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Earth and Environmental Technologies

City of Kent
Wellhead Protection Program
Clark, Kent, and
Armstrong Springs

Prepared for
City of Kent

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Executive Summary

EXECUTIVE SUMMARY

A wellhead protection program (WHPP) is being developed by the City of Kent (City) for the Clark, Kent, and Armstrong Springs water supply sources. The wellhead protection program is designed to protect groundwater resources supplying public wells used for drinking water. Development of the wellhead protection program is mandated by the 1986 Amendments to the Safe Drinking Water Act and the Washington State Drinking Water Regulations (WAC 246-290-135). The wellhead protection program builds on the South King County Groundwater Management planning process and is an important local tool for protecting groundwater quality. Delineation of wellhead protection areas helps to identify the most important areas of focus for protecting water supplies and the most appropriate areas to focus limited funding resources.

This project began in 1991 when the City applied to the Washington State Department of Ecology (Ecology) for a Centennial Fund Grant to help fund the program development. A Grant was awarded in 1992. The City is conducting program development efforts with the Covington Water District and Water District No. 111 who are simultaneously developing wellhead protection programs. Coordination efforts have occurred through a Project Review Committee set up for review and input to the process and including representatives from the three purveyors as well as the Seattle-King County Health Department, the State Department of Health, and Ecology's Water Quality Program.

Hydrogeology and Wellhead Protection Area Delineation

The City derives its water from shallow, highly transmissive, glacial outwash aquifers without significant confining layers between ground surface and the depth of groundwater withdrawal. Infiltration of precipitation is the principal source of recharge to the groundwater system in the study area. Infiltration is high in the permeable outwash sediments that comprise much of the area, particularly in the eastern foothills where precipitation averages 58 inches per year. The till-capped uplands provide recharge through runoff to the surrounding, highly permeable outwash channel deposits. Surface water features like Lake Sawyer provide some additional recharge to the groundwater system.

Groundwater flow in the area is predominantly east to west from the high recharge area of the foothills east of Clark Springs through two principal aquifers, the Vashon Recessional Outwash (Qvr) and the deeper, older Qc(2) glacial deposits. In the western area, till lies between the recessional outwash and the deeper Qc(2) aquifer in some locations; however, at the City's Kent Springs and Armstrong Springs properties the till seems to be absent, and these two aquifers are connected. In these areas the aquifer is more highly susceptible to contamination.

The east to west flow pattern creates capture zones that extend eastward from the wellheads. The wellhead capture zones were delineated through development of a regional groundwater flow model. The groundwater flow model, based in MODFLOW, was used in conjunction with a particle tracking model, PATH3D, to define 1-, 5-, and 10-year time of travel zones. An assessment of data uncertainties and coordination of management efforts with the area water

districts resulted in development of a composite Kent/Covington Wellhead Protection Area (WHPA).

Potential Contaminant Sources

With the WHPA defined, effort was focused on identifying potential groundwater contaminant sources within the WHPA and ranking the risks associated with those contaminant sources. Potential contaminant sources were identified based on review of current and historical land uses within the WHPA, review of regulatory agency database lists and files, and a windshield survey to reconnaissance for other unknown sites. Inventory considerations and methodology were reviewed by the Wellhead Protection Project Review Committee.

Potential sources of contamination were identified and ranked according to their potential risk. The ranking was performed in general accordance with the EPA Guidance Document entitled Managing Groundwater Contamination Sources in Wellhead Protection Areas: A Priority Setting Approach. The highest ranked risks to groundwater quality within the WHPA, in order of decreasing priority, were:

- Residential - medium-density land uses;
- Residential - rural land uses;
- Transportation corridors;
- Industrial/Commercial sites;
- Forestry land uses; and
- Mining land uses.

Proximity to the wellhead was given the highest priority level risk for each of the sources considered. This was followed by the type of contamination and the severity of the contamination, respectively, as the next priority levels. Contaminated sites identified in the regulatory databases ranked as the top priority risk for the Armstrong Springs source. For the Kent Springs source medium-density residential, rural residential, and transportation corridors ranked as top priority risks. The Landsburg mine ranked as the top priority risk for the Clark Springs source, followed by medium-density and rural residential land uses.

Management Strategies

Wellhead protection management tasks were developed based on our review of the tasks included in the South King County Groundwater Management Plan and our technical knowledge of the WHPA issues. Forty-eight tasks were developed in consort with the Wellhead Protection Project Review Committee. These tasks were created to help mitigate high priority risks to groundwater quality as identified above. Management strategies were then developed, based on the concept that an implementation steering group would need to "manage" the tasks in certain ways to implement the program. The management strategies were developed as follows:

- Management and Cooperation Strategies
  - Establish a WHP steering group.

- Manage large land parcels using Best Management Practices.

- Land Use Strategies
  - Consider special protection area designations for the WHPA.

- Regulatory Strategies
  - Perform hydrogeologic analyses for parcels which trigger SEPA review.
  - Delegate well drilling oversight authority to King County. Encourage frequent inspection of well installation.
  - Require engineering as-builts of septic systems to be recorded with the property deed.

- Planning Strategies
  - Require industrial and commercial facilities to connect to sanitary sewer. Develop emergency plans for sewer breaks.
  - Encourage funding of farm plans such that groundwater protection issues are identified and managed.
  - Encourage research of storm water discharge on aquifer quantity and quality. Evaluate the adequacy of storm water facilities.
  - Document the location and use of petroleum pipelines. Ensure that emergency response efforts are coordinated.
  - Investigate the feasibility of re-routing hazardous materials transport out of Zone 1 of the WHPA.
  - Establish formal communication with first responders for transportation hazardous materials incidents.

- Data Management Strategies
  - Participate in regional and local groundwater monitoring strategies. Implement the monitoring plan.
  - Conduct herbicide and pesticide use surveys. Encourage vegetation management practices which do not use chemicals.
  - Inventory underground storage tanks (including exempt tanks) within Zone 1 of the WHPA.
  - Encourage King County to monitor dry wells within the WHPA.
  - Inventory abandoned wells within the WHPA.

- Education Strategies
  - Continue public education program with focus toward protection of the WHPA.

Other WHPP Elements

There are three other elements of this WHPP which are required by the state program. They include a monitoring plan, spill response plan, and a water supply contingency plan.

The monitoring plan identifies a program for water level and water quality monitoring in selected areas throughout the WHPA. These data will be used to measure any water quality

degradation and will provide an early warning of groundwater quality changes. The monitoring plan also describes focused hydrogeologic studies that will be needed to more accurately interpret the monitoring data and refine the regional groundwater flow model developed for this project. Refinement of the regional flow model will provide a management tool for making both groundwater quality and quantity decisions into the future.

Spill response planning exists throughout national, state, and local programs. Depending on the nature and location of the spill incident, the local Fire Department and the State Patrol are normally the first responders for highway-related incidents, and Ecology is the lead agency for environmental pollution (i.e., hazardous waste spill).

Locally, the City of Kent is responsible for assisting the local fire districts with Hazardous Material Response within the WHPA. The City has a hazardous material response plan which identifies the personnel and procedures that are used in response to a hazardous materials incident within the WHPA. A copy of the response plan is included in Appendix D.

The water supply contingency plan identifies possible steps that could be taken to seek alternate supplies of water if one of the sources within the WHPA becomes contaminated. These steps include activating existing interties, treating contaminated groundwater at the source, or exploring for new sources of groundwater.

Introduction

CITY OF KENT
WELLHEAD PROTECTION PROGRAM FOR CLARK, KENT, AND ARMSTRONG SPRINGS

1.0 INTRODUCTION

The City of Kent began development of a wellhead protection program in August of 1993 for the Clark Springs, Kent Springs, and Armstrong Springs water supply source areas. The purpose of the wellhead protection project is to develop a program to protect long-term water quality at these three groundwater sources. These sources represent approximately 95% of the City's water supply. The Kent Wellhead Protection Program (WHPP) was developed in four parts, generally consistent with the Washington State Department of Health guidelines as follows:

- Evaluation of the hydrogeologic framework for the area around the springs;
- Delineation of Wellhead Protection Areas (WHPAs) based on time-related capture zones for each of the spring sources;
- Identification of potential and known sources of groundwater contamination within the WHPA; and
- Development of management strategies to minimize the threat of those potential and known sources of most concern.

The City's three spring source areas are located in the southeastern portion of King County as shown on the Vicinity Map, Figure 1-1. The springs source areas are within small land parcels owned by the City of Kent but surrounded by unincorporated King County. Most of the study area falls within the south half of Township 22 North, Range 6 East, but also includes an area of 1 to 2 square miles west, south, and east of this Township and Range.

The need for this work was recognized by the City because of the high susceptibility of the spring sources to contamination. The springs are fed by groundwater from shallow, highly transmissive glacial outwash aquifers surrounded by till and bedrock. These aquifers are rapidly recharged, often lack significant confining units, and are located in low lying, confined basins that tend to funnel surface water into the aquifer recharge area.

In 1991 the City began a proactive effort to evaluate ways to protect these high-quality, yet vulnerable, water supply sources. A Centennial Fund grant was applied for to assist in the effort of developing wellhead protection prior to the state's completion of a statewide wellhead program. A grant (G9400034) was awarded in 1992 from the Washington State Department of Ecology (Ecology) and is helping to fund this program development.

1.1 Scope of Kent's WHPP and Report Organization

This report documents the program developed over the past two years under the Centennial Fund grant and as a cooperative effort among the local purveyors which included Covington Water District, Water District No. 111, as well as the City of Kent. Specifically, this report begins by describing the hydrogeology of the area and the methods and analyses used for delineating the Wellhead Protection Area (WHPA) around the three spring sources (Sections 2.0 and 3.0). The known and potential contaminant sources within the WHPA, and their relative risk to groundwater quality, are presented in Section 4.0. Section 5.0 describes existing regulatory programs and how they work to protect groundwater quality. Management strategies and recommended tasks for protecting the WHPA are presented in Section 6.0. Section 7.0 contains the monitoring plan for the WHPA. The spill response plan and water supply contingency plan are contained in Sections 8.0 and 9.0, respectively. Section 10.0 presents a list of references cited in this report. Tables and figures supporting these sections are numbered to correspond to and are presented within or at the end of their respective sections.

There are four appendices included in the document. Appendix A includes the hydrogeologic data analysis. Appendix B includes the groundwater modeling procedures. The management tasks database is included in Appendix C; Appendix D contains a copy of the City of Kent Hazardous Materials Response Plan.

1.2 Coordination of Wellhead Protection Program Development

The City of Kent is coordinating WHPP elements with the Covington Water District and Water District No. 111 who are simultaneously developing wellhead protection programs for the Lake Sawyer Wellfield and North Meridian Aquifer, respectively. Covington's Lake Sawyer wellfield is located approximately 1,000 feet southwest of the City's Kent Springs source area. Water District No. 111's North Meridian Aquifer study area is located approximately 1 mile northwest of the Armstrong Springs Source, in area soon to be annexed by the City of Kent. Technical data were shared and regular meetings were held to coordinate source inventory efforts and to develop consistent management strategies.

A Project Review Committee was set up by Covington and Water District No. 111 to provide input to the projects and to review and comment throughout the course of program development. The review committee includes the three main water purveyors on the Covington Upland: Kent, Covington, and Water District No. 111, as well as representatives from the Ecology Water Quality Program, the State Department of Health, Seattle-King County Health Department, consultants Hart Crowser, Robinson & Noble, and Economic & Engineering Services Inc., and other local invitees.

1.3 Existing Data Sources

The work completed for this project relied on a number of important existing data sources. For the hydrogeologic analyses we used the South King County Groundwater Management Plan

(SKCGWMP), Grant No.1 Background Data Collection and Management Report Issues (1989) as our starting point for the regional hydrogeologic framework. Likewise, the draft South King County GWMP (March 1995) was used in development of the management strategies.

USGS geologic maps and more current geologic mapping conducted for King County's Cedar River Current and Future Conditions Report (1993) were used for geologic and hydrologic information east of the SKCGWMP study area boundary which falls near the Clark Springs. Several other published and unpublished reports prepared for the City of Kent and others provided valuable local information on hydrogeologic conditions. All significant documents used are listed in Section 10.0 References.

1.4 The Groundwater Sources

While the City's water sources are referred to Clark Springs, Kent Springs, and Armstrong Springs, the water supply derived from these three areas is actually a combination of spring infiltration galleries and wells. Production records maintained by the City indicate the following usage:

Clark Springs

- Provides 2,800 to 4,000 gpm (4 to 6 MGD) source of supply.
- Production is primarily from an infiltration gallery with occasional supplementation by production wells.

Kent Springs

- Provides 700 to 2,300 gpm (1 to 3.3 MGD) source of supply.
- Production is primarily from the infiltration gallery with peak demand (late summer) supply from Well Nos. 1 and 2.

Armstrong Springs

- Provides 70 to 700 gpm (0.1 to 1 MGD) source of supply.
- Production is from Well Nos. 1 and 2.

The City's Operations staff provided a substantial amount of information on the production from each of the spring areas as well as water level data and wellhead survey information for each of the three Spring properties. The City Engineering Department provided several consulting reports on their facilities, well construction, and well testing activities associated with each of the Spring properties. Data used to characterize the City's spring sources is discussed further in Appendix A.

Vicinity Map

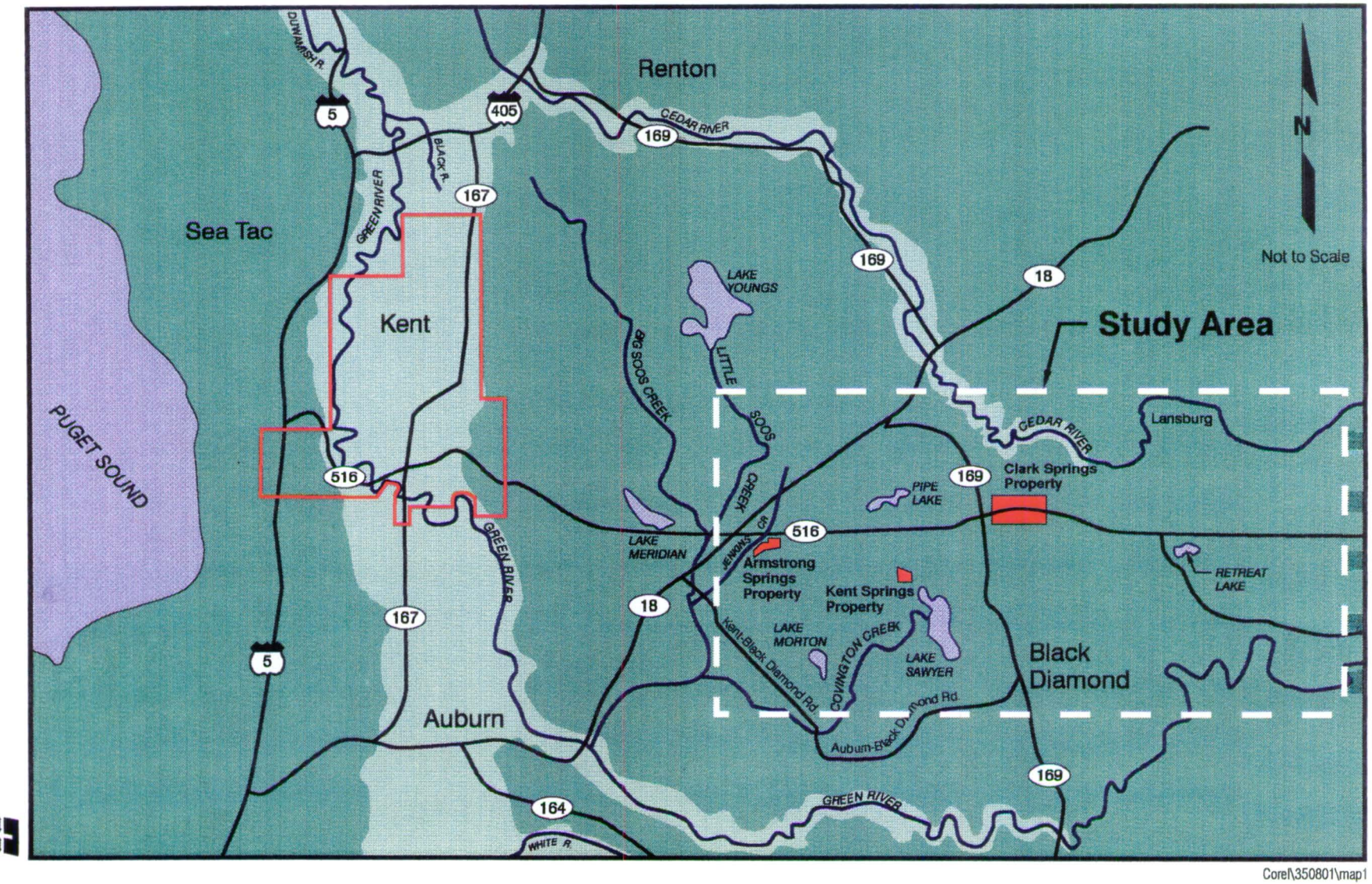

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Figure 1-1

Hydrogeology

2.0 HYDROGEOLOGY

The hydrogeologic setting provides the basis for the delineation of the wellhead protection area and assessment of the management strategies for aquifer protection. The hydrogeology in the 7 to 8 square mile area between Armstrong Springs in the west and Clark Springs in the east is complex because of the multiple geologic layers, varying recharge rates, and surface water-groundwater interactions. This section describes the conceptual hydrogeologic model that formed the basis for development of a regional groundwater flow model that allowed us to better understand the area's complexities, delineate the wellhead protection areas, and identify areas for more focused hydrogeologic study.

2.1 Topography and Drainage

The project area lies within the central portion of the Covington Upland (SKCGWMP, 1989) physiographic area (Figure 1-1). The Covington Upland is a glacial drift plain bounded on the north by the Cedar River Valley, the south and west by the Green River Valley, and on the east by the foothills of the Cascades. The topography of the central upland area ranges from bedrock foothills at elevations of almost 1,000 feet in the east study area (near the Clark Springs property) to gently sloping outwash plain at elevations of 500 to 400 feet in the west project area (between the Kent Springs and Armstrong Springs properties). Occasional till-capped knobs break up the outwash channels and several small kettle lakes and local marshy areas occur within the study area.

The eastern portion of the study area lies within the middle portion of the Cedar River Drainage Basin and the western portion of the study area lies within the Soos Creek Basin. Figure 2-12 shows the surface water divide between these two major drainage basins. The surface water divides are important in defining potential rainfall runoff areas which contribute recharge to the aquifers supplying the springs and in analysis of the overall system water budget.

2.2 Surface Water Features

The dominant surface water features of the study area include creeks which internally drain the outwash plain area and numerous lakes scattered throughout (See Figure 2-12). Rock Creek is the principal drainage feature in the east study area draining to the Cedar River. Rock Creek was identified by King County (1993) originating in the southeastern corner of the study area near Lake 12 with flow north then west through the City's Clark Springs property, eventually flowing northward to the Cedar River.

Ravensdale Creek, Covington Creek, Jenkins Creek, and the Little Soos Creek all originate in the drift plain west of Clark Springs. Each of these streams has a predominantly southwest flow pattern and eventually discharges to Soos Creek which flows into the Green River near Auburn.

Little is known about the hydraulic connection of the creeks to the groundwater system but it is suspected that a substantial relationship exists between the creeks and the shallow aquifer in the study area. For example, during the wet winter months the streams may be recharging the

groundwater system, while during the drier summer/early fall months the groundwater may be discharging to streams providing baseflows. These relationships may affect the amount of recharge to the aquifer system and groundwater flow patterns, particularly in the vicinity of the streams. Runoff from the till and bedrock knobs in the study area drains either into these streams or directly into the coarse-grained outwash deposits which surround the base of these till-capped hills.

Lake Sawyer is the largest lake in the study area. Ravensdale Creek flows into the lake on its east side and Covington Creek flows out from the lake on its west side. The lake, situated very close to the Covington and Kent Springs supply sources, appears to be situated in till over much of its subsurface area; however, a recessional outwash channel appears to occur in the northeast and southwest lake areas hydraulically connecting the lake to the recessional outwash aquifer.

A hydrogeologic study of the Lake Sawyer area (Hart Crowser, 1990) identifies at least 10 times as much outflow to the groundwater system as inflow indicating the lake as a source of recharge to the groundwater system. The study estimates an average outflow of between 1 and 4 cfs (range of 0.4 to 40 cfs) with the higher amount occurring during the dry season. Flow from the lake to the groundwater occurs primarily in the north and west sides of the lake. Several smaller lakes including Retreat Lake, Ravensdale Lake, Wilderness Lake, and Pipe Lake occur within the project area and may also provide recharge to the groundwater system.

2.3 Surficial Geology

The geology of the study area is characterized by Tertiary bedrock uplands in the eastern portion of the study area and a thick sequence of Quaternary glacial and alluvial sediments in the western portion of the study area. The bedrock is commonly mantled by till and interspersed with former drainage channels now infilled with glacial meltwater deposits. Moving westward, the bedrock dives deep beneath the subsurface, and a thick and variable sequence of glacial and interglacial sediments occur.

The west half of the study area is dominated by recessional outwash deposits at the surface. These deposits mark a major drainage pathway for meltwater streams during retreat of the last major glacial advance, the Vashon. Till-capped knobs underlain by pre-Vashon glacial and interglacial sequences are interspersed within the outwash of the western drift plain. Figure 2-1 presents a surficial geologic map for the study area.

2.4 Recharge and Infiltration Potential

Precipitation is the principal source of recharge to the groundwater system. The surficial geology plays a major role in the amount of precipitation that infiltrates the ground to become recharge. Likewise the surficial geology and infiltration potential help define the susceptibility of the groundwater system to water quality impacts and the ease with which contaminants can move into the subsurface. In terms of infiltration potential and aquifer vulnerability, there are two distinct surficial geologic material groups in the study area:

- The outwash plain deposits which are relatively permeable and allow good infiltration of precipitation. Recharge is likely highest in these areas as is aquifer vulnerability to contamination. Recharge rates in these deposits are estimated to range between 30 and 40 inches per year.

- The bedrock and till-capped hills, which are relatively low in permeability, have a lower infiltration potential. However, these areas provide good recharge because the relatively low infiltration capacity and steeper slopes cause runoff to the permeable outwash deposits surrounding these hills. In terms of aquifer susceptibility, these materials are important where they occur in the subsurface because they can provide some protection to deeper aquifers. An aquifer susceptibility map is developed for the WHPA as discussed in Section 3.5.

2.5 Water Quality

The groundwater quality from the spring and wells sources is good. Regular water quality monitoring conducted under the state Department of Health (DOH) regulations includes analyses for inorganic and volatile organic compounds every three years. The last inorganics analyses was conducted at each of the sources in 1993; the last volatile organics analyses conducted at each of the sources was in 1994. No contaminant concerns were indicated by the sampling results. No volatile organics were detected. No inorganics were detected above the drinking water standards.

Other special sampling conducted voluntarily by the City included 1/90, 8/91, and 8/93 priority pollutant analysis for metals, volatile organics, semivolatile organics, cyanide, PCBs and pesticides at the Clark Springs because of concerns about the Landsburg mine contamination. None of these compounds of potential concern were detected during these sampling events. The City also participated in a voluntary DOH Area-Wide Groundwater Monitoring Project for Synthetic Organic Compounds. No synthetic organic compounds were detected during this sampling.

Nitrate levels were reviewed for all three water sources to assess any potential degradation. The nitrate data available are presented in Table 2-1.

Table 2-1 - Nitrate Levels in Kent's Water Sources

Year	Clark Springs	Kent Springs	Armstrong Springs
	Nitrate Concentration in mg/L		
1983	1.09	0.4	—
1986	0.7	0.4	0.2
1989	0.7	0.9	0.7
1993	1.1	0.7	1.1

While these data are well within the drinking water standard of 10 mg/L, there is some indication that nitrate levels may be increasing. Additional data are needed to evaluate whether this is a statistically significant increase.

2.6 Principal Geologic Units

The surface and subsurface geology are evaluated and characterized by interpretation of geologic units using the SKCGWMP Background Data report and well drilling records (SKCGWAC, 1989). The geologic units identified in this report are consistent with the nomenclature used in the SKCGWMP Background Data Report. Geologic conditions in the area east of the SKCGWMP area were based on USGS reports (Vine, 1969) and work completed by Derek Booth for the King County Cedar Basin Study (1993). The major units delineated and described for this study and their characteristics are outlined below and delineated significantly on Figure 2-1.

Vashon Recessional Outwash (Qvr)

- Consists predominantly of well-sorted sand and gravel;
- Occurs at the surface as outwash plain throughout the study area with local areas of terrace and valley train deposits in the easternmost study area;
- Has a relatively high infiltration capacity; and
- Is an important aquifer supplying water to the City's spring sources.

Vashon Ice-Contact Deposits (Qvi)

- Consist primarily of sand and gravel but less sorted than the Qvr deposits;
- Occur at the surface east of Clark Springs;
- Have a moderate to high infiltration capacity; and
- Are likely an important source of recharge for the Qvr aquifer in the eastern portion of the study area.

Vashon Till (Qvt)

- Consists of a dense, unsorted mixture of clay, silt, sand, and gravel;
- Occurs at the surface throughout the area capping bedrock knobs and uplands, and in the subsurface beneath the Qvr in many areas;
- Has low infiltration capacity restricting local recharge; and
- Provides a protective layer to deeper aquifers from contaminant migration where it occurs in the subsurface.

Second Coarse-Grained Unit Qc(2)

- Older (than Vashon) glacial sequence possibly correlative with the Possession Drift sequence;
- Consists predominantly of granular soils and may include till layers;
- Occurs at depth in western portion of the study area and in outcrops at a few locations in the southwest and northern portion of the study area; and
- Is an important aquifer tapped by the Armstrong Springs, Kent Springs, and Covington wells.

Second Fine-Grained Unit Qf(2)

- Older interglacial sequence possibly correlative with the Whidbey Formation or the Kitsap Formation;
- Consists primarily of fine-grained alluvial and lacustrine sand, silt, clay, and peat; and
- Occurs primarily in the subsurface below the Qc(2) deposits and forms the lower boundary of the Qc(2) aquifer tapped by the City's wells.

Third Coarse-Grained Unit Qc(3)

- Next older glacial sequence may be correlative with the Salmon Springs Drift;
- Consists predominantly of coarse-grained materials and includes layers of till;
- Occurs at depth below the Qc(2) aquifer tapped by the City's wells and is typically recognized by its oxidized condition; and
- Next principal aquifer below the Qc(2).

Third Fine-Grained Unit Qf(3)

- Next older fine-grained sequence may be correlative with the Puyallup Formation; and
- Consists of a thick sequence of sand, silt, clay, and peat—difficult to distinguish from the Qf(2).

Tertiary Bedrock (Tbr)

- Primarily sedimentary bedrock of the Puget Group but also includes local outcrops of igneous rock;
- Occurs at shallow depths and at ground surface in the eastern portion of the study area but dives steeply to the west so that it is not a significant unit in the western portion of the study area; and
- Has low infiltration capacity restricting local recharge and generally considered to bound the area aquifers.

In addition to these primary units there are several other geologic units defined on the maps and cross sections prepared for this report. These include the Recent Alluvium (Qal) which occurs in the major river valleys along the margins of the study area, thin peat layers (Qp) which occur locally throughout, and the Vashon Advance Outwash (Qva) which, except for some minor deposits beneath the Pipe Lake area, is largely absent from this area. Because these deposits have no significant effect on the supply and transport of groundwater to the Kent supply sources, they are not discussed much further herein.

2.7 Subsurface Geology and Groundwater Flow

As the surficial geology is important to the infiltration of precipitation, the characteristics and distribution of geologic deposits in the subsurface are important to the movement of groundwater to the wellhead. Subsurface cross sections were developed around each of the City's Springs properties to provide additional information on the subsurface stratigraphy, the layering and occurrence of geologic units which define the aquifers, and the transport pathways for potential contaminant movement to the wellheads.

The subsurface geology and its effect on groundwater flow around each of the source areas are discussed below. Refer to the Surficial Geologic Map (Figure 2-1) and the Cross Sections (Figures 2-2 through 2-11) which support the discussions.

2.7.1 Clark Springs Area

The Clark Springs are situated in a narrow, sediment-filled channel bounded by till-capped bedrock knobs to the north and south. The infilled materials are very coarse-grained recessional outwash sand and gravel deposited as the last glacier retreated from this area. These coarse-grained glacial deposits, mapped as Qvr and Qvi on Figure 2-1, extend due east of the Clark Springs property, then fan out to the north and south just beyond the Georgetown area. The Qvr and Qvi comprise the aquifer which provides groundwater flow to Clark Springs. Cross sections C1-C1' through C4-C4' (Figures 2-2 and 2-3) depict the generalized hydrogeology through the Clark Springs aquifer area.

Bedrock confinement of the permeable outwash deposits to a narrow channel at the Clark Springs property may be the cause of the springs which naturally emanate in this area. As shown on Figure 2-1, bedrock surfaces again east, southeast, and southwest of Retreat Lake over 2 miles east of Clark Springs. In the area by Retreat Lake and southwestward, shallowing bedrock causes the Qvr and Qvi to rise in elevation (See Well group 32A, Figure 2-3). This rise distinguishes a northwest-southeast trending trough of recessional outwash that occurs along the east side of the bedrock knobs north and south of Georgetown and west of Retreat Lake. This trough may represent former meltwater discharge pathways to the Cedar and Green Rivers and a preferred pathway for groundwater flow through this area today.

Groundwater flow through the glacial deposits east of Clark Springs appears to be predominantly east to west as shown on the Groundwater Elevation Contour Map, Figure 2-12. However,

within the trough of recessional deposits along the east side of the bedrock knobs north and south of Georgetown, a northward flow pattern is indicated.

There appears to be significant volume of groundwater flow moving through this foothills recharge area. In addition to the groundwater flow toward the Clark Springs area (over 3,000 gpm), the existing data indicate there is a component of groundwater flow northward that discharges to the Cedar River, and a component of flow southwestward moving through the Ravensdale area toward the Kent Springs and Covington wellfields. In addition to supporting these large water supply systems, King County (1993) maintains that the groundwater in this area also provides a significant contribution to Rock Creek flow, the only major surface water drainage in the eastern portion of the study area and an important fishery resource stream in the Cedar River Basin.

2.7.2 Kent Springs Area

The Kent Springs property lies just north of Lake Sawyer within the glacial drift plain in the western portion of the study area. In this area the bedrock dives steeply beneath a thick sequence of glacial and interglacial sediments. The surficial deposits are predominantly Qvr, the permeable recessional outwash deposits seen further east. Till-capped knobs are interspersed within the flatter outwash channels. In this area the subsurface stratigraphy becomes more complex with a thicker sequence of variable material types. Cross sections K1-K1' through K3-K3' (Figures 2-4 and 2-5) show interpreted subsurface stratigraphy around the Kent Springs area.

The Kent Springs aquifer appears to be made up of two coarse-grained glacial sequences, the Qvr and the Qc(2) units. At the Kent Springs property these units appear to be in direct contact with each other, while to the north, east, and south, till typically separates these units. The till occurrence is illustrated on Figures 2-4 and 2-5. Till appears to occur beneath the Covington wells (Figure 2-4, Section K2-K2'), parts of Lake Sawyer (Figure 2-5, Section K3-K3'), and stretches beneath the ground surface between till-capped knobs to the northeast (Figure 2-1). However, as you near the Kent Springs property, the till deposits thin or are absent. Limited data also suggest that the till may also be absent for some distance west-southwest of the Kent Springs (Figure 2-4, Section K1-K1').

Geologic materials and seasonal behavior suggest the Kent Springs are derived from the shallower recessional outwash (Qvr) and the wells are completed in the Qc(2) deposits. Use of the springs occurs primarily in the wetter months of year and this would correlate with renewed recharge of the shallower Qvr deposits. In the drier summer and early fall months the deeper and more continuous Qc(2) unit provides a more reliable source. Well log data indicate the Qc(2) extends throughout the area beneath the till-capped knobs while the extent of the Qvr aquifer is limited by the till.

Groundwater flow through the Kent Springs vicinity is a continuation of the east to west flow pattern discussed for the Clark Springs property. Moving westward from the Georgetown area toward the Kent Springs property, groundwater passes through the bedrock-bounded recessional

outwash channel around Ravensdale Lake into the drift plain in the western portion of the study area. Water level and well log data suggest that much of the groundwater supplying the Kent Springs property flows through the Ravensdale channel toward Lake Sawyer.

Near Lake Sawyer, the groundwater flow bends slightly northwest as it flows toward the Kent Springs property. The aquifer supplying the Kent Springs also supplies the Covington Lake Sawyer wellfield just south of the Kent Springs property (see Figure 2-1). The effect of Lake Sawyer on groundwater flow is not well-studied. In the area of the Kent Springs, the geologic data suggest hydraulic separation; however, as previously discussed, some recharge (range between 0.4 and 40 cfs) to the groundwater system occurs.

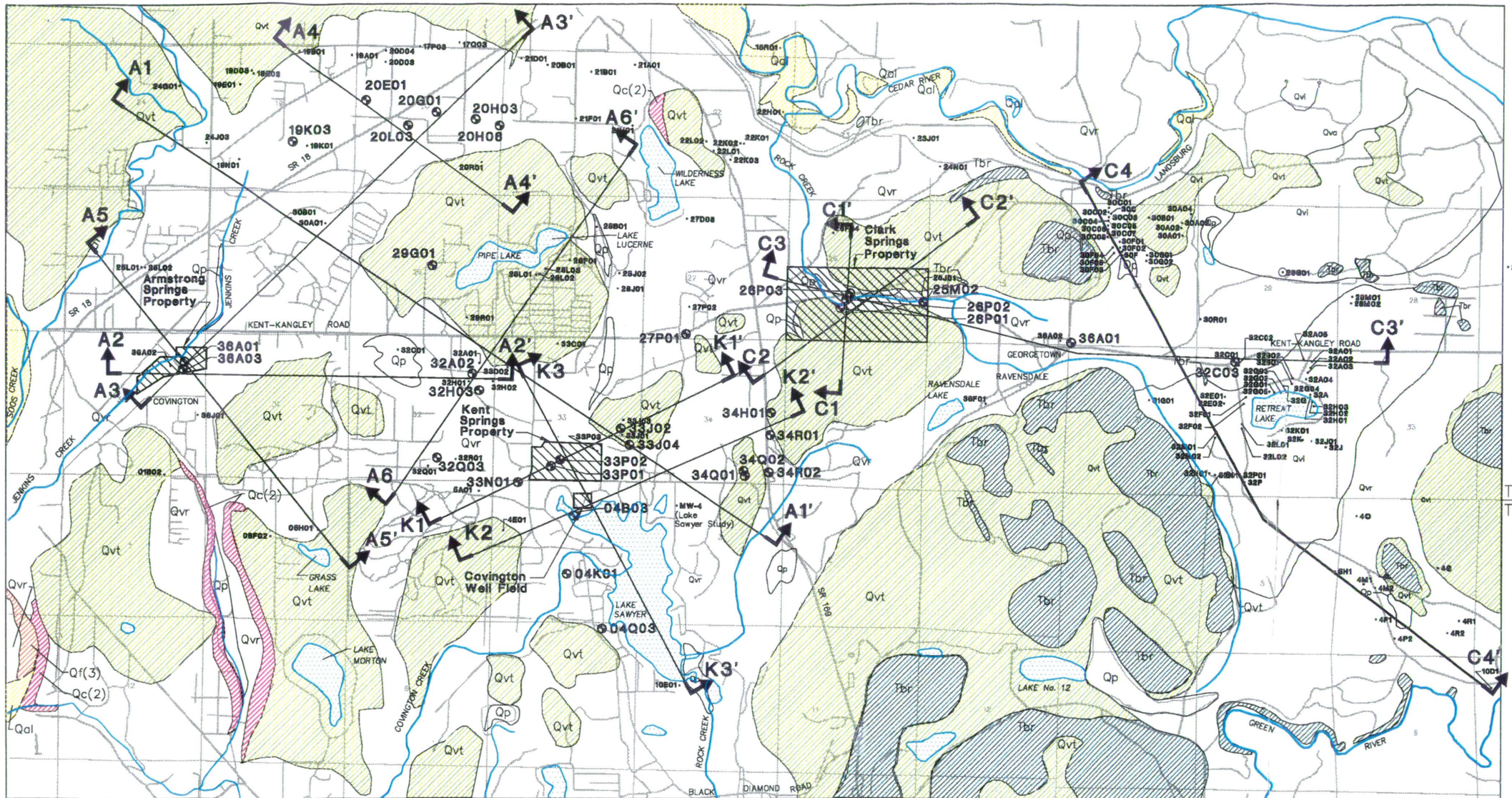
2.7.3 Armstrong Springs Area

The geology around the Armstrong Springs property is similar to the Kent Springs property. The property lies within the recessional outwash plain and the wells appear to tap into the deeper Qc(2), lying below the Qvr, in an area where the till seems to be thin or absent. Till occurs on hills to the southeast and northwest and till-like material appears to extend beneath the Qvr in these same directions away from the Armstrong Springs property. The till also appears eroded away in the area 1-1/2 miles to northeast of the property within the recessional outwash channel.

Cross sections A1-A1' through A6-A6' (Figures 2-6 through 2-11) present generalized geologic cross sections through the area around the Armstrong Springs. Sections A1-A1', A2-A2', and A3-A3' (Figures 2-6, 2-7, and 2-8) illustrate the apparent thinning of the till at the well site and along the outwash channel to the northeast of Armstrong Springs. Figures 2-9, 2-10, and 2-11 indicate significant thicknesses of till to the east and west of the property.

Groundwater flow patterns around the Armstrong Springs property are more complex than at the other properties because of multiple hydrogeologic boundary conditions. That is, several regional recharge and discharge factors appear to affect groundwater flow in this area. Regional recharge from the Lake Youngs area (SKCGWMP, 1989) creates a north to south flow pattern toward the Armstrong Springs property. This flow pattern converges with the regional east to west flow (dominating the Kent Springs property) in this same area. The Soos Creek valley, located less than a mile west of the spring property, is a central discharge area for both of these regional groundwater flow systems. Further complicating the groundwater flow interpretation is the likely location of a groundwater divide two miles to the northeast of Armstrong Springs where groundwater flow may be directed toward the Cedar River.

Surficial Geology and Cross Section Location Map



Qal — Recent Alluvium

Qvr — Vashon Recessional Outwash (Local Peat Areas Noted as Qp)

Qvi — Vashon Ice-contact Deposits

Qf(3) Qf(2) — Older Fine-grained Deposits

Qc(2) Qc(3) — Older Coarse-grained Deposits

Qvt — Vashon Till

Tbr — Tertiary Volcanic and Sedimentary Bedrock

A-A' — Cross Section Location and Designation

·30R01 — Wells with Logs used for Cross Section Development (from South King County GWMP Database)

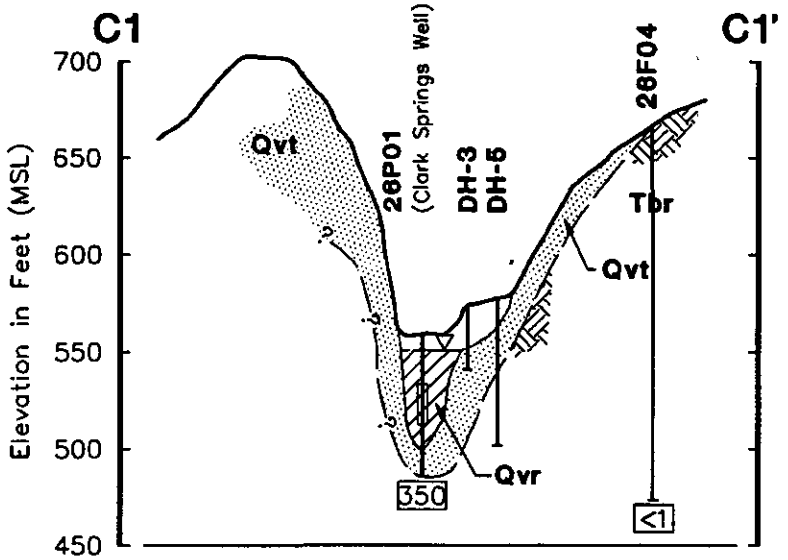
⊙ 20H03 — Monitoring Well Location and Number

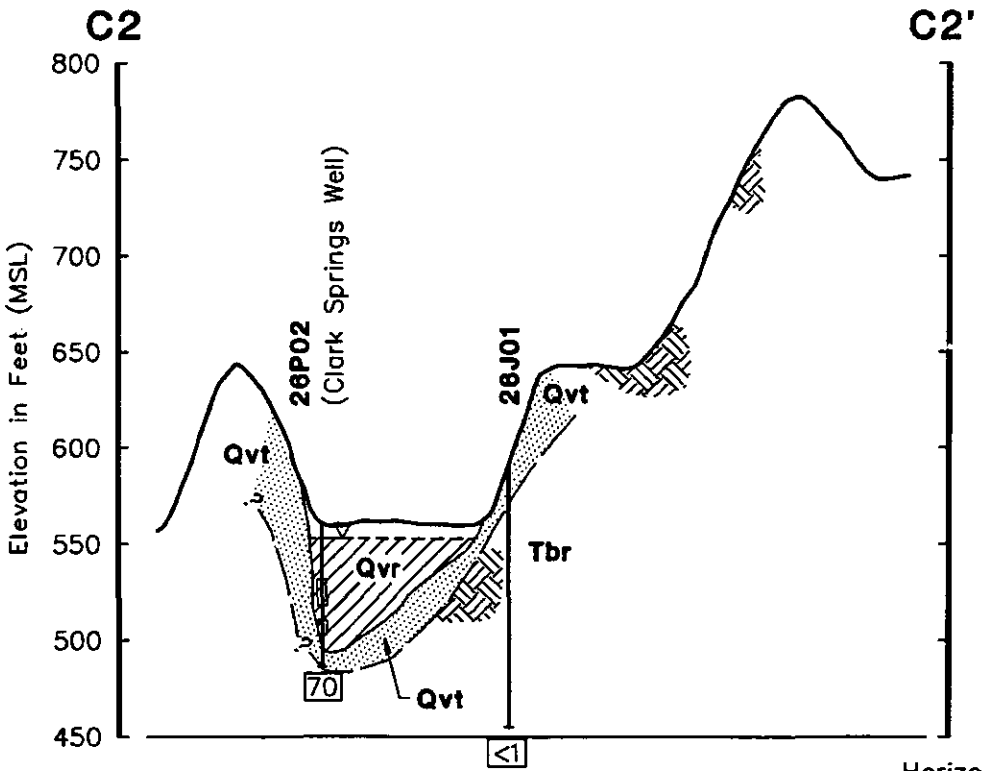
cvd 4/5/95 1=4000 color-larry
35080126

HARTCROWSER
J-3508-01 11/95
Figure 2-1

Clark Springs Area

Generalized Geologic Cross Section C1-C1' and C2-C2'





DH-3 Well Number

Well Location

Approximate Water Level (ATD or as measured by USGS, 1986 or Hart Crowser, 1994)

Screened Interval (if on record)

<1 Approx. Specific Capacity from Well Logs

Aquifer Zone

Horizontal Scale in Feet
0 2000 4000
0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

Notes: 1. See Figure 2 for geologic nomenclature.

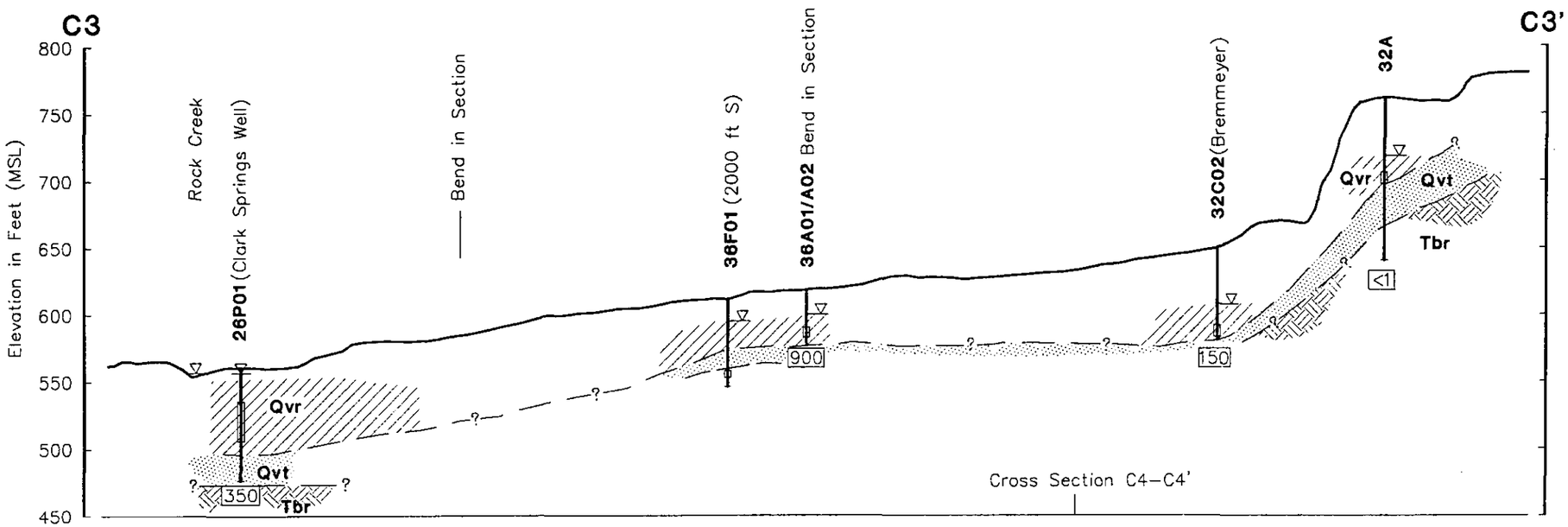
2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions based on currently available data.

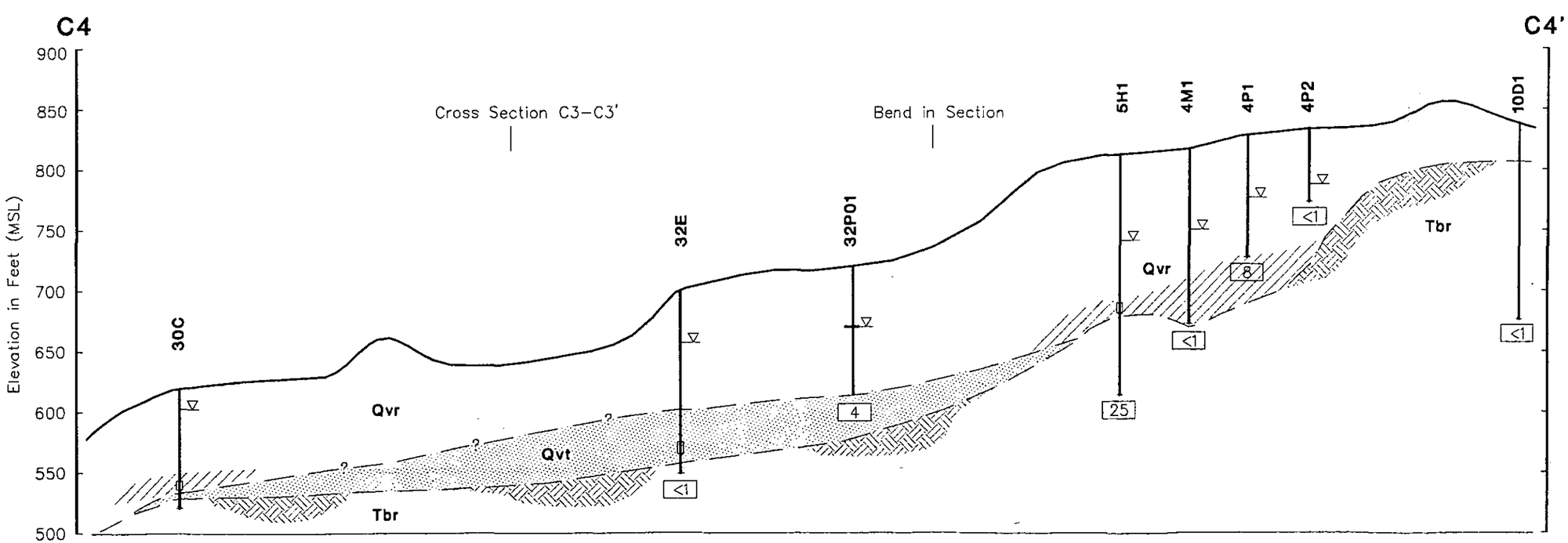
HARTCROWSER
J-3508-01 11/95
Figure 2-2

cvd 11/30/9 2000 HC.pcp
35080105

Clark Springs Area

Generalized Geologic Cross Section C3-C3' and C4-C4'





26P01 Well Number

Well Location

Approximate Water Level (ATD or as measured by USGS, 1986 or Hart Crowser, 1994

Screened Interval (if on record)

<1 Approx. Specific Capacity from Well Logs

Aquifer Zone

Notes: 1. See Figure 2 for geologic nomenclature.

2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions based on currently available data.

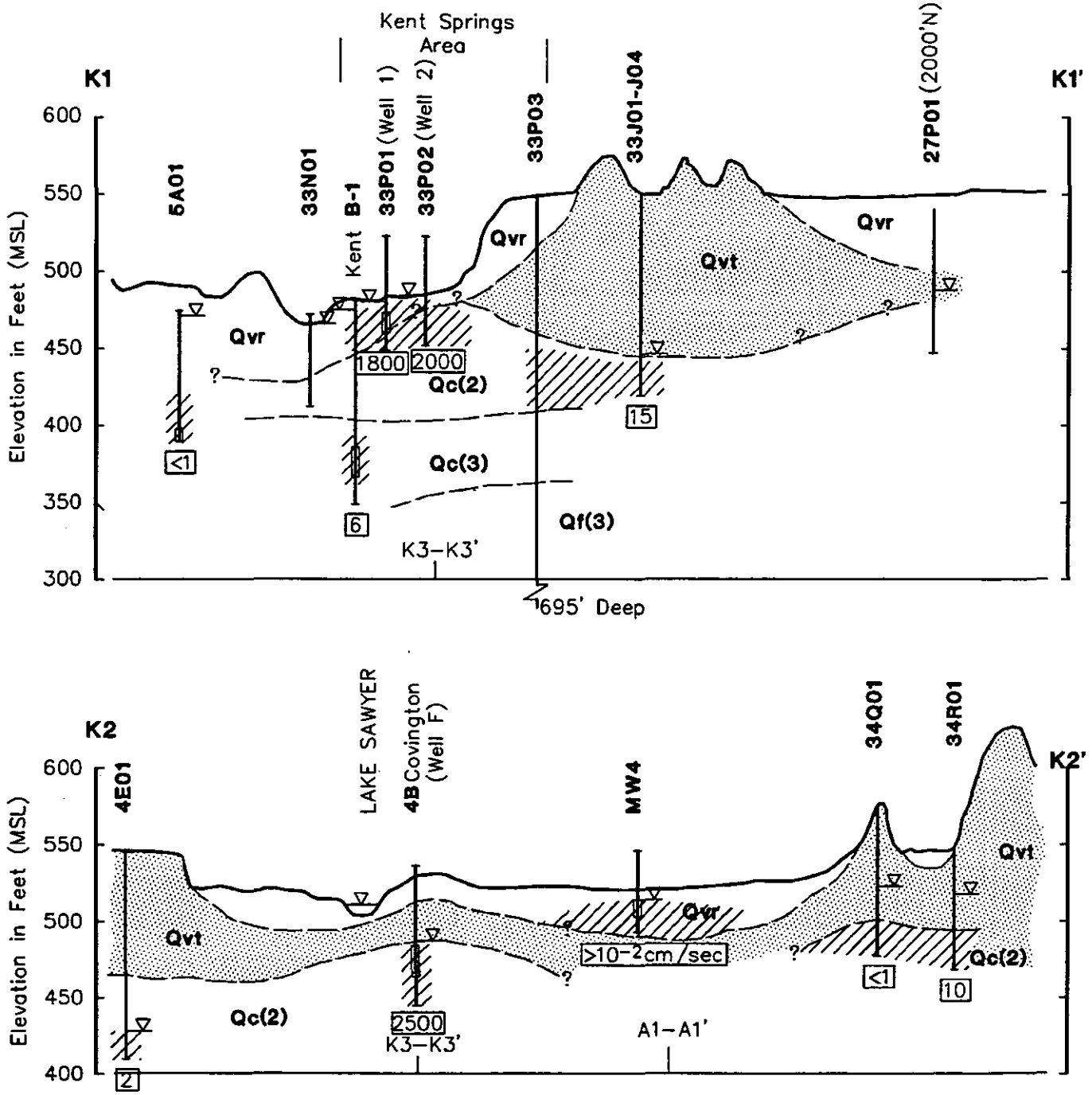
Horizontal Scale in Feet
0 2000 4000
0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

cvd 11/30/95 =2000 HC.pcp
35080106

HARTCROWSER
J-3508-01 11/95
Figure 2-3

Kent Springs Area

Generalized Geologic Cross Section K1-K1' and K2-K2'



5A1 Well Number

Well Location

Approximate Water Level (ATD or as measured by USGS, 1986 or Hart Crowser, 1994)

Screened Interval (if on record)

<1 Approx. Specific Capacity from Well Logs

Aquifer Zone

Note: 1. See Figure 2 for geologic nomenclature
2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions.

Horizontal Scale in Feet
0 2000 4000
0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

HARTCROWSER

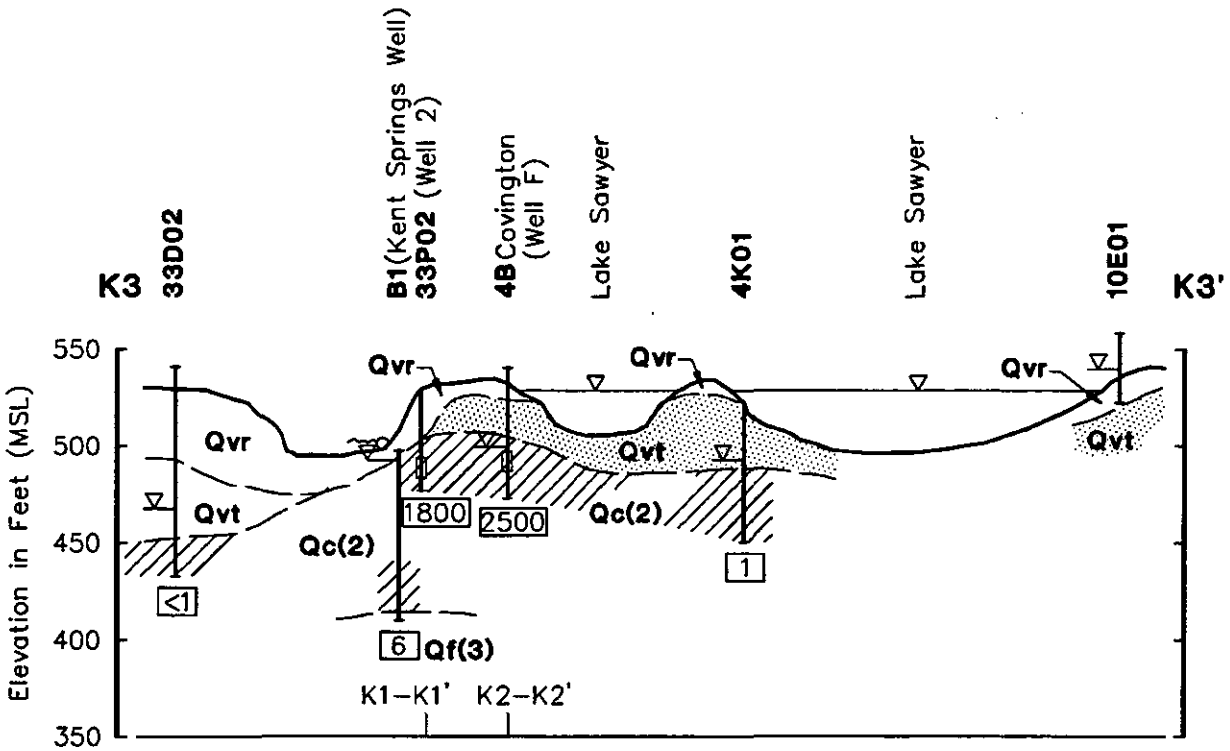
J-3508-01 11/95

Figure 2-4

SWP 11/30/9 2000 HC.pcp
35050113

Kent Springs Area

Generalized Cross Section K3-K3'



33D2 Well Number

Well Location

Approximate Water Level (ATD or as measured by USGS, 1986 or Hart Crowser, 1994)

Screened Interval (if on record)

<1 Approx. Specific Capacity from Well Logs

Seep/Spring

Aquifer Zone

Horizontal Scale in Feet
0 2000 4000
0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

Note: 1. See Figure 2 for geologic nomenclature.

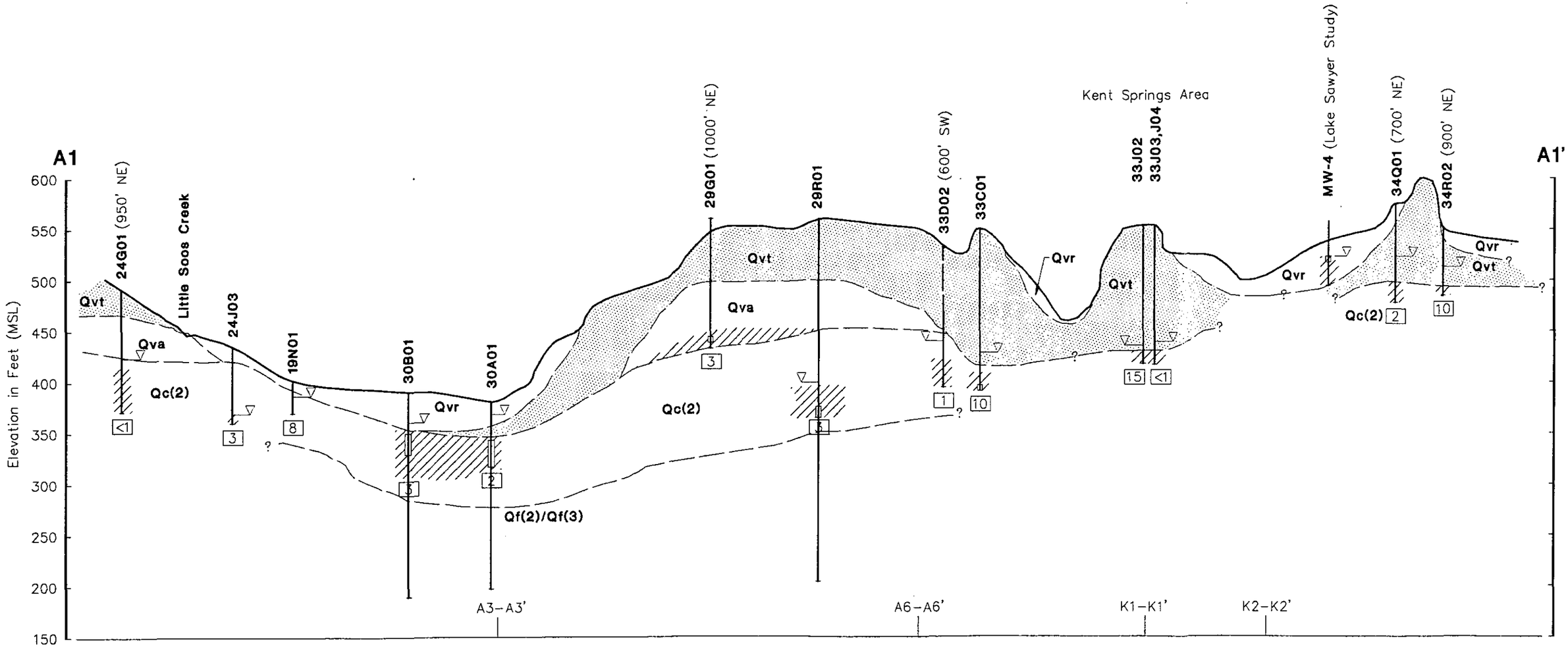
2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions.

cvd 11/30/9 2000 HC.pcp
35080114

HARTCROWSER
J-3508-01 11/95
Figure 2-5

Armstrong Springs Area

Generalized Geologic Cross Section A1-A1'



24J03 — Well Number

Well Location

Approximate Water Level (ATD or as measured by USGS, 1986 or Hart Crowser, 1994)

Screened Interval (if on record)

<1 — Approx. Specific Capacity from Well Logs

Aquifer Zone

Note:
1. See Figure 2 for geologic nomenclature.
2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions.

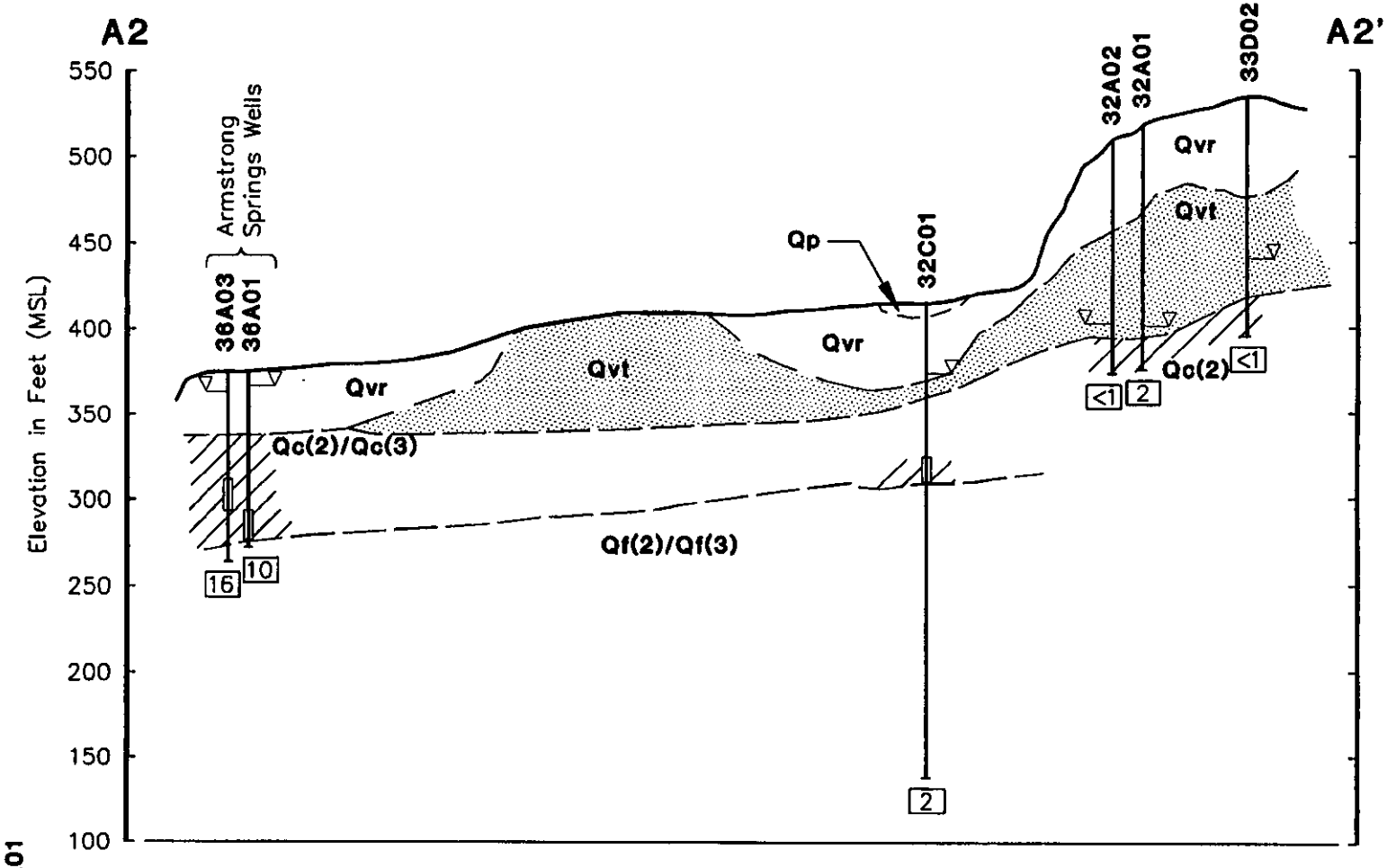
Horizontal Scale in Feet
0 2000 4000
0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

HARTCROWSER
J-3508-01 11/95
Figure 2-6

CVD 11/30/95 1=2000 HC.pcp
35080100

Armstrong Spring Area

Generalized Geologic Cross Section A2-A2'



38A01 Well Number

Well Location

Approximate Water Level (ATD or as measured by USGS, 1986 or Hart Crowser, 1994)

Screened Interval (if on record)

<1 Approx. Specific Capacity from Well Logs

Aquifer Zone

Note: 1. See Figure 2 for geologic nomenclature.

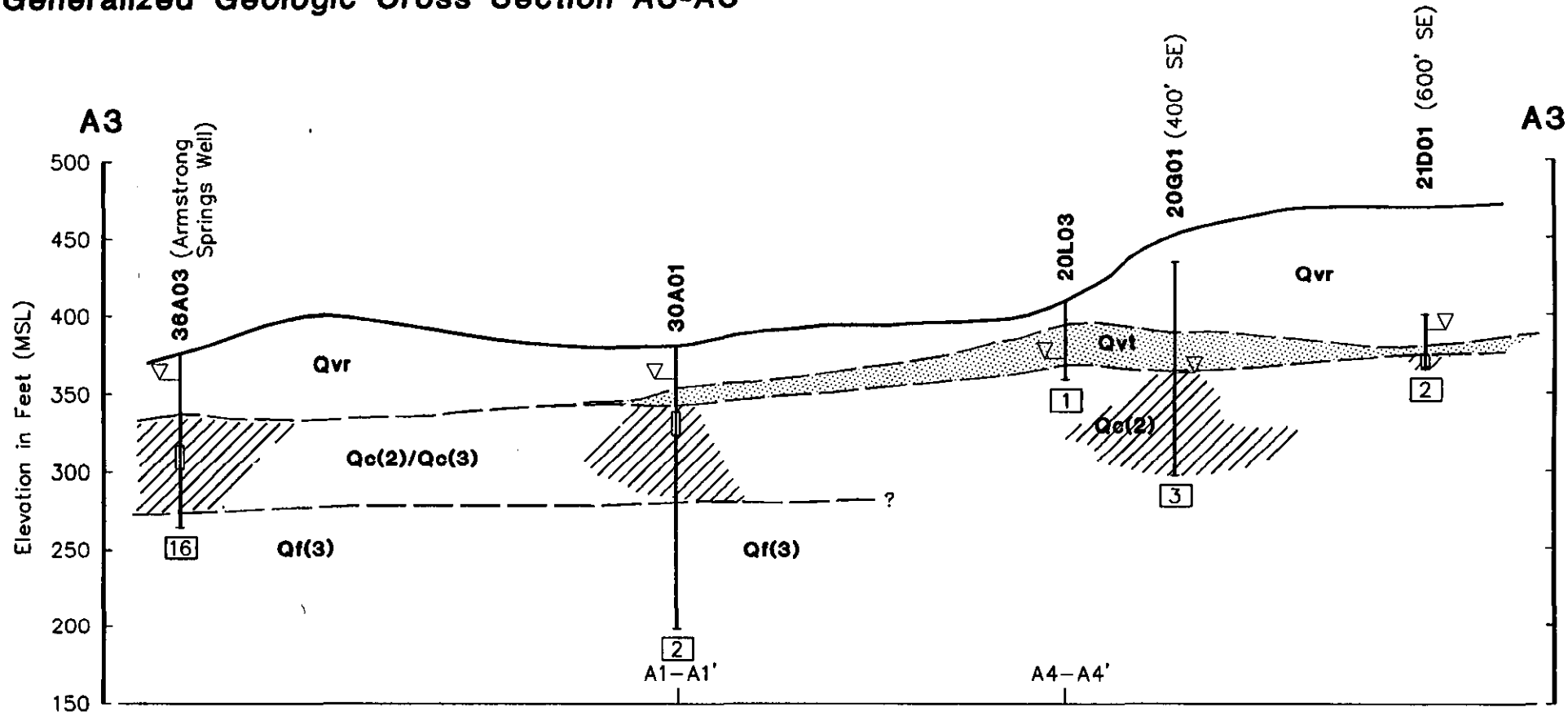
2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions.

Horizontal Scale in Feet
0 2000 4000
0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

HARTCROWSER J-3508-01 11/95
Figure 2-7

Armstrong Springs Area

Generalized Geologic Cross Section A3-A3'



38A03 Well Number

Well Location

Approximate Water Level (ATD or as measured by USGS, 1986 or Hart Crowser, 1994)

Screened Interval (If on record)

<1 Approx. Specific Capacity from Well Logs

Aquifer Zone

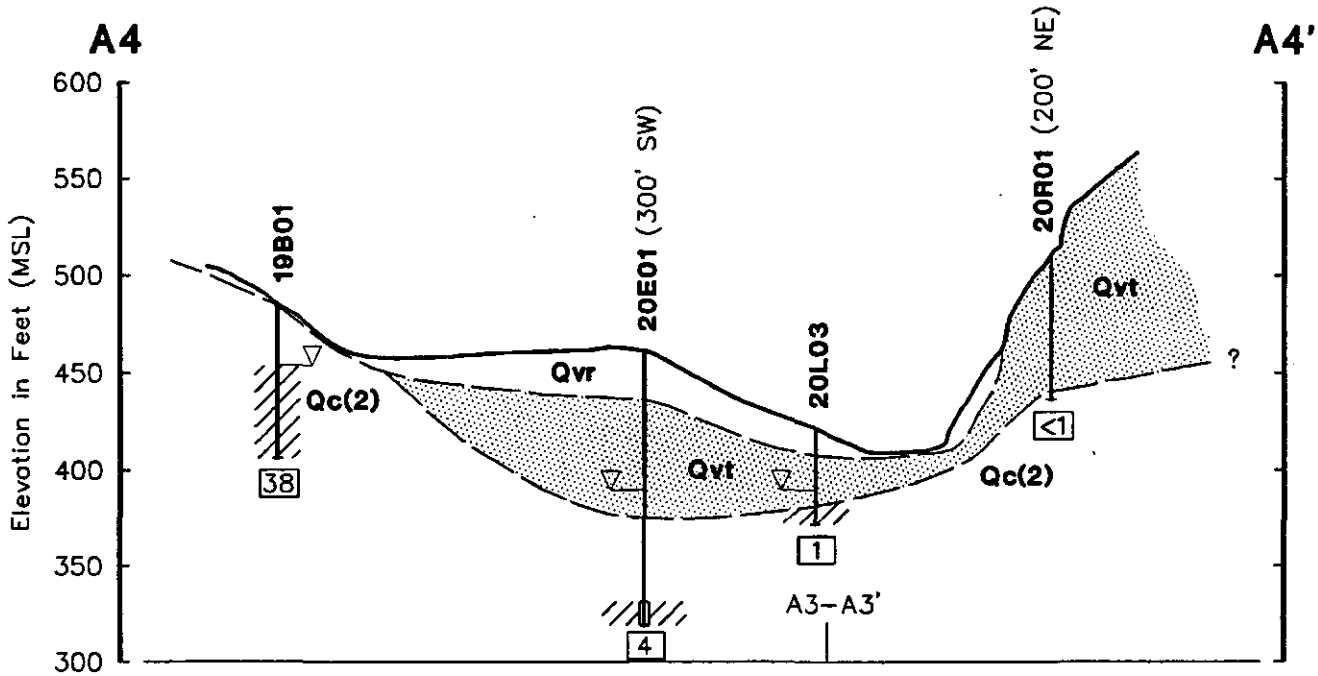
Horizontal Scale in Feet
0 2000 4000
0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

Notes: 1. See Figure 2 for geologic nomenclature.

2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions based on currently available data.

HARTCROWSER J-3508-01 11/95
Figure 2-8

Armstrong Springs Area
Generalized Cross Section A4-A4'



19B01 Well Number

Well Location

Approximate Water Level (ATD or as measured by USGS, 1986 or Hart Crowser, 1994)

Screened Interval (if on record)

<1 Approx. Specific Capacity from Well Logs

Aquifer Zone

Horizontal Scale in Feet
0 2000 4000
0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

Notes: 1. See Figure 2 for geologic nomenclature.

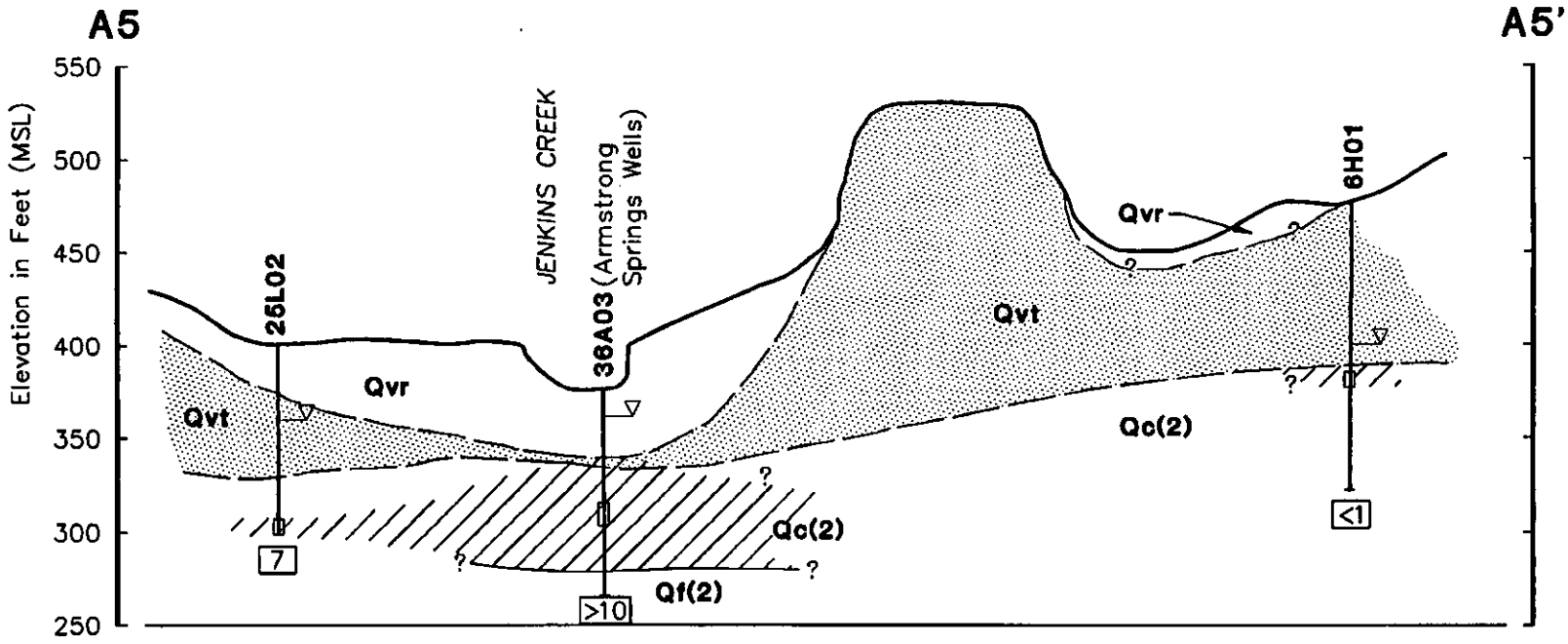
2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions based on currently available data.

CVD 11/30/95 1=2000 HC.pcp
35080102

HARTCROWSER
J-3508-01 11/95
Figure 2-9

Armstrong Springs Area

Generalized Cross Section A5-A5'



25L02 Well Number

Well Location

Approximate Water Level (ATD or as measured by USGS, 1986 or Hart Crowser, 1994)

Screened Interval (if on record)

<1 Approx. Specific Capacity from Well Logs

Aquifer Zone

Horizontal Scale in Feet
0 2000 4000
0 100 200
Vertical Scale in Feet
Vertical Exaggeration x 20

Notes: 1. See Figure 2 for geologic nomenclature.

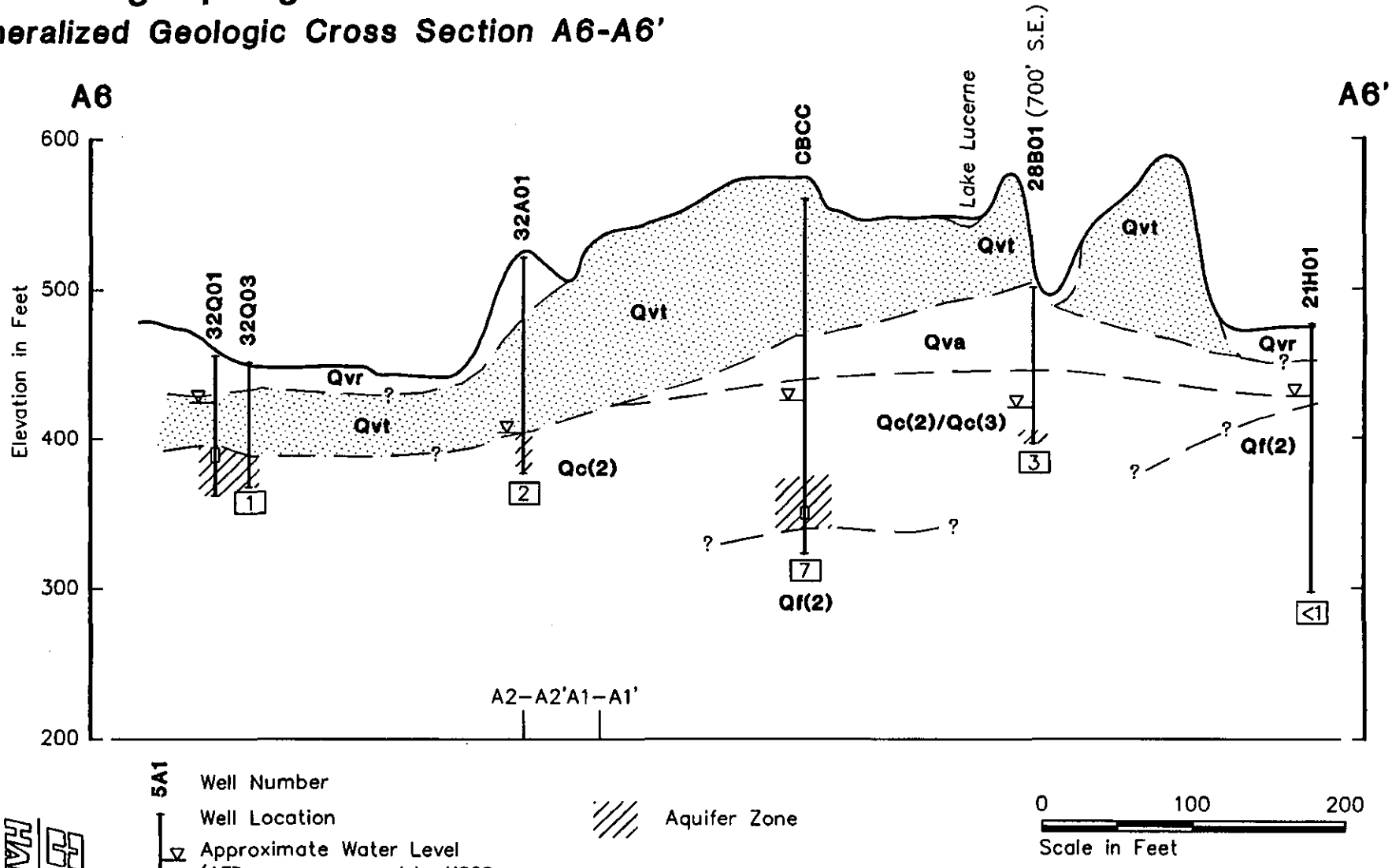
2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions.

HARTCROWSER
J-3508-01 11/95
Figure 2-10

CVD 11/30/95 1=100 HC.pcp
35080115

Armstrong Springs Area

Generalized Geologic Cross Section A6-A6'

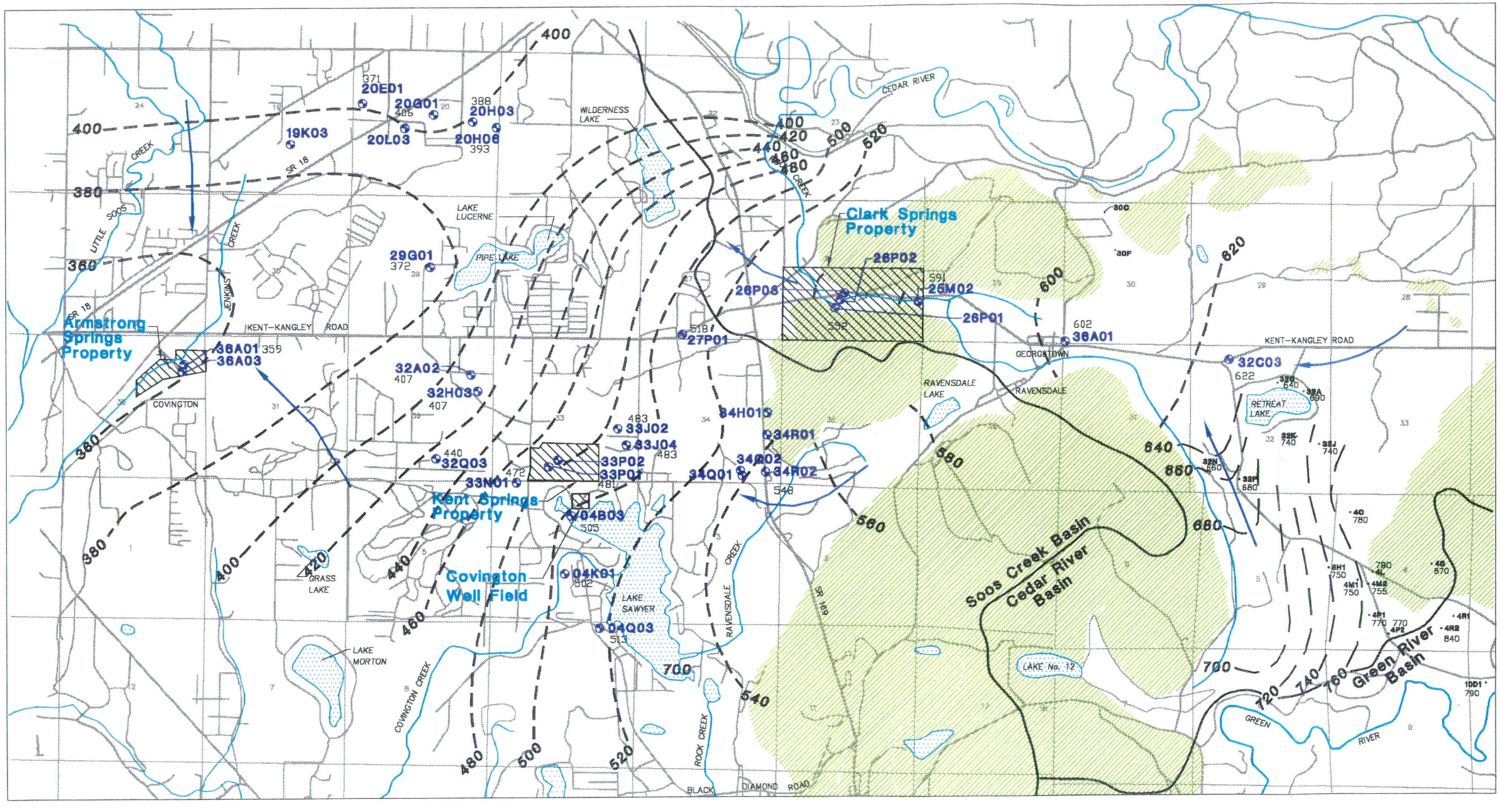


Notes: 1. See Figure 2 for geologic nomenclature.

2. Contacts between geologic units are based upon interpolation between wells and represent our interpretation of subsurface conditions.

HARTCROWSER J-3508-01 11/95
Figure 2-11

Groundwater Elevation Contour Map



Monitoring Well Location and Number

510 — Groundwater Elevation in Feet (April 1994)

·27E01 — Well Location and Number from Well Log Records.

400 — Groundwater Elevation Contour from April 1994

700 — Groundwater Elevation Contour from Well Log

Location of Low Permeability Geologic Materials (Primarily Qvt and Tbr) Considered to form Aquifer Boundary

Inferred Groundwater Flow Direction

N

0 4000 8000

Scale in Feet

HARTCROWSER

J-3508-01 11/95

Figure 2-12

CVD 11/30/95 1=4000 color.pcp
35080127

3.0 WELLHEAD PROTECTION AREA (WHPA) DELINEATION

The hydrogeology described around each of the spring sources forms the basis for delineation of the wellhead protection areas. A wellhead protection area is defined as the surface and subsurface area surrounding a well (or spring) that supplies a public water supply through which potential contaminants are likely to pass and eventually reach the water source (DOH, 1993). Determination of the wellhead protection area (WHPA) is the first step toward development of a wellhead protection program (WHPP) to manage the quality of groundwater-based drinking water supplies.

Delineation of the WHPA is an important component of the WHPP to ensure that the area managed will be protective of water quality and that no undue burden is placed on land use. Under the state's guidelines, the WHPA is determined based primarily on time-of-travel capture zones. Time-of-travel capture zones are estimates of the area constituting the most likely travel paths (based on travel times) of a hypothetical particle of water moving through the aquifer to the pumping well.

Three travel time zones are defined; the 1-, 5-, and 10-year time-of-travel capture zones. In addition, a buffer zone is considered to provide additional protection and compensate for any errors in calculating the WHPA. The intent of protection within each of these areas is outlined below.

- **1-Year Capture Zone.** This zone is managed to protect the drinking water supply from viral, microbial, and direct chemical contamination, and is the most intensely managed zone. The 1-year zone corresponds to the area with the most acute need for protection because there is not a great deal of time to identify a problem and take remedial action if a contaminant enters the aquifer.

- **5-Year Capture Zone.** This zone should be actively managed to control potential chemical contaminants with an emphasis on pollution prevention. While there is more time for response within the 5-year zone, all potential sources should be identified and controlled.

- **10-Year Capture Zone.** Within this zone, existing medium and high risk potential contaminant sources should be targeted to receive increased regulatory attention and technical assistance to prevent pollution and reduce risk.

- **Buffer Zone.** This zone includes the area upgradient of the groundwater capture zones which may include the remaining area of contribution and the recharge area to the aquifer providing the water supply.

3.1 Capture Zones Based on Numerical Modeling

The wellhead protection area for the City of Kent's spring sources was delineated primarily using numerical modeling and hydrogeologic mapping. A numerical modeling approach was used because of the size of the water system, the complexity of the hydrogeology and boundary

conditions in the vicinity of the City's Spring properties, and the susceptibility of the water sources to contamination. Results of the numerical modeling were used to define time-related capture zones.

The 1-, 5-, and 10-year capture zones were based primarily on development of a groundwater flow model using MODFLOW. The hydrogeologic conditions discussed previously and presented in the surficial geologic map, in subsurface cross section diagrams, and water level contour data formed the basis for the model construction. To accommodate the expected overlap of capture zones between the three spring sources, we developed an approximately 53-square-mile model. The model was calibrated to the measured water level data and achievement of a reasonable water balance for the overall system. Appendix B describes the numerical modeling approach and presents the model configuration.

The groundwater flow model was linked to a particle tracking model, PATH3D, to define the time-related capture zones. This particle tracking model releases particles from the wellhead and tracks the movement of these particles backward in time to their point of origin. The analysis was performed at each source area for a 1-, 5-, and 10-year period. The results of this analysis are presented on Figure 3-1.

Because groundwater flow is generally from east to west in the study region, the predicted capture zones generally extend east from the groundwater production areas. Because of the relatively high hydraulic conductivities of the aquifers providing the supply, the capture zones for the three City Springs sources overlap each other. The specific capture zone modeling results for each of the City's Springs properties are described below.

3.1.1 Armstrong Springs

The 1-year capture zone for Armstrong Springs extends approximately 5,000 to 6,000 feet east of the production area. The 5-year zone extends another 6,000 feet east of the 1-year zone. The 10-year zone extends roughly 10,000 feet further east in its northern portion and almost to Ravensdale along its southern portion. Lower groundwater velocities predicted southeast of Lucerne Lake and the till knob south of Clark Springs limit the northern portion of the 10-year zone, while higher permeability sediments east of the Kent Springs area cause the capture zone to extend further east in this area. The Armstrong 10-year capture zone overlaps with the Kent Springs 1- and 5-year capture zones.

3.1.2 Kent Springs

The 1-year capture zone for the Kent Springs source also extends approximately 5,000 to 6,000 feet east of the source area. Following the course of highly permeable recessional outwash deposits, the 5-year capture zone for Kent Springs extends east to the vicinity of Retreat Lake. The 10-year capture zone moves further down the valley south of Retreat Lake in the area of the glacial meltwater trough. The 10-year zone may extend as far as the surface water divide between the Green River and the Rock Creek drainage basin where a groundwater divide is also suspected to occur.

3.1.3 Clark Springs

The 1-year capture zone for Clark Springs is approximately 11,000 feet, approximately twice as long as the 1-year zone for the other source areas. The Clark Springs 1-year zone is substantially longer than the others because more groundwater is produced from Clark Springs and more permeable sediments were encountered east of Clark Springs compared to those encountered in the other two production areas. The 5-year capture zone for Clark Springs extends further east, ending in an area where the aquifer thins rapidly as the bedrock shallows. Bedrock outcrops on the eastern edge of the study region form the eastern limit of the 10-year capture zones.

The 1-, 5-, and 10-year capture zones from Clark Springs probably overlap the 5- and 10-year capture zones from Kent Springs. The dividing line drawn on the map is based on the concept of a dividing streamline. In reality, natural mixing in the aquifer, seasonal changes in groundwater elevation, and variable groundwater withdrawals will cause this dividing line to move somewhat north and south from the fixed position shown on Figure 3-1.

3.2 Surface Water Divide as Recharge Area

The surface water divide is used to distinguish the area providing recharge to the recessional outwash channel areas surrounding the spring sources. This divide is delineated where surface water runoff would move toward the capture zones. This area is particularly important in areas where till and bedrock hills occur because of the potential for runoff and infiltration into the more permeable recessional outwash deposits which surround these hills. The surface water divides were identified based on review of King County Surface Water Management group maps, local topography, and the predicted locations of the groundwater capture zones. The surface water divides are depicted on Figure 3-1 by a bounding dash-dot line and shading.

3.3 Assessment of Data Uncertainties

There are a number of areas within the study area where hydrogeologic data are limited or lacking. In these areas, hydrogeologic judgement based on experience in other similar environments and interpretations presented in the SKCGWMP Background Data report were used as the basis for our conceptual and numerical modeling. There are only a few areas where limited data are most likely to impact the capture zones. These are discussed below.

3.3.1 Groundwater Flow North-Northeast of Armstrong Springs

Little data exist on the aquifer properties north-northeast of Armstrong Springs. The relative magnitude of the groundwater flow contribution from the north versus the east influences the size and orientation of the capture zones. If more flow is derived from the northern area, the Armstrong Springs capture zone could orient more northeasterly. Additional data need to be developed in this area to better understand the flow contribution and its potential effect on groundwater capture at the Armstrong Springs property, particularly since till may be absent in a portion of this area. We address this uncertainty in development of a wellhead management area

discussed later and with additional data collection recommendations in Section 7.0 Monitoring Plan.

3.3.2 Quantity of Recharge

The groundwater moving through the aquifers is wholly derived from precipitation recharge. The amount of recharge will have a significant effect on overall development of the groundwater flow model. Recharge rates are, at best, rough estimates. Precipitation amount and patterns, soil types, topography, and land use all affect the amount of recharge to the groundwater system. We relied primarily on Landsburg precipitation data and the USGS summary graph of precipitation-recharge relationships (USGS, 1993). Since the summary graph was based on a recharge model for the Covington Upland area, this document should be reviewed when available and consideration given to updating the groundwater flow model and capture zone delineation using these data.

3.3.3 Aquifer Interaction with Surface Waters

A better understanding of surface water-groundwater interactions is needed to develop a more accurate hydrologic budget for the area. Aquifer-surface water interactions could also impact capture zones. For example, if we underestimated the degree to which Lake Sawyer is a source of groundwater to the underlying aquifers, the actual Kent Springs and Lake Sawyer wellfield capture zones may be substantially smaller than predicted. Likewise, a hazardous materials spill or release to a stream could adversely affect groundwater quality in losing reaches of the stream.

Stream gaging with nearby groundwater level monitoring such as has been completed on Rock Creek (a weir has been installed and is being monitored by the City of Kent) should be conducted on Ravensdale, Covington, Jenkins, and the Little Soos Creeks for better understanding of the surface water-groundwater interactions in the area.

3.3.4 Retreat Lake Area Groundwater Flow

Groundwater elevations, water table gradients, and groundwater flow rates through the drainage leading from Lake 12 past Retreat Lake toward the Georgetown area and northward to the Cedar River are not well known. Because the predicted capture zones for both the Kent Springs and Clark Springs properties extend into this area, additional data need to be developed to more accurately assess flow rates through this area and boundaries of the 5- and 10-year capture zones for the Clark Springs, Kent Springs, and Covington sources.

3.4 Composite Wellhead Management Area - Kent/Covington WHPA

A composite map was made for wellhead protection management purposes to address uncertainties in the hydrogeologic data and to include the capture zones for Covington's Lake Sawyer wellfield. Coordination of the wellhead protection activities has been a goal of program development since the work began and is particularly important for the Kent Springs and Lake Sawyer wellfields because of their close proximity. Additionally, capture zone delineation

indicates overlap of the three City sources and the Lake Sawyer wellfield. To accommodate these factors a proposed composite wellhead protection management area, the Kent/Covington (after the two major purveyors) Wellhead Protection Area, is identified. This proposed Kent/Covington Wellhead Protection Area is presented on Figure 3-2 and discussed below. The specific time-of-travel capture zones for this proposed composite Wellhead Protection Area, are delineated as Zone 1 (1-year zone), Zone 2 (5-year zone), and Zone 3 (10-year zone).

3.4.1 Armstrong Springs

Zone 1 at Armstrong Springs includes the 1-year capture zone plus the area to the northeast where the till appears to be thin or absent. As shown on Figure 3-2, Zone 1 is expanded northward to the surface water divide. Without any confining layers between ground surface and the aquifer supplying water to the Armstrong wells, the Qvr and Qc(2) aquifers are highly vulnerable to any contaminant release. Given the absence of till, the lack of pumping test data, and a poorly understood groundwater flow pattern, we believe inclusion of this area is appropriate to ensure adequate protection. Zones 2 and 3 use this same concept of expanding the 5-year and 10-year zones toward the surface water divide to incorporate uncertainties.

3.4.2 Kent Springs/Lake Sawyer Wellfield

Because of the proximity of the Kent and Lake Sawyer wellfield water supply sources we have developed composite Zones 1, 2, and 3, based on the 1-, 5-, and 10-year capture zones delineated by Hart Crowser and Robinson & Noble for their respective study areas. The Zone 1 boundary of both the Kent Springs and Lake Sawyer wellfield capture zones are slightly expanded beyond the 1-year capture area to account for the more southerly location of the Lake Sawyer wellfield, the more northerly location of the Kent wellfield, and to err on the conservative side with respect to uncertainty in the outer 1-year boundary. The composite protection area for Zone 2 also expands Kent's 5-year capture zone to the south to account for the more southerly location of the Lake Sawyer wellfield.

Precipitation on the small till-capped bedrock knob north of Ravensdale is likely to drain water into the highly permeable outwash deposits around Clark Springs and within the Ravensdale outwash channel. For this reason the protection area boundaries are extended to the surface water divide in this area for both the Kent Springs/Lake Sawyer Zone 2 and the Clark Springs Zone 1.

Zone 2 for the Kent Springs/Lake Sawyer wellfield source extends the 5-year zone modeled for the Kent Springs source roughly 4,000 to 5,000 feet further south of Retreat Lake. Zone 2 is thus a composite of the modeled 5-year boundary for the Kent Springs and the modeled 5-year boundary for the Lake Sawyer wellfield. Differences in the 5-year boundary for the Kent Springs and Lake Sawyer wellfield stem from uncertainties in the amount of recharge occurring in this area and a lack of good water level and hydraulic conductivity data.

3.4.3 Clark Springs

Zone 1 for the Clark Springs source is proposed to include the City's property and north and south to the surface water divides. The surface water divide boundary is included based on the likelihood that runoff from the low permeability till-capped bedrock surrounding the property infiltrates into the high permeability outwash deposits comprising the aquifer. Because this could happen over a very short period of time, we have extended these boundaries outward to include this area.

The boundary of the Clark Springs Zone 2 is extended northward to the Rock Creek surface water divide and bedrock outcrop. This larger area is proposed to account for uncertainties in the amount of flow to the Cedar River through this area.

3.4.4 Consider Surface Water Divide as a Buffer Zone

The surface water divide should be considered a buffer zone for groundwater quality protection. The hydrogeologic conditions indicate the potential for land use practices on adjacent upland areas to affect groundwater quality by degrading surface water recharge quality. Examples include; urban street runoff containing traces of gasoline or other petroleum products in areas providing surface water recharge to the Armstrong Springs, and surface water runoff from agricultural areas upland of the Clark Springs containing traces of fertilizers or pesticides.

The surface water boundary provides a margin of safety that addresses data uncertainties and natural variability in aquifer characteristics. Incorporating surface water recharge into the wellhead protection area is particularly important near Clark Springs. Because till-capped upland areas and bedrock outcrops dominate the recharge area for the Clark Springs and Kent Springs/Lake Sawyer wellfield source areas, runoff is a significant contributing factor to groundwater quality as well as quantity.

3.4.5 Future Data Collection Needs

Additional data could be collected to refine our understanding of groundwater flow to the water supply source areas. Hydrogeologic data collection should primarily include water level measurements, aquifer characteristics data, streamflow data, and water quality information. These data will provide a means to more accurately describe the groundwater flow system and refine the area model; thus providing a better tool for making groundwater-related decisions. The primary data needs include:

- Water level and aquifer characteristics data (geologic description and transmissivity estimates) north and west of Armstrong Springs in the Zone 1 area;

- Water level and aquifer characteristics data in the eastern portion of the Clark Springs Zone 1 to understand groundwater movement toward the Cedar River.

- Review the USGS recharge model for the Covington Upland when it is available and assess any model revisions that may be desirable;

- Water level and aquifer characteristics data in the Kent Springs/Lake Sawyer Zone 2 around Retreat Lake; and

- Streamflows gaging water level measurements around the Ravensdale, Covington, Jenkins, and Little Soos Creeks to better understand the interaction of surface water with groundwater.

Additional water quality monitoring is also recommended. Collection of regular water quality data from appropriately placed wells could help provide an early warning of potential water quality impacts as well as additional data for aquifer characterization. These data collection efforts are discussed in more detail in Section 7.0 Groundwater Monitoring Plan.

3.5 Areas Highly Susceptible to Contamination

An evaluation of the aquifer susceptibility was performed to characterize the WHPA in accordance with the Seattle/King County Health Department's Sensitive Aquifer Recharge Area designations. Although a portion of the study area was already mapped for susceptibility in the South King County groundwater management planning process, more detailed hydrogeologic analyses have been conducted for this wellhead protection study. Furthermore a significant portion of the recharge area and WHPA extends beyond the eastern boundary of the South King County Groundwater Management Planning area and the area mapped by King County. We used the County's methodology to delineate areas of high, moderate, and low infiltration potential. This map will be used to achieve County recognition of the sensitive nature of the wellhead area.

The methodology used was consistent with the predominant method used by the Seattle/King County Health Department in the groundwater management planning process to differentiate areas of high, moderate, and low infiltration potential. The analysis included mapping of four hydrogeologic criteria over the wellhead protection area. The criteria included:

- **Surficial Geology.** Areas where the Qvr occurs at ground surface were considered areas of high infiltration potential, areas where Qvi occurs at ground surface were considered as moderate in infiltration potential, and areas where Qvt and Tbr occurred were considered to have a low infiltration potential.

- **Soils.** Soils units as defined by the Soil Conservation Service were mapped as high, moderate, and low based on the description provided in the Soil Survey of the King County Area (1973). Generally the soil types corresponded directly with the surficial geologic unit; with Qvr and Qvi forming Everett soils which are excessively drained, and Qvr and Tbr forming moderately well-drained Alderwood Association soils.

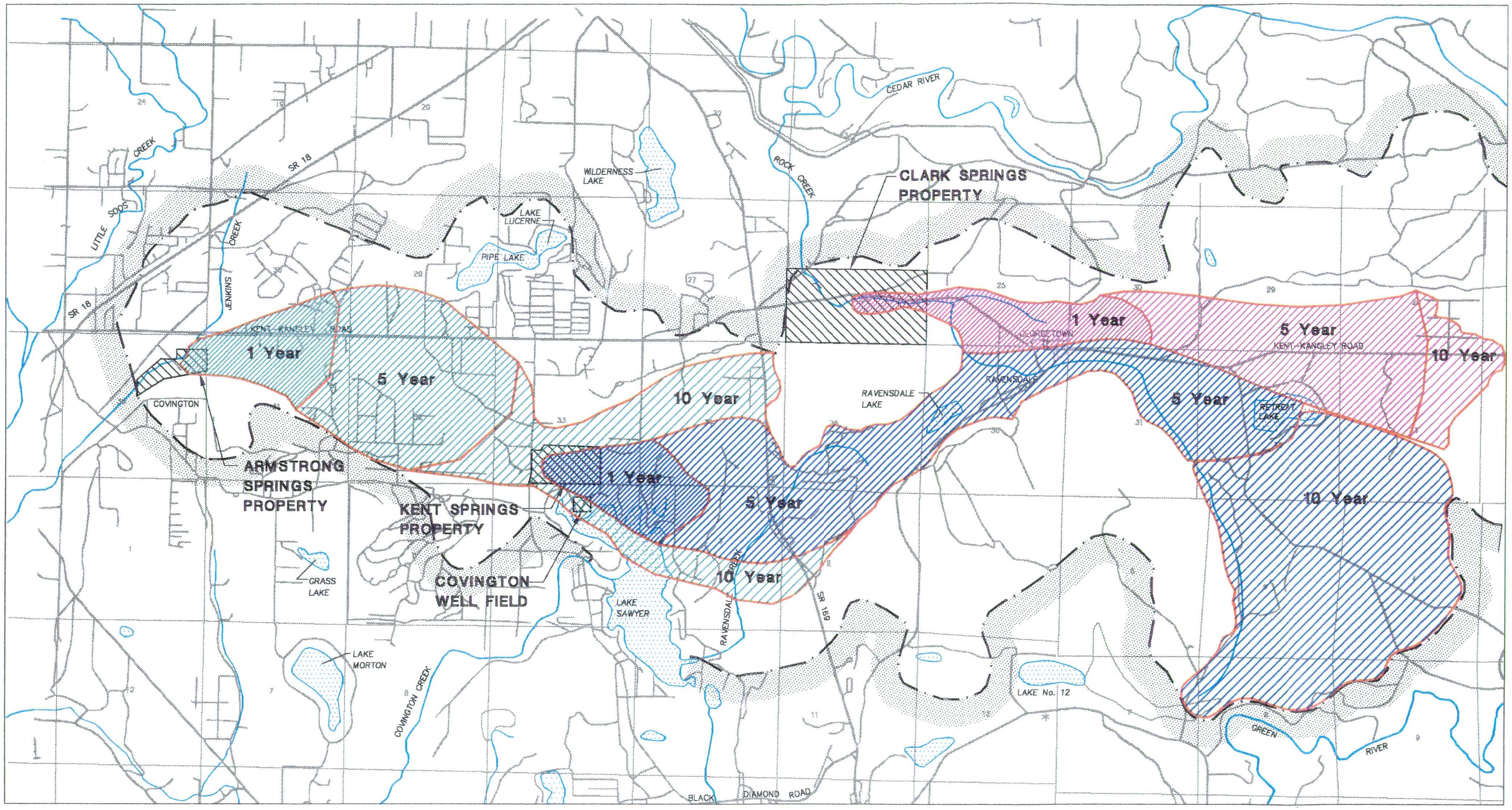
- **Slope.** Percent slope was obtained from topographic maps and the King County Soil Survey and the criteria used for the Redmond-Bear Creek Groundwater Management Area. High infiltration was assumed to occur when slopes were less than 40%. Moderate infiltration was assumed to occur with slopes between 40% and 80%, and low infiltration was assumed for slopes greater than 80%.

- **Depth to Groundwater.** The depth to groundwater is an important factor in determining the amount of time it would take a contaminant to reach the aquifer. High potential susceptibility was assumed where the depth to water is less than 25 feet. A moderate susceptibility factor was assumed where the depth to water is between 25 and 75 feet, and a low factor was assumed where the depth to water was greater than 75 feet.

An Aquifer Susceptibility Map was created by overlaying the four maps developed for each of the criteria outlined above. The resulting map is presented on Figure 3-3. The entire WHPA is either high or moderate in susceptibility with over 66 percent of the area being potentially Highly Susceptible to Groundwater Contamination.

King County recognition of the highly susceptible areas within this portion of the county is extremely important to future land use decisions. The King County Comprehensive Plan acknowledges the special level of protection needed for Critical Aquifer Recharge Areas and Areas Highly Susceptible to Groundwater Contamination. The information on the hydrogeology, the recharge area for the wellheads of these major City of Kent and Covington water sources, and the susceptibility mapping, illustrate the importance of protecting these wellhead areas. This will be particularly important given that much of the Armstrong Springs, Kent Springs, and Lake Sawyer wellfield protection zones fall within the county's proposed Urban Growth Boundary area where expedited permit reviews are planned.

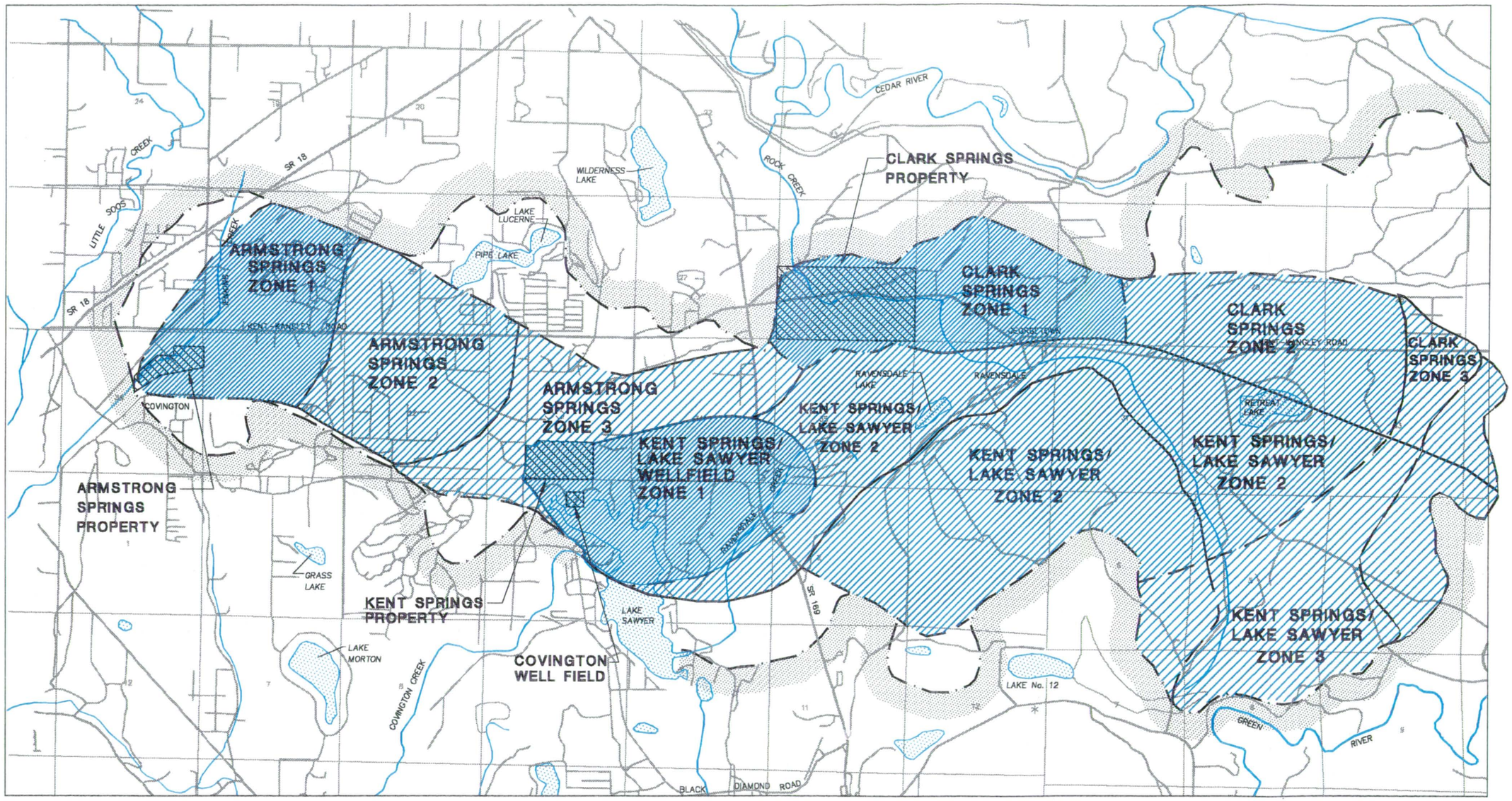
Modeled Capture Zones and Surface Water Divide Map



CVD 11/30/95 1=4000 color.pcp
35080119

HARTCROWSER
J-3508-01 11/95
Figure 3-1

Kent/Covington Wellhead Protection Area Map



ZONE 1 1–Year Capture Zone

ZONE 2 2–Year Capture Zone

ZONE 3 3–Year Capture Zone

Surface Water Divide

SWP 11/1/95 1=4000 color.pcp
35080134

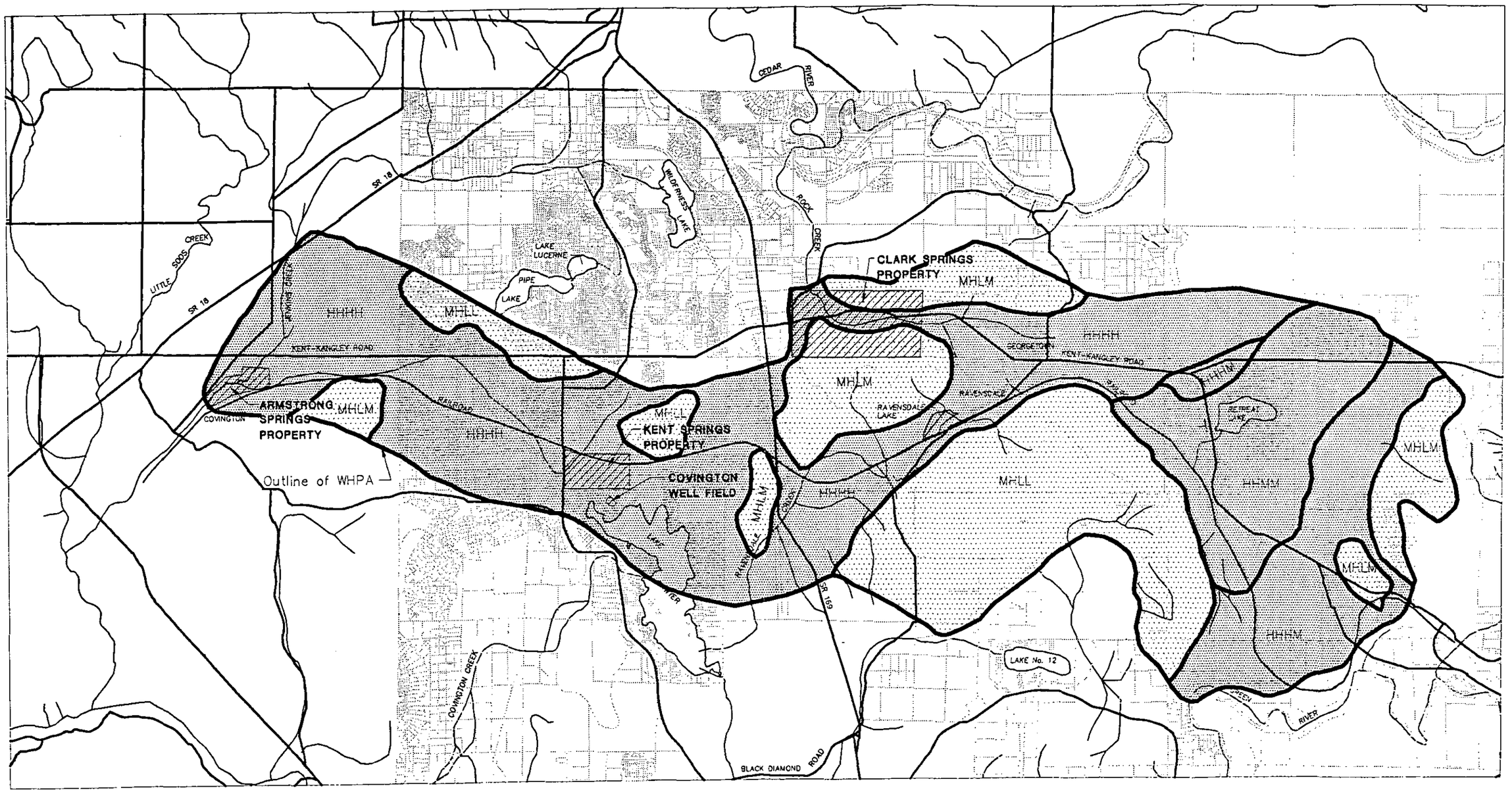
HARTCROWSER

J-3508-01 11/95

Figure 3-2

Aquifer Susceptibility Map

Kent/Covington WHPA



Relative Susceptibility

- High (HHHH, HHHM, and HHMM)
- Moderate (MHLM, MHLL)
- Low (None in WHPA Area)

Designation MHLM is the relative rating of the areas susceptibility to Groundwater contamination based on a high (H), moderate (M), or low (L) rating of physical parameters in the following order:

Soil Permeability
Geologic Materials
Depth to Water
Topography (Percent Slope)

Note: Methodology for rating from Seattle/ King County Health Dept.; King County Dept. of Development and Environmental Services; and the Groundwater Management Area Technical Reports (1994)

0 4000 8000
Scale in Feet

HARTCROWSER
J-3508-01 11/95
Figure 3-3

CAD 11/30/95 1=1 HC.pcp ref:KENTBASE.DWG
SURBOI 58

Source Inventory and Risks

4.0 POTENTIAL SOURCES OF GROUNDWATER CONTAMINATION

4.1 Contaminant Source Inventory Methodology

The inventory of potential contaminant sources within the WHPA was conducted according to the Washington State Department of Health guidance document entitled "Inventory of Potential Contaminant Sources in Washington's Wellhead Protection Areas," December 1993. This document summarizes the basic steps for conducting an inventory including review and identification of potential contaminant sources and prioritization of the risks to the WHPA. A summary of potential contaminant sources is provided in Table 4-1. These potential sources were considered when performing the contaminant inventory for the three WHPA's in this study area.

There were four primary activities conducted for the inventory of potential sources of contamination. These included:

- Review of current and historical land use practices in the study area;
- Compilation of available databases from EPA and Ecology;
- Windshield survey to confirm database site locations, land uses, and identify other potentially unregulated or unidentified sites; and
- Review of the source inventory methodology with the Wellhead Protection Committee as it was developed to allow local and county-wide input into the process.

A discussion of the inventory process and the findings are summarized below. A prioritization of these concerns follows the discussion of potential contaminant sources. Tables and figures at the back of the text in this section further identify the potential contaminant sources identified in the study area.

Identification of a site on one of the regulatory database listings does not necessarily indicate contamination associated with the listed site. Several of the lists, e.g., the RCRIS merely identify sites that generate, transport, or dispose of hazardous waste. Section 4.3 summarizes our findings of known sites of contamination based on the regulatory database listings.

4.2 Historical and Current Land Use

Hydrogeologic conditions indicate that long-term quality of the relatively shallow groundwater system is susceptible to contamination by historical and current land use activities throughout the WHPA. Knowledge of these land use practices is important to understand the potential concerns associated with the release of chemical constituents, such as pesticides, nitrates, or petroleum compounds associated with those land uses. Historical land uses were evaluated by review of historical aerial photographs from 1965, 1970, 1974, 1981, and 1988, and historical maps dating back to the late 1960s and revised to the early 1990s. Our review indicated the historical land uses were primarily residential, mining, and logging. A general review of historical and recent land use activities are described below.

4.2.1 Residential/Commercial/Industrial Land Use

Most of the residential/commercial/industrial lands uses are found west of the Maple Valley Black Diamond Road near its intersection with SR-516. Map and aerial photo review indicate that residential developments appear by the mid-1960s, but the majority of residential developments were constructed in the 1970s and 1980s. During the 1960s, several commercial and industrial uses appear. These land uses included, but are not limited to: sand and gravel mines; a rock quarry; an asphalt batch plant; gasoline stations; and a BPA substation. Most of these commercial and industrial land uses still exist today. Potential contaminants associated with these types of land use include petroleum hydrocarbons, solvents, explosives, metals, and PCBs. Specific sites which are known or suspected to be contaminated based on regulatory files are discussed in Section 4.3. Figure 4-1 presents the current land use zoning based on 1993 King County mapping. Electronic information was not available for the area around Armstrong Springs so it is not included on the map.

4.2.2 Mining and Forestry

Coal Mining Activities. Coal mining operations have occurred mostly east of the Maple Valley-Black Diamond Road. Coal was initially found in King County in the mid-1800s. Several coal mines in the Landsburg and Ravensdale areas opened in the late 1890s, along the Burlington rail line. The coal mines in this area included the Landsburg mine (formerly operated by the Palmer Coking Coal Company; Tobacco Prospect); the Raven and Ravensdale mines; the Dale mine; the McKay mine; the Anderson mine; Black Beauty and Okay mines; and the Section 6 mine (USGS). Most of these mines are no longer in operation although abandoned mine workings have been used for waste disposal in the past and provide a conduit for groundwater flow in an otherwise very low permeability strata. The Landsburg mine, located northeast of Clark Springs, is a known area of waste disposal in a former coal mine. The only current coal mining operation known to occur in the area is located near Lake 12 and is operated by the Pacific Coast Company. A Special Use Landfill and a Confirmed and/or Suspected Contaminants Site are listed in regulatory databases within the current mining area of the Pacific Coast Coal and Palmer Coking Coal Company (see Section 4.3)

Other Mining Activities. Sand and gravel mines have operated throughout the study area at various times, dating back to at least the 1940s. The Lake Wilderness Golf Course is located on a former gravel pit and at least two current sand and gravel mines exist in the west project area (see Figure 4-3). L-Bar Products/Reserve Silica Corporation currently operates a silica mine southwest of Ravensdale Lake.

Forestry. Forestry operations occur in the southeast portion of the study area, within Zone 2 of the Lake Sawyer/Kent Springs WHPA as shown on Figure 4-1. Herbicides and fertilizers may be used in these areas to eliminate competition from unwanted species and to encourage growth of planted species, respectively.

4.2.3 Current Zoning

Current land use in the WHPA ranges from rural residential to urban medium density and includes commercial, industrial, mining, and forestry uses. The WHPA is situated in a transitional location as King County's proposed Urban Growth Boundary falls in the west-central portion of the WHPA (see Figure 4-1). The Clark Springs wellhead, which is located roughly in the middle of the wellhead protection management area, is located at a breakpoint between the areas of differing land use. The western area is zoned primarily for urban medium-density and rural residential; a significantly smaller proportion of the area is zoned for commercial and industrial uses. In the eastern area, roughly equal portions of the land are zoned for rural residential development and forestry practices. Several localized areas are zoned for mining activities in both the eastern and western portions of the WHPA.

4.3 Potential Contaminant Sources Identified in Regulatory Databases

4.3.1 Regulatory Database Search

To search for potential point sources of groundwater contamination in the WHPA, existing information from various environmental databases was obtained and mapped. The following databases were reviewed and are discussed in order of descending importance relative to the potential for risk to the WHPA.

Washington State Department of Ecology (Ecology) Confirmed and Suspected Contaminated Sites Report. This report contains a list of sites investigated under the Model Toxics Control Act (MTCA). Sites on this list have been reported to Ecology. Ecology then typically performs a site hazard assessment (SHA) and determines whether further investigation is necessary. Other sites included on this list may be investigated and cleaned up under Ecology's Independent Remedial Action Program (IRAP). Owners or operators of these sites perform investigations and remedial actions independently of Ecology's review.

The inclusion of sites on these lists indicates that a release of chemical constituents has occurred, or is suspected to have occurred, at the facility. The database provides information on type of contaminants believed to have been released and the types of media which has been impacted. Table 4-2 contains the sites that were included on this list. Significant sites identified on the Confirmed and Suspected Contaminants list within the WHPA include:

▸ Landsburg Mine	Zone 1- Clark Springs
▸ L-Bar Products Inc (Reserve Silica Corporation)	Zone 2- Kent Springs/Lake Sawyer
▸ Northwest Pipeline	Zone 2 - Armstrong Springs
▸ Palmer Coking Coal	South of Zone 2 - Kent Springs/Lake Sawyer

The approximate location of these sites are identified on Figure 4-2, and the status of selected sites, based on a review of Ecology files, is discussed in Section 4.3.2.

Ecology Leaking Underground Storage Tank (LUST) List. Releases from USTs to the soil and groundwater which have been reported to Ecology's Northwest Regional Office (NWRO) are recorded on this list (Table 4-3). We have also included UST sites which have been contaminated (Table 4-5). The status of the investigation and cleanup for the contaminated UST sites is also recorded.

Owners and operators of registered USTs are required to report a confirmed release in accordance with Chapter 173-360 WAC (Washington State Department of Ecology's Underground Storage Tank Regulations) within twenty-four hours. Under the MTCA Cleanup Regulation, Chapter 173-340 WAC, even UST owners that are exempt from registering their UST with the State of Washington (e.g., heating oil UST) are required to report a release from their UST which may pose a threat to human health and the environment.

Tables 4-3 and 4-5 contain sites in the area of the WHPA that were included on the LUST and Contaminated UST Sites lists. The LUST and Contaminated UST sites identified within the WHPA (Figure 4-2) include:

- Junior High No. 6 Zone 2 - Armstrong Springs
- Multicare Zone 1 - Armstrong Springs
- Arco Station Zone 1 - Armstrong Springs

Ecology Underground Storage Tank (UST) Registration. This report contains a list of regulated USTs as defined in Chapter 173-360 WAC, which are registered with Ecology's NWRO. State UST regulations have been in effect since 1986. New USTs are required to meet all of the leak detection requirements as defined under Chapter 173-360 WAC by December 1993. Existing UST systems have until December 1998 to be in compliance with the corrosion protection and spill/overfill prevention requirements as defined in Chapter 173-360 WAC. All newly installed and registered USTs are likely to be in compliance with the leak detection requirements; leaks should be detected in time and corrective action can be taken immediately. Sites within the WHPA included on this list are identified on Figure 4-2 and listed on Table 4-4.

Exempt USTs (e.g., home heating oil USTs) as defined in Chapter 173-360 WAC are not typically included on this list. Because of these exemptions, this list may or may not represent the complete risk of environmental contamination from USTs.

Ecology Solid Waste Facility List (SWFL). This list contains a summary of information pertaining to solid waste landfills permitted by the County Health Department. No municipal landfills are present within the WHPA. One special waste landfill was found within the WHPA at the Reserve Silica Corporation site. Two other special waste landfills were found just outside the WHPA boundaries at Iddings and the Pacific Coast Coal Company. Table 4-6 contains the sites included on the SWFL list. Figure 4-2 illustrates the locations of these landfills.

EPA Region 10 CERCLIS. This list contains sites reviewed by EPA under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Four sites within the study area were investigated under CERCLA including:

- Landsburg Mine;
- L-Bar Products;
- BPA Covington Substation; and
- Toomey Property.

None of these sites were placed on the CERCLA National Priorities List (NPL). However, three of these sites are now being investigated and are also listed under the State's MTCA program. Of the three sites, only two are actually within the WHPA, the Landsburg Mine and L-Bar Products sites. All sites are identified on Figure 4-2.

EPA Region 10 Toxics Release Inventory System (TRIS) List. This list contains an inventory of toxic chemical emissions from certain facilities. The Emergency Planning and Community Right-to-Know Act (EPCRA, or SARA Title III) requires facilities that release chemicals above threshold amounts to report to EPA the annual amount released. Releases include releases to air, water, and soil. No facilities within the WHPAs are on the TRIS list.

EPA Region 10 RCRA Notifiers List. This list contains information on generators, transporters, and disposers of hazardous wastes. The inclusion of facilities on the RCRA list indicates that there is a potential risk for mishandling materials or spills at these facilities. Eighteen facilities were identified on the RCRA list. Six of those facilities are listed as conditionally exempt small quantity generators; these facilities generate less than 220 pounds of hazardous waste per month. Eight facilities were identified as small quantity generators; these facilities generate between 220 and 2,200 pounds of hazardous waste per month. There are four large quantity generators listed, including:

- Bremmeyer Logging Company;
- Covington Medical Park;
- Landsburg Mine; and
- Ravensdale Sand Pit.

Two sites were listed as commercial transporters. There were no permitted storage, treatment, or disposal sites identified on the list. The RCRA sites are listed in Table 4-7 and the locations of the large quantity generators, listed above, are illustrated on Figure 4-2.

4.3.2 Regulatory File Review of Selected Sites

Landsburg Mine. The Landsburg mine site is the location of a former underground coal mine located in Sections 24 and 25 (T22N, R6E) less than a mile northeast of Clark Springs (Figure 4-2). The mined section, the Rogers Seam, has a near vertical dip and was mined to a depth of up to 750 feet. Subsidence of the overburden left a trench roughly 60 to 100 feet wide, 20 to 60 feet deep, and approximately 3/4-mile long that was subsequently used in the late 1960s to the early 1980s for disposal of industrial wastes, and construction and land clearing debris. Drums, liquids from tanker trucks, and industrial wastes materials were disposed of in the northern portion of the trench.

The Landsburg mine site is under an Agreed Order with Ecology to cleanup the former mine site. The responsible parties are conducting a Remedial Investigation and Feasibility Study (RI/FS) to determine and evaluate cleanup alternatives, and Golder and Associates is the consultant conducting much of the work. The site has confirmed soil contamination and suspected groundwater and surface water contamination. Constituents detected include volatile and semivolatile organic compounds, PCBs, metals, and cyanide.

An expedited cleanup removed over 100 drums from the site in 1991. A Phase I site characterization has been completed, which included the installation of 7 monitoring wells. Two of the wells (installed adjacent to each other and screened in different zones) and a surface water seep near the south portal of the Rogers Seam mine are located within the Clark Springs Zone 1. The monitoring wells, the mine portals, and 15 private water supply wells in the surrounding area (including Clark Springs) have been sampled quarterly over the past year for a complete suite of priority pollutants. Another year of quarterly monitoring is planned before the RI/FS is completed. No water quality concerns have been identified at Clark Springs, the surface water seep, or the monitoring wells within the Clark Springs Zone 1.

L-Bar Products/Reserve Silica Corporation. This site is located within Zone 2 of the Lake Sawyer/Kent Springs wellhead. It is the site of former underground and strip coal mines which operated between the early 1900s and 1947. No mining activities occurred at this site between 1947 and 1968. The 380-acre site is currently an operating sandstone mine with three active mining areas and one abandoned mine. Operations at the site include strip mining of the sandstone from elongated pits, a sand washing plant, and settling ponds for the wash water. The sand is used primarily for glass and concrete manufacture.

The primary areas of interest at the site are the abandoned mine and the active cement kiln dust disposal area. Between 1979 and 1982 Ideal Basic Industries disposed of 180,000 tons of cement kiln dust into the abandoned mine. Cement kiln dust typically has a high pH (approximately 12) and may contain heavy metals. Contamination is suspected in the area of the abandoned mine in soil, groundwater, and surface water and the site is awaiting Site Hazard Assessment by Ecology. Listed contaminants include metals and corrosives.

The facility received a notice of violation from the Washington State DOH in 1986. Leachate from the cement kiln dust disposal area was found surfacing through an adjacent road bed and discharging down an embankment. The abandoned mine was closed in 1990 and capped with 4 feet of clay and 3 feet of soil cover.

Cement kiln dust is still being disposed of at this site into the Dale Number 4 Strip Pit. Laboratory analysis of the disposed material indicate that at least 1 sample failed the Extraction Procedure Toxicity (EP Tox) test for lead. However, Ideal Basic Industries has obtained an exemption from the State Dangerous Waste Regulations for disposal of this material. The exemption includes requirements for groundwater and portal (old mine shaft) monitoring around the disposal area.

Four groundwater monitoring wells have been installed around the Dale Number 4 Pit. Referenced reports indicate that groundwater is found at depths of approximately 15 to 200 feet below ground surface. Groundwater likely flows to the southwest toward Lake Sawyer, but groundwater flow direction at the site may be complex because of mining influences and naturally occurring fractures in the sandstone. Review of analytical data from the spring of 1992 indicate that pH in the monitoring wells is only slightly elevated above neutral (up to 8.0). Metals were detected in wells with lead being measured at 0.017 ppm, slightly above the EPA at-the-tap action level for lead of 0.015 ppm.

Northwest Pipeline. This site is included in the Confirmed and Suspected Contaminated site database and awaiting SHA by Ecology. The site was reported to Ecology when failure of a mercury flow meter released mercury to the soil. Northwest Pipeline performed an independent remedial action to remove the soil contamination. However, verification soil samples indicated that up to 92 ppm of mercury remained in the soil after the initial cleanup effort. Because Northwest Pipeline is performing an independent cleanup action, there was little information in Ecology files.

Palmer Coking Coal Company. This site is located just south of Zone 2 of the Lake Sawyer/Kent Springs wellhead. The principal concerns at this site involve historical disposal of wastewaters from coal washing operations and disposal of coal-coking slag and oily sludges from off site into a series of pits.

Newly mined coal was transported to the Palmer site from coal mines in the area. This coal was placed into tanks and washed to sort the lightweight coal fragments from heavier soil and rock particles. The heavier soil and rock materials which fell to the bottom to the tank were considered spoil materials and were scraped from the bottom of the tank and spread to dry in a 4-acre pit. Between 1969 and 1971, approximately 40,000 of oily wastewater (generated from steam cleaning of ship bilges and apartment house oil tanks) was also disposed of in the spoil disposal area.

Water remaining in the tank after coal washing operations was discharged to a much larger pond along the western boundary of the site. Discharge to this pond was permitted by a National Pollutant Discharge Elimination System (NPDES) permit (No. 3822).

E&E performed a site investigation for EPA in 1986, and URS performed a Level 1 Site Prioritization Inspection of the site in 1993. During the E&E study, surficial geologic materials were described as 25 to 35 feet of fill material overlying 2 to 6 feet of glacial till. Sandstone deposits were generally encountered in the bottom of the borings. Groundwater was found at depths of between 25 and 30 feet below ground surface.

Soil and groundwater sampling confirmed the presence of elevated concentrations of metals including As and Pb, aromatic and chlorinated solvents, and PCBs in the oily sludge disposal area. E&E (1986) concluded that additional information was needed, however, because of underlying bedrock they suspected only limited migration of waste materials from the disposal area may have occurred.

Minimal investigation has been conducted on the impact from the wastewaters and slag disposal. EPA concluded that no further action was required under CERCLA at this site in 1993. The site is currently being reclaimed as required by the Washington State Surface Mining Act.

4.4 Other Groundwater Quality Concerns

The relatively shallow depths to groundwater and the coarse-grained deposits identified at ground surface within most of the study area produce relatively susceptible conditions for groundwater contamination. The following discussion briefly summarizes the potential groundwater quality concerns associated with the land uses and sites of known contamination within each of the three WHPAs.

4.4.1 Nitrates in Groundwater

There are multiple potential sources of nitrates which could be released to groundwater in the WHPAs. These potential sources include septic systems, livestock keeping operations, and fertilizer applications to lawns, golf courses, and timber growing sites. These potential sources are discussed briefly below.

Septic systems are used in areas which are not served by sewers. The eastern portion of the WHPA is outside the proposed Urban Growth Boundary in King County and will likely remain unsewered for the foreseeable future. Wastewaters released from septic systems contain bacteria, nutrients, and may contain household chemicals which are flushed down the drain. However, the principal concern from properly maintained and used septic systems is the impact of nitrogen, which is converted in the environment and transported as nitrate in the groundwater system. Nitrate is the primary constituent of concern because of its relatively high mobility in groundwater systems and its potential toxicity to humans. Regional studies have shown that groundwater quality impacts from septic systems used in residential developments vary widely based on hydrogeologic setting and housing density.

Nitrates originating from golf courses are identified concerns in a variety of locations in Washington. Nitrate concentrations above the federal drinking water standard (of 10 mg/L) have been reported in groundwater collected near principal golf course fertilization sites such as putting greens.

Agriculture, forestry, and livestock keeping are additional land use practices within the eastern portion of the WHPAs which could result in the release of nitrates into the groundwater system. Multiple livestock keeping areas are located around the Retreat Lake area according to King County records. Properly designed and operated livestock facilities can mitigate the potential for nitrate releases by implementing best management practices defined by the US Soil Conservation Service (1990). Poorly managed facilities can release nitrates via surficial runoff and infiltration to the underlying groundwater system. Within the WHPAs in this study area, agricultural practices are limited primarily to small-scale operations and do not occupy a large identifiable blocks of land; however, they are numerous.

Forestry practice, which includes much of the undeveloped land in the eastern portion of the WHPAs apparently uses fertilizers to encourage tree growth in newly planted areas. Nitrogen, in the form of urea, is generally used at the rate of 300 pounds per acre.

The presence of multiple sources of nitrate in the WHPA results in the potential for additive nitrate loadings to the groundwater system resulting in a progressive decline in water quality. To date, nitrates have not been a detectable problem in the samples collected from the water supply sources.

4.4.2 Pesticide Application

Pesticides are typically used in residential areas, along transportation corridors, at electrical substations, golf courses, and in forestry operations. Pesticides may be most heavily used at electrical substations to prevent unwanted plant growth and risk of electrocution to workers. A summary of the pesticide applications inventoried during this study is provided in Table 4-8.

The term "pesticide" is used here to describe a suite of related products which include insecticides, herbicides, and fungicides. Available pesticides include 19 varieties which are restricted to permitted use (by the Washington State Department of Agriculture) and a wide variety of commercially available products. When applied in accordance with manufacturer specifications, pesticides are relatively immobile because they are consumed by the pests or become adsorped to soil. Most of the products are toxic to humans and animals in small quantities, with specific risk-based toxicity data available for active ingredients in the commonly used products.

Herbicides may be used in forestry operations in reseeded/replanted areas to limit the growth of competing weeds and trees such as alders. Spot applications of herbicides may also be used to remove tree stumps. Brush clearing operations are generally performed by burning or mechanical means rather than through the use of herbicides. This information was provided by communication with the Washington State University Extension Service. We were unable to discuss site-specific operations at these parcels with the timber companies who currently operate on the land.

Herbicides are also used on transportation corridors. State and county transportation departments are responsible for maintaining roads within the WHPA. Herbicides are used mainly to maintain highway shoulders to be free from plant growth. Oust, Escort, Round-Up, Diuron, and Garlon 3A, are used on the gravel along the shoulders. They are applied at rates between 4 oz per acre to 5.7 pounds per acre, depending on the herbicide. They are applied annually or more frequently as needed.

Pesticides are also used by homeowners. They are used to kill garden and lawn pests, destroy weeds, kill tree stumps, and eliminate fungus or treat plant diseases. Homeowners are able to purchase only chemicals which have been approved for retail sale. Instructions are included on container labels, but there are no further restrictions provided the chemicals are used as intended.

The presence of multiple sources of pesticides in the WHPA results in the potential for additive loadings to the groundwater system resulting in a possible progressive decline in water quality. To date, pesticides have not been a detectable problem in the samples collected from the water supply sources.

4.4.3 Petroleum Hydrocarbons

There are numerous potential sources for petroleum hydrocarbons within the WHPA. These include gasoline stations, industrial and commercial operations which fuel and maintain equipment and vehicles (including mining and forestry operations), and home and commercial heating oil tanks. Petroleum hydrocarbons are typically stored in USTs in volumes ranging for 300 gallons (residential use) to up to 10,000 per tank (gasoline service stations). Larger storage volume requirements, greater than 10,000 gallons, are typically stored above ground.

Petroleum hydrocarbons are not highly soluble in water. Their solubility is related to the length of the hydrocarbon chains which comprise the material. Short chain hydrocarbons, the types which are found in gasoline, are typically more soluble than longer chain hydrocarbons which are found in diesel fuel and heating oil. Because these materials are not highly soluble, they are not typically found to migrate very far from the source of the spill. The greatest potential threat to the wellhead could be from sources of petroleum hydrocarbons very close to the wellhead or large releases of petroleum hydrocarbons. Petroleum hydrocarbon releases may also be more of a threat at sites where other types of solvent have also been spilled: these materials could act as co-solvents and increase the solubility, and the likelihood of transport of the petroleum hydrocarbon to the wellhead.

4.4.4 Metals

Groundwater contamination from metals is a potential threat from commercial and industrial sites which handle or use materials with significant metallic constituents (paints, waste oil, etc.), historical pesticide use areas (historical pesticides were typically metal-based compounds), and could be a potential threat from mining sites. Metals are not highly soluble in water. Their solubility is generally related to pH and oxidation-reduction potential (Eh) in the aquifer. Naturally occurring metals could be solubilized in an aquifer near a mining site because changes in the Eh/Ph relationships could be induced in the mining area. High concentrations of metals do not typically migrate far from their source areas because of their low solubility, tendency to adsorb to clay particles or organic matter, or tendency to precipitate (depending of Eh/Ph relationships) or substitute to other minerals in the aquifer.

4.4.5 Corrosive Materials

Corrosive properties (acidic and basic compounds) may be present in some products used and in waste materials generated from industrial sites within the WHPA. As discussed in Section 4.3.2, 180,000 tons of cement kiln dust (pH of 12) have been disposed of at the Reserve Silica Corporation site. Changing the pH of shallow groundwater could induce corrosion problems in structures which are in contact with it (foundations, pipelines, etc.). Changing pH of

groundwater could result in mobilizing and or immobilizing other constituents, like metals, as described above. Extreme changes in pH, away from neutral, may make groundwater unsuitable for use in industrial processes or for human consumption. However, the buffering capacity of native soils and rock may minimize migration of corrosive groundwater long distances from their source.

4.4.6 Potential Pathways for Groundwater Contamination

As discussed above, the potential sources and types of contamination to the WHPA are important to understand for wellhead protection planning. However, potential pathways for contaminant migration are also important features to understand because these contaminant pathways can increase the vulnerability of an aquifer by changing travel time from a source to the wellhead. The following section briefly discusses the main mechanisms for transport of contaminants to the subsurface.

Discharge onto the Ground Surface. One of the main mechanisms for discharge of contaminants to an aquifer is discharge to the ground surface. Direct discharge to the ground surface occurs when products or waste materials are spilled or placed onto the ground. Discharge to the ground surface occurs, for example, when materials or chemicals are accidently released from their containers, when waste materials are placed into a landfill, when wastewaters are stored in ponds, and when chemicals such as pesticides and fertilizers are applied to the ground. With the help of rainfall infiltration, the materials percolate into the subsurface, and if sufficient volume of material is released, they eventually reach the water table and migrate in the aquifer in the downgradient direction.

Direct Discharge to the Subsurface. Discharge into the subsurface is another important mechanism for transport of materials to the aquifer. Discharge into the subsurface occurs with septic systems and dry wells. Discharge into the subsurface is a more direct mechanism for transport to the aquifer because the contaminants are discharged closer to the water table and subsurface discharge bypasses the upper layers of soil and its ability to absorb and disperse the contaminants.

Abandoned Wells. Groundwater monitoring wells and water production wells typically consist of a hole drilled into the ground into which metal or plastic pipe is inserted. The pipe is perforated at the interval or intervals where the groundwater will be extracted. Sand or gravel is typically placed in the space between the borehole and the perforated area of the pipe, and concrete or cement is placed between the pipe and the borehole up to ground surface. Wells which are no longer in use are currently abandoned by pressure injection of cement or overdrilling and removal of the well pipe followed by pressure filling with cement.

Washington State has standards for construction and abandonment of wells. These standards are provided in Chapter 173-160 WAC. Water well drillers in the state must also be licensed. The requirements for that program are contained in Chapter 173-162 WAC. Because of these standards, newly constructed or recently abandoned wells pose little increased risk for contamination of an aquifer. However, old, improperly constructed or abandoned wells can act

as direct conduits for contaminant transport to the aquifer or as conduits between shallow and deeper aquifers as chemicals may be transmitted between the ground surface and aquifer zones through inadequately constructed seals.

Storm Water Runoff. Storm water may contribute to groundwater contamination in that rainfall onto the ground either induces infiltration into the subsurface or induces runoff. The quality of the water which infiltrates or runs off is dependant on the type of land use which occurs and the contaminants which may be located on the ground surface. Storm water infiltration issues were discussed above, as discharge to the ground surface. Storm water runoff is considered differently as it runs over the surface of the ground, picks up and dissolves potential contaminants, and may eventually discharge those contaminants to groundwater via infiltration from ditches or ponds designed to percolate water.

The potential constituents of concern present in infiltrated water or runoff are diverse and reflect the land use activities in the areas of interest. Improved roadways, parking areas, and residential developments can contribute heavy metals and petroleum hydrocarbons which originate primarily from automobiles. Industrial and commercial areas can discharge the same constituents in addition to a wide variety of organic pollutants commonly used in business practice (e.g., solvents, paints, dry cleaning solutions). The open space which dominates the eastern portion of the wellhead protection management area poses a different risk when considering constituents present in storm water runoff. Instead of metals and petroleum hydrocarbons, water quality concerns from runoff in these areas consist primarily of high silt content and nutrients. The potential for runoff is influenced greatly by the condition of vegetative cover, slope of the land surface, and the nutrients application practice.

The largest quantities of storm water runoff are anticipated from the developed areas in the western portion of the WHPA where there is a higher percentage of impervious land surface cover. In the eastern portion of the management area, storm water runoff will originate from paved roadways, residential areas, and open spaces where vegetative cover has been removed (often from agricultural or forestry practice).

4.5 Establishing Risk Priority for Potential Contaminant Sources within the WHPA

4.5.1 Methodology for Establishing Risk Priority

The methodology for prioritizing contaminant risks in the Covington/Kent WHPA was based on the EPA Guidance document entitled "Managing Groundwater Contamination Sources in Wellhead Protection Areas: a Priority Setting Approach," October 1991. The guidance methodology was used in part, but the ranking effort was also based on a level of confidence in data and information which currently are available for known and potential contamination sites as discussed previously in Sections 4.1, 4.2, and 4.3.

The ranking was based on the proximity of the source to the WHPA, the type of contamination at the site, the severity of the contamination, the straight line distance to the well field, and the

media which contained the contamination. The overall decision level ranking is summarized in Table 4-9.

Table 4-9 - Covington/Kent Wellhead Protection Program Overall Risk Prioritization

Decision Level	Available Data and Information
I	Proximity of contaminated site to water source (1-year, 5-year, 10-year, Outside, DG)
II	Type of contamination per Ecology database (C&SCS, SWS, LUST)
III	Severity of contamination (toxicity + transport risk); highest risk is represented by the greatest number.
IV	Straight-line distance from the source to the contaminated site
V	Contaminated media (C-GW, GW, C-Soil, Soil, C-SW, SW)

In the event that more than one known or potential contaminated sites fall within a given decision level, then the sites were then sub-prioritized within that decision level. The criteria for sub-prioritizing sites within each decision level are discussed below.

Proximity to Source. For the first decision level (proximity to source), the sub-prioritization of contaminated sites was based on its location in the time-of-travel zone for each wellhead as shown on the GIS map. Known and potential contaminated sites were sub-prioritized as summarized on Table 4-10.

Table 4-10 - Covington/Kent Wellhead Protection Program Risk Sub-Prioritization - Proximity to Source

Sub-Priority Level	Proximity to Source
I.1	1-year time-of-travel from the source
I.2	5-year time-of-travel from the source
I.3	10-year time-of-travel from the source
I.4	Outside the time-of-travel region, but upgradient from the source
I.5	Downgradient from the source

Type of Contamination. For the second decision level (type of contamination), the sites were sub-prioritized as either known contamination or potential contamination sites. Known contamination sites were defined as sites located within the WHPA that have been identified in Ecology databases as discussed in Section 5.2. Potential contamination sites are sites or land areas of the WHPA that are known to used in ways which potentially could pose a risk to the water quality as discussed in Section 4.3. This category includes point and non-point sources. In the event that there are more than one contaminated site for a given type of contamination, then the sites are sub-prioritized based on contaminant severity (toxicity + transport risk), straight-line distance from the source, and contaminated media. The sub-prioritization hierarchy is summarized in Table 4-11.

Table 4-11 - Covington/Kent Wellhead Protection Program Risk Sub-Prioritization - Type of Contamination

Sub-Priority Level	Known or Suspected Contamination	Type of Contaminated Site	Code	Assumptions
II.1	Known	Confirmed and Suspected Contaminated Sites	C&SCS	As a worst case scenario, contamination is assumed to be comprised of the most toxic chemical identified for the site, based on information contained in the Ecology database.
II.2	Known	Leaking Underground Storage Tanks	LUST	All contamination sites assumed to contain petroleum products.
II.3	Potential	Septic Systems	Septic	Potential contamination sites are assumed to be located in residential communities. Nitrates and bacterial contamination are assumed to be health risks, but it is not known what the likelihood is for each site to contaminate the wellhead.
II.4	Potential	Fertilized Sites	Fert	This category includes fertilized lawns, golf courses, and agricultural areas. Residential users are assumed to add the highest concentration of fertilizer, followed by golf courses, and then agricultural users.
II.5	Potential	Resource Conservation and Recovery Act Sites	RCRA	It is a assumed that hazardous chemicals may be stored on site, but contamination has not necessarily occurred.
II.6	Potential	Operational Underground Storage Tanks Sites	O-UST	It is assumed that petroleum products are stored in underground storage tanks on site, but contamination is not eminent.
II.7	Potential	Solid Waste Sites	SWS	Based on a window survey, the SWS in the WHPA are assumed to contain low toxicity risk contaminants such as yard wastes, sand, and gravel.
II.8	Potential	Pesticide Application	PA	Pesticide use appears to be concentrated along transportation corridors, at electrical power substations, and one local golf course. For the purpose of this risk prioritization, pesticides were assumed to include chemicals such as aldicarb or dicamba.
II.9	Potential	Storm Water	Storm	This category includes the potential release of lead, petroleum products, and/or solvents in residential areas, and the possible release of silt and nutrients in rural areas.
II.10	Potential	Sewer Mains	Sewer	This category includes residential communities and assumes the potential release of nitrates and bacterial contaminants. The likelihood of an undetected release is assumed to be low.
II.11	Potential	Spills	Spills	This category includes highways and railroad tracks that pass through the WHPA. The risk is based on the possibility of hazardous material spill (e.g., gasoline).

Severity Risk. The severity risk was based on the EPA Risk Prioritization Model (1991). This model can be used to prioritize contaminated sites based on (1) the likelihood of well contamination and (2) the severity of well contamination.

(1) The likelihood of well contamination is based on the *Likelihood of Release at the Source* (how likely is it that the contaminant will be released from the source into the soil underlying the source) and the *Likelihood of Reaching the Well* (if the contaminant is released, how likely is it to reach the well within the planning period?).

For this WHPA study, we assumed that the likelihood of well contamination was the same for all contaminated sites. The type of site (e.g., storage tank, landfill, UST) was not assigned a risk because the required information was not available for each site (e.g., number and size of tanks, existence of clay liner at landfill, etc.). Once a release occurs, the quantity of contaminant released and the likelihood of the contaminant reaching the water source were assumed to be the same for all contaminant sites and sources.

(2) The severity of well contamination is based on the *Quantity* released at the Source (what is the amount of contaminant expected to be released from the source?), *Attenuation* during transport (what fraction of the contaminant released will reach the well at what concentration?), and *Toxicity* (how toxic is the contaminant?).

For the WHPA study, we assumed that the quantity released was the same for all contaminated sites. The attenuation during transport was based on uniform, sandy gravel media, depth of aquifer of 50 to 100 feet, a straight line distance from the contaminant site to source, and the mobility and persistence scores assigned to representative chemicals included in the EPA model. The toxicity for each contaminant was based on toxicity scores included in the EPA model. For sites with multiple contaminants, the most toxic substance was used as the representative contaminant for that source. The contaminant substances for each site were based on Ecology databases.

Straight-Line Distance from the Source. For contaminated sites with similar characteristics for prioritization levels I, II, and III, the straight-line distance from the contaminated site to the water source was used to sub-prioritize the sites further. Those sites closest to the water source were given a higher priority.

Contaminated Media. For contaminated sites with similar characteristics for prioritization levels I, II, III, and IV, the information regarding contaminated media included in Ecology databases were used to sub-prioritize the sites further. These sites were sub-prioritized in the order shown on Table 4-12.

Table 4-12 - Covington/Kent Wellhead Protection Program Risk Sub-Prioritization - Contaminated Media

Sub-Priority Level	Contaminated Media
V.1	Confirmed, ground water
V.2	Confirmed, soil
V.3	Confirmed, surface water
V.4	Suspected, ground water
V.5	Suspected, soil
V.6	Suspected, surface water

4.5.2 Results of the Risk Ranking

The following discussion summarizes the findings of the risk ranking for the Lake Sawyer/Kent, Clark Springs, and Armstrong Springs and wellheads. Tables 4-13 through 4-15 summarize the findings for each wellhead, respectively, while Table 4-16 prioritizes the risks to the whole study area.

Kent Springs. The risk ranking found ten high priority sites/land uses within Zones 1, 2, and 3. Residential medium-density, residential rural, and transportation corridors were ranked as the top three risks, respectively, because they are all within Zone 1. There are no known contaminant sources within Zone 1; however, potential contaminant sources from the residential areas include nitrate loading from septic systems and fertilizer applications, and pesticide applications. Home heating oil tanks could also be present at the residential sites. The potential sources of contaminants from the transportation corridors include pesticide application, potential hazardous material spills, and runoff from these areas.

The ranking analysis found six other high priority sites or types of land use within Zone 2. The Landsburg Mine, L-Bar Products, the Elk Run Golf Course, and Reserve Silica Corporation were ranked 4, 5, 6, and 8, respectively. The Landsburg Mine and the L-Bar Products site were ranked more highly than the other sites because of the type of site, the severity of contaminant, the distance from the wellhead, and because Ecology files indicated the soil contamination was suspected or confirmed on these properties. Section 4.3 contains detailed information on these sites.

Land uses such as mining and forestry were ranked 7 and 9, respectively. Potential contaminants related to the facilities include pesticide and fertilizer application at forestry sites and petroleum hydrocarbon use and storm water pollution from mining activities.

The only medium ranked site was the BPA substation on Retreat-Kanasat Road. This facility is within Zone 3 of the wellhead. This site was not listed as a contaminated site on any regulatory database, but it is likely that pesticides are used at this facility.

Clark Springs. The Clark Springs wellhead has six high priority sites within Zone 1. The Landsburg Mine was ranked as the top site because of the type of site, the severity of the

contaminants, the distance from the wellhead, and because Ecology databases indicated the soil contamination was suspected or confirmed on these properties. Section 4.3 contains more detailed information on the contamination at this site

Residential medium-density and residential rural land uses were ranked as 2 and 3. As with the residential land uses for the Lake Sawyer/Kent Springs area, potential contaminant sources include nitrate loading from septic systems and fertilizer applications, and pesticide applications. Home heating oil tanks could also be present at the residential sites.

Forest practices were ranked as number 4. Potential contaminants at forestry sites include pesticide and fertilizer applications described in Section 4.4.2.

The transportation corridor was ranked as number 5. The potential sources of contaminants include pesticide application and potential hazardous material spills.

Mining operations were the lowest of the high ranking sites and were ranked as number 6. Potential concerns include petroleum hydrocarbon use and storm water pollution.

Armstrong Springs. The Armstrong Springs wellhead has seven high priority and four medium priority sites within Zones 1, 2, and 3. The high priority sites included the Multicare property and an Arco Service Station located on SE Wax Road. These sites were ranked as the two highest priority sites, respectively, because they are located within Zone 1 and because Ecology LUST database indicated the soil or groundwater contamination was suspected or confirmed on these properties.

Residential medium-density and transportation corridors were ranked as 3 and 4 because they are found within Zone 1. As with the residential land uses for the Lake Sawyer/Kent Springs area, potential contaminant sources include nitrate loading from septic systems and fertilizer applications, and pesticide applications. Home heating oil tanks could also be present at the residential sites. The potential sources of contaminants from the transportation corridors include pesticide application and potential hazardous material spills.

The next tier of high priority sites were located within Zone 2. These sites included the NW pipeline, Kent Junior High School No. 6 and residential rural land use. The NW Pipeline and Kent JHS No. 6 were ranked highly because of the type of site, the severity of the contaminants, the distance from the wellhead, and because Ecology databases indicated the soil or contamination was suspected or confirmed on these properties.

The four medium priority sites all fall within Zone 3. These sites include L-Bar Products, the Elk Run Golf Course, the Reserve Silica Corporation, and mining land uses. These sites and land uses potentially impact the Armstrong Springs wellhead in the same way as described above for the other wellheads, except these sources are farther from Armstrong Springs wellhead than they are to either Lake Sawyer or Clark Springs.

4.5.3 Overall Risks to the WHPAs

Table 4-16 summarizes the general risks to the study area based on the individual risk ranking in each of the WHPAs. This risk ranking was generated by summing up the risk ranking for each type of site WHPA: the highest ranked total score (lowest number) resulted in the highest overall risk.

Table 4-16 - Overall Risk Ranking for WHPAs

Land Use/Site Description	Lake Sawyer/ Kent	Clark	Armstrong	Overall Ranking
Residential Medium-Density	1	3	3	7
Residential Rural	2	4	7	13
Transportation Corridors	3	6	4	13
Industrial/Commercial Sites	6.25[1]	1[1]	6.5[1]	13.75
Forestry	8	5	15[2]	28
Mining	10	7	11	28

[1] These scores are the averages of the ranks for all industrial/commercial sites with Zones 1, 2, and 3 for each WHPA.

[2] Forestry operations are not within the Armstrong Springs WHPA. This score was arbitrarily selected so that forestry land use was not artificially elevated in overall rank by having no score in the column.

As illustrated in Table 4-16, residential medium-density land uses ranked highest overall, with a score of 7. Residential rural, transportation corridors, and the industrial/commercial sites of known contamination were ranked in the middle, while forestry and mining uses were ranked lowest of the high ranking land uses.

CATEGORY I
Sources Designed to Discharge Substances

Subsurface Percolation (e.g., septic tanks and cesspools)
Injection Wells
- Hazardous waste
- Non-hazardous waste (e.g., brine disposal and drainage)
- Non-waste (e.g., enhanced recovery, artificial recharge solution mining, and *in situ* mining)

Land Application
- Wastewater (e.g., spray irrigation)
- Wastewater byproducts (e.g., sludge)
- Hazardous waste
- Non-hazardous waste

CATEGORY II
Sources Designed to Store, Treat, and/or Dispose of Substances; Discharge through Unplanned Release

Landfills
- Industrial hazardous waste
- Industrial non-hazardous waste
- Municipal sanitary

Open Dumps, Including Illegal Dumping (Waste)
Residential (or Local) Disposal (Waste)
Surface Impoundments
- Hazardous waste
- Non-hazardous waste

Waste Tailings
Waste Piles
- Hazardous waste
- Non-hazardous waste

Materials Stockpiles (Non-waste)
Graveyards
Animal Burial
Above-ground Storage Tanks
- Hazardous waste
- Non-hazardous waste
- Non-waste

Underground Storage Tanks
- Hazardous waste
- Non-hazardous waste
- Non-waste

Containers
- Hazardous waste
- Non-hazardous waste
- Non-waste

Open Burning Sites
Detonation Sites
Radioactive Disposal Sites

CATEGORY III
Sources Designed to Retain Substances during Transport or Transmission

Pipelines
- Hazardous waste
- Non-hazardous waste
- Non-waste

Materials Transport and Transfer Operations
- Hazardous waste
- Non-hazardous waste
- Non-waste

CATEGORY IV
Sources Discharging Substances as a Consequence of Other Planned Activities

Irrigation Practices (e.g., return flow)
Pesticide Applications
Fertilizer Appllications
Animal Feeding Operations
De-Icing Salts Applications
Urban Runoff
Percolation of Atmospheric Pollutants
Mining and Mine Drainage
- Surface mine-related
- Underground mine-related

CATEGORY V
Sources Providing Conduit or Inducing Discharge through Altered Flow Patterns

Production Wells
- Oil (and gas) wells
- Geothermal and heat recovery wells
- Water supply wells

Other Wells (non-waste)
- Monitoring wells
- Exploration wells

Construction Excavation

CATEGORY VI
Naturally Occurring Sources whose Discharge is Created and/or Exacerbated by Human Activity

Groundwater - Surface Water Interactions
Natural Leaching
Saltwater Intrusion/Brackish Water
- Upconing (or intrusion of other poor-quality natural water)

Table 4-2 - Confirmed and Suspected Contaminated Sites

DXF-TEXT	FACILITY	ADDRESS	CITY	ZIP CODES	COMMENTS	MEDIA	SUBSTANCE	STATUS
1	Four Corners Auto Wrecking	26615 Maple Valley Hwy. SE	Maple Valley	98038-8308		Soil, Surface Water, Drinking Water, and Groundwater		
2	Iddings, Inc.	27525 Covington Way SE	Kent	98042-9199		Soil and Surface Water		
3	L-Bar Products Inc./ Silica Mine Area	26000 Black Diamond - Ravensdale Rd	Ravensdale	98051		Groundwater, Soil, and Surface Water		
4	Landsburg Mine-Rogers Seam	Kent-Kangley Rd. & 268th Ave. SE	Ravensdale	98010		Soil, Drinking Water, and Surface Water		
5	Northwest Pipeline / Covington	19241 SE 272nd Ave.	Kent	98042-8501		Soil, Air, and Sediment		
6	Old Lawson Road	26115 Old Lawson Rd	Black Diamond	98010		Groundwater, Air, Sediment, and Soil		
7	Palmer Coking Coal Co.	3147 Hwy 169	Black Diamond	98010		Soil, Groundwater, Drinking Water, and Surface Water		

Table 4-3 - Leaking Underground Storage Tank Sites

DXF-TEXT	FACILITY	ADDRESS	CITY	ZIP CODES	COMMENTS	MEDIA	SUBSTANCE	STATUS
1	BP Oil Company #01964	16405 SE 272nd	Kent	98042-8211		Groundwater and Soil		
2	Covington Substation	28401 Covington Way SE	Kent	98042-9106		Soil		
3	Harris Enterprises #1	17239 SE 272nd	Kent	98042-4900		Groundwater and Soil		
4	Junior High #6	19600 SE 272nd	Kent	98042-		Soil		

Note: Refer to Figure 4-2 for Site locations.

Table 4-4 - Operational Underground Storage Tank Sites

DXF-TEXT	FACILITY	ADDRESS	CITY	ZIP CODES	COMMENTS	MEDIA	SUBSTANCE	STATUS
8	ARCO 5568	17450 SE 272nd St.	Kent				Unleaded Gas	
9	ARCO 5568	17450 SE 272nd St.	Kent				Unleaded Gas	
10	ARCO 5568	17450 SE 272nd St.	Kent				Leaded Gas	
1	BP Oil Company # 01964	16405 SE 272nd	Kent				Unleaded Gas	
2	BP Oil Company # 01964	16405 SE 272nd	Kent				Unleaded Gas	
3	BP Oil Company # 01964	16405 SE 272nd	Kent				Leaded Gas	
11	Circle K # 1525	17624 SE 272nd	Kent				Unleaded Gas	
12	Circle K # 1525	17624 SE 272nd	Kent				Leaded Gas	
13	Circle K # 1525	17624 SE 272nd	Kent				Unleaded Gas	
14	Covington Substation	28401 Covington Way SE	Kent				Diesel Fuel	
15	Covington Substation	28401 Covington Way SE	Kent				Diesel Fuel	
16	Covington Substation	28401 Covington Way SE	Kent				Unleaded Fuel	
17	Norman C. Grier DBA Crest	29300 179th Place SE	Kent				Aviation Fuel	
18	Norman C. Grier DBA Crest	29300 179th Place SE	Kent				Aviation Fuel	
19	Norman C. Grier DBA Crest	29300 179th Place SE	Kent				Aviation Fuel	

Table 4-5 - Current and Former Contaminated Underground Storage Tank Sites

DXF-TEXT	FACILITY	ADDRESS	CITY	ZIP CODES	COMMENTS	MEDIA	SUBSTANCE	STATUS
3	Arco Station Covington	Wax Rd. and SE 272nd	Covington	98042		Soil		In Progress
7	BP Oil Station #01964	16405 SE 272nd	Kent	98042-8211		Groundwater and Soil		Conducted
1	BP Oil Station #03144	26821 Maple Valley Hwy.	Maple Valley	98038		Soil		In Progress
8	BPA Covington Substation	28401 Covington Way SE	Kent	98042-9106		Soil		In Progress
2	Exxon Station #7-3465	26821 Maple Valley Hwy.	Maple Valley	98038		Groundwater and Soil		Conducted
4	Kent School Jr. High #6	19600 SE 272nd St.	Kent	98042		Soil		In Progress
6	Multicare Property Covington	17841 SE Wax Rd.	Covington	98042-4954		Groundwater and Soil		Conducted
5	Shell Station Kent 272nd	17239 SE 272nd	Kent	98042-4900		Groundwater and Soil		In Progress

Note: Refer to Figure 4-2 for Site locations.

Table 4-6 - Solid Waste Landfill Sites

DXF-TEXT	FACILITY	ADDRESS	CITY	ZIP CODES	COMMENTS	MEDIA	SUBSTANCE	STATUS
3	Iddings	27525 Covington Way SE	Kent	98042				
2	Pacific Coast Coal Co.	30700 Black Diamond - Ravensdale	Black Diamond	98010				
1	Reserve Silica Corporation	26000 Ravensdale - Black Diamond	Ravensdale	98501				

Table 4-7 - Resource Conservation and Recovery Act Sites

DXF-TEXT	FACILITY	ADDRESS	CITY	ZIP CODES	COMMENTS	MEDIA	SUBSTANCE	STATUS
1	AC Cushion Molders	20169 SE 284th			Small Qty Generator			
2	Ace Cleaners	26921 Maple Vly Black Diamond Rd.			Conditionally Exempt Generator			
3	ARCO Products Co. 5568 Prestige	17450 SE 272nd St.			Small Qty Generator			
4	Blair Industries	26872 172nd Pl SE			Conditionally Exempt Generator			
5	BP Oil Site 01964	16405 SE 272nd			Conditionally Exempt Generator			
7	Bremmeyer Logging Co.	27204 Kent Kangley Rd.			Large Qty Generator			
9	Clean Svc. Co. Inc.	23509 SE 254th St.			Comm. Transporter			
10	Covington Medical Park	17700 SE 272nd St.			Large Qty Generator			
41	Elk Run Golf Course	22500 SE 275th Pl.	Maple Valley	98038				
11	Exxon Co. USA 73465	26821 Maple Valley Hwy			Small Qty Generator			
13	EZ Dozing	23024 SE 272nd			Comm. Transporter			
14	Four Corners Cleaners	23900 SE Kent Kangley Rd.			Conditionally Exempt Generator			
42	Lake Wilderness Golf Course	25400 Witte Rd. SE	Maple Valley	98038				
19	Lakeridge Raving Co.	19601 SE Frontage Rd.			Small Qty Generator			
20	Lakeside Ind. Kent Div	26010 180th Ave SE			Small Qty Generator			
B	Landsburg Mine	T22N R6E S24 & S25			Site Investigation perform 1988; NFA under CERCLA			
21	Landsburg Mine	T22N R6E S24 & S25			Large Qty Generator			
22	Lees Cleaners	17051 SE 272nd			Conditionally Exempt Generator			
40	Meridian Valley Country Club	24830 136th Ave. SE	Kent	98042				
25	Northwest Pipeline Corp.	19241 SE 272nd St.			Small Qty Generator			
26	Ravensdale Sand Pit	26000 RAvensdale Black Diamond Rd.			Large Qty Generator			
28	Thomas Const.	26405 Hwy 169			Conditionally Exempt Generator			
C	Toomey Property Site	28836 164th SE			Preliminary Assessment performed 1985; NFA under CERCLA			
29	US Transmissions Inc.	27632 Covington Way SE			Small Qty Generator			
31	USDOE BPA Covington Substation	28401 Covington Way SE			Small Qty Generator; Self-Transporter			
D	USDOE BPA Covington Substation	28402 Covington Way SE			Site Discovery 1984; no additional information			

Note: Refer to Figure 4-2 for Site locations.

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Table 4-8 - Pesticides Used in WHPA

Pesticide Use	Constituents of Concern	Information Sources
Residential Use	Over-the-shelf products used for pest and weed control	Washington State Department of Ecology
Transportation Corridors	Non-regulated pesticides applied seasonally and in accordance with Department guidance, including Roundup, Oust, Escort, Diuron, and Garlon 3A	King County Roads Department, Washington State DOT
Power Lines/Substations	Heavy pesticide use at substations; cutting and trimming used to maintain area under transmission lines. Pesticides potentially used beneath transmission lines over 10 years ago	Bonneville Power Administration
Forestry Practices	Herbicides commonly used in reseeding areas to control weeds and alders	Washington State University Agricultural Extension Office, Weyerhaeuser, Plum Creek
Elk Run Golf Course	Non-regulated pesticide use in accordance with King County BMPs	Golf Course Maintenance Staff, King County

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Table 4-13 - Risk Ranking for Kent Springs

Site No.	Description	Proximity to Source	Type of Site	Contaminant Severity	Distance from Source in Feet	Contaminated Media	Rank Rank	Priority Priority
NPS-3	Residential - Medium Density	1	3	-1.8	0	Not Known	1	High
NPS-4	Residential - Rural	1	3	-2.8	4,800	Not Known	2	High
NPS-8	Transportation Corridors	1	8	-1.8	0	Not Known	3	High
PS-4	Landsburg Mine	5	1	-1.4	18,000	C-Soil	4	High
PS-3	L-Bar Products	5	1	-6.2	14,400	S-Soil	5	High
NPS-1	Elk Run Golf Course	5	4	-2.4	1,800	Not Known	6	High
NPS-5	Forestry	5	4	-3.7	10,800	Not Known	7	High
PS-19	Reserve Silica Corp	5	7	-3.2	13,200	Not Known	8	High
NPS-6	Mining	5	9	-20	9,600	Not Known	9	High
NPS-2	BPA Substation	10	8	-5.1	18,600	Not Known	10	Medium
PS-7	Palmer Coking Coal Co.	20	1	-1	12,000	C-GW	11	Medium
PS-1	Four Corner Auto Wrecking	20	1	-6.2	9,000	C-Soil	12	Medium
PS-6	Old Lawson Road	20	1	-6.4	17,400	C-GW	13	Medium
PS-15	Exxon Station	20	2	-11.1	9,000	GW	14	Medium
PS-14	BP Oil Station #03144	20	2	-11.1	9,000	Soil	15	Medium
NPS-7	Agriculture	20	4	-5.1	21,600	Not Known	16	Medium
PS-18	Pacific Coast Coal Co.	20	7	-3.2	13,200	Not Known	17	Medium
PS-12	Laferriere Property	20	2	-15.6	~20,000	Soil	18	Low
PS-5	NW Pipeline	50	1	-6.2	9,000	C-Soil	19	Low
PS-2	Iddings, Inc.	50	1	-15.6	18,000	C-Soil	20	Low
PS-11	Kent Jr HS #6	50	2	-15.6	9,600	Soil	21	Low
PS-9	BPA Covington Substation	50	2	-15.6	15,000	Soil	22	Low
PS-13	Arco Station	50	2	-15.6	16,200	Soil	23	Low
PS-16	Multicare Property	50	2	-15.6	16,800	GW	24	Low
PS-10	Shell Station	50	2	-15.6	17,400	GW	25	Low
PS-8	BP Oil Company #01964	50	2	-15.6	19,200	GW	26	Low
PS-17	Iddings	50	7	-3.4	19,200	Not Known	27	Low

Proximity
1 = 1-year TOT
5 = 5-year TOT
10 = 10-year TOT
20 = Outside
50 = Downgradient
C = Confined
S = Suspected

350801/TABLE5-5.xls

Table 4-14 - Risk Ranking for Clark Springs

Site No.	Description	Proximity to Source	Type of Site	Contaminant Severity	Distance from Source in Feet	Contaminated Media	Rank	Priority
PS-4	Landsburg Mine	1	1	-1	4,200	C-Soil	1	High
NPS-3	Residential - Medium Density	1	3	-1.8	0	Not Known	2	High
NPS-4	Residential - Rural	1	3	-1.8	0	Not Known	3	High
NPS-5	Forestry	1	4	-2.8	4,800	Not Known	4	High
NPS-8	Transportation Corridors	1	8	-1.8	0	Not Known	5	High
NPS-6	Mining	1	9	-20	3,600	Not Known	6	High
PS-12	Laferriere Property	20	2	-8.1	~30,000	Soil	7	Medium
PS-7	Palmer Coking Coal Co.	20	1	-1	12,600	C-GW	8	Medium
PS-3	L-Bar Products	20	1	-6	3,000	S-Soil	9	Medium
PS-6	Old Lawson Road	20	1	-6.4	18,000	C-GW	10	Medium
NPS-7	Agriculture	20	4	-5.1	27,600	Not Known	11	Medium
PS-19	Reserve Silica Corp	20	7	-3	3,600	Not Known	12	Medium
PS-18	Pacific Coast Coal Co.	20	7	-3.2	10,800	Not Known	13	Medium
PS-1	Four Corner Auto Wrecking	50	1	-5.7	1,200	C-Soil	14	Low
PS-5	NW Pipeline	50	1	-6.2	14,400	C-Soil	15	Low
PS-2	Iddings, Inc.	50	1	-15.6	25,800	C-Soil	16	Low
PS-14	BP Oil Station #03144	50	2	-6.5	1,200	Soil	17	Low
PS-15	Exxon Station	50	2	-6.5	1,200	GW	18	Low
PS-11	Kent Jr HS #6	50	2	-15.6	15,000	Soil	19	Low
PS-9	BPA Covington Substation	50	2	-15.6	22,200	Soil	20	Low
PS-13	Arco Station	50	2	-15.6	22,200	Soil	21	Low
PS-16	Multicare Property	50	2	-15.6	22,800	GW	22	Low
PS-10	Shell Station	50	2	-15.6	23,400	GW	23	Low
PS-8	BP Oil Company #01964	50	2	-15.6	25,800	GW	24	Low
NPS-1	Elk Run Golf Course	50	4	-3.7	5,400	Not Known	25	Low
PS-17	Iddings	50	7	-3.4	25,200	Not Known	26	Low
NPS-2	BPA Substation	50	8	-5.1	25,400	Not Known	27	Low

Proximity
1 = 1-year TOT
5 = 5-year TOT
10 = 10-year TOT
20 = Outside
50 = Downgradient
C = Confined
S = Suspected

350801/TABLE5-6.xls

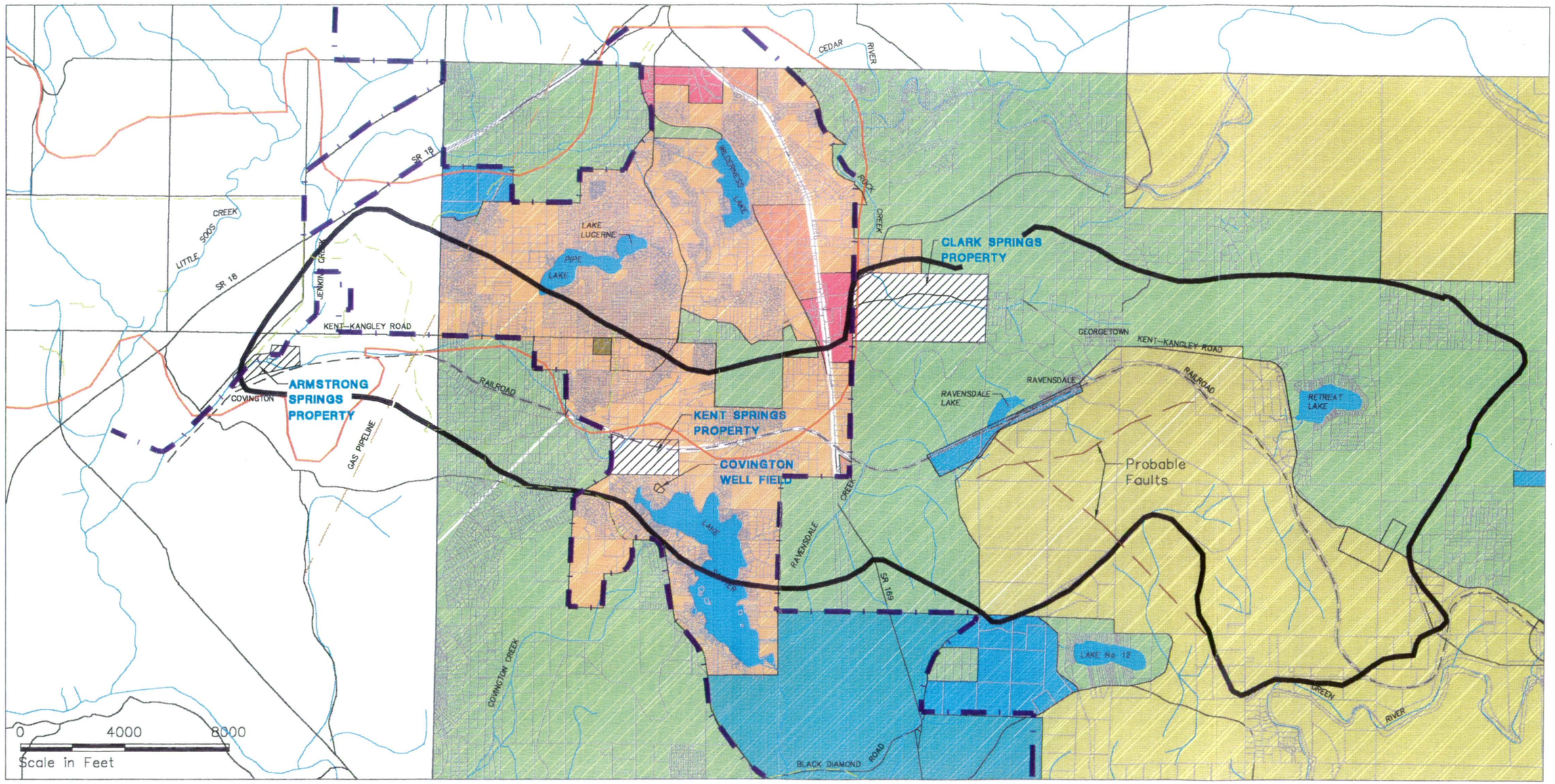
Table 4-15 - Risk Ranking for Armstrong Springs

Site No.	Description	Proximity to Source	Type of Site	Contaminant Severity	Distance from Source in Feet	Contaminated Media	Rank	Priority
PS-16	Multicare Property	1	2	-6.5	1,000	GW	1	High
PS-13	Arco Station	1	2	-6.5	1,200	Soil	2	High
NPS-3	Residential - Medium Density	1	3	-1.8	0	Not Known	3	High
NPS-8	Transportation Corridors	1	8	-1.8	0	Not Known	4	High
PS-5	NW Pipeline	5	1	-6.2	8,400	C-Soil	5	High
PS-11	Kent Jr HS #6	5	2	-15.6	7,200	Soil	6	High
NPS-4	Residential - Rural	5	3	-2.4	2,400	Not Known	7	High
PS-3	L-Bar Products	10	1	-6.4	29,400	S-Soil	8	Medium
NPS-1	Elk Run Golf Course	10	4	-3.7	13,200	Not Known	9	Medium
PS-19	Reserve Silica Corp	10	7	-3.4	27,600	Not Known	10	Medium
NPS-6	Mining	10	9	-20	26,000	Not Known	11	Medium
PS-7	Palmer Coking Coal Co.	20	1	-1.4	26,400	C-GW	12	Low
PS-1	Four Corner Auto Wrecking	20	1	-6.4	21,000	C-Soil	13	Low
PS-6	Old Lawson Road	20	1	-6.4	31,200	C-GW	14	Low
PS-15	Exxon Station	20	2	-15.6	21,000	GW	15	Low
PS-14	BP Oil Station #03144	20	2	-15.6	21,000	Soil	16	Low
NPS-7	Agriculture	20	4	-5.1	28,800	Not Known	17	Low
NPS-5	Forestry	20	4	-5.1	26,400	Not Known	18	Low
PS-18	Pacific Coast Coal Co.	20	7	-3.4	28,800	Not Known	19	Low
PS-12	Laferriere Property	20	2	-15.6	31,200	Soil	20	Low
PS-4	Landsburg Mine	20	1	-1.4	31,800	C-Soil	21	Low
PS-2	Iddings, Inc.	50	1	-7.1	2,400	C-Soil	22	Low
PS-10	Shell Station	50	2	-6.5	1,200	GW	23	Low
PS-9	BPA Covington Substation	50	2	-8.1	3,600	Soil	24	Low
PS-8	BP Oil Company #01964	50	2	-8.1	4,200	GW	25	Low
PS-17	Iddings	50	7	-3	3,000	Not Known	26	Low
NPS-2	BPA Substation	50	8	-2.8	3,600	Not Known	27	Low

Proximity
1 = 1-year TOT
5 = 5-year TOT
10 = 10-year TOT
20 = Outside
50 = Downgradient
C = Confined
S = Suspected

350801/TABLE5-7.xls

Land Use Zoning and Relavant Features Map



Ten-Year Capture Zone

Sewered Area

Sewer Line

Interim Urban Growth Boundary (from King County ...)

Commercial Center
Commercial Outside Center

Rural Neighborhood
Rural Residential

Urban Medium Density

Forestry

Industry

Mining

City of Black Diamond

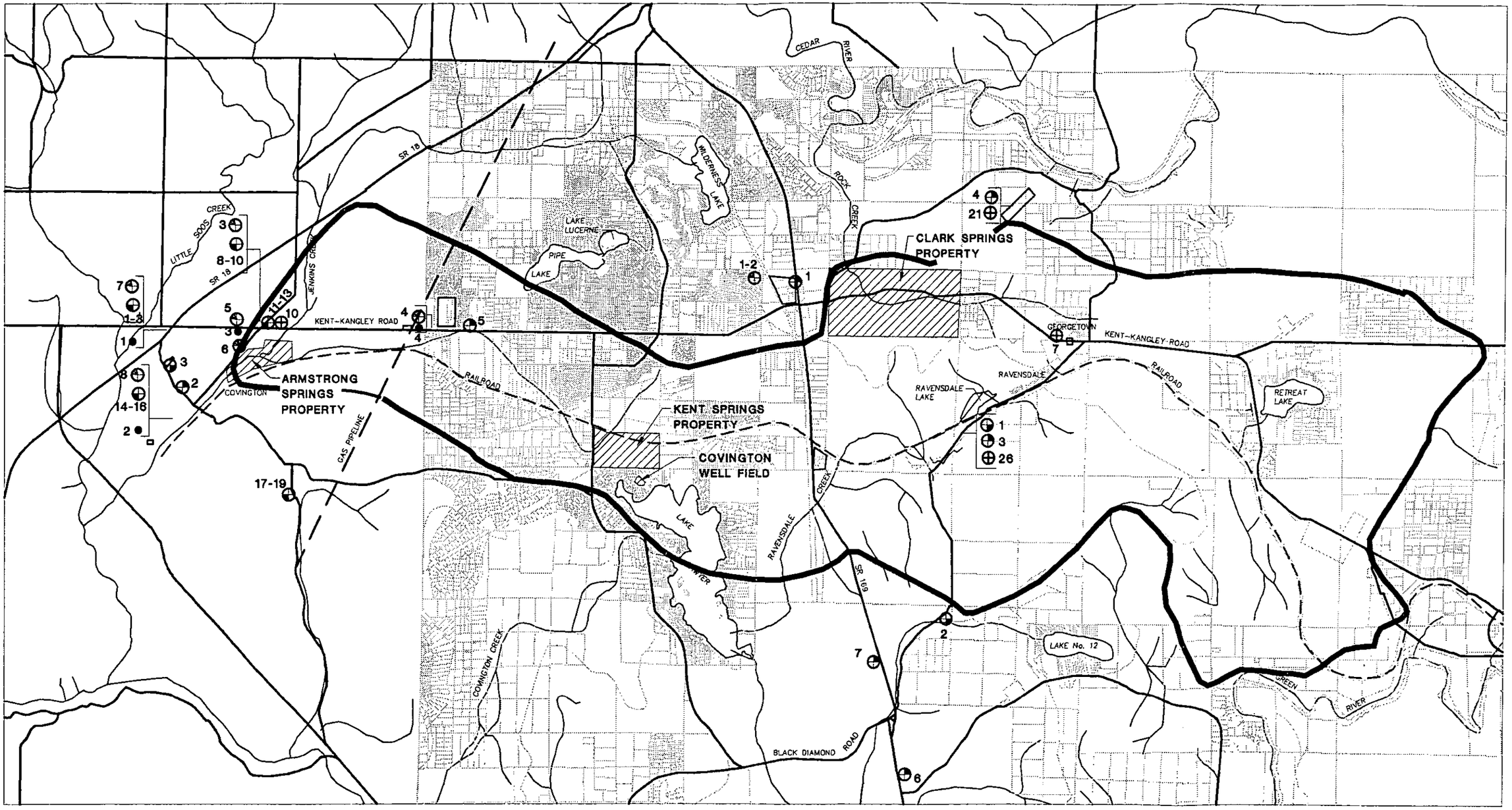
color.pcp

SWP 11/1/95 1=1
35080140

HARTCROWSER
J-3508-01 11/95
Figure 4-1

Potential Sources -

Regulatory Database Listings



Ten Year Capture Zone

Potential Sources of Contamination as Identified in Regulatory Database

- Landfill
- Operational USTs
- Confirmed and Suspected Contaminated Site
- Leaking UST
- RCRA Large Quantity Generators
- Current and Former Contaminated UST

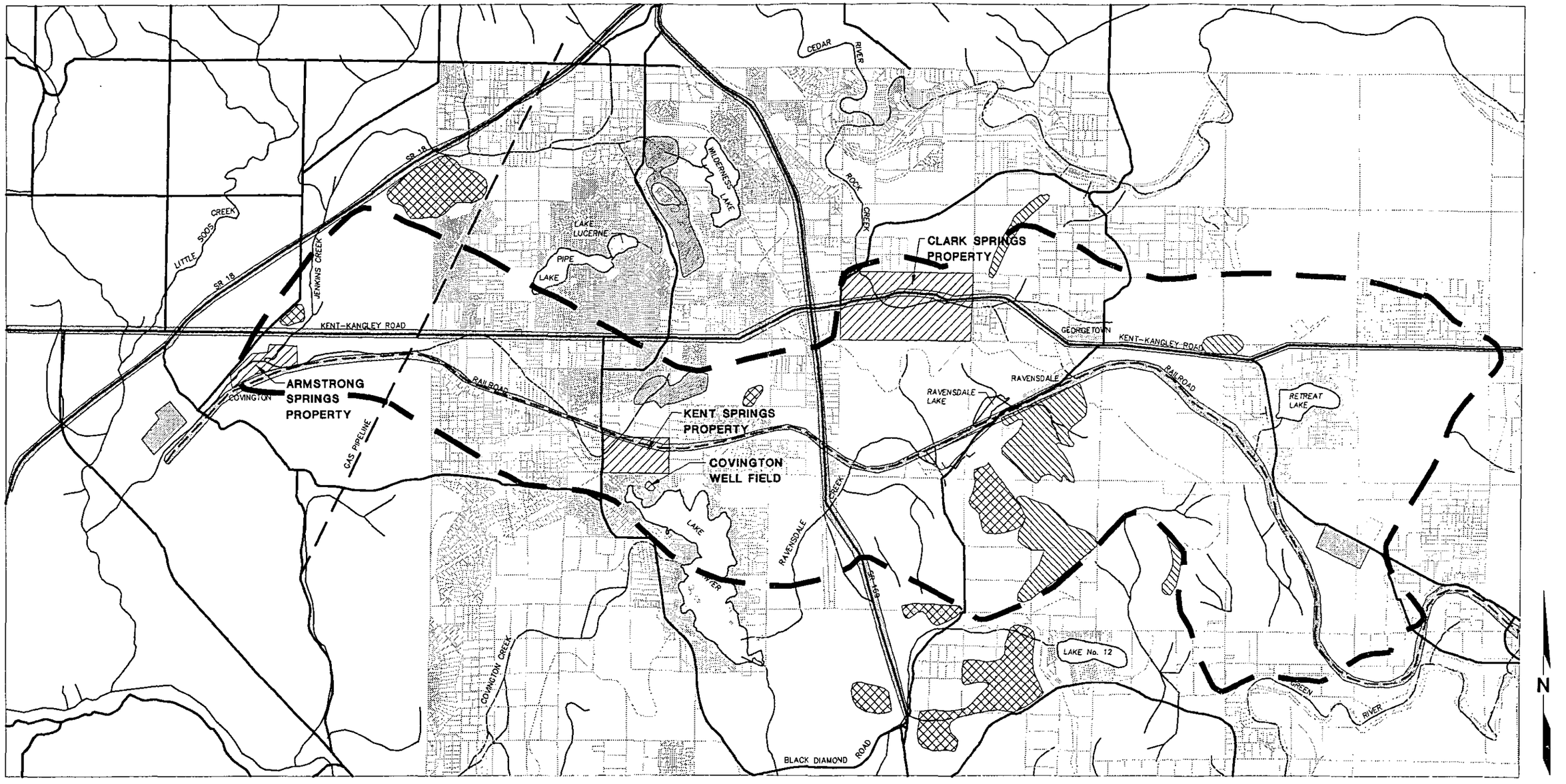
2 Number corresponds to listing in Tables 4-2 through 4-7.

0 4000 8000
Scale in Feet

HARTCROWSER
J-3508-01 11/95
Figure 4-2

SWP 11/30/95 1=1 hc.pcp xrefs:entbase
3508041

Other Potential Sources



xref=kentbase.dwq

CVD 11/30/95 1=1
35080136

Ten-Year Capture Zone

Pesticide Use

Abandoned Mine Area

Current Mine Area

0 4000 8000
Scale in Feet

HARTCROWSER
J-3508-01 11/95
Figure 4-3

Existing Regulatory Programs

5.0 EXISTING REGULATORY PROGRAMS

5.1 Introduction

The Potential Contaminant Source Inventory and Risk Ranking identified and ranked potential and known sources of contamination in the WHPA. This section examines existing regulatory programs designed to mitigate the risk associated with contaminant sources and identify management strategies which will be used to enhance the protection of groundwater within the WHPA.

Federal, state, and local regulatory programs have been in place for many years to help control pollutants from development and human activity. These programs have been implemented, and continue to be implemented, relatively independently of each other. For example, programs for water pollution control, have not always been coordinated with those of air pollution control, solid waste and hazardous materials management, etc. Nevertheless, these programs constitute the basis for pollution control in general, and a framework for a more integrated approach.

Wellhead protection programs offer an opportunity to integrate the existing regulatory programs into a more effective environmental protection effort. Specifically, wellhead protection programs have a limited geographic focus, they have specific risk-reduction priorities, and they are of considerable local interest and provide the opportunity for local control. These factors lend themselves to effective integration and focus of the many existing regulatory programs, with options for enhancement and new program development where the existing programs do not meet local needs.

King County under Chapter 173-100 WAC, is developing the South King County Ground Water Management Plan (GWMP). The draft GWMP (March 1995) contains management strategies designed to address the perceived threats to groundwater quality and quantity in South King County. Summaries of the GWMP recommendations are discussed here to portray the county-wide concerns and resulting recommendations for groundwater protection. It will be important to support and enhance the GWMP as it provides the building block for wellhead protection particularly since the WHPA is within the county's jurisdiction for zoning land use and implementations activities.

Finally, based on existing programs and the recommendation of the GWMP, we assessed possible enhancements to existing programs or the need for additional site-specific programs. These additional requirements are presented in the form of wellhead protection management strategies and associated tasks. These strategies are organized according to activity, and are presented in the next section of this report.

5.2 Existing Regulatory Programs

The following section provides a brief discussion of the existing regulatory programs which are in place and are designed to protect groundwater from contamination.

5.2.1 Contaminated Site Investigation and Cleanup - CERCLA and MTCA

The Federal "Superfund" legislation of 1980(Comprehensive Environmental Response, Compensation and Liability Act [CERCLA]) and the 1986 Superfund Amendments and Reauthorization Act (SARA) were created to assure that the nation's most contaminated sites were cleaned up. The major provisions of CERCLA include:

- Facility owners/operators are required to identify and report sites where hazardous substances were deposited in the past, and they are required to report current releases of hazardous substances;

- EPA promulgated regulations which outline the investigation and remedial action process for identified sites. These regulations are included in the National Contingency Plan (NCP)(40 CFR Part 300);

- EPA is authorized to investigate and inspect sites and use the information gathered during that process to "rank" sites to determine their priority. Sites that rank highly are placed on the National Priorities List (NPL); and

- EPA can use federal dollars to cleanup highly ranked contaminated sites, and can sue to recover dollars from the people who are responsible for the contamination, the Potentially Responsible Parties (PRPs).

There were four sites identified in the WHPA vicinity that were inspected under CERCLA as discussed in Section 4.3. None of these sites were nominated for the NPL.

The State of Washington had over 500 contaminated sites listed by the middle of the 1980s under CERCLA. In response to the need, Washington began a state cleanup effort. This effort was largely funded by general tax revenue, and because of the limited funding was targeted to only a few sites. The state legislature subsequently responded by providing a "State Superfund" legislation which was followed within two years (1988) by the Model Toxics Control Act (MTCA) - an initiative from the people (Initiative 97).

While the procedural details of these programs differ somewhat, the thrust has been to make progress on what has become a list of over 900 sites in Washington. The basic differences between the Superfund and MTCA programs are as follows:

- MTCA includes provisions to encourage responsible parties to perform voluntary cleanup of a site;

- MTCA provides specified cleanup standards for hundreds of constituents, including petroleum products, in air, soil, surface water and groundwater; and

- MTCA encourages public input into the cleanup process at many points, unlike superfund which allows for public participation once a remedy is selected.

Four sites; Landsburg Mine, L-Bar Products, Northwest Pipeline, and Palmer Coking Coal are located within the WHPA and are being addressed under MTCA as discussed in Section 4.3. Seven sites in the project area were identified.

5.2.2 Underground Storage Tanks

Underground storage tanks (USTs) typically contain motor fuels or heating oil, but may also contain solvents or other compounds. Old or improperly installed or maintained tanks frequently leak. The most common causes of leaks are structural failure, corrosion, improper fittings, improper installation, and natural phenomena. Soil and groundwater have been contaminated by leaks from USTs and associated piping.

Federal regulations (Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks, 40 CFR 290 Part 280) were developed by the EPA under Subtitle "I" of the RCRA to prevent leaks from USTs. The EPA regulations contain requirements for proper UST design, leak detection, overfill protection, tank inventory monitoring, financial responsibility, leak reporting, remedial action, and removal.

In 1989, the State of Washington enacted legislation creating a comprehensive program for the regulation of USTs and a reinsurance program to assist owners and operators in demonstrating financial assurance under EPA's financial responsibility requirements. The law contained in Chapter 90.76 RCW, required Ecology to develop UST rules as stringent as the EPA regulations. These rules are contained in Chapter 173-360 WAC.

The existing Ecology program for USTs is comprehensive. Owners of all tanks covered by the regulations must apply for and obtain an annual permit to operate the tanks. The regulations and permit requirements include:

- Properly completing an installation checklist filled out by a licensed tank installation supervisor;
- Certification of compliance with corrosion protection for tanks and piping, financial responsibility requirements, and release detection requirements;
- Performance standards are provided for new tanks. Existing tanks must upgrade according to a schedule;
- Examination and licensing for firms and persons involved in UST-related activities;
- Authorized representatives of the State may gain access to the premises for inspection of records, to sample, or otherwise monitor operations; and
- Permits may be revoked for non-compliance. It is illegal for suppliers to deliver a product to a tank unless a valid permit is displayed. It is also illegal to deliver to a tank known to be leaking.

Fifteen (15) tanks are registered with Ecology in the WHPA study area (see Table 4-4). The UST registration is discussed further in Section 4.3.

It is important to note that the above state and federal UST regulatory programs do not cover all USTs. Notable exceptions are:

- Farm or residential UST systems of 1,100 gallons or less capacity used for storing motor fuel for non-commercial purposes;
- UST systems used for storing heating oil for consumptive use on the premises where stored, except for systems with a capacity of more than 1,100 gallons have a reporting requirement; and
- USTs with a capacity of 10,000 gallons or less are exempted from environmental review under SEPA.

The first two exceptions noted above, however, are subject to local regulatory authority under Article 79 of the Uniform Fire Code (UFC). Installation and removal of abandoned home heating oil tanks is regulated by the King County Fire Marshal's Office, local fire districts, and cities under Article 79 of the UFC. The UFC requires that tanks which have been unused longer than a year be properly closed in a manner approved by the appropriate fire official.

Leaking Underground Storage Tanks. Leaking underground storage tanks (LUSTs) are handled by a separate (from the USTs or non-leaking tanks) regulatory approach by the federal and state regulators. Both EPA and Ecology have programs for cleaning up Leaking Underground Storage Tanks. For EPA, this has largely been a funding program to states to implement cleanup programs. For Ecology, the program has involved regulation development, reporting requirements, and cleanup standards.

Releases of hazardous substances from USTs in this state are currently addressed by Ecology through oversight of voluntary cleanup actions by tank owners or through enforcement actions under MTCA. MTCA created the Toxics Control Account and describes the many possible uses of revenues, one of which is funding for the Ecology LUST Program cleanup activities. In cases where a financially solvent owner/operator cannot be identified or is unwilling to undertake appropriate cleanup actions, Ecology will directly undertake the cleanup of a site under this Act. If a financially solvent responsible party can be identified, Ecology will seek to recover costs incurred in any cleanup action.

Jurisdiction for LUSTs in King County rests with Ecology. Four (4) LUSTs have been identified in the study area as discussed in Section 4.3 (Table 4-3) and shown on Figure 4-2.

5.2.3 On-Site Septic Systems

As described in Section 4.4, potential contaminants from septic tanks and drain fields include pathogenic organisms, toxic substances, and nitrogen compounds. Regulatory jurisdiction over

on-site sewage disposal systems depends on the type of waste and the size of the system. Industrial disposal, as well as large domestic on-site septic systems (14,500 gallons per day or more), is regulated by Ecology. DOH regulates systems with flows between 3,500 and 14,499 gallons per day, while the County Health Department has jurisdiction over smaller systems.

The purpose of the State On-site Sewerage Regulations (Chapter 248-96 WAC) is two fold:

- Minimize the potential for public exposure to sewage from on-site sewage systems; and
- Minimize adverse effects to public health of discharges from on-site sewage systems to groundwater and surface water.

Under this regulation, siting, design, construction, repair, and replacement of on-site sewerage system are controlled through the use of standards and permits. The goal is to achieve long-term sewage treatment and effluent disposal and to limit the discharge of contaminants to waters of the state. Both industrial and domestic systems must now comply with the state's Groundwater Standards (Chapter 173-200 WAC).

5.2.4 Hazardous Materials/Hazardous Waste

Hazardous Materials Use. Commercial use of chemicals can present significant risk to groundwater. While there is always the possibility of chemical release to the environment when using and handling chemicals, significant releases of liquids frequently occur in one of two ways:

- **Accidental Releases or Spills.** Handling materials always presents a risk of spills, but the risk can be reduced by proper handling methods, spill prevention measures, and spill response preparedness.
- **Improper Disposal.** Most waste materials which could be construed to be hazardous are regulated by EPA and/or Ecology. For the regulated materials, disposal decisions must be documented and reported, and the disposal facility must be licensed.

Hazardous Material Storage. The storage of hazardous materials is regulated under the Superfund Amendments and Re-authorization Act of 1986 (SARA). This law, in additional to providing the extension and changes to CERCLA as described above, contains Title III, provisions for "Community Right to Know" and Emergency Response.

Community Right to Know - As required by this law, facilities handling hazardous materials must report quantities which are stored on site to notify the community (especially emergency response groups and agencies) of the types and amounts of chemicals on hand. "Reportable Quantities" vary from chemical to chemical and can go as low as one pound. In addition, facilities must report annually on any releases of these chemicals into the environment. EPA keeps a database of the reported releases which is entitled the Toxic Release Inventory. No releases were identified in this database within the WHPA.

State and local fire regulations also regulate amount and type of hazardous materials stored at any location. For example, above-ground storage of gasoline is generally prohibited in most counties. Under the Uniform Fire Code (Articles 79 and 80), heating oil tanks which are not in use must be closed, and spill prevention measures need to be taken for storage of materials above ground.

Hazardous Material Transportation - Labeling, Placarding, Shipping Papers. Regulation of the transportation of hazardous materials is provided by the US Department of Transportation (DOT). DOT regulations are focused on three areas: Labeling, Placarding, and Shipping Papers (Manifests). The DOT has very specific requirements for labeling hazardous materials. Vehicles carrying these materials must be placarded with the appropriate DOT signage. Recent changes to DOT regulations require emergency information to be placed on shipping papers (such as a phone number where 24-hour emergency response information is available) and that emergency response information be maintained in the vehicle.

Hazardous waste transportation, is partially regulated under RCRA, and utilizes a specific manifest form which was developed to track waste material from point of origin to disposal.

There are no programs to provide notification to local government of special hazards related to transport of materials within their jurisdiction.

Hazardous Waste. The Federal Resource Conservation and Recovery Act (RCRA) of 1976 (40 CFR 260), as amended in 1984, regulates hazardous waste. RCRA was termed the "Cradle to Grave" legislation regulating hazardous wastes because the legislation required controls on hazardous wastes from the time of their creation to their ultimate disposal.

Washington was one of the first states to pass legislation and create regulations comprehensive enough to warrant partial "authorization by EPA to administer portions of RCRA." Under the state's Dangerous Waste Regulations (Chapter 173-303 WAC), waste materials thought to be hazardous must be "designated" through a process of determining the characteristics of the material. Large quantity hazardous waste generators must meet strict requirements for accumulation and storage of waste, recordkeeping, and disposal. Four large quantity RCRA facilities were identified in the study area as discussed in Section 4.3 (Table 4-7) and shown on Figure 4-2.

Like the federal regulations, generation of small quantities of hazardous is exempt from most provisions of the state rules. The regulatory threshold amounts, however, are 10 times lower under the state rules than those of EPA. "Small quantity generators," companies who generate up to 220 pounds of hazardous waste per month, are relatively uncontrolled and free from requirements.

Waste Reduction Planning is also required of Washington Businesses (Hazardous Waste Reduction Act of 1990). Under the terms of this legislation, large quantity generators of hazardous waste must develop plans for the reduction of hazardous wastes. The overall goal of the legislation is for a 50% reduction of hazardous waste generated in the state by 1995.

Emergency Response. The SARA Title III also required that local governments create a Local Emergency Planning Committee (LEPC) and have an Emergency Response Coordinator on staff. Part of this committee's function is to assimilate information on chemical use and release in the area. In an attempt to improve emergency response, an emergency response organization was required for each state.

Through the LEPC, topics such as training, chemical storage, and incident response are discussed. In this manner, close coordination is enhanced in the event of a release or spill.

In all cases, except state highways, the local fire district is the Incident Command Agency. For state highways, the State Patrol serves this role.

Under Section I of SARA, there are provisions for worker protection relating to emergency response. Federal and state rules require any business which handles hazardous materials to provide training for their workers in emergency response. The training is required at different levels depending on the level of emergency response expected from the worker.

5.2.5 Use of Pesticides and Fertilizers

The groundwater contamination potential from pesticides and fertilizers is discussed in Section 4.4. The use of pesticides is regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (1975). In Washington, this activity has been delegated to the state Department of Agriculture. FIFRA allows states authority to register or restrict pesticide use. Washington has its own statutory control under the Washington Pesticide Control Act (Chapter 15.58 RCW) and the Pesticide Application Act (Chapter 17.21 RCW). Washington Department of Agriculture is responsible for pesticide registration, quality control sampling, and testing and licensing of applicators.

Like many of Washington's counties, King County has an active Conservation District program which, with the assistance of the Washington State Cooperative Extension Service and the United States Department of Agriculture Soil Conservation Service, provides technical assistance to land owners. This assistance takes many forms. Fertilizer application rates, appropriate animal density, and animal waste disposal and utilization are common topics. In many cases, recommendations are formalized in a "Farm Plan." The Conservation District also provides a conduit for funding of soil and water conservation and environmental protection measures.

5.2.6 Landfills

Solid waste landfills are regulated by the federal, state, and local governments. Ecology regulations entitled Criteria of Municipal Solid Waste Landfills are included in Chapter 173-351 WAC. These regulations include standards for:

- Location of landfills relative to flood plains, wetlands, unstable areas, and seismic impact zones. These standards apply to new landfills and lateral expansions of existing landfills;

- Design criteria for new landfills including composite liners, leachate collection and removal systems, design of groundwater monitoring systems, groundwater sampling and analysis, reporting of groundwater monitoring data, groundwater modeling, hydrogeologic reports, and corrective action. The standards also include restrictions on the minimum separation between the bottom of the landfill and highest groundwater; and

- Operating the landfill.

King County has jurisdiction over design, construction, operation, and closure of solid waste facilities in King County. These facilities are regulated under the Code of the King County Board of Health, Title 10. Two Limited Purpose "Special Use" landfills were identified in the study area; one at the Reserve Silica mine and one at the Pacific Coast Coal Company as discussed in Section 4.3 and shown on Figure 4-2.

5.2.7 Storm Water

As discussed in Section 4.4, storm water is not only a source of groundwater recharge, but is also a potential source of contamination. Storm water discharges are regulated by the federal government under Section 402 of the Clean Water Act. Federal regulations were promulgated in 40 CFR Part 122. The intent of the federal program is to minimize the concentrations of pollutants which are discharged with storm water from industrial and construction sites. The federal program includes the following basic components:

- Permits are required for "storm water discharges associated with industrial activities." For example, industrial facilities which store raw materials, manufacture goods, or store products which may come in contact with storm water, must apply for a general permit;

- The permit requires that facilities implement a storm water pollution prevention (SWPP) plan and utilize best management practices (BMPs) to control the quality of storm water discharges. The SWPP plan summarizes BMPs including practices like covering raw material stockpiles, sweeping the site to minimize pollutants which could be carried by storm water runoff, or installing and maintaining sediment detention sumps or basins. The SWPP plan also summarizes reporting requirements, inspection and maintenance requirements, and establishes a team of people at each site who are responsible for implementation of the plan.

- The federal program also requires that construction sites which disturb more than 5 acres must apply for a general storm water permit. The intent behind this requirement is minimize sediment-laden storm water runoff from construction sites.

Ecology has jurisdiction over the storm water program in the state. Ecology has authored a general permit for discharges associated with industrial activity, which would typically apply to industrial facilities within the WHPA. They have written some industrial category-specific permits such as for sand and gravel mining sites. They have also authored a draft permit for construction sites.

The Ecology program goes somewhat farther than the federal program as it requires that permit holders monitor storm water quality at the point of discharge to surface water or groundwater. However, Ecology does not require the installation of groundwater monitoring wells to determine potential impact to groundwater from storm water infiltration practices.

King County also has jurisdiction over storm water runoff quality and quantity. The Storm Water Management Manual for the Puget Sound Basin outlines the best management practices that should be used in King County to control storm water from facilities during and after construction.

5.2.8 Monitoring Well Construction

As discussed in Section 4.4, groundwater monitoring wells can be a conduit for contaminant transport between the ground surface and an aquifer if they are improperly constructed or abandoned. Regulation of wells in Washington began in 1971 under the direction of Ecology. Two areas of focus of this program are well construction standards (Chapter 173-160 WAC-Minimum Standards for Construction and Maintenance of Wells) and licensing (Chapter 173-162 WAC Regulation and Licensing of Well Contractors and Operators).

The Minimum Standards for Construction and Maintenance of Wells includes:

- General requirements for well construction notification, design and construction of wells, sealing of casings, and capping requirements;
- Specific requirements for water supply wells including well location, design and construction of the well and seal, well testing, and well abandonments procedures; and
- Specific requirements of resource protection (monitoring) wells including design and construction standards for the casing, surface protection, seals, well screen, filter pack, development and abandonment procedures.

The Regulation and Licensing of Well Contractors and Operators includes requirements for licensing water well drillers, examination requirements, and the responsibilities of licensed well contractors.

5.3 South King County GWMP Strategies Planned for Risk Reduction

The South King County Ground Water Management Plan (GWMP) identified the topics or potential problems of concern and, as part of the planning process, will adopt groundwater management strategies. The GWMP (March 1995 Draft) identified the following topics for consideration:

- Special Area Designations to Enhance Ground Water Protection;
- Storm Water Management;
- Hazardous Materials Management;

- Underground Storage Tank Management;
- On-site Sewage Disposal System Use;
- Pesticides and Fertilizers;
- Well Construction and Abandonment;
- Sewer Pipes;
- Solid Waste Landfills;
- Burial of Human Remains;
- Sand and Gravel Mining;
- Land Application of Biosolids and Effluent; and
- Ground Water Quantity.

These topics were analyzed in an issue paper format, developed by South King County Health Department (SKCHD) and project consultants. The issue papers contained technical information about the topic, a description of the existing regulations and any existing programs, and then identified issues that could be addressed by one or more management strategies. A Ground Water Advisory Committee (GWAC), discussed and modified these to become strategy recommendations.

In developing the management strategies, the South King County GWAC attempted to make maximum use of existing governmental programs and regulatory structures. The management strategies were based upon thorough research into the problems as presented in the issue papers. Each strategy was evaluated for feasibility, including implementation cost. The South King County GWAC preferred strategies that could be understood and supported by the citizens in the South King County area.

As the South King County GWAC considered each issue, data collection and management, and educational management strategies were adopted for many of the issues. These were compiled into a Data Collection and Management Program and an Education Program.

The South King County GWAC realized that the adopted strategies would not completely prevent contamination problems from occurring in the South King County aquifers, but that it should greatly limit the frequency and severity of such problems. The South King County Ground Water Management Plan is intended to provide a framework to assist cooperation between various regulatory agencies through implementation of the adopted groundwater protection measures. It is also intended to serve as a guide to further focused research on the aquifers in addressing data and regulatory protection gaps.

The GWMP discussion of strategies is organized in the following way:

- Programs Related to Ground Water Quality and Quantity;
- Programs Related to Ground Water Quality; and
- Programs Related to Ground Water Quantity.

Tables 5-1 through 5-3 summarizes the groundwater management strategies listed in the GWMP.

The strategies that are presented in the GWMP were used as a basis for the strategies considered for this WHPA. The consultant team reviewed the strategies provided by the GWMP and augmented them with additional strategies which are specific and strategic to this WHPA. The following section presents the recommended wellhead protection strategies for this WHPA.

Table 5-1 - Programs Related to Groundwater Quality and Quantity

Special Area Designations	Storm Water	Education	Data
Areas with a critical recharging effect on aquifers used for potable water per RCW 36.70A Growth Management. Wellhead Protection Areas per the 1986 amendments to the federal Safe Drinking Water Act. Environmentally Sensitive Areas per Chapter 197-11 WAC State Environmental Policy Act Rules. Special Protection Areas per Chapter 173-200 WAC Water Quality Standards for Ground Waters of the State of Washington. Sole Source Aquifers per the federal Safe Drinking Water Act of 1974. Aquifer Protection Areas per RCW 36.36.	Amendment or adoption of the King County surface water design manuals to require infiltration, treatment, and no net reduction in recharge as appropriate. Maintenance of rural and open space in high potential aquifer recharge areas. Pretreatment of infiltrated storm water in high potential aquifer recharge areas. Sponsor research on long-term groundwater impacts. Coordination between Department of Ecology, Puget Sound Water Quality Authority, and King County surface water and groundwater quality planning efforts. Assess adequacy of existing storm water systems/establish priority for upgrades. Roadway runoff - priority to recharge areas for implementation of new standards. Evaluate effects of soil amendments on storm water moisture and nutrient retention.	Cooperation in including groundwater education in existing programs. Assess and report on adequacy of all education programs. Supplemental program development (New education elements). Coordinate implementation of education efforts (Joint groundwater education programs).	Continued data collection, analysis, and management.

Table 5-2 - Programs Related to Groundwater Quality Only

Hazardous Materials	Underground Storage Tanks	On-Site Sewage Treatment and Disposal Systems Use	Pesticide and Fertilizer Use	Well Construction and Abandonment	Sewer Pipe Concerns	Solid Waste Landfills	Burial of Human Remains	Sand and Gravel Mining	Land Application of Biosolids and Effluent
Support state hazardous waste plan implementation. Require vertical separation from groundwater for dangerous waste management units. Develop specific zones for treatment or storage facilities. Include assistance in site discovery and public education. Implement the Uniform Fire Code (Article 80).	Provide local implementation of Underground Storage Tank Regulations. Add control requirements within County. Regulate existing "exempt" tanks. Investigate local authority for underground home heating tanks. Amend Building Code to include home underground tanks (if necessary).	Require water systems to conduct nitrate loading analysis. Require alternative disposal in areas of high (>5 mg/L) nitrate. Initiate a hazardous materials management program for on-site systems. Prohibit sale of system cleaners. Prohibit use of systems for disposal of any materials except domestic sewage. Conduct household hazardous waste education.	Fund Farm Plan development. Evaluate pesticide reduction program of Extension Service. Cities and County to use low risk methods for vegetation management. Support strategies for education and management.	Support enforcement of standards. Seek delegation of well drilling program. Regulate well location identification. Explore funding for proper abandonment. Promote an education program on well construction.	Encourage Adoption of routine leak detection and repair programs. Require "leakproof" piping for new construction and accelerated program for replacement in aquifer areas. Improved backfill to reduce ground water transmission.	Determine existing level of ground-water protection. Improve regulations if necessary. Prohibit siting or expansion of landfills in high potential recharge areas by adoption of Chapter 173-351 WAC by reference. Evaluate waste screening procedures. Proceed with investigation of abandoned sites. Education on waste disposal and groundwater effects.	Search for and evaluated informational studies on the subject.	Regulatory compliance with NPDES and Ecology General Permit requirements. Support regulatory changes to provide better protection of groundwater. Include Best Management Practices in SEPA guidance document. Carefully evaluate land use of reclaimed mines. Amend zoning code to protect groundwater from effects of use of reclaimed mines.	Re-use Guideline Revision - Limits within Aquifer Areas.

Table 5-2 - Programs Related to Groundwater Quality (Continued)

Hazardous Materials	Underground Storage Tanks	On-Site Sewage Treatment and Disposal Systems Use	Pesticide and Fertilizer Use	Well Construction and Abandonment	Sewer Pipe Concerns	Solid Waste Landfills	Burial of Human Remains	Sand and Gravel Mining	Land Application of Biosolids and Effluent
Implement SARA Title III (Emergency Planning and Community Right to Know). Have water systems assess transportation risk/develop programs for mitigation. Work with DOT on transportation risk mitigation.	Regulate heating oil tank abandonment and maintenance. Database development on underground tanks. Educate owners on tanks and their risks.	Education programs on proper system maintenance. Require "As-builts" of systems to be recorded with deed.							

Table 5-3 -Programs Related to Groundwater Quantity Only

Program
Develop policies and ordinances: aquifer recharge/clearing/interim development standards/impervious cover.
SEPA enhancements.
Data needs - groundwater data program.
Support seawater intrusion policy (Ecology).
Utility pumping data to Ecology.
Adoption of landscaping ordinance - conservation.
Group B - water conservation.
Xeriscaping education.
Conservation education to individual system owners.
Investigate artificial recharge programs.
Recommendations to establish decline limits/prevent decline.

6.0 WELLHEAD PROTECTION MANAGEMENT STRATEGIES

6.1 Introduction

The next step in completing the Wellhead Protection Plan is to develop Wellhead Protection Management Strategies. The management strategies should be developed with the following criteria in mind:

- Geology and hydrogeology of the WHPA, keeping in mind the susceptibility of the aquifers to be protected, as discussed in Sections 2.0 and 3.0;
- The potential and known sources of contamination and the relative risks associated with those sources as identified in Section 4.0;
- Existing regulatory programs which are designed to protect groundwater from contamination as discussed in Section 5.0; and
- The desires of the local community which uses the water supply. This input was provided by the WHPA Advisory Committee during development of this program.

6.2 Wellhead Protection Tasks

Using the above criteria, more than 70 separate Wellhead Protection Tasks were considered by the Project Review Committee. These tasks were developed primarily through review of the implementation tasks identified in the March 1995 Draft of the South King County Ground Water Management Plan, with additional consideration for the wellhead-specific criteria listed above. These tasks were presented to the WHPA Advisory Committee, who considered and modified them as appropriate. Table 6-1 lists the 48 tasks that were approved by the committee.

6.2.1 Task Organization

Each one of the 48 wellhead protection tasks performs a number of different functions. There are various ways in which the tasks could be organized. Three obvious ways the tasks could be considered include:

Risk Area. Each task generally relates to one or more of the risk areas defined in Section 4.0, such as the risk relating to the use of septic systems in residential areas or the risk of using herbicides along transportation corridors. Additionally, some of the tasks relate to many or all of the risk areas, such as the task which specifies implementing a wellhead protection steering group.

Existing Programs. With many of the tasks, there is an existing regulatory program which, to some degree, is designed to minimize the risk to groundwater from regulated activities: such as federal and state regulations which apply to septic systems or to the manufacture, use, and applications of herbicides (see Section 5.0).

Type of Management Activity. The tasks could also be thought of in the framework with which they will be implemented: such as the task to implement a wellhead protection steering group is clearly a management function, while a task to document the type and amount of herbicide application on transportation corridors, forestry, agricultural, and recreational parcels is a data gathering task. The task which specifies participation in public education program to notify residents of the potential impact of septic systems within the WHPA is a education-oriented task.

Table 6-2 illustrates these three main ways to organize the wellhead protection tasks. Because the tasks could be looked at from so many perspectives, we created a database using Microsoft Access to store the tasks. We flagged each task within the database to identify to following information:

- Name of the task;
- Lead implementation agency;
- If the task is included in the SKCGWMP;
- The risk area(s) to which the task applies (residential medium-density, residential rural, industrial/commercial sites, transportation corridors, mining, or forestry);
- The existing regulatory program(s) to which the task applies; and
- The type of "management activity" to which the task applies (management, land use, regulatory, planning, cooperative, data gathering, or education).

Tables 6-3 through 6-8 present the tasks organized according to risk area. Table 6-3 includes the tasks which are common to all risk areas. The other tables include tasks which are common to one or more (but not all) risk areas. Organization of the tasks in this way, allows the implementation steering group to see how each task relates to the risks which were identified and prioritized in Section 4.0.

The following discussion on management strategies provides more insight into the intent of the wellhead protection management tasks. For the purposes of implementing this wellhead protection plan, we have organized the discussion into management strategies which are based on the type of "management activity" which will be performed. Table 6-9 illustrates how the strategies relate to management activities. Appendix C contains an electronic copy of the database as well as tables which sort the tasks according to management activity, and tables which sort the tasks according to lead implementation agency. Please refer to these tables when reviewing the following discussion.

6.3 Management and Cooperation Strategies

This WHPP must be implemented through continuing management activity. The plan will need to be adapted and to evolve as needed to meet future changes in the City's philosophies and/or changes in the physical or geochemical conditions of the aquifer system. As such, the management strategies and practices outlined within this study provide a general direction and tone, but will periodically need to be refined to fit future conditions. Additional adaptations may be needed to address future activities and regulations, or changes in current regulations, that may affect the WHPA. The following strategies are recommended to address the long-term management aspects of the plan.

Strategy No. 1—Establish a WHP Steering Group. The City should establish a WHP Steering Group. The group needs to meet periodically to:

- Evaluate the implementation status of the WHP tasks;
- Review federal, state, and local programs regarding the WHP;
- Review changes in surface activities within the WHPA; and
- Meet WHP regulations and requirements.

The group should strive to focus existing and future applicable water quality and quantity resource programs toward the WHPA; should meet, at a minimum, on a quarterly basis for the first three years following Plan implementation; and should establish an appropriate meeting schedule for the following the 3-year period. The Group should include a representation similar to that established for the project development Review Committee which included representatives from the City of Kent, Covington Water District, King County Water District 111, Washington State Department of Ecology, Washington Department of Health, King County Health, the Chamber of Commerce, and local citizens.

Strategy No. 2—Land Management Activities. The City should encourage owners or operators responsible for large land parcels and developments to use and monitor best management practices (BMP) for control of potential groundwater contaminants into the WHPA.

6.4 Land Use Strategies

City of Kent has no authority to directly control land use within the WHPA. Therefore, the City must develop a cooperative relationship with those state and local agencies which do administer land use programs. At the present time, the best strategy for the City is to seek appropriate special designations for the WHPA. Accordingly, the following is recommended.

Strategy No. 3—Special Protection Area Designation. The City should consider having the WHPA designated as a special protection area. Since various state and local regulations exist for designating special protection areas, the City should evaluate and seek the designation(s) which may be most beneficial. Specifically, the City could pursue any of the following: a Special Protection Area designation under the state Ground Water Quality Standards (Chapter 173-200 WAC), designation of Special Use Area by the Department of Agriculture, or

designation as an Environmentally Sensitive Area and/or a Critical Aquifer Recharge Area (CARA) under various King County programs. At a minimum the City should ensure that the WHPA is identified and mapped by the County as an Area of High Susceptibility to Groundwater Contamination.

6.5 Regulatory Strategies

This WHPP is designed to use the existing statutory rules and regulations to protect groundwater quality. The Steering Group, in coordination with state and local agencies having statutory authority in the area, will need to assist with monitoring regulated activities conducted under existing programs within the WHPA. Based on a preliminary review of the existing regulatory activities, the following regulatory strategies are recommended.

Strategy No. 4—SEPA/Hydrogeologic Evaluations. The City should request King County DDES to require hydrogeologic evaluations for any development within the WHPA which triggers SEPA action. Additionally, the City should agree upon a MOU with DDES requiring City comment on the effects such development will have on the groundwater system. Designation of the area as a Critical Aquifer Recharge Area will be the first step toward gaining such an agreement.

Strategy No. 5—WHPA Well Drilling. The City should encourage the delegation of well construction inspection authority be transferred from Ecology to the King County Health Department. With or without this transfer of authority, the City should encourage more frequent well construction inspections than currently occur.

Strategy No. 6—Septic Tanks. The City should request King County to require that engineering as-builts of new septic systems be recorded with property deeds. Additionally, the City needs to support the implementation of laws and regulations requiring proper inspection and maintenance of septic systems.

6.6 Planning Strategies

A substantial degree of future protection for the WHPA will be achieved through present-day planning and coordination. In order to maximize future protection, the following strategies are recommended.

Strategy No. 7—Sewers. The City should encourage the County to require all industrial and commercial facilities within the WHPA to connect to sanitary sewers, if such services are reasonably available. The City, in coordination with the managers of local sewer systems, need to develop emergency plans to be implemented in the advent of sewage leaks or spills.

Strategy No. 8—Farm Planning. The City and the County Conservation Districts in the area should discuss how farming practices can affect groundwater. The City should encourage and support the County Conservation Districts in their farm planning, such that farm plans include items specifically designed to protect groundwater quality.

Strategy No. 9—Storm Water Management. The City should promote research on the impact of storm water discharge on water quantity and quality. Additionally, the City, in coordination with the responsible agencies, need to evaluate the adequacy of storm water facilities, including proper routing, retention, and detention: A balance must be found that allows optimum recharge of storm water to groundwater systems while adequately protecting the water quality of the aquifers.

Strategy No. 10—Petroleum Pipelines. The City needs to document the location and use of petroleum pipelines and to establish emergency response plans for pipeline failure. These efforts should be coordinated with the pipeline companies and the federal, state, and county agencies responsible for emergency petroleum-product spill response.

Strategy No. 11—Hazardous Material Transport. The City should investigate the feasibility of re-routing the transport of hazardous materials away from the 1-year time of travel zone.

Strategy No. 12—Emergency Response for Transportation Corridors. The City shall notify the appropriate emergency response organizations on the location of the WHPA and establish formal communication protocols with the first-response emergency units.

6.7 Data Management Strategies

One of the principal goals of the WHPP is the development of a data collection network and analysis plan capable of providing the City with advance warning of contamination to the City's water supply. The following data management strategies seek to establish and maintain scientific data upon which future WHPP actions can be based.

Strategy No. 13—Groundwater Monitoring. The City should actively participate in the collection and analysis of regional and local groundwater information. This can be accomplished by cooperating with the other local purveyors (Covington and Water District No. 111), the South King County Regional Water Association, King County Health Department, Ecology, and other entities seeking to monitor the groundwater resources of the region and by following the WHPA monitoring plan detailed in this study. The monitoring plan has been designed to provide the City with long-term information on groundwater quality and quantity and to also serve as a central network system alerting the City of potential groundwater quality problems. The data collected through the network should be summarized and reviewed annually to resolve any identified problems and evaluate the effectiveness of the network.

Strategy No. 14—Herbicide and Pesticide Survey. The City should inventory and monitor major herbicide and pesticide use within the WHPA. This inventory may be used to guide future groundwater monitoring and WHP-related education programs. In addition, the City should encourage county, state, and private land managers to use vegetation management practices which protect groundwater quality.

Strategy No. 15—Underground Storage Tanks Inventory. The City needs to inventory and locate underground storage tanks within the 1-year time of travel zone. Besides those presently

identified by the current hazard inventory, this inventory should include new tanks placed after the hazard inventory was finished, and residential home heating oil USTs and/or other tanks that were not previously identified.

Strategy No. 16—Drywell Monitoring. The City needs to encourage King County Surface Water Management to develop an evaluation and monitoring plan for drywells within the WHPA.

Strategy No. 17—Abandoned Wells Inventory. The City needs to locate and inventory abandoned or unused wells. Owners of these wells should be notified of the potential liability such wells cause and be educated on the benefits of well decommissioning.

6.8 Education Strategies

Education of the public and industrial/commercial occupants of the WHPA concerning groundwater protection is a critical portion of the WHPP. Through proper education, the degree and potential for future contamination can be greatly reduced; therefore, the following recommendations are made.

Strategy No. 18—WHP Education Programs. The City has already begun groundwater educational programs and should continue to educate the WHPA residents, particularly on groundwater quality issues. The WHPA should be targeted for distribution of literature regarding septic tank maintenance, fuel oil storage tank maintenance and abandonment, residential use of herbicides and pesticides, and hazardous material use, disposal, and storage.

In addition to City-run programs, the City should strive to participate in and support small-quantity waste disposal programs and actively work with state and local government in developing and creating public education programs concerning groundwater.

Table 6-1 Wellhead Management Tasks

Conduct groundwater monitoring for analysis of nitrate according to groundwater monitoring plan. Establish nitrate early warning valve (EWV) to allow for timely action in the event of increasing nitrate concentrations.

Promote and coordinate public education program for household hazardous materials use, storage, and disposal within the WHPA.

Survey pesticide and herbicide use/work with Cooperative Extension and County with available data to modify future monitoring and education plans.

Inventory forest ownership, the extent of harvesting, and the harvesting practices used with the WHPA.

Document the location and use of petroleum pipelines within the WHPA, and develop appropriate emergency procedures.

Document use of hazardous materials in mining support activity

Establish formal communication with first responders

Update emergency response organizations on WHPA location.

Develop emergency response procedures for sewer force main breaks within the 1-year zone.

Coordinate and promote the evaluation of possible storm water routing, detention, retention priorities.

Work with responsible parties to assess adequacy of facilities and establish joint priority for storm water upgrades.

Consider seeking designation of aquifer(s) as "special protection areas" or other special designations.

Encourage requirement of as-builts of new septic systems (prepared by designer) to be recorded with the deed.

Support the implementation of state law/regulation on septic system inspection and maintenance programs.

Participate in education program to notify public of impact of septic systems to the WHPA.

Promote and coordinate public education program for proper septic system maintenance and hazardous waste disposal.

Review annual reports produced under SARA Title III to document inventory of chemicals used in the WHPA.

Develop data on number and size of exempt underground tanks within 1-year time of travel zone.

Table 6-1 Wellhead Management Tasks

Promote and coordinate public program to educate owners of exempt underground tanks of the hazards they represent, methods of leak detection, proper removal and closure procedures.

Fund Farm Plans through the local Conservation District which focus in wellhead zones.

Request County, State, and private land owners/managers to utilize vegetation management practices which protect water quality within the WHPA.

Encourage development and use of BMPs for large land units (large residential developments, schools, golf courses, parks, mining, and forest parcels).

Monitor use of BMPs on large land parcels.

Support King County in seeking delegation of well drilling regulatory program for advance notice of drilling and inspection of well construction.

Inventory abandoned or unused wells in the 1- and 5-year time of travel zones. Educate owners about proper well construction and abandonment within the WHPA.

Review routine leak detection procedures for sewer lines in the WHPA.

Request utilities to use "leakproof" piping for sewer for any new construction in wellhead zones - accelerate upgrade and replacement of existing risky lines.

Encourage careful analysis and adequate requirements for siting, operation, and reclaimation of mining in the WHPA during SEPA review.

Assure that the hydrogeologic impact of development of parcels within wellhead protection areas is adequately analyzed during SEPA review.

Participate in a regional groundwater data development and management effort to assure that an adequate regional groundwater monitoring program is developed.

Provide continual coordination of environmental education efforts in the County.

Create and operate an IMPLEMENTATION STEERING GROUP to assure focus of applicable state and local programs to wellhead protection areas. Review management strategies to incorporate new data, requirements, and approaches.

Conduct groundwater monitoring for analysis of pesticides and herbicides according to groundwater monitoring plan.

Promote research on the impacts of storm water discharge from residential areas.

Document the type and amount of herbicide application with focus on transportation corridors, forestry, agriculture, and recreation parcels.

Table 6-1 Wellhead Management Tasks

Investigate the need for re-routing transport of hazardous materials to areas outside of wellhead zones.

Locate signs within the WHPA along transportation routes - "Wellhead Protection Area."

Communicate location of the WHPA and wellhead protection concerns to mine operators.

Require mine operators to install monitoring wells capable to assess potential impacts from site operations for sites within the WHPA.

Prioritize investigation of contaminated and potentially contaminated sites within the WHPA.

Review MTCA, RCRA notifiers, and LUST sites files for sites within the WHPA annually.

Monitor Ecology's progress on the cleanup of MTCA and LUST sites within the WHPA.

Encourage Ecology and County inspections of RCRA hazardous waste generator facilities within the WHPA.

Communicate location of WHPA to industrial/commercial site owners.

Communicate the extent of wellhead protection areas to the County Planning Department for consideration in critical areas regulation, susceptibility mapping, and permitting.

Require sewer hook up for all industrial/commercial facilities within the WHPA, if sewer service is reasonably available.

Encourage periodic monitoring of drywells in the WHPA.

Review water quality data generated under the general NPDES Storm Water Permit.

Table 6-2 - Three Main Ways to Organize Wellhead Protection Tasks

Risk Area
Residential - Medium Density Housing
Residential - Rural Housing
Industrial/Commercial Sites
Transportation Corridors
Mining Land Use
Forestry Land Use

Existing Regulatory Program
Hazardous Waste Generation
Underground Storage Tanks
Landfills
CERCLA/MTCA Sites
NPDES Process Water/Storm Water

Type of Activity
Management
Land Use
Regulatory
Planning
Cooperative
Data Management
Education

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Table 6-3 - Common Tasks for All Risk Areas

Task	Implementation Lead	Included in the SKCGWMP
Create and operate an IMPLEMENTATION STEERING GROUP to assure focus of applicable state and local programs to wellhead areas. Review management strategies to incorporate new data, requirements, and approaches.	Purveyors	No
Communicate the extent of wellhead protection areas to the County Planning Department for consideration in critical areas regulation, susceptibility mapping, and permitting.	Purveyors	No
Consider seeking designation of aquifer(s) as "Special Protection Areas."	Purveyors	Yes
Assure that the hydrogeologic impact of development of parcels within wellhead areas is adequately analyzed during SEPA review.	County	Yes
Encourage development and use of BMPs for large land units (large residential developments, schools, golf courses, parks, mining, and forest parcels).	Purveyors	Yes
Monitor use of BMPs on large land parcels.	Purveyors	Yes
Participate in a regional groundwater data development and management effort to assure that an adequate regional groundwater monitoring program is developed.	Purveyors	Yes
Provide continual coordination of environmental education efforts in the County.	County	Yes
Encourage periodic monitoring of drywells in the WHPA.	County	No
Inventory abandoned or unused wells in the 1- and 5-year time of travel zones. Educate owners about proper well construction and abandonment within the WHPA.	Purveyors	No
Support King County in seeking delegation of well drilling regulatory program for advance notice of drilling and inspection of well construction.	County	Yes

Table 6-4 - Tasks for Residential Risk Areas

Task	Implementation Lead	Included in the SKCGWMP
SEPTIC SYSTEMS		
Encourage requirement of as-builts of new septic systems (prepared by designer) to be recorded with the deed.	County-Health	Yes
Support the implementation of state law/regulation on septic system inspection and maintenance programs.	Purveyors	No
Participate in education program to notify public of impact of septic systems to the WHPA.	County-Health	Yes
Promote and coordinate public education program for proper septic system maintenance and hazardous waste disposal.	County-Health	Yes
Conduct groundwater monitoring for analysis of nitrate according to groundwater monitoring plan. Establish nitrate early warning valve (EWV) to allow for timely action in the event of increasing nitrate concentrations.	Purveyors	Yes
HAZARDOUS MATERIALS		
Promote and coordinate public education program for household hazardous materials use, storage, and disposal within the WHPA.	County	Yes
STORM WATER		
Promote research on the impacts of storm water discharge from residential areas.	County	Yes
USTs		
Develop data on number and size of exempt underground tanks within 1-year time of travel zone.	Purveyors	No
Promote and coordinate public program to educate owners of exempt underground tanks of the hazards they represent, methods of leak detection, proper removal and closure procedures.	County	Yes
PESTICIDES/HERBICIDES		
Survey pesticide and herbicide use/work with Cooperative Extension and County with available data to modify future monitoring and education plans.	Purveyors	No
Fund Farm Plans through the local Conservation District which focus in wellhead zones.	County	Yes

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Table 6-5 - Tasks for Transportation/Pipeline Corridors Risk Areas

Task	Implementation Lead	Included in the SKCGWMP
PUBLIC EDUCATION		
Locate signs within the WHPA along transportation routes - "Wellhead Protection Area	Purveyors	No
HAZARDOUS MATERIALS		
Investigate the need for re-routing transport of hazardous materials to areas outside of wellhead zones.	Purveyors	No
EMERGENCY RESPONSE		
Document the location and use of petroleum pipelines within the WHPA, and develop appropriate emergency procedures.	Purveyors	Yes
Establish formal communication with first responders	Purveyors	No
Update emergency response organizations on WHPA location.	Purveyors	No
STORM WATER		
Work with responsible parties to assess adequacy of facilities and establish joint priority for storm water upgrades.	Purveyors	Yes
Coordinate and promote the evaluation of possible storm water routing, detention, retention priorities.	Purveyors	Yes
PESTICIDES/HERBICIDES		
Document the type and amount of herbicide application with focus on transportation corridors, forestry, agriculture, and recreation parcels.	Purveyors	No
Request County, State, and private land owners/managers to utilize vegetation management practices which protect water quality within the WHPA.	Purveyors	Yes
Conduct groundwater monitoring for analysis of pesticides and herbicides according to groundwater monitoring plan.	Purveyors	Yes
SEWERS		
Request utilities to use "leakproof" piping for sewer for any new construction in wellhead zones - accelerate upgrade and replacement of existing risky lines.	Purveyors	Yes
Develop emergency response procedures for seven force main breaks within the 1-year zone.	Purveyors	No

Table 6-6 - Tasks for Industrial Commercial Risk Areas

Task	Implementation Lead	Included in the SKCGWMP
SITE REVIEW		
Prioritize investigation of contaminated and potentially contaminated sites within the WHPA.	Ecology	No
Review MTCA, RCRA notifiers, and LUST sites files for sites within the WHPA annually.	Purveyors	No
Monitor Ecology's progress on the cleanup of MTCA and LUST sites within the WHPA.	Purveyors	No
Communicate location of WHPA to industrial/commercial site owners.	Purveyors	No
SEWERS		
Require sewer hook up for all industrial/commercial facilities within the WHPA, if sewer service is reasonably available.	County-Health	No
STORM WATER		
Review water quality data generated under the general NPDES Storm Water Permit.	Purveyors	No
Work with responsible parties to assess adequacy of facilities and establish joint priority for storm water upgrades.	Purveyors	Yes
HAZARDOUS MATERIALS/HAZARDOUS WASTE		
Review annual reports produced under SARA Title III to document inventory of chemicals used in the WHPA.	Purveyors	No
Encourage Ecology and County inspections of RCRA hazardous waste generator facilities within the WHPA.	Ecology	No
PESTICIDES/HERBICIDES		
Survey pesticide and herbicide use/work with Cooperative Extension and County with available data to modify future monitoring and education plans.	Purveyors	No
Request County, State, and private land owners/managers to utilize vegetation management practices which protect water quality within the WHPA.	Purveyors	Yes

Table 6-7 - Tasks for Mining Risk Areas

Task	Implementation Lead	Included in the SCKGWMP
SEPA		
Encourage careful analysis and adequate requirements for siting, operation, and reclaimation of mining in the WHPA during SEPA review.	County	Yes
GROUNDWATER		
Require mine operators to install monitoring wells capable to assess potential impacts from site operations for sites within the WHPA.	Ecology	Yes
SITE REVIEW		
Monitor Ecology's progress on the cleanup of MTCA and LUST sites within the WHPA.	Purveyors	No
Prioritize investigation of contaminated and potentially contaminated sites within the WHPA.	Ecology	No
Communicate location of the WHPA and wellhead protection concerns to mine operators.	Purveyors	No
Encourage Ecology and County inspections of RCRA hazardous waste generator facilities within the WHPA.	Ecology	
Review MTCA, RCRA notifiers, and LUST sites files for sites within the WHPA annually.	Purveyors	No
STORM WATER		
Review water quality data generated under the general NPDES Storm Water Permit.	Purveyors	No
HAZARDOUS MATERIALS/HAZARDOUS WASTE		
Document use of hazardous materials in mining support activity	Purveyors	No

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Table 6-8 - Tasks for Forestry Risk Areas

Task	Implementation Lead	Included in the SKCGWMP
FOREST PRACTICES		
Inventory forest ownership, the extent of harvesting, and the harvesting practices used with the WHPA.	Purveyors	No
PESTICIDES/HERBICIDES		
Request County, State, and private land owners/managers to utilize vegetation management practices which protect water quality within the WHPA.	Purveyors	Yes
Document the type and amount of herbicide application with focus on transportation corridors, forestry, agriculture, and recreation parcels.	Purveyors	No
Conduct groundwater monitoring for analysis of pesticides and herbicides according to groundwater monitoring plan.	Purveyors	No

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Table 6-9 - Management Strategies

Management and Cooperative	Land Use	Regulatory	Planning	Data Management	Education
On-going WHP steering group Land management activities (BMPs)	Evaluate Special Protection Area designations	Well drilling oversight at County level Hydrogeologic evaluations for developments which trigger SEPA Septic tank installation documentation and maintenance	Emergency response planning for sewer breaks Farm planning Storm water management Emergency response planning for petroleum pipeline failure Emergency response for transportation incidents within the WHPA Re-route hazardous materials transportation	Groundwater monitoring within the study area Locate and inventory abandoned wells Survey herbicide and pesticide use Inspect and monitor dry wells Locate and inventory USTs	Target public education programs to WHPA

Monitoring Plan

7.0 MONITORING PLAN

This monitoring plan is developed based on current understanding of the hydrogeology around the City's Springs sources and the land use and potential contaminant concerns identified within the WHPA. A groundwater monitoring program for the source springs and wells (outside of Department of Health rules) is proposed to measure groundwater quality degradation and allow early detection of groundwater quality changes. Monitoring provides a means of identifying trends and detecting problems before they reach the wellhead. Monitoring data can support protective regulatory actions and allow mitigative measures to be enacted before the wells are impacted.

Focused hydrogeologic studies are also recommended for some areas where uncertainties exist in understanding the groundwater travel pathways. These studies will help the City more accurately interpret the monitoring data and provide a framework for refinement of the regional groundwater model. The data collection and monitoring are an important part of regional groundwater management as they provide the basis for making appropriate groundwater-related decisions that ensure the long-term water quality and quantity.

7.1 Water Level and Water Quality Monitoring Recommendations

Groundwater monitoring includes water level measurement and groundwater quality sampling and analysis. Water level data are used to define flow directions and gradients and to detect seasonal and other temporal variations in groundwater flow. These data help define the migration pathway of any detected contaminants. Groundwater quality data collected from selected wells and streams can help identify any water quality degradation and serve as an early warning of water quality changes. Together these data can be used to identify a problem and assess the impact to the water supply.

Surface water monitoring is also recommended to characterize bedrock runoff quality, particularly around mining areas, and to better characterize the groundwater-surface water interactions. In the eastern study area bedrock outcrops are believed to generate runoff that infiltrates the aquifer within the Clark and Kent Springs Zones 1 and 2. Surface water monitoring includes measurement of flow and water quality sampling. Elevation data should be collected at all groundwater and surface water monitoring points.

Sentinel wells located near the protection zone boundaries can help to detect degradation in time to allow response. The water quality parameters selected for monitoring should include general indicators and specific analyses based on local land uses. Where possible, existing wells should be used for monitoring. Use of an existing well network is not only cost effective but helps to involve the community in understanding and protecting their water supplies. It will be necessary to inventory the areas planned for monitoring, find a well that's properly constructed and in the aquifer, and develop an agreement with the well owner for long-term access. If wells do not exist in recommended areas, then new wells dedicated to monitoring can be installed. Area-specific monitoring is discussed below.

7.1.1 Armstrong Springs

Develop Four Sentinel Well System. Within Armstrong Zone 1, four (4) monitoring wells are recommended to serve as sentinel wells, providing an early warning of water quality changes. Three wells would be located within Zone 1, and one well would be located within Zone 2. Recommended locations for the wells are shown on Figure 7-1 and the rationale is outlined below.

- The north well would be situated in an area northeast of Armstrong Springs on the Zone 1 boundary. In this location, limited data indicate the protective till layer may be absent between ground surface and the aquifer. Additionally, this area is located near Highway 18 and within the King County Urban Growth Boundary and will be useful for monitoring non-point sources such as runoff and pesticides. The existing database indicates there may be several wells in this area already that could be pursued as potential monitoring wells (See 30A1 and 30B01 on Figure 7-1).

- The east well would lie along Kent Kangley Road on the Zone 1 boundary. This location monitors for transportation corridor issues and lies within commercial land use zoning. The highway right-of-way provides a good location for locating a new well.

- A third well is recommended for Armstrong Zone 1 and would lie along Kent Kangley Road between the Armstrong Springs property and the Zone 1 boundary. A well is recommended in this area because of the high density commercial and residential development and to assist with better identification of groundwater flow patterns around Armstrong Springs. Again, the well could be located within the highway right-of-way.

- A fourth well would be situated on the Zone 2 boundary just downstream of Kent Springs. This well would be located near the railroad and on the Urban Growth boundary and would monitor for water quality changes.

Water Quality Parameters. Water samples collected from the sentinel wells should be analyzed for general water quality parameters twice a year. The general water quality analyses should include field testing for pH, specific conductivity, and temperature, and laboratory testing for bacteria, nitrates, chloride, lead, turbidity, and total petroleum hydrocarbons. Because of the urban land use of the area and the number of regulatory database sites listed in the vicinity we also recommend an annual monitoring for volatile organic compounds including both the aromatics and halogenated compounds and pesticides.

Focused Hydrogeologic Study in Armstrong Springs Area. A focused hydrogeologic study is recommended in the Armstrong Springs area to better characterize the flow patterns, the relationship of Jenkins Creek with the aquifer, and the potential for impact from the contaminant database sites identified near the springs. The study should include detailed review of Ecology files on the contaminated sites located in this area, noting particularly if monitoring wells already exist for some of these sites, the current monitoring plan for those wells, and any remediation planned. Areas for focused studies are also shown on Figure 7-1.

We also recommend a focused study of the flow patterns to the northeast of Armstrong Springs. For this study we would develop a water level measurement network using existing wells and survey the elevations of the wells in the network. The wells used for this study should be included along with another 5 to 10 additional wells, as possible. The water levels should be measured at least quarterly for several years. These data will help determine where the groundwater divide is between the Cedar River and the Soos Creek system and will be needed for future model updates and regional groundwater management decisions.

7.1.2 Kent Springs

Coordinate with Covington's Lake Sawyer Monitoring. Monitoring for the Kent Springs area should include coordination with Covington to share data and avoid duplication of efforts. The Lake Sawyer Wellhead Protection Plan (Robinson and Noble et al., 1995) proposes monitoring of 21 wells, 4 of which are referred to as sentinel wells because they are planning expanded water quality sampling of these. They have also proposed monitoring at 6 surface water locations.

The monitoring plan we recommend for the Kent Springs is consistent with Covington's plan as follows:

- The Four Sentinel Wells proposed for the Lake Sawyer wellfield will provide adequate information to identify any regional water quality degradation that may be occurring. These wells include one near the Zone 1 boundary, one well between Zones 1 and 2, and two wells near Zone 2 boundary (See Figure 7-1). Existing wells are proposed for use at these monitoring locations. Information on the well owner is presented in the Monitoring Well Network Plan of the Covington WHPP report (Robinson & Noble, 1995).

- The Six Surface Water Monitoring Points planned will be useful for evaluating impacts from mining and forestry activities as well as provide information on aquifer recharge rates. The surface water monitoring points include a monitoring location at Lake Sawyer, Ravensdale Lake, and Lake Retreat, along with monitoring of surface water flows from three drainages; the Ravensdale Draw (Reserve Silica Mine area), the Retreat Draw west of Retreat Lake, and the Sugarloaf Draw southeast of Retreat Lake as shown on Figure 7-1.

Review of the data from the other 17 wells planned for monitoring by Covington will also be useful, particularly for the focused hydrogeologic study work and future modeling as part of a regional groundwater management. Again, cooperative and coordinated efforts are recommended for all the monitoring activities associated with the Kent Springs and the Clark Springs protection areas in conjunction with Covington's Lake Sawyer monitoring.

Monitoring in Addition to Covington's Lake Sawyer Plan. We recommend the following additions be made to the Covington's monitoring plan for the Kent Springs:

- Monitor Ravensdale Lake at the outlet in a location where lake discharge to Ravensdale Creek can also be measured. These data can indicate any water quality impacts from the

Lake on the aquifer as well as provide valuable data on surface water-groundwater interactions for future modeling efforts.

- Include flowrate measurements at the three surface water quality data collection locations (Draws). These data will be needed to help establish recharge rates for the eastern area.

- Establish a water quality and flow rate monitoring point on Rock Creek near the Zone 2 boundary. These data can provide information on the interaction of Rock Creek and the aquifer as well as early warning of water quality changes from mining and forestry activities.

- Monitor for metals and petroleum hydrocarbons in the surface water samples in addition to the parameters planned by Covington because of the mining activities in these areas.

Focused Hydrogeologic Study of Retreat Lake and Zone 2/3. A focused study of the hydrogeology within the outer half of Zone 2 and Zone 3; particularly around and south of Retreat Lake is recommended. Data collection should include elevation control on wells and measurement of water levels, and information on hydraulic conductivity gained from pumping tests. Covington's Lake Sawyer plan includes water level monitoring in six wells around Retreat Lake. Collection and use of these data should be a coordinated effort between Covington and Kent.

To better understand the effect of Lake Sawyer on recharge to the aquifer and provide a better water balance for the regional model we recommend monitoring the flow out of Lake Sawyer to Covington Creek.

7.1.3 Clark Springs

Coordinate with Kent Springs/Lake Sawyer Monitoring. The data being collected for the Kent Springs/Covington Lake Sawyer wellhead protection within Zones 2 and 3 will also be useful for understanding the groundwater conditions at the Clark Springs facility. In addition to the monitoring discussed above, we recommend the following specific monitoring for the Clark Springs area.

Develop 1 Sentinel Well. Share data with Covington on the two wells proposed in the Georgetown area (CWD Ravensdale and Bremmeyer wells) and the 6 proposed for the Retreat Lake area and develop 1 more; at the Zone 1 boundary as shown on Figure 7-1.

Establish Surface Water Quality Monitoring Plan. Surface water quality data are currently being collected as part of the Landsburg Mine Remedial Investigation/Feasibility Study (RI/FS). We recommend monitoring the progress and data collected for this investigation which includes monitoring of a seep near the south portal of the Rogers No. 3 mine. As part of the wellhead protection program, Ecology should be requested to continue monitoring the seep to identify any long-term break-through of contaminants identified in the abandoned mine area. The surface water flowrates should be measured as well as water quality. The approximate location of the seep is shown on Figure 7-1.

We recommend establishment of a monitoring point on Rock Creek upstream of the Clark Springs property. This location should be selected in cooperation with King County so that any on-going monitoring of streamflow and water quality is understood and the data shared as appropriate.

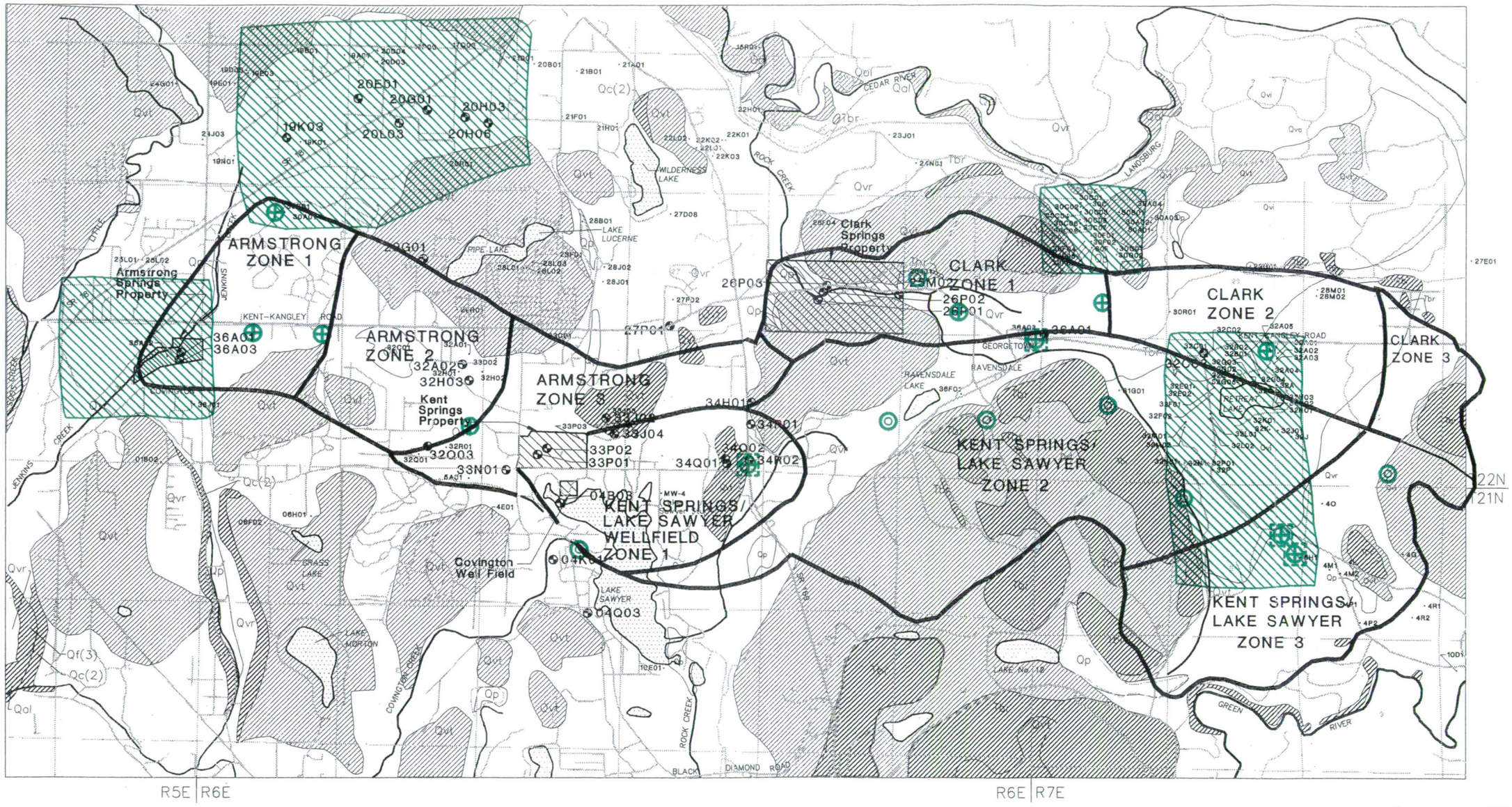
Focused Hydrogeologic Study in Clark Springs Area. We recommend a focused water level monitoring study in the north-half of Section 30 as shown on Figure 7-1 to establish the groundwater divide in this area. This study will require establishing 8 to 10 existing wells as monitoring points and making quarterly measurements in these wells for several years. In addition, we also recommend performing pumping test on selected wells to better quantify estimates of groundwater flow to the Cedar River in this area.

The focused study recommended for the Kent Springs area in the vicinity of Retreat Lake will also be useful for the Clark Springs area.

7.2 Future Model Refinement

The data collection recommended above can provide the basis for refinement of the numerical model developed for this project. Long-term aquifer management will require this type of tool for decision-making purposes and many of these data are essential for better calibration of the model. With a regional groundwater flow model, better decisions can be made. These decisions might relate to a water quality concern that becomes apparent during monitoring or decisions about developing a new water supply well. Section 3.0 and Appendix B provide additional information on the model that currently exists and discussions on future model refinement needs.

Groundwater Monitoring Plan Map



- Proposed Monitoring Well Locations
- Sentinel Wells Planned for Covington's Lake Sawyer WHPP
- Proposed Surface Water Monitoring Location
- Areas for Future Focused Hydrogeologic Study

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Figure 7-1

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Spill Response

8.0 SPILL RESPONSE

8.1 Introduction

The purpose of this section is to outline spill response procedures and capability for the WHPA. To conduct this evaluation, major spill response organizations were identified. Local response organizations were contacted to determine their response capabilities, back-up assistance, and general understanding of wellhead protection issues.

Spill events can be large or small and can consist of highly toxic to inert materials. Events can occur under conditions and in locations which are easily contained or where time is plentiful, or can be such that surface water, waterways, or groundwater are under immediate threat. This range has prompted a spill response (and emergency response) system which is nationwide in scope, which can involve federal agencies, yet one which is designed to handle the more common, small scale (yet potentially dangerous) spills. This assessment takes into account this range of systems.

However, the ability of the City to affect the protocols and procedures of the national and state response systems is limited. Also, the majority of spills are small and require local response. Therefore, for the purposes of this effort, focus is given to local response capabilities and needs associated with these local response systems.

8.2 National, State, and Local Spill Response Plans

Spill response planning has been ongoing throughout King County (County) and within Washington State for many years. As a result, there are many plans in existence, each focusing on a specific geographical area or type of substance. In addition, parties involved in the storage and transportation of hazardous materials have been required to develop contingency plans. Each of these contingency plans should be consistent with each other, and fit within the context of the response plans listed and described below. The following spill responses are in effect in Washington State and cover inland, or non-marine areas, such as wellhead protection areas and aquifer recharge areas:

- National Oil and Hazardous Substances Pollution and Contingency Plan (NCP) - prepared by the Environmental Protection Agency (EPA);
- Oil and Hazardous Substance Pollution Contingency Plan for Federal Region 10 (RCP) - prepared by Region 10 of EPA;
- Washington Statewide Master Oil and Hazardous Substance Spill Contingency Plan - prepared by Ecology;
- Washington State Emergency Response Plan - prepared by the Department of Community, Trade, and Economic Development (CTED); and
- Local Emergency Response Plans - prepared by city and county governments.

8.3 Spill Response Organizations

Depending on the magnitude of the spill event, numerous organizations at all levels of government, some voluntary organizations, and the private sector may have a role in spill response and cleanup. Each of the plans mentioned above describes the relationship and roles of these organizations in terms of the particular concern. Some of the organizations listed below might be, depending on the size and nature of the release, involved in a spill response in WHPA.

Spill response plans stress that spill response procedures be effectively executed. For that to be accomplished, each party must be fully aware of their specific roles and responsibilities. Moreover, there must be an understanding of the roles of other parties involved in response activities, as well as effective coordination, cooperation, and communication among responding agencies, organizations, and individuals.

The discussion below briefly summarizes the organizations that may be involved in spill response within the WHPA and describes their roles and responsibilities. The discussion below is organized in order from federal to local jurisdictions.

8.3.1 Federal Spill Response Teams

The EPA has primary responsibility for spills that occur on inland U.S. waters not under USCG jurisdiction, and all land spills. As directed by the NCP, the EPA is pre-designated as on-scene commander (OSC) for spills occurring under its jurisdiction. The EPA may call on the following response teams to assist them in responding to a spill.

National Response Team. The National Response Team (NRT) consists of representatives from the various federal agencies (such as EPA, the US Coast Guard, Fish and Wildlife Service, etc). It serves as the national body for planning and preparedness actions prior to a spill and as an emergency advisory center when a spill occurs.

Regional Response Team. The Regional Response Team (RRT), consisting of representatives from selected federal and state agencies, performs functions similar to those performed nationally by the NRT. Essentially, the RRT is the regional body responsible for planning and preparedness before an oil spill occurs, and provides advice to the OSC following such incidents.

Technical Assistance Team. The Technical Assistance Team (TAT) is a contractor used by the EPA Region 10 Office to provide technical oversight for spill response. Requests for the TAT are made via the EPA. Once on site, the TAT will report the situation to the EPA duty officer who then decides whether an EPA OSC needs to be on scene.

EPA Environmental Response Team. The Environmental Response Team (ERT), based in Edison, New Jersey, is established to advise the OSC and RRT on environmental issues surrounding spill containment, cleanup, and damage assessment, with personnel expertise in areas such as treatment technology, biology, chemistry, hydrology, geology, and engineering.

8.3.2 State Spill Response Organizations

Department of Ecology. Ecology is the lead state agency for environmental pollution response within the State of Washington. As such, it has pre-designated the state OSC and the Incident Commander (IC) for many spills occurring in state jurisdiction. In the event of a spill occurring on a state highway, Ecology coordinates with the Washington State Patrol (State Patrol), which assumes responsibility as IC, and Ecology acts as the lead agency responsible for cleanup activities. Ecology may utilize the following spill response teams or coordinate with the following state organizations.

Ecology Spill Response Team. The Ecology Spill Response Team consists of Ecology regional office personnel. This team is responsible for determining the source, cause, and responsible party, as well as initiating enforcement action as appropriate. Additional responsibilities include ensuring containment, cleanup, and disposal are carried out adequately. The team coordinates its actions with other state, federal, and local agencies.

Natural Resource Damage Assessment Team. The resource damage assessment program is an Ecology-led effort designed to organize the state natural resource trustee agencies into an effective resource damage assessment ask force. The state Natural Resource Damage Assessment (NRDA) team consists of representatives from Ecology, the Department of Fish and Wildlife (DFW), the Parks and Recreation Commission, the Department of Natural Resources (DNR), Department of Community, Trade, and Economic Development (CTED), and the Department of Health (DOH). In the event of a major pollution event which damages natural resources, this committee's mission is to organize personnel, materials, and equipment necessary to conduct reconnaissance evaluations and initiate detailed assessments of natural resource damages.

State Patrol. The State Patrol acts as the designated Incident Command Agency for incidents on interstate and state highways, and other roads and jurisdictions as delegated. When a spill occurs on a state highway, Ecology joins the Unified Command and acts as the lead agency for cleanup response.

Department of Community, Trade, and Economic Development (CTED) - Emergency Management Division. Washington State Emergency Management Division (EMD) is responsible for the following:

- Developing and maintaining a state Comprehensive Emergency Management Plan.
- Maintaining a 24-hour capability to receive notification of incidents and request for assistance and initial notification to local, state, federal response agencies.
- Activating the state Emergency Operations Center (EOC) as needed to coordinate state resource identification and acquisition in support of Ecology response.
- Providing Public Information Officer (PIO) support to the Incident Command.
- Maintaining an updated list of NRDA team members submitted by participating agencies.
- Maintaining and updating a notification list of local, state, and federal agencies involved in emergency response.

- Coordinating the procurement of state resources for use by the OSC or as requested by local EMD or other designated local response agency or state response agencies.
- Participating in the NRDA team.

Department of Fish and Wildlife (DFW). The DFW is a state agency with trustee responsibilities for wildlife, game fish, food fish, non-game fish, shellfish, and associated habitats. The agency is also responsible for state facilities (hatcheries, properties, launching ramps, and related facilities), and assorted equipment. Of special concern are high-value habitats which may be used as nursery grounds for fish or wildlife.

Department of Health (DOH). The DOH has the responsibility for beach closures for human health and safety purposes, public health concerns from contaminated food supply (e.g., shellfish), and general health-related matters for the safety of the public. In addition, DOH is to render all appropriate laboratory support and services to the OSC. DOH is a participant in the NRDA team.

Department of Transportation (DOT). The Washington State Department of Transportation (DOT) may provide traffic control, equipment, and personnel for non-hazardous cleanup activities on state and interstate highways. The DOT may provide and mobilize equipment necessary in a major spills incident.

8.3.3 Local Response

Local governments have a duty to be prepared for all disaster emergencies. The county's Emergency Management Division (EMD) is charged with establishing Local Emergency Planning Districts (LEPD) and Local Emergency Planning Committees (LEPC) to facilitate planning efforts.

LEPCs have the responsibility to create local emergency response plans. General requirements for local response plans are contained in Title III of the Superfund Amendments and Re-authorization Act of 1986 (SARA). Generally, local agencies, particularly fire services 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: fire and explosion controls investigation and documentation, perimeter control, evacuation, traffic controls, and initial containment or even removal, depending on the nature of the incident.

The "first responders" for the majority of spills are these local entities. They provide for immediate protection of health, property, and the environment. It is this group of responders who determine the need for additional assistance and mobilization of the additional resources provided by the state and federal government.

Local Spill Response Capability for the City of Kent WHPA. Local response to hazardous material spills is under the jurisdiction of local fire departments or districts. Local spill response for the WHPA is handled by Fire District Nos. 37, 43, and 17, as illustrated on Figure 8-1.

Two additional Fire Districts (Nos. 44 and 47) are also shown in the study area but fall outside the WHPA.

These districts rely on the City of Kent HAZMAT team for hazardous materials response. Currently, the City of Kent has a mutual aid agreement with Fire District No. 43, and an agreement is under consideration with District Nos. 17 and 37. The City of Kent has prepared a Hazardous Materials Emergency Plan. The Plan which is included as Appendix D contains the following information:

- Legal and regulatory authority;
- Map of high risk areas and list of facilities which require an emergency response plan;
- Operations plan;
- List for notification of response agencies;
- Incident information summary sheet;
- Public information/communication procedures;
- Resource list;
- Health and safety procedures;
- Containment and cleanup procedures; and
- Training requirements.

8.3.4 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), whether there is an approved contingency plan or not, is responsible for containment and cleanup of the spill, disposal of contaminated debris, restoration of the environment, and payment of damages. State and federal law specifically require that the removal of a discharge of oil or hazardous substance should be immediate.

Fire Districts Spill Response Jurisdiction Map

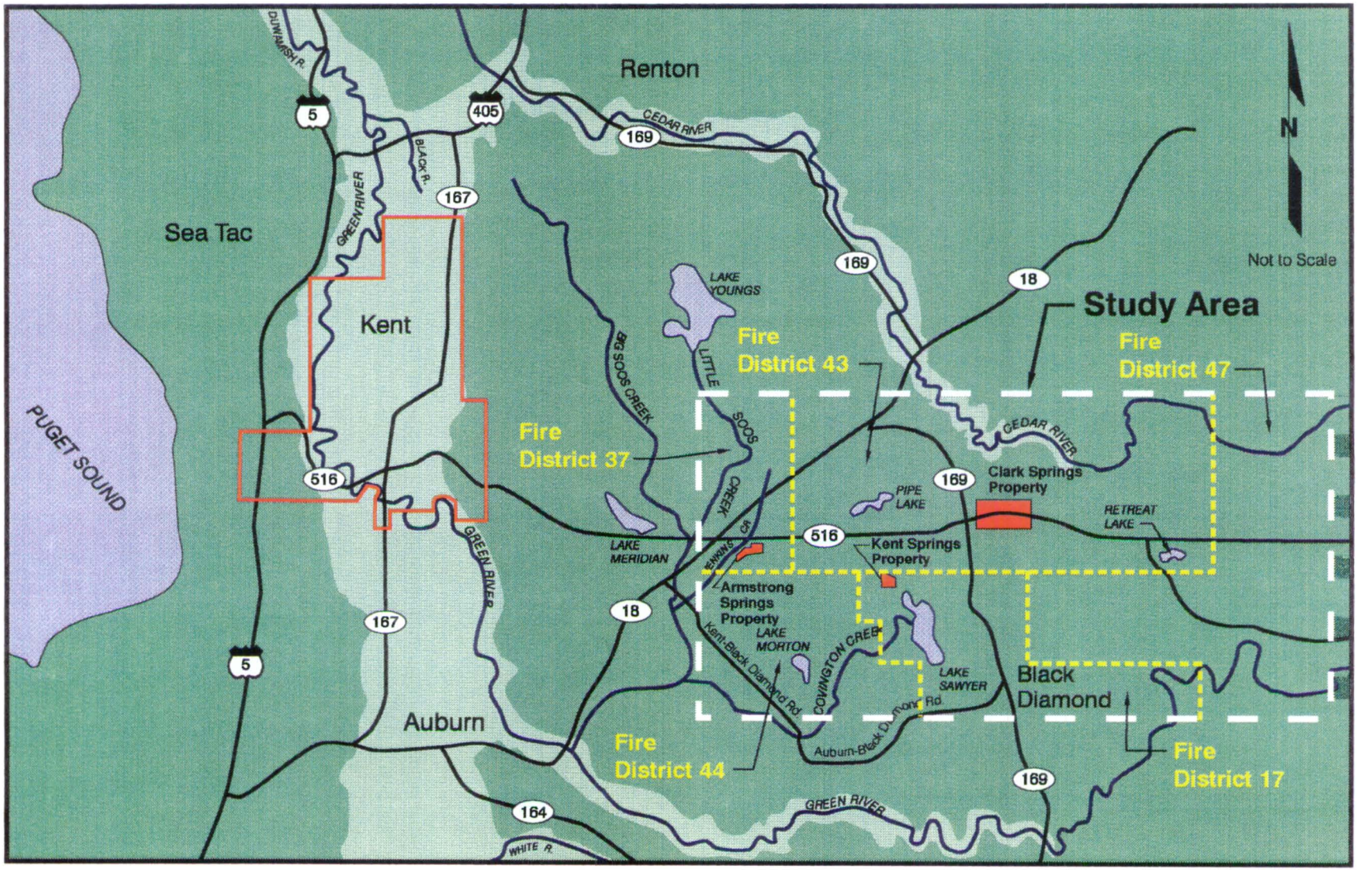

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Figure 8-1

Contingency Plan

9.0 KENT WHPP CONTINGENCY OPTIONS

9.1 Introduction

Subsection 1428(a)(5) of the 1986 Amendments to the Safe Drinking Water Act specifies that State WHP programs require public water systems develop contingency plans ". . .for the location and provisions of alternative drinking water supplies for each public water system in the event of well or wellfield contamination. . ." Contingency plans are also required by the State of Washington under the Water System Plan (CWSP) pursuant to Chapter 246-290-100 WAC and the Small Water System Management Program under Chapter 246-290-410 WAC.

Contingency plans are considered important because, even with careful planning, unforeseen incidents can occur. A proper contingency plan helps ensure that the City is prepared to respond to an emergency situation. Equally important is the fact that, should the City not be able to identify economically feasible alternatives for its supply, the protection plan and management strategies should be much more stringent.

The City of Kent updated its Water System Plan in 1990. As part of that process, overall source and storage of the system were examined to assure that minimum DOH standards were met. The Water System Plan includes:

- History of the current system;
- Description of the existing system including hydraulic analyses, storage facilities, and water supply;
- Water demand projections;
- Evaluation of the expansion options of the existing system's capacity to meet future demands for water in the service area;
- Capital improvement program; and
- Financial plan for future improvements.

The above planning requirements have been expanded as part of the state's Wellhead Protection Program (WHPP). Consistent with the SDWA requirements and according to the "Wellhead Protection Program" by DOH, additional contingency planning is being required as part of all future WSPs pursuant to Chapter 246-290 WAC. To meet these WHPP and WSP requirements, the following additional items are now included (Department of Health Wellhead Protection Program Guidance - 1993 and 1995):

- Identification of existing or potential interties with other public water systems and evaluation of the ability to deliver water assuming the loss of the largest well/wellfield.

- Identification of future potential sources of drinking water and description of quality assurances and control methods to be applied to ensure protection of water quality prior to utilization of potential sources as a drinking water supply.

- Evaluation of current procedures and the development of recommendations on contingency plans for emergency events.

- Maintenance of a current list of appropriate emergency phone numbers.

The purpose of this section is to address each of these current and proposed contingency plan requirements based on current guidance. The contingency plan developed for the City of Kent has both short- and long-term alternatives. Clark Springs wellfield represents about 40 percent of the City's production capacity (approximately 4 to 6 MGD). The loss of this field, even for a short period of time, would necessitate a series of dramatic changes in system operation and public use patterns. It is assumed that, if a problem is identified in the Clark Springs wellfield, the City must enact a stringent water use restriction policy and institute an extensive public education program to increase customer awareness of the problem and to reduce overall water use.

The alternative resource contingency plans for the City of Kent have been divided into the following three categories: 1) short-term; 2) long-term; and 3) permanent replacement. Each of these is described and expanded in the following sections.

9.2 Short-Term Contingency Plan

The short-term plan presumes that Clark Springs wellfield production will be lost for not more than 90 days. This time frame will probably not allow the drilling and/or development of additional wells, particularly considering permitting requirements, to achieve replacement of the 2,800 gpm produced by the Clark Springs wellfield. As a result, the short-term contingency plan is heavily dependent upon the purchase of water from neighboring water districts. The short-term plan consists of the following items.

9.2.1 Activate Interties Pursuant to Existing Agreements

Kent has existing intertie agreements with neighboring purveyors that could be enacted in the event of a short-term interruption of the Clarks Spring supply source. These include:

- An open-ended agreement with the City of Tukwila to provide water on 10 days notice or on an emergency basis. This intertie was envisioned primarily to provide Kent with up to 2 MGD in additional supply to help meet peak demands;

- An agreement with the Highline Water District (formerly Water District No. 75) for the later to provide continuous water service up to 1.42 MGD on request;

- An intertie agreement with the City of Renton for up to 6 MGD of supply.

The City should ensure that each of these agreements can provide as much water as possible under emergency situations. This option has a minimal up-front cost, but the actual cost of the water used may be substantially higher than the City's current costs for water, especially if

purchased under emergency conditions. These existing intertie agreements should be able to compensate for the total loss of the Clark Springs wellfield production, at least in the short-term. This contingency item would presume a concurrent maximum conservation effort.

9.2.2 Activate Interties with Other Area Purveyors

There are existing interties with the Soos Creek Water and Sewer District (formerly Water District No. 58) and the City of Auburn which could be activated. An intertie exists with Soos Creek SE 227th Street and 113th Avenue SE. Although no agreement governing its use has been pursued, the possibility could be further explored. An intertie with the Auburn Water System exists via the dissolution of Water District No. 87 but no agreement has been executed. Because of the hydraulics of the system, the flow from this intertie is only about 200 to 300 gpm. The City could explore the possibility of obtaining additional emergency supplies through these sources by establishing intertie agreements and evaluating the infrastructure upgrades which would be required to use the interties under emergency conditions.

9.3 Long-Term Contingency Plan

The long-term plan presumes the Clark Springs production will be lost for a period of up to three years. For this scenario, it is presumed that other sources could be brought on-line which are more economical or more consistently available than those presented in the short-term contingency plan. It is also presumed that the long-term plan would be used to offset the emergency use authority under which most of the short-term usage would be based. Options discussed below include installation of a treatment system and replacement with new sources.

9.3.1 Treatment and Use of the Clark Springs

The City could establish a testing program to evaluate the potential for removing the contaminant from the groundwater and then using the treated water as a potable water supply. This option may involve a relatively high cost in the evaluation of the treatment alternatives and construction of the treatment facilities.

9.3.2 Clark Springs Replacement

Should the circumstance that led to the closure of the Clark Springs be located sufficiently downgradient in the current wellfield capture zone, it may be possible to perform a groundwater exploration and production program in the upper capture zone to identify areas where non-contaminated groundwater could be produced. The Georgetown area is considered a potentially productive source although limited by seasonal precipitation lows. The Covington Water District currently has a supplemental well in this area that reportedly has limited capacity some years during the dry season. More detailed investigation such as seismic and test drilling surveys would be needed farther out in the capture zone area prior to pursuing any other groundwater development in this area. This option would also involve significant transmission main costs and land acquisition costs, although transferring existing water rights to the new facility is likely feasible.

9.3.3 Other Groundwater Source Exploration

The following groundwater exploration has occurred in the Kent area. These sites could be considered as potential sources for long-term contingency supply.

- The Ravensdale area and west to the Kent Springs source is considered a potentially productive aquifer area because of its geological setting. However, the site has not been adequately explored. Development of an additional source in this area is currently being considered to fully utilize the water rights for the Kent Springs source.

- Another possible source of water could be provided by wells drilled at the site of the proposed storage impoundment. A hydrogeologic study of the site indicated a potential year-round flow of about 900 gpm (1.3 MGD); however, the water had unacceptably high levels of manganese, iron, and turbidity, and so would require treatment. It is not considered an economically attractive source, however, may be a considered as a long-term contingency source.

- Another possible source is the Ranney well field explored for on a bend of the Green River near the former confluence of the Green and White Rivers. Tests have indicated a potential yield of 10 MGD, however, because the water is hydraulically connected to the Green River, production would be tied to the Green River low flow regulations. With production limited to 7 months out of the year, capacity would be limited to an average annual yield of 5.8 MGD if storage is provided to offset pumping restrictions during low flow periods.

9.3.4 Current Water Rights Moratorium

It may be difficult to develop new water sources that require obtaining new water rights. Ecology has placed what is essentially a moratorium on issuance of new water rights for the Soos Creek Basin as a result of its recent Green/Duwamish River Basin Assessment. This basin assessment closes the Green-Duwamish River Basins to further groundwater appropriations because of critical low flows in streams (including Soos Creek) during the late summer/fall period. At the current large-scale level of assessment, all wells within the Covington upland are assessed to be hydraulically connected to local streamflows which eventually end up in the Green-Duwamish system.

A data collection and monitoring program as outlined in Section 7.0 will be needed to better assess the inter-relationship of groundwater and surface water. These data provide the framework for refinement of the regional groundwater flow model that can be used as a tool for making future decisions on additional groundwater development.

9.4 Permanent Replacement Contingency Plan

In the event that the Clark Springs Source is lost to production for a period of longer than three years, it is probable that the City may consider the wellfield permanently lost. As a result, it would be advisable to seek a permanent transfer of the water certificate to the appropriate

supplies developed under the short- or long-term plans. The viability of other groundwater sources will be based on having developable amounts of water and the cost of bringing that water into the distribution system. Additionally, the current water rights situation (discussed above) could make it very difficult to develop new sources.

Other, more specific, permanent alternatives concern conjunctive use options. These options generally involve the development of a storage mechanism to allow the City to collect and store winter surplus water for use during the drier summer months. These types of projects are generally large in scale and could require regional participation. Several potential alternatives are discussed below.

9.4.1 Aquifer Storage and Recovery

The City could explore for an aquifer that is capable of storing excess winter water until it could be utilized during the summer. At the present time, no such aquifers have been explicitly defined in the Kent area, although there is the possibility that such an aquifer exists around the Ravensdale area. This type of project has a high degree of infrastructure cost and would require a substantial degree of permitting. Additionally, a source of reliable surplus winter water must be identified and transported to the storage aquifer.

9.4.2 Surface Reservoir Storage

The City has identified a site suitable for the construction of a surface reservoir to hold excess winter water for later use. The land has been purchased and the soils investigation completed for development of a surface water impoundment. The need for a permanent water supply replacement could propel completion of this project. The City's transmission main runs through this area, as does Tacoma's Pipeline 5. The reservoir would be designed to work conjunctively with the Ranney wellfield development, or one of the other potential groundwater sources discussed above. Pipeline #5 could also be called on to provide permanent replacement should the need arise.

9.5 Contingency Procedures and Emergency Phone Numbers

Contingency procedures for fires, earthquakes, chlorine gas leaks, mechanical failures, bomb threats, major power outages, personnel accidents or illness, and subzero weather are included in the WSP starting on page 152. Emergency phone numbers are also included on page 151 of the WSP.

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Appendix A

APPENDIX A
HYDROGEOLOGIC DATA ANALYSIS

APPENDIX A
HYDROGEOLOGIC DATA ANALYSIS

This appendix presents information on the hydrogeologic data collected and analyzed as part of the wellhead protection area delineation. Specifically we present precipitation data, database and well information, groundwater elevation data, and production information for the City's supply sources.

Precipitation Data Summary and Analysis

Monthly total precipitation recorded at Landsburg, Washington, between January 1989 and February 1994 is presented in Table A-1. Landsburg is located approximately 20 miles east of Kent on the Cedar River (Figure 1-1). Precipitation data from the Landsburg station are believed to more accurately represent precipitation trends in the study area than SeaTac data although long-term trends were observed to be similar between the two stations.

Figure A-1 graphically depicts monthly total precipitation and the cumulative departure from the average monthly precipitation. The average monthly precipitation was calculated by National Oceanic and Atmospheric Administration (NOAA). The cumulative departure curve on Figure A-1 was calculated beginning in January 1989 as the difference between the recorded total monthly precipitation and the calculated average monthly precipitation.

As illustrated on Figure A-1, average monthly total precipitation at Landsburg is approximately 4.8 inches. Annual average precipitation at Landsburg is approximately 58 inches. As indicated by the cumulative departure curve, generally lower than average precipitation was observed at Landsburg beginning in the winter of 1991. The total departure at Landsburg is approximately 20 inches for the two-year period ending in January 1994.

Water Level Data Collection

Water level data were collected throughout the study area to provide a better understanding of the groundwater flow and gradients, their variability, and to provide data for flow model calibration. Two rounds of water level measurements were made in a selected set of wells. The computerized database program developed for the SKCGWMP was accessed for well information. Approximately 216 wells were identified within the study area. A subset of these wells were field checked and used in this study for water level measurements. These wells and the available information are presented in Table A-2. Criteria for selection generally included availability of a well log and construction information, accessibility, and location within the aquifer of interest.

The plan included collecting a seasonal low water level expected to occur in early Fall and a seasonal high water level expected in the Spring. Water levels were measured over a two- to three-day period between October 19 and 22, 1993, and between April 13 and 14, 1994. In addition to depth to water, elevation was estimated for each well based on USGS 7½-minute

Quadrangle map elevations and altimeter measurements obtained during the period of water level measurement. The water level data are presented in Table A-4.

The wells are referenced to the State Plane Coordinate System as identified in the database with the following exceptions:

- Several of the wells field-located during this study were assigned a new coordinates based on our relocation of these wells on the study area map. These are noted (f) in Table A-2.

- As a part of this study the City Engineering Department surveyed the Kent Springs Wells 1 and 2. These wells are identified as 33P01 and 33P02 on the table and maps. The State Plane Coordinates on these wells can be used as a fixed reference point.

Groundwater Elevation Data and Water Level Hydrographs

Table A-3 presents monthly water level monitoring data collected from one well at each of the three springs properties between August 1990 and October 1993. Figures A-2 through A-4 present hydrographs for the wells monitored monthly (Well A3 at Armstrong Springs, Well No. 1 at Kent Springs, and Well No. 1 at Clark Springs). Additional data collected by the City of Kent Operations group during routine daily or near daily monitoring of the water supply system are also graphically presented on Figures A-2 and A-3 for Armstrong Springs Well Nos. 1 and 2 and Kent Springs Well No. 1.

For comparison purposes, the hydrographs are plotted on the same scale as the precipitation plot (Figure A-1). A review of the hydrographs suggests a slight trend of decreasing water levels in wells at each of the three watersheds possibly as a result of the lower precipitation observed in the area after the winter of 1991. The hydrographs also illustrate seasonal fluctuations in water levels at the three water sheds which amount to approximately 5 feet at Clark Springs and as much as 10 feet at Armstrong Springs and Kent Springs.

Table A-4 presents water level monitoring data collected in October 1993 and April 1994 at selected wells distributed throughout the study area. In general the water levels measured in the Fall of 1993 and Spring of 1994 differ by less than 2 feet. This magnitude of difference may not reflect the range of groundwater elevation fluctuations during wetter years such as those prior to 1991 because of the lower precipitation noted more recently. Figure 2-12 presents a groundwater elevation contour map for the April 1994 water level data.

Groundwater Production Data

The City of Kent Operations group maintains a computer database of monitoring data for each of the Kent properties. Data collected include pumping rate, hours of operation, volume pumped, water levels in selected wells, and limited water quality parameters (pH, chloride concentration, and temperature). Data for each of the supply sources are tabulated in Tables A-5, A-6, and A-7 and summarized graphically on Figures A-5 through A-7.

Armstrong Springs

Table A-5 summarizes water production data for the period January 1989 to April 1994. Figure A-5 depicts individual and combined total water production from the two wells, Nos. 1 and 2, used for groundwater extraction at Armstrong Springs. The two wells have generally only been used for meeting additional peak demand in late summer. However, the wells produced approximately 100 million gallons (mg) of water in the fall/winter of 1993/1994. Well No. 2 has been producing water at a higher peak rate of approximately 30 mg per month (roughly 1 million gallons per day [MGD]) compared to approximately 20 mg per month (0.67 MGD) for well No. 1. Production from both wells was down in 1993 compared to previous years.

Kent Springs

Table A-6 summarizes water production data for the period January 1989 to April 1994. Figure A-6 depicts individual and combined total water production from the two wells, Nos. 1 and 2, and the infiltration gallery used for groundwater extraction at Kent Springs. The bulk of the water production is from the infiltration gallery with average yields of approximately 60 mg per month (2 MGD). The two wells have generally only been used for meeting additional peak demand in late summer and fall with peak production rates of 40 to 60 mg per month (1.3 to 2 MGD). The calculated 1-year running average total combined production rate suggests a slight decline in production from a high of approximately 90 mg per month in 1991 to approximately 70 mg per month in 1993.

Clark Springs

Table A-7 summarizes water production data for the period January 1989 to April 1994. Figure A-7 depicts individual and combined total water production from the three wells, Nos. 1, 2, and 3, and the infiltration gallery used for groundwater extraction at Clark Springs. The bulk of the water production is from the infiltration gallery with average yields of approximately 120 mg per month (4 MGD). The three wells were only used for two months in 1989. The calculated 1-year running average total combined production rate suggests a slight decline in production from a high of approximately 130 mg per month in 1991 to approximately 110 mg per month in 1993.

Table A-1 - Landsburg Monthly Total Precipitation

			Values in inches			
Year	Month	Decimal Date	= Monthly Total Precipitation	Average Monthly Precipitation	Departure from Average	Cumulative Departure from Average
1989	1	1989.042	7.46	7.93	-0.47	-0.47
1989	2	1989.125	4.1	5.93	-1.83	-2.3
1989	3	1989.208	8.31	5.3	3.01	0.71
1989	4	1989.292	4.46	4.3	0.16	0.87
1989	5	1989.375	4.15	3.2	0.95	1.82
1989	6	1989.458	2.29	2.99	-0.7	1.12
1989	7	1989.542	1.08	1.49	-0.41	0.71
1989	8	1989.625	1.12	2.06	-0.94	-0.23
1989	9	1989.708	0.85	3.3	-2.45	-2.68
1989	10	1989.792	3.15	4.87	-1.72	-4.4
1989	11	1989.875	7.34	7.48	-0.14	-4.54
1989	12	1989.958	5.93	8.71	-2.78	-7.32
1990	1	1990.042	11.07	7.93	3.14	-4.18
1990	2	1990.125	6.23	5.93	0.3	-3.88
1990	3	1990.208	5.42	5.3	0.12	-3.76
1990	4	1990.292	3.35	4.3	-0.95	-4.71
1990	5	1990.375	4.57	3.2	1.37	-3.34
1990	6	1990.458	6.66	2.99	3.67	0.33
1990	7	1990.542	1.48	1.49	-0.01	0.32
1990	8	1990.625	2.95	2.06	0.89	1.21
1990	9	1990.708	0.28	3.3	-3	-1.79
1990	10	1990.792	9.71	4.87	4.84	3.05
1990	11	1990.875	14.66	7.48	7.18	10.23
1990	12	1990.958	4.65	8.71	-4.06	6.17
1991	1	1991.042	6.87	7.93	-1.06	5.11
1991	2	1991.125	8.59	5.93	2.66	7.77
1991	3	1991.208	6.21	5.3	0.91	8.68
1991	4	1991.292	8.62	4.3	4.32	13
1991	5	1991.375	3.02	3.2	-0.18	12.82
1991	6	1991.458	2.15	2.99	-0.84	11.98
1991	7	1991.542	0.54	1.49	-0.95	11.03
1991	8	1991.625	1.85	2.06	-0.21	10.82
1991	9	1991.708	0.1	3.3	-3.2	7.62
1991	10	1991.792	2.1	4.87	-2.77	4.85
1991	11	1991.875	9.68	7.48	2.2	7.05
1991	12	1991.958	4.59	8.71	-4.12	2.93
1992	1	1992.042	8.14	7.93	0.21	3.14
1992	2	1992.125	3.9	5.93	-2.03	1.11

Table A-1 - Landsburg Monthly Total Precipitation

			Values in inches			
Year	Month	Decimal Date	= Monthly Total Precipitation	Average Monthly Precipitation	Departure from Average	Cumulative Departure from Average
1992	3	1992.208	2.27	5.3	-3.03	-1.92
1992	4	1992.292	6.2	4.3	1.9	-0.02
1992	5	1992.375	0.89	3.2	-2.31	-2.33
1992	6	1992.458	2.09	2.99	-0.9	-3.23
1992	7	1992.542	3.16	1.49	1.67	-1.56
1992	8	1992.625	0.86	2.06	-1.2	-2.76
1992	9	1992.708	2.35	3.3	-0.95	-3.71
1992	10	1992.792	3.24	4.87	-1.63	-5.34
1992	11	1992.875	8.34	7.48	0.86	-4.48
1992	12	1992.958	6.47	8.71	-2.24	-6.72
1993	1	1993.042	5.1	7.93	-2.83	-9.55
1993	2	1993.125	0.49	5.93	-5.44	-14.99
1993	3	1993.208	5.85	5.3	0.55	-14.44
1993	4	1993.292	7.05	4.3	2.75	-11.69
1993	5	1993.375	5.15	3.2	1.95	-9.74
1993	6	1993.458	4.32	2.99	1.33	-8.41
1993	7	1993.542	2.87	1.49	1.38	-7.03
1993	8	1993.625	0.94	2.06	-1.12	-8.15
1993	9	1993.708	0.04	3.3	-3.26	-11.41
1993	10	1993.792	4.31	4.87	-0.56	-11.97
1993	11	1993.875	2.8	7.48	-4.68	-16.65
1993	12	1993.958	6.08	8.71	-2.63	-19.28
1994	1	1994.042	4.68	7.93	-3.25	-22.53
1994	2	1994.125	6.07	5.93	0.14	-22.39

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Table A-2 - Summary of Well Construction Data for Wells Monitored

Well Designation	Current Owner (3)	State Plane Coordinates (1) Northing in feet	Easting in feet	Estimated Well Head Elevation in feet MSL (2)	Well Depth in feet	Bottom of Screen Elevation in feet MSL
Wells Monitored at Armstrong Springs						
22N/05E-36A01	City of Kent Well 1	132094	1685055	370	107	100
22N/05E-36A03	City of Kent Well 2	131794	1684955	370	90	280
22N/06E-19K03	Torrey	140439	1689056	394	38	356
22N/06E-20E01	C. Purdue	142104 (f)	1691711	450	142	308
22N/06E-20G01	B. Chelette	141509 (f)	1694332	443	138	305
22N/06E-20H03	D. Loran	141243	1695746	387	77	310
22N/06E-20H06	Stuivenga	141026	1696637	395	30	365
22N/06E-20L03	F. Boccamzo	141021 (f)	1693284	410	50	360
22N/06E-29G01	T. Schermerhorn	135893 (f)	1694200	560	200	360
22N/06E-32A02	Dodge	131922	1695666	510	138	372
22N/06E-32H03	P. Trench	131309	1695931	515	106	409
22N/06E-32Q03	M. Perrault	128700 (f)	1694235	476	87	389
Wells Monitored at Kent Springs						
21N/06E-04B03	L. Ladderuna	126695	1699371	538	54	484
21N/06E-04K01	G. Tollber	124558	1699117	517	99	418
21N/06E-04Q03	5 Star Resort	122543	1700409	531	52	479
22N/06E-27P01	R. Hoerner	133117	1703397	574	91	483
22N/06E-33J02	D. Termacel	129911	1701074	599	135	464
22N/06E-33J04	D. Waite	129297	1701409	591	160	431
22N/06E-33N01	Bass	127943	1697324	475	57	418
22N/06E-33P01	City of Kent Well 1	128271 (s)	1698460	525 (s)	75	66
22N/06E-33P02	City of Kent Well 2	128491 (s)	1698822	524 (s)	72	452
22N/06E-34H01	D. Svedarsky	130231	1706520	623	155	468
22N/06E-34Q01	D. Lasher	127915	1705589	617	98	519
22N/06E-34Q02	Pleasance	128093	1705536	577	*	
22N/06E-34R01	L. Maiers	129412 (f)	1706513	591	80	511
22N/06E-34R02	V. Drllevich	128046 (f)	1706449	577	65	512
Wells Monitored at Clark Springs						
22N/06E-25M02	Donnelly	134591	1712280	600	16	584
22N/06E-26P01	City of Kent Well 3	134102 (f)	1709027	560	50	510
22N/06E-26P02	City of Kent Well 2	134402 (f)	1709277	560	60	
22N/06E-26P03	City of Kent Well 1	133552 (f)	1707777	560	56	
22N/06E-36A01	Fire District #43	133149 (f)	1717235	620	40	580
22N/07E-32C03	F. Pinchinini	132113	1723778	660	73	587

Notes:

(1) State Plane Coordinates derived from the SKCGWMP database except as noted (f) where relocated based on field observations or (s) where surveyed.

(2) Elevation estimated from USGS topography and field altimeter measurements except as noted (s) where surveyed.

(3) Owner identified at time of field sampling; may not be same as owner on original Water Well Report.

* No log available.

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Table A-3 - Monthly Monitoring Data from Kent Watersheds

Date Measured	Armstrong Springs Well A3 - - 22N/5E - 36A01		Kent Springs Well No. 1 - - 22N/6E-33P01		Clark Springs Well No. 1 - - 22N/6E-26P03	
	Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation
8/14/90	20.22	349.78	55.81	469.59	9.62	550.38
9/17/90	20.26	349.74	51.94	473.46	7.94	552.06
10/15/90	10.05	359.95	52.68	472.72	9.54	550.46
11/13/90	8.37	361.63	45.74	479.66	6.44	553.56
12/17/90	7.78	362.22	43.57	481.83	5.06	554.94
1/5/91	7.54	362.46	44.01	481.39	4.7	555.3
2/12/91	8.14	361.86	44.27	481.13	5.47	554.53
3/15/91	7.56	362.44	43.82	481.58	4.65	555.35
4/2/91	8.34	361.66	44.15	481.25	6.24	553.76
5/17/91	8.71	361.29	46.79	478.61	8.54	551.46
6/17/91	9.23	360.77	45.44	479.96	9.43	550.57
7/16/91	20.41	349.59	50.77	474.63	9.4	550.6
8/13/91	20.95	349.05	53.49	471.91	9.99	550.01
9/16/91	17.45	352.55	49.84	475.56	10.14	549.86
10/22/91	19.89	350.11	57.16	468.24	7.42	552.58
12/3/91	16.61	353.39	47.86	477.54	6.09	553.91
1/21/92	9.79	360.21	45.25	480.15	9.73	550.27
2/21/92	8.76	361.24	44.1	481.3	6.1	553.9
3/19/92	9.14	360.86	44.17	481.23	6.28	553.72
5/4/92	9.16	360.84	44.69	480.71	7.72	552.28
6/22/92	19.97	350.03	46.87	478.53	10.41	549.59
10/12/92	20.22	349.78	51.14	474.26	10.34	549.66
11/17/92	16.53	353.47	49.53	475.87	7.24	552.76
1/7/93	9.92	360.08	45.03	480.37	8.47	551.53
4/27/93	8.71	361.29	44.47	480.93	7.59	552.41
10/5/93	19.98	350.02	51	474.4	10.15	549.85

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Table A-4 - Groundwater Elevation Data - City of Kent Monitoring Program

Well Designation	Well Head Elevation	Historic Data			October 1993 Data			April 1994 Data			Change Fall to Spring
		Depth to Water (ft)	Groundwater Elevation (ft)	Date Measured	Depth to Water (ft)		Groundwater Elevation (ft)	Depth to Water (ft)		Groundwater Elevation (ft)	
		Wells Monitored at Armstrong Springs									
22N/05E-36A01	370	8.57	361.43	8/12/82	12.75	k	357.25	10.55	k	359.45	2.2
22N/05E-36A03	370	14.73	355.27	8/17/82	13.30	k	356.70	11.50	k	358.5	1.8
22N/06E-19K03	394	14.00	380.00	9/18/79	11.05		382.95	na		na	na
22N/06E-20E01	450	70.00	380.00	1/4/83	70.83		379.17	69.02		380.98	1.81
22N/06E-20G01	443	70.00	373.00	5/18/84	41.70		401.30	39.09		403.91	2.61
22N/06E-20H03	387	0.00 f	387.14	5/25/78	2.75		384.39	0.00	f	387.14	>2.75
22N/06E-20H06	395	4.00	391.00	8/27/83	4.32		390.68	2.41		392.59	1.91
22N/06E-20L03	410	37.00	373.00	8/23/85	20.80		389.20	18.95		391.05	1.85
22N/06E-29G01	560	107.31	452.69	1/25/63	188.20		371.80	187.62		372.38	0.58
22N/06E-32A02	510	104.00	406.00	5/1/80	105.29		404.71	102.91		407.09	2.38
22N/06E-32H03	515	84.00	431.00	9/16/75	109.55		405.45	107.61		407.39	1.94
22N/06E-32Q03	476	37.00	439.00	10/25/71	36.27		439.73	na		na	na
		Wells Monitored at Kent Springs									
21N/06E-04B03	538	27.47	510.53	8/16/62	38.00		500.00	32.86		505.14	5.14
21N/06E-04K01	517	40.00	476.73	10/26/83	18.20		498.53	14.54		502.19	3.66
21N/06E-04Q03	531	25.00	506.00	9/18/75	21.37		509.63	18.11		512.89	3.26
22N/06E-27P01	574	65.00	509.15	9/21/79	61.88		512.27	56.28		517.87	5.6
22N/06E-33J02	599	117.00	481.75	11/26/74	120.10		478.65	115.55		483.20	4.55
22N/06E-33J04	591	110.00	480.55	11/22/77	110.76		479.79	107.45		483.10	3.31
22N/06E-33N01	475	3.00	472.00	2/18/83	3.17		471.83	2.70		472.30	0.47
22N/06E-33P01	525	45.25	480.15	11/17/77	46.44	k	478.96	44.74	k	480.66	1.7
22N/06E-33P02	524	42.00	482.24	12/18/77	51.00		473.24	16.80	s	na	na
22N/06E-34H01	623	119.00	504.36	1/4/80	118.35		505.01	115.68		507.68	2.67
22N/06E-34Q01	617	53.00	563.80	6/20/78	55.46		561.34	53.14		563.66	2.32
22N/06E-34Q02	577	na	na	na	52.96		524.47	50.25		527.18	2.71
22N/06E-34R01	591	40.00	550.55	6/17/80	31.44		559.11	28.71		561.84	2.73
22N/06E-34R02	577	30.00	547.43	6/9/83	31.94		545.49	29.02		548.41	2.92
		Wells Monitored at Clark Springs									
22N/06E-25M02	600	11.44	588.56	8/16/62	11.50		588.50	9.42		590.58	2.08
22N/06E-26P01	560	4.00	556.00	1/1/68	10.15		549.85	7.63		552.37	2.52
22N/06E-26P02	560	4.50	555.50	2/5/68	na		na	32.90	s		
22N/06E-26P03	560	7.00	553.00	12/1/67	na		na	37.60	s		
22N/06E-36A01	620	10.00	610.00	2/15/82	27.18		592.82	17.54		602.46	9.64
22N/07E-32C03	660	45.00	615.00	8/16/89	38.45		621.55	34.16		625.84	4.29

Elevations in feet MSL f - flowing well s - water level in ft above suction k - City of Kent data

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Table A-5 - Armstrong Springs Water Production Summary

	Monthly Water Production in Million of Gallons			
				1-Year Running Average
Date	Total	Well No. 1	Well No. 2	Total
Jan-89	0.00	0.00	0.00	
Feb-89	0.00	0.00	0.00	
Mar-89	0.00	0.00	0.00	
Apr-89	0.00	0.00	0.00	
May-89	0.01	0.00	0.00	
Jun-89	12.60	5.04	7.57	
Jul-89	49.09	17.45	31.64	
Aug-89	58.84	23.15	35.69	
Sep-89	52.12	20.46	31.68	
Oct-89	26.31	10.69	15.62	
Nov-89	0.92	0.00	0.92	
Dec-89	0.00	0.00	0.00	16.66
Jan-90	0.01	0.00	0.00	16.66
Feb-90	0.00	0.00	0.00	16.66
Mar-90	0.00	0.00	0.00	16.66
Apr-90	0.01	0.01	0.01	16.66
May-90	0.00	0.00	0.00	16.66
Jun-90	0.00	0.00	0.00	15.61
Jul-90	33.37	12.54	20.84	14.30
Aug-90	49.53	18.18	31.35	13.52
Sep-90	42.83	16.43	26.41	12.75
Oct-90	19.11	7.34	11.76	12.15
Nov-90	1.46	0.57	0.90	12.19
Dec-90	0.01	0.00	0.01	12.19
Jan-91	0.00	0.00	0.00	12.19
Feb-91	0.03	0.01	0.02	12.20
Mar-91	0.00	0.00	0.00	12.20
Apr-91	0.00	0.00	0.00	12.19
May-91	0.01	0.00	0.01	12.20
Jun-91	0.02	0.01	0.01	12.20
Jul-91	41.97	14.69	27.28	12.91
Aug-91	50.85	19.08	31.77	13.02
Sep-91	47.72	18.34	29.38	13.43
Oct-91	35.63	13.78	21.84	14.81
Nov-91	32.79	11.88	20.91	17.42
Dec-91	9.35	0.00	9.35	18.20
Jan-92	0.00	0.00	0.00	18.20
Feb-92	0.00	0.00	0.00	18.19
Mar-92	0.00	0.00	0.00	18.19
Apr-92	0.00	0.00	0.00	18.19
May-92	0.00	0.00	0.00	18.19
Jun-92	33.80	10.01	23.78	21.01
Jul-92	44.70	17.11	27.58	21.23
Aug-92	49.21	18.67	30.54	21.10
Sep-92	42.81	16.18	26.63	20.69
Oct-92	38.35	14.03	24.33	20.92
Nov-92	30.72	7.57	23.15	20.74
Dec-92	9.33	1.07	8.26	20.74

Table A-5 - Armstrong Springs Water Production Summary

	Monthly Water Production in Million of Gallons			
				1-Year Running Average
Date	Total	Well No. 1	Well No. 2	Total
Jan-93	0.02	0.01	0.01	20.74
Feb-93	0.00	0.00	0.00	20.74
Mar-93	12.95	3.14	9.82	21.82
Apr-93	1.87	1.86	0.01	21.98
May-93	1.19	0.00	1.19	22.08
Jun-93	0.02	0.01	0.01	19.26
Jul-93	0.01	0.00	0.01	15.54
Aug-93	0.48	0.00	0.48	11.48
Sep-93	28.82	9.89	18.93	10.31
Oct-93	16.35	5.76	10.59	8.48
Nov-93	9.67	3.50	6.17	6.72
Dec-93	12.68	3.99	8.68	7.00
Jan-94	7.245	2.385	4.86	7.61
Feb-94	19.113	6.531	12.582	9.20
Mar-94	9.032	2.999	6.033	8.87
Apr-94	2.797	1.125	1.672	8.95

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Table A-6 - Kent Springs Water Production Summary

	Monthly Water Production in Millions of Gallons							
	Combined		Well	Well	Total	1-Year Running Averages		
Date	Total	Gallery	No. 1	No. 2	Wells	Total	Gallery	Wells
Jan-89	41.11	41.11	0.00	0.00	0.00			
Feb-89	43.79	43.79	0.00	0.00	0.00			
Mar-89	64.90	64.90	0.00	0.00	0.00			
Apr-89	59.70	59.70	0.00	0.00	0.00			
May-89	76.82	76.82	0.00	0.00	0.00			
Jun-89	64.69	58.13	2.77	3.79	6.57			
Jul-89	109.16	46.79	25.43	36.94	62.37			
Aug-89	83.75	36.82	17.57	29.36	46.93			
Sep-89	61.44	30.65	11.00	19.79	30.79			
Oct-89	81.26	35.17	16.97	29.13	46.10			
Nov-89	85.71	35.88	17.67	32.16	49.83			
Dec-89	109.53	47.49	25.05	36.99	62.04	73.49	48.10	25.38
Jan-90	129.99	57.37	29.22	43.40	72.62	80.90	49.46	31.44
Feb-90	110.05	49.46	24.10	36.49	60.59	86.42	49.93	36.49
Mar-90	77.16	66.22	4.39	6.54	10.93	87.44	50.04	37.40
Apr-90	71.84	71.84	0.00	0.00	0.00	88.45	51.05	37.40
May-90	75.65	75.65	0.00	0.00	0.00	88.35	50.96	37.40
Jun-90	73.36	73.36	0.00	0.00	0.00	89.07	52.23	36.85
Jul-90	114.31	72.91	22.68	18.72	41.40	89.50	54.40	35.10
Aug-90	87.16	42.81	20.96	23.39	44.35	89.79	54.90	34.89
Sep-90	106.02	47.27	31.30	27.45	58.75	93.50	56.29	37.22
Oct-90	113.95	52.11	32.23	29.61	61.84	96.23	57.70	38.53
Nov-90	90.17	58.19	17.38	14.60	31.98	96.60	59.56	37.04
Dec-90	77.72	77.72	0.00	0.00	0.00	93.95	62.08	31.87
Jan-91	98.03	98.03	0.00	0.00	0.00	91.29	65.47	25.82
Feb-91	88.00	88.00	0.00	0.00	0.00	89.45	68.68	20.77
Mar-91	89.50	89.50	0.00	0.00	0.00	90.48	70.62	19.86
Apr-91	95.08	95.08	0.00	0.00	0.00	92.41	72.55	19.86
May-91	98.17	98.17	0.00	0.00	0.00	94.29	74.43	19.86
Jun-91	74.33	74.33	0.00	0.00	0.00	94.37	74.51	19.86
Jul-91	108.77	61.29	24.55	22.93	47.48	93.91	73.54	20.37
Aug-91	73.92	41.20	4.86	27.86	32.72	92.81	73.41	19.40
Sep-91	65.08	32.82	10.56	21.70	32.26	89.39	72.20	17.19
Oct-91	85.20	32.45	5.12	47.63	52.75	87.00	70.57	16.43
Nov-91	30.90	27.41	1.69	1.80	3.49	82.06	68.00	14.06
Dec-91	78.72	54.37	11.52	12.83	24.35	82.14	66.05	16.09
Jan-92	83.02	83.02	0.00	0.00	0.00	80.89	64.80	16.09
Feb-92	74.90	74.90	0.00	0.00	0.00	79.80	63.71	16.09
Mar-92	83.86	83.86	0.00	0.00	0.00	79.33	63.24	16.09
Apr-92	79.91	79.82	0.07	0.02	0.09	78.06	61.97	16.09
May-92	78.03	78.03	0.00	0.00	0.00	76.39	60.29	16.09
Jun-92	80.10	65.74	7.27	7.08	14.36	76.87	59.58	17.29
Jul-92	120.94	61.78	28.87	30.29	59.16	77.88	59.62	18.26
Aug-92	72.26	37.17	5.72	29.38	35.09	77.74	59.28	18.46
Sep-92	46.78	23.39	0.79	22.60	23.39	76.22	58.49	17.72
Oct-92	57.02	29.11	5.84	22.07	27.91	73.87	58.22	15.65
Nov-92	84.35	44.70	18.26	21.39	39.65	78.32	59.66	18.67
Dec-92	56.09	51.38	2.16	2.56	4.72	76.44	59.41	17.03

Table A-6 - Kent Springs Water Production Summary

	Monthly Water Production in Millions of Gallons							
	Combined		Well	Well	Total	1-Year Running Averages		
Date	Total	Gallery	No. 1	No. 2	Wells	Total	Gallery	Wells
Jan-93	39.66	39.66	-0.00	0.00	0.00	72.82	55.79	17.03
Feb-93	37.42	37.42	0.00	0.00	0.00	69.70	52.67	17.03
Mar-93	85.02	85.00	0.01	0.01	0.02	69.80	52.76	17.03
Apr-93	68.06	68.03	0.01	0.02	0.03	68.81	51.78	17.03
May-93	60.86	60.84	0.01	0.01	0.03	67.38	50.35	17.03
Jun-93	82.43	82.40	0.01	0.01	0.03	67.57	51.74	15.84
Jul-93	78.82	78.66	0.09	0.07	0.17	64.06	53.14	10.92
Aug-93	52.95	52.78	0.09	0.08	0.17	62.45	54.45	8.01
Sep-93	82.52	47.64	17.31	17.57	34.88	65.43	56.47	8.97
Oct-93	100.72	56.93	19.47	24.32	43.79	69.08	58.79	10.29
Nov-93	81.75	53.85	12.23	15.66	27.89	68.86	59.55	9.31
Dec-93	30.65	30.58	0.04	0.04	0.07	66.74	57.82	8.92
Jan-94	49.74	49.74	0.00	0.00	0.00	67.58	58.66	8.92
Feb-94	55.12	55.10	0.01	0.01	0.02	69.05	60.13	8.92
Mar-94	72.73	72.72	0.01	0.01	0.01	68.03	59.11	8.92
Apr-94	71.84	71.84	0.00	0.00	0.00	68.34	59.42	8.92

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Table A-7 - Clark Springs Water Production and Streamflow Summary

Date	Monthly Water Production in Millions of Gallons							Rock Creek Flow Rate in CFS	
	Combined Total	1-Year Running Average*	Gallery	Well No.1	Well No. 2	Well No. 3	Total Wells	Monthly Avg. Average	1-Year Running Average
Jan-89	144.46		144.46	0.00	0.00	0.00	0.00	33.04	
Feb-89	134.30		134.30	0.00	0.00	0.00	0.00	25.17	
Mar-89	118.29		118.29	0.00	0.00	0.00	0.00	30.96	
Apr-89	135.21		118.63	0.00	0.00	16.59	16.59	33.54	
May-89	156.34		153.34	0.00	0.00	3.00	3.00	16.37	
Jun-89	128.66		128.65	0.00	0.00	0.01	0.01	9.03	
Jul-89	115.73		115.73	0.00	0.00	0.00	0.00	6.23	
Aug-89	116.92		116.92	0.00	0.00	0.00	0.00	4.48	
Sep-89	106.81		106.81	0.00	0.00	0.00	0.00	3.31	
Oct-89	116.76		116.76	0.00	0.00	0.00	0.00	2.66	
Nov-89	107.84		107.84	0.00	0.00	0.00	0.00	4.13	
Dec-89	102.45	123.65	102.45	0.00	0.00	0.00	0.00	14.43	15.28
Jan-90	138.42	123.15	138.38	0.02	0.01	0.01	0.04	27.38	14.81
Feb-90	123.60	122.25	123.60	0.00	0.00	0.00	0.00	35.50	15.67
Mar-90	129.97	123.23	129.90	0.00	0.00	0.08	0.08	32.84	15.82
Apr-90	145.27	124.06	145.22	0.01	0.01	0.03	0.05	15.34	14.31
May-90	136.50	122.41	136.50	0.00	0.00	0.00	0.00	9.92	13.77
Jun-90	133.93	122.85	133.93	0.00	0.00	0.00	0.00	15.50	14.31
Jul-90	140.20	124.89	140.19	0.00	0.00	0.00	0.00	9.16	14.55
Aug-90	124.15	125.49	122.96	1.18	0.01	0.00	1.19	5.81	14.67
Sep-90	106.20	125.44	106.20	0.00	0.00	0.00	0.00	4.32	14.75
Oct-90	126.82	126.28	126.77	0.01	0.01	0.02	0.04	4.05	14.87
Nov-90	125.70	127.77	125.08	0.20	0.20	0.22	0.62	24.09	16.53
Dec-90	136.32	130.59	136.30	0.01	0.00	0.01	0.02	35.50	18.28
Jan-91	134.75	130.28	134.75	0.00	0.00	0.00	0.00	32.50	18.71
Feb-91	112.09	129.32	112.04	0.01	0.02	0.02	0.05	35.50	18.71
Mar-91	112.50	127.87	112.50	0.00	0.00	0.00	0.00	35.50	18.93
Apr-91	126.17	126.28	126.10	0.01	0.02	0.05	0.07	35.14	20.58
May-91	128.85	125.64	128.81	0.01	0.01	0.03	0.05	12.70	20.82
Jun-91	114.22	124.00	114.20	0.00	0.01	0.01	0.02	10.54	20.40
Jul-91	125.24	122.75	124.91	0.04	0.07	0.23	0.33	7.05	20.23
Aug-91	115.99	122.07	115.49	0.02	0.22	0.26	0.50	5.21	20.18
Sep-91	114.77	122.79	114.77	0.00	0.00	0.00	0.00	3.61	20.12
Oct-91	112.22	121.57	112.19	0.00	0.01	0.01	0.03	2.56	19.99
Nov-91	99.04	119.35	99.04	0.00	0.00	0.00	0.00	3.54	18.28
Dec-91	124.03	118.32	124.03	0.00	0.00	0.00	0.00	7.34	15.93
Jan-92	120.61	117.14	120.56	0.01	0.01	0.03	0.05	9.07	13.98
Feb-92	116.86	117.54	116.86	0.00	0.00	0.00	0.00	18.99	12.60
Mar-92	129.80	118.98	129.76	0.01	0.01	0.02	0.04	13.33	10.76
Apr-92	121.54	118.60	121.51	0.01	0.01	0.02	0.03	11.58	8.79
May-92	119.29	117.80	119.29	0.00	0.00	0.00	0.00	9.74	8.54
Jun-92	124.15	118.63	124.09	0.01	0.02	0.03	0.06	6.53	8.21
Jul-92	113.81	117.68	113.78	0.01	0.01	0.02	0.04	4.67	8.01
Aug-92	117.38	117.79	117.38	0.00	0.00	0.00	0.00	3.23	7.85
Sep-92	112.54	117.61	112.49	0.01	0.01	0.03	0.05	2.33	7.74
Oct-92	107.11	117.18	107.06	0.01	0.02	0.03	0.06	2.21	7.71
Nov-92	105.18	117.69	105.14	0.01	0.01	0.01	0.04	3.38	7.70
Dec-92	127.95	118.02	127.34	0.02	0.19	0.39	0.61	7.26	7.69

Table A-7 - Clark Springs Water Production and Streamflow Summary

	Monthly Water Production in Millions of Gallons							Rock Creek Flow Rate in CFS	
Date	Combined Total	1-Year Running Average*	Gallery	Well No.1	Well No. 2	Well No. 3	Total Wells	Monthly Avg. Average	1-Year Running Average
Jan-93	120.57	118.02	120.57	0.00	0.00	0.00	0.00	10.21	7.79
Feb-93	106.23	117.13	106.18	0.00	0.00	0.04	0.04	13.23	7.31
Mar-93	129.16	117.08	127.32	0.09	0.52	1.23	1.85	8.51	6.91
Apr-93	122.63	117.17	122.56	0.02	0.02	0.03	0.07	14.58	7.16
May-93	90.13	114.74	90.09	0.01	0.01	0.01	0.04	15.57	7.64
Jun-93	118.34	114.25	118.24	0.01	0.01	0.08	0.10	14.12	8.27
Jul-93	96.55	112.81	96.51	0.01	0.01	0.02	0.04	10.08	8.73
Aug-93	118.57	112.91	118.50	0.01	0.02	0.05	0.07	5.84	8.94
Sep-93	108.88	112.61	108.88	0.00	0.00	0.00	0.00	4.62	9.13
Oct-93	98.62	111.90	98.58	0.01	0.01	0.02	0.04	4.17	9.30
Nov-93	113.78	112.62	113.77	0.00	0.00	0.00	0.01	3.72	9.32
Dec-93	82.98	108.87	82.98	0.00	0.00	0.00	0.00	5.22	9.16

* Of Combined Total

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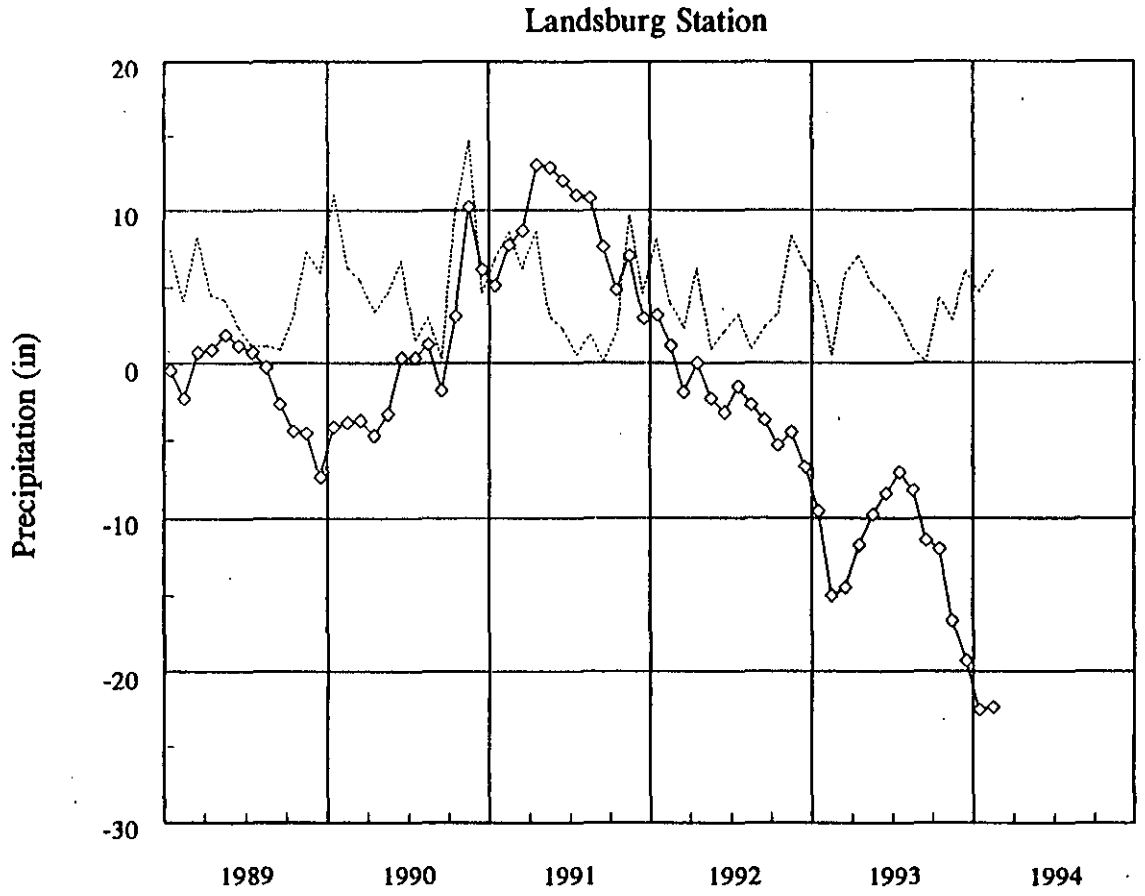
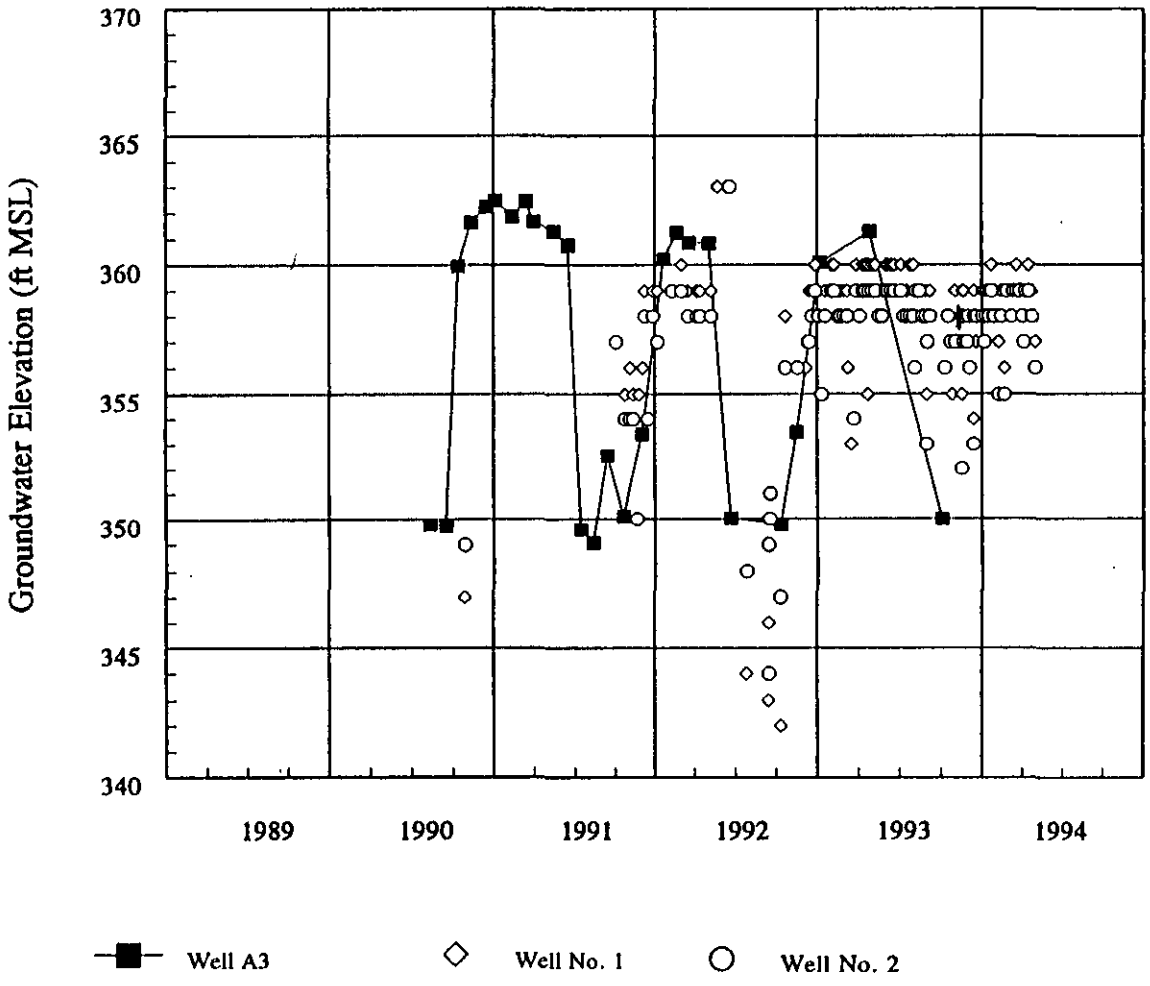
Monthly Total Precipitation and Cumulative Departure



HARTCROWSER
J-3508-01 11/95
Figure A-1

Armstrong Springs Water Levels



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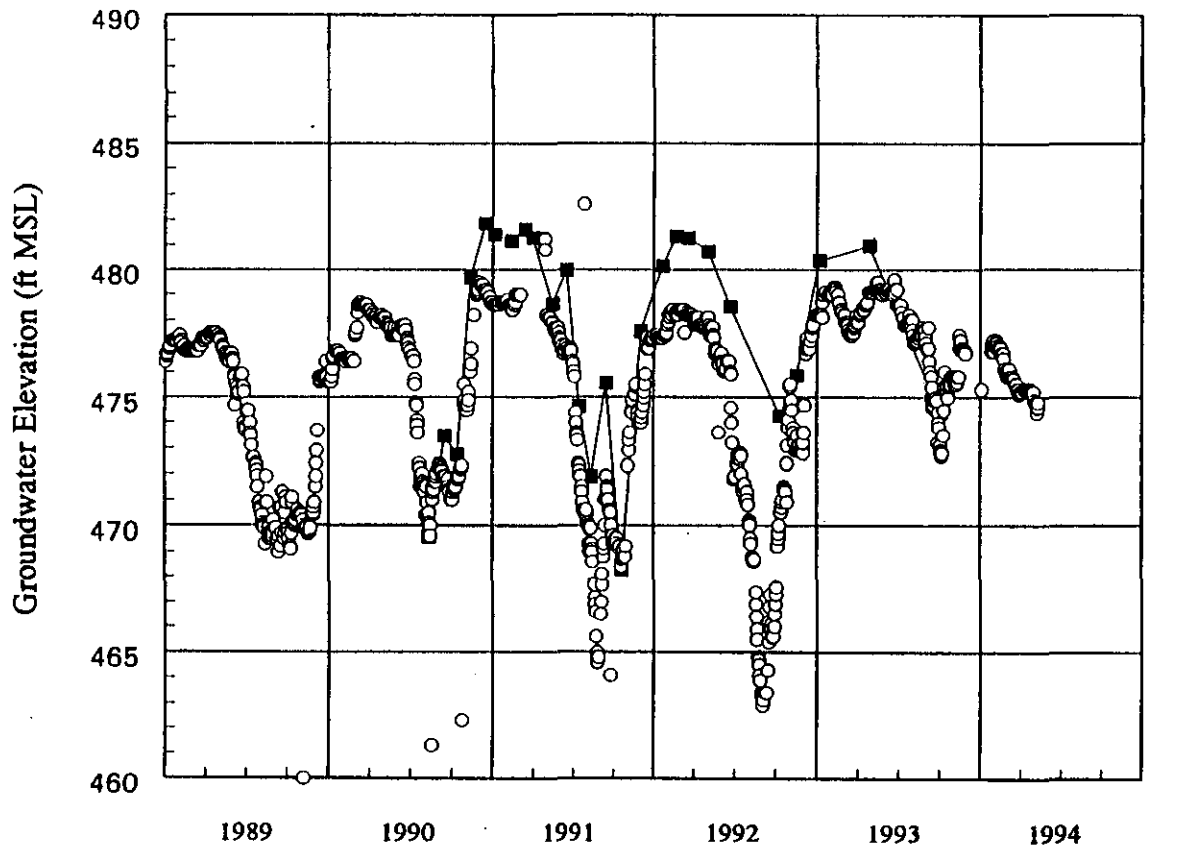
J- 3508-011 11/95
Figure A-2

Kent Springs Water Levels



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J-3508-01 11/95
Figure A-3

Clark Springs Well No. 1

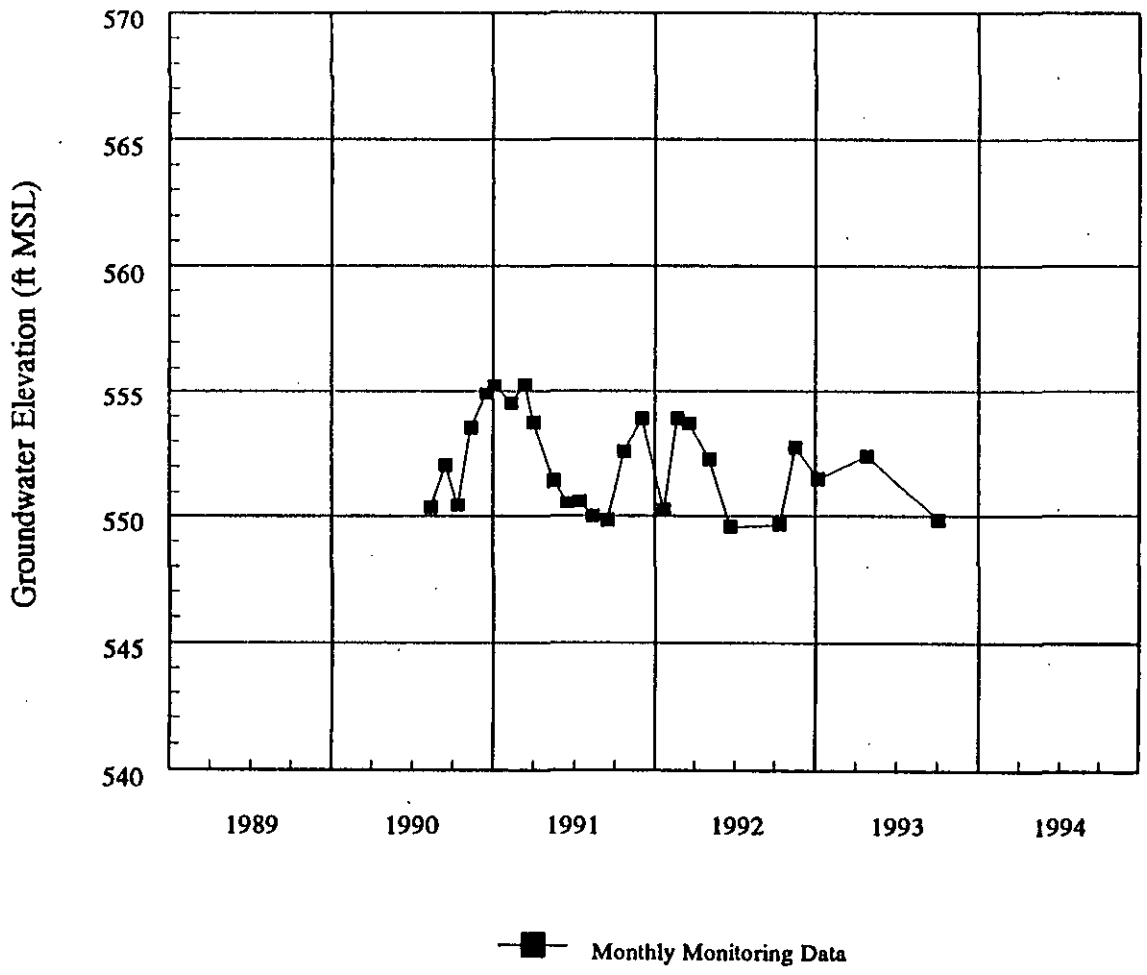

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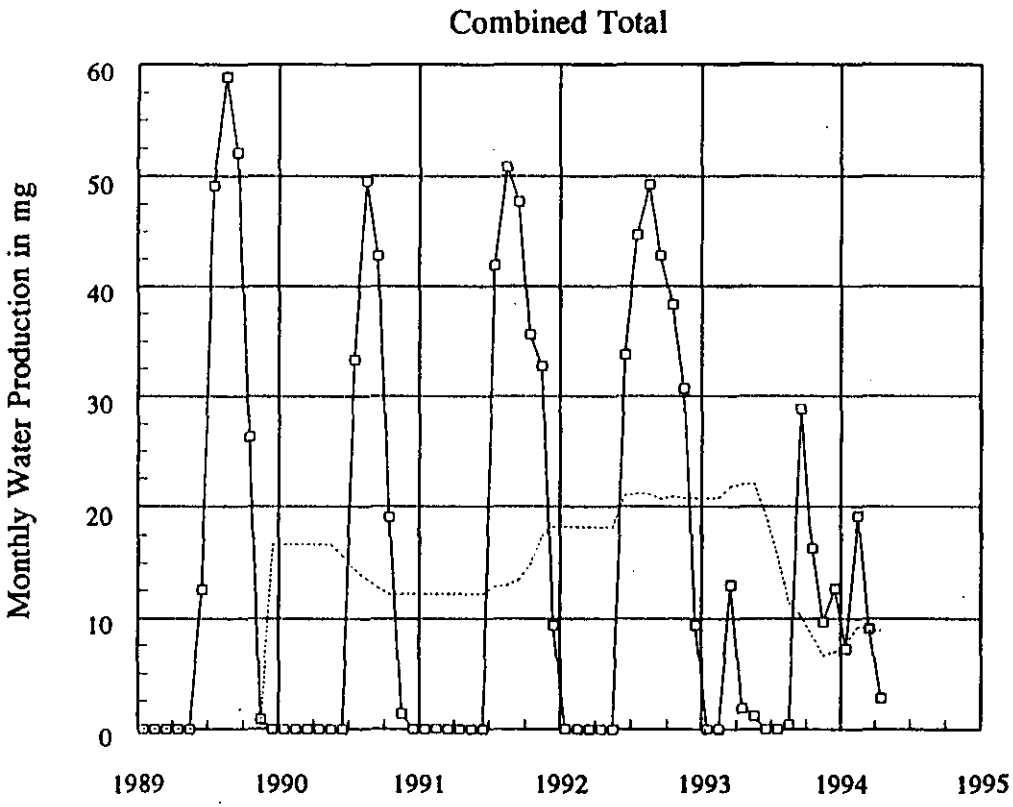
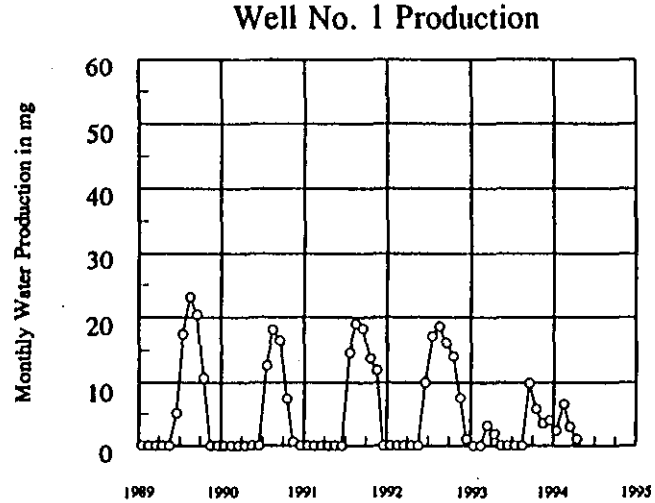
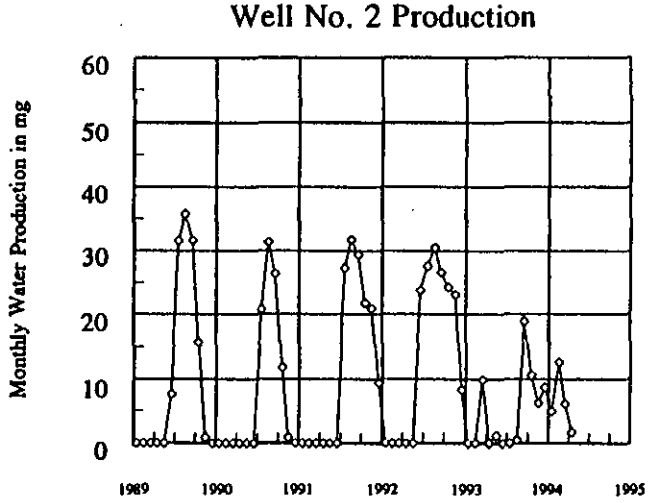
Figure A-4

Armstrong Springs Water Production







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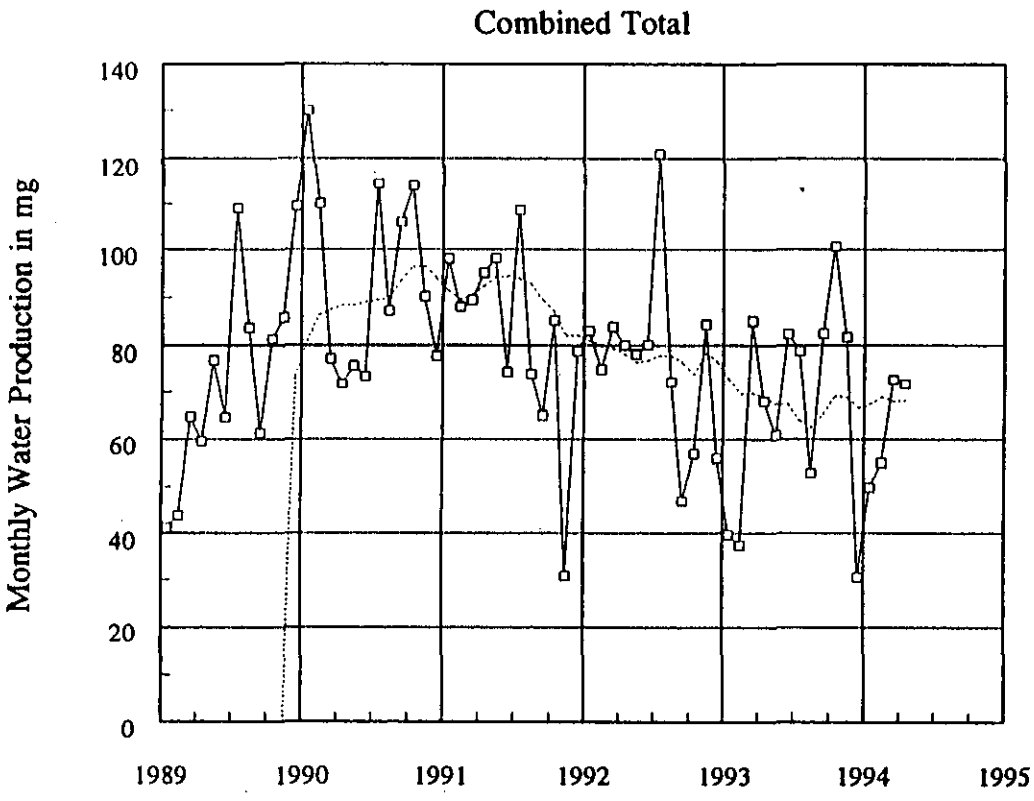
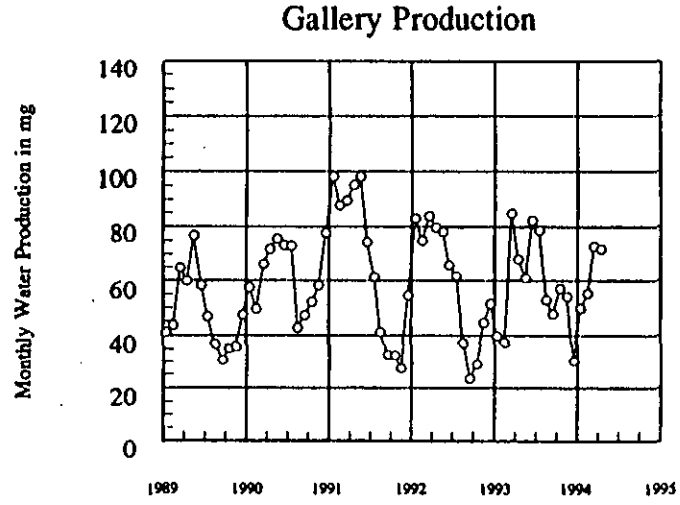
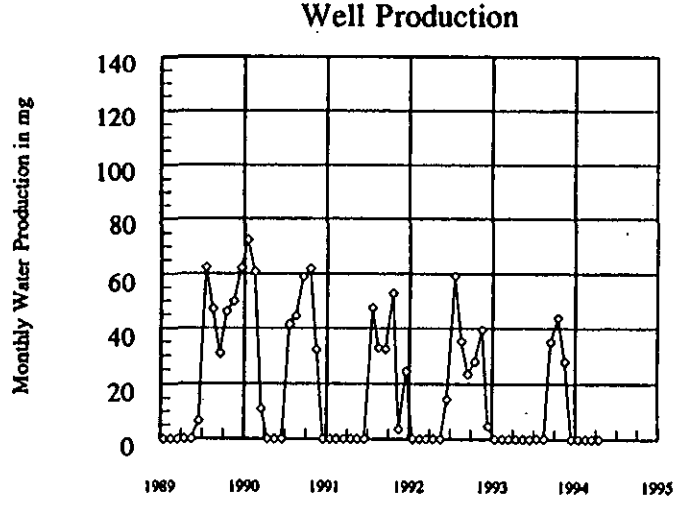
J-3508-01 11/95
Figure A-5

Kent Springs Water Production







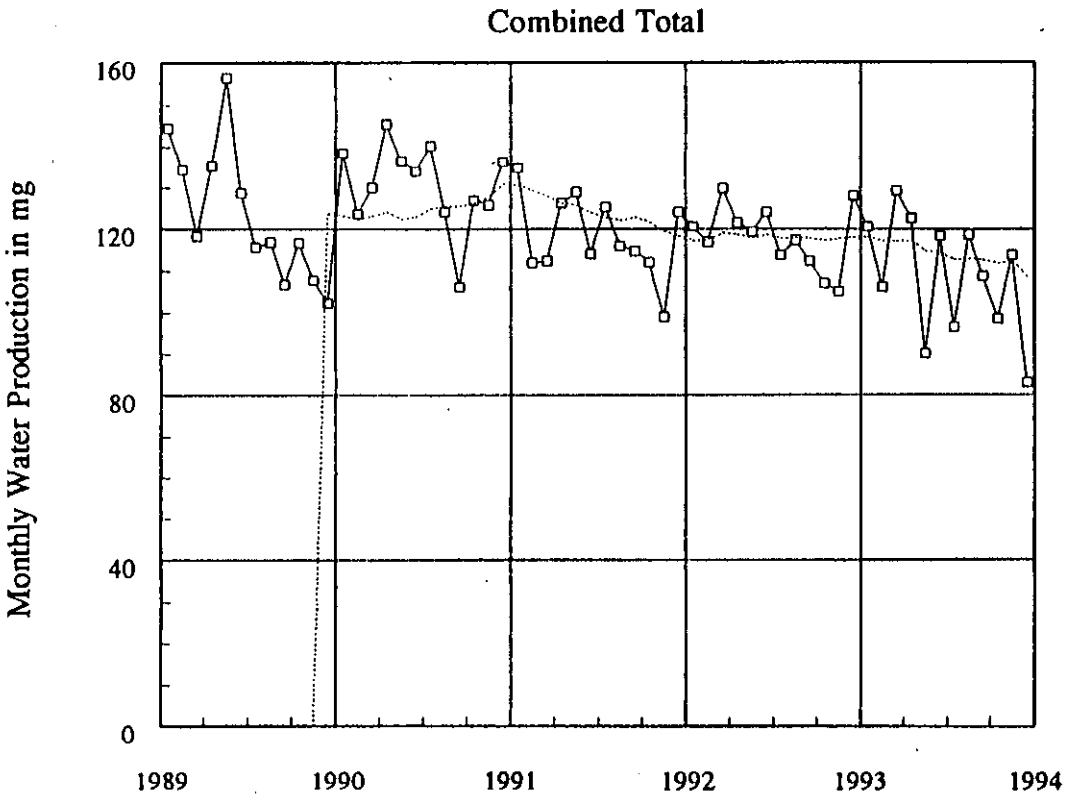
Gallery Production

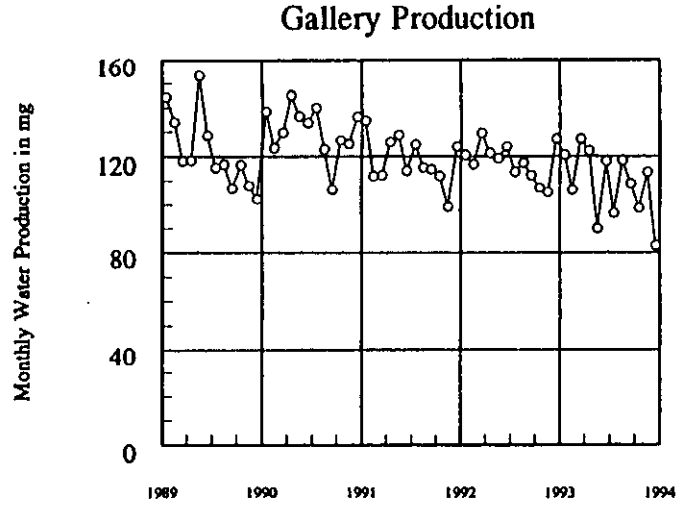
Total Well Production

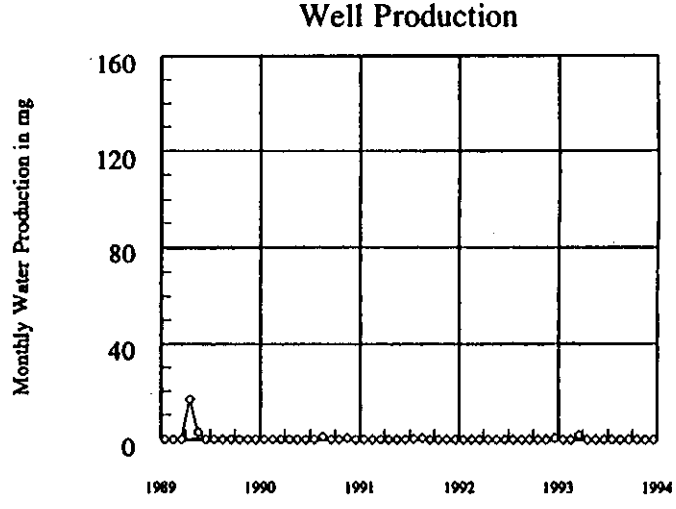
1-Year Running Average
(Combined Total)

HARTCROWSER
J-3508-01 11/95
Figure A-6

Clark Springs Water Production







Gallery Production

Total Well Production

1-Year Running Average
(Combined Total)

HARTCROWSER
J-3508-01 11/95
Figure A-7

Appendix B

APPENDIX B
GROUNDWATER MODELING PROCEDURES

APPENDIX B
GROUNDWATER MODELING PROCEDURES

This appendix discusses procedures used for developing the groundwater flow and capture zone evaluation model. For this modeling work we used the U.S.G.S. MODFLOW code (McDonald and A.W. Harbaugh, 1988) for groundwater flow simulation and PATH3D (Zheng, 1992), a discrete particle tracking code, for capture zone evaluation. Both computer codes are recognized in the literature as standards for this kind of work. We obtained these particular versions MODFLOW (386/486 Extended Memory Version) and PATH3D (Ver. 3.0) from S.S. Papadopulos & Associates, Inc., of Bethesda, Maryland.

Approach and Parameter Selection

We used a hydrogeologic mapping approach to developing the basic model grid for the City's watersheds. We began with development of available geologic information by constructing a map of the surficial geology of the area to identify till and bedrock outcrops (aquifer boundaries) and to identify areas where recessional outwash or other coarse-grained sediments (potential aquifer materials) were likely present (see Figure 2-1). Geologic cross sections were then developed to identify the depth, extent, and nature of aquifer materials in the subsurface. These are presented on Figures 2-2 through 2-11.

Groundwater elevation contour maps spanning the three watersheds were developed based on water levels measured in selected wells in October 1993 and April 1994. The contouring was based on these water levels, inferred regional boundary conditions, and groundwater flow patterns indicated by similar mapping performed for the South King County Ground Water Management Plan (SKCGWAC et al, 1989).

Finally, we approximated the likely areal limits of the aquifers tapped by the Kent production wells based on the location and depth extent of till and bedrock units, sand and gravel horizons, and rivers and lakes (most importantly the Cedar River and Little Soos Creek). The boundaries of several portions of the model domain were determined by (inferred) bounding groundwater flow streamlines. Figure B-1 shows the model grid and associated boundaries.

Conceptual Basis for Numerical Model

For the purposes of assessing wellhead protection capture zones, we established a numerical representation of the groundwater flow system. For the model, water-bearing zones above the Qf(2)/Qf(3) fine-grained horizons were represented as a single vertically homogenized water-bearing zone. This is incorrect in some places where till is present between layers of recessional gravels (Qvr) and older sands and gravels [Qc(2)] but probably does not introduce significant error into the model because the Qvr is often unsaturated in those areas.

Potential water-bearing zones below the Qf(2)/Qf(3) fine-grained horizons in the western part of the model grid and bedrock underlying the eastern part of the model grid were not explicitly

represented in the model. We did this to simplify the overall model. Because a generally downward vertical gradient appears to exist between the shallow aquifer zone and deeper water-bearing zones, any vertical groundwater flow component is probably downward. As discussed in the SKCGWAC, groundwater in the deeper water-bearing zones most likely drains to the Green and Cedar Rivers.

Downward groundwater flow to deeper water-bearing zones could have been represented explicitly by adding one or more additional layers to the model. Instead, because the downward flow appears to simply exit the shallow aquifer zone, we represented this component by simply reducing the areal recharge by an amount equivalent to the downward loss. The results of the unpublished USGS recharge model indicated that on the average some 2 inches of the total annual precipitation finds its way down to the deeper water-bearing zones from the shallower water-bearing zones.

We used no flow cells (cells in which head and flow are not computed) to represent bedrock and till outcrops in the eastern portion of the model domain. Because of the large difference between the hydraulic conductivity of the outwash deposits and till or bedrock, horizontal groundwater flow in these units should be negligible. The low permeability units are more important for their effect on flow directions and rates in the adjacent outwash deposits, e.g., channeling flow through the Clark Springs area.

An implicit assumption of this approach is that the till outcrops in the eastern portion of the model domain are underlain by bedrock which, as noted above is assumed to discharge out of the model domain to the Green and Cedar River. In fact, some portion of the precipitation recharge infiltrating the till probably infiltrates adjacent outwash deposits. As a result, the model may underestimate the total water budget. If the USGS recharge model results are taken at face value, then the model may underestimate the water budget over the area of the eastern till outcrops. The eastern till outcrops do not cover a large area of the model domain. Coal seams and other conductive horizons within the bedrock may locally increase downward flow above the 2-inch per year average value.

The model domain was assumed to be bounded on the east by bedrock outcrops (east of Retreat Lake) and on the west by Soos Creek and its tributaries (the ***Boundary Conditions Set*** section describes model boundary conditions in more detail). Groundwater flow is generally from east to west, principally driven by precipitation recharge in the Covington Uplands. Explicit groundwater discharge from the model occurs via Rock Creek and a short stretch of the Cedar River on the north and to Soos Creek and its tributaries on the west. All westward groundwater flow is assumed to be intercepted by Soos Creek and its tributaries (Little Soos Creek and Jenkins Creek). This is consistent with the topography of the area (the basal elevation of Soos Creek is below the bottom of the shallow aquifer zone throughout most of the model domain). Several surface water bodies, namely Covington and Ravensdale Creeks, may play some role in water transfers within the model domain and out of the study area. Because we had no data regarding base flow in these streams, they are not represented in the model.

Steady State Model Selected

Principally because backward particle tracking (tracking a hypothetical contaminant particle from its point of capture at a City extraction well backward to its point of origin) requires a steady state groundwater flow model, the groundwater model is a steady state model. We also simplified the model setup by making all model cells unconfined. Because the water level changes observed at the site during routine monitoring are not substantial, this simplification has little effect on the accuracy of the model.

For the model, water-bearing zones above the Qf(2)/Qf(3) fine-grained horizons were represented as a single vertically homogenized water-bearing zone. This is incorrect in some places where till is present between layers of recessional gravels (Qvr) and older sands and gravels [Qc(2)] but probably does not introduce significant error into the model because the Qvr is often unsaturated in those areas. Spatial variations in aquifer permeability are represented by varying hydraulic conductivity values across the model grid. MODFLOW automatically computes aquifer transmissivity as the product of the hydraulic conductivity and saturated thickness (water level at start of time step minus bottom elevation) for each cell in the model grid.

Model Grid Constructed

For this study, we developed a model grid consisting of 53 rows and 82 columns in one layer. The grid spans a distance of 55,492 feet from west to east and 27,000 feet from north to south. The row spacings range from 200 feet in the City watersheds to as much as 1,650 feet on the northern boundary of the grid. The column spacings likewise range from 200 feet in the City watersheds to as much as 2,000 feet on the eastern boundary of the grid. Water-bearing materials are represented in the grid by model cells with spatially varying hydraulic conductivity and other properties. Areas where glacial till and bedrock are believed to largely inhibit groundwater flow were represented by inactive cells within the model grid. Figure B-1 presents our model grid with selected boundary conditions.

Model Parameters Identified

The principal parameters affecting groundwater flow include:

- Hydraulic conductivity;
- Bottom elevation; and
- Precipitation recharge.

Because it affects groundwater migration rates, porosity is a significant additional parameter affecting potential contaminant migration rates. Our evaluation of each of these parameters is discussed below.

Hydraulic Conductivity. We initially set out to delineate hydraulic conductivity within the modeled region using a combination of aquifer pumping test data, specific capacity data as

reported on driller's logs, and professional judgement based on materials identified on driller's logs and our experience with similar materials at other locations in the Puget Sound area. Much of the available pumping test data and specific capacity data are presented on the subsurface geologic cross sections presented on Figures 2-2 through 2-11. The production well-specific capacity data turned out to be less useful than expected. After reviewing a number of well logs and comparing the specific capacity data to presumably more representative pumping test results, we concluded that the specific capacity results more likely reflected the effects of variations in well completion (continuous slot versus torch cut or open bottom casing) than the effects of variations in aquifer hydraulic properties. In the end, we primarily relied on pumping test results augmented with professional judgement during the model calibration process.

Figure B-2 presents the available pumping test data. These data were used in conjunction with Golden Software's SURFER program and the bottom elevation of the aquifer (discussed below) to generate our starting hydraulic conductivity grid. Hydraulic conductivity values used in the model were adjusted during the calibration process described in the ***Model Calibration*** section below. Figure B-3 shows the final calibrated hydraulic conductivity distribution as used in model.

Bottom Elevation. Aquifer bottom elevation values were calculated for the model by reviewing Ecology well logs from the South King County Ground Water Management Plan database and additional information provided by Robinson & Noble and others to develop a map of the bottom of the shallow water-bearing zones [mainly Qvr and Qc(2)]. For this analysis, individual wells were located on a 1:24000 USGS topographic map of the area. When available, wellhead survey data were used to calculate the bottom elevation based on the depth at which a lower fine-grained unit (typically Qf(2) or Qf(3) in the west study area or Qvt or Tbr in the east study area) was reported on the driller's log. More generally, the wellhead elevation was estimated from the U.S.G.S. topographic quadrangle maps for the study area. Please note that the topography on the 1949 USGS, photorevised 1968 and 1973 Quadrangle map for Maple Valley, Washington, is off by 40 feet relative to field survey data referenced to NGVD and the newer 1983 metric 7½x15 minute Quadrangle map for Auburn, Washington. The well locations in Lambert (State-Plane) coordinates and the estimated bottom elevation values were then input into Golden Software's SURFER program to generate a bottom elevation contour map.

The bottom elevation values were changed in some places during the model calibration process, principally because of initial data gaps in portions of the eastern third of the model grid and the narrow valley between Ravensdale Lake and Lake Sawyer where fewer well logs were available to review. Figure B-4 illustrates the final distribution of bottom elevation used in the model.

Precipitation Recharge. Precipitation recharge values for the model were developed in a three-step process. First, we used precipitation data for Landsburg, Washington, to develop a plot of monthly total precipitation versus time. Figure A-1 presents monthly total precipitation for this station for the period 1989 to July 1994. Discussion with David Hartley of the King County Surface Water Management group (Hartley, 1994) indicated that precipitation over the area, including and east of the Clark Springs property, would likely be comparable to that recorded at

the Landsburg station while precipitation in the western portion of the study area would probably be on the order of 80 percent of that recorded at the Landsburg station.

Our next step was a review of the precipitation-recharge relationship developed by the USGS through recharge modeling work conducted for the Covington Upland area for the South King County GWAC. Although the modeling results are in press and not currently available, a relationship between precipitation and recharge, derived from the model results is presented in the DRAFT Geohydrology and Quality of Ground Water report for the East King County area. We initially considered this relationship (See Figure B-6) to estimate groundwater recharge rates for the till and outwash areas in the model. During the model calibration process we reduced the recharge rates to 20 inches in the western area and 30 inches in the eastern area to improve the match between the water budget of the numerical model and our conceptual model of the site.

Recharge values for the outwash sands and gravels followed directly from this relationship. In the till-capped bedrock upland areas some portion of the incident precipitation becomes groundwater recharge and a larger portion most likely becomes runoff. Because of their likely low hydraulic conductivity, we assumed that groundwater flow in the till and bedrock upland areas need not be considered in the groundwater model. For areas in which surface water drainage is toward the City's aquifers, the runoff from these upland areas probably does need to be considered.

We incorporated the effect of runoff from upland areas by calculating the runoff from upland areas as precipitation minus recharge minus evapotranspiration. Figure B-5 shows the surface water catchment areas associated with the City's aquifers that we treated as Runoff Zones. For this analysis we divided the catchment areas into subregions. Then we took the runoff (runoff rate in feet/day times the subregion area in ft^2) and distributed this volume over several adjacent active cells in the groundwater model. This approach may not be the most accurate for fine-scale analysis but does incorporate the basic water balance for the region reasonably well. Table B-1 details the subregions identified, estimated areas, and model cells used to inject the upland runoff into the active portions of the model.

Boundary Conditions Set

The study area encompasses a relatively complex groundwater flow domain which we represented using noflow, river, and drain nodes. Figure B-1 illustrates boundary conditions used in the model.

Noflow Boundaries. Based on our hydrogeologic mapping we identified several areas across which limited groundwater flow occurs. These principally include till and bedrock uplands but also include portions of the southwest and northwest model boundaries across which the groundwater elevation contour maps indicate little potential for groundwater flow. Noflow boundaries are the default in MODFLOW (no flow across model grid boundaries unless specified as constant flux). Irregular noflow boundaries internal to the grid are created making selected cells inactive.

River Boundaries. Portions of the Cedar River, Lake Sawyer, and Soos Creek were represented in the model by means of river node boundary conditions.

Figure B-1 shows the locations of river node boundary cells. Table B-2 summarizes the values assigned to each of the nodes. In MODFLOW, each river node has three properties:

- Stage;
- Bottom elevation; and
- Conductance.

River node properties can vary with time in MODFLOW, but lacking data to characterize possible variations, we used fixed values for this steady-state simulation. Stage was generally set by reference to elevations presented on the USGS topographic maps for the study area. Information regarding the elevation of Lake Sawyer was obtained from the Lake Sawyer Hydrogeologic Study (Hart Crowser, 1990). Because we generally did not have specific information, bottom elevation for the river nodes was generally set to 20 to 30 feet below the river stage elevation. We also did not have data regarding river bed conductance. Consequently we developed conductance values during the model calibration process in terms of the best fit to observed groundwater elevation data for the study area.

Pumping Well Nodes. Two pumping well nodes each at Armstrong Springs and Kent Springs and one at Clark Springs were used to represent the City's groundwater withdrawal. Because the Covington Water District produces a significant quantity of groundwater, we added a fourth pumping well node near Covington's Lake Sawyer wellfield. For the steady-state model, the pumping rate for each node was set to the annual average daily pumping rate for the period from January 1989 to April 1994. This appears likely to yield conservatively high pumping rates for long-term capture zone evaluations because actual well yields at the Armstrong, Kent, and Covington wellfields appear to have decreased slightly over the period of record (See Appendix A for discussion).

This yields the following pumping rate values in ft^3/day (gpm):

Armstrong Springs	64,123 (333)
Kent Springs	340,378 (1768)
Covington	384,531 (1997)
Clark Springs	526,597 (2735)

To represent southerly groundwater flow from the Lake Youngs area, a specified flux boundary was specified along a portion of the northern boundary of the model grid. For this boundary, fixed rate injection wells were specified in ten finite difference cells to inject an aggregate total of 115,500 ft^3/day (600 gpm). This flow rate was estimated based on the prevailing water table gradient, saturated thickness, and hydraulic conductivity in that area.

Drain Nodes. Drain nodes were used in the model to represent the interaction between the City's aquifers and Rock Creek north of Clark Springs. Drain nodes in MODFLOW have two

properties: conductance and elevation. The elevation of the drain nodes was set to 550 feet based on topography near the Clark Springs property. The conductance of the drain nodes was set to 400,000 ft^2/day during the model calibration process. Just three drain nodes were used to represent the aquifer discharge at Rock Creek. Based on discussions with David Hartley of the King County Surface Water Management group, Rock Creek does not appear to interact with the aquifer in its reach north of Clark Springs.

Model Calibration

The groundwater flow model was calibrated in an iterative process during which various model parameters were adjusted until satisfactory agreement was obtained between observed and predicted groundwater elevations. In some cases compromises had to be made. Because the most reliable groundwater elevation data were obtained generally closer to the three City properties, more weight was assigned to water levels in these areas than to areas to the north and east for which there are little data. Similarly, we did not adjust hydraulic conductivity substantially in areas for which we had fairly good pumping test data while we were somewhat more liberal in areas where only boring logs or specific capacity data were available.

Near the water supply sources, the predicted groundwater elevation values agree to within plus or minus five feet of the observed groundwater elevations in April 1994 (Figure B-7). In other areas, the variability is between 10 and 20 feet. The accuracy of the predicted elevations is consistent with the measured data, given the accuracy of the water level monitoring data points. Near the production wells where the monitoring points are surveyed, the accuracy is greater, while further out, monitoring point elevations were estimated from USGS topographic maps and are accurate to plus or minus 10 to 20 feet.

In the Retreat Lake area, the model overpredicted groundwater elevations by as much as 80 feet. Predicted groundwater elevations in this area are strongly dependent on assumed recharge rates and the estimated hydraulic conductivity of soils transmitting water from this area to areas to the west. This part of the model grid is difficult to calibrate because areas of inferred low saturated thickness east of Retreat Lake and up Sugarloaf Mountain are directly adjacent to areas of high hydraulic conductivity west of Retreat Lake.

The high predicted groundwater elevations are the result of our attempt to control the total rate of groundwater flow in the model. For this we adjusted recharge rates and hydraulic conductivity values to reduce the total flow to improve the correspondence between predicted groundwater discharge rates at Soos Creek and observed values.

Future data collection efforts in this area should focus on assessing the extent and saturated thickness of the aquifer south and east of Retreat Lake, hydraulic conductivity, groundwater elevation, baseflow in Rock Creek, and precipitation recharge to the area. Recalibration of the model may need to consider seasonal fluctuations in water levels and possibly seasonally dry aquifer areas.

The water budget for the numerical model is summarized as follows:

Inflow	ft^3/day	cfs
Precipitation Recharge	5,462,055	63.2
Lake Sawyer	48,675	.6
Lake Youngs specified flux	115,500	1.3
Total	**5,626,230**	**65.1**
Outflow	ft^3/day	cfs
Cedar River	787,280	9.1
Rock Creek Drain	244,041	2.8
Water Supply Withdrawals	1,315,630	15.2
Soos Creek and Tributaries	3,318,772	38.4
Total	**5,665,723**	**65.5**

The difference between inflow and outflow in the final steady-state model amounts to approximately 0.7% of the total water budget. Many of the values are consistent with available monitoring data and conceptual assessment. For example, a baseflow of about 2 to 4 cfs, derived from groundwater discharge has been estimated for Rock Creek based on stream gaging data. Low flow baseflows for the Soos Creek alone have been estimated at between 20 and 35 cfs (Ecology, 1995). Although the Soos Creek value may be a little high, the differences may be attributed to lack of a deeper layer in the model to account for deeper recharge, additional domestic groundwater withdrawals that occur in the area, and failure to incorporate groundwater discharge to Jenkins, Little Soos, and Covington Creeks (for which no data were identified).

Capture Zone Delineation

Using the calibrated groundwater flow model as a base, 1-, 5-, and 10-year capture zones were calculated for each of the three City groundwater extraction areas (Armstrong, Kent, and Clark Springs). We used PATH3D, a general particle tracking program, which can be used for calculating groundwater flow paths and travel times in steady-state or transient, two- or three-dimensional flow fields. Generally speaking, capture zones can be delineated using this software by releasing a number of particles at the groundwater extraction wellheads and tracking the movement of these particles backward in time to their point of origin.

Because the three City groundwater extraction areas are located in areas of relatively high hydraulic conductivity, releasing tracking particles at the wellheads would likely predict relatively tightly focused, narrow capture zones. Particularly for the Armstrong and Kent Springs properties, these capture zones could be unconservatively narrow because the regions of

higher conductivity are in turn surrounded by regions of lower hydraulic conductivity (capture zones tend to spread out more laterally in regions with lower hydraulic conductivity). To mitigate the effect of these high conductivity regions, we developed a hybrid approach in which tracking particles were released in a broader area around the extraction wells roughly corresponding to the dimensions of the higher hydraulic conductivity regions. This results in a larger starting area and consequently yields a broader capture zone.

In addition to the hydraulic parameters developed for the groundwater flow model, capture zone evaluation using PATH3D requires specification of aquifer porosity, saturated thickness, and top elevation.

Porosity

Specific data regarding the porosity of the City aquifers were not identified. We used a value of 0.25 (25%) based on our experience with similar materials at other sites in the area.

Saturated Thickness

We set a default value of 100 feet for saturated thickness. This value was based on the maximum saturated thickness in the model grid. Because PATH3D calculates saturated thickness at runtime for an unconfined aquifer this value was only indicated as a default value.

Top Elevation

We set a default value of 710 feet (10 feet higher than the highest groundwater elevation in the model grid) for the elevation of the top of the City aquifers in PATH3D. Because finite difference cells in the groundwater flow model are all unconfined, PATH3D automatically limits particle travel to top of the water table in individual cells. Therefore, this parameter has little effect on the capture zone evaluation discussed herein.

Sensitivity Analysis and Model Limitations

After obtaining a satisfactory calibration, we performed a limited sensitivity analysis to assess the dependence of the model predicted groundwater elevations and capture zones on various input parameters. This was accomplished by incrementally adjusting the value of one parameter or group of parameters by a small amount, typically 10%, and noting the effect this change had on predicted water levels or capture zones.

We were not able to perform a first order error analysis on the model parameter set. There are too many basic parameters and the values of the parameters vary from location to location across the study area. Adjustment of some key parameters and groups of parameters such as pumping rate at one of the spring sources or river bed conductance for the Cedar River did show the sensitivity of the predicted capture zones to varying parameter values.

The sensitivity analysis indicated that the capture zones are not particularly sensitive to changes in the groundwater influx from the Lake Youngs area or discharge to the Cedar River. This is a fortunate result because the magnitudes of those fluxes are not well known. The capture zones for individual spring sources are not particularly sensitive to changes in pumping rates at the other spring sources. This is a result of the high hydraulic conductivities characteristic of the glacial deposits encountered in the study area and the relatively large spacing between spring sources.

The predicted capture zones are very sensitive to changes in parameters that affect groundwater flow and velocity. These include porosity, hydraulic conductivity, recharge, water table gradient, and surface water flows.

- Porosity is a difficult parameter to measure but is not likely to be a major factor in the accuracy of the predicted capture zones. This is because although halving the soil porosity doubles the predicted capture zone, actual porosity values do not typically vary substantially for the types of sediments encountered in the study area. In the study area, porosity values probably range from 0.2 to 0.3 with a mean of 0.25.

- Hydraulic conductivity is more readily measured in the field and does substantially affect predicted capture zones. Halving the hydraulic conductivity in an area; e.g., east of Kent Springs, halves the upgradient length of the predicted capture zone. This is a parameter that must be measured because typical values in the study area probably range from 10 to greater than 10,000 ft/day (0.0035 to 3.5 cm/sec). Fortunately, some 15 pumping tests with hydraulic conductivity estimates were identified in the study area. Additional testing may be needed in some key areas where pumping tests have not been performed in the past (e.g., north of Armstrong Springs, southwest of Ravensdale Lake, and south of Retreat Lake).

- Recharge is not easily measured and based on the modeling analysis greatly affects predicted capture zones. Because recharge is distributed over an area, the effect of a change in recharge is not directly proportional as it is for porosity or hydraulic conductivity. However our sensitivity analysis indicated that increasing the recharge rate from 30 in/yr to 40 in/yr in the Retreat Lake area nearly doubled the length of the capture zones from Clark and Kent Springs. This is significant because our uncertainty in the recharge rate for this area is probably on the order of 10 to 15 in/yr for precipitation falling on the outwash areas and 5 to 15 in/yr for the surrounding bedrock and till-capped upland areas.

- Water table gradient is readily measured in locations where suitable wells are available and greatly affects predicted capture zones. Here doubling the water table gradient from 0.002 to 0.004 near Armstrong Springs doubles the length of predicted capture zones. Water table gradient varies seasonally and probably varies on longer cycles (years to decades in length) in response to changes in precipitation recharge in the study area. For this reason, quarterly monitoring over a several year period may be needed to statistically characterize the expected value and extremes for water table gradient. These data could then be built into a groundwater model to better characterize mean and extreme values for capture zones.

- Surface water flows are readily measured but it takes some effort to evaluate their effect on underlying groundwater. Surface water flows indirectly affect capture zones. For example, numerical models and hydrogeologic mapping predict capture zones from Kent Springs and the Covington wellfield which extend well up to Retreat Lake when groundwater discharge from Lake Sawyer is assumed minimal. If the groundwater discharge from Lake Sawyer was found to be a substantial portion of the local water budget (at least 5 cfs), which is conceivable based on the Lake Sawyer study (Hart Crowser, 1990), then the model sensitivity analysis indicated that the wells get more water from the lake. This alters and shortens the predicted capture zones. Similarly, if baseflow from Ravensdale Creek is a significant fraction of the local water budget, then the capture zones could be cut off west of Ravensdale Creek.

One final parameter which was not evaluated for this modeling effort is the sensitivity to downward flow to deeper aquifers and into bedrock. Lacking any real data on gradients, hydrogeologic units at depth, hydraulic properties, or vertical flow rates, we elected not to build this into the current numerical model. A review of the water budget of the current model indicates that the model predicts a groundwater discharge rate to Soos Creek of some 38 cfs. This may be high by 20 cfs or more. Some portion of the "extra" water may in fact be carried out of the basin in other surface water drainages; e.g., Covington Creek. A larger portion could be migrating downward to deeper aquifers which discharge to the Green River.

The effect of this extra discharge to Soos Creek is to exaggerate the groundwater flow rate in the western portion of the model. If we are 20 cfs high on our estimate of discharge to Soos Creek (half of the total discharge) then we are probably a factor of two high on our estimated groundwater flow rates near Armstrong Springs. This means that the predicted capture zones may be twice what they should be. We do not think that the modeled capture zones are this far off because the groundwater elevations and water table gradients in the western half of the model are reasonably close to observed values. However, this issue does need further exploration.

Table B-1 - Runoff Zone Calculations for Kent Numerical Model

Model Zone	Surface Water(1) Catchment Area ft2	Runoff from(2) Precipitation in/yr	Injection (3) Area ft2	Recharge(4) Rate ft/day	Model Zone(5) Recharge Rate ft/day
5	14,544,722	10	4,030,000	0.0082	0.0151
6	19,293,292	10	1,738,000	0.0253	0.0322
7	9,259,117	10	1,273,000	0.0166	0.0234
8	18,034,260	10	1,455,000	0.0283	0.0351
13	13,835,176	10	6,375,000	0.0050	0.0118
14	81,038,073	10	3,268,000	0.0566	0.0634
15	23,158,910	10	10,060,000	0.0053	0.0121
16	71,436,861	10	2,886,000	0.0565	0.0633
17	10,271,963	10	2,155,000	0.0109	0.0177
20	41,838,457	10	1,383,000	0.0690	0.0759

Notes:

1 - Estimated area of contributing surface water subbasin.

2 - Calculated as precipitation falling on low permeability area minus groundwater recharge and evapotranspiration.

3 - Total area of model cells receiving runoff from adjacent low permeability area.

4 - Calculated as ratio of catchment area to injection area times runoff rate.

5 - Calculated as rate (4) plus areal recharge rate for Clark Springs area (0.0068 ft/day [30 in/yr]).

350801\recharge.xls

Table B-2 - River Node Parameters

Row	Column	Stage (ft)	Conductance (1/Day)	Bottom Elevation (ft)
Cedar River				
6	72	541.5	50000	501.3
1	48	427.3	40000	402.2
2	48	430.7	40000	405.4
2	49	435.3	40000	409.9
2	50	441	40000	415.3
2	51	446.6	40000	420.7
3	51	451.5	40000	425.3
3	52	456.1	40000	429.7
3	53	468.5	10000	441.7
3	54	471.8	40000	444.8
3	55	474.9	40000	447.7
3	56	476.4	40000	449.2
3	57	477.7	40000	450.5
3	58	479.2	40000	451.9
3	59	481	40000	453.6
3	60	483	40000	455.5
3	61	485	40000	457.4
3	62	487	40000	459.3
3	63	488.9	40000	461.2
3	64	491.2	40000	463.4
3	65	494.2	40000	466.2
3	66	498.6	40000	470.4
4	52	460.4	40000	433.9
4	53	464.4	40000	437.7
4	66	504.8	40000	476.3
4	67	509.7	40000	481
4	68	515.4	40000	486.5
4	69	522.7	40000	493.4
5	69	526.7	40000	497.3
5	70	530.8	40000	501.2
6	70	536.3	40000	506.5
6	71	539	40000	509.1
1	39	415	40000	407
1	40	415	40000	407
1	41	415	40000	407
1	42	415	40000	407
1	43	415	40000	407
1	44	415	40000	407
1	45	415	40000	407
1	46	415	40000	407
1	47	415	40000	407

Table B-2 - River Node Parameters

Row	Column	Stage (ft)	Conductance (1/Day)	Bottom Elevation (ft)
Soos Creek				
53	1	340	10000	280
52	1	340	10000	280
14	5	340	20000	280
15	5	340	20000	280
16	5	340	20000	280
18	5	340	20000	280
19	5	340	20000	280
20	5	340	20000	280
17	5	340	20000	280
51	1	340	10000	280
50	1	340	10000	280
49	1	340	10000	280
48	1	340	10000	280
47	1	340	10000	280
46	1	340	10000	280
45	1	340	10000	280
21	4	340	20000	280
22	4	340	20000	280
23	4	340	20000	280
24	3	340	20000	280
25	3	340	20000	280
27	3	340	20000	280
26	3	340	20000	280
28	3	340	20000	280
29	3	340	20000	280
30	3	340	20000	280
31	3	340	20000	280
32	3	340	20000	280
33	3	340	20000	280
34	2	340	15000	280
35	1	340	10000	280
36	1	340	10000	280
38	1	340	10000	280
40	1	340	10000	280
39	1	340	10000	280
41	1	340	10000	280
42	1	340	10000	280
37	1	340	10000	280
43	1	340	10000	280
44	1	340	10000	280
3	16	380	3000	330
4	17	380	1000	330
2	14	380	3000	330
5	14	360	1000	330
6	9	360	3000	330

Table B-2 - River Node Parameters

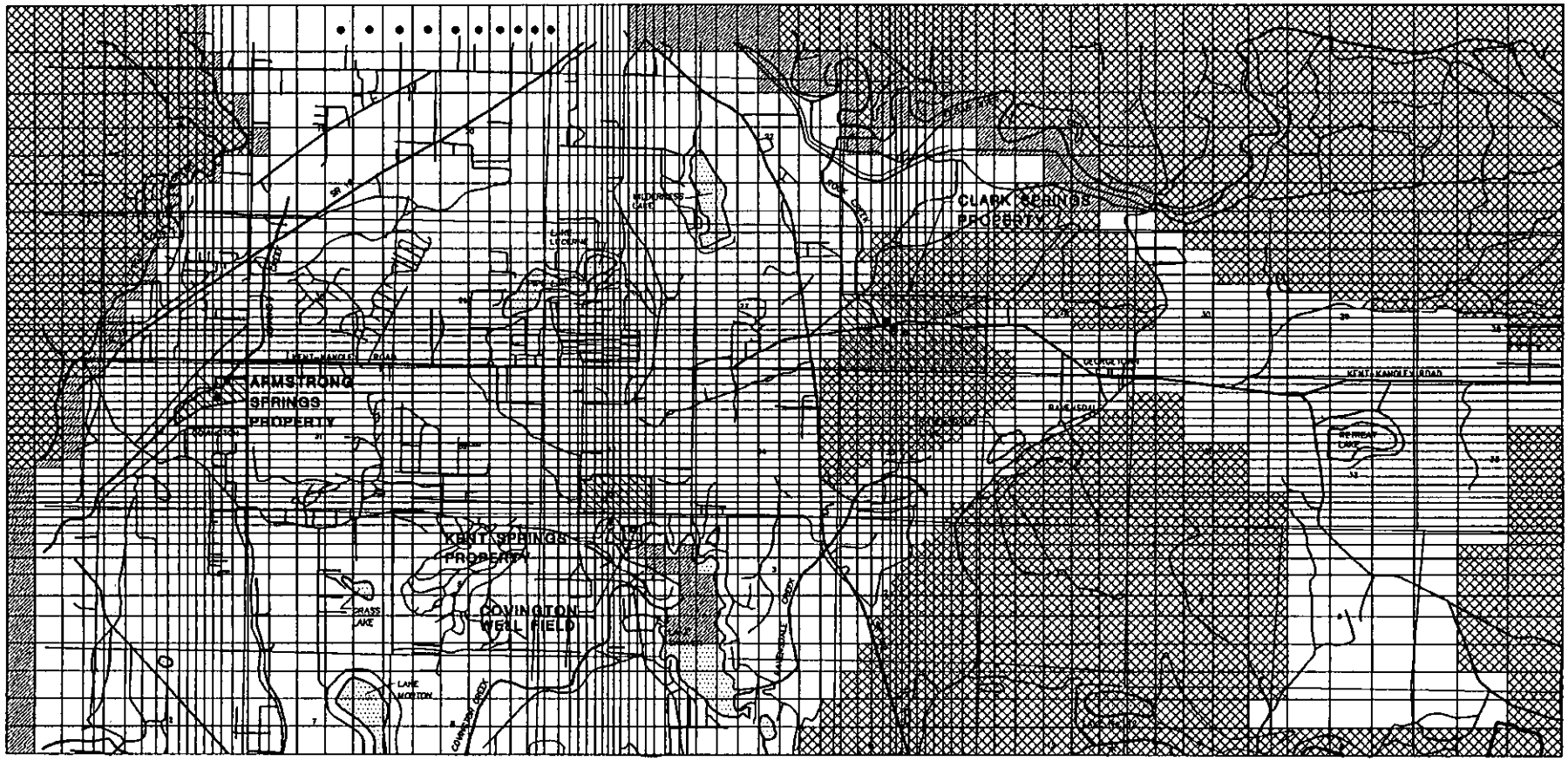
Row	Column	Stage (ft)	Conductance (1/Day)	Bottom Elevation (ft)
Soos Creek, Continued				
10	7	350	20000	330
9	7	350	20000	330
11	7	350	20000	330
8	8	355	3000	330
7	9	355	3000	330
12	6	345	20000	330
13	6	345	20000	330
1	12	380	3000	330
Lake Sawyer				
45	41	517	100	470
45	42	517	100	470
46	42	517	100	470
46	43	517	100	470
46	44	517	100	470
47	44	517	100	470
47	45	517	100	470
48	44	517	100	470
48	45	517	100	470
49	44	517	100	470
49	45	517	100	470
49	43	517	100	470
45	40	517	100	470
45	39	517	100	470
46	41	517	100	470
45	44	517	100	470

350801\rivernod.xls

cvd 11/[redacted]5 1=6000 hc~pcp

35080130

Model Boundaries



- Well or Drain Node
- River Node
- Inactive Node

N

0 6000 12000

Scale in Feet

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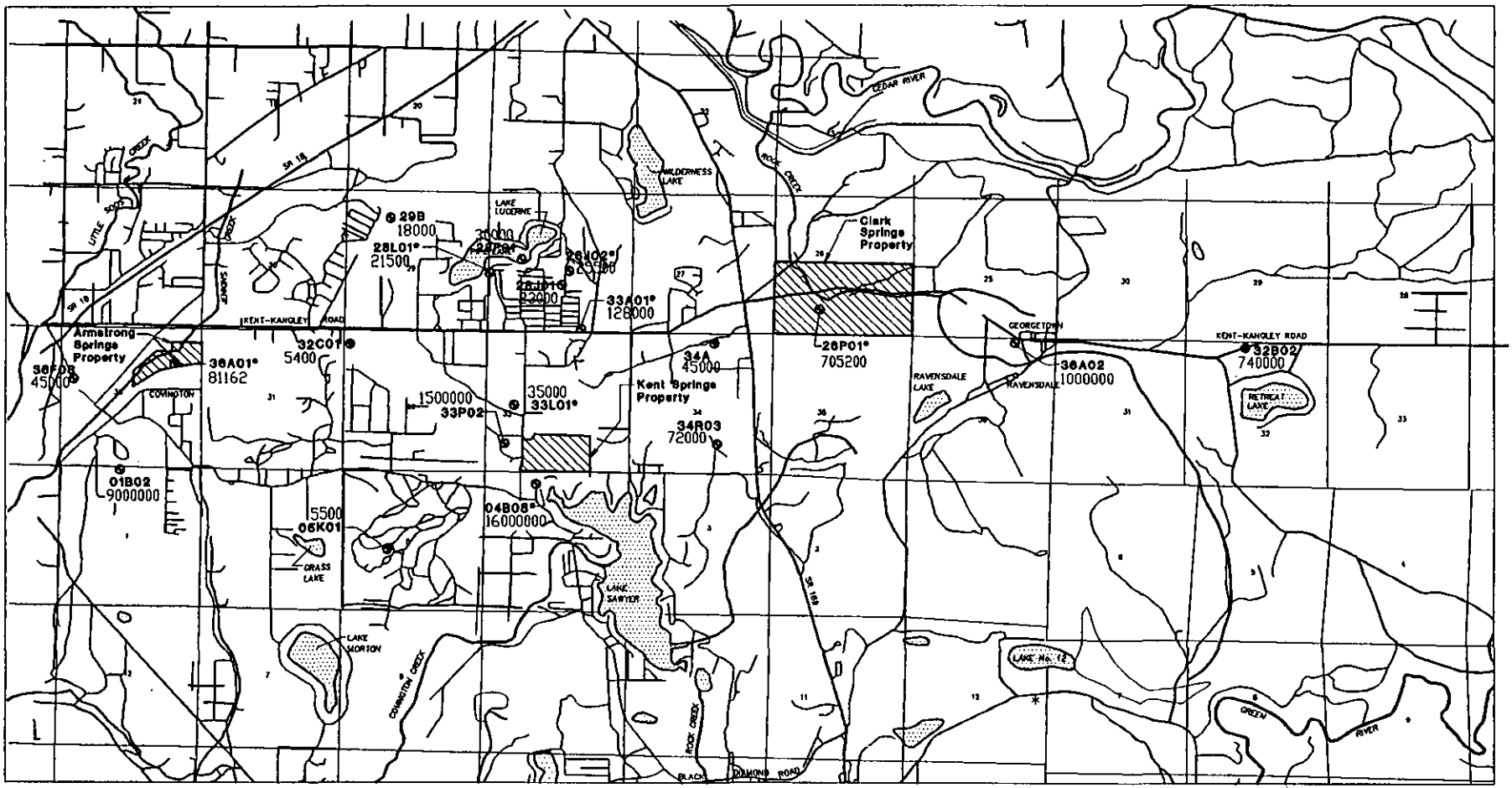
Figure B-1

Pumping Test Transmissivity Data



0 6000 12000
Scale in Feet

29B Well Location and Number

18000 Transmissivity in gpd/ft

. (Value Averaged from Several Pumping Tests)

N

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Figure B-2

Hydraulic Conductivity Distribution

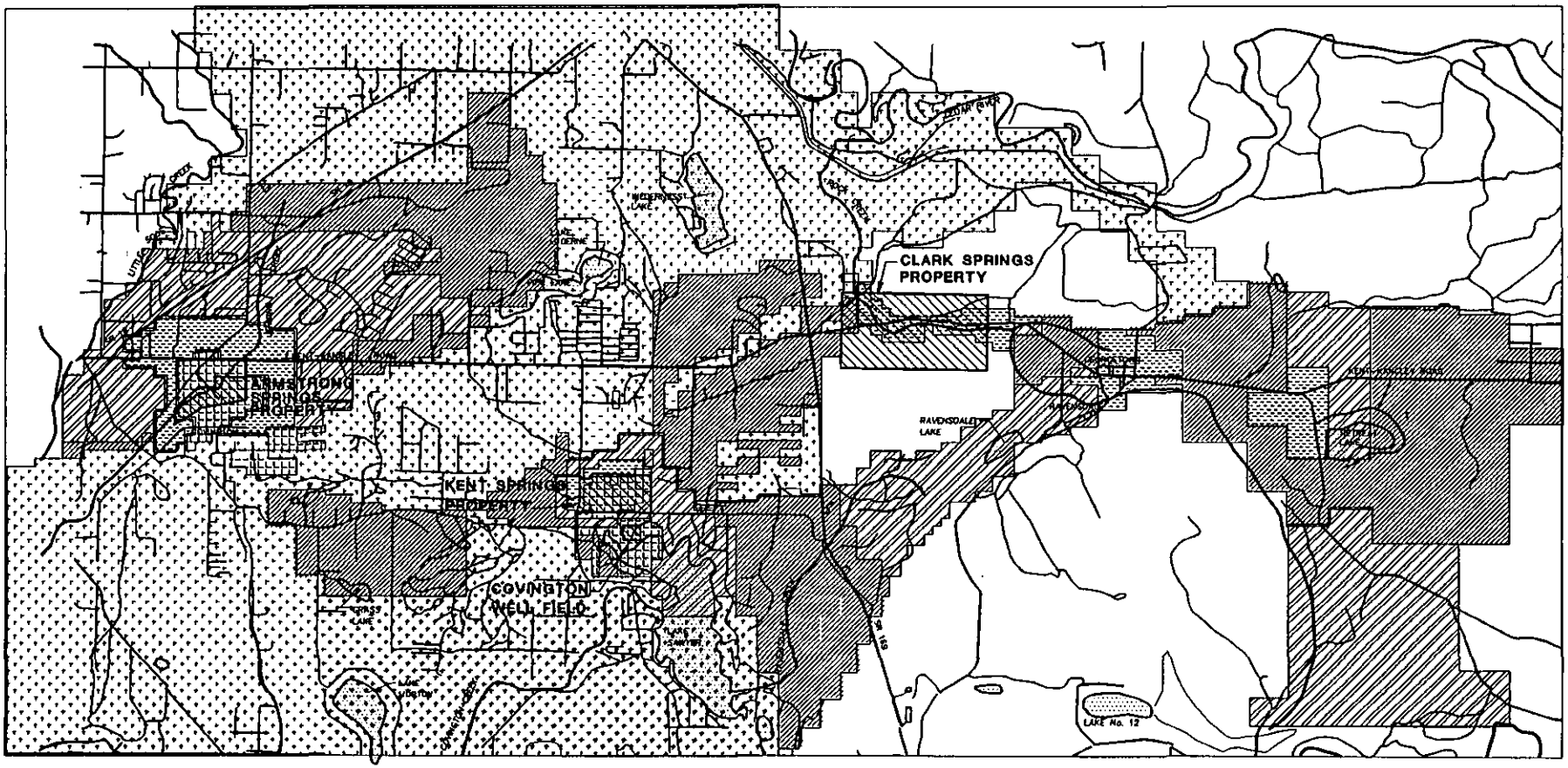

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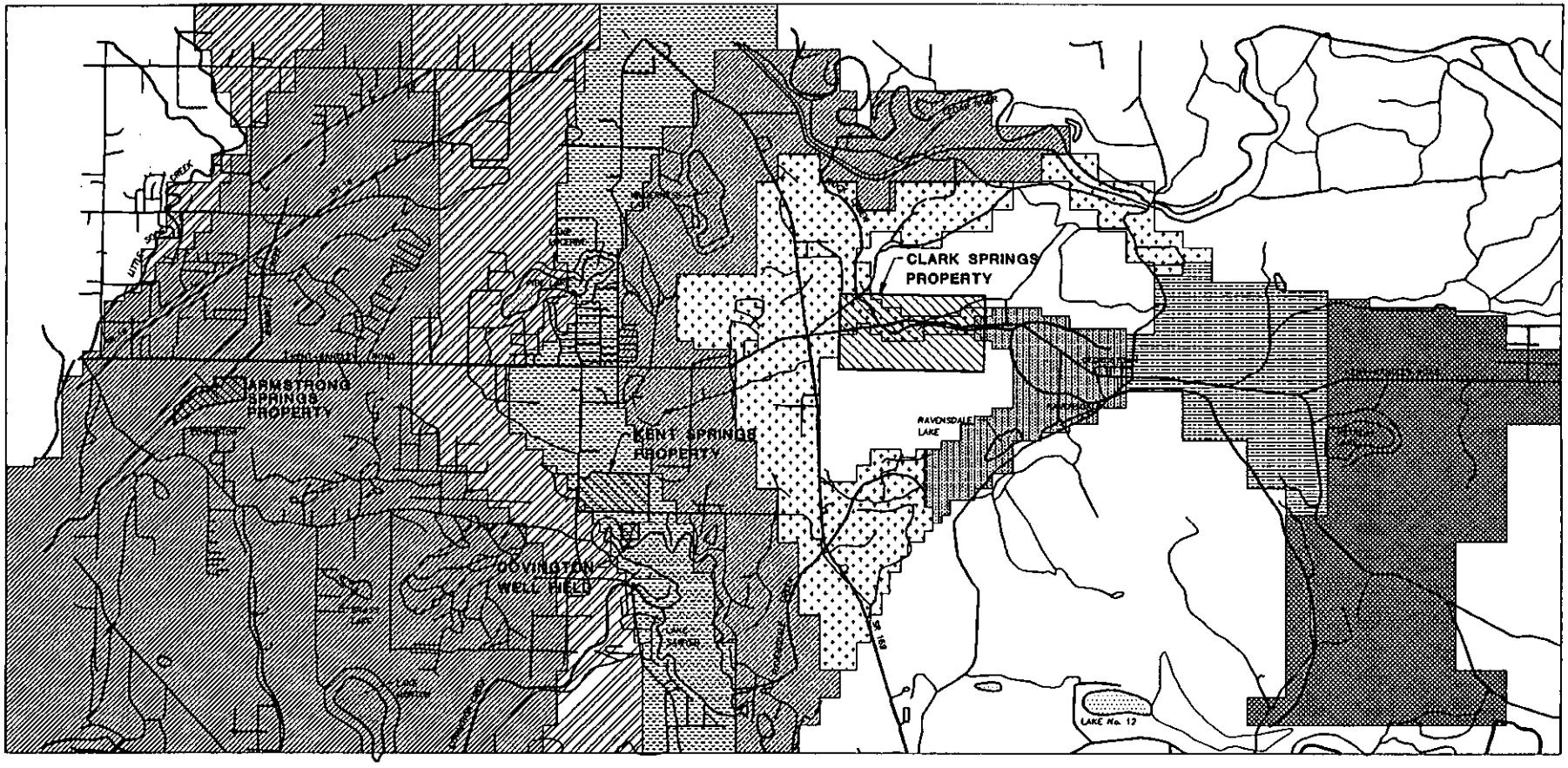
Figure B-3

Bottom Elevation Distribution



Bottom Elevation in feet MSL

240 – 300	460 – 500
310 – 350	510 – 550
360 – 400	560 – 600
410 – 450	610 – 720

N

0 6000 12000
Scale in Feet

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Figure B-4

Recharge Distribution

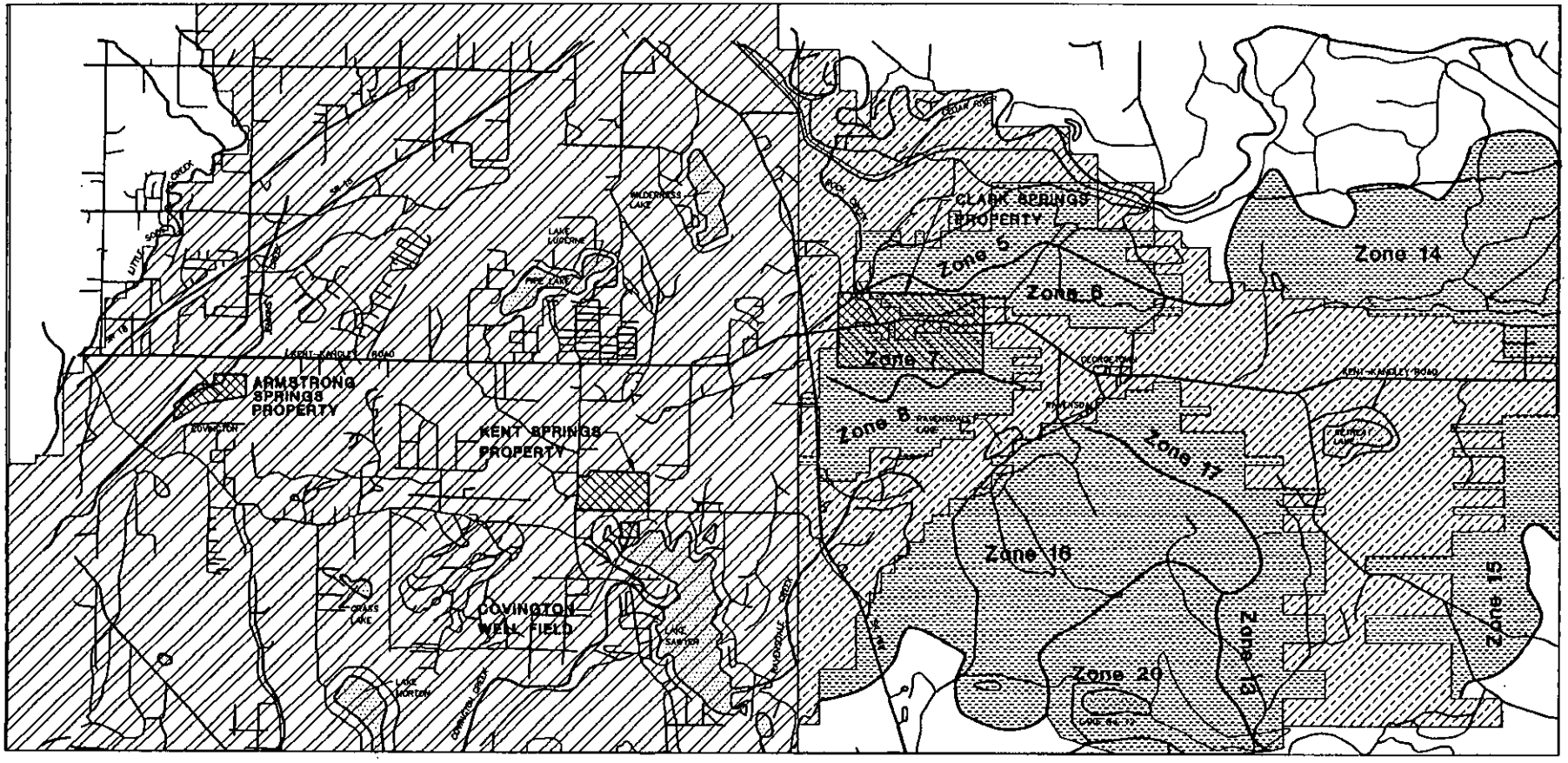

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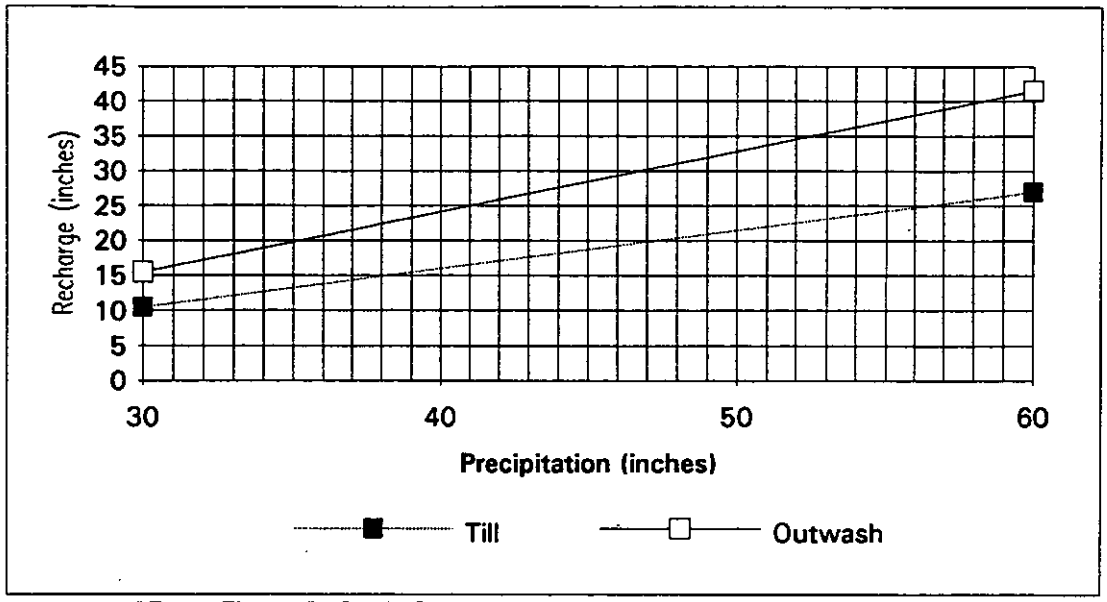
Figure B-5

Precipitation–Recharge–Runoff Relations Used in Groundwater Model



*From Figure B, Draft Geohydrology and Quality of Groundwater Report for East King County Ground Water Advisory Committee; after work completed for the South King County Groundwater Management Plan for the Covington Upland (USGS, 1994).

	Rates in in/yr					
			Evapo-	Outwash	Till/Bedrock Uplands	
Model Area	Precipitation(1)		transpiration(2)	Recharge(3)	Recharge (3)	Runoff (4)
Eastern	Landsburg	58	19	40	26	13
Western	80% of Landsburg	46.4	21	30	20	5.4

Notes:

(1) From data collected by NOAA.
(2) South King County Ground Water Management Plan.
(3) Read from figure above.
(4) Calculated as P - Et - R.

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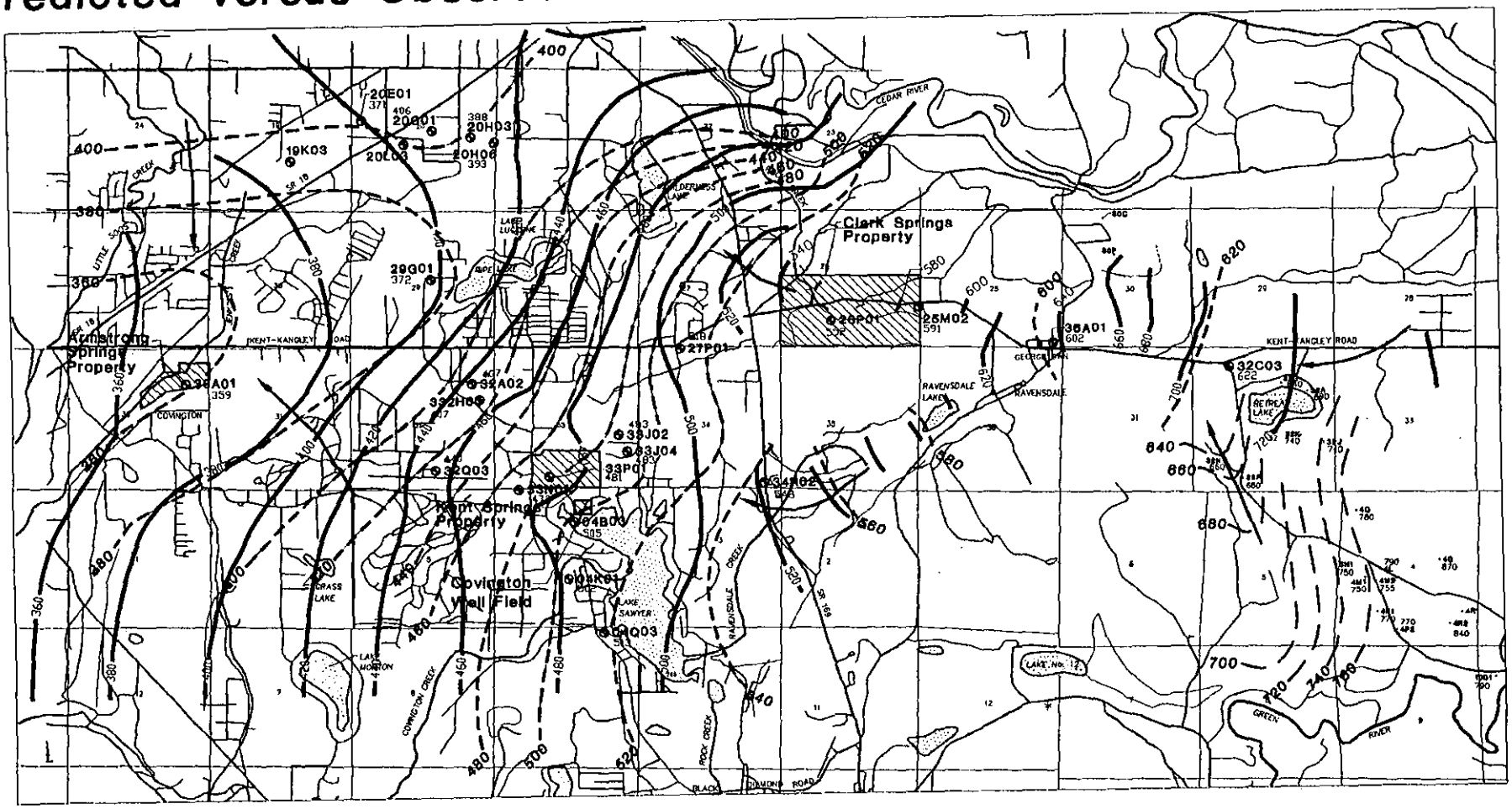
Figure B-6

35080132

Predicted versus Observed Groundwater Elevation



⊕04Q03	Monitoring Well Location and Number
510	Groundwater Elevation in Feet (April 1994)
•27P01	Well Location and Number from Well Log Records.
---400---	Groundwater Elevation Contour in Feet from April 1994
— —700	Groundwater Elevation Contour in Feet from Well Log
—380—	Predicted Groundwater Elevation in Feet
←	Inferred Groundwater Flow Direction

N

0 6000 12000

Scale in Feet

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Figure B-7

Appendix C

APPENDIX C
MANAGEMENT TASK DATABASE

TASK/COOPERATIVE

31-Oct-95

Task	Implementation Lead	Forestry	Industrial Commercial	Mining	Residential	Transportation Corridor
Conduct groundwater monitoring for analysis of nitrate according to groundwater monitoring plan. Establish nitrate early warning valve (EWV) to allow for timely action in the event of increasing nitrate concentrations.	Purveyors	No	No	No	Yes	No
Promote and coordinate public education program for household hazardous materials use, storage, and disposal within the WHPA.	County	No	No	No	Yes	No
Inventory forest ownership, the extent of harvesting, and the harvesting practices used with the WHPA.	Purveyors	Yes	No	No	No	No
Establish formal communication with first responders	Purveyors	No	No	No	No	Yes
Update emergency response organizations on WHPA location.	Purveyors	No	No	No	No	Yes
Work with responsible parties to assess adequacy of facilities and establish joint priority for storm water upgrades.	Purveyors	No	Yes	No	No	Yes
Consider seeking designation of aquifer(s) as "special protection areas" or other special designations.	Purveyors	No	No	No	Yes	No
Support the implementation of state law/regulation on septic system inspection and maintenance programs.	Purveyors	No	No	No	Yes	No
Review annual reports produced under SARA Title III to document inventory of chemicals used in the WHPA.	Purveyors	No	Yes	No	No	No
Develop data on number and size of exempt underground tanks within 1-year time of travel zone.	Purveyors	No	Yes	No	Yes	No
Fund Farm Plans through the local Conservation District which focus in wellhead zones.	County	No	No	No	Yes	No
Request County, State, and private land owners/managers to utilize vegetation management practices which protect water quality within the WHPA.	Purveyors	Yes	Yes	No	No	Yes
Encourage development and use of BMPs for large land units (large residential developments, schools, golf courses, parks, mining, and forest parcels).	Purveyors	Yes	Yes	Yes	Yes	No
Monitor use of BMPs on large land parcels.	Purveyors	Yes	Yes	Yes	Yes	No
Support King County in seeking delegation of well drilling regulatory program for advance notice of drilling and inspection of well construction.	County	No	Yes	No	Yes	No

Task	Implementation Lead	Forestry	Industrial Commercial	Mining	Residential	Transportation Corridor
Review routine leak detection procedures for sewer lines in the WHPA.	Purveyors	No	No	No	Yes	No
Request utilities to use "leakproof" piping for sewer for any new construction in wellhead zones - accelerate upgrade and replacement of existing risky lines.	Purveyors	No	Yes	No	Yes	No
Participate in a regional groundwater data development and management effort to assure that an adequate regional groundwater monitoring program is developed.	Purveyors	Yes	Yes	Yes	Yes	Yes
Provide continual coordination of environmental education efforts in the County.	County	No	No	No	Yes	No
Create and operate an IMPLEMENTATION STEERING GROUP to assure focus of applicable state and local programs to wellhead protection areas. Review management strategies to incorporate new data, requirements, and approaches.	Purveyors	Yes	Yes	Yes	Yes	Yes
Conduct groundwater monitoring for analysis of pesticides and herbicides according to groundwater monitoring plan.	Purveyors	Yes	Yes	No	Yes	Yes
Promote research on the impacts of storm water discharge from residential areas.	County	No	No	No	Yes	No
Document the type and amount of herbicide application with focus on transportation corridors, forestry, agriculture, and recreation parcels.	Purveyors	Yes	No	No	No	Yes
Investigate the need for re-routing transport of hazardous materials to areas outside of wellhead zones.	Purveyors	No	No	No	No	Yes
Locate signs within the WHPA along transportation routes - "Wellhead Protection Area."	Purveyors	No	No	No	No	Yes
Communicate location of the WHPA and wellhead protection concerns to mine operators.	Purveyors	No	No	Yes	No	No
Prioritize investigation of contaminated and potentially contaminated sites within the WHPA.	Ecology	Yes	Yes	Yes	No	Yes
Monitor Ecology's progress on the cleanup of MTCA and LUST sites within the WHPA.	Purveyors	No	Yes	Yes	No	No
Communicate location of WHPA to industrial/commercial site owners.	Purveyors	No	Yes	No	No	No
Communicate the extent of wellhead protection areas to the County Planning Department for consideration in critical areas regulation, susceptibility mapping, and permitting.	Purveyors	Yes	Yes	Yes	Yes	Yes
Review water quality data generated under the general NPDES Storm Water Permit.	Purveyors	No	Yes	Yes	No	No

TASK/REGULATORY

31-Oct-95

Task	Implementation Lead	Forestry	Industrial Commercial	Mining	Residential	Transportation Corridors
Encourage requirement of as-builts of new septic systems (prepared by designer) to be recorded with the deed.	County-Health	No	No	No	Yes	No
Review annual reports produced under SARA Title III to document inventory of chemicals used in the WHPA.	Purveyors	No	Yes	No	No	No
Support King County in seeking delegation of well drilling regulatory program for advance notice of drilling and inspection of well construction.	County	No	Yes	No	Yes	No
Encourage careful analysis and adequate requirements for siting, operation, and reclaimation of mining in the WHPA during SEPA review.	County	No	No	Yes	No	No
Assure that the hydrogeologic impact of development of parcels within wellhead protection areas is adequately analyzed during SEPA review.	County	Yes	Yes	Yes	Yes	Yes
Create and operate an IMPLEMENTATION STEERING GROUP to assure focus of applicable state and local programs to wellhead protection areas. Review management strategies to incorporate new data, requirements, and approaches.	Purveyors	Yes	Yes	Yes	Yes	Yes
Require mine operators to install monitoring wells capable to assess potential impacts from site operations for sites within the WHPA.	Ecology	No	No	Yes	No	No
Prioritize investigation of contaminated and potentially contaminated sites within the WHPA.	Ecology	Yes	Yes	Yes	No	Yes
Communicate the extent of wellhead protection areas to the County Planning Department for consideration in critical areas regulation, susceptibility mapping, and permitting.	Purveyors	Yes	Yes	Yes	Yes	Yes
Encourage periodic monitoring of drywells in the WHPA.	County	No	Yes	No	Yes	Yes

TASK/PLANNING

31-Oct-95

Task	Implementation Lead	Forestry	Industrial Commercial	Mining	Residential	Transportation Corridors
Conduct groundwater monitoring for analysis of nitrate according to groundwater monitoring plan. Establish nitrate early warning valve (EWV) to allow for timely action in the event of increasing nitrate concentrations.	Purveyors	No	No	No	Yes	No
Consider seeking designation of aquifer(s) as "special protection areas" or other special designations.	Purveyors	No	No	No	Yes	No
Encourage careful analysis and adequate requirements for siting, operation, and reclaimation of mining in the WHPA during SEPA review.	County	No	No	Yes	No	No
Assure that the hydrogeologic impact of development of parcels within wellhead protection areas is adequately analyzed during SEPA review.	County	Yes	Yes	Yes	Yes	Yes
Create and operate an IMPLEMENTATION STEERING GROUP to assure focus of applicable state and local programs to wellhead protection areas. Review management strategies to incorporate new data, requirements, and approaches.	Purveyors	Yes	Yes	Yes	Yes	Yes
Conduct groundwater monitoring for analysis of pesticides and herbicides according to groundwater monitoring plan.	Purveyors	Yes	Yes	No	Yes	Yes
Investigate the need for re-routing transport of hazardous materials to areas outside of wellhead zones.	Purveyors	No	No	No	No	Yes
Communicate the extent of wellhead protection areas to the County Planning Department for consideration in critical areas regulation, susceptibility mapping, and permitting.	Purveyors	Yes	Yes	Yes	Yes	Yes
Review water quality data generated under the general NPDES Storm Water Permit.	Purveyors	No	Yes	Yes	No	No

TASK/LAND USE

31-Oct-95

Task	Implementation Lead	Forestry	Industrial Commercial	Mining	Residential	Transportation Corridors
Consider seeking designation of aquifer(s) as "special protection areas" or other special designations.	Purveyors	No	No	No	Yes	No
Encourage careful analysis and adequate requirements for siting, operation, and reclaimation of mining in the WHPA during SEPA review.	County	No	No	Yes	No	No
Assure that the hydrogeologic impact of development of parcels within wellhead protection areas is adequately analyzed during SEPA review.	County	Yes	Yes	Yes	Yes	Yes
Create and operate an IMPLEMENTATION STEERING GROUP to assure focus of applicable state and local programs to wellhead protection areas. Review management strategies to incorporate new data, requirements, and approaches.	Purveyors	Yes	Yes	Yes	Yes	Yes
Communicate location of the WHPA and wellhead protection concerns to mine operators.	Purveyors	No	No	Yes	No	No
Communicate the extent of wellhead protection areas to the County Planning Department for consideration in critical areas regulation, susceptibility mapping, and permitting.	Purveyors	Yes	Yes	Yes	Yes	Yes
Review water quality data generated under the general NPDES Storm Water Permit.	Purveyors	No	Yes	Yes	No	No

TASK/DATA/DATA MANAGEMENT

31-Oct-95

Task	Implementation Lead	Forestry	Industrial Commercial	Mining	Residential	Transportation Corridors
Conduct groundwater monitoring for analysis of nitrate according to groundwater monitoring plan. Establish nitrate early warning valve (EWV) to allow for timely action in the event of increasing nitrate concentrations.	Purveyors	No	No	No	Yes	No
Survey pesticide and herbicide use/work with Cooperative Extension and County with available data to modify future monitoring and education plans.	Purveyors	No	Yes	No	Yes	No
Inventory forest ownership, the extent of harvesting, and the harvesting practices used with the WHPA.	Purveyors	Yes	No	No	No	No
Document the location and use of petroleum pipelines within the WHPA, and develop appropriate emergency procedures.	Purveyors	No	No	No	No	Yes
Document use of hazardous materials in mining support activity	Purveyors	No	No	Yes	No	No
Develop emergency response procedures for sewer force main breaks within the 1-year zone.	Purveyors	No	No	No	Yes	No
Coordinate and promote the evaluation of possible storm water routing, detention, retention priorities.	Purveyors	No	No	No	No	Yes
Consider seeking designation of aquifer(s) as "special protection areas" or other special designations.	Purveyors	No	No	No	Yes	No
Develop data on number and size of exempt underground tanks within 1-year time of travel zone.	Purveyors	No	Yes	No	Yes	No
Monitor use of BMPs on large land parcels.	Purveyors	Yes	Yes	Yes	Yes	No
Support King County in seeking delegation of well drilling regulatory program for advance notice of drilling and inspection of well construction.	County	No	Yes	No	Yes	No
Inventory abandoned or unused wells in the 1- and 5-year time of travel zones. Educate owners about proper well construction and abandonment within the WHPA.	Purveyors	No	Yes	No	Yes	No
Participate in a regional groundwater data development and management effort to assure that an adequate regional groundwater monitoring program is developed.	Purveyors	Yes	Yes	Yes	Yes	Yes
Create and operate an IMPLEMENTATION STEERING GROUP to assure focus of applicable state and local programs to wellhead protection areas. Review management strategies to incorporate new data, requirements, and approaches.	Purveyors	Yes	Yes	Yes	Yes	Yes

Task	Implementation Lead	Forestry	Industrial Commercial	Mining	Residential	Transportation Corridors
Conduct groundwater monitoring for analysis of pesticides and herbicides according to groundwater monitoring plan.	Purveyors	Yes	Yes	No	Yes	Yes
Promote research on the impacts of storm water discharge from residential areas.	County	No	No	No	Yes	No
Document the type and amount of herbicide application with focus on transportation corridors, forestry, agriculture, and recreation parcels.	Purveyors	Yes	No	No	No	Yes
Require mine operators to install monitoring wells capable to assess potential impacts from site operations for sites within the WHPA.	Ecology	No	No	Yes	No	No
Prioritize investigation of contaminated and potentially contaminated sites within the WHPA.	Ecology	Yes	Yes	Yes	No	Yes
Monitor Ecology's progress on the cleanup of MTCA and LUST sites within the WHPA.	Purveyors	No	Yes	Yes	No	No
Communicate the extent of wellhead protection areas to the County Planning Department for consideration in critical areas regulation, susceptibility mapping, and permitting.	Purveyors	Yes	Yes	Yes	Yes	Yes
Encourage periodic monitoring of drywells in the WHPA.	County	No	Yes	No	Yes	Yes
Review water quality data generated under the general NPDES Storm Water Permit.	Purveyors	No	Yes	Yes	No	No

TASK/EDUCATION

31-Oct-95

Task	Implementation Lead	Forestry	Industrial Commercial	Mining	Residential	Transportation Corridors
Promote and coordinate public education program for household hazardous materials use, storage, and disposal within the WHPA.	County	No	No	No	Yes	No
Consider seeking designation of aquifer(s) as "special protection areas" or other special designations.	Purveyors	No	No	No	Yes	No
Support the implementation of state law/regulation on septic system inspection and maintenance programs.	Purveyors	No	No	No	Yes	No
Participate in education program to notify public of impact of septic systems to the WHPA.	County-Health	No	No	No	Yes	No
Promote and coordinate public education program for proper septic system maintenance and hazardous waste disposal.	County-Health	No	No	No	Yes	No
Review annual reports produced under SARA Title III to document inventory of chemicals used in the WHPA.	Purveyors	No	Yes	No	No	No
Develop data on number and size of exempt underground tanks within 1-year time of travel zone.	Purveyors	No	Yes	No	Yes	No
Promote and coordinate public program to educate owners of exempt underground tanks of the hazards they represent, methods of leak detection, proper removal and closure procedures.	County	No	Yes	No	Yes	No
Fund Farm Plans through the local Conservation District which focus in wellhead zones.	County	No	No	No	Yes	No
Encourage development and use of BMPs for large land units (large residential developments, schools, golf courses, parks, mining, and forest parcels).	Purveyors	Yes	Yes	Yes	Yes	No
Monitor use of BMPs on large land parcels.	Purveyors	Yes	Yes	Yes	Yes	No
Inventory abandoned or unused wells in the 1- and 5-year time of travel zones. Educate owners about proper well construction and abandonment within the WHPA.	Purveyors	No	Yes	No	Yes	No
Review routine leak detection procedures for sewer lines in the WHPA.	Purveyors	No	No	No	Yes	No
Request utilities to use "leakproof" piping for sewer for any new construction in wellhead zones - accelerate upgrade and replacement of existing risky lines.	Purveyors	No	Yes	No	Yes	No

Task	Implementation Lead	Forestry	Industrial Commercial	Mining	Residential	Transportation Corridors
Provide continual coordination of environmental education efforts in the County.	County	No	No	No	Yes	No
Create and operate an IMPLEMENTATION STEERING GROUP to assure focus of applicable state and local programs to wellhead protection areas. Review management strategies to incorporate new data, requirements, and approaches.	Purveyors	Yes	Yes	Yes	Yes	Yes
Locate signs within the WHPA along transportation routes - "Wellhead Protection Area."	Purveyors	No	No	No	No	Yes
Communicate location of the WHPA and wellhead protection concerns to mine operators.	Purveyors	No	No	Yes	No	No
Communicate location of WHPA to industrial/commercial site owners.	Purveyors	No	Yes	No	No	No
Communicate the extent of wellhead protection areas to the County Planning Department for consideration in critical areas regulation, susceptibility mapping, and permitting.	Purveyors	Yes	Yes	Yes	Yes	Yes

TASKS TO BE IMPLEMENTED BY COUNTY/COUNTY-HEALTH

31-Oct-95

Task: Promote and coordinate public education program for household hazardous materials use, storage, and disposal within the WHPA.

Task: Encourage requirement of as-builts of new septic systems (prepared by designer) to be recorded with the deed.

Task: Participate in education program to notify public of impact of septic systems to the WHPA.

Task: Promote and coordinate public education program for proper septic system maintenance and hazardous waste disposal.

Task: Promote and coordinate public program to educate owners of exempt underground tanks of the hazards they represent, methods of leak detection, proper removal and closure procedures.

Task: Fund Farm Plans through the local Conservation District which focus in wellhead zones.

Task: Support King County in seeking delegation of well drilling regulatory program for advance notice of drilling and inspection of well construction.

Task: Encourage careful analysis and adequate requirements for siting, operation, and reclaimation of mining in the WHPA during SEPA review.

Task: Assure that the hydrogeologic impact of development of parcels within wellhead protection areas is adequately analyzed during SEPA review.

Task: Provide continual coordination of environmental education efforts in the County.

Task: Promote research on the impacts of storm water discharge from residential areas.

Task: Require sewer hook up for all industrial/commercial facilities within the WHPA, if sewer service is reasonably available.

Task: Encourage periodic monitoring of drywells in the WHPA.

TASKS TO BE IMPLEMENTED BY ECOLOGY

31-Oct-95

Task: Require mine operators to install monitoring wells capable to assess potential impacts from site operations for sites within the WHPA.

Task: Prioritize investigation of contaminated and potentially contaminated sites within the WHPA.

Task: Encourage Ecology and County inspections of RCRA hazardous waste generator facilities within the WHPA.

TASKS TO BE IMPLEMENTED BY PURVEYORS

31-Oct-95

Task: Conduct groundwater monitoring for analysis of nitrate according to groundwater monitoring plan. Establish nitrate early warning valve (EWV) to allow for timely action in the event of increasing nitrate concentrations.

Task: Survey pesticide and herbicide use/work with Cooperative Extension and County with available data to modify future monitoring and education plans.

Task: Inventory forest ownership, the extent of harvesting, and the harvesting practices used with the WHPA.

Task: Document the location and use of petroleum pipelines within the WHPA, and develop appropriate emergency procedures.

Task: Document use of hazardous materials in mining support activity

Task: Establish formal communication with first responders

Task: Update emergency response organizations on WHPA location.

Task: Develop emergency response procedures for sewer force main breaks within the 1-year zone.

Task: Coordinate and promote the evaluation of possible storm water routing, detention, retention priorities.

Task: Work with responsible parties to assess adequacy of facilities and establish joint priority for storm water upgrades.

Task: Consider seeking designation of aquifer(s) as "special protection areas" or other special designations.

Task: Support the implementation of state law/regulation on septic system inspection and maintenance programs.

Task: Review annual reports produced under SARA Title III to document inventory of chemicals used in the WHPA.

Task: Develop data on number and size of exempt underground tanks within 1-year time of travel zone.

Task: Request County, State, and private land owners/managers to utilize vegetation management practices which protect water quality within the WHPA.

Task: Encourage development and use of BMPs for large land units (large residential developments, schools, golf courses, parks, mining, and forest parcels).

Task: Monitor use of BMPs on large land parcels.

Task: Inventory abandoned or unused wells in the 1- and 5-year time of travel zones. Educate owners about proper well construction and abandonment within the WHPA.

Task: Review routine leak detection procedures for sewer lines in the WHPA.

Task: Request utilities to use "leakproof" piping for sewer for any new construction in wellhead zones - accelerate upgrade and replacement of existing risky lines.

Task: Participate in a regional groundwater data development and management effort to assure that an adequate regional groundwater monitoring program is developed.

Task: Create and operate an IMPLEMENTATION STEERING GROUP to assure focus of applicable state and local programs to wellhead protection areas. Review management strategies to incorporate new data, requirements, and approaches.

Task: Conduct groundwater monitoring for analysis of pesticides and herbicides according to groundwater monitoring plan.

Task: Document the type and amount of herbicide application with focus on transportation corridors, forestry, agriculture, and recreation parcels.

Task: Investigate the need for re-routing transport of hazardous materials to areas outside of wellhead zones.

Task: Locate signs within the WHPA along transportation routes - "Wellhead Protection Area."

Task: Communicate location of the WHPA and wellhead protection concerns to mine operators.

Task: Review MTCA, RCRA notifiers, and LUST sites files for sites within the WHPA annually.

Task: Monitor Ecology's progress on the cleanup of MTCA and LUST sites within the WHPA.

Task: Communicate location of WHPA to industrial/commercial site owners.

Task: Communicate the extent of wellhead protection areas to the County Planning Department for consideration in critical areas regulation, susceptibility mapping, and permitting.

Task: Review water quality data generated under the general NPDES Storm Water Permit.

Appendix D

APPENDIX D
CITY OF KENT SPILL RESPONSE PLAN

CITY OF KENT

HAZARDOUS MATERIALS EMERGENCY PLAN

CITY OF KENT

HAZARDOUS MATERIALS EMERGENCY PLAN

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RECORD OF REVISIONS

Rev. No.	Nature of Change	Date of Change	Change Made By
1	SARA Title III Facilities and Map (Pages 26-28)	7/17/90	Lyn Hoffman-Gross
1	Apparatus Inventory (Pages 47-49)	7/17/90	Lyn Hoffman-Gross
2	Update SARA Title III Facilities/Map (Pages 27-29)	8/08/91	Michelle R. Hale
2	Update Emergency Telephone Roster (Pages 37-39)	8/08/91	Michelle R. Hale

PURPOSE

The Hazardous Materials Emergency Plan is intended for the use of the responding agencies of the City of Kent when responding to a hazardous material emergency of significant proportion. This plan is the guide for coordinating all resources, both public and private toward preparedness, response and mitigation efforts. These efforts may be utilized in fixed facility or transportation related hazardous material emergencies. This plan shall be used in conjunction with the City of Kent Disaster Plan. This plan may also be used in conjunction with the King County Emergency Operations Plan, the King County Hazardous Materials Plan and State and Federal Emergency Plans when the incident is of significant proportion to exhaust local resources.

STATEMENT OF INTENT

1. To provide a basic plan for the City of Kent that will result in minimizing, to the greatest degree possible, hazardous material emergencies.

2. To provide a basic plan to be used in conjunction with established facility plans, which will minimize the impact of a hazardous materials release associated with site specific emergencies.

3. To utilize present City Government structure and identify the responsibility of each department: who does what, when and where in a hazardous material emergency.

4. To recognize our responsibility to support other Government agencies as well as to receive their support if and when conditions warrant and resources are available.

5. To assure that maximum resources (public and private) are used effectively to cope with a hazardous materials emergency.

6. To be consistent with County, State and Federal regulations and procedures.

7. To establish procedures for direction, control and coordination of emergency apparatus to the type, magnitude and phase of the hazardous materials emergency.

8. To provide for dissemination of warning and evacuation information to all Department Heads and personnel of the City of Kent and to the general population of the City of Kent.

9. To include an adequate damage assessment system for decision making, direction, control and reporting purposes.

10. To provide an evacuation plan in a hazardous materials emergency.

11. To pre-determine the types of hazardous material emergencies which pose the greatest threat to life and property in the City of Kent.

LEGAL AUTHORITY AND RESPONSIBILITY FOR RESPONDING

This Hazardous Material Emergency Response Plan is published consistent with the Superfund Amendment and Re-authorization Act of 1986, Public Law 99-499; and the Revised Code of Washington, Title 38, Chapter 38.52.070 as revised, Washington Administrative Code, Chapter 118-40, RCW 34.04, Administrative Procedures Act, Law of Washington and Ordinance of the City of Kent.

The Chief Elected Officer has designated the Chief of the Fire Department to be the Director of Emergency Operations. He has further designated that the Fire Department will be the Incident Commander in responding to Hazardous Material Incidents within the boundaries of the City of Kent.

Chapter 118-40 WAC

HAZARDOUS CHEMICAL EMERGENCY RESPONSE PLANNING AND COMMUNITY RIGHT-TO-KNOW REPORTING

WAC 118-40-010 INTRODUCTION

On October 17, 1986, the Superfund Amendments and Reauthorization Act of 1986 (SARA) was signed into law (P.L. 99-499). One part of the SARA provisions is Title III: "The Emergency Planning and Community Right-to-Know Act of 1986." Title III establishes requirements for federal, state, and local governments, and industry regarding emergency response planning and community right-to-know on hazardous chemicals.

The emergency planning provisions of Title III (Sections 301-305) are designed to develop state and local government hazardous chemical emergency preparedness and response capabilities through better coordination and planning, especially at the local level.

Community right-to-know provisions of Title III (Sections 311, 312, and 313) require the owners and/or operators of facilities to provide information about the nature, quantity, and location of chemicals manufactured, processed, stored, or used at their facility sites. The purpose of these provisions is to increase public knowledge of the presence of hazardous chemicals in communities and to better prepare for potential emergencies.

WAC 118-40-020 PURPOSE AND SCOPE

It is the purpose of this chapter to implement the provisions of Title III in the State of Washington to establish a mechanism for compliance by state and local governmental agencies and industry with the provisions of Title III. This chapter is promulgated under the general policy and rule-making authority of the department of community development as established by RCW 38.52.030(2); 38.52.050 (1) and (3); and 43.63A.060.

Compliance with the requirements of Title III, as recognized by the United States Environmental Protection Agency, is regarded as compliance with the provisions of this chapter. Where federal regulations are duplicated or referred to in this chapter, Title III citations are provided. This chapter is not intended to mandate any new compliance requirements beyond those required by Title III.

WAC 118-40-030 DEFINITIONS

"SARA" means the Superfund Amendments and Reauthorization Act of 1986, as amended.

"CERCLA" means the Comprehensive Emergency Response, Compensation and Liability Act of 1980, as amended.

"Commission" means the emergency response commission for Washington State.

"Local committee" means the local emergency planning committee established for each state emergency planning district established by the commission.

"Title III" means Title III of the Superfund Amendments and Reauthorization Act of 1986; also titled the Emergency Planning and Community Right-to-Know Act of 1986, as amended.

"Administrator" means the administrator of the Environmental Protection Agency (EPA).

"Environment" includes water, air, and land and the interrelationship which exists among and between water, air, and land and all living things.

"Extremely hazardous substances" means a substance described in Section 302 (a) (2) of Title III as now authorized or hereafter amended.

"Facility" means all buildings, equipment, structures, and other stationary items which are located on a single site or on contiguous or adjacent sites and which are owned or operated by the same person (or by any person which controls, is controlled by, or under common control with such person). For the purpose of Section 304, Title III, the term includes motor vehicles, rolling stock and aircraft, shipping, and pipelines.

"Hazardous chemical" means any chemical which is a physical hazard or a health hazard as defined by OSHA Hazard Communication Standard (29 CFR 1910.1200). Exceptions to the definition of "hazardous chemical" in Title III and in 29 CFR 1910.1200 shall also apply in this chapter.

"Health hazard" means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed individuals. The term health hazard includes chemicals which are carcinogens, toxic or highly toxic agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membrane.

"Physical hazard" means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, or organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water reactive.

"Material Safety Data Sheet (MSDS)" means the sheet required to be developed under Section 1910.1200 (q) of Title 29 CFR, as that section may be amended from time to time.

"NRT-1 guidebook" means the Hazardous Materials Emergency Planning Guide published by the National Response Team, March 1987.

"NPT-1 guidelines" means the guidance outlined in the Hazardous Materials Emergency Planning Guide.

"OSHA" means Occupational Safety and Health Act of 1970.

"Person" means any individual, trust, firm, joint stock company, corporation (including a government corporation), partnership, association, state, municipality, commission, political subdivision of state, or interstate body.

"Release" means any spill, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing to the environment of any hazardous chemical, extremely hazardous substance, or toxic chemical.

"Toxic chemical" means a substance described in Section 313 (c) of Title III, as now authorized or hereafter amended.

"WISHA" means Washington Industrial Safety and Health Act of 1973.

WAC 118-40-040 STATE EMERGENCY RESPONSE COMMISSION--ESTABLISHMENT, MEMBERSHIP, CHAIRPERSON.

(1) In keeping with the provisions of Section 301 (a) of Title III, the governor of Washington state has established a state emergency response commission composed of the following members of their designees:

(a) Director of the department of community development.
(b) Director of the department of ecology.
(c) Chief of the Washington state patrol.

(2) The director of the department of community development shall be the chairperson of the commission.

(3) The assistant director, division of emergency management, department of community development, shall serve as alternate chairperson of the commission in the absence of the chairperson.

WAC 118-40-050 COMMISSION--PURPOSE, RESPONSIBILITIES.

The purpose of the state emergency response commission is to coordinate hazardous material issues and carry out the mandate of Title III (P.L. 99-499), as now authorized or hereafter amended.

The commission shall be responsible for the establishment of a state hazardous materials emergency preparedness, response, and community right-to-know program as required by Title III. Specific duties of the commission include:

(1) Establishment of a state level hazardous materials advisory committee.

(2) Designation of local emergency planning districts.

(3) Appointment of members to local committees established for each of the local emergency planning districts designated by the commission.

(4) Reception and evaluation of local emergency response plans.

(5) Delegation of responsibilities between the department of ecology, the Washington State patrol, and the department of community development in implementing the Title III program in Washington State.

(6) Establishment of a single address, telephone number and the procedures for the receipt of, management and access to all notifications, reports, plans and all other information required by Title III.

WAC 118-40-060 DEPARTMENT OF COMMUNITY DEVELOPMENT--TITLE III RESPONSIBILITIES.

Specific responsibilities of the department of community development include, but are not limited to, the following duties:

(1) Receive and record verbal emergency toxic chemical release reports through the twenty-four-hour duty officer system. Track and maintain records of events annually.

(2) Develop emergency planning guidance and provide assistance to local committees in the development of an emergency response plan for their district. Advise and assist industry in the planning process.

(3) Coordinate the review of each emergency plan as it is submitted.

(4) Serve as repository agency for the local emergency response plans.

(5) Set up community right-to-know program to allow citizens to view emergency response plans, upon request.

(6) Provide staff to commission and hazardous material advisory committee to develop agendas, prepare minutes, coordinate meeting places, draft policy letters, and carry out other support functions as needed.

(7) Prepare and respond to correspondence for signature by the chairperson of the commission.

(8) Receive and coordinate the distribution of correspondence, information, and written reports to offices in the departments of community development and ecology and the Washington State patrol, and local committees, as well as other state agencies when appropriate.

(9) Serve as chairperson of the training subcommittee of the hazardous materials advisory committee.

(10) Develop and apply for training grants, as authorized and provided under Section 305 of Title III.

(11) Provide training and maintain training records for the state hazardous materials training program as authorized and funded through Section 305 of Title III.

WAC 118-40-070 DEPARTMENT OF ECOLOGY--TITLE III RESPONSIBILITIES.

Specific responsibilities of the department of ecology include, but are not limited to, the following duties:

(1) Serve as advisor to the commission on emergency spill response and environmental restoration issues.

(2) Serve as advisor for emergency responder equipment and training needs at the state and local levels.

(3) Serve as advisor for on-scene spill response and environmental needs at the state and local levels.

(4) Serve as advisor to the commission on community right-to-know issues.

(5) Develop, implement, and maintain a Title III Community Right-to-Know Program which may include, but is not limited to:

(a) Data management of reports and notifications submitted by businesses.
(b) Technical assistance to businesses regarding compliance with Title III.
(c) Accessing and communicating information to the public.
(d) Outreach to businesses and the public about Title III.

(6) Serve as chairperson or member of the community right-to-know subcommittee of the hazardous materials advisory committee.

(7) Serve as liaison between the commission and the Environmental Protection Agency on community right-to-know issues.

(8) Provide training for hazardous substances spill response and cleanup.

WAC 118-40-080 WASHINGTON STATE PATROL--TITLE III RESPONSIBILITIES.

Specific Responsibilities of the Washington State patrol include, but are not limited to, the following duties;

(1) Serve as advisor to the commission on emergency response and coordination of on-scene activities on state and interstate highways and other areas where it has been designated incident command agency.

(2) Serve as chairperson of the emergency response subcommittee of the hazardous materials advisory committee.

(3) Serve as advisor for emergency responder equipment and training needs at the state and local levels.

(4) Serve as a member of the training subcommittee of the hazardous materials advisory committee.

WAC 118-40-090 HAZARDOUS MATERIALS ADVISORY COMMITTEE--ESTABLISHMENT, MEMBERSHIP.

In order to achieve a broader representation of hazardous materials interests in state emergency response planning and community right-to-know, the commission may establish a state level hazardous materials advisory committee. At a minimum, the committee membership shall consist of members appointed by the commission from the following interest groups:

(1) Four state legislators. One from each caucus in the House of Representatives and one from each caucus in the Senate.

(2) One representative of the Washington association of counties.

(3) One representative of the association of Washington cities.

(4) One representative of the Washington state emergency management association.

(5) One representative of the Washington State association of fire chiefs.

(6) One representative of the Washington association of sheriffs and police chiefs.

(7) One representative of the Washington State utilities and transportation commission.

(8) One representative of the Washington State department of agriculture.

(9) One representative of the Washington State council of firefighters.

(10) Two representatives of the association of Washington businesses.

(11) Two representatives of the Washington environmental council.

(12) Others may be appointed as appropriate.

WAC 118-40-100 HAZARDOUS MATERIALS ADVISORY COMMITTEE--PURPOSE, RESPONSIBILITIES.

(1) The purpose of the hazardous materials advisory committee is to serve as a policy advisory body regarding hazardous chemical emergencies and community right-to-know.

(2) The members of the hazardous materials advisory committee shall serve the commission in a technical advisory capacity regarding the development and implementation of a hazardous chemical emergency response process and community right-to-know functions. The committee's responsibilities include, but are not limited to, providing advice on the following topics:

(a) Contingency planning at the state and local levels.
(b) Enhances hazardous materials training.
(c) Assessment of emergency response equipment needs at the state and local levels.
(d) Enhancement of emergency response capabilities at the state and local levels.
(e) State and federal hazardous waste programs.
(f) Interstate planning and agreements.
(g) Joint purchase of equipment and specialized materials.
(h) Develop and propose legislation to meet future needs.

(3) The hazardous materials advisory committee shall provide advice to the commission regarding the establishment of a community right-to-know program including procedures for the receipt of hazardous and toxic chemical information and the release of such information to the general public.

WAC 118-40-150 EMERGENCY PLANNING DISTRICTS--DESIGNATION.

(1) Emergency planning districts shall be based on the statutory requirement set forth in RCW 38.52.070 which authorized local emergency management organizations.

(2) Cities and towns that do not have active emergency management organizations as required by chapter 38.52 RCW are considered part of the county planning district in which they are located for the purposed of Title III emergency response planning.

(3) If the provision in WAC 118-40-150 (2) is unacceptable to a jurisdiction, the presiding official or officials of that jurisdiction may request that the commission designate that jurisdiction as a Title III emergency planning district.

WAC 118-40-160 LOCAL COMMITTEE--ORGANIZATION, MEMBERSHIP.

(1) Each local committee shall include, at a minimum, representatives from each of the following groups or types of organizations as specified by Section 301 (c) of Title III:

(a) State and local officials.
(b) Law enforcement.
(c) Emergency management.
(d) Firefighting.
(e) First aid.
(f) Health profession.
(g) Local environment.
(h) Hospital.
(i) Transportation personnel.
(j) Broadcast and print media.
(k) Community groups.
(l) Owners and operators of facilities subject to the requirements of Section 302 (b) of Title III.

(2) Each local emergency planning committee shall appoint a chairperson and establish rules by which the committee shall operate.

(3) Committee rules shall include provisions for public notification of committee activities, public meetings to discuss the emergency plan, public comments, response to such comments by the committee, and distribution of emergency response plans to the general public.

WAC 118-40-170 LOCAL COMMITTEE--RESPONSIBILITIES

(1) Not later than October 17, 1988, each local committee shall complete the preparation of a hazardous materials emergency response plan. In the development of the plan, as specified by Sections 303(a), (b), (c) and 324(a), (b), Title III, committee duties include, but are not limited to:

(a) Forming a local planning team.
(b) Designating a team leader.
(c) Evaluating the resources needed to develop, implement, and exercise the emergency plan.
(d) Identifying existing emergency response equipment and personnel.
(e) Conducting a needs assessment of emergency response equipment and personnel requirements.
(f) Providing oversight for preparation of the plan by the local planning team.

(2) Each local committee shall establish procedures for receiving and processing requests from the general public for information under Section 324 (including Tier II information under Section 312) Title III. Such procedures shall include the designation of an official to serve as committee coordinator for all information requests.

WAC 118-40-180 HAZARDOUS MATERIAL EMERGENCY RESPONSE PLAN--CONTENT, GUIDELINES, EVALUATION PROCESS.

(1) Each local committee shall complete a hazardous materials emergency response plan as required by Section 303 (a), (b), (c), Title III.

(2) The committee shall transmit three copies of the completed plan to:

Chairperson
Washington State Emergency Response Commission
Department of Community Development
9th and Columbia Building, GH-51
Olympia, Washington 98504-4151

(3) At a minimum, the plan shall include the requirements of Title III, the standards of the NRT-1 guidelines, and the concepts of the Washington state comprehensive emergency plan as it is written.

(4) Upon receipt of a local committee hazardous material emergency response plan, the state emergency response commission shall:

(a) Send a letter to the local committee formally acknowledging the receipt of the plan and informing them of the review process.

(b) Copies of the plan will then be sent to the following organizations for review and comment.

(i) The state division of emergency management, department of community development, to review it against required federal criteria and the state comprehensive emergency management plan.

(ii) The hazardous materials advisory committee's subcommittee for contingency planning.

(iii) The hazardous materials advisory committee's subcommittee for emergency response.

(c) The above organizations shall review the plan and within ninety days submit their comments and recommendations, if any, to the state emergency response commission on whether the plan meets the requirements of Title III, the recommendations of the NRT-1 guidelines and the concepts of the Washington State comprehensive emergency management plan.

In the event that there are significant differences in the recommendations of the committees, the full state hazardous materials advisory committee will be asked to resolve the differences and make its recommendation to the emergency response commission within forty-five days of the date of referral to the state hazardous materials advisory committee.

(d) Within forty-five days of the receipt of the recommendations, the state emergency response commission will review the recommendations. Upon completion of this review the commission shall, as appropriate, send a letter to the submitting local committee stating one of the following alternative evaluations of the local committee's plan:

(i) The plan has been reviewed and is considered to meet the requirements of Title III, the standards of the NRT-1 guidelines, and the concepts of the state comprehensive emergency management plan as it is written.

(ii) The plan has been reviewed and is considered to meet the standards of the NRT-1 guidelines, Title III requirements and the comprehensive emergency management plan concept, but suggestions are included on how it may be improved at its nest revision.

(iii) Serious omissions are apparent in the plan. Please note the following suggestions on the changes that are needed to meet the Title III requirements, the guidelines of the NRT-1 guidebook and the concept of the Washington State comprehensive emergency management plan.

(5) The local committees shall review and update their plans annually, and submit them to the commission for review under the procedures and guidelines prescribed in this section.

WAC 118-40-190 EMERGENCY RESPONSE TRAINING

(1) The department of community development, division of fire protection services, shall provide training as authorized by Section 305, Title III, for emergency first responders, including firefighters, law enforcement, and emergency medical personnel. Other constituencies to be trained may include federal, state, and local governmental employees who may directly or indirectly involve themselves in a hazardous materials incident. Such personnel may include health officials, public works personnel, elected officials, emergency and city managers, and personnel employed by private industry.

(2) Emergency training programs shall be designed to improve emergency planning, preparedness, mitigation, response, and recovery capabilities. Such programs shall provide special emphasis with respect to emergencies and responsibilities associated with hazardous materials and Title III.

(3) The division of fire protection services may officially schedule, conduct, and/or contract for courses throughout the state, and may also provide training sessions upon written or verbal request from public or private organizations, agencies, or departments.

WAC 118-40-300 TITLE III--FACILITIES COMPLIANCE

The owner or operator of a facility shall meet all of the applicable requirements of Title III, or of rules adopted by the administrator to implement Title III, as now authorized or hereafter amended, including the planning, notification, reporting, access, and information availability requirements as specified by Sections 301, 302, 303, 304, 311, 312, 313, 324 of Title III.

WAC 118-40-400 TITLE III--ENFORCEMENT, PENALTIES.

Enforcement of all Title III provisions and the administration of penalties for violations of the provisions shall be pursuant to Section 325 of Title III, as now authorized or hereafter amended.

Title 70 RCW:

70.136.010 Legislative Intent

It is the intent of the legislature to promote and encourage advance planning, cooperation, and mutual assistance between applicable political subdivisions of the state and persons with equipment, personnel, and expertise in the handling of hazardous materials incidents, by establishing limitations on liability for those persons responding in accordance with the provisions of RCW 70.136.020 through 70.136.070 [1982 c 172 § 1.]

70.136.020 Definitions

The definitions set forth in this section apply throughout RCW 70.136.010 through 70.136.070.

1) "Hazardous materials" means:

   a) Materials which, if not contained may cause unacceptable risks to human life within a specified area adjacent to the spill, seepage, fire, explosion, or other release, and will, consequently, require evacuation;

   b) Materials that, if spilled, could cause unusual risks to the general public and to emergency response personnel responding at the scene;

   c) Materials that, if involved in a fire will pose unusual risks to emergency response personnel;

   d) Materials requiring unusual storage or transportation conditions to assure safe containment; or

   e) Materials requiring unusual treatment, packaging, or vehicles during transportation to assure safe containment.

2) "Applicable political subdivisions of the state" means cities, towns, counties, fire districts, and those port authorities with emergency response capabilities.

3) "Person" means an individual, partnership, corporation, or association.

4) "Public agency" means any agency, political subdivision, or unit of local government of this state including, but not limited to, municipal corporations, quasimunicipal corporations, special purpose districts, and local service districts; any agency of the state government; any agency of the United States; any Indian tribe recognized as such by the federal government; and any political subdivision of another state.

5) "Hazardous materials incident" means an incident creating a danger to persons, property, or the environment as a result of spillage, seepage, fire, explosion, or release of hazardous materials, or the possibility thereof.

6) "Governing body" means the elected legislative council, board, or commission or the chief executive of the applicable political subdivision of the state with public safety responsibility.

7) "Incident command agency" means the predesignated or appointed agency charged with coordinating all activities and resources at the incident scene.

8) "Representative" means an agent from the designated hazardous materials incident command agency with the authority to secure the services of persons with hazardous materials expertise or equipment.

9) "Profit" means compensation for rendering care, assistance, or advise in excess of expenses actually incurred. [1987 c 238 § 1; 1982 c 172 § 2.]

70.136.030 Incident command agencies -- Designation by political subdivisions

The governing body of each applicable political subdivision of this state shall designate a hazardous materials incident command agency within its respective boundaries, and file this designation with the director of community development.
In designating an incident command agency, the political subdivision shall consider the training, manpower, expertise, and equipment of various available agencies as well as the Uniform Fire Code and other existing codes and regulations. Along state and interstate highway corridors, the Washington state patrol shall be the designated incident command agency unless by mutual agreement that role has been assumed by another designated incident command agency.

If a political subdivision has not designated an incident command agency within six months after July 26, 1987, the Washington state patrol shall then assume the role of incident command agency by action of the chief until a designation has been made. [1987 c 238 § 2; 1986 c 266 § 50; 1985 c 7 § 132; 1984 c 165 § 1; 1982 c 172 § 4.]

70.136.035 Incident command agencies -- Assistance from state patrol.

In political subdivisions where an incident command agency has been designated, the Washington state patrol shall continue to respond with a supervisor to provide assistance to the incident command agency. [1987 c 238 § 3.]

70.136.040 Incident command agencies -- Emergency assistance agreements.

Hazardous materials incident command agencies, so designated by all applicable political subdivisions of the state, are authorized and encouraged, prior to a hazardous materials incident, to enter individually or jointly into written hazardous materials emergency assistance agreements with any person whose knowledge or expertise is deemed potentially useful. [1982 c 172 § 3.]

70.136.050 Persons and agencies rendering emergency aid in hazardous materials incidents -- Immunity from liability -- Limitations.

An incident command agency in the good faith performance of its duties, is not liable for civil damages resulting from any act or omission in the performance of its duties, other than acts or omissions constituting gross negligence or wilful or wanton misconduct.

Any person or public agency whose assistance has been requested by an incident command agency, who has entered into a written hazardous materials assistance agreement before or at the scene of the incident pursuant to RCW 70.136.060 and 70.136.070, and who, in good faith, renders emergency care, assistance, or advise with respect to a hazardous materials incident, is not liable for civil damages resulting from any act or omission in the rendering of such care, assistance, or advise, other than acts or omissions constituting gross negligence or wilful or wanton misconduct. [1987 c 238 § 4; 1984 c 165 § 2; 1982 c 172 § 5.]

70.136.055 Person transporting hazardous materials -- Responsibility for incident clean-up -- Liability of person causing hazardous materials incident.

See RCW 4.24.314.

70.136.060 Written emergency assistance agreements -- Terms and conditions -- Records

Hazardous materials emergency assistance agreements which are executed prior to a hazardous materials incident shall include the following terms and conditions:

1) The person or public agency requested to assist shall not be obligated to assist;

2) The person or public agency requested to assist may act only under the direction of the incident command agency or its representative;

3) The person or public agency requested to assist may withdraw its assistance if it deems the actions or directions of the incident command agency to be contrary to accepted hazardous materials response practices;

4) The person or public agency requested to assist shall not profit from rendering the assistance.

5) Any person responsible for causing the hazardous materials incident shall not be covered by the liability standard defined in RCW 70.136.050.

It is the responsibility of both parties to ensure that mutually agreeable procedures are established for identifying the incident command agency when assistance is requested, for recording the name of the person or public agency whose assistance is requested, and the time and date of the request, which records shall be retained for three years by the incident command agency. A copy of the official incident command agency designation shall be a part of the assistance agreement specified in this section. [1987 c 238 § 5; 1982 c 172 § 6.]

70.136.070 Verbal emergency assistance agreements -- Notification -- Form

1) Verbal hazardous materials emergency assistance agreements may be entered into at the scene of an incident where execution of a written agreement prior to the incident is not possible. A notification of the terms of this section shall be presented at the scene by the incident command agency or its representative to the person or public agency whose assistance is requested. The incident command agency and the person or public agency whose assistance is requested shall both sign the notification which appears in subsection (2) of this section, indicating the date and time of signature.

If a requesting incident command agency deliberately misrepresents individual or agency status, that agency shall assume full liability for any damages resulting from the actions of the person or public agency whose assistance is requested, other than those damages resulting from gross negligence or wilful or wanton misconduct.

2) The notification required by subsection (1) of this section shall be in substantially the following form:
NOTIFICATION OF "GOOD SAMARITAN" LAW
You have been requested to provide emergency assistance by a representative of a hazardous materials incident command agency. To encourage your assistance, the Washington state legislature has passed "Good Samaritan" legislation (RCW 70.136.050) to protect you from potential liability. The law reads, in part:

> "Any person or public agency whose assistance has been requested by an incident command agency, who has entered into a written hazardous materials assistance agreement . . . at the scene of the incident pursuant to . . . RCW 70.136.070, and who, in good faith, renders emergency care, assistance, or advice with respect to a hazardous materials incident, is not liable for civil damages resulting from any act or omission in the rendering of such care, assistance, or advice, other than acts or omissions constituting gross negligence or wilful or wanton misconduct."

The law requires that you be advised of certain conditions to ensure your protection:

1. You are not obligated to assist and you may withdraw your assistance at any time.
2. You cannot profit from assisting.

3. You must agree to act under the direction of the incident command agency.
4. You are not covered by this law if you caused the initial accident.

I have read and understand the above.
(Name)_____
Date_____Time_____
I am a representative of a designated hazardous materials incident command agency and I am authorized to make this request for assistance.
(Name)_____
(Agency)_____
Date_____Time_____

[1987 c 238 § 6; 1982 c 172 § 7.]

SITUATION

The City of Kent is a rapidly developing urban area comprised of three main geographical areas. Two areas located on the east and west hills are primarily residential with community related commercial development intermingled. The third area consists of the valley floor area which includes heavy commercial and industrial development as well as single and multi-family residential areas.

Studies have been done in regard to the hazardous materials within the Kent area. A study done by the Puget Sound Council of Governments revealed that the City of Kent has the third largest concentration of hazardous materials in the Puget Sound area. Another study, done by the Kent Fire Department in 1986-87 identified specific locations of these materials and further defined areas of potential risk. The subsequent enactment by the Federal Government of The Superfund Amendments and Reauthorization Act has assisted in identifying those facilities using "Extremely Hazardous Substances" which pose the greatest threat to the community.

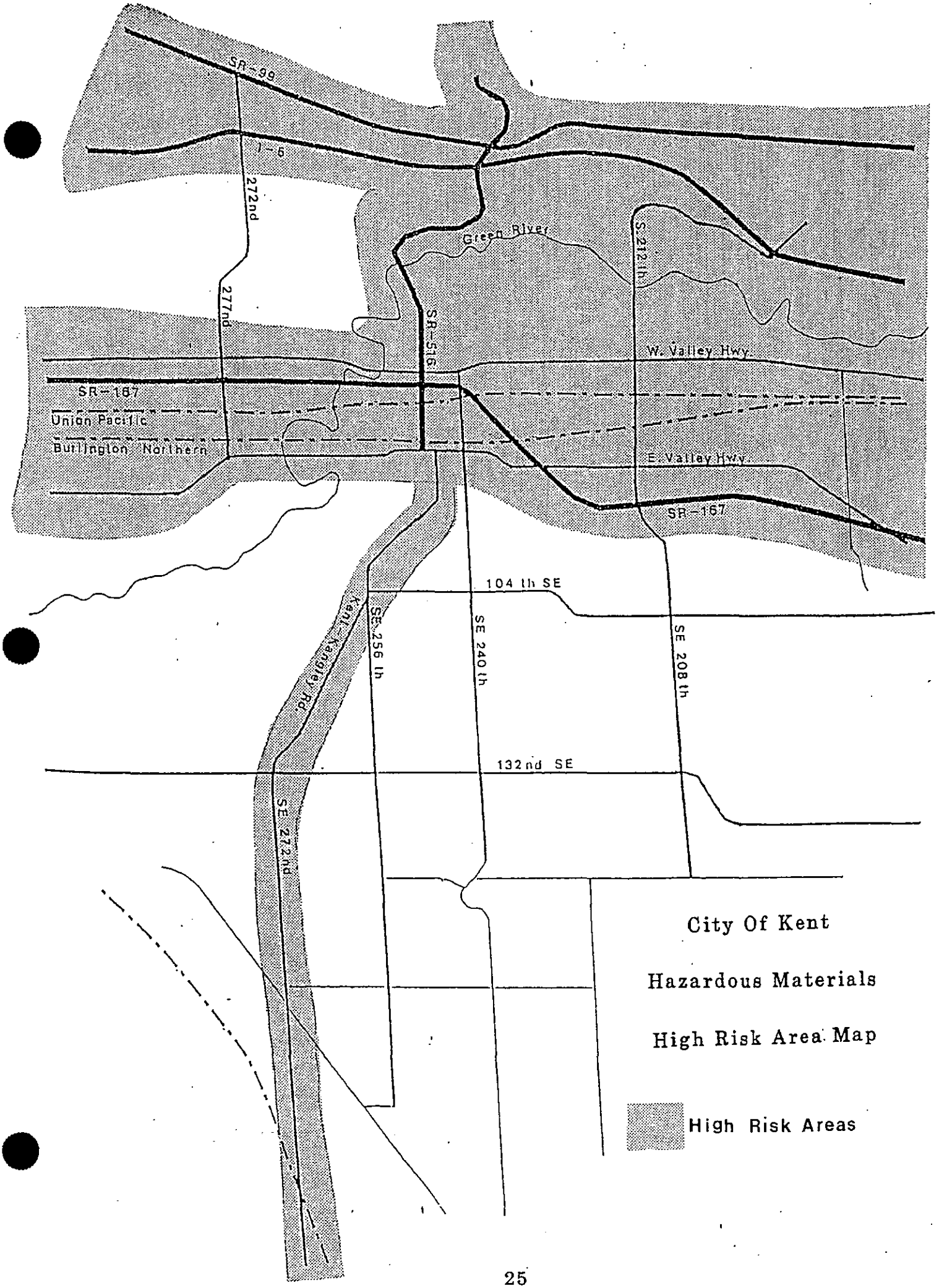
Transportation routes for hazardous materials include three State and one Interstate Highway and two railroad lines on which most of the hazardous materials transported north and south within the State of Washington travel. Additionally, there are two limited access roadways within Kent which are considered prime areas for a transportation related hazardous material incident. These are the primary routes for distribution of hazardous materials to local facilities.

The valley area houses in excess of 200 facilities which use hazardous materials in their business activities. Of those facilities, 21 have been identified as SARA Planning Facilities. These facilities have above threshold planning quantities of "Extremely Hazardous Substances" as defined by SARA.

The Kent Fire Department Haz-Mat Team responds to nearly 100 hazardous material incidents annually. It is further known that many on site incidents are handled by facility workers and are never reported to local authorities.

In consideration of the facts provided both here and in the Hazardous Materials Analysis, it is apparent that an incident of significant proportion could occur within Kent. Response measures and the need for evacuation would depend upon the amount and type of material released.

Additional information is provided in the Hazardous Material Analysis (Attachment B).


SR-99
I-5
272nd
277nd
Green River
S. 212th
SR-516
W. Valley Hwy.
SR-167
Union Pacific
Burlington Northern
E. Valley Hwy.
SR-167
104th SE
SE 256th
Kent-Kangley Rd.
SE 240th
SE 208th
132nd SE
SE 272nd
City Of Kent
Hazardous Materials
High Risk Area Map
High Risk Areas

HAZARDOUS MATERIALS FACILITIES REQUIRING PLANNING

1 American National Can
1220 N. 2nd Ave.
Kent, WA 98032
Jay Burton
854-9950 or 774-7327

2 Americold
8805 S. 190th
Kent, WA 98031
Mark Fisk
251-9571

3 Ashland Chemical
831 5th Ave. S.
P.O. Box 220
Kent, WA 98032
Gary Crome
850-1585

4 Boeing Space Center
20403 68th Ave. S.
Kent, WA 98032
P.O.Box 3999 MS-89-02
Seattle, WA 98124
Mary Armstrong-Russell
773-3528

5 Boeing Commercial
Airplane Group
Propulsion Systems Div
7615 S. 212th
Kent, WA 98032
Yvette Barnett
237-9263 or 237-9900

6 Boeing-Kent Benaroya
20651 84th Ave. S.
Kent, WA 98032
Yvette Barnett
237-9263 or 237-9900

7 Borden Chemical
421 1st Ave.
P.O. Box 428
Kent, WA 98031
William Kramer
852-9300

8 Chemical Processors Inc.
20245 77th Ave S.
Kent, WA 98032
Richard Lee
872-8030 or 821-5821

9 Continental Mills, Inc.
6320 S. 190th St. Kent
P.O. Box 88176
Seattle, WA 98138
872-8400 or 226-2841

10 Crain Industries
19635 78th Ave. S.
Kent, WA 98032
Mark Stuart
872-0170 or 838-2967

11 Crescent Foods
21612 88th Ave. S.
Kent, WA 98032
P.O. Box 3985
Seattle, WA 98124
Victor Dang
461-1440

12 Davis Wire Corp
19411 80th Ave. S.
Kent, WA 98032
Mike Herman or
Bob Wahlberg
872-8910

13*Emerald City Chemical
21000 - 77th Ave. S.
Kent, WA 98032
Glen Dodge
872-5511

14 Evergreen Engravers
1819 S. Central #24
Kent, WA 98032
Jeff Hilton
852-6766

15 Exotic Metals
5411 S. 226th St.
Kent, WA 98032
Craig Adams
395-3710

16 Fisher Scientific
8030 S. 228th St.
Kent, WA 98032
Eli Burks
872-0330

17*Furon Aerospace Component
7035 212th St. Bldg. 3,Kent
3711 S. Hudson St.
P.O. Box 18319
Seattle, WA 98118
Mary Downing
723-5600

18*Heath Tecna Aerospace Co.
Plants 1,2,3,4,6,6a
19819 84th Avenue South
Kent, WA 98032
Roy Chandler
872-7500

19 Holman Distribution Center
22430 76th Ave. S.
Kent, WA 98032
Robert Downie Jr.
872-7140

20 Hytek Finishes Co.
8127 S. 216th St.
Kent, WA 98032
Cliff Johnson
872-7160

21 Kent District Swimming Pool
25316 101st Ave SE, Kent
King County Parks Aquatics
2040 84th Ave SE
Mercer Island, WA 98040
Steve Chavey
284-2555

22 City of Kent Water Department
Clark Springs Well
24875 Kent Kangley Road
220 4th Ave.,Kent,WA 98032
Mr. Leland Fingerson
859-3395

23 City of Kent Water Department
East Hill Well
24525 104th Ave SE
220 4th Ave S.,Kent,WA 98032
Mr. Leland Fingerson
859-3395

24 City of Kent Water Department
Kent Springs Well
28600 216th Ave SE
220 4th Ave S.,Kent,WA 98032
Mr. Leland Fingerson
859-3395

25 City of Kent Water Department
Soos Creek Well
11834 Kent Kangley Road
220 4th Ave. S.,Kent,WA 98032
Mr. Leland Fingerson
859-3395

26 City of Kent Water Department
212th St. Well
9001 S. 212th St.
220 4th Ave S.,Kent, WA 98032
Mr. Leland Fingerson
859-3395

27 King Command Meats
7622 South 188th
Kent, WA 98032
Bill Klosterman
251-6788

28 Liquid Air Corp.
8008 S. 222nd St.
Kent, WA 98032
Dale Fix
872-7007

29 Matlack Inc.
19929 77th Ave.S.
Kent, WA 98032
Vince Helt
872-8925

30 MCI Telecommunications Corp
West Division
12001 SE 227th Place
Kent, WA 98031
Anthony Fantham
631-8292

31 Oberto Sausage Company
7060 S. 238th St.
Kent, WA 98032
Mr. Bruce Firnhaber
228-2003

32 Pacific Propeller Inc.
5802 S. 228th St.
P.O. Box 1187
Kent, WA 98035-1187
Greg McCarrel
872-7767

33 Protective Coatings Inc.
1215 North 2nd Ave.
Kent, WA 98032
Dan De Vaney
854-9330

34 Reynolds Metals
27402 72nd Ave. S.
P.O. Box 1108
Kent, WA 98035
Sam Hewlett
95-0790

35 Royal Reprographics
18817 E. Valley Hwy.
Kent, WA 98032
Jay Stanton
251-8230

36 Sea-Kent Cold Storage
621 Railroad Ave. N.
P.O. Box 368
Kent, WA 98035
Janet Larson
852-4400

37 Surftech Finishes
22436 72nd Ave. S.
Kent, WA 98032
Randy Haworth
872-0280

38 Tahoma District
Swimming Pool
18230 SE 240th,Kent
King County Parks Aquatics
2040 84th Ave SE
Mercer Island, WA 98040
Tom Warren
284-2555

39 US West Communications
Network Switching
206 S. State,Kent
Steve Marczewski
1600 Seventh Ave.,Rm 1501
Seattle, WA 98191
623-2447

40 US West Communications
Network Switching
19640 68th Ave S.,Kent
Steve Marczewski
1600 Seventh Ave.,RM 1501
Seattle, WA 98191
623-2447

41 US West Communications
Network Switching
7235 S. 228th, Kent
Steve Marczewski
1600 Seventh Ave., Rm 1501
Seattle, WA 98191
623-4032

42 Van Waters & Rogers
8201 S. 212th St.
Kent, WA 98032
Jack Datin
872-5000

43 Western Processing
Chemical Waste Management
20015 72nd Ave. S.
Kent, WA 98032
Nicholas D. Lewis
395-0573

44 Wilbur Ellis Co.
8643 S. 212th St.
Kent, WA 98031
John Hartman or Jim Lassen
872-6920 or 935-2701

***Facilities which have an Emergency Plan but are not SARA Title III sites**

KENT, WASHINGTON and Vicinity

Produced by
PUGET SOUND AREA MAPS
P.O. BOX 68041 No. 8004
SEATTLE, WA 98168 98004-0968

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N

PLEASE NOTE...
To find advertiser locations, check map coordinates in corner of ad.

0 ¼ ½ ¾ 1
Approximate Scale in Miles

KENT

LAKE DESIRE
SHADY LAKE
SPRING LAKE
LAKE YOUNG
BOEING SPACE CENTER
CRYSTAL GLEN
TWIN MAPLES
MERIDIAN VILLA
MISTY MEADOWS
WILDWOOD
KELSINGTON HIGH
MERIDIAN VALLEY GOLF & COUNTRY CLUB
MATTSON
SHILOH WOODS
CRESTWOOD
KENTWOOD
MERIDIAN HEIGHTS
TAHOMA
BENSON CENTER
EAST HILL CENTER
SEQUOIA
LAKE MERIDIAN

Green River
Russell Rd
Frager Rd
Kent Des Moines Rd
Military Rd
Meeker St
James St
Morton Rd
Smith St
Canyon Drive
Central Avenue
Valley Freeway
West Valley Highway
Benson Highway
Industrial Rd
Industrial Blvd
Industrial Ln
Willis St
Dorre Don Way
Novak Ln
Desire Dr
Spring Lake Dr
S Lk Youngs Rd
Peter Grubb Rd
Wax Road
Timberlane Dr
Kent Meridian Rd
Kentwood Rd
Tahoma Blvd
Sr Hwy 18

28

CONCEPT OF OPERATIONS

CITY OF KENT

The Mayor is the executive head of the city and is responsible for direction and control in an emergency to protect citizens in a disaster.

The City Council is the legislative body of the city. They are responsible for passing ordinances, resolutions and laws governing the city.

Director of Emergency Services

a. Plans for and coordinates emergency service activities carried out within the city before, during and following a hazardous material emergency or disaster.

b. Acts as the coordinating agent for the government of the city to assure the best use of resources from the city, county, state and federal agencies as well as from the private sector.

c. Advises and assists other departments of the city and appropriate organizations of the private sector in preparing a hazardous materials emergency plan pertinent to their function during a disaster.

KING COUNTY

King County Executive is responsible for directing and controlling all county activities to protect lives and property from the effects of any disaster.

Director of Emergency Services is appointed by the executive and is authorized to act in his behalf to coordinate with the State and Federal Government to mitigate the disaster satisfactorily.

General Responsibilities shall be as defined in the King County Emergency Plan for Hazardous Material Incidents.

STATE OF WASHINGTON

The Governor is legally responsible for the direction and control of all emergency services activities within the State. His appointed Emergency Services Director is delegated the authority to act on his behalf in coordinating all activities and organizations for emergency services within the State and maintaining liaison and cooperating in emergency matters with the Federal Government, the Providence of British Columbia and other states.

Department of Emergency Services organizes state and district emergency services organizations to insure capability to accomplish emergency missions. Coordinates all state and local emergency services organizations during declared emergencies as defined in the Washington State Disaster Preparedness Plan. See Annex O, Appendix 2, Section II B of the Washington State Disaster Preparedness Plan.

Other State Agencies responsibilities shall be as defined in the Washington State Disaster Preparedness Plan. They shall be assigned emergency responsibilities by the Department of Community Development, Division of Emergency Services based on their respective capabilities.

FEDERAL GOVERNMENT

FEMA Region Ten shall, under the guidance of the National Headquarters, Federal Emergency Management Agency acting in concert with federal field establishments and the military; Interpret national policy and program direction, coordinate mobilization activities of Federal Field Offices and states to assure uniform application within the region, make emergency decisions on the use of resources and coordinate disaster relief activities of the Federal Government in accordance with applicable public laws, and coordinate the activities of other federal agencies.

TESTING THE PLAN

PURPOSE

To provide an adequate means of evaluating the effectiveness and feasibility of the plan and its standard operating procedures to ensure maximum readiness of agencies and facilities involved in hazardous material incident response.

OPERATIONAL CONCEPT

1. "Testing" refers to the exercise of all or part of the Hazardous Material Emergency Plan to ensure that all elements work in harmony. All or part of the organizations and agencies involved may be active participants in the testing process. After the test, a critique by participants shall be held to identify any elements in the plan that need to be revised or updated. This process shall assure that operational concepts are sound and resources are adequately prepared to carry out necessary functions in a hazardous material emergency.

2. All agencies, organizations and SARA Planning facilities will be informed of the testing and will be invited to participate or observe, as appropriate, for the type of test planned.

RESPONSIBILITY

The Director of Emergency Services or his/her designee shall provide for and organize a minimum of one test/exercise annually. This test or exercise may be in the form of a table top, functional drill, or full scale exercise.

UPDATING THE PLAN

PURPOSE

To provide a satisfactory means of updating information and standard operating procedures in the plan. Ensure that the plan is updated on an annual basis and that all plan holders are informed of the changes.

OPERATIONAL CONCEPT

1. The plan shall be updated annually or following each test/exercise of the plan. Following the critique of the test/exercise, any necessary changes as identified by the evaluating group of the basic plan or its standard operating procedures shall be initiated. In addition to changes identified in the critique, all current information in regards to personnel assignments, emergency phone lists and resources shall be reviewed for accuracy and updated.

2. Revisions to the plan shall be distributed by first class mail to all agencies, organizations and facilities which hold copies of the plan within 30 days of the final revision.

RESPONSIBILITY

The Director of Emergency Services or his designee shall provide for the plan to be updated following each test/exercise and distribute final revisions to all plan holders according to operational guidelines identified.

DIRECTION AND CONTROL

1. The City of Kent Fire Department has been appointed Incident Command Agency for hazardous material incidents within the City of Kent, except upon State and Interstate roadways, (Washington State Patrol will assume the role of Incident Command upon arrival at the scene.)

2. The Incident Command structure shall be as published, by the National Fire Academy and the National Emergency Management Institute. The Incident Commander shall utilize the positions of the Incident Command System as deemed necessary at the time of the incident.

3. Upon the request of the Incident Commander, the City of Kent Emergency Management Division will provide coordination between the Incident Commander and the various responding agencies.

4. The Incident Commander shall determine if the incident has exhausted resources or capabilities of local agencies. A unified command with an On-Scene Commander from the Environmental Protection Agency or the United States Coast Guard will be initiated upon their arrival at the scene.

5. When local resources have been exhausted, the Mayor or his designee will request activation of the King County Emergency Plan. Upon activation, the Kent Division of Emergency Management shall relinquish primary control of the coordination of resource responsibilities to King County Department of Emergency Management.

6. The command post will be located at a safe area as near as practical to the incident scene. The Incident Commander may determine an alternate location more suitable to the type or size of the incident in progress.

7. The operations functions will remain at the incident scene regardless of the location of the command post.

8. It will be the responsibility of the Incident Commander to request aid from outside agencies. Representatives from the following agencies may be located at the command post:

   Kent Emergency Management

   Kent Police Department

   Kent Fire Department

   Kent Public Works Department - Operations Division

   Technical Advisors (as requested by the Incident Commander)

   Shippers (for transportation related incident)

   Facility Coordinator (for fixed facility incident)

   County Agencies (as requested)

   State Agencies (as requested)

   Federal Agencies (as requested)

9. The Emergency Operations Center will be located at Kent City Hall in the courtroom. Representatives of the following agencies may be located in the Emergency Operations Center:

Emergency Operations Center Coordinator

Mayor

City Council Members

Public Information Officer

City of Kent Department Heads and/or their designee. Health Services.

10. The following guidelines may be used by the Incident Commander as assistance in determining required resources to control a hazardous material incident:

Response Level 1. Potential Emergency Condition

Description: An incident or threat of a release that can be controlled by City of Kent responders with advice from outside agencies. The incident is not an immediate threat to life or property. Evacuation is limited to the immediate area or involved structure only.

Contact:
Kent Fire Department
Kent Police Department
Kent Public Works Department
Washington State Department of Ecology
Chemtrec (Transportation incident only)
National Response Commission (NRC)

Response Level 2. Limited Emergency Condition

Description: An incident involving a greater hazard or potential for threat to life of property. May require limited evacuation of surrounding area.

Contact:
All agencies in level 1
City of Kent Emergency Operations Center Staff
King County Office of Emergency Management
Washington State Patrol

Response Level 3. Full Emergency Condition

Description: An incident that poses a severe hazard to life and property or covers a large area requiring large scale evacuation. The incident may require the resources of County, State, Federal or private agencies.

Contact:
All agencies in level 1 & 2
Washington State Department of Emergency Management
Federal Emergency Management Agency (FEMA)
Environmental Protection Agency (EPA) or
United States Coast Guard (USCG)

INITIAL NOTIFICATION OF RESPONSE AGENCIES

1. **911** will be the telephone number used to notify all local emergency response personnel of an emergency situation within the city limits of Kent. Those calls originating outside the protection area must call (206) 852-2121.

2. Notification of potential problems should be reported by calling the business number of the Kent Fire Department. (206) 859-3322.

3. The City of Kent Emergency Management Division will be responsible for notification of the following agencies based on the nature and severity of the incident.

   a. <u>King County Agencies</u>

King County Police		(206) 344-4080
King Co. Dept. of Emergency Mgmt.		(206) 344-3830
24 hour number		(206) 344-4080
METRO (Barbara Badger)		(206) 684-2404
(Renton Treatment Plant)	24 hr. #	(206) 226-3680

   b. <u>State Agencies</u>

Department of Energy Radioactive Response Team		(206) 682-5327
Department of Ecology	24 hr. #	(206) 649-7000
Dept. of Emergency Mgmt.	24 hr. #	(206) 753-5990
		1-(800)-262-5990
Washington State Patrol	24 hr. #	(206) 455-7700
(Commercial Vehicle Enforcement)		(206) 455-7903

   c. <u>Federal Agencies</u>

National Response Center		1-(800)-424-8802
United States Coast Guard	24 hr. #	(206) 286-5400

   d. <u>Technical Assistance</u>

Chemtrec	1-(800) 424-9300

EMERGENCY ASSISTANCE TELEPHONE ROSTER

CITY

Fire		859-3322 or 911
Fire Chief	Norm Angelo	859-3322 or Home 630-4334
Police		859-4167 or 911
Police Chief	Ed Crawford	859-4167 or Home 627-5567
Engineering	Don Wickstrom	859-4170 or Home 852-5196
Engineering	Gary Gill	859-4170 or Home 432-0846
Public Works	Tim Heydon	859-3395 or Home 527-1488
Local Emergency Planning Committee		859-3322
Mayor-Dan Kelleher		872-3355

AGENCIES

Environmental Protection Agency	553-1263
Department of Ecology	649-7000
Department of Transportation	562-4000
Washington State Patrol	455-7700
Metro	226-3680
Public Health	361-2891
King County Emergency Services	296-3830 or 296-3311
Wa. St. Dept. of Emer. Management	753-5990 1-800-262-5990
National Response Center	1-800-424-8802
Chemtrec	1-800-424-9300
U.S. Coast Guard	286-5540
Puget Sound Air Pollution Control	296-7330

CLEANUP CONTRACTORS

Amalgamated Services	854-6643
Chemical Processors	872-8030
Northwest Enviroservice	622-1090
Chempro Env. Services	838-1543 or 872-8030
Olympus Environmental	854-5094

RAILROADS

Union Pacific	1-503-257-9188 collect or 1-800-228-9948
Burlington Northern	625-6246 939-1050

MEDICAL

Evergreen Hospital	821-1111
Overlake Hospital	454-4011
Auburn Hospital	833-7711
ırien Hospital (Riverton)	244-9970
ɔmmunity Memorial Hospital Enumclaw	825-2505
Riverton Hospital	244-0180
Valley Medical Center	228-3450
King County Ambulance	872-6046
Shepard Ambulance	852-6030

NEWS MEDIA	TELEVISION	RADIO
KING	448-3850	443-3981
KIRO	728-7777	728-7777
KOMO	443-4145	443-4101
KASY		833-5220
KVI		223-5700
KIRO		728-7777
KZOK		281-5627
KJR		454-6397
MAGIC		622-3251
KLSY		455-1540

NEWSPAPER

\LLEY	872-6600 or weekends 872-6604
EDERAL WAY	839-0700
SEATTLE TIMES	464-2200, 2239, 2272, or 2237
POST INTELL.	448-8303
ASSOCIATED PRESS	682-1812
UPI	283-3262

OTHER

NORTHWEST PIPELINE	244-6605
WASHINGTON NATURAL GAS	464-1999
PUGET POWER	1-800-424-5555
	255-2464

INCIDENT INFORMATION SUMMARY

DATE_____ TIME_____

NAME OF PERSON RECEIVING CALL_____

ON SCENE CONTACT: NAME_____ PHONE_____

INCIDENT LOCATION_____

NEARBY POPULATIONS_____

NATURE OF INCIDENT_____

TIME OF RELEASE_____

POSSIBLE HEALTH EFFECTS_____

EMERGENCY MEDICAL INFORMATION_____

_____

_____

NUMBER OF INJURED/DEAD-WHERE TAKEN_____

_____

_____

NAME OF MATERIAL RELEASED_____PHYSICAL STATE_____

CHARACTERISTICS OF MATERIAL_____

AMOUNT OF RELEASE_____

POTENTIAL AMOUNT OF RELEASE_____

OTHER HAZARDOUS MATERIALS IN AREA_____

_____

_____

TYPE OF EXPOSURE TO ATMOSPHERE_____

_____

PLUME INFORMATION_____

_____

WEATHER CONDITION_____

_____

LOCAL TERRAIN_____

_____

PERSONNEL ON SCENE_____

_____

_____

Communications

It is the responsibility of the communications personnel to organize, establish and maintain a communications capability sufficient to meet the emergency services requirements during a hazardous material incident in the City of Kent by use of land line, wire and radio service.

Communications during a hazardous material incident are, at best, difficult. The following information for radio frequency use is a recommendation based on standard operating procedures. It is not intended to limit the use of any radio frequency available at the time of the incident.

1. In order to ease radio operations, portable radios will be used at the incident scene.

2. Fire frequency 2 and/or 3 will be used as directed by the Fire Operator at Valley Communications Center.

3. City frequency 8 will be used as the direct tie between the Incident Commander and the Public Works Operations Center or Public Works field personnel.

4. Law Enforcement Agencies may utilize the LEARN or MAARS frequencies.

5. Communication between the Emergency Management Agencies may utilize the OSCAR frequency.

COMMON RADIO FREQUENCIES

NAME	FREQUENCY
FIRE 1	154.070
FIRE 2	154.445
FIRE 3	154.310
FIRE 4	154.250
FIRE 5 (Federal Way Fire Dept.)	
FIRE 7 (HEAR)	
FIRE 8 (City Government)	156.000
TAC 1	155.685
TAC 2	155.250
TAC 3	155.925
TAC 4	155.535
TAC 5 (City Government)	
LEARN	155.370
MAARS Transmit 154.650 - Receive	155.190
OSCAR	153.755

Public Information Officer

The Public Information Officer shall act as liaison between the Incident Commander the media and the public in chemical emergency situations.

The Public Information Officer will provide media representatives with news releases in order to provide incident information and warning of danger to the community. This information is provided so that the public will be aware of any potential need for evacuation, shelter in place, or other emergency procedures necessary to protect themselves in a chemical emergency.

All information from the Incident Commander shall be reported to the Public Information Officer for dissemination to the media and the public.

Community Relations

The Local Emergency Planning Committee shall provide public information to the community regarding chemical emergency planning and preparedness at least once annually by one of the methods listed below.

Information regarding chemical emergency planning and/or preparedness may be released to the public by any of the following methods.

* Public Information Programs
* Newspaper, radio, or television announcements
* Pamphlets (utility bill mailers or handouts at community events)
* City Line publication
* Facility specific training programs (schools, hospitals, public facilities etc.)
* Media coverage of training exercises.

WARNING SYSTEMS AND EMERGENCY PUBLIC NOTIFICATION

Warning Systems

The City of Kent has no emergency warning system designed to warn the community at large of a chemical or other type emergency currently in place.

Emergency Public Notification

The City of Kent, utilizing existing resources, will notify the public of an emergency situation to the best of its ability by one or more of the following methods:

* Through the established procedures utilized by the Public Information Officer to notify the various media sources.

* Telephone contact of vulnerable populations and facilities as identified in the site specific plans.

* Public announcements through the use of public address systems on radio equipped city vehicles.

* Door to door notification.

* Emergency Broadcast System.

Fire Service

It is the responsibility of the Kent Fire Department to provide emergency response to hazardous material incidents within the City of Kent and act as Incident Commander (except on state and interstate highways where the Washington State Patrol will assume incident command during the incident). Effectively utilize all available City of Kent equipment and manpower, as well as mutual aid equipment and manpower to save lives and property.

a. Provide coordination and control of manpower and equipment through the communications center and at a command post near the scene.

b. Provide manpower and equipment for decontamination and emergency medical aid at the scene of a hazardous material incident.

c. Provide manpower and equipment for control and containment of a hazardous material release or fire involving hazardous materials whenever possible.

Law Enforcement

It is the responsibility of the Kent Police Department to provide effective coordination of the law enforcement agency during a hazardous material emergency.

a. Provide a capability for effective traffic control and control of evacuation routes during a hazardous material emergency.

b. Insure that law enforcement personnel are familiar with procedures for the identification and movement of essential personnel during a hazardous material emergency.

c. Assist where necessary in the rapid dissemination of warning and evacuation information to the public as an augmentation segment of the established warning procedure.

d. Perform evacuation within parameters established for specific incident action plan.

Public Works

a. Provide equipment and manpower to assist in the containment of a hazardous material release.

b. Provide equipment and manpower to repair essential city facilities damaged as a result of a hazardous material release.

c. Provide assistance to the Police Department in regards to traffic control on evacuation routes and at the incident scene.

d. Provide mitigation measures whenever possible for the protection of the city water and sewer systems.

FIRE DEPARTMENT

APPARATUS 750

MISCELLANEOUS EQUIPMENT
- Binoculars
- D.O.T. Response Book
- Complete Tool Box
- 6 - Complete SCBA's

CLEAN-UP/CONTAINMENT EQUIPMENT
- Shovel, scoop (4)
- Broom, push (1)
- Tubs (4)
- Lath
- Absorbent pads
- Traffic Cones (12)
- PB35
- Visqueen (20 Foot)
- Water/Gas shut-off wrench
- Saw, circular

APPARATUS 748

CAB, DRIVER'S SIDE
- 1 - Door Opener
- 1 - HM, CGI & 02 meter MSA
- 1 - HM, TLV, Probes, filters

GLOVE BOX
- 3 - Flares, smoke
- 1 - Box, Ph paper
- 1 - Calculator
- 1 - Book, DOT, Emerg. Resp. Guide
- 1 - Book, FF's Handbook of HM
- * 911 Stickers
- 1 - Accident Report forms

COMPARTMENT 2, MIDDLE
- 1 - SCBA. complete
- 1 - SCBA, spare bottle
- 1 - Axebelt with axe
- 1 - Dropbag with rope
- 1 - Bundle, Cedar shakes

COMPARTMENT 2, BOTTOM
- 1 - Wrench adjustable hydrant
- 1 - Come-a-long, with chains
- 1 - Wrench, PIV
- 3 - Metal bars

CONSOLE
- 1 - Radio, Portable #705
- 1 - Radio, case
- 1 - Lantern
- 1 - Book, Map, Kent
- 1 - Book, Map, Mutual aid
- 2 - Books, Apartment
- 1 - Clipboard

COMPARTMENT 2, TOP
- 1 - Crate, containing: Metro sampling kit
- 4 - Broom handles
- 1 - "A" Box
  - 5 - Duct tapes
  - 1 - Box trash bags
  - 1 - Box vinyl exam gloves
  - 12- Pair boot covers
  - 4 - Pair silver shield gloves
  - * - Latex gloves
  - 17- Pair Nitrile gloves
  - 1 - Box Ph paper
- 1 - "E" Box
  - 12- 1 piece Tyvek Saranex suits
  - 4 - Tyvek Saranex Hoods

COMPARTMENT 4
- 1 - EMS, Aid kit
- 1 - EMS, Blanket
- 1 - Extinguisher, pressurized water
- 1 - Extinguisher, dry chemical
- 1 - Extinguisher, soda ash
- * - Library, containing:
  - 2 - CHRIS Manuals
  - 1 - SAX Manuals
  - 1 - Manual, Explosives, AARR
  - 1 - Manual, H2O, Emer. Resp. King Co.
  - 1 - Book, Dangerous Art. Emergency Guide

* Denotes an Expendable Supply

COMPARTMENT 6

- 4 - PB-35 Gallons, dry
- 1 - Recovery drum, small
- 1 - "H" Box
  - 6 - Fire Retardant Cotton Coveralls

COMPARTMENT 4

- * - Library Continued:
  - 1 - Book, NFPA #49
  - 1 - Fluorine Info Packet
  - 1 - Clipboard, exposure sheets
  - 1 - Conversion Tables
  - 1 - SCAN Telephone Directory
  - 1 - Liquid Air Pre-plan
  - 1 - Fiberchem Pre-plan
  - 15- Haz-Mat Incident Forms C-26
  - 1 - NIOSH Pocket guide

COMPARTMENT 8

- * - SCBA, thread protectors
- 4 - Cascade, Air, bottles
- 1 - Cascade, Air, valve assembly
- 1 - Cascade, Air, gauge
- 2 - Absorbant booms, 20'
- 3 - Visqueen, 20'
- * - Poly Propylene, Absorbant pads
- 4 - Decon, pools
- 1 - Decon, Layout visqueen
- 2 - Long handle scrub brushes
- 1 - Decon Kit:
  - 2 - Garden hoses, w/nozzles
  - 1 - 5/8" Non-clappered wye
  - 4 - Scrub brushes
  - 5 - Waste baskets
  - 1 - Eye wash bottle
  - 2 - Decon diagrams
  - 2 - Boxes trash bags
  - 1 - Car wash soap
  - * - Bamboo sticks

COMPARTMENT 5

- 1 - Radiological monitoring kit
- 6 - Flares
- 1 - Perimeter tape, box
- 4 - Bicycle helmets
- 1 - Spreader
- 1 - Gas clamp, Large
- 1 - Gas clamp, Small
- 10- Gallons, Soda ash

COMPARTMENT 3

- 12- SCBA. spare bottles
- 16- Sprinkler wedge sets
- 1 - Extinguisher, CO2, cartridge
- 1 - Rope, utility

COMPARTMENT 1, TOP

- 1 - Probe, Brass, CGI
- 1 - Wrench, 36" Pipe
- 1 - "G" Box:
  - 4 - Tyvek Saranex encapsulating suits
- 1 - Patch Kit, QUICK KIT
  - 5 - Sprinkler wedges
  - 1 - PVC, Couplers 2", 1-1/2", 3/4", 1/2"
  - 4 - Brushes Acid
  - 2 - Tubes, epoxy
  - 1 - Bag Oakum
  - 2 - Teflon tape
  - 2 - Joint compound
  - 2 - Galvanized pipe plugs, 1", 2-1/2", 2-3/4"
  - 1 - 4" Pipe plug
  - * - Pipe straps, asst.
  - 5 - Male plugs, asst.
  - 1 - Bag assorted Bungs
  - 4 - Brass gate valves
  - 4 - Hose clamps

* Denotes an Expendable Supply

1 - Tool Kit, QUICK KIT
- 1 - Wrench, Universal Bung
- 1 - Mallet, dead blow
- 1 - Mallet, rubber
- 2 - Grounding cables
- 1 - Caulking gun, w/caulk
- 1 - Drum lift strap
- 1 - Lead wool, bag
- 1 - Plier, vice grip
- 1 - Tin snips
- 1 - Dish soap
- 1 - Wire brush
- 1 - Wrench, 10" Crescent
- 1 - Wrench, 12" Crescent
- 1 - Wrench, 16" Crescent
- 1 - Wrench, 5/16" Crescent
- 1 - Pressure gauge
- 6 - Screwdrivers, Straight blade
- 1 - Pop Rivet gun, w/rivets
- 1 - Scissor
- 2 - Strap set, Rachet

1 - "D" Box:
- 6 - Nitrile boots

1 - "B" Box:
- 3 - PVC, Hooded raincoats (green)
- 4 - Yellow raincoats
- 6 - Yellow raincoats
- 4 - Yellow Tyvek, Encap. suits

1 - Accessories Kit, QUICK KIT:
- 2 - Goggles
- 4 - Nitrile gloves
- * - "T" Bolts
- 1 - Water Gauging Paste
- 1 - Aqua Seal
- 1 - Petro Seal
- 2 - Mega Sticks
- 1 - PCB Screening Kit
- 1 - Mega Quick Syringe
- 5 - Ear Plugs, min.
- * - Asst. Wooden Plugs
- 3 - Tennis Balls
- * - Gasket material
- 1 - Duct Tape
- 2 - Rubber Balls
- * - Patching Plates

COMPARTMENT 1, MIDDLE
- 1 - SCBA, complete
- 1 - SCBA, spare bottle

COMPARTMENT 1, BOTTOM
- 1 - Chain, tow
- 1 - Chains, tire
- 4 - Brooms, push

* Denotes an Expendable Supply

PUBLIC WORKS

TRUCKS
- 1 Ton Dump (1)
- 5 Ton Dump (2)
- Water
- Sanders (3)

HEAVY EQUIPMENT

Graders (2)	Tractors (2)
Dozer	Backhoes (3)
Forklift	Front-end Loader

Vactor (3) (Super Suckers)

Ambulance Service

Ambulance service shall be provided by local ambulance services and fire department aid vehicles when appropriate. Mutual aid services may be requested at the discretion of the Incident Commander, based on the scope of the incident. These services shall be dispatched through Valley Communications at the request of the On Scene Commander either by radio or telephone.

Emergency Medical Treatment

On scene decontamination and emergency medical treatment shall be provided by fire department personnel and other available emergency medical personnel dispatched through Valley Communications as requested by the on scene commander.

All persons requiring medical treatment shall be decontaminated prior to emergency medical treatment and transport to a hospital or other emergency facility. Decontamination procedures are defined in the Kent Fire Department Hazardous Materials Response Guide (Attachment 'A' to this plan).

Health

The Incident Commander, in cooperation with the Public Works Department, shall, to the best of their ability, take action to protect area water and sanitation resources from chemical contamination.

Clean up and recovery from chemical contamination of the environment may require outside assistance from state or federal agencies and private contractors and consultants.

Other Health and Medical Assistance

Health and medical assistance beyond the capabilities of existing local resources and mutual aid participants shall be under the direction of the Director of the Seattle/King County Health Department, The State Department of Social and Health Services and/or the U.S. Department of Health, Education and Welfare as determined by the scope of the disaster and defined in Annex K of the City of Kent Disaster Plan.

RESPONSE PERSONNEL SAFETY

During any hazardous material emergency it is essential that response personnel are protected to the greatest degree possible from adverse effects resulting from exposure to hazardous materials involved in an incident. In order to provide an acceptable standard of personnel safety, detailed standard operating procedures have been established.

1. Initial precautions
    a. protective clothing
    b. determination of hazardous material presence
    c. establishment of command post at safe distance
    d. approach to incident site

2. Incident size up
    a. isolate area
    b. identify hazardous material
    c. assess potential danger of incident

3. Call for resources
    a. identify resources needed
    b. request Haz Mat Team response

4. Safety
    a. rescue operations
    b. containment
    c. evacuation
    d. decontamination

The procedures outlined above are contained in the Kent Fire Department Hazardous Material Response Guide and may be reviewed in complete form in Attachment A of this plan.

PERSONAL PROTECTION OF CITIZENS

During any hazardous material emergency it is essential that the citizens of the community be protected to the greatest degree possible from the adverse effects of exposure to hazardous materials involved in an incident. In order to provide for personal protection of the citizens located in an affected area the following guidelines have been established.

1. Shelter in Place

Indoor protection shall be the preferred method whenever possible, to protect citizens from exposure to hazardous materials released during an incident. The decision to shelter in place shall be based on the quantity of material released, the hazardous properties of the material and technical expertise available at the time of the incident. The incident commander shall be responsible for determining the need for sheltering in place and executing warning and communication procedures as outlined in the Warning and Emergency Notification section of this plan.

The following instructions shall be given to citizens during a shelter in place situation:

a. Stay inside until you are notified by television, radio, or other means that it is safe to go outside.

b. Close all doors and windows.

c. Turn off all heating, cooling and ventilation systems.

d. Do not use the fireplace or woodstove. Put any burning fires out and close the damper.

e. Listen to your local radio or television stations for further instructions.

Additional information will need to be provided in the event it is necessary for citizens sheltering in place need to protect their breathing. The following instructions will shall be given:

a. Cover mouth and nose with a damp handkerchief or towel to protect breathing. Thin cloths should be folded over several times.

b. Follow all instructions for shelter in place.

2. Evacuation

The following instructions shall be given to citizens when they are notified to evacuate. The volume of information may be reduced if the incident commander determines that the circumstances, or warning methods to be used do not allow for effective communication of all information.

a. Gather what you and your family will need. Pack only what you will need most.

b. Turn off heating, ventilation and cooling systems and appliances. Leave the refrigerator on.

c. Lock the house or building when you leave.

d. Do not use the phone unless it is urgent. Keep any emergency call very short.

e. Take only one car and drive safely. Keep all windows and vents closed, turn on the radio for evacuation routes and up to date information.

f. Follow directions given by officials along evacuation routes.

g. Carpool if possible to help reduce traffic congestion during the evacuation. If you do not have transportation ride with a neighbor, friend or relative.

h. Do not call your children's school or go to pick them up. They will be the first ones moved if any evacuation is necessary in their location. You will be notified by radio or television where you can pick them up.

HUMAN SERVICES

It is essential during any emergency situation, either chemical or otherwise, that persons which have been evacuated from their homes or businesses due to impending danger to life and health or actual destruction of property be provided with essential human services. These essential services should include but not be limited to food, shelter and clothing.

In the event of an emergency situation requiring human services, the City of Kent Director of Emergency Services or designee shall call the American Red Cross and/or The Salvation Army for assistance in this area.

American Red Cross

The American Red Cross will provide temporary housing, mass care shelter and feeding facilities, emergency first aid and medical services, welfare inquiries, information services and financial assistance for essentials based on the immediate need at the time of the emergency.

Salvation Army

The Salvation Army will assist the American Red Cross with food collection and distribution, provide clothing, bedding essential furnishings and spiritual and family counseling for displaced individuals during an emergency situation.

Other Agencies

Other local agencies may be called or may volunteer to assist with human services during times of emergency. These agencies or citizen groups may include civic organizations, church groups, businesses etc. These agencies may provide human services support in the areas of shelter, food, clothing or other immediate needs during an emergency.

LOCAL AMERICAN RED CROSS SHELTERS

Schools

Totem Jr. High	26630 40th S.	852-5100
Mt. Rainier High	22450 19th S.	433-2441
Pacific Middle School	22705 24th S.	433-2581
T. Jefferson High	4248 S. 288th	839-7490
Auburn High School	800 4th St. NE - Auburn	931-4880
Cascade Jr. High	1015 24th NE - Auburn	931-4995
Kent Meridian High	9800 SE 256th	859-7404
Kentridge Sr. High	12430 SE 208th	859-7345
Kentwood Sr. High	25800 164th SE	859-7680
Kent Jr. High	620 N. Central	859-7446
Mattson Jr. High	6400 SE 251st	859-7671
Meeker Jr. High	12600 SE 192nd	859-7284
Meridian Jr. High	23480 120th SE	859-7383
Sequoia Jr. High	11000 SE 264th	859-7542

Churches

First Christian Church	11717 SE 240th	852-2957
United Methodist Church	11010 SE 248th	631-2564
Covington Comm. Church	17455 Wax Rd.	631-9090
Covington Baptist	21115 SE 272nd	432-5330
Kent Lutheran	336 S 2nd	630-9181
Zion Lutheran	25105 132nd Ave. SE	631-0942

ONGOING INCIDENT ASSESSMENT

The City of Kent has limited means of monitoring a hazardous materials emergency. While the Kent Fire Department has the responsibility for this function, they will do so only to their capabilities. Beyond those capabilities, the Environmental Protection Agency's "Technical Assistance Team" will be requested to monitor an emergency risk area. In some incidents, the specific facility may be able to monitor their own release and will be used in those instances.

Monitoring Equipment

Kent Fire Department

MSA C.G.I. and Oxygen meter
T.L.V. meter
Gastrack
Radiological Monitoring Kit

Other Monitoring Agencies

Department of Ecology

Metro

United States Coast Guard

Washington Natural Gas

CONTAINMENT AND CLEAN UP

The containment and clean-up of a hazardous material spill or release is of vital concern to the citizens of Kent. The Kent Fire Department, being the agency responsible for the initial response shall perform to the best of its ability any necessary measures for the control of a hazardous material release. These efforts will focus on limiting the effects of a release on people, property and the environment.

Containment

Containment by the Kent Fire Department of a hazardous material release shall consist of operations which limit the size of the initial release and attempt to mitigate adverse effects on the community.

Specific procedures for containment of a hazardous materials release can be found in the Kent Fire Department Hazardous Materials Response Procedures, Spill Control Section (Attachment A to this document).

Clean-up and Disposal

The clean-up and disposal of a hazardous materials release is the responsibility of the owner or transporter of the material. Title 4 RCW 4.24.314. Clean-up and disposal measures must be coordinated between the responsible party and state/federal regulatory agencies or private clean-up and disposal contractors as determined by the nature and severity of the release.

Washington Department of Ecology (WDOE) is the lead state agency for overseeing the clean up and disposal of hazardous materials and waste. In the event that the owner/spiller is unknown or unwilling, WDOE is authorized by state law to pay for the clean up and disposal of the spilled materials and pursue the owner/spiller for reimbursement. Authorization must be obtained through WDOE prior to beginning clean up and disposal operations in order for them to pay for clean up and disposal costs.

4.24.314 Person transporting hazardous materials -- Responsibility for incident clean-up -- Liability of person causing hazardous materials incident.

1) Any person transporting hazardous materials shall clean up any hazardous materials incident that occurs during transportation, and shall take such additional action as may be reasonably necessary after consultation with the designated incident command agency in order to achieve compliance with all applicable federal and state laws and regulations.
Any person responsible for causing the hazardous materials incident, other than operating employees of a transportation company, is liable to the state or any political subdivision thereof for extraordinary costs incurred by the state or the political subdivision in the course of protecting the public from actual or threatened harm resulting from the hazardous materials incident.

2) "Extraordinary costs" as used in this section means those reasonable and necessary costs incurred by a governmental entity in the course of protecting life and property that exceed the normal and usual expenses anticipated for police and fire protection, emergency services, and public works. These shall include, but not be limited to, overtime for public employees, unusual fuel consumption requirements, any loss or damage to publicly owned equipment, and the purchase or lease of any special equipment or services required to protect the public during the hazardous materials incident. [1984 c 165 § 3.]

Documentation

The Incident Commander shall be responsible for documentation of a hazardous material incident by means of the Fire Incident Report (WAFIRS) and the Hazardous Material Data Sheet as well as necessary reports on injuries and casualties as appropriate for the specific incident.

The individual or company responsible for the release shall submit appropriate reports as determined by individual company procedures and state and federal regulations.

Investigative Follow-up

Investigative follow-up shall be the responsibility of the individual and/or company responsible for the release and state of federal regulatory agencies per their standard operating procedures, as appropriate for the specific incident.

The Training Division of the Kent Fire Department shall act as coordinator and provide scheduling and record keeping for all inter-city hazardous materials training. Training schedules and information are available through the Training Officer.

It is intended that all first responding members of the Fire Department and selected members of the Police and Public Works Departments will be trained to the First Responder - "Awareness Level" as defined in 29 CFR 1910.120. First responding members of the Fire Department in addition to all members of the Hazardous Materials Team will receive all or part of the additional training as defined in 29 CFR 1910.120 and outlined below.

The City of Kent will also utilize training resources available through the National Fire Academy, the Washington State Department of Community Development and the Federal Government. Training which may become available from time to time through private agencies will be utilized and considered part of the regular training requirements.

TRAINING LEVELS

1. First Responder - Awareness Level

   * Recognition and Identification of Hazardous Materials

2. First Responder - Operations Level
   (24 hours training and demonstrate competency)
   * Knowledge of basic hazard and risk assessment techniques
   * Personal protective equipment for first responder level
   * Basic control, containment and/or confinement operations
   * Basic decontamination procedures
   * Understanding of Standard Operating and Termination Procedures

3. Hazardous Materials Technician
   (Minimum 24 hours training and demonstrate competency)

   * Knowledge of leak repair.

4. Hazardous Materials Specialist
   (Minimum 24 hours training and demonstrate competency)

   * Respond with, and provide support for hazardous materials technician.
   * Act as On Scene Commander