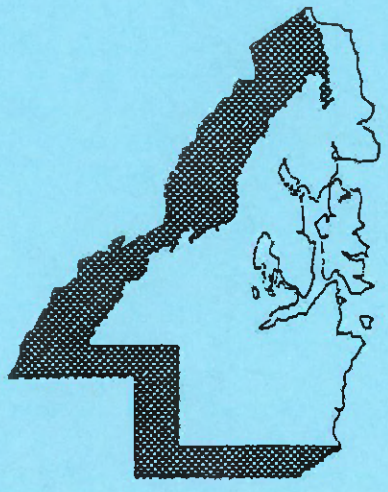
SECTION III



SECTION III

FUTURE DATA COLLECTION

The Ground Water Management Plan (GWMP) Grant No. 1 activities have identified an abundance of hydrogeologic data with which to define aquifer systems, production potential, and resource vulnerability. However, there are still deficiencies in the ability of existing data to resolve all specific hydrogeologic issues. Therefore, one of the benefits of the assessment of existing hydrogeologic data is the definition of areas where insufficient information exists to confidently make regional interpretations. Several types of data are required in defining and managing groundwater resources. These include: (1) groundwater level monitoring; (2) additional evaluation of aquifer characteristics for identified aquifers; (3) generation of preliminary hydrogeologic information in data-poor areas by test drilling, aquifer testing and sampling; (4) collection of pumpage information; (5) background water quality sampling and monitoring with time; (6) collection of stream flow and precipitation data; and (7) monitoring of lake surface elevations. In some areas the available data needed for characterizing groundwater resources and establishing management alternatives is satisfactory. There are, however, some areas which require additional data to monitor and manage the groundwater resources.

This report recommends the collection of additional hydrogeologic, hydrologic, and water quality data to more accurately assess the areas' aquifer characteristics and their relationship with surface water and land surface activities. The intent is that Grant No. 2 efforts will prioritize these activities and develop a long-term comprehensive monitoring program. Since each subarea has it's own specific needs, data collection efforts will be discussed on a subarea basis. Where possible specific locations for data collection are suggested, as shown in Exhibit III-1. It must be noted, however, that these suggestions should not preclude data collection opportunities which may arise nearby. Where offered, explicit data collection efforts are presented to provide conceptual clarity as to how the data needs may be met. In no case are they presented as the only solution to the problem of data paucity.

The recommendations presented within this Section recognize that additional information and a comprehensive monitoring program are warranted throughout all areas, not just those of known or existing major supplies or suppliers. This list of activities was also developed with the knowledge that sources of funding for implementing these recommendations are unresolved, as yet. These will be addressed during Grant No. 2. However, exploratory drillings or other data collection activities by State and local agencies, private interests, or public purveyors, during the interim, should be influenced by this list of recommended actions.

It is possible that many existing wells will adequately aid in this effort. Many wells of record have not been computerized given the limitations on project resources. Field survey of wells would provide accurate definition of well location, elevation, construction details, water levels, and ownership. At a minimum, all public water system wells should be field checked to incorporate into the database.

It is also recommended that collection of information cited in subsequent paragraphs be done in a manner consistent with the GWMP's Quality Assurance Project Plan (QAPP) and reported in accordance with the GWMP's Data Management Plan.

The first part of this section discusses hydrogeologic data collection. It is followed by a discussion of hydrologic data collection needs. The third and final part of this section considers future water quality data collection.

1. HYDROGEOLOGIC DATA COLLECTION

Many of the test drilling and well monitoring suggestions were developed by analysis of the information presented in Exhibit II-8, which displays the principal aquifers of Kitsap County. This analysis defined numerous data needs for proper definition and management of the groundwater resources of the county. The relative unknown lateral extent and the incomplete understanding of aquifer parameters for most of the delineated aquifers clearly indicates that extensive test drilling and aquifer evaluation testing should be considered in long range planning. Also apparent are the large areas which have no presently identified aquifers, especially in the western and southern portions of the county. This lack of identified aquifers most likely reflects a lack of data rather than a lack of aquifers. In addition, a system for standardizing data gathering and recording during pumping and non-pumping periods should be established throughout the County.

Another critical data need is the collection of information which will allow refinement of the water budget calculations for the county. A particular need for water level and runoff data exists. This means regular measurement of key wells to create hydrographs and gauging of streams and lakes and wetland areas to provide definition of the surface/groundwater interaction. The following data collection plans are designed to supply that supplemental data that can reasonably be generated at this time. (In the water quality data collection part of this section a number of wells are proposed for background water quality monitoring in the shallow aquifer. These same wells could be used for obtaining water level data in the shallow aquifer.)

A. Hansville-Indianola Subarea

A water level monitoring program for each of the five designated aquifers should be developed and implemented as soon as possible, with at least one dedicated monitor well in the Hansville, Poulsbo and Port Gamble

South aquifers and two in the Kingston and Suquamish-Miller Bay aquifers. A suggested monitor well location for the Hansville aquifer is T28N R02E Sec 28G. Several test wells are known to exist in the Hansville aquifer which may qualify as monitoring sites, such as well 22N01. The first effort in this area should be to determine the status of these wells and select the most appropriate as a monitoring site. In the Port Gamble South aquifer, Well 28C02, known as the old Wolfe Elementary School Well, is recommended as a possible monitoring site. Two areas are recommended in the Kingston aquifer, one in T27N R02E Sec 25 (Well 25E03) and a second in T27N R02E Sec 35 (Well 35K01). The Suquamish-Miller Bay aquifer should be monitored in T26N R02E Sec 9 and T26N R02E Sec 20, suggested specific wells within this area are 20L01 and 09H01. A new well in T26N R02E Sec 13G is suggested for the Poulsbo aquifer. Monitoring wells should be set up such that the water levels are measured at least on a monthly basis. The data should be verified and placed in the database every 6 months.

The principal resource management need for the Hansville aquifer is for the identification of an innovative method of efficiently extracting the water from the aquifer. This may be through a periphery collection system, by numerous low-yield wells within the aquifer, or by a method as yet not considered. Monitoring of fluctuation of water levels in this aquifer is critical to proper management of its production and to the recognition of the point where production limits of the aquifer are reached.

Recent drilling efforts in the Port Gamble South aquifer at the Wolfe Elementary School have demonstrated the limits of the aquifer to the southeast. Due to the limited number of successful wells in this unit (4), the principal need here is for additional test drilling to define the lateral extent of the aquifer and to establish better understanding of aquifer parameters. A site between Wolfe School and the PUD well at Gamblewood, probably within T27N R02E Sec 21N, is recommended for test drilling to a level of about 200 feet below sea level. Additional options for deep exploration should also be considered. Following completion of this well a second similar test well should be considered in T27N R02E, in the east half of Section 19 or along the western edge of Section 20.

The Kingston aquifer could possibly have a greater potential pumping capacity with its existing wells than the aquifer can supply. Prior to installing more production wells a thorough monitoring system should be installed to evaluate both the shallow and deep systems. Suggested monitoring well locations are T27N R02E Sec 25 (Well 25E03) and T27N R02E Sec 35 (Well 35K01). Should the monitoring data show that the

capacity of the aquifer has not been exceeded then deep exploration to evaluate the southwestern extension of the aquifer (T26N R02E Sec 2J) should be considered.

The Suquamish-Miller Bay aquifer contains several potentially high yielding wells which have been completed at varying depths. One of the major users at this time is the Suquamish Tribal Hatchery, who may possess the paramount right to the water. The PUD has drilled several test wells in the area which showed good potential. One of these wells should be dedicated as a permanent water level monitoring site, i.e., Well 09H01. At least one other well on the east side of Miller Bay should also be dedicated to long term water level monitoring for this portion of the aquifer (Well 20L01).

The Poulsbo aquifer is identified by several good wells completed in a stratigraphic horizon between 175 feet above sea level down to sea level. This aquifer should have a dedicated monitor well placed in T26N R01E Sec 13G. Should expansion of the production from this aquifer be desired, it is suggested that the test drilling pattern be designed to evaluate the lateral extent of the shallow system and to provide stratigraphic information of any deeper systems. No information is available regarding the possible presence of deep aquifers beneath the Poulsbo aquifer. However, the area appears promising for deep well sources, principally because of its relative distance from deep salt water bodies.

Areas of exploration for new water sources are somewhat limited in the Hansville-Indianola Subarea, due to the close proximity of Puget Sound on three sides, the related possibilities of sea water intrusion and because of the limited recharge area available on the upper peninsula. Deep test wells may be justified to evaluate the local stratigraphy in T27N R02E Sec 9G, T26N R02E Sec 6J, T27N R02E Sec 18L and T26N R02E Sec 3F. A summary of the recommended monitoring and exploration locations for the Hansville-Indianola Subarea can be seen in Table III-1.

B. Bainbridge Island Subarea

Bainbridge Island has recently undergone a significant amount of test drilling, which has identified several new and potentially prolific aquifer zones. At this time it appears that the subarea is more in need of aquifer evaluation than identification of additional aquifers. A water level monitoring program for five of the six designated aquifers should be developed and implemented as soon as possible with at least one dedicated monitoring well for each aquifer. The Gilberton-Fletcher aquifer contains the PUD's Fletcher Bay Well (Well No. 20K01), which presently is being regularly monitored.

The Meadowmere aquifer is heavily utilized in the local area and as such is in serious need of a dedicated monitoring well, probably located at some distance from the present pumping centers, possibly in T25N R02E Sec 9Q. This would more accurately reflect the regional water level response of the aquifer. In addition to water level monitoring the amount of water pumped by the current users needs to be measured, reported and evaluated in light of the water level record from the monitored wells.

The impending production from the Wardwell aquifer by the City of Winslow at the recently completed Sands Road Well (Well No. 22J02) makes the monitoring of that well and the PUD's Wardwell Road well (Well No. 15J01) critical. The long-term production capacity of this aquifer is unknown. Assessment of the information collected over the next few years will provide insight into the ultimate production capacity of this system.

The Bayhead aquifer, which represents the primary source of water for the City of Winslow, appears to have somewhat more capability than is presently being pumped. A water level and total pumpage monitoring program should be developed to establish base line data for this aquifer. Well 27E03 could be dedicated to monitor these conditions. It may be found that additional yield can be obtained from the City of Winslow's existing well field through a designed program of efficient operation of existing wells. Further drilling is not advised at this time due to the limited area available for additional well sites.

For the Creosote aquifer, the planned monitoring program at the Port Blakely Well No. 1 (Well No. 35G01) should provide much needed data on the aquifer characteristics. No additional yield should be planned until the evaluation of the monitoring data assures that increased production is feasible. New production will likely be developed within the presently identified boundaries, due to the geographic limits to the north and east (Eagle Harbor and Puget Sound) and the known bedrock high to the south.

There is some evidence that the Lynwood aquifer can yield more water than is presently being produced. This may be possible by placement of optimally spaced wells. Test drilling would be required to provide several observation wells and to better define the local aquifer geometry and other aquifer characteristics. Several shallow test wells in T24N R02E Sec 4B and T25N R02E Sec 33L would allow a proper definition of the hydrogeology and provide an appropriate water level monitoring network. The cost effectiveness of maximizing production of the aquifer should be considered.

Exploration for new aquifers should be contemplated in the northern portion of the island where there is a paucity of data, especially regarding the deeper systems. The first deep test well should be contemplated in T25N

R02E Sec 10A. A summary of the recommended monitoring and exploration locations for Bainbridge Island can be seen in Table III-2.

C. Poulsbo-Bremerton Subarea

This subarea contains the greatest number of aquifers identified in the study and also possesses the greatest number of major producing wells. A water level monitoring program for each of the principal aquifers in the subarea should be developed and implemented as soon as possible. It is suggested that at least one dedicated monitoring well be placed in the Edgewater, Keyport and Island Lake aquifers. Multiple monitoring wells should be set up in the Bangor, Silverdale, Bucklin Hill, Gilberton-Fletcher, and Manette-Bremerton North aquifers.

The Edgewater aquifer, which contains two production zones, requires testing and water level monitoring in order to clarify aquifer response to pumping and to evaluate the production capacity of the system. An existing well (27F02) could be set up to provide aquifer characteristics, as an observation well for production well testing, and to monitor regional water levels. Unless this information demonstrates that the aquifer cannot support additional expansion, test wells should be drilled to the south in T27N R01E Sec 34R and 35Q.

The aquifer characteristics of the Keyport aquifer have been fairly well defined by the five deep wells on the U.S. Navy torpedo station. Reportedly these wells produced about 600 gpm on a nearly continuous basis from two of the five wells for cooling water. The long-term withdrawal effectively demonstrates that a major water supply exists within this aquifer.

The PUD presently has a possible monitoring well at their Keyport No. 2 site (Well No. 36M01). Records from that well, combined with pumping use in the area, may demonstrate that additional production is possible from this aquifer. Should the assessment of this data demonstrate the possibility of expanding production from the aquifer, deep test drilling should be contemplated along Liberty Bay to the northwest and southeast and may be possible across the bay near Lamolo. Test drilling sites would depend primarily on property availability but may be suggested in T26N R01E Sec 27P, T26N R01E Sec 01E, and T26N R01E Sec 30R.

The Bangor aquifer is a major system which, except for Vineland, is essentially confined to Navy property and almost exclusively used by the Subbase Bangor facility. Historical records, including records prior to extensive pumping in this area are very good for this aquifer. Evaluation and monitoring of this aquifer was performed by Robinson & Noble, Inc. over a 7-year period, from 1975 to 1982, while the base was being

constructed. Later records of water use and water levels need to be assessed. Major surpluses of water beyond the Navy's requirements may be available from this aquifer. Estimated natural subsurface flow for the aquifer system is at least 2,000 gpm. During dry-dock construction, a withdrawal of 3,500 gpm induced moderate saltwater intrusion. Development of these sources would most likely require access to Navy property. Refinement of the aquifer characteristics could be accomplished by developing a dedicated monitoring program for Wells 31B02 and 19P01.

The Island Lake aquifer is defined by three major Silverdale Water District wells with a potential pumping capacity of over 2000 gpm. The base of the aquifer is above sea level and the aquifer may have continuity to the north. The principal data need for this aquifer is a thorough monitoring program which documents pumping and non-pumping water levels and production rates for each well. By 1988 the aquifer was undergoing its first major stress. A dedicated monitoring well located near the center of the area in T25N R01E Sec 03G would be useful. Such a well would measure general aquifer water level response and be less influenced by a pumping well in close proximity. If this monitoring program does not demonstrate that the aquifer capacity has been reached the expansion of production may be reasonable. Any expansion of production should be from within the defined aquifer boundaries or very near the east and west edges of the delineated area.

A secure staff gauge should be set in Island Lake to measure water level changes. The lake may be hydraulically connected to the Island Lake aquifer system.

The Silverdale aquifer is found between sea level and 250 feet below sea level. This aquifer served all of Silverdale's needs for more than 30 years until the Island Lake wells came on line. Although no aquifer depletion is evident at the present time, dedicated monitoring wells should be set up in wells 16J01 and 20C01.

A new well is presently planned to be drilled at T25N, R01E, Sec 19P to test for a western extension of the Silverdale aquifer. A redeveloped well ("Newberry Hill Interchange", Well 29D01) has shown a deep aquifer zone that had not been previously recognized. Monitoring of these new wells is important prior to increasing the production stress on the aquifer.

The Bucklin Hill aquifer system is shared by North Perry Avenue District, Bremerton and Silverdale. It is a relatively deep system which has not to date been subjected to major pumping. Monitoring of pumping and of water levels is essential to determine the response of this system to

current pumping and to evaluate it's potential for increased withdrawal. Dedicated monitoring wells are suggested at the Parkwood East well (Well No. 23N02), which is reportedly unused and may be available for monitoring access, and at Silverdale's Selbo Road well (Well No. 22F03).

The Gilberton-Fletcher aquifer is represented by deep wells at Gilberton on the Manette peninsula and near Fletcher Bay on Bainbridge Island. These areas are separated by Port Orchard Bay which is a relatively shallow arm of the Puget Sound. The bottom of the Bay is appreciably higher in elevation than the aquifer. There is reason to speculate continuity between the Gilberton and Fletcher Bay Areas, with the bay perched well above the aquifer. The continuity between the two areas is implied and the aquifer configuration as presented on Exhibit II-9 probable, but not proven. An extensive amount of water level monitor information is available on the Fletcher Bay side from the PUD's Fletcher Bay Monitor Well (Well No. 20K01). These records show response to pumping and apparent aquifer pressure equilibrium during pumping. The well exhibits a high amplitude tidal fluctuation suggestive of elastic loading as opposed to an actual influx and egress of salt water from within the aquifer. Water levels remain above sea level. At Gilberton, a more sporadic set of records shows major declines in water levels due to pumping. These levels appear to be at least 50 feet below sea level which may provide a long-term potential for saltwater intrusion. A monitoring program similar to the Fletcher Bay Well is needed. A possible site for this monitoring well is near the Gilberton No. 1 Well (Well No. 19M01).

Numerous wells owned by North Perry Avenue Water District and the City of Bremerton have been producing from the Manette-Bremerton North aquifer system for many years. A thorough monitoring system must be developed to assess the results of this heavy use. Suggested new monitoring well sites are in T25N R01E Sec 35R and T24N R01E Sec 01P. Existing Well 07M02 could be converted to serve as a dedicated monitoring well. Close comparison of current levels with historic water level patterns is necessary to establish trend evaluations. Suspicions of an overdraft situation in this aquifer should be evaluated. More water may be available but should only be considered after a monitoring plan is operational and sufficient data has been generated. Expansion of this aquifer's production, if warranted, would likely come from within or very near the presently identified boundaries, due primarily to geographical constraints. A summary of the recommended monitoring and exploration locations for the Poulsbo-Bremerton subarea can be seen in Table III-3.

D. West Kitsap Subarea

This subarea contains only one defined aquifer, the Big Beef aquifer, although other major aquifers almost certainly exist. The Big Beef aquifer is likely to be among the best in Kitsap County, possibly better than the Bangor aquifer. It has been demonstrated to have high transmissivity and presumably is recharged from a large catchment area to the south including the northern slopes of Green Mountain.

The principal hydrogeologic data needs in this subarea are the definition of stratigraphic and hydrologic conditions necessary to define aquifers. This will require extensive test drilling. There is ample justification to speculate that major aquifers exist elsewhere in the subarea.

Although the Big Beef aquifer is mapped as a small area east of Seabeck where a major aquifer has been developed, the actual aquifer area may be much larger. Current use is primarily for fish propagation by the University of Washington Big Beef Station and by the nearby Lakes Trout Farm. These wells may have a combined and continuous yield of about 1,500 gpm. In that the University of Washington facility depends solely upon artesian flow and the facility has not expressed a problem with diminished flow, aquifer depletion does not appear to have occurred. This fact does not constitute a complete evaluation of trends. Some procedure for monitoring and recording water use and water level (or in the case of flowing artesian wells, the shut-in pressure) data at the facilities should be implemented at wells 14E01, 22A02, 22A03 and 22A04.

Although distant from population centers, the aquifer would be a candidate for a regional groundwater supply to be transported to more distant areas of demand within the county. If such plans were to be considered, extensive test drilling to depths of at least 300 feet below sea level would be required to determine aquifer geometry and to properly define transmissivity and storativity. Suggested locations for these test wells are in T25N R01W Sec 22N, 23P, 27H, 28Q, 33L, and 34H and T24N R01W Sec 3A, 4D, and 5D.

Other exploration targets should be developed along the Seabeck and Stavis Creek drainages possibly in T25N R01W Sec 01F, T24N R01W Sec 06M, T24N R02W Sec 01E, T24N R02W Sec 11F, T24N R02W Sec 14F, and T24N R02W Sec 30A. In addition, the well recently completed for the community of Holly (Well No. 19K01), which has one of the highest specific capacity values in the entire county, may be indicative of another major aquifer.

It is highly probable that the groundwater production potential far exceeds the demand suggested for projected future population trends for

this subarea. The data collection for this area may be best oriented toward the identification of major aquifers which can be developed for future export of the resource to other sections of the County. Monitoring of the response to withdrawal at the University of Washington Big Beef facility will give some insight as to aquifer response to stress. A summary of the recommended monitoring and exploration locations for the West Kitsap subarea can be seen in Table III-4.

E. South Kitsap Subarea

The data collection needs of this subarea tend to fall into two distinct categories. These are divided rather neatly between the needs of the northern and those of the southern portions. The northern portions contain seven defined aquifers located principally along the more densely populated areas of Gorst, Port Orchard and Manchester. The southern portion presently has no defined principal aquifer units. As a result the future data collection needs of the southern portion of the subarea are quite different.

Several dedicated monitoring wells are suggested for the Gorst Creek aquifer and at least one dedicated water level monitoring well is recommended in each of the other defined aquifers.

The Clam Bay aquifer is an aquifer with a very small areal extent, yet is utilized by Manchester, the Navy, and the Wautauga Beach community. It is bounded by bedrock and by relatively impermeable glacial deposits; as such it has the geometric conditions that make aquifer overdraft likely. Water quality is variable within the aquifer particularly with respect to iron content which is very high at Wautauga Beach. Two new wells have been recently drilled by Manchester Water District. Since there are no plans to place these in service in the immediate future, one of these wells (Well 21B01) is suggested as a key well in monitoring of the aquifer.

The Yukon Harbor aquifer is presently used exclusively by Manchester Water District. Production is principally from two adjacent wells off Garfield Road. The original well (Colby), near the Yukon Harbor shoreline is in limited use. The older well (33J01) should be dedicated as a monitoring well for this relatively small aquifer system. The lateral extent of the aquifer is poorly defined by existing data. This should be rectified by a test drilling program. The first effort should consider drilling to the southwest in T24N, R02E, Sec 33P.

The Wilson Creek aquifer has recently been put to use by Manchester Water District where there are three wells in the same field. Pumping tests have indicated the presence of confining boundaries which will ultimately limit withdrawal. One of the shallower wells in the field, perhaps

Well 10G03, should be considered as a candidate for conversion to a dedicated monitoring point to record seasonal and long-term changes. Wilson Creek itself appears to have a strong baseflow which may indicate capture of groundwater from beyond its topographic basin boundary. Wilson Creek should be gauged to define seasonal variation in stream flow.

Numerous very deep wells which are completed in the Port Orchard Deep aquifer, have been used in and near Port Orchard for over 50 years. Past water level monitoring has been sporadic at best. Recent reviews of this data suggest no major declines in artesian pressure in these wells. A more systematic monitoring program is required to draw definitive conclusions. When proper monitoring is accomplished, it may be found that additional groundwater is available from this aquifer. Several unused wells exist in the area. Some of these may be available for monitoring by both the Annapolis (Well 25Q02) and Port Orchard Water Districts (Well 26K05).

The North Lake-Bremerton South aquifer actually contains three aquifer zones. The shallowest is tapped by McCormick Woods Water Co. This zone has recently been put to heavy use and has experienced subtle water level declines, which may be indicative of either aquifer depletion or recent relative drought conditions. Overflow from this shallow system ultimately feeds Anderson Creek which should be considered for stream gauging to evaluate seasonal variations in flow volumes.

Bremerton's Anderson Creek well field taps the deeper systems. The shallower of these extends to about 200 feet below sea level; the deeper extends to about 500 feet below sea level. Pumping of each has minor influence on the other, but there is considerable interference between wells within the same system. Bremerton has several old wells that could be scheduled for abandonment. Prior to this, efforts should be made to equip such wells as monitoring wells to better assess the seasonal and long-term water level changes in Wells 33L02, 33K02, and 09C02.

The shallower component of this aquifer tapped by the McCormick Woods wells may extend a considerable distance to the south and is believed to be a possible source of groundwater flow into Coulter Creek. Test drilling is recommended south of North Lake in T23N, R02E, Sec 9. In addition, stream gauging of Coulter Creek should be implemented to define water flow volumes.

The Gorst Creek valley, from near its mouth west to Twin Lakes, has been recently studied and several test wells have been drilled. Based upon this program the fairly shallow, highly transmissive Gorst Creek

aquifer has been identified. To-date, there has been no major production. This aquifer system could become very important to Bremerton as a groundwater supplement to the City's surface water supply. Monitoring plans should be developed immediately to establish baseline water level conditions prior to initiation of additional production from this aquifer in Wells 31F01, 35R01 and 36R02.

The Salmonberry aquifer system, which is roughly 150 to 200 feet below sea level, is used by both Annapolis and Port Orchard Water Districts. The aquifer may be an eastern continuation of the shallower zone at Bremerton's Anderson Creek well field. The system has been in use for at least 15 years. A monitoring system should be initiated to facilitate evaluation of the aquifer response characteristics in Wells 02M03 and 01K01. The aquifer is thought be extensive to the south. Test drilling about a mile south of the Salmonberry well field in T23N, R01E, Sec 1K is advisable to delineate the southern boundary of the aquifer.

The available hydrogeologic data from the southern portion of the subarea is dominated by shallow domestic wells with occasional wells drilled to moderate depths. Future test drilling in this area should focus on definition of deeper stratigraphy and evaluation of aquifer parameters. Test wells can only be realistically considered where population growth supports the development of larger water production facilities. At the present time these areas appear to be to the south of McCormick Woods and along the State Highway 16 corridor. Deep test wells could be considered in T23N R02E Sec 32L, T22N R02E Sec 07J, T23N R02E Sec 21R, T23N R01E Sec 24G, T23N R01E Sec 35F, T22N R01E Sec 09L, T23N R 01E Sec 28M, T22N R01E Sec 06H, T23N R01W Sec 24R, and T23N R01W Sec 35G. A summary of the recommended monitoring and exploration locations for the South Kitsap subarea can be seen in Table III-5.

2. HYDROLOGIC DATA COLLECTION

A. Stream Gaging

Streamflow data is a critical element in evaluating water balance relationships within any given drainage basin. Streamflow data can also provide insight into possible hydrogeologic impacts related to groundwater development. Currently, there is only one active stream gaging station within the County. The site is located on Big Beef Creek near Seabeck. Previously however, in the 1940s and 1950s many other stations were operated within the County. Additional streamflow data should be collected throughout the County.

Criteria for selecting stream gaging sites would be as follows:

- o Locate sites in proximity to major groundwater pumping centers;
- o Locate sites where historical streamflow data are available;
- o Locate some sites within urbanized areas to evaluate effects of urbanization on runoff; and
- o Accessibility, channel geometry, and other siting factors.

See Table III-6 for potential stream gaging sites listed by subarea.

Implementation of streamflow measurements could be coordinated with the surface water data collection recommendations for Kitsap County's Basin Planning effort. These recommendations have been reported by the Kitsap County Watershed Ranking Committee.

B. Precipitation Monitoring

Precipitation information is a major component in water balance calculations. Accurate and extensive data can help to refine recharge/discharge relationships and provide a more detailed assessment of groundwater resources.

Currently, there is only one active U.S. Weather Bureau site in Kitsap County which is located in Bremerton. Precipitation rates vary widely throughout the County from as little as 20 inches/year in the Hansville area to as much as 80 inches/year in the western portion of the County. Additional precipitation data sites are needed to evaluate this wide range. The orographic influence of the Green and Gold Mountains is poorly understood. Additional data is required to evaluate the distribution of precipitation within this area.

See Table III-6 for potential precipitation monitoring sites.

C. Lakes and Wetland Habitat Gaging

Staff gaging data from lakes and wetlands can provide valuable information on potential hydraulic continuity between surface and groundwaters. Several representative lakes and wetland areas have been recommended for staff gaging data collection, and are listed by Subarea in Table III-6.

3. WATER QUALITY DATA COLLECTION

It is recommended that a water quality monitoring network be developed which acknowledges the impact of land use activities in relation to the hydrogeology of the area. The network should provide adequate background data and continuing water quality information for the aquifers in each subarea. It should incorporate existing monitoring networks where they exist. Indicator water quality parameters have been recommended based on major land use categories found in the subarea, parameters of health concern, frequency of occurrence in the groundwater, and aesthetic parameters which help to assess the hydrogeologic characteristics of the aquifer. Specifically, the parameters have been sorted to reflect potential contamination from land uses associated with urbanization, industrial/commercial, or agricultural activities.

Specific subarea monitoring needs are listed below. These monitoring needs discuss well location, parameters to be measured and the frequency of measurement. In addition to wells located in specific aquifers, an overall network of wells representing the shallow groundwater system have been identified. Evaluation of water quality data from this shallow system will provide overall areal coverage of the County, while wells in specific aquifers will help to assess any impacts on major groundwater resources. A specific network will be prepared during Grant No. 2 activities. Where selected well locations are not yet known, it is noted that well locations are "to be identified." In most cases, the wells recommended for water quality data collection have also been slated for water level monitoring.

A. Hansville-Indianola Subarea

(1) Monitoring Locations

Specific groundwater quality monitoring locations are presented in Table III-7.

(2) Parameters

Parameters should include indicators of agricultural activity and urbanization. Specifically:

Agricultural Indicators

Nitrate
Ammonia
Atrazine
Dicamba
Hexazinone
Methomyl
Picloram
Conductivity, pH
EDB
Garlon
2, 4-D

Urbanization Indicators

Total and Fecal Coliforms
Nitrate
Chloride
Sulfate
Conductivity, pH

Other

Primary/Secondary Contaminants for public water supplies
Volatile Organics

(3) Frequency

Indicator parameters for urban and agricultural land uses should be taken quarterly or twice/year. Background data on volatile organic chemicals should be taken quarterly the first year then twice per year for following years. Primary and secondary drinking water contaminants from public water supplies should be incorporated into the database. These parameters are monitored according to compliance schedules.

B. Bainbridge Island Subarea

(1) Monitoring Locations

Specific monitoring locations are presented in Table III-8.

(2) Parameters

Parameters should include indicators of urban and industrial/ commercial activity, as well as agricultural activity. Specifically:

Urbanization Indicators

Total and Fecal Coliforms
Nitrate
Chloride
Sulfate
Conductivity, pH

Industrial/Commercial

Conductivity
pH
Trichloroethylene
Tetrachloroethylene
1,1,1-trichloroethane
Methylene Chloride
Vinyl Chloride
Cyanide
Chromium
Cadmium
Phenols

Agricultural Indicators

Nitrate
Ammonia
Atrazine
Dicamba
Hexazinone
Methomyl
Picloram
EDB
Garlon
2, 4-D
Conductivity, pH

Other

Primary/Secondary Contaminants for public water supplies
Volatile Organics

(3) Frequency

Indicator parameters for industrial and urban land uses should be taken quarterly or twice/year. Background data on volatile organic chemicals should be taken quarterly the first year then twice per year for following years. Primary and secondary drinking

water contaminants from public water supplies should be incorporated into the database. These parameters are monitored according to compliance schedules.

C. Poulsbo-Bremerton Subarea

(1) Monitoring Locations

Specific monitoring locations are presented in Table III-9.

(2) Parameters

Parameters should include indicators of urban and industrial/ commercial activity, agricultural activity, and saltwater intrusion in the Gilberton-Fletcher aquifer. Specifically:

Urbanization Indicators

Total and Fecal Coliforms
Nitrate
Chloride
Sulfate
Conductivity, pH

Industrial/Commercial

Conductivity
pH
Trichloroethylene
Tetrachloroethylene
1,1,1-trichloroethane
Methylene Chloride
Vinyl Chloride
Cyanide
Chromium
Cadmium
Phenols

Agricultural Indicators

Nitrate
Ammonia
Atrazine
Dicamba
Hexazinone
Methomyl

Picloram
EDB
Garlon
2, 4-D
Conductivity, pH

Saltwater Intrusion

Chloride
Sodium
TDS, Conductivity

Other

Primary/Secondary Contaminants for public water supplies
Volatile Organics

(3) Frequency

Indicator parameters for industrial and urban land uses should be taken quarterly or twice/year. Background data on volatile organic chemicals should be taken quarterly the first year then twice per year for following years. Primary and secondary drinking water contaminants from public water supplies should be incorporated into the database. These parameters are monitored according to compliance schedules.

D. West Kitsap Subarea

(1) Monitoring Locations

Specific monitoring locations are presented in Table III-10.

(2) Parameters

Parameters should include indicators of agricultural and forestry activity. Specifically:

Agricultural Indicators

Nitrate
Ammonia
Atrazine
Dicamba
Hexazinone
Methomyl
Picloram

2, 4-D
EDB
Garlon
Conductivity, pH

Other

Primary/Secondary Contaminants for public water supplies
Volatile Organics

(3) Frequency

Indicator parameters for industrial and urban land uses should be taken quarterly or twice/year. Background data on volatile organic chemicals should be taken quarterly the first year then twice per year for following years. Primary and secondary drinking water contaminants from public water supplies should be incorporated into the database. These parameters are monitored according to compliance schedules.

E. South Kitsap Subarea

(1) Monitoring Locations

Specific monitoring locations are presented in Table III-11.

(2) Parameters

Parameters should include indicators of urban and industrial/commercial activity, as well as agricultural activity. Specifically:

Urbanization Indicators

Total and Fecal Coliforms
Nitrate
Chloride
Sulfate
Conductivity, pH

Industrial/Commercial

Conductivity
pH
Trichloroethylene
Tetrachloroethylene

1,1,1-trichloroethane
Methylene Chloride
Vinyl Chloride
Cyanide
Chromium
Cadmium
Phenols

Agricultural Indicators

Nitrate
Ammonia
Atrazine
Dicamba
Hexazinone
Methomyl
Picloram
EDB
Garlon
Conductivity, pH
2, 4-D

Other

Primary/Secondary Contaminants for public water supplies
Volatile Organics

(3) Frequency

Indicator parameters for industrial and urban land uses should be taken quarterly or twice/year. Background data on volatile organic chemicals should be taken quarterly the first year then twice per year for following years. Primary and secondary drinking water contaminants from public water supplies should be incorporated into the database. These parameters are monitored according the compliance schedules.

TABLE III-1

HANSVILLE-INDIANOLA SUBAREA

POTENTIAL HYDROGEOLOGIC MONITORING
AND EXPLORATION LOCATIONS

STR	Well ID	Aquifer
T28N R02E S22	22N01	Hansville
T27N R02C S28	28C02	Port Gamble South
T27N R02E S25	25E03	Kingston
T27N R02E S35	35K01	Kingston
T26N R02E S09	09H01	Suquamish/Miller Bay
T26N R02E S20	20L01	Suquamish/Miller Bay
T26N R02E S13G	New Well	Poulsbo
T27N R02E S21N	New Well	Port Gamble South
T27N R02E S19E or	New Well	Port Gamble South
S20W	New Well	Port Gamble South
T26N R02E S2J	New Well	Kingston
T27N R02E S09G	New Well	
T26N R02E S06J	New Well	
T27N R02E S18L	New Well	
T26N R02E S03F	New Well	

TABLE III-2

BAINBRIDGE ISLAND SUBAREA

POTENTIAL HYDROGEOLOGIC MONITORING
AND EXPLORATION LOCATIONS

STR	Well ID	Aquifer
T25N R02E	20K01	Gilberton-Fletcher
T25N R02E S09Q	New Well	Meadowmere
T25N R02E	22J02	Wardwell
T25N R02E	15J01	Wardwell
T25N R02E	27E03	Bayhead
	35G01	Creosote
T24N R02E S04B	New Well	Lynwood
T25N R02E S33L	New Well	Lynwood
T25N R02E S10A	New Well	--

TABLE III-3

POULSBO-BREMERTON SUBAREA

POTENTIAL HYDROGEOLOGIC MONITORING
AND EXPLORATION LOCATIONS

STR	Well ID	Aquifer
T27N R01E	27F02	Edgewater
T27N R01E S34R	New Well	Edgewater
T27N R01E S35Q	New Well	Edgewater
T26N R01E	36M01	Keyport
T26N R01E S27P	New Well	Keyport
T26N R01E S01E	New Well	Keyport
T26N R01E S30R	New Well	Keyport
T26N R01E	31B02	Bangor
T26N R01E	19P01	
T25N R01E S03G	New Well	Island Lake
T25N R01E	16J01	Silverdale
T25N R01E	20C01	Silverdale
T25N R01E	29D01	Silverdale
T25N R01E S19P	New Well	Silverdale
T25N R01E	23N02	Bucklin Hill
T25N R01E	22F03	
T25R R02E	19M01	Gilberton-Fletcher
T25N R01E S35R	New Well	Manette-Bremerton
T24N R01E S01P	New Well	
	07M02	

TABLE III-4

WEST KITSAP SUBAREA

POTENTIAL HYDROGEOLOGIC MONITORING
AND EXPLORATION LOCATIONS

STR	Well ID	Aquifer
T25N R01W	14E01	Big Beef
T25N R01W	22A02	Big Beef
T25N R01W	22A03	Big Beef
T25N R01W	22A04	Big Beef
T25N R01W S22N	New Test Well	Big Beef
T25N R01W S23P	New Test Well	Big Beef
T25N R01W S27H	New Test Well	Big Beef
T25N R01W S28Q	New Test Well	Big Beef
T25N R01W S33L	New Test Well	Big Beef
T25N R01W S34H	New Test Well	Big Beef
T24N R01W S03A	New Test Well	Big Beef
T24N R01W S04B	New Test Well	Big Beef
T24N R01W S05D	New Test Well	Big Beef
Other Exploration Locations		
T25N R01W S01F	New Test Well	
T24N R01W S06M	New Test Well	
T24N R02W S01E	New Test Well	
T24N R02W S11F	New Test Well	
T24N R02W S14F	New Test Well	
T24N R02W S30A	New Test Well	

TABLE III-5

SOUTH KITSAP SUBAREA

POTENTIAL HYDROGEOLOGIC MONITORING
AND EXPLORATION LOCATIONS

STR	Well ID	Aquifer
T24N R02E	21B01	Clam Bay
T24N R02E	33J01	Yukon Harbor
T24N R02E S33P	New Test Well	
T23N R02E	10G03	Wilson Creek
T24N R01E	25Q02	Port Orchard-Deep
T24N R01E	26K05	
T24N R01E	33L02	N. Lake Bremerton-South
T24N R01E	33K02	N. Lake Bremerton-South
T24N R01E	09C02	N. Lake Bremerton-South
T23N R02E S09	New Test Well	N. Lake Bremerton-South
T24N R01E	31F01	Gorst Creek
T24N R01W	35R01	Gorst Creek
T24N R01W	36R02	Gorst Creek
T23N R01E	02M03	Salmonberry
T23N R01E	01K01	Salmonberry
T23N R01E S01K	New Test Well	Salmonberry

Other Exploratory Deep Test Wells

T23N R02E S32L
T23N R02E S07J
T23N R02E S21R
T23N R01E S24G
T23N R01E S35F
T23N R01E S09L
T23N R01E S28M
T22N R01E S06H
T23N R01W S24R
T23N R01W S35G

Table III-6 Potential Stream, Precipitation, and Lake Gaging Sites
Kitsap County

SUBAREA	STREAM GAGING SITES	PRECIPITATION GAGING SITES	LAKE GAGING SITES
Hansville-Indianola	Gamble Creek Grovers Creek	Hansville	Miller Lake
Bainbridge Island	Unknown Stream Tributary to Manzanita Bay Unknown Stream Tributary to Fletcher Bay	Winslow	
Poulsbo-Bremerton	Dogfish Creek Clear Creek Steel Creek Barker Creek Steel Creek Chico Creek	Bremerton (exist.) Poulsbo Bangor	Island Lake Kitsap Lake
West Kitsap	Big Beef Creek (exist.) DeWatto Creek	Union River Reservoir/ Gold Mountain Area DeWatto	
South Kitsap	Gorst Creek Blackjack Creek Burley Creek Salmonberry Creek Anderson Creek Wilson Creek Coulter Creek	Burley	Long Lake

TABLE III-7

HANSVILLE-INDIANOLA SUBAREA

GROUNDWATER QUALITY MONITORING LOCATIONS

STR	Well ID	Aquifer
T28N R02E S33	33A01	Shallow System
T28N R02E S21	21C02	Shallow System
T28N R02E S28G	New Well	Hansville
T28N R02E S22	22N01	Hansville
T27N R02E S28	28C02	Port Gamble South
T27N R02E S25	25E03	Kingston
T27N R02E S03	03A01	Shallow System
T27N R02E S14	14L01	Shallow System
T27N R02E S16	16Q01	Shallow System
T27N R02E S07	07A01	Shallow System
T27N R02E S27	27N01	Shallow System
T27N R02E S36	36N01	Shallow System
T26N R02E S09	09H01	Suquamish/Miller Bay
T26N R02E S29	29M02	Shallow System
T26N R02E S12	12P01	Shallow System
T26N R02E S13G	New Well	Poulsbo
Additional Wells in the Hansville Aquifer	To Be Identified	Hansville
Additional Wells in the Poulsbo Aquifer	To Be Identified	Poulsbo

TABLE III-8

BAINBRIDGE ISLAND SUBAREA

GROUNDWATER QUALITY MONITORING LOCATIONS

STR	Well ID	Aquifer
T24N R02E S11	11G02	Shallow System
T24N R02E S04B	New Well	Lynwood
T25N R02E S33L	New Well	Lynwood
T25N R02E S09Q	New Well	Meadowmere
T25N R02E S28	28O05	Shallow System
T25N R02E S29	29J01	Shallow System
T25N R02E S17	17L01	Shallow System
T25N R02E S09	09H02	Shallow System
T26N R02E S34	34P04	Shallow System
T26N R02E S33	33G01	Shallow System
	22J02	Wardwell
	20K01	Gilberton-Fletcher
T25N R02E S03	27E03	Bayhead
T25N R02E S35	35G01	Creasote
Additional Wells in the Lynwood Aquifer	To Be Identified	Lynwood
Additional Wells in the Meadowmere Aquifer	To Be Identified	Meadowmere
Wycoff Facility	To Be Identified	--
Eagle Harbor	To Be Identified	--
Monitoring Wells	To Be Identified	--

TABLE III-9

POULSBO-BREMERTON SUBAREA

GROUNDWATER QUALITY MONITORING LOCATIONS

STR	Well ID	Aquifer
T24N R01F S31	31G01	Shallow System
T24N R01E S06	06K01	Shallow System
T25N R01E S12	12C01	Shallow System
T25N R01E S11	11N01	Shallow System
T25N R01E S25	25J01	Shallow System
T25N R01E S03G	New Well	Island Lake
T25N R01W S01	01A01	Shallow System
T26N R01E S17	17K02	Shallow System
T26N R01E S21	21R01	Shallow System
T26N R01E S09	09R01	Shallow System
T27N R01E S27	27J01	Shallow System
T27N R01E S27	27F02	Edgewater
	36M01	Keyport
T26N R01E S31	31B02	Bangor
T26N R01E S19	19P01	Bangor
T25N R01E S16	16J01	Silverdale
T25N R01E S20	20C01	Silverdale
T25N R01E S23	23N02	Bucklin Hill
	29K01	Gilberton-Fletcher
T24N R02E S07	07M02	Manette-Bremerton
Bangor Sub-base Monitoring Wells	To Be Identified	--
Additional Wells in the Silverdale Area	To Be Identified	--

TABLE III-10

WEST KITSAP SUBAREA

GROUNDWATER QUALITY MONITORING LOCATIONS

STR	Well ID	Aquifer
T24N R01W S11	11C01	Shallow System
T24N R01W S05	05P02	Shallow System
T24N R01W S31	31P01	Shallow System
T24N R02W S24	24A01	Shallow System
T24N R02W S23	23F01	Shallow System
T24N R02W S10	10B01	Shallow System
T25N R01W S23	23H01	Shallow System
T25N R01W S26	26E01	Shallow System
T25N R01W S31	31A01	Shallow System
T25N R01W S33	33F01	Shallow System
T25N R01W S14	14E01	Big Beef
T25N R01W S22	22A02	Big Beef
T25N R01W S22	22A03	Big Beef
T25N R01W S22	22A04	Big Beef

TABLE III-11

SOUTH KITSAP SUBAREA

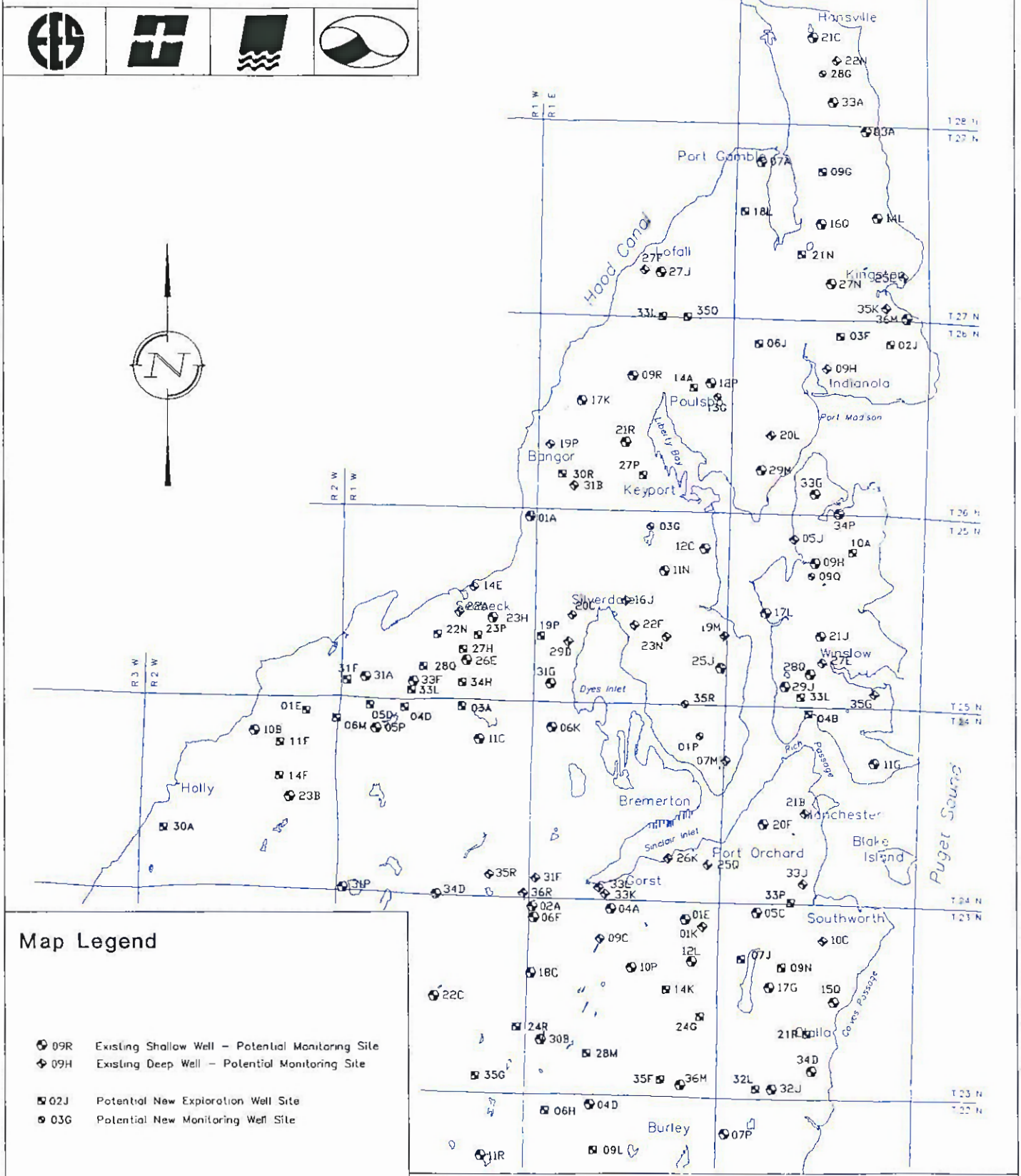
GROUNDWATER QUALITY MONITORING LOCATIONS

STR	Well ID	Aquifer
T22N R01E S04	04O01	Shallow System
T22N R01W S11	11R01	Shallow System
T22N R02E S07	07P01	Shallow System
T23N R01E S10	10P01	Shallow System
S30	30B01	Shallow System
S18	18C01	Shallow System
S06	06F01	Shallow System
S04	04A01	Shallow System
S01	01E01	Shallow System
S12	12L02	Shallow System
S36	36M01	Shallow System
T23N R01W S22	22C01	Shallow System
T23N R01W S02	02A01	Shallow System
T23N R02E S15	15Q01	Shallow System
T23N R02E S32	32J01	Shallow System
T23N R02E S17	17G01	Shallow System
T23N R02E S34	34D01	Shallow System
T24N R01W S34	34O01	Shallow System
T24N R02E S05	05C01	Shallow System
T24N R02E S20	20F02	Shallow System
T24N R02E S21	21B01	Clam Bay
T24N R02E S33	33J01	Yukon Harbor
T23N R02E S10	10G03	Wilson Creek
T24N R01E S26	26K05	Port Orchard-Deep

TABLE III-11 continued

STR	Well ID	Aquifer
T23N R01E S9	09C02	N. Lake Bremerton-South
T23N R02E S9	New Well	N. Lake Bremerton-South
T24N R01E S31	31F01	Gorst Creek
T23N R01E S02	02M03	Salmonberry
Strandley Scrap Metal Site - Monitoring Wells	To Be Identified	--

Kitsap County
Ground Water Management Plan



Map Legend

- 09R Existing Shallow Well – Potential Monitoring Site
- 09H Existing Deep Well – Potential Monitoring Site
- 02J Potential New Exploration Well Site
- 03G Potential New Monitoring Well Site

Scale in Miles
0 1 2 4

EXHIBIT III-1
Location of Potential Monitoring Sites