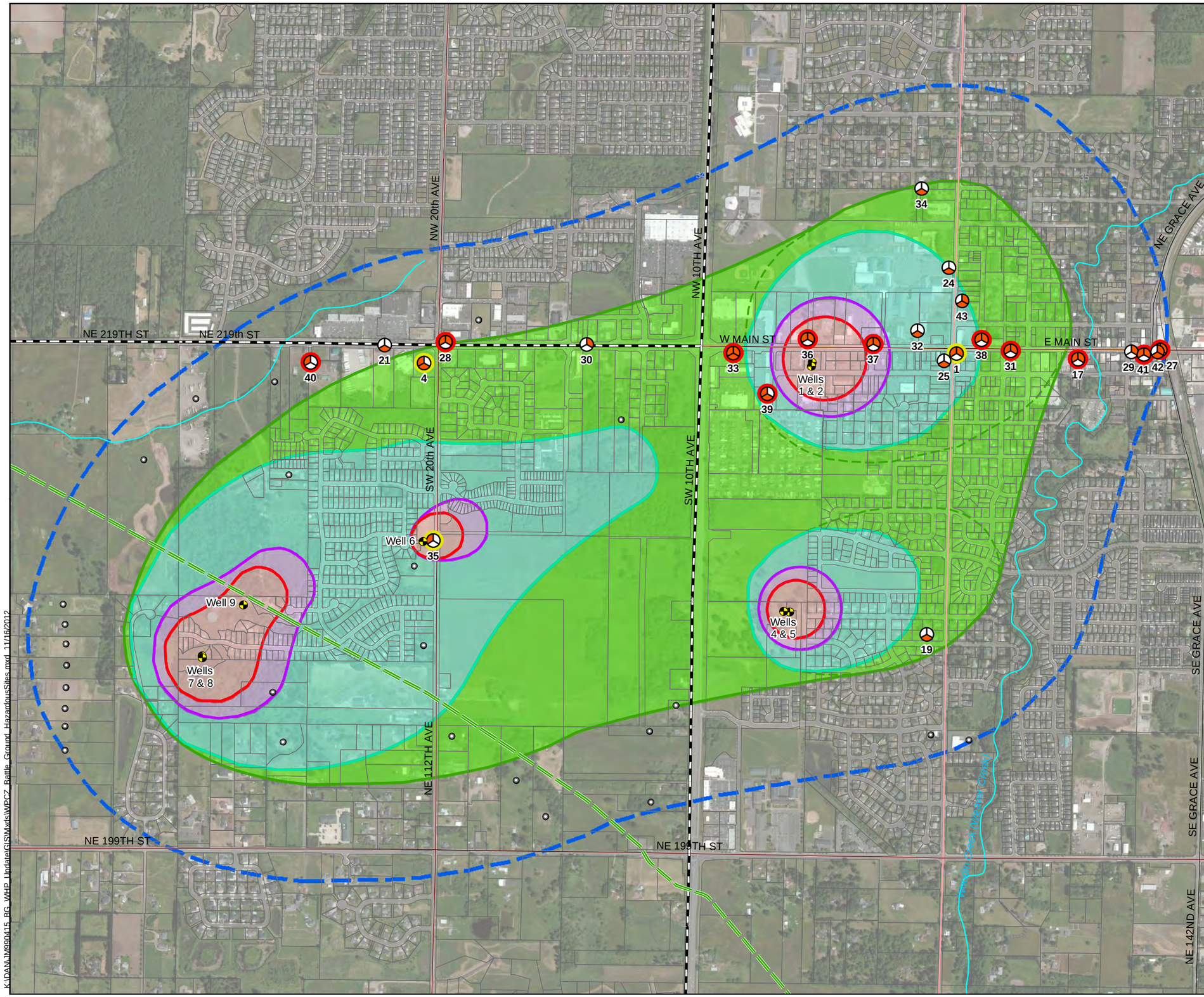


Figure A-1

Environmental Sites within Wellhead Protection Capture Zones

Prepared for
City of Battle Ground

Prepared by
Pacific Groundwater Group

Battle Ground Supply Well

DOE Sites of Concern

Known Release

Known Release (No Further Action)

Table 5 ID → 11 ← UST/LUST

Cleanup Site

Hazardous Materials

Refer to Section 4.3 and Table 5 for description.

Septic Systems (from County)

Gas Transmission Pipelines

Wellhead Protection Capture Zones

6 Month Capture Zone

1 Year Capture Zone

5 Year Capture Zone

10 Year Capture Zone

1000-foot Buffer

0 1,000 Feet

Map Projected in Washington State Plane, South Zone, NAD83 Datum

K:\DAN\IM990415_BG_WHP_Update\GIS\Mxds\WPCZ_Battle_Ground_HazardousSites.mxd 11/16/2012