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City of Tumwater
Wellhead protection plan
98190025

City of Tumwater Wellhead Protection Plan

CITY OF
TUMWATER
Washington's First Community

Economic and Engineering Services, Inc.
Pacific Groundwater Group
Daily Environmental

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1.1 Overview

The purpose of this report is to establish a Wellhead Protection Program/Plan (WHPP) for the City of Tumwater's (City) water supply wells.

Wellhead protection is a community-based program to prevent contamination of groundwater used as a drinking water supply. Wellhead protection measures provide "early warning" of contamination so another source can be found or a treatment system installed before an emergency occurs. Wellhead protection focuses on the causes (or risks) of groundwater contamination, and on reducing or eliminating those risks.

It makes sense to implement measures which provide wellhead protection. However, not all utilities understand the risks which threaten their supplies. Also, contamination and loss of source of supply have only recently become national issues resulting in national regulatory requirements for wellhead protection planning.

The City has had first-hand experience with wellfield contamination. The City is totally dependent on groundwater sources to meet the supply needs of the community. In 1993, the City discovered contamination in the Palermo Wellfield which resulted in loss of three of their production wells (25 percent of the City's supply). The investigation into sources of this contamination continue today. Aside from the considerable investigation costs, there is a continuing threat to the rest of the wellfield which may ultimately require significant expense to replace or treat the Palermo supply. The City has experienced the compelling reasons to implement wellhead protection measures as soon as practicable.

1.1.1 Proactive Approach

The City has taken a proactive approach to the development and implementation of this WHPP. Early project scoping efforts included discussions about action programs to deal with known potential threats to the City's water supplies. The City decided to expend the effort necessary to expedite the remediation of known contamination issues and potential threats from commercial/industrial activity. These activities were undertaken as part of the wellhead protection planning effort.

Among the major issues and sites addressed during this project, were the contamination of the Palermo Wellfield, and contamination at both the Hytec and Texaco Bulk Plant Storage facilities.

Consultant services under this WHPP provided guidance for immediate action in response to contamination discovered in 1993 in water samples taken from the Palermo Wellfield. That contamination resulted in the loss of 25 percent of the City's supply.

The City, with consultant assistance, reviewed and made suggestions to the Technical Work Plan of the United States Environmental Protection Agency (EPA) for investigating contamination of the Palermo Wellfield. The City provided the EPA with the latest technical data and expertise on local hydrogeology generated under this wellhead protection program, and played a key role in providing direction to the site investigations conducted by the EPA.

The City also took a proactive approach and directly influenced the status of known contaminated sites listed by the Washington State Department of Ecology (Ecology). For instance, as a result of the City's early actions to direct cleanup studies, Ecology has removed Hytec (a contaminated site 100 yards from a City production well) from its list of confirmed and suspected contaminated sites. The site was removed following additional water quality evaluation and monitoring. The City requested the specific monitoring efforts to confirm that no further remediation is required at the site.

With the City's prompting, contamination at the Texaco Bulk Plant Storage facility has been re-ranked by Ecology from a 3 to a 2 priority because of the City's wellhead protection concerns. The City has also met with Texaco representatives, negotiated options for further action, and secured cleanup progress and water quality monitoring agreements pertaining to the Texaco Bulk Plant Storage facility.

As part of the development of this WHPP, the City approached the Business Pollution Prevention (BPP) program staff of the Thurston County (County) Environmental Health Division in 1995 and proposed a joint technical assistance effort targeted to the City's wellhead protection zones. The City and the County subsequently worked together to successfully complete a pilot outreach project affecting businesses located within the City's wellhead protection areas (WHPAs).

In the summer of 1995, the City and the County's BPP staff teamed up together and conducted an inventory of hazardous materials at the majority of residencies and businesses within the City's five-year time-of-travel capture zones. The objective was to learn about hazardous waste management practices at local businesses.

Of the businesses that took advantage of the technical assistance visit, 50 percent were not in compliance with the County's hazardous waste ordinance. All businesses were in full compliance with the ordinance by the end of the pilot project.

1.1.2 Regulatory Requirements

Section 1428 of the 1986 Amendments to the federal Safe Drinking Water Act (SDWA) mandates the development of a WHPP by each State. The SDWA requires Group A water systems (purveyors who use groundwater as the source of supply and serve 25 or more persons or 15 or more connections), to develop and implement a WHPP. In July 1994, Chapter 246-290 of the Washington Administrative Code (WAC) was modified to require each Group A public water system in Washington State to develop, implement, and maintain a WHPP.

The Washington State Department of Health (DOH) is the designated lead agency responsible for the development and implementation of Group A water system WHPPs. According to DOH's *Wellhead Protection Program Guidance Document* (April 1995), a public water system's WHPP must, at a minimum, include the following elements:

- ❑ A completed susceptibility assessment;
- ❑ A delineated wellhead protection area for each well, wellfield, or spring;
- ❑ An inventory within the wellhead protection area of all potential sources of contamination that may pose a threat to the water bearing zone (aquifer) utilized by the well, wellfield, or spring;
- ❑ Documentation that delineation and inventory findings are distributed to required entities;
- ❑ Contingency plans for providing alternative sources of drinking water in the event that contamination does occur; and
- ❑ Coordination with local emergency responders for appropriate spill or incident response measures.

This WHPP, when adopted and implemented by the City, will meet DOH regulatory requirements. To remain current with and keep abreast of changing land development practices, the City's WHPP will need to be updated regularly. Inventory data, according to DOH, must be updated no less than every two years. Required WHPP coordination with emergency responders and loss of source contingency plan should be updated every two years, or more often if the situation warrants it.

According to DOH regulations, the City's WHPP must be integrated with the City's Water System Plan (WSP) updates, which are required every six years. The City's 1996 WHPP and 1992 WSP will need to be integrated and updated for DOH review in 1998.

The ultimate aim of the City's WHPP is to reduce existing threats and potential risks to the City's drinking water supplies. Because the Cities of Tumwater, Olympia, Lacey, and Thurston County share the same aquifers, a parallel goal is to protect the region's overall groundwater quality through the Northern Thurston County Ground Water Management Program.

2.1 Section 1: Introduction

The City's three major supply sources are the Palermo Wellfield, the Bush Middle School Wellfield, and the Port Wells. Altogether, the City has 11 active production wells which supply water to more than 4,700 service connections within a distribution system area of approximately 10.7 miles. The combined maximum capacity of all City wells totals about 5,255 gallons per minute (7.57 MGD).

Water quality of these sources is generally very good. However, land use activities, population growth, and the potential for accidental spills increase the risk that groundwater could become contaminated. Once contaminated, a public water supply may remain unsafe for many decades.

The City applied for and received a Centennial Clean Water Fund Program FY 94 grant (Grant No. G9400) from Ecology. The purpose of the grant was to protect the aquifers supplying the City's water by establishing a WHPP for the City's water supply wells. As a result of a competitive process, the City selected Economic and Engineering Services (EES), Pacific Groundwater Group (PGG), and Dally Environmental to develop and produce the City's WHPP.

This project's scope of work has included the following: construction of monitoring wells, field investigation and analysis, aquifer characterization leading to delineation of time-of-travel capture zones and wellhead protection area boundaries for each of the City's active production wells, water quality analyses, identification and analysis of existing and potential sources of contamination, and prioritization of threat categories.

3.1 Section 2: Hydrogeology and Wellhead Delineation

3.1.1 Wellhead Protection Area Delineations

Time-of-travel capture zones were modeled for each of the City's current production wells using computer groundwater flow simulation software (QuickFlow). The simulation was calibrated to United States Geological Survey (USGS) water level data. These modeled capture zones were later modified to be consistent with higher resolution water level data collected within the scope of the WHPP. WHPAs larger than the capture zones are recommended for long-term management to account for uncertainty in the input data and temporal changes (see Exhibits 2-14 and 2-15).

3.1.2 Water Quality Monitoring - Results

Groundwater samples were analyzed to characterize general water quality and to assess specific potential sources of contamination. Nitrate (as nitrogen; MCL = 10 mg/L) ranges from below the laboratory detection limit of 0.05 mg/L to 3.2 mg/L, with one detection of 6.2 mg/L on the bluff above the Palermo Wellfield. The concentration of nitrate in groundwater is expected to increase gradually in the future as a result of impact from septic systems, landscaping fertilization, and possibly agricultural practices.

The presence of Freon-11 in groundwater was confirmed in the Bush Middle School area. Immediate action is not warranted, although further monitoring of this area is recommended.

Monitoring well installations and groundwater sampling was conducted to complement the EPA investigation of chlorinated solvents that are impacting the Palermo Wellfield. Detailed characterization of the aqueous geochemistry in this area was obtained and is available to assist in the assessment of various remedial and/or treatment options.

Professional on-call services should be retained to advise the City, with respect to potential contamination sources, on a case-by-case basis. These services would include assessing the severity of potential contamination threats and formulating appropriate responses and options to adequately protect the City's drinking water sources.

3.1.3 Water Level Monitoring - Results

A network of 56 wells over an area of approximately 22 square miles was identified, surveyed, and used to monitor water levels in the three shallowest aquifers (Qvr/al, Qva/al, and Qc/TQu) supplying the City's wells. City monitoring wells, private domestic wells, and environmental monitoring wells were used. Groundwater flow patterns as determined by the USGS were confirmed on the large scale. However, new water level data revealed that groundwater flow gradients near the edge of the Deschutes River Valley are larger and oriented more easterly toward the river.

3.1.4 Summary of Hydrogeology

There are four sand and gravel aquifers of primary interest to the City as potential sources of potable groundwater. These are, from shallowest to deepest, the Deschutes River alluvial and Vashon recessional outwash sediments along the Deschutes River and extending west from the Palermo Wellfield (Qal/Qvr), the Vashon advance outwash (Qva), penultimate drift (Qc), and underlying undifferentiated deposits (TQu).

A shallow unconfined aquifer consisting of Vashon recessional deposits (Qvr) lies at land surface outside of the Deschutes River Valley but is not considered a potential source of water for the City.

These aquifers are separated in most places by low permeability layers (aquitards) that inhibit vertical flow between the aquifers to varying degrees. The Vashon till (Qvt) underlies the surficial Qvr aquifer and separates it from the Qva aquifer, while the Kitsap Formation (Qk) separates the Qva from the deeper Qc and TQu aquifers. The Qvr is poorly defined or absent in the vicinity of Port Well Nos. 9 and 10 and west of the Bush Middle School area, and is a leaky aquitard in the Bush Middle School area. The TQu is comprised of several layers, some of which are aquitards.

City production wells are completed in three different settings. The Palermo Wellfield (Well Nos. 2, 3, 4, 5, 6, and 8) and Trails End Well No. 20 are completed in the Qvr/Qal aquifer. The Qvr/Qal aquifer is generally unconfined, contains the water table, and is susceptible to contamination from ground surface. Port Well No. 7 is completed in the TQu aquifer, is overlain by the Qk and Qvt aquitards, and is well-protected from contamination introduced at ground surface. The rest of the wells (Well Nos. 9, 10, 11, 12, 14, and 15) are completed in the Qva aquifer. The Qvt till is a thick protective aquitard in the vicinity of Well Nos. 11 and 15, is considered thin and permeable in the vicinity of Bush Middle School Well Nos. 12 and 14, and is poorly defined or absent in the vicinity of Port Well Nos. 9 and 10.

3.1.5 Hydrogeology and Wellhead Delineation Recommendations

- ❑ Undertake feasibility study for protecting Palermo Wellfield.
- ❑ Monitor water quality to identify areas of concern and target action programs.
- ❑ Implement water quality and water level database.
- ❑ Evaluate contamination source threats.
- ❑ Monitor water levels to identify areas of concern and target action programs.

4.1 Section 3: Contaminant Source Inventory

A key element of the wellhead protection program is an inventory of known and potential sources of groundwater contamination within the City's delineated wellhead capture zones. The purpose of this section is to inventory land use activities and contaminant sources that may pose a threat to the City's water supply. By identifying the nature of the threats, effective management strategies can be developed to eliminate or minimize the possibility that potential contaminant sources may become actual sources of groundwater contamination.

Land use/parcel inventory data are presented to provide an understanding of the known risks and potential sources of contamination to the City's wellheads. At the City's initiative a business inventory and technical assistance outreach project was completed within the City's WHPAs as part of the development of this WHPP.

Nine confirmed and suspected contaminated sites within the City focus area are identified. Petroleum is a confirmed pollutant with respect to soil contamination, and suspected with respect to groundwater and sediment contamination. Six of the nine known contaminated sites are within the City's designated WHPAs:

- ❑ Poages Automotive and Towing, Inc., located within the one-year time-of-travel capture zone of the Palermo Wellfield;
- ❑ Southgate Dry Cleaners, also located within the one-year time-of-travel capture zone of the Palermo Wellfield;
- ❑ The BP gas station (formerly the Exxon gas station), located just outside the one-year time-of-travel capture zone of the Palermo Wellfield;
- ❑ American Fiberglass, located on the boundary line of the ten-year time-of-travel capture zone of the Bush Middle School Wellfield;
- ❑ Hytec, Inc., located within the one-year capture zone (about 100 feet) time-of-travel capture zone of Port Well Nos. 9 and 10 (now removed by Ecology from the list because of early actions taken by the City during the development of this WHPP); and
- ❑ Tumwater Pickup Parts, located within the WHPA just outside the five-year time-of-travel capture zone of the Palermo Wellfield.

Other known and potential contamination threats that exist within the City's delineated capture zones and WHPAs are also identified and discussed. The primary risks include:

- ❑ Hazardous materials (use and storage);
- ❑ On-site septic systems;
- ❑ Underground storage tanks;
- ❑ The Olympic Pipeline (petroleum products);
- ❑ Transportation spills;
- ❑ Stormwater runoff;
- ❑ Agriculture/hobby farming, golf courses, parks, landscaping; and
- ❑ Wells (poor construction or improper abandonment).

4.1.1 Contaminant Source Inventory Recommendations

- ❑ Increase the availability of hazardous materials technical assistance and audits to small businesses, private industry, and government agencies within the City's WHPAs.
- ❑ Request the Thurston Conservation District to inventory and assess existing agriculture/hobby farming, golf course, and park land use activities within the City's WHPAs and focus its farm and land management technical assistance programs accordingly.
- ❑ Update the parcel and contaminant source inventory every two years, expanding upon and improving the inventory process used in development of this plan.

5.1 Section 4: Risk Analysis

Known and potential contaminated sites located in or near capture zones of City municipal wells have been compiled, and elements contributing to the risk posed by each of these sites have been assessed. This identification, characterization and prioritization of contaminated sites is for risk management purposes. The information presented in this section should provide the City with a basis for development and enforcement of related groundwater protection ordinances.

Each wellfield's contribution to the City's total supply and future water supply planning influences the priority given to protecting each WHPA and to developing management activities specific to each wellfield.

The following are considered the top three risk sources to the City's groundwater supply:

- ❑ Petroleum hydrocarbons and chlorinated solvents associated with both Restover Truck Stop and American Fiberglass located south/southwest of the Bush Middle School Wellfield;
- ❑ Petroleum hydrocarbons and chlorinated solvents associated with underground storage tanks directly west of the Palermo Wellfield in the vicinity of Interstate 5 and Trosper Road; and,
- ❑ Petroleum hydrocarbons and chlorinated solvents associated with underground storage tanks and aboveground sources in the vicinity of Port Well Nos. 9, 10, and 15.

In addition, the Olympic Pipeline Company maintains a subsurface petroleum product pipeline that is located in the one-, five-, and ten-year time-of-travel zone delineated for the Port Wells. The 14-inch pipeline carries all grades of gasoline, diesel fuel, jet fuel, and other oil-based products manufactured by British Petroleum, Arco, and Texaco.

The transmission pipeline pressure is rated at 14,040 psi but has withstood pressures up to 21,000 psi. A branch line off the main pipeline transports this array of petroleum products to Tumwater's Texaco Bulk Plant Storage facility adjacent to the Olympia Airport. The presence of this pipeline increases the risk of contamination at Port Wells Nos. 9, 10, and 15. The pipeline and its potential impact to groundwater presents a significant risk to the City's water supply.

As a result of the City's proactive approach and early wellhead protection initiatives:

- Three additional contaminant sources that likely impact the Palermo Wellfield have been identified. These include Southgate Dry Cleaners, a Washington State Department of Transportation (WDOT) facility, and Poages Automotive Service. All of these sites have been found to be a source, or potential source, of chlorinated hydrocarbons.
- Seven sites were listed as being outside of the WHPA for the Palermo Wellfield. These sites have now conclusively been determined to be located within the zone of contribution to Palermo, and therefore, within the WHPA for Palermo as a result of the EPA study (1996).
- No confining Vashon Till layer was observed in the EPA study (1996) directly west of the Palermo Wellfield in the vicinity of Capitol Boulevard and Trosper Road, indicating greater groundwater vulnerability to land surface activities than previously believed.
- No confining Vashon Till layer was observed in the work done for Hytec Fiberglass in the vicinity of Port Well Nos. 9 and 10, indicating greater groundwater vulnerability to land surface activities than previously believed.
- Very low levels of Freon-11 (at or below detection limits) were detected in a residential well within the Bush Middle School WHPA.
- Groundwater quality sampling through September of 1996 did not indicate any additional areas of contamination.

Each of the City's three production well groups are characterized by distinctly different contamination threats, as summarized below:

5.1.1 Palermo Wellfield

The Palermo Wellfield (Well Nos. 2-6, and 8) currently produces a total of 1070 gallons per minute (gpm), representing 20 percent of the City's water supply. The WHPA for this wellfield is characterized by non-residential land use, known contaminated sites (primarily chlorinated hydrocarbons and petroleum products), known contaminated groundwater and contaminated wells, and underground storage tanks. The wellhead protection strategy for this WHPA involves:

- Targeting existing sites for cleanup efforts.
- Monitoring to detect further contamination of the wellfield.

- ❑ Continued monitoring of sites with known underground storage tanks.
- ❑ Wellhead protection efforts that specifically address business practices that lead to contamination of this WHPA.
- ❑ Best management practice (BMP) requirements that target known contaminated sites that are continuing to operate in this designated WHPA.
- ❑ Business outreach programs focusing on business and industry in the WHPA.
- ❑ Ordinance development and enforcement.

5.1.2 Port Wells (Well Nos. 9, 10, 11, 15, and 7)

The Port Wells supply 45 percent of the City's drinking water. The confining Vashon Till layer has been found to be absent in some areas of this WHPA near the wellheads. The wellhead protection area for these wells is largely non-residential, a portion of which is not serviced by sewers. With the elimination of Hytec from the list of contaminated sites, this WHPA has fewer known or potential contamination sites than does the Palermo Wellfield. Sites include the Fisheries Maintenance Yard, Tumwater Lumber, and Airport Fuel Stop. The Texaco Bulk Fuel Facility is included for consideration under this WHPP due to its proximity to currently recommended WHPA's, and because it may be located in future WHPAs as discharge from production wells increase. The Port of Olympia (Port) and its lease operations comprise a large portion of this WHPA. The Olympic Pipeline runs through the one-, five- and ten-year time-of-travel zones of this WHPA. Wellhead protection strategies for this WHPA include:

- ❑ Business outreach geared directly toward the Port, the Olympic Pipeline Company, and Texaco Bulk Fuel Plant.
- ❑ Incorporate underground petroleum pipeline strategies into an Aquifer Protection Ordinance.
- ❑ Working with the Port regarding implementation of BMPs that specifically address Port lease operation activities, including the handling of potentially hazardous materials and stormwater management.
- ❑ Language in the City's Aquifer Protection Ordinance addressing the type of activity characteristic of the Texaco Bulk Fuel Plant located in close proximity to the wellheads in this WHPA.
- ❑ Aquifer Protection Ordinance should require contaminated facilities to monitor water quality on a regular basis.
- ❑ A traffic plan should be prepared for the transport of hazardous materials in relation to the Texaco Bulk Fuel Facility and other Port of Olympia locations.

5.1.3 Bush Middle School Wellfield (Well Nos. 12 and 14)

The two wells comprising the Bush Middle School Wellfield represent 34 percent of the City's current water production and are anticipated to provide a substantially larger proportion of future supply. The delineated WHPA for the Bush Wells is largely residential in nature and not served by sewers. A small area of Port of Olympia property is also located within the one-year capture zone of this WHPA. Contamination associated with Restover Truck Stop and American Fiberglass is a suspected threat to these wells. Wellhead protection efforts should:

- ❑ Be aimed at the residential community in the form of education that stresses proper septic system maintenance and use of pesticides, as well as residential turf management practices.
- ❑ Address the cleanup of the Restover Truck Stop and assess the threat of the American Fiberglass site.

5.1.4 Trails End Well No. 20

It is understood that the City is considering further resource development in the Trails End area. It is recommended that a more detailed wellhead protection assessment of this area be undertaken in anticipation of further development.

5.1.5 Risk Analysis Recommendations

- ❑ Assess nitrate levels in groundwater for specific areas within Tumwater's WHPAs based on nitrate loading model.
- ❑ Prioritize level of effort and program implementation elements by WHPA.
- ❑ Develop and implement petroleum pipeline management strategies.
- ❑ Investigate current procedures for pesticide and herbicide use.

6.1 Section 5: Spill Response Assessment

This section outlines spill response procedures and operational capabilities for protecting the City's WHPAs. Since most spills are small and require local response, this section focuses on local response capabilities and the needs associated with these local response systems.

The effectiveness of spill response is often tied to the cooperative efforts, capability, and training of the "first responders." Depending on the event timing and location, first responders are the local fire department, the local police, or the State Patrol. Their primary mission is human safety, but closely related is the goal of environmental protection.

These first responders often have the task of acting immediately to protect health, property, and the environment from chemical contamination. Their actions can effectively reduce risk or increase risk to groundwater depending on their initial decisions. First responders also determine the need for assistance and mobilization of additional resources from the local, State and federal government.

The City has a duty to be prepared for and respond to all disaster emergencies within its boundaries. This includes establishing, maintaining, and updating a spill response plan to protect its drinking water supplies. The City has an Emergency Disaster Plan (EDP). Spill response is an integrated component of the City's EDP and is detailed under Annex O - Radiological and Technological Protection.

Emergency management is a major function of the Tumwater Fire Department. The Fire Chief is the designated Director of Emergency Management for the City. In that leadership role and as directed by the Mayor and City Administrator, the Tumwater Fire Chief is responsible for carrying out, maintaining, and updating the City's EDP.

The City uses the nationally recognized and accepted Incident Command System (ICS) as the basic management structure for emergency response to and recovery from an incident. The organization of ICS is structured around four major functional areas: command, planning, logistics, and administration. The ICS program is built on teamwork, coordination, and cooperation between all of the entities involved (or potentially involved) in a spill response.

Because the City's WHPAs are located both within and outside the City's corporate limits, local response to hazardous material spills may be under the jurisdiction of the Tumwater Fire Department (within the City and service area boundaries of Fire District No. 15) or Fire District Nos. 5, 6, or 11 (outside of the City). The address or location of the spill incident reported to Thurston County's 911 Emergency Dispatch Center would determine whether the Tumwater Fire Department (TFD), Fire District Nos. 5 (Black Lake), 6 (East Olympia), or 11 (South Tumwater) is designated as the first responder agency.

As lead first responder agencies, TFD as well as Fire District Nos. 5, 6, and 11 identify potential problems, obtain equipment, and train personnel for an emergency or disaster. Spill response may be achieved through mutual aid agreements with other local fire service agencies. TFD and Fire District Nos. 5, 6, and 11 have lead responsibilities for providing identification of hazardous substances, spill containment, fire fighting services, and initial security at the scene. This includes providing emergency medical treatment and triage of patients when needed, giving life support services, and transporting victims to acute care centers or the hospital.

Wellhead protection is a new program yet to be added to the City's EDP. With the development and implementation of this WHPP, the City's Public Works Department has the opportunity to improve existing coordination with and increase its support of first responder organizations to an oil spill or hazardous materials incident that may occur within the City's WHPAs.

The ability of the City to affect the protocols and procedures of the State and federal emergency management planning organizations and spill response systems is limited. The majority of oil spills and hazardous materials releases are small and require effective organizational coordination and timely local response capabilities.

6.1.1 Spill Response Assessment Recommendations

- ❑ Develop a Tumwater Spill Response Plan for each of the City's WHPAs.
- ❑ Update the City's Emergency Disaster Plan and Hazardous Materials Response Plan to include WHPAs and capture zones.
- ❑ Provide the City's WHPA information to emergency management planning and spill response organizations in northern Thurston County. Encourage Thurston County to update its Emergency Disaster Plan to include all designated WHPAs.
- ❑ Develop an integrated wellhead protection and spill response inservice training program for the City's Fire, Police, and Public Works Departments.
- ❑ Request the Thurston County Board of Commissioners to reactivate the Thurston County Local Emergency Planning Committee. Encourage the LEPC to update the Countywide Hazardous Materials Emergency Response Plan and include WHPAs.
- ❑ Establish and maintain a Regional Spill Response Subcommittee under the Ground Water Policy Advisory Committee (GWPAC) to develop a regional spill response plan for WHPAs.
- ❑ Enhance existing business education programs and work with local businesses to promote effective spill prevention practices in WHPAs.

7.1 Section 6: Contingency Plan Assessment

What happens when a wellfield is contaminated and cannot be used as a drinking water source?

The purpose of this section is to help ensure that alternative sources of drinking water are available in the event of a short-term or extended loss of supply. This assessment emphasizes the importance that each source of supply has to the City.

The principal focus of this section is on loss of source from the City's two major wellfields:

- Loss of the uncontaminated wells at the Palermo Wellfield, which provides 20 percent of the City's total drinking water supply.
- Loss of the Bush Middle School Wellfield, which provides 34 percent of Tumwater's total supply.

In accordance with federal and State law, emphasis is placed on the existing reaction capabilities of the City's system to effectively provide an adequate quantity and quality of drinking water supply to its customers under emergency conditions. Most importantly, this information provides a framework for deciding the extent to which system enhancements, alternative sources of supply, and capital facility improvements are needed should the City experience the sudden loss of a major well or wellfield.

Although the Port wells produce 45 percent of the City's total drinking water supply, they were not subjected to this assessment because the physical distance between these wells precludes them from being treated as a single wellfield.

7.1.1 Scenario 1: Loss of Palermo Wellfield

With the loss of the 1,070 gpm (1.54 MGD) capacity of the Palermo Wellfield, the City's current surplus in source of supply reverses to an overall system deficit of approximately 315 gpm (0.45 MGD). Without the addition of a new source of supply, curtailment in water consumption, or intertie supplements to make up for the loss of 315 gpm, the total storage capacity of the City under this scenario could be exhausted in about 12 days.

7.1.2 Scenario 2: Loss of Bush Middle School Wellfield

Similarly, the loss of the 1,800 gpm (2.59 MGD) source production capacity of the Bush Middle School Wellfield would produce a system-wide deficit in supply of 1,045 gpm (1.50 MGD). Again, without the addition of a new source of supply, curtailment in water consumption, or intertie supplements to make up for the loss of 1,045 gpm, the total storage capacity of the City under this scenario could be exhausted in about four days.

7.1.3 System-wide Impact

Overall, the system-wide impacts resulting from the loss of the Palermo Wellfield represent approximately seven percent of the City's total peak day demand compared to approximately 23 percent of the City's total peak day demand that would result from the loss of the Bush Middle School Wellfield.

7.1.4 Emergency Interties

Use of emergency interties can provide temporary relief for the loss of source or during emergency situations where supplemental water supply is required. Currently, the City's interties are underdeveloped for purposes of providing a reliable and sufficient source of supply during long-term emergency situations.

7.1.5 New Sources

The City's wellfield investigations and placement of future production wells should be targeted to hydrological locations and land use zones that will satisfy forecasted demand and provide the lowest potential contaminant risk to the City's sources of supply. These targeted wellhead placements should be located within the City's urban growth area where future water and sewer services will be provided as a result of land development. Commercial and industrial development should be excluded from the City's WHPAs to the greatest extent practical. At a minimum, new wells should be located so that the City's WHPAs have the least possible overlap with current or future industrial zoned land.

While the City presently lacks a written loss of source contingency plan, this contingency plan assessment shows that the City has the ability to accommodate peak day demand and effectively manage a short-term (24-hour) loss of source should either the Palermo Wellfield or the Bush Middle School Wellfield be placed out-of-service.

Along with the analyses presented in the City's 1992 WSP, this review demonstrates that (during a period of peak day demand) an extended loss of source beyond four days for the Bush Middle School Wellfield and 12 days for the Palermo Wellfield would produce a system-wide crisis unless peak day demand could be curtailed, mitigated, or reduced to a level below the City's available supply.

Several opportunities are present for the City to develop, establish, and maintain a comprehensive loss of source contingency plan for its public water system.

7.1.6 Contingency Plan Assessment Recommendations

- ❑ Prepare and disseminate a written contingency plan for loss of source from contamination, technical problems, or system failure.
- ❑ Evaluate the potential benefits and consequences of source augmentation by increasing current pumping regimes to equal the City's perfected water rights on an emergency basis.
- ❑ Pursue groundwater source exploration and the development of new sources of supply.

- ❑ Consistent with WSP requirements, develop and implement a comprehensive hydraulic improvement plan for the City's water distribution and transmission system.
- ❑ Evaluate permanent intertie capabilities with the Cities of Olympia and Lacey as well as other water purveyors such as the Pabst Brewing Company.
- ❑ Initiate a coordinated approach toward regional water supply contingency planning and source development with the Cities of Olympia and Lacey, and Thurston County.

8.1 Section 7: Existing Risk Mitigation Programs

This section outlines existing pollution prevention strategies and risk mitigation programs available to protect the City's drinking water supplies. This section also recommends pollution control enhancements where opportunities for improved protection of the City's WHPAs are possible.

Wellhead protection programs offer the City and the region as a whole an opportunity to coordinate and integrate all of the existing management strategies and pollution control programs into a more effective environmental protection effort. Specifically, WHPPs have a limited geographic focus, they have specific risk reduction priorities, they are of considerable local interest, and they provide the opportunity for establishing and maintaining local control.

The City's basic wellhead protection strategies and programs may be categorized as follows:

- ❑ Program management and coordination
- ❑ Monitoring and data management
- ❑ Public involvement and education/technical assistance
- ❑ Land use planning and regulation
- ❑ Other regulatory programs

8.1.1 Program Management and Coordination

At the City of Tumwater, groundwater protection is primarily the responsibility of the Public Works Department. Specific program planning and water resource operations are the responsibility of the water, stormwater, and sewer utilities. The City relies on the County Health Department for management of on-site septic systems to prevent groundwater contamination from that source. Preparing for quick response to spills of hazardous materials and other potential contaminants is a primary responsibility of the Tumwater Fire Department in coordination with the City's Police and Public Works Departments, as well as other State and local agencies.

The City's delineated wellhead protection zones are located within the Northern Thurston County Ground Water Management Area (GWMA). The GWMA was established by Ecology in 1987, initiating a cooperative Ground Water Advisory Committee (GWAC) planning effort funded by Ecology, Thurston County, and the Cities of Tumwater, Lacey, and Olympia. The work of the GWAC resulted in the development and adoption of the Northern Thurston County Ground Water Management Plan (GWMP) in September 1992.

The GWMP presents regional approaches to groundwater protection, and also proposes many program expansions and enhancement activities. The City has supported implementing the GWMP as an integrated regional program. Regional support is dependent upon the development and implementation of an appropriate scope of activity, allocation of responsibilities, and funding mechanism among the four affected entities (Tumwater, Lacey, Olympia, and Thurston County).

The City of Tumwater and its neighbors (Lacey, Olympia, and Thurston County) remain committed to implementing the GWMP as much as possible within their jurisdictions. Coordination occurs through the Groundwater Policy Advisory Committee (GWPAC), Public Works Directors Steering Committee, Education Technical Advisory Committee (ETAC), and Groundwater Technical Advisory Committee (GWTAC), representing elected officials, senior management, and technical staff of the County and Cities.

In the absence of a single agency with formal regional responsibility for environmental protection, the existing coordinating committees provide a basic framework for regional coordination of wellhead protection activities. An overriding program management strategy of this WHPP is to focus existing groundwater protection programs in the City's designated wellhead protection areas. The objective is to reduce existing risks from potential threats not adequately covered by existing land use controls or other regulatory program activities.

Program Management and Coordination Recommendations

- ❑ Review all City environmental protection programs that might affect groundwater and evaluate their effectiveness in preventing groundwater contamination in WHPAs.
- ❑ Provide routine leak detection on all sewer force mains within the one- and five-year time-of-travel zones of each designated WHPA.
- ❑ Through the GWPAC and GWTAC, develop a regional hazard ranking system to set wellhead protection priorities and land use permit conditions.
- ❑ Through the GWPAC and GWTAC, coordinate pollution control policies and management strategies related to Wellhead Protection Programs for the Cities of Tumwater, Olympia, Lacey, and Thurston County.

8.1.2 Monitoring and Data Management

The County Health Department is monitoring regional groundwater quality. The Cities of Tumwater, Lacey, and Olympia are developing and implementing Wellhead Protection Programs for their groundwater supply sources, which share the same aquifer systems. Through the coordinating committees described above, local jurisdictions are working toward a regional monitoring network to optimize use of existing resources and avoid duplication.

A groundwater monitoring network has been established in the City's WHPAs. Public and private wells are used to monitor water quality and water levels for this WHPP. The Cities of Tumwater, Olympia, and Lacey have completed baseline inventories of land use and sources of contamination within their designated WHPAs as part of the development of their individual WHPAs.

Basic systems are in place for local wellhead protection monitoring and data management purposes, but ongoing data collection and analysis by the City and at the regional level are needed. Satisfying these City and regional wellhead protection monitoring and data management needs will require dedication of resources by the City and other regional jurisdictions.

Monitoring and Data Management Recommendations

- ❑ Support regional water quality monitoring efforts.
- ❑ Monitor and coordinate inspection programs carried out by local fire agencies, Thurston County's Moderate Risk Waste Program, Ecology, and Department of Health.
- ❑ Integrate City supply and use data into regional systems.
- ❑ Routinely share land use regulatory data and information with other members of the GWPAC, GWTAC, and the public.
- ❑ Establish and maintain a comprehensive underground storage tank inventory and leak detection program within the City's designated WHPAs.

8.1.3 Public Involvement and Education/Technical Assistance

Public involvement and education have become essential components of environmental management over the past decade. Every major environmental planning effort in Washington State has included a substantial public participation element. DOH's guidelines for comprehensive water system and wellhead protection planning rely extensively on active public involvement, education and technical assistance efforts for protecting groundwater sources and implementing water conservation programs.

Existing public involvement and education/technical assistance programs in the City include the following major water resource and wellhead protection efforts:

Stream Team

Stream Team is a citizen education and monitoring program sponsored by Tumwater, Lacey, Olympia, and Thurston County. The program involves adults and children in the protection and enhancement of water resources through workshops, environmental monitoring, training, field trips, and action projects. Stream Team is funded by stormwater utility fees.

Project GREEN

The City of Tumwater supports the Budd/Deschutes Project GREEN which provides watershed processes, environmental education, and action research to northern Thurston County's watershed communities through local school teachers to K-12 students. Project GREEN is funded through grants, government, and business contributions. It is not a permanently funded program. City funding is from stormwater utility fees.

Public Outreach Program

As part of the development of this WHPP, the City approached the BPP staff of the Thurston County Environmental Health Division in 1995 and proposed a joint technical assistance effort targeted to the City's wellhead capture zones. The City and the County subsequently worked together to successfully complete a pilot outreach project to assist businesses located within Tumwater's WHPAs. The City/County pilot project was funded by solid waste fees and by hazardous waste grants from Ecology created by Initiative 97.

Moderate Risk Hazardous Waste Program

The County Health Department has an information program targeted to small businesses called the Moderate Risk Hazardous Waste Program. Under a grant from Ecology, this coordinated prevention program offers information, and business "audits" on request. In addition, efforts are being made to work with other Ecology information and outreach programs as well as provide curriculum materials for schools. This program could easily be expanded and represents an alternative to increased regulation. The Moderate Risk Hazardous Waste Program focuses on waste elimination and reduction.

Thurston Conservation District

The County has an active Conservation District which provides technical assistance to landowners. This assistance takes many forms. Fertilizer application rates, appropriate animal density, as well as animal waste disposal and utilization are common topics. In many cases, recommendations are formalized in a "Farm Plan." The Thurston Conservation District (TCD) also provides a conduit for funding of soil and water conservation together with environmental protection measures. "Turf Management Plans" and "Integrated Pest Management Plans" are also common formalized approaches to land management where the land is used for a small farm, a golf course, or a park. These approaches can provide valuable guidance, and be an important tool in preventing groundwater contamination.

Education Technical Advisory Committee

The regional Education Technical Advisory Committee (ETAC) has developed a long-range framework on public involvement and education for stormwater and surface water management. ETAC's framework for long-range public involvement and education activities has been adopted in regional basin plans.

Despite the local commitment to public involvement, major gaps in groundwater programs were identified as part of the Northern Thurston County Ground Water Advisory Committee (GWAC) planning process. For example, groundwater protection and water conservation programs typically were found to be funded temporarily through grants or insufficiently funded.

As the City continues to address today's water resource management and regulatory compliance issues, the need for public involvement and education programs will grow and intensify. Traditionally, public involvement and education programs have not played a major role in the City's water utility operations. However, faced with issues which require the public's awareness, participation and support (such as the contamination of Palermo Wells), the City will need to give more attention and priority to creating its own or expanding the County's environmental education and wellhead protection public involvement and education programs.

Public Involvement and Education/Technical Assistance Recommendations

- ❑ Request ETAC to develop a regional working agenda for wellhead protection public involvement and education programs; to the maximum extent possible, have GWPAC member jurisdictions jointly participate, fund, and develop wellhead protection materials for use in designated WHPAs throughout northern Thurston County.
- ❑ Assure direct contact with each commercial business and industrial site within the City's wellhead zones every two years, advising them of the locations of wellhead zones, major issues of concern, and available technical assistance.
- ❑ Remind all residential property owners in wellhead protection areas regularly of their special responsibility for pollution prevention. Seek their participation

in all public involvement and education activities and volunteer opportunities, and inform them about issues of concern and available technical assistance programs.

- Develop school-related wellhead protection programs within the City's WHPAs, in cooperation with the Tumwater School District, the Tumwater Fire Department, Fire District Nos. 5, 6, and 11, and other local community, neighborhood, and volunteer organizations.

8.1.4 Land Use Planning and Regulation

Zoning (and other land use regulations) to restrict the type of land use in wellhead protection areas is one of the primary means of reducing risk of groundwater contamination. Land use controls can either prohibit an activity or establish conditions under which an activity may locate in a particular area. Such controls may vary depending on the proximity (time-of-travel) to the wellhead, vulnerability of the water supply, and existing land uses. Overlay zoning (such as Tumwater has already established for aquifer protection throughout the City) is commonly used where land uses and development are already established, making downzoning impractical.

Washington State's 1990 Growth Management Act (RCW 36.70A) mandates comprehensive planning for rapidly-growing cities and counties. As a rapidly growing region, Tumwater and Thurston County's Comprehensive Plans must direct growth to urban growth areas that are environmentally suitable and will be adequately provided with municipal services, including sewers and drinking water.

Comprehensive plans include restrictions to encourage the most appropriate use of land, facilitate the adequate provision of water, and protect the quality and quantity of groundwater used for public water supplies. A comprehensive plan provides general guidance for future development, a blueprint which proposes rather than disposes.

Zoning, on the other hand, must comply strictly with statutory procedures and be consistent with the comprehensive plan. It must be by ordinance, and must include a map clearly defining the zones. Consistent zoning standards for the 25,000-acre urban growth area that surrounds the Cities of Tumwater, Lacey, and Olympia have been enacted by the Thurston County Board of Commissioners (August 1996). The new zoning standards were developed as a result of a 1995 agreement between the County and the Cities to create consistent development standards in urban growth areas that are compatible with the long-term aspirations of the three Cities as identified in comprehensive plans adopted jointly by the Cities and Thurston County as they develop and grow during the next 20 years.

Reducing the risk from various current and future land uses will involve a complicated set of possible controls. Any land use regulation has serious implications to the environment, the character, and the economics of the area, and needs to be considered carefully. One way for the City to move toward improved resource protection through land use regulation would be through a phased approach.

A first phase might consider only future land uses and permits for proposed actions. Such an effort would consider such things as:

- ❑ Overlay zones and restricted (and prohibited) uses;
- ❑ Expanded project review; and
- ❑ More restrictive development requirements.

A second phase might focus on existing land use and related impacts. Such efforts might involve:

- ❑ Operating permits
- ❑ Construction standards,
- ❑ Enhanced enforcement.

Finally, a third phase on non-conforming uses (historical uses which are non-conforming under today's standards) might be addressed with a combination of incentives and regulatory controls.

Throughout the process, educational efforts will need to be stressed so that a maximum amount of knowledge and program understanding are conveyed to those stakeholders who are potentially regulated.

The desired result of such requirements would be project designs and land uses which do not impact groundwater quality. One way to achieve such a result would be to establish (through City Ordinance) a requirement for specific hydrogeological analysis of the project prior to permitting.

A key to success in this effort will be the ability to define the City's groundwater protection goals. The "anti-degradation" goal of the State's groundwater standards (Chapter 173-200 WAC) may provide the appropriate goal for the City. Under guidance from Ecology, this goal has been translated into protection standards (numeric values) related to drinking water standards. These could be used by the City in its review and analysis process. This WAC also contains guidance, as does the County's critical areas ordinance, which may prove useful in guiding the appropriate hydrogeological assessment.

The difference between an analysis which might be required by the City and one which would be required by Ecology (under the groundwater standards), is that the City would require an analysis of all potential discharges as opposed to proposed discharges which are routinely regulated by Ecology.

A second, and important, objective for ordinance development will be to target appropriate proposed projects. For example, because of low potential impact, it may be desirable to exclude certain types of uses such as residential uses on septic tanks. Under the Growth Management Act (GMA), rural residential densities may be low enough to not represent a significant threat, and urban densities will often receive sewer service. Therefore, such exclusions should allow for effective and targeted administration of the program to commercial and industrial uses, and higher residential densities served by community septic systems.

The City may also wish to consider the existing aquifer recharge area provisions within Thurston County's Critical Areas Ordinance (TCC Chapter 17.15.500-540) for possible integration into the City's permit review system.

Land Use Planning and Regulation Recommendations

- ☐ Revise the Comprehensive Plan to emphasize the importance of WHPAs and designate standards for development and operation of facilities in wellhead zone, such that those facilities do not increase risk to the water supply.
- ☐ Require additional analysis concerning pollution control issues prior to site development.
- ☐ Assure proper local well siting and utility service review through the well drilling "start" card and building permit review process.
- ☐ Revise the Zoning Code to include a permanent overlay zone for WHPAs.
- ☐ Revise the Zoning Code to add performance standards to conditional use requirements.
- ☐ Revise the Zoning Code criteria for expansions and alterations of non-conforming structures/uses within the City's one- and five-year time-of-travel zones.
- ☐ Revise the regional Stormwater Drainage and Erosion Control Manual to specify stormwater treatment practices best used in WHPAs.
- ☐ Require all commercial agriculture and recreational land users within the City's wellhead zones to develop and implement land management plans through the Coordinated Resource Management Process (under the direction of the Thurston Conservation District).

8.1.5 Other Regulatory Programs

In addition to local land use controls, many other federal, State, and local regulatory programs are designed to protect drinking water supplies from contamination. Each of these programs has a specific mandate to address one or more particular types of contamination. These programs are often implemented independently of each other. For example, septic tank drainfields are regulated separately from underground storage tanks; solid waste and hazardous materials are regulated by several agencies; and stormwater management systems are regulated separately from wastewater disposal systems.

In Washington State, DOH has primary responsibility for protecting public health and Ecology has primary responsibility for protecting water resources and the environment. States are mandated to implement major regulatory programs under federal legislation such as the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In turn, the State delegates authority in some programs to local agencies such as the County Board of Health, City and County governments, local fire departments and fire protection districts.

Federal, State, and local regulatory programs are generally adequate for protecting the City's drinking water supplies. However, budget constraints and lack of coordination generally inhibit the effectiveness of many regulatory programs. Wellhead protection programs offer an opportunity to improve the effectiveness of existing regulatory programs by focusing them in the City's wellhead protection areas as a first priority.

Other Regulatory Programs Recommendations

- ☐ Through the GWPAC and GWTAC, annually review State and local regulatory activities in the region and jointly influence them to focus their activities in WHPAs.
- ☐ Through the GWTAC, annually review progress on contaminated (Model Toxics Control Act) sites located in the designated WHPAs of the region. Collaborate to provide Ecology with a regional focus and a prioritized list of MTCA sites.

9.1 Section 8: Evaluation of Recommendations

This section presents a compilation and an evaluation of all WHPP recommendations presented in previous sections. These are organized in the sequence in which each action item was previously discussed. No priority should be implied by the presentation sequence. Individual recommendations are evaluated separately by potential benefit or effectiveness in protecting the City's drinking water supply, feasibility or ease of implementation, and estimated cost. Costs are classified as low ($1,000 to $5,000); medium ($5,000 to $10,000); or high (over $10,000). Also included is a recommendation as to each action item's relative priority for implementation. Items recommended for the basic WHPP should receive the highest priority, with those recommended for "an enhanced program" receiving additional analysis for potential future use.

10.1 Section 9: Implementation Plan and Estimated Budget

This final section addresses the primary risk factors posing a threat to the City's drinking water supplies by extending the evaluation results detailed in Section 8 in two ways.

- First, 34 (71 percent) of the 48 recommended actions are included in a "basic" WHPP. Implementing this Service Level 1 program would provide an adequate level of protection for the City's wellheads. Fully implemented, the basic WHPP totals an estimated annual cost of $76,500 in 1998, $60,800 in 1999, and $60,700 in 2000 and beyond. Table 9-1 provides an outline of the basic WHPP level of effort involved. Table 9-3 presents a proposed implementation schedule and estimated annual costs of individual action items comprising the basic WHPP for the City.

- Second, an "enhanced" program includes the remaining 14 (29 percent) of the 48 recommended actions compiled from all previous sections. Implementing this Service Level 2 program (in conjunction with the minimum program of the Thurston County Ground Water Management Plan), would provide an excellent level of protection for the City's wellheads. On an annual basis, the enhanced program would cost an estimated $356,000 in 1998, $240,000 in 1999, and $227,000 in 2000 and beyond. The enhanced program actions are listed separately as shown on Tables 9-2 and 9-4.

For Tables 9-3 and 9-4, full-time equivalent (FTE) staff requirements have been converted into dollars using $60,000 as the average annual cost of a City position.

11.1 Summary Statement

Developing, implementing, and updating the City's WHPP is an excellent way to avoid the high financial costs of a contaminated public water supply. A proactive pollution prevention program is far more cost-effective than having to pay for an alternative source of drinking water supply or initiating large-scale groundwater remediation actions. The City's awareness that local groundwater supplies are vulnerable to contamination, coupled with the high costs associated with mitigating groundwater pollution, provides a compelling force for the City to adopt and implement selected WHPP action recommendations as soon as practicable.

Section 1

Section 1
Introduction

1.1 Purpose

The purpose of this report is to establish a Wellhead Protection Program/Plan (WHPP) for the City of Tumwater's (City) public water supply wells. The City's WHPP has been designed to accomplish the following:

- ❑ Reduce the likelihood that potential contaminant sources will pollute the City's drinking water supply;
- ❑ Establish a monitoring program to provide an "early warning" of contaminant entry into the City's delineated wellhead protection areas (WHPAs);
- ❑ Develop action recommendations to foster and promote long-term management of groundwater quality;
- ❑ Evaluate the City's contingency plan to provide alternative sources of drinking water in the event that, notwithstanding reasonable protective measures, contamination does occur; and
- ❑ Meet the requirements of Chapter 246-290 WAC and the provisions of the Washington State Department of Health's *Wellhead Protection Program Guidance Document* (April 1995).

1.2 Need

The City is totally dependent upon groundwater supplies to meet its drinking water needs. The City's only supply sources are the Palermo Wellfield, the Bush Middle School Wellfield, and the Port Wells. Altogether, the City has 11 active production wells which supply water to more than 4,700 service connections within a distribution system area of approximately 10.7 miles. The combined maximum capacity of all City wells totals about 5,255 gallons per minute (7.57 MGD).

Natural water quality of these sources is generally very good. However, land use activities, population growth, and the potential for accidental spills increase the risk that groundwater could become contaminated and that one or more sources could become unfit for public use. Once contaminated, a public water supply may remain unsafe for many decades.

On August 3, 1993, the City discovered that groundwater contamination had actually occurred when trichloroethene (TCE) was discovered in water samples collected from Palermo Well Nos. 2, 4, and 5 during routine monitoring. TCE was detected in a water sample collected from Well No. 2 at a concentration more than twice as high as the federal drinking water standard. This episode resulted in the loss of 25 percent of the

City's water supply. Subsequent monthly sampling conducted by the City indicates that TCE persists in the capture zone of Well Nos. 2, 4, and 5. These three wells remain out-of-service and are now listed on the federal Superfund site list.

The threat of contamination and resulting loss of supply have become a significant concern in many areas of the country. As a result, wellhead protection planning is required under the 1986 Federal Safe Drinking Water Act (SDWA). Accordingly, Washington State has developed a State WHPP, defined in Chapter 246-290 of the Washington Administrative Code (WAC) and administered by the Washington State Department of Health (DOH).

1.3 Scope

The City applied for and received a Centennial Clean Water Fund Program FY 94 grant (Grant No. G9400) from the Washington State Department of Ecology (Ecology). This grant is to protect the aquifers which supply the City's water by establishing a WHPP for its public water supply wells. Through the issuance and advertisement of a Request for Engineering Services, the City solicited Statements of Qualifications (SOQs) from several firms having relevant experience. As a result of a competitive interview and evaluation process, the City selected Economic and Engineering Services, Inc. (EES), the Pacific Groundwater Group (PGG), and Dally Environmental to develop and produce the City's WHPP.

This project's scope of work has included construction of monitoring wells; field investigation and analysis; aquifer characterization leading to delineation of one-year, five-year, ten-year time-of-travel zones and wellhead protection area boundaries for each of the City's active production wells; water quality analyses; identification and analysis of existing and potential sources of contamination; and, prioritization of threat categories. The completion of these critical tasks led directly to the following:

- ❑ Identification and evaluation of existing spill response capabilities;
- ❑ Assessment of the City's present contingency plan for loss of source;
- ❑ Review of existing pollution prevention strategies and risk mitigation program measures (particularly for the high threat categories);
- ❑ Extensive water quality and water level monitoring program activities; and
- ❑ Development of specific recommendations for needed WHPP enhancement and improvement actions.

Throughout this project, the City and its consultants have recognized that the effective implementation of this WHPP for the City's wells (particularly since the City's designated WHPAs extend beyond the City's jurisdictional boundaries), is dependent upon actions by other entities, the business community, and the general public. For example, the City only has direct land use control within the City limits and must rely on Thurston County in unincorporated areas, especially in the City's established urban growth area.

Substantial opportunities exist for the City to explore and resolve wellhead protection issues with the Cities of Lacey, Olympia, Thurston County, the Ground Water Policy Advisory Committee (GWPAC), Ecology, and Health.

Therefore, the overall approach throughout this project has been to support and utilize existing work and regional programs whenever possible. Effort was made to avoid needless duplication and keep abreast of related wellhead protection activities in northern Thurston County. Focused land use controls and regulatory programs, along with enhanced wellhead protection requirements, will have the best likelihood of protecting the City's groundwater sources in the future. A primary factor influencing the ability of the City to protect its drinking water supply will be the extent wellhead protective measures are implemented consistently across jurisdictional boundaries.

While the City must keep its own municipal needs and self-interests uppermost, many recommended actions call for the City to implement wellhead protection policies and practices in coordination with the Cities of Lacey, Olympia, and Thurston County. The City's best wellhead protection prospects reside with many other stakeholders, including the Port of Olympia, the Pabst Brewing Company, and the Tumwater School District.

Following review by the public and the DOH, a final draft of the City WHPP and an accompanying proposed ordinance will be submitted to City Council for consideration. A public hearing will be held prior to adoption of the City's WHPP as an amendment to the 1992 Water System Plan. DOH requires that the City's Water System Plan be updated every six years. DOH guidelines also require the City's WHPP to be integrated into the City's Water System Plan update in 1998.

Section 2

Section 2 Hydrogeology and Wellhead Delineation

2.1 Hydrogeology

A hydrogeologic characterization of the groundwater resources of the City of Tumwater (City) was compiled in a report entitled "*Preliminary Characterization and Task 3 Work Plan*" (EES and PGG, 1995). Work conducted since completion of that report has provided a more refined characterization of groundwater flow directions. Recent work associated with environmental investigations of chlorinated solvents around the Palermo Wellfield and the Hytec site have improved the understanding of hydrogeologic stratigraphy in these areas.

The physiography of the project area consists of areas of low hills on the northwest and southeast separated by a broad, flat, plain trending from the northeast to the southwest. The hills are generally 300 to 400 feet above mean sea level (msl) and are underlain by volcanic rocks and marine sediments. The plain is a very consistent 180-200 feet msl and is underlain by unconsolidated sediments that fill a trough in the bedrock between the two ranges of hills. These sediments were deposited by glaciers, glacial melt waters, and by streams and lakes during non-glacial periods. The plain is cut by the Deschutes River Valley which runs along the eastern portion of the project area and is about 100 feet msl (Exhibit 2-1). The Black River drainage runs along the western margin of the project area but is not incised as deeply into the glacial outwash sediments plain.

A Water Resource Inventory Area (WRIA) boundary between the Deschutes River WRIA No. 13 and the Upper Chehalis River WRIA No. 23 runs northwest-southeast across the southwest corner of the study area. This boundary is based on surface water drainage patterns but generally correlates to a groundwater divide in the shallow aquifers between the Black River drainage basin and the Deschutes River drainage basin.

All of the City's groundwater resources are developed in unconsolidated sands and gravels in four aquifers (Exhibits 2-2 and 2-3). The stratigraphy of the aquifers from which the City extracts drinking water is described below including aquifer water levels and flow directions.

2.1.1 Stratigraphy

Quaternary Alluvium (Aquifer)

Alluvial sediments (Q_{al}) along the Deschutes River Valley are interpreted to be infilling an older deeper river valley. This erosional trough was cut through the underlying strata that are described below. The Q_{al} is in contact with adjacent older strata that subcrop along the sides of the buried valley. Sediments of a fluvial system usually consist of coarse channel and fine overbank deposits that are vertically and laterally discontinuous. Previous interpretations of the stratigraphy identified gravel layers in this trough as older strata.

The Palermo and Trails End wells withdraw groundwater from gravely layers in this formation as do some domestic wells and some wells of the Pabst Brewery. This aquifer is susceptible to contamination because downward movement of contaminants is not impeded by an overlying aquitard. Upward-flowing vertical gradients mitigate this degree of susceptibility.

Recent work by the United States Environmental Protection Agency (EPA) (1996) has determined that the Vashon Till is absent between the Palermo Wellfield and Barnes Lake. This area may represent a post-glacial erosional trough that has been in-filled by alluvial sediments or by Lake Russell sediments of Vashon Recessional Outwash as described next.

Vashon Recessional Outwash (Aquifer)

Surficial sediments in the outwash plain between the Deschutes and Black Rivers consist of loose, fine-grained sand of the Vashon recessional outwash (Q_{vr}). These sediments contain sparse gravel at surface, and coarsen downwards to gravely medium-grained sand. Silty lamina are present throughout, but are present in higher frequency towards the surface. Most of this formation was deposited by streams emanating from the melting and receding Vashon glacier. Due to the fluvial nature of the depositional environment, laterally-limited layers of relatively clean gravels exist. This formation ranges between 25 and 50 feet thick over most of the upland area, and between 100 and 200 feet thick in the Deschutes Valley. The uppermost portion of this stratum includes fine-grained sand deposited by the historical preglacial Lake Russell. Differentiation in the field between the outwash and lacustrine sediments is difficult and is not attempted in this report.

Vashon Till (Aquitard)

The Vashon Till (Q_{vt}) underlies the Q_{vr} and forms the first aquitard. This formation consists of variably compacted sub-rounded to angular gravel in a sandy, silt and clay matrix. Well drillers commonly describe the till as "hardpan" or "cemented gravel." Thickness of the till typically ranges from 8 to 50 feet. It is absent, however, along the Deschutes River Valley where it was eroded away and north of Trosper Road at least as far west as Barnes Lake. The contact with the overlying formation is sharp, while the lower contact is usually gradational over several feet. The uppermost five feet or so of the Q_{vt} is brown, indicating an oxidized zone and changes with depth to a gray color indicating that it is reduced.

The role of the Q_{vt} as an aquitard in the hydrogeologic system is important. The till generally has low permeability. To a degree, it impedes the vertical movement of groundwater. However, its thickness and permeability is highly variable, and it may be absent in some areas. In areas where it is thick and dense it provides a significant degree of protection to wells from the migration of contaminants from ground surface. In other areas such as near the Bush Middle School and in the vicinity of the Hytec site, it is thinner and more permeable or absent, and is not as protective a layer. Sometimes the till is so poorly defined that it may not be recognizable, or may be absent, such as at the Hytec site in the vicinity of Well Nos. 9 and 10. The depiction of a continuous sheet of Q_{vt} in Exhibits 2-2 and 2-3 is a simplification of the undulating and heterogeneous nature of this till layer.

Vashon Advance Outwash (Aquifer)

The Vashon advance outwash aquifer (Q_{va}) occurs below the till and varies from 50 feet to 100 feet thick. The Q_{va} was deposited by glacier melt waters in front of the Vashon ice sheet as the ice sheet advanced. The formation consists of coarse sandy gravel in the upper portion and grades downward to fine sand with silty interbeds. The silt content, which varies from less than one percent to greater than five percent, greatly affects the permeability of the formation. The fluvial nature of the depositional environment has created laterally-limited layers of well-sorted coarser material in the Q_{va} including interbeds of cobbles and boulders.

The Q_{va} is an important aquifer which supplies many domestic wells and most of the City's production capacity. The Q_{va} aquifer is susceptible to impact from surface sources of contamination because this unit is shallow, the overlying Q_{vt} is locally permeable, thin or is absent. Because the Q_{va} aquifer is locally highly permeable, contaminants may enter the aquifer in places where there is no protective aquitard and migrate horizontally to other areas even if there is a protective aquitard in those areas. The Qva aquifer is also susceptible to non-point contamination such as nitrate as a result of diffuse recharge through the Qvt.

Kitsap Formation (Aquitard)

The Kitsap Formation (Q_k) is stratigraphically below the Q_{va} aquifer, and the top of the formation generally occurs between 100 and 0 feet msl in the study area and ranges in thickness from 30 feet to 130 feet. This unit separates the Q_{va} aquifer from the underlying coarse-grained penultimate glacial aquifer. The Q_k consists predominately of clay and silt with minor sand, gravel, peat, and wood, and usually has a distinctive greenish hue. The Q_k is sandy and poorly defined in the southern portion of the study area (i.e. in the Bush Middle School and Pederson areas). The Q_k is generally thicker to the north and east portions of the study area and thinner in the south and west parts.

The Kitsap Formation is considered a continuous aquitard that inhibits rapid migration of groundwater and contamination vertically through it. Windows through the Q_k are not known in the project area but may occur; sandy areas of Q_k with higher hydraulic conductivities are present as noted above. Discontinuity in the Q_k may exist in the Deschutes River valley where it is interpreted to have been partially eroded (Exhibit 2-3). Although the Q_k is presumed to be continuous under the Deschutes River Valley, this is not well established. Separation of aquifers by the Q_k typically causes water levels in wells screened below the Q_k to be higher than water levels in wells screened above the Q_k.

Penultimate Glacial Deposits (Aquifer)

The penultimate glacial aquifer (Q_c) is stratigraphically below, and confined by, the Q_k unit. The top of the Q_c typically occurs between 50 and -50 feet msl and is therefore also known as the "sea level" aquifer. This unit consists of coarse sand and gravel. Noble and Wallace (1966) refer to this unit as the Salmon Springs Drift. The United States Geological Survey (USGS) refers to this unit as the penultimate drift based on nomenclature and descriptions of Lea (1984). However, sediments deposited by other glacial events may have occurred between the Vashon and Salmon Springs glaciations. Similar to the USGS unit classification, the Q_c aquifer represents only the coarse-grained deposits of the sea level drift (Dion et al., 1994). Any underlying finer-grained deposits that may be associated with the sea level drift are grouped in the underlying Tertiary-Quaternary undifferentiated deposits unit (TQ_u).

The Q_c aquifer is approximately 34 feet thick in the vicinity of Well No. 13. Well No. 13 has not been used for water supply since the collapse of the formation during redevelopment in 1991. Well No. 7 is interpreted to be completed in the uppermost part of the underlying TQ_u deposits but may be completed in the lowest portion of the Q_c. There are no other City of Tumwater wells completed in this aquifer. This aquifer was evaluated at the Bush Middle School Wellfield but was not productive. However, the Q_c aquifer is an important aquifer in the area of the City of Lacey where it is thick and extensive over a wide area (individual well capacities of up to 1,500 gpm).

Tertiary-Quaternary Undifferentiated Deposits (Aquifer)

The undifferentiated deposits (TQ_u) comprise all unconsolidated sediments below the Q_c aquifer from a depth of about -50 feet to locally deeper than -550 feet msl. This unit consists of sand and gravel aquifers with interbedded clay and silt and minor peat, wood, and volcanic ash. In general, a fine-grained unit separates the Q_c from the underlying TQ_u sand and gravel aquifer zones. Well No. 7 is believed to be screened in the uppermost part of the TQ_u. Although several exploration wells have been drilled in these deposits along the Deschutes River Valley, mostly by the brewery, the extent of aquifer zones in the area of the TQ_u deposits is not well-known.

2.1.2 Hydrology

The water cycle consists of three general components: the region's climate, surface water, and groundwater. All three components are interdependent and can be characterized in terms of a regional water budget. At the scale of the study area, the water budget includes hydrologic factors such as precipitation, runoff, evapotranspiration, recharge, natural and controlled discharge. Other factors include changes in water storage in lakes or aquifers which may only be substantial on a long-term basis. Although the climate, surface water, and groundwater are equally important to the water cycle of the study area, this report focuses on the regional and local groundwater system. A brief description of climate and surface water features is presented in the following two sections.

Precipitation and Groundwater Recharge

Northern Thurston County has a marine warm-temperate climate, with relatively warm dry summers and typically mild, rainy winters. Annual average precipitation averaged 51 inches per year (in/yr) between 1951 and 1980 at the Olympia Airport (Golder Associates, 1988). Precipitation is greatest between the beginning of October and the end of March, when monthly totals exceed 4 inches. Variability of total annual precipitation can be substantial. Annual precipitation at the Olympia airport between 1950 and 1961 varied between 38 and 67 in/yr. Based on a water budget calculation the USGS estimated evapotranspiration to be approximately 17 in/yr in the northern Thurston County Groundwater Management Area. This allows an average of 34 in/yr of precipitation to infiltrate and recharge to groundwater where downward hydraulic gradients are present over most of the plain. No significant recharge is expected to occur along the Deschutes River Valley where upward hydraulic gradients and groundwater discharge is occurring.

Surface Water Features

Three principal surface water drainages in the Wellhead Protection study area are (Exhibit 2-1): the Black Lake/Black River system on the west side of the study area that drains south to the Chehalis River; the Trosper Lake/ Percival Creek system on the north side of the area that drains north to Capitol Lake and then to Puget Sound; and, the Deschutes River to the east that flows north into Capitol Lake. Several small lakes with no surface drainage are also present on the east side of the study area (Munn, Susan, Trails End, Hewitt and Ward Lakes) and on the north side of the study area (Barnes Lake).

Black Lake and Trosper Lake have streams draining from them but no streams draining into them. Barnes Lake also doesn't have a stream flowing from it and its maximum level is maintained by overflowing to the southeast over a dam. Stormwater runoff from the airport is directed into Swamp Lake. It is believed that most of these lakes reflect approximate groundwater levels.

The USGS has recorded data from various stream gauging stations over different periods along the Deschutes River. Data collection is reportedly ongoing at stations near the town of Rainier, and at the E Street Bridge located just upstream of the falls in the vicinity of the brewery.

Groundwater Flow

Groundwater in the study area flows under unconfined, semi-confined, and confined conditions. Unconfined conditions occur where water levels in a coarse-grained unit are below a fine-grained unit or where permeable formation extends from land surface to the water table, as for the Q_{vr} and Q_{al} aquifers. Confined conditions occur where aquifers, such as the Q_c and TQ_u aquifers and in some places, the Q_{va} aquifer, are overlain by competent, continuous aquitards. Semi-confined conditions occur in areas where aquitards are discontinuous or otherwise allow water to leak into the aquifers; this condition is believed to occur locally in the Q_{va} aquifer.

Water level data for wells in the study area were obtained in September/October and December, 1995, and in March, 1996 (Tables 2-1 and 2-2; Exhibits 2-4 through 2-6). Because the Q_{al} aquifer is assumed to be in hydraulic continuity with both the Q_{vr} and Q_{va} aquifers, wells completed in the Q_{al} aquifer (principally in the Palermo area) are used to characterize water levels in both the Q_{vr} and Q_{va} aquifers. In contouring the data, a surface elevation of 157.7 feet is used for Barnes Lake as measured by the City in March, 1992.

Water level data sets are most complete for December, 1995, and March, 1996 and these are presented for each of the aquifers (Q_{al}/Q_{vr}, Q_{al}/Q_{va}, and Q_c) in Exhibits 2-7 through 2-12.

Table 2-1
Groundwater Level Measuring Point Survey Data
(Survey data provided by the City of Tumwater. Well locations shown in Exhibits 2-4 through 2-6)

WELL SITE	NORTHING (NAD27)	EASTING (NAD27)	NORTHING (NAD83)	EASTING (NAD83)	M.P. ELEV. (NGVD88)	Location	Screened Interval (feet bgs)	Aquifer	Township & Range	Sec. & 1/4-1/4
BLACKLAKE #1	608606	1383584	608553	1023705	216.95	78th and Fairview	184-200	Qc	T17N/R2W	08E01
BREWERY #27	618979	1401167	618926	1041288	102.85	Palermo (NE)	~125	Qal	T18N/R2W	35F
BREWERY #38	620514	1402667	620460	1042788	188.00	Palermo (NE)	270-294	Qc	T18N/R2W	35B05
BURDICK	603587	1390919	603534	1031040	196.22	2723 85th Ave. SW	59	Qva	T17N/R2W	16F
CRITTENDEN	603935	1390437	603882	1030558	191.11	2810 85th	40	Qva	T17N/R2W	16F
DALRYMPLE	613930	1405715	613877	1045836	181.70	6310 Wildflower St	92	Qva	T17N/R2W	01E02
DNR #5	601432	1387759	601379	1027880	192.79	93rd & Blomberg	175-199	Qva	T17N/R2W	17R
EBBEN	602018	1385199	601965	1025320	185.80	8844 Littlerock Rd. SW	75-80	Qva	T17N/R2W	17L02
ECKLOFF	604354	1393601	604301	1033722	197.90	8449 Kimmie Rd	34	Qva	T17N/R2W	16A
ELWANGER	599826	1402425	599773	1042546	197.43	800 93rd Ave	40	Qvt	T17N/R2W	14Q02
EPA MW-ES-1	617931	1399083	1039204	617877	173.50	Former Binger's Gull Stn.	90-100	Qal/Qvr	T18N/R2W	34J
EPA MW-ES-2	617711	1399473	1039595	617657	174.65	Former Binger's Gull Stn.	95-105	Qal/Qvr	T18N/R2W	34J
EPA MW-ES-3	617597	1399346	1039467	617543	175.07	5150 Capitol Blvd SE	113-123	Qal/Qvr	T18N/R2W	34J
EPA MW-ES-4	617598	1399351	1039472	617544	175.11	5150 Capitol Blvd SE	50-60	Qal/Qvr	T18N/R2W	34J
EPA MW-ES-5	617578	1399076	1039198	617525	175.05	Southgate Mall	86-96	Qal/Qvr	T18N/R2W	34J
EPA MW-ES-6	617579	1399087	1039208	617526	175.30	Southgate Mall	46-56	Qal/Qvr	T18N/R2W	34J
EPA MW-ES-7	617196	1397859	1037980	617143	177.89	Trosper @ 2nd Ave	25-35	Qal/Qvr	T18N/R2W	34K
EPA MW-ES-8	617214	1396932	1037053	617161	177.17	Lk. Park Dr. @ Trosper	25-35	Qal/Qvr	T18N/R2W	34L
EPA MW-ES-9	617822	1399893	1040014	617769	108.33	Rainier @ O St.	20-30	Qal/Qvr	T18N/R2W	35M
EPA MW-ES-10	617833	1399893	1040014	617780	108.25	Rainier @ O St.	82-92	Qal/Qvr	T18N/R2W	35M
EPA MW-ES-11	617625	1398366	1038488	617572	166.28	WDOT on 2nd Ave.	80-90	Qal/Qvr	T18N/R2W	34K
FELT	603922	1394287	603869	1034409	198.72	8522 Kimmie Rd	39	Qva	T17N/R2W	15D
GUNTER	605059	1394278	605005	1034400	195.39	2045 83 Ave. SW	25	Qvr	T17N/R2W	15D
HECK #3	605017	1396013	604964	1036134	201.49	1441 83rd Ave. SW	unknown	Qva	T17N/R2W	15C
HENAGE	604749	1395363	604696	1035485	195.50	1635 83rd Av SW	36	Qva	T17N/R2W	15C
HOOVER	601968	1395408	601915	1035529	201.79	1551 88th Ave SW	52-58	Qva	T17N/R2W	15L04
HYTEC MW-1	609159	1397632	609106	1037753	193.92	711 Airdustrial	49-59	Qvr	T17N/R2W	10A
HYTEC MW-2	609561	1397718	609508	1037839	193.10	711 Airdustrial	39-49	Qvr	T17N/R2W	10A
HYTEC MW-3	609193	1397315	609140	1037436	193.63	711 Airdustrial	49-59	Qvr	T17N/R2W	10A
JONES	613014	1391968	612960	1032089	199.25	2635 Vacation Dr SW	45	Qva	T17N/R2W	04K04

Table 2-1(Cont)

WELL SITE	NORTHING (NAD27)	EASTING (NAD27)	NORTHING (NAD83)	EASTING (NAD83)	M.P. ELEV. (NGVD88)	Location	Screened Interval (feet bgs)	Aquifer	Township & Range	Sec. & 1/4-1/4
KLIES	608691	1392133	608638	1032255	192.89	7715B Prine Dr.	50-55.5	Qva	T17N/R2W	09K
LOWE	602788	1404339	602734	1044461	194.51	1146 88th Av SE	50	Qva	T17N/R2W	14H03
MONACO PARK	611449	1404326	611395	1044447	191.19	73rd Ave. SE	76-86	Qal/Qva	T17N/R2W	02R03
NELSON	614802	1403449	614749	1043570	179.86	901 E. "V" St.	200	Qal	T17N/R2W	02B02
OLD #12-43	608904	1401554	608851	1041675	193.72	Airport	74-80	Qva	T17N/R2W	11L
PARKS	596663	1388345	596610	1028467	189.83	10011 Blomberg Rd SW	57	Qva	T17N/R2W	20J03
PEDERSON #1	605330	1387636	605277	1027757	192.99	Littlerock @ 83rd Ave SW	40-102	Qva	T17N/R2W	17B
RESTOVER MW-12	600100	1390830	600047	1030951	198.57	Near 93rd Ave & I-5	~30-50	Qva	T17N/R2W	16P
SUMMER HILL	609683	1391251	609629	1031372	202.73	2705 Summerhill Ct SW	51-56	Qva	T17N/R2W	09C02
TEXACO MW-21	-	-	-	-	-	7370 Linderson	~10-25	Qvr	T17N/R2W	10B
Thurston Co. Main. Shop	597589	1398596	597536	1038717	203.08	9605 Tilley Rd	62-67	Qva	T17N/R2W	22H02
TRAILS END #21	606883	1406102	606830	1046224	207.15	Trails End	141-157	Qal	T17N/R2W	12L
TUMWATER #1	617546	1400491	617492	1040612	109.70	Palermo Well Field	~70-80	Qal	T18N/R2W	35M
TUMWATER #7	611601	1398964	611548	1039085	195.74	Airport/Israel Rd S.W.	307-333	Qc	T17N/R2W	03R
TUMWATER #9	609054	1397431	609001	1037553	198.65	Airport/Airdustrial	57-71.5&88-96.4	Qva	T17N/R2W	10B02
TUMWATER #11	611566	1399193	611512	1039314	189.18	Airport/Israel Rd S.W.	109-117	Qva	T17N/R2W	03R
TUMWATER #13	605993	1403207	605940	1043328	209.99	Airport	175-199	Qc	T17N/R2W	11Q
TUMWATER MW-93-02	617213	1400223	617159	1040344	112.76	Palermo	6-11	Qal	T18N/R2W	35M
TUMWATER MW-93-03	617537	1399737	617484	1039858	121.83	Palermo	187	Qal	T18N/R2W	35M
TUMWATER MW-93-05	606000	1394813	605947	1034934	196.04	Bush Middle School	80-90	Qva	T17N/R2W	10N
TUMWATER MW-93-06	605975	1395297	605921	1035418	199.17	Bush Middle School	145-150	Qc	T17N/R2W	10N
TUMWATER PW-93-07	616086	1405491	616033	1045612	118.17	Pioneer Park	58-68	Qal	T18N/R2W	36N
TUMWATER MW-94-10	605570	1390293	605517	1030414	194.52	Pederson Property	153-163	Qc	T17N/R2W	16D
TUMWATER MW-94-11	605404	1390151	605351	1030272	196.58	Pederson Property	60-80	Qva	T17N/R2W	16D
TUMWATER MW-94-12	605615	1391046	605562	1031168	191.58	Pederson Property	5.5-15.5	Qvr	T17N/R2W	09P
TUMWATER MW-96-15	-	-	605173	1035983	205.56	Southgate Mall	69-79	Qvr/Qal	T18N/R2W	34J
TUMWATER MW-96-16	-	-	605799	1036936	195.87	Linda Street	44.5-54.5	Qvr/Qal	T18N/R2W	35N
TUMWATER MW-96-17	-	-	607671	1036867	197.13	Linda Street	45.5-55.5	Qvr/Qal	T18N/R2W	35N
TUMWATER MW-96-18	-	-	616770	1039836	180.45	Center & 78th	22-32	Qvr	T17N/R2W	10K
TUMWATER MW-96-19	-	-	616828	1039709	181.73	Center & Pat Kennedy Wy	8.8-18.8	Qvr/Qvt	T17N/R2W	10Q
TUMWATER MW-96-20	-	-	617162	1038944	170.37	83rd Ave SW	20-30	Qvr	T17N/R2W	10P
Yi (formerly Minkler)	-	-	-	-	-	6141 Kirsop Rd. SW	33	Qvr	T17N/R2W	05A02

Table 2-2
Groundwater Level Data

Well	September, 1995				December, 1995				March, 1996			
	Date	Time	Depth to Water (ft)	Water Level (NGVD 88)	Date	Time	Depth to Water (ft)	Water Level (NGVD 88)	Date	Time	Depth to Water (ft)	Water Level (NGVD 88)
Black Lake Estates #1	9/11/95	14:45	74.17	142.78	12/13/95	12:25	69.17	147.78	3/19/96	14:45	67.43	149.52
Brewery #27	10/9/95	14:00	11.94	90.91	12/11/95	16:15	7.98	94.87	3/22/96	13:10	14.68	88.17
Brewery #38	-	-	-	-	12/13/95	16:50	108.13	79.87	-	-	-	-
Burdik	9/19/95	16:40	15.94	180.28	-	-	-	-	-	-	-	-
Crittendon	-	-	-	-	12/11/95	10:20	6.30	184.81	3/20/96	13:30	1.72	189.39
Dalrymple	9/19/95	1300	67.16	114.54	12/13/95	1545	64.8	116.90	3/19/96	1455	63.9	117.80
DNR #5	9/18/95	11:45	14.77	178.02	12/11/95	9:15	9.01	183.78	3/19/96	13:06	6.20	186.59
Ebben	10/12/95	17:00	10.86	174.94	12/11/95	17:30	5.96	179.84	3/19/96	15:30	3.91	181.89
Eckloff	8/19/95	19:00	17.59	180.31	12/11/95	17:15	12.73	185.17	3/20/96	10:20	7.17	190.73
Elwanger	9/19/95	1400	5.18	192.25	12/12/95	1445	9.97	187.46	3/19/96	1430	9.7	187.73
Elwanger	-	-	-	-	12/14/95	1250	9.55	187.88	-	-	-	-
EPA MW-ES-1	-	-	-	-	12/12/96	-	44.3	129.20	3/22/96	-	40.58	132.92
EPA MW-ES-2	-	-	-	-	12/12/96	-	63.79	120.86	3/22/96	-	51.55	123.10
EPA MW-ES-3	-	-	-	-	12/12/96	-	49.75	125.32	3/22/96	-	46.76	128.31
EPA MW-ES-4	-	-	-	-	12/12/96	-	49.82	125.29	3/22/96	-	47.11	128.00
EPA MW-ES-5	-	-	-	-	12/12/96	-	45.3	129.75	3/22/96	-	41.71	133.34
EPA MW-ES-6	-	-	-	-	12/12/96	-	45.72	129.58	3/22/96	-	42.09	133.21
EPA MW-ES-7	-	-	-	-	12/12/96	-	21.14	156.75	3/22/96	-	18.31	159.58
EPA MW-ES-7	-	-	-	-	12/13/95	13:15	21.10	156.79	-	-	-	-
EPA MW-ES-8	-	-	-	-	12/12/96	-	16.55	160.62	3/22/96	-	14.43	162.74
EPA MW-ES-9	-	-	-	-	12/12/96	-	0.00	108.33	3/22/96	-	0.00	108.33
EPA MW-ES-10	-	-	-	-	12/12/96	-	0.00	108.25	3/22/96	-	0.00	108.25
EPA MW-ES-11	-	-	-	-	12/13/95	14:30	16.65	149.63	-	-	-	-
EPA MW-ES-11	-	-	-	-	12/13/95	-	16.61	149.67	3/22/96	-	13.81	152.47
Felt	10/16/95	18:30	19.00	179.72	12/11/95	19:20	13.40	185.32	3/19/96	10:20	7.64	191.08
Gunter	10/16/95	19:15	15.90	179.49	12/11/95	11:25	10.50	184.89	3/20/96	9:45	4.73	190.66
Heck #3	9/19/95	17:30	21.80	179.69	12/11/95	13:00	17.38	184.11	3/19/96	11:00	10.12	191.37
Henage	-	-	-	-	12/13/95	15:45	10.63	184.87	3/19/96	11:15	4.86	190.64
Hoover	10/12/95	12:30	21.26	180.53	12/11/95	12:00	15.16	186.63	3/19/96	10:45	9.40	192.39
Hytec-1	-	-	-	-	12/14/95	15:45	13.47	180.45	3/19/96	16:10	6.60	187.32
Hytec-2	-	-	-	-	12/14/95	15:05	12.73	180.37	3/19/96	15:55	6.18	186.92
Hytec-3	-	-	-	-	12/14/95	15:20	13.05	180.58	3/19/96	16:00	6.29	187.34

Table 2-2 (cont)

Well	September, 1995				December, 1995				March, 1996			
	Date	Time	Depth to Water (ft)	Water Level (NGVD 88)	Date	Time	Depth to Water (ft)	Water Level (NGVD 88)	Date	Time	Depth to Water (ft)	Water Level (NGVD 88)
Jones	10/9/95	19:15	24.76	174.49	12/11/95	13:50	22.06	177.19	3/19/96	14:30	17.22	182.03
Klies	9/20/95	16:00	13.70	179.19	12/11/95	18:30	9.30	183.59	3/20/96	8:55	3.37	189.52
Klies	9/20/95	16:03	13.74	179.15	-	-	-	-	-	-	-	-
Lowe	10/10/95	12:00	21.20	173.31	12/11/95	13:20	17.28	177.23	3/20/96	11:10	10.86	183.65
Monaco Pk.	9/11/95	15:15	46.08	145.11	12/13/95	9:01	45.45	145.74	3/20/96	10:50	40.46	150.73
Monaco Pk.	9/11/95	15:15	45.19	146.00	-	-	-	-	-	-	-	-
Neff	9/19/95	1120	85.49	-	12/13/95	1430	35.46	-	-	-	-	-
Neff	-	-	-	-	12/19/95	1550	36.51	-	-	-	-	-
Nelson	-	-	-	-	12/13/95	10:18	71.15	108.71	3/20/96	18:15	73.29	106.57
Old #12	10/12/95	13:45	18.38	175.34	12/12/95	14:47	15.75	177.97	3/19/96	11:30	8.40	185.32
Parks	10/10/95	13:30	11.47	178.36	12/11/95	10:00	2.65	187.18	3/19/96	13:00	1.96	187.87
Pederson #1	9/19/95	16:00	15.72	177.27	12/11/95	11:00	10.28	182.71	3/19/96	15:00	6.85	186.14
Pederson #1	9/19/95	16:05	15.71	177.28	12/12/95	15:48	9.98	183.01	-	-	-	-
Restover (MW-12)	9/20/95	10:15	17.14	181.43	12/11/95	8:45	11.65	186.92	3/20/96	8:20	7.72	190.85
Summer Hill	9/20/95	11:18	23.56	179.17	12/13/95	15:10	19.23	183.50	3/19/96	14:07	14.28	188.45
Texaco MW-21	-	-	-	-	-	-	-	-	3/27/96	9:00	6.66	-
Thurston Co. Maint. Sho	9/19/95	1450	17.1	185.98	12/12/95	1500	9.8	193.28	3/19/96	1350	9.45	193.63
Thurston Co. Maint. Sho	-	-	-	-	12/14/95	1400	9.44	193.64	-	-	-	-
Trails End #21	-	-	-	-	-	-	-	-	3/19/96	11:45	63.09	144.06
TUMWATER #1	9/14/95	14:02	16.31	93.39	12/13/95	16:05	13.72	95.98	3/20/96	12:30	14.68	95.02
TUMWATER #9	9/14/95	12:49	21.20	177.45	12/12/95	13:25	18.22	180.43	3/20/96	15:45	11.31	187.34
TUMWATER #11	9/14/95	11:23	76.04	113.14	12/12/95	14:20	30.89	158.29	3/20/96	15:25	22.51	166.67
TUMWATER #13	10/12/95	14:00	38.66	171.33	12/13/95	8:30	37.57	172.42	3/19/96	11:15	29.01	180.98
TUMWATER MW-93-02	9/14/95	14:31	7.20	105.56	12/12/95	10:08	4.17	108.59	3/20/96	13:45	4.38	108.38
TUMWATER MW-93-03	9/14/95	14:16	5.37	116.46	12/12/95	10:15	4.18	117.65	3/20/96	13:50	2.49	119.34
TUMWATER MW-93-05	9/14/95	9:30	16.14	179.90	12/12/95	12:15	11.78	184.26	3/20/96	10:00	5.96	190.08
TUMWATER MW-93-06	9/14/95	9:47	20.69	178.48	12/12/95	12:25	16.53	182.64	3/20/96	10:05	14.09	185.08
TUMWATER PW-93-07	9/14/95	13:43	10.33	107.84	12/12/95	11:17	6.54	111.63	3/20/96	16:00	7.18	110.99
TUMWATER MW-94-10	9/14/95	10:29	15.75	178.77	12/12/95	15:35	10.73	183.79	3/19/96	15:20	5.93	188.59
TUMWATER MW-94-11	9/14/95	10:20	15.90	180.68	12/12/95	15:30	10.79	185.79	3/19/96	15:20	6.05	190.53
TUMWATER MW-94-12	9/14/95	10:44	9.63	181.95	12/12/95	16:00	3.87	187.71	3/20/96	17:45	0.84	190.74
Yi (formerly Minkler)	9/19/95	1200	4.37	-	12/13/95	1450	2.1	-	3/19/96	1518	2.8	-

Generally, groundwater is recharged over most of the area, and vertical gradients are downward over most of the upland areas between the Deschutes and Black River drainages. Flow is radial from the south-central part of the study area and discharges by upward flow into the river drainages. The following discussion focuses on flow in the aquifers. The influences of the bounding aquitards are discussed with respect to the individual aquifers.

Q_{al} This aquifer is largely limited to the topographic low of the Deschutes River Valley. There is no identifiable till in the Trails End area, nor in the area west of the Palermo Wellfield. Therefore, sediment in these areas is assumed to be Q_{al}. The groundwater level reflects the unconfined water table. In the Deschutes River Valley, the groundwater level is similar to that in the Deschutes River, and is typically within a few feet below ground surface. The lack of a confining layer between the Deschutes River and the aquifer suggests that the aquifer is hydraulically connected with the river. Seepage is common along the sides of the valley, and wetlands exist along the floor of the valley. Because the sediments of this aquifer were deposited in an eroded trough that cut through deeper strata, the Q_{al} probably receives lateral groundwater flow from the Q_{vr}, Q_{va}, and possibly deeper aquifers along the edge of the erosional trough. Upward flow of groundwater from deeper aquifers under the valley floor may also contribute to the Q_{al} aquifer.

The City of Tumwater has developed this aquifer in the Palermo Wellfield area and conducted exploratory drilling near the Palermo Wellfield and in the Pioneer Park area (PGG, 1993c). The Pabst Brewery has also developed and explored this aquifer extensively. Extensive aquifer testing was conducted in the Palermo Wellfield in 1992 and measured the aquifer transmissivity at approximately 50,000 gallons per day per foot (gpd/ft; PGG, 1992; Table 2-3). The shallowness of the water table, and lack of any protective overlying aquitard cause this aquifer to be particularly susceptible to impact from surface contamination sources.

Q_{vr} This aquifer contains the unconfined water table in the outwash plain. The shape of the water table approximates the ground surface topography and typically fluctuates seasonally from between 10 feet to 20 feet below ground surface (bgs). Only the lower portion of the Q_{vr} is saturated.

This aquifer receives approximately three feet of recharge from annual precipitation. The quick and substantial recharge, and the paucity of surface runoff features reflect the highly permeable nature of these surficial sediments. The large amount of recharge, shallowness of the water table, and lack of any protective overlying aquitard cause this aquifer to be particularly susceptible to impact from surface contamination sources.

Q_{va} Groundwater flow is best documented for the Q_{va} aquifer (Exhibits 2-8 and 2-11). Water level elevations range from around 190 feet msl near the south central part of the study area to 100 feet msl in the northeast corner of the study area. Regional groundwater flow in this aquifer flows radially to the west, east and north from the south-central part of the area. Horizontal hydraulic gradients range from near zero in the Bush Middle School area, to a high of 0.02 just west of the Palermo Wellfield.

Table 2-3
Aquifer Parameter Summary

Well Number	Aquifer	Date of Test	Specific Capacity (gpm/ft)	T (gpd/ft)	S	Confidence in T	Confidence in S	Aquifer[a] Thickness (ft)	Remarks
3	Q_{al}	1/92	6[b]	50,000	0.0003	High	High	100(?)	Possibly unconfined.
7	TQ_u	-	8	-	-	-	-	27	No pumping test
9	Q_{va}	4/72	28[c]	93,000	-	Mod.	-	39	Leaky aquifer.
10	Q_{va}	-	12	-	-	-	-	21	No pumping test
11	Q_{va}	7/1/93	4[d]	12,000	-	High	-	10	Confined
12-94	Q_{va}	4/30/94	12[e]	160,000	0.0002	High	High	67	Leaky aquifer.
13	Q_c	4/29/91	3[f]	10,000	-	Mod.	-	34	Well not operational.
14-94	Q_{va}	5/94	75[e]	160,000	0.0002	High	High	66	Leaky aquifer.
15	Q_{va}	8/19/91	15[g]	62,000	0.0002	High	Low	31	Obs. well not in same zone as Well 15.

[a] Interpreted effective hydraulic thickness.
[b] PGG, 1992
[c] R&N, 1972
[d] PGG, 1993
[e] PGG, 1994a
[f] PGG files
[g] R&N, 1991

Aquifer transmissivity ranges from a low of 12,000 gallons per day per foot (gpd/ft) at Well No. 11 (Pacific Groundwater Group, 1993a), and increases to 160,000 gpd/ft in the southeast near the Bush Middle School area (Pacific Groundwater Group, 1994a). The wide range of transmissivity is related to variation in both the coarse-grained nature and the thickness of the sediments. Aquifer tests indicate that the productive portion of the Q_{va} aquifer is well-confined and approximately ten feet thick at Well No. 11, while it is leaky and 65 feet thick in the Bush Middle School area. This leakage may be occurring from either the overlying or underlying strata. Aquifer storage is estimated to be approximately 0.0002.

Groundwater flow direction in the Q_{vr} aquifer (Exhibits 2-7 and 2-10) is similar to that in the Q_{va} aquifer.

Q_c Data from the Q_c aquifer are too sparse to contour (Exhibits 2-9 and 2-12). Water level elevations in the Q_c, where defined over the study area, range from approximately 190 ft msl near the southern study area boundary to less than 100 ft msl along the north side of the study area boundary. Local flow in the Q_c aquifer system is generally to the north with a horizontal hydraulic gradient ranging from 0.002 in the south to 0.007 in the north. The transmissivity of the aquifer measured in Well No. 13 was 10,000 gpd/ft.

The Q_c aquifer is an important aquifer at the City of Lacey where it is thick and extensive area-wide (individual well capacities of up to 1,500 gpm). Qualitative aquifer testing of the Q_c aquifer in the Bush Middle School and Pederson areas indicated transmissivities too low to warrant further resource development at these locations.

TQ_u The sediments below the Q_c are lumped into one unit because insufficient deep borehole data exist to laterally correlate aquifers and aquitards. Tumwater Well No. 7 develops water from the upper portions of the TQ_u (or possibly in the lower part of the Q_c). Few attempts have been made to explore for potable water resources in the TQ_u in the project area. Groundwater flow directions are not well known although they are believed to be similar to those of the Q_c aquifer.

Vertical Gradients Groundwater also moves vertically in addition to its horizontal motion. Water levels in the Q_{vr} are slightly shallower than those in the Q_{va}. In the central project area the vertical hydraulic gradient is downward, and water levels in the Q_{va} aquifer are higher than water levels in wells screened in the deeper Q_c aquifer (for example, Well Nos. 7 and 11, Well Nos. 14 and MW-93-06, and Wells MW-94-10 and PW-94-12; Table 2-4). These downward hydraulic gradients indicate downward groundwater flow and a groundwater recharge area.

Table 2-4
Vertical Hydraulic Gradients

Well	Aquifer	Date	Water Level (feet msl)	Screened Interval (feet msl)	Vertical Gradient	Flow Direction
MW-93-05	Q_{va}	6/5/94	175.97	105-115	0.04	Downward
MW-93-06	Q_c	6/5/94	173.51	43-53		
MW-94-12	Q_{vr}	3/7/95	182.90	170-180	0.02	Downward
MW-94-11	Q_{va}	3/7/95	181.64	110-130		
MW-94-11	Q_{va}	3/7/95	181.64	110-130	0.02	Downward
MW-94-10	Q_c	3/7/95	179.80	25-35		
No. 11	Q_{va}	7/1/93	156	74-82	0.13	Downward
No. 7	TQ_u	7/68	130[a]	(-142) - (-116)[a]		
Brewery No. 39	TQ_u	5/82	131.5	(-127)	0.11	Upward
Ground surface	-	-	105	105		

[a] Ground surface elevation corrected to 191 feet msl (vs. 198 feet msl as marked in well log).

Near the Deschutes River this vertical flow direction is reversed, with wells screened in the shallow Q_{al} / Q_{va} aquifer having water levels 5 to 10 feet bgs, and deep wells in the Q_c and TQ_u flowing at land surface. These upward hydraulic gradients reflect upward groundwater flow and a groundwater discharge area.

2.1.3 General Groundwater Quality

Water in the Q_{al}/Q_{vr} aquifer is derived principally from recharge by precipitation and so is naturally very low in dissolved solids. Most of the water in the Q_{va} aquifer is presumed to be derived from recharge from the surficial Q_{vr} aquifer through the Q_{vt} till aquitard. Groundwater quality in the brown-colored Q_{va} aquifer is very good with total dissolved solids usually less than 100 mg/L, less than 10 mg/L of chloride, slight hardness of approximately 50 mg/L as calcium carbonate, and low concentrations of iron and manganese (e.g. less than 0.01 mg/L each).

Nitrate naturally occurs in concentrations less than 1 mg/L as nitrogen. Nitrate concentrations across the Tumwater area are usually between 1 and 3 mg/L, are highest in the surficial Q_{vr}/Q_{al} aquifers, and decrease with depth. A nitrate concentration of 6.2 mg/L as nitrogen in Well No. MW-96-16 is considered anomalously high. This well should be resampled to confirm these results. The principal sources of nitrate to groundwater in the Tumwater area are probably septic systems, landscaping fertilizers, and possibly agricultural practices. Time-trends of nitrate in wells suggest that nitrate concentrations are increasing slowly with time.

In the Tumwater area, water in the Q_c aquifer generally has iron and manganese concentrations close to, or above, their secondary maximum contaminant levels (SMCLs) of 0.3 mg/L and 0.05 mg/L, respectively, and occasionally hydrogen sulfide that are undesirable in drinking water. The water hardness is approximately 35 mg/L. The Q_c aquifer is usually greenish-gray colored and is overlain by the Q_k that contains organic material. These two factors and the higher iron and manganese concentrations indicate that redox conditions are probably lower in the Q_c aquifer than in the brown-colored Q_{va} aquifer.

The limited available data indicate that water quality in the TQ_u varies with depth. The shallowest TQ_u water is similar to Q_c water, while the deeper TQ_u waters have higher mineral content. Well No. 7 waters represent the stratigraphically highest TQ_u waters; total mineral content of the water is low but the water exceeds the manganese SMCL of 0.05 mg/L and therefore this well is used by the City for peaking demand and backup only. Groundwater from 628 feet depth in well T-53 (Pioneer Park) represents the deepest TQ_u water that has been sampled in the project area. It contained relatively high concentrations of chloride and sodium (229 and 540 mg/L, respectively). However water from 426 feet in Well No. T-53, drilled in Pioneer Park, in the Deschutes River valley, contained only slightly elevated levels of sodium and chloride. Iron concentrations in TQ_u waters from Well No. T-53 (in Pioneer Park) were below the Secondary MCL of 0.3 mg/L.

2.2 Wellhead Delineations

Time-of-travel capture zones are estimated for each production well using currently available data. A time-of-travel capture zone is the area surrounding the pumping well that will supply groundwater to the well within a specific period. The location of the time-of-travel capture zones together with the aquifer vulnerability assessment provides a basis for identifying areas for future monitoring and implementation of measures to protect the quality of groundwater used in these areas as drinking water.

Preliminary wellhead protection areas were delineated as part of the wellhead protection preliminary characterization and work plan (EES, PGG, and Dally Environmental, 1995). In the following section (2.2.1 Model Approach), the criteria used to delineate the preliminary time-of-travel capture zones are presented. Data collected during execution of the work plan are used to refine the capture zones and recommend management areas based on those capture zones (Section 2.2.2 Final WHPA Delineations).

2.2.1 Model Approach

A two-dimensional analytical element model called QuickFlow™ (version 1.17) was used to estimate preliminary capture zones for 6-month, and one-, five-, and ten-year travel times. The model is available from Geraghty & Miller, Inc. and uses functions developed by Strack (1989). The physical properties of an aquifer are input. The regional flow field is calibrated to water level data compiled by the USGS (Dion et al., 1994). Pumping wells are then inserted into the flow field and particle traces are used to delineate time-of-travel capture zones.

Annual extraction rates of the wells are estimated based on the groundwater extraction during 1992, plus 5 percent for demand growth (total projected annual extraction = 895,473,000 gallons). Groundwater extraction from Well No. 7 is a fixed amount because it is only used under high demand periods due to undesirable natural water quality. The annual pumping rate of the rest of the wells is calculated by multiplying the capacity of each well by the length of time (2,341 hours) that all wells (less Well No. 7) pumping simultaneously would take to produce the projected extraction (Table 2-5). It is assumed that all wells are used proportional to their capacity. The sequence that various wells are turned on in response to increasing demand is not considered. Actual use of these wells may be different.

Well No. 14-94 was included in the simulations in anticipation that it would be put into production in the near future. Although Well Nos. 2, 4 and 5 are not currently extracting drinking water, extraction rates are calculated for these wells in case they are to be used in the future. This creates a larger capture zone relative to current conditions at the Palermo Wellfield and is therefore considered a conservative approach that defines a larger wellhead protection area with an added margin of safety.

Table 2-5
Pumping Rates of Wells Used for Capture Zone Modeling
(Data supplied by the City of Tumwater)

City of Tumwater Well	Sustainable Pumping Rate (gpm)	Percent of City Capacity (as modeled)	Total Annual Extraction (feet^3)
No. 2[a]	220	-	4,131,176
No. 3	290	5	5,445,015
No. 4[a]	480	-	9,013,476
No. 5[a]	250	-	4,694,519
No. 6	450	7	8,449,161
No. 7	480	-	3,211,123[b]
No. 8	330	5	6,196,051
No. 9	400	6	7,510,365
No. 10	485	8	9,106,318
No. 11	275	4	5,163,376
No. 12-94	750	12	14,081,940
No. 14-94	2350	38	44,123,400
No. 15	800	13	15,020,730
No. 20	75	1	1,408,194
Subtotal A (excluding Well Nos. 2, 4, 5 and 7)	6205	99	116,504,550
Subtotal B (excluding wells 2, 4 and 5)	6685	-	119,715,673 (895,473,000 gal.)
Total	7635	-	137,554,844

[a] Not currently used for drinking water, however they may be used in the future.
[b] Based on volume extracted in 1992; used only under emergency demand conditions.

Modeling Capture Zones in the Qva Aquifer

A significant hydraulic connection may exist between the Q_{al} and Q_{va} aquifer. Therefore, one continuous aquifer is used in modeling groundwater flowing to wells extracting water from these two aquifers. This includes all wells in Table 2-5 with the exception of Well No. 7. Modeling efforts are based on the available data at that time and selected representative values of recharge, transmissivity and hydraulic gradient. The preliminary capture zones were used to identify areas for land use inventory.

A representative aquifer transmissivity of 64,000 gpd/ft is used in modeling flow in the Q_{va} aquifer. An aquifer porosity of 0.25 was used which is typical of coarse-grained, poorly-sorted sediments (Freeze and Cherry, 1979). Calibration of the model was arrived at by imposing a regional hydraulic gradient of 0.001 and a recharge of two feet/year. Recharge of two feet/year to the Q_{va}

aquifer is consistent with the approximately three feet of recharge estimated by Dion et al. (1994) to occur annually to the overlying Q_{vr} aquifer. Constant head points and head linesinks were imposed along the Black River, Deschutes River, and Trosper Lake using water surface elevations. One constant head point and linesink was used to represent the cluster of small lakes northeast of the airport. The resulting modeled hydraulic head distribution is shown in Exhibit 2-13.

Modeling Capture Zones to Model Flow in the Qc/TQu Aquifer

Well No. 7 extracts water from the TQ_u and a separate calculation of the capture zone for that well is required. No water level data have been compiled by the USGS for the TQ_u aquifer, and no transmissivity data exist for the TQ_u. However, Well No. 7 is screened in the TQ_u aquifer and close to the Q_c aquifer, so water level and transmissivity data from the Q_c are used to model flow in the TQ_u.

A transmissivity of 10,000 gpd/ft as measured in Well No. 13 is used while an aquifer porosity of 0.25 is assumed. A hydraulic gradient of 0.008 to the north is used in an aquifer 27 feet thick. The ten-year capture zone derived for the TQ_u is contained within the wellhead protection area defined for resources developed in the Q_{va} aquifer (Exhibit 2-15). The TQ_u aquifer is protected by two aquitards (Q_{vt} and Q_k)that protect it from contamination originating at ground surface. Therefore the long-term groundwater management area defined for the Q_{va} aquifer is considered to adequately protect the groundwater resources currently developed in the TQ_u aquifer.

2.2.2 Final Wellhead Protection Areas

The final recommended Wellhead Protection Areas (WHPAs) are shown in Exhibit 2-14 along with December, 1995 potentiometric contours in Qva the aquifer. The same WHPAs are shown in Exhibit 2-15 with March, 1996 potentiometric contours in the Qva aquifer. The WHPAs were arrived at by superimposing the modeled capture zones on potentiometric data contours. The modeled capture zones were then modified according to influences identified in Section 2.2.3 (Sensitivity Analysis) to be consistent with the potentiometric data.

The modeled preliminary capture zones for the Port Wells (Well Nos. 7, 9, 10, 11 and 15) and the Bush Middle School Wells (Well Nos. 12-94 and 14-94) were considered consistent enough with the field data that they did not require modification. However the capture zones for the Palermo Wells (Well Nos. 2 through 6, and 8) and the Trails End Well (Well No. 20) were modified. First they were rotated about the wellheads so that the sides of the capture zones are approximately perpendicular to the potentiometric contours. The shapes of the capture zones were then widened where necessary to better intersect the potentiometric contours at right angles. Modeled and measured hydraulic gradients were considered similar enough to not require modification of the length of the modeled capture zones.

The WHPAs shown in Exhibits 2-14 and 2-15 are larger than the calculated capture zones in order to compensate for some of the uncertainty in capture zone locations resulting from uncertainties in model input parameters (e.g. aquifer transmissivity), simplifying assumptions (e.g. aquifer homogeneity), and seasonal changes in water levels and flow directions.

2.2.3 Sensitivity Assessment for Capture Zone Areas

Because of the simplifying assumptions used in the QuickFlow™ program, and the uncertainty in the model input parameters, the actual capture zones resulting from pumping City wells will differ to some degree from the capture zones presented in this report. A qualitative sensitivity assessment is given below that describes the effect of model input parameters on capture zone results. The "magnitude comparison" refers to the factor by which the parameter was changed relative to the model parameters used. Length and width dimensions of a capture zone refer to the long and short axes defined by the capture zone limit.

Parameter	Magnitude Comparison	Possible Effect on Capture Zone
Pumping Rate	Increase by 2	Twice the width, similar length
	Decrease by 2	Half the width, similar length
Porosity	Increase by 2	Same width, half the length
	Decrease by 2	Same width, twice the length
Hydraulic Conductivity	Increase by 2	Half the width, twice the length
or Hydraulic Gradient	Decrease by 2	Twice the width, half the length
Aquifer Thickness	Increase by 2	Half the width, similar length
	Decrease by 2	Twice the width, similar length

Capture zones can be less sensitive to changes in model parameters than indicated above due to interdependent, counterbalancing effects. Changes in pumping rate and porosity usually affect the shape and size of the calculated capture zones directly. However the effects of varying the hydraulic gradient, hydraulic conductivity and aquifer thickness can be muted if other parameters (such as recharge rates) are varied in order to maintain a reasonable fit of modeled water level to observed water level data. Muted effects may also result from interaction between wells and boundary conditions, such as linesinks; however, the boundary conditions in this simulation are considered distant enough from the pumped wells that this is not expected to be a factor.

The orientations of the capture zones shown in Exhibits 2-13 through 2-15 depend on the gradient directions obtained from the potentiometric contours. Gradient directions that differ from those estimated from the contour maps would result in capture zones for wells that would be similar in shape to those shown but would be rotated about the well location.

Wells that pump water from aquifers that are hydraulically connected with overlying or underlying permeable zones will commonly derive water from strata that are stratigraphically above or below the principal water production zone. The effect of this "vertical leakage" would be to decrease the width of the capture zones within the pumped aquifer. Therefore, the capture zone of the TQ_u aquifer could be significantly smaller than shown depending on the amount of leakage that may be occurring.

Pumping tests indicate that significant vertical leakage occurs at the Bush Middle School (Q_{va}) Wells. The degree to which the Q_{vt} impedes downward movement of groundwater is unknown. Well log records indicate that the Q_{vt} is a competent aquitard approximately 45 feet thick at Well No. 11 but only eight feet thick at Well No. 12-94. Recent exploratory drilling in the Pederson area indicates a loose aquitard approximately eight feet thick. Pumping tests indicate a trend in leakage into the Q_{va} aquifer from minimal vertical leakage at Well Nos. 11 and 15, some leakage at Well No. 9 and significant leakage at the Bush Middle School Wells. Significant leakage is also interpreted to occur at the Palermo Wellfield although this may in part be due to the unconfined nature of the wellfield. Beside leakage potentially occurring down through overlying sediments, significant upward leakage of water through underlying sediments may also occur.

2.3 Water Level and Water Quality Monitoring

Water level and water quality monitoring has been initiated. Six monitoring wells were installed as part of the wellhead protection program. Three are located west of the Palermo Wellfield, and three are located south of the Port Wells (Well Nos. MW-96-15 through -20; Exhibit 2-16; Appendix G). One set of 21 water quality samples were collected. Water levels were monitored in 56 wells in September and December of 1995, and in March of 1996.

Water quality data produced during the Wellhead Protection Work Plan are contained in a Technical Attachment I in both electronic and hard copy. Nitrate and VOC data are summarized in this section. Three rounds of water level measurements were conducted (September and December, 1995, and March, 1996). Detailed documentation of the monitoring points has been compiled and are contained in Technical Attachment II, including maps, photographs, data sheets, well construction details, contact names and phone numbers, measuring point survey information, and other data. (Technical Attachments I and II are available upon request from Water Resources Specialist Kathy Callison, City of Tumwater.)

2.3.1 Water Quality Sampling Results

The wells sampled as part of the wellhead protection work plan are listed in Table 2-6 and shown in Exhibit 2-16. Nitrate and VOC results are listed in Table 2-6. Selected sites are discussed below.

Table 2-6
Nitrate and VOC Analytical Results.

Area	Well	Aquifer	NO3 (mg/L)	VOCs 524.2 (mg/L)
	MW-96-15	$Q_{vr/al}$	3.1	nd[a]
	MW-96-16	$Q_{vr/al}$	**6.2**	nd
	MW-96-17	$Q_{vr/al}$	2.6	nd
Palermo	MW-ES-7	$Q_{vr/al}$	2.4	**13[b] TCE, 0.76 PCE**
	MW-ES-11	$Q_{vr/al}$	1.3	**1.8 TCE**
	MW-93-04a	$Q_{vr/al}$	nd	nd
	MW-93-04b	$Q_{vr/al}$	0.29	nd
	Well No. 7	Q_c	nd	nd
Port	Hytec No. 1	Q_{vr}	2.9	nd
	MW-96-18	Q_{vr}	3.2	nd
	MW-96-19	Q_{vr}	0.15	nd
Trails End	Well No. 20-UZ	$Q_{vr/al}$	2.8	nd
	Well No. 20-LZ	$Q_{vr/al}$	0.29	nd
	MW-96-20	Q_{vr}	1.2	nd
	Henage	Q_{va}	0.75	nd
BMS	Gunter	Q_{vr}	1.5	nd
	Felt	Q_{va}	2.7	**0.16 Freon-11**
	Eckloff	Q_{va}	2.9	nd
N of BMS	Summerhill	Q_{va}	2.4	nd
Pederson	MW-94-12	Q_{vr}	0.07	nd
Pederson	Crittendon	Q_{va}	1.8	nd

nd = no significant detections All samples also analyzed for inorganic parameters.
[a] PCE was detected in a Geoprobe sample 0.2 mg/L but not in a monitoring well sample
[b] Average of duplicate analyses

Palermo

Three Well (Nos. 2, 4, and 5) of the Palermo Wellfield have been impacted by chlorinated solvents (TCE and PCE). A review of work conducted by the EPA to date identifies one source of contamination (Southgate Cleaners), one area with a source (Trosper-Littlerock Road junction), and one possible source (WDOT). Other unidentified sources may exist. The data indicate that contamination continues to impact the three wells already impacted, and that the remaining clean wells are susceptible to impact and may be at risk.

A dual completion monitoring well (No. MW-93-04A and -04B) was installed in 1993 in a clean portion of the aquifer. The purpose of these monitoring wells was to detect movement of the contaminant plume southward toward the remaining clean wells. Quarterly monitoring of these wells by the EPA detected TCE in Well No. MW-93-04B only in March 1996 at an estimated concentration of 0.2 μg/L. Resampling of these wells as part of the wellhead protection work plan did not confirm the EPA detection.

Review of EPA documents revealed the possible presence of a chlorinated solvent plume moving from the Trosper/Littlerock Road intersection, eastward along the north side of Trosper Road toward the Palermo Wellfield (Appendix C; letter from PGG to Kathy Callison May 31, 1996). It was decided to install a monitoring well to assess this scenario (MW-96-15; Appendix G). Vertical water quality samples were collected with a push probe (Geoprobe) to determine the screened interval of the monitoring well. PCE (0.2 μg/L) was detected at a depth of 75 feet below ground surface. Monitoring Well No. MW-96-15 was installed with a screened interval from 70 to 80 feet bgs. Subsequent sampling did not detect any chlorinated solvents above a detection limit of 0.2 μg/L.

Hytec

This site (Site A3, Exhibit 4-1) was listed in the Department of Ecology's Confirmed and Suspected Contaminated Sites listing and was included in the preliminary risk assessment (PGG, 1993b). Three monitoring wells were installed by the current operator and sampled for a wide range of analytes. The current operator applied to Ecology for a determination of "No Further Action". A review of the report and confirmatory sampling conducted by PGG supported the application and a determination of "No Further Action" was granted by Ecology. This site is not considered a risk to drinking water quality.

Freon-11 - Bush Middle Schools

Freon-11 has previously been detected in monitoring wells in the one-year capture zone of the Bush Middle School Wells at concentrations of less than 0.5 μg/L (Well No. MW-93-06 and the Routley Well; (PGG, 1994a and 1994b). Well No. MW-93-06 is located approximately 250 feet east of production well 14, while the Routley well is located between the Henage and Gunter wells which are shown in Exhibit 2-16. Freon-11 has also been detected at a concentration below 0.5 μg/L in the latest sampling round in the Felt well. These concentrations are not considered detections as defined by the Washington State Department of Health (DOH). There is no Maximum Contaminant Level (MCL) for Freon-11, however, the State has established a State Advisory Level (SAL) of 1,300 μg/L. The wells in which Freon-11 has been detected are located downgradient of the American Fiberglass site (Site A5, Exhibit 4-1). Annual monitoring of water quality in this area is included in the recommendations. Freon-11 is not considered to be a significant risk to the Bush Middle School Wells; however, continued monitoring of the area is warranted in case the Freon-11 is associated with other compounds of concern which have not yet been detected.

Other sites

A groundwater monitoring well was installed on the American Fiberglass site by Ecology. Access to the site by representatives of the City of Tumwater for the purposes of sampling the well was denied by the property owner. However, this site remains a concern in relation with the presence of Freon-11 in groundwater downgradient of this site and upgradient of the Bush Middle School Wellfield, and should be sampled if the opportunity arises. If access to the well is not anticipated, the well should be abandoned according to Ecology regulations (Ch. 173-160 WAC). Ecology is willing to transfer ownership of the well to the City (Mr. Dick Heggen, personal communication). The site remains an unquantified risk to Bush Middle School Well Nos. 12 and 14.

Poages Automotive Services is located at 5403 Capitol Boulevard SE. Soil sampling conducted by Thurston County Public Health Department detected chlorinated solvents and petroleum products in a pit in the floor of the shop. Additional sampling was inconclusive with respect to assessing the extent of contamination. No additional work is currently planned on this site. Two monitoring wells were installed by the City downgradient of Poages Automotive Services, immediately west of the Palermo Wellfield (Well Nos. MW-96-16, and -17) as part of the Tumwater Wellhead Protection Program. No chlorinated solvents were detected in groundwater samples from these wells. A nitrate concentration of 6.2 mg/L as nitrogen in Well No. MW-96-16 is considered anomalously high. This well should be resampled to confirm these results. This high nitrate concentration is not believed to be associated with Poages Automotive.

Texaco has conducted a site investigation of petroleum contaminants in groundwater at the bulk fuel facility at the corner of Airdustrial and Center St. The City is currently reviewing the results of that work. The principal concern at this site is associated with vertical migration of contaminants from the shallow contaminated (Q_{vr}) aquifer, under the influence of downward-flowing hydraulic gradients, into the aquifer (Q_{va}) from which Well Nos. 9 and 10 extract drinking water. The site remains an unquantified risk to Port Well Nos. 9, 10 and 15.

Monitoring Well No. MW-96-18 was installed at the corner of 78th Street SW and Center Street SW, downgradient of the Tumwater Lumber Company and upgradient of several drinking water wells. Monitoring wells were installed immediately downgradient of the Airport Fuel Stop (No. MW-96-19; at the corner of 78th Street SW and Pat Kennedy Way SW) and of the American Heritage Campground (No. MW-96-20; across the street from 1441 83rd Street SW) both of which have petroleum products in underground storage tanks. No compounds of concern were detected in either of these three wells.

2.3.2 Water Level Data

A network of 56 wells over an area of approximately 22 square miles were used wells to monitor water levels in the three shallowest aquifers ($Q_{vr/al}$, $Q_{va/al}$ and Q_c/TQ_u). City monitoring wells, private domestic wells and environmental monitoring wells were used. Groundwater flow patterns as determined by the USGS were confirmed on the large scale. However new water level data revealed that groundwater flow gradients near the edge of the Deschutes River Valley are larger and oriented more easterly toward the river.

Several "snapshots" of water levels have been collected (Tables 2-1 and 2-2; Exhibits 2-7 through 2-12). These have provided a more detailed characterization of groundwater elevations and flow patterns across the wellhead protection area. Collection of water level data was coordinated with EPA, Thurston County Public Health Department, and the Cities of Lacey and Olympia. Survey data on the measuring point coordinates were supplied by the City of Tumwater Surveyor in NAD 83 and NVGD 88 coordinates. Water levels were measured to the nearest hundredth of a foot.

Because water levels across the system are constantly changing, the data within each snapshot were generally collected over a period of three days to get the most accurate representation of water levels at a moment (hence, a "snapshot"). However, effects such as precipitation, barometric pressure, well pumping or recovery, or other influences may have affected the data, and may therefore exhibit local transient artifacts. These artifacts are not expected to significantly affect the data as presented in Exhibits 2-7 through 2-12. The interpretation of surface water elevations relative to groundwater elevations may be significant and locally change the interpretation of groundwater flow patterns. An evaluation of such influence was conducted in a review of EPA groundwater flow data (Appendix C; letter from PGG to Kathy Callison May 31, 1996). The possibility of these artifacts being present should be considered if data are used for detailed interpretation.

Several specific improvements in the understanding of the direction of groundwater flow in the focus area were obtained as a result of obtaining the water level data. Along the edge of the Deschutes River Valley, hydraulic gradients are now understood to be much higher and more perpendicular to the bluff that borders the valley. This results in the capture zones of the Palermo and Trails End Wells to be oriented in a more east-west direction near the wellfield (Exhibits 2-13 through 2-15).

In addition, groundwater level contours along the east side of the focus area suggest a concentration of groundwater flow in the vicinity of Trails End and Munn Lakes (Exhibit 2-11). A data point important to the interpretation of water levels in this area is Trails End Well No. 21. No data was collected from this well in December 1995, however the trends observed in March 1996 were projected to create December contours that are considered representative (Exhibit 2-8). The overall interpretation in this area is strongly influenced by the assumption that the water level elevations of surface water bodies (the lakes and the Deschutes River) closely reflect those of groundwater. Such flow patterns would normally be accompanied by higher aquifer transmissivities along the trough outlined by the groundwater potentiometric contours.

This has been partially corroborated by recent aquifer testing on Well No. 20 which indicates an aquifer transmissivity of 125,000 gpd/ft (PGG, 1996). This value is only exceeded by values on the order of 160,000 gpd/ft in the Bush Middle School area. This water level trough extends towards the Deschutes River in the vicinity of Pioneer Park near Henderson Boulevard, and the City should consider this a potential resource exploration area. As part of an exploration plan, a well inventory should be conducted including water level and water quality monitoring on a resolution similar to that done in the Bush Middle School area (PGG, 1994b).

2.4 Summary

2.4.1 Summary of Hydrogeology

The City currently operates production wells in four areas. These are the Palermo Wellfield, the Port of Olympia area, the Bush Middle School area, and the Trails End area. The City is also currently exploring development potential in other areas.

- ❑ The physiography of the study area consists of bedrock hills on the northwest and southeast sides with a trough of glacially-deposited sediments trending northeast to southwest between the hills. These sediments generally consist of relatively continuous flat-lying strata with local discontinuities.

- ❑ There are four sand and gravel aquifers of primary interest to the City as potential sources of potable groundwater. These are, from shallowest to deepest, the Deschutes River alluvial and Vashon recessional outwash sediments along the Deschutes River and that extend west from the Palermo Wellfield (Q_{al}/Q_{vr}), the Vashon advance outwash (Q_{va}), penultimate drift (Q_c), and underlying undifferentiated deposits (TQ_u). In addition, a shallow unconfined aquifer consisting of Vashon recessional deposits (Q_{vr}) lies at land surface outside of the Deschutes River Valley but is not considered a potential source of water for the City.

- These aquifers are separated in most places by low permeability aquitards that inhibit vertical flow between the aquifers to varying degrees. The Vashon till (Q_{vt}) overlies the Q_{va} aquifer, while the Kitsap Formation (Q_k) separates the Q_{va} from the deeper Q_c and TQ_u aquifers. The Q_{vt} is absent in the vicinity of Well Nos. 9 and 10, is poorly defined west of the Bush Middle School area, and is a leaky aquitard in the Bush Middle School area. The TQ_u is composed of different layers some of which are aquitards.

- The Q_{vr} and Q_{al} aquifers are at ground surface and are extremely susceptible to contamination from surface sources. The Palermo Wellfield (Well Nos. 2 through 6, and 8) and the Trails End Well No. 20 are interpreted to be drawing water from the Q_{al}/Q_{vr}. The susceptibility of these wells to contamination has recently been illustrated by the entry of trichloroethene to three of the Palermo Wells which was discovered during sampling in 1993.

- The Q_{va} aquifer varies in depth from 30 feet to 100 feet below ground surface (bgs). The susceptibility of wells screened in this aquifer to impact from surface sources of contamination is partly a function of the presence and permeability of the overlying Q_{vt}. The Q_{vt} is poorly defined or absent around Well Nos. 9 and 10, and so these wells are considered highly susceptible. A thick dense sequence of Q_{vt} is present at Well No. 11 and therefore Well No. 11 is considered to be well-protected. Well No. 15 is located between Well Nos. 9 and 11 and so it is considered to be somewhat susceptible. The Q_{vt} at Bush Middle School Well Nos. 12-94 and 14-94 is believed to have a relatively high permeability (it is leaky) and so these wells are somewhat susceptible to impact. The susceptibility of all wells in this aquifer is illustrated by the slow increase of nitrate, which is infiltrated from ground surface, in older wells in this area over past years. The Q_{va} aquifer is an important candidate for further groundwater resource development.

- The deeper Q_c and TQ_u aquifers are relatively well-protected from surface sources of contamination through the additional protection of the Q_k aquitard. Water quality problems in these wells are usually associated with naturally-occurring parameters such as iron, manganese and hydrogen sulfide. Well No. 13 drew water from the Q_c, while Well No. 7 draws water from the TQ_u.

- The flat ground and permeable surface soils of the Tumwater area allow for rapid infiltration of groundwater recharge. An average of 34 inches of precipitation per year are estimated to infiltrate to become groundwater recharge out of a total of 51 inches of annual precipitation. A groundwater mound centered southwest of the City limits (e.g. Exhibit 2-11) is the top of a divide from which groundwater flows radially east toward the Deschutes River, north, and west toward the Black River.

- City production wells are completed in three different settings. The Palermo Wellfield (Well Nos. 2, 3, 4, 5, 6, and 8) and Well No. 20 are completed in the Q_{vr}/Q_{al} aquifer. The Q_{vr}/Q_{al} aquifer is generally unconfined, contains the water table, and is susceptible to contamination from ground surface. Well No. 7 is completed in the TQ_u aquifer, is overlain by the Q_k and Q_{vt} aquitards, and is well-protected from contamination introduced at ground surface. The rest of the wells (Well Nos. 9, 10, 11, 12, 14 and 15) are completed in the Q_{va} aquifer. The Q_{vt} till is a thick protective aquitard in the vicinity of Well Nos. 11 and 15, is considered thin and permeable in the vicinity of Well Nos. 12 and 14, and is poorly defined or absent in the vicinity of Well Nos. 9 and 10.

2.4.2 Summary of Wellhead Protection Area Delineations

Time-of-travel capture zones were modeled for each of the City's production wells currently in production using computer groundwater flow simulation software (QuickFlow®). The simulation was calibrated to USGS water level data. These modeled capture zones were then modified to be consistent with higher resolution water level data collected within the scope of the Wellhead Protection Program. Recommended wellhead protection areas larger than the capture zones are recommended for long-term management to account for uncertainty in the input data and temporal changes (Exhibits 2-14 and 2-15). Periodic review of the WHPA delineations should be undertaken considering new data and changing discharge conditions, and modification of the WHPAs, if needed, should be performed.

2.4.3 Summary of Water Quality Monitoring

Twenty-one groundwater samples were collected and analyzed for a wide suite of parameters (Table 2-6; Exhibit 2-16). The purpose of these analyses was to characterize general water quality and to assess specific potential sources of contamination.

The concentration of nitrate (as nitrogen) in the groundwater samples ranges from below the laboratory detection limit of 0.05 mg/L to 3.2 mg/L, with one detection of 6.2 mg/L on the bluff above the Palermo Wellfield. The concentration of nitrate in groundwater is expected to increase in the future as a result of impact from septic systems, landscaping fertilization, and possibly agricultural practices. Quarterly monitoring for nitrate in drinking water sources is generally required by DOH when concentrations rise above 5 mg/L. The nitrate MCL is 10 mg/L.

The presence of Freon-11 (trichlorofluoromethane) in groundwater was confirmed in the Bush Middle School area in concentrations below 0.5 µg/L. Further monitoring of this area is recommended.

Analyses of samples from EPA wells west of the Palermo Wellfield confirmed the presence of chlorinated compounds. Analysis for chlorinated solvents in a set of samples collected from various depths in the south end of Southgate Mall detected PCE (0.2 µg/L). However, placement of a monitoring well and subsequent sampling did not confirm the presence of PCE at this location. Detailed characterization of the aqueous geochemistry in this area was obtained and is available to assist in the assessment of various remedial options.

Professional on-call services should be retained to advise the City on specific sources of contamination. These services would include assessing the severity of such threats and formulating recommended appropriate responses and options to adequately protect drinking water sources.

2.4.4 Summary of Water Level Monitoring

A network of 56 wells over an area of approximately 22 square miles were used wells to monitor water levels in the three shallowest aquifers ($Q_{vr/al}$, $Q_{va/al}$ and Q_c/TQ_u). City monitoring wells, private domestic wells and environmental monitoring wells were used. Groundwater flow patterns as determined by the USGS were confirmed on the large scale. However new water level data revealed that groundwater flow gradients near the edge of the Deschutes River Valley are larger and oriented more easterly toward the river.

Water level contours reveal that there may be a high transmissivity aquifer zone in the area of Trails End and Munn Lakes, and Pioneer Park that the City should consider as a potential resource exploration area.

2.5 Recommendations

Recommendation 2-1: Feasibility Study for Protecting the Palermo Wellfield

Half of the wells in the Palermo Wellfield have been impacted by chlorinated solvent contamination. The remaining wells are considered susceptible. The City should conduct a feasibility assessment on the future of the Palermo Wellfield. The assessment should consider whether the City will be able to continue to use the wellfield, whether the wellfield can be re-established at a new location, and whether the water rights for the wellfield can be transferred. Continued use of the existing wellfield will probably necessitate measures to mitigate VOC contamination at the contamination source, the contaminant plume, and/or at the wellhead. Re-establishing the wellfield will require exploration and, if an aquifer location with adequate yield is found, development costs. If regulatory agencies allow the transfer of water rights to other areas, the City's drinking water distribution system may need to be modified.

An additional role within this recommendation would be to provide support to the City with respect to providing internal review of remedial actions conducted by other parties in this area.

Recommendation 2-2: Monitor Water Quality

A list of wells recommended for long-term water quality monitoring are presented in Table 2-7 and Exhibit 2-16. The regimen of monitoring wells, analytical parameters, and frequency of sampling for water quality should be constantly reviewed and possibly updated when new information is available, or when there is a change in the status of potential contamination sources. Detailed recommendations are herein presented.

Long-term water quality monitoring at six wells is recommended in addition to routine monitoring of drinking water supply wells (Table 2-7 and Exhibit 2-16). The purpose of such monitoring will allow the City to consider appropriate responses if a contaminant source threatens drinking water supply wells before the wells are impacted. Volatile organic compounds (VOCs) are considered the most serious threat to the City's drinking water supply and so analysis for these compounds is recommended in all water quality monitoring wells. The frequency of monitoring varies from quarterly to annually depending on the perceived threat of contamination, and the capture zone that the monitoring well is located in. It is recommended that the City specify detection limits of 0.2 µg/L for most of the VOCs. EPA is interested in including Well Nos. MW-93-04(A & B) and MW-96-15 in quarterly sampling of groundwater as part of EPA's continuing investigation of chlorinated solvents in groundwater west of the Palermo Wellfield.

Table 2-7
Recommended Water Quality Monitoring Wells (Wells Shown in Exhibit 2-16).

Well	Parameters	Frequency	Approx. annual analytical cost
Felt	524.2[a]	Annually	$225
MW-93-04 (A &B)	524.2	Quarterly	$1,800
MW-94-15	524.2	Quarterly	$900
MW-94-16	524.2	Quarterly	$900
MW-94-19	524.2	Annually	$225
MW-94-20	524.2	Annually	$225
All above wells	Inorganics[b]	Triennially	$400
Total average annual approximate analytical cost:			$4,675

[a] All 524.2 analyses should have 0.2 mg/L detection limits and tentatively identified compounds.
[b] Includes Ca, Cr, Fe, K, Mg, Mn, Na; Cl, F, NO3, NH4, SO4, TDS, and Conductivity.

It is recommended that a set of inorganic analysis (Ca, Cr, Fe, K, Mg, Mn, Na; Cl, F, NO_3, NH_4, SO_4, total dissolved solids, and conductivity) be conducted in these wells every three years. This wider suite of analyses contains indicator parameters that may indicate the presence of other water quality problems that would not be detected directly by VOC analysis or this inorganic suite of parameters. If there is an unexplained increase in any of the parameters, causes of such increases should be investigated. This is considered a cost-effective and efficient way to monitor water quality. It is recommended that professional services be retained, at a minimum on a triennial basis, to provide expert interpretation of the collected water quality data.

Problems associated with the laboratory in reporting results have reduced confidence in the analytical data (Technical Attachment I). It is recommended that Well Nos. MW-96-16, MW-96-17, MW-93-04A and MW-93-04B be resampled for inorganic parameters as a quality control and quality assurance measure.

Recommendation 2-3: Implement Data Management

Water quality and water level data should be entered into a database. This database should be maintained as a tool for the management of groundwater resources and to facilitate using the data. PGG can provide software applications based on Microsoft's Access database. This would allow better use of the data, and to more easily present the data in tabular, graphical and GIS format. Water quality data could be analyzed by plotting time trends, ion ratios and their relationship to water level data.

New data could be delivered by the analytical laboratory to the City in electronic format. The capability of various laboratories to provide electronic data varies greatly. Many laboratories provide an excellent product, although some do not, and some provide the data in a condition that requires a degree of reformatting. Receiving data in electronic format should be pre-arranged with the laboratory providing the services. The City may wish to also invest some time in entering historical data. This will expand the time range over which data can be analyzed. It is our experience that once hard copies of historical are compiled, that double data entry by professional data entry personnel is a cost-efficient way of entering the data with a relatively high level of quality control.

Water level data should also be entered into a database. A single water resource database application is available to manage both water quality and water level data. The database application currently has data entry and management capability, as well as a variety of data reporting functions. PGG continues to expand the capabilities of this application, particularly the number of reporting format options available. If the City decides to use this database application, an approximate one-time outlay of $6,500 for development and training, plus staff time, would be expected to be applied toward further product development in a manner tailored to the City's needs.

Recommendation 2-4: Evaluate Contamination Source Threats

Engagement of potentially liable parties with respect to mitigation of contamination that may impact drinking water sources is a critical preventative measure. Throughout the preparation of the Wellhead Protection Plan, the City has been aggressive in asserting its interests and the protection of the drinking water resources at several known and suspected contaminated sites. This proactive approach has successfully resulted in actions on the part of others to directly address these issues. Sources requiring ongoing attention include the Palermo TCE plume and the Texaco bulk fuel site. The American Fiberglass site should be further investigated since it may pose a direct threat to the City's newest wellfield (Bush Middle School). A first step in evaluating the significance of contamination in groundwater in the vicinity of the American Fiberglass site would be to collect water quality samples from surrounding private wells. Other sources requiring assessment and possible action will probably arise on a regular basis.

This recommendation provides a form of insurance on the investment made by the City in developed resources including well installation and associated infrastructure. Once a well or wellfield is impacted, the time to full recovery of the resource may be on the order of decades. Interim treatment of contaminated water to drinking water standards may be costly. The likelihood of finding new resources to replace the impacted source is uncertain and, if found, may be difficult to obtain in the current regulatory climate surrounding water rights. Therefore, it is considered necessary for the City to assume an aggressive presence with respect to potential threats to drinking water resources.

Professional consulting services should be retained to support the City. Annual costs are estimated to be on the order of $10,000, however this may vary greatly depending of the amount of involvement required on any particular site. Most services are expected to be in a review capacity. Independent action taken by the City as a result of inaction on the part of potentially liable parties, or in response to newly discovered impact on a drinking water source, may be costly.

Recommendation 2-5: Monitor Water Levels

Two groundwater level monitoring efforts are recommended. High resolution (monthly) water level monitoring is recommended for a set of ten wells (Table 2-8, Exhibit 2-17). These wells comprise nests of monitoring wells (i.e. a set of wells completed in different aquifers, or elevations, in one locale) in three widely spaced areas (Pederson, Palermo and Port/Bush Middle School areas).

The purpose of monitoring this set of wells is principally to produce hydrographs for resource management, to understand long-term trends and seasonal impacts on operation of production wells, and to support future water rights applications. Water level monitoring should continue indefinitely.

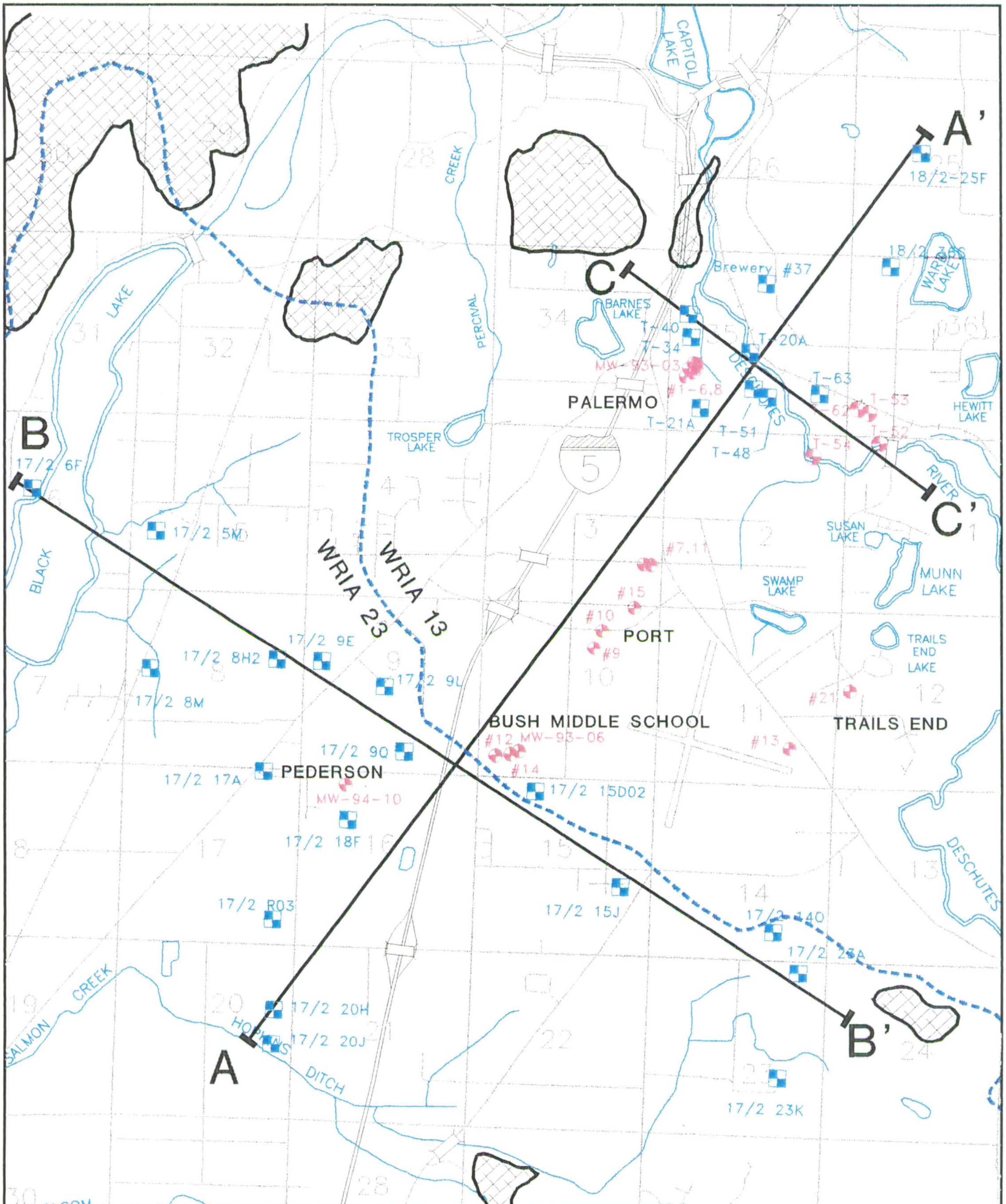
Table 2-8
Recommended Water Level Monitoring Wells to be Measured Monthly (Wells Shown in Exhibit 2-17).

Well	Aquifer	Well	Aquifer
Pederson area		Palermo area	
MW-94-12	Q_{vr}	MW-93-02	$Q_{vr/al}$
MW-94-11	Q_{va}	MW-96-15	$Q_{vr/al}$
MW-94-10	Q_c	EPA-11	$Q_{vr/al}$
Port area		MW-93-03 (part of Paleromo Area)	$Q_{vr/al}$
MW-96-19	Q_{vr}		
Lowe	Q_{va}		
Well No. 13	Q_c		

Area-wide measurement of water levels, as conducted for this Wellhead Protection Program are recommended to be taken every three-to-five years. When area-wide water level measuring is conducted, a pair of measurements should be taken. One set should be taken during November, or the seasonal low water level period, and one set should be taken during March, or the seasonal high water level period. Area-wide measurement rounds should be coordinated with the Cities of Olympia and Lacey, and with Thurston County Department of Health to obtain the largest possible data sets.

2.6 References

A list of reference sources reviewed and used in the development of Sections 2 and 4 is provided in Appendix A.



LEGEND

- Tumwater well
- Non-city well

Wells used in compilation of cross sections

- Cross-section location
- Water Resource Inventory Area boundary
- Bedrock outcrop (after Dion et al., 1994)

N

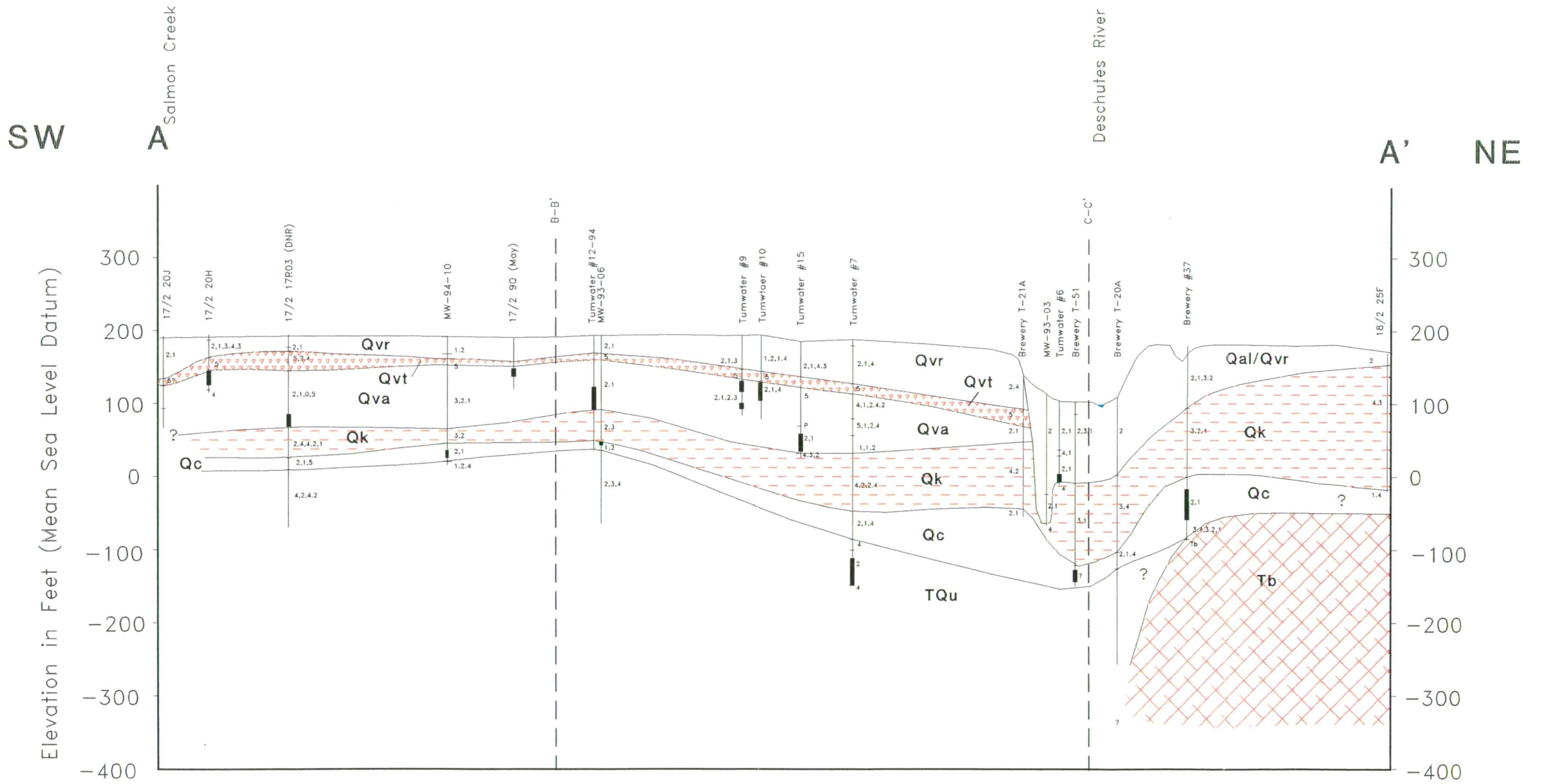
0 2,000 4,000
Scale in Feet

Tumwater Wellhead Protection Program

EXHIBIT 2-1
HYDROGRAPHY and CROSS SECTION LOCATIONS

JE9401 2-1-XSEC.DWG 11/10/96

Pacific Groundwater Group



Qal	Quaternary Alluvium
Qvr	Vashon Recessioal Outwash
Qvt	Vashon Till
Qva	Vashon Advance Outwash
Qk	Kitsap Formation
Qc	Penultimate Glacial Drift
TQu	Undifferentiated Glacial Drift
Tb	Bedrock

17/2 9E Well Number

1 GRAVEL
2 SAND
3 SILT
4 CLAY
5 TILL
3,4 SILT and CLAY (read "," as "and")
1,2 Sandy, GRAVEL (read "," as adjective)
Tb BEDROCK

Screen or Open Section

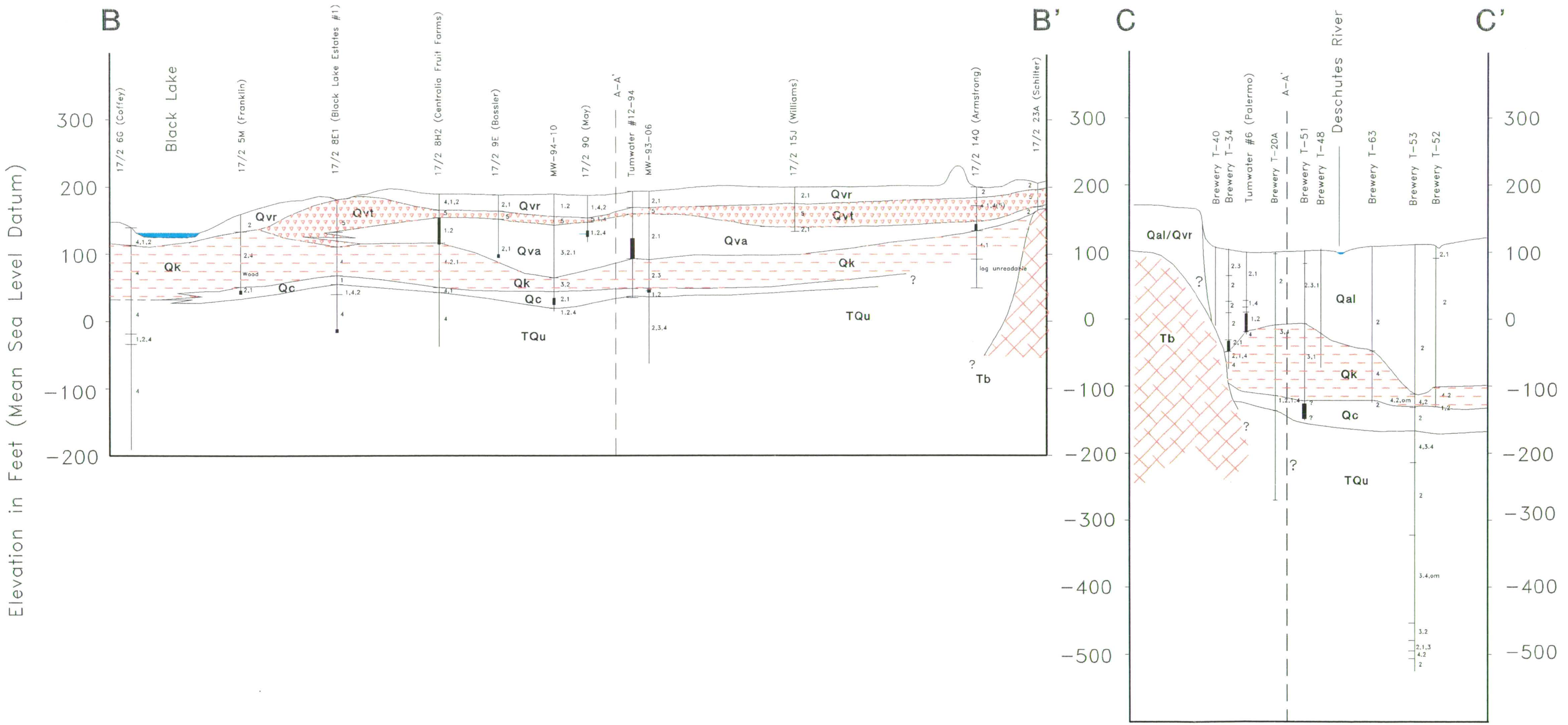
0 3000 6000
HORIZONTAL SCALE IN FEET

TUMWATER WELLHEAD PROTECTION PLAN

EXHIBIT 2-2
HYDROGEOLOGIC CROSS-SECTION A-A'

JE9401 2-2-AA.DWG 11/5/98

Pacific Groundwater Group



Qal	Quaternary Alluvium
Qvr	Vashon Recessioal Outwash
Qvt	Vashon Till
Qva	Vashon Advance Outwash
Qk	Kitsap Formation
Qc	Penultimate Glacial Drift
TQu	Undifferentiated Glacial Drift
Tb	Bedrock

17/2 9E — Well number, indicating township(N), range(W), section and 1/4-1/4 section. Trailing number is USGS-designated.

1 GRAVEL
2 SAND
3 SILT
4 CLAY
5 TILL
3,4 SILT and CLAY (read "," as "and")
1.2 Sandy, GRAVEL (read "." as adjective)
Tb BEDROCK

Screen or Open Section

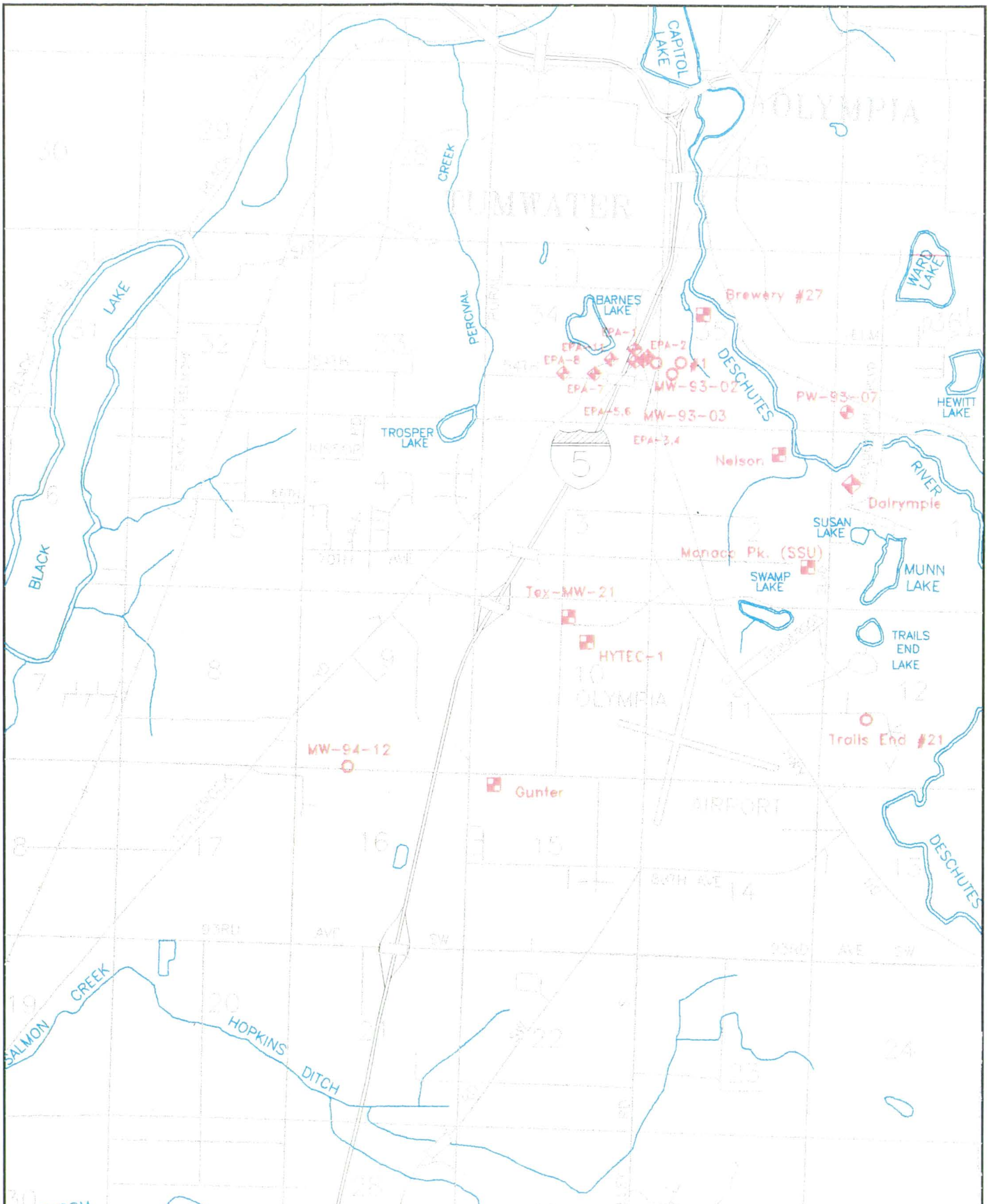
0 3000 6000
HORIZONTAL SCALE IN FEET

TUMWATER WELLHEAD PROTECTION PLAN

EXHIBIT 2-3
HYDROGEOLOGIC CROSS-SECTIONS B-B' and C-C'

Pacific Groundwater Group

JE9401, 2-3-BB.DWG, 11/10/96



N

City monitoring wells

City production wells

Wells monitored in past by USGS/TCPHD

Private wells

0 4000

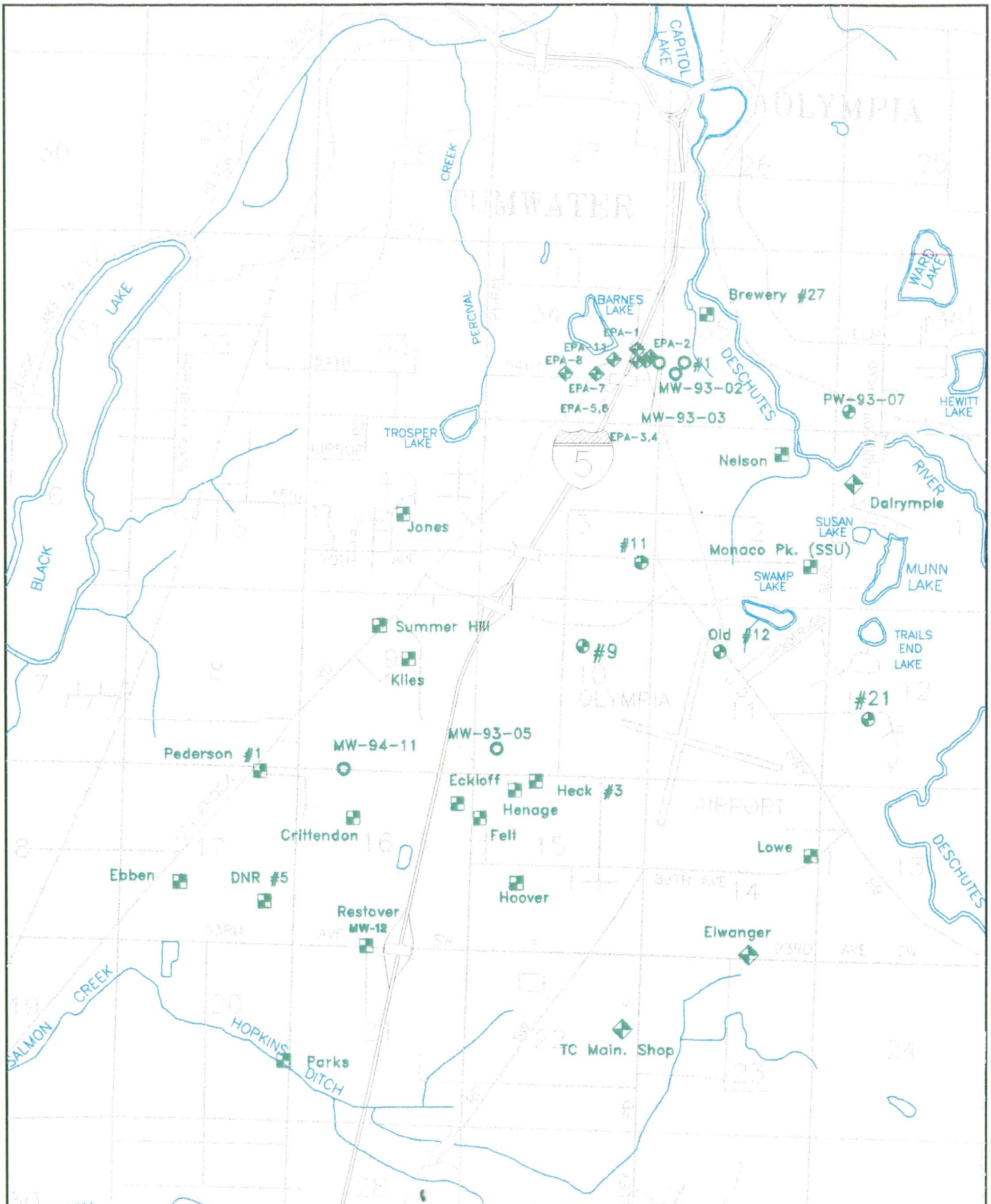
Scale in Feet

Tumwater Wellhead Protection Program

EXHIBIT 2-4
Qvr/Qal WATER LEVEL
MONITORING POINTS

Pacific Groundwater Group

JE9401 2-4-WLMW.DWG, 11/10/96



○ City monitoring wells

◐ City production wells

◆ Wells monitored in past by USGS/TCPHD

▣ Private wells

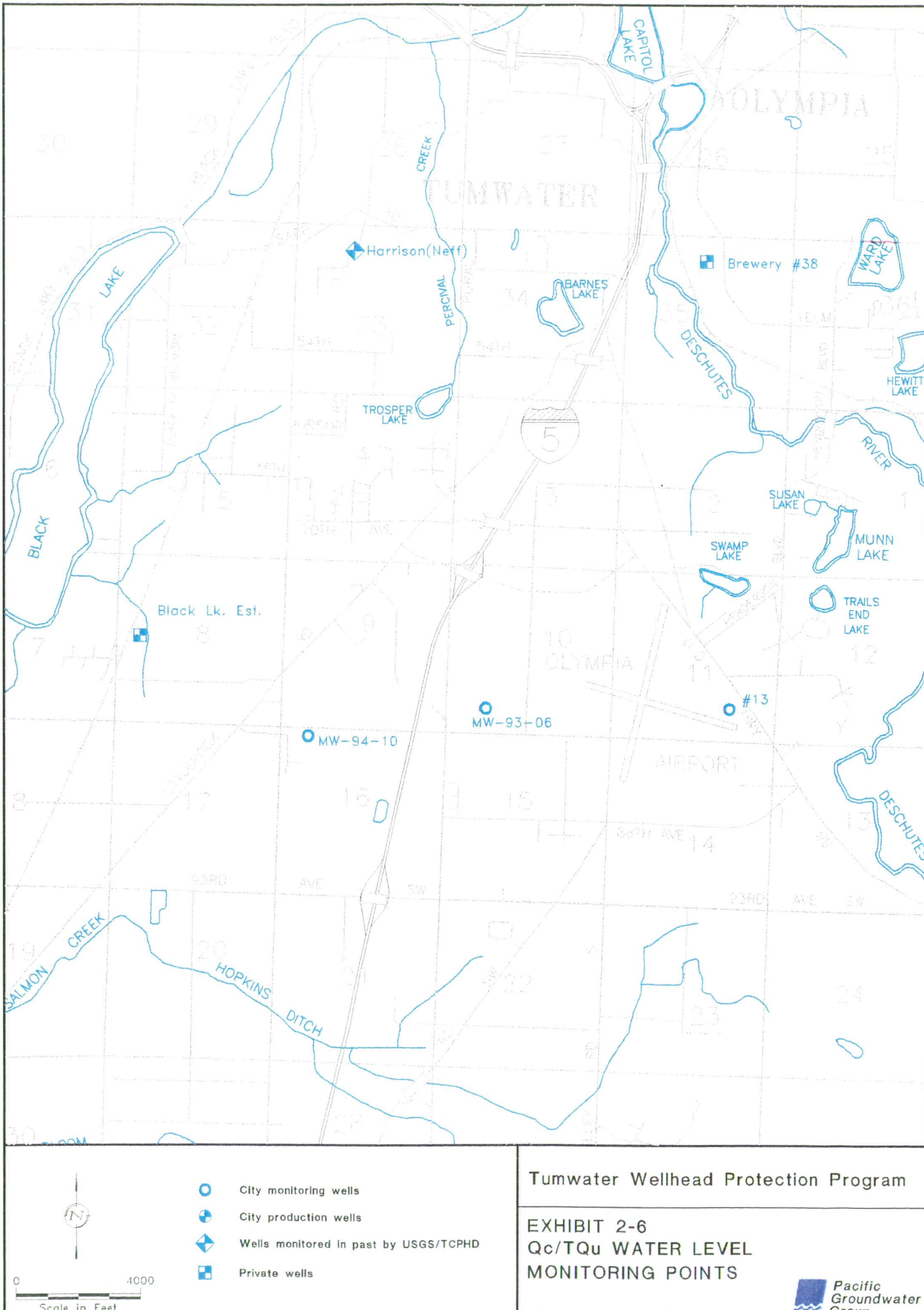
0 4000
Scale in Feet

Tumwater Wellhead Protection Program

FIGURE 2-5
Qva/Qal WATER LEVEL
MONITORING POINTS

Pacific Groundwater Group

JE9401 2-4-WLMW.DWG 11/10/96

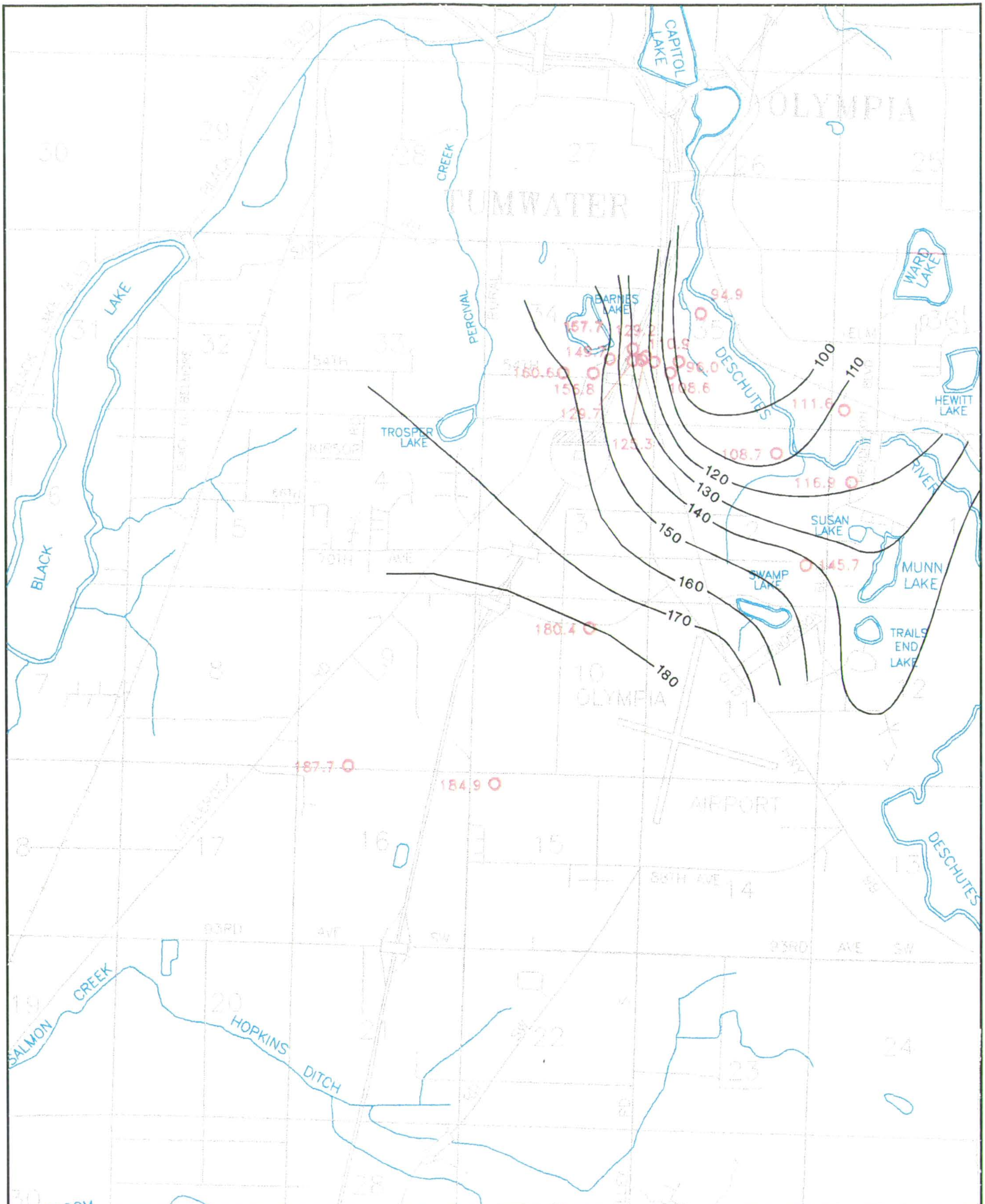


Tumwater Wellhead Protection Program

EXHIBIT 2-6
Qc/TQu WATER LEVEL
MONITORING POINTS

Pacific Groundwater Group

JE9401 2-4-WLMW.DWG, 11/10/96



177.6 Water level measuring point and water level in feet msl

170 Groundwater potentiometric contour and elevation in feet msl

N

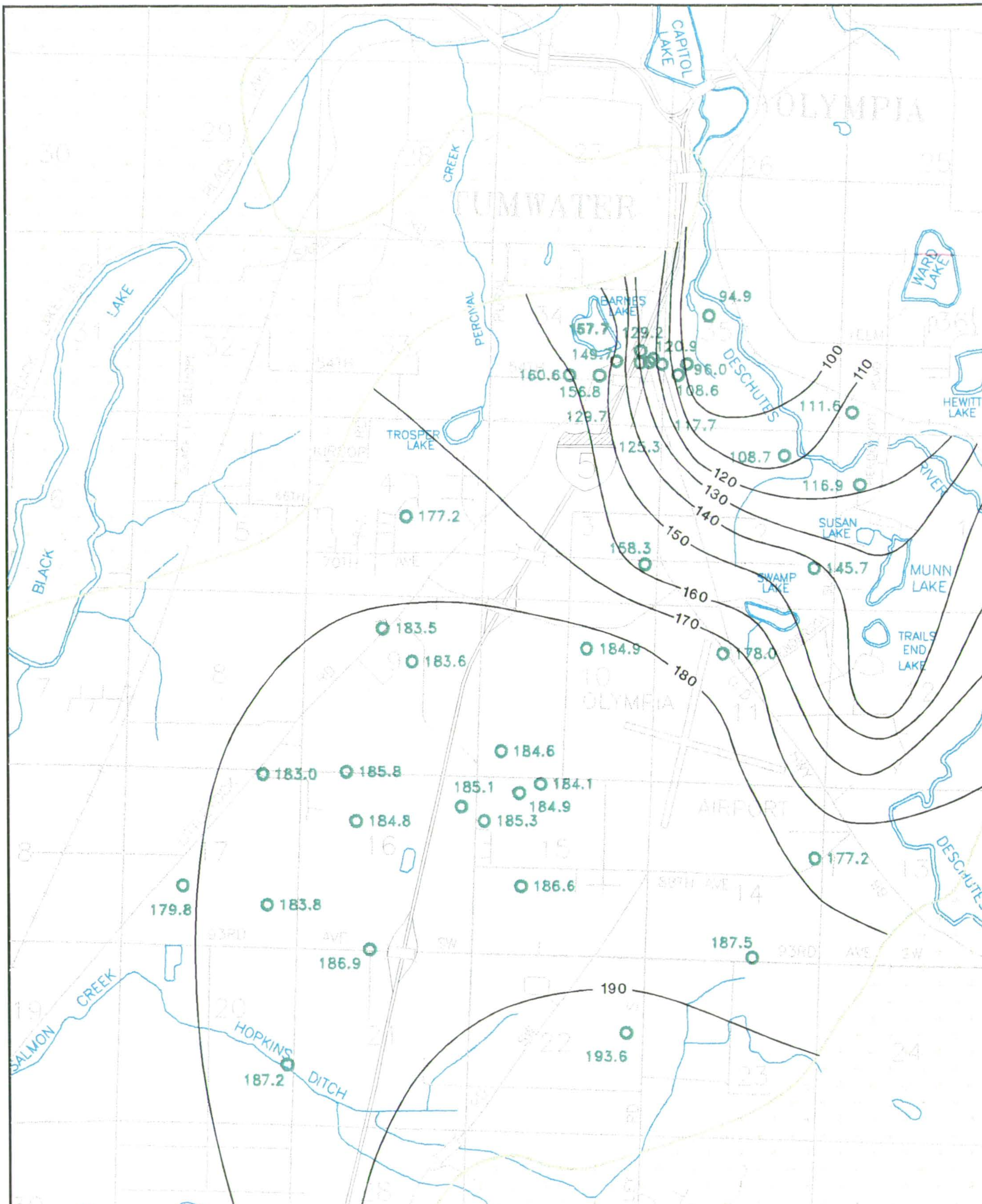
0 4000
Scale in Feet

Tumwater Wellhead Protection Program

EXHIBIT 2-7
Qvr/Qal WATER LEVELS
DECEMBER, 1995

Pacific Groundwater Group

JE9401 2-4-WLMW.DWG, 11/10/96



177.6 Water level measuring point and water level in feet msl

170 December, 1995 groundwater potentiometric contours (elevation in feet msl)

Qva/Qal aquifer absent (after Dion et al., 1994)

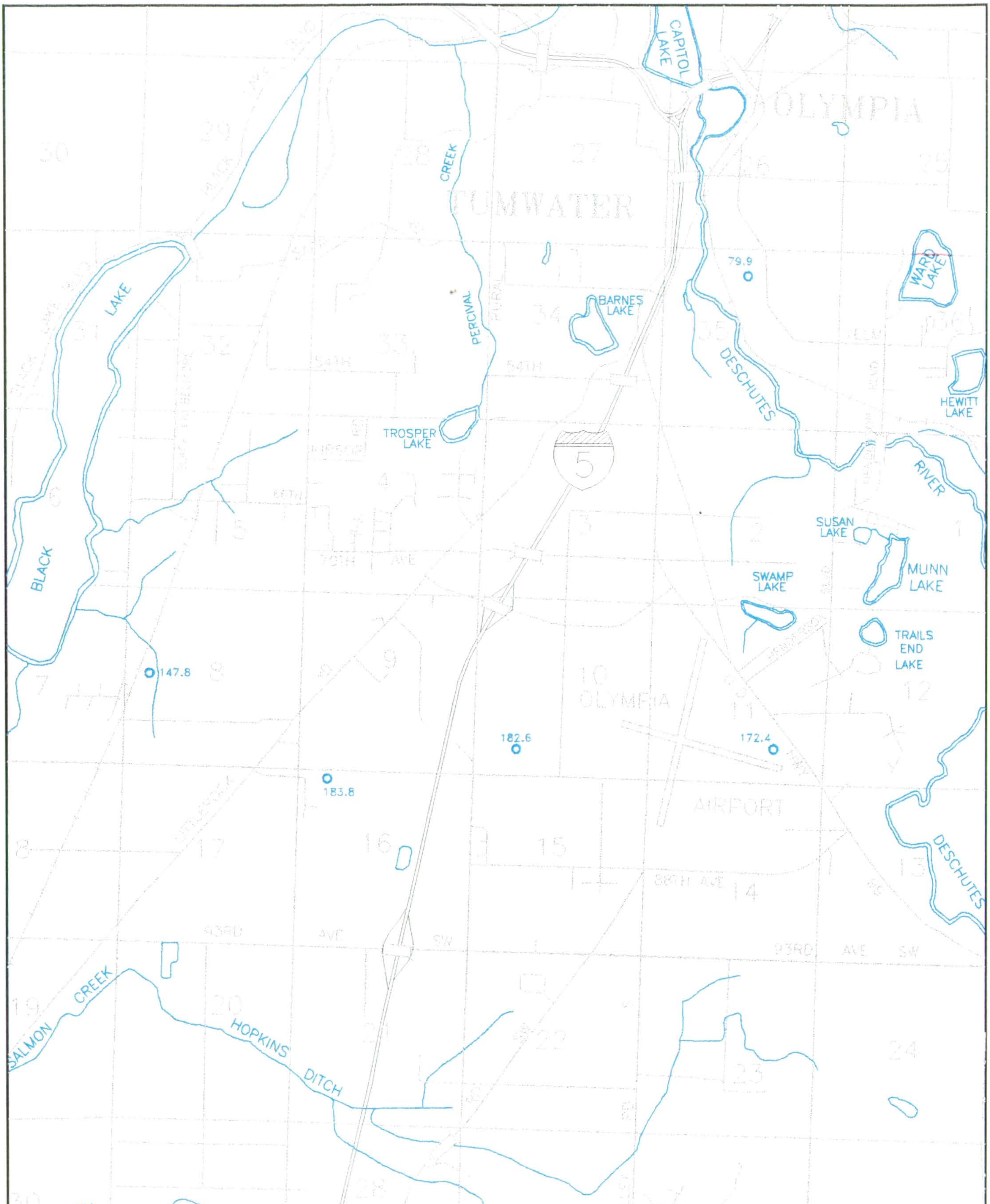
0 4000
Scale in Feet

Tumwater Wellhead Protection Program

EXHIBIT 2-8
Qva/Qal WATER LEVELS
DECEMBER, 1995

Pacific Groundwater Group

JE9401 2-4-WLMW.DWG, 11/10/96



N

0 4000
Scale in Feet

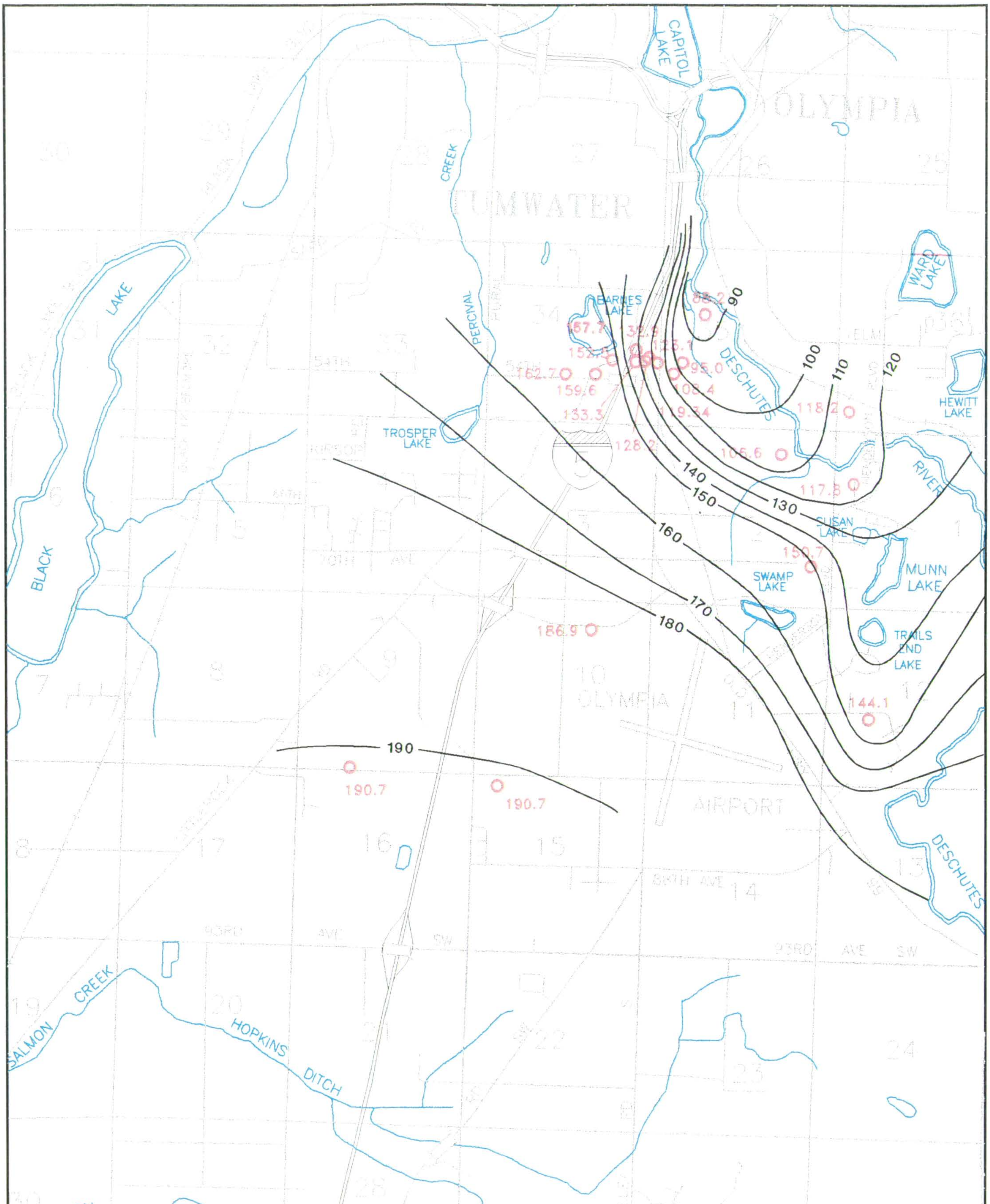
177.6 Water level measuring point and water level in feet msl

Tumwater Wellhead Protection Program

EXHIBIT 2-9
Qc/TQu WATER LEVELS
DECEMBER, 1995

Pacific Groundwater Group

JE9401 2-4-WLMW.DWG, 11/10/96



177.6 Water level measuring point and water level in feet msl

170 Groundwater potentiometric contour and elevation in feet msl

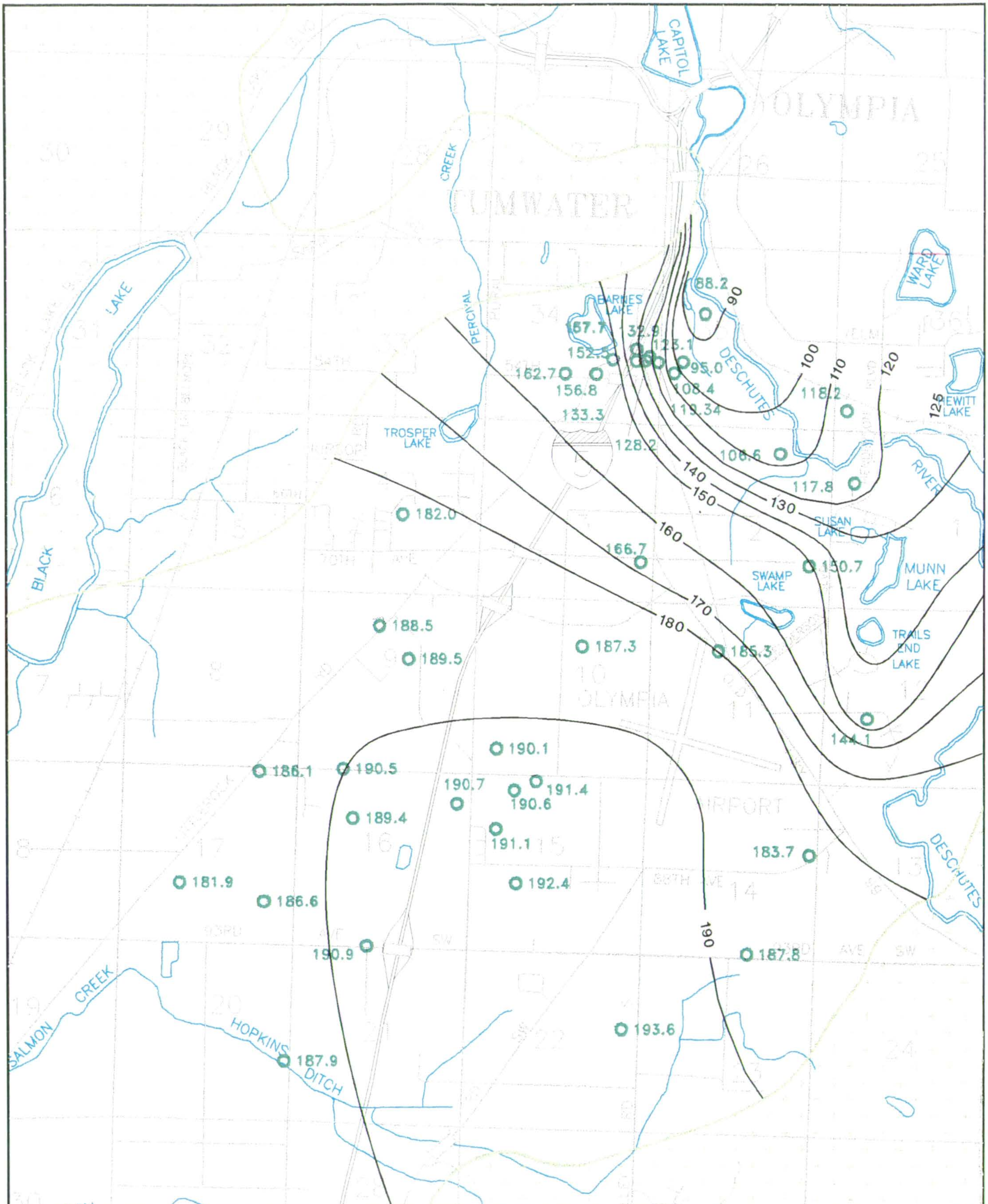
0 4000
Scale in Feet

Tumwater Wellhead Protection Program

EXHIBIT 2-10
Qvr/Qal WATER LEVELS
MARCH, 1996

Pacific Groundwater Group

JE9401 2-4-WLMW.DWG. 11/10/96



177.6 Water level measuring point and water level in feet msl

170 March, 1996 groundwater potentiometric contours and elevation in feet msl

Qva/Qal aquifer absent (after Dion et al., 1994)

0 4000

Scale in Feet

Tumwater Wellhead Protection Program

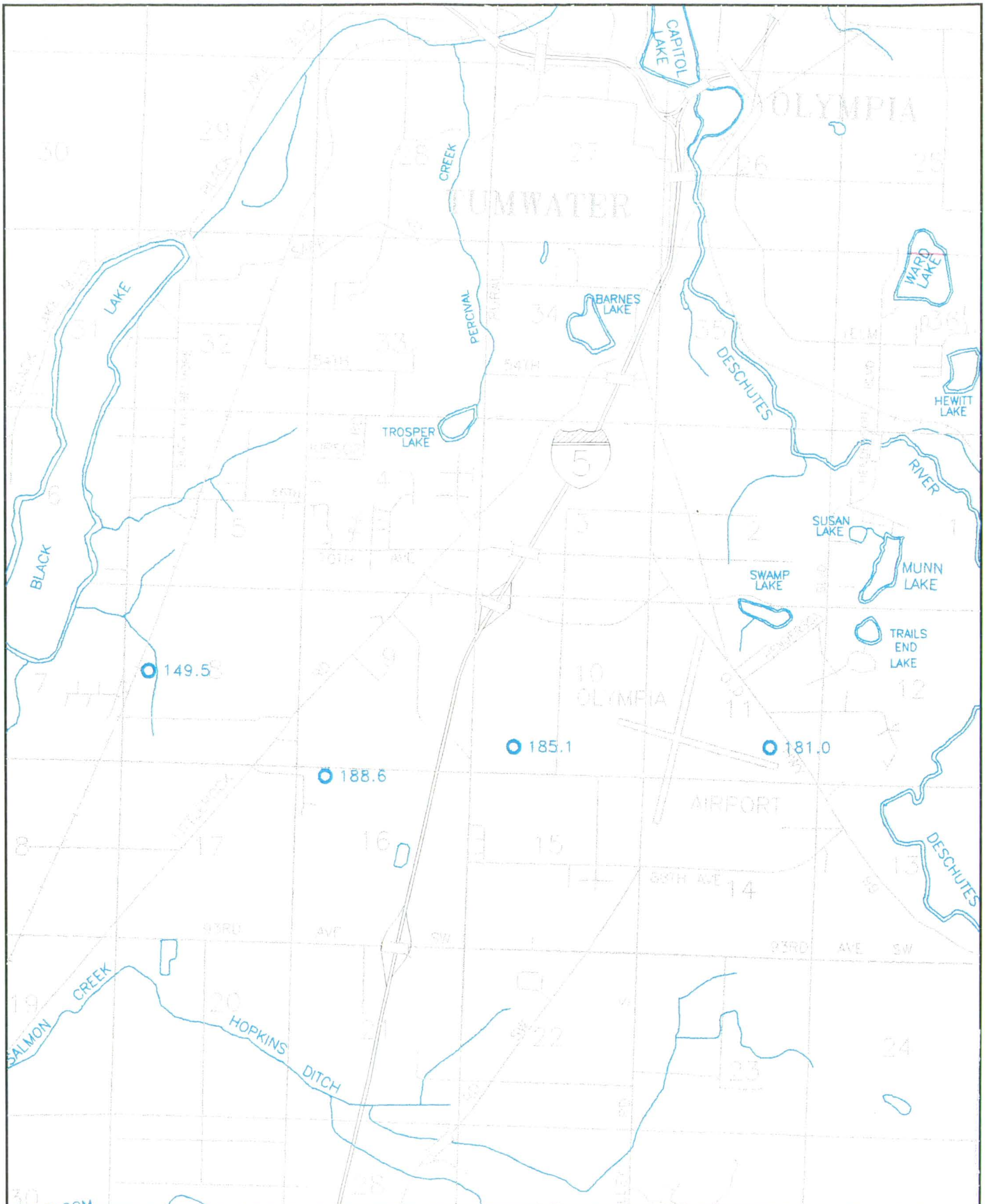
EXHIBIT 2-11

Qva/Qal WATER LEVELS

MARCH, 1996

Pacific Groundwater Group

JE9401 2-4-WLMW.DWG, 11/10/96



N

0 4000
Scale in Feet

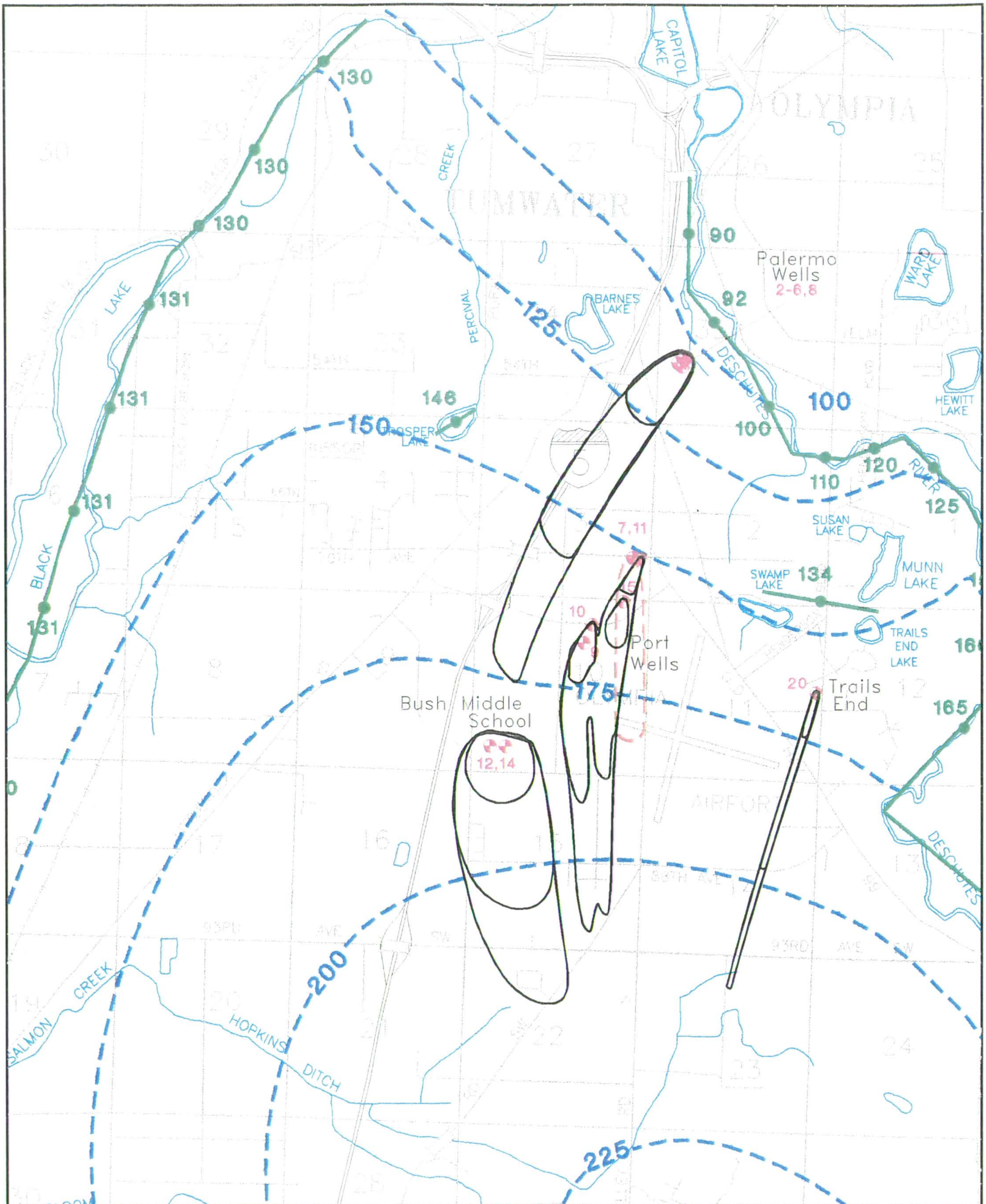
177.6 Water level measuring point and water level in feet msl

Tumwater Wellhead Protection Program

EXHIBIT 2-12
Qc/TQu WATER LEVELS
MARCH, 1996

JES401 2-4-WLMW.DWG, 11/10/96

Pacific Groundwater Group



Modeled groundwater potentiometric contour elevation in feet msl

Well 7 10-year capture zone in the Qc aquifer

Nested 1-, 5-, & 10-year capture zones in the Qva/al aquifer

14 City of Tumwater production well

Surface water linesink and constant head point

Model reference head point (185 feet msl)

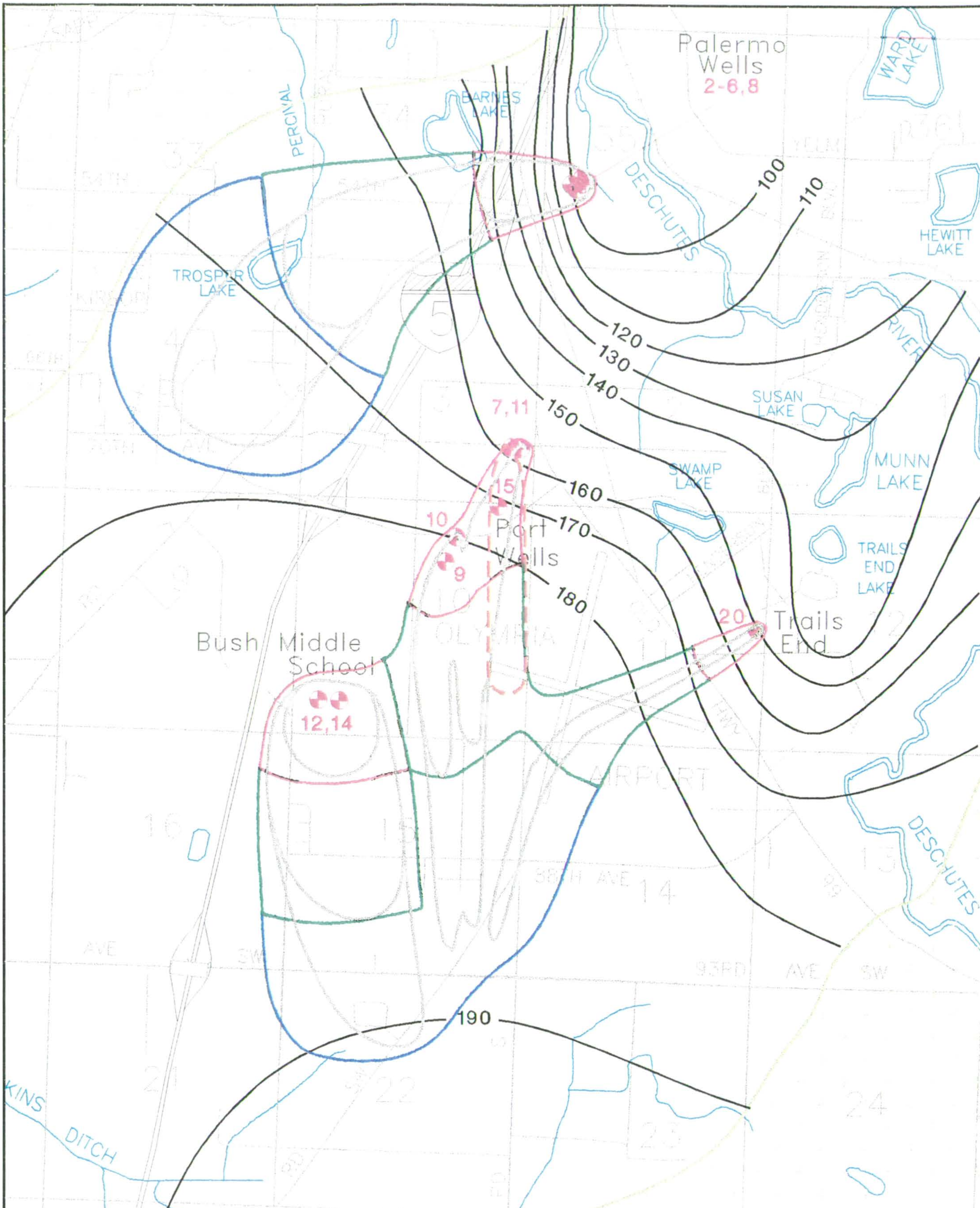
0 4000
Scale in Feet

Tumwater Wellhead Protection Program

EXHIBIT 2-13
PRELIMINARY CAPTURE ZONES & MODELED Qal/Qva FLOW FIELD

Pacific Groundwater Group

JE9401 2-4-WLMW.DWG. 11/10/96



Qva/Qal aquifer absent (after Dion et al., 1994)

Well 7 10-year capture zone in the Qc aquifer

December, 1995 groundwater potentiometric contours (elevation in feet msl)

14 City of Tumwater production well

0 3000
Scale in Feet

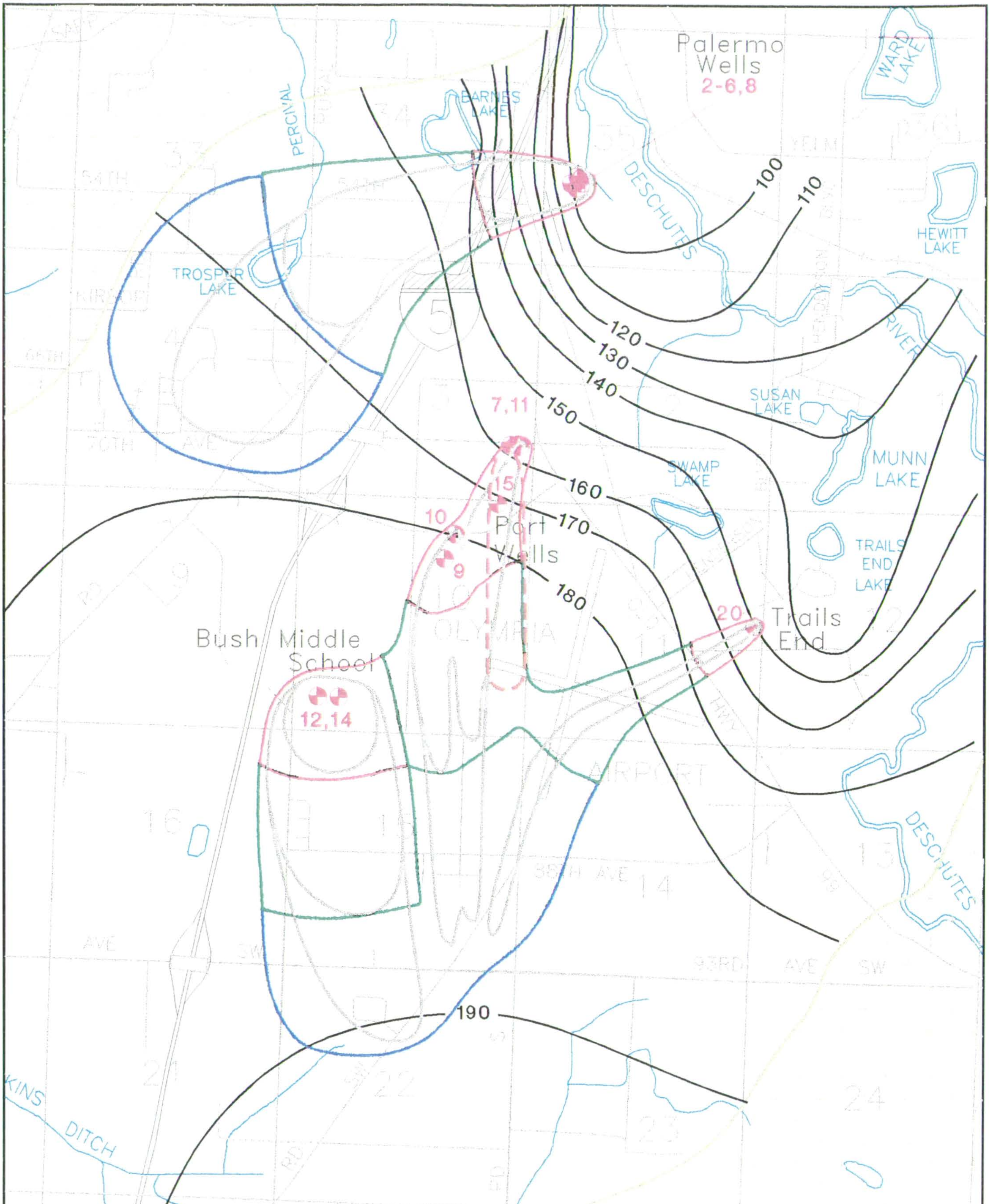
Qva aquifer nested 1-,5-,& 10-year modified capture zones (gray) & recommended WHPAs (color)

Tumwater Wellhead Protection Program

EXHIBIT 2-14
WHPAs & DECEMBER 1995
Qva WATER LEVELS

Pacific Groundwater Group

JE940, 2-14DWHP.DWG, 11/10/96



Qva/Qal aquifer absent (after Dion et al., 1994)

Well 7 10-year capture zone in the Qc aquifer

170 December, 1995 groundwater potentiometric contours (elevation in feet msl)

14 City of Tumwater production well

Qva aquifer nested 1-,5-,& 10-year modified capture zones (gray) & recommended WHPAs (color)

0 3000
Scale in Feet

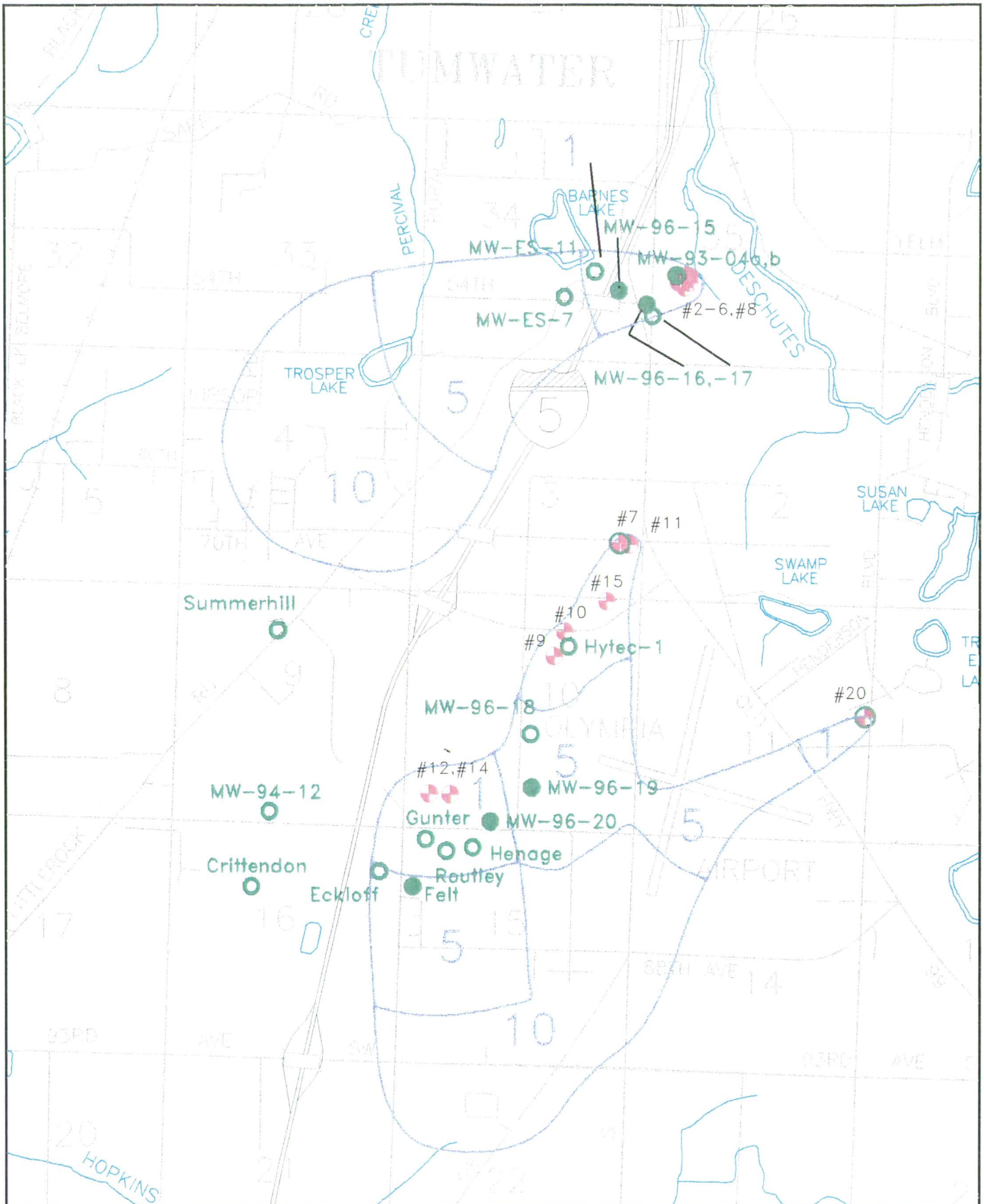
N

Tumwater Wellhead Protection Program

EXHIBIT 2-15
WHPAs & DECEMBER 1995
Qva WATER LEVELS

JE9401 2-4-WLMW.DWG 11/10/96

Pacific Groundwater Group



City of Tumwater production well

Sampled well: solid center indicates well recommended for continued water quality monitoring

Nested 1-, 5- and 10-year WHPAs

N

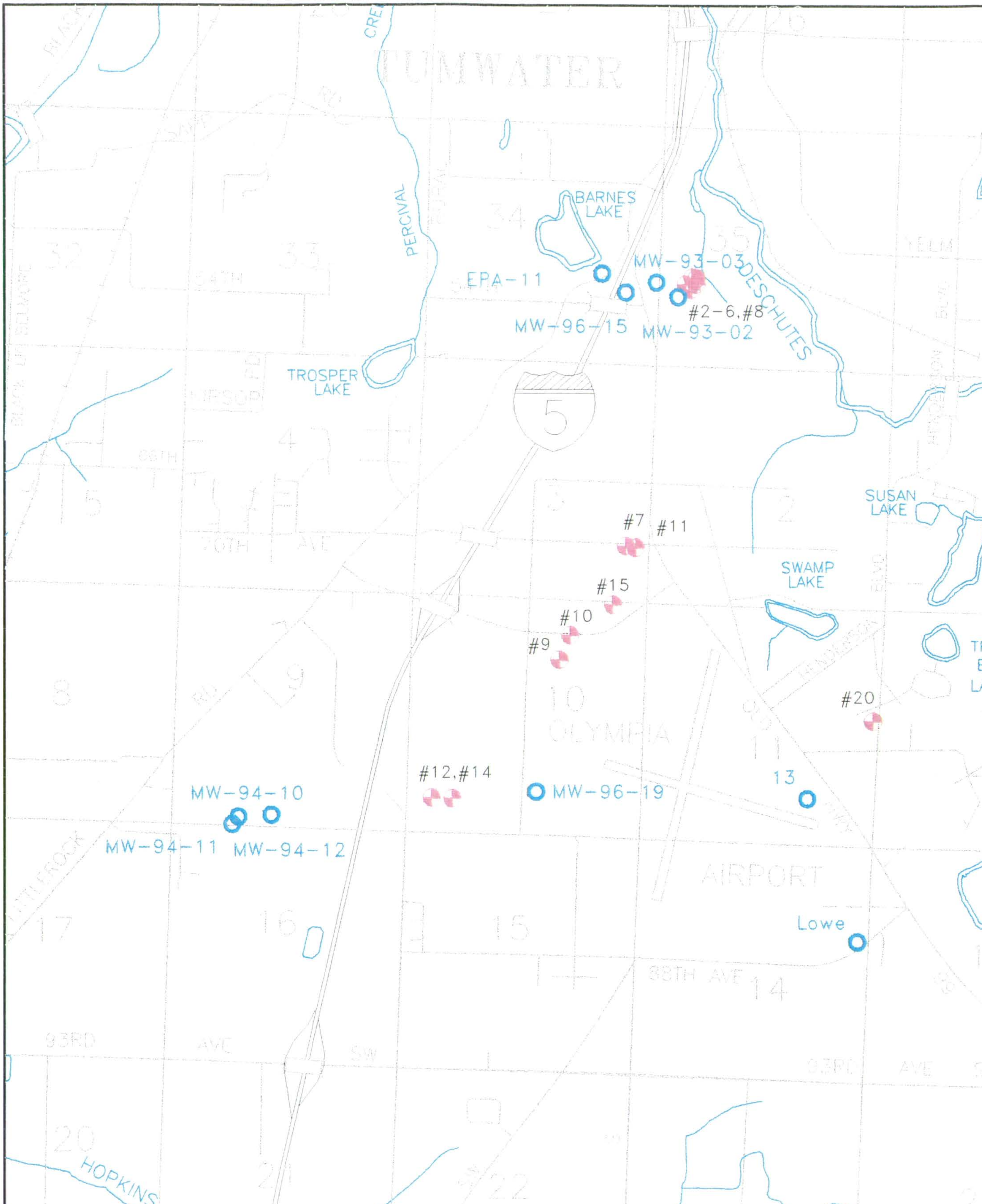
0 3000
Scale in Feet

Tumwater Wellhead Protection Program

EXHIBIT 2-16
WATER QUALITY
MONITORING POINTS

Pacific Groundwater Group

JE9401, 2-16-WQ.DWG, 11/10/96



City of Tumwater production well

Recommended wells for monthly water level monitoring

0 3000

Scale in Feet

Tumwater Wellhead Protection Program

EXHIBIT 2-17
RECOMMENDED WATER LEVEL
MONITORING POINTS

Pacific Groundwater Group

JE9401, 2-17-WL.DWG, 11/10/96

Section 3

Section 3
Contaminant Source Inventory

3.1 Introduction

A key element of the Wellhead Protection Program/Plan (WHPP) is an inventory of known and potential sources of groundwater contamination within the City of Tumwater's (City) delineated wellhead protection areas (WHPAs). The purpose of this section is to present an inventory of land use activities/parcels and contaminant sources that may pose a threat to the City's water supply. By identifying the nature of the threats, effective management strategies can be developed to eliminate or minimize the possibility that potential contaminant sources may become actual sources of groundwater contamination. Potential contaminant sources were identified using existing land use data (Thurston County Assessor's data and City zoning data) and new parcel information (inventory data).

Groundwater contamination can originate from point and nonpoint sources. Point sources of contamination are those that can be traced to a specific discharge point such as an industrial discharge pipe, landfill, or transportation spill. A nonpoint source cannot be attributed to a single identifiable location, but rather to a more widespread release. Examples of nonpoint sources of contamination include agricultural applications of pesticides/herbicides, septic systems, and stormwater runoff.

This section reviews land use conditions within the WHPAs and provides an inventory of potential threats that could adversely affect the quality of the City's drinking water supplies. The major contaminant sources within each WHPA are assessed and ranked in Section 4.

As presented below, the City's land use/parcel and contaminant source inventory can be useful in two important ways. First, the inventory may be used to provide an understanding of the existing potential for contamination of the City's wellheads. Second, the subsequent risk analysis and ranking of contaminant sources in Section 4 presents essential information for determining the need to design and apply a variety of land use control measures and other management strategies in specific WHPAs.

3.2 Land Use

Two sources of data were mapped to show land use in the City's WHPAs. The first data set was the County Assessor's database, containing land use types based on various codes used for assigning a property tax rate. The second data set was constructed from the City's zoning designations for permissible land use within the City's jurisdiction. The two maps generally show similar patterns with some differences resulting from the categories used to display assessed land use and zoned land use.

3.2.1 Assessed Land Use

Assessed land use data were provided by the Thurston GeoData Center (TGDC) from the Assessor Treasury database (ATIM). This database contains the parcel classifications used by the County to assign a property tax to an individual property. Data in ATIM are grouped by parcel type and by whether the parcel is improved (developed) or unimproved (undeveloped). The database includes a large list of land use activity codes that were aggregated into four major groups based on similar potential contamination threats. The general land use groupings include commercial/industrial, residential, agricultural/parks, and forest land/open spaces. The distribution of existing assessed land use across the City's WHPAs are presented in Exhibit 3-1 and Exhibit 7-1.

As explained in Section 2.2, the June 1995 preliminary WHPAs and capture zones were revised in July 1996. As shown on Exhibits 3-1 through 3-3, the capture zones for the Palermo Wellfield (Well Nos. 2-6 and 8) and the Trails End Well No. 20 were substantially modified in the process. It is important to note, that the figures and tables presented below only reflect the results of the parcel inventory based on the final WHPA and capture zone boundaries. The following points are inclusive in the methodology used to produce these parcel inventory figures and tables from the survey database:

- Parcels and all attributes of parcels were obtained from the Thurston County GeoData Center, and were used for all parcel based analyses.
- Parcels which were in-whole or in-part inside a capture zone were included as in the capture zone.
- Parcels which were in more than one capture zone for the same well (for example, one- and five-year) were counted in the closest capture zone to the well.
- Parcels which were in more than one capture zone for the different wells (for instance, in the five-year zone for both Bush and Port wells) were counted in both zones.
- Parcels with more than one tenant on the same parcel number were counted separately. For example, there is one large shaded parcel (Airdustrial Park) in the center of the focus area, owned by the Port of Olympia (see Exhibits 3-1 through 3-3). Though this is only one parcel, each of the tenants surveyed were counted separately.

Assessed land use data within the Bush Middle School/Port/Trails End and the Palermo WHPAs are summarized in Table 3-1 on the following page.

Table 3-1
Number of Parcels Within Each WHPA and Capture Zone

	Bush Middle School			Port of Olympia			Trails End			WHPA
Land Use Category	1-Yr	5-Yr	10-Yr	1-Yr	5-Yr	10-Yr	1-Yr	5-Yr	10-Yr	
Residential	12	98	73	0	2	55	3	0	15	76
Commercial/Industrial	6	7	10	15	7	0	7	3	0	27
Agriculture/Parks	2	3	0	1	2	0	0	0	0	8
Forest / Open Spaces	0	0	0	0	0	0	0	0	0	0
Totals	20	108	83	16	11	55	10	3	15	111

Palermo Wells				
Land Use Category	1-Yr	5-Yr	10-Yr	WHPA
Residential	23	71	308	271
Commercial/Industrial	38	64	1	57
Agriculture/Parks	0	0	6	6
Forest / Open Spaces	1	1	1	6
Totals	62	136	316	340

Summary of All Wells	
Land Use Category	Totals
Residential	1007
Commercial/Industrial	242
Agriculture/Parks	28
Forest / Open Spaces	9
Grand Total	1286

Non-residential assessed land use in the Palermo WHPA is predominantly in the one-year time-of-travel capture zone and only slightly less prevalent than residential land use in the five-year zone. Residential land use dominates the ten-year time-of-travel capture zone and the surrounding WHPA. The primary commercial and industrial corridors in the Palermo WHPA are along Littlerock Road and Capitol Boulevard (a north-south orientation) and along Trosper Road (an east-west orientation). The Interstate 5 corridor is within the one-year time-of-travel capture zone and is directly upgradient from the Palermo Wellfield. Most of the commercial parcels in this area are developed and sewered. Much of the Palermo WHPA is unsewered.

Assessed use in the Bush Middle School/Port/Trails End WHPA is predominantly residential. The non-residential area (comprised mostly of commercial/industrial parcels) is dominated by the Port of Olympia's Airdustrial Park and the Olympia Airport. Most of the WHPA is unsewered.

3.2.2 Zoned Land Use

The zoning classifications for the Palermo and Bush Middle School/Port/Trails End WHPAs are presented in Exhibit 3-1. The zoned land use information is presented in only two categories: residential and non-residential parcels. Individual residential and non-residential land use parcels inventoried in both of the City's WHPAs are also identified on Exhibit 3-1. Permissible land uses in the Palermo WHPA include a fairly balanced mix of residential and non-residential development in the one- and five-year capture zones, while residential land uses dominate the ten-year capture zone and the WHPA. Portions of the Palermo ten-year capture zone and the WHPA extend westerly beyond the current Tumwater City limits but within the City's urban growth area boundary.

Permissible land use in the Bush Middle School/Port/Trails End WHPA is also a mixture of residential and non-residential parcels. Land uses within the Bush Middle School Wellfield capture zones are heavily residential. The Port and Trails End wellhead areas are dominated by commercial/industrial land uses in the one- and five-year capture zones, but dominated by residential land uses in the ten-year capture zones and the WHPA. A large portion of the Bush Middle School/Port/Trails End WHPA extends southward far beyond the current Tumwater City limits and past the City's established urban growth boundary.

3.3 Parcel Inventory

3.3.1 Inventory Methodology

Parcel inventories were used to identify potential pollution risks within the City's preliminary WHPAs and capture zones. The inventories provide baseline data for characterizing the types of activities occurring on residential and commercial properties which might pose short- or long-term threats to the City's drinking water quality.

The land use/parcel surveys were accomplished though a partnership between the Cities of Tumwater and Olympia, Thurston County, and the Retired and Senior Volunteer Program (RSVP).

Residential and commercial forms were developed for the parcel inventory. The forms were designed to collect information on potential contaminant sources as well as to educate the public about wellhead protection issues and concerns. Both forms included general questions about the source of drinking water, stormwater disposal, and wastewater disposal. The commercial form includes a more detailed set of questions on waste storage and handling practices. Commercial property owners were requested to identify the quantity and nature of the chemicals they store, handle, or generate on-site and how they disposed of their wastes. The chemical categories included automobile wastes (oil, fuel, antifreeze); chlorinated solvents (paint thinners, wood preservatives); agricultural and landscaping chemicals (fertilizers, pesticides, herbicides); and other miscellaneous wastes (batteries, lab/medical/photo wastes, metal plating).

Contaminant source information was linked by parcel identification numbers in a parcel database provided by the Thurston GeoData Center. In this way, Geographic Information System (GIS) analysis techniques could be used to analyze and map the data within the various wellhead protection capture zones.

A database system was developed using Microsoft's Access software to manage the input and manipulate inventory data. Customized data input forms were developed based on the survey questionnaire forms.

All of the questionnaire data were entered into the inventory database and data summaries were prepared to assess potential land use concerns within each of the capture zones. The geographic distribution of the potential land use concerns were mapped using ArcView, a GIS query system. The ArcView system is dynamically linked to the Access database system through the Thurston County Assessor's parcel numbers. The system is designed to facilitate future inventory of land use threats. New data entered into the Access system can be automatically displayed in ArcView.

A more detailed overview of the land use inventory methodology (including a copy of the residential and commercial questionnaire forms) is presented in Appendix B. The results of the survey effort are summarized below.

3.3.2 Inventory Results

Of 233 residential surveys distributed, 68 percent were returned to the City (22 percent of which were completed and mailed in by the property owner involved). Of the 300 commercial businesses originally selected for the survey, 43 were actually surveyed. The survey covered approximately 22 percent of the parcels within the City's one- and five-year time-of-travel capture zones. Approximately 62 percent of the inventoried parcels are residential and the remaining parcels are commercial. About 24 percent of the inventoried parcels are located in the Palermo WHPA.

Table 3-2 on the following page provides a breakdown of surveyed parcels based on the residential and commercial land use activity in the City's WHPAs and capture zones.

Table 3-2
Number of Parcels Providing a Response to the Survey

	Bush Middle School			Port of Olympia			Trails End			WHPA
Land Use Category	1-Yr	5-Yr	10-Yr	1-Yr	5-Yr	10-Yr	1-Yr	5-Yr	10-Yr	
Residential	1	46	0	0	0	0	0	0	0	0
Commercial/Industrial	5	0	0	9	4	0	1	0	0	2
Totals	**6**	**46**	**0**	**9**	**4**	**0**	**1**	**0**	**0**	**2**

Palermo Wells				
Land Use Category	1-Yr	5-Yr	10-Yr	WHPA
Residential	3	0	0	5
Commercial/Industrial	9	1	0	3
Totals	**12**	**1**	**0**	**8**

Summary of All Wells	
Land Use Category	**Totals**
Residential	**55**
Commercial/Industrial	**34**
Grand Total	**89**

The land use survey information was evaluated relative to major risk categories:

- ❑ Active or inactive well on-site.
- ❑ On-site septic system.
- ❑ Fuel heating tank on-site.
- ❑ Chemical storage and handling (auto wastes, solvents, fertilizers/pesticides/ herbicides, acids/bases, lab/photo and other wastes).

Table 3-3 on the following page presents the distribution of contaminant risk categories for the City's WHPAs and capture zones based on the land use survey responses.

Table 3-3
Contaminant Risk Category Responses by City WHPA and Capture Zone

Risk Category	Bush Middle School 1-Yr	Bush Middle School 5-Yr	Bush Middle School 10-Yr	Port of Olympia 1-Yr	Port of Olympia 5-Yr	Port of Olympia 10-Yr	Trails End 1-Yr	Trails End 5-Yr	Trails End 10-Yr	WHPA
Active or inactive well on-site	2	12	0	0	0	0	0	0	0	0
On-site septic system	3	46	0	1	0	0	0	0	0	0
Fuel heating tank on-site	3	1	0	2	1	0	0	0	0	0
Commercial storage/generation of auto wastes	3	0	0	4	4	0	0	0	0	1
Commercial storage/generation of solvents	3	0	0	4	1	0	0	0	0	0
Commercial storage/generation of fertilizers/pesticides	0	0	0	0	1	0	0	0	0	0
Commercial storage/generation of batteries/acids/bases	2	0	0	3	0	0	0	0	0	1
Commercial storage/generation of lab, photo, and other waste	2	0	0	3	0	0	0	0	0	0
Total Commercial Parcels Inventoried	**5**	**0**	**0**	**9**	**4**	**0**	**1**	**0**	**0**	**2**
Total Commercial Parcels In WHPA	7	8	10	18	9	1	7	3	0	27
Total Residential Parcels Inventoried	**1**	**46**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Residential Parcels In WHPA	12	98	75	0	2	55	3	0	16	76

Risk Category	Palermo Wells 1-Yr	Palermo Wells 5-Yr	Palermo Wells 10-Yr	Palermo Wells WHPA
Active or inactive well on-site	0	0	0	0
On-site septic system	0	0	0	0
Fuel heating tank on-site	4	1	0	3
Commercial storage/generation of auto wastes	4	1	0	0
Commercial storage/generation of solvents	1	0	0	1
Commercial storage/generation of fertilizers/pesticides	0	0	0	0
Commercial storage/generation of batteries/acids/bases	1	0	0	0
Commercial storage/generation of lab, photo, and other waste	1	0	0	0
Total Commercial Parcels Inventoried	**9**	**1**	**0**	**3**
Total Commercial Parcels In WHPA	38	70	1	59
Total Residential Parcels Inventoried	**3**	**0**	**0**	**5**
Total Residential Parcels In WHPA	23	75	308	278

Table 3-3 (continued)	
Summary of All Wells	
Risk Category	**Totals**
Active or inactive well on-site	**14**
On-site septic system	**50**
Fuel heating tank on-site	**15**
Commercial storage/generation of auto wastes	**17**
Commercial storage/generation of solvents	**10**
Commercial storage/generation of fertilizers/pesticides	**1**
Commercial storage/generation of batteries/acids/bases	**7**
Commercial storage/generation of lab, photo, and other waste	**6**
Total Commercial Parcels Inventoried	**34**
Total Commercial Parcels In WHPA	258
Total Residential Parcels Inventoried	**55**
Total Residential Parcels In WHPA	1021

Based upon the land use inventory database, 92 percent of the reported on-site septic systems are located within the five-year capture zone of the Bush Middle School Wellfield. Another 6 percent of the on-site septic systems are located within the one-year capture zone of the Bush Middle School Wellfield. Overall, the figures and tables extracted from the land use inventory database represent the reported contaminant risk categories for 13 percent of the total commercial parcels (34 of 258) and 5 percent of the total residential parcels (55 of 1021) within all of the City's delineated WHPAs and capture zones.

Underground storage tanks, both those in use and those abandoned, within the City's preliminary WHPAs and capture zones are shown by inventoried parcels on Exhibit 3-2.

Exhibit 3-3 identifies one non-city active well in the preliminary Palermo WHPA and a total of 13 active wells and two abandoned wells (both within the five-year capture zone of Well Nos. 12 and 14) on inventoried parcels in the Bush Middle School/Port/Trails End WHPA. These 14 active wells may provide opportunities to augment the City's monitoring network. Other wells (poorly constructed or abandoned) can act as conduits that facilitate transport of contaminants to the aquifer.

Inventoried parcels reporting the use of on-site septic systems are also shown on Exhibit 3-3. On-site septic systems in the Bush Middle School/Port/Trails End WHPA and capture zones appear frequently because most of it is in the unsewered area of the City. Based upon the inventoried parcels, on-site septic systems are concentrated within the five-year capture zone of the Bush Middle School Wellfield.

Exhibit 3-4 shows that a large portion of the Palermo Wellfield's five-year and ten-year capture zone and WHPA that are not served by a sewer system. Almost all of the Bush Middle School/Port/Trails End WHPA is not served by a sewer system. Sewer service is provided to all of the one-year capture zone, most of the five-year capture zone, but none of the ten-year capture zones delineated for the Port Wells. None of the delineated capture zones for the Bush Middle School Wellfield or the Trails End Well No. 20 are served by a sewer system.

3.3.3 Business Inventory and Technical Assistance

As part of the development of this WHPP, the City approached the Business Pollution Prevention staff of the Thurston County Environmental Health Division in 1995 and proposed a joint technical assistance effort targeted to the City's wellhead protection zones. The City and the County subsequently worked together to successfully complete a pilot outreach project affecting businesses located within the City's WHPAs. The Tumwater project was funded by solid waste fees and by hazardous waste grants from the Department of Ecology (Ecology) created by Initiative 97.

The Business Pollution Prevention program serves small businesses in the Cities of Bucoda, Lacey, Olympia, Rainier, Tenino, Tumwater, Yelm, and Thurston County. The program does not duplicate services provided by other local and State agencies. The phrase *Business Pollution Prevention* (BPP) was coined in 1993 to integrate the various hazardous waste technical assistance features of the 1991 Thurston County local hazardous waste plan. BPP provides services not otherwise available to small businesses, such as waste management and disposal information, education about local ordinances, on-site waste audits, and, when necessary, enforcement and compliance actions.

In the summer of 1995, the City and the County's BPP staff teamed together and conducted an inventory of hazardous materials at the majority of residences and businesses within the City's five-year time-of-travel capture zones. The objective was to learn about hazardous waste management practices at local businesses within the City's WHPAs.

Once the inventory was completed, those businesses having small quantity generator (SQG) status were identified and contacted by the County with an offer for free, non-regulatory technical assistance. The technical assistance effort focused on educating business owners on the requirement for compliance with the County's Nonpoint Source Pollution Ordinance, on reducing hazardous waste generation, and on improving waste management practices. The educational goal was to prevent pollution of the City's water resources by requiring proper management of hazardous materials.

As a result of this outreach effort, owners of four of the eight businesses voluntarily requested a technical assistance visit the first time the BPP staff offered the free service. Two business owners accepted the second time it was offered, and two business owners participated in the compliance audit only. The technical assistance visits took between 30-to-90 minutes to complete, while the compliance audits took about 30 minutes each.

Of the six businesses that took advantage of the technical assistance visit, three (50 percent) were in full compliance with the ordinance, while the remaining three businesses (50 percent) were not in compliance. Both businesses who provided the compliance audit only were in compliance with the ordinance at the time of the audit.

Of the three businesses that were not in compliance at the time of the visit, one was not in compliance because of the uncontrolled discharge of hazardous waste directly into the ground through a dry well. Another was out of compliance because of the potential for a hazardous liquid to be discharged directly to the ground through an excavation in the floor. The third business was not in compliance due to an incomplete designation of a hazardous waste. All eight businesses were in full compliance with the ordinance by the end of the pilot project.

3.4 Contamination Threats

Known and potential contaminant threats that exist within the City's Wellhead Protection Areas (WHPAs) are discussed below. Based on the Northern Thurston County Ground Water Management Plan (GWMP), the City's parcel inventory data, and other information developed for this report, the primary risks to the City's water supply may be from:

- Known Contaminated Sites
- Hazardous Materials (use and storage)
- On-Site Septic Systems
- Underground Storage Tanks
- The Olympic Pipeline
- Transportation Spills
- Stormwater Runoff
- Agriculture/Hobby Farming, Golf Courses, Parks, Landscaping
- Wells (poor construction or improper abandonment)

3.4.1 Known Contaminated Sites

The identities of nine confirmed and suspected contaminated sites within the area are listed on Table 3-4. This contaminated site information is maintained and continuously updated by Ecology. Petroleum is a confirmed pollutant with respect to soil contamination, and suspected with respect to groundwater and sediment contamination.

Table 3-4
Confirmed and Suspected Contaminated Sites

Map Key	Site Name	Contaminant Conditions
A1	BP 03158 Trosper Road @ I-5	Surface runoff of TPH, ethylene glycol and oil.
A2	Texaco Bulk Plant 7370 Linderson	Surface runoff and groundwater impact by benzene (5.2 ppb) diesel (4.5 ppm) and gas (3 ppm). Petroleum product in soil and groundwater due to spill.
A3	Hytec Fiberglass 711 Airdustrial Road	**NOW CLOSED,** confirmed soil contamination w/phenolic compounds, suspected contamination of gw and soil with chlorinated solvent. Also reported petroleum contamination.
A4	Restover Truck Stop 93rd Ave. SW and I-5	Release of 65,000 gallons of gas and diesel in unconfined aquifer, free product floats on shallow water table.
A5	American Fiberglass 8904 Kimmie Road	Groundwater and soil impacted by chlorinated and phenolic compounds (formerly a fiberglass facility, currently a paint shop) possibly a source of freon detected in wells to the north.
A7	Tumwater Pickup Parts 5945 Littlerock Road	Soil impacted by metals, pesticides, petroleum and organic solvents.
A8	Fisheries Maintenance Yard 700 Airdustrial Way	Petroleum contaminated soils.
A10	Poages Automotive Service	Chlorinated solvents in a dry pit.
A11	Southgate Dry Cleaners	PCE in shallow soil (258,000 ppb), PCE in groundwater, TCE in soil (1480 ppb), TCE in groundwater c-DCE in groundwater, Vinyl Chloride in groundwater.

Six of the nine known contaminated sites in the area are located within the City's WHPAs:

- ❑ Poages Automotive and Towing (A10) is a known contaminated site within the one-year time-of-travel capture zone of the Palermo Wellfield.
- ❑ Southgate Dry Cleaners, also located within the one-year time-of-travel capture zone of the Palermo Wellfield, is a known contaminated site.
- ❑ The BP gas station, formerly the Exxon gas station (A1), is located just outside the one-year capture zone of the Palermo Wellfield.
- ❑ American Fiberglass (A5) is located on the boundary line of the ten-year time-of-travel capture zone of the Bush Middle School Wellfield.

- Situated within the one-year time-of-travel capture zone (within 100 feet) of Port Well Nos. 9 and 10 is Hytec (A3), a contaminated site that has now been removed from the list by Ecology and the City (see additional discussion below).
- Tumwater Pickup Parts (A7) is located in the ten-year time-of-travel capture zone of the Palermo Wellfield.

Early project scoping efforts included discussions about action programs to deal with existing and known potential threats to the City's water supplies. The City decided to expend the effort necessary to expedite the mitigation of known contamination issues at a few selected sites, and to undertake this activity as part of this wellhead protection planning effort. Among the major issues and selected sites addressed during this project were the contamination of the Palermo Wellfield, the Hytec facility, and the Texaco Bulk Plant Storage facility. Support was also provided the City for several smaller sites.

Palermo Wellfield Contamination

The Palermo Wellfield is comprised of six active wells which have supplied up to 50 percent of the City's drinking water in the past. On August 3, 1993, trichloroethene (TCE) was discovered in water samples collected from Palermo Well Nos. 2, 4, and 5 during routine monitoring. TCE was detected in a water sample collected from Well No. 2 at a concentration more than twice as high as the federal drinking water standard. That episode resulted in the loss of 25 percent of the City's water supply. Subsequent monthly sampling conducted by the City indicates that TCE persists in the capture zone of Well Nos. 2, 4, and 5.

Consultant services under this WHPP provided guidance to modify the pumping regime in this wellfield to mitigate any adverse impact on the remaining clean wells.

The City has been actively cooperating in identifying the source, or sources, of contamination since 1993. Under State law, Ecology has primary responsibility for such activity. However, after some preliminary investigation, Ecology's position was that they had neither the funding nor resources to handle this issue, and they requested assistance from the United States Environmental Protection Agency (EPA).

The City, with consultant assistance, has played a key role in the site investigation to date. Specifically, the City has provided:

- Review and suggestions to EPA's Technical Work Plan to investigate the contamination.
- Routine communication on technical issues providing all available technical data and expertise on local hydrogeology.

- Review and comments on sampling programs and results.
- Technical review of reports produced during the investigation.
- Liaison with citizens and property owners with regard to drinking water concerns and impacts on their property.

Some pivotal documents are included in Appendix C.

To ensure safe drinking water, the City immediately took all three wells out-of-service. Two new drinking water wells (Well Nos. 12 and 14) have replaced the water supply lost due to the contamination of the Palermo Wellfield.

In August 1993, the City, in coordination with Ecology, conducted an initial investigation to determine the potential source(s) of contamination of the Palermo Wellfield. A number of potential sources were identified. In September 1993, Ecology and the City requested the EPA's assistance in furthering the City's investigation. In September 1994, a site reconnaissance and interviews were conducted by EPA to identify locations for soil gas, groundwater, and soil sampling. In October and November 1994, Phase 1 field sampling was performed. In addition to TCE, tetrachloroethene or perchloroethene; (also known as PCE) was detected in soil and groundwater samples in the vicinity of the Southgate Mall. Based on the findings of Phase 1, potential source areas were identified for site-specific sampling under Phase 2.

Phase 2, as reported in Weston's *Expanded Site Inspection Report* for the Palermo Wellfield (April 1996), found that an elongated east-west trending TCE compound plume extends approximately 2,500 feet from the Palermo valley west to the intersection of Trosper and Littlerock Roads. In the uplands and in the Palermo valley, the plume is about 400 feet wide. The PCE plume is similar in geometry but is limited to the uplands area and the Palermo bluff. Surface water collected at the base of the bluff indicate that the PCE plume has migrated to the edge of the Palermo valley and has the potential of further contaminating the Palermo Wellfield.

Based on the EPA-funded field investigations of the Palermo Wellfield, the potential sources of TCE and PCE contamination have been narrowed to past on-site disposal practices at Southgate Dry Cleaners (TCE and PCE) in the Southgate Mall, the Chevron Station (TCE) on Trosper Road, and the Washington State Department of Transportation (WDOT) testing laboratory (TCE) on Second Avenue. All sites are upgradient from the Palermo Wellfield and in close proximity to one another. Monitoring wells installed at the Chevron Station, WDOT facility, and the Southgate Mall will continue to be sampled by EPA on a quarterly basis. The City will continue its routine monitoring of the City's Palermo supply wells.

With the completion of Phase 2 and EPA's issuance of Weston's report, Washington State Governor Mike Lowry wrote to EPA Administrator Carol Browner on August 20, 1996, urging her to add the City's three contaminated wells to the federal Superfund list for cleanup. These wells are now listed on EPA's Superfund list and are undergoing remedial action. The federal Superfund list already includes about 50 contaminated sites in the State. The estimated cost of treatment at Well Nos. 2, 4, and 5 is $1.2-million.

Hytec Facility

Hytec, a fiberglass manufacturer, formerly located at 711 Airdustrial Way, is suspected of illegally disposing waste chemicals. This suspicion is based on complaints filed with Ecology in 1985 and 1986. Barrels of waste chemicals were reportedly decanted to a storm drain which discharged to a swampy area near the Hytec facility site. Six hundred gallons of waste per month were reported to have been dumped over an unspecified period. Wastes included such chemicals as acetone, methylene chloride, methyl-ethyl ketone peroxide, dimethylamine, tricresyl phosphate (TCP), and polyester resins. The suspected spill area is near two City drinking water wells (Port Well Nos. 9 and 10).

A 1,500 gallon acetone spill was also reported to have occurred near outside storage tanks located at the southeast corner of the building (Heggen, 1991).

The Hytec property was used by the military during World War II. Large cement blocks south of the fence line were identified as remnants of military structures (Port of Olympia, 1991).

The property is owned by the Port of Olympia and has been leased by The Great American Herb Company for several years. Operations at this facility involve the drying of herbs, adding synthetic fragrances, and packaging herbs (Armitage, 1991).

Surface geology of the area is predominately Vashon Drift comprised of recessional sand and gravel, till, and advanced outwash (USGS, 1961 and 1966). The City's log for Well No. 9 shows 15 feet of fine sand overlying interlayered sand and gravel to the bottom of the 105 foot hole. The fill in this area is poorly defined or absent. These deposits are highly permeable and allow for rapid percolation of water to the water table. Well No. 9 is located approximately 125 feet west of the suspected spill area. The depth to the water table is estimated to fluctuate seasonally between 3 to 13 feet. Again, contamination at this location primarily included the solvent TCE and several semivolatile compounds.

Since this site is within a hundred feet of the City's production wells, the City was keenly interested in evaluating the threat that this site presented to water quality. Consequently, services were provided under the WHPP for involvement and review of proposed site investigation which included the following:

- ❑ Access and review of Ecology records.
- ❑ Review of, and comment on, Site Assessment Work Plan.
- ❑ Negotiations on location of monitoring wells, construction details, and sampling sites.
- ❑ Preparation of recommendations for Ecology consideration.
- ❑ Review and interpretation of Site Assessment Results.

Some important documents prepared under this activity have been included as Appendix D.

As a result of these actions, Ecology and the City have decided to remove Hytec from the list of confirmed and suspected contaminated sites. No further action is required at the site at this time to protect the City's drinking water supplies.

Texaco Bulk Plant Storage Facility

The Texaco Bulk Plant Storage facility (Tumwater Sales Terminal) site appears to have been the location of several petroleum spills and leaks. In January 1982, approximately 25,000 gallons of #2 Diesel were spilled. In 1989, two underground tanks were removed and soil was found to be contaminated with gasoline. The location of the two tanks was in the vicinity of a truck loading rack, suggesting possible unreported spills of unknown quantity. In 1991, another storage tank was removed and a report was made of soil contamination and "free product" (#2 Diesel) floating on the groundwater.

The 1982 spill was caused by operator error during tank filling. The spill response was standard for that era. It involved the Responsible Party and Ecology, and was complemented with contracted assistance. About 2,500 gallons of product were recovered immediately. Several monitoring wells were installed and two product recovery wells were constructed. Contaminated soil (about 3,000 cubic yards) was removed to an Anacortes treatment facility. Approximately 100 gallons of product were removed from the water table.

During the 1982 spill, a "pump and treat" system was established, pumping water from the two recovery wells at about 100 gpm. Water treatment was through an oil/water separator. This activity and monitoring of perimeter wells continued until sometime between August 1984 and February 1985. At that time, product recovery from the wells was reported at "essentially zero", water quality was reported as good and improving. Consequently, pumps were removed and the collection system dismantled.

In 1989, two underground tanks were removed and an old 10,000 gallon oil/water separator was abandoned (closed). During removal, soil and groundwater were found to be contaminated with gasoline. In November 1993, approximately 830 cubic yards of soil were removed from beneath the former truck loading rack (near the location of the two tanks) and shipped to Rabanco's Landfill in Roosevelt, Washington. Contaminated soils were left on-site because equipment was not capable of deeper excavation, the potential threat to existing structures, and truck traffic at the site. As a result of the remaining contamination, a vapor extraction system was installed along with additional monitoring wells.

A 1,000 gallon tank was removed in 1991. About 25 yards of soil were removed in the process. At the time, "free product" (#2 Diesel) was observed on the water table. More monitoring wells were constructed.

No monitoring information for the period between 1982 and 1992 was available in the files reviewed. Additional information for this period is located in the State Archives and may need to be retrieved to understand the history of this site. However, since the 1989 tank and soil removal, additional monitoring wells have been installed. Quarterly groundwater monitoring has been gathered. Over 20 monitoring locations have been established on-site. Of these, several are showing hydrocarbons above the Model Toxics Control Act (MTCA) standards. Two wells in a recent sampling could not be sampled for groundwater because they had "free product" floating on the surface (Fax from Texaco to Callison, 12/02/94).

Texaco site remediation has resulted in some cleanup with the obvious removal of soils and product. The vapor extraction has ranged from 0.4 lb/day (March 1994 Quarterly Report) to 2.6 lbs/day (October 1993 Quarterly Report). These levels of extraction have been declining recently. However, groundwater and soil contamination continue to be documented and remain above the MTCA required cleanup levels.

Ecology's handling of the site appears to have been fairly standard. Once the cleanup activity of the first documented spill was completed in 1982, the remaining cleanup was left to the recovery system (two wells with oil/water separation). Archived information would need to be retrieved to determine the frequency of monitoring, inspection, or other oversight by Ecology.

Under MTCA, Ecology developed a site ranking system to help with priority setting. The Texaco Bulk Plant facility has been ranked twice by Ecology. The first ranking was in 1991 and resulted in a ranking of 3 (1 is the highest priority and 5 is the lowest concern). This was done with little consideration of groundwater contamination and, in particular, the City's drinking water supply.

The site has recently (with the City's prompting) been re-ranked by Ecology to a 2 priority because of further consideration of the City's groundwater concerns.

Recent correspondence between Ecology and Texaco indicates:

- Ecology believes further, and more aggressive, cleanup activity should occur on the site (Ecology response to the July 1993 Quarterly Report - November 3, 1993).
- Texaco installed a product recovery device in Well No. 16B. They also installed additional groundwater monitoring wells, a sparge point (bubbling air through groundwater and extraction of resulting vapors), and conducted a sparge test. The sparge test was intended to help in design of a groundwater treatment system (Quarterly Report Cover Letter - March 11, 1994).
- Texaco continues to monitor and report with apparently no specific plans or schedule for overall site remediation.

As of monitoring conducted in April 1995, the vapor extraction system was repaired after a period of failure and free product recovery returned to a quarterly manual effort because of failure of an automatic passive device in Well No. 16B.

As of monitoring conducted in May of 1996, the vapor extraction system and air induction systems (sparge point) were not operational because of equipment failure.

To more fully evaluate this site and its threat to the City's water supply, the City requested consultant services to:

- Obtain and review Ecology files on the site.
- Develop a strategy for complete assessment of the site and action plan development.
- Meet with Texaco representatives and negotiate options for future action.
- Draft approaches for consideration.
- Obtain monitoring agreements with Texaco including preparation of a "Health and Safety Plan."
- Ongoing review of quarterly reports on cleanup progress and water quality monitoring.

Some materials developed during this effort are included as Appendix E.

Additional consultant services are pending and relate to results of an investigation of vertical contamination extent and a proposal by Texaco for expansion of these storage facilities.

3.4.2 Hazardous Materials (Use and Storage)

Commercial use of chemicals can present a significant risk to groundwater. The two major pathways for release of chemicals are accidental spills or improper disposal. Accidental releases or spills can happen at any time. Proper on-site waste management, spill prevention measures, and spill response preparedness can reduce some risk.

Improper disposal is the most common pathway for chemicals to be released into the environment. Most waste materials considered hazardous are regulated, with the exception of "small quantities" related to household uses. For the regulated materials, disposal decisions must be documented and reported, and the disposal facility must be licensed. For small quantities of regulated hazardous materials, and for materials not regulated, improper/illegal disposal can occur virtually anywhere and cause problems.

The land use survey conducted by the City identified a number of businesses that store and handle hazardous materials such as fuels, chemicals, solvents, and other miscellaneous wastes. Most of the chemical and waste storage and handling are associated with the commercial corridor along Capitol Boulevard and Trosper Road.

The riskiest waste handling practices are related to solvent use and storage. Solvents are both miscible and immiscible in water and can migrate over long distances, depending on the characteristics of the aquifer. A very large plume of contamination can be created with a very small quantity of solvent.

3.4.3 On-Site Septic Systems

Sewage in the City's WHPAs is handled either by on-site septic systems or by the sewer system operated by the LOTT partnership (Lacey-Olympia-Tumwater-Thurston County). Inventoried parcels that utilize septic systems in the City's WHPAs and capture zones are shown on Exhibit 3-3. On-site septic systems can pose a risk to a groundwater source where relatively high densities of residential systems occur and where hazardous wastes are discharged to septic systems. Potential contaminants from septic systems include nitrogen compounds, toxic substances, and pathogenic microorganisms.

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 or ammonia 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 infants at higher concentrations.

Ammonia and nitrate are highly soluble in water and can be expected in detectable quantities wherever portions of an aquifer are affected by septic system discharges. Septic systems are a source of nitrogen in groundwater throughout Thurston County. Typical nitrate concentrations in the Qvr and Qva aquifers, and locally the Qc aquifer, are in the range of 1 to 3 mg/L. These concentrations are indicative of impact by human activity and are expected to increase gradually in the future. The drinking water MCL for nitrate is 10 mg/L as nitrogen.

In addition to on-site septic systems, potential nitrate sources include livestock keeping operations, fertilizer applications to lawns, golf courses, parks and timber growing sites. Of these, septic systems may be the most important potential source of nitrate contamination to the City's drinking water supplies.

Household hazardous chemicals can also be transported to groundwater via a septic system. Cleaners, polishes, waxes, paints, and thinners are the primary materials of concern. Some of these products contain toxic and persistent chemicals, which can cause low level contamination in an area with a high density of septic systems. Homeowners often improperly apply or dispose of chemicals because they are unaware of the impact this may have on groundwater quality.

In some areas, business and commercial facilities still utilize on-site septic systems for sewage disposal. Routine use and disposal of chemicals can lead to serious problems. Business, commercial, and industrial operations that rely on septic systems need to take special precautions to avoid contamination of their wastewater.

Septic wastes can contribute pathogenic bacteria and parasites to groundwater. The extent to which pathogens are transported away from a septic drainfield depends on the type of pathogen, subsurface chemical, and physical conditions. In general, proper siting, construction, and maintenance of a septic system will limit the transport of microorganism away from a septic drainfield.

3.4.4 Underground Storage Tanks

Underground Storage Tanks (USTs) usually contain flammable motor fuels or heating oils, but may contain other compounds used by industry, government, or business. A comprehensive inventory of USTs for the City is shown on Exhibit 3-5. The April 1996 listing was obtained from Ecology and identifies each UST by site, address, installation date, status, tank material, and substance stored. Of the 102 underground storage tanks listed, 57 have been removed, five are in the process of closure, three are closed in place, and 29 are reported to be operational. Gasoline is the primary substance being stored.

Contamination of soil and groundwater by leaks from USTs and associated piping has been and continues to be a prevalent environmental, legal, and regulatory issue. The EPA (1991) estimated that 35 percent of all USTs could be leaking. The most common cause of leaks is structural failure, corrosion, improper fittings, improper installation, and natural phenomena.

Leakage from USTs and associated piping often occurs without detection. Even relatively small amounts of certain compounds can have serious adverse impacts on groundwater quality. For instance, one gallon of gasoline can render a million gallons of groundwater unpotable for as long as several decades. A 1/4-inch hole in an underground storage tank can release up to 930 gallons of gasoline in a single day. Once released from an UST, some volatile organic compounds and petroleum products can rapidly migrate through the soil to groundwater. This problem is especially serious in areas with permeable soils such as sand and gravel.

Table 3-5 presents a list of leaking underground storage tanks (LUSTs) located in the focus area. Most of these have since been brought into regulatory compliance or are being addressed. Three of the listed LUSTs are within the one-year capture zone, two LUSTs are within the five-year capture zone, and another one is in the WHPA of the Palermo Wellfield. Two additional LUSTs are located in the Bush Middle School/Port/Trails End WHPA between the five-year capture zones of the Bush Middle School Wellfield and the Port Wells. Two LUSTs are located at the Continental Baking Company and the Washington State Department of Transportation testing laboratory (WDOT). The WDOT facility on Second Avenue is on the boundary line between the one- and five-year capture zones of the Palermo Wellfield.

Of the many materials stored in USTs, solvents are considered the most toxic and the most persistent. However, petroleum products may pose a greater risk because of the large number of tanks containing such products. In addition, petroleum products contain many potential pollutants, including three EPA priority pollutants: benzene, toluene, and ethylbenzene. Benzene is a known human carcinogen. Petroleum products are biodegradable. Waste oil tanks may contain a mixture of solvents and petroleum products and therefore may be a source of multiple types of contaminants.

Table 3-5
Registered Leaking Underground Storage Tanks Listing

Map Key	Site Name	Contaminant Conditions
L1	Drews Mobile 110 Trosper Road	Broken waste oil tank and dry well are suspected sources. No analyses for VOX[a]. Existed for 25 years.
L2	Texaco 157-060 5200 Capitol Blvd.	Diesel, below MTCA[a] - defined cleanup levels in soils.
L3	Deschutes Animal Clinic 7248 Capitol Blvd.	Heating oil tank, properly closed.
L4	Chevron 60090956 670 Trosper Road	BETX[a], and TPH[a] below cleanup levels. 15-80 ppb TCE[a] in groundwater, flow to north-northeast..
L5	Tumwater Lumber Co. 8277 Center Street SW	Independent cleanup in April 1993. 75 yd^3 of diesel contaminated soil stock-piled on site. No Ecology review..
L6	Merchant's Moving 5880 Linderson Way	Properly closed.
L7	Black Lake Grocery 4409 Black Lake Road	Gasoline released to soil and groundwater. Cleanup in progress.
L8	Vortac at Olympia Olympia Airport	Gasoline released from LUST, which are now removed. Dec. 21, 1993 update Olympia Mun. Airport final cleanup.
L9	Villa Grove Foodliner 9200 Littlerock Road SW	Site is closed.
L10	Airport Fuel Stop 82nd and Center	No files available. On east side of L5 still operating December 1993.
L11	Former Gull 256 5101 Capitol Blvd.	Has been properly closed.
L12	NW Deli Mart 6131 Capitol Blvd.	Repeated leakage from dispenser pumps reported due to faulty machinery.
L13	Central Reddi-Mix 3150 29th Street SW	Leaking gasoline and diesel tanks. Properly closed.
L14	Tumwater Old City Hall 215 Second Avenue	BTEX and TPH in groundwater. Tanks were properly closed out.
L15	Exxon 7-7134 501 Trosper Road	Free product gasoline, and 0.9-2.1 ppb TCA[a] in 4 of 8 monitoring wells. Groundwater gradient = 0.01 to east.
L16	Continental Baking Co. 6301 Capitol Blvd.	Petroleum product in soil, underground storage tank closure.
L17	WDOT Facility	Low concentration of TCE in soil sample (<7 ppb). UST liquid has TCE, PCE, C-DCE, and T-DCE. Potential source of chlorinated hydrocarbons.

There are many potential sources for petroleum hydrocarbons within the City's WHPAs. These include the presence of gasoline stations, industrial and commercial operations which fuel and maintain equipment and vehicles, as well as home and commercial heating oil tanks. Petroleum hydrocarbons are typically stored in underground storage tanks in volumes ranging from 300 gallons (residential use) up to 10,000 gallons per tank (gasoline service stations). Larger storage volume requirements, greater than 10,000 gallons, are typically stored in aboveground storage tanks.

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 found in gasoline, are typically more soluble than longer chain hydrocarbons found in diesel fuel and heating oil. Because these materials are not highly soluble, they rarely migrate very far from the source of the spill. The greatest potential threat to a wellhead could be from petroleum hydrocarbon sources very close to the wellhead or from large releases of petroleum hydrocarbons. Petroleum hydrocarbon releases are more of a threat at sites where other types of solvent have also been spilled. Together, these materials could act as co-solvents and potentially result in the contamination of a single wellhead or an entire wellfield.

3.4.5 Olympic Pipeline

Although not listed by Ecology, the Olympic Pipeline is another potential contaminant source. More than four billion gallons of refined petroleum products are transported annually through the Olympic Pipeline. Over 400 miles long, the Olympic Pipeline links oil refineries in Skagit and Whatcom Counties with terminals in Vancouver, Washington, and Portland, Oregon. Buried at a depth of only three feet, the 14-inch "finished product" pipeline carries all grades of gasoline, diesel fuel, jet fuel, and other oil-based products manufactured by British Petroleum, Arco, and Texaco. Branch lines off the main pipeline transport this array of petroleum product to Sea-Tac International Airport, Seattle, Renton, Tacoma, and Tumwater's Texaco Bulk Plant facility adjacent to and west of the City's Port Well Nos. 9, 10, and 15. Olympic Pipeline's branch line to the Tumwater Texaco Bulk Plant traverses portions of the one-, five-, and ten-year time-of-travel capture zones of the City's Bush Middle School/Port/Trails End WHPA.

3.4.6 Transportation Spills

Vehicles transporting hazardous material can be a source of groundwater contamination through accidents and resultant chemical spills. Hazardous materials are transported through the Tumwater area on a daily basis. The major arterials in the Palermo WHPA are Interstate 5, Capitol Boulevard, Trosper Road, and Littlerock Road. A major spill on Interstate 5 near the Trosper Road Exit could adversely impact groundwater that potentially recharges the Qal aquifer for the entire Palermo Wellfield (Well Nos. 1-6, and 8). The major arterials within the Bush Middle School/Port/Trails End WHPA are Old Highway 99, Israel Road, Airdustrial Way, 88th and 93rd Avenues.

3.4.7 Stormwater Runoff

Much of the stormwater runoff is discharged to the subsurface through dry wells, infiltration basins, and infiltration through ditches, lawns, and other vegetated areas. Stormwater can dissolve many pollutants and serve as a carrier for other compounds which may not be soluble. As a result, stormwater runoff from highways and roads can introduce contaminants such as heavy metals and organic compounds into the groundwater system. Stormwater runoff from lawns and agricultural areas can introduce nitrate, herbicides, pesticides, and bacterial contaminants into the groundwater system.

A 1989 study conducted by the Thurston County Environmental Health Division for the Cities of Olympia and Lacey characterized stormwater at seven Olympia and Lacey storm sewer systems that discharge to Woodland and Woodard Creeks. Both stormwater and sediments were sampled during November and December, 1988. Because all sampling was conducted during the winter, it was not possible to draw conclusions regarding seasonal variations of local runoff. However, nitrate, ammonia phosphate pesticide, and herbicide use are higher in summer and may be higher in runoff during the summer.

Twenty-nine organic contaminants and seven toxic metals were detected in sediments. Twenty-nine organic contaminants were also detected in stormwater, although at an order of magnitude lower than sediment concentrations and mostly near the detection limits for the parameters. Commercial land uses were seen as contributing to higher relative concentrations of polynuclear aromatic hydrocarbons, compounds typically associated with fossil fuel combustion. Conventional parameters measured in stormwater at the outfalls were within the ranges detected in urban stormwater in Bellevue by the US Geological Survey between 1979 and 1982 (Ebbert, Poole, and Payne, 1985). The median fecal coliform concentration was 2,500 organisms/100 mL, which was well above receiving water quality standards of 50 organisms/100 mL. Nitrate-nitrogen concentrations measured in one storm event were relatively low at levels between 0.013 and 0.2 mg/L.

Water quality impacts are of particular concern in commercial and high density residential development areas where large runoff volumes can occur. Impervious surfaces in the commercial areas of the City's WHPAs contribute substantial amounts of runoff. Another area of potential future runoff is future residential development. The impacts of stormwater infiltration in the City's wellhead capture zones are largely a long-term contaminant loading problem, unless a major contaminant spill were to occur.

3.4.8 Agriculture/Hobby Farming, Golf Courses, Parks, and Landscaping

Agricultural activity, golf courses, parks, forestry, homeowner landscaping, and other similar land uses can provide a source of nitrogen, in the form of fertilizers and livestock manure, as well as pesticides and herbicides (such as EDB, DBCP, and dicamba) to the groundwater. Whether agriculture, golf courses, and parks are a significant land use concern in the City's WHPAs and capture zones is not known.

Comprehensive agricultural data is not available for the City's WHPAs. The Thurston Conservation District (TCD) has conducted livestock inventories in the Allison Springs and East Olympia WHPAs. TCD estimated that as much as 900 kg of manure-derived nitrogen may be generated in the Allison Springs WHPA each year (personal communication Konovsky, 1996). Assuming all this nitrogen impacts groundwater, and given a recharge rate of 25 inches per year over the entire Allison Springs WHPA, the "average" large-scale nitrate loading would be 0.13 mg/L. This conservatively large estimate suggests that livestock manure in the Allison Springs WHPA is not a significant source of nitrogen. Livestock activity in Tumwater's WHPAs and capture zones should, however, be identified and evaluated, but is not believed to be greater than the Allison Springs WHPA.

Another source of nitrogen is golf courses. Wells can be vulnerable to contamination from golf course activities if turf chemicals leach into the groundwater system. Whether the City of Tumwater Valley Golf Course (immediately adjacent to the Palermo wellheads), the Olympic Memorial Gardens/Union Cemeteries on Littlerock Road (within the five-year capture zone of the Palermo Wellfield), and other similar agricultural/park/forestry land use activities are potential sources of contamination to the City's drinking water supplies is unknown.

The transport of herbicides/pesticides to the groundwater system is complex given the variability in local soil conditions and chemical transformations that can occur after application to turf. An example of a vulnerable nature of the groundwater system in the East Olympia area is demonstrated by the detection of the herbicide dicamba in a community supply well located in the central part of the Capitol City golf course. Dicamba is an herbicide used for control of broad leaf weeds. The source of the dicamba in the well water is unknown, although potential source areas include dicamba applied to golf course turf or domestic lawns near the well. Other potential sources include leaks or spills from containers that store dicamba, or discharge from septic drainfields in which improper disposal of dicamba has occurred.

Pesticides are typically used along transportation corridors, in residential areas, 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.

The term "pesticide" is used to describe a suite of related products, including insecticides, herbicides, and fungicides. Available pesticides include 19 varieties restricted to permitted uses by the Washington State Department of Agriculture and a variety of commercially available products. When applied as specified by the manufacturer, pesticides are relatively immobile because they are consumed by pests or become absorbed by 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 found on the typical household or business premises.

Herbicides may be used in small hobby farms and 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 the Washington State University Extension Service.

State and local governments are responsible for maintaining roads within the City's WHPAs. Herbicides are used primarily to keep highway shoulders free from unwanted plant growth. Oust, Escort, Round-Up, Diuron, and Garlon 3A are typical products used on gravel along highway shoulders. Herbicides on transportation corridors are applied annually or more frequently as needed to maintain highway shoulders.

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

The presence and application of multiple sources of pesticides in the City's WHPAs results in the potential for additive loading to the groundwater system. This can lead to a progressive decline in water quality.

3.4.10 Wells (Poor Construction or Improper Abandonment)

Well casings can provide a conduit between the ground surface and the underlying aquifer(s). Improperly constructed or abandoned wells pose several potential problems.

In situations where the well has no surface seal, contaminants introduced near the wellhead can move vertically behind the casing and be transported to an underlying aquifer. Many older wells constructed prior to Washington State's stringent construction standards (WAC 173-160) have no surface seal to act as a barrier to flow.

Unused wells that have not been properly abandoned are in many cases left uncapped. These pose a special risk in that contaminants can be introduced directly into the aquifer. Wells that are no longer in service can also pose a risk when they are damaged during site re-development. Any of these situations can provide a conduit for contaminants to enter groundwater.

According to the GWMP, there are between 4,000 and 6,000 wells in the County. The number and location of these wells have not been inventoried, so some of these wells likely have been abandoned without proper decommissioning. Some of the 66 active or inactive wells identified during the inventory work for this study may also be poorly constructed or improperly abandoned. Decommissioning generally consists of backfilling the well with low permeability grout materials and must be done by a licensed driller (WAC 173-160).

Exhibit 3-2 pinpoints two abandoned wells within the five-year time-of-travel capture zone of the Bush Middle School Wellfield. It is likely that other abandoned wells exist within the City's WHPAs. The identification, location, and condition of additional wells within the City's WHPAs should be a priority in updating the City's existing land use activity/parcel and contaminant source inventory database. The City should ensure that these wells are properly abandoned.

3.5 Summary and Recommendations

The City's initial land use activity/parcel inventory process for identifying known and potential sources of contamination within the City's WHPAs needs to be expanded upon and improved. A good start has been made during the development of this WHPP. Specific recommendations for enhancing Tumwater's contaminant source identification and assessment efforts are presented below.

***Recommendation 3-1:* Update the parcel and contaminant source inventory for wellhead protection areas every two years, using the help of community volunteers for a portion of the effort.**

The Department of Health (DOH) guidance requires that land use practices and potential contaminant sources within each of the City's designated WHPAs be inventoried, evaluated, and updated at least every two years. Given the dynamics of land development activities and changes in hazardous materials practices that occur in an urban environment, the City should make this a top priority action item.

An initial wellhead protection field survey of residences and commercial businesses within the City's delineated one-year and five-year time-of-travel wellhead zones was undertaken by the City during the preparation of this WHPP. The development of separate residential and commercial survey forms as well as the implementation of the parcel inventory were carried out as a collaborative process by the Cities of Tumwater and Olympia with the assistance and support of the Thurston County Health Department.

This initial parcel and contaminant source inventory survey effort needs to be expanded, institutionalized, and made more comprehensive. Each of the City's WHPAs and capture zones need to be inventoried, mapped, and evaluated to determine the specific location and level of risks associated with potential contaminants being used, handled, and stored on a parcel-by-parcel and zone-by-zone basis. Ecology's list of confirmed and suspected contaminated sites is in the process of being available on-line. The updated inventory should be used for contacting landowners and hazardous materials users to assure the application of pollution prevention strategies and best management practices.

A thorough review and evaluation of existing City and County land use databases and hazardous materials information should provide much of the baseline information on which to build a comprehensive parcel and potential contaminant source inventory. This information should be routinely shared and effectively used by each of the stakeholders.

For internal coordination and modeling purposes, this ongoing wellhead protection activity could also serve as a working partnership between and team building program for the City's Public Works Department (contingency planning and water quality assurance), the Tumwater Development Services Department (land use review and building permit issuance), the Tumwater Fire Department (fire prevention and spill response planning), the Thurston County Permit Assistance Center (land use review and building permit issuance), and the Thurston County Health Department (environmental health planning and risk assessment).

The City's initial parcel and contaminant source inventory findings should be shared with the Cities of Lacey and Olympia and the Thurston County Ground Water Policy Advisory Committee (GWPAC). The potential development, maintenance, and updating of a regional wellhead protection parcel and contaminant source inventory database and mapping system should be explored by the GWPAC in consultation with the Cities of Tumwater, Lacey, Olympia, and Thurston County.

Recommendation 3-2: **Increase the availability of hazardous materials technical assistance and audits to small business, private industry, and government agencies within designated WHPAs.**

This recommendation is intended to supplement existing programs that do not reach all hazardous materials operations of concern. This would include those operations that use hazardous materials but are exempt from State or local regulation because they do not generate hazardous wastes, those operations that store or use significant quantities of hazardous materials but fall below the thresholds established by the Uniform Fire Code or State regulations, and those operations that are regulated but may be inspected infrequently. The effort should be designed to coordinate and integrate these supplemental activities with existing programs as well as fill a variety of major gaps and overlaps between existing programs.

The first step for the City would be to review current State and local hazardous materials inspection lists to identify all potential users of hazardous materials within each delineated wellhead zone. A second step would be to assess existing gaps within, and overlaps between, technical assistance/inspections carried out by the Tumwater Fire Department, the Thurston County Health Department, Ecology, and other technical assistance/regulatory agencies. A third step would be to develop and implement an action plan that will fill existing technical assistance/inspection gaps, coordinate State and local regulatory inspection schedules and findings, and assure best management practices by hazardous materials handlers and users within the City's WHPAs.

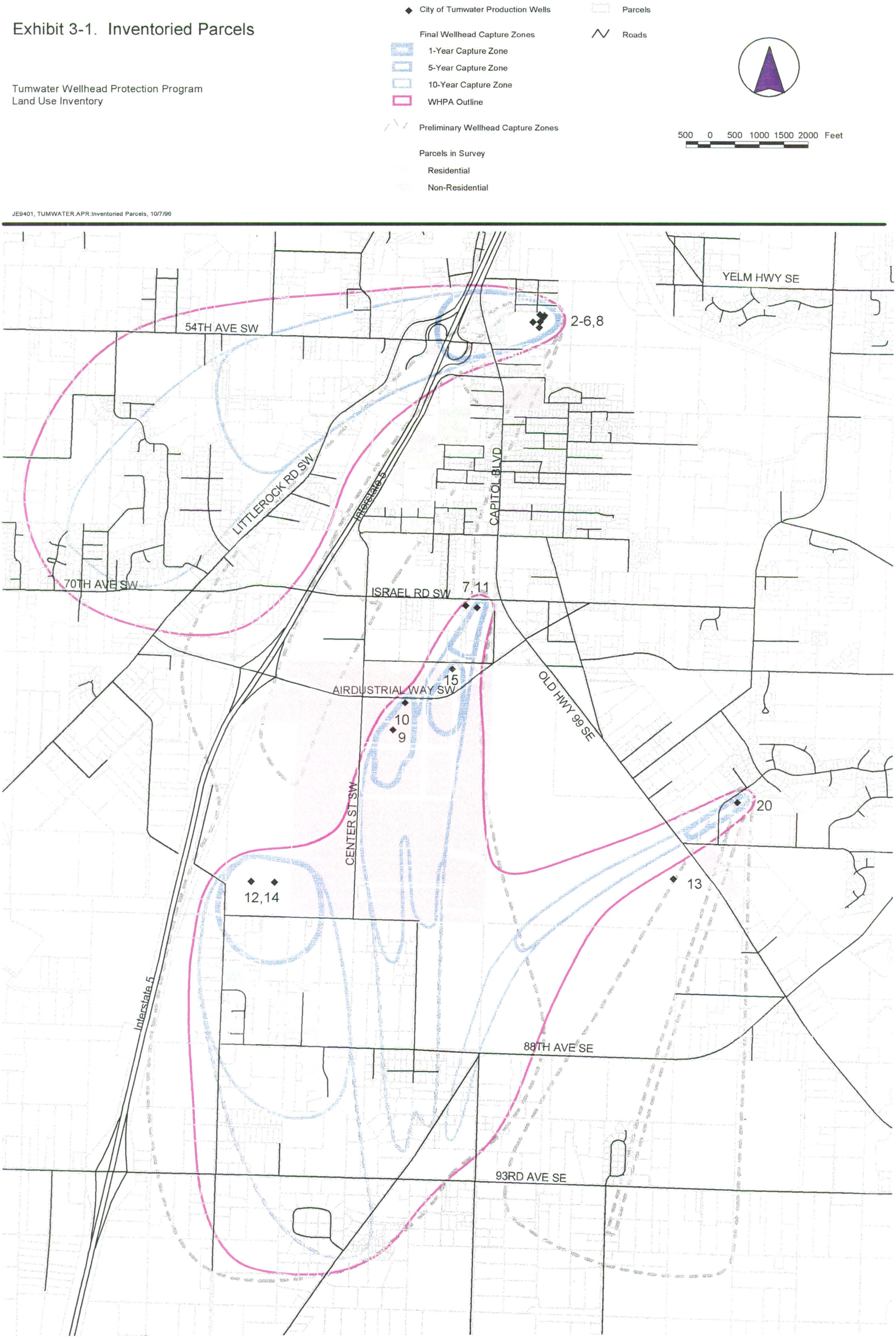
Ideally, the action plan would be presented to and supported by each of the jurisdictions involved. The Cities of Tumwater, Lacey, Olympia, and Thurston County should place a value on the need for this program by funding these wellhead protection activities on a water utility connection assessment or cost-of-service fee basis. However, Tumwater could pursue this program independently and provide the leadership to establish and maintain such an effort.

Recommendation 3-3: **Request the Thurston Conservation District to inventory and assess existing agriculture/hobby farming, golf course, and park land use activities within the City's WHPAs and focus its farm and land management technical assistance programs accordingly.**

Potential sources of contamination posed by existing agriculture/hobby farming, golf course, parks, forestry, and other similar land use activities within the City's WHPAs and capture zones have not been quantified. The City should request that the TCD prepare a comprehensive inventory and assessment of the presence and practices of these land uses within the City's WHPAs. The goal of this inventory and assessment process would be to determine the need and specific-site requirements for TCD farm and land management technical assistance services to protect the City's groundwater sources.

Exhibit 3-1. Inventoried Parcels

Tumwater Wellhead Protection Program
Land Use Inventory



JE9401, TUMWATER.APR:Inventoried Parcels, 10/7/96

Exhibit 3-2. Underground Storage Tanks

Tumwater Wellhead Protection Program
Land Use Inventory

◆ City of Tumwater Production Wells

Parcels with Underground Storage Tanks

- In use
- Abandoned
- Don't know

Final Wellhead Capture Zones

- 1-Year Capture Zone
- 5-Year Capture Zone
- 10-Year Capture Zone
- WHPA Outline

Preliminary Wellhead Capture Zones

Parcels

Roads

500 0 500 1000 1500 2000 Feet

JE9401, TUMWATER.APR:Underground Storage Tanks, 10/7/96

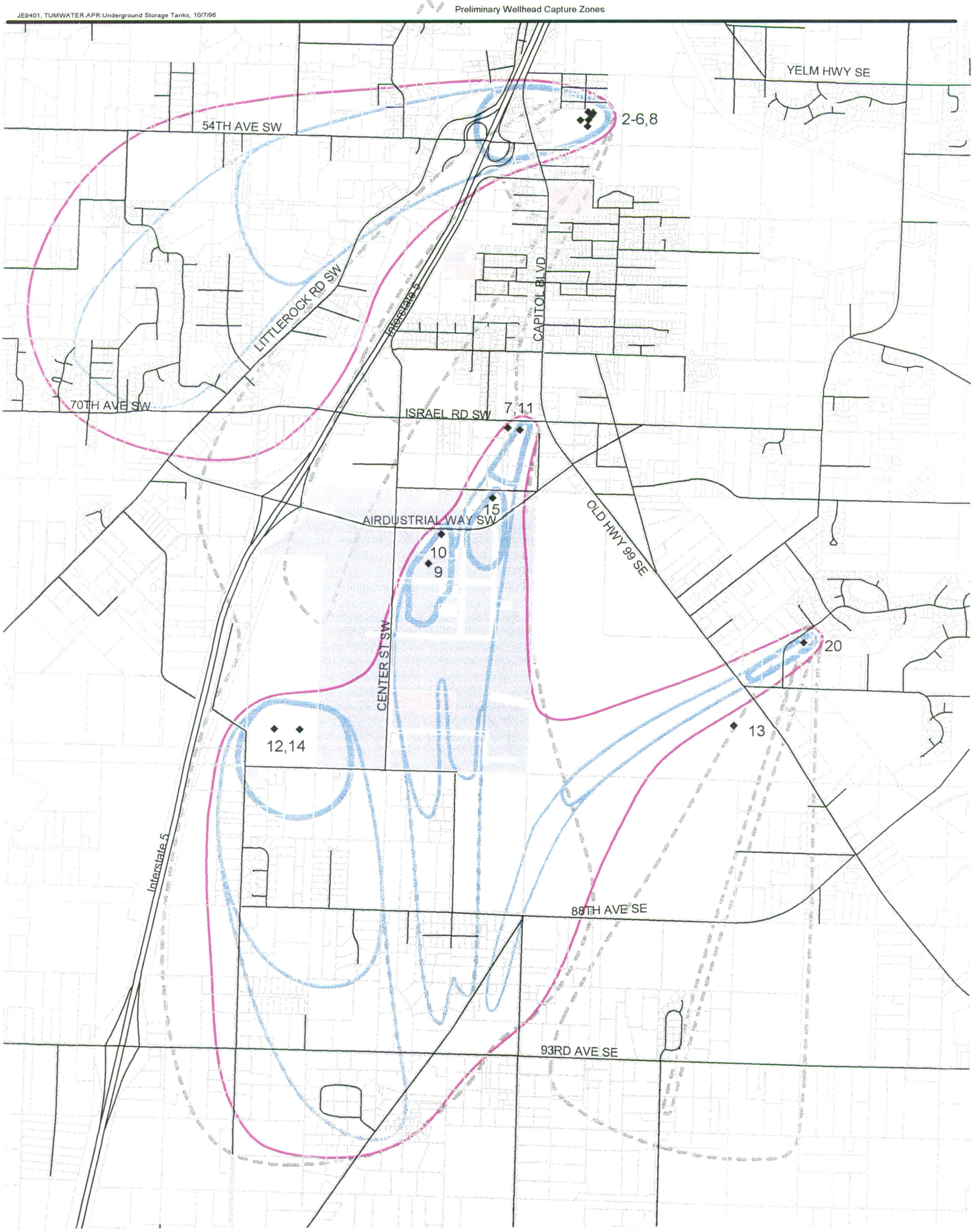


Exhibit 3-3. On Site Septic Systems and Wells

Tumwater Wellhead Protection Program
Land Use Inventory

◆ City of Tumwater Production Wells

Parcels with Wells On Site
- Well - Active
- Well - Abandoned

Parcels with Septic Systems On Site

Final Wellhead Capture Zones
- 1-Year Capture Zone
- 5-Year Capture Zone
- 10-Year Capture Zone
- WHPA Outline

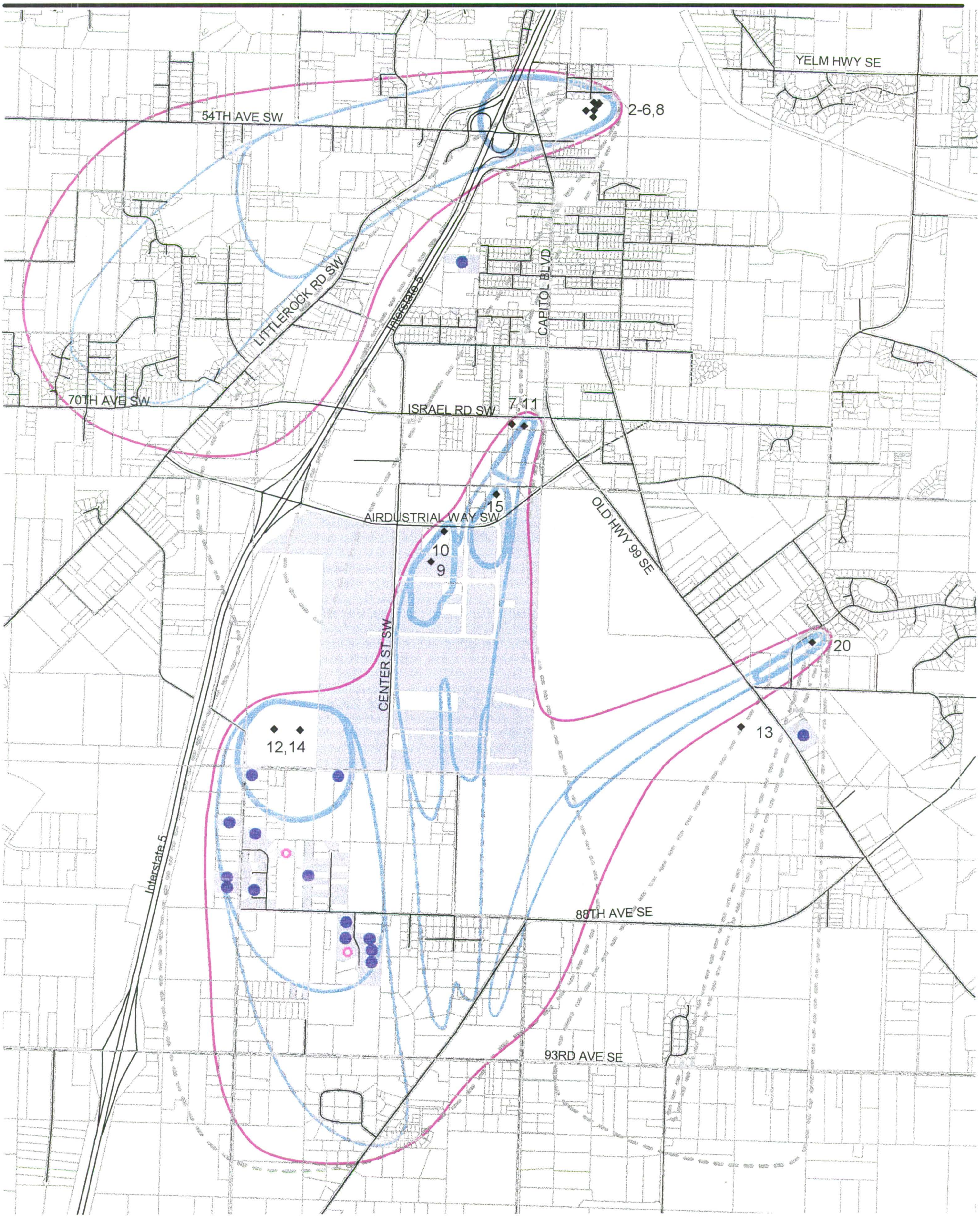
Preliminary Wellhead Capture Zones

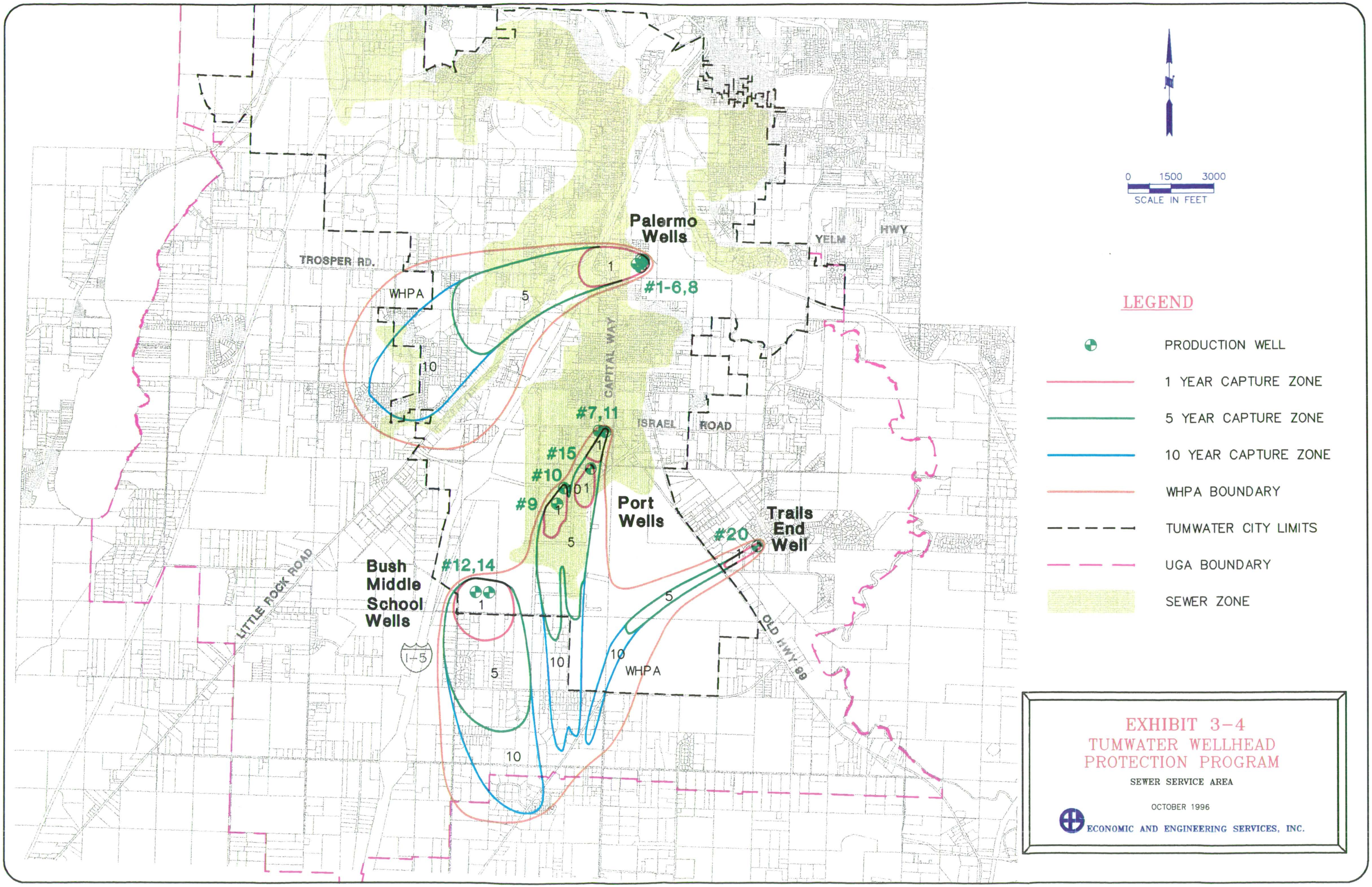
Parcels

Roads

500 0 500 1000 1500 2000 Feet

JE9401, TUMWATER.APR:On Site Septic Systems, 10/7/96





M: \TUMWATER\P44650\EXHIBITS\TUM3-4EX.DWG
PLOT DATE: 10/07/96 TIME: 08:38

Exhibit 3-5
Underground Storage Tank Listing for Tumwater
April 1996

Site	Address	Tank ID	Install Date	Status	Material	Substance
CITY OF TUMWATER	7200 NEW MARKET ST	DIESEL	5/14/87 0:00	Operational	Coated Steel	
ABANDONED FORMER SHELL CO OPERATION	SE CORNER PSH 1 & LATHROP R	1	12/31/64 0:00	Closed in Place		
ABANDONED FORMER SHELL CO OPERATION	SE CORNER PSH 1 & LATHROP R	2	12/31/64 0:00	Closed in Place		
ABANDONED FORMER SHELL CO OPERATION	SE CORNER PSH 1 & LATHROP R	3	12/31/64 0:00	Closed in Place		
TUMWATER SCHOOL DISTRICT 33	600 W ISRAEL RD	1	8/10/70 0:00	Operational	Steel-Unprotected	
VALLEY RENTALS - TUMWATER	6070 LINDERSON WAY	1	2/15/90 0:00	Operational	Steel-Unprotected	
VALLEY RENTALS - TUMWATER	6070 LINDERSON WAY	1	2/15/90 0:00	Operational	Steel-Unprotected	
TEXACO REFINING AND MARKETING	5200 CAPITOL BLVD	4	1/1/88 0:00	Operational	Fiberglass Reinforced Plastic	
ABANDONED FORMER SHELL CO OPERATION	SE CORNER PSH 1 & LATHROP R	4	12/31/64 0:00	Closed in Place		
ABANDONED FORMER SHELL CO OPERATION	SE CORNER PSH 1 & LATHROP R	5	12/31/64 0:00	Closed in Place		
MEIER & MEIER DEVELOPMENT	2775-29 SW	1	12/31/64 0:00	Removed		LEADED GASOLINE
MEIER & MEIER DEVELOPMENT	2775-29 SW	2	12/31/64 0:00	Removed		UNLEADED GASOLINE
CALVARY CEMETERY	3850 CLEVELAND AVE SE	1	12/31/64 0:00	EXEMPT		HEATING FUEL
CALVARY CEMETERY	3850 CLEVELAND AVE SE	2	12/31/64 0:00	OPERATIONAL		UNLEADED GASOLINE
TUMWATER US ARMY RES CENTER	921 S 4TH STREET	1	12/31/64 0:00	Exempt	Steel-Unprotected	HEATING FUEL
TUMWATER SCHOOL DISTRICT 33	600 W ISRAEL RD	4	8/10/68 0:00	Removed	Steel-Unprotected	AVIATION FUEL
CITY OF TUMWATER	7200 NEW MARKET ST	GASOLINE	5/14/87 0:00	Operational	Coated Steel	UNLEADED GASOLINE
NORTHWEST DELI MART #10	6131 CAPITOL BLVD	3-R	12/1/81 0:00	Operational	Steel-Unprotected	LEADED GASOLINE
TUMWATER SCHOOL DISTRICT 33	600 W ISRAEL RD	2	8/10/68 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
TUMWATER SCHOOL DISTRICT 33	600 W ISRAEL RD	3	8/10/68 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
TUMWATER SCHOOL DISTRICT 33	600 W ISRAEL RD	5	12/31/64 0:00	REMOVED		USED OIL/WASTE OIL
NORTHWEST DELI MART #10	6131 CAPITOL BLVD	1-P	12/1/81 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
NORTHWEST DELI MART #10	6131 CAPITOL BLVD	2-N	12/1/81 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
PACIFIC COCA-COLA BOTTLING COMPANY	500 SIMMONS LANE	1	12/31/64 0:00	Removed	Steel-Unprotected	LEADED GASOLINE
TEXACO REFINING AND MARKETING	5200 CAPITOL BLVD	5	12/31/64 0:00	Removed	Fiberglass Reinforced Plastic	HEATING FUEL
TEXACO REFINING AND MARKETING	5200 CAPITOL BLVD	1	1/1/88 0:00	Operational	Fiberglass Reinforced Plastic	LEADED GASOLINE
TEXACO REFINING AND MARKETING	5200 CAPITOL BLVD	2	1/1/88 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
TEXACO REFINING AND MARKETING	5200 CAPITOL BLVD	3	1/1/88 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
CITY OF TUMWATER	7200 NEW MARKET ST	WASTE OIL	5/14/87 0:00	Operational	Coated Steel	USED OIL/WASTE OIL
TEXACO REFINING AND MARKETING	5200 CAPITOL BLVD	6	1/1/88 0:00	CLOSED IN PLACE	Fiberglass Reinforced Plastic	USED OIL/WASTE OIL
RUNWAY II TEXACO	7219 OLD HWY 99 SE	UL1	7/18/94 0:00	Operational	Coated Steel	UNLEADED GASOLINE
RUNWAY II TEXACO	7219 OLD HWY 99 SE	PPL2	7/18/94 0:00	Operational	Coated Steel	UNLEADED GASOLINE
RUNWAY II TEXACO	7219 OLD HWY 99 SE	PPR3	7/18/94 0:00	Operational	Coated Steel	UNLEADED GASOLINE
7-ELEVEN FOOD STORE #2303-14479	5310 CAPITOL BLVD	NOL	9/1/72 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
7-ELEVEN FOOD STORE #2303-14479	5310 CAPITOL BLVD	REG	5/1/79 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
7-ELEVEN FOOD STORE #2303-14479	5310 CAPITOL BLVD	SNL	9/1/72 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
DAPAUL INC.	P.O. BOX 4094 8200 KIMMIE RD.	#1	12/31/64 0:00	Removed	Steel-Unprotected	HEATING FUEL
DAPAUL INC.	P.O. BOX 4094 8200 KIMMIE RD.	#2	12/31/64 0:00	Removed	Steel-Unprotected	LEADED GASOLINE
LIBERTY #905	415 CLEVELAND	1	6/15/70 0:00	Operational	Steel-Unprotected	LEADED GASOLINE
LIBERTY #905	415 CLEVELAND	2	6/15/70 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
LIBERTY #905	415 CLEVELAND	3	6/15/70 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
STOP IN FOOD STORE	533 CUSTER WAY	3	12/30/86 0:00	Operational	Fiberglass Reinforced Plastic	LEADED GASOLINE
STOP IN FOOD STORE	533 CUSTER WAY	1	12/30/86 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
STOP IN FOOD STORE	533 CUSTER WAY	2	12/30/86 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
MASONIC MEMORIAL PARK CEMETERY	455 NORTH ST	1	12/31/64 0:00	Removed	Steel-Unprotected	LEADED GASOLINE

Exhibit 3-5 (cont)
Underground Storage Tank Listing for Tumwater
April 1996

Site	Address	Tank ID		Install Date	Status	Material	Substance
MERCHANTS MOVING & STORAGE	5880 LINDERSON WAY		1	12/31/64 0:00	Exempt	Steel-Unprotected	
MERCHANTS MOVING & STORAGE	5880 LINDERSON WAY		2	12/31/64 0:00	Removed	Steel-Unprotected	LEADED GASOLINE
JACK N THE BOX (DREWS MOBIL)	110 TROSPER RD		3	12/31/64 0:00	Closure in Process	Steel-Unprotected	
JACK N THE BOX (DREWS MOBIL)	110 TROSPER RD		2	12/31/64 0:00	Closure in Process	Steel-Unprotected	UNLEADED GASOLINE
JACK N THE BOX (DREWS MOBIL)	110 TROSPER RD		1	12/31/64 0:00	Closure in Process	Steel-Unprotected	LEADED GASOLINE
FORMER GULL 256	5101 CAPITOL BLVD		6	12/31/64 0:00	Removed	Steel-Unprotected	
FORMER GULL 256	5101 CAPITOL BLVD		2	12/31/64 0:00	Removed	Steel-Unprotected	LEADED GASOLINE
FORMER GULL 256	5101 CAPITOL BLVD		4	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
FORMER GULL 256	5101 CAPITOL BLVD		24	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
POAGE'S AUTOMOTIVE & TOWING INC.	5403 CAPITAL BLVD		2	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
POAGE'S AUTOMOTIVE & TOWING INC.	5403 CAPITAL BLVD		1	12/31/64 0:00	Removed	Steel-Unprotected	USED OIL/WASTE OIL
BLACK HILLS DISTRIBUTING/CLOSED	6080 LINDERSON WAY		1	12/31/64 0:00	Unknown		LEADED GASOLINE
BLACK HILLS DISTRIBUTING/CLOSED	6080 LINDERSON WAY		2	12/31/64 0:00	Unknown		LEADED GASOLINE
TUMWATER RENTALS	6135 CAPITOL BLVD		1	12/31/64 0:00	Operational	Steel-Unprotected	LEADED GASOLINE
DESCHUTES ANIMAL CLINIC INC. P.S.	7248 CAPITOL BLVD		2	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
DESCHUTES ANIMAL CLINIC INC. P.S.	7248 CAPITOL BLVD		1	12/31/64 0:00	Closed in Place	Steel-Unprotected	UNLEADED GASOLINE
TEXACO TERMINAL	7370 LINDERSON WAY		2	12/31/64 0:00	Removed	Steel-Unprotected	
TEXACO TERMINAL	7370 LINDERSON WAY	2-10000		12/31/64 0:00	Exempt	Steel-Unprotected	
TEXACO TERMINAL	7370 LINDERSON WAY	1-4000		1/1/89 0:00	Operational	Steel Clad with Fiberglass	
TEXACO TERMINAL	7370 LINDERSON WAY		1	12/31/64 0:00	Removed	Steel-Unprotected	LEADED GASOLINE
HYTEC INC	711 AIRDUSTRIAL WAY		1	12/31/64 0:00	REMOVED		
B AND B MARKET	7706 OLD HIGHWAY 99	1-P		12/1/80 0:00	Operational	Steel-Unprotected	LEADED GASOLINE
B AND B MARKET	7706 OLD HIGHWAY 99	3-R		12/1/80 0:00	Operational	Steel-Unprotected	LEADED GASOLINE
B AND B MARKET	7706 OLD HIGHWAY 99	2-N		12/1/80 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
UNITED PARCEL SERVICE-TUMWATER	7383 NEW MARKET ST SW		1	6/1/72 0:00	REMOVED	Steel Clad with Fiberglass	UNLEADED GASOLINE
UNITED PARCEL SERVICE-TUMWATER	7383 NEW MARKET ST SW	1UNLEAD		5/26/95 0:00	Operational	Fiberglass Reinforced Plastic	Unleaded Gasoline
MODULAR BLDG. DEPT. OF PRINTING CB&G	7580 NEW MARKET ST SE		1	3/5/81 0:00	CLOSURE IN PROCESS	Steel-Unprotected	
DART CONTAINER CORPORATION	600 ISRAEL RD SE		24970	3/1/85 0:00	REMOVED		
DART CONTAINER CORPORATION	600 ISRAEL RD SE		24971	12/31/64 0:00	REMOVED		HEATING FUEL
OLYMPIC REGION HEADQUARTERS SITE	5720 CAPITOL BOULEVARD	66C02001		1/1/84 0:00	Removed	Steel-Unprotected	
OLYMPIC REGION HEADQUARTERS SITE	5720 CAPITOL BOULEVARD	66C13007		4/20/94 0:00	Operational	Fiberglass Reinforced Plastic	
OLYMPIC REGION HEADQUARTERS SITE	5720 CAPITOL BOULEVARD	66C02002		1/1/75 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
OLYMPIC REGION HEADQUARTERS SITE	5720 CAPITOL BOULEVARD	66C02003		1/1/84 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
OLYMPIC REGION HEADQUARTERS SITE	5720 CAPITOL BOULEVARD	66C04007		12/31/64 0:00	Closed in Place	Steel-Unprotected	USED OIL/WASTE OIL
OLYMPIC REGION HEADQUARTERS SITE	5720 CAPITOL BOULEVARD	66C04008		12/31/64 0:00	Closed in Place	Steel-Unprotected	USED OIL/WASTE OIL
OLYMPIC REGION HEADQUARTERS SITE	5720 CAPITOL BOULEVARD	66C13006		4/20/94 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
OLYMPIC REGION HEADQUARTERS SITE	5720 CAPITOL BOULEVARD	66C04001		12/31/64 0:00	Exempt	Steel-Unprotected	USED OIL/WASTE OIL
GREAT WESTERN SOIL	9418 OLD HWY 99 SE	2-D		1/1/70 0:00	Removed	Steel-Unprotected	
GREAT WESTERN SOIL	9418 OLD HWY 99 SE	2-D		1/1/70 0:00	Removed	Steel-Unprotected	
GREAT WESTERN SOIL	9418 OLD HWY 99 SE	3-D		1/1/70 0:00	Removed	Steel-Unprotected	
GREAT WESTERN SOIL	9418 OLD HWY 99 SE	3-D		1/1/70 0:00	Removed	Steel-Unprotected	
GREAT WESTERN SOIL	9418 OLD HWY 99 SE	1-N		1/1/70 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
GREAT WESTERN SOIL	9418 OLD HWY 99 SE	1-N		1/1/70 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
GREAT WESTERN SOIL	9418 OLD HWY 99 SE	4-W		12/31/64 0:00	Removed		USED OIL/WASTE OIL
GREAT WESTERN SOIL	9418 OLD HWY 99 SE	4-W		12/31/64 0:00	Removed		USED OIL/WASTE OIL

Exhibit 3-5 (cont)
Underground Storage Tank Listing for Tumwater
April 1996

Site	Address	Tank ID	Install Date	Status	Material	Substance
FORMER TEXACO STATION	3333 CAPITOL BLVD	1	1/1/64 0:00	Removed		LEADED GASOLINE
FORMER TEXACO STATION	3333 CAPITOL BLVD	2	1/1/64 0:00	Removed		UNLEADED GASOLINE
FORMER TEXACO STATION	3333 CAPITOL BLVD	3	1/1/64 0:00	Removed		UNLEADED GASOLINE
FORMER TEXACO STATION	3333 CAPITOL BLVD	4	1/1/64 0:00	Removed		UNLEADED GASOLINE
FORMER TEXACO STATION	3333 CAPITOL BLVD	6	1/1/64 0:00	Removed		USED OIL/WASTE OIL
FORMER TEXACO STATION	3333 CAPITOL BLVD	5	1/1/64 0:00	Removed		HAZARDOUS SUBSTANCE
CENTRAL REDDI-MIX INC	3150 29TH ST SW	1	12/31/64 0:00	REMOVED		
AIRPORT FUEL STOP	82ND & CENTER ST	1	12/1/88 0:00	Operational	Coated Steel	
OLYMPIA (MOTTMAN) MAINTENANCE SITE	MOTTMAN ROAD	66C01007	12/31/64 0:00	REMOVED		
MUTUAL MATERIALS CO - TUMWATER	3150 29TH AVE SW	2 DIESEL	12/31/64 0:00	Removed	Steel-Unprotected	
CHEVRON U.S.A. INC., CO-OP #0956	670 TROSPER RD	4	12/31/64 0:00	Removed	Steel-Unprotected	
OLYMPIA (MOTTMAN) MAINTENANCE SITE	MOTTMAN ROAD	66C12001	1/1/88 0:00	Operational	Fiberglass Reinforced Plastic	
AIRPORT FUEL STOP	82ND & CENTER ST	2	12/1/88 0:00	Operational	Coated Steel	LEADED GASOLINE
OLD CITY HALL	215 SECOND AVENUE	1	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
AIRPORT FUEL STOP	82ND & CENTER ST	3	12/1/88 0:00	Operational	Coated Steel	UNLEADED GASOLINE
OLYMPIA (MOTTMAN) MAINTENANCE SITE	MOTTMAN ROAD	66C01008	12/31/64 0:00	REMOVED		UNLEADED GASOLINE
CHEVRON U.S.A. INC., CO-OP #0956	670 TROSPER RD	2	12/31/64 0:00	Removed	Steel-Unprotected	LEADED GASOLINE
CHEVRON U.S.A. INC., CO-OP #0956	670 TROSPER RD	1	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
CHEVRON U.S.A. INC., CO-OP #0956	670 TROSPER RD	3	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
CHEVRON U.S.A. INC., CO-OP #0956	670 TROSPER RD	5	12/31/64 0:00	Removed	Steel-Unprotected	USED OIL/WASTE OIL
MUTUAL MATERIALS CO - TUMWATER	3150 29TH AVE SW	1 GAS	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
CHEVRON U.S.A. INC., CO-OP #0956	670 TROSPER RD	2-2R	2/23/89 0:00	OPERATIONAL	FIBERGLASS REINFORCED PLASTIC	LEADED GASOLINE
CHEVRON U.S.A. INC., CO-OP #0956	670 TROSPER RD	1-1R	2/23/89 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
CHEVRON U.S.A. INC., CO-OP #0956	670 TROSPER RD	3-3R	2/23/89 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
OLYMPIA (MOTTMAN) MAINTENANCE SITE	MOTTMAN ROAD	66C12002	1/1/88 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
HARRISON BUILDING SUPPLY	2780 29TH AVE SW	1	12/31/64 0:00	Removed		UNLEADED GASOLINE
ANDY JOHNSON & CO., INC.	2450 MOTTMAN RD., S.W.	4D	12/1/76 0:00	Operational	Steel-Unprotected	
LESNICK NEWS CO INC	2442 MOTTMAN RD SW	1	12/31/64 0:00	Removed	Steel-Unprotected	LEADED GASOLINE
ANDY JOHNSON & CO., INC.	2450 MOTTMAN RD., S.W.	1R	12/1/76 0:00	Operational	Steel-Unprotected	LEADED GASOLINE
ANDY JOHNSON & CO., INC.	2450 MOTTMAN RD., S.W.	2U	12/1/76 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
ANDY JOHNSON & CO., INC.	2450 MOTTMAN RD., S.W.	3U	12/1/76 0:00	Unknown	Steel-Unprotected	UNLEADED GASOLINE
CITY OF TUMWATER PUBLIC WORKS DEPT.	517 WEST BATES	4	12/31/64 0:00	Removed	Steel-Unprotected	
CITY OF TUMWATER PUBLIC WORKS DEPT.	517 WEST BATES	2	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
CITY OF TUMWATER PUBLIC WORKS DEPT.	517 WEST BATES	3	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
CITY OF TUMWATER PUBLIC WORKS DEPT.	517 WEST BATES	1	12/31/64 0:00	Removed	Steel-Unprotected	UNLEADED GASOLINE
BP 03158	501 TROSPER RD	3	1/1/88 0:00	Operational	Fiberglass Reinforced Plastic	LEADED GASOLINE
BP 03158	501 TROSPER RD	1	1/1/88 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
BP 03158	501 TROSPER RD	2	1/1/88 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE
BP 03158	501 TROSPER RD	4	1/1/88 0:00	REMOVED	Fiberglass Reinforced Plastic	USED OIL/WASTE OIL
TONY CAIRONE	2821 25TH SW	4	12/31/64 0:00	REMOVED	Steel-Unprotected	
TONY CAIRONE	2821 25TH SW	1	12/31/64 0:00	TEMPORARILY CLOSED	Steel-Unprotected	
TONY CAIRONE	2821 25TH SW	2	12/31/64 0:00	TEMPORARILY CLOSED	Steel-Unprotected	
TONY CAIRONE	2821 25TH SW	3	12/31/64 0:00	REMOVED	Steel-Unprotected	USED OIL/WASTE OIL
CONTINENTAL BAKING CO	6301 CAPITAL BLVD	1	10/1/56 0:00	Closure in Process	Steel-Unprotected	LEADED GASOLINE
LABOR & INDUSTRIES BLDG	7273 LINDERSON WAY SW	EGEN	7/15/92 0:00	Operational	Fiberglass Reinforced Plastic	DIESEL

Exhibit 3-5 (cont)
Underground Storage Tank Listing for Tumwater
April 1996

Site	Address	Tank ID	Install Date	Status	Material	Substance
ACCENT BUILDING SPECIALTIES INC.	3100 29TH AVE SW P O BOX 7638	1	12/31/64 0:00	Removed	Steel-Unprotected	LEADED GASOLINE
FORMER SHELL STATION	2440 93RD AVE SW	3	12/31/64 0:00	Removed		
FORMER SHELL STATION	2440 93RD AVE SW	2	12/31/64 0:00	Removed		LEADED GASOLINE
FORMER SHELL STATION	2440 93RD AVE SW	4	12/31/64 0:00	Removed		LEADED GASOLINE
FORMER SHELL STATION	2440 93RD AVE SW	5	12/31/64 0:00	Removed		LEADED GASOLINE
FORMER SHELL STATION	2440 93RD AVE SW	1	12/31/64 0:00	Removed		USED OIL/WASTE OIL
FRONTIER FOODS	7000 LITTLEROCK RD SW	2	8/1/84 0:00	Operational	Steel-Unprotected	LEADED GASOLINE
FRONTIER FOODS	7000 LITTLEROCK RD SW	1	8/1/84 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
FRONTIER FOODS	7000 LITTLEROCK RD SW	3	8/1/84 0:00	Operational	Steel-Unprotected	UNLEADED GASOLINE
TRANSPORTATION CENTER	3000 SW JOHNSON BLVD	4	7/28/93 0:00	Operational	Fiberglass Reinforced Plastic	
TRANSPORTATION CENTER	3000 SW JOHNSON BLVD	5	7/28/93 0:00	Operational	Fiberglass Reinforced Plastic	
TRANSPORTATION CENTER	3000 SW JOHNSON BLVD	3	7/28/93 0:00	Operational	Fiberglass Reinforced Plastic	UNLEADED GASOLINE

Section 4

Section 4
Risk Analysis

4.1 Ranking of Threats to Groundwater by Contaminant Sources

4.1.1 Introduction

Known and potential contaminated sites located in or near capture zones of City of Tumwater (City) municipal wells have been compiled, and elements contributing to the risk posed by each of these sites have been assessed. This identification, characterization, and prioritization of contaminated sites is intended for risk management purposes. The information presented in this section should provide the City with a basis for enforcement of Best Management Practices (BMPs) and development of related groundwater protection ordinances. In addition, this work provides direction to the City to assist in development of groundwater education programs. Water quality data collected through September of 1996 were integrated into this assessment. Additional groundwater quality data may be collected in the future that indicate other, more severe risks to the City's groundwater supply.

The sites included in this ranking of threats to groundwater quality were identified in a review of Washington State Department of Ecology (Ecology) listings of leaking underground storage tanks (LUSTs) (Ecology 1993a), the Confirmed and Suspected Contaminated Sites Report (CSCS) (Ecology, 1993b), and in windshield surveys conducted to fulfill the requirements of the water supply monitoring waiver forms for each wellhead (submitted by City of Tumwater to Department of Health, June 16, 1994). Further information was provided in the Environmental Protection Agency's (EPA) April 1996 Site Investigation Report for the Palermo Wellfield and from water quality monitoring specified in the Task 3 Work Plan Report for the Tumwater Wellhead Protection Program (Pacific Groundwater Group, June 1995). All sites that are known to be contaminated and located in or near wellhead protection zones for one-year, five-year and ten-year time-of-groundwater-travel to a City wellhead are ranked. These sites are shown in Exhibit 4-1.

Nonpoint sources that may potentially affect groundwater quality are also addressed in this section. These include potential contamination from stormwater runoff; power line and other right-of-way maintenance; underground petroleum pipelines; nitrate and phosphorus loading from septic systems, fertilizer use, and small hobby farms; and spills occurring in major transportation corridors such as Interstate-5.

There is uncertainty involved in the designation of every wellhead protection area (WHPA) that reflects uncertainty in our understanding of the subsurface. WHPAs that are very long and thin in shape tend to have a higher degree of uncertainty associated with them because a slight change in the direction of groundwater flow from that assumed in the capture area model will result in a different area. Uncertainty is incorporated in this assessment of risk to each wellhead by including in the assessment, those sites that are physically located outside of, but very near to, the one-, five-, and ten-year capture zones. These sites are located in an "area of uncertainty."

4.1.2 Ranking Methodology

The ranking methodology used to rank contaminant sources and source types in designated WHPAs in Tumwater incorporates aspects of EPA's priority setting approach in WHPAs where appropriate (USEPA, 199_) and is tailored to the type of contamination known to occur in the area and the level of knowledge of the sources identified thus far in the City's WHPAs.

The following characteristics of each source were used to rank their respective threat to groundwater:

Contaminant Properties

Representative contaminant(s) of concern
Toxicity of contaminant
Mobility of contaminant (contaminant travel time to a well)
Persistence of contaminant

Hydrogeologic Properties

Hydrogeologic unit (Qva, Qc, Qvr (with no overlying till))
Groundwater travel time

Location

Six month, one-, five-, or ten-year WHPAs, or in area of uncertainty
Above or below ground source
Multiple locations (for instance, septic tanks, stormwater infiltration)

Known Current Contamination

Soil contamination
Groundwater contamination

Capacity of Affected Wellfield as Stated by City Staff

Palermo (20 percent of City supply)
Port (45 percent of City supply)
Bush (34 percent of City supply)
Trails End Well No. 20 (1 percent of City supply)

4.1.3 Results of Preliminary Risk Analysis

Point Sources

Table 4-1 presents a listing of the sites that are included in this assessment, and the elements of risk associated with each site. Where data were available specific contaminants are listed. Where data were unavailable, contaminants representative of each site were assumed based on the activities that currently occur, or previously occurred, at the site. The relative toxicity and persistence of each of the representative chemicals are listed. In addition, the groundwater travel time and contaminant travel time to the closest well have been computed based on flow model results (see Section 2) and chemical specific retardation rates. The hydrogeologic unit in which the threatened well is screened is noted, as well as the absence of a protective till layer (where known). The location of the source relative to ground surface is presented and confirmation of soil and groundwater contamination is noted.

Consideration of all of the elements listed in Table 4-1 is required to assess the risk posed to the overall water quality of the City's groundwater supply. In addition, the well or wellfield impacted by the source is considered with respect to the actual percent of City pumping capacity the affected wellfield can provide under existing conditions. For example, Palermo Wellfield (with its limited pumping capacity due to contamination) provides approximately 20 percent of the City's water supply, whereas the Port of Olympia (Port) Wells (including backup wells) supply 45 percent of the current city supply. The two wells comprising the Bush Middle School Wellfield produce 34 percent of the current City water. Therefore, all risk criteria being equal, a source presenting a potential threat to the Port Wells would be ranked higher than a similar source posing a risk to the Palermo Wellfield.

A preliminary ranking of the threats to groundwater was performed to help direct data collection efforts for the City's Wellhead Protection Program/Plan (WHPP). The results of the preliminary risk ranking are presented in Chapter 7 of the Task 3 Work Plan for the project (Pacific Groundwater Group, June 1995). The one-, five- and ten- year time-of-travel zones, and the City's overall WHPAs were revised subsequent to the Risk Analysis work presented in the 1995 Work Plan (see Section 2.0). Additional contaminated sites have also been identified: (1) as a result of data collected as part of the Work Plan; and (2) from an EPA Report discussing investigations of the Palermo Wellfield contamination incident (USEPA, April 1996).

Subsequent to the Work Plan, data have been collected that indicate the following:

- Three additional contaminant sources in the Palermo WHPA have been identified. These include Southgate Dry Cleaners, a Washington Department of Transportation (WDOT) facility, and Poages Automotive Service. All of these sites have been found to be a source, or potential source, of chlorinated hydrocarbons.
- Seven sites were listed as being outside of the WHPA for the Palermo Wellfield, but close enough to be considered in the "zone of uncertainty" in the preliminary threat ranking in the work plan. These sites have now conclusively been determined to be located within the zone of contribution to Palermo, and therefore, within the WHPA for Palermo as a result of the water level survey conducted as part of the work plan.
- In the work conducted for the USEPA, no confining Vashon Till layer was observed directly west of the Palermo Wellfield in the vicinity of Capitol Boulevard and Trosper Road, indicating greater groundwater vulnerability to land surface activities than previously believed in this area.
- Hytec Fiberglass, previously listed as a known source in the Task 3 Work Plan, has been further investigated and a determination has been made by Ecology in cooperation with the City, that the site requires no further action. This site had been considered a threat to the Port Wells at the time the Work Plan was prepared.
- No confining Vashon Till layer was observed in the work done for Hytec Fiberglass in the vicinity of Port Wells Nos. 9 and 10, indicating greater groundwater vulnerability to land surface activities than previously believed in the vicinity of these wells.
- Very low levels of Freon-11 (at or below detection limits) were detected in a residential well within the Bush Middle School WHPA.
- Groundwater quality sampling as specified in the work plan and conducted through September of 1996 did not indicate any additional areas of contamination.

As a result of the City's revised WHPA boundaries, newly identified contaminated sites, and data collected as part of Task 3 of the WHPP, Table 4-1 has been revised significantly. The criteria used to rank the threat posed to groundwater by known contaminant sources are similar to those used in the preliminary ranking in the work plan. New results have been ascertained regarding contamination threats to the City's groundwater supply:

Revised Summary of Results

1. Of the known sites included in this analysis, benzene, from petroleum contamination sites, is the most frequently encountered chemical of relatively high toxicity. Only carbon tetrachloride (assumed to be present from past fiberglass operations) is greater in relative toxicity. Benzene, and more generally, lighter end petroleum hydrocarbons, are more mobile and soluble than most metals and pesticides, adding to the risk they pose to the groundwater supply. However, benzene ranks relatively low in its persistence in the groundwater environment; therefore, concentrations are expected to decrease over time (given no additional inputs), independent of remedial actions. Petroleum contamination sites are located within the WHPAs of each of the major wellfields, with the greatest density located in the Palermo and Port WHPAs.
2. Sites with known contamination by chlorinated hydrocarbons (e.g., trichloroethene (TCE) and tetrachloroethene (PCE)) have been encountered, primarily in the WHPA for the Palermo Wellfield (USEPA, 1996). These substances are not as toxic as benzene; however, they are more persistent over time and can degrade into more toxic compounds such as vinyl chloride.
3. There is a higher density of sites **known** to be contaminated within the one- and five- year time-of-travel zones of the Palermo Wellfield than for any other production wells.
   - Contaminated sites in this area include those with confirmed or suspected groundwater and/or soil contamination (BP, Poages Automotive Service, Southgate Dry Cleaners, Drews Mobile, Texaco, Chevron, Tumwater Pickup Parts, Former Gull, Exxon, WDOT Facility).
   - These sources include both petroleum products and chlorinated solvents that are associated with older waste oil tanks and/or dry wells.
   - Contaminants associated with these sites include, but are not limited to, chlorinated solvents (PCE, TCE, Dichloroethene (DCE), and Vinyl Chloride (VC)) and petroleum hydrocarbons. Chlorinated solvents have a greater persistence in groundwater than do BETX compounds associated with petroleum products, and potentially pose a greater risk.
   - The protective glacial till layer (Qvt) above the aquifer has been found to be absent or discontinuous in this area.
   - The risk of contamination from these sources to the Palermo Wellfield is obvious, in light of the recently discovered contamination in Well Nos. 2, 4, and 5. The remaining wells at Palermo are also at risk.
4. Although the WHPA for the Port Wells contains fewer known contaminated sites than the WHPA for the Palermo Wellfield, the importance of potential contamination to the Port Wells should not be downplayed.

- The Port Wells provide 45 percent of the City water supply.
- The protective glacial till layer (Qvt) above the Qva aquifer in the vicinity of Well Nos. 9 and 10 has been found to be absent or discontinuous.
- The area has not been intensively studied, as the Palermo WHPA has, and therefore, may have additional contaminated sites that have yet to be identified.
- The land use in the area supports industrial and commercial uses, including an airport operation.
- A major pipeline traverses the Port WHPA and interfaces with the Texaco Bulk Plant located approximately 750 feet west of Well No. 10 in an area where the protective till layer has been found to be absent.
- The land use inventory conducted as part of this wellhead protection effort identifies portions of this WHPA as unsewered, and is therefore susceptible to nitrate contamination.

5. Determining the northern extent of contamination from the Restover and American Fiberglass sites would help to quantify the risk of contamination to the Bush Middle School Wellfield and the need for expansion of the early warning monitoring in this area. The groundwater and contaminant travel times from these sites to the Bush Wells are long, relative to other sites. However, the toxicity of the chlorinated and phenolic compounds that may occur at the American Fiberglass site is high. Low levels of Freon-11 have been detected in three monitoring wells in the one-year time-of-travel zone of the Bush Middle School Wellfield. Although Freon-11 is not considered to be a significant risk to the Bush Middle School Wellfield (see Section 2), detections of this constituent could be an early indicator of other less mobile chemicals (for example, chlorinated and phenolic compounds) originating from the American Fiberglass site. The protective till layer (Qvt) is poorly defined or absent west of the Bush Middle School area, and is a leaky aquitard in the Bush Middle School area (see Section 2). The Bush Middle School Wellfield currently provides 34 percent of the City water supply and may provide a substantially larger proportion of the future supply.
6. Nonpoint sources of contamination (for example, septic systems, pesticide and fertilizer use, right-of-way maintenance, underground petroleum pipelines, and storm runoff) are not directly compared to point sources in Table 4-1. However, it has been determined, based on preliminary review of nitrate concentrations over time, that nitrate in groundwater in some areas of Tumwater is increasing in concentration. An analysis of nitrate trends and a nitrate loading analysis for the study area should be performed to assess the urgency of the nitrate level increases. In addition, all wells should be monitored for nitrate on a regular schedule.

Nonpoint Sources

Nonpoint sources in the City's WHPAs that may potentially affect groundwater quality are not ranked but are addressed independently of the point sources listed in Table 4-1. These include potential contamination from stormwater runoff; power line and other right-of-way maintenance; underground petroleum pipelines; nitrate and phosphorus loading from septic systems; fertilizer and pesticide use in residential areas and at small hobby farms; and, spills occurring in major transportation corridors such as Interstate-5. Nonpoint sources are discussed below.

Stormwater Runoff: Rainfall onto the ground results as either infiltration into the subsurface or runoff. The quality of the water that infiltrates or runs off the surface is dependent on the type of land use and the presence or potential presence of contaminants on the land surface. Stormwater runoff is water that runs over the surface of the ground, gathering and dissolving potential contaminants. Stormwater may eventually discharge to groundwater via infiltration from ditches, ponds or permeable land surfaces.

The potential constituents of concern present in infiltrated water or runoff are diverse and reflect land use activities. Improved roadways, parking areas, and residential developments contribute heavy metals and petroleum hydrocarbons that originate primarily from automobiles. Industrial and commercial areas can discharge similar constituents, and in addition, a wide variety of organic contaminants commonly used in business and industrial practices (for example, solvents, paints, dry cleaning solutions).

Mitigation of the impacts of stormwater runoff on the quality of groundwater is an important groundwater protection strategy for the City. The porous, sandy soils, surrounding topography, and underlying aquifer system have historically allowed large quantities of stormwater to directly infiltrate on-site in the vicinity of the Port Wells WHPA as well as other areas in the City. The most shallow Qva aquifer, where unprotected by an overlying till layer, and Qal/Qvr aquifers are believed to receive urban runoff as evidenced by potentially elevated nitrate levels in these aquifers in various areas of the City (see Table 2-6, Section 2). These nitrate concentrations suggest that land surface activities and/or septic system use do, in fact, affect the quality of shallow groundwater. Sparse water Quality data from the Qc and TQu aquifers suggest that these aquifers are unimpacted by surface sources of contamination.

There are many BMPs that address stormwater runoff issues, specifically in reference to the protection of groundwater resources. The Airdustrial Park Stormwater Master Plan (Port of Olympia, 1994) addresses protection of groundwater resources in the vicinity of Airdustrial Park which overlies the zones of recharge for Port Wells. The Stormwater Plan includes mitigation intended to prevent any contamination from Port property from entering even the shallow aquifer without treatment at the surface. BMPs include grass biofilters, wet or dry ponds, and wetlands.

Nitrate and organics have been identified as the two constituents of greatest concern in stormwater runoff with regard to groundwater resource protection. Because nitrate removal is a biological process sensitive to temperature, it is not likely that grass biofilters, wet ponds, or constructed wetlands will provide much nitrate reduction in this area in winter months. Organics, such as petroleum hydrocarbons, are also not effectively removed by grass swales, wet ponds or wetlands. However, because 90 percent of all organics are associated with suspended solids, and because all three of these biological treatment techniques are effective in removing solids, effective removal of organics can be expected to occur with the grassy biofilters, wet ponds/dry pond treatment systems, as proposed in the Stormwater Master Plan (Port of Olympia, 1994).

Right-of-Way Maintenance: Right-of-way corridors present potential contamination from maintenance practices including herbicide and pesticide use, chemical roadside maintenance, potential spills from accidents and vehicle use of transportation rights-of-ways. (See Section 3.4.6 for rights-of-way identified in the contaminant source inventory).

Underground Petroleum Pipelines: The Olympic Pipeline Company maintains a subsurface petroleum product pipeline that is located in the one, five- and ten-year time-of-travel zone for the Port Wells. The presence of this pipeline increases the risk of contamination at these wells. The pipeline and its potential impact to groundwater presents a significant risk to the City's water supply.

Olympic Pipeline has been operating a transmission line in western Washington since 1965. The 14-inch pipeline carries all grades of gasoline, diesel fuel, jet fuel, and other oil-based products manufactured by British Petroleum, Arco, and Texaco. The transmission pipeline pressure is rated at 14,040 psi, but has withstood pressures up to 21,000 psi. A branch line off the main pipeline transports this array of petroleum products to Tumwater's Texaco bulk plant adjacent to the Olympia Airport (see Exhibit 4-1). The pipeline is buried at a depth of only three feet and is sometimes ruptured as a result of digging. For instance, a local construction company ruptured the pipeline in the Olympia area recently. The physical condition and routine maintenance of this pipeline should remain a concern to both the City and the region because of the location of its transmissions lines, the pipeline delivery point at the Texaco bulk plant, and its close proximity to the Port Wells.

General management strategies related to underground petroleum pipelines and the protection of groundwater resources are presented in Section 4.3. These strategies are intended to provide a framework for the development of specific policies by the City that address the risks to the Port Wells.

Nitrogen Loading: Sources of nitrogen inputs to groundwater include sewage (primarily from septic systems), lawn and agricultural fertilizer applications, livestock from small hobby farms, road and roof runoff. Nitrogen can be found in many forms in the subsurface environment, including nitrate-, nitrite-, ammonia-, and organic nitrogen. In shallower, oxygenated groundwater environments, nitrate-nitrogen is the most stable form and more complex nitrogen compounds will convert to this relatively quickly. Typically, sources of nitrogen to groundwater are also sources of phosphorus.

Wastewater released from septic systems contains bacteria, nutrients, and potentially household chemicals. However, the principal concern regarding these systems is the impact of nitrogen, which is subsequently converted and transported in the subsurface as nitrate. Effluent contains approximately 40 to 60 mg/l of nitrogen. Nitrate-nitrogen is the primary constituent of concern because of its relatively high mobility in groundwater systems and its harmful health effects to humans at high concentrations. Regional studies have shown that groundwater quality impacts from septic systems used in residential developments vary widely based on hydrogeologic setting, housing density, and system age, type and maintenance.

Septic systems are used in areas that are not currently serviced by sewers. The approximate sewer service area for the City is shown in Exhibit 3-4. Exhibit 3-3 indicates the surveyed parcels that have septic tanks. It should be noted that although the parcel containing the Port properties indicates the presence of septic tanks over a large area, only a small portion of that parcel is actually unsewered. The Bush Middle School Wellfield is the primary wellfield that is threatened by nitrates from septic systems and small hobby farms. However, nitrate levels in groundwater throughout the City have been found to be elevated (1.5 -3 mg/L) in the uppermost, shallow aquifers (see Table 2-6 and Exhibit 2-16).

Due to health concerns, the maximum contaminant level (MCL) for nitrogen in groundwater has been set at 10 milligrams per liter (mg/l) of nitrate-nitrogen by the EPA. Since the MCL has been established, certain nitrogen compounds have also been found to form carcinogens (Witten and Horsley, 1995). As discussed in Section 2, levels in nitrate-nitrogen in shallow groundwater in the WHPA and vicinity have been increasing and are a concern to the City.

The Thurston County Health Department has evaluated nitrate data and nitrogen loading within the McAllister Springs Geologically Sensitive Area (GSA) of Thurston County, located north and northeast of the City. McAllister Springs is a major water supply source for the City of Olympia, and water quality data from the Springs indicate a trend of increasing nitrogen concentrations in groundwater in that area that may soon endanger supply. A nitrate loading estimate for the McAllister Springs GSA estimated that nitrogen from septic systems, lawn fertilizer and stormwater accounted for approximately 53 percent of the total nitrogen loading in 1987, compared to 40 percent from agriculture (Thurston County Health Department, 1990). Agriculture is a large source of nitrogen for the McAllister Springs Area. It is expected that nitrogen loading in the City WHPAs would be less than at the Springs because agriculture does not constitute a major land use in the WHPAs. If levels of nitrate-nitrogen do become a greater issue in the City WHPAs, a mass balance model should be used to predict future nitrogen concentrations in groundwater based on overlying land uses, and subsequently direct the City's land use planning efforts. In some areas of western Washington, it has been found that the nitrogen loading from residential turf management is greater than from septic system use. This type of information will be beneficial in the development of the City's wellhead protection ordinance and other related ordinances.

Pesticide Use: Pesticides are typically used in residential areas, along transportation corridors, and along some rights-of-way. The term pesticide is inclusive of a suite of related products including insecticides, herbicides and fungicides. Most of the products that fall into this category are toxic to humans and animals in small quantities. Herbicides are used on transportation corridors. State, County, and City transportation departments are responsible for road maintenance in the City's WHPAs. Herbicides are primarily used to keep highway shoulders clear of plant growth. Pesticides are also used by homeowners. The presence of multiple sources of pesticides in the WHPA result in the potential for additive loadings to the groundwater system which could potentially result in a decline in groundwater quality. To date, pesticides have not been a detectable problem in the samples collected from potable water sources.

Transportation Corridor Spills: Contamination incidents associated with spills and/or runoff from major transportation corridors such as Interstate-5 and Old Highway 99 are in close proximity to the Palermo and Bush Middle School Wellfields. The Interstate-5 corridor parallels the one- and five-year time-of-travel capture area for Bush Wells and lies within the one-year time-of-travel capture area for Palermo. Old Highway 99 is contained in the WHPA for the Trails End Well and the Palermo Wellfield. The depth to, and the potential absence of, the Qvt layer at Palermo increase risk at this wellfield. Transportation related contamination is addressed in the Contaminant Source Inventory (Section 3).

4.1.4 Conclusions

Point Sources

Each of the City's three production well groups are characterized by different contamination threats. Therefore, the top three point sources threatening the groundwater supply have not been quantitatively ranked. City staff should assess each wellfield's contribution to City supply and determine their own priorities for addressing each wellfield. Future water supply planning will likely dictate the priority given to each WHPA. Groundwater management activities will be different for each wellfield. As a result of an evaluation of existing data on aquifer contamination, land use, and site contamination, the following are currently considered to be the highest risks to the City's groundwater supply posed by point sources. The risk scenarios are listed by wellfield.

- ❑ Chlorinated solvents associated with American Fiberglass located south of the **Bush Middle School Wellfield;**
- ❑ Petroleum hydrocarbons and chlorinated solvents associated with underground storage tanks directly west of the **Palermo Wellfield** in the vicinity of Interstate-5 and Trosper Road. In addition, three known contaminant sources that adversely impact the Palermo Wellfield have been identified and are being studied by the EPA. All sites are suspected to be a source or potential source of chlorinated hydrocarbons; and,
- ❑ Petroleum hydrocarbons and chlorinated solvents associated with underground storage tanks and aboveground sources in the vicinity of **Port Well** Nos. 9, 10, and 15 (includes nonpoint sources, for instance, the Olympic Pipeline and surface water runoff). There have been actions taken that indicate these solvents may not be as much of a threat as previously believed.

Nonpoint Sources

Although nitrate in groundwater is not a point source, it could also become a highly ranked groundwater protection issue after it is thoroughly assessed. The severity of the nitrate problem will be better understood following sampling and an evaluation of trends.

All nonpoint sources of groundwater contamination threaten the aquifers underlying the City. Priority should be given to several nonpoint sources that pose the greatest threat to shallow groundwater (and possibly deeper aquifers in the future). These nonpoint sources include:

- ❑ Potential leakage from the underground petroleum pipeline,
- ❑ Nitrate-nitrogen loading to the subsurface, and
- ❑ Infiltration of untreated stormwater.

Nitrate loading from septic tank and fertilizer use, as well as from infiltration of stormwater runoff containing high levels of nutrients, is a nonpoint source of groundwater contamination. Septic tank densities are highest in the unsewered areas in the wellhead protection area south of the Bush Middle School Wellfield. Nitrate-nitrogen levels appear to be slightly elevated (1.5 to 3 mg/L) in the shallow Qva aquifer in this area and north of the Bush Wells at Summerhill. However, similar nitrate-nitrogen levels have also been found in the Qvr aquifer in the Port and Palermo WHPAs, much of which is currently sewered. (Table 2-6 and Exhibit 2-16 indicate current levels of nitrate in groundwater throughout the study area). This information indicates a need for further data collection and subsequent analysis of trends in nitrate concentration in all three WHPAs.

It is recommended that nitrate levels continue to be observed in the City's groundwater sampling program, and that trends in nitrate concentration over time be assessed statistically to determine if current land surface activities (including septic system use) are causing an increase in nitrate concentrations in groundwater over time. A mass balance model is recommended for predicting concentrations of nitrate-nitrogen in groundwater based on projected land uses. This type of model allows for cumulative impact assessment, meaning that it provides a comparison of the impacts of a proposed project with other development that might affect a resource area. This approach can help predict the additive effects of all development and can direct City staff in determining appropriate land use planning approaches (for example, zoning densities that are protective of groundwater quality, landscaping ordinances, and so forth).

4.2 Implications for Management of Wellhead Protection Areas

Protection of the wellheads in these WHPAs will involve implementation of education programs (including business outreach), preparation of aquifer protection ordinances, and enforcement of those ordinances. Because each of the City's three production well groups are characterized by different land uses and contamination threats, they will require different approaches to wellhead protection, as summarized below:

4.2.1 Palermo Wellfield

The Palermo Wellfield currently produces a total of 1,070 gallons per minute (gpm), representing 20 percent of the City's water supply. The WHPA for this wellfield is characterized by non-residential land use, known contaminated sites (primarily chlorinated hydrocarbons and petroleum products), known contaminated groundwater and contaminated wells, and underground storage tanks. The strategy for this WHPA involves:

- ❑ Targeting existing sites for cleanup efforts.
- ❑ Monitoring to detect further contamination of the wellfield.
- ❑ Continued testing of sites with known underground storage tanks.
- ❑ Wellhead protection ordinance language that specifically addresses business practices that lead to contamination of this WHPA.
- ❑ BMP requirements that target known contaminated sites that are continuing to operate in this designated WHPA.
- ❑ Business outreach programs focusing on business and industry in the WHPA.

- Ordinance development and enforcement.

4.2.2 Port Wells (Well Nos. 9, 10, 11, 15, and 7)

The Port Wells supply 45 percent of the City's drinking water. The confining Vashon Till layer has been found to be absent in some areas of this WHPA near the wellheads. The WHPA for these wells is largely non-residential, a portion of which is not serviced by sewers. With the elimination of Hytec, Inc. from the list of contaminated sites, this WHPA has fewer known or potential contamination sites than does the Palermo Wellfield. Sites include the Fisheries Maintenance Yard, Tumwater Lumber, and Airport Fuel Stop (see Table 4-1). The Texaco Bulk Fuel Facility is included for consideration under this WHPP due to its proximity to currently recommended WHPAs, and because it may be located in future WHPAs as discharge from production wells increase. The Port of Olympia (Port) and its lease operations comprise a large portion of this WHPA, and the Olympic Pipeline runs through the one-, five- and ten-year time-of-travel zones of this WHPA. Wellhead protection strategies for this WHPA include:

- Business outreach geared directly toward the Port of Olympia and Olympic Pipeline Company and Texaco Bulk Fuel Facility.
- Incorporate underground petroleum pipeline strategies into an Aquifer Protection Ordinance.
- BMPs that specifically address Port and Port lease operation activities, including the handling of potentially hazardous materials and stormwater management.
- Language in the City's Aquifer Protection Ordinance addressing the type of activity characteristic of the Texaco Bulk Fuel Plant located in close proximity to the wellheads in this WHPA.
- Aquifer Protection Ordinance should require existing facilities to cleanup and monitor water quality on a regular basis.
- A traffic plan should be prepared for the transport of hazardous materials related to the Texaco Bulk Fuel Facility, and other Port-related operations.

4.2.3 Bush Middle School Wellfield

The two wells comprising the Bush Middle School Wellfield represent 34 percent of the City's current water production. They are anticipated to provide a substantially larger proportion of future supply. The delineated WHPA for Bush Middle School Well Nos. 12 and 14 is largely residential in nature and not served by sewers. A small area of Port of Olympia property is also located within the one-year capture zone of this WHPA. Contamination associated with Restover Truck Stop and American Fiberglass are known threats to these wells. Wellhead protection efforts should:

- Be aimed at the residential community in the form of education that stresses proper septic system maintenance and use of pesticides, as well as residential turf management practices.
- Address cleanup requirements and the use of best management practices by Restover and American Fiberglass.

4.3 Risk Management Recommendations

The following recommendations are based on the results of the risk analysis presented in Section 4.1 above. Implementation of these recommendations will help to protect the City groundwater supply by: (1) better defining the severity of potential contaminant threats, or (2) assuring BMPs are implemented by business, industrial, and residential communities located within the City's WHPAs.

Recommendation 4-1: **Assess nitrate levels in groundwater for specific areas within Tumwater's WHPAs based on nitrate loading model.**

An analysis of nitrate trends for the study area should be performed to assess the urgency of potential nitrate level increases. It is recommended that: (1) a nitrate sampling program be implemented where nitrate levels are systematically measured in the City's groundwater sampling program; and, (2) that trends in nitrate concentration over time be assessed statistically to determine if current land surface activities (including septic system use) are causing an increase in nitrate concentrations in groundwater over time. Historical nitrate data should also be used. Also, locations of historical sample events should be considered in designing the current nitrate sampling program. A mass balance model is recommended for predicting future concentrations of nitrate-nitrogen in groundwater based on projected land uses. This approach can help predict the additive effects of all development and can direct City staff in determining appropriate land use planning approaches (e.g., zoning densities that are protective of groundwater quality, landscaping ordinances, sewer system expansion, etc.).

Recommendation 4-2: **Prioritize level of effort and program implementation by WHPA.**

Section 4.1.4 summarizes the top three, high risk point sources and contaminant threats to the City's groundwater supply by wellfield, and Section 4.2 discusses management strategies that should be implemented to address the risk posed to each of the primary wellfields. Implementation of these management strategies must be prioritized by City staff based on time and resources available. Future water supply planning should dictate the priority given to each WHPA. For example, if the Bush Wells are anticipated to provide a substantially larger proportion of the future supply, then management strategies targeting threats in the Bush WHPA should be emphasized.

Recommendation 4-3: **Develop and implement petroleum pipeline management strategies.**

The following are management strategies pertaining to the location, design, and contingency planning for underground petroleum pipelines as proposed in the Draft East King County Ground Water Management Plan (July, 1996). These sample pipeline management strategies are intended to serve as a model, or framework, for the development of specific management strategies for the City (elements of which may be contained in a City ordinance):

Pipeline application review by the Energy Facility Siting Council includes review of existing policies and zoning codes to determine compliance. The City Comprehensive Plan does not contain any policies regarding the location or design specification for petroleum product pipelines; therefore, the City has little control over the preliminary siting of new pipelines in their WHPAs. These policies are needed because a petroleum product pipeline location must be in compliance with existing land use plan (comprehensive plan) policies and zoning codes of the jurisdictions it is proposed to pass through, to obtain state approval. Existing local policies and codes can help protect groundwater from potential contamination from petroleum product pipelines.

Proposed Pipeline Strategies

Adopt the following amendments in land use, zoning and/or comprehensive plans:

Location and Design

1. No pipeline shall be located within 500 feet of any groundwater supply well.
2. In cases where pipelines and water mains are located in the same general area, minimum separation criteria of 24 inches (vertical) and 10 feet (horizontal) will be applied, wherein, the pipeline will be located below the water line.
3. Ground motion and pipe stress sensors are required for pipelines located near areas of high potential mass wasting (i.e., landslides, liquefaction) and fault zones.
4. Rapid leak detection and shutdown systems (such as state-of-the-art Supervisory Control and Data Acquisition (SCADA) systems) with verifiable performance criteria and back-up communication shall be required where pipelines are located over aquifers that provide a source of potable water.
5. Double wall pipe with continuous leak detection is required for any pipeline segment located in, or within, 500 feet of a susceptible recharge area.

Emergency Response Planning

Land use plans shall require contingency planning prior to location and development of pipeline corridors. Contingency Plans will include the following elements:

1. Require automatic, remotely-controlled shutoff valves at closely spaced intervals (every four miles or less, based on resources at risk) in areas of high physical susceptibility.
2. Require pipeline operators to notify all private well owners and water purveyors within one mile of the pipeline about the pipeline's location and how to identify and respond to potential hazards.
3. Require notification of all private well owners and water purveyors whenever a report of possible damage has been filed.
4. Require site-specific rapid response contingency plans for physically susceptible and recharge areas.
5. Assemble, train, and maintain a HAZMAT team to respond to local emergencies.
6. Require that every leak or spill be reported to local officials, regardless of whether the hazardous material reaches a water body or causes property damage.
7. Require operators to provide local jurisdictions, fire departments, and public safety agencies with maps, inventories, descriptions of transported substances, and a copy of operations, maintenance, and emergency manuals. Changes in procedures, maintenance schedules and emergency response capabilities shall be provided within an annual operations report. Results of the previous year's integrity testing shall be included.

Ongoing Maintenance and Monitoring

1. Require independent hydraulic pressure testing for integrity every two or three years.
2. Require independent systematic assessments of pipeline corrosion using "elastic wave smart pigs" on a regular basis.
3. Require regular surveillance of the right-of-way by line walking and hydrocarbon gas monitoring.
4. Require soil and groundwater monitoring in physically susceptible and recharge areas.

Recommendation 4-4: **Investigate current procedures for pesticide and herbicide use.**

Contact City and County Operations staff to determine current practices for application of pesticides and herbicides in residential areas, along transportation corridors and along rights-of-way. Work with operations staff to further reduce or eliminate use of these chemical products in the City's WHPAs.

Recommendation 4-5: Prepare Port Area Traffic Plan.

It is suspected that high volumes of hazardous materials are regularly transported through the Port area. Restricting the transport of hazardous materials in and out of the Port area, and particularly the Texaco Bulk Fuel Facility, would minimize the potential for a spill occurring within the capture zone of the Port wells. A master traffic plan should be prepared, and a complete traffic plan could be required of transporters of hazardous materials. This can be prepared by City staff or the transporters of the hazardous materials.

4.4 References

A list of reference sources reviewed and used in the development of Sections 2 and 4 is provided in Appendix A.

Table 4-1
Risk Analysis Sites and Elements Considered

Map Key	Site Name	Contaminant Conditions	Representative Chemicals	Relative Toxicity (a)	Persistence (b)	Well(s) Potentially Impacted	Map Key	Approx. GW travel time to well (years)	Koc (c)	Foc (d)	R (e)	Contam. travel time to well (years)	Hydro-geologic unit	TOT	Above or Below Ground	Known soil contam.	Known groundwater contam.
Confirmed or Suspected Contaminated Sites Listing							**Confirmed or Suspected Contaminated Sites Listing**										
A1	BP 03158	surface runoff of TPH, ethylene glycol and oil	assume benzene	2	L	Palermo (#1-6,8)	A1	1.5	83	0	1.7	2.5	Qvr (no till)	Close to 1 yr. TOT for Palermo	above, runoff	?	?
	Trosper Rd @ I-5							1.5	0.02	0	1.0	1.5					
A2	Texaco Bulk Plant	surface runoff and groundwater impact by benzene (5.2 ppb)	benzene	2	L	Possibly Port Wells #10,11, 15	A2	1	83	0	1.3	1.3	Qva near #15	Port well # 15 in 1 yr TOT; in area of uncertainty	both	yes	yes
	7370 Linderson	diesel (4.5 ppm) and gas (3ppm). Petroleum product in	assume naphthalene	-1.1	L	travel time estimates for well # 15)		1	1290	0	6.4	6.4		Port well 11 in 5 yr TOT: in area of uncertainty			
		soil and groundwater due to spill												Port well # 10, upgradient but very close to site			
A3	Hytec Fiberglass	NOW CLOSED, Confirmed soil contamination w/phenolic	assume 2,4,6-Trichlorophenol	1.8	M	Port Wells #9, 10, 11 and 15	A3	0.1	2000	0	9.4	0.9	Qva	0.1 yr TOT for well 10,	above	yes	yes
	711 Airdustrial Road	compounds, suspected contamination of gw and soil with	assume carbon tetrachloride	2.5	L	(TT estimates for #10)		0.1	439	0	2.8	0.3		also close to 5 yr TOTs for wells 11 and 15			
		chlorinated solv., Also reported petroleum contamination	assume benzene	2	L			0.1	83	0	1.3	0.1					
A4	Restover Truck Stop	Release of 65,000 gallons of gas and diesel in unconfined	assume benzene	2	L	Possibly Bush wells 12 and 14	A4	10	83	0	1.3	13.5	Qvr/Qva	outside of 10yr TOT, but plume	below	?	yes
	93rd Ave. SW and I-5	aquifer, free product floats on shallow water table.	assume naphthalene	-1.1	L	Pederson well		10	1290	0	6.4	64.2		detected 2000 ft to the north			
A5	American Fiberglass	Groundwater and soil impacted by chlorinated and phenolic	assume carbon tetrachloride	2.5	L	Bush wells 12 and 14	A5	6	439	0	2.8	17.1	Qva	within 10 year TOT for Bush wells	above	potential	potential
	8904 Kimmie Rd	cmpds (Formerly a fiberglass facility, currently a paint shop)	assume 2,4,6-trichlorophenol	1.8	M			6	2000	0	9.4	56.5					
		possibly a source of freon detected in wells to the north															
A7	Tumwater Pickup Parts	Soil impacted by metals, pesticides, petroleum and	assume metals: cadmium	1.7	H	Palermo (#1-6,8)	A7	3.5	1080	0	10.1	35.3	Qvr (no till)	Within 5 yr TOT for Palermo	above	yes	?
	5945 Littlerock Road	organic solvents	assume benzene	2	L			3.5	83	0	1.7	5.9					
			assume TCE(trichloroethylene)	1.5	M			3.5	126	0	2.1	7.2					
			assume 2,4,-D	0.5	L			3.5	19.6	0	1.2	4.1					
A8	Fisheries Maintenance Yard	Petroleum contaminated soils	assume benzene	2	L	#11, 15	A8	0.8	83	0	1.3	1.1	Qva	1 year TOT zone for 15, in area of uncertainty		yes	?
	700 Airdustrial Way					very close, but upgrad. of # 10		(from well #15)						Port well # 10, upgradient but very close to site			
A10	Poages Automotive Service	Chlorinated solvents in a dry pit	assume TCE (trichloroethylene)	1.5	M	Palermo (#1-6,8)	A10	0.5	126	0	2.1	1.0	Qvr	within 1 year zone for Palermo	above and below	?	?
			assume PCE (tetrachloroethylene)	0.5	M			0.5	364	0	4.1	2.0	Qvr				
A11	Southgate Dry Cleaners	PCE in shallow soil (258,000 ppb), PCE in groundwater	PCE (tetrachloroethylene)	0.5	M	Palermo (#1-6,8)	A11	0.8	364	0	4.1	3.2	Qvr (no till)	within 1 year zone for Palermo	below	yes	yes
		TCE in soil (1480 ppb), TCE in groundwater	TCE (trichloroethylene)	1.5	M			0.8	126	0	2.1	1.6	Qvr (no till)				
		C-DCE in groundwater	Trans-Dichloroethylene	0.2	L			0.8	59	0	1.5	1.2	Qvr (no till)				
		Vinyl Chloride in groundwater	Vinyl Chloride	3.8	L			0.8	57	0	1.5	1.2	Qvr (no till)				
Leaking Underground Storage Tank Listing							**Leaking Underground Storage Tank Listing**										
L1	Drews Mobile	Broken waste oil tank and dry well. Existed for 25 years	assume benzene	2	L	Palermo (#1-6, 8)	L1	0.6	83	0	1.7	1.0	Qvr (no till)	Within 1 year TOT zone for Palermo	below	yes	likely
	110 Trosper Rd.	assume chlorinated solvents and petroleum products	assume trichloroethylene	1.5	M			0.6	126	0	2.1	1.2					
L2	Texaco 157-060	Diesel, below MTCA cleanup levels in soil	assume benzene	2	L	Palermo (#1-6,8)	L2	0.5	83	0	1.7	0.8	Qvr (no till)	Within 1 year TOT zone for Palermo	below	yes	?
	5200 Capitol Blvd.																
L4	Chevron 60090956	BETX and TPH below cleanup levels, up to 110 ppb TCE	assume benzene	2	L	Palermo (#1-6,8)	L4	1.5	83	0	1.7	2.5	Qvr (no till)	slightly greater than 1 yr. TOT	below	yes	yes
	670 Trosper Rd.	in gw, 25 ppb TCE in soil, no PCE in soil	TCE	1.5	M			1.5	126	0	2.1	3.1					
L5	Tumwater Lumber	Diesel contaminated soil. Independent cleanup	assume benzene	2	L	#9, 10 and 15	L5	1.2	83	0	1.3	1.6		Between 1 year TOT for Bush wells and 5 year TOT	below	yes	unknown
	8277 Center St. SW		assume naphthalene	-1.1	L			1.2 (to well #14)	1290	0	6.4	7.7	Qva	for Port wells; within area of uncertainty			
L6	Merchants Moving	Property closed				Possibly Palermo (#1-6,8)	L6										
	5880 Linderson Way																
L11	Former Gull 258	Property Closed, TCE detected in gw below the site,				Palermo (#1-6,8)	L11										
	5101 Capitol Blvd	source may be elsewhere															
L12	NW Deli Mart	Leakage from dispenser pumps - petroleum	assume benzene	2	L	Possibly Palermo (#1-6,8)	L12	2.5	83	0	1.7		Qvr (no till)	Area of uncertainty for 5 year TOT for Palermo	below	likely	unknown
	6131 Capitol Blvd																
L15	Exxon 7-7134	Free product gasoline and 0.9-2.1 ppb TCA	assume benzene	2	L	Palermo (#1-6,8)	L15	1.4	83	0	1.7	2.4	Qvr (no till)	Within 5 yr TOT, and close to 1 yr TOT for Palermo	below	likely	yes
	501 Trosper Rd.	groundwater gradient is 0.01 to east (toward Palermo)	TCA	-0.5	M			1.4	152	0	2.3	3.2					
L16	Continental Baking Co.	Petroleum product in soil, underground storage tank closure	assume benzene	2	L	Possibly Palermo (#1-6,8)	L16	3	83	0	1.7	5.1	Qvr (no till)	Area of uncertainty for 5 year TOT for Palermo	below	yes	unknown
	6301 Capitol Blvd																
L17	WDOT Facility	Low conc of TCE in soil sample (<7 ppb)	Trichloroethylene (TCE)	1.5	M	Palermo (#1-6,8)	L17	1.5	126	0	2.1	3.1	Qvr (no till)	Within 5 year TOT for Palermo, very close to 1 yr. TOT	below	yes	yes, but likely another source
		UST liquid has TCE, PCE, C-DCE, and T-DCE. Potential	Tetrachloroethylene (PCE)	0.5	M			1.5	364	0	4.1	6.1	Qvr (no till)				
		source of chlorinated hydrocarbons	Cis-Dichloroethylene (C-DCE)					1.5	65	0	1.5	2.3	Qvr (no till)				
			Trans-Dichloroethylene (T-DCE)	0.2	L			1.5	59	0	1.5	2.2	Qvr (no till)				

(a) Toxicity score is the logarithm of the inverse of the critical concentration resulting in either a 10E-6 cancer risk for carcinogens or the oral reference dose for non-carcinogens(USEPA 570/9-91-023, October 1991)

(b) persistence score is based on the degradation rate as follows:

- low: degradation rate greater than 19/year
- medium: degradation rate between 0.0069/year and 19/year
- high: degradation rate less than 0.0069/year

R=1+(Pb*koc*focm)

1.85 ^=Pb = dry bulk density (kg/l)

foc= fraction organic carbon in soil/groundwater matrix

0.22 ^=n=porosity

(c) Koc is the soil/organic carbon partition coefficient

(d) assume Qva has fraction organic carbon = 0.0005
assume Qvr has fraction organic carbon = 0.001

(e) R is the retardation factor of the chemical

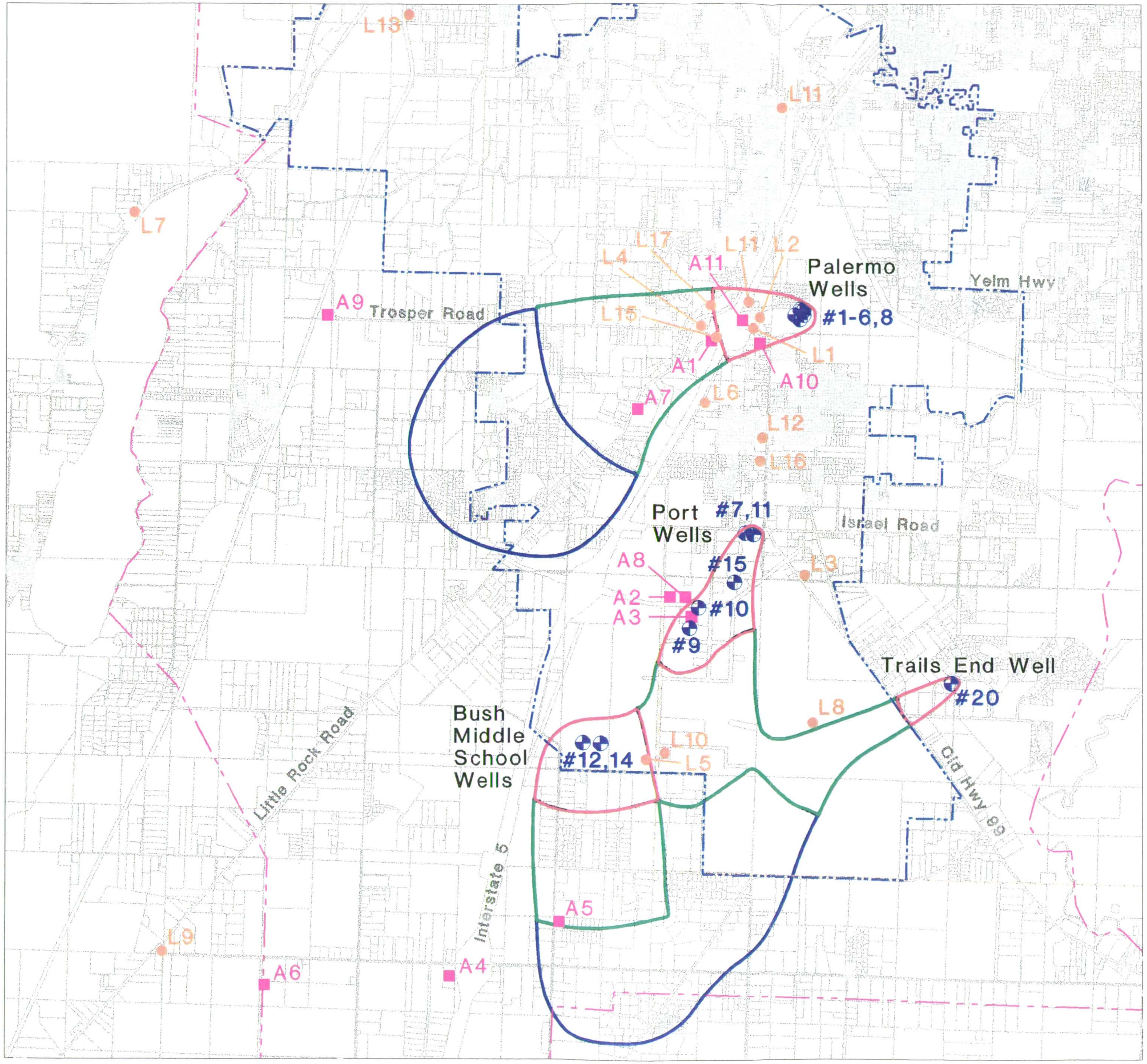


FIGURE 4-1
TUMWATER WELLHEAD PROTECTION PROGRAM

LEAKING UNDERGROUND STORAGE TANKS AND KNOWN OR SUSPECTED CONTAMINATED SITES

NOVEMBER, 1997

ECONOMIC AND ENGINEERING SERVICES, INC.

Pacific Groundwater Group

LEGEND

WELLHEAD PROTECTION ZONES

- 1 YEAR ZONE
- 5 YEAR ZONE
- 10 YEAR ZONE

#1 PRODUCTION WELLS

CITY LIMITS

UGA BOUNDARY

OLYMPIC PIPELINE

Data source:
Ecology 1993 files.

0 3000
SCALE IN FEET

L1 Leaking Underground Storage Tanks w/Map Key

Map Key	Site Name
L1	Drew's Mobile
L2	Texaco 157-060
L3	Deschutes Animal Clinic
L4	Chevron 60090956
L5	Tumwater Lumber Co.
L6	Merchant's Moving
L7	Black Lake Grocery
L8	Vortac @ Olympia
L9	Villa Grove Foodliner
L10	Airport Fuel Stop
L11	Former Gull 256
L12	NW Deli Mart
L13	Central Reddi-Mix
L14	Tumwater Old City Hall
L15	Exxon 7-7134
L16	Continental Baking Co.
L17	WDOT

A1 Confirmed and Suspected Contaminated Sites w/ Map Key

Map Key	Site Name
A1	BP 03158
A2	Texaco Bulk Plant
A3	Hytec
A4	Restover truck Stop
A5	American Fiberglass
A6	USDA Pac. NW Forest
A7	Tumwater Pickup Parts
A8	Fisheries Main Yard
A9	USDOE Oly. Substn.
A10	Poages Auto Services
A11	Southgate Drycleaners

JE9401 4-1-con.dwg 11/97

Section 5

Section 6

Section 6
Contingency Plan Assessment

6.1 Introduction

What happens when a wellfield is contaminated and cannot be used as a drinking water source? The purpose of this section is to help ensure that alternative sources of drinking water are available in the event of a short-term or extended loss of supply. This assessment emphasizes the importance each source of supply has to the City of Tumwater (City).

The 1986 Amendments to the Safe Drinking Water Act (SDWA) mandated that each State require public water systems to develop contingency plans for the location and distribution of alternate drinking water supplies in the event of well or wellfield contamination (Subsection 1428 (a)(5)).

Consistent with the SDWA provisions and the Washington State *Wellhead Protection Program Guidance Document* prepared by the Department of Health (April 1995), contingency planning is required as part of developing and updating water system plans pursuant to WAC 246-290-100 and the Small Water System Management Program under WAC 246-290-410. Analyses to meet these requirements include:

- ❑ Identification of existing or potential interties with other public water systems and evaluation of the ability to deliver water assuming loss of the largest well or wellfield.
- ❑ Evaluation of current procedures and development of recommendations on contingency plans for emergency events.
- ❑ Identification of future potential sources of drinking water and a description of quality assurances and control methods to be applied to ensure protection of water quality prior to utilization as a drinking water supply.
- ❑ Maintenance of a current list of appropriate emergency phone numbers.

The 1992 draft of the City Water System Plan (WSP) examined overall source and storage capacity of the system to assure that minimum Department of Health (DOH) standards were met. This analysis involved:

- ❑ Identification of the maximum water system capacity in relation to source, distribution system, and water rights restrictions, assuming the loss of largest well or wellfield.
- ❑ Evaluation of the expansion options of the existing system's capacity to meet current water rights/availability.

These analyses were conducted to assure a safe and reliable supply during both routine operations as well as short-term disruptions.

Specifically, the analysis of loss of supply provides information on the adequacy of water source and storage to meet demand if the largest well or wellfield were to be disrupted for a short or extended period. The short-term analysis is based upon DOH storage criteria designed to meet a 24-hour demand.

An analysis of expansion options is generally conducted as part of the evaluation of future demand. Installing additional pumping capacity to fully utilize a specific water right is the preferred approach. The history of the water right and its development are evaluated to determine the feasibility of fuller utilization.

Contingency and emergency response plan procedures for earthquakes, power failures, water transmission line failures, contamination of sources of supply, and gaseous chlorine leaks are included in the City's 1992 WSP. Emergency operations, a seismic vulnerability analysis, and an earthquake response plan are outlined on pages 8-4 and 8-5, as well as in Appendix G of the 1992 WSP; however, a contingency plan for loss of source is not included.

6.2 Description of Water System

The City supplies water to more than 4,000 service connections within a distribution system area of approximately 10.7 square miles. Exhibit 6-1 shows the City's water service area and distribution system. Tumwater's existing water distribution and transmission piping ranges in size from less than 2 inches to 24 inches in diameter.

An overview of the City's existing water system facilities and hydraulic profile, including wells, pressure zones, storage reservoirs, booster pump stations, pressure reducing values, and two interties with the City of Olympia, is provided on Exhibit 6-2.

6.2.1 Source of Supply

The City depends on groundwater as its sole source of supply. The City has 11 active operating wells. The combined maximum capacity of all City wells is approximately 5,255 gallons per minute (7.57 MGD).

Table 6-1 provides an overview of, and current status information on, each source as stated by City staff.

Table 6-1 City of Tumwater Well Production and Status			
Well No.	**Location**	**Current Status**	**Production (gpm)**
1-31	Palermo	Out-of-Service	-
2-39	Palermo	Out-of-Service	-
3-44	Palermo	In-Service	290
4-65	Palermo	Emergency Only*	-
5-65	Palermo	Emergency Only*	-
6-67	Palermo	In-Service	450
8-82	Palermo	In-Service	330
		Total for Palermo Wellfield:	**1,070**
12-94	Bush Middle School	In-Service	600
14-94	Bush Middle School	In-Service	1,200
		Total for Bush Middle School Wellfield:	**1,800**
7-88	Israel Road/City Hall	In-Service	550
9-72	Port of Olympia	In-Service	500
10-85	Port of Olympia	In-Service	485
11-93	Port - Israel Road	In-Service	275
12-43	DNR Right of Way	Out-of-Service	-
13-69	Port of Olympia	Out-of-Service	-
15-91	Port of Olympia	In-Service	500
20	Trails End	In-Service	75
21	Trails End	Out-of -Service	-
22	Trails End	Out-of-Service	-
23	Trails End	Out-of-Service	-
		Total Production Available:	**5,255**

* Under emergency conditions only, Palermo Well Nos. 4 and 5 may supply 760 gpm.

City Well Production Capacity and Locations

Seven wells (Well Nos. 1, 2, 3, 4, 5, 6, and 8) are located in the Palermo Wellfield in the east-central area of the lowest pressure zone (350 Zone). These are the City's oldest wells dating back as far as 1931. The Palermo Wells are close together and cannot be pumped simultaneously. If the wells could be pumped simultaneously, the output from all of the pumps together would be about 2,500 gallons per minute (gpm). Actual output is limited by seasonal variations in the aquifer level and by the existing control system which cannot individually select each well for production. During the summer months, production was in the 1,750 gpm range before August 1993 when TCE contamination eliminated the use of Well Nos. 2, 4, and 5. It has been assumed that the production rates of the Palermo Wellfield could be increased if the pump rates and output of each well were throttled back (reduced). All of the wells in the Palermo Wellfield are connected by underground conduit to a central location. However, each well is not equipped with an individual flow meter, sounding probes, or ports for level transducer access. Control of the pump is by automatic call system or manual control. The Palermo Wellfield produces 20 percent of the City's total drinking water supply. Well Nos. 12 and 14 comprise the Bush Middle School Wellfield. Located in the southwestern area of the City, both of these wells were brought on-line in 1994. They are the City's newest sources of supply. With a combined capacity of 1,800 gpm under current conditions and a rated capacity of 3,300 gpm, the Bush Middle School Wellfield produces 34 percent of the City's total supply. Well Nos. 12 and 14 are the City's most productive sources for drinking water.

Well No. 7, with a production capacity of 550 gpm, is located near City Hall on Israel Road. Brought on-line in 1988, this well pumps from a deeper aquifer than the Palermo Wellfield. Well No. 7 has a history of being inactive and being pumped for emergency use only because of high iron and manganese levels.

Well Nos. 9 and 10 are located in the south-central area of the central plain in the Port of Olympia's (Port) Airdustrial Park. These two wells were constructed by the Port to serve the airport area before it was annexed by the City. Well No. 9 pumps to an elevated reservoir that was constructed concurrently with the wells and has an overflow elevation of 350 feet. Well No. 15, located northeast of Well Nos. 9 and 10, is also located on Port property and was constructed by the City in 1991.

Well Nos. 20, 21, 22, and 23 are located in the southeastern area just outside of the City. Known as the Trails End Wells, only Well No. 20 is operational at 75 gpm and has the lowest production capacity of all City wells.

Altogether, the City's existing source of supply is comprised of Well Nos. 3, 6, 7, 8, 9, 10, 11, 12, 14, 15, and 20. Well Nos. 4 and 5 are contaminated, but may be used during emergencies.

6.2.2 Storage Capacity

The City's water system includes five reservoirs with a total storage capacity of over six million gallons (6.28 MG). Refer to Exhibits 6-1 and 6-2 for the location and capacity of each City storage facility.

6.2.3 Booster Pumps and Pressure Reducing Valves

Due to the relatively wide range of elevations in the City's service area, the City system has several booster pump stations (BPSs) and pressure reducing valves (PRVs). In addition, there are a multitude of pumps located throughout the City system. These hydraulic features are illustrated on Exhibit 6-2. The combined total pumping capacity of all BPSs is 1,850 gpm (2.664 MGD).

6.2.4 Transmission and Distribution

The City maintains over 83 miles of transmission and distribution piping. Over 57 percent of the City's system is constructed with 6-inch and 8-inch diameter water mains. A large portion of the 8-inch mains are transmission pipelines used to move water south from the Palermo Wellfield to the remainder of the system.

Over 100,000 feet of 10- to 24-inch water mains have been installed to enhance the system's transmission capability. These are the largest mains in the system and when combined represent over 20 percent of the City's total water pipe inventory.

The City's water system is located on both sides of Interstate 5 and the Deschutes River. This arrangement makes it more difficult and expensive to construct water mains across these major landmarks to meet the City's overall transmission and distribution requirements.

6.3 Approach to Loss of Supply

The principal focus of this section is on loss of source from the City's two major wellfields:

- Loss of the remaining clean wells at the Palermo Wellfield, which provides 20 percent of the City's total drinking water supply.
- Loss of the Bush Middle School Wellfield, which provides 34 percent of Tumwater's total supply.

In accordance with federal and State law, emphasis is placed on the existing reaction capabilities of the City's system to effectively provide an adequate quantity and quality of drinking water supply to its customers under emergency conditions.

Although the Port Wells produce 45 percent of the City's total drinking water supply, they were not subjected to this evaluation because the physical distance between these wells precludes them from being treated as a single wellfield.

For each scenario it is determined whether, and to what extent, water supply to customers must be curtailed and available storage capabilities would be exhausted. The ability of the distribution system to meet fire flow requirements is also evaluated.

An attempt is made to pinpoint the impacts that would occur in each of the two scenarios, and determine if existing storage and interties are capable of covering these losses, we would also like to determine whether, and to what extent, new sources of supply are needed to meet peak demand throughout the system. Most importantly, this information provides a framework for deciding the extent to which system enhancements, alternative sources of supply, and capital facility improvements are needed should the City experience the sudden loss of a major well or wellfield.

6.3.1 Existing Source Capacity Versus Current Peak Day Demand

An evaluation of the loss of the Palermo Wellfield and the Bush Middle School Wellfield was performed to determine the ability of the City system to meet peak day demands under major source loss conditions.

Current peak day demand was stated by City staff to be equal to 4,500 gpm (6.48 MGD). Current maximum production capacities for each City production well were also determined by City staff to be 5,255 gpm for the purposes of this loss of supply analysis (see Table 6-1).

With all sources in operation, City well production capacity is approximately 755 gpm (1.09 MGD) in excess of the total supply needed to satisfy the City's current peak day demand.

6.3.2 Impacts of Loss of Supply

The results of these analyses are summarized below and the impacts of both source loss scenarios are shown in Tables 6-2 and 6-3.

Table 6-2
Analysis of Effects of Losing Wellfields

Item		Existing Conditions	Loss of Wellfield Scenario Palermo	Loss of Wellfield Scenario Bush
System-wide Demand				
Peak Day Demand (gpm)		4,500	4,500	4,500
Well Production				
Well No.	Location	Production (gpm)		
1-31	Palermo	Out-of-Service	-	-
2-39	Palermo	Out-of-Service	-	-
3-44	Palermo	290	-	290
4-65	Palermo	Out-of-Service	-	-
5-65	Palermo	Out-of-Service	-	-
6-67	Palermo	450	-	450
8-82	Palermo	330	-	330
	Total for Palermo:	**1,070**	**-**	**1,070**
12-94	Bush Middle School	600	600	-
14-94	Bush Middle School	1,200	1,200	-
	Total for Bush:	**1,800**	**1,800**	**-**
7-88	Israel Road near City Hall	550	550	550
9-72	Port of Olympia	500	500	500
10-85	Port of Olympia	485	485	485
11-93	Port - Israel Road	275	275	275
12-43	Old DNR Right-of-Way	Out-of-Service	-	-
13-69	Port of Olympia	Out-of-Service	-	-
15-91	Port of Olympia	500	500	500
20	Trails End	75	75	75
21	Trails End	Out-of-Service	-	-
22	Trails End	Out-of-Service	-	-
23	Trails End	Out-of-Service	-	-
	Total Production Available:	**5,255**	**4,185**	**3,455**
	Total Surplus/(Deficit):	**755**	**(315)**	**(1,045)**

Table 6-3			
Mitigation to Loss of Source through Storage			
	Existing	Lose Wellfield	
Item	Conditions	Palermo	Bush
System-wide Demand			
Peak Day Demand (gpm)	4,500	4,500	4,500
Total Surplus/(Deficit) (From Table 6.2)	755	(315)	(1,045)
Storage			
New Reservoir Facility (Replaces C St.)	4,000,000	4,000,000	4,000,000
Airport Elevated Reservoir	200,000	200,000	200,000
Mottman Reservoir No. 3 (Transfer)	80,000	80,000	80,000
Mottman Reservoir No. 4 (Transfer)	1,000,000	1,000,000	1,000,000
Somerset Hill Reservoir No. 5 (Transfer)	1,000,000	1,000,000	1,000,000
Total	6,280,000	6,280,000	6,280,000
Less Fire Flow	630,000	630,000	630,000
Available for Emergency	**5,650,000**	**5,650,000**	**5,650,000**
Storage Volume Required to Supplement Loss of Wellfield			
1 Day		453,600	1,504,800
7 Days		3,175,200	10,533,600
Surplus/(Deficit) w/Storage			
Total Surplus/(Deficit) 1 Day*		5,196,400	4,145,200
Total Surplus/(Deficit) 7 Days**		2,474,800	(4,883,600)
Available Days with Source Deficit***		12.46	3.75

*If no decrease in demand occurs, and loss is made up by removing water from storage, this is the total amount of source remaining in storage after one day of meeting peak demand under each loss of source scenario.

**If no decrease in demand occurs, and loss is made up by removing water from storage, this is the total amount of source remaining in storage after seven days of meeting peak demand under each loss of source scenario.

***This is the total number of days peak demand can be met through the City's available storage capacity under each loss of source scenario.

Scenario 1:

Loss of Palermo Wellfield

With the loss of the 1,070 gpm (1.54 MGD) capacity of the Palermo Wellfield, the City's current surplus in source of supply reverses to an overall system deficit of approximately 315 gpm (0.45 MGD). Without the addition of a new source of supply, curtailment in water consumption, or intertie supplements to make up for the loss of 315 gpm, the total storage capacity of the City under this scenario could be exhausted in 12.46 days.

Scenario 2:

Loss of Bush Middle School Wellfield

Similarly, the loss of the 1,800 gpm (2.59 MGD) source production capacity of the Bush Middle School Wellfield would produce a system-wide deficit in supply of 1,045 gpm (1.50 MGD). Again, without the addition of a new source of supply, curtailment in water consumption, or intertie supplements to make up for the loss of 1,045 gpm, the total storage capacity of the City under this scenario could be exhausted in 3.75 days.

System-wide Impact

Overall, the system-wide impacts resulting from the loss of the Palermo Wellfield represent approximately 7 percent of. the City's total peak day demand compared to approximately 23 percent of the City's total peak day demand that would result from the loss of the Bush Middle School Wellfield.

Distribution System Pressures

Simulations were performed using the Cybernet hydraulic model created for the City's WSP. The objective was to determine what changes would occur in local pressures as a result of the loss of source from either the Palermo Wellfield or the Bush Middle School Wellfield. A baseline simulation was run with all sources active and a total peak day demand of 4,500 gpm established throughout the system. The demand was allocated to nodes in the same proportion as was used in the development of the City's WSP.

This baseline simulation resulted in the identification of pressures throughout the distribution system which reflect the simultaneous operation of all of the City's active wells. Additional simulations were run for the two scenarios: first, with the wells in the Palermo Wellfield out-of-service, and second, with the Bush Middle School Wellfield out-of-service. These wellfields were "turned off" separately to determine the extent of change in distribution system pressures that would occur during each of the two different loss of supply scenarios.

When each wellfield was turned off (assumed lost), the pressures in the area near the Palermo Wellfield (under the first scenario) and the Bush Middle School Wellfield (under the second scenario) decreased below the baseline pressures. The maximum decrease in pressure with the loss of the Palermo Wellfield was approximately 15 psi. The maximum decrease with the loss of the Bush Middle School Wellfield was approximately 40 psi. While the local drop in pressure caused by the loss of either wellfield was significant, the pressures throughout the system remained at or above the DOH recommended minimum of 30 psi.

Pressures in the two upper zones were not affected by the loss of either wellfield because they are both served primarily by booster pumps and reservoirs. Should the source deficit continue and result in loss of storage, pressures in the upper zones would be affected due to the lower water surface levels in the reservoirs.

6.3.3 Mitigation of Loss of Source

Demand Curtailment

The deficits calculated above are based on the peak day demand. Demands below that of the available source, even with loss of an entire wellfield, can be met without experiencing adverse impacts. Should an entire wellfield be lost during a peak demand period, curtailment of demand can offset the adverse impacts of the loss of either the Palermo Wellfield or the Bush Middle School Wellfield.

Peak days normally occur in the summer months when outside water use is high. Curtailment of outside uses can decrease the demand sufficiently to drop the demand below the available source. A decrease of 7 percent (Palermo Wellfield) or 23 percent (Bush Middle School Wellfield) would be necessary to lower the demand to a level below the available source should one of these wellfields be lost permanently.

Storage Capacity

A short-term loss of source capacity can be mitigated through the use of existing water storage. Table 6-3 indicates the amount of available storage that can be used to offset a source outage. The available storage volume was obtained from City staff. The Fire Chief's recommended allowance for fire flow storage (630,000 gallons) is reserved (not by regulation but on the basis of prudent management) and not considered available for loss of source mitigation purposes.

Based on Table 6-4, the loss of either the Palermo or Bush Middle School Wellfield could be tolerated for a 24-hour period with little adverse effect. The primary impact would be a decrease in available storage and lower pressures as the water level in the City's five reservoirs drops. In fact, the available storage is sufficient to supply water at the peak day rate to the entire system for up to 3.75 to 12.46 days with the total loss of the Bush Middle School or Palermo Wellfield, respectively (see Table 6-3).

Using the entire amount of storage is not advisable, but it does provide a cushion, or window of time, before the City may be forced to initiate more costly measures. This period should be sufficient for the City to inform the community at-large and individual major customers about the loss of source and implement water conservation measures in combination with other necessary mitigation actions.

Table 6-4
City of Tumwater - Well Sources Update

Well No.		Peak	Percent	Status Notes
Palermo Wellfield Scenario				
1-31	Palermo	0 GPM		Out of Service - Casing Only
2-39	Palermo	0 GPM		Out of Service - TCE Contamination
3-44	Palmero	290 GPM	5.52%	In Service
4-65	Palermo	(480 GPM)		Can be Used for Emergency Service Only - TCE Contamination
5-65	Palermo	(280 GPM)		Can be Used for Emergency Service Only - TCE Contamination
6-67	Palermo	450 GPM	8.56%	In Service - Winter Capacity 576 GPM
8-82	Palermo	330 GPM	6.28%	In Service
Total Palermo Wells:		**1070 GPM**	**20.36%**	
Bush Wellfield Scenario				
12-94	Bush Middle School	600 GPM	11.81%	
14-94	Bush Middle School	1200 GPM	22.84%	New VFD Controller will Allow Lower Production
Total Bush Wells:		**1800 GPM**	**34.25%**	
Port Wellfield - All Other Wells				
7-88	Israel Road Near City Hall	550 GPM	10.47%	In Service as Backup Well - Manganese Near MCL - New Booster Pump
9-72	Port	500 GPM	9.52%	In Service - New Valve Increased Capacity from 400 GPM
10-85	Port	485 GPM	9.23%	In Service -
11-93	Port - Israel Road	275 GPM	5.23%	Prior No. 11 was an Unsuccessful Exploratory Well
12-43	Old DNR Right	0 GPM		Old Domestic Well for Hanger Area - Out of Service
13-69	Port	0 GPM		Out of Service - Collapsed Formation
15-91	Port	500 GPM	9.52%	In Service - Has New Impellers and Motor
20	Trails End	75 GPM	1.43%	In Service - Could Support Higher Yield with New Pump/Motor
21	Trails End	0 GPM		Out of Service - Not Economically Viable to Refit Pump
22	Trails End	0 GPM		Out of Service - Not Economically Viable to Refit Pump
23	Trails End	0 GPM		Casing Only - Not Economically Viable to Fit Pump
Total Port Wells:		**2385 GPM**	**45.39%**	
Total System Source Capacity:		**5255 GPM**	**100.00%**	In Emergency Use Palermo Well Nos. 4 & 5 for 760 GPM Supply
Total System Peak Demand:		**4500 GPM**	**100.00%**	
Olympia/Tumwater Interties Summary:				
Mottman Intertie Zone 455:		1300 GPM		No Agreement Exists - Would be very Expensive to Use!!!
Carlyon Avenue Intertie Zone 350:		400 GPM		No Agreement - Crash Cart Unavailable - Need Larger Main!
Potential Pabst Brewery Intertie		250 GPM		No Agreement Exists - Fire Hose Used to Connect Limits GPM!
Total Intertie Capacity:			**1950 GPM**	Use of Interties Lacks Agreements and Essential Facilities!!!

Table 6-4 (cont.)
City of Tumwater - Well Sources Update

Current System Storage Capacity:			
Zone No. 1 - Zone 350 - Storage Available:		**Zone No. 1 Storage Required:**	
New Reservoir Facility (Replaces "C" ST):	4,000,000	Equalizing Storage :	1,000,000
Airport Elevated Reservoir:	200,000	Fire Flow Storage:	0
Mottman Reservoir No. 3 (Transfer):	9,500	Standby Storage:	1,000,000
Mottman Reservoir No. 4 (Transfer):	115,000		
Somerset Hill Reservoir No. 5 (Transfer):	30,000		
Total Usable Amount:	**4,354,500**	Total:	2,000,000
Zone No. 2 - Zone 455 Zone - Storage Available:		**Zone No. 2 Storage Required:**	
Mottman Reservoir No. 3:	70,500	Equalizing Storage :	72,900
Mottman Reservoir No. 4:	885,000	Fire Flow Storage:	0
Somerset Hill Reservoir No. 5 (Transfer):	495,000	Standby Storage:	1,028,800
Total Usable Amount:	**1,450,500**	Total:	1,101,700
Zone No. 4 - Zone 549 - Storage Available:		**Zone No. 4 Storage Required:**	
Somerset Hill Reservoir No. 5:	980,000	Equalizing Storage :	0
		Fire Flow Storage:	630,000
		Standby Storage:	124,800
Total Usable Amount:	**980,000**	Total:	754,800
Total System Storage Capacities:	**6,785,000**		
Total System Storage Required:	**3,856,500**		

Source Contamination Scenario Questions:

1. Assuming Loss of Entire Palermo Wellfield, What System Storage, Fire Flow, and Supply Distribution Problems Would Most Likely Occur:
   - 24-Hour Short-Term Wellfield Loss
   - One Week Medium Wellfield Loss
   - Multiple Month Wellfield Loss
   - Long-Range Permanent Wellfield Loss
2. Assuming Loss of Entire Bush Wellfield, What System Storage, Fire Flow, and Supply Distribution Problems Would Most Likely Occur:
   - 24-Hour Short-Term Wellfield Loss
   - One Week Medium Wellfield Loss
   - Multiple Month Wellfield Loss
   - Long-Range Permanent Wellfield Loss
3. Develop a Matrix for the Above and Specific Recommendations to Overcome Source Loss Problems
   - 24-Hour Short-Term Wellfield Loss
   - One Week Medium Wellfield Loss
   - Multiple Month Wellfield Loss
   - Long-Range Permanent Wellfield Loss

Drawbacks to the use of existing storage capacity for offsetting the loss of either the Palermo or Bush Middle School Wellfields would include the following consequences:

- Distribution system pressures would decrease as a result of the reduced storage volume and drop the normal water level in the City's storage reservoirs;
- The City's ability to meet fire flow requirements and react to a large-scale emergency would be reduced by the extent of any major drawdown of the City's reservoir storage capacity; and
- Water quality would be lessened to the extent that stagnant water would be drawn from portions of the reservoirs not utilized under normal operating conditions.

Storage is generally based upon a system's need to provide emergency volumes, equalizing storage, and adequate fire flow. The total combined volume of these three components is used as the City's storage goal.

In accordance with DOH policy, a reduction in calculated standby storage is allowed if the system has multiple sources, reliable power supplies, adequate hydraulic looping, and is maintained adequately. In calculating the credit, the largest producing well or wells on a single electrical transformer must be considered out-of-service. For this analysis, a multi-well storage credit was calculated, assuming that the City's largest wellfield source, the Bush Middle School Wellfield (1,800 gpm), is unusable during peak usage conditions. Under this set of assumptions, the City has 3,455 gpm (or 4.98 MGD) of production capacity under emergency conditions for use during the peak summer months.

Emergency Interties

Use of emergency interties can provide temporary relief for the loss of source or during emergency situations where supplemental water supply is required. Currently, the City's interties are underdeveloped for purposes of providing a reliable and sufficient source of supply during long-term emergency situations.

The City has two locations where interties with the City of Olympia have been designated. The first site is located near Carlyon and Capitol Boulevard. The distribution system at this location consists of small diameter pipe. The ability to move water into either the Olympia or Tumwater system is limited. Larger mains are relatively close to this existing site and, if utilized for intertie purposes, could produce a much greater source of supply for both systems. The second site is located in the 455 pressure zone near Mottman Road. The distribution system near this site appears to be of sufficient size for an intertie capable of transferring a large volume of water from one system to another.

The hydraulic grade of the City's system at the Mottman Road Intertie site is substantially higher than Olympia's system. This would necessitate the construction of a pump station (or a connection for a portable pump station) at the site. A booster pump would be needed for transferring large quantities of water from the Olympia system to the Tumwater system. The needed equipment and facilities are not in place.

Simulations of the City water system with as much as 1,100 gpm entering the City's distribution system at the Mottman Road location indicate a small increase in pressures near the intertie.

According to City staff, a large capital investment would be required to make these existing interties sites operational as a reliable and sufficient emergency source of supply for the Tumwater system. The development of intertie facilities and acquisition of related equipment are not among the priorities funded in the City's 1996-2001 Capital Facilities Project (CFP) financial plan.

A written agreement for an intertie between the Cities of Tumwater and Olympia does not exist. Prior to the construction of a fully developed, permanent intertie facility, a written agreement covering the terms and conditions for the joint development and use of system interties should be negotiated by and between the Tumwater and Olympia Public Works Departments. Any agreement reached should be formally approved by both the Tumwater and Olympia City Councils.

A third intertie is feasible between the Pabst Brewing Company and City water systems. A fire hydrant hose has been used in the past on a temporary basis to transfer water from the Brewery system to the City system during periods of low pressure and peak demand. Whether the development of a permanent intertie between the Brewery and the City would be cost-effective is not known. As an alternative source for emergency or supplemental supply, the potential for the development and use of this intertie should be explored and included as a mitigation option of the City's contingency plan for loss of supply. According to the City's WSP, a minimal length of water main extensions would be required to establish an intertie with the Pabst Brewery, which, as CFP Project No. 32, was estimated to cost $23,580 to accomplish (see 1992 WSP, page 7-9).

A potential fourth intertie is reportedly possible between the Olympia system and the City system when Olympia extends its transmission and distribution lines closer to the City system. The feasibility and timing for such a joint venture needs to be explored and resolved by and between the Tumwater and Olympia Public Works Departments. This does not appear to be a priority in Olympia's 1996 - 2001 Capital Facilities Plan. Olympia's water transmission and distribution system upgrades and oversizing to carry adequate flow, according to the City's Water Comprehensive Plan, are selected by UFC fire flow criteria, community growth requirements, asphalt overlay/street reconstruction projects, service records, and customer complaints.

The bottom line is that written agreements and capital investments for developing and utilizing water system interties on a routine or emergency basis between the Cities of Tumwater and Olympia, as well as the Pabst Brewery, do not exist. This leaves Tumwater's existing and potential intertie capacities uncertain and underdeveloped. The City's existing interties are incapable of providing a reliable and sufficient source of supply at the present time.

Source Augmentation

Under emergency conditions such as the loss of the Bush Middle School Wellfield, the City may activate TCE contaminated Well Nos. 4 and 5 to augment the City's available supply. Doing so would provide a total maximum sustainable capacity of 760 gpm. This alone could more than cover 42 percent of the loss of the Bush Middle School Wellfield on a temporary basis. The effect this would have on plume mitigation is uncertain.

New Source Development

The last method or strategy for mitigating the loss of either the Palermo or Bush Middle School Wellfields is through the construction of new well sources. Water rights for a new well would be essential, but the necessary rights could be supplemental to existing primary rights and need not involve any greater instantaneous or annual quantities. The purpose of the new source well would be to assist the City in meeting peak day demand during the loss of supply from an existing City well or wellfield. Water right applications for the development of new production wells should be pursued by the City to increase the quality and quantity of available source and, along with water conservation measures, help meet future demand.

6.4 Evaluation of Expansion Options

6.4.1 Purpose

A groundwater supply planning study was conducted by the Pacific Groundwater Group (assisted by Economic and Engineering Services, Inc. (EES)) for the City several years ago. The purpose of the study, completed before the discovery of TCE in Well Nos. 2, 4, and 5, was to answer two questions: (1) what should the City do with the existing Palermo Wellfield?; and, (2) where should the City look for additional future sources of groundwater?

A water rights evaluation was performed by EES as part of the study to clarify the status of the City's water right applications on file with the Department of Ecology (Ecology) and to clarify the limits of water rights already granted to the City. These analyses helped determine whether the City has adequate supplies of water available to meet future demand and the position Tumwater should present to Ecology concerning the City's pending water rights applications.

As of May 11, 1992, the City had a total instantaneous withdrawal right of 7,260 gpm (10.45 MGD) and a total volume of annual withdrawal not to exceed 4,418 acre feet. These totals exclude any water rights for the Bush Middle School Wellfield (Well Nos. 12 and 14), the Trails End Wells (Well Nos. 20 through 23), as well as any other pending water right applications and supplemental amounts.

6.4.2 Options for Additional Pumping

To determine how the Palermo Wellfield should be redeveloped and where additional groundwater supply could be developed within the City's urban growth area, pump tests were performed on five of seven Palermo Wells, the factors limiting supply at the Palermo Wellfield (water rights, well yields, and aquifer yield) were defined, and a regional groundwater assessment was completed.

The September 16, 1992, final report of the groundwater planning project contains three specific findings for the Palermo Wellfield:

- The City has been certified or has permits for 3,050 gpm under an umbrella water right for Palermo. No further rights will likely be granted at this location for the Qva Aquifer; however, additional water rights may be possible for the Qc Aquifer at Palermo.
- The seven wells in the Palermo Wellfield cannot fully utilize the Qva Aquifer potential and existing water rights largely because of well inefficiencies. Well interference is also a contributing factor.
- The Qva Aquifer at Palermo is theoretically capable of providing the likely future maximum instantaneous water right of 3,050 gpm. Wells spaced further apart than the existing wells will most easily allow this to be achieved. To pump all of the allowable source, the yields of replacement wells must be greater than those of the existing wells because the City will likely be limited to seven wells at Palermo.

These findings were then transformed into the following recommendations for the City to develop additional groundwater supply:

- The City should meet with Ecology and present the results and recommendations of the 1992 groundwater planning project report. Implementation of recommendations should consider Ecology's opinions.
- The City should maintain both the Palermo Wellfield and all other City Wells as near to their maximum instantaneous withdrawal rates as practical. This will provide optimum flexibility in operation and serve as insurance against interrupted flows in the event of system breakdown or source contamination. Supplemental groundwater rights for the Port and Palermo Wells allow for flexibility in operation.

- Specific recommendations for the Palermo Wellfield assume the granting of the umbrella water right. The City should replace Well Nos. 1 and 2 and redevelop and/or replace Well Nos. 4 and 5 to achieve the combined maximum instantaneous withdrawal for the Palermo Wellfield as a whole. All wells should be periodically tested for specific capacity and surge-block redeveloped when capacity is substantially reduced. Replacement wells in the Qva Aquifer at Palermo should be placed to the west of the current wellfield on City property. Oversized well casings may be warranted to minimize well loss.
- Test drilling for additional groundwater supplies in the Qc Aquifer at Palermo should be performed. A location south of the current Palermo Wellfield is recommended.
- The City should explore future groundwater supplies southwest of the current City limits, preferably within the established urban growth area (UGA). Target areas include Sections 9, 15, 16, and the south part of Section 10. Sections 9 and 10 are favored because they are zoned largely residential and thus have a relatively low risk potential for contamination. Sections 16 and 10 have large tracts of land zoned for industrial and a much higher risk level for potential contamination. Wellhead Protection Areas (WHPAs) should not include industrial zoned land, if possible. WHPAs in the recommended exploration sections should be precisely delineated.
- The City should delineate WHPAs around all of its current water sources and implement Wellhead Protection Program/Plans (WHPPs). Sufficient information should be gathered in the City's targeted exploration areas to allow preliminary delineation of WHPAs in that vicinity as well. The City should pursue State Centennial Grant funding for a portion of this work. DOH and the Thurston County Health Department are generating specific requirements for this work. Wellhead protection issues at Palermo Wellfield include infiltration of urban runoff in the nearby slough. Wellhead protection issues at the Port wells are dominated by industrial activities and stormwater infiltration. Wellhead protection issues in the targeted exploration area include seepage, agricultural practices, and potential upgradient future industrial land uses.
- The City should give low priority to the development of the potential Pioneer Park water supply unless Ecology is willing to grant water rights at that location based upon conceptual discussions.
- The groundwater supply at the Port source should focus on full utilization of the existing appropriation. Work should include replacement of Well No. 10 at its current location. The water right for the Port source allows a total of five wells, three of which currently exist (Well Nos. 9, 10, and 15). A future well is allowed in Section 15 under this existing water right. Well No. 13, which is in the Port and is authorized by a separate water right, should also be replaced.

Presently, the City's three wells contaminated by industrial solvent (Palermo Well Nos. 2, 4, and 5) are being considered for placement on the federal Superfund list by the United States Environmental Protection Agency (EPA).

If the City decides to maintain and further develop the Palermo Wellfield, all of the above findings and recommendations should remain in place for consideration. Should the City decide not to maintain or further develop the Palermo Wellfield (because of the existing contamination and the potential threat of additional source contamination in the future), the above findings and recommendations pertaining to the Palermo Wellfield will need to be dramatically modified or eliminated from further consideration.

The City is currently undertaking a wellfield investigation which will identify future source(s) of supply.

6.4.3 Options for Alternative Pumping Regimes

The City should also study the potential for additional source supply through alternative pumping regimes at each existing well and wellfield facility. A total of $125,000 has been approved in the current CFP budget for well pump replacements. An analysis of alternative pumping regimes available for producing increased supply should be integrated with the City's established priorities for well pump replacements and the water utility's CFP funding limitations.

6.5 Current Source of Supply Policies

According to the City's 1992 WSP, it is the City's policy to:

- Supply all water system customers within its service area from the City's supply sources.
- Actively pursue saturation planning for supply sources so that future water resource limitations can be handled effectively and the impact of source limitations can be minimized.
- Assure that the capacity of the source of supply, including wells, booster stations, and transmission mains, shall be sufficient to meet maximum day demand (including industrial demand) and to replenish storage used during a fire within 72 hours.

The supply system should be capable of meeting these criteria with the largest supply source out-of-service, or any combination of system failure considered reasonable.

6.6 Identification and Development of Potential New Sources

6.6.1 System Demand Forecast

A detailed analysis of system demands is critical to the planning processes of the City. In accordance with federal and State laws, system demands need to be analyzed to determine if the existing system can provide an adequate supply under the most severe conditions.

A future system demand analysis was completed for the 1992 WSP through the year 2010 and projected to an unspecified date when saturation development will occur within the City's UGA. The WSP forecast that the City's existing source capacity may be exceeded by system demand before the year 2000.

An updated system demand forecast should be completed for the next 20 years. The updated forecast should then be evaluated in the context of the City's planned source development projects as funded and scheduled in the City's approved capital facilities plan.

6.6.2 Projected Zoning and Land Use Impacts

Tumwater's wellfield investigations and placement of future production wells should be targeted to hydrological locations and land use zones that will satisfy forecasted demand and provide the lowest potential contaminant risk to the City's sources of supply. These targeted wellhead placements should be located within the City's urban growth area where future water and sewer services will be provided as a result of land development. Commercial and industrial development should be excluded from the City's WHPAs to the greatest extent practical. At a minimum, new wells should be located so that the City's WHPAs have the least possible overlap with current or future industrial zoned land.

6.6.3 Recommended Target Area for New Source Exploration

Hydrogeologic, specific capacity, recharge, and existing appropriation data indicate the City should explore for additional groundwater sources in Sections 9, 15, 16, and the southern portion of Section 10. Refinement of this recommendation to specific land parcels based upon probable well yields was not possible with existing information as of September 1992. However, the construction of a water main parallel to Littlerock Road south to 93rd Avenue Southwest (see City of Tumwater 1992 to 1997 CFP Worksheet) favor well exploration and development in the west half of Section 9 and the southern half of Section 15 that are zoned residential and rural residential, respectively. The southern half of Section 15 is upgradient of the industrial zones.

The target area offers the best opportunity to encounter high transmissivity aquifers in areas where additional development will not impact existing groundwater or surface water rights, according to the September 16, 1992, *City of Tumwater Groundwater Planning Project Final Report* (see pages 13-17 and Figure 9). A potential disadvantage of the target area, according to a Thurston County Health Department evaluation, is that it lies within an area of relatively high aquifer vulnerability to surface-derived contamination and its proximity to industrial lands. The County's evaluation used the shallowest groundwater levels from the shallowest wells and therefore indicates a maximum vulnerability. Actual vulnerability (see page 16 of the 1992 report) is much lower than the County index because the wells and water levels are much deeper and the aquifer is protected by the Qf aquitard. The Qf aquitard has relatively low vulnerability.

Groundwater quality in the target area is very good. Two Group A water systems are located in Section 9. Both systems use shallow to intermediate depth wells. There are also at least four smaller water systems in the target area. No primary maximum contaminant levels (PMCLs) have been exceeded in these systems as of 1992. Low dissolved solid concentrations in this high groundwater recharge area are expected. No regulated pollutant volatile organic compounds have been detected in these wells.

As noted previously (see Sections 3, 4, and Exhibit 4-1), two contaminated sites, Restover Truckstop and American Fiberglass, have been identified and ranked for risk level by Ecology in or adjacent to the target area. The potential migration of contaminants from these two sites should be considered in the City's wellhead protection planning and new source development processes.

The City should evaluate the relatively high vulnerability of the shallow groundwater when planning new source development and establishing wellhead protection policies in the target area.

6.7 Current Contingency Plan for Loss of Source

The City presently lacks a written loss of source contingency plan. The only document available from the City related to a written contingency plan for loss of supply is a water shortage response binder containing:

- ❑ A draft water shortage scenario dated August 8, 1994, that lays out a two-page response strategy outline consisting of:
  - <u>Warning Phase</u> when water demand is likely to exceed supply and storage capabilities within a few days;
  - <u>Phase I - Potential Crisis Looms</u> requiring voluntary private and institutional water conservation efforts; and

- Phase II - Crisis is Imminent banning all residential and commercial lawn watering and mandating water consumption reductions by commercial and institutional customers;

- Local media contacts, press releases, and meeting notes for coordinating the Lacey, Olympia, Tumwater 1994 Summer Water Conservation Program; and
- City water production spreadsheets for tracking system demand, well production, and storage levels on a daily basis from July 5 through September 26, 1994. These spreadsheets and conservation efforts have been maintained to the present time. In 1994 a mandatory lawn watering ban was put in place. In 1995 and 1996 a voluntary lawn watering ban was implemented based on the recommendations of the water shortage response plan.

6.8 Emergency Contacts

A current list of emergency contacts and telephone numbers is maintained by the Public Works Department and distributed to the appropriate emergency response agencies on a routine basis. This includes a detailed after-hour and weekend call-out schedule of City duty personnel, supervisors, and backup personnel.

6.9 Summary and Recommendations

This contingency plan assessment has shown that the City has the ability to accommodate peak day demand and effectively manage a short-term (24-hour) loss of source should either the Palermo Wellfield or the Bush Middle School Wellfield be contaminated and placed out-of-service.

Along with the analyses presented in the City's 1992 WSP, this review demonstrates that (during a period of peak day demand) an extended loss of source beyond three days for the Bush Middle School Wellfield and 12 days for the Palermo Wellfield would produce a system-wide crisis unless peak day demand could be curtailed, mitigated, or reduced to a level below the City's available supply.

Several opportunities are present for the City to develop, establish, and maintain a comprehensive loss of source contingency plan for its public water system. Recommendations are presented to help ensure that Tumwater officials and system operators are prepared to respond to emergency situations and provide reliable alternative sources of supply should a wellfield be contaminated or lost. Specifically, the City's existing lack of a contingency plan for loss of source and inability to meet long-term peak day demand suggest the need to implement several courses of action as follows.

Recommendation 6-1: **Prepare and disseminate a written contingency plan for loss of source from contamination, technical problems, or system failure.**

A written short- and long-term loss of source contingency plan needs to be developed and kept current as a vital component of the City's Wellhead Protection Program. It is required by the Department of Health that land use practices and potential contaminated sources be evaluated and updated at least every two years.

Besides mitigating and resolving the concerns and issues raised in this section, the loss of supply contingency plan should document the City's phased responses to source loss events that would severely restrict or eliminate system capacity to meet peak demand. Each phase should identify and define water supply emergency situations that are reasonable and specific. Loss of source communication protocols, triggers, decisions, and actions required of water system officials should be predetermined and documented for carrying out each phase of the plan. The City's contingency plan for loss of supply should be coordinated with and integrated into Tumwater's Emergency Disaster Plan (EDP) well in advance of the City experiencing a sudden loss of source.

The preparation and frequent updating of the City's contingency plan for loss of supply can be a valuable educational experience for both water officials and system operators alike. Identifying feasible alternative long-term drinking water sources of supply and the costs associated with bringing new supplies on-line tends to raise the value of existing sources. It also tends to heighten the desire of community leaders to implement more stringent program management efforts to mitigate and prevent wellhead contamination.

At the very minimum, the City's loss of source contingency plan should provide:

- ❑ A phased approach to a variety of loss scenarios;
- ❑ A current list of emergency contacts and communication protocols;
- ❑ Identification of alternative mitigation measures;
- ❑ The costs associated with obtaining alternate sources of supply; and
- ❑ Specific actions needed to assure water quality and system-wide distribution within available supply.

Recommendation 6-2: **Evaluate the potential benefits and consequences of source augmentation by increasing current pumping regimes to equal the City's perfected water rights.**

Source of supply may be further augmented by increasing current pumping regimes to equal the City's perfected water rights. How much volume this would provide, and the cost associated with this approach, is not known, but should be evaluated and used for loss of supply contingency planning and mitigation purposes. Before initiating emergency pumping of Well Nos. 4 and 5, the City needs to evaluate system hydraulics, plume migration, and the potential contamination threat the existing plume represents to the remaining clean Palermo Wells (Well Nos. 3, 6, and 8).

***Recommendation 6-3:* Pursue groundwater source exploration and the development of new sources of supply.**

The City is currently undertaking a wellfield investigation to identify future source(s) of supply. As part of this process, the City should initiate the exploration and development of new sources of supply west of the Olympia Airport area and across the I-5 Interstate outside of the City's current WHPAs, but within the UGA of the City. Future land uses and the presence of a water main parallel to Littlerock Road south to 93rd Avenue Southwest in the western half of Section 9, together with the southern half of Section 15 have been recommended as the priority target area for new source exploration and development.

Wellfield investigations and the placement of future production wells should be targeted to satisfy forecasted demand and provide the lowest potential contaminant risk to the City's sources of supply. If these targeted wellhead placements are located within the City's established urban growth boundary, they should match up with those areas where future sewer and water services will be provided.

***Recommendation 6-4*: Develop and implement a comprehensive hydraulic improvement plan for the City's water distribution and transmission system.**

A systematic hydraulic assessment and an aggressive improvement action plan for Tumwater's water system should be developed and implemented by the City. This would further ensure that a comprehensive loss of source contingency plan is prepared and ready for any major loss of supply or storage capability in all areas of the City. The action plan should identify needed hydraulic improvements to correct present transmission and distribution deficiencies. The plan should also ensure that system configuration matches the scenarios which form the basis of the City's contingency plan and new source development initiatives. Current hydraulic deficiencies include:

- Transmission capability from the Bush Middle School Wellfield to the distribution areas served by the Palermo Wellfield (the existing pipe capability is causing a 40 psi drop in pressure to occur now);
- Construction of additional storage capacity between the Palermo Wellfield and the Bush Middle School Wellfield to increase system reliability and boost line pressure during a loss of source emergency;
- North - south transmission capability from "C" Street to the Olympia Airport area;
- West - east transmission capability from "C" Street and Palermo Wellfield areas to the northeast section of the service area;
- Fire flow capabilities in many areas, but especially in Bush Mountain, Black Lake School, Tumwater Junior High School, and parts of Somerset Hill;

- Transmission redundancy from Booster Station 4 to 549 Zone reservoir;
- Transmission redundancy from the Mottman 455 Zone reservoirs to the Mottman Industrial Park area;
- Undersized mains throughout many parts of the system; and
- Insufficient looping of mains throughout many parts of the system.

The City should also study the potential expansion options available through alternative pumping regimes at each existing source of supply. The ultimate aim of this effort should be to make sure that all of the City's existing water rights are developed and utilized for maximum instantaneous supply. The findings of this analysis should be integrated with the City's established priorities for well pump replacements and other system maintenance and operations requirements.

Recommendation 6-5: **Evaluate, negotiate, and construct permanent intertie capabilities with the Cities of Olympia and Lacey as well as other water purveyors such as the Pabst Brewing Company.**

The City has two designated, underdeveloped, unwritten agreement interties for emergency supplies with the City of Olympia. A potential exists for a third and fourth intertie to be developed and utilized in the event of a short-term interruption of source from the City's wells or wellfields. To take advantage of these opportunities, the City should:

- Perform cost-benefit analyses with Olympia to determine feasibility of fully developing the existing Mottman and Carlyon intertie sites;
- Negotiate a written intertie agreement with the City of Olympia;
- If cost-effective, construct and equip a permanent, automatically controlled intertie with the City of Olympia at the existing Mottman Road intertie site (the City's new on-line telemetry system could be used for this purpose);
- In collaboration with the City of Olympia, move the existing Capital Way and Carlyon Avenue intertie site to a water main location that will provide sufficient pipe capacity for transferring a large volume of water between both systems under emergency situations;
- Determine the best site, cost-benefit, and timing of constructing and equipping a third intertie between Olympia and Tumwater to be located along the east City boundary near the Yelm Highway; and
- Perform cost-benefit analyses with the City of Lacey and Olympia to determine the feasibility of interconnecting the three water systems to augment emergency capabilities;
- If cost-effective, negotiate a written agreement between the Cities of Tumwater, Olympia, and Lacey for the development and operation of interjurisdictional

interties capable of transferring large volumes of supply to and from all three systems.

- If cost-effective, construct and equip permanent, remotely controlled interties by and between the Cities of Lacey, Olympia, and Tumwater.
- Perform a cost-benefit analysis with the Pabst Brewery Company to determine the feasibility of fully developing and utilizing an intertie between the two systems.
- If cost-effective, negotiate a written intertie agreement between the City and the Pabst Brewing Company.
- If cost-effective, construct and equip a permanent, automatically controlled intertie between the Tumwater and Brewery systems (the 1992 WSP cost estimate was $23,580).
- Explore the feasibility of establishing and maintaining an emergency intertie capability with other neighboring water purveyors.

Recommendation 6-6: **Initiate a coordinated approach toward regional water supply contingency planning and source development among the Cities of Tumwater, Olympia, Lacey, and Thurston County.**

An integrated regional groundwater testing program should be initiated with the goal of determining the potential yield and water quality of the region's major supply areas. Most of the important water supply areas in northern Thurston County are located close to a proposed secondary water transmission pipeline that would originate in the vicinity of Olympia's McAllister Springs and terminate near Tumwater's Palermo Wellfield or possibly in West Olympia near Allison Springs.

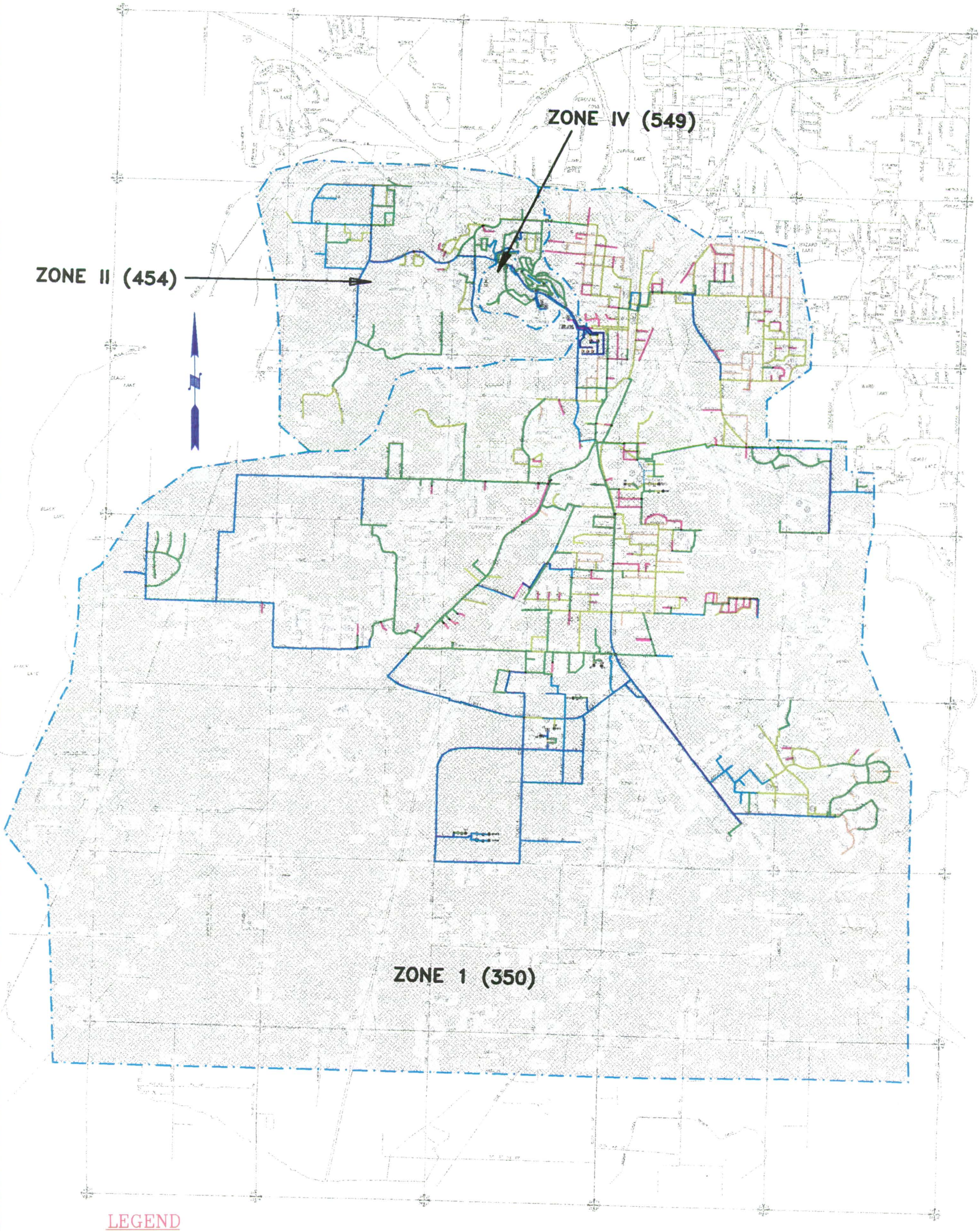
Presently, the City of Olympia is planning to develop new sources of supply upgradient from McAllister Springs in the McAllister Gravel (MG) Aquifer. The City of Lacey is considering development of new water supplies from several local aquifers that are in the vicinity of this proposed alignment. Many existing and proposed sources located along this alignment could be integrated into a regional supply and intertie network. This regional approach should be designed and organized to address other resource issues such as water right transfers, aquifer and wellhead protection, as well as instream flow impacts.

The loss of source contingency plan should summarize water system characteristics (including interjurisdictional interties capable of flowing in both directions), assess the vulnerability of individual sources, and specify agreed-upon actions and mitigation measures in the event of a loss of supply. The plan should identify who must be consulted, informed, and included in the decision making process. Areas set aside for emergency and future source development, as well as emergency response or supplemental supply infrastructure and equipment purchases, should be jointly planned and financed on a northern Thurston County or regional basis.

The City should request that the Thurston County Ground Water Policy Advisory Committee (GWPAC), utilizing the Local Emergency Planning Committee (LEPC) as an action planning forum, encourage and review the establishment, maintenance, and updating of an interjurisdictional loss of source contingency planning effort. The plan should include provision for the development and operation of interjurisdictional interties for responding to a catastrophic loss of source (such as the Lacey Main System, McAllister Springs, or the Palermo Wellfield) and other emergency response scenarios.

The regional emergency and contingency planning process should include an evaluation of the costs associated with the development of new sources, the protection of existing sources, and the opportunities for realizing potential economies of scale/cost-savings through coordinated or integrated water system facilities, equipment, and operations. A regional emergency and contingency plan would help ensure that the most cost-effective use of available resources is achieved over time.

City of Tumwater



LEGEND

- TWO INCH & SMALLER
- THREE INCH
- FOUR INCH
- SIX INCH
- EIGHT INCH
- TEN INCH
- TWELVE INCH
- SIXTEEN INCH
- EIGHTEEN INCH
- TWENTY INCH
- TWENTY FOUR INCH

EXHIBIT 6-1

TUMWATER WELLHEAD PROTECTION PROGRAM

CURRENT WATER SERVICE AREA
AND
DISTRIBUTION SYSTEM

OCTOBER 1996

ECONOMIC AND ENGINEERING SERVICES, INC.

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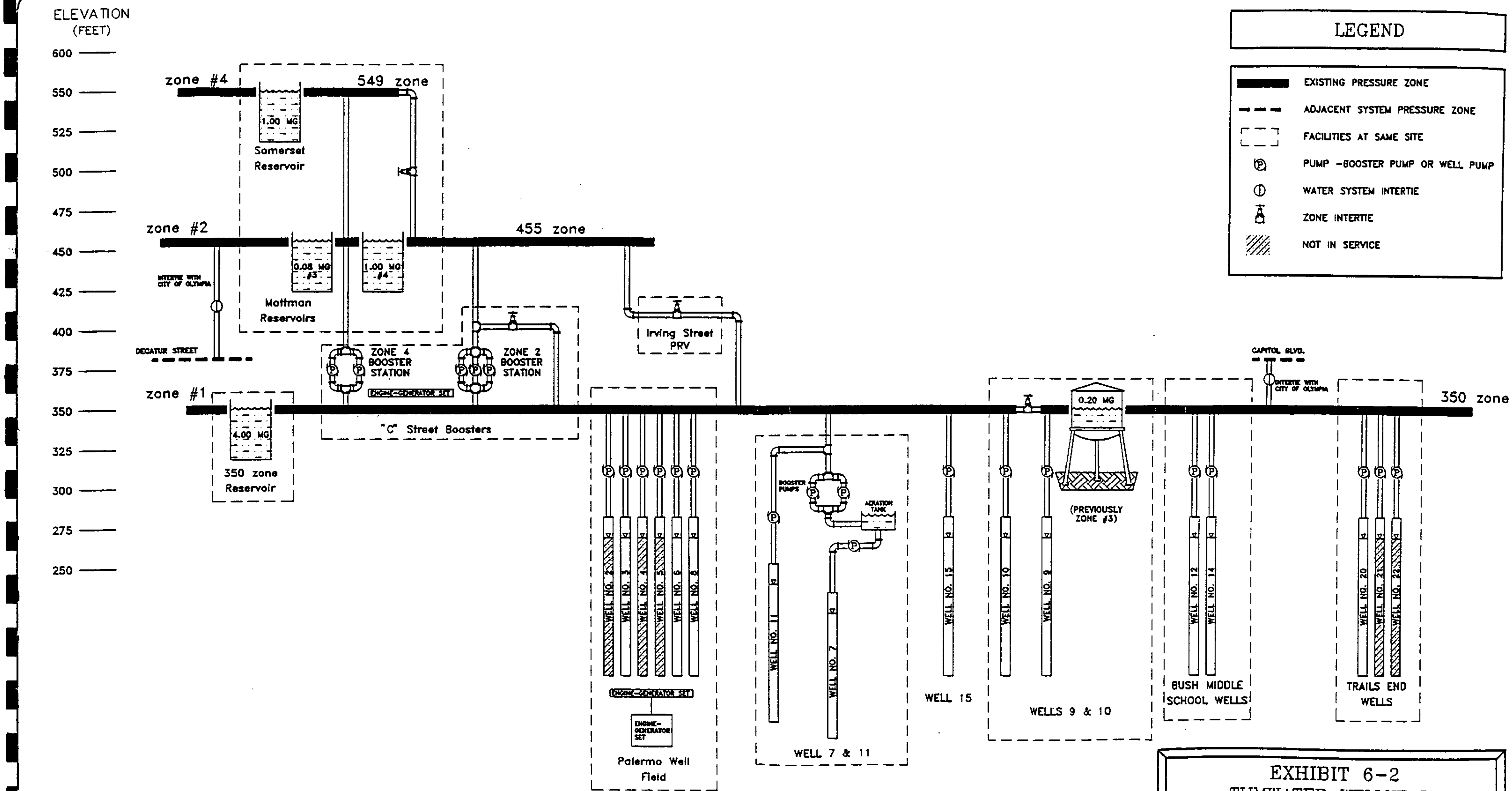


EXHIBIT 6-2
TUMWATER WELLHEAD PROTECTION PROGRAM
CURRENT WATER SYSTEM HYDRAULIC PROFILE

OCTOBER 1996

ECONOMIC AND ENGINEERING SERVICES, INC.

City of Tumwater
Comprehensive Water System Plan

Section 7

Section 7
Existing Risk Mitigation Programs

7.1 Introduction

This section outlines existing pollution prevention strategies and risk mitigation programs available to protect the City of Tumwater's (City's) drinking water supplies. This section also recommends pollution prevention enhancements or new risk mitigation programs where opportunities for improved protection of the City's Wellhead Protection Areas (WHPAs) are possible. These recommendations focus on specific program areas or protection activities where existing pollution control measures or management strategies do not satisfy the City's wellhead protection needs.

Wellhead protection programs offer the City and the region as a whole an opportunity to integrate all of the existing management strategies and pollution prevention programs into a more effective environmental protection effort. Specifically, wellhead protection programs have a limited geographic focus, they have specific risk reduction priorities, they are of considerable local interest, and they provide the opportunity for establishing and maintaining local control.

For this section, basic Wellhead protection strategies and risk mitigation programs have been categorized and will be discussed as follows:

- Program management and coordination
- Monitoring and data management
- Public involvement and education/technical assistance
- Land use planning and regulation
- Other regulatory programs

7.2 Program Management and Coordination

The City is an active participant in implementing the Northern Thurston County Ground Water Management Plan, adopted in September 1992, which provides a regional framework for groundwater protection. Local jurisdictions coordinate activities through several regional committees. These City and regional program management systems are generally well suited to coordinating the development, implementation, and upgrading of wellhead protection programs.

7.2.1 City Program Management and Coordination

In the City of Tumwater, groundwater protection is primarily the responsibility of the Public Works Department. Program planning and water resource operations are the responsibility of the water, stormwater, and sewer utilities. For example, the water utility updates the City's Comprehensive Water System Plan every six years. It will soon incorporate wellhead protection and water conservation plans into the City's overall water system plan. The water utility is also responsible for contingency planning to prepare for the possible loss of a water supply source due to contamination or other emergency (see Section 6).

To minimize the risk of groundwater contamination from stormwater runoff, the stormwater utility prepares drainage basin plans, constructs regional storage and treatment facilities, maintains the drainage system, reviews development plans, and coordinates public involvement and education activities. A 1997 Centennial Clean Water Fund grant will support comprehensive stormwater program improvements. This will include mapping and identifying the condition of all public and private stormwater facilities, evaluation of an ordinance for compliance with regulations, and enhancement of enforcement, maintenance and pollution prevention programs.

The sewer utility operates the City's wastewater collection system, including maintenance, to prevent leakage which might contaminate groundwater. The Sewer Comprehensive Plan will provide for the extension of sewers throughout the City and its urban growth area. Meanwhile, the City relies on the Thurston County Health Department for management of on-site septic systems to prevent groundwater contamination from that source.

Preparing for quick response to spills of hazardous materials and other potential contaminants is a primary responsibility of the Tumwater Fire Department in coordination with the City's Police and Public Works Departments, as well as other State and local agencies (see Section 5).

7.2.2 Regional Ground Water Management Plan

The City's delineated wellhead protection zones are located within the northern Thurston County Ground Water Management Area (GWMA). The GWMA was established by the Department of Ecology (Ecology) in 1987, initiating a cooperative Ground Water Advisory Committee (GWAC) planning effort funded by Ecology, Thurston County, and the Cities of Tumwater, Lacey, and Olympia. The work of the GWAC resulted in the development and adoption of the Northern Thurston County Ground Water Management Plan (GWMP) in September 1992.

The Plan presents regional approaches to groundwater protection, and also proposes many program expansions and enhancement activities involving:

- ❑ Special Protection Areas (including WHPAs)
- ❑ Groundwater Quantity Management and Protection
- ❑ Wastewater Treatment
- ❑ Hazardous Materials Management
- ❑ Use of Pesticides and Fertilizers
- ❑ Stormwater Management
- ❑ Well Construction and Abandonment

Recommendations were developed for these and other areas. For this WHPP, the GWMP effort was reviewed in terms of aquifer and wellhead protection background information, methods of analysis, and level of priority for implementation.

The City has supported implementing the GWMP as an integrated regional program, provided an appropriate scope of activity, allocation of responsibilities, and funding mechanism can be developed and implemented among the four affected entities (Tumwater, Lacey, Olympia, and Thurston County).

The Cities of Tumwater, Lacey, and Olympia remain committed to implementing the GWMP as much as possible within their jurisdictions. Coordination occurs through the Groundwater Policy Advisory Committee (GWPAC), Public Works Directors Steering Committee, Education Technical Advisory Committee (ETAC), and Groundwater Technical Advisory Committee (GWTAC), representing elected officials, senior management, and technical staff of the County and cities.

Table 7-1 outlines the recommendations of the GWMP by general planning category. Included in Table 7-1 is a summary of the implementation status of recommended GWMP tasks and activities as of March 1996.

Regional Coordinating Committees

Several regional committees have been established to coordinate groundwater protection activities in Thurston County:

- ❑ The Groundwater Technical Advisory Committee (GWTAC) includes technical staff from the four jurisdictions and Thurston Conservation District. It meets as needed to coordinate technical aspects of regional program implementation, assess progress, and recommend regional priorities for work programs and budgets.
- ❑ The Education Technical Advisory Committee (ETAC) includes public involvement and education (PIE) specialists from the local jurisdictions, school districts, and other agencies. The ETAC meets every two months to coordinate public involvement and education on a wide range of environmental issues and maintains a regional calendar of events.
- ❑ The Public Works Steering Committee also has a general role in coordinating the activities of the local public works departments. It focuses on utility coordination issues related to drinking water, wastewater, stormwater and solid waste management issues.

Table 7-1
Status of Groundwater Management Plan Recommendations
Northern Thurston County

GWMP Reference		Task/Activity	Status
AQ	1	Allocation of water to facilities in unfinished agenda.	No action
AQ	2	Review State's general permit process after four years.	No action
ASA	1	Support an Aquifer Sensitive Area (ASA) designation in the County's Comprehensive Plan.	Some progress as part of CARA ordinances.
ASA	2	Establish Policy for ASAs through the Interlocal Committee.	GWPAC has that role.
ASA	3	ASA will include categories I and II of Aquifer Sensitive Area Map.	Done
GR	1	Incorporate the policies of the GWMP into laws and regulations of jurisdictions.	Stormwater manual reflects recommendations of the GWMP - CARA also contains some recommendations.
GR	2	A groundwater education program should be designed and established to reach the wide variety of citizens who live or work within the area.	Some aspects covered by Hazardous Materials education and Solid Waste Education and activities.
GR	3	Support the review and revision of the GWMP.	In process
GR	4	Support the Thurston County Health Department in providing staff to respond to local groundwater quality and quantity concerns that are not already covered by other programs.	Respond to request to the extent staff are available.
GR	5	Dedicated emergency account.	No action
GR	6	Coordinate with Fort Lewis and Tribes during implementation.	Limited coordination
HM	1	Seek optimum funding for the Moderate Risk Waste Plan.	Funded at moderate level
HM	2	Develop and administer a local underground storage tank program with partial funding from Ecology.	No action as result of Ecology's policy on fees.
HM	3	Encourage and assist in the implementation of a program within the Thurston County Health Department to minimize risk associated with currently un-regulated underground tanks.	MRW developed informational brochure.
HM	4	Develop and implement a policy for new or replaced USTs located within WHPAs and ASAs.	No action. Only possible with local program.
HM	5	Administer education and technical assistance programs for home heating oil tanks concentrating on finding and remedying leaking tanks within WHPAs and ASAs.	No action
HM	6	Implement a hazardous materials transportation spill prevention program.	Limited action: utilities are considering what, if any, structural improvements are feasible.
HM	7	Improve existing spill-response mechanisms.	LEPC is meeting. Revisions to emergency plan is progress and addressed in WH plans.
HM	8	Route transportation of hazardous materials out of zone 1 (except local delivery).	No action
HM	9	Designate routes for transport of hazardous material in wellhead zones and focus highway improvements including those for stormwater and containment on those routes.	No action
HM	10	Collaborate with BN to reduce risks.	Limited dialogue
HM	11	Health Department and BN to focus on WHPAs first.	Limited dialogue

Table 7-1
Status of Groundwater Management Plan Recommendations
Northern Thurston County

HM	12	Require facility to retrofit or hook-up to sewer for facilities within the UGMA that may incidentally discharge residual amounts of hazardous materials to their wastewater systems.	No action
HM	13	Cooperatively develop a Hazardous Materials Program to address the use and storage of hazardous materials by business, industries, and government agencies. This program will focus on an inventory, education, technical assistance, and regulatory measure.	Initial evaluation step (assessment of gaps and overlaps by fire/health/business) is not being undertaken. Some aspects of the recommendation are being covered by the MRWP (five- to seven-year inspection cycle) or are covered by the nonpoint ordinance.
HM	14	Develop a hazard rating system and apply it to sites that use, handle, or store hazardous materials.	Discussion only
HM	15	Do not allow an increase in intensity of a non-conforming use in WHPAs.	No action
HM	16	No new activity covered by the HM-13 standards allowed in WHPAs.	No action
HM	17	Mitigation required for high risk activities of HM-13.	No action
HM	18	System to update Hm-13 standards.	No action
HM	19	Hazardous materials recommendations for ASAs. Policy to be reviewed and implemented by GWPAC.	No action
HM	20	Support the development of a Memorandum of Understanding between the Department of Ecology and the Health Department which will assure local input is incorporated into any ranking and site review and assessments under the Model Toxics Control Act.	Applied for and received a grant to conduct site hazard assessment - eight completed in 1995.
HM	21	Request that the Department of Ecology enter into a Memorandum of Understanding with Thurston County Health Department to assure that local interests and concerns are incorporated into the proposed siting of any hazardous waste landfill in the County.	Applied for and received a grant to conduct site hazard assessments - eight completed in 1995.
HM	22	Education regarding illegal disposal of hazardous materials.	Implemented as part of the MRWP.
PF	1	Educate homeowners and small-scale farmers about the potential negative impacts of pesticides and fertilizers (or byproducts) in groundwater.	Work with homeowners through IPM nursery program and CS work associated with various grants.
PF	2	Focus initial education and technical assistance programs for homeowners to ASAs and wellhead zones.	Work with homeowners through IPM nursery program and CD work associated with various grants.
PF	3	Identify small-scale farms in ASA or wellhead areas that have a high potential to contaminate groundwater and work with these farmers to develop Farm Plans.	No action
PF	4	Use non-chemical vegetation management along right-of-ways within wellhead areas.	No action
PF	5A	Require Farm Plans for all commercial farms located in wellhead areas.	Two plans completed (all farms expected to be reached in five years).
PF	5B	Model pesticide mobility under local conditions.	Work completed - report available.
PF	5C	Develop locally appropriate Integrated Pest Management techniques for crops grown in Thurston County and provide technical assistance to local growers in application of these techniques.	No action
PF	5D	Monitor groundwater for pesticides and fertilizers and their breakdown products.	No regional monitoring in WHPA.

Table 7-1
Status of Groundwater Management Plan Recommendations
Northern Thurston County

PF	5E	Request that the Washington State Department of Agriculture develop special regulations for pesticide application in areas within wellhead zones.	Meetings held with Department of Agriculture. Use of this regulatory tool deemed un-warranted at this time.
PF	5F	Require all golf courses, school districts, parks, lakes management districts, and other establishments with large areas requiring intensive management, to create and adopt Integrated Pest Management Plans.	Technical assistance provided to schools in 1995 on storage, handling, and disposal of chemicals.
QT	1	Participate in implementation of the GWMP monitoring plan.	Limited quantity monitoring is carried out by utilities and regional groundwater program. Quality program established.
QT	2	Address maintenance of aquifer recharge through stormwater management recommendations.	Focus is primarily on structural fixes through implementation of drainage manual requirements.
QT	3	Participate in a coordinated general education program on water conservation - under the general direction of the Thurston County Health Department.	Utilities have started developing programs.
QT	4	Complete a Conservation Plan with the goal of a ten percent reduction in demand over 15 years.	DOH requires through guidance and policy.
QT	5	Support the Chelan Agreement process.	Philosophical support only.
ST	1	Support the creation of a common stormwater policy and design manual.	Unknown
ST	2	Support existing public education and technical assistance efforts in the area of stormwater management.	Unknown
ST	3	Support increased inspection and enforcement efforts where hazardous materials might contaminate stormwater.	Unknown
ST	4	Support improved maintenance of stormwater treatment and storage facilities.	Unknown
ST	5	Support an inventory of stormwater storage, treatment, and conveyance systems.	Unknown
ST	6	Examine stormwater regulations, ordinances, and policies for consistency with the objective of minimizing stormwater generation.	City of Olympia has completed preliminary analysis under impervious surface study.
ST	7	Encourage or require cluster development.	Included in most recent zoning revisions in the County.
ST	8	Encourage the use of alternative forms of transportation.	Commute trip reduction programs are underway.
ST	9A	Modify the stormwater facility design manual to add screening tables to help designers and reviewers determine which BMPs are most appropriate for a particular site.	No action
ST	9	Monitor stormwater facility types and measure their performance against a performance guideline to encourage the development of new BMPs.	No local action - some work at the State level.
ST	10A	Increase the required minimum vertical separation between the seasonal high water table and the bottom of stormwater facilities.	Unknown
ST	10	Require stormwater pre-setting or detention ponds to be able to be isolated and sealed to prevent accidental spills from reaching infiltration areas.	Included in the design manual

Table 7-1
Status of Groundwater Management Plan Recommendations
Northern Thurston County

ST	11	Require a more extensive, critical review of stormwater design when in ASA or wellhead areas.	No action - included in CARA
ST	12	Encourage aboveground conveyance of stormwater in ASA or wellhead areas.	Unknown
ST	13	Require additional stormwater treatment before infiltration in ASA or wellhead areas to remove additional soluble pollutants.	Unknown
SW	1	Endorse the State priorities for solid waste management.	Unknown
SW	2	Prohibit the future development of landfills in the ASAs or wellhead areas.	Unknown
SW	3	Encourage the Thurston County Health Department or the State to assess the likelihood of potential problems with closed landfill sites in the Lacey area.	Unknown
SW	4	Increase funding to the Thurston County Health Department for staffing for enforcement, and/or seek to add the ability of the Department to levy fines for solid waste violations.	Enforcement level has increased and County has increased enforcement and civil penalties available.
SW	5	Reduce the waste stream going to landfill and reduce hazardous material going to landfills.	Very active solid waste programs in Olympia and County-wide.
SW	6	Assure proper storage and disposal of manure.	SCS and CD and Ecology are working with local dairies primarily in South County.
SW	7	Endorse Thurston County's efforts to eliminate tire piles.	Tire piles largely eliminated.
SW	8	Promote the State's priorities for solid waste handling by assisting in the development of programs for use of sewage sludge.	No action
WC	1	Support Thurston County Health Department in creation of a local regulatory program for management of certain aspects of well siting, construction, identification, and abandonment.	Unknown
WC	2	Support the Thurston County Health Department in their efforts to get the Department of Ecology to establish a committee to address well construction, maintenance, and abandonment.	Unknown
WC	3	Discourage proliferation of wells in zone 1, and prioritize well construction and abandonment programs in this area.	Unknown
WP	1	Development of a joint Wellhead Protection program with neighboring jurisdictions.	Unknown
WP	2	Establish an Interlocal Wellhead Protection and Financial Policy Committee.	Unknown
WP	3	Thurston County Health Department wellhead protection policies should be prepared and submitted to the Interlocal Wellhead Committee.	Unknown
WP	4	Submit Wellhead Plan to the Interlocal Wellhead Committee for review.	Unknown
WP	5	Include time-of-travel (TOT) zones in wellhead plan.	Required by DOH
WP	6	The Interlocal Committee should prepare guidance for variances to land use restrictions in wellhead zones.	Unknown
WP	7	Wellhead zones should be priority areas for groundwater protection programs.	Unknown

Table 7-1
Status of Groundwater Management Plan Recommendations
Northern Thurston County

WP	8	Site new wells only after preliminary wellhead risk analysis and submittal to Interlocal Committee for approval.	Unknown
WW	1	Conduct Regular Water Quality Monitoring.	Limited monitoring by regional groundwater program in 1994. DCAP under peer review.
WW	2	Develop GW education plan.	Limited number of workshops in 1994 - 1995, with limited number planned for 1996.
WW	3	Jurisdictions consider ordinances and policies to reduce or eliminate septic system cleaners and phosphate detergents.	State WAC prohibits cleaners - no other activity.
WW	4	No recommendation - removed prior to adoption.	No recommendation.
WW	5	Use the 10 mg/l nitrate level as the maximum acceptable level in water supplies.	No known areas exceed standard. Individual wells have exceeded standard. Policy paper completed by ?
WW	6	Support efforts to model nitrate loading from septic system and other sources in Thurston County.	No action
WW	7	Implement an operational permit program for maintenance of septic systems within the wellhead zones.	Limited O&M program for new or repaired systems.
WW	8	Establish interim zoning of one unit per five acres where septic systems will be permanent in ASAs or WHPAs.	Established in part under current zoning, limited areas have higher densities.
WW	9	Allow residential densities for on-site systems in Urban Growth Areas and ASAs (temporary systems) which are higher than 1 per 10 acres unless modeling or monitoring indicates aquifer problems.	Established in part under current zoning, limited areas have higher densities.
WW	10	Recommend that DOH support research on new on-site technologies and that Thurston County modify regulations to incorporate appropriate new technology.	No action
WW	11	Allow zoning densities for sewered areas only if stormwater facilities are adequate to mitigate stormwater effects.	No action
WW	12	Specify various land use and remedial responses to findings of certain levels of nitrates.	Completed in 1995.

AQ = Aquaculture
ASA = Aquifer Sensitive Areas
GR = General Recommendations
HM = Hazardous Material
PF = Pesticides and Fertilizers
QT = Quantity
ST = Stormwater
SW = Solid Waste
WC = Well Construction
WP = Wellhead Protection
WW = Wastewater

In addition to ongoing program coordination, these groups have been instrumental in initiating new cooperative efforts, such as:

- Standard regional survey forms so the same land use and contaminant source information can be collected for all individual City wellhead protection plans.
- Standard data entry forms for water quality monitoring so data can be easily entered into and accessed from the regional database.
- Standards for land uses to be prohibited or restricted in wellhead protection areas.
- Experimental stormwater facilities such as collection and treatment waste from storm drains.
- Cooperative education and technical assistance program to prevent surface and groundwater contamination from high-risk businesses (Operation Water Works and Business Pollution Prevention).

Three issues that have been identified as a priority for regional cooperation are:

(1) Research into the relationship between land use density and risk of nitrate contamination from on-site septic systems.

(2) Coordination of inspection programs by local Fire Districts, Thurston County's Moderate Risk Waste Program, Ecology, and DOH.

(3) Comprehensive inventory of underground storage tanks.

Use of Ground Water Management Plan as Baseline Template

The development of the GWMP was funded by the Washington State Centennial Clean Water Fund, Thurston County, and the Cities of Lacey, Olympia, and Tumwater. The GWMP was prepared by Thurston County Health Department for and with the assistance of the Northern Thurston County Ground Water Advisory Committee. It was the third plan in the State to be certified by the Ecology as consistent with the intent of Chapter 173-100 WAC, Ground Water Management Areas and Programs. The GWMP presents an array of approaches and strategies to protect the region's groundwater resources. In addition, the GWMP proposes many management strategies and pollution control activities to protect wellhead capture zones.

Because the GWMP planning effort was completed several years ago, some aspects of the September 1992 Final Report recommendations have been implemented (see Table 7-1), while others have become outdated. Furthermore, because of the regional nature of the document, not all elements, activities, and programs are directly applicable to the City's wellheads. However, many of the specific wellhead-related actions proposed in the GWMP remain applicable to Tumwater for the development of this WHPP.

GWMP recommendations (or closely related recommendations) presented in this section are referenced to coincide with the identifiers in the GWMP (for example, WP-1: "The jurisdictions of Lacey, Olympia, Tumwater, and Thurston County shall jointly establish a wellhead protection program for publicly and privately owned water systems").

Those GWMP recommendations not referenced or discussed below either require no further specific actions by the City or will be pursued through the City's ongoing involvement in GWMP implementation activities.

In addition to GWMP recommendations, several actions or programs are identified below which could be undertaken or improved to reduce risk to the City's delineated wellhead capture zones.

7.2.3 Summary and Recommendations

In the absence of a single agency with formal regional responsibility for environmental protection, the existing coordinating committees provide a basic framework for regional coordination of wellhead protection activities. An overriding program management strategy of this plan is to work through existing systems to focus existing groundwater protection programs in the City's designated wellhead protection areas.

Program management and coordination efforts to improve wellhead protection comprise the least expensive program category of the City's WHPP.

The primary focus of program management and coordination efforts is to reduce existing risks from potential threats not adequately covered by current land use controls or other regulatory program activities. To this end, the following actions are recommended.

Recommendation 7-1: **Review all City environmental protection programs that might affect groundwater and evaluate their effectiveness in preventing groundwater contamination in WHPAs.**

Like many State, federal, and local programs, Tumwater's environmental protection efforts may also benefit from redirection and focus. The City has many programs designed to protect groundwater, directly or indirectly. These range from public health and safety regulations to environmental permits and land use controls. Many of these programs have been in place for a number of years and pre-date the Northern Thurston County Groundwater Management Plan. With the development of this Wellhead Protection Plan (WHPP), it is appropriate that these programs be inventoried, audited for effectiveness and cost, and evaluated in terms of whether they should be eliminated, changed, combined, or improved.

This effort should start with an inventory of all policies, programs, and processes which might affect the quality of groundwater. This WHPP contains much of this information. Secondly, a set of audit criteria should be developed for use in measuring the policy or program's success. Finally, an audit of these elements needs to occur, preferably by an entity other than the City, and the results provided to the City for action.

Recommendation 7-2: **Provide routine leak detection on all sewer force mains within the one- and five-year time-of-travel zones of each designated WHPA.**

Most of the land area within the one-year and five-year time-of-travel zones of the Port Wells and the Palermo Wellfield are sewered (see Exhibit 3-4). A leak in a sewer force main may inject wastewater effluent into the aquifer below and contaminate the City's drinking water supply. Leaks in sewer force mains may not be detected unless they are routinely searched for, discovered, and investigated for repair (hopefully, on a timely basis).

A permanent leak detection program needs to be established and maintained by Tumwater's Public Works Department to systematically determine if the City's sewer force mains are leaking and in need of repair. All force mains within the City's one-year time-of-travel wellhead zones should be inspected at least once each year. Force mains within the City's five-year time-of-travel wellhead zones should be inspected at least once every two years.

Routine leak detection on all sewer force mains within the region's delineated one-year and five-year wellhead zones should be a policy issue before the GWPAC for universal application throughout the existing and expanding Lacey-Olympia-Tumwater-Thurston County (LOTT) sewerage collection and treatment system.

Recommendation 7-3: **Through the GWPAC and GWTAC, develop and use a regional hazard ranking system to provide assistance to legislative bodies of the individual jurisdictions in implementing wellhead protection priorities and land use permit conditions.**

As recommended by the Northern Thurston Ground Water Management Plan, a regional hazard ranking system should be developed and used to evaluate the risks associated with all existing and new land users in WHPAs. The rating system would rank the types and quantities of hazardous materials used, handled, or stored on each site. The past record of the particular type of activity should be considered in the rating structure. The hazard ranking system would be used to determine whether a proposed land use activity or practice should be allowed within the zone, what types of controls might be required, and whether a non-conforming use could make changes to those established for the site. Non-conforming uses are activities prohibited by the zoning code but which are already legally present in the zone (WP-5).

By using this hazard ranking method, lists of medium and high risk industries would be delineated. This approach contrasts with traditional zoning practices in that non-conforming uses would be allowed to expand their facilities so long as their hazard rating does not increase. Existing businesses could be replaced with new businesses that have an equivalent or lower hazard rating. This would allow new businesses to move into a wellhead zone without increasing the potential for groundwater contamination.

The hazard rating system for activities that use, handle, or store hazardous materials in designated WHPAs should be developed by the GWPAC with the advice and support of the GWTAC. Once adopted, the system could be used by the Cities of Tumwater, Lacey, Olympia, and Thurston County in a consistent manner based upon standardized criteria. In developing the program, the GWTAC should review the feasibility of replicating the City of Dayton's (Ohio) model hazard ranking system, work with affected industries and businesses, especially waste handlers, and other regulators, such as local fire departments, Thurston County Health Department, and Ecology (HM-13 through HM-18).

Recommendation 7-4: **Through the GWPAC and GWTAC, coordinate pollution control policies and management strategies related to Wellhead Protection Programs for the Cities of Tumwater, Olympia, Lacey, and Thurston County.**

The four member GWPAC is comprised of an elected Council member from the Cities of Tumwater, Olympia, Lacey, and an elected member of the Thurston County Board of Commissioners. The GWTAC is the technical advice and policy development support staff to the GWPAC. The GWTAC is comprised of an appointed staff representative from each of the four member jurisdictions. This group should foster and underscore the ongoing need for interjurisdictional policy planning coordination and consensus making to protect the drinking water source supplies of northern Thurston County (WP-2).

The GWPAC and GWTAC provide an excellent forum for encouraging regional coordination and consistency among the participating jurisdictions. The GWPAC and GWTAC can develop joint management strategies, WHPP program initiatives, and interjurisdictional resolve for implementing wellhead protection and pollution prevention measures. The GWPAC and GWTAC can also promote new regional sources of supply, emergency transmission and distribution capabilities, as well as upgrading the region's spill response and loss of supply contingency planning capabilities over time within existing staffing and funding levels.

A logical starting place would be for the Cities of Tumwater, Lacey, and Olympia to present their respective WHPPs to the GWPAC for review. The goal would be establishing focus and setting priority on specific wellhead protection activities that will best serve the overall groundwater supply interests and risk mitigation requirements of northern Thurston County.

Tumwater has made an excellent start in this direction through regular briefings before the GWPAC during the development of this plan.

7.3 Monitoring and Data Management

7.3.1 Overview

The Thurston County Health Department is monitoring regional groundwater quality. The Cities of Tumwater, Lacey and Olympia are developing and implementing Wellhead Protection Plans for their groundwater supply sources, which share the same aquifer systems. Through the coordinating committees described above, local jurisdictions are working toward a regional monitoring network to optimize use of existing resources and avoid duplication.

As described in Section 2, a groundwater monitoring network was established in the City's WHPAs. Public and private wells were used to monitor water quality and water levels for this WHPP. Tumwater, Olympia, and Lacey have completed baseline inventories of land use and sources of contamination within their designated WHPAs as part of the development of their individual wellhead protection programs.

7.3.2 Data Management

The Thurston GeoData Center (TGC), operated by Thurston County with funding from other jurisdictions, serves as a regional resource for accessing County databases and satisfying regional data storage, data management, and mapping requirements.

Tumwater can develop and maintain its own wellhead protection databases and graphic displays through its existing Computer Aided Design (CAD) system capabilities; while the TGC is not designed as a comprehensive data management and archiving facility, the Thurston GeoData Center, with its Geographic Information Systems (GIS), is equipped and positioned to manage regional wellhead protection data on land use, potential contamination sources, and water quality.

The GeoData Center's use of GIS technology allows user jurisdictions to query the regional database for specific data, display the results graphically, and integrate all of the data sets through standardized protocols. The GeoData Center, for instance, has direct access to and use of the County Assessor's parcel database.

7.3.3 Summary and Recommendations

Basic systems are in place for local wellhead protection monitoring and data management purposes, but ongoing data collection and analysis by the City and at the regional level are needed. Satisfying these City and regional wellhead protection monitoring and data management needs can be expensive.

Recommendation 7-5: **Support regional water quality monitoring efforts.**

The City should identify and coordinate its water quality monitoring efforts and share data with the principal water supply purveyors and wellhead operators serving the region. The City's coordination effort should include the Thurston County Health Department, the Cities of Olympia and Lacey, the Pabst Brewing Company, and other private sector entities who own and operate wellheads that may impact the City's present and future drinking water quality. Coordinated monitoring throughout northern Thurston County can provide data for identifying water quality issues and evaluating groundwater trends on a regional level.

In partnership with the GWPAC and in support of coordinated regional water quality monitoring efforts, the City should follow the specific recommendations derived from hydrogeologic characterizations, water quality assessments, and data gathering requirements identified over the course of the development and implementation of this WHPP. This effort should include ongoing support and integration of Tumwater's wellhead protection monitoring efforts with the water quality data protocols and monitoring routines established and maintained by the Cities of Olympia, Lacey, and Thurston County.

Recommendation 7-6: **Monitor and coordinate inspection programs carried out by local fire agencies, Thurston County's Moderate Risk Waste Program, Ecology, and Department of Health.**

Several local and State agencies routinely inspect business and industrial properties, checking for conditions which might threaten public health and safety. Each agency has a different area of responsibility, but all include checking for improper storage and handling of hazardous materials. Representatives of these agencies should meet once a year to exchange notes on conditions they have observed at properties they have visited and plan to visit in the coming year. This information should then be given to the Groundwater Technical Advisory Committee (GWTAC) to assist its work in monitoring the effectiveness of regulatory activity in reducing risk of contaminating groundwater in wellhead protection areas of northern Thurston County.

Recommendation 7-7: **Integrate City Supply and Use Data into Regional Systems.**

To develop a long-term groundwater and wellhead water resource management program that balances and integrates all uses and needs throughout the region, additional water level data gathering and interpretation is necessary.

The City's water level measurements and frequency of data collection should be coordinated through the GWPAC and integrated with the Thurston County Health Department, the Cities of Olympia and Lacey, the Pabst Brewing Company, and other private sector entities who own and operate wellheads that may impact the region's present and future available quantity and quality of supply.

Coordinated water level monitoring throughout northern Thurston County can provide long-term data for identifying how much water is available and how it needs to be managed, as well as assessing groundwater flow directions and regional water levels.

Recommendation 7-8: **Routinely share land use regulatory data and information with other members of the GWPAC, GWTAC, and the public.**

Wellhead protection plans are being prepared and implemented by the Cities of Tumwater, Olympia, and Lacey. As the City develops and updates its portion of a comprehensive regional wellhead protection land use activity database and potential contaminant source inventory, a regional need will emerge to frequently discuss and routinely share wellhead protection information between jurisdictions. For instance, specific pollution prevention issues and risk mitigation actions resulting from the review of building permit applications and land use practices within designated WHPAs of the Cities of Tumwater, Lacey, Olympia, and Thurston County are of keen interest to all stakeholders. The GWTAC, in support of the mission and policy concerns of the GWPAC, would appear to be an ideal forum for this regional wellhead protection information exchange and pollution prevention assessment to take place on a regular basis.

Interjurisdictional sharing of land use regulatory practices and potential contaminant source information on a regional zone-by-zone and parcel-by-parcel basis can foster better assessments, improved coordination, and more effective application of local land use regulatory activities and risk mitigation practices throughout northern Thurston County.

Recommendation 7-9: **Establish and maintain a comprehensive underground storage tank inventory and leak detection program within the City's designated WHPAs.**

Table 4-1 and Exhibit 4-1 identify more than a dozen leaking underground storage tanks (LUSTs) located within the designated wellhead protection areas of the City of Tumwater. A variety of products may be stored in these tanks, including pesticides, aviation fuel, home heating oil, automobile fuel, and other petroleum products and hazardous substances. Cleanup is complex, expensive, and often only partially successful.

Altogether (according to Tom Allen, owner/manager of Acme Energy Services in Olympia), there are an estimated 3,000 underground storage tanks (USTs) in Thurston County. Acme Energy Services alone provides home heating fuel supplies to some 2,100 customers of an estimated 3,500 to 4,000 homes that rely on oil for heat in the County. About five percent of the County's total households use oil for heating purposes. Most USTs were made of single-walled, unprotected steel prior to 1988. Although USTs typically remain in the ground for many decades, single-walled tanks and piping often start to leak after 15 years of operation. The United States Environmental Protection Agency (EPA) has estimated that as many as 25 percent of all USTs may now be leaking. Because the number of LUSTs may be much larger than the EPA estimate, USTs may represent a significant threat to groundwater throughout the region (1992 GWMP Final Report).

A comprehensive inventory of underground storage tanks (USTs) within the City's designated wellhead protection areas has not been conducted. Although a local UST program was recommended in the GWMP, no action has been taken. The current perception is that Ecology's policy on fees has precluded State funding for the effort (HM-2).

Ecology's UST program does not provide the site-specific level of control over USTs that would be possible under a locally funded and operated program. Because a comprehensive inventory does not exist, the actual number, locations, condition and status of USTs remains unknown throughout the City and the region.

The City, in partnership with the Thurston County Health Department, should take the lead in establishing and maintaining a comprehensive inventory and leak detection program for USTs throughout the City's designated WHPAs. This effort should begin with a comprehensive parcel-by-parcel UST inventory and a systematic LUST detection program within each of the City's delineated one-year time-of-travel wellhead capture zones. The effort should proceed sequentially through each wellhead zone until all USTs have been inventoried and assessed for leaks throughout each of the City's designated WHPAs. Local home heating fuel suppliers (like Acme Energy Services), the Thurston County

Environmental Health Division, and Ecology should be solicited to advise and assist the City in completing the UST inventory process as well as in developing a cost-effective leak detection and cleanup methodology for LUSTs.

Once the initial UST inventory, leak detection, and cleanup actions have been completed throughout the City's designated WHPAs, the program should be institutionalized and made available on a UST owner request basis as a regular service of the City of Tumwater and Thurston County.

7.4 Public Involvement and Education/Technical Assistance

7.4.1 Overview

According to the Ecology's 2010 action agenda, "Education can help people regulate themselves by developing widespread understanding of, and appreciation for, what is at stake and how those stakes can be protected." Public involvement and education (PIE) have become essential components of environmental management over the past decade. Every major environmental planning effort in Washington State has included a substantial public participation element in recent years. Department of Health's (DOH) guidelines for comprehensive water system and wellhead protection planning rely extensively on active PIE and technical assistance efforts for protecting groundwater sources and implementing water conservation programs.

7.4.2 The City of Tumwater Water Resource PIE Programs

Existing public involvement and education/technical assistance programs in the City include the following major water resource and wellhead protection efforts:

- Stream Team is a citizen education and monitoring program sponsored by Tumwater, Lacey, Olympia, and Thurston County. The program involves adults and children in the protection and enhancement of water resources through workshops, environmental monitoring, training, field trips, and action projects. In Olympia, the program also includes summer day camps for youth between eight and thirteen years old. Stream Team is funded by stormwater utility fees.
- The City supports the Budd/Deschutes Project GREEN which provides watershed processes, environmental education, and action research to northern Thurston County's watershed communities through local school teachers to K-12 students. Project GREEN is funded through grants, government and business contributions. It is not a permanently funded program.
- As part of the development of this WHPP, the City approached the Business Pollution Prevention (BPP) program staff of the Thurston County Environmental Health Division in 1995 and proposed a pilot joint technical assistance effort targeted to the City's wellhead capture zones. The City and the County subsequently worked together to successfully complete a BPP

outreach project to assist businesses located within Tumwater's WHPAs (see Section 3.3). The Tumwater pilot project was funded by solid waste fees and by hazardous waste grants from Ecology created by Initiative 97.

Additional PIE activities of the City and County associated with the development of this WHPP are described in Section 3 and Appendix B.

7.4.3 Thurston County PIE/Technical Assistance Programs

Described below are the County's most active environmental protection/pollution prevention programs.

Moderate Risk Hazardous Waste Program

The County Health Department has an information program targeted to small businesses. Under a grant from Ecology, this coordinated prevention program offers information, and business "audits" on request. In addition, efforts are being made to work with other Ecology information and outreach programs as well as provide curriculum materials for schools. This program could easily be expanded and represents an alternative to increased regulation.

Under State law (RCW 70.105.220), all counties in the State are required to develop Moderate Risk Waste Reduction Programs. Moderate Risk Waste is hazardous waste which is present in such quantities that it is not regulated by the State or federal government. Thurston County adopted such a plan in 1991. Implementation has since involved elements of technical assistance and education (in addition to regulation).

Thurston County's Moderate Risk Waste Plan is being implemented by the County Department of Health through a contract with the Office of Community and Environmental Programs. The program is funded through a three percent "tipping" fee collected from users of the Thurston County landfill.

A survey of residents and waste practices was conducted in 1991 to develop this program. From this survey, priorities were set and waste generators and practices were targeted. To assess progress, this survey was repeated in 1993 to determine changes in behavior or attitude. In addition, specific program evaluation efforts have been undertaken to determine the effectiveness of the various elements of the program.

The County's program has two targeted waste categories: 1) Household Hazardous Waste and 2) Small Business Hazardous Waste. Both programs include a mix of technical assistance and educational activities as well as enforcement. Generally, the Household Hazardous Waste Program is focused more on educational activities, while the Small Business Hazardous Waste Program is carried out in more of a technical assistance mode.

(1) Small Business Hazardous Waste Program

The Small Business Hazardous Waste Program involved targeted business types during the first year of operation. These have included printers and photo processors. Future groups include gravel operations, dry cleaners, and fiberglass manufacturing. Inventory efforts have identified about 3,000 moderate risk waste generators in the County. The current program staffing level is sufficient to visit each facility once in seven-to-ten years.

The County started with letters to targeted businesses, inviting participation in a non-regulatory pollution prevention audit. The businesses were advised that a "regulatory compliance" visit would follow at a later time. Participation levels have been high (74 percent).

(2) Household Hazardous Waste Program

The Household Waste Program has a technical assistance element which by many measures has been very successful. "Hazo-House," a collection facility at the Thurston County Landfill, has been operating for several years and is staffed two days a week. This facility accommodates about 600 cars a day and handles nearly all household hazardous wastes and automotive oil. The County also sponsored "Hazardous Waste Collection Days" until the fall of 1993 when funds for this effort were exhausted.

Hazardous Waste Reduction Education

The Thurston County Moderate Risk Waste Program is one of many programs which offer environmental curriculum and more formal education materials and opportunities. Materials range from formal curriculum to workshops and production of educational materials and are used with school classrooms, supermarkets, nurseries, and other community organizations and businesses. The City has begun a pilot program to target these activities within its WHPAs.

The Moderate Risk Waste Program focuses on waste elimination and reduction. Some materials include:

- Home hazardous materials curriculum for school grades K-6 and 7-12.
- Waste reduction presentations for workshops and youth events.
- Shop smart tours emphasizing hazardous products and waste reduction.
- The Common Sense Gardening series of publications for nurseries.
- Home gardening and lawn care lectures for gardening groups.
- Programs on beneficial insects designed for school grades K-6.
- Pamphlets on proper automotive waste disposal for driver's education students.

7.4.4 Thurston Conservation District

The County has an active Conservation District which, with the assistance of the Washington State Cooperative Extension Service and the United States Department of Agriculture Natural Resources Conservation Service, provides technical assistance to landowners. This assistance takes many forms. Fertilizer application rates, appropriate animal density, as well as animal waste disposal and utilization are common topics. In many cases, recommendations are formalized in a "Farm Plan." The Thurston Conservation District (TCD) also provides a conduit for funding of soil and water conservation together with environmental protection measures. Over 60 conservation plans have been written for farms in the GWMA to date, of which 14 of the 60 completed conservation plans were for commercial farms.

"Turf Management Plans" and "Integrated Pest Management Plans" (IPM) are also common formalized approaches to land management where the land is used for a small farm, a golf course, or a park. These approaches can provide valuable guidance, and be an important tool in preventing groundwater contamination. Several commercial conservation plans have included IPM techniques.

TCD's current five-year work plan (1994-1999) is to contact some 80 small farms in Thurston County. Current funding for TCD's development of farm and land management programs is provided by a $5 per household assessment and matching grant dollars. TCD staff examine soil maps and data, topographic maps, water resource information, and other data to develop farm plans with specific management practices for woodlands, wildlife areas, pasture, and other sections of the farm. The TCD staff work cooperatively with small farm operators and landowners to list the specific changes needed and to identify methods for implementation of farm plans designed to protect the environment. The program has seven components:

(1) A formal agreement to administer the program is established between the Thurston County Health Department and the TCD.

(2) Criteria are developed to identify and inventory small-scale farms of greatest concern within designated aquifer areas and WHPAs.

(3) About six to eight individual farm plans are developed each year and workshops are conducted on common issues for small-scale farms. About 18 individual conservation plans are developed each year in the groundwater program.

(4) TCD newsletter articles and local television segments are produced.

(5) A small farm database and status reports are developed and maintained for local interagency use.

(6) Support services are provided for the program.

(7) Periodic program assessments and performance evaluations are completed.

In addition, TCD's current five-year work plan (1994-1999) calls for the staff to contact and offer technical assistance/farm plans to all major commercial farms (PF-5A).

TCD also educates homeowners and small-scale farmers about the potential negative impacts of pesticides and fertilizers or their byproducts on groundwater and assists them in changing their practices (PF-1). TCD's funding sources and program efforts in these areas need to be augmented and focused on designated WHPAs by the Cities of Tumwater, Lacey, Olympia, and Thurston County.

7.4.5 Regional PIE Programs

The regional Education Technical Advisory Committee (ETAC) has developed a long-range framework on public involvement and education for stormwater and surface water management. ETAC's framework for long-range PIE activities has been adopted in regional basin plans. ETAC's framework provides:

- Community grants
- Education and training
- Public Information
- Technical assistance and code enforcement
- Coordination, needs assessment, and evaluation
- Data management
- Policy and program development

Despite the local commitment to public involvement, major gaps in groundwater programs were identified as part of the Northern Thurston County Ground Water Advisory Committee (GWAC) planning process. Groundwater protection and water conservation programs typically were found to be funded temporarily through grants or insufficiently funded.

The ultimate aim of these public involvement and education programs is to provide members of the public with water resource information and technical assistance services that are coordinated, effective, and integrated. For example, stormwater, water utility, and wellhead protection services can be integrated because drinking water issues are clearly connected to surface water, land use, and management practices.

Table 7-2 provides an overview of the types of environmental education and public information programs that are currently available to County residents. Most of these regional programs have reached maximum capacity. Current staff have to give up existing community services to accommodate new activities. Within northern Thurston County, most ongoing PIE activities are funded through stormwater and solid waste utility fees. Several program elements have the potential to be enhanced or expanded to address the pollution prevention concerns of the City's WHPP.

Stream Team

One example of an existing regional PIE program sponsored by the Cities of Tumwater, Olympia, Lacey, and Thurston County is Stream Team. The program involves citizens in the protection and enhancement of water resources through workshops, environmental monitoring, training, field trips, and action projects. In many cases, it is possible to link surface water education and groundwater education. For example, Stream Team workshops and technical assistance programs for reducing pesticide and fertilizer use could be structured for both resources.

Operation: Water Works

Another existing water resources PIE program is Operation: Water Works. This business education and technical assistance program focuses on automotive, equipment repair, construction, landscaping, and janitorial businesses. To learn how to prevent stormwater pollution and proper disposal of hazardous waste, the program offers small businesses on-site consultations, annual workshops, handbooks, and self-assessment pollution prevention workbooks. Operation: Water Works is sponsored by Olympia, Lacey, and Thurston County.

Table 7-2
Summary of Current Environmental Education Programs in North Thurston Region

Program Name	Audiences	Major Messages	Funding Sources
Common Sense Gardening	Gardening adults	Integrated pest management Drought tolerant and native plant selection Alternatives to pesticides	Tipping fees and grants
Master Gardeners and Recyclers	Adults and families	Native plant salvage Home composting Recycling Gardening training	State grants
WSU Cooperative Extension Thurston County	Adults and children	Country living (septics, wells, yard maintenance, and watersheds)	State grants
Dirtworks (west and east)	Adults and children in Thurston County	Waste reduction Home composting Common Sense Gardening	Tipping and Solid Waste utility fees
Stream Teams	Adults and children in Thurston County, Olympia, and Lacey	Watersheds and land use Personal action-taking Community-based learning	Stormwater utility fees
Operation: Water Works	Businesses in Thurston County, Olympia, and Lacey that contribute to surface to surface water pollution	Best management practices Pollution prevention Impacts to water resources	Stormwater utility fees
Business Pollution Prevention	Businesses in Thurston County that generate moderate risk levels of hazardous waste	Proper use and disposal Alternative products Pollution prevention Groundwater impact of septics	Tipping fees and grants
Household Hazardous Waste Education	Adults and children in Thurston County	Proper use and disposal Alternative products Groundwater impacts of septics	Tipping fees and grants
Solid Waste Education	Adults and children in Thurston County	Reduce, reuse, recycle Waste reduction	Utility and tipping fees
Budd/Deschutes Project GREEN and Nisqually Watershed Education project	K-12 teachers and students Watershed communities	Watershed processes, environmental education Action research, community building	Grants, governments, and business contributions (not permanent)
The Evergreen State College	Adults	Interdisciplinary adult education in environmental studies	State and federal agencies, grants
Black Hills Audubon Society	Adults and children	Habitat protection, enhancement, and education	Volunteer
South Puget Sound Environmental Education Clearinghouse (SPEECH)	Adults and children	Environmental education and information Publication of Green Pages and Green Guides	Volunteer
League of Women Voters	Voting age adults	Groundwater and voter education	Volunteer
Sasquatch Chapter Sierra Club	Adults	Environmental advocacy	Volunteer
South Puget Sound Community College	Adults	General adult education	State and federal agencies, grants

Business Pollution Prevention

Still another existing regional PIE program, one that has been used as a pilot PIE project in the City of Tumwater, is the Business Pollution Prevention (BPP) program. BPP was coined in 1993 to encompass the various hazardous waste technical features of the 1991 Thurston County local hazardous waste plan. The County Health Department has undertaken the BPP program targeting small businesses. Under a grant from Ecology and fees from waste generators, this coordinated prevention program offers information and business audits on request. The BPP program does not duplicate services provided by other local or State agencies.

BPP is designed to help coordinate existing education and enforcement efforts. The program provides hazardous waste services not otherwise available for small businesses, such as waste management and disposal information, education about local ordinances, on-site waste audits, and when necessary, enforcement and compliance actions. Efforts are being made to work with other Ecology information and outreach programs, as well as provide curriculum materials for schools.

The County started the BPP program with letters to targeted businesses, inviting participation in a non-regulatory pollution prevention audit. Businesses were advised that a regulatory compliance visit would follow at a later time. Participation levels for the BPP program have been high (74 percent). This program could easily be expanded (with additional money and staff), and represents an alternative to increased regulation.

7.4.6 Department of Ecology Public Involvement and Education Programs

Complementary efforts abound with other environmental curricula developed by Ecology and other State agencies. For instance, Ecology's groundwater model is reserved far in advance as a visual aid to classrooms or other events. Providing such aids to the classroom can enhance the acceptance and implementation of environmental education curriculum.

Ecology has provided a variety of educational materials pertaining to hazardous materials management and compliance with hazardous waste regulations, underground tank rules, and general environmental protection. In addition, they have offered help to businesses in recycling efforts. Recently, Ecology has offered a pilot program to help several businesses develop model Waste Reduction Plans required under the Hazardous Waste Reduction Act (1990).

7.4.7 Summary and Recommendations

As the City continues to address today's water resource management and regulatory compliance issues, the need for PIE programs will grow and intensify. Traditionally, public involvement and education programs have not played a major role in the City's water utility operations. However, faced with issues which require the public's awareness, participation, and support (such as the contamination of Palermo Well Nos. 2, 4, and 5), the City will need to give more attention and priority to creating its own, or expanding the County's, environmental education and wellhead protection PIE programs. The following are directed toward keeping the public informed, involved, and supportive of the City's wellhead protection program.

Recommendation 7-10: **Request ETAC to develop a regional working agenda for wellhead protection PIE programs. To the maximum extent possible, have GWPAC member jurisdictions jointly participate, fund, and develop wellhead protection materials for use in designated WHPAs throughout northern Thurston County.**

A variety of educational materials and informational publications exist which describe wellhead protection programs and actions. In most areas, each member of GWPAC has set its own separate program priorities and working agenda for the development and distribution of wellhead protection activities and other water resource related public information, education, technical assistance programs.

There is a growing regional need for a cohesive program of public information, educational curriculum, and technical assistance to protect wellhead zones. Regionally coordinated efforts offer many advantages in reaching targeted groups and the general public. A recent example is a 4"x5" table tent display fold-up that was provided to local restaurants and other businesses by the regional jurisdictions for the past three years (1994-96) during National Drinking Water Week. The two-sided fold-up presents basic groundwater information and drinking water protection ideas. It represents an effective marketing tool and can be used uniformly throughout the region.

Given the limited resources available and the broad number of existing programs and materials, many opportunities exist for developing and implementing a coordinated approach on a regionally planned and multi-jurisdictional funded basis. These PIE efforts should be developed by the regional Education Technical Assistance Committee (ETAC) and supported by the membership of GWPAC in partnership with Ecology, DOH, and other State agencies involved with groundwater and wellhead protection programs.

Recommendation 7-11: **Assure direct contact with each commercial business and industrial site within the City's wellhead zones every two years, advising them of the locations of wellhead zones, major issues of concern, and available technical assistance.**

The Business Pollution Prevention (BPP) program pilot project completed by the County during the development of this WHPP is the only systematic outreach effort available to businesses located within the City's WHPAs. While regulatory programs are numerous, efforts to contact businesses and industries with wellhead protection information and technical assistance under the County's Moderate Risk Waste Program are modest and infrequent. There is ample opportunity to target these limited efforts to specific wellhead zones, and thus deliver prioritized groundwater protection to those areas most susceptible to contamination of the City's drinking water source supplies.

The City should explore with the County's BPP staff and GWPAC the possibility of establishing a targeted business and industry wellhead protection information program on a prioritized basis within delineated wellhead zones throughout northern Thurston County. In addition, these efforts should be coordinated with Ecology, DOH, and other State agencies involved with groundwater and wellhead protection programs.

Technical assistance funding should be established and maintained by the City so that targeted groups such as business and industry located within the City's designated WHPAs may access and tap into available local and State resources on demand. This would undoubtedly require additional funding and increased support levels by each participating jurisdiction (water utility) benefiting from the BPP program outreach effort.

Recommendation 7-12: **Remind all residential property owners in wellhead protection areas regularly of their special responsibility for pollution prevention. Seek their participation in PIE activities and volunteer opportunities, and inform them about issues of concern and available technical assistance programs.**

DOH regulations suggest that all potential pollution sources be advised of their location within a wellhead zone.

The City should use mailings or other point media to reach each WHPA property owner. Information would be targeted or general (City-wide) depending on the type of notice and ability to separate WHPA property from the general list.

One possible action would be to prepare a regional WHPP pamphlet to be bulk mailed, or newspaper inserted (many residents do not subscribe to a newspaper), to every residence within each of the WHPAs designated by the Cities of Olympia, Lacey, and Tumwater. The initial effort should be public awareness and knowledge of the region's WHPPs. Special focus (personal contact through community volunteers) may be needed for residents within the one-year time-of-travel capture zone.

Among the many information options available, one is to develop and enclose GWPAC-issued wellhead protection informational material with the billing statements for the public water utilities and those adjacent water provider entities whose distribution systems are contiguous to or fall within each city WHPP.

The presence and use of potential contaminants by households in wellhead zones poses a risk to the City's drinking water source supplies. Strategies for risk reduction will, under any scenario, require homeowner awareness and resident educational programs as a key element of the City's WHPP effort. The City should also evaluate the cost-effectiveness of mailing wellhead protection and pollution prevention information directly to all homeowners and residents every two years as an integral part of implementing and updating the City's WHPP.

Recommendation 7-13: **Develop school-related programs within the City's WHPAs, in cooperation with the Tumwater School District, the Tumwater Fire Department, Fire District Nos. 5, 6, and 11, and other local community, neighborhood, and volunteer organizations.**

For example, City staff could work directly with Project GREEN teachers to help them effectively use Ecology's groundwater model and other available groundwater education tools. Other possibilities include school tours to City wells as components of classroom environmental health education program activities. The goal would be to educate youth and their families regarding wellhead protection, risk reduction, and pollution prevention.

7.5 Land Use Planning and Regulation

7.5.1 Overview

Zoning and other land use regulations to restrict density and type of land use in wellhead protection areas is one of the primary means of reducing risk of groundwater contamination. Land use controls can either prohibit an activity or establish conditions under which an activity may locate in a particular area. Such controls may vary depending on the proximity (time-of-travel) to the wellhead, vulnerability of the water supply, and existing land uses. Overlay zoning (such as has been established for aquifer protection throughout the City) is commonly used where land uses and development are already established, making downzoning impractical.

Below are brief descriptions of comprehensive planning, zoning prohibitions and restrictions, subdivision regulations, the Drainage Design and Erosion Control Manual, the State Environmental Policy Act, and the existing critical areas ordinances/aquifer protection plans for the City of Tumwater and Thurston County. These summaries are followed by specific land use planning and regulation recommendations.

7.5.2 Comprehensive Plans

Washington State's 1990 Growth Management Act (RCW 36.70A) mandates comprehensive planning for rapidly-growing cities and counties. As a rapidly growing region, the City's and Thurston County's Comprehensive Plans must direct growth to urban growth areas that are environmentally suitable and will be adequately provided with municipal services, including sewers and drinking water.

Comprehensive plans include restrictions to encourage the most appropriate use of land, facilitate the adequate provision of water, and protect the quality and quantity of groundwater used for public water supplies. The plan must include a review of drainage, flooding, and stormwater runoff. Sewer and water plans may be developed as part of the Comprehensive Plans adopted by the City of Tumwater and Thurston County.

7.5.3 Zoning Prohibitions and Restrictions

The Washington State Constitution (Article 11, Section 11) delegates to cities and counties the power to make and enforce within their jurisdictional limits local police, sanitary, and other regulations not in conflict with the general laws of the State. Article 11, Section 11, by itself, is sufficient to empower the City of Tumwater and Thurston County to zone. In addition, the statutory powers of Washington State municipalities, which existed long before the development of zoning, included the power to restrict certain trades to areas where they will not adversely impact the environment or contaminate local drinking water supplies.

After a Comprehensive Plan is approved, the legislative body (such as the Tumwater City Council and the Thurston County Board of Commissioners) may enact ordinances needed to implement the plan. A comprehensive plan is merely advisory, a blueprint which proposes rather than disposes. Zoning, on the other hand, must comply strictly with statutory procedures: It must be by ordinance, and must include a map clearly defining the zones.

Exhibit 7-1 highlights the current zoning map for commercial and industrial land uses throughout the City of Tumwater and the established urban growth area. The potential risks of contaminants reaching the City's existing wellheads and the impact commercial and industrial land uses may have on future drinking water supplies appear worthy of review and evaluation by Tumwater's top-level elected and appointed officials. Exhibit 7-1 should also be a useful reference in searching for and investing in new sources of supply.

Consistent zoning standards for the 25,000-acre urban growth area that surrounds the Cities of Tumwater, Lacey, and Olympia have been enacted by the Thurston County Board of Commissioners (August 1996). The new zoning standards were developed as a result of a 1995 agreement between the County and the Cities to create consistent development standards in urban growth areas that are compatible with the long-term aspirations of the three Cities as they develop and grow during the next 20 years.

7.5.4 Subdivision Regulations

Under State law, subdivision of land is regulated by cities and counties. Cities and counties must evaluate proposed plats to determine whether they make provision for public health and safety. Public health and safety includes making provisions for potable water and sewage disposal.

At the preliminary plat stage, cities and counties consider only the general design of the project. The City of Tumwater and Thurston County need not, for instance, determine whether septic systems will comply with the relevant provisions of the Washington Administrative Code (this may be dealt with later by the local health officer). The City of Tumwater and Thurston County can and should, however, disapprove a plan which shows on its face that it cannot comply with relevant zoning or health rules.

Development rights vest with the filing of a complete preliminary plat, with a resulting freeze on the zoning, subdivision and health regulations to be applied to the project.

7.5.5 Drainage Control Manual

The Drainage Design and Erosion Control Manual for Thurston Region, most recently revised in 1994 and used by the City of Tumwater, aims to control water quantity, protect water quality, reduce erosion during construction, and foster innovative design of effective and aesthetically pleasing treatment systems. The manual:

- Defines the size of stormwater detention areas by volume and surface area;
- Limits the rates at which stormwater may be released to surface water and groundwater; and
- Provides detailed guidance on the level and methods of treatment of runoff to be used during and after construction.

The manual requires a drainage and erosion control plan for most new site development. All developed parcels are required to provide on-site storage (detention) for stormwater. On-site storage slows down the runoff from a site and protects downstream areas. Standards for stormwater treatment erosion control are also specified. The manual currently has no specific standards for WHPAs.

7.5.6 State Environmental Policy Act

The State Environmental Policy Act (SEPA) requires local governments to evaluate the environmental impacts of proposed actions. If an action is likely to significantly affect the quality of the environment, an environmental impact statement (EIS) must be prepared. When required, the EIS formally documents:

- Adverse environmental effects which cannot be avoided if the proposal is implemented;
- Alternatives to the proposed action;
- Relationship between short-term uses, and long-term productivity; and
- Irreversible and irretrievable commitments of resources.

Under SEPA, Tumwater has adopted standards and guidelines for the environmental review process, and may condition or deny projects which fail to meet these standards, even if the projects otherwise comply with the relevant zoning, building, health, and subdivision laws and regulations.

Local governments, like the City and the County, are encouraged to apply SEPA in proactive fashion, to avoid making crisis decisions and minimize the loss of investment if a project must be denied. SEPA plays an important role in groundwater protection, particularly in delineated areas like aquifer recharge areas and WHPAs.

7.5.7 Critical Areas Ordinances

Under the State's 1990 Growth Management Act, Comprehensive Plans must designate areas having a critical recharging effect on aquifers used for potable water. The City must also impose development restrictions in designated critical areas to ensure aquifer protection.

Tumwater's Conservation Plan

As set forth in City Resolution No. 418, Tumwater adopted its Conservation Plan (August 20, 1991) to identify, protect, and conserve critical environmental areas, including aquifer recharge areas, and valuable natural resources. Whenever a conflict exists between the two goals of protecting critical areas and effectively conserving/utilizing natural resources, the plan declares that the priority of preserving and protecting critical areas will be superior to conserving/utilizing natural resources.

The Conservation Plan is a section of the City's Land Use Element of Tumwater's Comprehensive Plan. The plan was immediately implemented into law (Tumwater Municipal Code (TMC) Title 16) by the concurrent adoption of companion Ordinance Nos. 1276 through 1283. Because of the suddenness of this Growth Management Act (GMA) requirement being placed upon the City, its large scope of coverage, and the brevity of time allowed to complete the work involved, the plan and its implementing ordinances were adopted with the knowledge that subsequent plan updates would likely occur as conditions warrant.

For instance, the 1991 Conservation Plan states that certain technical studies should be accomplished. Among these are a City-wide Geologic Study and an Aquifer Protection Plan based upon a refined definition of aquifer sensitivity. The development of this Wellhead Protection Plan represents an opportunity to act upon that knowledge based upon the hydrogeology and a refined definition of "aquifer sensitivity" in terms of delineated wellhead capture time-of-travel zones.

The goal of the City's aquifer protection program, as presented in Chapter 2, Section 2 of the Tumwater Conservation Plan, is to effectively maintain the quality of the City's groundwater by preventing contamination, with particular attention to recharge areas of high susceptibility. Classification of these aquifer sensitivity areas include:

- The degree to which the aquifer is used, now or in the future, as a potable (drinking) water source;
- Protective measures to preclude further degradation;
- Practicability of treatment measures to maintain potability;
- Availability of alternative drinking water sources; and
- The degree of sensitivity of contaminants entering the aquifer."

Among the examples of areas that require a groundwater recharge protection overlay are those designated for wellhead protection pursuant to the federal Safe Drinking Water Act. The City's Conservation Plan states that the City's major groundwater concerns include:

- Few alternative sources of drinking water exist;
- Geologic conditions in the region leave aquifers unprotected and groundwater extremely vulnerable to pollution;
- Septic systems, stormwater runoff, chemical spills, pesticides and fertilizers can add contaminants to groundwater;
- Though the region's groundwater is generally of good quality, it is showing increasing effects of human activities; and
- Urbanization and population growth are placing increased demands on limited groundwater resources.

The plan lists specific techniques that may be used to protect geologically-sensitive areas. These include:

- Adopting specific protection measures to protect drinking water supplies;
- Encouraging water system interties between purveyors;
- Changing zoning so that hazardous industry cannot locate close to major wells without strict mitigation and protection measures;
- Requiring stormwater treatment and conveyance to reduce contaminants;
- Maintaining stormwater facilities to ensure effective operation;
- Requiring industries that use hazardous chemicals to have containment facilities to capture chemicals that might spill;
- Restricting the use of some pesticides in aquifer sensitive areas;
- Providing education and technical assistance on pesticides and fertilizers to homeowners and farmers; and
- Establishing an annual permit and inspection program for all commercial and industrial establishments utilizing underground storage tanks, aboveground bulk plants and underground vaults.

According to the City's Conservation Plan, soils overlying the aquifer in the City are of two general types:

(1) Alderwood-Everett Association (85%) - these soils are moderate to very deep and moderate to excessively drained, all placed on top of glacial outwash plains; or

(2) Spanaway - Nisqually Association (15%) - these soils are very deep, somewhat excessively drained, and placed on glacial outwash terraces.

Both soil groupings have moderate to high rates of water transmission to the aquifer below. The poor filtering capacity of these soils results in groundwater contamination. Septic tanks, stormwater discharges, and storage of hazardous substances on excessively drained soils are critical concerns of the City.

The Plan recommends that the Tumwater City Council consider mandatory septic tank testing or sewer line connection as an aquifer protection technique. Section 2.5 states that land uses which store and/or utilize hazardous substances should be further studied and regulated. The implementation of a groundwater discharge permit system is also recommended for exploration by the City, with the Thurston County Health Department named as lead agency.

Given the vulnerability of the aquifer throughout Tumwater, the City created a new overlay zone (AQ-P) called "Critical Areas - Aquifer Protection District" (Ordinance No. 1279), to include all properties within the City (Ordinance No. 1280), and specific aquifer protection standards to be applied City-wide (Ordinance No. 1281).

Ordinance No. 1279 (adopted August 20, 1991) restricts certain land uses from locating within the corporate limits of the City, unless the use of new technologies/best management practices can conclusively demonstrate that no greater threat to groundwater resources will result than that posed by a non-restricted use. The approval procedure for locating a restricted land use within the City, as set forth in TMC 18.56, is by Conditional Use Permit. The restricted land uses are:

(1) Chemical manufacturer and reprocessing.

(2) Creosote/asphalt manufacture or treatment.

(3) Electroplating activities.

(4) Manufacture of flammable or combustible liquids as defined in the current edition of the Fire Code.

(5) Petroleum products; Refineries, including reprocessing.

(6) Wood products preserving.

(7) On- and off-site hazardous waste treatment and storage facilities.

Ordinance No. 1280 (adopted August 20, 1991) applies the new Critical Areas - Aquifer Protection (AQ-P) Zone District (overlay zone district) to all properties within the City of Tumwater and amends the City's Official Zoning Map accordingly.

Ordinance No. 1281 (adopted August 20, 1991) sets forth the definitions, approval required, aquifer protection standards, and violation penalty involved in the construction of regulated facilities within the City's Aquifer Protection Zone District.

A copy of each of the above ordinances implementing the City's Aquifer Protection Plan are included for reference purposes under Appendix F.

Thurston County's Critical Areas Ordinance

Chapter 17.15 of the Thurston County Code lays out the Critical Areas Ordinance (adopted December 20, 1993) review standards and administrative actions for protecting aquifer recharge areas. WHPAs are included under the County's critical area definitions. The County's ordinances give considerable control to the County over land use and development in wellhead capture or aquifer recharge areas that are highly susceptible to contamination. Section 17.15.500, for instance, declares that the policy aims of Thurston County are:

- To maintain groundwater recharge.
- To prevent the degradation of groundwater resources.

- To recognize the delicate balance between surface and groundwater resources.
- To balance competing needs for water while preserving essential natural functions and processes.
- To comply with the State's groundwater quality standards (Chapter 173-200 WAC, as amended).

Thurston County uses a rating system categorized by four levels of aquifer sensitivity. Most soils in Tumwater and the City's WHPAs are categorized as either Category I - Extreme Aquifer Sensitivity (those areas which provide very rapid recharge, little protection, and are derived from glacial outwash materials), or Category II - High Aquifer Sensitivity (those areas which provide slightly lower recharge, little protection, and are from materials of glacial deposit). The County uses this sensitivity categorization and whether the land use activity is either on sewer or not on sewer as the determining factors in applying aquifer protection measures or targeted commercial and industrial land use prohibitions.

Specified uses and activities involving the use, handling, storing, or generation of hazardous materials may be allowed only when there will be no significant risk to groundwater. Similar to Tumwater's Conservation Plan, when conflicts arise between the Thurston County Code (TCC 17.15.500-550) and the Northern Thurston County Groundwater Management Plan (adopted pursuant to WAC 173-100), the standards which would produce the more effective controls govern.

While performance standards have not been developed for land use activities, the following are subject to the review authority of TCC 17.15.500-550 and, based on the purposes and provisions of the Critical Areas Ordinance, may be prohibited by the County:

- Chemical manufacturing
- Chemical mixing and remanufacturing
- Chemical waste reprocessing
- Dry cleaning (not clothing pick-up)
- Electroplating
- Furniture stripping
- Municipal, County, and State garages
- Landfill - demolition, municipal sanitary, and wood waste
- Metal processing with etchers and chemicals
- Tanning
- Textile dying
- Wood preservers

Similarly, specific land use activities that may be subject to the County's aquifer protection review standards include:

- Biological research
- Boat repair
- Chemical research
- Fabric coating
- Fuel pipelines
- Coal and hard rock mining
- Gravel mining
- Printing and publishing
- Solid waste handling/processing
- Aboveground and underground storage tanks
- Vehicle repair and wrecking
- All other activities using, handling, storing hazardous materials, or generating hazardous materials by their activities or actions.

The following performance standards apply to all of the above listed land use activities (as listed on Table 2 in Subsection 17.15.515), when carried out within an aquifer protection area:

- To protect the public health and safety, prevent aquifer contamination, and preserve the groundwater resource for continual beneficial use, the above listed land use activities are to be most limited in those areas having the highest degree of risk.
- Agricultural impacts may be mitigated through implementation of the Northern Thurston County Ground Water Management Plan (GWMP) as amended, where applicable, and Article VI of the Thurston County Sanitary Code, the Rules and Regulations Governing Nonpoint Source Pollution. In areas not covered by the GWMP, the County review authority and the health officer may employ technically sound methods that result in protection from aquifer contamination.
- Hazardous Materials
    - Review for presence and containment of hazardous materials may be performed and conditions set during the Group A and B permit processes by the health officer and others having expertise and jurisdiction.
    - Persons who possess hazardous materials (see TCC 17.15.505 C) must provide a secondary containment method that will contain all liquid and soluble hazardous materials and that will prevent discharge on-site.

- Stormwater
  - Stormwater impacts must be mitigated through application of the standards contained within the Drainage Design and Erosion Control Manual for the Thurston Region (1990) as amended, the Northern Thurston County Ground Water Management Plan (1991) as amended, and Article VI of the Sanitary Code as amended. In addition, spill prevention and contamination prevention may be considered during project review to avoid accidental release of pollutants.
  - The maximum residential density, or the maximum development intensity of non-residential projects, may only be achieved if the stormwater facilities meet the standards contained within the Drainage Design and Erosion Control Manual for the Thurston Region as amended.

- Water Resources
  - In addition to other reviews, the review authority and the health officer must consider the impact on water quality of proposed projects for which a hydrogeological report has been required. This evaluation applies to impacts on both groundwater and surface water, including in-stream flows, which may influence or be influenced by groundwater. This does not affect any right to use or appropriate water under State or federal law.

- Mining, Gravel
  - The prevention of detrimental impacts on groundwater is a primary goal when reviewing or permitting gravel mining activities. Correction or mitigation of groundwater impacts are a primary goal in reviewing applications for the expansion of existing gravel mining facilities or when established in permit conditions.
  - Best management practices (described in Section 20.54.070(21) of the Thurston County Zoning Code and TCC 17.20) must be employed until superseded by State law or modified by local action. Provision for performance monitoring must also be included in gravel mining permits.
  - The protection of groundwater is to be given the highest priority in the approval of land uses after cessation of use as a gravel mine.

To assure aquifer protection, Thurston County may require detailed examination of land use activities in critically sensitive areas, apply conditions to approval, or deny project approvals in critical areas subject to regulatory review. Control over proposed land use and development is exercised through environmental review as well as documentation of protection measures and potential impacts. For instance, the health officer may require a project applicant to provide a Drainage and Erosion Control Plan and a Hydrogeological Report when:

- Groundwater information is insufficient to perform an adequate review to assure aquifer protection; or
- The project will likely possess, store, use, transport, or dispose of hazardous materials.

A Hydrogeological Report identifies the proposed development plan and the risks associated with on-site septic systems or other activities which may degrade the groundwater beneath or downgradient from the site. The County requires that the report be prepared by a qualified professional engineer licensed in Washington State or a geologist schooled and trained in geology and groundwater systems. A report may be reviewed and evaluated by other County departments and qualified consultants under the direction of the health officer.

The report must contain:

- A description of the soil, geological and hydrological characteristics of the area under permit application consideration, including the relationships between groundwater and surface water and stream flows;
- A discussion of how the proposed project and above characteristics will influence drainage and the movement of water and contaminants in the groundwater, surface water, and in-stream flows;
- A description of conditions prior to project development;
- A description of conditions as they will exist after complete development of the proposed project, and their impact on groundwater quantity and quality;
- A list of recommendations to mitigate any potential groundwater impacts, including the effects of sewage disposal, lawn and yard activities, agricultural and animal husbandry, household chemical use, stormwater impacts, and any other impacts associated with the proposed project; and
- The effects of the activities likely to occur as a result of the complete development and use of the project.

The health officer may also require water quality or quantity monitoring as a condition of approval and to document compliance with permit conditions. Monitoring must be performed by a qualified person or delegated to another county department and paid for by the applicant. The need for continued monitoring must be periodically reviewed by the health officer. The County's review process may be waived or limited by the health officer if the scope of the project and its impacts are generally known, or the impacts of the project have been mitigated by source control strategies (see Sections 17.15.530-540).

7.5.8 Summary and Recommendations

Many options exist for protecting the City's designated WHPAs through land use regulations. Some protective actions are obvious and unlikely to be considered controversial. Others, particularly zoning changes, directly impact property interests.

A three phase approach is recommended. (1) The development and implementation of overlay zones and expanded environmental review in 1997; (2) land use education operating permits, construction standards, and enforcement in 1998; and, (3) attention to non-conforming uses in 1999.

Based on the risk assessments presented in Section 4, each of the City's well groups (Port, Bush, and Palermo) are characterized by different contamination threats. City staff need to evaluate each well group's contribution to the total supply and determine what land use controls or zoning prohibitions and restrictions should be established for protecting each WHPA. However, as a result of existing aquifer contamination data, land use, and known site contamination, the City's land use planning and regulations should focus on the following top three, high risk sources and contaminant threats to the City's drinking water supply:

- ❑ Petroleum hydrocarbons and chlorinated solvents associated with both Restover Truck Stop and American Fiberglass located south to southwest of the **Bush Middle School Wellfield**;
- ❑ Petroleum hydrocarbons and chlorinated solvents associated with underground storage tanks directly west of the **Palermo Wellfield** in the vicinity of Interstate 5 and Trosper Road. In addition, three known contaminant sources that adversely impact the Palermo Wellfield have been identified and are being studied by the EPA. All sites are suspected to be a source or potential source of chlorinated hydrocarbons; and,
- ❑ Petroleum hydrocarbons and chlorinated solvents associated with underground storage tanks and aboveground sources in the vicinity of **Port Well** Nos. 9, 10 and 15 (includes nonpoint sources, for instance, the Olympic pipeline and surface water runoff). There have been actions taken that indicate these sources may not be as much of a threat as previously believed.

Although nitrate in groundwater is not a point source, it could also become a highly ranked groundwater protection issue after it is thoroughly addressed. The severity of the nitrate problem will be better understood following sampling and a thorough assessment of trends.

All nonpoint sources of groundwater contamination threaten the aquifers underlying the City of Tumwater. In terms of land use planning and regulation, priority should be given to several nonpoint sources that pose the greatest threat to shallow groundwater (and possibly deeper aquifers in the future). These include:

- Potential leakage from the underground petroleum pipeline;
- Nitrate-nitrogen loading from septic tank and fertilizer use; and
- Infiltration of untreated stormwater.

The land use planning and regulation strategy aims primarily to prevent potential problems associated with future land use, while other strategies focus on reducing risk or managing emergencies arising from existing land uses. The Wellhead Protection Plan land use recommendations include:

- Comprehensive Plan amendments to emphasize the importance of WHPAs;
- Zoning Code revisions to establish permanent overlay zones, downzone land to reduce density, and revise other development standards; and
- Other regulatory amendments to the Drainage Manual and site plan review (SEPA processes and performance criteria requirements.

Recommendation 7-14: **Revise the Comprehensive Plan to emphasize the importance of Wellhead Protection Areas and designate land uses and densities that do not increase risk to the water supply.**

As shown on Exhibit 7-1, the current Comprehensive Plan's land use map dramatically conflicts with the wellhead protection area delineations and, in several cases, promotes commercial and industrial uses that are incompatible with groundwater protection.

The City should review its future land use plan in light of the delineated wellhead protection areas and revise zoning designations to prohibit uses/densities that present threats (long- or short-term) to the City's drinking water supply.

The City should take the position that a future land use is inappropriate within the City's designated wellhead protection areas (particularly within the one-year time-of-travel zone), if it uses, stores, disposes of, or transports any materials deemed hazardous in quantities beyond those associated with reasonable household use and/or renders a significant portion of the building site impervious.

Recommendation 7-15: **Revise the Zoning Code to include a permanent overlay zone for Wellhead Protection Areas.**

The mapped WHPAs should be adopted as permanent overlay zoning districts. This new districts should contain specific use allowances, conditional use criteria, and detailed presentation of performance criteria for development and land use within the WHPAs. Prohibited and restricted uses should be incorporated into the permanent overlay zone ordinance.

In one-year time-of-travel zones, more uses should be prohibited to prevent contamination. In five-, ten-year, and WHPA capture zones, more uses may be allowed but size may be restricted and performance criteria imposed.

A procedure for variances from these prohibitions is recommended. If a proponent documents that the proposal activity presents no risk to groundwater, the use could be allowed provided it meets other environmental and land use requirements.

The GWTAC noted policy questions that should be considered in restricting land use. These include:

- Should a particular land use activity be prohibited outright, or should expanded checklists be used instead to allow engineering solutions to mitigate contamination risks?
- Should these land use activity prohibitions refer only to those systems which are specified in the GWMP for establishing wellhead protection zones (1,000 connections)?
- Should these prohibited activities apply to existing land uses? If so, would there be a requirement for relocation? Economic incentives for relocation?
- What is the most acceptable method for institutionalizing these recommended land use prohibitions - Critical Areas Ordinances, Wellhead Planning Documents, Zoning Ordinances, and so forth?

Tumwater should encourage "risky" new land uses to locate outside of the ten-year time-of-travel zones. To minimize general groundwater risk, these uses should be required to use sewers and practice enhanced spill prevention and response.

The overlay zone approach should be tempered by common sense. For instance, where large numbers of existing businesses and industries are already located in WHPAs, adding new businesses and industries may not substantially increase the current risk level.

The GWMP also recommends requiring source controls for all existing high risk activities within the one-, five-, and ten-year time-of-travel zones (HM-17). Source controls include physical, structural, and managerial practices such as:

- Requiring secondary containment for hazardous materials;
- Maintaining an inventory of hazardous materials;

- ❑ Developing an approved spill response and notification plan;
- ❑ Training employees in the use, handling, and storage of hazardous materials; and
- ❑ Hooking up to sewers if reasonably available.

Recommendation 7-16 **Revise the Zoning Code to add performance standards to conditional use requirements.**

The City may choose to include criteria to safeguard public supply wells from threatening land uses by including performance standards within designated WHPAs as a precondition of permit approval.

Criteria for the issuance of a conditional use permit should include enabling the Hearing Examiner to ensure that:

- ❑ Groundwater quality will not be degraded beyond an articulated level (e.g., nitrate-nitrogen concentrations not to exceed 3 milligrams per liter);
- ❑ The applicant be required to conduct or pay for ongoing monitoring of groundwater at downgradient property boundaries;
- ❑ Appropriate safeguards are employed with respect to the specific materials used/stored on site;
- ❑ A bond or similar security be posted in the event of an accident or permit violation, and
- ❑ Other requirements necessary to protect groundwater supplies be met by the applicant.

Similar conditions could also be imposed under the City's SEPA program implementation.

Recommendation 7-17: **Revise the Zoning Code criteria for expansions and alterations of non-conforming structures/uses within the City's one- and five-year time-of-travel zones.**

This recommendation seeks to prevent pre-existing uses of land from jeopardizing water quality due to the existing use(s) or from expanded or altered uses. The aim is to provide guidance to the Hearing Examiner in designated WHPAs as to the granting of a permit to expand, alter, or change a pre-existing, non-conforming use or structure. (A pre-existing, non-conforming use or structure is defined as a use or structure that lawfully pre-dates the zoning ordinance that would otherwise make the use or structure unlawful without a zoning change or variance.) The Examiner should be provided with specific criteria for reviewing applications for expansions of non-conforming uses/structures within the WHPAs. For example, pre-existing uses seeking to expand can be limited by size, density, sewage generation, impervious coverage and other area and bulk issues that affect groundwater quality.

The Code also should be revised to include specific mention of requirements the Examiner may impose in exchange for granting a conditional use permit to change to another use within the City's time-of-travel zones.

Recommendation 7-18: **Revise the regional Stormwater Drainage and Erosion Control Manual to specify stormwater treatment practices best used in WHPAs.**

The current Drainage and Erosion Control Manual sets regional standards for treatment of stormwater runoff. The manual should be revised to specify stormwater treatment practices most appropriate for wellhead protection areas.

Recommendation 7-19: **Require additional analysis concerning pollution control issues prior to site development.**

Additional analyses on pollution control issues and risk mitigation concerns should be required by the City as a condition of permit review and approval prior to site development within the City's designated WHPAs.

The desired results of such requirements would be project designs and land uses which do not impact groundwater quality. One way to achieve such a result would be to establish (through City Ordinance) a requirement for specific hydrogeological analysis of the project prior to permitting.

A key to success in establishment and implementation of such a requirement will be the ability to define the groundwater protection goals. The "anti-degradation" goal of the State's groundwater standards may provide the appropriate goal for the City. Under guidance from the Department of Ecology, this goal has been translated into protection standards (numeric values) related to drinking water standards. These could be used by the City in its review and analysis process.

The difference between an analysis which might be required by the City and one which would be required by Ecology (under the groundwater standards), is that the City would require an analysis of all potential discharges as opposed to proposed discharges which are routinely regulated by Ecology.

A second, and important, objective for ordinance development will be to target appropriate proposed projects. For example, because of low impact potential, it may be desirable to exclude certain types of uses such as residential uses on septic tanks. With this example, the logic might be that under the Growth Management Act, rural residential densities will be low and therefore not represent a significant threat, and urban densities should be designed for concurrent sewer service. Such exclusions would allow for effective and targeted administration of the program to commercial, and industrial uses.

The City may also wish to consider the existing aquifer recharge area provisions within Thurston County's Critical Areas Ordinance (TCC Chapter 17.15) for possible integration into the City's permit review system.

The City's enhanced land use permit review and approval process should be carried out as a cooperative effort by all jurisdictions in the northern Thurston County focus area. The goal should be to achieve and maintain a consistent and integrated project review and land use permit approval process to assure the protection of designated WHPAs across jurisdictional boundaries.

Recommendation 7-20: **Assure proper local well siting and utility service review through the well drilling "start" card and building permit review process.**

RCW Chapter 19.27.097 requires applicants for building permits involving structures that require a potable water supply to submit proof that an adequate supply of potable water is available prior to a building permit being issued. The authority to administer and enforce the approval process for the construction or decommissioning of individual wells has been delegated by Ecology to Thurston County.

Jefferson County, for example, is considering adopting policies and procedures for the Jefferson County Permit Center and Jefferson County Environmental Health to improve the management of groundwater resources, discourage practices that result in water source degradation, as well as minimize the construction and usage of individual wells. The review and approval process for the construction of a well requires a water well notification review to prove that an adequate supply exists, plus a utility service review to determine whether a community water source of supply is already available. If the public water purveyor certifies that sufficient capacity is available to satisfy the property owner's required potable water, the property owner must connect to the existing public water system and the proposed new individual source well may not be used.

The City should request that the GWPAC, with the technical support of the GWTAC, develop policies and procedures for the consideration of and adoption by the Thurston County Board of Health. These policies should assure that proper well siting and public water purveyor review takes place before a building permit may be issued whenever the construction or decommissioning of an individual well is involved.

Recommendation 7-21: **Require commercial agriculture and recreational land users within the City's wellhead zones to develop and implement land management plans through the Coordinated Resource Management Process.**

As use of the region's natural resources increases and open land disappears under the pressure of an expanding and urbanizing population, wise management of the remaining land and natural resources becomes pivotal to maintaining the quality of the local environment (including drinking water quality). Adjacent resource areas are often owned and managed individually. Landowners and operators manage for different goals and may cancel out the efforts of neighboring landowners and operators to protect the environment. Areas identified for Coordinated Resource Management Planning (CRMP) may include forestry or range allotments, stream corridors, watersheds, wildlife management reserves and farms or ranches.

Thurston Conservation District's (TCD's) CRMP process is designed to bring landowners, public agencies, and resource users together to address environmental issues and natural resource management concerns. CRMP's goal is to identify common interests and achieve constructive problem-solving through shared decision making processes. CRMP's guiding principles are that active involvement, local acceptance, and community backing will reduce conflict and generate support for accomplishing common resource management goals.

For the City, resource owners and managers include commercial agriculture and recreational land users (for instance, golf courses, parks) operating within the City's delineated wellhead zones and designated WHPAs. The City should request that the TCD provide a current inventory and list of all commercial agriculture and recreational land users located within the City's delineated wellhead zones. This should include recreational properties owned by the City and other governmental entities such as the Tumwater School District.

With the technical guidance and ongoing support of TCD, the City should require that all commercial agricultural and recreational land users located within the City's wellhead zones develop and implement a land management plan through the CRMP process within two years of the adoption of this WHPP. The agreed upon land management plan should result in improved coordination and management of local natural resources, better communications and understanding among all of the participants involved, and specific application of pollution prevention control measures to protect the City's drinking water supplies.

7.6 Other Regulatory Programs

7.6.1 Overview

In addition to local land use controls, many other federal, State, and local regulatory programs are designed to protect drinking water supplies from contamination. Programs most relevant to known and potential contamination sources in the City's WHPAs are reviewed below.

Each of these programs has a specific mandate to address one or more particular types of contamination. These programs are often implemented independently of each other. For example, septic tank drainfields are regulated separately from underground storage tanks; solid waste and hazardous materials are regulated by several agencies; and, stormwater management systems are regulated separately from wastewater disposal systems.

Wellhead protection programs offer an opportunity to integrate existing regulatory programs by focusing the resources of many agencies on relatively small, highly vulnerable areas. Specific priorities established for WHPAs provide a rationale for prioritizing resources in this way.

The following provides a summary of the existing statutory framework for developing, implementing, and enhancing the City's WHPP. In Washington State, the DOH has primary responsibility for protecting public health and Ecology has primary responsibility for protecting water resources. States are mandated to implement major regulatory programs under federal legislation such as the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In turn, the State delegates authority in some programs to local agencies such as the County Board of Health, City and County governments, local fire departments and fire protection districts.

7.6.2 Public Health

DOH plays a leading role in health matters. DOH promulgates regulations and sets standards for public water systems and the disposal of various wastes, including sewage and garbage. Local health departments (as well as City and County law enforcement officers) must enforce these regulations. Standards for septic systems are set by State administrative regulation. As lead agency for implementation of the federal SDWA, DOH manages the State's Wellhead Protection Program.

Cities and counties also play an active role in protecting drinking water. DOH is required to consult with local health departments in preparing its biennial report regarding health priorities. Local health departments have independent power to make rules and abate nuisances.

County Health Departments issue permits for septic systems, identify failing or failed septic systems, and have discretion to waive local plumbing or building rules, if this will make possible the use of alternative systems as approved by DOH. Cities and counties may set standards for such systems that are stricter than those imposed by State law.

7.6.3 Water Resources

The State also plays a major role in natural resource protection. Ecology has the lead role in general water resource regulation, planning, development, and pollution control, including permitting.

The statutes governing the allocation and use of water apply to groundwater. Ecology is the lead agency for groundwater planning.

City and county governments also play important roles. Ecology cooperates with local governments and water users to identify groundwater management areas. Ecology is required to seek participation of local governments in water resource planning and give top priority to the protection of sole source aquifers used for drinking water.

Assuming that the City's sewer system meets State standards, Ecology may delegate to the City the power to issue permits for connection to its sewers. Ecology may also delegate to the City the implementation of the Underground Storage Tank (UST) program.

Cities are given independent power to protect drinking water by RCW 15.88.010, et seq., which gives municipalities authority over water supplies, and the watershed which drains into them, whether they are within the City limits or outside. Cities and towns may make ordinances forbidding acts which threaten the water supply, may appoint special police to enforce them, and may sue for an injunction to abate nuisances. This may include the maintenance of feed lots or slaughter pens sufficiently near the City's drinking water sources to threaten the purity of the groundwater.

Counties may establish Aquifer Protection Areas, to fund the protection, preservation, and rehabilitation of groundwater. Within these areas, the County may impose fees for water withdrawals or on-site sewage disposal. The revenue may be used for groundwater planning and management, construction of various anti-pollution, sewage disposal, drainage, and water treatment systems.

7.6.4 Hazardous Materials

The Federal Resource Conservation and Recovery Act (RCRA) of 1976 (40 CFR 260), as amended in 1984, is a comprehensive piece of legislation created in reaction to improper handling of waste materials. The legislation contains provisions for handling a variety of hazardous and other waste streams. The types of provisions for the various waste streams are discussed on the following pages.

Hazardous Wastes

RCRA, termed the "Cradle to Grave" legislation, regulates hazardous wastes from the time of their creation to their ultimate disposal. Washington State was one of the first to pass legislation and develop regulations allowing EPA to administer the hazardous waste portions of RCRA. Washington State has more stringent regulations than the federal program and has been regulating hazardous wastes since 1984.

Under Washington State's dangerous waste regulations (Chapter 173-303 WAC), waste materials classified as hazardous must be designated through a process of determining the characteristics of the material. Like the federal regulation, hazardous waste generation of small quantities is exempt from most provisions of the State rules. The regulatory threshold amounts are ten times lower under the State rules than those of EPA. While larger generators must meet strict requirements for record keeping, storage, and disposal, small quantity generators are relatively uncontrolled and free from State requirements. Small quantities can be amounts of dangerous waste up to 220 pounds per month.

Waste reduction planning has recently been required of Washington State businesses (Hazardous Waste Reduction Act of 1990). Under the terms of this legislation, large (regulated) generators of hazardous waste must develop plans for the reduction of hazardous wastes. The overall goal of the legislation was to attain a 50 percent reduction in hazardous wastes by 1995.

Thurston County administers hazardous waste programs at the local level that fill many of the gaps in the State program. Under the County Nonpoint Source Pollution Ordinance (November 1992), practices are described for the protection of surface and groundwater from nonpoint source pollution. The focus of the ordinance is pollution prevention from moderate risk waste (hazardous waste below quantities regulated by the State or federal government), and domestic animal wastes from small farm operations.

Under the moderate risk waste provisions, waste must be recycled or disposed of through a licensed treatment, storage, or disposal facility. The ordinance also provides for storage requirements, cleanup in the event of a spill, and enforcement authority.

Local fire inspections provide an opportunity to systematically inspect facilities in WHPAs. The Tumwater Fire Department (TFD), Fire District Nos. 5 (Black Lake) and 11 (South Tumwater) have inspection and regulatory authorities under provisions of Articles 79 and 80 of the Uniform Fire Code. Similar to the TFD, these fire districts are responsible for the conduct of hazardous waste inspections relating to moderate risk generators.

The hazardous material inspection approach of the TFD and Fire District Nos. 5 and 11 focuses primarily on safety and potential fire hazard due to handling or storage of certain materials. Their inspection emphasis is on education first and voluntary compliance, then formal enforcement and reinspection to assure compliance.

Personnel from the Lacey-Olympia-Tumwater-Thurston County (LOTT) wastewater partnership also conduct inspections of hazardous material handling practices at industrial sites which discharge to the LOTT regional system. These inspections are part of a pretreatment effort to reduce wastes prior to discharge. During these inspections, a survey or audit of hazardous material handling and spill prevention is often conducted. There is an opportunity to complement or enhance these efforts with other inspections or audits in coordination with the TFD, Fire District Nos. 5 and 11, or the County.

Hazardous Material Storage: Above and Below Ground Storage Tanks

Federal regulations (Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (USTs), 40 CFR 290 Part 280) have been developed by the EPA under Subtitle I of the RCRA. EPA regulations specify UST design, leak detection, overfill protection, tank inventory monitoring, financial responsibility, leak reporting, remedial action, and removal requirements. However, EPA does not have resources necessary to directly enforce their regulations.

In 1989, Washington State 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. State legislation, Engrossed Substitute House Bill (ESHB) No. 1086, now codified as Chapter 90.76 RCW, required Ecology to develop and adopt UST rules as stringent as the EPA regulations. The rules, Chapter 173-360 WAC, were filed by Ecology on November 28, 1990.

Unlike EPA's UST program, a permanent funding mechanism has been established for Ecology's program. RCW 90.76 requires UST owners to pay an annual fee of $75 per tank.

Under RCW 90.76, Ecology is encouraged to delegate part or all of the State UST programs to a city or county upon request from the local jurisdiction. Ecology must be satisfied that the requesting city or county can adequately enforce the regulations and has sufficient resources to implement the program. The delegation agreement includes an identification of fee distribution ratio between Ecology and the city or county assuming responsibility for the program. At present, however, a local jurisdiction seeking delegation should be prepared to fund the entire program because all tank fees are needed by and being used for Ecology's state-wide program.

Local UST requirements, more stringent than State rules, can be implemented in Environmentally Sensitive Areas (ESAs) designated by Ecology (after being proposed by local jurisdictions). A supplementary local fee, not to exceed 50 percent of the State fee, may be imposed in ESAs with more stringent rules, if necessary for enhanced program administration and/or enforcement. The supplementary local fee must be authorized by Ecology.

ESAs are portions of the State that possess physical characteristics that make them especially vulnerable to releases from USTs. A city or county can petition Ecology to have an area within its jurisdiction designated as an ESA. If a single ESA is located in more than one jurisdiction, such as two different cities or one city and one county, the jurisdictions can jointly request that Ecology designate the area as environmentally sensitive.

ESA designation under Chapter 90.76 RCW is not synonymous with an Environmentally Sensitive Area designation under WAC 197-11-908 of SEPA, although the same single area could be designated as an ESA under both Chapter 90.76 RCW and SEPA. Designation under Chapter 90.76 RCW affects only the construction and operation of USTs, while designation under SEPA can affect a much broader range of land use activities.

The rules (WAC 173-360-510 through -530) for establishing ESAs under Chapter 90.76 RCW are unclear. The implication under WAC 173-360-510(3)(d) is that portions of the County's groundwater management area (GWMA) could automatically qualify as an ESA; yet, WAC 173-360-510(4) requires compliance with WAC 173-360-530, which provides a very rigorous set of criteria for establishing an ESA. The overall tone of Section 530 implies that the need for more stringent requirements must be well documented.

The existing Ecology program for USTs is comprehensive under Chapter 173-360 WAC. Among other things, the regulations require examination and licensing for firms and persons involved in UST-related activities. Some of the activities that must be done in the presence of licensed personnel are:

- All facets of installation of the tank and associated piping;
- Retrofitting existing tanks to meet new requirements;
- Installation and testing of cathodic protection systems and release detection equipment;
- Testing of tank and piping tightness; and
- Decommissioning including excavating around the tank, tank purging, removal of sludge and vapors, and removal of the UST.

Owners of USTs covered by the regulations must apply for and obtain an annual operating permit. Permit requirements include: (1) a properly completed installation checklist filled out by an Ecology-licensed installation supervisor; and (2) certification of compliance with corrosion protection of tanks and piping, financial responsibility, and release detection requirements. Owners or operators of existing USTs must notify Ecology of the tank(s). Owners and operators of USTs must annually certify compliance with the State's regulatory requirements to obtain the subsequent year's operating permit.

Permits may be revoked for non-compliance. Penalties may also be levied against persons who violate regulations. 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.

Authorized representatives of the State may gain access to the premises for inspection of records, to sample, or otherwise monitor operation.

Performance standards are provided for new tanks. Existing tanks must upgrade according to a predetermined schedule.

There are federal and State programs designed to assure cleanup of releases of contaminants from USTs. Section 205 of the Superfund Amendments and Reauthorization Act of 1986 created an UST Trust Fund intended to pay for the cleanup of releases of hazardous substances, including petroleum products, from USTs. The fund, administered by the EPA Office of Underground Storage Tanks (OUST), made a total of $500-million available over a five-year period that ended in 1992. The life of this fund was extended by Congress for an additional five years through 1997.

The fund is intended to support cleanup of leaking underground storage tanks (LUSTs) in cases where no financially solvent owner/operator can be identified, where the owner/operator refuses (or is unable) to promptly respond to the problem, or where an imminent hazard to public health or the environment exists. The fund also provides financial assistance to State governments for development of LUST response programs.

Ecology received assistance from the fund to develop this State's LUST program, which was finalized in September of 1989. Ecology currently uses money from the fund to offset salaries and related expenses for the State LUST program.

Releases of hazardous substances from USTs in Washington State are currently addressed by Ecology through oversight of voluntary cleanup actions by tank owners. Oversight is also exercised through enforcement actions under the Washington Model Toxics Control Act, which was passed by voters as Initiative 97 in 1988. One of the main purposes of this Act was to raise sufficient funds to cleanup all hazardous waste sites in the State. The bulk of the revenue is generated through a tax on industry. The Act creates the Toxics Control Account. Toxic Control Account revenues, among other possible uses, fund Ecology's LUST program cleanup activities. In cases where a financially solvent owner/operator cannot be identified or is unwilling to undertake necessary 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.

The above federal and State 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 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 exempt from environmental review under SEPA.

The first two exceptions noted above are subject to local regulatory authority under Article 79 of the Uniform Fire Code (UFC).

Ecology has developed a six-page informational document on Unused Underground Residential Heating Oil Tanks including considerations for operational home heating oil tanks.

Installation and removal of abandoned home heating oil tanks are regulated by the Thurston County Fire Marshal's Office, cities, and local fire districts under Article 79 of the Uniform Fire Code (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. The Thurston County Fire Marshal's Office is organized within the County's Department of Water and Waste Management.

Generally, the public is unaware of the regulations governing home heating oil underground storage tanks, the enforcement of Article 79 of the UFC relating to these tanks is not rigorous, and inspections of operational tanks is minimal. However, because of potential liability exposures, some banks are requiring disclosure of tank status in real estate transactions. For this reason, sale of land is the point at which awareness of home heating tanks and their status is most likely.

Under Articles 79 and 80 of the UFC, unused heating oil tanks must be closed, and spill prevention measures need to be taken for aboveground storage of materials. The County adopted these provisions of the Code in 1990. Chemical fires, injuries, evacuations, and environmental contamination have led to regulations covering how specific types and quantities of chemicals, such as pesticides and fertilizers, are stored.

For aboveground storage tanks, existing controls consist of State and local fire regulations as well as federal and State contingency planning requirements for large bulk petroleum storage (such as the Texaco bulk plant facility).

Hazardous Materials: Spills and Contaminated Site Cleanup

Often referred to as the federal Superfund legislation of 1980, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) was created to assure that the nation's worst contaminated sites are cleaned up. CERCLA has received considerable attention because of the large, highly toxic contamination it has addressed (for example, Times Beach and the Love Canal). It has also received considerable criticism with widespread reports of lack of progress despite the substantial fund being spent nationwide.

Regardless of the criticism, it was clear from the inception of the Superfund program that there were more contaminated sites than the fund and EPA could reasonably accommodate and manage. Many would simply not get attention because of their size and lower priority ranking. Washington State, for instance, had over 500 contaminated sites listed by the middle of the 1980s.

In response to the need, Washington State began a cleanup effort of its own in the early 1980s. This effort was largely funded by general tax revenue. Because of limited funding, cleanup work was targeted to only a few sites. The Legislature subsequently responded by enacting legislation to create a State Superfund, which, within two years (1988), was followed by Initiative 97, the Model Toxics Control Act (MTCA).

As Washington State's hazardous waste cleanup law (Chapter 70.105D RCW), MTCA mandates that site cleanups be completed to protect the State's citizens and the environment. A major portion of developing MTCA's cleanup standards and requirements for cleanup actions was completed in February 1991. Ecology's cleanup regulations under MTCA (WAC 173-340) specify a two-step approach as described below.

Establishing Cleanup Standards

Standards provide a uniform, state-wide approach to cleanup that is applied on a site-by-site basis. The primary components are - cleanup levels and points of compliance - established for each site. Cleanup levels determine at what point a particular hazardous substance does not threaten human health or the environment. Points of compliance designate the site location(s) where the cleanup levels must be met.

Selecting Cleanup Actions

This second step includes the evaluation of what methods to use for site cleanup and achieve the cleanup standards established for the site under step one. In addition to meeting the standards, the cleanup actions must also provide permanent cleanup solutions, a reasonable time frame for cleanup and include ongoing monitoring to ensure the long-term effectiveness of the cleanup after the required corrective actions are completed.

While the procedural details of these State programs have differed, the overall thrust has been to make progress on what has become a list of over 900 contaminated sites in Washington State. In theory, the RCRA and Dangerous Waste programs would prevent any new sites from being developed, and the cleanup programs would reduce the past practice threat.

Two major factors have caused the number of sites to nearly double from 500 in the late-1980s to over 900 in the 1990s. First, there has been a continual discovery of sites previously unknown to the regulators. Second, new incidences of spills, fires, and chemical releases have increased the total number of sites needing cleanup work.

The federal process is limited, and only sites which rank high in the Hazard Ranking process can be nominated for the National Priority List (NPL). The NPL ranking process is lengthy and tedious. Furthermore, EPA's expenditure of Superfund money is largely limited to these NPL sites (none are in the Tumwater focus area unless the Palermo Wellfield contamination site is approved by EPA).

The State has instituted a similar (but less lengthy) process to prioritize its cleanup sites, and can generally take action more quickly. Nevertheless, actual cleanup progress is slow.

Many sites are receiving independent and voluntary attention by owners or responsible parties as a matter of necessity to make immediate use of the land or limit further liability. Ecology's involvement has been limited. Most of their resources are focused narrowly on highest priority NPL sites.

Both the State and federal processes can, and have, become bogged down in legal maneuvering. The stakes, in terms of cleanup costs and liability, are generally high. Each action is considered from legal and technical angles before action is taken. From the perspective of the involved parties, this is prudent. But from the viewpoint of concerned citizens and interest groups, the process is painfully slow.

Contaminated sites resulting from LUSTs are handled in a separate regulatory approach (from USTs or non-leaking tanks) by the federal and State governments. Both EPA and Ecology have programs for cleaning up LUSTs.

For EPA, this has largely been a funding program for States to implement their own cleanup programs. For Ecology, the program has concentrated on the development of regulations, reporting requirements, and cleanup standards.

At the local level, there are no programs that deal with contaminated sites with the exception of underground tank programs in some areas of the State. Pierce County, for instance, has a program that deals with USTs and LUSTs; however, Thurston County does not have a LUST program. Jurisdiction over LUSTs continues to rest with Ecology throughout Thurston County.

Hazardous Materials: Community Right-to-Know Act

The Superfund Amendments and Title III of the Re-authorization Act of 1986 (SARA) contains provisions for the Community Right to Know Act and Emergency Response. The Act specifies reporting requirements for entities handling hazardous materials in an attempt to let the community (especially emergency response agencies) know the types and amounts of chemicals on-hand. Reportable quantities vary from chemical to chemical. A reportable quantity can be as low as a single pound. SARA Title III facilities must also annually report any release(s), accidental or process-related, of these chemicals into the environment. Reporting thresholds for releases are much lower. EPA maintains a database of hazardous materials releases reported by these facilities.

Hazardous Materials Facilities and Emergency Response

Under SARA Title III and the provisions of the Community Right to Know Act, an emergency response organization is required for each State. In Washington State, the local level of this national structure is the County's Local Emergency Planning Committee (LEPC). Through Thurston County's LEPC, topics such as hazardous materials training, chemical storage, and incident response are discussed and evaluated (see Section 5).

Annex O of the Tumwater Emergency Disaster Plan lists 13 SARA Title III facilities in Thurston County as of October 17, 1988. The list of hazardous materials facilities includes the Columbia Beverage Company at 3003 R. W. Johnson Boulevard (Tumwater's biggest water customer); the Dart Container Corporation at 600 East Israel Road; and the Pabst Brewing Company at 100 Custer Way. The Tumwater Fire Department is the designated first responder to these three SARA Title III facilities. CH2O, Incorporated at 8820 Old Highway 99 (south of the Olympia Airport near 88th Avenue) is also listed as a SARA Title III facility. The designated first responder to the CH2O facility is Fire District No. 6 (South Tumwater).

County-wide SARA Title III facility hazardous materials information is reported to and maintained by the County's LEPC. LEPC data on each SARA Title III facility is available to the City or the public on a request basis.

Under Section I of SARA Title III are provisions for worker protection relating to emergency response. Federal and State rules require any business which handle regulated hazardous materials to provide emergency response training for their workers. The training is required at different levels depending on the degree of emergency response expected from the worker.

Many businesses are unaware of these requirements. With awareness and guidance, businesses could develop a coordinated program to meet standards for worker protection, worker right-to-know, spill response and contingency planning. These efforts will reduce risk to workers, the environment, and local groundwater sources in the City's aquifer recharge areas and wellhead capture zones.

Hazardous Materials: Transportation

United States Department of Transportation (DOT) regulations concerning the transportation of hazardous materials is focused on three areas: Labeling, placarding, and shipping papers (manifests). DOT has very specific requirements for labeling hazardous materials. Vehicles carrying these materials must be signed with the required DOT information.

DOT regulations also require emergency information to be placed on shipping papers (such as a phone number where 24-hour emergency response information is available). Emergency response information must be maintained in the vehicle (typically this is a copy of DOT's Emergency Response Guidebook).

Hazardous wastes (under RCRA) shippers must utilize a specific manifest form developed to record and track waste material from point of origin to final disposal.

There are no programs to notify local governments of special hazards related to the transport of materials. However, an inventory of the types of hazardous materials typically traveling along the highways of the County could provide guidance as to the level of risk particular substances might pose to the City's drinking water supplies.

7.6.5 Solid Waste Management

A portion of the RCRA statute covered the more traditional solid waste stream. Activity under that portion of the statute, however, has lagged behind the actions of Ecology under the State's solid waste legislation (Chapter 70.95 RCW).

Ecology has developed "Minimal Functional Standards" (Chapter 173-304 WAC). Ecology's standards require lined landfills, leachate collection, and a variety of measures that federal rules have required only recently.

Washington State is generally ahead of many parts of the nation in environmental protection from landfill operations. The result has been a decrease in the risk these operations pose to groundwater sources. When past operations are closed properly, the risk will be even further reduced. All non-conforming landfills in Washington State should have been closed or in the process of closing by November 1989. There are no known or closed landfills in the City's WHPAs.

Under the State solid waste laws (Chapter 70.95 RCW), local governments are charged with administrating solid waste regulations as they apply to landfills and transfer stations. This function has been handled by local health districts and departments throughout Washington State. In Thurston County, the lead agency is the Department of Public Health and Social Services (the County Health Department).

Currently, site compliance is good in Thurston County. All operating landfills are in compliance (sanitary and others) with standards or are operating under compliance schedules issued by DOH or Ecology.

7.6.6 Wastewater

Sewerage Systems (City and County)

The County Services Act (Chapter 36.94 RCW) requires that counties adopt a Sewerage General Plan for areas to be served by sanitary sewer systems. For the City of Tumwater, this is the Lacey-Olympia-Tumwater-Thurston County (LOTT) service area.

Wastewater - On-Site Disposal

Regulatory jurisdiction over on-site disposal systems depends on the type of waste and the size of the system. Industrial disposal and sanitary waste for large domestic on-site septic systems (14,500 gallons per day or more) are generally regulated by Ecology. DOH regulates wastewater disposal systems with flows between 3,500 and 14,499 gallons per day. The County Health Department has jurisdiction over systems less than 3,500 gallons per day. DOH has contracted with the County Health Department to regulate medium-sized systems within the County (instead of DOH).

The County implements the State On-Site Sewerage Regulations (Chapter 248-96 WAC) through Article IV of the Thurston County Sanitary Code. Under this regulation, the sitting, design, construction, repair, and replacement of an on-site sewerage system are regulated. Standards are also included under this regulation along with specific requirements for subdivisions and permitting. The conditions for connection to sanitary systems, when available, are also covered.

For proposed on-site systems under Ecology's jurisdiction, the chances of obtaining a permit to operate are remote. Ecology generally discourages the design of large on-site domestic systems, and both industrial and domestic systems must now comply with the State's Ground Water Standards (Chapter 173-200 WAC). These standards do not allow degradation of groundwater, and the conditions for any disposal operation can be onerous (as well as time- and cost-prohibitive).

7.6.7 Well Construction and Abandonment

The regulation of well construction and abandonment of the many wells in the County and those throughout Washington State began in 1971 under the direction of Ecology.

Two of the principal focus areas of this pollution control strategy are well drilling standards and licensing. This program is formalized under Chapter 18.104 RCW, Chapter 173-160 WAC (minimum standards for construction and maintenance of wells), and Chapter 173-162 WAC (regulation and licensing of well contractors and operators).

Ecology's well construction standards include:

- 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 abandonment 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.

Chapter 173-162 WAC specifies Ecology's regulations for licensing water well drillers, examination requirements, and the responsibilities of licensed well contractors.

7.6.8 Stormwater Management

From the perspective of wellhead protection, stormwater is not only a source of groundwater recharge, but also a potential source of contamination. Stormwater has been locally regulated for many years. Historically, the purpose of this control has been primarily to prevent local flooding; it was not intended to protect water quality. In recent years, however, regulatory controls have focused increasingly on the impact that stormwater has on water quality. In response, local jurisdictions in Washington State have developed comprehensive and technically sophisticated stormwater management programs.

Tumwater's Stormwater Controls

The City has developed a Comprehensive Stormwater Management Plan update that has been adopted by the Tumwater City Council. The City's stormwater management program is enforced through regulatory controls. These include:

- Land use controls through the City's Growth Management Plan and Comprehensive Plan
- Environmentally sensitive areas ordinances
- Clearing and grading ordinance
- Drainage design and erosion control manuals
- Inspection and enforcement procedures for both new and existing drainage facilities

The City created and funded a stormwater management utility in 1988. Independently funded, the City has established a monthly service fee for both flood control and water quality enhancement. The City's present stormwater program includes the creation and use of development controls, watershed and basin planning, capital facility design and construction, a maintenance program, water quality monitoring, protection and enhancement of water quality, groundwater, wetlands, habitat areas and fisheries. The City supports citizen monitoring and water resource enhancement programs, including Project GREEN and Stream Team.

A new Fiscal Year 1997 Centennial Clean Water Fund grant will support comprehensive stormwater program improvements, including mapping and identifying the condition of all public and private stormwater facilities, evaluation of City ordinances for compliance with regulations, and enhancement of local enforcement, maintenance and pollution prevention programs.

The City's stormwater management program is directed by a series of federal, State, regional, and local stormwater management regulations.

At the federal level, the City must comply with the 1972 Clean Water Act (amended in 1987) to minimize the discharge of pollutants into surface water runoff. This program has been delegated to Ecology and is implemented through the issuance of stormwater National Pollution Discharge Elimination Systems (NPDES) permits.

At the State level, Washington State has developed a myriad of stormwater-related legislation focused on flood control and water quality enhancement. The regulations that directly affect the City's stormwater management program and its protection of regional groundwater resources are primarily the requirements of the 1994 Puget Sound Water Quality Management Plan (PSWQMP). Compliance with PSWQMP includes meeting the requirements of both the Basic and Comprehensive State Stormwater Programs. As of January of 1995, the City was in compliance with most of the State's Comprehensive Stormwater Program. The program emphasizes water quality enhancement and must be complied with by the year 2000. The State has not issued stormwater NPDES permits to municipalities with populations smaller than 100,000 residents. If and when it does, Ecology staff suggest that the conditions of future stormwater NPDES permits (for municipalities like Tumwater) will likely be similar to the conditions of the Comprehensive Stormwater Program, as described in the 1994 PSWQMP.

At the local level, considerable regional stormwater planning efforts have been initiated by the City with the County. Acknowledging that water recognizes no boundaries, the Cities of Tumwater, Lacey, Olympia, and Thurston County have adopted a common set of drainage design standards. These standards have been in effect since 1991 for all new construction. The standards specifically emphasize the protection of water quality and the use of best management practices (BMPs) to enhance water quality throughout the County. Local jurisdictions participate in the regional stormwater technical advisory committee, and jointly support stormwater projects of mutual benefit.

Also of significance in preserving regional water quality has been the development of a series of comprehensive drainage basin plans. The plans present a series of projects and activities to be funded and implemented by local agencies, including Tumwater. These projects and activities aim to prevent stormwater pollution, treat contaminated runoff, maintain aquifer recharge areas, restore summer base flows in urban streams, and attempt to enhance local fisheries and habitat areas. Basin plans have been developed for Percival Creek (1993), Budd Inlet - Deschutes River Watershed Action Plan (1995), and several other local basins.

Effectively linking the management of surface water runoff to the preservation and use of the region's groundwater resources is the 1992 Northern Thurston County Ground Water Management Plan (GWMP). This unique plan integrates surface water management activities with wellhead protection, aquifer recharge and water quality protection. The Cities of Tumwater, Lacey, Olympia, and Thurston County have adopted and agreed to fund and implement the GWMP.

The GWMP states that the ultimate aims of the region's stormwater programs should be to treat all stormwater prior to discharge/infiltration, maintain its natural water quality, manage stormwater quantity, and maintain the natural hydrologic characteristics of the area. These goals will be locally achieved by:

- Minimizing the generation of stormwater
- Minimizing the loading of pollutants into stormwater
- Treating the water to achieve the highest quality practicable
- Releasing/discharging surface water

Additional information regarding the federal Clean Water Act and the State Puget Sound Water Quality Management Plan are presented below. It is the following federal and State regulations that provide most of the regulatory guidance for and direction to the City's stormwater management program.

Federal Clean Water Act Requirements

In 1987, Section 402 of the federal Clean Water Act required that municipal stormwater systems be regulated under the NPDES. Federal regulations were promulgated in 40 CFR Part 122.

The intent of the federal program is to minimize the concentrations of pollutants discharged with stormwater from industrial and construction sites. The federal program is comprised of three basic elements:

- Permits are required for stormwater discharges associated with industrial activities. For example, industrial facilities which store raw materials, manufacture goods, or store products that may come in contact with stormwater must apply for a general permit.
- The permit requires that facilities implement stormwater pollution prevention plans (SWPP) and apply best management practices (BMPs) to control the quality of stormwater discharges. The SWPP summarizes BMPs covering raw material stockpiles, sweeping the site to minimize pollutants that could be carried by stormwater runoff, or installing and maintaining sediment detention sumps or basins. Reporting, inspection and maintenance requirements are summarized by the SWPP as well. An implementation team responsible for the plan at each site is also established by the SWPP.
- Construction sites disturbing more than five acres must apply for a general stormwater permit. The intent of this requirement is to minimize sediment-laden stormwater runoff from construction sites.

Ecology has jurisdiction over the stormwater program in Washington State. Ecology has authored a general permit for discharges associated with industrial activity. The permit requirements apply to industrial facilities within the City's designated WHPAs.

In addition, Ecology has written some industrial category-specific permits, such as for sand and gravel mining sites. Furthermore, Ecology has also authorized a draft permit for construction sites.

Ecology's stormwater program goes further than the federal program in that it requires permit holders to monitor stormwater 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 stormwater infiltration practices.

Puget Sound Water Quality Management Plan Requirements

The Washington State Legislature adopted the Puget Sound Water Quality Management Plan in 1987. In the most recent (1994) revised plan, the City is required to comply with both the Basic and Comprehensive Stormwater Programs. Compliance with the Basic Program was to be achieved by January 1, 1995. Compliance with the Comprehensive Program is expected to be achieved by the year 2000.

The State's Basic Stormwater Program requires the City to:

- B1—Develop and adopt local ordinances for all new development and redevelopment which address:
  - Control of runoff water quality.
  - Use of source control BMPs.
  - Effective treatment of the water quality design storm.
  - Use of infiltration (where appropriate).
  - Protection of stream channels and wetlands.
  - Prevention of erosion and sedimentation.
- B2—Develop and enforce the proper operation and maintenance of all new and existing public and private stormwater systems (minimum standards are defined in Ecology's Stormwater Management Manual).
- B3—Develop and maintain a record keeping program for all new public and private drainage systems and facilities.
- B4—Adopt Ecology's Technical Manual or develop a manual with substantially equivalent technical standards (manuals other than the Ecology manual were to be pre-approved by Ecology by January 1, 1995). Tumwater's manual, along with that of the County, has been approved by Ecology (Drainage Design and Erosion Control Manual for Thurston Region).
- B5—Develop and implement education programs to educate citizens about stormwater and its effects on water quality, flooding, and fish/wildlife habitat, and to discourage illicit dumping into storm drains.
- B6—Coordinate the City's stormwater program with the provisions of the GMA, where appropriate.

Tumwater has satisfied many of the requirements of the Basic Plan.

The goal of the Comprehensive Stormwater Program is to identify and correct the sources of stormwater pollution. In addition to the elements of the Basic Stormwater Program, the Comprehensive Stormwater Program includes the following components:

- C1—Identification and ranking of significant pollutant sources and their relationship to the drainage system and water bodies through an ongoing assessment program (identify water quality problems associated with urban stormwater runoff).
- C2—Investigations and corrective actions of problem storm drains including sampling and identifying illicit connections.
- C3—A water quality response program, to investigate sources of pollutants, spills, fish kills, illegal hook-ups, dumping, and other water quality problems. These investigations should be used to support compliance and enforcement efforts.
- C4—Assurance of adequate local funding for the stormwater program through the formation of surface water utilities, sewer charges, fees, or other revenue generating sources.
- C5—Local coordination arrangements, such as interlocal agreements, joint programs, consistent standards, and/or regional boards or committees.
- C6—An ongoing stormwater public education program aimed at residents, businesses and industries in the urban area.
- C7—Inspection, compliance, and enforcement measures for stormwater facility inspections, elimination of illicit connections, and investigation/verification of corrective actions.
- C8—An implementation schedule delineating the phasing in of required Comprehensive Stormwater Program elements over a five-year period from the starting date assigned by Ecology. (Note: This schedule may change if Ecology chooses to write the compliance schedule for the Comprehensive Stormwater Plan into the City's future Phase I NPDES Stormwater Permit.) Full implementation is expected by the year 2000, including issuance of the City's NPDES permit.

The PSWQMP further states that:

- If after implementing the eight Comprehensive Stormwater Program elements listed above, there are still discharges that cause significant environmental problems, retrofitting of existing development and/or treatment of discharges from new and existing development may be required.

Although the City is well on its way in being in compliance with the State's Comprehensive Stormwater Program by the year 2004, it is important to realize that there are considerable opportunities to technically, programmatically, and administratively integrate the City's stormwater, wellhead protection, and groundwater management programs. In addition to achieving compliance with existing and future regulatory requirements in a cost-effective manner, there are also considerable savings to be realized in integrating these City programs. Tumwater's FY-1997 Centennial Clean Water Fund grant provides an excellent opportunity to consider groundwater protection issues as they pertain to the City's stormwater management program.

7.6.9 Pesticides and Fertilizers

EPA regulates pesticide labeling under the 1975 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). In Washington State, the regulatory functions governing the use of pesticides and fertilizers have been delegated to the State Department of Agriculture. FIFRA allows States to register or restrict pesticide use. Washington State has its own statutory control under the Washington Pesticide Control Act (Chapter 15.58 RCW) and the Pesticide Application Act (Chapter 17.21 RCW). These statutes charge the Washington State Department of Agriculture with the responsibility for pesticide registration, quality control sampling, testing, and licensing of all applicators.

At the federal level, the SDWA requires comprehensive monitoring of all public drinking water supplies for many pesticides. For instance, since 1990 public water providers have been required to monitor over 100 pesticides for drinking water sources that are vulnerable to contamination under the Synthetic Organic Chemical Rules. This requirement has been modified by DOH through a waiver process. Tumwater has received monitoring waivers for all sources.

In Thurston County, a pesticide policy and procedures program was adopted in 1989. The main thrust of this program is to implement an integrated vegetation management program to minimize pesticide use by the County agencies, especially the County Roads and Transportation Services Department.

Under the Thurston County Nonpoint Source Pollution Ordinance (November 1992), practices are described for the protection of surface and groundwater from nonpoint source pollution. The aim of this ordinance is to prevent pollution from moderate risk waste (hazardous waste in quantities below those regulated by the State or federal government), and domestic animal wastes from small farm operations. The County enforces its ordinances in the City as well as in the unincorporated areas of Tumwater's delineated WHPAs. The City responds only to reports of direct dumping to catch basin and stormwater pond facilities. Pollution prevention measures for small animal operations include stormwater controls, management of animal density and manure application rates, and such water quality protection measures as grass or other vegetation buffers designed to protect surface waters, fencing, and limit or restrict livestock access to water bodies. The Thurston Conservation District, often depended upon for referral of problem sites by regulatory agencies, administers pollution prevention programs for farms.

7.6.10 Summary and Recommendations

Federal, State, and local regulatory programs are generally adequate for protecting the City's drinking water supplies. However, budget constraints and lack of coordination generally inhibit the effectiveness of many regulatory programs. Wellhead protection programs offer an opportunity to improve the effectiveness of existing regulatory programs by focusing them in the City's wellhead protection areas as a first priority. Recommendations are presented below to marshal the resources of local governments in Thurston County towards this end.

Recommendation 7-22: **Through the GWPAC and GWTAC, annually review State and local regulatory activities in the region and jointly influence them to focus their activities in WHPAs.**

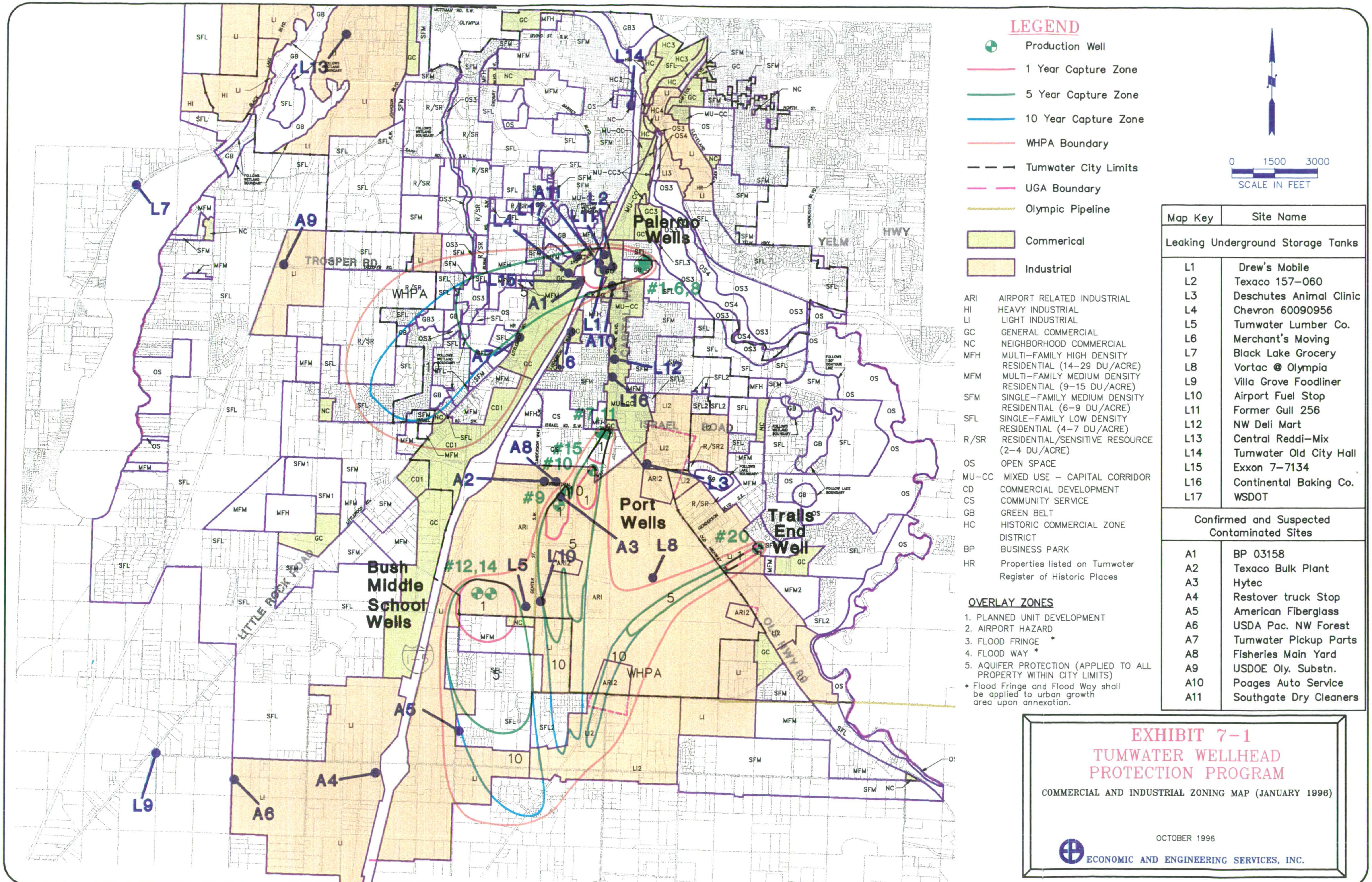
With the encouragement, focus, and guidance of the Cities of Tumwater, Olympia, Lacey, and Thurston County, the GWPAC should convene a one-day annual state and local government wellhead protection conference/workshop. The working agenda of the annual event should be to review, evaluate, and prioritize regulatory activities carried out by the Thurston County Health Department, Ecology, and DOH. The goal of the annual one-day conference/workshop should be to develop coordinated state and local action plans for addressing wellhead protection issues throughout northern Thurston County.

Recommendation 7-23: **Through the GWTAC, annually review progress on contaminated (MTCA) sites located in the designated WHPAs of the region. Collaborate to provide Ecology with a regional focus and a prioritized list of MTCA sites.**

Table 4-1 lists and Exhibit 4-1 pinpoints a number of Model Toxics Control Act (MTCA) confirmed and suspected sites within the Tumwater focus area. A large number of MTCA hazardous materials sites in Thurston County and Washington State have been designated for cleanup by Ecology. State resources are limited for the conduct of this work and progress is relatively slow. Ecology has established a process for prioritizing MTCA sites to take corrective action more quickly so that the State's worse contaminated sites are cleaned-up first.

Consequently, many MTCA sites are receiving independent attention by owners or responsible parties to make immediate use of the land or as an initiative to limit their liability. Ecology's involvement has been restricted because of limited resources and the need to concentrate their cleanup efforts on the highest priority sites.

The GWPAC should request Ecology's current list and cleanup schedule/status of all MTCA sites in northern Thurston County. Once received, the GWTAC should monitor and update the list for the GWPAC on an ongoing basis. On an annual basis, the GWTAC should review Ecology's planned versus actual progress or scheduled action plan for cleaning up each site. A list of MTCA sites located within designated wellhead protection areas should be developed by the GWTAC for review by the GWPAC. An interjurisdictional ranking process should be used to prioritize each site by risk level or perceived threat in terms of its actual or potential for contaminating the region's drinking water supply. On an annual basis, the GWPAC should officially adopt MTCA site cleanup priorities for northern Thurston County and meet with Ecology to focus their regulatory attention and cleanup resources on GWPAC's MTCA site priorities for the region.



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Section 8

Section 8
Evaluation of Recommendations

8.1 Overview

This section presents a compilation and an evaluation of all Wellhead Protection Program (WHPP) recommendations presented in previous sections. These are organized in the sequence in which each action item was previously discussed. No priority should be implied by the presentation sequence. Individual recommendations are evaluated separately by potential benefit or effectiveness in protecting the City of Tumwater's (City) drinking water supply, feasibility, and estimated cost. Costs are classified as being low ($1,000 - $5,000), medium (between $5,000 and $10,000), or high (over $10,000). Also, included is a recommendation as to the relative priority for implementation. Items recommended for inclusion into the City's basic WHPP should receive the highest priority, with those recommended for an enhanced program receiving additional analysis and selection for potential future use.

8.2 Compilation and Evaluation of WHPP Recommendations

Section 2: Hydrogeology and Wellhead Delineation

Recommendation 2-1:	Conduct feasibility study for Palermo Wellfield.
Benefit	High: Half of the Palermo Wellfield has been impacted by contamination. The remaining half is vulnerable and may be impacted in the near future. The feasibility study would evaluate continued use of the Palermo wellfield as compared to transfer of water rights and capacity to a new location. This project would also provide critical review and comment on remedial actions proposed by other parties, and an evaluation of the pursuit of repayment of city costs by potentially responsible parties.
Feasibility	High: Substantial information is available.
Cost	This activity is being performed and funded by EPA.
Recommended Action	None. Site is listed on Superfund Site list.

Recommendation 2-2:	Monitor water quality.
Benefit	High: Monitoring water quality provides early detection of possible contamination before drinking water supply wells are impacted, allowing for timely and appropriate response. Initial phase would include installation of dedicated pumps for those wells not having one now and monitoring of water quality at six monitoring wells on a scheduled basis. Evaluation of expanded monitoring network would be undertaken in the first year.
Feasibility	High: Certified analytical lab services are available. Personnel training, laboratory QA/QC, and interpreting analytical results may be required and are available. Evaluation of network expansion would be a first-year in-house task.
Cost	Low: Approximately $5,000 per year in analytical costs. Acquisition of and installation of dedicated monitoring well pumps. A contract with the County or a consultant is an option for routine wellhead monitoring. $ 5,000 annually.
Recommended Action	Include in WHPP. Begin in 1997, with one-half year program, at a cost of $ 2,500 for lab costs and 3 days of staff or intern time.

Recommendation 2-3:	Implement water quality and water level database.
Benefit	Moderate: Enter data into a database to facilitate water level and water quality trend analysis. Initial phase would involve selecting a database, training personnel and establishing procedures.
Feasibility	High: Pacific Groundwater Group (PGG) has appropriate software and training program available. City personnel should be selected on the basis of providing continuity or training to others.
Cost	Medium: Approximately $3,600 one-time outlay for database development. Then $500.00 per year costs thereafter.
Recommended Action	Include in WHPP. Start in 1998.

Recommendation 2-4:	Evaluate high-priority contamination threats.
Benefit	High: Working with owners of contaminated sites with respect to mitigation of contamination and prevention of future contamination that may impact drinking water is a critical preventative measure. Sites currently requiring attention include the Palermo wellfield and the Texaco bulk storage facility. New developments requiring assessment and comment are arising on a regular basis.
Feasibility	High: Staff evaluation and negotiation may be augmented by engineering and hydrogeologic consulting services and possible legal counsel.
Cost	High: It is recommended that $10,000 per year be allocated to this item. Actual expenses will vary depending on response required. In some cases, the City may be able to pursue cost recovery from potentially liable parties.
Recommended Action	Include in WHPP. Ongoing, beginning in 1998.

Recommendation 2-5:	Monitor water levels.
Benefit	High: Monitoring water levels in recommended wells will provide a baseline for various aquifers. This data will be useful in applying for water rights and diagnosing problems in operating wells. Monthly monitoring in ten wells is recommended, along with area-wide measurements every three to five years in coordination with other regional and federal jurisdictions.
Feasibility	High: The City has a water level indicator, and has initiated water level monitoring on a resources-available basis.
Cost	Low: Estimated annual cost $ 1,000.00.
Recommended Action	Include in WHPP.

Recommendation 2-6	Update WHPA Delineations
Benefit	Medium: Capture zones and resulting WHPAs will change in response to future increased groundwater extraction. New data, such as aquifer parameters from aquifer tests or water level data, may also cause a change in the WHPA delineations.
Feasibility	High: Professional technical consulting services are available to conduct this work.
Cost	Medium: Approximately $5000 on an annualized basis is recommended. Updates would be conducted every two to three years. Modification of WHPAs may not be warranted with each update.
Recommended Action	Include in WHPP.

Section 3: Contaminant Source Inventory

Recommendation 3-1:	Update the parcel and contaminant source inventory for wellhead protection areas every two years.
Benefit	High: An update of potential contaminant sources is required by Washington State Department of Health (DOH) every two years. Based on this inventory, assessors or other maps used by the city for development review or regulatory purposes should be updated concurrently. Use of volunteers in the survey, as in the initial survey, can provide an important public information and involvement benefit.
Feasibility	High: Techniques for this activity were developed and implemented as part of the planning process. See Appendix B.
Cost	Low: Requires up to one month intern time plus volunteer support biannually. Approximate cost $ 5,000.00 in 1998, and $2,500 in 2000 and beyond.
Recommended Action	Include in WHPP. Update required in 1998.

Recommendation 3-2:	Increase the availability of hazardous materials technical assistance and audits to small business, private industry, and government agencies within designated WHPAs.
Benefit	High: Working with these groups provides the biggest "bang for the buck" since they comprise the groups with the highest potential for contaminating the City's drinking water.
Feasibility	High: The 1995 pilot effort carried out by the Business Pollution Prevention program staff was a highly successful experience for the City and the businesses involved, resulting in increased compliance with county ordinances and state requirements.
Cost	Low: This can be accomplished through contract with the Business Pollution Prevention program of the Thurston County Environmental Health Division. A $2,500 per year budget for this effort would establish an ongoing program.
Recommended Action	Include in WHPP. Begin in 1998 and carry out biannual programs concurrent with parcel inventory update.

Recommendation 3-3:	Request the Thurston Conservation District to inventory and assess existing agriculture/hobby farming, golf course, and park land use activities within the City's WHPAs and focus farm and land management technical assistance in the Urban Growth Area.
Benefit	High: This action provides an evaluation of specific types of land uses.
Feasibility	High: Cooperation with the Conservation District has already begun for city properties in the Deschutes Valley. The Conservation District is interested in pursuing urban projects.
Cost	Medium: No cost to the utility for properties in Tumwater Valley (1997); $5,000 for other City properties in 1999. Funding source may be utility or Thurston Conservation funds. The Conservation District can provide a limited amount of service to the city through 10/98 under its CCWF groundwater grant. Beyond then, the Conservation District must seek additional funds to carry out activities suggested by the WHPP.
Recommended Action	Include in WHPP. Continue efforts at the Tumwater Valley Golf course in 1997, expanding to other city properties in 1999, with other land ownership parcels identified for potential volunteer participation in future years.

Section 4: Risk Analysis

Recommendation 4-1:	Assess nitrate levels in groundwater for specific areas within Tumwater's WHPAs based on nitrate loading model.
Benefit	Medium: Rising nitrate levels in some areas have raised questions of allowable septic tank densities, agricultural activities and appropriate residential and commercial fertilizer use. This effort has regional implications. A regional effort would more comprehensively assess the risk and help target mitigation efforts.
Feasibility	Medium: Assessment of nitrate trends and nitrate loading model on a regional basis, based on current and proposed future land use, could be useful, on a planning level basis. However, assumptions may make accurate predictions difficult; also additional planning is not the highest priority for the jurisdictions.
Cost	Service Level 1 - Low: $2,500 per year starting in 1999. Efforts currently being undertaken by the City of Olympia could be a starting-point for regional evaluation. Service Level 2 - Medium: This effort may require that additional nitrate data be collected as part of the City's and the region's monitoring program. Estimated cost, $10,000 as part of regional effort starting in 1999.
Recommended Action	Special project in future years.

Recommendation 4-2:	Prioritize program implementation by WHPA.
Benefit	High: Prioritization of activity based on the vulnerability of Wellhead Protection Areas, potential, benefit of the augmented program, and resources available will assure an effective program.
Feasibility	High: Preliminary list of high risk areas and sites has been identified in this report. Identification of priorities is within existing information and can be accomplished within existing job duties.
Cost	Low: This is an ongoing management task for staff with Council direction.
Recommended Action	Include in WHPP. Ongoing.

Recommendation 4-3:	Develop and implement petroleum pipeline management strategies.
Benefit	High: Large volumes of fuel are transported through the fuel pipeline. Augmented standards for construction of new facilities and operation of existing or new facilities could potentially substantially reduce or eliminate risk of contamination from this source.
Feasibility	Medium: Regional policy development is in addition to enhanced ordinances for development review and franchise arrangements.
Cost	Low: One time contribution to regional policy effort, and three weeks' staff time to write ordinances and request approval by council. $ 4,000 total estimated cost for 2000 and beyond.
Recommended Action	Special project, future years.

Recommendation 4-4:	Investigate current County and City procedures for pesticide and herbicide use within Wellhead Protection Areas; with the goal of reduction of chemical use where possible.
Benefit	High: An assessment of chemical use would indicate level of risk.
Feasibility	High: Contact and survey of county and city operations staff regarding current procedures and research risks and alternatives.
Cost	Low: This can be accomplished by an intern with the assistance of Thurston County Moderate Risk Waste Program. Approximate cost $ 1,200.
Recommended Action	Special project in 1999.

Recommendation 4-5:	Prepare Port Area Traffic Plan
Benefit	High: It is suspected that a high volume of hazardous material is transported through the Port area. Restricting the transport of hazardous materials in and out of the port area, and particularly the Texaco Bulk Fuel Facility, would minimize the potential for a spill occurring within the capture zone of the Port wells.
Feasibility	High: A master traffic plan could be prepared by the City, and be modified by transporters of hazardous materials. Alternatively, complete traffic plans could be required of transporters of hazardous materials.
Cost	Low: Current City staff or transporters of hazardous materials could prepare plans.
Recommended Action	Include in WHPP.

Section 5: Spill Response Assessment

Recommendation 5-1:	Develop a City Spill Response Plan for each of the City's WHPAs.
Benefit	High: Spill response is an important risk reduction measure given the transport of a variety of hazardous materials in the area in day-to-day commerce.
Feasibility	High: Public Works staff should determine, in cooperation with the Fire Department, what augmentations of existing spill response capability are needed. The Local Emergency Planning Committee through which the regional spill response agencies coordinate activities should be approached by the regional jurisdictions for review and adoption of a spill response plan for the City's WHPAs.
Cost	Low: Annual coordination with this group and other local communities through the Ground Water Technical Advisory Committee will require about $5,000.00 for 1998.
Recommended Action	Include in WHPP. Ongoing effort.

Recommendation 5-2:	Update the City's Emergency Disaster Plan and Hazardous Materials Response Plan to include WHPAs.
Benefit	High: Routine review of wellhead issues as part of fire service and utility emergency management will help avoid loss of water supply.
Feasibility	High: The City of Olympia upgraded its Emergency Management Plan (October 1995). This and other models could be used to incorporate wellhead protection issues into ongoing fire service and utility management responsibilities.
Cost	Service Level 1 - Low: A staff review team should establish WHPP criteria and emergency spill response requirements, then evaluate and update the City's Emergency Disaster Plan. Approximately $ 3,600.00 in 1999. Service Level 2 - Medium: A consultant and staff team is recommended approach. Staff time could amount to 0.2 FTE for a year. Consultant cost estimated at $32,000.
Recommended Action	Special project every five years.

Recommendation 5-3:	Provide the City's WHPA information to emergency management planning and spill response organizations in northern Thurston County. Encourage Thurston County to update its Emergency Disaster Plan to include all designated WHPAs.
Benefit	High: Notification is a Department of Health requirement. This activity will help foster communication with the spill response agencies in the area upon which the City depends for early action.
Feasibility	High: These groups are readily identifiable and meet regularly.
Cost	Low: This can be completed by Public Works and Fire Department staff contact with regional organizations. No specific resource allotment required.
Recommended Action	Include in WHPP.

Recommendation 5-4:	Develop a wellhead protection and spill response in-service training program for Tumwater's Fire, Police, and Public Works Departments.
Benefit	High: This would focus attention on wellhead issues, communication, and specific actions required from emergency responders.
Feasibility	Medium: These organizations have much to do and have limited resources; however, this effort can be an augmentation of existing training efforts.
Cost	Service Level 1 - Medium: Resources are needed to conduct the training and provide back-up field presence while training is occurring. Estimated costs: $5,000 every other year starting in 1999. Service Level 2 - High: Resources can be expensive for training and back-up field presence. A moderate budget for the first few years would be about $15,000 per year.
Recommended Action	Include as an enhancement to WHPP. Special project every 2 years.

Recommendation 5-5:	Request the Thurston County Board of Commissioners to reactivate the Thurston County Local Emergency Planning Committee. Encourage the LEPC to update the Countywide Hazardous Materials Emergency Response Plan and include WHPAs.
Benefit	High: This committee coordinates regional spill response activities and approves specific spill response plans. It can serve as a vehicle to gather information and incorporate wellhead issues into plans.
Feasibility	Medium to High: This group has the potential of becoming a focal point for hazardous material management in the area; however, the purposes and meeting schedule for the group are unclear. The Groundwater Policy Advisory Committee is exploring opportunities for cooperation.
Cost	Low: This should be completed with routine staff contact.
Recommended Action	Include in WHPP.

Recommendation 5-6:	Encourage discussion of spill response issues by the Groundwater Policy Advisory Committee (GWPAC) to develop regional spill response policies for WHPAs.
Benefit	High: This activity elevates regional awareness of spill response issues and identifies policies that may be implemented jointly by utilities in the region.
Feasibility	High: The Groundwater Technical Advisory Committee (GWTAC) meets currently; this subject is under discussion.
Cost	Low: Within existing staff time dedicated to regional effort.
Recommended Action	Include in WHPP.
Recommendation 5-7:	Enhance existing business education programs and work with local businesses to promote effective spill prevention in WHPAs.
Benefit	High: A targeted effort focused on those facilities which handle larger quantities of hazardous materials can result in substantial risk reduction.
Feasibility	High: Excellent programs exist such as, Thurston County's Business Pollution Prevention Program to carry out this task.
Cost	Low: A funding enhancement of $ 2,500 per year to support expansion of existing efforts would target key sources of potential spills.
Recommended Action	Include in WHPP. Biannual effort concurrent with parcel inventory, beginning in 1998.

Section 6: Contingency Plan Assessment

Recommendation 6-1:	As part of the Water System Plan Updates, beginning in 1998, prepare a written contingency plan for loss of source from contamination, technical problems, or system failure.
Benefit	High: Emergency response planning should include specific actions for various loss of source scenarios. Actions should be identified to mitigate both short- and long-term loss and to trigger both local and regional response, including opportunities for interties.
Feasibility	Medium to High: Thorough evaluation of engineering and operational needs could require substantial resources.
Cost	Service Level 1: None. Not applicable as part of the wellhead plan. Service Level 2: High. This effort might take up to 0.4 FTE staff to complete over a one year period. $24,000 cost for 1998, $6,000 for 1999, and $3000 for 2000 and beyond.
Recommended Action	Incorporate into future water system plan updates.

Recommendation 6-2:	As part of the 1998 water system plan update, evaluate the potential benefits and consequences of augmenting short-term source of supply by increasing pump rates under two scenarios: 1.) pumping to equal the City's permitted or perfected water rights, and 2.) pumping to the maximum capacity in excess of permitted water rights.
Benefit	High: In combination with information regarding operations and system hydraulics, evaluation of short-term pumping capacity will form the basis for short-term contingency plans.
Feasibility	High: Hydrogeologists can evaluate pumping scenarios in loss of source scenarios by modeling in conjunction with analyses of system hydraulic response.
Cost	Not applicable as part of wellhead protection plan.
Recommended Action	Incorporate into 1998 water system plan update, and future water system plan updates as appropriate.

Recommendation 6-3:	Pursue groundwater source exploration and the development of new sources of supply.
Benefit	High: New source is required to meet contingency supply needs and future source of supply.
Feasibility	Medium: Standard hydrogeologic modeling techniques are used. Longer lead times are required for water rights processing. Sources and water rights are uncertain. This process is under way.
Cost	High: This project is budgeted at $ 44,000 in 1997. See Water System Capitol Facilities plan.
Recommended Action	This project is incorporated into separate programs in water utility.

Recommendation 6-4:	As part of the 1998 Water System Plan, develop and implement a comprehensive hydraulic improvement plan for the City's water system in conjunction with Water System Planning and Contingency Planning.
Benefit	High: Recommended hydraulic improvements based on various scenarios including potential interties, could provide flexibility in the event of loss supply.
Feasibility	Medium to High: Hydraulic improvements will be recommended as part of the 1998 Water System Plan; however, contingency loss of supply scenarios are not currently part of the evaluation and should be incorporated into the effort.
Cost	Service Level 1: None. Not applicable to wellhead protection program. Service Level 2: High. Costs for this activity can be high. Staff time could take up to 0.6 FTE over one year. $36,000 cost for 1998.
Recommended Action	Incorporate into 1998 and subsequent water system plan updates.

Recommendation 6-5:	Evaluate permanent intertie capabilities with the Cities of Olympia and Lacey as well as other water purveyors such as the Pabst Brewing Company. Interties have existed on an informal basis for years, but do not have permanent facilities or procedures and are not DOH approved.
Benefit	High: Interties are cost effective means to augment short term source of supply when generally compared to other options.
Feasibility	High: Hydraulic analysis can be incorporated into 1998 water system plan update. Discussion with neighboring jurisdictions, Pabst and DOH can be accomplished following hydraulic evaluation.
Cost	Service Level 1: None. Not applicable as far as hydraulic analysis is concerned. This can be incorporated into the 1998 water system plan. Discussions with other entities would be a special project for 1999. See Water System Capital Facilities plan.
	Service Level 2: High: The first step, evaluation, would be fairly inexpensive. Other aspects might raise the cost to a moderate level. A one-time FTE level of 0.5 or consultant costs of around $25,000 should take care of first year costs. Total capital costs remain unknown.
Recommended Action	Hydraulic analysis will be part of the water system plan, policy and procedures as part of the 1999 special project.

Recommendation 6-6:	Support a coordinated approach toward regional water supply contingency planning and source development among the Cities of Tumwater, Olympia, Lacey, and Thurston County.
Benefit	High: The benefits of regional development of water supplies include potentially lower development costs, justification for water rights, and the reliability and redundancy of interdependent systems.
Feasibility	High: This project has been undertaken by the regional jurisdictions, but requires on-going support in order to meet long-term supply needs.
Cost	Service Level 1: None: Cost of Regional supplies development will be estimated and budgeted as a separate project in the water utility. Regional coordination and policy development can be brought forward in future years through GWPAC. Service Level 2: High: Considerable technical effort will be needed. Up to 0.5 FTE staff over two years would be optimal. $30,000 for 1998
Recommended Action	Special project in future years.

Section 7: Existing Risk Mitigation Programs
Program Management and Coordination

Recommendation 7-1:	Review all City environmental protection programs that may affect groundwater and evaluate their effectiveness in preventing groundwater contamination in WHPAs.
Benefit	High: The City's efforts should be routinely reviewed as part of general utility management. All city properties as well as policies should be evaluated, generating good public relations and establishing a leadership role for the city in environmental protection.
Feasibility	Medium: The City has the capability to conduct this review as part of its routine utility management. Capital improvement costs would be identified as part of the review. However, the multiplicity of potential players will require cooperation and coordination between departments. Council direction regarding city environmental policies will be required.
Cost	Medium: A staff review team should gather information, criteria and evaluate programs. Intern and staff time for about three weeks will be required, every 5 years at a cost of $ 3,600.00 starting in 1998.
Recommended Action	Include in WHPP as special project every 5 years.

Recommendation 7-2:	Provide routine leak detection on all sewer force mains and all sewer lines above the water table within the one- and five-year time-of-travel zones of each designated WHPA.
Benefit	Medium to Low: The risk posed from a leak may be low, but the impact could be large.
Feasibility	High: Sewer leak detection technology is readily available.
Cost	Service Level 1: Medium: Within current level budget. Service Level 2: Medium: A $10,000 per year budget would create an ongoing program.
Recommended Action	Include as an enhancement to WHPP.

Recommendation 7-3:	Through the GWPAC and GWTAC, develop and use a regional hazard ranking system to set wellhead protection priorities and land use permit conditions.
Benefit	High: This topic has been subject of much discussion by the Groundwater Policy Advisory Committee and staff. A compromise approach is being proposed to provide enhanced environmental review under critical areas ordinances triggered by specified quantities of regulated materials on-site, rather than a full-blown quantitative ranking system.
Feasibility	High: The regional jurisdictions have developed a policy for new land uses which will be brought forward for adoption and may be augmented if desired, by the city. Existing uses will be regulated in a phased approach in future years.
Cost	Low: Following adoption of appropriate policies, development of implementing ordinances will require about $1,200 in 1998.
Recommended Action	Special projects for 1998 (new uses), 1999 (existing uses) and future years.

Recommendation 7-4:	Through the GWPAC and GWTAC, coordinate regional wellhead protection policies and management strategies for the Cities of Tumwater, Olympia, Lacey, and Thurston County.
Benefit	High: Coordination and focus will provide the opportunity for efficient, long-range, and cost-effective programs.
Feasibility	Medium: The structure exists and regional discussions have been productive on wellhead issues to date. Coordination of implementation efforts will require dedication of staff resources over and above jurisdiction-specific needs and discussion of sometimes controversial issues, but will pay off in terms of consistency across jurisdictional boundaries.
Cost	Service Level 1: Low: Working in a group environment and with regional objectives will take staff (and management) time. Estimated annual cost (4 weeks staff time): approximately $ 5,000.00. Service Level 2: Medium: Working in a group environment and with regional objectives will take staff (and management) time. Staff resources could reach 0.4 FTE. Cost would be $24,000 for 1998, 1999, and 2000 and beyond.
Recommended Action	Include in WHPP. Ongoing.

Monitoring and Data Management

Recommendation 7-5:	Support Regional Water Quality Monitoring Efforts.
Benefit	High: Regional data is critical to understanding water resources, predicting impacts to wells, and developing water resources and water rights for future source of supply.
Feasibility	High: This project is supported through the city's existing contribution; future augmentation may be desirable depending on identified needs.
Cost	Service Level 1: Low: No enhancement from regular improvement plan. Service Level 2: High: The City's contribution for this effort could be $25,000 per year.
Recommended Action	Include in WHPP; ongoing through the regional groundwater program.

Recommendation 7-6:	Coordinate with regulatory inspection programs carried out through local fire agencies, Thurston County's Moderate Risk Waste Program, Ecology, and DOH, for identifying and managing contamination risk.
Benefit:	High: Several entities inspect currently for different, but related purposes. Coordination of these efforts will assure a more comprehensive coverage of wellhead protection areas and provide a more effective risk identification and mitigation program.
Feasibility:	High: This effort will require communication and meetings to start. Coordination is already underway with Tumwater Fire Department and Department of Ecology. The GWPAC can provide a forum for identification of project needs.
Cost:	Low: Initial investigation can be carried out by an intern regarding existing programs with discussions for regional coordination taking place at the GWPAC within the existing work program. Future year costs to be developed based on these initial steps.
Recommended Action:	Special research project 1998 in coordination with discussions about possible regulation of existing uses in wellhead protection areas. Incorporate recommendations into future work programs.

Recommendation 7-7:	Integrate City water level and use data into regional database systems.
Benefit	Medium: Regional water level and water use data are becoming important as water rights and water resources management considerations. A regional database will help all parties justify well drilling and water withdrawal proposals. Compilation of data is also required under Department of Health conservation guidelines.
Feasibility	Medium: Water level data are being gathered on a spreadsheet basis by the city and regional level within a limited regional program. Regional database set up, access and maintenance issues have not been evaluated. Coordination and consistency of city and regional approaches are important.
Cost	Low: This project should be pursued within regional groundwater program and city WHPP.
Recommended Action	Include in WHPP, in conjunction with regional program for 1998.

Recommendation 7-8:	Routinely share land use regulatory data and information with other members of the GWPAC, GWTAC, and the public.
Benefit	High: Sharing information on land use decisions and permitting will help foster common agendas and regional consistency.
Feasibility	Medium: This effort will take extra effort from staff who have not routinely shared these data. City should encourage Groundwater Policy Advisory Committee tan Groundwater Technical Advisory Committee to identify and implement strategies to share land use development information, update WHPA maps, and coordinate review processes.
Cost	Medium: Estimated 1998 costs: 2 weeks staff time and intern time $1,200. 1999 and beyond: $500.
Recommended Action	Include in WHPP, focusing on establishing coordination mechanisms in 1998.

Recommendation 7-9:	Consider augmenting existing regulatory efforts for underground storage tanks to raise awareness about underground tanks and encourage testing and/or removal. This activity might take the form of inventory and leak detection or public outreach.
Benefit	High: Brings attention to the risks of underground tanks, and provides the opportunity for preventive action.
Feasibility	Medium: Leak detection for the non-regulated tanks (regulated tanks have required leak detection) involves homeowner cooperation and funding. Fear of cleanup cost and other concerns will likely dampen enthusiasm for this type of project. Education efforts can be reasonably undertaken by staff with intern support and funding for publications and outreach.
Cost	Service Level 1: Low: The number of tanks and potential ramifications of leaks could make a comprehensive program very expensive. An outreach effort might be considered with a budget of approximately $2,500 for brochures and mailing once every 5 years beginning in 1998. Service Level 2: High: The number of tanks and leaks could make this program very experience. However, a limited program might be budgeted annually at $25,000.
Recommended Action	Include as an enhancement to WHPP.

Public Involvement and Education/Technical Assistance

Recommendation 7-10:	Request the Education Technical Advisory Committee (ETAC) to develop wellhead protection public involvement and education (PIE) programs; to the maximum extent possible, GWPAC member jurisdictions should jointly participate, fund, and develop wellhead protection materials for use in designated WHPAs throughout northern Thurston County.
Benefit	High: Individual efforts will cost more for the same benefit and community involvement is very effective once the profile of the issue has been raised.
Feasibility	High: Channels of cooperation and communication are already established through the GWPAC.
Cost	Low: Already included as basic element of regional program.
Recommended Action	Include in WHPP.

Recommendation 7-11:	Contact each commercial business and industry within the City's wellhead zones every two years, advising them of the locations of wellhead zones, major issues of concern, and available technical assistance.
Benefit	High: Commercial operations pose the greatest potential risk to water quality. Good communication will foster improved management of hazardous materials and early warning of problems.
Feasibility	High: Coordination with existing programs such as Thurston County Business Pollution Prevention Program and Fire Department inspections, required biannual wellhead protection contaminant source inventory, will make this project more efficient.
Cost	Medium: \$5,700 every other year starting in 1998 in coordination with Recommendations 3-2 and 5-7. (\$2,000 intern time, \$2,500 for Thurston County program contract services, and \$ 1,200 administrative oversight).
Recommended Action	Include in WHPP.

Recommendation 7-12:	Contact all residential property owners in wellhead protection areas, explain their special responsibility for pollution prevention, seek their participation in PIE activities and volunteer opportunities, and inform them about issues of concern and available technical assistance programs.
Benefit	High: The general public responds well, as was seen in the original contaminant source inventory, to direct contact and communication on wellhead issues.
Feasibility	High: This can be done as part of the Potential Contaminant Source Inventory update conducted every two years.
Cost	Low: Design, printing, and mailing will be about \$2,500 every two years starting in 1998, in addition to personal contact during contaminant source inventory (\$1,000 staff or intern time).
Recommended Action	Include in WHPP.

Recommendation 7-13:	Integrate wellhead protection issues into school-related programs, in cooperation with the Tumwater School District, Project Green, the Tumwater Fire Department and Fire District Nos. 5, 6, and 11, neighborhood groups, other local community and volunteer organizations.
Benefit	High: The future residents, landowners, and decision makers are in our schools. Their understanding of wellhead protection may reduce risks significantly in the future.
Feasibility	High: ETAC can provide regional guidance for development of consistent groundwater protection messages. Project Green has indicated an interest in expanding programs to include groundwater protection messages.
Cost	Service Level 1: Low: Curriculum development and implementation should be pursued jointly with the schools at a cost of approximately $1,200. Service Level 2: High: Properly developed programs and curriculum can be expensive. This effort could take $50,000 per year and 0.5 FTE staff.
Recommended Action	Special project within the regional groundwater program, to be proposed for 1999.

Land Use Planning and Regulation

Recommendation 7-14:	Revise the Comprehensive Plan and city ordinances as necessary to provide special protections in Wellhead Protection Areas, and consider water supply issues when developing land use policies or ordinances. Revisions should be developed in a phased approach over three years. (1) overlay zones and expanded environmental review; (2) education, operating permits, construction standards, and enforcement; and (3) non-conforming uses. Land use policies are being developed regionally and can be enhanced by the city as needed.
Benefit	High: Land use policies provide protection of water supplies by limiting uses of land in vulnerable areas.

Feasibility	Medium: Revisions to land use are politically difficult especially when a perceived lower land value is associated with the land use changes. Balancing considerations are the cost of loss of supply, cleanup or treatment that may be charged to the rate payer or the property owner.
Cost	Service Level 1: Medium: Approximately $ 6,000 of combined staff time per year should be allocated in Public Works and Policy and Planning over a two-year period starting in 1998. Then, $1,200 every two years. Service Level 2: High: Staff time and other resources can be expensive. For an effort such as this, 1.0 FTE should be allocated until land use decisions are completed (one to two years). Cost $60,000 per year.
Recommended Action	Dedicate resources for three years as a special project for ordinance development. Evaluate land use revisions routinely as part of biannual comprehensive plan review process.

Recommendation 7-15:	Revise the Critical Areas ordinance to include a permanent overlay zone for the City's Wellhead Protection Areas.
Benefit	High: This effort will establish areas where restrictions and special permitting actions will occur.
Feasibility	High: This technique fits with the existing city Aquifer Protection Areas.
Cost	Low: Establishment of WHPA Overlay Zone(s) can be accomplished by cooperation among existing staffs of the Public Works, Long-Range Planning and Development Services Departments.
Recommended Action	One-time project in 1997 and every 6 years during water system plan update.

Recommendation 7-16:	Revise the Critical Areas ordinances and other ordinances as needed to add performance standards to development review.
Benefit	High: Performance standards will help reduce the risks posed by allowed uses.

Feasibility	High: The city already reviews development proposals for compliance with aquifer protection ordinances. The regional proposal to require all known available and reasonable technology (AKART) for projects involving certain quantities of hazardous materials on-site may be adopted and augmented by the city as desired.
Cost	Medium: Development of regulations should be accomplished by existing staff of Public Works, Long-Range Planning and Development Services, at a cost of approximately $1,200.
Recommended Action	One time project in 1998 and every six years during water system plan update.

Recommendation 7-17:	Revise the Zoning Code criteria for expansions and alterations of non-conforming structures/uses within the City's one- and five-year time-of-travel zones.
Benefit	Medium: This activity will control changes (expansions and modifications) to existing uses within the wellhead zones and may be set up to require improvements.
Feasibility	Medium: The same political issues are raised; however, the goal is not necessarily removal of non-conforming uses, but upgrade and improvement wherever possible.
Cost	Medium: This project, like recommendation 7-16, may be accomplished by existing interdepartmental staff, at a cost of approximately $2,400.
Recommended Action	One time revisions 1999; with issues revisited during biannual Comprehensive Plan revisions.

Recommendation 7-18:	Revise the Stormwater Drainage and Erosion Control Manual to specify stormwater treatment practices best used in WHPAs.
Benefit	Medium: This will help reduce risk by properly handling stormwater from subdivisions and businesses.
Feasibility	High: Wellhead Protection issues will be raised in the context of regional manual update discussions at the regional storm TAC.
Cost	Low: Approximately one week staff time at $3,500.
Recommended Action	1998 project; then revise concurrent with Drainage Manual revisions.

Recommendation 7-19:	Require enhanced development review, and submittal of additional engineering information prior to site development approval in wellhead protection areas.
Benefit	High: As part of risk reduction, requirements for AKART and analysis of potential impacts of projects relative to groundwater will assure protections for new and remodeled site development.
Feasibility	High: This will require language changes to ordinances. Current regional focus is on technology-based controls, but additional review may be appropriate in certain cases. This element will also require on-going attention to proposed development projects.
Cost	High: Interdepartmental staff effort will be needed for one-time ordinance development and at an annual cost of $ 7,500.
Recommended Action	One time ordinance development in 1998 and on-going incorporation of development review as part of WHPP.

Recommendation 7-20:	Assure proper local well siting and utility service review through coordinated water system plan processes, ordinance(s) placing restrictions on well drilling in the city, and coordination with the county for review of wells proposed for approval in city wellhead zones in the county.
Benefit	Low: This activity will reduce risk by preventing unnecessary penetration of aquifers and preventing risk of contamination from individual wells in wellhead zones for city sources of supply.
Feasibility	Medium: County staff currently review proposals. Additional ordinances will be required as well as coordination with Thurston County Environmental Health to assure city involvement.
Cost	Service Level 1: Low: Approximately $ 600 per year cost. Service Level 2: High: Administration of any permitting effort requires resources and could include 0.25 FTE staff for this effort. Cost $15,000 per year.
Recommended Action	Include in WHPP.

Recommendation 7-21:	Require commercial agriculture and recreational land users within the City's wellhead zones to work with the Thurston Conservation District Coordinated Resource Management Program to develop and implement resource protection plans.
Benefit	High: Resource protection plans will reduce risk from pesticides, fertilizers and other chemicals.
Feasibility	High: This will require language changes to ordinances. The city is already taking the lead by working with the Conservation District to develop resource protection plans for the city golf course and other properties in the Tumwater Valley.
Cost	Low: One-time cost of $1,200 for ordinance changes and outreach to large land owners in 1999.
Recommended Action	One time ordinance development in 1999 outreach on a biannual basis after that in conjunction with contaminant source inventory.

Other Regulatory Programs

Recommendation 7-22:	Through the GWPAC and GWTAC, annually monitor State and local regulatory activities in the region and jointly influence regulatory agencies to focus activities in WHPAs.
Benefit	High: The result in of regulatory attention in wellhead areas will be increased awareness of the program and decreased risk to groundwater.
Feasibility	High: The GWPAC and GWTAC together can provide significant incentive and visibility for local wellhead issues and the need for increased inspections and regulatory activity in these zones. They should invite regulators to annual program evaluation sessions.
Cost	Low: This effort can be done with existing resources assigned to these committees.
Recommended Action	Include in WHPP. Recommend as annual project to GWPAC.

Recommendation 7-23:	Through the GWTAC, annually review progress on contaminated (MTCA) sites located in the designated WHPAs of the region. Collaborate to provide Ecology with a regional focus and a prioritized list of MTCA sites.
Benefit	High: The number of these sites in the regional area is small. However, the size of the potential contamination is large.
Feasibility	High: The GWPAC and GWTAC together can provide significant incentive and visibility of local wellhead issues and the need for increased activity on these sites. The activities of these groups will focus the efforts of Ecology.
Cost	Low: This effort can be done with existing resources assigned to these committees.
Recommended Action	Include in WHPP. Recommend as annual project to GWPAC.

Section 9

Section 9
Implementation Plan and Estimated Budget

9.1 Overview and Summary

This section summarizes recommendations to address potential threats to the City's drinking water supplies. Two levels of service are selected which represent a range of potential program responses to identified problems. First, 34 or 71 percent of the 48 recommended actions are included in a "basic" Wellhead Protection Program Plan (WHPP). Implementing this Service Level 1 program would provide an adequate level of protection for the City's wellheads using minimum additional support to existing staff and programs. Many of the actions identified will be carried out through small contracts with professional service providers or other jurisdictions. Fully implemented, the basic WHPP totals an estimated annual cost of $76,500 in 1998, $60,800 in 1999, and $60,700 in 2000 and beyond. Table 9-1 provides an outline of the basic WHPP level of effort involved. Table 9-3 presents a proposed implementation schedule and estimated annual costs of individual action items comprising the recommended basic WHPP for the City.

Second, an "enhanced" program includes the remaining 14 or 29 percent of the 48 recommended actions compiled from all previous sections, as well as enhanced basic program elements. Implementing this Service Level 2 program (in conjunction with the minimum program of the Thurston County Ground Water Management Plan), would provide an excellent level of protection for the City's wellheads. The Service Level 2 program would involve substantial increases in water utility staff. On an annual basis, the enhanced program would cost an estimated $356,000 in 1998, $240,000 in 1999, and $227,000 in 2000 and beyond. The enhanced program actions are listed separately as shown on Tables 9-2 and 9-4 on the following pages.

For Tables 9-3 and 9-4, all estimated full-time equivalent (FTE) staff requirements have been converted into dollar costs using $60,000 as the average annual salary and benefits of a City position.

Table 9-1
Basic Wellhead Protection Program Recommended Actions
(Service Level 1)

Section/Category Recommended Action	Activity Description	Estimated Benefit and Feasibility	Estimated Cost City Water Utility
Hydrogeology and Wellhead Delineation (Recommendation 2-1)	Feasibility study for protecting Palermo Wellfield.	High; High	Low: Currently provided and funded by the EPA.
Hydrogeology and Wellhead Delineation (Recommendation 2-2)	Monitoring water quality.	High; High	Low: Approximately $5,000 per year in analytical costs.
Hydrogeology and Wellhead Delineation (Recommendation 2-3)	Implement water quality and water level database.	Moderate, High	Low: Approximately $3,600 one-time outlay for training in 1998, $500 per year thereafter.
Hydrogeology and Wellhead Delineation (Recommendation 2-4)	Evaluate contamination source threats.	High; High	Medium: It is recommended that $10,000 per year be allocated to this item.
Hydrogeology and Wellhead Delineation (Recommendation 2-5)	Monitor water levels.	High; High	Low: Estimated $1000 annual cost.
Contaminant Source Inventory (Recommendation 3-1)	Update the parcel and contaminant source inventory for wellhead protection areas every two years, with the help of community volunteers.	High, High	Low: Approximate cost of $5000 in 1998, $2500 in 2000.
Contaminant Source Inventory (Recommendation 3-2)	Increase the availability of hazardous materials technical assistance and audits to small business, private industry, and government agencies within designated WHPAs.	High, High	Low: A $2,500 per year budget would create an ongoing program.

Table 9-1 (Cont.)
Basic Wellhead Protection Program Recommended Actions
(Service Level 1)

Section/Category Recommended Action	Activity Description	Estimated Benefit and Feasibility	Estimated Cost City Water Utility
Contaminant Source Inventory (Recommendation 3-3)	Request the Thurston Conservation District to inventory and assess existing agriculture/hobby farming, golf course, and park land use activities within the City's WHPAs and focus its farm and land management technical assistance programs accordingly.	High; High	Low: $5,000 for City properties in 1999.
Risk Analysis (Recommendation 4-1)	Assess nitrate levels in groundwater for specific areas within WHPAs based on nitrate loading models	Medium; Medium	Low: $2500 per year starting in 1999.
Risk Analysis (Recommendation 4-2)	Prioritize level of effort and program implementation by WHPA	High; High	Low: Management should be able to deal with this effort within existing job duties.
Risk Analysis (Recommendation 4-3)	Develop and implement petroleum pipeline management strategies.	High; Medium	Low: $4000 total estimated cost starting in 2000.
Risk Analysis (Recommendation 4-4)	Investigate current procedures for pesticide and herbicide use	High; High	Low: Approximate cost $1200 in 1999.
Spill Response Assessment (Recommendation 5-1)	Develop a Tumwater Spill Response Plan for each of the City's WHPAs.	High; High	Low: Estimated $5,000 cost in 1998.
Spill Response Assessment (Recommendation 5-4)	Develop a wellhead protection and spill response in-service training program for Tumwater's Fire, Police, and Public Works Departments	High; Medium	Low: Estimated cost of $5,000 in 1999.
Spill Response Assessment (Recommendation 5-6)	Establish and maintain a Regional Spill Response Subcommittee under the Groundwater Policy Advisory Committee (GWPAC) to develop a regional spill response plan for WHPAs.	High; High	Low: Within existing budget.

Table 9-1 (Cont.)
Basic Wellhead Protection Program Recommended Actions
(Service Level 1)

Section/Category Recommended Action	Activity Description	Estimated Benefit and Feasibility	Estimated Cost City Water Utility
Spill Response Assessment (Recommendation 5-7)	Enhance existing business education programs and work with local businesses to promote effective spill prevention practices in WHPAs.	High ; High	Low: $2,500 per year targeting key sources of potential spills.
Contingency Plan Assessment (Recommendation 6-3)	Pursue groundwater source exploration and the development of new sources of supply.	High; Medium	High: See Water System Capital Facilities Plan.
Contingency Plan Assessment (Recommendation 6-5)	Evaluate permanent intertie capabilities with the Cities of Olympia and Lacey as well as other water purveyors such as the Pabst Brewing Company.	High; High	Low: See Water System Capital Facilities Plan.
Contingency Plan Assessment (Recommendation 6-6)	Support a coordinated approach for a regional water supply contingency planning and source development with Cities of Tumwater, Olympia, Lacey, and Thurston Co.	High; High	Cost will be estimated and budgeted as a separate project in the water utility.
Existing Risk Mitigation Programs <u>Program Management and Coordination</u> (Recommendation 7-1)	Review all City environmental protection programs that might affect groundwater and evaluate their effectiveness in preventing groundwater contamination in WHPAs.	High; Medium	Low: Total cost estimated at $3,600 in 1998, then $3600 in 2000 and every five years after that.
Existing Risk Mitigation Programs <u>Program Management and Coordination</u> (Recommendation 7-2)	Provide routine leak detection on all sewer force mains and all sewer lines above the water table within the one- and five-year time-of-travel zones of each designated WHPA.	Medium to Low; High	Medium: Within current level budget.
Existing Risk Mitigation Programs <u>Program Management and Coordination</u> (Recommendation 7-3)	Through the GWPAC and GWTAC, develop and use a regional hazard ranking system to set wellhead protection priorities and land use permit conditions.	High; High	Low: Approximately $1,200 in 1998.

Table 9-1 (cont.)
Basic Wellhead Protection Program Recommended Actions
(Level 1)

Section/Category Recommended Action	Activity Description	Estimated Benefit and Feasibility	Estimated Cost City Water Utility
Existing Risk Mitigation Programs Monitoring and Data Management (Recommendation 7-5)	Support Regional Water Quality Monitoring Efforts	High; High	Medium: Include in WHPP; Ongoing through the regional groundwater program. No enhancement from regular improvement plan.
Existing Risk Mitigation Programs Monitoring and Data Management (Recommendation 7-6)	Monitor and coordinate inspection programs carried out through local fire agencies, Thurston County's Moderate Risk Waste Program, Ecology, and DOH.	High; High	Low: Within current level budget.
Existing Risk Mitigation Programs Monitoring and Data Management (Recommendation 7-7)	Integrate City supply and use data into regional systems	Medium; Medium	Low: This project should be pursued within regional groundwater program and city WHPP.
Existing Risk Mitigation Programs Monitoring and Data Management (Recommendation 7-8)	Routinely share land use regulatory data and information with other members of the GWPAC, GWTAC, and the public.	High; Medium	Low: Estimated 1998 cost of $1,200. Thereafter, $500 per year.
Existing Risk Mitigation Programs Monitoring and Data Management (Recommendation 7-9)	Augmenting existing regulatory efforts for UGST to raise awareness about UST's and encourage testing and/or removal.	High; Medium	Low: Outreach effort approximately $2,500 for brochures and mailing once every 5 years.
Existing Risk Mitigation Programs Public Involvement and Education/Technical Assistance (Recommendation 7-10)	Request the Education Technical Advisory Committee (ETAC) to develop a regional working agenda for wellhead protection public involvement and education (PIE) programs; to the maximum extent possible, have GWPAC member jurisdictions jointly participate, fund, and develop wellhead protection materials for use in designated WHPAs throughout northern Thurston County.	High; High	Low: Cost should be the same as currently planned. Already included as basic element of regional program.

Table 9-1(cont.)
Basic Wellhead Protection Program Recommended Actions
(Level 1)

Section/Category Recommended Action	Activity Description	Estimated Benefit and Feasibility	Estimated Cost City Water Utility
Existing Risk Mitigation Programs <u>Public Involvement and Education/Technical Assistance</u> (Recommendation 7-11)	Assure direct contact with each commercial business and industrial sites within the City's wellhead zones every two years, advising them of the locations of wellhead zones, major issues of concern, and available technical assistance.	High; High	Medium: $5,700 every other year in coordination with Recommendations 3-2 and 5-7 starting in 1998.
Existing Risk Mitigation Programs <u>Public Involvement and Education/Technical Assistance</u> (Recommendation 7-12)	Remind property owners in wellhead protection areas of their responsibility for pollution prevention. Seek participation in PIE activities and volunteering. Inform them of issues of concern and available technical assistance programs.	High; High	Low: Design, printing, and mailing will be about $2500 every two years starting in 1998.
Existing Risk Mitigation Programs <u>Public Involvement and Educational/Technical Assistance</u> (Recommendation 7-13)	Integrate wellhead protection issues into school-related programs, in cooperation with the Tumwater School District, Project Green, the Tumwater Fire Department, and Fire District Nos. 5, 6, and 11, neighborhood groups , and local community and volunteer organizations.	High; High	Low: 1999 cost of $1,200.
Existing Risk Mitigation Programs <u>Land Use Planning and Regulation</u> (Recommendation 7-14)	Revise the Comprehensive Plan and city ordinances as necessary to provide special protections in Wellhead Protection Areas, and consider water supply issues when developing land use policies or ordinances.	High; Medium	Medium: Approximate cost of $6000 for 1998 and 1999. Then, $1200 every two years.
Existing Risk Mitigation Programs <u>Land Use Planning and Regulation</u> (Recommendation 7-15)	Revise the Zoning Code to include a permanent overlay zone for the City's Wellhead Protection Areas.	High; High	Low: Within existing budget.
Existing Risk Mitigation Programs <u>Land Use Planning and Regulation</u> (Recommendation 7-16)	Revise the Zoning Code to add performance standards to conditional use requirements.	High; High	Low: $1,200 for 1998. Within existing budget thereafter.

Table 9-1 (cont.)
Basic Wellhead Protection Program Recommended Actions
(Level 1)

Section/Category Recommended Action	Activity Description	Estimated Benefit and Feasibility	Estimated Cost City Water Utility
Existing Risk Mitigation Programs Land Use Planning and Regulation (Recommendation 7-17)	Revise the Zoning Code criteria for expansions and alterations of non-conforming structures/uses within the City's one- and five-year time-of-travel zones.	Medium; Medium	Low: $2,400 cost for 1998. Within existing budget thereafter.
Existing Risk Mitigation Programs Land Use Planning and Regulation (Recommendation 7-18)	Revise the Stormwater Drainage and Erosion Control Manual to specify stormwater treatment practices best used in WHPAs.	Medium; High	Low: Approximately $2,500 in 1998.
Existing Risk Mitigation Programs Land Use Planning and Regulation (Recommendation 7-19)	Require additional analysis concerning pollution control issues prior to site development.	High; High	Medium: Annual cost of $7500 starting in 1998.
Existing Risk Mitigation Programs Land Use Planning and Regulation (Recommendation 7-20)	Assure proper well siting ad utility service review through coordinated water system plan processes, ordinance(s) placing restrictions on well drilling in the city, and coordination with the county for review of wells proposed for approval in city wellhead zones in the county.	Low; Medium	Low: Approximately $600 per year cost.
Existing Risk Mitigation Programs Land Use Planning and Regulation (Recommendation 7-21)	Require all commercial agriculture and recreational land users within the City's wellhead zones to utilize the Coordinated Resource Management Process to develop and implement land management plans.	High; High	Low: One time cost of $1200 for ordinance changes in 1999.
Existing Risk Mitigation Programs Land Use Planning and Regulation (Recommendation 7-22)	Through the GWPAC and GWTAC, annually monitor State and local regulatory activities in the region and jointly influence them to focus these activities in WHPAs.	High; High	Low: This effort can be done with existing resources assigned to these committees.

Table 9-1 (cont.)
Basic Wellhead Protection Program Recommended Actions
(Level 1)

Section/Category Recommended Action	Activity Description	Estimated Benefit and Feasibility	Estimated Cost City Water Utility
Existing Risk Mitigation Programs *Other Regulatory Programs* (Recommendation 7-23)	Through the GWTAC, annually review progress on contaminated (MTCA) sites located in the designated WHPAs of the region. Collaborate to provide Ecology with a regional focus and a prioritized list of MTCA sites.	High; High	Low: This effort can be done with existing resources assigned to these committees.

Table 9-2
Enhanced Wellhead Protection Program Recommended Actions
(Service Level 2)

Section/Category Recommended Action	Activity Description	Estimated Benefit and Feasibility	Estimated Cost City Water Utility
Risk Analysis (Recommendation 4-1)	Assess nitrate levels in groundwater for special areas within Tumwater's WHPAs based on nitrate loading model.	Medium; Medium	Medium: ($10,000). This effort may require that additional nitrate data be collected as part of the City's monitoring program. Monitoring in conjunction with the existing program can help keep costs down.
Spill Response Assessment (Recommendation 5-2)	Update the City's Emergency Disaster Plan and Hazardous Materials Response Plan to include WHPAs and capture zones.	High; High	High: A consultant and staff team is recommended approach. Staff time could amount to 0.2 FTE for a year. Consultant cost estimated at $32,000.
Spill Response Assessment (Recommendation 5-4)	Develop an integrated wellhead protection and spill response inservice training program for Tumwater's Fire, Police, and Public Works Departments	High; Medium	High: Resources can be expensive for training and backup field presence. A moderate budget for first few years would be about $15,000 per year.
Contingency Plan Assessment (Recommendation 6-1)	Prepare and disseminate a written contingency plan for loss of source from contamination, technical problems, or system failure.	High; Medium to High	High: This effort might take up to 0.4 FTE staff to complete over a one year period. $24,000 cost for 1998, $6000 for 1999, and $3000 for 2000 and beyond.
Contingency Plan Assessment (Recommendation 6-4)	Develop and implement a comprehensive hydraulic improvement plan for the City's water distribution and transmission system.	High; Medium to High	High: Costs for this activity can be high. Staff time could take up to 0.6 FTE over one year. $36,000 cost for 1998.

Table 9-2 (cont.)			
Section/Category Recommended Action	**Activity Description**	**Estimated Benefit and Feasibility**	**Estimated Cost City Water Utility**
Contingency Plan Assessment (Recommendation 6-5)	Evaluate, negotiate, and construct permanent intertie capabilities with the Cities of Olympia and Lacey as well as other water purveyors such as the Pabst Brewing Company.	High; High	High: The first step, evaluation, would be fairly inexpensive. Other aspects might raise the cost to a moderate level. A one-time FTE level of 0.5 or consultant costs of around $25,000 should take care of first year costs. Total capital costs remain unknown.
Contingency Plan Assessment (Recommendation 6-6)	Initiate a coordinated approach toward regional water supply contingency planning and source development among the Cities of Tumwater, Olympia, Lacey, and Thurston County.	High; High	High: Considerable technical effort will be needed. Up to 0.5 FTE staff over two years would be optimal. Cost for 1998 is $30,000.
Existing Risk Mitigation Programs *Program Management and Coordination* (Recommendation 7-2)	Provide routine leak detection on all sewer force mains within the one- and five-year time-of-travel zones of each designated WHPA. (PM-1)	Medium to Low; High	Medium: A $10,000 per year budget would create an ongoing program.
Existing Risk Mitigation Programs *Program Management and Coordination* (Recommendation 7-4)	Through the GWPAC and GWTAC, coordinate pollution control policies and management strategies related to Wellhead Protection Programs for the Cities of Tumwater, Olympia, Lacey, and Thurston County. (PM-3)	High; Medium	High: Working in a group environment and with regional objectives will take staff (and management) time. Staff resources could reach 0.4 FTE. Cost is $24,000 per year.
Existing Risk Mitigation Programs *Monitoring and Data Management* (Recommendation 7-5)	Support Regional Water Quality Monitoring Efforts.	High; High	High: The City's contribution for this effort could be $25,000 per year.

Table 9-2 (cont.)			
Section/Category Recommended Action	**Activity Description**	**Estimated Benefit and Feasibility**	**Estimated Cost City Water Utility**
Existing Risk Mitigation Programs <u>*Monitoring and Data Management*</u> (Recommendation 7-9)	Establish and maintain a comprehensive underground storage tank inventory and leak detection program within the City's designated WHPAs.	High; Low	High: The number of tanks and leaks could make this program very expensive. However, a limited program might be budgeted annually at $25,000.
Existing Risk Mitigation Programs <u>*Public Involvement and Education/Technical Assistance*</u> (Recommendation 7-13)	Develop school-related programs within the wellhead protection areas, in cooperation with the Tumwater School District, the Tumwater Fire Department and Fire District Nos. 5, 6, and 11, neighborhood groups, other local community and volunteer organizations.	High; High	High: Properly developed programs and curriculum can be expensive. This effort could take $50,000 per year and 0.5 FTE staff.
Existing Risk Mitigation Programs <u>*Land Use Planning and Regulation*</u> (Recommendation 7-14)	Revise the Comprehensive Plan to emphasize the importance of Wellhead Protection Areas and designate land uses and densities that do not increase risk to the water supply.	High; Low	High: Staff time and other resources can be expensive. For an effort such as this, one FTE should be allocated until land use decisions are completed (one to two years). Cost $60,000 per year.
Existing Risk Mitigation Programs <u>*Public Involvement and Education/Technical Assistance*</u> (Recommendation 7-14)	Revise the Comprehensive Plan to emphasize the importance of Wellhead Protection Areas and designate land uses and densities that do not increase risk to the water supply.	High; Low	High: Staff time and other resources can be expensive. For an effort such as this, one FTE should be allocated until land use decisions are completed (one to two years). Cost of $60,000 per year.

Table 9-2 (cont.)			
Section/Category Recommended Action	**Activity Description**	**Estimated Benefit and Feasibility**	**Estimated Cost City Water Utility**
Existing Risk Mitigation Programs *Land Use Planning and Regulation* (Recommendation 7-20)	Assure proper local well siting and utility service review through the well drilling "start" card and building permit review process.	Low; High	High: Administration of any permitting effort requires resources and could include 0.25 FTE staff for this effort. Cost of $15,000 per year.

Table 9-3
Implementation Schedule and Estimated Budget
Basic Wellhead Protection Program - (Service Level 1)

Recommended Action	1998 Costs	1999 Costs	2000 and Beyond Costs
Recommendation 2-1: Feasibility study for Palermo Wellfield.	Funded by EPA	.	.
Recommendation 2-2: Monitoring water quality.	$5,000	$5,000	$5,000
Recommendation 2-3: Implement water quality and water level database.	$3,600	$500	$500
Recommendation 2-4: Evaluate contamination threats.	$10,000	$10,000	$10,000
Recommendation 2-5: Monitor water levels.	$1,000	$1,000	$1,000
Recommendation 3-1: Update the parcel and contaminant source inventory for wellhead protection areas every two years, using the help of community volunteers for a portion of the effort.	$5,000	.	$2,500
Recommendation 3-2: Increase the availability of hazardous materials technical assistance, printed materials, and audits to small business, private industry, and government agencies within designated WHPAs.	$2,500	$2,500	$2,500
Recommendation 3-3: Request the Thurston Conservation District to inventory and assess existing agriculture/hobby farming, golf course, and park land use activities within the City's WHPAs and focus its farm and land management technical assistance programs accordingly.	.	$5,000	-

Table 9-3 (cont.)

Recommended Action	1998 Costs	1999 Costs	2000 and Beyond Costs
Recommendation 4-1: Assess nitrate levels in groundwater for specific areas within Tumwater's WHPA's based on nitrate loading model.	.	$2,500	$2,500
Recommendation 4-2: Prioritize level of effort and program implementation by WHPA.	Use Existing Staff	Use Existing Staff	Use Existing Staff
Recommendation 4-3: Develop and implement petroleum pipeline management strategies	.	.	$4,000
Recommendation 4-4: Investigate current procedures for pesticide and herbicide use	.	$1,200	.
Recommendation 5-1: Develop a Tumwater Spill Response Plan for each of the City's WHPAs.	$5,000	.	.
Recommendation 5-2: Update Emergency Response Plan	.	$3,600	$3,600 every five years
Recommendation 5-3: Provide the City's WHPA information to emergency management planning and spill response organizations in northern Thurston County. Encourage Thurston County to update its Emergency Disaster Plan to include all designated WHPAs.	Within existing budget	Within existing budget	Within existing budget
Recommendation 5-4: Develop a wellhead protection and spill response in-service training program for Tumwater's Fire, Police, and Public Works Departments.	.	$5,000	.

Table 9-3
(cont.)

Recommended Action	**1998 Costs**	**1999 Costs**	**2000 and Beyond Costs**
Recommendation 5-5: Request the Thurston County Board of Commissioners to reactivate the Thurston County Local Emergency Planning Committee. Encourage the LEPC to update the Countywide Hazardous Materials Emergency Response Plan and include WHPAs.	Within existin g budget	Within existing budget	Within existing budget
Recommendation 5-6: Establish and maintain a Regional Spill Response Subcommittee under the GWPAC to develop a regional spill response plan for WHPAs.	Within existin g budget	Within existing budget	Within existing budget
Recommendation 5-7: Enhance existing business education programs and work with local businesses to promote effective spill prevention practices in WHPAs.	$2,500	$2,500	$2,500
Recommendation 6-1: Beginning in 1998, Prepare a written contingency plan for loss of source from contamination, technical problems, or system failure.	N/A	N/A	N/A
Recommendation 6-2: Evaluate the potential benefits and consequences of short-term source augmentation by increasing current pumping regimes to equal the City's permitted or perfected water rights.	N/A	N/A	N/A
Recommendation 6-3: Pursue groundwater source exploration and the development of new sources of supply.	See Water System Capital Facilities Plan	See Water System Capital Facilities Plan	See Water System Capital Facilities Plan
Recommendation 6-5: Evaluate permanent intertie capabilities with the Cities of Olympia and Lacey as well as other water purveyors such as the Pabst Brewing Company.	See Water System Capital Facilities Plan	See Water System Capital Facilities Plan	See Water System Capital Facilities Plan

Table 9-3 (cont.)

Recommended Action	1998 Costs	1999 Costs	2000 and Beyond Costs
Recommendation 7-1: Review all City environmental protection programs that might affect groundwater and evaluate their effectiveness in preventing groundwater contamination in WHPAs.	$3,600	.	$3,600 every five years
Recommendation 7-2: Provide routine leak detection on all sewer force mains and all sewer lines above the water table within the one- and five-year time-of-travel zones of each designated WHPA.	Within current level budget.	Within current level budget.	Within current level budget.
Recommendation 7-3: Through the GWPAC and GWTAC, develop and use a regional hazard ranking system to set wellhead protection priorities and land use permit conditions. (PM-5)	$1200	-	-
Recommendation 7-4: Through the GWPAC and GWTAC, coordinate regional wellhead protection policies and management strategies for the Cities of Tumwater, Olympia, Lacey, and Thurston County.	$5,000	$5,000	$5,000
Recommendation 7-6: Monitor and coordinate inspection programs carried out through local fire agencies, Thurston County's Moderate Risk Waste Program, Ecology, and DOH.	Use Existing Staff	Use Existing Staff	Use Existing Staff
Recommendation 7-7: Integrate City supply and use data into regional systems.	Use Existing Staff	Use Existing Staff	Use Existing Staff
Recommendation 7-8: Routinely share land use regulatory data and information with other members of the GWPAC, GWTAC, and the public.	$1,200	$500	$500

Recommended Action	1998 Costs	1999 Costs	2000 and Beyond Costs
Recommendation 7-9: Consider augmenting existing regulatory efforts for underground storage tanks to raise awareness about underground tanks and encourage testing and/or removal. This activity might take the form of inventory and leak detection or public outreach.	$2,500	.	.
Recommendation 7-10: Request ETAC to develop a regional working agenda for wellhead protection PIE programs; to the maximum extent possible, have GWPAC member jurisdictions jointly participate, fund, and develop wellhead protection materials for use in designated WHPAs throughout northern Thurston County.	Within Current Level Budget	Within Current Level Budget	Within Current Level Budget
Recommendation 7-11: Assure direct contact with each commercial business and industrial site within the City's wellhead zones every two years, advising them of the locations of wellhead zones, major issues of concern, and available technical assistance. Coordinate effort with Recommendations 3-2 and 5-7.	$5,700		$5,700
Recommendation 7-12: Remind all residential property owners in wellhead protection areas regularly of their special responsibility for pollution prevention. Seek their participation in PIE activities and volunteer opportunities, and inform them about issues of concern and available technical assistance programs.	$2,500	.	$2,500
Recommendation 7-13: Integrate wellhead protection issues into school-related programs in conjunction with the Tumwater School District, Project Green, the Tumwater Fire Department and Fire District Nos. 5, 6, and 11, neighborhood groups, other local community and volunteer organizations.	.	$1,200	.

Table 9-3 (cont.)

Table 9-3 (cont.)

Recommended Action	**1998 Costs**	**1999 Costs**	**2000 and Beyond Costs**
Recommendation 7-14: Revise the Comprehensive Plan and city ordinances as necessary to provide special protections in Wellhead Protection Areas, and consider water supply issues when developing land use policies or ordinances. Revisions should be developed in a phased approach over three years. Land use policies are being developed regionally and can be enhanced by the city as needed.	$6,000	$6,000	$1,200
Recommendation 7-15: Revise the Zoning Code to include a permanent overlay zone for the City's Wellhead Protection Areas.	Use Existing Staff	Use Existing Staff	Use Existing Staff
Recommendation 7-16: Revise the Zoning Code to add performance standards to conditional use requirements.	$1,200	Use Existing Staff	Use Existing Staff
Recommendation 7-17: Revise the Zoning Code for expansions and alterations of non-conforming structures/uses within the City's one- and five-year time-of-travel zones.	$2,400	Use Existing Staff	Use Existing Staff
Recommendation 7-18: Revise the Stormwater Drainage and Erosion Control Manual to specify stormwater treatment practices best used in WHPAs.	$2,500	-	-
Recommendation 7-19: Require additional analysis concerning pollution control issues prior to site development.	$7,500	$7,500	$7,500
Recommendation 7-20: Assure proper local well siting and utility service review through coordinated water system plan processes, ordinance(s) placing restrictions on well drilling in the city, and coordination with the county for review of wells proposed for approval in city wellhead zones in the county.	$600	$600	$600

Table 9-3 (cont.)			
Recommended Action	**1998 Costs**	**1999 Costs**	**2000 and Beyond Costs**
Recommendation 7-21: Require commercial agriculture and recreational land users within the City's wellhead zones to utilize the Coordinated Resource Management Process to develop and implement land management plans.	.	$1,200	.
Recommendation 7-22: Through the GWPAC and GWTAC, annually monitor State and local regulatory activities in the region and jointly influence them to focus these activities in WHPAs.	Use Existing Staff	Use Existing Staff	Use Existing Staff
Recommendation 7-23: Through the GWTAC, annually review progress on contaminated (MTCA) sites located in the designated WHPAs of the region. Collaborate to provide Ecology with a regional focus and a prioritized list of MTCA sites.	Use Existing Staff	Use Existing Staff	Use Existing Staff
Total estimated annual cost:	$76,500	$60,800	$60,700

Note: Average FTE staff position is estimated at $60,000 per year.

Table 9-4
Implementation Schedule and Estimated Budget
Enhanced Wellhead Protection Program - (Service Level 2)

Recommended Action	1998 Costs	1999 Costs	2000 and Beyond Costs
Recommendation 4-1: Assessment of nitrate levels in groundwater for specific areas within the City's WHPAs based on nitrate loading model.		$10,000	-
Recommendation 5-2: Update the City's Emergency Disaster Plan and Hazardous Materials Response Plan to include WHPAs and capture zones.	$32,000	-	-
Recommendation 5-4: Develop an integrated wellhead protection and spill response inservice training program for Tumwater's Fire, Police, and Public Works Departments.	-	$15,000	$15,000
Recommendation 6-1: Prepare and disseminate a written contingency plan for loss of source from contamination, technical problems, or system failure.	$24,000	$6,000	$3,000
Recommendation 6-4: Develop and implement a comprehensive hydraulic improvement plan for the City's water distribution and transmission system in conjunction with Water System Planning and Contingency Planning.	$36,000	-	-
Recommendation 6-5: Evaluate, negotiate, and construct permanent intertie capabilities with the Cities of Olympia and Lacey as well as other water purveyors such as the Pabst Brewing Company.	$25,000	See Water System Capital Facilities Plan	See Water System Capital Facilities Plan
Recommendation 6-6: Initiate a coordinated approach toward regional water supply contingency planning and source development among the Cities of Tumwater, Olympia, Lacey, and Thurston County.	$30,000	-	-

Table 9-4 (cont.)			
Recommended Action	**1998 Costs**	**1999 Costs**	**2000 and Beyond Costs**
Recommendation 7-2: Provide routine leak detection on all sewer force mains within the one- and five-year time-of-travel zones of each designated WHPA	$10,000	$10,000	$10,000
Recommendation 7-4: Through the GWPAC and GWTAC, coordinate pollution control policies and management strategies related to Wellhead Protection Programs for the Cities of Tumwater, Olympia, Lacey, and Thurston County.	$24,000	$24,000	$24,000
Recommendation 7-5: Support regional water quality monitoring efforts.	$25,000	$25,000	$25,000
Recommendation 7-9: Establish and maintain a comprehensive underground storage tank inventory and leak detection program within the City's designated WHPAs.	$25,000	$25,000	$25,000
Recommendation 7-13: Develop school-related programs within the wellhead protection areas, in cooperation with the Tumwater School District, the Tumwater Fire Department and Fire District Nos. 5, 6, and 11, neighborhood groups, other local community and volunteer organizations.	$50,000	$50,000	$50,000
Recommendation 7-14: Revise the Comprehensive Plan to emphasize the importance of Wellhead Protection Areas and designate land uses and densities that do not increase risk to the water supply.	$60,000	$60,000	$60,000
Recommendation 7-20: Assure proper local well siting and utility service review through the well drilling "start" card and building permit review process.	$15,000	$15,000	$15,000
Total estimated annual cost:	$356,000	$240,000	$227,000

Note: An average FTE staff position is estimated to cost $60,000 per year.

Appendix A

Appendix A

References

Appendix A
References

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Appendix B

Appendix B

Land Use Inventory Methodology

Appendix B
Land Use Inventory Methodology

Introduction

Land use/parcel inventories were completed by the City of Tumwater to identify potential pollution risks within the City's wellhead protection areas (WHPAs). The inventories provide baseline data for characterizing the types of activities occurring on residential and commercial properties which might pose short or longer term threats to the quality of Tumwater's drinking water. The primary elements of this task (residential and commercial) included designing a survey methodology, conducting surveys, and entering survey data. For the residential inventories, coordination with participating organizations, and recruiting and training volunteers, were also important tasks.

Residential Inventories

Partnership Process

The residential surveys were accomplished through a partnership between the City of Tumwater, the City of Olympia, and the Retired and Senior Volunteer (RSVP) Program. This method of surveying was chosen because it would increase public involvement and awareness of groundwater protection issues, and build a community investment in protecting water resources. It also proved to be cost-effective given the limited budgets available to the jurisdictions to complete the land use/parcel inventory survey process.

The partnership between Tumwater, Olympia, and RSVP was formed in April, 1995. The Cities contracted with RSVP to help recruit and train volunteers. The project team recruited and trained high school students attending summer school and fall Social Studies classes. High school students were included when it became evident that more help would be needed than could be provided by RSVP's volunteers.

Students received the same training as the RSVP volunteers. They dedicated four days to surveying, in pairs of two. Several adults were recruited through RSVP to join the students. RSVP was able to extend their volunteer insurance coverage to all project volunteers.

The first round of training was done in June, 1995, with surveys completed immediately after the training. Between April and June, RSVP implemented an outreach strategy for recruiting volunteers, contacting local civic, educational, and environmental organizations. These organizations included local high schools and colleges, the Audubon Society, the Sierra Club, the

Washington State Department of Health, Master Gardeners, Stream Team volunteers, the League of Women Voters, the Lions Club, the Kiwanis, the Rotary Club, Boy Scouts, Girl Scouts, and homeowners groups. RSVP followed up with calls to over 250 of their own members.

Survey Coverage

Both Tumwater and Olympia chose to concentrate on the one-year and five-year time-of-travel capture zones for the residential surveys. In Tumwater, these surveys covered the City's preliminary WHPAs and capture zones. The project team decided to focus volunteer efforts on surveying residential land uses, and set aside the commercial properties for evaluation by City and County staff familiar with pollution prevention practices for businesses.

Volunteer Training

For phase one surveys, two trainings were organized, lasting 2.5 hours each. The project team chose two trainings because of the varied schedules of the volunteers (accommodating those who preferred daytime activities versus evening activities).

Some of the "props" available at the training included:

- ❑ A large map showing the wellhead protection areas for Olympia's six public wells. The map shows the one-, five-, and 10-year time-of-travel capture zones.
- ❑ A groundwater flow model showing how groundwater travels and how wells can become contaminated.

The Mayors from both Tumwater and Olympia welcomed and thanked the volunteers at each of the training sessions. During the training classes volunteers were told about the survey, how to conduct the survey, and what to do in specific instances. They learned about the importance of groundwater protection, aquifer recharge and hydrology, how pollutants move through the soil into groundwater, as well as who to contact for technical questions. Several speakers, including Kathy Callison, presented informative lectures.

Volunteers were instructed to make two attempts at each residence in the one-year time-of-travel, and one attempt in the five-year time-of-travel, before leaving a mail-in survey. The mail-in surveys were identical, but the landowner was required to complete the survey and mail it back to the City in the return envelope without assistance from a volunteer.

Volunteers were instructed to signout for their packets. The packets were organized so that volunteers could choose their own neighborhood or another familiar neighborhood. The training packets contained a survey script, an evaluation, an agenda, an icebreaker game, a sample survey and outline, as well as "how to" guidelines.

For the phase two surveys, training involved a modified, two-hour training presented to the high school students in the classroom. RSVP recruited several adult volunteers to chaperone student teams and they also participated in the training sessions. Packets distributed were identical to those used in the phase one survey work.

Residential Survey Forms

While Tumwater's wellhead protection brochures were being produced, two forms needed to be created: a residential survey and a commercial survey. The survey forms were developed cooperatively with the City of Olympia, Thurston County, Pacific Groundwater Group (PGG), and Economic and Engineering Services, Inc. (EES). Completion of the two forms took several weeks to allow the various organizations to review and comment on several drafts.

Once the contents were established, there were two problems to address. First, on the residential form, the project team decided it would be too laborious and time consuming to ask residents to choose from a long list of contaminants. Therefore, the list had to be generalized to make it more user friendly. For example, rather than ask for quantities of gas, diesel, motor oil, antifreeze, brake and transmission fluid, a general category (petroleum products) was used, which asked for only gasoline, motor oil, and other. This made the list less specific, but still gave the information needed. The second problem to address was chemical quantity. The project team did not want to be too vague by asking for 1 - 5 gallons, 5 - 10 gallons, and so forth. While one gallon of one substance might be harmless, one gallon of another substance could pose a serious environmental threat. The project team decided to ask for specific quantities and a "don't know" option for residents to use.

The residential survey forms were pilot-tested by Thurston County Health Department staff in a rural area of southern Thurston County (not part of this project). Through this testing, the survey team discovered that it took an average of 25 minutes to complete each survey and proceed to the next residence. Out of the 50 homes attempted during the pilot testing, only three refused to complete the survey.

Commercial Survey Forms

The commercial forms were modified slightly from the residential forms to include queries requested by Donna Freier of the Moderate Risk Waste/Business Pollution Prevention program sponsored by the Thurston County Environmental Health Division. These questions required more time for the business owner to complete. The County Health Department's involvement was based on their decision to target business pollution prevention (BPP) efforts in Tumwater's designated WHPAs, as a pilot project. Previously, BPP program efforts had focused on targeted business types.

Survey Development Process

Once the content of the survey forms was finalized, they were given to Steven Swope of PGG. Using the County Assessor's database, PGG used Microsoft Access to create pre-printed forms and mailed them to the City in hardcopy form. Over 300 pre-printed commercial survey forms and 233 residential survey forms were produced for Tumwater by PGG. Meanwhile, using the County Assessor's database and their own digitized wellhead protection area maps, EES created the maps necessary to correspond with specific sets of survey forms.

Advice about the survey was sought and given by David Jennings of the State Department of Health (DOH) wellhead protection program, and Tikva Breuer, also of DOH, who participated as a volunteer in the survey as well. After consulting with DOH, the project team concluded that, to expedite the survey, only the one-year and five-year time-of-travel zones for both residential and commercial portions would be surveyed. To further expedite the survey, only businesses determined to be potentially threatening to groundwater would be surveyed this time. These "threatening" businesses included those that dealt with vehicles (including aircraft), businesses that are small quantity generators, and businesses using hazardous materials on a regular basis.

PGG was able to customize the survey forms for both Tumwater and Olympia with preprinted addresses from the County Assessor's property database. This process was time-consuming, but made it relatively easy for volunteers to find the properties. PGG organized the addresses by alphabetizing the street names (thus making it easier to organize). Staff added a map to each packet of 5 - 12 preaddressed survey forms, a corresponding map, up to six door hangers (with pre-stamped return envelopes and a "sorry we missed you" note), coupons redeemable at a local pizza restaurant, a City of Tumwater wellhead protection brochure, and a "thank you" letter. Volunteers who wanted to help but could not conduct the survey put the packets together for both Tumwater and Olympia.

Conduct of Residential Survey

For phase one of the residential survey, volunteers wore name badges with all three agency logos, along with the volunteer's name. They also wore an "I Drink Groundwater" pin. The first phase of the surveys was completed on a Saturday, which provided the highest probability of finding someone at home. If the resident was not home, a "sorry we missed you" door hanger was left, along with a self-addressed, stamped envelope for residents to fill out the survey and return it by mail. In phase one, all of the surveys were either conducted in person or left as a door hanger at the residence.

In phase two, the surveys were taken door-to-door in the neighborhoods, using high school students and some RSVP volunteers. Because the survey form was designed to be used in a face-to-face interview, we believe the response rate and quality of the information received from mailed-in surveys was probably lower than those completed in person at the residences.

Conduct of Commercial Survey

Tumwater decided City Intern Aaron Klotz would conduct the commercial portion of the survey with the help of Donna Freier of Thurston County Environmental Health. She agreed to help conduct the survey and offer advice and technical support to small quantity generators.

As was done for the residential surveys, PGG provided the commercial survey forms with preprinted addresses from the County Assessor's property database. However, staff found through record searches that many of the parcels had several businesses. In response to this finding, PGG had to modify the Access database to allow entry of data for multiple businesses on one parcel (PGG had constructed the database anticipating only one business per parcel). This change enabled us to accommodate parcels, such as Airdustrial Park and shopping plazas, with several businesses with differing operations. After the change was affected, staff simply made as many copies of the survey form for such parcels as were needed to survey all businesses.

The commercial portion of the survey was quick and smooth. Again, to save time, only business felt to be potential threats to groundwater were surveyed. Forty three (43) of the original 300 businesses met this criteria and were surveyed.

Most businesses seemed to welcome the survey with little or no resistance. Only one business failed to finish the survey. Because of the nature of their business, it was a very busy time for them and completing a mail-in survey was not a priority. Some people were apprehensive but honest, some refused to answer all the questions, and some were glad the City and County were doing the survey. Some businesses even gave the surveyors a tour of their facilities.

Data Entry

Once all the forms were returned, the next task was to enter the data. Steven Swope of PGG took the lead on this. PGG provided two copies of the previous database (one for the residential survey and one for the commercial survey) in a format that could be manipulated using Microsoft ACCESS. Aaron devoted the better part of two weeks entering all the forms into the two databases. Once this was completed, the databases and the original hand surveyed forms were returned to Steven Swope of PGG for final data extraction.

Survey Results

After months of planning and preparation, the residential survey was completed in less than three weeks. Of the 233 residential surveys distributed, over 68% were returned to the City (22% of which were mailed in by the property owner). Volunteers reported that most people were honest and cooperative; however, one volunteer was ordered off the premises by the owner who thought this was a governmental trick of some sort.

The commercial survey went very smoothly. Both Donna and Aaron were very happy with the results. All the businesses were in compliance with State and local laws and some even wanted to know what else they could do to be even more environmentally friendly.

The parcel inventory results are summarized in Exhibits 3-1 through 3-3 and Tables 3-1 through 3-3 in Section 3.

Residential and Commercial Questionnaire Forms

Displayed below are the residential and commercial questionnaire forms used by the Cities of Tumwater and Olympia for the parcel inventory response and contaminant risk category assessment process.

City of Tumwater - Wellhead Protection - **RESIDENTIAL** Parcel Inventory - {Date Visited: ___/___/ 95}

Parcel #: ________________
Township: ______ Range: ______ Section: _______
Landowner's name: ____________________________
Address: ____________________________________
City: _______________ Zip Code: ____________
Phone:

☐ Single-family
☐ Apartment Complex
☐ Condominium Complex
☐ Townhouse (duplex, etc.)
(Apartment Complex, Condominium Complex, Townhouse: Skip question # 9)
☐ Unimproved Site

Well No.: __________ Capture Zone: (1, 5, 10, Out)
Soils Type: ____________________ Surveyor's name: ______________________

1. What is your source of water?
   a. City of Tumwater water
   b. Well on-site → Depth: ________ ft.; Age: _______years
   c. Community well → Location: ____________________________
   d. Don't know

2. Is there an abandoned well on-site?
   a. No
   b. Yes
   c. If Yes, has it been: capped, filled, or plugged ? (circle appropriate response)
   d. Don't know

3. Where does rain water from your property run off to? (more than one answer is possible)
   a. Discharges to a city storm drain or as surface water (i.e. ditch, stream, wetland, lake, etc.)
   b. Discharges to a retention pond within neighborhood
   c. Does not run off of site

4. Which of the following types of waste disposal systems do you have?
   a. City of Tumwater Sewer (go to question #6)
   b. On site septic system
   c. Community septic
   d. Don't know

5. If septic, when was it last pumped?: _____________

6. Do you have a fuel or heating oil storage tank on-site? → (No / Yes)
   If yes, → Above ground or Below ground
   → In-use or Abandoned
   → Age: ________ years

7. Do you store 5 gallons or more of chemicals or solvents on-site? → (No / Yes)
   (i.e. gasoline, thinners, furniture strippers, etc.)

8. If you have an active or inactive well-pump-house, do you store chemicals in it? → (No / Yes)

9. Do you maintain your vehicle's automotive fluids? → (No / Yes)
   → If yes, how do you dispose of: Used oil? _____
   (R=recycle, T=trash, G=ground/storm drain, O=other) Used oil filters? _____
   Used anti-freeze? _____

10. Do you fertilize your lawn or garden? → (No / Yes)
→ If yes, how often: ________(number of times in a year)
→ If yes, do you typically store more than 50 lbs.? → (No / Yes)
→ If yes, do you use manure? → (No / Yes)

11. Do you use herbicides or insecticides in your yard? → (No / Yes)
→ If yes, what product names?: ____
→ If yes, how often?: _______ times per year
→ If yes, do you typically store more than 1 concentrated gallon of these? → (No / Yes)

12. Do you operate a business out of your home? → (No / Yes)
→ If yes, what type? (Auto repair/painting, Carpet cleaning, Landscaping, Other: ______________)

13. Did you know that you live in a critical aquifer recharge area? → (No / Yes)

AGRICULTURAL ONLY:

14. How much livestock do you keep on site?

______ Horses	______ Cattle / Calves	______ Other: ______________________
______ Pigs	______ Sheep / Llamas	

15. How many acres of pasture are these animals on?: _____________ acres

16. Do you have a manure pile? → (No / Yes)
→ If yes, is it covered? → (No / Yes)

17. Do you plant crops beyond a typical garden? → (No / Yes)

18. Do you use farm chemicals? → (No / Yes)
→ If yes, on how many acres? ___________
→ If yes, at what rate do you apply these chemicals? ____________
→ If yes, what trade names do you use? ______________________

City of Tumwater - Wellhead Protection - **COMMERCIAL** Parcel Inventory - {Date Visited: ___/___/ 95}

Parcel #: ____________ SIC Code: ___________
Township: _____ Range: _____ Section: ______

Business name: ___________________________
Business owner: ___________________________ Landowner's name: ________________________
Business address: __________________________ Address: ______________________________
City: ______________ Zip Code: ________ City: ______________ Zip Code: ___________
Business phone: ________________ Phone: ______________

☐ Check here if unimproved site Well No.: __________ Capture Zone: (1, 5, 10, Out)
Soils Type: ______________________ Surveyor's name: ______________________

1. What is your source of water?
   a. City of Tumwater water
   b. Well on-site → Depth: ________ ft.
   c. Community well → Location: ______________________________
   d. Don't know

2. Is there an abandoned well on-site?
   a. No
   b. Yes, unimproved
   c. If Yes, has it been: capped, filled, or plugged ? (circle appropriate response)
   d. Don't know

3. Where does rain water from your property run off to? (more than one answer is possible)
   a. Discharges to a city storm drain or as surface water (i.e. ditch, stream, wetland, lake, etc.)
   b. Discharges to a retention pond within neighborhood
   c. Does not run off of site

4. Which of the following types of waste disposal systems do you have?
   a. City of Tumwater Sewer (go to question #5)
   b. On site septic system
   c. Community septic
   d. Don't know

5. If septic, when was it last pumped?: _____________

6. If you have floor drains, where do they discharge?
   a. City of Tumwater Sewer
   b. On-site septic
   c. City storm drain, ditch, stream, wetland, lake
   d. Sump or vault
   e. Other: ___________________________
   f. Don't know

7. Do you have a fuel/heating oil storage tank or vehicle on-site? → (No / Yes / Removed, when____)

   If yes, → Above ground or Below ground
   → In-use or Abandoned
   → Age: ________ years
   If yes, → Has it been tested for leaks recently? → (No / Yes)

8. If you have an above ground tank, is secondary containment provided? → (No / Yes)

9. Do you fertilize your lawn/landscaping or hire a landscaping service? → (No / Yes)
   If yes, → How often: _____ times per year
   → Do you typically store more than 50 lbs.? → (No / Yes)

10. Do you use herbicides, insecticides, or fungicides on your landscaping? → (No / Yes)
   → If yes, what product names?: ____________________
   → If yes, how often?: _______ times per year
   → If yes, do you typically store more than 1 concentrated gallon of these? → (No / Yes)

11. What hazardous materials do you consume/generate per year?

Type	Quantity (gal., lbs., count)	Disposal or Treatment Method
Pesticides (Concentrated)		
Fertilizers		
Wood Preservatives		
Spent Solvents		
Solvent Still Bottoms		
Ignitable Paint Waste		
Paint Stripper		
Other Ignitable Waste		
Acids		
Bases		
Heavy Metal Dust		
Heavy Metal Sludge		
Oil & Grease		
Lead Acid Batteries		
Photography Waste		
Chemical Lab Waste		
Medical Lab Waste		
Anti-Freeze		
Oil Filters		
Other: ________		
Other: ________		
Other: ________		

12. Do you have a spill response and accident prevention plan? → (No / Yes)

13. Have you ever had your property evaluated for environmental hazards (s.a. soil contamination)?→ (No / Yes
   Are you willing to share this with us? (attach if received)

14. How many years have you been in business at this location? __________

15. What was this site used for before? ______________________________

16. Did you know that your business is in a critical aquifer recharge area? → (No / Yes)

17. Would you be interested in receiving any technical assistance from the Thurston County Business Polution Prevention Program, *or others ?????* ? → (No / Yes)

Appendix C

Appendix C

Palermo Wellfield Contamination Activities

Pacific Groundwater Group
2377 Eastlake Ave. E.
Seattle, Washington 98102
206.329.0141 FAX 329.6968

May 31, 1996

City of Tumwater
Department of Public Works
555 Israel Road SW
Tumwater, Washington 98501

Attn.: Ms. Kathleen Callison
Water Resources Specialist

Re: General technical review of the report titled "*Expanded Site Investigation Report: Palermo Well Field, Tumwater, Washington*" dated April 1996, prepared by Weston for EPA.

Dear Ms. Callison,

At your request, Pacific Groundwater Group has reviewed the referenced report issued by the United States Environmental Protection Agency (EPA) in April, 1996, on the occurrence of chlorinated solvents in groundwater near the Palermo Well Field. In this letter report, we also consider the EPA March, 1996 sampling results and water level data that are not included in the EPA report.

LIMITATIONS

This report constitutes a preliminary impression based on a partial review of documents listed in the attached bibliography. A better understanding can be obtained with further analysis. For the purposes of brevity and conciseness, arguments presented in this report are not fully documented but are presented in a manner to stimulate thoughts/action in order to assist the development of a comprehensive strategy. We recommend that a meeting be held to ensure a proper understanding of the points communicated in this letter. Many of the recommendations contained in our letter to you dated March 8, 1995 remain valid and should be reviewed. Further details, including proposed methodology, are available upon request.

The EPA report has much useful data and has significantly advanced the understanding of the occurrence of chlorinated solvents in the vicinity of the Palermo Well Field. However, we believe that in some cases the data are presented or interpreted in ways that may lead to confusion or an incorrect understanding. In those cases we are concerned the interpretations will come to be accepted as truths unless an addendum is issued. We provide some comments in an attachment, and are willing to provide a more thorough review of the report if requested. The comments that we provide here focus on extracting and presenting important points from the EPA report.

We wish to point out to the City that EPA and Weston have been very open and receptive to an exchange of ideas. They have been cooperative in coordinating the collection and exchange of water quality and water level data. Access to some wells has been provided to facilitate Tumwater's Wellhead Protection Program.

MOTIVATION

City interest in EPA work is primarily motivated by a desire to protect the Palermo Well Field. This well field represented 50% of the City's drinking water supply. Half of the wells in the well field have been impacted by chlorinated solvent contamination. The City is closely monitoring conditions that may impact the remaining clean wells, and hopes to recover the use of the impacted wells. The City recognizes that the possibility exists that it may be forced under certain conditions to abandon the well field in the future.

The City is also concerned about protecting the health of its people, the economic interests of its businesses, and the benefit of its water rights. An assessment of the range of potential impacts and contaminant pathways has not been conducted. We identify a number of these here. Contaminated groundwater is seeping to the ground surface at the base of the Palermo Bluff thereby creating a direct exposure of the public to contaminants. We believe that the plumes of contaminated groundwater continue to migrate east towards, into, and across the Palermo Valley impacting some wells and may impact additional wells in the future (e.g. currently unimpacted City drinking water supply wells and brewery wells). As the plumes continue to migrate, a larger geographic area becomes impacted. Other concerns also exist.

IMPORTANT POINTS

We consider the following points to be the most important:

- Plumes of contaminated groundwater continue to be generated at the source areas. We believe that contaminant plumes will continue to be generated for the foreseeable future (e.g. decades) unless the sources are removed or contained.

- Plumes are probably not at steady state. The plumes will probably continue to evolve, with downgradient contaminant concentrations increasing with time.

- Contours of contaminant concentrations, as presented in the EPA report, appear to delineate a single plume. A more accurate conceptualization is that there is a plume associated with each identified source area. The direction of migration of each plume should be identified. It is possible that the source in the vicinity of the intersection of Trosper and Littlerock Roads is generating a plume that is migrating from west to east, south of Southgate Cleaners. The significance of this is that such a plume may be directly upgradient of the currently clean wells within the Palermo Well Field (Figure 1).

- PCE- and TCE-contaminated groundwater that is seeping to ground surface immediately west of Rainier Street may be a public health concern.

- Contamination has been detected in the City of Tumwater monitoring well MW-93-04 for the first time.

- The easterly edge of a plume extends further than represented in the figures of the EPA report. For the past three years contaminants have been present in production wells of the Palermo Well Field. We assume that contaminants have continued to migrate at ambient groundwater velocities east from the well field for at least three years. Wells used by the brewery may be impacted in the future based on the apparent direction that the plumes are moving. No early warning monitoring wells exist for the brewery wells.

The above points together illustrate that the plumes are not at steady state. Time is an important element. Therefore EPA should be thinking very seriously about what can be done now to mitigate future impact. We consider it prudent that adequate resources be allocated to effectively implement the following actions.

RECOMMENDED ACTIONS - GENERAL

Source Control
Upon identifying sources of drinking water contamination, measures should be implemented to minimize or eliminate such sources. Possible actions may be isolation or remediation of the sources.

Plume Control
We emphasize that failure to take action on plume control sooner, rather than later, will result in larger plumes. Larger plumes will impact more people, will cost more to cleanup (or control), and will take longer to cleanup (or control). Hydraulic control such as pump-and-treat is not a permanent cleanup option; however it is an excellent tool for plume control and should be used now to avoid further impact while a final remedy is chosen.

Install Monitoring Wells
Monitoring wells should be installed down gradient of the plumes in order to assess the rate of advance of the plumes. Monitoring well locations for this purpose should include at least: between GP-05 and Southgate Cleaners to monitor plume migration from the Trosper-Littlerock Roads intersection; and northeast of the Palermo Well Field. Geoprobe work should be used to best locate the latter well.

The water level of Barnes Lake should be monitored because of the effect that it has on interpretation of groundwater flow directions. The City of Tumwater installed a stage gauge in the lake approximately 15 years ago. If this gauge is still operational, it should be surveyed and stage levels should be measured along with the quarterly well water levels that EPA is collecting.

RECOMMENDED ACTIONS - SPECIFIC

Southgate Cleaners
We recommend that the following three actions be conducted at Southgate Cleaners site:

- Contaminated soil at Southgate Cleaners that is contributing contaminants to groundwater and should be removed.

- A soil vapor extraction system should be installed to extract contamination that remains in the vadose zone under Southgate Cleaners after soil removal.

- Installation of an air-sparging system under Southgate cleaners to remove source material from below the water table under Southgate Cleaners should be seriously considered.

- Plume control should be implemented.

Washington Department of Transportation
The report on tank removal from WDOT should be reviewed. We do not believe that the presence of potential drinking water contaminant sources has been sufficiently evaluated at this site.

Trosper-Littlerock Roads Intersection Area
The source of contamination in the area of the Trosper-Littlerock Roads intersection should be identified. Upon identification of a contamination source in this area, relevant steps should be taken to control further generation of a contaminant plume.

Palermo Well Field
The City should request the analytical lab that conducted previous analyses of MW-93-04 samples to review data for detections of TCE below the reporting limit. Monitoring well MW-93-04 should be resampled (both the shallow and deep completions). If the previous detection of TCE is confirmed, monthly sampling of the wells should be considered. Wells #1 in the Palermo Well Field should also be sampled. Wells #4 and #5 should also be sampled with a low capacity pump, if feasible.

The significance of the recent detection of TCE (0.2 μg/L) in MW-93-04 is not well understood. Three possibilities are currently recognized:

- The first hypothesis is that the shape and extent of the plume is evolving as a result of natural hydraulic gradients. If this is occurring, further migration of the plume could eventually result in impact to wells #3, #6 and #8.

- The second hypothesis is that contamination has been drawn southward toward the well field in response to pumping of the well field. However, based on previous work and our current understanding, we do not recommend any changes to the pumping schedule outlined in our memorandum dated September 27, 1995.

- The third possibility is that the low concentration TCE has been present at the well for a while but analytical reporting limits were not low enough to detect it.

The analytical laboratory services that the City has used to date provide deliverables in a paper format, and provide a method detection limit of 0.5 micrograms per liter (µg/L). The City should recontract for these services to include lower detection limits (e.g. 0.2 µg/L) and electronic deliverables.

ADDITIONAL

We believe that the amount of data that has been collected to date, and their complexity, warrant the use of a three-dimensional site-visualization software package. This will facilitate the presentation and the understanding of such data, especially to lay audiences.

The list of recommendations included in this letter is not complete nor fully developed. The investigation work by EPA is a valuable reference and provides an excellent basis for mitigative actions. We appreciate the opportunity to provide these comments to you. Should you wish further expansion or wish to discuss this letter, please do not hesitate to call me.

Sincerely,
Pacific Groundwater Group

Chris V. Pitre
Hydrogeologist

Attachments: Partial list of detailed comments on the EPA report (3 pages).
Figures (3)

Bibliography (documents used in the preparation of this report):

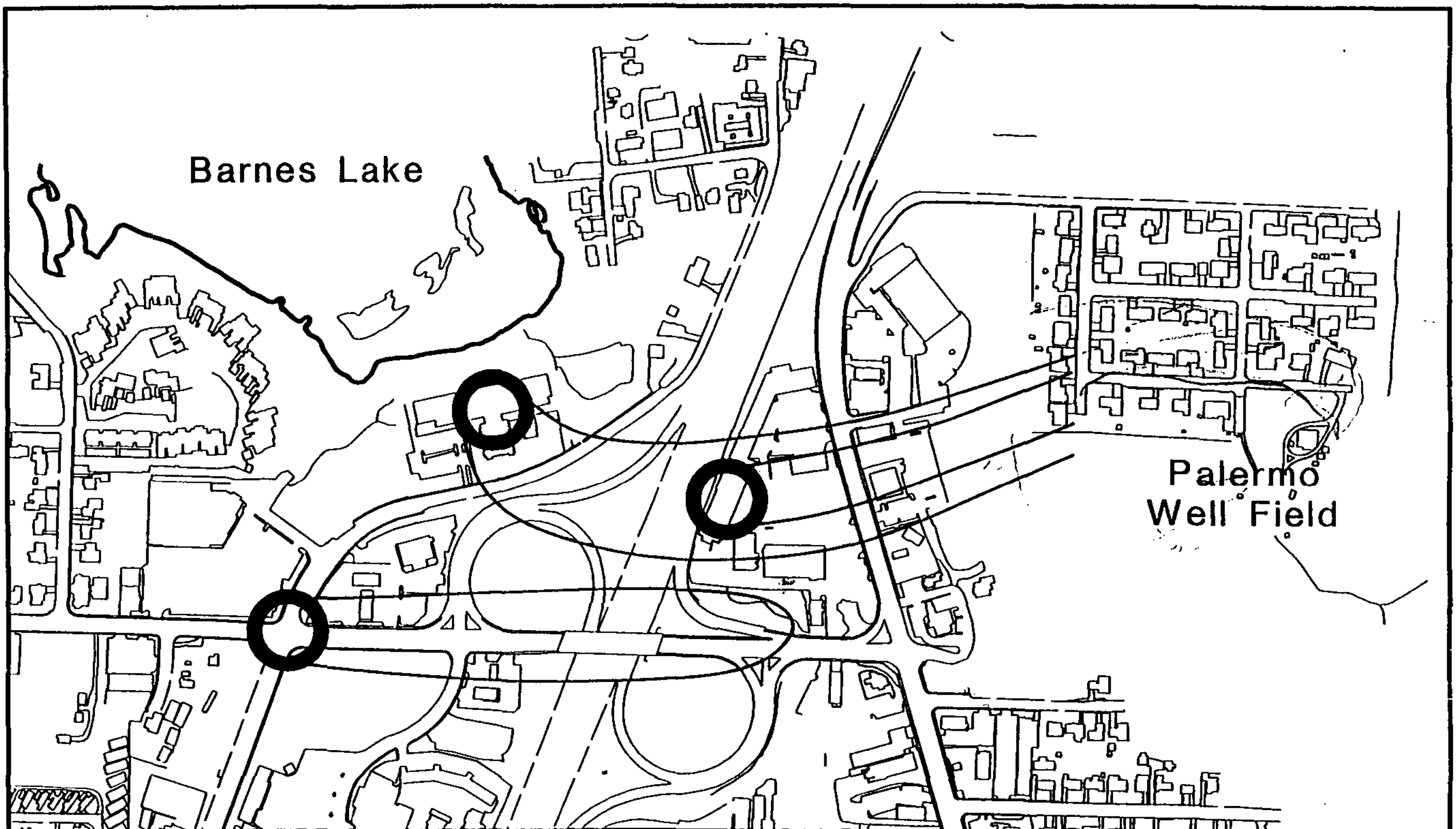
Environmental Protection Agency, March 1995. Trip Report: Soil gas, groundwater, and soil sampling - Palermo Well Field ESI, Tumwater, Washington.

Environmental Protection Agency, April 1996. Expanded Site Investigation Report: Palermo Well field, Tumwater, Washington.

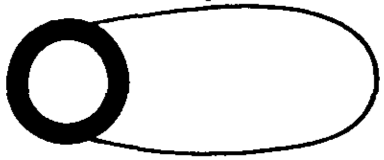
Pacific Groundwater Group, September 1993. Summary Report: Trichloroethene contamination at the Palermo Well Field. Report prepared for the City of Tumwater.

Pacific Groundwater Group, June, 1995. Preliminary characterization and task 3 work plan: Tumwater wellhead protection program. Prepared for the City of Tumwater.

Pacific Groundwater Group, September 27, 1995. Water quality monitoring at the Palermo Well Field. Technical memorandum prepared for Kathy Callison of the City of Tumwater.



LEGEND



Confirmed or suspected source area
and associated plume
based on groundwater flow
as depicted in Figure 3.

0 200 400
Scale in Feet

N

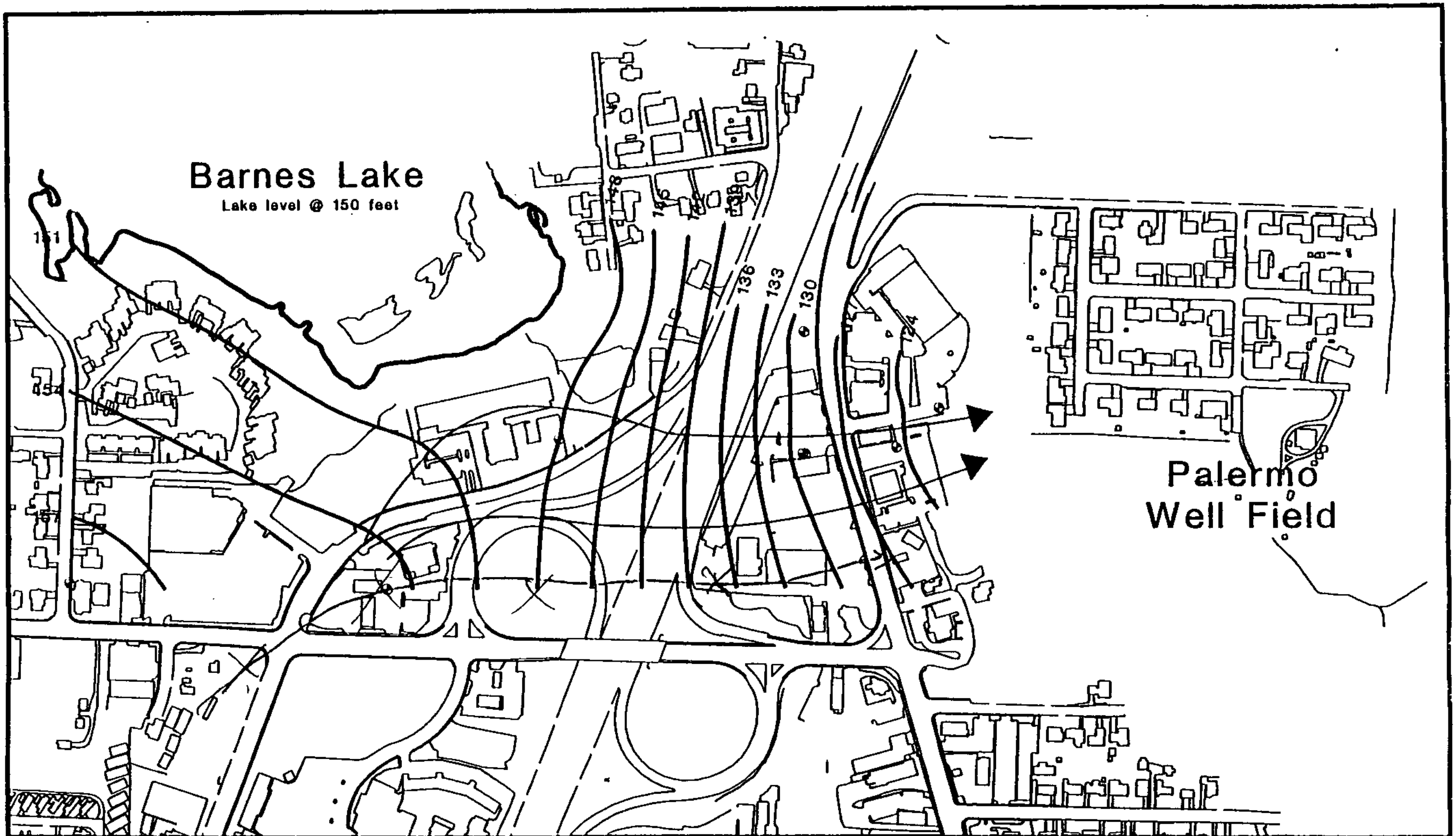
City of Tumwater aerial photo base map, 1992.

FIGURE 1
CONCEPTUAL DISTRIBUTION
of CHLORINATED SOLVENT
PLUMES

TUMWATER WELLHEAD PROTECTION PROGRAM
CONTAMINATED SITES

JE9401, EPA-96.DWG, 5/31/96

Pacific Groundwater Group



LEGEND

EPA groundwater elevation monitoring well

157

Groundwater contour with elevation and groundwater flow path

0 200 400
Scale in Feet

N

City of Tumwater aerial photo base map, 1992.

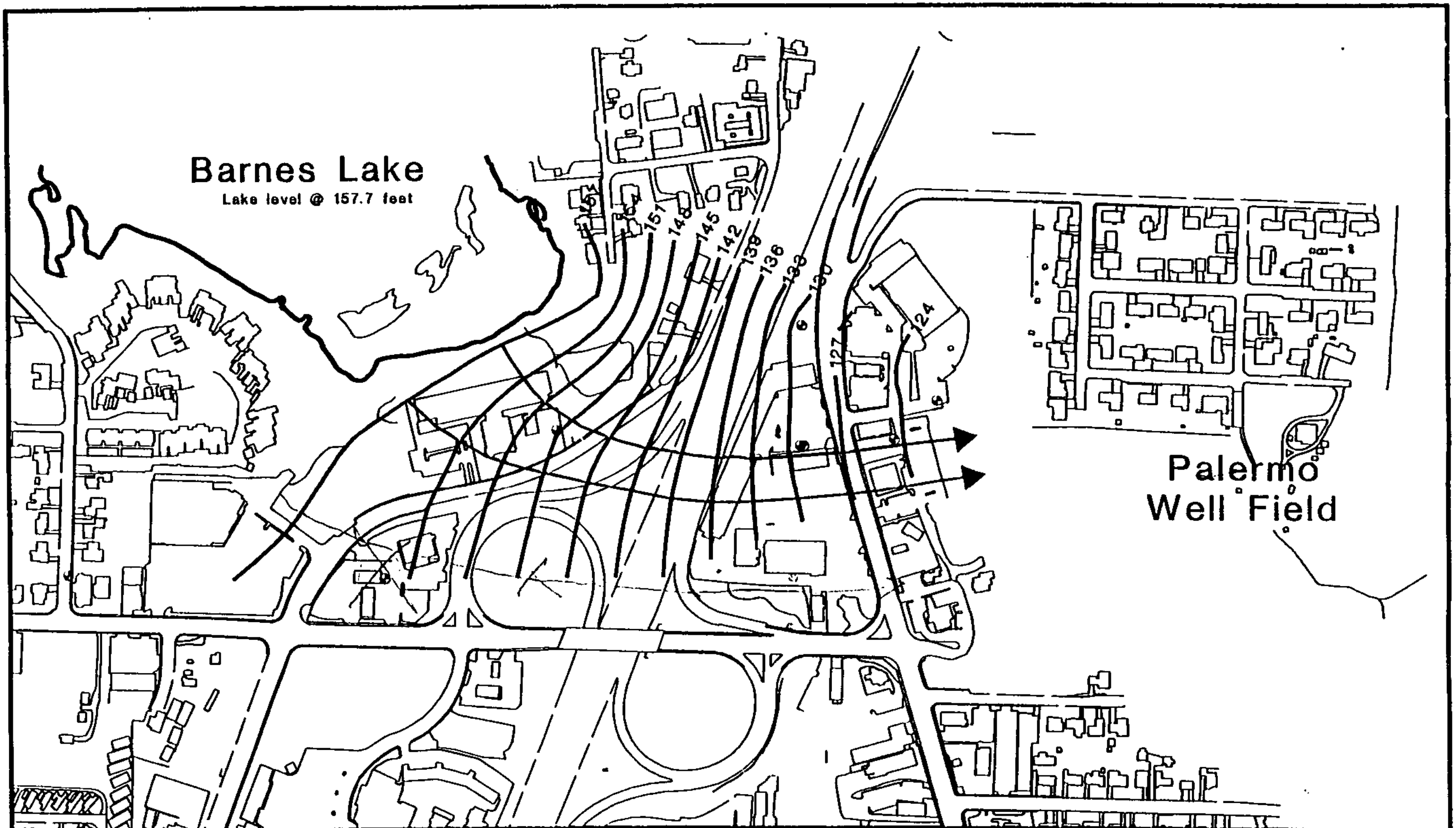
All elevations are NAVD 1988
Lake level taken from EPA (1996) report.
Nov. 1995 groundwater elevation data from EPA, 1996.
Water level contours created with SURFER.

FIGURE 2
GROUNDWATER CONTOURS and FLOW with BARNES LAKE at 150 feet ELEVATION

TUMWATER WELLHEAD PROTECTION PROGRAM
CONTAMINATED SITES

JE9401, EPA-96.DWG, 5/31/96

Pacific Groundwater Group



LEGEND

EPA groundwater elevation monitoring well

157

Groundwater contour with elevation
and groundwater flow path

0 200 400
Scale in Feet

N

All elevations are NAVD 1988
Lake level taken City of Tumwater survey data..
Nov. 1995 groundwater elevation data from EPA, 1996.
Water level contours created with SURFER.

City of Tumwater aerial photo base map, 1992.

FIGURE 3
GROUNDWATER CONTOURS
and FLOW with BARNES LAKE
at 157.7 feet ELEVATION

TUMWATER WELLHEAD PROTECTION PROGRAM
CONTAMINATED SITES

JE9401, EPA-96.DWG, 5/31/96

Pacific
Groundwater
Group

Attachment to the letter to: **Ms. Kathleen Callison**
Water Resources Specialist

May 31, 1996

Re: Partial list of comments on the report titled "*Expanded Site Investigation Report: Palermo Well field, Tumwater, Washington*" dated April 1996, prepared by Weston for EPA.

The following comments are provided for the benefit of the City of Tumwater. These do not represent a complete editorial review.

CORRECTIONS

Section 2.4.3 (p. 2-6): The text states that groundwater flow direction is to the north/northwest. It should state that groundwater flow direction is easterly.

Section 6.2.1 (p. 6-1): Redox values should have units.

Section 6.2.1.3 (p. 6-2): It is stated that a 50-gallon drum was removed from the floor of Southgate Cleaners. Appendix E (Technical Assistance Team report) reports the drum to have 30-gallon capacity.

Tank removal was commissioned by the operator, not the owner.

Table 4-1. The data qualifier for PCE in GP-27 at 27 feet is "UN". If PCE was detected, it should be included in Figure 4-3.

Figure 2-3: The (relative and absolute) elevation of Barnes Lake in this figure is inconsistent with that in Figure 4-1. Well screens are shown as 30 feet long when they are actually 10 feet long. Relative relief is off by up to 30 feet.

Figure 3-1: The locations of HA and CR samples are not shown. Analytical results for sample SW-01 cannot be found in the tables of analytical results.

Figure 4-1: The water level elevations (msl) for wells MW-ES-09 and MW-ES-10 are misleading as they imply that they are static water levels. Depth to water data for flowing artesian wells should not be recorded as zero. An arrangement should be made to obtain valid water level data from these wells, such as with a flexible plastic tubing standpipe. Also, release of contaminated groundwater from the wells onto the surface may complicate future interpretation of near-surface solvent distributions.

Figures 4-2 through 4-8: Some data plotted in these figures are inconsistent with tabular data. A complete check of Figure 4-8 and checking of all data against laboratory analytical sheets was not conducted by Pacific Groundwater Group. The more significant inconsistencies include:

Figure	Location	Concentration in Figure	Concentration in Table
Figure 4-2	GP-3 GP-13 TW-WDOT	7 nd 700	nd 2.3 15,700
Figure 4-3	GP-3	78	6.2
Figure 4-4	GP-19	70	0.7
Figure 4-6	GP-12	nd	11
Figure 4-8	GP-12	283	28.3

Appendix E, (TAT report) Conclusions: The last paragraph states that a maximum depth of 42.5 feet below ground surface was explored. The maximum depth actually explored was 30 feet below ground surface.

COMMENTS

Section 2.4.1 (p. 2-5): The characterization of the stratigraphy in the vicinity of the Palermo Well Field should be updated. Stratigraphic logs of some of the original production wells indicated the presence of a till, or confining layer. More recent work (PGG, September 1993 and June 1995) identifies the Palermo production aquifer as post-glacial alluvium with no overlying confining unit.

Section 5.2.2: It is stated that a ravine may be a preferential pathway for the migration of DNAPL. We propose the concept that there is an immobile DNAPL source, and a mobile aqueous contaminant phase.

The groundwater elevation contour map does not suggest the presence of a preferential pathway. There is no evidence in the geologic logs to support the presence of an in-filled ravine whose surface extended below the water table. However, the idea that there is a preferential flow pathway should still be considered.

Section 6.2.3: Groundwater flow in the WDOT area has not been adequately characterized to justify assuming a northeasterly flow direction.

Table 4-2: The location for station number ES02 is mislabeled.

Figures 3-1 and 4-1 through 4-7: The scale indicated for the figures are off by a factor of approximately 2.6.

Figure 4-1: The Barnes Lake water elevation is assumed in the EPA report to be 150 feet msl (NAVD, 1988). City of Tumwater air photo survey data from March 12, 1992 measured the water surface at approximately 157.7 feet msl (NAVD 1988). On May 22, 1996, the lake level was approximately 157 feet msl (NAVD 1988). The interpretive effect of using these different lake water level elevations on groundwater flow directions is shown in Figures 2 and 3.

Groundwater elevation data from City of Tumwater monitoring wells should be used to create a more comprehensive coverage.

Figures 4-2 through 4-7: The figures should indicate data sources. The dates over which the samples were collected should be indicated in the text, tables, and/or figures. Criteria for inclusion/exclusion of water quality data presentation in different zones and data sources in these figures should be clear.

The contours should not be closed in areas where the data do not warrant it (e.g. downgradient area). Data from monitoring wells should also be presented to qualify the Geoprobe data.

Since most of the data have a detection limit of 2 µg/L, the 1 µg/L contour line should probably be dashed to indicate uncertainty in its location.

The Palermo Well Field currently is the primary receptor of concern. The brewery wells are potential receptors. It would be appropriate to extend the area covered by figures to include these wells.

Appendix A (Field Methodology): All data collected by the investigation, such as water level data, should be presented in the report. This would create a better document for future use.

Table A-2: Electrical conductivity is an order of magnitude higher in ES-01, -02, and -06 than other wells. This variation may help in understanding groundwater flow patterns.

References: The City should obtain copies of the following reports:

Geoengineers, 1994 (Section 6.2.2: Chevron tank removal report)
Morris Environmental, 1994 (Section 6.2.1.3: Southgate Cleaners tank removal)
Weston, 1994 (Appendix E, [TAT report]: EPA trip report and interviews).

TECHNICAL MEMORANDUM

To: **Kathy Callison**, Water Resources Specialist, City of Tumwater

From: Chris Pitre, Hydrogeologist, Pacific Groundwater Group
Charles "Pony" Ellingson, Principal Hydrogeologist, Pacific Groundwater Group

Date: September 27, 1995

Re: Water Quality Monitoring @ the Palermo Well Field

cc: Marc Horton, Engineering and Environmental Services

Job #: JE9401 - Tumwater Wellhead Protection Project

In response to your request, this is a recommendation to alter water monitoring at the Palermo Well Field. The object is to minimize costs and maintain a reasonable degree of protection to the wells that have not been impacted. First, our current understanding of the situation is described, followed by options that the City may consider.

Trichloroethene was first detected in wells #2, #4 and #5 in August, 1993. Monthly samples have since been collected from all six production wells. On alternating months, monitoring well MW-93-04a and MW-93-04b were sampled. Well #2 has been continuously pumped to waste (at approximately 110 gallons per minute) as a precautionary measure against the entry of contamination to the currently unimpacted wells #3, #6, and #8.

Chlorinated solvents have been detected in wells #2, #4 and #5. There was a single detection of dichloroethene in well #8. The significance of a single detection in this well is not known. There have been no detections in any of the other wells. Concentrations vary seasonally and are typically at their annual maximums in early August. Concentrations are highest in well #2 and, for portions of the year, are below the analytical detection limit in wells #4 and #5.

A good baseline has been developed by the sampling routine conducted by the City to date, and a stable and predictable pattern has been established. We are not aware of the details of the current pumping regime. However, if the pumping regime used over the past two years is continued, we believe that it would be acceptable to decrease the monitoring frequency to a quarterly basis (every three months). Since the highest concentrations have typically occurred during early August, we recommend that sampling be conducted in February, May, August and November. We also believe that it is acceptable to monitor only wells #2, #3, #6, #8 and MW-93-04. Alternating the collection of samples between MW-93-04a and MW-93-04b is recommended. This will decrease the number of samples collected annually from 84 to 20.

Preliminary computer flow modeling (Pacific Groundwater Group, 1993, Figure 5) suggests that the City may stop pumping well #2 to waste during periods of low extraction rates (i.e. during the winter) if well #3 is not pumped and extraction from wells #6 and #8 is minimized. If this pumping routine is to be considered, it is recommended that flow modeling incorporating the pumping rates being considered should be conducted first to assess possible effects. Also, this would result in a pumping regimen for which a baseline has not been established. Therefore, if such a pumping schedule were implemented, it is recommended that monthly monitoring of all wells be reinstituted for at least one season. Observed changes in contaminant concentrations in the observation points resulting from a change in the pumping schedule, may be useful in further characterizing the contaminant plume and managing the drinking water resources at the Palermo Well Field.

Please do not hesitate to give us a call if you wish to explore these options further.

Pacific Groundwater Group
2377 Eastlake Ave. E.
Seattle, Washington 98102

206.329.0141 FAX 329.6968

· JE9401

March 8, 1995

City of Tumwater
555 Israel Road
Tumwater, Washington 98501

Attn.: **Kathleen Callison**
Water Resources Specialist

Subject: Suggested objectives and approaches for further investigation and remediation of chlorinated solvent contamination near the City of Tumwater's Palermo Well Field.

Dear Kathy,

This letter summarizes the objectives and approaches that we believe the City of Tumwater should assume with respect to characterization and remediation of chlorinated solvents affecting the Palermo Well Field. The United States Environmental Protection Agency (EPA) has the lead role in managing field efforts, and has completed a Phase I Environmental Site Investigation (ESI; Weston, 1995). At a meeting on February 9, 1995, involving the City, EPA, and other agencies, EPA solicited comments from the City with respect to the direction and management of further work. Our recommendations are presented herein. These recommendations are not complete and have been compiled with limited background preparation. A partial compilation of groundwater data is presented in **Figure 3-1**. We hope that these comments will be of use to EPA in the preparation of the next workplan and, ultimately, full restoration of the Palermo Well Field.

OBJECTIVES

We understand that the City continues to consider the Palermo Well Field an important recoverable resource. The capacity of the well field represented 50% of the City's water supply. Before the loss of wells to contamination, the water supply system of the City was already over-taxed. Loss of half of the wells at the Palermo Well Field, which represent 25% of the total public water supply, has increased the stress on the supply system and has resulted in periodic water use restrictions. Available undeveloped groundwater resources are limited and have proven difficult to locate. Demand growth for the next decade is projected by the City to be 5% per annum. Recovery of full use of the Palermo Well Field in the future is the ultimate objective of any mitigative effort and we recommend that the City urge the EPA to pursue this objective.

We estimate that an aggressive remedial action program could restore full use of the well field in 15 years under favorable conditions. Groundwater flow velocity immediately upgradient of the Palermo Well Field is estimated to be on the order of 600 feet per year. This relatively high groundwater velocity may allow flushing of the currently developed plume after remediation of the sources without pump-and-treat of the plume itself. Additionally, hydraulic control of the plume could allow recovery of the impacted City drinking water wells sooner, before complete flushing of the plume under natural hydraulic conditions. To allow the City to manage their utilities, the City should request that EPA maintain an updated estimated time schedule to completion of each task, including attainment of full use of the well field.

APPROACH

A conceptual framework for restoring use of the Palermo Well Field is presented in **Figure 1**, and involves:

1) Identification of potential sources (Phase I ESI; completed);
2) Source evaluation (Phase II ESI); and
3) Source control investigation and interim remedial action.

The purpose of the Phase II ESI is to identify contamination sources that are degrading the quality of the drinking water supplied by the Palermo Well Field. The Phase II ESI should be conducted on the same geographic scale as the Phase I ESI and should collect hydrogeologic information that will support further work.

Once critical sources are confirmed and potentially responsible parties are given a chance to respond, source control investigation/interim remedial action should be conducted at these sites in quick succession. Such actions may be conducted under the Removal Authority of the Comprehensive Environmental Recovery and Liability Act (CERCLA) if private parties do not respond, or, EPA may know of other regulatory vehicles that can quickly and best restore the environment and protect human health.

DETAILS

Phase II ESI

The primary objective of the Phase II ESI is identification of contamination sources that have contaminated the Palermo Well Field. Specific approaches for the Phase II ESI are suggested below. The first point summarizes current knowledge. Points two to four are recommended as preparation for field work. Points five to eight address recommended field work. Further clarification or elaboration on the approaches listed below will be provided upon request.

1) Potential contamination source areas identified include:
    i) Department of Transportation (DOT) facility on Second Avenue;
    ii) Chevron Station at Second and Trosper;
    iii) Brewery City Pizza;
    iv) Southgate Cleaners;
    v) Illegal dumping along the bluff above the Palermo Valley;
    vi) The former Binger's/Gull station north of Southgate Mall;
    vii) Former gas stations in Southgate Mall including Drew's Mobil;
    viii) The former drainage ditch draining from near DOT to Palermo

   The first four areas were identified by Weston (1995). The last four points were mentioned during the meeting between the City, EPA, and other agencies (Feb. 9, 1995). More sites may be identified as work progresses.

2) EPA has suggested that information be solicited from the public by publishing a newspaper article. We believe that such a solicitation may be useful. Information on potential historical contamination sources would be requested.

3) A summary of historical air photo interpretation should be documented.

4) An inventory of wells in the area covered by the ESI should be conducted. Well logs from the Department of Ecology files and other available sources, including gas stations, should be reviewed to better characterize the stratigraphy. Wells that penetrate till may provide potential conduits for contamination to migrate between aquifers. Such wells should be identified and abandoned. Wells that are completed in the water table aquifer should be incorporated into a water quality and water level monitoring plan. Pacific Groundwater Group compiled well logs in the area and reviewed them for the presence of till; these records are available to EPA pending City approval.

5) The Phase II ESI should focus on groundwater sampling as opposed to soil sampling. Groundwater samples are most useful and more efficient than soil samples in identifying potential contamination sources.

6) The presence and extent of the Vashon Till at each of the potential source sites should be established. A till layer may define the vertical extent of contamination and depth of investigation. The presence of a till would also indicate whether there is a protected aquifer from which the Palermo wells are deriving water. A till, if present at the sites, may define the maximum depth of contamination by limiting the downward migration of DNAPL that may be the source of the contaminants seen in groundwater. An auger boring should be advanced at each of the potential contamination sites identified in the Phase I ESI to characterize the stratigraphy. Continuous soil samples should be collected for stratigraphic logging. Soil samples or groundwater samples collected by a Hydropunch™ or similar manner could be analyzed by an on-site gas chromatograph.

7) The vertical distribution of groundwater contamination downgradient from potential sources identified in the Phase I and Phase II ESIs should be characterized with the Geoprobe™ after the stratigraphy is defined with a boring. A series of probes should be advanced in a line across the hydraulic gradient, to different depths, immediately downgradient of the identified potential sources. A method capable of collecting discrete groundwater samples from below the water table should be employed. Groundwater samples should also be collected upgradient of the potential source.

8) We concur with Weston that monitoring wells should be installed at the top of the bluff above the Palermo Well Field and in the Palermo Valley. The southern extent of the plume at the top of the bluff should be established and monitored. If the plume migrates further south, currently clean wells of the Palermo Well Field may be impacted.

Source Control Investigation / Interim Remedial Action

The objective of source control investigation and interim remedial action (SCI/IRA) is to restore full use of the Palermo Well Field as a drinking water source. Sites that are confirmed by the Phase II ESI to prevent the successful recovery of the well field should undergo SCI/IRA. It is emphasized that the SCI/IRA need not be conducted sequential to the Phase II ESI. Implementation of SCI/IRA should occur as soon as a site is determined to be a source of groundwater contamination whose remediation is necessary for the recovery and indefinite use of the well field. A suggested approach is outlined below.

1) EPA meets with the City and provides a schedule for conducting the SCI/IRA, or alternative actions. Cost estimates, public notification, and cost recovery considerations would also be presented by EPA.

2) EPA and the City present the information in the above point to the public. This is intended to provide an invitation for private parties to conduct remediation.

3) Conduct the site-specific tasks outlined for the Phase II ESI, if not yet completed;

4) Identify potential contaminant pathways (sewers, drainfields, spill areas);

5) Document the site history and solvent inventory (records review);

6) Determine the extent of contamination in soil;

7) Assess the presence of dense, non-aqueous phase liquids (DNAPL) above and below the water table; and

8) Install monitoring wells using Geoprobe™ data for optimizing well locations.

The above-listed data-collection tasks constitute the source control investigation.

Once it is determined that remediation of a particular site is necessary for recovery of the well field, interim remedial action should be implemented as quickly as possible. The actions implemented will be selected based on the source control investigation data. Possible interim remedial actions that may be implemented are:

9) If plume generation is continuing, hydraulic containment within the scale of the site should be implemented as soon as this is recognized.

10) If solvent concentrations in accessible shallow soil are high, excavate soil for off-site disposal;

11) If a dense non-aqueous phase liquid (DNAPL) is present in the unsaturated zone under a building, a vapor extraction system may be installed; and

12) If DNAPL is present below the water table, air-sparging may be initiated.

To avoid inadvertent remobilization of DNAPL that may be present, the presence of DNAPL should be assessed before deciding to conduct intrusive investigation into the suspected central area of contamination.

Full recovery of the Palermo Well Field as a public drinking water supply, possibly within 15 years, is considered a feasible objective. The Phase I ESI successfully identified several potential contamination sources. A Phase II ESI should be conducted to evaluate the impact that these and other sites may have on the well field. Confirmation that sites are significantly impacting the well field would warrant these sites to be addressed under an interim remedial action. We believe that a timely and sustained effort in each of these tasks will result in a rapid and cost effective return of full use of the Palermo Well Field public drinking water supply.

We appreciate the opportunity to provide these comments. Should any clarification or elaboration be desired, please do not hesitate to contact either of us.

Respectfully submitted,
Pacific Groundwater Group

Charles T. Ellingson
Principal Hydrogeologist

Chris V. Pitre
Hydrogeologist

cc: Mark Horton, Engineering & Economic Services, Inc.

Attachments: Figure 1: Interim remedial action under Removal Authority.
Figure 3-1: Schematic groundwater flow and contaminant distribution.

Figure 1: <u>INTERIM REMEDIAL ACTION under REMOVAL AUTHORITY</u>

Phase I ESI
Identification of Potential Sources

- Completed

↓

Phase II ESI
Source Evaluation

- Update potential sources
- Historical air photo review
- Inventory of wells in area
- Characterization of stratigraphy w/ HSA
- Groundwater sampling with Geoprobe™

↓

Is Contamination Source Confirmed?

No → No Action under Removal Authority

Yes ↓

Is Source Significantly Impacting the Palermo Wells?

No → No Action under Removal Authority

Yes ↓

Meet with City & Public

↓

Source Control Investigation / Interim Remedial Action

Source Control Investigation:

- Complete Phase II ESI tasks
- Determine extent of soil contamination
- Install monitoring wells

Interim Remedial Action:

- Hydraulic containment if plume generation is on-going
- Vapor extraction if DNAPL is in soil under building
- Air sparging if DNAPL is under the water table
- Dig & haul if soil concentrations are high

Pacific Groundwater Group
2377 Eastlake Ave. E.
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206.329.0141 FAX 329.6968

JE9401

February 20, 1995

City of Tumwater
555 Israel Road
Tumwater, Washington 98501

Attn.: Kathleen Callison
Water Resources Specialist

Subject: Review of - *Draft Trip Report: Soil Gas, Groundwater and Soil Sampling, Palermo Well Field ESI, Tumwater, Washington* - dated February 1995, by Roy F. Weston, Inc. for the Environmental Protection Agency, Region X

Dear Kathy,

In response to your request, we have reviewed the draft version of the recent investigation of chlorinated solvents in the vicinity of the Palermo Well Field and are providing comments herein. Although some format edits are included, this review focuses on the material content of the report and does not constitute a complete review.

Corrections

1) Section 2.3.1 (p. 2-6) Based on past investigations, there is no proof that the water table in the Palermo Valley is perched. It is our opinion that the groundwater is continuously saturated in the valley.

2) Section 2.3.1 (p. 2-6) Use of the term aquiclude is inappropriate in our opinion. We recommend the use of the term aquitard.

3) Section 2.3.4 (p. 2-7) States that groundwater flow is to the north to northwest. Data from the field work indicate an general flow direction to the east (see attached figure).

4) Section 2.4 (p. 2-7) Dichloroethene was also detected in Well 8. Samples from Wells 1, 3, 4, and 5 did not constitute one set, notwithstanding the inclusion of Well 8.

5) Section 2.4 (p. 2-7) The third paragraph from bottom implies that a sewer outfall soil sample from within 150 feet of the impacted wells contained tetrachlorethene. That sample is from ~1,200 feet south of well field.

6) Section 2.4.1 (p. 2-8) The six production wells and the dual-completion monitoring well in the Palermo Valley are sampled monthly, not quarterly.

7) Section 2.4.1 (p. 2-8) The last sentence states that trichloroethene (TCE) is the only chlorinated compound detected in the wells. Dichloroethene was also detected.

8) Section 3.2.3 (p. 3-6) Although Sample 22 was collected from a greater depth from ground surface than most samples, it was collected from within 10 ft of the water table and may not be appropriately considered a deeper sample.

9) Figure 4-2. Concentrations should be reported in μg/kg, not as μg/L.

10) Section 5.1 (p.5-1) It is stated that deep sample results "likely reflect lower than actual concentrations". Shallower contamination could also have been dragged down from above and cause higher than actual concentrations.

11) References cited in the text are inconsistent with those listed in the back of the report (e.g. Section 2.3.4; Delta Consultants, 1994). Table numbers are improperly cited in the text (e.g. Section 4.1, Table 3-2).

12) Water levels shown in Figure 2-1 do not reflect the values shown in Table 3-2 in the area between Capitol Boulevard and the Palermo Valley.

<u>Clarifications Recommended</u>

Section 2.4 (p. 2-7) Although it is correct to state that it was concluded that pumping only Well 2 to waste was required to prevent contamination of the remaining clean wells, other pumping schedules are also adequate and have been used by the City this past fall when the pump in Well #2 failed. It should also be stated that installation of a dual-completion monitoring well was completed in the Palermo Valley.

Section 5 (p. 5-1) The third paragraph questions the sampling and analytical methodology for the municipal wells. Any reasons to question the integrity of the analytical methods should be clearly stated and only after discussion with the laboratory involved if any clarification is warranted. If volatilization of analytes occurred during collection of the samples from the municipal wells, a high degree of variability would be expected in the analytical results. In fact, the analytical results are reproducible to a degree that is rarely seen in these types of investigations. Although the sampling method from the municipal wells is not ideal, it is our opinion that the results are representative of in-well concentrations. The contaminated municipal wells derive water from both clean and contaminated parts of the aquifer. Therefore, the concentrations seen in the municipal wells appear to be consistent with concentrations seen in the aquifer.

Section 5.1 (p. 5-1) Does reference to pooling TCE or tetrachloroethene mean a non-aqueous phase liquid (NAPL)? We do not believe that there has been any direct encounter with NAPLs in this investigation.

Do field results actually have lower detection limits than laboratory results? Are the analytical results reported with the correct number of significant figures?

Suggestions

The depth to water data provided in the report were contoured by Pacific Groundwater Group (see accompanying figure). The data appear to be consistent enough to schematically define the ambient flow field. Including such a figure in the report would greatly assist the planning of subsequent investigations.

Hand contouring of groundwater concentrations (Figures 4-3 and 4-4) may provide more accurate presentations of the actual distributions than the computer-generated contours. If computer-generated contours are used, an alternate solution technique should be used to generate more accurate solutions.

A section integrating the results from this field work with the work conducted in August, 1993 would be useful. The EPA document is misleading as presented because it suggests that contaminants are not present in the valley. The investigation conducted by Pacific Groundwater Group (1993) demonstrated the presence of contaminants in the valley. Contaminants have continued to enter the impacted wells since at least August, 1993, until present. Displaying the distribution of contaminants detected by both investigations illustrates the pathway of contaminants in the area of interest. The lack of detection of chlorinated solvents in the valley by the EPA investigation is probably because depth-specific samples were not collected, and they were collected from depths different from the 1993 investigation.

We very much appreciate the opportunity to review and comment on this draft report. The Environmental Site Investigation has obtained valuable data and has achieved its objectives of identifying a number of potential sources of the chlorinated solvents entering the City of Tumwater's public drinking water supply wells of the Palermo Well Field. The work has also significantly improved the understanding of the hydrogeological regime within the study area and provided a knowledge base for use in determining the next scope of work.

Respectfully submitted,
Pacific Groundwater Group

Chris V. Pitre
Hydrogeologist

cc: Mark Horton, Engineering & Economic Services, Inc.

Enclosure: Figure

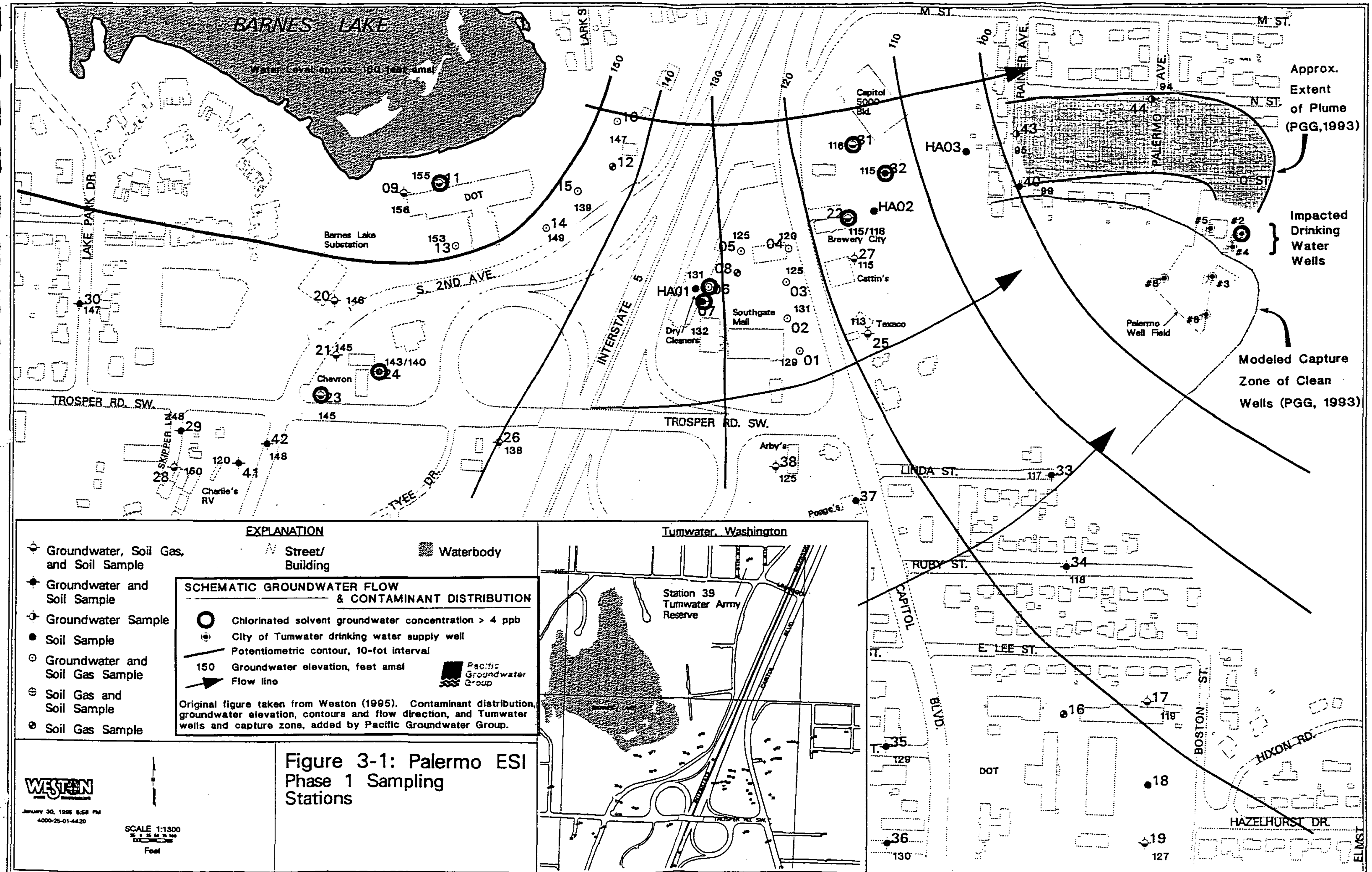


Figure 3-1: Palermo ESI Phase 1 Sampling Stations

Appendix D

Appendix D

Hytec Facility Cleanup Activities

MEMORANDUM

To: **Kathy Callison**, Water Resources Specialist, City of Tumwater

From: Chris Pitre, Hydrogeologist, Pacific Groundwater Group (PGG) CP

Date: February 14, 1996

Re: Former HYTEC Facility - Review of December, 1995 AGRA Earth & Environmental (AEE) Report: "Phase II site Assessment, Former HYTEC Facility, 711 Airdustrial Way, Tumwater, Washington"

Job #: JE9401 - Tumwater Wellhead Protection Project

The above-mentioned report was reviewed. In general, we believe that the analytical results of the work conducted indicate that further investigation of the property is not warranted. However several items listed in the work plan were not followed. A sample was supposed to have been collected from the swampy area of reported dumping ("Suspected Spill Area" in figure accompanying original work plan). We are also concerned about how the wells are completed. Specific qualifications are presented here.

Stratigraphic Interpretation

Wells MW-1 and MW-3 are located approximately 230 feet and 190 feet, respectively, from City of Tumwater Well #9. Well MW-2 is located approximately 30 feet from City of Tumwater Well #10.

The well log for Well #9 indicates the presence of material consistent with till between depths of 49 feet bgs and 56.5 feet bgs. The well log for Well #10 indicates the presence of material consistent with till from 42 feet bgs to 52 feet bgs. The USGS (Dion and others, 1994) also recognize the presence of a till in this area.

AEE's interpretations of the drill logs do not include the presence of an aquitard. However the blow counts and sample recovery records reported in the AEE boring logs may indicate the presence of till below approximately 42 feet bgs that was not recognized.

Well Completions

The original work plan stated default ten-foot screened intervals in the absence of elevated PID readings or an aquitard. All PID readings were zero, and no till was identified by AEE. The default screened interval for well MW-1 was 40 feet bgs to 50 feet bgs. The default screened intervals for wells MW-2 and MW-3 were five feet below the groundwater surface. Static groundwater elevations are on the order of 15 feet bgs to 20 feet bgs. Therefore, the bottom of the screened intervals for wells MW-2 and MW-3 should have been no deeper than 35 feet bgs.

The final work plan listed the default screened intervals to be from 40 feet bgs to 50 feet bgs for well MW-1, and from 10 feet bgs to 30 feet bgs for wells MW-2 and MW-3.

Wells MW-1 and MW-3 are completed to a total depth of 59 feet bgs, while well MW-2 is completed to a total depth of 49 feet bgs. The screened intervals of the wells are located where the aquitard (till) would be if present. Copies of boring logs are attached. The well screen completion intervals are included with the aquitard interval from the Tumwater wells indicated for comparison.

Water Quality

Four priority pollutant metals (Cr, Cu, Ni and Zn) were detected in well water samples collected from wells MW-1 and MW-2 by AEE. The analytical detection limits for priority pollutant metals do not meet those specified by the state for drinking water (Table 1) as requested by the City. However, resampling of well MW-1 by PGG did not detect any priority pollutant metals. We believe that the analytical results may be a result of different sample filtering methods, and that the analytical results for priority pollutant metals reported by AEE are not accurate.

Phthalates were detected in well MW-1, while chloroform was detected in wells MW-1 and MW-3. Both of these compounds are commonly introduced to samples from well construction or laboratory sources. We do not believe that these compounds have been shown to be a concern in the groundwater at the site.

We believe that selection of Method B cleanup level for chromium (III) (i.e. 16,000 μg/L) may be inappropriate. The analytical method used does not distinguish between the different forms of chromium. The cleanup level for chromium (VI) is 80 μg/L. Therefore the results as reported in the Phase II report may exceed Method B cleanup levels and drinking water Maximum Contaminant Levels. However, as mentioned above, we believe that the analytical results for priority pollutant metals reported by AEE are not accurate.

Table 1: Detection limits.

Parameter	Detection Limits	
	HYTEC Report	Drinking Water Requirements
Sb	**100**	5
As	**200**	10
Be	**5**	2
Cd	**5**	2
Cr	10	10
Cu	**30**	20
Pb	**200**	2
Hg	**1**	0.5
Ni	30	40
Se	**150**	5
Ag	**20**	10
Tl	**200**	2
Zn	20	50

Bold parameters are usually analyzed by GFAAS methods.
Bold detection limits signify where drinking water specified detection limits are not met.

Recommended Actions

Given the currently available information at this time, we do not recommend against a designation of "No Further Action" for the site. An assessment should be conducted of whether the screened intervals of the wells are completed across an aquitard. We first recommend that a comparison be made of water levels in the monitoring wells with water levels in nearby wells that are completed in the surficial aquifer (Q_{vr}) and nearby wells completed in the drinking water aquifer (Q_{va}). If a significant difference (e.g. five feet) in water levels exists between the surficial and drinking water aquifers, a review of water levels may be useful. A difference in water levels between the aquifers may be accentuated by measuring the water levels while the production wells are pumping.

A downward hydraulic gradient is expected at the site and water levels in the Q_{vr} aquifer are expected to be higher than those in the Q_{va} aquifer. Horizontal hydraulic gradients in the vicinity of the site in the Q_{vr} aquifer are very small. Therefore, Q_{vr} water levels in Texaco monitoring wells are expected to be representative of those at the site. Water levels in the Q_{va} aquifer at the site may be taken from city wells #9 and #10.

Accurate elevations of the measuring points used in measuring the water levels are needed to make valid comparisons. The elevation of the water level measuring point for Well #9 has already been requested from the city surveyor. Access to Texaco well MW-21 has recently been obtained, and it should be requested that the city surveyor measure the elevation of the water level measuring point for that well. Access to the Texaco well can be arranged with Mr. Dick Brevik (360-956-3382). The City has the key to access the Hytec wells. I believe that a ratchet with a 9/16-inch socket is needed to open the monument, however I recommend that a socket set be brought out. The water level measuring points for Texaco well MW-21 and the Hytec wells are the top of the two-inch PVC casings inside of the flush-mount monuments.

Wells that are completed in the shallow aquifer, or which have sand packs that extend partially into the till aquitard, are expected to have water levels similar to or representative of the shallow aquifer. A well that is completed in the drinking water aquifer, or which has a seal above a sand pack that extends partially into the till aquitard is expected to have a water level similar to or representative of the drinking water aquifer. Wells in which the sand pack extends across the aquitard will have water levels intermediate between those in either of the aquifers.

If water levels in the wells are representative of those in either of the aquifers, then a breach of the aquitard may not have been created. If the water levels in the monitoring wells is intermediate to those in either of the aquitards, then it is possible that a breach exists.

Conclusive results are apparently not available and may not be obtained from a review of water levels in wells. A conservative option at this point is to abandon the wells by overdrilling and remove any questions as to whether breaches in the aquitard have been created by the wells.

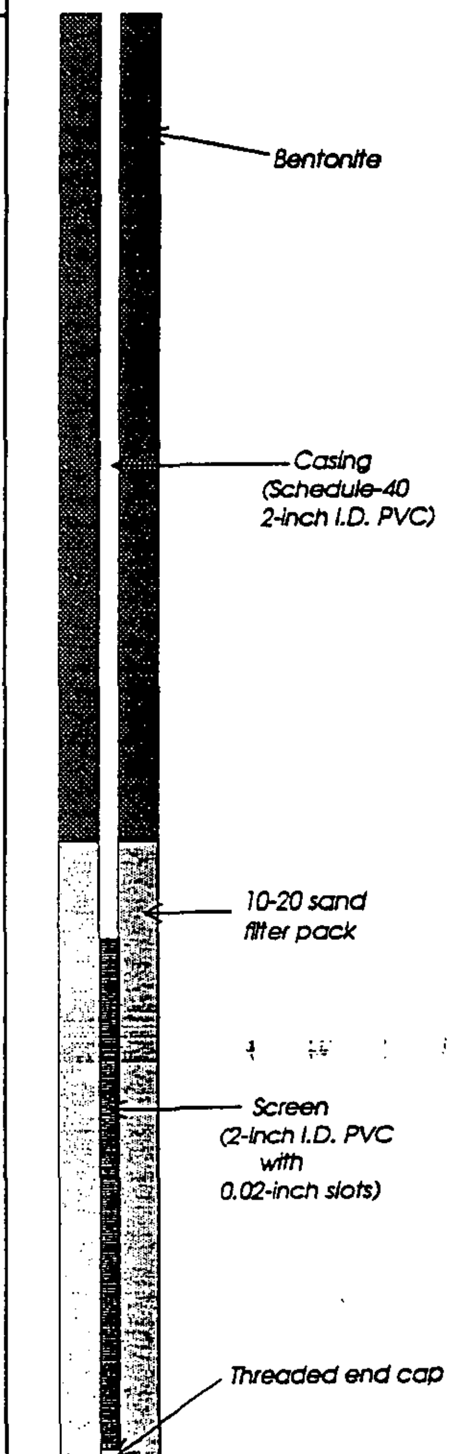
PROJECT: *HYTEC* W.O. *11-10565-00* WELL NO. *MW-1*

Elevation reference: *100.00 Feet* Well completed: *16 October 1995*
Ground surface elevation: *Unknown* Casing elevation: *99.51 Feet*

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
30						
35	*SAND (as above)*	I	MW-1/ 35.0	78/ 5"	0	
40		I	MW-1/ 40.0	82/ 5"	0	
45		I	MW-1/ 45.0	100/ 5"	0	
		I	MW-1/ 47.0	100/ 6"	0	
50	*Dense, wet, gray GRAVEL with SAND*	I	MW-1/ 50.0	100/ 5"	0	
	Dense, wet, gray, fine to medium SAND	I	MW-1/ 52.0	100/ 5"	0	
55		I	MW-1/ 55.0	100/ 5"	0	
		I	MW-1/ 57.0	100/ 6"	0	
60	*Dense, wet, gray GRAVEL with sand*	I	MW-1/ 60.0	100/ 5"	0	

Well #9 interpreted aquifer

AS-BUILT DESIGN



TESTING

Bottom of boring at 60 feet.

LEGEND

I 2-inch O.D. split-spoon sample

Observed groundwater level ATD = at time of drilling

AGRA Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling started: *16 October 1995* Drilling completed: *16 October 1995* Logged by: *RAL*

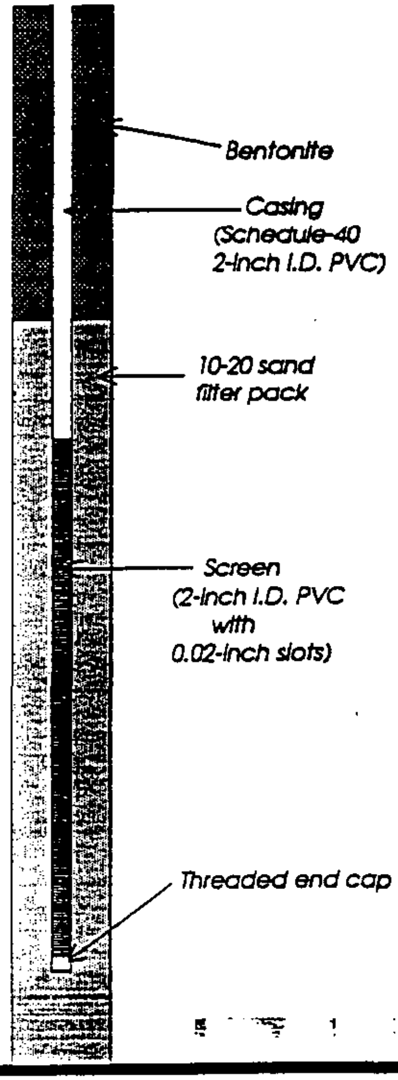
PROJECT: *HYTEC* W.O. *11-10565-00* WELL NO. *MW-2*

Elevation reference: *100.00 Feet*	Well completed: *16 October 1995*	AS-BUILT DESIGN	Page 2 of 2
Ground surface elevation: *Unknown*	Casing elevation: *98.72 Feet*		

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER	TESTING
30	*SAND (as above)*						
	Medium to coarse SAND with trace gravel	I	MW-2/ 35.5	50/ 5"	0		
35							
		I	MW-2/ 40.5	47	0		
40		X	MW-2/ 42.0	50/ 3"	0		
		X	MW-2/ 43.5	50/ 5"	0		
		I	MW-2/ 45.0	120	0		
45							
		I	MW-2/ 47.5	150	0		
50							
		I	MW-2/ 51.5	80/ 5"	0		
	Bottom of boring at 52 feet.						
55							
60							

well # 10

interpreted aquitard



LEGEND

2-inch O.D. split-spoon sample

X Sample not recovered

Observed groundwater level ATD = at time of drilling

AGRA Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling started: *16 October 1995* Drilling completed: *16 October 1995* Logged by: *RAL*

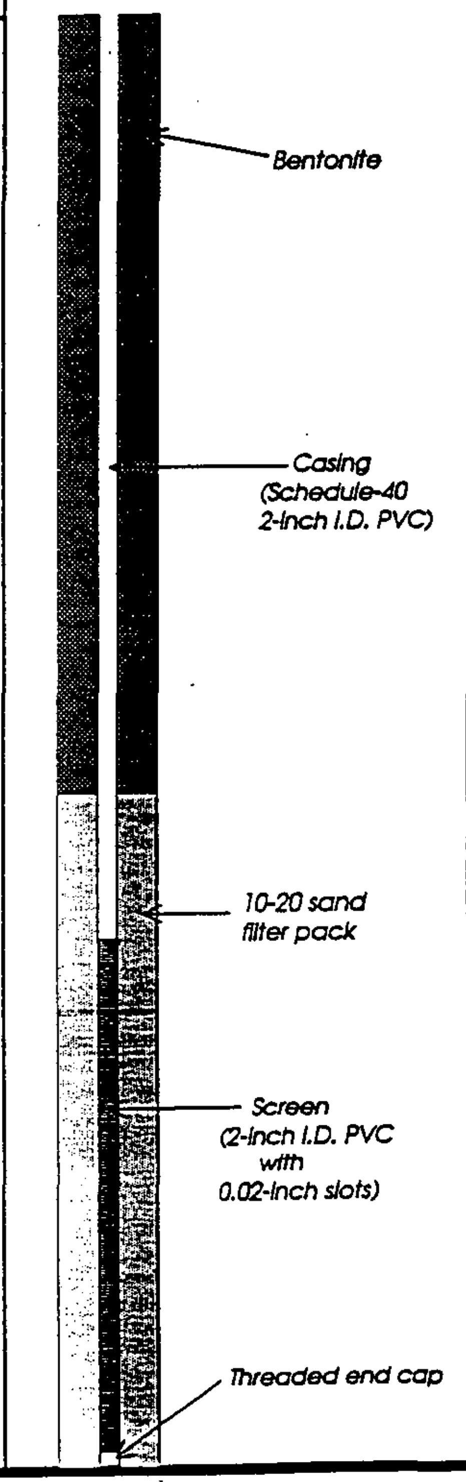
PROJECT: *HYTEC* W.O. *11-10565-00* WELL NO. *MW*

Elevation reference: *100.00 Feet*
Ground surface elevation: *Unknown*
Well completed: *16 October 1995*
Casing elevation: *99.25 Feet*

AS-BUILT DESIGN

Page 2 of

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
30	*GRAVEL (as above)*					
35		I	*MW-3/ 35.5*	*50/ 3"*	*0*	
40		I	*MW-3/ 40.5*	*81/ 5"*	*0*	
45		I	*MW-3/ 45.5*	*79/ 5"*	*0*	
50		I	*MW-3/ 50.5*	*80/ 6"*	*0*	
55	*Well ?? interpreted aquitard*	I	*MW-3/ 55.5*	*50/ 4"*	*0*	
60		I	*MW-3/ 60.0*	*78/ 6"*	*0*	



TESTING

Bottom of boring at 60 feet.

LEGEND

I 2-inch O.D. split-spoon sample

ATD Observed groundwater level ATD = at time of drilling

AGRA Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling started: *16 October 1995* Drilling completed: *16 October 1995* Logged by: *RAL*

MEMORANDUM

To: **Kathy Callison,** Water Resources Specialist
City of Tumwater

From: Chris Pitre, Hydrogeologist
Pacific Groundwater Group

CP

Date: June 15, 1995

Re: Former Hytec Facility

Job #: JE9401 - Tumwater Wellhead Protection Project

At your request, we have reviewed the proposed work plan prepared by AGRA Earth & Environmental (AEE) for the former Hytec site located near Tumwater production wells #9 and #10. We have also reviewed the Hytec soil gas survey report (less appendices) prepared by Ecology.

The strategy proposed by AEE in using a portable PID to determine sampling and well screen placement is sound. However, decisions should only be based on PID readings that are significantly above background levels. Otherwise, sampling and screen placement should be conducted according to the default options.

The Ecology report states that illegal dumping was conducted to a nearby swampy area for an unspecified period of time. According to Dick Malin (personal communication with K. Callison), there is also a drain field on site. These two possible contaminant source areas have not been addressed by the AEE workplan.

AEE proposes to analyze soils and upgradient wells for chlorinated volatile organic compounds (Method 8010/601). The downgradient well is to be analyzed for volatile organic compounds (VOCs; Method 624), semi-volatile organic compounds (Method 625), and metals.

Previous investigation by Ecology has detected a wide range of contaminants. Fiberglass manufacture, which occurred on the property, involves a wide suite of compounds. Source areas of these contaminants have not been identified.

Based on our current understanding of the site, we have two recommendations with respect to assessing potential threats to wells #$9 and #10. The first recommendation is to identify and investigate the reported illegal dumping area and drain field. At a minimum, proposed monitoring well MW-2 should be moved north to the other side of the presumed (former) location of the drain field, as you suggested.

The second recommendation is to conduct analysis for an expanded list of parameters on all proposed wells. Analysis using EPA Method 524.2 for volatile organic compounds is justified given the proximity of public drinking water supply wells. Analysis using EPA Method 8270 for semivolatile organic compounds should be conducted to cover a list of analytes comparable to the Target Compound List of EPA's Contract Laboratory Program.

The City should request that AEE collect survey coordinates with respect to a specified datum so that the City may incorporate the data collected in this investigation into the Wellhead Protection Program.

As we discussed earlier today, it is in the City's best interest to secure access to any monitoring wells. If needed, the City will then be able to collect samples and analyze for any parameters that the City considers important, but that are not covered by other independent parties.

It has been a pleasure to provide you with this review. Please call me to discuss this further if you wish.

Appendix E

Appendix E

Texaco Bulk Plant Storage Facility Cleanup Activities

MEMORANDUM

To: **Kathy Callison,** Water Resources Specialist
City of Tumwater

From: Chris Pitre, Hydrogeologist, Pacific Groundwater Group CJP
Charles "Pony" Ellingson, Principal Hydrogeologist, Pacific Groundwater Group

Date: March 19, 1996

Re: Texaco Work Plan for 7370 Linderson Way SW, Tumwater (revised)

cc: Marc Horton, Economic and Engineering Services

Job #: JE9401 - Tumwater Wellhead Protection Project

This memorandum is a review of the proposed work plan by Texaco for work to be conducted at their bulk fuel facility at the corner of Linderson Way SW and Airdustrial Way SW, in Tumwater. To summarize Texaco's work plan, it is proposed that a monitoring well be installed next to MW-3 and a boring next to MW-20. Sample collection to characterize the vertical distribution of contaminants is only proposed in the boring next to MW-20, at every 15 feet starting at 15 feet below ground surface (bgs). We offer the following comments.

Groundwater flow directions vary over time. Old reports (1991) show flow directions to the northwest, while recent reports (1995) show flow directions to the northeast. Therefore we believe that advancing a boring next to MW-2, which is in the middle of the north side of the facility, may be a better downgradient location than next to MW-3.

Horizontal hydraulic gradients are on the order of 0.002. This results in a horizontal groundwater velocity of approximately 70 feet per year, assuming a relatively high hydraulic conductivity of 30 feet per day (typical of coarse sand) and a porosity of 0.3. Recharge of precipitation in this area is high and is estimated to be on the order of two feet per year. This translates into a vertical groundwater velocity on the order of six feet per year. Given this ratio between the estimated vertical and horizontal groundwater flow velocities, and the amount of error inherent in such estimations, we believe that an additional location for the vertical characterization of contaminant distribution is warranted. We propose a location between monitoring wells MW-8 and MW-11.

Characterization of the aqueous vertical distribution of contaminants should be conducted at both locations (i.e. next to MW-2 and MW-20). We agree with initiation of sample collection at 15 feet bgs, however we believe that samples should be collected at a minimum of every 10 feet. The geoprobe investigation should be advanced to a maximum depth of 50 feet bgs or refusal, which ever is reached first. An additional sample should also be collected at the greatest extent of advance.

We agree that all samples should be analyzed for total petroleum hydrocarbons in the gasoline and diesel ranges (WTPH-G and WTPH-D, or Environmental Protection Agency [EPA] method equivalent), and for benzene, toluene, ethylbenzene and xylenes (EPA Method 8020). The deepest sample from each boring should also be analyzed for lead (to a detection limit of 0.001 milligrams per liter), and with EPA Method 524.2 including quantification of naphthalene. If naphthalene is detected, analysis for a wider suite of polyaromatic hydrocarbons should be conducted. An extra sample should be collected in a one-liter amber glass bottle from each sampling point in case the initial analytical results indicate that analyses of additional parameters will be useful.
We do not believe that a monitoring well in the Q_{vr} is necessary at this time, as proposed in the work plan. However, if vertical water quality profiling shows that contamination has migrated a significant distance below the water table, we anticipate that a more comprehensive investigation will be required that will include the installation of monitoring wells. If a monitoring well is installed at this time, we would appreciate the opportunity to be present during drilling so that we may learn more about the nature of the till in this area.

We hope that these comments are helpful. Please do not hesitate to call either of us at (206) 329-0141 should you wish further elaboration or to discuss this memorandum.

MEMORANDUM

To: **Kathy Callison**, Water Resources Specialist
City of Tumwater

From: Chris Pitre, Hydrogeologist, Pacific Groundwater Group
Charles "Pony" Ellingson, Principal Hydrogeologist, Pacific Groundwater Group

Date: September 27, 1995

Re: Texaco Bulk Fuel Site @ 7370 Linderson Way SW, Tumwater

cc: Marc Horton, Engineering and Environmental Services

Job #: JE9401 - Tumwater Wellhead Protection Project

At your request, we are submitting our recommendations resulting from a review of the Texaco bulk fuel site in Tumwater located at 7370 Linderson Way SW. We understand that the bulk fuel facility has been in operation for more than 25 years. During that time, a significant release of diesel occurred (~25,000 gallons), as well as smaller releases associated with two underground storage tanks. It appears that Texaco has done an excellent job in recovering released product and mitigating impact from these spills. We understand that the site is being managed in accordance with guidance covering leaking underground storage tanks.

Water level data as interpreted by Texaco indicate that horizontal hydraulic gradients at the site are so small that lateral migration from the site has not been significant. Given the amount of precipitation and the high infiltration rates typical of the area, and mass balance considerations, we believe that vertical hydraulic gradients and transport of contaminants may be significant. This concern is further supported by the drop in the average water table elevation by approximately five feet in 1991, at about the time that the City of Tumwater's public drinking water supply well #15 started pumping.

The site is located within the preliminary wellhead protection area for City of Tumwater drinking water wells. Wells #9 and #10 are located less than 1,000 feet from the site, to the south-southeast and southeast respectively. Well #15 is located approximately 2,000 feet east of the site. We consider it prudent to further assess whether contamination at the site poses a threat to these wells and human health. In our opinion, this will involve characterizing vertical hydraulic and chemical gradients across the surficial aquifer (Q_{vr}), the till aquitard (Q_{vt}) and into the supply aquifer (Q_{va}), and measuring the horizontal gradient in the Q_{va} aquifer.

It is recommended that monitoring wells be installed and screened across the uppermost portion (e.g. ten feet) of the Q_{va} aquifer. Three wells are needed to measure the horizontal hydraulic gradient. There are no other wells in the Q_{va} aquifer located nearby that we are aware of that can be used to reduce the minimum number of recommended wells. The recommended Q_{va} wells can also be used in conjunction with existing water table wells to measure vertical hydraulic gradients.

Vertical chemical profiling through the Q_{vr} aquifer and the Q_{vt} till on a five-foot interval is recommended. These samples should be analyzed for total petroleum hydrocarbon (TPH), and benzene, toluene, ethyl benzene and xylenes (BTEX). The lowermost sample collected in the Q_{vr} aquifer, immediately above the Q_{vt} till should additionally be analyzed by Environmental Protection Agency-approved Method 524.2 and include quantification of naphthalene. Samples from the Q_{va} aquifer should be analyzed for TPH, BTEX, and lead, and by Method 524.2, including quantification for naphthalene. If naphthalene is detected in any of the samples, resampling and analysis for a wider suite of polyaromatic hydrocarbons should be conducted.

All analyses should be conducted using methods to achieve detection limits consistent with those required for drinking water analysis by Washington State Department of Health or lower. A round of sampling of the pre-existing, shallow monitoring well network at Texaco and analysis to similar detection limits should be done in order to have at least one consistent data set.

Should you wish to discuss any of these issues, please do not hesitate to call either of us.

Appendix F

Appendix F

City of Tumwater Aquifer Protection Ordinances

ORDINANCE NUMBER 1279

AN ORDINANCE establishing an Aquifer Protection (AQ-P) Zone District (overlay zone district); and adding a new chapter, Chapter 18.39, to Title 18, Zoning, of the Tumwater Municipal Code.

WHEREAS, the 1991 Tumwater Conservation Plan has been approved by the Tumwater Planning Commission and the Tumwater City Council; and

WHEREAS, the 1991 Tumwater Conservation Plan calls for the creation of an Aquifer Protection (AQ-P) Zone District (overlay zone district;

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF TUMWATER, STATE OF WASHINGTON, DOES ORDAIN AS FOLLOWS:

Section 1. A new chapter, Chapter 18.39, entitled "Aquifer Protection (AQ-P) Zone District," is hereby added to the Tumwater Municipal Code to read as follows:

"Chapter 18.39

AQUIFER PROTECTION (AQ-P) ZONE DISTRICT

Sections:

"**18.39.010 - Intent.** The intent of the Aquifer Protection (AQ-P) Zone District (overlay zone district) is to identify, classify and protect vulnerable aquifer recharge areas within the City. Protection is to be accomplished by controlling the use and handling of hazardous substances. This district imposes additional restrictions on development in order to protect public health and safety by preserving the existing and future groundwater supply for the City. It is the intent of this district to protect vulnerable aquifers from hazardous substance pollution by controlling or abating pollution from commercial and industrial sources and by preventing future pollution from new or different land uses or activities.

18.39.020 - Definitions Referral. The use of terms within this district shall refer to definitions contained in Section 16.24.030 of this Code, in addition to the definitions found in this chapter. In case of conflict, Section 16.24.030 definitions will prevail.

18.39.030 - Scope and Applicability. All property within the district shall be subject to the following restrictions, as well as the use, setback, and other controls of the zoning district in which it is located, and owners of property shall comply with the mandates of this chapter in addition to the zoning requirements of the district in which such property is presently or may later be located. In the event of conflict with the regulations of the underlying zoning district and the mandates of this district, the provisions of this district shall control.

18.39.040 - Restricted Uses - Discharges and Disposal. The following uses of land shall be restricted from locating within the boundaries of this district, unless such a use complies with the provision herein on new technologies and best management practices:

1. Chemical manufacture and reprocessing.
2. Creosote/asphalt manufacture or treatment.
3. Electroplating activities.
4. Manufacture of flammable or combustible liquids as defined in the current edition of the Fire Code.
5. Petroleum products refinery, including reprocessing.
6. Wood products preserving.
7. On and off-site hazardous waste treatment and storage facilities.

18.39.050 - Improved Technology/Best Management Practices. A restricted land use may be considered for location within the district only upon conclusive demonstration that application of new or improved technology or best management practice will result in no greater threat to the groundwater resources than that posed by a non-restricted use. The approval procedure for location as an allowed use shall be by Conditional Use Permit, as set forth in Chapter 18.56 of this Code."

Section 2. This ordinance shall become effective five days after passage, approval and publication.

ADOPTED this 20th day of August, 1991.

CITY OF TUMWATER

Peter N. Fluetsch, Mayor

ATTEST:

Gayla L. Gjertsen, Clerk/Treasurer

Published: August 23, 1991

APPROVED AS TO FORM:

Thomas J. Taylor

Thomas J. Taylor, City Attorney

Ordinance #1279

ORDINANCE NUMBER 1280

AN ORDINANCE applying the Aquifer Protection (AQ-P) Zone District (overlay zone district) to the City of Tumwater and amending the Official Zoning Map of the City of Tumwater.

WHEREAS, the 1991 Tumwater Conservation Plan has been approved by the Tumwater City Council; and

WHEREAS, the 1991 Tumwater Conservation Plan has recommended the creation of an Aquifer Protection Overlay Zone District; and

WHEREAS, the City Council has approved Ordinance #1279, creating the Aquifer Protection (AQ-P) Zone District, amending Title 18, Zoning, of the Tumwater Municipal Code;

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF TUMWATER, STATE OF WASHINGTON, DOES ORDAIN AS FOLLOWS:

Section 1. All properties within the City of Tumwater are hereby re-zoned to be subject to the Aquifer Protection (AQ-P) Zone District as an overlay zone, in addition to the underlying zone district which continues to exist.

Section 2. The zone changes so described in Section 1, above, be so designated on the Official Zoning Map of the City of Tumwater.

Section 3. This ordinance shall become effective five days after passage, approval and publication.

ADOPTED this 20th day of August, 1991.

CITY OF TUMWATER

Peter N. Fluetsch, Mayor

ATTEST:

Gayla L. Gjertsen, Clerk/Treasurer

Published: August 23, 1991

Ordinance #1280

APPROVED AS TO FORM:

Thomas J. Taylor

Thomas J. Taylor, City Attorney

Ordinance #1280

ORDINANCE NUMBER 1281

AN ORDINANCE adding a new chapter, Chapter 16.24, Aquifer Protection Standards, to Title 16, Environment, of the Tumwater Municipal Code, and further adding a new Subsection 16.04.150 (D) (3) (m).

THE CITY COUNCIL OF THE CITY OF TUMWATER, STATE OF WASHINGTON, DOES ORDAIN AS FOLLOWS:

Section 1. A new chapter, Chapter 16.24, entitled "Aquifer Protection Standards," is hereby added to the Tumwater Municipal Code to read as follows:

"Chapter 16.24

AQUIFER PROTECTION STANDARDS

Sections:

16.24.010 Short Title.
16.24.020 Intent.
16.24.030 Definitions.
16.24.040 Approval Required.
16.24.050 Aquifer Protection Standards.
16.24.060 Violation - Penalty.
16.24.070 Severability.

16.24.010 - Short Title. This chapter shall be known and may be cited as the "Aquifer Protection Standards Ordinance" of the City of Tumwater.

16.24.020 - Intent. It is the declared policy of the City of Tumwater to conserve and protect the underground waters and aquifers over which the City rests. Any development which occurs within the City will be designed to eliminate chemical and biological contaminants from entering underground waters and aquifers which are now, or in the future, likely to be used as a potable drinking water source.

16.24.030 - Definitions.

A. "Aquifer" means a saturated geologic formation which will yield a sufficient quantity of water to serve as a private or public water supply.

B. "Contaminants" means hazardous substance(s) which, if released in sufficient quantity, would impair a component of the environment as a useful resource.

C. "Facility" means all structures, contiguous land, appurtenances, and other improvements on or in the land.

D. "Groundwater" means all water found beneath the ground surface, including the slowly-moving sub-surface water present in aquifers and vadose zones.

E. "Hazardous Substance(s)" means any material, either singularly or in combination, which may pose a present or potential hazard to human health or to the quality of the drinking water supply (now or in the future) in the aquifer system underlying the City of Tumwater when improperly used, stored, transported, or disposed of or otherwise mis-managed, including those materials identified as a hazardous waste in 40 CFR 261, as amended, or defined as a hazardous substance in 40 CFR 302, as amended, WAC 173-360-120, as amended. Hazardous substances shall include petroleum products and by-products, including crude oil or any faction thereof such as gasoline, diesel, and waste oil which is liquid at standard conditions of temperature and pressure (60° Fahrenheit, 14.7 pounds per square inch absolute).

F. "Release" means any spilling, leaking, emitting, discharging, escaping, leaching or disposing of hazardous substance(s) from a facility or activity into or onto soil, air, water, groundwater, or other materials.

G. "Release Detection" means a method or methods of determining whether a release or discharge of a hazardous substance has occurred from a regulated facility into the environment.

16.24.040 - **Approval Required.** No person, corporation, or other legal entity shall engage in the construction of regulated facility/facilities contained in this ordinance without having received approval by the City through the environmental review process and/or applicable discretionary permit(s) and construction permit(s).

16.24.050 - **Aquifer Protection Standards.** The following aquifer protection techniques will be applied on a city-wide basis for new development construction:

1. <u>Stormwater Retention Facilities</u> - New stormwater retention facilities serving ten or more single family residences, multiple family residences with four or more living units, and all commercial/industrial land uses must cleanse the stormwater of chemical and biological pollutants to applicable standards. The contaminant catch load must be dealt with in a way to prevent its entry into the groundwater system. Specific performance standards for stormwater cleansing and groundwater contaminant shielding to be established by the Public Works Director on an interim basis and subsequently identified by the City's Development Standards process by no later than one year past the date of Department of Ecology's final rules on stormwater.

2. <u>Facilities with Underground Tanks/Underground Storage Vaults</u> - All new underground storage facilities used or to be used for the underground storage of hazardous substances

shall be designed and constructed so as to:

a. Prevent releases due to corrosion or structural failure for the operational life of the tank or vault;

b. Be cathodically protected against corrosion, constructed of non-corrosive material, steel clad with a non-corrosive material, or designed in a manner to prevent the release or threatened release of any stored substance;

c. Use material in the construction or lining of the tank which is compatible with the substance to be stored; and

d. Provide for release detection method(s).

e. Have double walls or single walls with liners.

3. <u>Facilities with Aboveground Tanks/New Aboveground Tanks</u>

a. No new aboveground storage facility or part thereof shall be fabricated, constructed, installed, used, or maintained in any manner which may allow the release of a hazardous substance to the ground, groundwaters, or surface waters.

b. No new aboveground tank or part thereof shall be fabricated, constructed, installed, used, or maintained without having constructed around and under it an impervious containment area enclosing or underlying the tank or part thereof. Impervious containment will be equal to the volume of the tank to avoid an overflow of the containment area.

4. <u>Modification of Performance Standards</u> - Projects which are located outside of the Aquifer Protection Zone District (TMC Title 18) may be granted reductions in the above-specified performance standards by the submittal and approval of an aquifer protection plan. This plan will outline how the project proposal will effectively protect the aquifer from releases of contaminants. The Aquifer Protection Plan will be made a part of the environmental review as outlined in the City's Environmental Policy Code (TMC Title 16.04), if applicable, and be a condition of approval for any discretionary permits or construction permits.

16.24.060 - Violation - Penalty.

A. Violation of the provisions of this chapter or failure to comply with any of the requirements shall constitute a misdemeanor and shall be punishable by a fine of not more than three hundred dollars or by imprisonment for not more than ninety days, or by both such fine and imprisonment. Each day such violation continues shall be considered a separate, distinct offense.

B. Any person who commits, participates in, assists or maintains such violation may be found guilty of a separate offense and suffer the penalties as set forth in subsection A of this section.

C. In addition to the penalties set forth in subsections A and B of this section, any violation of the provisions of this chapter is declared to be a public nuisance and may be abated through proceedings for injunctive or similar relief in Superior Court or other court of competent jurisdiction.

D. Upon determination that a violation of the provisions of this chapter has occurred, the Building Official shall withhold issuance of building permits and/or certificates of occupancy for the affected property until corrective action is taken by the responsible party. However, if mitigating circumstances exist and reasonable commitments for corrective action are made, the Building Official may issue building permits and/or the certificates of occupancy.

16.24.070 - Severability. If any section, paragraph, subsection, clause or phrase of this chapter is for any reason held to be unconstitutional or invalid, such decision shall not affect the validity of the remaining portions of the chapter.

Section 2. A new Subsection 16.04.150 (D)(3)(m) is hereby added to the Tumwater Municipal Code to read as follows:

16.04.150 (D)(3)(M) Aquifer Protection Standards Ordinance."

Section 3. This ordinance shall become effective five days after passage, approval and publication.

ADOPTED this 20th day of August, 1991.

CITY OF TUMWATER

Peter N. Fluetsch, Mayor

ATTEST:

Gayla L. Gjertsen, Clerk/Treasurer

Published: August 23, 1991

APPROVED AS TO FORM:

Thomas J. Taylor, City Attorney

Ordinance #1281

ORDINANCE NUMBER 1282

AN ORDINANCE adding a new chapter, Chapter 16.20, Geologically-Hazardous Areas, to Title 16, Environment, of the Tumwater Municipal Code, and further adding a new Subsection 16.04.150 (D)(3)(n).

THE CITY COUNCIL OF THE CITY OF TUMWATER, STATE OF WASHINGTON, DOES ORDAIN AS FOLLOWS:

Section 1. A new chapter, Chapter 16.20, entitled "Geologically-Hazardous Areas," is hereby added to the Tumwater Municipal Code to read as follows:

"Chapter 16.20

GEOLOGICALLY-HAZARDOUS AREAS

Sections:

16.20.010 - Short Title. This chapter shall be known and may be cited as the "Geologically-Hazardous Areas Ordinance" of the City of Tumwater.

16.20.020 - Intent. It is the declared policy of the City of Tumwater to encourage land uses that are compatible with underlying geological conditions through the use of appropriate engineering, design and construction practices. It is also recognized that at times even the best of efforts to properly design and apply technology will not adequately reduce the risks of geological hazards. In these instances, areas of extreme geological instability are to be avoided as sites for development and placement of structures.

16.20.030 - Definitions.

A. "Slope" means an inclined ground surface the inclination of which is expressed as a ratio of horizontal distance to vertical distance.

B. "Site" means any lot, tract, parcel, large lot holding, either owned or leased, and any contiguous combination thereof, intended to be developed.

C. "Landslide Area" means those areas susceptible due to combinations of bedrock, soil, slope gradient, slope aspect, hydrology, and other identified factors.

16.20.040 - Approval Required. No person, corporation, or other legal entity shall engage in construction on a site which has a high probability of experiencing soil liquefaction during earthquakes; an average slope of 15% or greater; or a maximum slope of 40% or greater (pre-construction) without having received approval by the City through application of this ordinance and applicable construction permit(s).

16.20.050 - Geologically-Hazardous Areas Development Requirements.

A. All building permit applications, for new structures, applied for within the City, shall be submitted with site information on the following characteristics:

- Maximum and average slopes on the site: pre-construction;
- Identification of known groundwater seepage areas;
- Soils present with identified propensity for liquefaction during earthquakes;
- Any known landslide activity; and
- Identification of stream incision points and streamside erosion points.

B. Development sites for new structures identified with high probability of experiencing soil liquefaction during earthquakes shall have all new structures designed in accordance with the requirements of Chapter 23, Section 2312 of the 1988 Uniform Building Code, as written now or hereafter amended.

C. Development sites for new structures shall be designed in accordance with the requirements of Chapter 23, Section 2312, and Chapter 29, Section 2907(d) of the 1988 Uniform Building Code as written now or hereafter amended when the following conditions exist:

- Slopes steeper than 15%;
- Hillsides intersecting geologic contacts of a relatively permeable sediment overlying a relatively impermeable sediment or bedrock;
- Springs or groundwater seepage;
- Slopes of 40% or steeper with a vertical relief of ten or more feet except areas composed of consolidated rock.

D. Development sites for new structures identified as potentially experiencing landslide activity shall have all new structures designed in accordance with the requirements of Appendix, Chapter 29, Section 2907 (d) and Appendix, Chapter 70 of the 1988 Uniform Building Code as written now or hereafter amended.

E. Development sites for new structures identified with ground water seepage areas and average slopes of 15% or greater or maximum slopes of 40% or greater shall have all structures located a minimum of 50 feet away from such seepage areas or such structures will be required to have on-site drainage systems installed to be designed to mitigate such site constraints. Such building design is to meet the specifications of the Building Official and be prepared by an engineer, licensed by the State.

F. Development sites for new structures identified with intermittent or perennial streamside incision or erosion areas shall have all structures located a minimum of 50 feet away from such areas. Structures will have on-site drainage installed to conduct water away from streamside incision or erosion areas as much as practicable. Such a drainage system is to meet the specifications of the Building Official and be prepared and designed by an engineer, licensed by the State.

16.20.060 - Appeals. If, in the opinion of the Building Official, geologically-hazardous areas, as described in Section 16.20.050, represent a severe risk which cannot be successfully ameliorated by structural design, the affected site or portion thereof may be declared unbuildable. Appeals of the Building Official are as provided for in Section 204 of the Uniform Building Code as adopted or hereafter amended.

16.20.070 - Violation - Penalty.

A. Violation of the provisions of this chapter or failure to comply with any of the requirements shall constitute a misdemeanor and shall be punishable by a fine of not more than three hundred dollars or by imprisonment for not more than ninety days, or by both such fine and imprisonment. Each day such violation continues shall be considered a separate, distinct offense.

B. Any person who commits, participates in, assists or maintains such violation may be found guilty of a separate offense and suffer the penalties as set forth in subsection A of this section.

C. In addition to the penalties set forth in subsections A and B of this section, any violation of the provisions of this chapter is declared to be a public nuisance and may be abated through proceedings for injunctive or similar relief in Superior Court or other court of competent jurisdiction.

D. Upon determination by the Building Official that a violation of the provisions of this chapter has occurred, the Building Official shall withhold issuance of building permits and/or certificates of occupancy for the affected property until corrective action is taken by the responsible party. However, if mitigating circumstances exist and reasonable commitments for corrective action are made, the Building Official may issue building permits and/or certificates of occupancy.

16.20.080 - Severability. If any section, paragraph, subsection, clause or phrase of this chapter is for any reason held to be unconstitutional or invalid, such decision shall not affect the validity of the remaining portions of the chapter.

Section 2. A new Subsection 16.04.150 (D)(3)(n) is hereby added to the Tumwater Municipal Code to read as follows:

16.04.150 (D)(3)(n) Geologically-Hazardous Areas Ordinance."

Section 3. This ordinance shall become effective five days after passage, approval and publication.

ADOPTED this 20th day of August, 1991.

CITY OF TUMWATER

Peter N. Fluetsch, Mayor

ATTEST:

Gayla L. Gjertsen, Clerk/Treasurer

Published: August 23, 1991

APPROVED AS TO FORM:

Thomas J. Taylor, City Attorney

Ordinance #1282

ORDINANCE NUMBER 1283

AN ORDINANCE adding a new chapter, Chapter 16.32, Fish and Wildlife Habitat Protection, to Title 16, Environment, of the Tumwater Municipal Code, and further adding a new Subsection 16.04.150 (D)(3)(o).

THE CITY COUNCIL OF THE CITY OF TUMWATER, STATE OF WASHINGTON, DOES ORDAIN AS FOLLOWS:

Section 1. A new chapter, Chapter 16.32, entitled "Fish and Wildlife Habitat Protection", is hereby added to the Tumwater Municipal Code to read as follows:

"Chapter 16.32

FISH AND WILDLIFE HABITAT PROTECTION

Sections:

16.32.010 - Short Title. This chapter shall be known and may be cited as the "Fish and Wildlife Habitat Protection Ordinance" of the City of Tumwater.

16.32.020 - Purpose. It is the policy of the City of Tumwater that the preservation of fish and wildlife habitat is critical to the protection of suitable environments for animal species and in providing a natural beauty and healthy quality of life for Tumwater and its citizens. The conservation of habitat means active land management for maintaining species within their preferred habitats and accustomed geographic distribution. In this way, isolated sub-populations are not created which are more susceptible to predation, dislocation and inadequate food supplies. Habitat protection does not require that all individuals of all species are protected, but does demand that land use planning be sensitive to the priority of saving and protecting animal-rich environments.

16.32.030 - Definitions.

A. "Areas with which endangered, threatened and sensitive species have a primary association" are defined as seasonal ranges and habitats with which federal and state-listed endangered, threatened and sensitive species have a primary association and which, if altered, may reduce the likelihood that the species will maintain and reproduce over the long term.

B. "Naturally occurring ponds under twenty acres and their submerged aquatic beds that provide fish and wildlife habitat" are defined as naturally occurring ponds not including ponds deliberately designed and created from dry sites, such as canals, detention facilities, wastewater treatment facilities, farm ponds, temporary construction ponds (of less than three years duration) and landscape amenities. However, naturally occurring ponds may include those artificial ponds intentionally created from dry areas in order to mitigate conversion of ponds, if permitted by a regulatory authority.

C. "Waters of the state" are defined in Title 222, WAC, the Forest Practice Rules and Regulations; further defined as the classification system established in WAC 222.16.030 as exists now or hereafter amended.

D. "Lakes, ponds, streams, and rivers planted with game fish" are defined to include game fish planted in these water bodies under the auspices of a federal, state, local, or tribal program or which supports priority fish species as identified by the Department of Wildlife.

E. "Buffer" is defined as an area of land used or created for the purpose of insulating or separating a structure or land use from a fish and/or wildlife habitat area in such a manner as to reduce or mitigate any adverse impacts of the developed area.

F. "Residential density" means the permissible number of dwelling units that may be developed on a specific amount of land area measured in number of dwelling units per acre.

G. "Allowed uses and activities" means any authorized land use or activity allowed alone or in conjunction with another use.

H. "Site" means any lot, tract, parcel, large lot holding, either owned or leased, intended to be developed.

16.32.040 - **Approval Required.** No person, corporation, or other legal entity shall engage in construction on a site which supports a protected fish and wildlife habitat area as defined by this ordinance without having received approval for proper protection or mitigation by the City through the environmental review process and/or applicable discretionary permit(s) and construction permit(s).

16.32.050 - **Habitats Defined and Protected.** The following habitats are defined and protected:

A. The following fish and wildlife habitat areas are to be protected within the City of Tumwater:

1. Areas with which endangered, threatened, and sensitive species have a primary association;
2. Naturally occurring ponds under twenty acres and their submerged aquatic beds that provide fish and wildlife habitats;

3. Lakes, ponds, streams, and rivers planted with game fish; and

4. Waters of the state, to include the DesChutes River, Percival Creek, Black Lake drainage ditch, Barnes Lake, Trosper Lake, Fishpond Creek, and their associated wetlands.

B. Habitats and species as identified by the Washington State Department of Wildlife's "Priority Habitats and Species Project Documents", including future revisions thereof, for the Tumwater area.

16.32.060 - Habitat Areas - Buffers. To retain and protect adequate urban wildlife habitats, buffers will be established on a case-by-case basis to be defined by a habitat protection plan.

16.32.070 - Habitat Areas - Allowed Uses and Activities. Uses within protected habitat areas are limited to low intensity land uses designed not to adversely affect the habitat. These uses will be:

Agriculture
Boat ramps
Docks and floats
Wildlife blinds
Scientific research
Beach access
Emergency - Temporary Permits
Enhancement
Existing structures remodeled (including enlargement) or replaced
Fences
Fill with mitigation
Forest practice permits
Outdoor recreation activities
Open space area
Parks
Public structures
Stormwater facilities
Trails and related facilities
Utility lines
Wildlife nesting structures

16.32.080 - Habitat Areas - Residential Densities. For the purpose of calculating residential densities for sites containing protected wildlife habitat areas, the underlying zoning density shall apply and be available to use for the total density allowed on a project.

16.32.090 - Habitat Areas - Protection Plan. When a protected habitat is located on a site to be developed, a Habitat Protection Plan will be submitted by the permit applicant. The Habitat Protection Plan shall contain the following information as a minimum and will be subsequently used as part of the

Environmental Review process and is a condition of approval for Discretionary Permit(s) and/or construction permits:

A report which contains:

A. A description of the nature, density and intensity of the proposed development in sufficient detail to allow analysis of such land use change upon the protected fish or wildlife habitat.

B. The applicant's analysis of the effect of the proposed development, activity or land use change upon the fish and/or wildlife species.

C. A plan by the applicant which shall explain how he will mitigate any adverse impacts to protected fish or wildlife habitats created by the proposed development.

A map(s) prepared at an easily readable scale, showing:

A. The location of the proposed development site.

B. The relationship of the development to the adjacent habitat area.

C. The nature and density of the proposed development or land use change.

D. Proposed building locations and arrangements.

E. A legend which includes:

1. A complete and accurate legal description as prescribed by the development application form. The description shall include the total acreage of the parcel;
2. Title, scale and north arrows; and
3. Date, including revision dates if applicable.

F. Existing structures and landscape features including the name and location of all water courses, ponds and other bodies of water.

Possible mitigation measures shall include, but are not limited to:

A. Establishment of buffer zones;

B. Buffer zone enhancement by planting indigenous plant species;

C. Preservation of critically important plants and trees;

D. Limitation of access to habitat area; and

E. Seasonal restriction of construction activities.

16.32.100 - Violation - Penalty.

A. Violation of the provisions of this chapter or failure to comply with any of the requirements shall constitute a misdemeanor and shall be punishable by a fine of not more than three hundred dollars or by imprisonment for not more than ninety days, or by both such fine and imprisonment. Each day such violation continues shall be considered a separate, distinct offense.

B. Any person who commits, participates in, assists or maintains such violation may be found guilty of a separate offense and suffer the penalties as set forth in subsection A of this section.

C. In addition to the penalties set forth in subsections A and B of this section, any violation of the provisions of this chapter is declared to be a public nuisance and may be abated through proceedings for injunctive or similar relief in Superior Court or other court of competent jurisdiction.

D. Upon determination that a violation of the provisions of this chapter has occurred, the Building Official shall withhold issuance of building permits and/or certificates of occupancy for the affected property until corrective action is taken by the responsible party. However, if mitigating circumstances exist and reasonable commitments for corrective action are made, the Building Official may issue building permits or certificates of occupancy.

16.32.110 - Severability. If any section, paragraph, subsection, clause or phrase of this chapter is for any reason held to be unconstitutional or invalid, such decision shall not affect the validity of the remaining portions of the chapter.

Section 2. A new Subsection 16.04.150 (D)(3)(o) is hereby added to the Tumwater Municipal Code to read as follows:

> **16.04.150 (D)(3)(o) Fish and Wildlife Habitat Protection Ordinance;"**

Section 3. This ordinance shall become effective five days after passage, approval and publication.

ADOPTED this 20th day of August, 1991.

CITY OF TUMWATER

Peter N. Fluetsch, Mayor

ATTEST:

Gayla H. Gjertsen, Clerk/Treasurer

Published: August 23, 1991

APPROVED AS TO FORM:

Thomas J. Taylor, City Attorney

Ordinance #1283

Appendix G

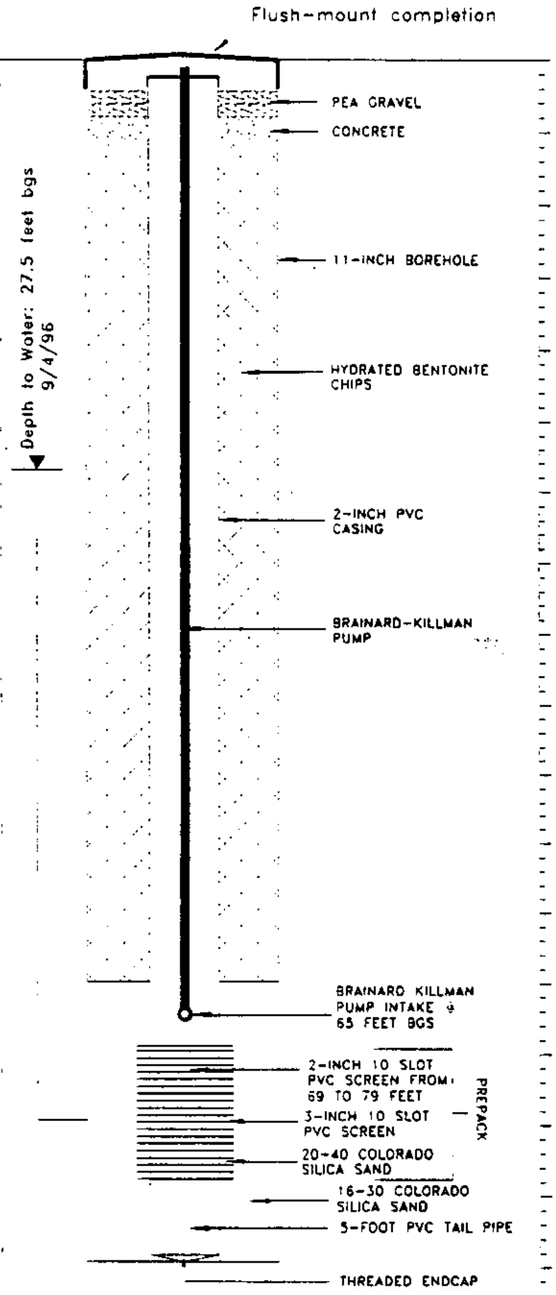
Appendix G

Well Logs

DEPTH	GEOLOGIC LOG	SAMPLE BLOW COUNT PER 6 INCHES	GEOLOGIC UNIT
	Ground Elevation Approximately === feet msl		
0	Dark brown, dry to moist, organic-rich soil		
		22	
10		24	
	Brown, dry, very loose, fine SAND with moist interbed of silt @15.5 feet	27	
20		50	
	grades down to gray-brown, loose, fine SAND water encountered @ 26.5 feet	36	
30	heaving, add water		
	Gray-brown, wet, very loose gravelly fine to medium SAND	86	
	Gray-brown, wet, very loose, fine SAND	50	
40	heaving, add water	55	
	grades down to fine to medium SAND		
		48	Qal
50		46	
	Gray-brown, wet, medium loose, SILT and very fine SAND	55	
60		50	
	@ 64 feet: 1-2 inch zone of red-brown (oxidized), very fine SAND and SILT	38	
70	heaving, add water	45	
	Brown-gray, wet, very loose, very slightly silty, fine SAND	50	
80		19	
	heaving, add water.	50	
	Bottom of boring @ 84.5 feet		
90			
100			

Note: - Soil Description Does Not Correpond to Blow Counts (N).
- BGS = Below Ground Surface.

WELL CONSTRUCTION DETAILS



DRILLING METHOD: 6.25-in ID Hollow Stem Auger
SAMPLING METHOD: 2.5-in ID Spoon, 140-lb Wt
FIRM: Cascade Drilling
DRILLER: Rodney LaBrosse
INSTALLED: August 21, 1996
CONSULTING FIRM: Pacific Groundwater Group
REPRESENTATIVE: Jim Mathieu

WELL NAME: MW-96-15
UWID=: ACB 844
DEPTH TO WATER: 27.5 feet bgs
WATER LEVEL DATE: 9/4/96
LOCATION: NE 1/4 SE 1/4 Sec.34,T18N,R2W

Tumwater Wellhead Protection Project

EXHIBIT G1
WELL MW-96-15 LOG AND AS-BUILT

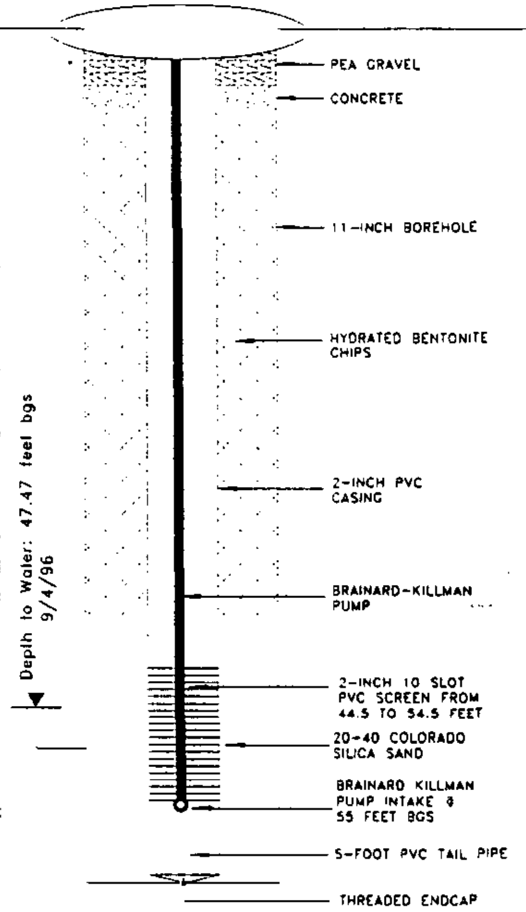
JE9401 DRILLING MW1596.DWG, 9/13 96

Pacific Groundwater Group

DEPTH	GEOLOGIC LOG	SAMPLE	BLOW COUNTS PER FOOT	GEOLOGIC UNIT
0	Ground Elevation Approximately === feet msl			
	Dark brown, organic-rich soil			Qal
	Brown to slightly gray-brown, dry, very loose, fine SAND	☒	17	
10		☒	28	
		☒	28	
20	Brown-gray, dry to damp, v. loose, slightly silty fine SAND	☒	25	
	Dark gray-white, dry, very loose, fine SAND	☒	43	
30		☒	42	
	Brown-gray, dry, very loose, very fine SAND	☒	57	
40	Brown-gray, damp to dry, loose, SILT and very fine SAND	☒	55	
	Brown-gray, damp to moist, loose, very slightly silty, very fine SAND. encountered water @48 feet	☒	65	
50	minor medium sand below 50 feet, add water @ 52.5 ft	☒	35	
	Slightly brownish-gray, wet, very loose, fine to medium SAND.	☒	31	
60	Bottom of boring @ 60 feet	☒	37	
70				
80				
90				
100				

WELL CONSTRUCTION DETAILS

Above-ground completion, 2-foot stick-up, see Figure = for detail.



Note: - Soil Description Does Not Correpond to Blow Counts (N).
- BGS = Below Ground Surface.

DRILLING METHOD: 6-inch ID Hollow Stem Auger
SAMPLING METHOD: 2.5-in Spoon, 140-lb Wt
FIRM: Cascade Drilling
DRILLER: Rodney LaBrosse
INSTALLED: August 22, 1996
CONSULTING FIRM: Pacific Groundwater Group
REPRESENTATIVE: Jim Mathieu

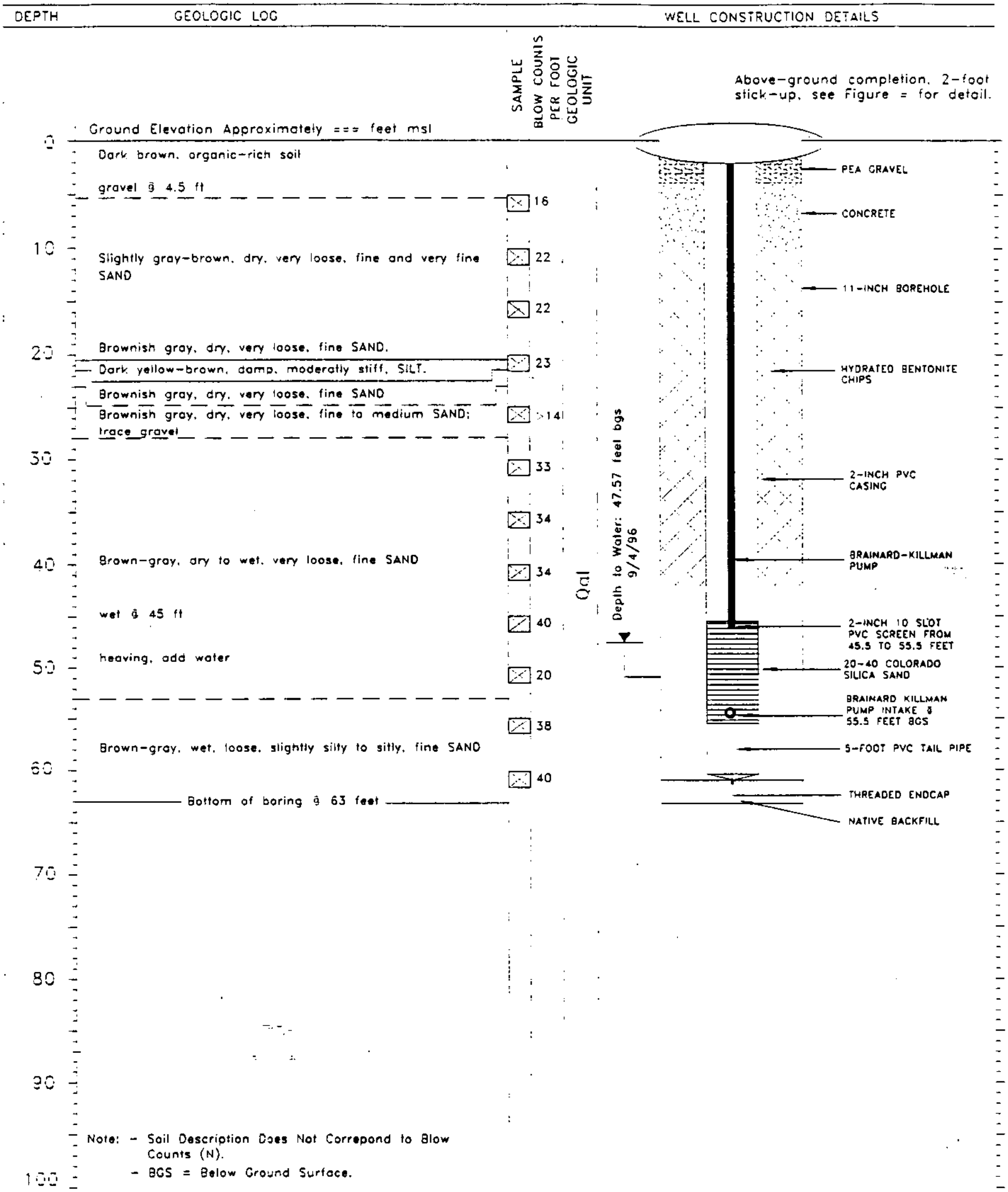
WELL NAME: MW-96-16
UWID=: ACB 845
DEPTH TO WATER: 47.47 feet bgs
DATE OF WATER LEVELS: 9/4/96
LOCATION: SW ¼ SW ¼ Sec.35,T18N,R2W

Tumwater Wellhead Protection Project

EXHIBIT G2
WELL MW-96-16 LOG AND AS-BUILT

JE9401 DRILLING MW1696.DWG, 9/18/96

Pacific Groundwater Group



DRILLING METHOD: 6.25-in ID Hollow Stem Auger
SAMPLING METHOD: 2.5-in Spoon, 140-lb Wt
FIRM: Cascade Drilling
DRILLER: Rodney LaBrosse
INSTALLED: August 22, 1996
CONSULTING FIRM: Pacific Groundwater Group
REPRESENTATIVE: Jim Mathieu

WELL NAME: MW-96-17
UWID#: ACB 843
DEPTH TO WATER: 47.57 feet bgs
WATER LEVEL DATE: 9/4/96
LOCATION: SW 1/4 SW 1/4 Sec.35,T18N,R2W

Tumwater Wellhead Protection Project

EXHIBIT G3
WELL MW-96-17 LOG AND AS-BUILT

JE9401 DRILLING MW1796.DWG, 9/18/96

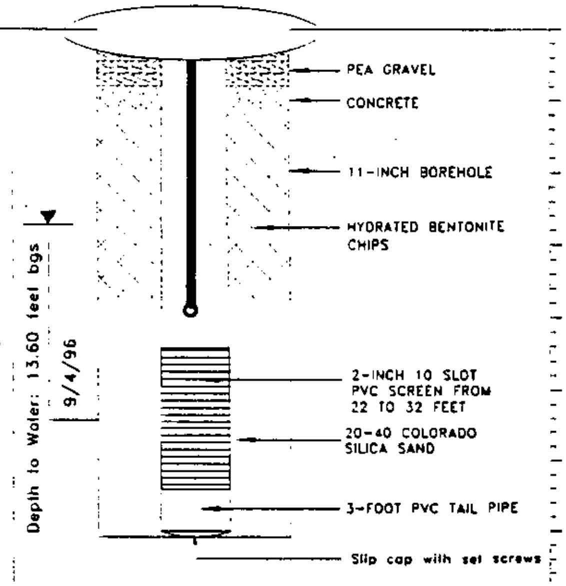
Pacific Groundwater Group

DEPTH	GEOLOGIC LOG	SAMPLE	BLOW COUNTS PER FOOT	GEOLOGIC UNIT
0	Ground Elevation Approximately === feet msl			
	Dark brown, organic-rich soil			
	Dark brown-gray, dry to wet, loose to sticky, SILT	☒	17	
10	wet @ 10.5 ft	☒	15	
	brown to yellow-brown color @ 14.5 ft			
	Gray-brown, damp to moist, loose to sticky, silty fine SAND	☒	5	
20	Brown-gray, wet, sticky, SILT	☒	7	Qvr
	Gray, wet, SILT and very fine SAND			
	Gray-brown, wet, very loose, fine SAND.	☒	12	
30				
	Bottom of boring @ 35 feet	☒	45	
40				
50				
60				
70				
80				
90				
100				

Note: - Soil Description Does Not Correpond to Blow Counts (N)..
- BGS = Below Ground Surface.

WELL CONSTRUCTION DETAILS

Above-ground completion, 2-foot stick-up, see Figure = for detail..



DRILLING METHOD: 6.25-in ID Hollow Stem Auger
SAMPLING METHOD: 1.5-in Spoon
FIRM: Cascade Drilling
DRILLER: Rodney LaBrosse
INSTALLED: August 23, 1996
CONSULTING FIRM: Pacific Groundwater Group
REPRESENTATIVE: Jim Mathieu

WELL NAME: MW-96-18
UWID=: ACB 847
DEPTH TO WATER: 13.60 feet bgs
WATER LEVEL DATE: 9/4/96
LOCATION: NW¼ SE¼ Sec.10,T17N,R2W

Tumwater Wellhead Protection Project

EXHIBIT G4
WELL MW-96-18 LOG AND AS-BUILT

JE9401 DRILLING MW1896.DWG, 9/18/96

Pacific Groundwater Group

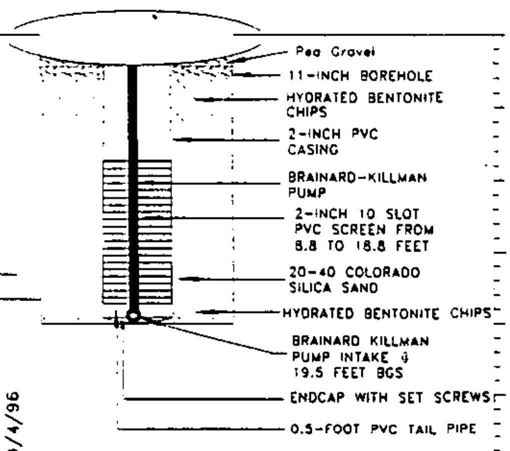
DEPTH	GEOLOGIC LOG	SAMPLE	BLOW COUNTS PER FOOT	GEOLOGIC UNIT
	Ground Elevation Approximately === feet msl			
0	Brown to light-brown, dry, organic rich soil with some rounded gravel			
	Brown, dry, very silty, very fine SAND	☒	17	
10	Brown-gray, wet, moderatly loose, silty to very silty, SAND and GRAVEL, some gravels are silt-coated			Qvr
	heaving, add water	☒	50	
20	Brown-gray, wet, loose, slightly silty, fine to medium SAND and GRAVEL with some cobbles	☒	50	
	Bottom of boring @ 20 feet			
30				
40				
50				
60				
70				
80				
90				
100				

Depth to Water: 16.65 feet bgs
9/4/96

Note: - Soil Description Does Not Correpond to Blow Counts (N).
- BGS = Below Ground Surface.

WELL CONSTRUCTION DETAILS

Above-ground completion, 2-foot stick-up, see Figure = for detail.



DRILLING METHOD: 6.25-in ID Hollow Stem Auger
SAMPLING METHOD: 1.5-in Spoon, 140-lb Wt
FIRM: Cascade Drilling
DRILLER: Rodney LaBrosse
INSTALLED: August 23, 1996
CONSULTING FIRM: Pacific Groundwater Group
REPRESENTATIVE: Jim Mathieu

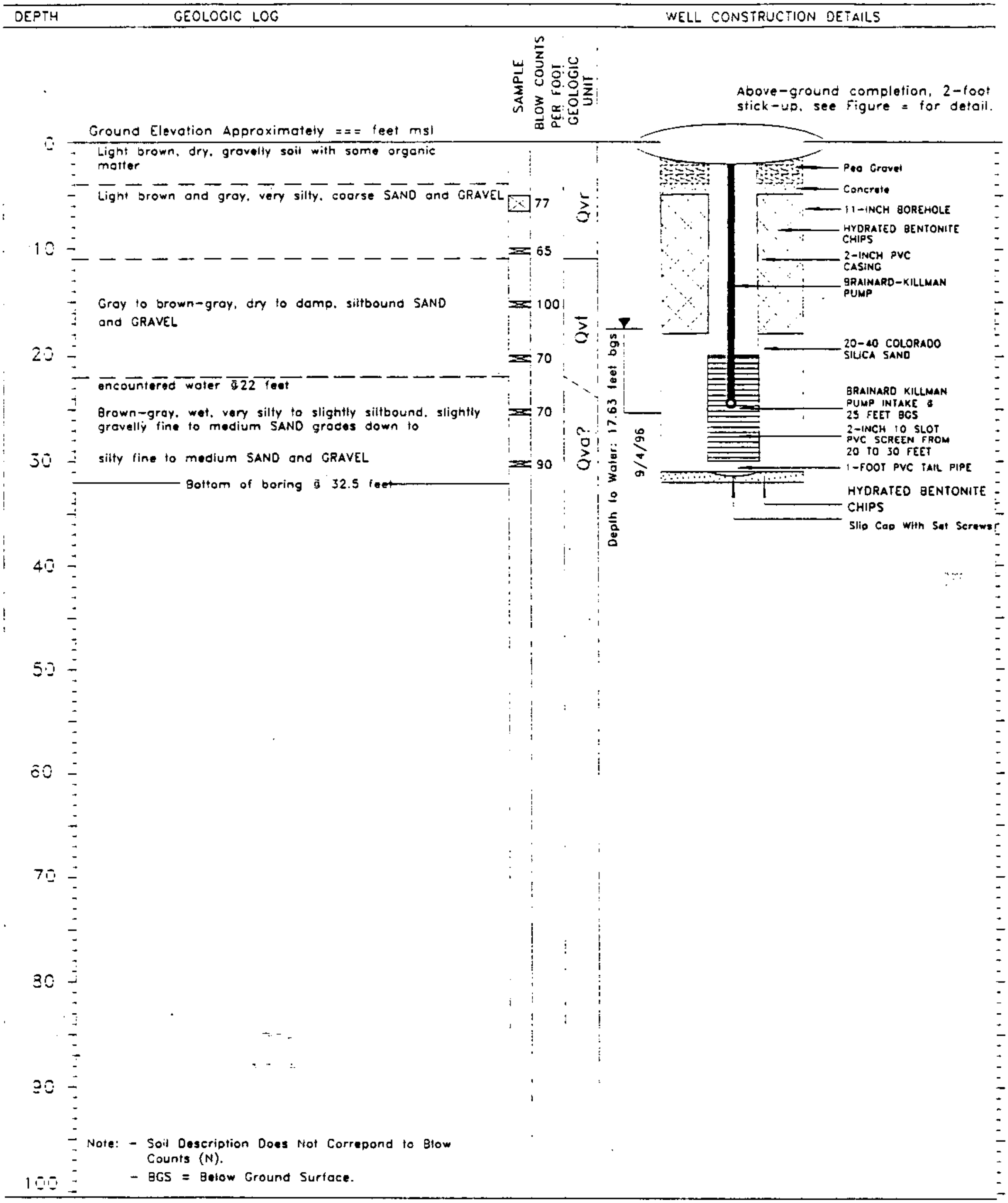
WELL NAME: MW-96-19
UWID=: ACB 848
DEPTH TO WATER: 16.65 feet bgs
WATER LEVEL DATE: 9/4/96
LOCATION: SW¼ SE¼ Sec.10,T17N,R2W

Tumwater Wellhead Protection Project

EXHIBIT G5
WELL MW-96-19 LOG AND AS-BUILT

JE9401 DRILLING MW1996.DWG, 9/18/96

Pacific Groundwater Group



DRILLING METHOD: 6.25-in ID Hollow Stem Auger
SAMPLING METHOD: 2.5-in Spoon, 140-lb Wt
FIRM: Cascade Drilling
Scott Kreuger
INSTALLED: August 27, 1996
CONSULTING FIRM: Pacific Groundwater Group
REPRESENTATIVE: Jim Mathieu

WELL NAME: MW-96-20
UWID=: AC8850
DEPTH TO WATER: 17.63 feet bgs
DATE OF WATER LEVELS: 9/4/96
LOCATION: SE 1/4 SW 1/4 Sec.10,T17N,R2W

Tumwater Wellhead Protection Project

EXHIBIT G6
WELL MW-96-20 LOG AND AS-BUILT

JE9401 DRILLING MW2096.DWG, 9/18/96

Pacific Groundwater Group

Appendix H

Appendix H

Reviewer's Comments and City Response

Appendix H

City of Tumwater Wellhead Protection Plan: Reviewer's Comments and City Response

The people listed below reviewed and submitted comments, suggestions, and/or recommendations for the Wellhead Protection Plan. Their letters and comments have been attached in this section following the City's response. The Draft version of the Wellhead Protection Plan should be referenced to examine and compare specific text changes:

Chris Pitre - Pacific Groundwater Group, Seattle, WA
Ron Holcomb - Dept. of Ecology
Andrea Fontenot - Port of Olympia
John Konovsky - Thurston Conservation District
Jane Hedges - Thurston County, Pub. Health and Social Services Dept.
John Carpenter - Tumwater Fire Department

City's Response to Comments and Suggestions submitted by:

John Konovsky, Thurston Conservation District - Letter dated Mar. 27, 1997

Specific Comments (page numbers refer to pages in the WHPP):

Page No.	Paragraph/ Section	City's Response
Page 7-5 -	PF1	"CS" was changed to "CD."
Page 7-5 -	PF3	This information was included on Page 7-20.
Page 7-5 -	PF5A	This information was added to Page 7-20.

Page 7-5 -	PF5C	This information was added to Page 7-20.
Page 7-20 -	7.4.4	The name of the Conservation Service has been changed to reflect the new name. The additional information in the following paragraphs was added or adjusted in it's respective spot of section 7.4.4.
Page 8-5 -	3.3	The information was added to Recommendation 3.3.

Ron Holcum, Department of Ecology - Material received Mar. 31, 1997

Material Submitted:

Incident Command System (ICS) Orientation, Northwest Contingency Plan, Glossary of related terms. These items are located in this section following the City's response to comments.

Specific Comments - as received by Kathy Callison in a telephone conversation on March 26,1977. (Page numbers relate to respective pages in the Wellhead Protection Plan):

Page No.	Paragraph/ Section	City's Response
Page 5-2-	5.2 P2	The bullet stated that the Washington State-wide Master Oil and Hazardous Substance Spill Contingency Plan prepared by Ecology was a spill response plan currently covering the City's WHPA's. That was plan was revised and is superseded by the N.W. Area Contingency Plan.
Page 5-4-	Exhibit 5-1	Added that Command is in charge. Added a bullet labeled Operations under Command. Added "/Finance" to the Administrative bullet.
Page 5-4-	Exhibit 5-1	Deleted four boxes that were located under the Incident Command System box with the heading "Incident Command Agency".
Page 5-6-	Exhibit 5-3	The IC and OSC were presented as individual and separate people. The IC and the OSC are typically one and the same person. The language has been changed in the text to reflect this.

Page 5-7-	5.3.1 P2	The Emergency Response Strategy section, 1st paragraph, 2nd sentence, was revised to read "...under the direction of the ICS command organizer: ..." Operations was added as a functional area. Added "/finance" to administration functional area.
Page 5-7-	5.3.1 P4	Third paragraph of Emergency Response Strategy section, 1st sentence, was revised to reflect that the Incident Commander, or a group of On-Scene Coordinators are in charge of the whole operation. Added "Actions of people under the direction of Command are to carry out the responsibility of cleaning the spill and/or protecting the public health and environment." after the first sentence of the paragraph.
Page 5-7-	5.3.1 P5	Fourth paragraph of Emergency Response Strategy section, 1st sentence, "...in some circumstances..." was deleted.
Page 5-8-	5.3.1 P1	The first sentence was revised to reflect that, "...'four' key OSCs share decision making authority and..." The first sentence was also revised by adding "local" and "responsible party(s)" to the list of OSCs, and industry representatives was deleted. The last sentence of the paragraph was deleted.
Page 5-8-	5.3.1 P5	The fourth sentence "...and disasters requiring more than one agency to respond to..." was revised to read "...and disasters exceeding the City's ability to respond to..."
Page 5-13-	5.3.4 P2	The word "Site" in parenthesis was deleted from the second sentence. In the third sentence the wording was adjusted to reflect that Ecology's involvement for clean-up activities and coordination would depend on the circumstances and situations encountered.

Page 5-13-	5.3.4 P5	The second sentence was deleted completely. New wording outlining penalties for different levels and severity's of spills replaces the second sentence.
Page 5-13-	5.3.4 P6	A local, 24-hour, phone number for reporting spills and hazardous materials to Ecology was added to the bottom of the paragraph.
Page 5-14-	5.3.4 P1	Emergency Management Division of the Military Department (EMD) was deleted from this Natural Resource Damage Assessment Team list.
Page 5-14-	5.3.4 P3	The last bullet in the Emergency Management Division, Military Department, was deleted.
Page 5-15-	5.3.4 P1	The toll-free 800 number for the Emergency Management Division was updated and revised to reflect their new number.
Page 5-15-	5.3.5 P6	The toll-free numbers in the last paragraph were updated and revised to reflect the most current numbers.

John Carpenter, Battalion Chief, Tumwater Fire Department -

Specific Comments - as received by Kathy Callison in a telephone conversation on March 28,1997. (Page numbers relate to respective pages in the Wellhead Protection Plan):

Page 5-5-	Exhibit 5-2	Added "Fire District No. 15" to Tumwater Fire Department (Tumwater) box. Deleted Fire District No. 15 from the ICA box.
Page 5-7-	5.3.1 P1	Revised 2[nd] sentence from "...location for management of the emergency response. The role of the EOC, when..." to read "... location for resource management. The role of the EOC, when..."

Page 5-8-	5.3.1 P4	Revised the fourth sentence from "...and disasters requiring more than one agency to respond to..." to read "...and disasters exceeding the City's ability to respond to..."
Page 5-11	5.3.3 P1	First full paragraph, first bullet, added "and all state highways," following "...in many incorporated areas...".

Jane Hedges, Thurston County Public Health and Social Services Dept. -

From a letter dated April 1, 1997.

General comments:

Encourages Tumwater to continue to look regionally at/for long term supply options which focus on providing locations where source control can be maintained.

City Response: This comment is duly noted and will be taken into consideration in the development of any future water supplies.

Suggests instituting a consistent layout for Executive Summary section that corresponds with the layout of the Plan. This would ease locating references mentioned in the Executive Summary.

City Response: Due to human resource and time constraints, this revision could not be attempted at this time. The City will consider instituting this change when the plan is updated and revised during subsequent updates.

Specific comments (page numbers refer to pages in the Wellhead Protection Plan):

Page No.	Paragraph/ Section	City's Response
Page ES4	3.1.1 P1	The draft text had said that "The simulation was calibrated to United States Coast Guard (USCG) water level data." That has been changed by replacing United States Coast Guard (USCG) with "...United States Geological Survey (USGS)..."
Page 2-33 to 2-49	Section 2	All Section 2 and other Section Exhibits, not Figures - as referenced in the comment letter, have been included in the final publication. Some copies of the Draft edition were missing some Exhibits and Tables.

Page 2-17-	2.2.1 P2	This paragraph had several problems with wording and typo's. All issues have been addressed, and changes were made as required. The correct text is as presented in this final version of the Plan.
Page 4-12-	4.2.1 P1	The City has Aquifer Sensitive Areas in place for groundwater protection. The city will augment those ordinances with specific comprehensive plan amendments and revised or new ordinances to protect designated wellhead areas.
Page 4-13-	4.2.2 P1	The bulleted items are only presented as suggested recommendations for the protection of the wellhead areas. Specific language will have to be determined and formulated for each site on a case-by-case basis.
Page 7-11-	7.2.3 P5	The County's comments for Recommendation 7-3 have been acknowledged and noted. The city will use the draft text as it was written and presented in the Plan.
Page 7-13-	7.3.2	Tumwater will use the services of the Thurston GeoData Center as feasible, in conjunction with the databases formulated and maintained by the City. Integration of GIS files and each city's records for all regional jurisdictions could be utilized as an effective and powerful tool.
Page 7-44-	Rec. 7-20	The text of the plan has been revised to reflect the reviewer's comments and suggestions regarding the construction and decommissioning of wells being delegated to Thurston County.

Other comments that were not addressed to a specific area or section of the Wellhead Plan have been noted. These suggestions may be incorporated into future updates of the Wellhead Plan. Due to time and staff constraints some of the suggested revisions were not incorporated into the Plan at this time.

Chris Pitre, Pacific Groundwater Group - Notes from a telephone call received by Kathy Callison, Sept. 18, 1997.

General Comments:

Page ES4	3.1.1 P1	USGS is the correct reference to use in this paragraph, not USCG. The text has been revised to reflect this.
Page 2-17-	2.2.1 P1	The last sentence of paragraph one (Modeling Capture Zones to Model Flow in the Qc/TQu Aquifer) was revised as recommended to include "to model flow in the TQu."
Page 2-33- to 2-49-	Section 2	Some preliminary draft copies of the plan that were reviewed were missing various figures, tables, and exhibits. These have been accounted for and are now included in the final version of the Plan.
Page 2-19-	Sect. 2.2.3	The letter from Jane Hedges, County Health and Social Services Department dated April 1, 1997, had indicated that modeling by the County had shown different results than were reported by Pacific Groundwater Group. Pacific Groundwater Group stands by their original report and analysis of the results they obtained during hydrogeologic modeling for the plan.

Response to a letter sent by Tory Tjersland to the City dated July 24, 1997 that included five pages of review comments submitted by Chris Pitre.

A suggested list of acronyms and abbreviations will be included in future updated versions of the Plan. This suggestion was well received by the City, but due to time constraints and staffing levels, these features were not included in the Plan at this point in time.

Rather than list each item mentioned in Chris Pitre's five pages of comments, the letter is included in this section along with the other reviewer's comments. Changes were made to the Plan as suggested where practicable and text was edited to incorporate the recommended revisions.

Comments of Andrea Fontenot, Port of Olympia, conveyed in a telephone conversation with Kathy Callison, City of Tumwater, April 1, 1997.

Regarding Exhibit 4-1 showing potential leaking underground tanks, several corrections should be made to that exhibit.

- L-8, the airport Vortac, tank has been removed.
- L-5, Tumwater Lumber Company, tank has been removed and all procedures followed.
- L-10, Airport Fuel Facility (Small & Sons), card lock, has been removed.
- There was a question as to whether there is a fuel tank at the former Hytec site on Airdustrial Way. (A-3)
- Fisheries main yard (A-8), tanks have been removed.
- Fuel storage tanks exist at two fixed base operations (Gower and Pearson).

Staff Response:

With regard to the leaking underground storage tanks, the source of this information is 1993 Ecology files. Comments have been noted. In future contaminant source inventory surveys, these sites will be deleted from the figure, as appropriate, upon confirmation of removal from Ecology list or site-specific confirmation of tank removal. With regard to Hytec and Fisheries main yard, the issue identified in Figure 4-1, is not whether underground tanks exist at the site, but whether the sites are confirmed and/or suspected contaminated sites. Hytec is a recently de-listed MTCA site and will be removed from the figure in future updates of the plan.

PGG edits to Draft Tumwater WHPP

Suggest list of acronyms (Table 1-1?).

Capture zones are presented in Exhibit 2-15. Recommended WHPAs are presented in Exhibit 2-16. I suggest that WHPAs be used in all subsequent figures (e.g. Exhibits 3-4, 4-1) since WHPAs are going to be the management and implementation tool.

---

p. 4, Sec 3.1.1, 3rd line should read: "United States Geological Survey (USGS)"

p. 5, Sec 3.1.4, bottom of page, change to: "...sediments along the Deschutes River and extending west from the Palermo..."

p. 6, Sec. 3.1.4, 3rd para., 3rd line: change "Qva" to "Qvr"
5th line: change "Qvr" to "Qvt"

p. 6, Sec. 3.1.4, 4th para., 2nd line: change "Well No. 21" to "Well No. 20"

p. 10, Sec 5.1.2, line 7: Modify as follows; "Sites include ~~Texaco Bulk Fuel Facility,~~ Fisheries maintenance...Fuel Stop. The Texaco Bulk Fuel Facility is included for consideration under this WHPP due to its proximity to currently recommended WHPAs, and because it may be located in future WHPAs as discharge from production wells increase. The Port of Olympia (Port)..."

p. 10, Sec 5.1.2: Insert final bullet at bottom of page - "A traffic plan should be prepared for the transport of hazardous materials in relation to the Texaco Bulk Fuel Facility and other Port of Olympia locations."

p. 11, Sec 5.1.3, 1st para, change 2nd last sentence to: "Contamination associated with American Fiberglass is a suspected threat to these wells."

p. 11, Sec 5.1.3, change 2nd bullet to read: "Assess threat of American Fiberglass site."

p. 11, Sec 5.1.4: Delete complete section and insert: "It is understood that the City is considering further resource development in the Trails End area. It is recommended that a more detailed wellhead protection assessment of this area be undertaken in anticipation of further development."

---

p. 2-12, Sec. 2.1, Table 2-3: footnote annotations have been lost in the reformatting. Include: [d] PGG, 1993; [e] PGG, 1994a; [f] PGG files; [g] R&N, 1991

p. 2-13, 1st para., insert reference at end of 1st sentence, as follows: "...to 0.007 in the north (Dion et al., 1994)"

p. 2-15, Sec 2.2, 2nd para., 2nd line: Include Lisa Dally-Wilson as follows: "(EES, PGG and Dally Environmental, 1995)"

p. 2-17, 2nd para., 1st line: Change "80,000" to "64,000"

p. 2-17, 3rd para., 4th line: Change sentence to read "However, Well No. 7 is screened in the TQu aquifer..."

p. 2-20, 1st complete sentence: Change to read: "One set of 21 water quality samples were collected."

p. 2-20, Sec. 2.3.1, 1st para, 2nd line: Change "Table 2-7" to "Table 2-6"

p. 2-21, 2nd para., 1st line: spell "well" with lower case.

p. 2-22 1st line: Change to read as follows: "...(PGG, 1994a and 1994b). <u>Well No. MW-93-06 is located approximately 250 feet east of production well 14, while the Routley well is located between the Henage and Gunter wells which are shown in Exhibit 2-16. Freon-11 has also been detected at a concentration below 0.5 µg/L</u> ~~and~~ in the latest..."

p. 2-23, 2nd para., end of 3rd line: Delete "was".

p. 2-24, 2nd para., 4th line: Change "parallel" to "perpendicular".

p. 2-24, 2nd para., 6th line: Insert to read "...Palermo <u>and Trails End</u> Wells..."

p. 2-24, 3rd para., line 7: Change from "Exhibit 2-10" to "Exhibit 2-8"

p. 2-26, 1st line: Change to read "...of all ~~of~~ wells in this..."

p. 2-26: Insert in last para. at bottom of page; "Periodic review of the WHPA delineations should be undertaken considering new data and changing discharge conditions, and modification of the WHPAs, if needed, should be performed.

p. 2-27, Sec 2.4.3, 1st line: Change to read: "Twenty-one groundwater samples were collected and analyzed..."

p. 2-29, Table 2-7: In table, change "524.2 [b]" to "524.2 [a]"
change "Inorganics [c]" to "Inorganics [b]"
Below table, delete footnote "a", change "b" to "a", and change "c" to "b"

p. 2-29, 2nd para., 2nd last line: change "triennially" to "triennial".

p. 2-31, Table 2-8: Modify table so that it is clear that MW-93-03 is part of the Palermo Area.

p. 2-32, after 1st para.: Insert:
"Recommendation 2-6: Update WHPA Delineations

Water level and well discharge data should be compiled and reviewed every two years in conjunction with the required threat inventory updates. The well capture zones should be modeled and. If necessary, appropriate wellhead management areas should then be modified accordingly. A consultant should be retained for this work with an annualized budget of $5,000."

---

p. 3-10, Sec. 3.4, 1st line: Insert "...that exist within the **focus area and the** City's WHPA's..."

p. 3-11, Table 3-4: Change title to "Confirmed and Suspected Contaminated Sites in the Focus Area"
Add footnote: "Note: not all sites are located within recommended WHPAs."

p. 3-11, 4th bullet: change to read as follows: "American Fiberglass is located in the 10-year recommended WHPA for the Bush Middle School Wellfield"

p. 3-13, 3rd para.,8th line: Change to read as follows: "In addition to TCE, tetrachloroethene (also known as perchloroethene or PCE) was detected..."

p. 3-15, Texaco Bulk Plant Storage Facility: Insert the following para at beginning of this section:
"Preliminary delineations indicated that the Texaco Bulk Fuel Storage Facility was located within recommended WHPAs. Refined WHPA delineations indicate that the facility is now considered to be outside of recommended WHPAs. The following text reviews the site history and process of evaluation within the context of this WHP project."

p. 3-17, middle of page: Modify as follows: "To more fully evaluate this site and its threat to ~~the City's water supply~~ groundwater, the City..."

p. 3-22, Sec. 3.4.5, line 11: Modify as follows: "Bulk Plant Facility ~~adjacent to and~~ west of..."

Section 4 Throughout, downplay importance of Restover.

p. 4-2, 1st para., 2nd last line: Modify as follows: "...and ten-year ~~boundaries~~ capture zones."

p. 4-4, 1st bullet: Modify as follows: "Three additional contaminant sources ~~that likely impact~~ in the Palermo ~~Wellfield~~ WHPA have been identified."

p. 4-11, Sec 4.1.4, 1st bullet: Modify as follows: "~~Petroleum hydrocarbons and c~~ Chlorinated solvents associated with ~~both Restover Truck Stop and~~ American Fiberglass located south ~~to southwest~~ of the..."

p. 4-11, Sec 4.1.4, 3rd bullet, 4th line: Modify as follows: "There ~~has~~ have been..."

p. 4-13, Sec. 4.2.2, 6th line: Modify as follows: "Sites include ~~Texaco Bulk Fuel Facility,~~ Fisheries maintenance...Fuel Stop. The Texaco Bulk Fuel Facility is included for consideration under this WHPP due to its proximity to currently recommended WHPAs, and because it may be located in future WHPAs as discharge from production wells increase. The Port of Olympia (Port)..."

p. 4-14 2nd bullet: Modify as follows: "...existing facilities to cleanup and monitor..."

p.4-14, after 2nd bullet, insert additional bullet: "A traffic plan should be prepared for the transport of hazardous materials related to the Texaco Bulk Fuel Facility, and other Port-related operations."

p. 4-16, Location and Design, point 5: Modify last line as follows: "of a ~~physically~~ susceptible ~~and~~ recharge area."

Table 4-1

---

p.8-3: Insert:

"Recommendation 2-6: Update WHPA Delineations

Benefit	Medium: Capture zones and resulting WHPAs will change in response to future increased groundwater extraction. New data, such as aquifer parameters from aquifer tests or water level data, may also cause a change in the WHPA delineations.
Feasibility	High: Professional technical consulting services are available to conduct this work.
Cost	Medium: Approximately $5,000 on an annualized basis is recommended. Updates would be conducted every two to three years. Modification of WHPAs may not be warranted with each update.
Recommended Action	Include in WHPP"

p. 8-7: Insert (<u>get this one reviewed by Marc</u>):
"Recommendation 4-5: Prepare Port Area Traffic Plan

Benefit	High: It is suspected that a high volume of hazardous material is transported through the Port area. Restricting the transport of hazardous materials in and out of the Port area, and particularly the Texaco Bulk Fuel Facility, would minimize the potential for a spill occurring within the capture zone of the Port wells.
Feasibility	High: A master traffic plan could be prepared by the City, and be modified by transporters of hazardous materials. Alternatively, complete traffic plans could be required of transporters of hazardous materials.
Cost	Low: Current City staff or transporters of hazardous materials could prepare plans.
Recommended Action	Include in WHPP"

INCIDENT COMMAND SYSTEM

NATIONAL TRAINING CURRICULUM

ICS ORIENTATION

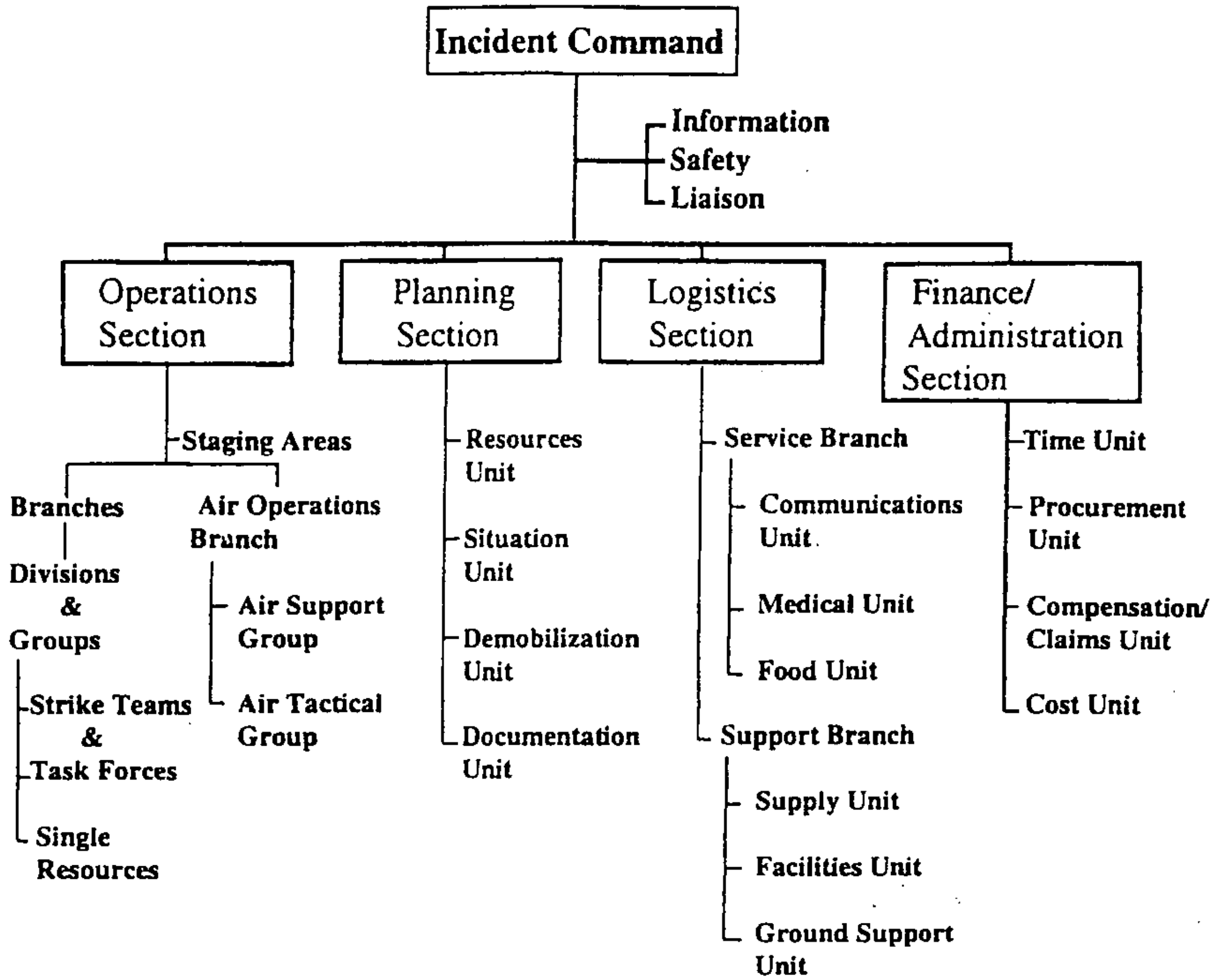
MODULE 1
I-100

NATIONAL WILDFIRE COORDINATING GROUP

ADMINISTRATOR REFERENCE TEXT
OCTOBER 1994

NFES 2438

INCIDENT COMMAND SYSTEM ORGANIZATION



Incident Command System Organization (Figure 1-1)

ICS ORIENTATION

I. Introduction

The Incident Command System is used to manage an emergency incident or a non-emergency event. It can be used equally well for both small and large situations.

The system has considerable internal flexibility. It can grow or shrink to meet differing needs. This makes it a very cost-effective and efficient management system. The system can be applied to a wide variety of emergency and non-emergency situations. Listed below are some examples of the kinds of incidents and events that can use the ICS:

APPLICATIONS FOR THE USE OF
<u>THE INCIDENT COMMAND SYSTEM</u>

- Fires, HAZMAT, and multicasualty incidents
- Multijurisdiction and multi-agency disasters
- Wide-area search and rescue missions
- Pest eradication programs
- Oil spill response and recovery incidents
- Single and multi-agency law enforcement incidents
- Air, rail, water, or ground transportation accidents
- Planned events; e.g., celebrations, parades, concerts
- Private sector emergency management programs
- State or local major natural hazards management

Application for the Use of the Incident Command System (Figure 1-2)

ICS has a number of features which will be covered in this module. Major areas to be covered include:

- ICS Organization
- Incident Facilities
- The Incident Action Plan
- Span of Control
- Common Responsibilities
- Applications

II. ICS Organization

Every incident or event has certain major management activities or actions that must be performed. Even if the event is very small, and only one or two people are involved, these activities will still always apply to some degree.

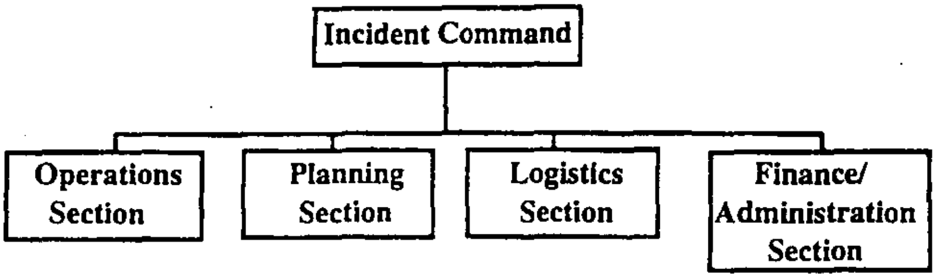
The organization of the Incident Command System is built around five major management activities. These are depicted in Figure 1-3.

<u>COMMAND</u> SETS OBJECTIVES AND PRIORITIES, HAS OVERALL RESPONSIBILITY AT THE INCIDENT OR EVENT
<u>OPERATIONS</u> CONDUCTS TACTICAL OPERATIONS TO CARRY OUT THE PLAN DEVELOPS THE TACTICAL OBJECTIVES, ORGANIZATION, AND DIRECTS ALL RESOURCES
<u>PLANNING</u> DEVELOPS THE ACTION PLAN TO ACCOMPLISH THE OBJECTIVES, COLLECTS AND EVALUATES INFORMATION, MAINTAINS RESOURCE STATUS
<u>LOGISTICS</u> PROVIDES SUPPORT TO MEET INCIDENT NEEDS, PROVIDES RESOURCES AND ALL OTHER SERVICES NEEDED TO SUPPORT THE INCIDENT
<u>FINANCE/ADMINISTRATION</u> MONITORS COSTS RELATED TO INCIDENT, PROVIDES ACCOUNTING, PROCUREMENT, TIME RECORDING, AND COST ANALYSES

Incident Command System Major Activities (Figure 1-3)

These five major management activities are the foundation upon which the ICS organization develops. They apply whether you are handling a routine emergency, organizing for a major event, or managing a major response to a disaster.

On small incidents, these major activities may all be managed by one person, the Incident Commander (IC). Large incidents usually require that they be set up as separate Sections within the organization as shown in Figure 1-4 below.



ICS Sections (Figure 1-4)

Each of the primary ICS Sections may be sub-divided as needed. The ICS organization has the capability to expand or contract to meet the needs of the incident.

A basic ICS operating guideline is that the person at the top of the organization is responsible until the authority is delegated to another person. Thus, on smaller situations where additional persons are not required, the Incident Commander will directly manage all aspects of the incident organization.

Now we will look at each of the major functional entities of the ICS organization starting with the Incident Commander and the Command Staff.

A. Incident Commander and the Command Staff

Incident Commander

The Incident Commander is the person in charge at the incident, and must be fully qualified to manage the incident. As incidents grow in size or become more complex, a more highly qualified Incident Commander may be assigned by the responsible jurisdiction or agency. The Incident Commander may have one or more deputies from the same agency or from other agencies or jurisdictions. Deputies must always be as qualified as the person for whom they work.

The Incident Commander may assign personnel for both a Command Staff and a General Staff. The Command Staff provides Information, Safety, and Liaison services for the entire organization. The General

Staff are assigned major functional authority for Operations, Planning, Logistics, and Finance/Administration.

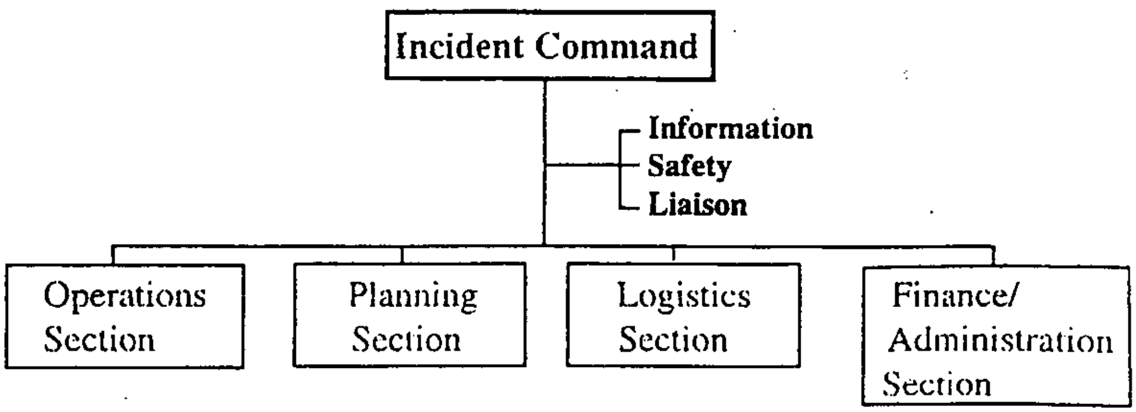
Initially, assigning tactical resources and overseeing operations will be under the direct supervision of the Incident Commander. As incidents grow, the Incident Commander may delegate authority for performance of certain activities to others as required.

Taking over command at an incident always requires that there be a full briefing for the incoming Incident Commander, and notification that a change in command is taking place.

Command Staff

In addition to the primary incident response activities of Operations, Planning, Logistics, and Finance/Administration, the Incident Commander has responsibility for several other important services. Depending on the size and type of an incident or event, it may be necessary to designate personnel to handle these additional activities.

Persons filling these positions are designated as the Command Staff and are called Officers. The Command Staff is shown in Figure 1-5. There is only one Command Staff position for each of these functions. The Command Staff does not have deputies. However, each of these positions may have one or more assistants if necessary. On large incidents or events, it is not uncommon to see several assistants working under Command Staff Officers.



ICS Command Staff (Figure 1-5)

- **Information Officer** - The Information Officer will be the point of contact for the media, or other organizations seeking information directly from the incident or event. Although several agencies may assign personnel to an incident or event as Information Officers, there will only be one Incident Information Officer. Others will serve as assistants.

- **Safety Officer** - This individual monitors safety conditions and develops measures for assuring the safety of all assigned personnel.

- **Liaison Officer** - On larger incidents or events, representatives from other agencies (usually called Agency Representatives) may be assigned to the incident to coordinate their agency's involvement. The Liaison Officer will be their primary contact.

B. The General Staff

The people who perform the four major activities of Operations, Logistics, Planning, and Finance/Administration are designated as the General Staff.

THE INCIDENT COMMAND SYSTEM GENERAL STAFF

- Operations Section Chief
- Planning Section Chief
- Logistics Section Chief
- Finance/Administration Section Chief

ICS General Staff (Figure 1-6)

Each of the General Staff may have a deputy, or more than one if necessary. The role of the deputy position is flexible. The deputy can work with the primary position, work in a relief capacity, or be assigned specific tasks. Deputies should always be as qualified as the person for whom they work.

In large events, especially where multiple agencies or jurisdictions are involved, the use of deputies from other agencies can greatly increase interagency coordination.

At the Section level, the person in charge will be designated as a Chief. For example, in the Logistics Section, the person in charge will always be called the Logistics Section Chief.

Within the ICS organization, there are a number of organizational elements which can be activated as necessary. Each of the major Sections has the ability to expand internally to meet the needs of the situation.

Let's start with the Operations Section of the ICS organization.

1. Operations Section

   The Incident Commander will determine the need for a separate Operations Section at an incident or event. Until Operations is established as a separate Section, the IC will have direct control of tactical resources.

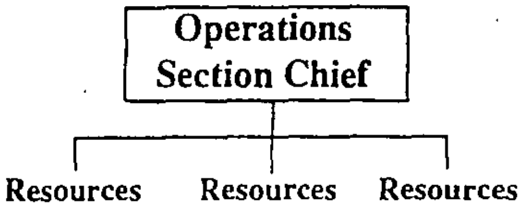
   When activating an Operations Section, the IC will assign an individual as the Operations Section Chief. The Operations Section Chief will develop and manage the Operations Section to accomplish the incident objectives.

   There is only one Operations Section Chief for each operational period. That person is normally (but not always) from the jurisdiction or agency which has the greatest involvement either in terms of resources assigned or area of concern. The Operations Section Chief may have deputies from the same agency, or from other agencies or jurisdictions. Using deputies from other agencies often helps in the coordination of actions.

   Within the Operations Section, two additional levels of organization can be used as necessary. These are Divisions and/or Groups, and Branches.

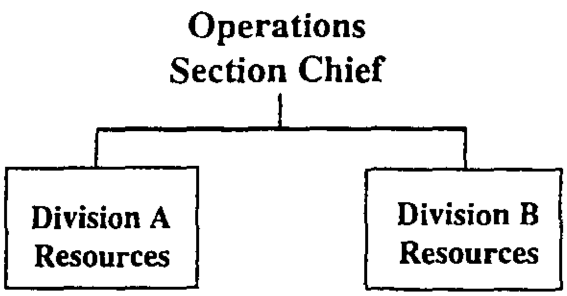
Divisions

The Operations organization usually develops from the bottom up. This is due to the need to expand supervision as more and more resources are applied. For example, the Incident Commander or the Operations Section Chief on an incident may initially work with only a few single resources. This is shown in Figure 1-7.



Single Resources in Operations (Figure 1-7)

As more resources are added to the incident, another layer of organization may be needed within the Operations Section to maintain proper span of control (see page 1-20). Normally, this will be done at the Division or Group level as shown in Figure 1-8.



Example of Two Divisions Within Operations Section (Figure 1-8)

The goal is to keep the organization as simple and as streamlined as possible, and not to overextend the span of control.

A Division is established to divide an incident geographically. How that will be done will be determined by the needs of the incident. Divisions covering an area on the ground are usually labeled by letters of the alphabet. Within a building, divisions are often designated by floor numbers. The important thing to remember about ICS divisions is that they describe some geographical area related to incident operations.

Groups

Groups are established to describe functional areas of operation. The kind of group to be established will be determined by the needs of an incident. For example, in an earthquake incident with widespread structural damage, search and rescue activity would be organized geographically, using divisions.

A specialized resource team, using dogs or electronic equipment in an earthquake, or a salvage group in a maritime incident may be designated as functional groups. Groups will work wherever they are needed, and will not be assigned to any single division.

Divisions and Groups can be used together on an incident. Divisions and Groups are at an equal level in the organization. One does not supervise the other. When a functional group is working within a division on a special assignment, division and group supervisors must closely coordinate their activities. Division and group supervisors always report to the Incident Commander unless the Operations Section Chief and/or Branch Director positions have been established. Deputies are not used at the Division and Group level.

Branches

On some incidents, it may be necessary to establish another level of organization within the Operations Section called Branches.

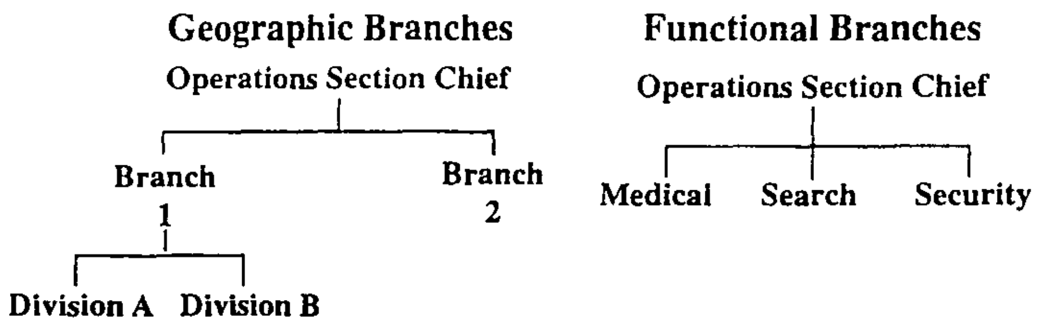
There are generally three reasons to use Branches on an incident or an event.

- Span of Control (see page 1-20) - If the number of Divisions and Groups exceeds the recommended Span of Control, another level of management is necessary. Span of Control will be discussed in more detail later in this module.

- Need for a Functional Branch Structure - Some kinds of incidents have multiple disciplines involved, e.g., police, fire, search and rescue, and medical, that may create the need to set up incident operations around a functional branch structure.

- Multijurisdictional Incidents - In some incidents it may be better to organize the incident around jurisdictional lines. In these situations, Branches may be set up to reflect differences in the agencies involved. For example, in flooding, earthquake, or wildfire incidents, federal, county, and city property all could be simultaneously affected. One way of organizing operations in these kinds of incidents is to designate a separate Branch for each of the agencies involved.

Various kinds of Branch alignments are shown in Figure 1-9 below.



Options for Establishing Branches Within ICS (Figure 1-9)

Each branch that is activated will have a Branch Director. Deputies may be used at the Branch level.

There are two other parts of the Operations Section that you may need to understand.

Air Operations

If established separately at an incident, Air Operations will be activated at the Branch level within the Operations Section. Usually this is done on incidents which may have complex needs for the use of aircraft in both tactical and logistical operations.

Staging Areas

Staging Areas may be established wherever necessary to temporarily locate resources awaiting assignment. Staging Areas and the resources within them will always be under the control of the Operations Section Chief. Staging Areas will be discussed later under incident facilities.

Summary

There is no one "best" way to organize an incident. The organization should develop to meet the functions required. The characteristics of the incident and the management needs of the Incident Commander will determine what organization elements should be established. The incident organization may change over time to reflect the various phases of the incident.

2. Planning Section

Planning Section

- **Resources Unit**
- **Situation Unit**
- **Documentation Unit**
- **Demobilization Unit**
- **Technical Specialist**

Planning Section (Figure 1-10)

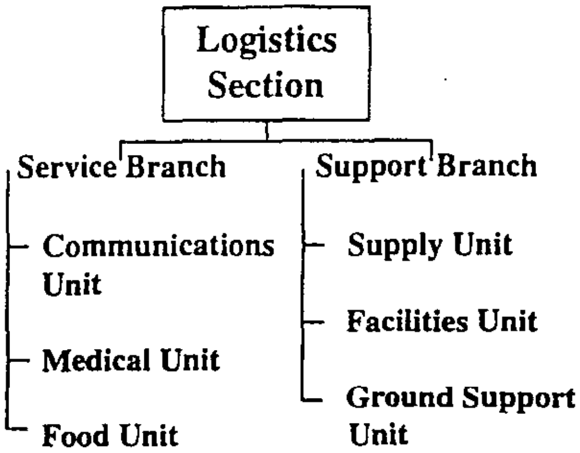
Briefly stated, the major activities of the Planning Section are to:

- Collect, evaluate, and display information about the incident.
- Develop Incident Action Plans for each operational period, conduct long-range planning, and develop plans for demobilization at the end of the incident.
- Maintain resource status information on all equipment and personnel assigned to the incident.
- Maintain incident documentation.

The Planning Section is also the initial place of check-in for any Technical Specialists assigned to the incident. Depending on their assignment, Technical Specialists may work within the Planning Section, or be reassigned to other incident areas.

Several Planning Section Units may be established. Duties of each Unit are covered in other modules. Not all of the Units may be required, and they will be activated based upon need. Planning Section Units are shown in Figure 1-10.

3. Logistics Section



Branches and Units in the Logistics Section (Figure 1-11)

The Logistics Section is responsible for all of the services and support needs of an incident, including obtaining and maintaining essential personnel, facilities, equipment, and supplies.

The Incident Commander will determine the need to establish a Logistics Section on the incident. This is usually determined by the size of the incident, complexity of support, and how long the incident may last. Once the IC determines that there is a need to establish a separate Logistics function, an individual will be assigned as the Logistics Section Chief.

Six functional units can be established within the Logistics Section. If necessary, a two-branch structure can be used to facilitate span of control. The titles of the units are self descriptive. Detailed duties of each unit are covered in other modules. Not all of the units may be required, and they will be established based upon need. Branches and Units in the Logistics Section are shown in Figure 1-11.

4. Finance/Administration Section

Finance/Administration Section

- **Time Unit**
- **Procurement Unit**
- **Compensation/Claims Unit**
- **Cost Unit**

Finance/Administration Section Units (Figure 1-12)

The IC will determine if there is a need for a Finance/ Administration Section, and designate an individual to perform that role. If no Finance Section is established, the IC will perform all finance functions.

The Finance/Administration Section is set up for any incident that may require on-site financial management. More and more, larger incidents are using a Finance/Administration Section to monitor costs.

Smaller incidents may also require certain Finance/Administration functions. For example, the Incident Commander may establish one or more units of the Finance/Administration Section for such things as procuring special equipment, contracting with a vendor, or for making cost estimates of alternative strategies.

The Finance Section may establish four units as necessary. Duties of each unit are covered in other modules. Not all of the units may be required, and they will be established based upon need.

Finance/Administration Section Units are shown in Figure 1-12.

C. Organization Terminology

At each level in the ICS organization, individuals with primary responsibility positions have distinctive titles, as shown in Figure 1-13.

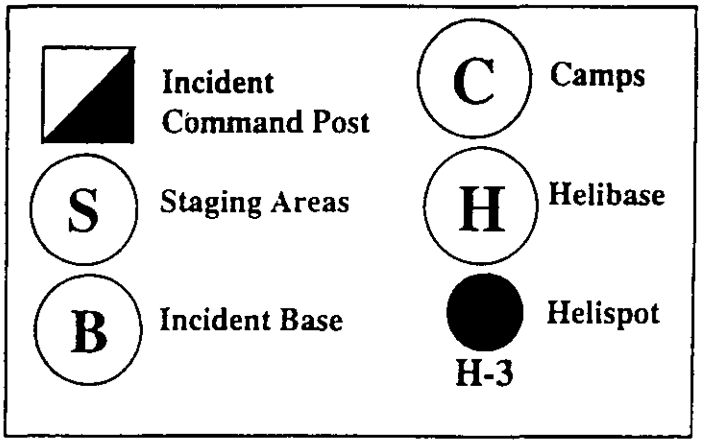
Primary Position	Title	Support Position
Incident Commander	Incident Commander	Deputy
Command Staff	Officer	Assistant
Section	Chief	Deputy
Branch	Director	Deputy
Division/Group	Supervisor	N/A
Strike Team/Task Force	Leader	N/A
Unit	Leader	Assistant ~~Manager~~
Single Resource	Use Unit Designation	N/A

ICS Organizational Terminology (Figure 1-13)

D. Incident Facilities

Facilities will be established depending on the kind and complexity of the incident or event. It is important to know and understand the names and functions of the principal ICS facilities. Not all of those listed below will necessarily be used.

Incident Facilities



ICS Facilities (Figure 1-14)

Each of the facilities is briefly described below:

- **Incident Command Post (ICP)** - The location from which the Incident Commander oversees all incident operations. There is only one ICP for each incident or event. Every incident or event must have some form of an Incident Command Post.

- **Staging Areas** - Locations at which resources are kept while awaiting incident assignment. Most large incidents will have a Staging Area, and some incidents may have several. Staging Areas will be managed by a Staging Area Manager who reports to the Operations Section Chief or to the Incident Commander if an Operations Section has not been established.

- **Base** - The location at the incident at which primary service and support activities are performed. Not all incidents will have a Base. There will only be one Base for each incident.

- **Camps** - Incident locations where resources may be kept to support incident operations. Camps differ from Staging Areas in that essential support operations are done at Camps, and resources at Camps are not always immediately available for use. Not all incidents will have camps.

- **Helibase** - A location in and around an incident area at which helicopters may be parked, maintained, fueled, and equipped for incident operations. Very large incidents may require more than one Helibase.

- **Helispots** - Helispots are temporary locations where helicopters can land and load and off-load personnel, equipment, and supplies. Large incidents may have several Helispots.

E. Incident Action Plan

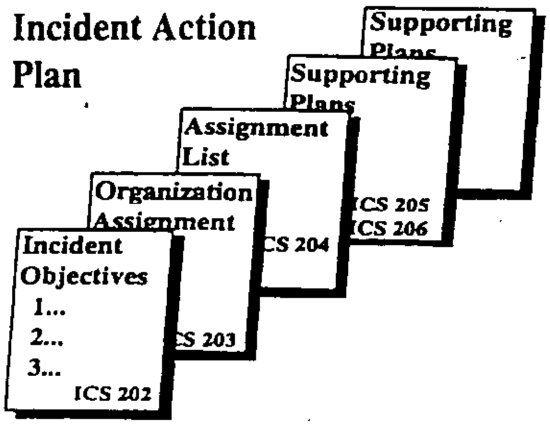
Every incident must have an oral or written action plan. The purpose of the plan is to provide all incident supervisory personnel with direction for future actions. Action plans which include the measurable tactical operations to be achieved, are always prepared around a time-frame called an Operational Period.

Operational Periods can be of various lengths, but should be no longer than twenty-four hours. Twelve-hour Operational Periods are common on many large incidents. It is not unusual, however, to have much shorter Operational Periods covering, for example, two- or four-hour time periods. The length of an Operational Period will be based on the needs of the incident, and these can change over the course of the incident.

The planning for an Operational Period must be done far enough in advance to ensure that requested resources are available when the Operational Period begins.

Large incidents, which involve a partial or full activation of the ICS organization, should have a written Incident Action Plan. Incidents extending through an Operational Period should also have a written Incident Action Plan to ensure continuity due to personnel changes. The decision to have a written action plan will be made by the Incident Commander.

Several forms have been developed to help in preparing the Incident Action Plan. These are shown in Figure 1-15. They will be discussed in other modules.



Forms Commonly Used in Incident Action Plan (Figure 1-15)

Essential elements in any written or oral Incident Action Plan are:

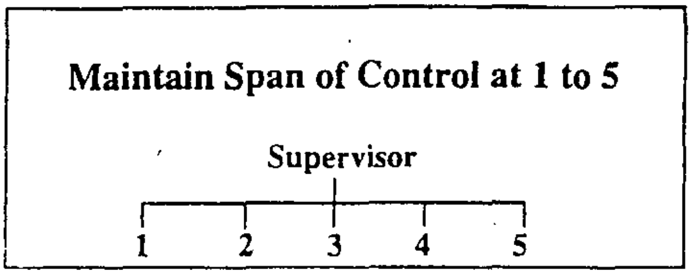
- Statement of Objectives - Appropriate to the overall incident.
- Organization - Describes what parts of the ICS organization will be in place for each Operational Period.
- Assignments to Accomplish the Objectives - These are normally prepared for each Division or Group and include the strategy, tactics, and resources to be used.
- Supporting Material - Examples can include a map of the incident, communications plan, medical plan, traffic plan, etc.

The Incident Action Plan must be made known to <u>all</u> incident supervisory personnel. This can be done through briefings, by distributing a written plan prior to the start of the Operational Period, or by both methods.

F. Span of Control

Span of Control means how many organizational elements may be directly managed by another person. Maintaining adequate Span of Control throughout the ICS organization is very important. Effective

Span of Control may vary from three to seven, and a ratio of one to five reporting elements is recommended. If the number of reporting elements falls outside of those ranges, expansion or consolidation of the organization may be necessary. There will be exceptions, for example in some applications specially trained hand crews may utilize a larger Span of Control.



Recommended ICS Span of Control Guideline (Figure 1-16)

G. Common Responsibilities

There are certain common responsibilities or instructions associated with an incident assignment that everyone assigned to an incident should follow. Following these simple guidelines will make your job easier and result in a more effective operation.

1. Receive your incident assignment from your organization. This should include, at a minimum, a reporting location and time, likely length of assignment, brief description of assignment, route information, and a designated communications link if necessary. Different agencies may have additional requirements.

2. Bring any specialized supplies or equipment required for your job. Be sure you have adequate personal supplies to last you for the expected stay.

3. Upon arrival, follow the Check-in procedure for the incident. Check-in locations may be found at:

    - Incident Command Post (at the Resources Unit)
    - Staging Areas
    - Base or Camps
    - Helibases
    - Division or Group Supervisors (for direct assignments)

4. Radio communications on an incident should use clear text, that is, no radio codes. Refer to incident facilities by the incident name, for example, Rossmoor Command Post, or 42nd Street Staging Area. Refer to personnel by ICS title, for example, Division C not numeric code or name.

5. Obtain a briefing from your immediate supervisor. Be sure you understand your assignment.

6. Acquire necessary work materials, locate, and set up your work station.

7. Organize and brief any subordinates assigned to you.

8. Brief your relief at the end of each Operational Period and, as necessary, at the time you are demobilized from the incident.

9. Complete required forms and reports and give them to your supervisor or to the Documentation Unit before you leave.

10. Demobilize according to plan.

III. Conclusion

The information you have learned through this short self-study module will provide you with enough general background to understand the principles and primary organizational elements of the ICS.

You are encouraged to expand your understanding of ICS by taking other modules or courses.

Please complete the self-study examination starting on the next page.

The specific roles and responsibilities of each Command Staff position are described below.

2.2.3.1.12.1 Incident Commander (IC)

- Assess the incident priorities.
- Determine in cooperation with other incident commanders the strategic goals and tactical objectives.
- Develop or approve the incident action plan and implement those portions for which their agency is responsible.
- Develop IC structure within his/her agency appropriate for the incident.
- Assess response needs in cooperation with other ICs; order, deploy, and release needed resources and identify appropriate assignment of personnel within the ICS structure.
- Serve as the ultimate incident safety officer; responsible for preventing injuries and/or death of response personnel.
- Authorize information releases to the media in cooperation with other ICs.

2.2.3.1.12.2 Safety Officer (SO)

- Ensure a site safety plan is prepared and released in coordination with unified command counterparts.
- Assess safety hazards and unsafe situations on an ongoing basis.
- Ensure that response personnel are briefed daily or more often as required regarding safety work practices.
- Ensure all agency personnel have the training required to participate in spill response under the OSHA regulations.
- Provide or ensure training as necessary to meet OSHA regulations related to worker safety.
- Work with unified command counterparts to ensure consistency of site safety standards.
- Establish with unified command counterparts, decontamination procedures and contamination reduction zones for all on-scene personnel and equipment.
- Work with local public health officials regarding general health concerns related to oil contamination (i.e., beach closures, marina closures,
- Assess environmental conditions to determine the level of personal protective gear required for response operations.

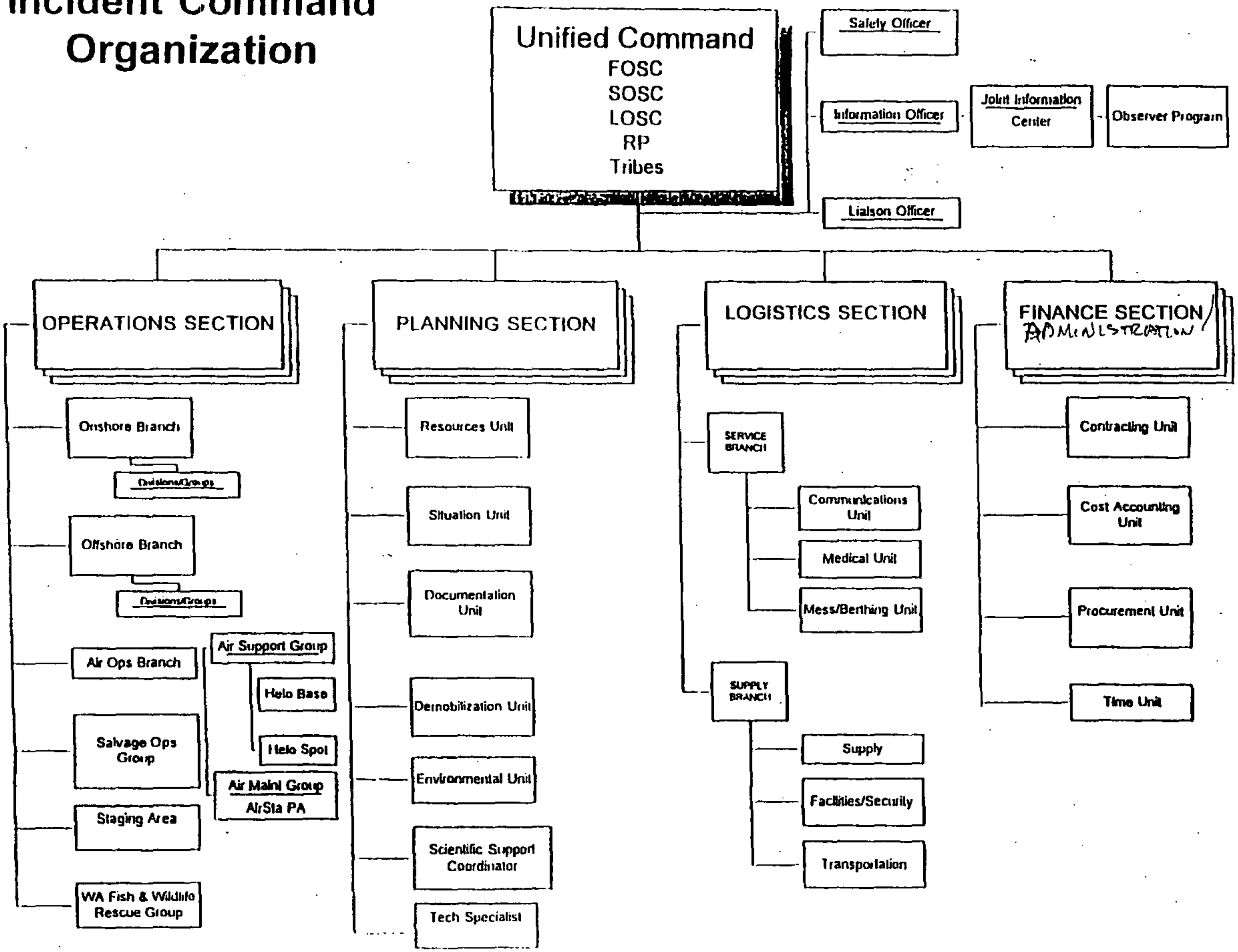
2.2.3.1.12.3 Liaison Officer (LO)

- Serve as the initial point of contact for participating federal, state and local agencies with a *vested* interest in the response.
- Maintain a spill response summary distribution list for all public and private entities requesting spill response status reports.
- Receive and coordinate all calls from public and private entities offering assistance or requesting information.
- Identify public and private concerns related to the status and effectiveness of the spill response to the IC.

2.2.3.1.12.4 Public Information Officer (PIO)

The role of the Public Information Officer will depend on the size and scope of the incident. In a small incident , the PIO will perform all of the necessary public information and outreach tasks. In a large incident, the command staff PIO will act as a liaison for a Joint Information Center (JIC), which will conduct public

Incident Command Organization



information and community outreach tasks with a team of public information specialists. Chapter 12 of this plan covers Public Affairs issues in greater detail.

Principle duties of the public information officer include:

- Establish in cooperation with counterparts in the unified command a press area and Joint Information Center.
- Serve as the central clearing point for the dissemination of public information from the agency they represent to both the unified command and the media.
- Coordinate the approval of the unified command prior to releasing information to the media.
- Organize and serve as a central clearing house for all media tours as approved by the unified command.
- Organize and conduct unified command media briefings.
- Resolve conflicting information and identify media concerns to the unified command.

2.2.3.1.13 General Staff Positions
The General Staff is organized into four functional sections each with a designated Chief. The General Staff functions consist of the following:

- Planning
- Operations
- Logistics
- Finance

Within the four General Staff sections designated specific functions can be increased or decreased to meet the needs of the response. Within each section further division can occur into units. The determination as to whether it is appropriate to develop unit groups is predicated on the complexity of the area that the unit will be addressing and the span of control. As an example, wide spread shoreline impacts of oil will typically require the formation of a unit due to the number of cleanup crews required and the different cleanup protocols required for the different shoreline types.

Federal, state, and responsible party representatives will all work together at the section level to achieve common goals and also represent their specific perspective. However, each section only has one chief that reports to the IC. For instance, in Finance, you might have the RP representative organizing the company's financial resources, the state representative ensuring proper state accounting procedures are implemented, and the USCG representative providing guidance on what is acceptable under the OPA Fund process. The section chief could be any one of the three.

During large or complex events it is important to remember the guidelines for effective span of control addressed in the ICS introduction (three to seven with five being optimal). The roles and responsibilities of the General Staff section Chiefs are as follows:

2.2.3.1.14 Planning
Definition: Planning is responsible for the collection, evaluation, dissemination, and use of information about the development of the incident and the status of resources.

When faced with a complex or rapidly escalating incident, the IC will require assistance from the ICS Planning section. A wide range of factors may impact on incident operations. Planning must include an assessment of the present and projected situation. Proactive incident management is highly dependent on an accurate assessment of the incident's potential and prediction of likely outcomes. In addition to assessment of the situation status, there is a critical need to maintain information about resources to the incident and projected resource requirements. Planning members from the Federal, state, and local government, and the responsible party, should convene as quickly as possible to facilitate the pooling of knowledge regarding the habitats at risk, key booming strategies and their priorities, and vessel safety, stability, and salvage, to name a few.

The Planning section must develop effective plans for both the near and long term time frames. Breaking the planned response into 12, 24, 36, and 60 hour time frames initially will assist the Unified Command in formulating the initial incident action plan. By working together early in the event, the combined knowledge of the current natural environment, spill status and response resources from all parties in the Unified Command will hasten an efficient response. By early integration in planning we hope to quickly reach an early consensus of the Unified Incident Commanders as to a plan of action.

It is critical that the Planning Section Chief anticipate the needs of the spill response for both the current status and what is anticipated days and weeks into the future. Feedback from the Operations Section on the effectiveness of the spill response is critical to effectively complete this task. (The Planning Section Chief is usually occupied by the state because of its jurisdiction and expertise in volunteer management, natural resource protection, and disposal. Close coordination is required with Federal natural resource agencies.)

2.2.3.1.14.1 Planning Section Chief Responsibilities

The Planning Section Chief is responsible for information management evaluation regarding incident status and resources. As a part of this overall responsibility the Planning Section Chief, performs the following functions:

- Collects information regarding the incident with respect to quantity and type of oil, loss rate, projected total loss before spill is secured, weather conditions, current and projected trajectory of oil over time.
- Current and projected response resources and schedule of delivery.
- Natural, cultural, and economic resources actually impacted and projected impacts based upon trajectory, and their sensitivity.
- Recommends oil spill response activity priorities.
- Potential oil spill countermeasures (skimming, booming, application of dispersants, etc.) to be recommended to the unified commanders.
- Develops an effective incident action plan based upon projected needs.
- Modifies the incident action plan to meet changing needs.
- Anticipates changing resource needs.
- Prepares alternative strategies and tactical operations based on incident potential and effectiveness of current

operations (following consultation with operations chief).

- Develop units within the section to meet the needs of the spill.
- Identifies to the IC specific areas where assistance is required from the staff of the other represented Unified Commanders.

Because of the complexity and number of issues that the Planning Section is responsible for, the Planning Section Chief usually is required to form units to maintain the proper span of control and avoid being overwhelmed. The recommended subdivisions are illustrated as units.

2.2.3.1.14.2 Situation Unit

The Situation Status Unit is responsible for analysis of the situation as it progresses, through the recording and evaluation of information about the current status of the incident. Information addressed by this unit should include:

- Quantity and type of oil lost.
- Loss rate, if continuing.
- Projected total loss of oil before spill is secured.
- Weather and sea conditions.
- Current oil location and projected trajectory over time.

2.2.3.1.14.3 Resource Unit

The Resource Unit is responsible for recording the status of resources and volunteers committed to the incident. Major responsibilities of this Unit are recording and evaluation of:

- Current and projected response resources and schedule of delivery. This includes personnel, equipment, materials, and supplies required to meet the response strategies.
- Impact that additional responding resources will have in meeting the spill response objectives and/or implementation of strategies.
- Evaluate response resource ability to meet response priorities established by the Unified command.
- Works closely with Operations to address needs and ongoing effectiveness of resources as well as with logistics to assure resource availability.
- All applicable federal and state volunteer plans must be complied with.

2.2.3.1.14.4 Environmental Unit

The Environmental Unit is responsible for predicting potential impacts on natural resources from the spill and reviewing pre-identified protection measures from Geographic Response Plans to be implemented by the Operations Section. The Environmental Unit should be chaired by the natural resource agency representative affected by the spill. The Environmental Unit is responsible for identifying potential impacts to natural resources and recommending response strategies for the protection of those natural resources during a spill response. It is important that agreement and coordination between trustee agencies and the responsible party regarding NRDA be accomplished early in the response. Response activities that could reduce or mitigate resource damages need to be identified quickly to the Planning Section Chief. NRDA protocols need to be reviewed and agreed to as soon as possible in a spill response to minimize duplication of effort and ensure consistency of approach. Responsibilities include:

- Identifying sensitive natural resources and recommending a strategy for protecting these resources, including priorities for protection.

- Identifying potential type and number of wildlife and fishery resources that will require recovery and rehabilitation based upon.
  a. Species
  b. Sensitivity to oil
  c. Mobility
- Capture and care protocols based upon.
  a. Species
  b. Location
  c. Available care facilities
  d. Trustee relationships
- Identification of logistic support needs based upon 2 and 3 above.
- Recommending to the IC clean up techniques and the possibility of using dispersants, other chemical countermeasures, or in situ burning as a preventative measure. The state's Dispersant and In Situ Burning policies and procedures will be utilized.

2.2.3.1.14.5 Disposal and Decontamination Unit

The Disposal and Decontamination Unit is responsible for:

- Creating a waste disposal plan
- Ensuring that wastes are properly characterized for appropriate disposal
- Ensuring that decontamination of personnel and response equipment is conducted with consistency and in compliance with statutes.

2.2.3.1.14.6 Documentation Unit

The main responsibilities of the Documentation Unit are to record and protect all documents relevant to the incident. Examples of incident documentation include: incident reports, communication logs, injury claims, and situation status reports. Thorough documentation is critical to post-incident analysis. Some of these documents may originate in other sections. This unit shall ensure each section maintains and provides appropriate documents. This unit is also responsible for gathering and maintaining all relevant and necessary documentation associated with the oil spill. The Legal Section may need to be consulted.

2.2.3.1.14.7 Demobilization Unit

The Demobilization Unit is responsible for the development of a plan for the demobilization of the resources committed to an incident and assisting in the implementation of that plan. In incidents requiring a major resource commitment, an effective, safe, and cost-effective demobilization and return of resources to service is dependent on adequate planning.

2.2.3.1.14.8 Scientific Support Coordinator

The SSC will be part of the Planning Section in order to communicate and coordinate directly with the environmental unit to avoid duplicative scientific advising. The SSC will also have direct access to OSCs if the situation demands.

2.2.3.1.15 Operations

Definition: Operations is responsible for management of all tactical operations at the incident.

Operations is the tactical implementing force for the objectives and strategies developed in planning and agreed to by the Unified Commanders. The Operations Section expands to meet the needs of the incident action plan. It is critical that the planning and operations sections have early consultation to ensure the tactical operations envisioned in planning can be implemented based upon existing response resource capabilities and conditions. The Operations Sections Chief must ensure that tactical objectives are organized into compatible branches within the Operations Section and that each branch incorporate the appropriate members from the Unified Command agencies and/or their contractors.

2.2.3.1.15.1 Operations Section Chief Responsibilities

The Operations Section Chief is responsible for the direction and coordination of all tactical operations. As a part of this overall responsibility, Operations implements, policies, objectives, and plans that the Command and Planning Sections have devised. Operations also:

- Assists the IC in developing strategic goals and tactical objectives for the incident.
- Develops operational plans.
- Requests or releases resources through the IC.
- Consults with the IC about the overall incident action plan.
- Keeps the IC informed of situation and resource status within Operations.
- Supervises the unit operations.
- Provides reports on spill response counter-measures efficiency.

2.2.3.1.15.2 Staging Unit

The Staging Unit is responsible for identifying locations from which operations will be conducted that are appropriate to the task. Examples include but are not limited to:

- Shoreline cleanup staging area(s).
- Vessel support base(s).
- Staging of equipment and supplies at key locations.
- Helicopter landing/departure areas.

2.2.3.1.15.3 Offshore Operations (On-Water Recovery) Unit

The Offshore Operations Unit is responsible for maintaining on water oil recover activities and deployment of containment, diversion, and absorbing boom in locations identified. Depending upon the size and location of the oil spill, the Offshore Operations Unit may further focus on specific operational areas such as:

- Close to shore
- Open water
- Inland
- Skimmer support booming
- Diversionary booming
- Containment booming
- Estuary/Marsh booming

The Offshore Operation Unit is responsible for the following;

- Coordinates delivery and deployment of skimmers.
- Provides a field status of skimming operations to the Operations Section Chief.
- Maintains estimates of recovered oil.
- Identifies field conditions related to the effectiveness of the skimming operation.

- Identifies logistic support needs for the skimming operation.
- Ground proofs booming strategies based upon field conditions.
- Complies with booming priorities and provides realistic booming completion times.
- Reports on the effectiveness of booming to the Operations Section Chief.
- Identifies boom needs, including type, length, anchoring requirements, and vessel support needs.
- Proposes alternative strategies based on field results and conditions.

2.2.3.1.15.4 Beach Operations Unit

The Beach Operations Unit is responsible for managing shoreside cleanup operations in compliance with the priorities and protocols adopted by the Unified command. Depending upon the size and location of the spill, the Beach Operations Unit may further focus on specific areas based upon shoreline geomorphology and/or length of shoreline needing cleanup. Examples include:

- Marsh
- Sandy beach
- Break water
- Cobble beach
- Rocky shoreline

The Beach Operations Unit is responsible for the following:

- Manages the personnel and equipment necessary to accomplish the cleanup priorities and protocols adopted by the Unified command.
- Identifies logistic support needs.
- Reports on the efficiency of the cleanup methods.
- Projects cleanup completion date.
- Requests trustee agency sign off on shoreline beach cleanup activities.

2.2.3.1.15.5 Salvage Unit

The salvage unit is responsible of coordinating the safe salvage of the involved vessel(s). Salvage operations are generally broken into three phases for stranded vessels:

1. Stabilization
2. Refloating
3. Post-refloating

Salvage may also include recovery of sunken vessels and towing rescues of vessels in distress. Chapter 3 of this plan contains detailed information on salvage operations.

2.2.3.1.15.6 Air Operations Unit

The Air Operations Unit is responsible for coordinating and providing air support services to response personnel. The principle needs for air support services which in a large spill, may warrant designation as separate units includes:

- Oil spill trajectory mapping.
- Skimmer encounter surveillance.
- Natural resources damage assessment.
- Deployment and retrieval of personnel to otherwise inaccessible areas.

The Air Operations Unit is responsible for the following:

- Identifies air assets and needs of the response plan.
- Coordinates with FAA as necessary.
- Coordinates flight departures and arrivals.
- Maintains a status board of flight assets and status.

- Schedules flights in compliance with Unified Command priorities.
- Maintains flight safety.

2.2.3.1.15.7 Wildlife Operations Unit
The Wildlife Operations Branch will be managed by the state Department of Wildlife utilizing the Wildlife coalition and Wildlife Rescue and rehabilitation Management Plan, and coordinating with the US. Fish and Wildlife Service and affected tribal trustees. The Wildlife Operations Unit is responsible for the recovery and rehabilitation of wildlife impacted by the spill, and may include functions such as:

- Marine Mammals Recovery
- Marine Mammals Rehabilitation
- Bird Recovery
- Bird Rehabilitation

The Wildlife Operations Unit is responsible for the following:

- Directs wildlife recovery operations.
- Maintains a central clearing point for all recovered wildlife.
- Maintains an evidence, tagging and storage procedure for all wildlife recovered.
- Identifies all support needs to logistics.

2.2.3.1.15.8 Waste Handling and Disposal Unit
The Waste Handling and Disposal Unit is responsible for the storage, transportation, and disposal of recovered oil, oily debris, and other oil contaminated materials. Depending upon the size and location of the spill. This includes:

- Acquires the necessary permits to allow the storage of recovered oil and contaminated materials.
- Directs the storage of recovered oil and oil contaminated materials.
- Directs the transportation of the recovered oil and contaminated materials to an appropriate storage or disposal facility.
- Maintains an accurate accounting of the amount of all oil recovered.
- Identifies all support needs to logistics. (Note: It is essential that adequate storage containers for recovered oil are available quickly or the cleanup effort can be severely hampered.)

2.2.3.1.16 Logistics
Definition: Logistics is responsible for providing facilities, services, and materials for the incident.

As incidents grow in size, complexity, and duration, the logistical needs of the operating forces also increase. Even in a relatively simple oil spill, there are requirements for lodging, food, drinking water for fluid replacement, and provision of emergency medical care for response personnel. When faced with a major incident, such as a very large oil spill affecting several hundred miles of coastline, the logistical requirements are significant. Long duration incidents of any type require provisions for feeding personnel, toilet facilities, refueling of apparatus, and a myriad of other service and support resources.

The potential magnitude of the service and support requirements may indicate that the IC delegate the functional authority for Logistics to maintain an effective span of control and an acceptable workload.

2.2.3.1.16.1 Logistics Section Chief Responsibilities

The Logistics Section Chief manages service and support resources required for the incident. The Logistics Section Chief is responsible for all Logistics functions needed for an incident. This individual should establish functional Units when needed to maintain an acceptable workload and span of control. Subordinate Logistics functions may be combined, when workload permits.

The Logistics Section Chief should be assigned before implementation of subordinate Units to prevent an excessive span of control or information overload for the IC. Branches may be required within Logistics to maintain span of control when all six functional Units are established.

2.2.3.1.16.2 Communications Unit

The Communications Unit develops the incident communications plan, distributes communications equipment, supervises the communications network, and maintains/repairs communications equipment. This branch serves a vital support function in most incident command systems. It is necessary to prevent hampering the response efforts and overall coordination.

2.2.3.1.16.3 Medical Unit

The Medical Unit is responsible for providing emergency medical treatment of response personnel. This unit does not provide treatment for the public at large. If there is a requirement for provision of emergency medical services for the public, this would be an Operations function.

2.2.3.1.16.4 Messing and Berthing Unit

The Messing and Berthing Unit provides meals and lodging for personnel involved with an incident. This may be a significant logistical task at major incidents and is often required even at relatively minor incidents during severe environmental conditions or extended operations.

2.2.3.1.16.5 Supply Unit

The Supply Unit orders the equipment and supplies required for incident operations and maintains ongoing inventory and control of these resources. Equipment and supplies may include additional sea-curtain booms; zodiac-style boats; skimmers; or may be expendable supplies, such as Tyvek coveralls or adsorbent booms and pads, etc. Depending on the nature and complexity of the incident, this unit may have to be staffed by three organizations: federal, state and responsible party.

2.2.3.1.16.6 Facilities Unit

The Facilities Unit provides fixed facilities for an incident. Fixed facilities are most often required for incidents of long duration, and may include:

- Command Post (CP). The CP should be large enough to accommodate the incident commanders and their immediate support staff. The CP should have at least two rooms; one large room for support staff to work and place phone calls; and one room large enough for the incident commanders and other appropriate personnel to hold meetings and conferences without being disturbed or interrupted.
- Incident base. The Base serves several functions. It is the location where primary support activities are performed and serves as a reporting

and marshaling area for resources not considered available for immediate assignment. The Base is not commonly used at small or minor events. However, it may be used during large oil spills which effect a large geographical area.

- Other fixed facilities include: Feeding and sleeping areas and sanitary facilities.

2.2.3.1.16.7 Ground Support Unit

The Ground Support Unit is responsible for fueling, maintenance or repair of vehicles, and vessels, transportation of personnel and supplies, and preparation of an incident traffic plan if necessary to facilitate the flow of vehicles, vessels, and equipment within the incident area.

2.2.3.1.17 Finance

Definition: Finance is responsible for tracking all incident costs and evaluating the financial considerations of the incident.

Financial considerations are not always a major factor during most incident operations. However, when a department or private entity is involved in any incident that requires the use of private-sector resources or incidents where agencies involved in response will be seeking reimbursement, the financial considerations can be extensive.

Specific Responsibilities: The specific responsibilities of each section chief and the associated units are described on the following pages.

2.2.3.1.17.1 Finance Section Chief Responsibilities.

The Finance Section Chief must provide for the documentation of all incident costs, and provide guidance to the IC on financial issues that may have an impact on incident operations. These responsibilities include:

- Future payments.
- Future budgeting.
- Payment of personnel costs.
- Cost recovery.
- Timely administration of contracts.

2.2.3.1.17.2 Staffing of Finance Section

Finance is usually staffed in large-scale or complex incidents. Since most of the activities of Finance do not require face-to-face communication, these operations may be located remote from the incident site.

The Finance Section Chief is responsible for all finance functions needed for an incident. This individual should establish functional Units when needed to maintain an acceptable workload and span of control. Subordinate Finance functions may be combined when workload permits.

The Finance Section Chief should be assigned before implementation of subordinate units to prevent an excessive span of control or information overload for the ICs.

2.2.3.1.17.3 Time Unit

The primary function of the Time Unit is the time keeping required for personnel working at an incident. To do this effectively each agency, the responsible party, and all contractors will need to address this function. To the degree it is integrated into a similar format and procedure, the entire system will work more smoothly. To ensure this happens, each agency, responsible party, contractor, etc., should have some formalized method of checking in and out for all personnel.

2.2.3.1.17.4 Procurement Unit

When incident operations require procurement of goods or services from vendors, the Procurement Unit manages this function.

2.2.3.1.17.5 Compensation/Claims Unit

The function of the Compensation/Claims Unit involves record-keeping and financial claims related to damages created by the spill.

2.2.3.1.17.6 Cost Unit

The principal functions of the Cost Unit are tracking costs, analyzing cost data, making cost estimates, contracts, and recommending cost-saving measures.

Note: It is critical that all parties in the Unified Command adopt consistent cost documentation for later cost recovery from either the responsible party, Federal, and/or State funds.

2.2.3.1.18 Incident/Unified Command System Summary

To meet and fulfill Federal and state regulatory requirements, the organizational structure of industry contingency plans must demonstrate the ability to integrate into the UCS. The UCS is merely a system for response management. The effectiveness of UCS depends upon the leadership of the command and general support staff deployed.

GLOSSARY OF TERMS

This glossary contains definitions of terms frequently used in ICS documentation.

AGENCY REPRESENTATIVE - Individual assigned to an incident from an assisting or cooperating agency who has been delegated full authority to make decisions on all matters affecting their agency's participation at the incident. Agency Representatives report to the Liaison Officer.

AIR OPERATIONS BRANCH DIRECTOR - The person primarily responsible for preparing and implementing the air operations portion of the Incident Action Plan. Also responsible for providing logistical support to helicopters operating on the incident.

ALLOCATED RESOURCES - Resources dispatched to an incident.

ALTERNATIVE RESPONSE TECHNOLOGIES (ART) - Response methods or techniques other than mechanical containment or recovery. ART may include use of chemical dispersants, in-situ burning, bioremediation, or other alternatives. Application of ART must be authorized and directed by the OSC.

ASSIGNED RESOURCES - Resources checked-in and assigned work tasks on an incident.

ASSIGNMENTS - Tasks given to resources to perform within a given operational period, based upon tactical objectives in the Incident Action Plan.

ASSISTANT - Title for subordinates of the Command Staff positions. The title indicates a level of technical capability, qualifications, and responsibility subordinate to the primary positions. Assistants may also be used to supervise unit activities at camps.

ASSISTING AGENCY - An agency directly contributing tactical or service resources to another agency.

AVAILABLE RESOURCES - Incident-based resources which are immediately available for assignment.

BASE - That location at which the primary logistics functions are coordinated and administered. (Incident name or other designator will be added to the term "Base") The Incident Command Post may be collocated with the base. There is only one base per incident.

BRANCH - That organizational level having functional/geographic responsibility for major incident operations. The Branch level is organizationally between Section and Division/Group in the Operations Section, and between Section and Units in the Logistics Section.

CACHE - A pre-determined complement of tools, equipment and/or supplies stored in a designated location, and available for incident use.

CAMP - A geographical site, within the general incident area, separate from the base, equipped and staffed to provide sleeping areas, food, water, and sanitary services to incident personnel.

CHECK-IN - The process whereby resources first report to an incident. Check-in locations include: Incident Command Post (Resources Unit), Incident Base, Camps, Staging Areas, Helibases, Helispots, and Division Supervisors (for direct line assignments).

CHIEF - The ICS title for individuals responsible for command of functional sections: Operations, Planning, Logistics and Finance.

CLEAR TEXT - The use of plain English in radio communications transmissions. No Ten Codes, or agency specific codes are used when using Clear Text.

COMMAND - The act of directing, ordering and/or controlling resources by virtue of explicit legal, agency, or delegated authority. May also refer to the Incident Commander/Unified Command.

COMMAND POST - See Incident Command Post.

COMMAND STAFF - The Command Staff consists of the Information Officer, Safety Officer, and Liaison Officer, who report directly to the Incident Commander. They may have an assistant or assistants, as needed.

COMMUNICATION UNIT - A vehicle (trailer or mobile van) used to provide the major part of an incident Communication Center.

COOPERATING AGENCY - An agency supplying assistance other than direct tactical or support functions or resources to the incident control effort (e.g., Red Cross, telephone company, etc.).

COST UNIT - Functional unit within the Finance Section responsible for tracking costs, analyzing cost data, making cost estimates, and recommending cost-saving measures.

DEPUTY - A fully qualified individual who, in the absence of a superior, could be delegated the authority to manage a functional operation or perform a specific task. In some cases, a Deputy could act as relief for a superior and therefore must be fully qualified in the position. Deputies can be assigned to the Incident Commander, General Staff, and Branch Directors.

DEMOBILIZATION UNIT - Functional unit within the Planning Section responsible for assuring orderly, safe and efficient demobilization of incident resources.

DIRECTOR - The ICS title for individuals responsible for supervision of a Branch.

DISPATCH - The implementation of a command decision to move resources from one place to another.

DISPATCH CENTER - A facility from which resources are directly assigned to an incident.

DIVISION - That organization level having responsibility for operation within a defined geographic area or with functional responsibility. The Division level is organizationally between the Task Force/Team and the Branch. (See also "Group")

DOCUMENTATION UNIT - Functional unit within the Planning Section responsible for collecting, recording and safeguarding all documents relevant to the incident.

EMERGENCY MEDICAL TECHNICIAN (EMT) - A health- care specialist with particular skills and knowledge in pre-hospital emergency medicine.

EMERGENCY OPERATIONS CENTER (EOC) - A pre- designated facility established by an agency or jurisdiction to coordinate the overall agency or jurisdictional response and support to an emergency.

FACILITIES UNIT - Functional unit within the Support Branch of the Logistics Section that provides fixed facilities for the incident. These facilities may include the Incident Base, feeding areas, sleeping areas, sanitary facilities, etc.

FIELD OPERATIONS GUIDE (FOG) - A pocket-size manual of instructions on the application of the Incident Command System.

FINANCE SECTION - The Section responsible for all incident costs and financial considerations. Includes the Time Unit, Procurement Unit, Compensation/Claims Unit and Cost Unit.

FOOD UNIT - Functional unit within the Service Branch of the Logistics Section responsible for providing meals for incident personnel.

FUNCTION - In ICS, function refers to the five major activities in the ICS, i.e., Command, Operations, Planning, Logistics and Finance. The term function is also used when describing the activity involved, e.g., "the planning function."

GENERAL STAFF - The group of incident management personnel comprised of: Incident Commander, Operations Section Chief, Planning Section Chief, Logistics Section Chief, Finance Section Chief.

GEOGRAPHIC INFORMATION SYSTEM (GIS) - An electronic information system which provides a geo-referenced data base to support management decision making.

GROUND SUPPORT UNIT - Functional unit within the Support Branch of the Logistics Section responsible for fueling, maintaining and repairing vehicles, and the ground transportation of personnel and supplies.

GROUP - Groups are established to divide the incident into functional areas of operation. Groups are composed of resources assembled to perform a special function not necessarily within a single geographic division. (See Division.) Groups are located between Branches (when activated) and Resources in the Operations Section.

HEALTH AND SAFETY PLAN (HASP) - Site specific document required by State and Federal OSHA regulations and specified in the Area Contingency Plan. The HASP shall at minimum address, include, or contain the following elements: health and safety hazard analysis for each site task or operation, comprehensive operations workplan, personnel training requirements, PPE selection criteria, site specific occupational medical monitoring requirements, air monitoring plan, site control measures, confined space entry procedures (if needed), pre-entry briefings (tailgate meetings, initial and as needed), pre-operations commencement health and safety conference for all incident participants and quality assurance of HASP effectiveness.

HELIBASE - A location within the general incident area for parking, fueling, maintenance, and loading of helicopters.

HELISPOT - A location where a helicopter can take off and land. Some helispots may be used for temporary loading.

INCIDENT ACTION PLAN (IAP) - The Incident Action Plan, which is initially prepared at the first meeting, contains general control objectives reflecting the overall incident strategy, and specific action plans for the next operational period. When complete, the Incident Action Plans will have a number of attachments.

INCIDENT AREA - Legal geographical area of the incident to include affected area and traffic route to corresponding storage and disposal sites.

INCIDENT BASE - See BASE.

INCIDENT COMMANDER (IC) - The individual responsible for the management of all incident operations.

INCIDENT COMMAND POST (ICP) - That location at which the primary command functions are executed and usually collocated with incident base.

INCIDENT COMMAND SYSTEM (ICS) - A standardized on-scene emergency management concept specifically designed to allow its user(s) to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries.

INCIDENT COMMUNICATION CENTER - The location of the Communications Unit and the Message Center.

INCIDENT OBJECTIVES - Statements of guidance and direction necessary for the selection of appropriate strategies, and the tactical direction of resources. Incident objectives are based on realistic expectations of what can be accomplished when all allocated resources have been effectively deployed. Incident objectives must be achievable and measurable, yet flexible enough to allow for strategic and tactical alternatives.

INCIDENT SITUATION DISPLAY - The Situation Unit is responsible for maintaining a display of status boards which communicate critical incident information vital to establishing an effective command and control environment.

INFORMATION OFFICER (IO) - A member of the Command Staff responsible for interfacing with the public and media or with other agencies requiring information on the incident. There is only one Information Officer per incident. The Information Officer may have assistants.

INITIAL ACTION - The actions taken by resources which are the first to arrive at an incident.

INITIAL RESPONSE - Resources initially committed to an incident.

JOINT INFORMATION CENTER (JIC) - A facility established within or near Incident Command Post were the Information Officer and staff can coordinate and provide information on the incident to the public, media and other agencies. The JIC is normally staffed with representation from the OSC, State IC and RP.

JURISDICTION - The range or sphere of authority. Public agencies have jurisdiction at an incident related to their legal responsibilities and authority for incident mitigation. Jurisdictional authority at a incident can be political/geographical (e.g., city, county, state or federal boundary lines), or functional (e.g., police department, health department, etc.). (See Multi-Jurisdiction).

JURISDICTIONAL AGENCY - The agency having jurisdiction and responsibility for a specific geographical area, or a mandated function.

LANDING ZONE - See Helispot.

LEADER - The ICS title for an individual responsible for a Task Force/Strike Team, or functional Unit.

LIAISON OFFICER (LO) - A member of the Command Staff responsible for coordinating with representatives from cooperating and assisting agencies.

LOGISTICS SECTION - The Section responsible for providing facilities, services and materials for the incident.

MANAGERS - Individuals within ICS organizational units that are assigned specific managerial responsibilities (e.g., Staging Area Manager or Camp Manager).

MEDICAL UNIT - Functional unit within the Service Branch of the Logistics Section responsible for the development of the Medical Emergency Plan, and for providing emergency medical treatment for personnel.

MESSAGE CENTER - The message center is part of the Communications Center and collocated with. It receives, records, and routes information about resources reporting to the incident, resource status, and administration and tactical traffic.

MULTI-AGENCY COORDINATION GROUP (MAC) - Cohesive group of all affected agencies established to aid in the overall response, facilitate briefings and share issues during a response.

MULTI-AGENCY COORDINATION SYSTEM (MACS) - The combination of facilities, equipment, personnel, procedures, and communications integrated into a common system with responsibility for coordination of assisting agency resources and support to agency emergency operations.

MULTI-AGENCY COORDINATION GROUP COORDINATOR - Serves as facilitator to organize and accomplish goals of the MAC Group.

MULTI-AGENCY INCIDENT - An incident where one or more agencies assist a jurisdictional agency or agencies. May be single or unified command.
MULTI-JURISDICTION INCIDENT - An incident requiring action from multiple agencies that have a statutory responsibility for incident mitigation. In ICS, these incidents will be managed under Unified Command.

NOAA WEATHER STATION - A mobile weather data collection and forecasting facility (including personnel) provided by the National Oceanic and Atmospheric Administration which can be utilized within the incident area.

NATURAL RESOURCE DAMAGE ASSESSMENT (NRDA) - The process of identifying and quantifying the resource impacts and evaluating the value of impacted resources for the purpose of restoration.

OFFICER - The ICS title for the personnel responsible for the Command Staff positions of Safety, Liaison, and Information.

ON-SCENE COORDINATOR (OSC) - The predesignated federal On-Scene Coordinator operating under the authority of the National Contingency Plan (NCP).

OPERATIONAL PERIOD - The period of time scheduled for execution of a given set of operation actions as specified in the Incident Action Plan. Operational Periods can be various lengths, usually not over 24 hours.

OPERATIONS SECTION - Responsible for all operations directly applicable to the primary mission. Directs the preparation of unit operational plans, requests or releases resources, makes expedient changes to the Incident Action Plan as necessary and reports such to the Incident Commander. Includes the Recovery and Protection Branch, Emergency Response Branch, Air Operations Branch, and Wildlife Branch.

OUT-OF-SERVICE RESOURCES - Resources assigned to an incident but unable to respond for mechanical, rest, or personnel reasons.

PLANNING MEETING - A meeting, held as needed throughout the duration of an incident, to select specific strategies and tactics for incident control operations and for service and support planning.

PLANNING SECTION - Responsible for the collection, evaluation, and dissemination of tactical information related to the incident, and for the preparation and documentation of Action Plans. The section also maintains information on the current and forecasted situation, and on the status of resources assigned to the incident. Includes the Situation, Resource, Documentation, and Demobilization Units, as well as Technical Specialists.

POLREP - Pollution report.

PROCUREMENT UNIT - Functional unit within the Finance Section responsible for financial matters involving vendor contracts.

QUALIFIED INDIVIDUAL (Q.I.) - The person authorized by the responsible party to act on their behalf, authorize expenditures, and obligate organization's resources.

RADIO CACHE - A cache may consist of a number of portable radios, a base station and in some cases a repeater stored in a predetermined location for dispatch to incidents.

RECORDERS - Individuals within ICS organizational units who are responsible for recording information. Recorders may be found in Planning, Logistics, and Finance Units.

REGIONAL RESPONSE TEAM (RRT) - The Federal response organization, consisting of representatives from selected Federal and State agencies, which acts as a regional body responsible for planning and preparedness before an oil spill occurs and for providing advice to the OSC in the event of a major or substantial spill.

REPORTING LOCATION - Any one of six facilities/locations where incident assigned resources may check-in. The locations are: Incident Command Post-Resources Unit, Base, Camp, Staging Area, Helibase or Division Supervisor for direct line assignments. (Check-in at one location only)

RESOURCES - All personnel and major items of equipment available, or potentially available, for assignment to incident tasks on which status is maintained.

RESOURCES UNIT - Functional unit within the Planning Section responsible for recording the status of resources committed to the incident. The Unit also evaluates resources currently committed to the incident, the impact that additional responding resources will have on the incident, and anticipated resource needs.

R.P. - Responsible Party

SAFETY OFFICER (SO) - A member of the Command Staff responsible for monitoring and assessing safety hazards or unsafe situations, and for developing measures for ensuring personnel safety. The Safety Officer may have assistants.

SECTION - That organization level having functional responsibility for primary segments of incident operation such as: Operations, Planning, Logistics, Finance. The Section level is organizationally between Branch and Incident Commander.

SERVICE BRANCH - A Branch within the Logistics Section responsible for service activities at the incident. Includes the Communications, Medical and Food Units.

SINGLE RESOURCE - An individual, a piece of equipment and its personnel complement, or a crew or team of individuals with an identified work supervisor that can be used on an incident.

SITE SAFETY PLAN - Legal document required by OSHA before entry into site, prepared by Safety Officer.

SITUATION UNIT - Functional unit within the Planning Section responsible for the collection, organization and analysis of incident status information, and for analysis of the situation as it progresses. Reports to the Planning Section Chief.

SPAN OF CONTROL - The supervisory ratio of from three-to-seven individuals, with five-to-one being established as optimum.

STAGING AREA - That location where incident personnel and equipment are assigned awaiting tactical assignment.

STATE I.C. - State Incident Commander.

STRATEGY - The general plan or direction selected to accomplish incident objectives.

SUPERVISOR - The ICS title for individuals responsible for command of a Division or Group.

SUPPLY UNIT - Functional unit within the Support Branch of the Logistics Section responsible for ordering equipment and supplies required for incident operations.

SUPPORT BRANCH - A Branch within the Logistics Section responsible for providing personnel, equipment and supplies to support incident operations. Includes the Supply, Facilities and Transportation Units.

SUPPORTING MATERIALS - Refers to the several attachments that may be included with an Incident Action Plan (e.g., communication plan, map, safety plan, traffic plan, and medical plan).

TACTICAL DIRECTION - Direction given by the Operations Section Chief which includes the tactics appropriate for the selected strategy, the selection and assignment of resources, tactics implementation, and performance monitoring for each operational period.

TASK FORCE - A group of resources with common communications and a leader assembled for a specific mission.

TECHNICAL SPECIALISTS - Personnel with special skills that can be used anywhere within the ICS organization.

TEAM - Specified combinations of the same kind and type of resources, with common communications and a leader.

TEMPORARY FLIGHT RESTRICTIONS (TFR)- Temporary airspace restrictions for non-emergency aircraft in the incident area. TFR's are established by the FAA to ensure aircraft safety and are normally limited to a five-nautical-mile radius and 2000 feet in altitude.

TIME UNIT - Functional unit within the Finance Section responsible for recording time for incident personnel and hired equipment.

UNIFIED COMMAND (UC) - In ICS, Unified Command is a unified team effort which allows all agencies with responsibility for the incident, either geographical or functional, to manage an incident by establishing a common set of incident objectives and strategies. This is accomplished without losing or abdicating agency authority, responsibility or accountability.

UNIT - That organizational element having functional responsibility for a specific incident planning, logistic, or finance activity.

VESSEL SUPPORT UNIT - Functional unit within the Support Branch of the Logistics Section responsible for implementing the Vessel Routing Plan and coordinating transportation on the water and between shore resources.

VOLUNTEER - Any individual accepted to perform services by the Lead Agency which has the authority to accept volunteer services. A volunteer is subject to the provisions of the authorizing statute.

Thurston
Conservation District

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TUMWATER PUBLIC WORKS

Local solutions to local problems

Conservation Planning • Habitat Restoration • Bio-engineering • Soils Analysis • Conservation Education • Project GREEN • Nutrient Management

27 March, 1997

Kathy Callison
City of Tumwater
555 Israel SW
Tumwater, WA 98501

Dear Kathy,

After reviewing the draft *City of Tumwater Wellhead Protection Plan*, I have several comments. In general, the Thurston Conservation District supports the goals and recommendations outlined in the plan to protect the city's drinking water supply.

The recommendations that relate specifically to the Conservation District (3.3, 4.4, 7.21) fit well with the District's goals and philosophy. However, I want everyone to be clear that the District does not necessarily have funds to accomplish these tasks. The current CCWF groundwater grant funds most of the District activity related to the WPA's and it closes at the end of 1998. The workplan to complete the grant is set: it includes an inventory of agricultural activity in the WPA's and assistance to the city in developing a conservation plan for the golf course.

Beyond the end of 1998, the District will need to seek additional funding to carry out recommendations in the WHPP. Any support the City of Tumwater can lend to grant applications, renewal of the District's special assessment, or direct funding will further the District's contribution to the city's WHPP.

In addition to this general comment, I have some specific comments.

Page 7-5	PF1	The "CS" in should be "CD."
Page 7-5	PF3	Over 60 conservation plans have been written for farms in the GWMA to date.
Page 7-5	PF5A	14 of the 60 completed conservation plans were for commercial farms.
Page 7-5	PF5C	Several of the commercial conservation plans have included IPM techniques
Page 7-20	7.4.4	The "Soil Conservation Service" is now called the "Natural Resources Conservation Service."
		Funding for the CD is more complex then presented here. The 5 year work program referred to is the groundwater program workplan, not the entire workplan for the CD. The plan is to develop conservation plans for 90 small-scale and commerical farms in the GWMA by the end of 1998.

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The assessment referred to in the text provides match for this and many other grants.

In point (3), about 18 individual conservation plans are developed each year in the groundwater program.

Page 8-5 3.3 Cost: the CD can provide a limited amount of service to the City through 10/98 under its CCFW groundwater grant. Beyond then, the CD must seek additional funds to carry out activities suggested by the WHPP.

If you have any questions about my comments, please feel free to call me.

Sincerely,

John Konovsky
Groundwater Specialist

COUNTY COMMISSIONERS
Judy Wilson
District One
Diane Oberquell
District Two
Dick Nichols
District Three

THURSTON COUNTY
WASHINGTON
SINCE 1852

PUBLIC HEALTH AND SOCIAL SERVICES DEPARTMENT

Patrick M. Libby, Director
Diana T. Yu, MD, MSPH
Health Officer

April 1, 1997

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APR - 2 1997
TUMWATER PUBLIC WORKS

Kathy Callison, Water Resources Specialist
City of Tumwater
Department of Public Works
555 Israel Road SW
Tumwater, WA 98501

RE: Draft - City of Tumwater Wellhead Protection Plan

Dear Kathy:

Thank you for the opportunity to review and comment on the draft Wellhead Protection Plan for the City of Tumwater. Please accept my apologies for the delay in sending you our comments. We have combined the comments of Thurston County staff into a single submittal. In general we found the draft document to be understandable and the scientific methodology used in delineating capture zones to be sound.

One issue we felt the draft Plan made very evident was the sensitivity of Tumwater's well field sources to contamination from historical and existing land uses. We encourage Tumwater to continue to look at regionally at long term supply options which focus on locations where source control could be maintained.

One general comment on the document lay out; the Executive Summary has its own numbering which is slightly confusing when you go to reference something in the document text. For example, the Executive Summary labels 5.1 Section 4: Risk Analysis and proceeds to give a list of suggested strategies for each well field which it labels 5.1.1 - 5.1.4, these sections in the text are actually sections 4.2.1 - 4.2.3, making cross referencing the Executive Summary and the specific sections in the document more difficult. Perhaps the sections of the Executive Summary could be labeled with Roman numerals or letters and the specific portions of the text that are included in the Executive Summary labeled to match their location within the document text. Below we have listed specific points that we felt could add clarity to the document.

Environmental Health Division: 2000 Lakeridge Drive SW, Olympia, Washington 98502-6045 (360) 754-4111
FAX (360) 754-2954 • TDD (360) 754-2933

- Page 6; Section 3.1.1 Did they really mean US Coast Guard or was it USGS?

- Figure 2-1 - 2-17 are missing.

- Page 2-17 "Modeling Capture Zones in the Qc/Tqu Aquifer. The last sentence in the first paragraph has missing words and does not make sense.

- Page 2-18; Section 2.2.3; The "Possible Effect on Capture Zone" significantly overstates the sensitivity of the capture zone delineations. The effect is generally of the type listed, but the magnitude is less than listed in the table. For example, in some quick sample runs we conducted using the EPA WHPA code, using some Tumwater data, doubling the pumping rate did not double the width but did significantly lengthen the capture zone. This was for a well with a pumping rate that was relatively large compared to the regional gradient. In some cases it appears that the effect of some of the changes would be closer to a doubling or halving of the area of the capture zone, rather than one of its linear dimensions.

  The author was undoubtably trying to simplify the presentation of the complex results of this type of sensitivity analysis so that it would not be a major report by itself, which is good. But the results presented would diminish the apparent value of the delineated capture zones by making them appear overly sensitive to input values, or give an incorrect impression of the results, which might be misapplied with unfortunate results. Perhaps there is a way that a less simplified result could be portrayed, without becoming too complex to be useful to the majority of readers.

- Page 4-13; Section 4.2.1; Palermo Well field: One of the strategies listed includes ordinance development and enforcement. It might be more clear to state aquifer protection ordinances, especially since these recommendations are also found in the executive summary which does not provide the information on the type of ordinances proposed.

- Page 4-13-14; Section 4.2.2; Port Wells: The second, fourth and fifth recommended strategies refer to recommendations to be placed in an Aquifer Protection Ordinance, however, due to the text construction it is difficult for the reader to determine if these are all to be the same ordinance, if the ordinance exists or is proposed, and what specific objectives are intended to be incorporated into the ordinance.

- page 7-11; Section 7.2.3; Recommendation 7-3: Though clear to reviewing staff a lay reader may interpret this recommendation to mean that the GWPAC and GWTAC have authority to *"set"* land use conditions when in reality this authority would rest with the legislative bodies of the individual jurisdictions.

- Page 7-12; Section 7.3.2; Data Management: The Thurston Geodata Center is a facility designed to make and provide access to maps and supporting data. It is not designed as a comprehensive data management and archiving facility. While TGC is a wonderful facility and a powerful resource, using it for functions for which it was not designed may not produce satisfactory results.

- Page 7-43; Rec. 7-20; Ecology has already delegated its authority to regulate the construction and decommissioning of wells to Thurston County.

- There are two additional well construction issues Tumwater may wish to consider incorporating into your planning recommendations. First, that ordinances be revised to require proper abandonment or decommissioning of private and small public wells when re-development or municipal connection occurs, and second, that ordinances specifically prohibit or restrict the drilling of individual wells within the Tumwater urban growth area in an effort to reduce the pathways of contamination to the aquifer.

- The Land Use Planning and Regulation Recommendations 7-14 to 7-19 are not clear in stating how land use review staff from other jurisdictions are to receive guidance about what Tumwater wants and expects from land use reviews that are outside Tumwater's jurisdiction but affect Tumwater's WHPAs. Is this expected to come from the zoning code? The report would be a stronger tool for managing land uses if it made recommendations about how to better coordinate land use reviews between jurisdictions. Through discussions with the GWPAC subcommittee on land use policies for wellhead areas information has been provided that indicates the Critical Areas Ordinances may be a more flexible tool than the zoning or SEPA codes for evaluation of proposals, and implementation of performance conditions.

- One other issue not addressed in this plan which may be a consideration in the Land Use Planning and Regulation is Tumwater's role in satellite system management in the urban growth area and it's effect on land use and zoning in wellhead protection areas. It may be an area where policy or ordinance development is needed and could be addressed as part of other policy considerations.

Thurston County
Tumwater Wellhead Protection Plan Review

We hope you find these comments useful in your wellhead plan development process. We sincerely appreciate Tumwater's commitment to regional planning and wellhead protection. Please call Bob Mead or me if you have questions or concerns regarding the comments noted above.

Sincerely,

Jane

Jane Hedges, Program Manager
Resource Protection Program

cc. Commissioner Judy Wilson, GWPAC-Thurston County
Water Resource Program Managers
Bob Mead
Phil Brinker