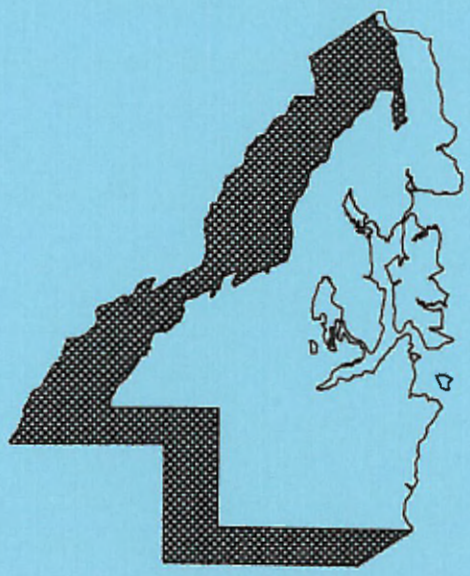
KITSAP COUNTY

GROUND WATER MANAGEMENT PLAN

GRANT NO. 1

BACKGROUND DATA COLLECTION AND MANAGEMENT ISSUES

VOLUME I



April 1991

Prepared By

Kitsap County Ground Water Advisory Committee
Economic and Engineering Services, Inc.
Hart-Crowser, Inc.
Pacific Groundwater Group
Robinson & Noble, Inc.

A Project Funded In Part
Through The
Centennial Clean Water Fund

WASHINGTON STATE DEPARTMENT OF ECOLOGY

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April 28, 1991

File # 41660.0

Ms. Clair Burwell
5028 N.W. El Dorado Blvd.
Bremerton, WA 98312

Subject: Kitsap County Ground Water Management Plan
Grant No. 1 - Volume I & Volume II Report

Dear Ms. Burwell:

Economic and Engineering Services, Inc., in association with Hart-Crowser, Inc., Pacific Groundwater Group, and Robinson & Noble, Inc., is pleased to submit documentation for the Kitsap County Ground Water Management Plan (GWMP), Grant No. 1 activities.

Grant No. 1 activities focused upon the collection and analysis of data used to characterize the groundwater of Kitsap County. Where data was insufficient to accurately characterize conditions of particular interest, a specific program was recommended to collect and analyze additional information during Grant No. 2 activities and in later years. In addition, resource issues and management strategies were identified which require further refinement in Grant No. 2.

This information is presented in two volumes. This letter transmits Volume I. Volume I provides a summary of the approach, major findings, and recommendations of this effort. Volume II presents several appendices of supporting information for the study and each Subarea. The information in this final version of Volumes I and II incorporates appropriate changes and suggestions to the original draft document.

We have enjoyed working with the Ground Water Advisory Committee on this important and challenging portion of the GWMP. We look forward to continued activity during Grant No.2 as refinement and implementation of many of the enclosed recommendations are pursued.

Sincerely,

John M. Maxwell

John M. Maxwell, P.E.
Vice President

JMM:aa:9

Enclosure

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ACKNOWLEDGEMENTS

The authors of the Kitsap County Ground Water Management Plan, Grant No. 1 Background Data Collection and Management Issues, Volumes I and II, would like to acknowledge the extensive assistance by all those contributing to the technical and administrative issues presented in this report.

A Bibliography is enclosed at the back of Volume I to cite the major published and unpublished sources of information used in preparation of the text and exhibits in this document.

Special recognition is provided to the entire Kitsap County Ground Water Advisory Committee and the agencies and individuals listed below who assisted throughout this phase of the project.

Bremerton Kitsap County Health Department

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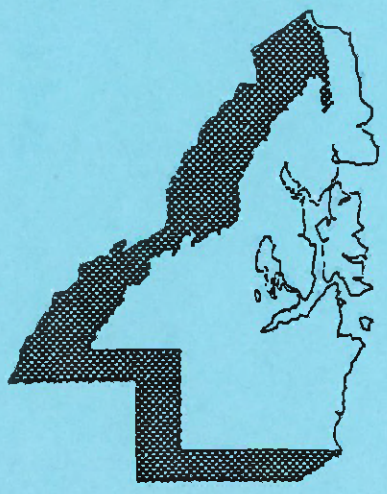

SECTION I

SUMMARY

1. INTRODUCTION

Kitsap County is a rapidly growing area which is heavily reliant upon groundwater resources. The issue of water resource management, both in quantitative and qualitative terms, is a concern shared by the citizens, municipalities, utilities, and County agencies who live in and serve the Kitsap County area. The ever increasing demands for municipal, industrial, domestic, recreational, and aesthetic enjoyment and, to a lesser degree, agriculture and irrigation, have raised questions regarding the adequacy of existing resources to meet the combined demands of all groundwater resource users. In addition, examples of water quality contamination at specific sites within Kitsap County and elsewhere throughout the State and nation have increased the importance in evaluating the quality of the groundwater resources throughout the area.

This document culminates activities for the first of two grants provided by the Department of Ecology (Ecology). The grants, in part, are funding the preparation of a Ground Water Management Plan (GWMP) for Kitsap County. This document has been prepared under a program initiated by the Washington State Legislature in 1985. It directed Ecology to establish a process of designating groundwater areas for development of groundwater management programs. Preparation of the GWMP has been done in accordance with the requirements of Chapter 173-100 WAC, Ground Water Management Areas and Programs. These regulations led to the designation of Kitsap County as a Ground Water Management Area (GWMA) on October 7, 1986. An Interlocal Agreement was entered between the Kitsap County Public Utility District No. 1 of Kitsap County (District) and the Kitsap County Board of Commissioners (County) on December 15, 1986. This Agreement established both entities as co-lead agencies for the evaluation and preparation of the GWMP.

The District is responsible for water resource development and management throughout Kitsap County, whereas the County is responsible for wastewater management. Therefore, the District worked cooperatively with the County to initiate the GWMP process. The District and County have also jointly sponsored the preparation of a Coordinated Water System Plan (CWSP) for Kitsap County. In addition, both entities joined Ecology and the U.S. Geological Survey (USGS) in an earlier groundwater study on Bainbridge Island.

A Ground Water Advisory Committee (GWAC) was formed in accordance with WAC 173-100-050, to guide development of the GWMP. The GWAC is composed of a variety of public and private interest groups. The GWAC submitted a grant request to Ecology on January 30, 1987, for assistance in preparing this document. Notice to proceed on the GWMP was provided by Ecology on December 10, 1987. In view of limited grant funding, preparation of the GWMP was segregated into two grants. Activities of the first grant have focused on collecting and evaluating background data regarding the quantitative and qualitative aspects of the groundwater resource, along with identifying resource management and strategy issues which need to be addressed in Grant No. 2.

This document is presented in two volumes. Volume I provides a summary of the major findings, conclusions, and recommended implementation efforts needed to continue development of the GWMP in the second grant activities. Volume II provides technical supporting data and additional information developed for the study and each of the study's five individual subareas. This first grant effort has initiated action on a variety of management issues and policies deemed appropriate by the GWAC in order to provide a comprehensive management strategy for groundwater resources throughout Kitsap County.

A completed GWMP will be submitted at the conclusion of Grant No. 2 activities. This Grant No. 1 report, and results of Grant No. 2 activities, will be reviewed and accepted by the GWAC and its policy, technical, and public involvement subcommittees. The eventual adoption of the completed GWMP under both grant activities will lead to certification of the GWMP by the GWAC. Certification will be required of all participating GWAC members and State agencies. Affected local governments will eventually need to adopt or amend regulations or ordinances implementing the provisions and recommendations of the GWMP. The document prepared for Grant No. 1 activities does not require certification now but summarizes the basic findings and recommendations to-date.

2. AUTHORIZATION

This GWMP Grant No. 1 report was developed jointly by Economic and Engineering Services, Inc. (EES), Hart-Crowser and Associates, Inc. (HC), Pacific Groundwater Group (PGG), and Robinson and Noble, Inc. (RN). The Consultant team prepared this document under the direction of the co-lead agencies and the GWAC.

3. GOALS AND OBJECTIVES

One of the first activities of the GWAC was to establish goals and objectives to be used as guidelines in development of the GWMP. A general program goal and several specific program objectives were identified by the GWAC. The general program goal for the GWMP was the following:

To ensure an adequate quantity of high quality groundwater through conservation and by adopting and enforcing a sensible Groundwater Resource Plan.

Exhibit I-1 provides a complete listing of the 14 specific program objectives developed by the GWAC and adopted at their January 20, 1988, meeting for preparation of this document.

It is the intent of the GWAC to review and compare the findings and recommendations contained within this document with the original program goals and objectives before initiating work on Grant No. 2. Confirmation or modification of these goals and objectives will be instrumental in developing management strategies during Grant No. 2.

4. STUDY AREA AND APPROACH

The GWMA used for the study includes the entire County and ends at the County border on the south. The GWMP was segregated to provide a more detailed evaluation of five subareas within Kitsap County. These five subareas include: Hansville-Indianola; Bainbridge Island; Poulsbo-Bremerton; West Kitsap; and South Kitsap.

Development of the complete GWMP, as required by Ecology, includes five major phases of work:

Phase 1 - Program Development/Grant Application;
Phase 2 - Public Involvement/Administration;
Phase 3 - Data Collection/Analysis;
Phase 4 - Management Alternatives and Implementation Plan; and,
Phase 5 - Public Review and Adoption.

As mentioned above, Grant No. 1 activities focused primarily on work elements in Phase 3, with initial efforts in Phase 4. The essence of Grant No. 1 was to analyze and trend existing information characterizing the topography/geology, climate, water quality, and water resource requirements of the GWMP. Further, it evaluated land use patterns in comparison to quantitative and qualitative issues. This led to a definition of problems perceived to exist throughout the area based upon existing information. In addition, resource management issues have been identified which may result in the implementation of new or revised local policies, ordinances, or State guidelines and statutes.

Throughout preparation of the document, close coordination was maintained with other State and local agencies, USGS, and the U.S. Environmental Protection Agency (EPA). A master database of hydrogeologic information was developed for Kitsap County. This database relied upon data provided by USGS for approximately 3,350 wells. Data was extracted for approximately 350 reliable

wells with suitable locations. Data for an additional 450 wells was added from reliable data obtained from records maintained by the hydrogeological consultants on the project. Geologic logs for approximately 700 wells were also computerized. This information was entered on a database, in accordance with the Data Management Program established to meet Ecology requirements. Some new information was also collected during drilling of test wells throughout the course of the study. This information was entered into the database only if it conformed to provisions of the Quality Assurance/Quality Control criteria established by Ecology. The information on the database has also been digitized to facilitate computer mapping as generated from information within the database.

Information on water rights and water quality was also entered in the database. Correlation of this information to individual wells was not always possible due to insufficient location information. One major detriment in effectively analyzing water resource/water quality conditions throughout Kitsap County and the State, is the lack of a common identification system. An improved locating system would allow the correlation of water resource data to specific wells and the aquifer they withdraw from. Water quality analyses were evaluated for over 550 wells reported for public and private uses by the Bremerton-Kitsap Health Department (BKHD), Ecology, Department of Health (DOH), EPA, or other entities. Statistical analyses were conducted on over 535 of these wells. The results of key indicator parameters tested since 1970 were analyzed to evaluate regional trends in water quality. Where possible, excessive concentrations of specific test results were evaluated to determine if contamination presence was occurring at a specific location. Results from known contamination sites were not included in the statistical trend analysis in order to not skew the trend results. It was determined by the GWAC that known contamination sites frequently have an abundance of information and did not merit further evaluation. Whereas, these contamination sites are of concern, the GWAC focused on background concentrations and any increasing regional trends in water quality.

Key activities in development of the GWMP document were guided by the GWAC and its three subcommittees. The GWAC met approximately 15 times during preparation of the GWMP and several times previously during development of the Scope of Work and grant application. The Technical Subcommittee met approximately 8 times to review the technical approach, findings, and recommendations within this document. In addition, the Policy Subcommittee met approximately 2 times to address potential management issues, strategies, and policy requirements that will require further refinement in Grant No. 2. The Public Involvement Subcommittee met approximately 15 times to establish a means of advising the community of the ongoing effort, its findings, and generally creating a public awareness of groundwater management goals and responsibilities. During Grant No. 1, the Public Involvement Subcommittee prepared a

Public Involvement Plan. This Plan incorporates a variety of media and public education activities including newspaper articles, speakers bureau at local civic groups, releases for radio and television, and a public workshop during Grant No. 1 activities. All of the above actions were pursued, including presentation of a groundwater fair on April 4, 1989, at Olympic College in Bremerton.

5. RELATED STUDIES

Simultaneous to the development of the GWMP, several other ongoing local activities have complimented the GWMP effort. Listed below are some of these major activities.

A. U.S. Geological Survey

In 1984, the USGS initiated efforts related to an evaluation of groundwater resources on Bainbridge Island. The Island is almost solely dependent on groundwater, as there are no significant surface water supplies. USGS study activities preceded that of the GWMP. However, development of technical information in the GWMP was coordinated between both study efforts.

The objectives of the study are listed below:

- Define, to the extent available data allow, the general lithology of the unconsolidated deposits on the Island and the groundwater flow system within those deposits.
- Define the present quality of groundwater beneath the Island based on data collected during the study.
- Identify groundwater quality problems where they exist.
- Design a monitoring network of wells for determining changes in groundwater levels and quality with time.
- Determine whether the groundwater resources of the Island can be assessed adequately using existing data and data collected as part of this study and, if not, what additional data would be required to do so.

Approximately 250 of 600 recorded wells were selected for field visits, beginning in October, 1984. Selection of wells for field visits was based on several criteria: (1) existence of water level and (or) water quality data; (2) existence of drillers' lithologic logs; (3) geographic location; (4) depth; (5) geologic framework; (6) well use; and (7) permission from owner or tenant to include the well in this study.

The available data allowed a detailed study of the stratigraphy of the upper 200 feet of unconsolidated deposits that underlie Bainbridge Island, based on surface geology, geophysical data, and drillers' well logs. Well yield and specific capacity data were based on reports submitted by drillers to Ecology.

About 210 wells were visited in the spring and fall of 1985 to measure depth to water and to collect a water sample for analyses of specific conductance and chloride concentration. Forty-eight of the samples collected in April were analyzed for major cations and anions, nitrate, iron, manganese, and fecal-coliform bacteria; nine of the 48 samples were also analyzed for trace metals. Water levels and (or) chloride concentrations were measured monthly in 24 selected observation wells to document the magnitude of seasonal fluctuations in those constituents. Water quality data were compared with historical data in an attempt to identify areas where deterioration, especially seawater intrusion, has occurred with time.

The study concluded that Bainbridge Island is underlain by as much as 1,600 feet of unconsolidated glacial and nonglacial deposits of Quanternary age, and that most stratigraphic units have limited vertical and lateral extent. The upper 200 feet of deposits are divided into three permeable, water-bearing geohydrologic units (aquifers) and three semi-confining geohydrologic units. None of the aquifers are laterally continuous across the Island, although water level and water quality data suggest that the stratigraphic units are hydraulically interconnected.

Recharge to the groundwater system occurs throughout most of the Island. Potentially greater recharge occurs, for the most part, near the periphery of the Island. The Island's aquifers are recharged chiefly by direct precipitation and, in part, by leakage through the overlying stratigraphic unit.

Drillers' reports indicate that more than two-thirds of the study wells, as constructed, are capable of yielding from 6 to 20 gallons per minute.

Groundwater on Bainbridge Island generally is suitable for most purposes. However, 3 of 48 samples exceeded the criterion for iron and 19 exceeded the criterion for manganese. However, the criteria exceeded pertain only to aesthetics and not to human health, so the situation is not seen as a major water quality problem.

Water samples for analysis of chloride concentration were collected in April, when groundwater levels are usually highest, and in September, when levels are usually lowest. Median chloride concentrations in September were essentially the same as in April, and wells finished below

sea level contained water with slightly smaller chloride concentrations than water from wells finished above sea level. Because of the physiography of the study area, seawater intrusion constitutes a serious potential threat to the groundwater resources of Bainbridge Island. Seawater intrusion currently is not a problem on Bainbridge Island. Groundwater development on the Island to-date has not been sufficient to induce the movement of seawater into the freshwater aquifers. In order to detect the onset of seawater intrusion, the study recommended development of a network of potential observation wells used to monitor groundwater levels and chloride concentrations. This monitoring network has been initiated.

A comparison of chloride concentrations observed in 1985 with those observed in similar studies in 1967 and 1978 indicates that, of 26 wells, only one showed an increase in chloride concentration with time.

The study concluded that available data are adequate to permit an assessment of the groundwater resources of the Island, but only in a qualitative manner and only for the uppermost part of the thick unconsolidated deposits. The data are inadequate to permit the calculation of a detailed water budget, to delineate the position of the freshwater-seawater interface, to determine the potential for additional groundwater development from known or unknown aquifers, or to assess the effects of such additional development.

The report is available for review and is entitled Preliminary Evaluation of the Groundwater Resources of Bainbridge Island, Kitsap, County, Washington, Report #87-4237.

B. Coordinated Water System Plan

The District has also worked cooperatively with Kitsap County Department of Community Development in preparation of a CWSP for the entire County. The CWSP presents an assessment of municipal and industrial water supply needs in Kitsap County and a program to effectively provide supply and service to customers throughout the area. The CWSP is enacted through Chapter 70.116 RCW. These procedures are outlined in Chapter 248-56 WAC. The Public Water System Coordination Act provides for water utilities throughout the State to coordinate through planning and construction programs with other water utilities and local governments in the same geographic area.

A preliminary assessment was conducted in 1986 for Kitsap County and other areas. The preliminary assessment identified several issues of concern throughout the County that may preclude the delivery of safe, efficient, and reliable water service to its customers. The preliminary assessment made the following conclusions:

- Preventive action for the provision of reliable service and the protection of water supplies serving current customers is prudent and cost-effective.

- The County's Comprehensive Plan projects a continued growth in population and water demand that will most effectively be met primarily by existing water utilities.

- The County currently has more than 800 public water systems, with coordination of utility services only occurring between the major purveyors.

- Preliminary estimates on growth, population, and water demand exceed the anticipated available groundwater resources.

- Ecology has released draft regulations for the Instream Resources Protection Program which severely limit the possibility of developing an Olympic Peninsula surface supply for public water use within Kitsap County. It is necessary to coordinate the water supply development, protection, and transmission, particularly if a new surface water supply is required to meet future needs.

- The existing County Water Plan was completed in 1970, and its findings may no longer be valid.

- With the continued growth anticipated within Kitsap County, the responsibilities for protecting and managing the available groundwater resources consistent with County policies, must be established both for existing and future customers.

The CWSP was prepared under the direction of a Water Utility Coordinating Committee (WUCC). The WUCC is composed of public water systems throughout the area having 50 or more service connections. In combination, it is anticipated that the GWMP study will characterize the groundwater supplies and establish methods to properly monitor and manage the resource. The CWSP provides administrative procedures to ensure the coordinated utilization of the resource and a regional strategy to ensure the public water supplies can meet future demands created by adopting Kitsap County land use policies.

CWSP efforts relating to water resource issues, principally focus upon demand forecasts and comparison to existing water rights and water supply capacities. Water demand forecasts were conducted under four varying assumptions. These evaluated, respectively, the impact of continued consumption at the current rates, reduced per capita consumption created by conservation, reduced consumption created by increased multi-family densities, and reduced consumption created by the combined effect of conservation and multi-family living units. Conservation impacts were assumed to result in a 10 percent reduction in water demands by the year 2000. A similar level of reduced consumption was forecast through the year 2040. The conclusion of this analysis indicated that peak daily water demands would increase throughout the area from approximately 68 MGD in 1990 to between 115 and 133 MGD in 2040 based on the range of demand scenarios.

The CWSP also noted very few systems within Kitsap County having adequate groundwater monitoring programs in place to properly manage groundwater resources. Such a monitoring program should be initiated cooperatively with all water purveyors and local governments.

An evaluation of source alternatives for the Kitsap County are currently being developed and evaluated. Source availability, development problems, water right conflicts, and treatment costs indicate that significant surface supplies within the County will be limited to the 15 MGD current and 20 MGD proposed supply capacity for the City of Bremerton's Cascade Dam Supply System. Further, reliance upon imported surface water from the Olympic Peninsula is considered a potential option if groundwater supplies appear insufficient to meet the high growth rate anticipated in Kitsap County. The City of Bremerton and the District both have 100 cubic feet per second (cfs) water right applications on surface water withdrawals, respectively, from the Hamma Hamma and Duckabush Rivers. Alignments from the transmission facilities are either a submerged crossing of Hood Canal or following the City of Tacoma's powerline right-of-way from Lake Cushman around the southern leg of Hood Canal into Pierce County. This latter alignment provides an opportunity to work with the Gig Harbor GWMP to meet their future supply requirements. The transmission network also facilitates an option for artificial recharge of aquifers in Kitsap County.

C. Local Authorities

A variety of drilling activities occurred during the development of the GWMP which provided useful data to the study. These drilling activities were sponsored primarily by individual utilities throughout the study area.

The majority of these wells were predominantly for test purposes. A total of seventeen wells were drilled which provide useful information for the database:

- o PUD - 4 wells at Keyport, Kingston, and Bainbridge Island which ranged in depth from 805 feet to 1,040 feet. The Bainbridge Island well was drilled near Wardwell Road to a depth of 1,040 feet where data on deep wells is limited.

- o City of Bremerton - 6 wells at Twin Lakes, Gorst, Alder Bottom, Central Valley, and Anderson Creek. These Wells ranged in depth from 55 feet to 327 feet. Some of the wells are intended for increased production with yields up to 1,000 gpm.

- o Manchester Water District - 2 wells were drilled by the District with depths of 269 feet and 356 feet. Yields ranged from 80 to 310 gpm.

- o City of Poulsbo - 1 well to 310 feet deep with a yield of 758 gpm.

- o City of Winslow - 1 well at Sands Road to a depth of 1,053 feet and yields of 288 gpm. This well also helped characterize deeper aquifers on Bainbridge Island.

- o Other Owners - Wells were also drilled by Port Blakely Lumber Company, McCormick Woods Development, and Suquamish Tribe Fisheries at key locations. These wells ranged, respectively, from 958 feet to 270 feet in depth.

These wells were drilled and tested in conformance with the Quality Assurance/Quality Control criteria specified by Ecology for new information collected by the GWMP.

All of the above documents have assisted in building upon information provided in Washington State Water Supply Bulletin No. 28 prepared in 1969, which had previously been the primary document in describing the groundwater system for Kitsap County. All of these major documents have been incorporated into the Bibliography for this report.

6. CONCLUSIONS AND RECOMMENDATIONS

The major conclusions and recommendations of Grant No. 1 activities for the GWMP are summarized below. These statements are based on the information presented within Volumes I and II.

A. Technical

(1) General Issues

Conclusions

Twenty-seven principal aquifer areas have been identified within Kitsap County. These aquifer areas are mainly contained within five stratigraphic units. From shallowest to deepest, the units include:

- Qg1a
- Qg2
- Qg3
- Qg4
- Qg5

The units Qg1a, Qg2, and locally, Qg3 are found above sea level. The units Qg4 and Qg5 are exclusively below sea level. Units Qg1a, Qg2, and Qg3 are the most susceptible to land use impacts given their shallow occurrence.

The productivity within the stratigraphic units is highly variable. The Qg1a, Qg2, Qg3, and rarely, Qg4 are used extensively for domestic and small community supplies. These units, as well as the deeper layer Qg5, serve major water purveyors within localized areas.

Glacial units, designated by the letter "g", are generally coarse grained materials (sand and gravel) deposited in high-energy environments such as meltwater streams and margins of glaciers. Most major aquifer zones occur within these coarse-grained, glacial deposits. Nonglacial units, designated by the letter "n", are generally fine-grained materials (silt and clay) that were deposited in low energy environments such as still or deep water. A few aquifer zones occur within the nonglacial units, but they typically have low yields.

The extent and character of each of the stratigraphic layers are generally well defined in areas of high concentration of well data and poorly defined in areas lacking in data, particularly in the West Kitsap Subarea.

The following is a list of the identified aquifer systems of Kitsap County grouped by the stratigraphic unit in which they are completed.

Qgla

Hansville
Meadowmere
North Lake-Bremerton South (upper)

Qn2

Bangor (upper)

Qg2

Port Gamble
Poulsbo
Wilson Creek

Qg3

Kingston (upper)
Suquamish-Miller
Wardwell (upper)
Bayhead
Lynwood Center
Edgewater
Bangor (upper)
Island Lake
Clam Bay
Manette-Bremerton North
Yukon
Gorst

Qg4

Big Beef
Silverdale
Salmonberry
North Lake-Bremerton South (middle)
Bangor (lower)
Gilberton-Fletcher (upper)

Qn5

Creosote

Qg5

Kingston (lower)
Wardwell (lower)
Gilberton-Fletcher
Keyport
Bucklin Hill
Port Orchard Deep
North Lake-Bremerton South (lower)

Qn6

Keyport

There are large areas which have no presently identified aquifers, especially in the western and southern portions of the County.

- An analysis of recharge and water balance relationships suggest that the western and southern portions of the County may be the most promising areas for additional groundwater supply. The productivity of the various aquifer zones which occur within these areas is poorly defined at this time.

- A relatively extensive network of gaging stations was operated by the USGS in the 1940s and 1950s to assess surface water supply potential within the County. Only one gaging station is currently being operated.

- Precipitation varies considerably throughout the County. Long-term average annual precipitation varies from a low of approximately 20 inches/year in the north portions of the County to as high as 80 inches/year in the west portions of the County. Very little precipitation data is currently being collected within the County. The only long-term precipitation recording station is located within Bremerton.

- In general, water quality conditions evaluated since 1970 throughout the GWMP study area were found to be satisfactory. With the exception of some site specific occurrences of contamination, the available data does not indicate a trend of water quality degradation.

- Naturally occurring concentrations of iron and manganese above the maximum contaminant levels promulgated by State and federal regulations were found occasionally. However, those are an aesthetic concern without health-related impacts. Information regarding organic concentrations within the groundwater was limited. A wider sample base is needed to more thoroughly assess this situation.

- No evidence of saltwater intrusion was noted along coastal wells during the study.

- Expanded water quality monitoring is needed to establish ongoing analysis of background indicator parameters.

- Insufficient data was generally found for accurately correlating pumpage, weather, and water level trends.

- Projected population and total water resource demands within Kitsap County were estimated through the year 2040. Population forecasts were based on 1988 Puget Sound Council of Governments forecasts, with straight-line extrapolation from 2020 to 2040. The population within the GWMP is anticipated to increase from a 1989 population total of 183,400, to approximately 258,600 in 2010, and 366,400 in 2040.

- Total water resource demands are expected to experience similar growth for the combined requirements of municipal/domestic supply, commercial/industrial demands, irrigation, fish propagation, heat exchange, and stock watering.

- Approximately 76 percent of water demands throughout the area are utilized to meet municipal/domestic supplies.

- The combined peak daily water resource requirements for the GWMP study area increase from approximately 74 MGD in 1989 to a range of 123 MGD to 141 MGD in 2040, based on reduced demands created by conservation and multi-family structures. Average daily water resource requirements fluctuate from 32 MGD in 1989 to 48 MGD to 55 MGD in 2040 under the same scenarios.

- An evaluation of water rights issued within the study area indicate that many unused groundwater wells still carry their water rights. This leads to an inflated total of groundwater rights when compared to consumption requirements.

Recommendations

- Additional and continued hydrogeologic data including well construction, geologic logs, water levels, pumpage, and water use should be systematically collected and entered into the GWMP database to provide a basis for ongoing analysis and management of the project area resource.

- Additional well drilling and testing programs are needed and should be coordinated with the water purveyors and the GWMP database to provide a basis for ongoing analysis and management of the project area resource.

- o Additional groundwater quality testing data should be routinely collected throughout the area for inorganic, organic, and bacteriological parameters.

- o Streamflow monitoring is needed throughout the County to establish baseline trends and possible impacts related to groundwater development.

- o Ongoing precipitation monitoring is needed throughout the County to establish a database from which to better assess the spatial and temporal variations of precipitation and other water balance components.

- o A comprehensive ongoing monitoring program including well water levels, pumpage, stream flow, lake levels, and water quality should be implemented throughout the study area.

- o Relinquishment of many existing water rights should be pursued to clean up existing records and establish an accurate assessment of future water right requirements.

(2) Hansville/Indianola Subarea

Conclusions

Principal aquifer systems:

- Hansville
- Port Gamble-South
- Kingston
- Suquamish-Miller Bay
- Poulsbo

- o Hansville - Encountered between +200 and +100 feet Mean Sea Level (MSL) within Unit Qg1a. This sand aquifer is the source for the Hansville area water supply. There are no recorded deep wells in this area which penetrate Qg4, i.e., -300 feet MSL.

- o Port Gamble-South - Encountered between -50 and -175 feet MSL within Unit Qg2. The extent of this aquifer is poorly defined due to lack of wells.

- Kingston - This is a two-aquifer system. The upper aquifer is encountered between -25 and -150 feet MSL within Unit Qg3. The lower aquifer is encountered between -600 and -725 feet MSL in Unit Qg5. These aquifers are inconsistent and localized in nature.

- Suquamish-Miller Bay - Encountered between 0 to -300 feet MSL within Unit Qg3. Aquifer characteristics are fairly well defined. It is unknown if there is any continuity between the Qg3 aquifer in this area and Kingston.

- Poulsbo - Encountered between +170 and 0 feet MSL within Unit Qg2. The extent of this above sea level aquifer is generally not present at sites where ground surface elevation is less than +50 feet MSL.

- Areas of exploration for new water resources are 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 limited recharge area available on the upper peninsula.

Recommendations:

- Deep test wells are needed in the Hansville and Poulsbo areas to explore the presence of Qg4 and Qg5 aquifers, i.e., -300 to -800 MSL.

- A test well is recommended between Suquamish-Indianola and Kingston to verify the continuity of the Qg3 aquifer and the presence of Qg4 and Qg5 aquifers.o Wells should be drilled immediately north of Gamblewood to evaluate the Qg2 and Qg3 aquifers in this area.

- In view of the limited data regarding the availability of the deeper aquifers for the Hansville area, land surface activities should be closely scrutinized to ensure the water quality and quantity of the shallow aquifers are not impacted.

(3) Bainbridge Island Subarea

Conclusions:

Principal aquifer systems:

- Meadowmere
- Wardwell
- Bayhead
- Creosote
- Lynwood Center
- Gilberton-Fletcher

o Meadowmere - Encountered between +100 and 0 feet MSL within Unit Qg1a. Characterized by large variation in transmissivity values (4,000 to 190,000 gpd/ft). The extent of this above sea level aquifer is generally not present at sites where ground surface elevation is less than +50 feet MSL.

o Wardwell - This is a two-aquifer system. The upper aquifer is encountered between -75 and -175 feet MSL within Unit Qg3. The lower aquifer is encountered between -650 to -975 feet MSL. The lower aquifer has major groundwater potential. The extent of the upper aquifer is poorly defined. The extent of the lower aquifer is poorly defined in all directions except to the southwest where the Island Center well has not encountered this aquifer.

o Bayhead - Encountered between 0 and -150 feet MSL within Unit Qg3. The extent of this aquifer is fairly well defined to the north and east, but poorly defined to the south and west. Based on existing information, it appears that the Qg3 is extensively utilized and may be reaching its potential supply capacity.

o Creosote - Encountered between -600 to -800 feet MSL within Unit Qg5 or Qn5. The aquifer's extent is well defined in all directions except to the west.

o Lynwood Center - Encountered between -25 to -125 feet MSL within Unit Qg3. In spite of the presence of several wells within the aquifer, the extent of this aquifer is poorly defined. It is anticipated that this aquifer encompasses a greater area except toward the southeast where bedrock is encountered.

- o Gilberton-Fletcher - On Bainbridge Island this aquifer is encountered between -850 and -900 feet MSL within Qg5. The boundaries are extended to the Manette Peninsula. The aquifer's extent on Bainbridge Island is poorly defined.

Recommendations:

- o A water level monitoring program for all of the designated aquifers should be developed and implemented along with Fletcher Bay which is already sufficiently monitored.

- o Exploration for new aquifers should be conducted in the northern portion of the Island where there is paucity of data, especially regarding the deeper systems, i.e., Qg4 and Qg5 aquifers.

- o Shallow test wells in the area of the Lynwood aquifer system are needed to allow a proper definition of the hydrology and to provide an appropriate water level monitoring network.

(4) Poulsbo/Bremerton Subarea

Conclusions:

Principal aquifer systems:

- Edgewater
- Bangor
- Keyport
- Island Lake
- Silverdale
- Bucklin Hill
- Gilberton-Fletcher
- Manette

- o Edgewater - Encountered between +200 to -150 feet MSL within Unit Qg3. Aquifer characteristics are highly variable. The extent of the aquifer is poorly defined. It is suspected that the Qg3 aquifer may extend south to Bangor, but needs further exploration to confirm this.

- o Bangor - This is a two-aquifer system. The upper aquifer is encountered between +25 to -25 feet MSL within Units

Qg3 and Qn2. The lower aquifer is encountered between -50 to -250 feet MSL within Unit Qg4. The eastern boundary of the aquifer system is well defined. The extent to the north and south of those aquifers is poorly defined.

- Keyport - Encountered between -675 to -800 feet MSL within Units Qg5 and Qn6. The lateral extent of this productive aquifer is poorly defined due to lack of deep wells in the immediate area.

- Island Lake - Encountered between +150 to 0 feet MSL within Unit Qg3. The lateral extent of this productive, above sea level aquifer is generally not present at sites where ground surface elevation is less than +50 feet MSL.

- Silverdale - Encountered between MSL to -250 feet MSL within Unit Qg4. The extent of this moderately productive aquifer is poorly defined. The Qg4 aquifer overlaps the deeper Bucklin Hill Qg5 aquifer at the western edge of Bucklin Hill.

- Bucklin Hill - Encountered between -400 to -700 feet MSL within Unit Qg5. The northeastern boundary of the aquifer is well defined, but the extent in other directions is poorly defined.

- Gilberton-Fletcher - This is a two-aquifer system. The upper aquifer is encountered between -300 to -475 feet MSL within Unit Qg4. The lower aquifer is encountered between -575 to -650 feet MSL within Unit Qg5. the extent of the aquifer system is limited by the lack of deep-well data in the vicinity.

- Manette-Bremerton North - Encountered between 0 to -250 feet MSL within Unit Qg3. Although numerous wells are completed in this aquifer, the boundaries are not well defined though they are assumed not to encompass much greater of an area than drawn.

Recommendations:

- Exploratory drilling is needed between the Edgewater and Bangor areas to confirm continuity of the Qg3 aquifer.

- Deep test wells are needed in the Island Lake area into the Qg4 and Qg5 aquifers.

- o Additional deep test wells are also needed in the Keyport and Silverdale areas to confirm the presence of the Qg5 aquifer.

- o Test wells are needed south of Bangor to penetrate and locate the extent of the Qg3 aquifer in this area.

- o A thorough monitoring system must be developed to assess the results of heavy use in the Gilberton and Manette-Bremerton North aquifer systems.

(5) West Kitsap Subarea:

Conclusions:

Principal aquifer systems:

- Big Beef

- o Big Beef - Encountered between -100 to -250 feet MSL within Qg4. The extent of this highly productive aquifer is poorly defined and probably extends a great distance to the south.

- o It is highly probable that the groundwater production potential far exceeds the demand suggested for projected future population trends for this subarea.

- o The Big Beef aquifer system may provide adequate groundwater supplies for transmission to meet regional demands throughout the County. However, additional groundwater data is needed to fully evaluate this option.

Recommendations:

- o Extensive test drilling of the Qg3 and deeper aquifers is required in this area to define the stratigraphic and hydrologic conditions.

- o The University of Washington's Big Beef Fish Farm and Laks Trout Farm artesian wells should be monitored to measure aquifer stress.

(6) South Kitsap Subarea:

Conclusions:

Principal aquifer systems:

- Clam Bay

- Yukon
- Wilson Creek
- Port Orchard Deep
- Salmonberry
- Northlake-Bremerton
- Gorst

o Clam Bay - Encountered between 0 to -150 feet MSL within Qg3. The extent of this aquifer is limited by the occurrence of the surrounding bedrock Unit Tb.

o Yukon - Encountered between 0 to -150 feet MSL within Unit Qg3. The extent of this aquifer is poorly defined due to a lack of wells with reliable data.

o Wilson Creek - Encountered between +150 to +50 feet MSL within Unit Qg2. The extent of this aquifer is poorly defined, but is suspected to extend appreciably beyond the boundaries as drawn.

o Port Orchard Deep - Encountered between -650 to -1,100 feet MSL within Qg5. The extent of this aquifer is poorly defined due to the lack of deep-well data.

o Salmonberry - Encountered between -150 to -250 feet MSL within Unit Qg4. The extent of this aquifer is poorly defined, again due to the lack of deep wells.

o Northlake-Bremerton South - This system is comprised of three aquifers. The upper aquifer is encountered between +250 to +200 feet MSL within Qg1a. The middle aquifer is encountered between -150 to -200 within Qg4. The lower aquifer is -450 to -525 feet MSL within Qg5. The upper aquifer is found in the southern area of the system and could possibly be extended further south.

o Gorst - Encountered between +50 to -100 feet MSL within Qg3. The extent of this very productive aquifer is limited to

north by bedrock and is poorly defined in other directions. There is the likelihood for a large amount of recharge from the Gold Mountain area.

- o The principal aquifer systems are all located to the north, principally along the more densely populated areas. The southern portion presently has no defined principal aquifer systems.

- o The available hydrogeologic data from the southern portion of the subarea is dominated by shallow domestic wells with occasional wells drilled to moderate depths.

Recommendations:

- o Several dedicated monitoring wells should be established for the Gorst aquifer system and at least one dedicated water level monitoring well is recommended in each of the other defined aquifers.

- o Future test drilling in the southern portion of this subarea should focus on the stratigraphy and aquifer parameters of the deeper aquifer systems below Qg2.

B. Institutional/Management Issues

Conclusions

- o There are numerous agencies at the local, State, and federal level which operate programs with the potential to affect groundwater quality and quantity.

- o In general, these ongoing programs are diligently pursued, but occasionally result in overlapping or uncoordinated efforts.

- o Existing resource management concerns which merit further evaluation include:

  - Data limitations
  - Data management responsibilities
  - Improved inter-agency coordination
    - Uniform Well Identification Numbering System
    - Abandoned Wells

- Water rights
- Aquifer overdrafts and limitation of new wells
- Conjunctive use/artificial recharge
- Public education/awareness

o The County has authority under SEPA (Chapter 43.20C RCW) and the Planning Enabling Act (Chapter 36.70 RCW), to control development so as to protect groundwater. However, conditioning or denial of permits must be based on specific adverse impacts. Furthermore, reasonable mitigation measures must be set forth, or, if no mitigation exists, reasons why impacts are unavoidable must be stated.

o The GWMP Grant No. 1 activities did not establish a basis to render site specific land use decisions based on impacts to either groundwater quality or quantity. However, sensitive areas were established within subareas where land surface practices should be reviewed more closely to assess their impacts.

o Many of the management issues identified by existing technical data require coordinated efforts between various local, State, and federal agencies.

o Coordination and development of some major policy changes and procedures to address the above issues and others established in Grant No. 2 may not be accomplished within a short period.

Recommendations

o Continue during Grant No. 2 to identify local resource management issues and their solutions.

o Encourage a broad base of public and political support for change regarding key management issues.

o Develop regional and State-wide support for legislative change where necessary, to address issues common to areas outside Kitsap County.

o Pursue development of policies by the GWAC and its Policy Subcommittee.

C. Implementation

Conclusions

- The most immediate action items once Grant No. 2 is initiated is implementation of the comprehensive hydrogeologic and water quality monitoring network recommended herein.

- Financial and political support for continued groundwater management activities are required to implement effective management strategies.

Recommendations

- Refine and implement a hydrogeologic and water quality monitoring network to develop comprehensive and sustained background data.

EXHIBIT I-1

KITSAP COUNTY
GROUND WATER MANAGEMENT PROGRAM

PROGRAM GOALS AND OBJECTIVES

WHEREAS, Kitsap County is primarily dependent upon groundwater for the continued viability of water supply to its existing and future citizens, and

WHEREAS, Several existing and potential impacts on the quality and quantity of groundwater resources in Kitsap County have been identified; and

WHEREAS, it is desirable to identify groundwater management procedures that are consistent with both local needs and state water resource policies and management objectives including the protection of water quality, assurance of quantity, and efficient management of water resources to meet future needs; and

WHEREAS, the Department of Ecology pursuant to RCW 90.44.00 and its implementing rules, Chapter 173-100 WAC have designated Kitsap County as a Ground Water Management Area; and

WHEREAS, a Ground Water Advisory Committee has been formed to oversee the development of the Ground Water Management Program, review the work plan, budget, and assure that the program is technically and functionally sound;

NOW THEREFORE, the Ground Water Advisory Committee endorse the general goal and specific objectives listed below to be used in the development of the Ground Water Management Program:

General Program Goal

To ensure an adequate quantity of high quality groundwater through conservation and by adopting and enforcing a sensible Groundwater Resource Plan.

Specific Program Objectives

Evaluate Existing Conditions and Concerns

1. To the extent that available funding permits, define/delineate hydrogeology of the County's aquifers.

2. Establish existing water quality conditions and areas of existing or potential water quality degradation trends.

3. Identify recharge areas and measures to protect them from contamination by surface water runoff and other pollutant sources.

4. Project the current and future water demands and identify pumpage impacts upon groundwater quantity and quality.

5. Evaluate the benefits, advantages, and viability of regional resource utilization.

6. Identify area-wide and subarea groundwater resource issues.

Identify Management Procedures and Responsibilities

7. Identify land use and water use policies which are inconsistent with these goals and objectives and recommend needed changes.

8. Identify management policies and practices which encourage conservation at all levels.

9. Recommend land use policies to protect aquifers and recharge areas.

10. Evaluate the proliferation of individual and small public water supplies and their impact on groundwater resources.

11. Define the long-term priority of use for groundwater.

12. Recommend a procedure for and the responsible entities to continually update and manage groundwater resource data.

13. Review existing laws, ordinances, procedures, responsibilities, and their efficacy with respect to groundwater resource management and protection and recommend such revisions as are appropriate. Identify the proper agency or entity with responsibility for implementation and enforcement.

14. Utilize a citizen participation process in meeting the above objectives.

The above Ground Water Management Program Goals and Objectives are hereby formally reviewed and adopted by the Kitsap County Ground Water Advisory Committee on January 20,1987.

Clair H. Burwell

Chairperson, Kitsap County
Ground Water Advisory Committee