

Leavenworth Water Problems Study

Final Report
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- B. Photo point slide series notebook.
- C. Geotechnical Engineering Studies, Valley View Estates Subdivision. Report to the City of Leavenworth, Gifford Consultants, Inc., June, 1995.
- D. *Wenatchee River Watershed Action Plan: A Plan Containing Nonpoint Pollution Source Control and Implementation Strategies*, March, 1998. *Wenatchee River Watershed Ranking Report Addendum, Technical Supplement 1*, August 1996. *Wenatchee River Watershed Ranking Project Watershed Characterization and Ranking Report*, June, 1994.
- E. Leavenworth Water Problems Study, Landowner cover letter and survey.
- F. Chapter 246-272 WAC On-Site Sewage Systems, Rules and Regulations of the Washington State Board of Health (effective January 1, 1995).
- G. Letter from Keith Tower, Chelan-Douglas Health District, 8/1/98.
- H. *Wetlands Regulations Guidebook*, Publication #88-5, Washington State Department of Ecology, revised December 1994.
- I. Aerial photos of the Leavenworth area (1954, 1975, 1992, 1994).
- J. Leavenworth area excerpt from the hydrogeology map, USFS Wenatchee Watershed Report.
- K. Leavenworth area excerpt from the National Wetlands Inventory (NWI) Map, USFW, 1987.
- L. Soil Survey of Chelan Area, Washington, NRCS 1969, (Leavenworth area mapped on Sheet 28) and Chelan County Area, WA, Comprehensive Hydric Soils List, 4/3/95.
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- P. Climate data, Leavenworth 3 S, Washington, National Weather Service Recording Station for the period of record, 1948-1998.
- Q. *Washington State Wetlands Identification and Delineation Manual*, Publication #96-94, Washington State Department of Ecology, March, 1997.
- R. Field data forms: Ski Hill Inventory Form and Routine Wetland Determination Data Form (1987 ACOE Wetlands Delineation Manual).
- S. Compiled Results Database for 249 parcels in the Leavenworth Water Problems Study.
- T. Summary Database for 249 parcels in the Leavenworth Water Problems Study.
- U. Water reports completed by Cascade Analytical, Inc., on 6/30/98 for 3 samples from the Ski Hill Basin.
- V. Potential funding sources for projects applicable to the Ski Hill Basin, with local case history descriptions, followed by published brochures and informational text issued by these funding sources:
 - Chelan County Conservation District*
 - The Washington State Department of Transportation (WSDOT)*
 - The Washington State Department of Ecology (DOE)*
 - WA State Department of Community, Trade, & Economic Development (CTED)*
 - Washington Wildlife and Recreation Program (WWRP)*
 - Chelan County Public Benefits Rating System (PBRS)*
 - US. Environmental Protection Agency (EPA)*
 - USDA Rural Utilities Service (RUS)*
 - USDA. Natural Resource Conservation Service (NRCS)*
 - USDA Farm Service Agency (FSA)*
 - US Fish and Wildlife Service (USFWS)*
 - Land Trust Alliance*
 - The National Fish and Wildlife Foundation*

INTRODUCTION

Area Description

The City of Leavenworth is located just east of the Cascade Mountains in the Wenatchee River watershed along State Highway 2 (Figure 1). The current population estimate for Leavenworth is 2,250. The 1990 population for the City was 1,692 and for the Leavenworth rural area was 1,445 (Source: Wenatchee River Watershed Report 95-12). The surrounding terrain is very rough with mountains rising to elevations of 5,000 to 8,000 feet within two to ten miles of the City. The Wenatchee Mountains are to the south and the Entiat Mountains are north of the City. These ranges extend in a northwest-southeast direction from the summit of the Cascade Range to the Columbia River. As the elevation increases in a westerly direction away from Town, Highway 2 and the Wenatchee River wind through the narrow Tumwater Canyon. In an easterly direction, the valley widens. Agricultural lands are located in the valleys and along the lower slopes. Rivers are a source of irrigation water necessary for the growing of crops and orchards, as well as an attraction to tourists. The Leavenworth vicinity offers year-round recreation to visitors, and tourism has become the most important base for the City's economy.

This study was initiated by the City in response to several types of water problems reported by landowners residing in the Ski Hill Drive area. The following section describes the course of events that led to this study.

FIGURE 1. Leavenworth area, Northeast portion of the USGS Leavenworth, WA, Quadrangle, 1989.

City Planning Efforts to Date

This section authored by Pam Trudeau, Assistant Planner, City of Leavenworth

The City's land use planning efforts began in the 1960's with the revitalization of Leavenworth into a Bavarian village. Comprehensive land use plans were adopted by the City in 1968, 1972 and 1982. After the Growth Management Act (GMA) was passed in 1990, the City began a process to comply with the requirements of the Act. Residents were appointed to serve on a citizen's advisory committee to formulate a draft comprehensive plan. This draft plan was refined by the Planning Commission and on March 12, 1996, the City Council approved an interim adoption of the comprehensive plan, which was amended and officially adopted on December 10, 1996. Further amendments to the plan were adopted on January 13, 1998, in compliance with GMA's allowance for yearly amendments.

The City's comprehensive plan was developed in accordance with the Growth Management Act to address growth issues in the Leavenworth area. It includes the following elements: housing, land use, capital facilities, utilities, transportation, and economic development. The appendices include: County-wide planning policies, population projection and inventory, capital facility financing plans, fire district financing plans, and a right of way analysis. The plan also includes a land use map with an interim urban growth area (UGA) designated and a transportation system map.

The population projections for the comprehensive plan are based on the 1990 US Census of Population and Housing, and were developed in conjunction with Chelan County and the County-wide Planning Policies. The City's interim UGA includes residential areas with the following densities: RL 20 with a 20,000 square foot minimum lot size, RL 12 with a 12,000 square foot minimum lot size, RL 10 with a 10,000 square foot minimum lot size, and a residential multi-family designation (RM).

In November 1993 the City Council received a request to entertain annexation of the Ski Hill Loop area up to Detillion Road. The Council decided to table the decision for six months so that further information could be obtained on things such as domestic water, sewer, streets, and density and affordability of housing. Personnel from the WA State Dept. of Ecology assisted City staff in looking at part of the proposed annexation area on June 21, 1994. It was concluded that wetlands most likely occur on at least part of the property. Although the City Council voted in July to entertain the annexation, no formal petition was received so the full area was not annexed. The research done in preparation of the staff report on the annexation helped alert staff to the potential water problems in the Ski Hill area.

In 1995, the City became aware of water problems inside the City limits, south of Wheeler Street and west of Mine Street. The first two houses built in the Valley View Subdivision experienced flooded crawl spaces and subsided concrete walkways and steps. The Marson Subdivision just south of Valley View also experienced increased water levels that spring. In a preliminary report, the City contract engineer, Bill Schmidt of IntegriTech, recommended the City commission a water table/drainage study of the subdivision and adjacent areas. On April 11, 1995, the City Council decided to hire a consultant to do a soils study in the Valley View Subdivision. Gifford Consultants, Inc. submitted a report of subsurface explorations and limited geotechnical engineering studies to the City in June 1995 (Appendix C). As a result of the study, the City now requires that property owners in the two subdivisions have their lots evaluated by a soils engineer before a building permit is issued.

City officials were also alerted to the potential for continued water problems in the UGA by increased volumes of water flowing down Ski Hill Drive and across properties to the west of Ski Hill Drive during the winters of 1995/96 and 1996/97. Part of the reason for this occurrence may have been that the County had not been maintaining the ditch along Ranger Road and Ski Hill Drive just north of Pine Street. The City routinely has to clean the drain intakes at Ski Hill Drive/Pine Street and at Poplar Street in the spring and fall, as well as during storm events, in order to keep the drains operational.

These indicators prompted the City to look for a way to get information on the water patterns and trends in the Ski Hill area, much of which is within the City's UGA. If there actually were as much area of high groundwater or wetland as it seemed there might be, the densities that had been planned for the UGA may not be feasible and may need to be revised. It was the City's hope that the information a study would produce would help the City to evaluate the suitability of the current UGA and/or the proposed densities within it.

Regional Wenatchee Watershed Planning Efforts

The Leavenworth Ranger District, USFS, and the Chelan County Conservation District have each recently completed separate Wenatchee River watershed planning documents that focus on water quality. The USFS document, *Mainstem Wenatchee Watershed Assessment*, includes several elements:

- 1) Characterization of watershed;
- 2) Issues related to individual resources;
- 3) Description of both current and historical conditions; and
- 4) Synthesis of the above information which leads to the development of management recommendations.

The Conservation District plan is discussed in detail below because it identifies and addresses many of the same water problems as the Leavenworth Water Problems Study, but on a larger, watershed scale. It is titled the *Wenatchee River Watershed Action Plan, A Plan Containing Nonpoint Pollution Source Control and Implementation Strategies* and was published in March 1998 (Appendix D). The plan was developed by a committee of twenty people formed in 1995 by the Chelan County Conservation District. This committee became the Wenatchee River Watershed Steering Committee. A technical advisory committee was also formed to provide guidance to the Committee. Each sub-watershed was analyzed and ranked in terms of Washington State water quality standards. The plan was then created as a guidance document for entities responsible for protecting and/or restoring water quality in the watershed. The planning process was funded by the Department of Ecology through the Centennial Clean Water Fund in an effort to provide local citizens with the means to develop a local water quality action plan. The document contains recommendations, and action items, with an emphasis on information and education, providing technical assistance, and establishing incentives to protect or improve water quality.

The purpose of the plan is to implement an effective, coordinated program of actions that will identify, correct, and prevent nonpoint source pollution, as well as protecting the beneficial uses of water. The plan identifies the section of the Wenatchee River at Leavenworth and the Chumstick Creek sub-watershed as two of the three main problem areas for water quality. The action plan recommendations are divided into four categories: on-site sewage disposal, agriculture, forestry, and stormwater/erosion. The three categories of action plan goals that pertain to the Leavenworth Water Problems Study are summarized below:

◆ Action Plan Goals for On-site Septic Systems:

1. Inform the public about sewage disposal problems
2. Encourage regular maintenance of on-site systems.
3. Encourage municipal sewers or innovative systems for areas with poor suitability for on-site systems.
4. Identify and provide financial assistance programs to help homeowners repair or replace failing on-site systems.
5. Encourage repair or replacement of failing systems.
6. Be more rigorous and thorough in reviewing new subdivisions and individual sites for suitability of on-site sewage systems.
7. Identify priority or critical septic/water quality problem areas and inform the public (prospective buyers) of these problems.
8. Establish a consistent funding base for the Chelan-Douglas Health District.
9. Create a permit file for all on-site sewage systems in Chelan County.

◆ Action Plan Goals for Stormwater and Erosion:

1. Encourage stewardship through education.
2. Minimize runoff from construction sites and development areas to reduce impacts to downstream land and water.
3. Eliminate impact to surface and ground waters by reducing contamination of stormwater.
4. Determine which eligible industries and construction sites are unpermitted and get them under the appropriate NPDES permit.

◆ Action Plan Goals for Agriculture Practices:

1. Reduce the impact of agriculture practices on water quality in the Wenatchee River Watershed while maintaining the viability of the industry.
2. Promote an environmental stewardship ethic through information and education.
3. Provide technical and financial assistance to encourage use of BMP's.
4. Protect natural ecosystems such as wetlands, stream corridors, and uplands from adverse agriculture practices.
5. Retain and promote the rural/agricultural lifestyle while minimizing negative impacts of agricultural practices on water quality.

The City can use the Leavenworth Water Problems Study to begin a cooperative relationship with the Conservation District to address water problems in tandem. In the fall, 1998, the Chelan County Conservation District began planning implementation of its goals for on-site septic systems. The District has been funded through the Department of Ecology to evaluate on-site systems in identified problem areas and to develop a community education program. The City will provide this study to the Conservation District to help them evaluate the needs of residents in the Leavenworth UGA.

City Identification of Water Problems in Ski Hill Basin

Lands currently designated in the City's UGA were not field-checked for any site specific development constraints prior to being designated within the UGA. Water problems were brought to the City's attention in 1995-98, by residents in a new neighborhood on the west side of the City. The 1995 report by Gifford Consultants, Inc. concluded in part the following:

The western edge of the City of Leavenworth appears to be a historically poorly drained area, as evidenced by the existing springs and the presence of drainage ditches that were built to improve drainage. Although this year's late winter/early spring conditions were unusually wet, we believe that it would be reasonable to expect the ground water level in this area to rise within a foot or two of the surface almost every spring. (Appendix C, page 7)

The presence of these problems suggested that some of the designated UGA lands might have similar water problems and would not be able to support the designated densities. City staff identified the need to know more about the density potential of UGA designated lands, specifically in the Ski Hill Basin. The City did not have funds or staff available to gather the needed technical information, so a volunteer consultant was enlisted. The Washington State Department of Fish & Wildlife and the US Army Corps of Engineers committed technical assistance and field support to the City for the project. A joint meeting of the above parties was held on August 29, 1997, to define the goals and objectives, designate a study site, and to develop a timeline for the project. It was decided that the study area would include portions of the City of Leavenworth, the City's UGA, and parts of Chelan County outside the UGA (Figure 2).

The Leavenworth Water Problems Study

Long Term Goals of the Water Problems Study:

- ◆ To avoid in future developments the water problems current residents have experienced;
- ◆ To have a sufficient amount of developable land within the urban growth area to meet the growth needs of the City; and
- ◆ To protect critical areas within the urban growth area.

The City needs to have information that will enable the City to determine whether or not the current population density projections for the City's UGA need to be reassessed, and subsequently whether or not the location of the UGA should be changed. This project supports these long term goals by providing City staff with a technical tool to use to assist them in making planning recommendations.

Project Objectives

- ◆ Compile a history of water features and problems experienced by landowners in the study area;
- ◆ Assess natural resource features within the study area;
- ◆ Conduct a general inventory of uplands and wetlands areas in order to provide baseline information;
- ◆ Broadly assess wetland functions and values;
- ◆ Determine impacts of wetland areas on the City's UGA as it pertains to projected population densities and population allocation; and
- ◆ Provide preliminary management recommendations regarding strategies for wetland protection in concert with development.

Paste figure 2

Landowner Survey

City staff recognized the need to compile information from the landowners in the Urban Growth Area before designing the field component of the project. The purpose of the fieldwork was to investigate the water problems brought forward by both the City staff and landowners. City staff gave great attention to writing the survey questions and ample space was allowed for landowners to diagram or map their properties. A cover letter explained the reasons for the study and the need for landowner participation (Appendix E). The survey was sent out in January, after the holiday season, to maximize the return potential. Local newspapers printed articles alerting landowners to look for the survey in the mail.

Time Line

August 29, 1997	Preliminary study planning initiated by City staff.
October 14, 1997	Study proposal presented to council. Council approved.
Oct. 1997-Feb. 1998	Reviewed background materials on study area to identify possible, probable, or known water problems.
November, 1997	Plan of action developed to formulate landowner survey.
December, 1997	City prepared landowner survey and map of study site.
January, 1998	City announced survey to local newspapers. City mailed surveys to 266 landowners.
February, 1998	Short articles in <i>Echo</i> and <i>Wenatchee World</i> about survey Extensive article about survey in <i>Echo</i> Landowners returned completed surveys to City.
March 10, 1998	Consultant collected background materials and maps. Postcards mailed to 264 landowners inviting them to 3/18/98 public information meeting concerning fieldwork for the project.
March 11, 1998	Short notice in Brieflies (<i>Echo</i>) on public meeting.
March 18, 1998	Public information meeting held for landowners to ask questions of the City, consultant, & Dept. of Fish & Wildlife.
April, 1998	City staff telephoned landowners for permission to enter their land during fieldwork.
April 15-17, 1998	Fieldwork. Teams surveyed each parcel, collecting data on soils, hydrology, and botany, using wetland delineation methodology.
April 23-24, 1998	
May-July 1998	Hydrogeologist monitored stormwater flows and Bradford well (assisted by City staff).
June 24, 1998	City staff collected 3 water samples for analysis by Cascade Analytical, Inc.
Sept.-Jan., 1999	Fieldwork compiled and report written by consultant. GIS maps prepared by Chelan County Assessor's Office staff
January, 1999	Draft report submitted to City of Leavenworth.

BACKGROUND

Climate

In the study area, precipitation is light in summer, increasing in fall, reaching a peak in winter, and then gradually decreasing in the spring, with an increase in June and a sharp drop in July. Snow generally remains on the ground from mid-December until after the first of March. Summers are warm, dry, and sunny. Average annual precipitation is 25.13 inches (which includes the liquid equivalent of 95.7 inches average annual snowfall). The valley floor is subject to downward air drainage from the surrounding higher ridges. This air pattern reduces the danger of frost in spring and fall. Within short distances up and down the valley, several days' difference in the length of the growing season can be found. Thus, temperatures recorded at the Leavenworth weather station may differ from those in other parts of the valley.

Geology

This general overview is an excerpt of the Gifford Consultants, Inc., geotechnical report, page 4-5, description of the local geology setting (Appendix C). See the hydrogeology results on page 71 of this report for a specific description of the Ski Hill Basin geology.

The City of Leavenworth is located on the west edge of a geologic province known as the Chiwaukum Graben, which is down-dropped tectonic block that is underlain primarily by sedimentary rocks. These rocks are collectively known as the Chumstick Formation and consist of conglomerate, sandstone, and shale. The Chiwaukum Graben is bounded on the West Side by several branches of the Leavenworth Fault.

The area west of Leavenworth and the Chiwaukum Graben are part of the Mount Stewart Batholith and the Ingalls Tectonic Complex. Rocks of the Mount Stewart Batholith are primarily medium grained igneous rocks, which are mafic to intermediate in composition, and include tonalite, granodiorite, diorite, and gabbro. Rocks of the Ingalls Tectonic Complex are primarily mafic metamorphic rocks, including hornblende schist, amphibolite, and biotite schist.

During the Pleistocene Epoch, the mountainous terrain west of Leavenworth was eroded by several pulses of alpine glaciation. Major glacial lobes moved down Tumwater Canyon and Icicle Canyon, deeply scouring these two valleys and depositing glacial drift near their confluence in the vicinity of Leavenworth. The outlet of the Wenatchee River at the confluence area (with the Columbia River) was dammed periodically by glacial ice or drift deposits, causing several successive glacial lakes to form. As the glaciers receded, melt water carried detrital material and deposited it as fine to medium-grained lake sediments. Boulders and cobbles were rafted into the lake on remnants of glacial ice and deposited into finer grained sediments.

City/County Services

Water

City residents are served by the City water plant and are fully metered. The only regions of the UGA in the Leavenworth Water Problems Study served by City water are the residential properties west of Mill and Mine Streets, in the disjunct part of the study area.

Residents of the study area not served by City water rely on individual or private community wells. Well permits are obtained by the well driller from the Department of Ecology. A copy of the well log is on file with the Department. When a private landowner wishes to get a building or septic permit, the Chelan-Douglas Health District requires a *Private Water Review* application. The owner is required to have water samples analyzed for nitrates and bacteria. The water analysis report and a copy of the well log are submitted to the County.

The Health District conducts a physical inspection of the well and writes a report to approve the water source. The well owner may be required to bring the well up to standards. If nitrate levels exceed 10 ppm, this condition is legally recorded on the deed. Septic systems, barns, or penned animals are required to be outside a 100 foot radius around the well. If the well radius extends onto adjoining property, the owner obtains a restrictive covenant that prevents the adjoining landowner from violating the 100 foot restriction zone.

Wastewater

The Leavenworth Water Problems Study included parcels outside of the City limits in Chelan County where residents use on-site sewage systems. The study area is under the jurisdiction of the Chelan-Douglas Health District, which permits and regulates on-site septic systems with quantities less than 3,500 gallons/day. Locally, the rules and regulations of the State Board of Health are followed (Appendix F, Chapter 246-272 WAC On-Site Sewage Systems). These rules are administered under the authority of state law prohibiting discharge of sewage into surface water (RCW chapter 70.05, 70.08, 70.46, and 43.70). The local health officer implements the law for on-site septic systems, including these requirements:

- ◆ Groundwater conditions are evaluated prior to construction of a new system.
- ◆ Owner/operators may be required to evaluate any effects an existing on-site sewage system may have on ground water or surface water.
- ◆ When failure of a system can be demonstrated, the on-site septic system must be brought into compliance with current regulations.

Mr. Keith Tower, Environmental Health Specialist 2 for the Chelan-Douglas Health District, summarized past and current practices for on-site sewage systems in the Ski Hill Basin (Appendix G):

...Prior to 1989, the water table in this area was not completely recognized, and was thought to occur in May and June. Test holes were not required for every site. Therefore, gravity septic systems may have been placed into the seasonal water table...During the drier years of the early 90's, water tables were observed, but were not as high as they have been in recent years. Therefore, some systems may not meet the minimum requirements in the wetter years.

Tower described the current practice of evaluating test holes on new properties for one year, using a perforated pipe to establish the highest seasonal water table (usually in March). The septic system is then designed to fit the site. In some cases, no system is possible.

In the Ski Hill Basin, curtain drains have been installed to lower the groundwater table. The Health District evaluates the curtain drain effect on downstream properties to meet the 30-foot setback requirements and that the discharge not run onto downstream properties. Usually, drainage from curtain drains goes to existing ditches (Tower, personal communication, 10/22/98).

When an existing system shows failure, it is usually not possible to wait one year to establish the highest seasonal water table. In these cases, evidence from the soil column and personal experience in the area are used to determine how to bring the owner into compliance (Appendix G). Once failure has been demonstrated, the system must be replaced with one that meets present requirements. The Chelan-Douglas Health District is working on a plan for monitoring systems in the year 2000, as required by state law. The District is currently pursuing two different funding sources to help residents finance replacement of failed septic systems. The District participated with the Chelan County Conservation District to develop the Wenatchee River Watershed Plan and expect to participate in the implementation of the plan (Tower, personal communication, 10/22/98).

Stormwater

Stormwater in the study area includes surface and subsurface natural flows and runoff from curtain drains, ditches, roadways and structures. The City of Leavenworth has no stormwater treatment system in place. Stormwater is collected at grated culverts and piped underground (Appendix M). The existing City stormwater system consists of 29,389 lineal feet of storm sewer pipe, 90 storm sewer manholes, 27 shared access manholes where sanitary sewer pipe is located above the storm sewer pipe, and seven discharge points into the Wenatchee River. (Source: Appendix D). At this time, no periodic monitoring of the

discharge points is done to determine the impact of stormwater on the water quality of the Wenatchee River.

At several locations, the storm sewer is connected directly to the sanitary sewer because storm sewer was not available at time of construction. The City is not aware of any storm sewer connections to the sanitary sewer in the Ski Hill area. Where connections exist, it is problematic during storm events. Stormwater can overload the sewage treatment plant, causing partly treated sewage to discharge into the Wenatchee River. The City applied for grants in 1997 and 1998 and some funding was received to separate these systems. Work is planned for the sanitary sewer collection system, but has not been scheduled at this time (Mike Deason, Director of Public Works, personal communication, 10/98).

The Chelan County Public Works Department maintains a system of grassed ditches, culverts, and buried pipe that serve to channel runoff in the UGA. The map diagrams Chelan County's collection network for the Ski Hill Basin (Appendix N). Grass growing in the ditches serves to filter sediments out of the runoff. Year-round, County staff checks the ditches regularly to look for excessive sod buildup. Sod buildup is partially caused by winter sand that is washed by rain and snowmelt into ditches. Too much sod impedes the flow of water so the County removes it by excavation. In the summer of 1998, the County ditch paralleling Wheeler Street was deepened, but work was delayed due to excessive soginess of the soil. The stormwater from the Ski Hill Basin enters the City stormwater system at grated culverts (Figure 3). The City of Leavenworth is responsible for checking and cleaning these intake culverts. The City's routine practice during spring runoff and all major runoff events is to monitor all stormwater intakes.

The section of Ski Hill Drive south of Pine Street is problematic to residents that adjoin the west side of the street. Here, the elevation of the street is higher than the adjacent properties. Standard practice for the City is to construct curbs on streets to confine runoff from the street within the street and not allow street drainage to run onto private property. The City recognizes that in some cases, it is too expensive, or impossible due to topography, to construct a street lower than all property adjoining the street.

FIGURE 3. Location map showing an “x” at City of Leavenworth stormwater intake grates where Chelan County stormwater enters the City system. Numbers 1-3 indicate points where the City sampled water quality on June 24, 1998.

Vegetation

The most prevalent native forest community in the study site is classified as the Douglas-Fir Series (See detailed description in *Field Guide for Forested Plant Associations of the Wenatchee National Forest*, Lillybridge, et. al., 1995, USDA F.S. Pacific NW Research Station, Portland, OR). This classification is based on the native plants (i.e. those species that would naturally regenerate) that would be found at a site. Douglas Fir and Ponderosa Pine are the dominant trees and the forest is characterized as open woodlands. Grasses and some shrubs are found in the undergrowth. More detailed identification of the specific plant association must be done on-site due to the wide variation in slope, aspect, and micro-climatic factors.

Much of the study site has been used for agriculture for more than fifty years. Lands with well-drained soils have been used for orchards that are supported by irrigation water. Poorly draining lands have been used as pasture or for hay production. Some of this agricultural land has been converted to residential developments.

One plant species, Wenatchee larkspur (*Delphinium viridescens*) is listed as endangered by Washington State and is known to occur in the Leavenworth area. It is a local endemic, meaning it is only found in the Wenatchee Mountains of Chelan and Kittitas Counties, Washington. Wenatchee larkspur grows where there is surface water or saturated upper soil layers in spring to early summer, with drying in the summer at elevations from 1,800-4,200 feet. There is no State endangered species law, so protection is voluntary. Preservation of rare plants on private property is dependent upon the goodwill and cooperation of landowners.

Fish and Wildlife

Lack of native shrubs and trees as well as the presence of roads and structures have reduced the diversity that likely once existed, particularly in the lower, less seasonal wetland areas. Although a number of animals would be expected to inhabit wetlands in this basin, loss of structural diversity and human disturbance over a long period of time have reduced this function. The Washington Department of Fish and Wildlife Priority Habitat and Species database does not show any documented use of priority species in the study area; however, cliffs, riparian areas (inland adjacent to the study area) and wetlands are priority habitats (Figure 4). Some species that are not wetland dependant would be expected to use this area due to the proximity to Forest Service land, as well as to the Wenatchee River and Chumstick Creek. The Leavenworth area has recently experienced an increased number of reports of black bear and cougar sightings.

FIGURE 4. Washington Department of Fish and Wildlife Priority Habitat and Species database map of priority species in the Leavenworth, WA, area.

The wetlands of the Ski Hill Basin do not support fish, but they have direct influence on anadromous and resident fish populations in the Wenatchee River and Chumstick Creek. The stormwater runoff from the Ski Hill Basin outlets into the Wenatchee River in an area near Blackbird Island which is known to be a spawning area for salmonids. Fish use in the immediate area includes (but is not limited to) steelhead, chinook, bull trout, and west slope cutthroat. As of 3/9/99, chinook, bull trout, and steelhead are listed species under the Endangered Species Act (ESA). Protection of water quality in critical habitat for salmonids listed under the ESA is a high priority. Local governments and private landowners have a responsibility under the ESA to protect and restore these populations. The listing also authorizes the pertinent federal agency to allocate funds to state agencies that are helping conserve the listed species. Listing of a species under the ESA triggers several actions, such as the following:

- ◆ Experts on the species develop a plan outlining steps for recovery.
- ◆ Federal agencies are required to insure that any actions they fund, authorize, or carry out do not jeopardize the continued existence of any listed species.
- ◆ Everyone is prohibited from maliciously damaging or destroying, collecting, or selling the species.

Overview of Wetlands

What Is A Wetland?

Wetlands include permanently flooded aquatic systems and the transitional area leading up to dry uplands. Wetlands vary in size and geographic location. The depth and duration of water in one particular wetland varies greatly, both seasonally and from year to year. Because of this continual fluctuation, the boundary of a wetland cannot always be determined by the presence of water at a single time. Scientists and regulators use different definitions for wetlands; however, all wetlands definitions include three parameters:

- ◆ Water is present, either at the surface or within the plant root zone;
- ◆ Wetlands have unique soil conditions that differ from adjacent uplands; and
- ◆ Wetlands support plants that are adapted to growing in wet conditions (hydrophytes).

(Source: Mitsch, W.J. and J.G. Gosselink, 1993, *Wetlands*, 2nd edition, Van Nostrand Reinhold, New York, N.Y., pg. 22-23.

The federal and Washington State regulatory definition of wetlands is:

Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. (Appendix Q, pg. 9-10)

In addition to these definitions, the Shoreline Management Act (SMA) and Growth Management Act (GMA) definitions add:

Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate the conversion of wetlands. (Appendix Q, pg. 9-10)

Functions and Values of Wetlands

The functions and values of wetlands have only recently been recognized and translated into wetland protection laws and regulations. Wetlands can be called “the kidneys of the landscape” because of the function they perform in water and nutrient cycles. Wetlands function as downstream cleansers for both natural and human sources of waste, and help to control flooding and slow erosion. Wetlands are also an important source of surface water and for ground water recharge. By supporting extensive food chains and providing unique habitat for a wide variety of plants and animals, wetlands serve as “biological superstores”. Wetlands also provide aesthetic and recreational values to people.

What Federal Laws Regulate Wetlands?

At the federal level, “waters of the US” are regulated through the permit and enforcement processes of Section 404 of the Clean Water Act. The term, “waters of the US” has broad meaning and includes both deepwater aquatic habitats and special aquatic sites, including wetlands. Congress recognized the potential for continued and accelerated degradation of the Nation’s waters. The objective of the Act is to maintain and restore the chemical, physical, and biological integrity of the waters of the US. Appendix H, *Wetlands Regulations Guidebook*, contains a thorough description of all federal laws pertaining to wetlands.

The regulatory definition of wetlands is found in the regulations used by the US Army Corps of Engineers (USACOE) to implement the Clean Water Act. The USACOE is required to issue permits for the discharge of dredged or fill material into the waters of the US, including wetlands.

What State Laws Regulate Wetlands?

In the State of Washington, a series of laws affect development activities in and near wetlands. Two of these specifically apply to wetlands in the Ski Hill Basin: the Water Pollution Control Act and the Growth Management Act. Appendix H,

Wetlands Regulations Guidebook, contains a thorough description of all state laws pertaining to wetlands.

State Water Pollution Control Act

The State Water Pollution Control Act regulates the discharge of pollutants into waters of the state, including wetlands. The Washington State Department of Ecology (DOE) implements it. The primary policy stated in the Revised Code of Washington (RCW) 90.48.080, is that it is unlawful to discharge polluting matters to waters of the state. Pollution includes physical, chemical, and biological changes that "...will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to the public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life." (RCW 90.48.020)

State agencies adopt Washington Administrative Codes (WAC) to regulate and implement laws that are part of the Revised Code of Washington. Surface and ground water quality standards are the primary regulations that apply to wetlands. The state of Washington has an anti-degradation policy in order to protect existing and future beneficial uses of surface and ground water (WAC 173-200-030 for ground water, WAC 173-201A-070 for surface water). The regulations specifically require protection of ground water quality, and recognize that surface water from a wetland may become groundwater or that groundwater may enter a wetland.

Additional sections of the water quality regulations specifically address wetlands. The general requirements for protecting surface water quality also apply to wetlands (WAC 173-201A-030, 173-201A-070). Within wetlands, groundwater exchange and stormwater attenuation must be protected. The hydrologic conditions, hydrophytic vegetation, and substrate characteristics (i.e. soils) of wetlands must be maintained (WAC 173-201A-060(10)).

These State standards protect a wide range of beneficial uses including domestic and agricultural water supply, recreation and aesthetic values, and wildlife habitat. Both point and non-point source pollution is covered. Permits are required for any point source discharge into wetlands and a water quality certificate is required for some federal licenses or permits to conduct an activity that may result in a discharge into wetlands. The Department of Ecology issues permits for a limited range of activities. To maintain existing water quality, their general policy is to encourage use of "Best Management Practices" to prevent or reduce pollutant discharges (WAC 173-201A-010).

On-site septic systems have the potential to impact groundwater quality. The Department of Ecology generally discourages the use of septic systems for areas

of concentrated development due to cumulative impacts of a large number of sites. It is problematic to adequately monitor such sites for compliance and difficult to enforce replacement when septic systems begin to fail. The Department of Ecology takes on regulatory authority once an on-site septic system is identified as a source of pollution. This is usually when ground or surface water testing has been required by the health officer for a system in use and pollution is documented.

State Growth Management Act (GMA)

The Growth Management Act requires Chelan County and the City of Leavenworth to protect wetlands through the designation of “critical areas” in their comprehensive plans. Critical areas include wetlands, areas with a critical recharging effect on aquifers used for potable water, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas. There is overlap within the five categories of critical areas and a given wetland may fit all five categories. Thus, the County and City implement the most significant regulations that apply to wetlands. The County identifies a limited number of uses that are allowed in wetlands. Most activities, like construction, must occur beyond certain specified buffer zone widths, which are based on the classification of the wetland. County assessors are required to adjust the assessed value of property that has been designated as a critical area if the designation results in a change of property value.

Christy Osborn, Assistant Director, Chelan County Planning Department, outlined the current practice used to designate wetlands in accordance with the County’s current interim ordinance (personal communication, 10/98). Staff evaluates parcels on a case-by-case basis in order to meet the GMA requirement to designate critical areas. Within the last year, Chelan County adopted the current interim ordinance, prior to which there was little, if any, environmental review with regards to wetlands. When a development or building permit is submitted to Chelan County, the land is evaluated by County staff, with technical assistance from state and federal agencies, to see if it contains wetlands.

County staff first checks to see the parcel’s status on the USFWS National Wetlands Inventory map (NWI), which identifies and classifies wetlands. The classification system ecologically describes wetlands, and each type is coded on the NWI map. These maps are used as a first step to identify the potential presence of wetlands. NWI maps are generally the most accurate national and statewide inventory to date, but discrepancies are often found between the maps and actual site observations. This is due to the scale of the aerial photographs used to create the inventory, and the difficulty in identifying forested wetlands from air photos. Wetlands are dynamic systems, subject to change by human or natural disturbance so maps can become inaccurate. Thus, existing wetlands may not show on the NWI map, or a wetland may not be present, even if the

NWI maps identify wetlands in an area. A disclaimer is printed on each map stating this point. It is necessary to field check the NWI maps to determine the presence or absence of wetlands on a parcel. The County staff will now be able to use the Leavenworth Water Problems Study, which includes a higher level of analysis, as supplemental information to the NWI map.

What Are Seasonal Wetlands?

Some types of wetlands, such as swamps, bogs, and marshes, are easily recognized. The wetlands in the Ski Hill Basin are less distinct. The Ski Hill Basin has historically been used as pasture/hay lands and orchard, and has been altered by decades of agriculture use. Heavy seasonal snowmelt and runoff characterizes the basin in the spring, but these areas are often dry by late summer/early fall. This is a common condition for seasonal wetlands. Because of this fluctuation, water, sewer/septic systems, storm drainage, street, and drainage systems (both effective and ineffective) have been built without first determining if wetlands are present. As a result homeowners have experienced unanticipated water problems such as wet foundations, surface drainage, and saturated soils.

What Is A Delineation?

In order to know if federal and state wetland laws apply to a parcel, the landowner needs to know if a regulated wetland exists on the property. The USACOE developed a technical method to identify a wetland, which is called **delineation**. The 1995 Washington State Legislature enacted a bill (SSB 5776) requiring the State Department of Ecology to develop a wetland delineation manual. The resulting *Washington State Wetlands Identification and Delineation Manual* implements and is consistent with the USACOE 1987 manual and guidances issued since 1987. The complete Washington State manual is found in Appendix Q.

The purpose of delineation is to decide whether or not an area can be classified as a wetland, and to determine its boundary in order to enact applicable federal and state laws. The boundary separates a wetland area from surrounding uplands. Other methods are then used to classify a wetland by type or to assess the wetland's functions and values.

In a delineation, three criteria, vegetation, soils, and hydrology, must be met in order to classify an area as a wetland. The manual lists a series of field indicators that serve as evidence for each criterion. If there is positive evidence of these field indicators, then the criteria have been met. To be a wetland, all three criteria described below must be met. (Appendix Q)

- ◆ Prevalence of Hydrophytic Vegetation. These are water-loving plants adapted to life in saturated, low oxygen soil conditions. They have structural or bio-chemical adaptations that allow sufficient oxygen uptake in low-oxygen environments.
- ◆ Presence of Hydric Soils. Soils that are frequently saturated, flooded, or ponded during the growing season have recognizable features. In these hydric soils, water fills the air spaces making the soil anaerobic, or without oxygen. Hydric soils have undergone chemical changes that have recognizable physical features in the field.
- ◆ Presence of Hydrology. This means the presence of water on a site for a significant part of the growing season. It encompasses areas that are periodically inundated or have soils saturated to the surface during the growing season.

How Are Criteria Met In A Delineation?

In a delineation, a site is tested to see if it meets all three criteria of hydrophytic vegetation, hydric soils, and hydrology. It requires a qualified professional to conduct a delineation. An area that is found to have positive field indicators for each of the three criteria is a jurisdictional wetland. There are special procedures to follow for some problem or disturbed sites, as defined in the state manual's methodology (Appendix Q, pages 71-85). Wetlands are systems subject to change, so delineation results may differ from year to year. Delineations are conducted at the time of a proposed project to determine the location and extent of wetlands and applicability of federal, state, and local regulations.

Use of Delineation Methodology for This Study

The Leavenworth Water Problems Study is not a full delineation of wetlands that occur in the study area. One of the objectives was to conduct a general inventory of lands within the study area. The study utilized the delineation criteria each time a soil pit was dug and a data sheet is on file for each soil pit. Specific boundaries between uplands and wetlands were not determined. The presence of wetlands on a parcel will probably necessitate consultation and may require permits with federal or state agencies.

In this study, each surveyed parcel received a designation of its likelihood of containing a wetland, based upon field indicators for hydrology, soils, and plants. When the study area is viewed as a whole, the County and City can use it as a tool to help them determine an appropriate location for the Urban Growth Area. Additionally, staff can use the study's results to help evaluate building or development permit applications for individual parcels, and to help determine if a delineation is necessary on a site.

METHODS

Landowner Survey

266 surveys were mailed to landowners in the study. For landowners owning multiple parcels, only one survey was mailed to cover all properties. A follow up postcard reminded landowners to return their surveys and announced the public information meeting held March 18, 1998. At the meeting, all landowners in attendance were asked to clarify and confirm (on a map) specific items they discussed in their surveys. Some surveys were returned after the public meeting. In late March and April, 17 additional surveys were mailed out: nine were sent to people in the southwest area of the study who had not yet been mailed a survey and six were sent upon request to City residents who lived adjacent to the study boundary. One was mailed to former long-time residents within the study boundary and one was mailed to the Chelan County Public Works Department shop in Leavenworth.

Assembly of Background Material

Existing sources of information and data about the study area were assembled and used in research and to help design the fieldwork. A packet of background information was assembled and mailed to each field investigator prior to their arrival to do field work. These sources are listed below:

Aerial photographs (Appendix I)

Aerial photos were found for the study area on file at the Wenatchee National Forest Supervisor's Office in Wenatchee, WA. , for the following dates: 10/15/1954, 8/12/1975, 7/15/1992, and 9/8/1994 . No photos were available for spring or early summer.

USGS Topographic Map (Figure 1)

Leavenworth, Washington, Quadrangle, 7.5 Minute Series (scale of 1:24,000), Provisional Edition, 1989.

USFS Hydrogeology Map of Chelan County (Appendix J)

Prepared as part of the Wenatchee Watershed assessment report, by Taboc, et.al.

Chelan County Section Parcel Maps & Plat maps and their digitized GIS format (Figure 2)

The Chelan County Assessor's Office maintains these maps, allowing identification of a parcel by number. All land in the study area was identified by parcel number. A computer database allowed correlation between parcel number and study results in a GIS map format.

National Wetlands Inventory (NWI) Map, Leavenworth 1987 (Appendix K)

These maps were prepared in 1987 by the US Fish and Wildlife Service by stereoscopic analysis of high altitude aerial photographs (scale of 1:58,000). Wetlands were identified on the photographs based on vegetation, visible hydrology, and geography using the Cowardin classification system. The following wetland designations are found on the N.W.I. map in the study area:

- PEMC - Palustrine, emergent, seasonally flooded
- PSSA - Palustrine, Scrub/shrub, temporarily flooded
- PSSC - Palustrine, Scrub/shrub, seasonally flooded
- POWHx - Palustrine, open water, permanently flooded, excavated

In the study area, POWHx designation was found once, showing a pond (ID #185) that is surrounded by PEMC. For these results, it is categorized as PEMC. Two excavated ponds were observed in the field (ID #42, 49) but were not designated on the 1987 NWI Map, suggesting excavation after 1987.

Soil Survey of Chelan Area, Washington, NRCS 1969 and Chelan County Area, WA, Comprehensive Hydric Soils List, 4/3/95 (Appendix L)

The survey describes soils present in the study area. The map of the study area is Chelan County Area, Washington Sheet Number 28 (Scale 1:20,000). It is not designed to identify a soil at a specific site, but rather to be compared with soils found at a site visit. The separate list of hydric soils is a supplement to the survey.

City Stormwater Drainage Map (Appendix M)

The stormwater drainage map for the City of Leavenworth was used to locate points of entry for County storm water to the City's system.

Chelan County, Ski Hill Basin, Stormwater Drainage Map (Appendix N)

Hand-drawn map based on driving tour of the area given by Chelan County Public Works Department, Leavenworth Foreman on 3/19/98.

Engineer Study (Appendix C)

Geotechnical Engineering Studies, Valley View Estates Subdivision, Leavenworth, Washington (June, 1995).

Department of Ecology Well Log Records and Chelan/Douglas Health District site evaluation reports (Appendix O)

Climate data (Appendix P)

Information was obtained from the Leavenworth 3 S, Washington, National Weather Service recording station for the period of record 1948-1998. It included general climate summary for precipitation, monthly climate summary, and monthly average total precipitation. It can be accessed via web site

(<http://www.wrcc.dri.edu/cgi-bin>) at the Western Regional Climate Center, Desert Research Institute, Reno, Nevada, (702) 677-3106.

Washington State Wetlands Identification and Delineation Manual, Publication #96-94, Washington State Department of Ecology, March, 1997 (Appendix Q).

Photo Documentation

Starting on March 19, 1998, a series of slide photos were taken to periodically document water features such as ponds, channels, or ditches during the growing season. These sites were visible from public roads. The study data notebook lists the photo points and dates. Photos are labeled by parcel identification number and landowner name, and are filed together in the data notebook (Appendix B). The purpose of the slides was to document the presence of hydrology during the growing season, as evidenced by green, growing plants.

Video camera footage with location narration was filmed on many of these days while driving the roads within the study area. Time did not allow inclusion of this data in the study results.

Field Work

Field work was planned and directed by Susan Ballinger, and took place on April 16, 17, 23, and 24, 1998. Over the four-day period, 8 volunteer wetland scientists from six federal or state agencies participated as field investigators. On April 16-17, a botanist and a soil scientist visited the survey teams to provide technical assistance.

Field teams of two or three people were formed and assigned a set of parcels to visit. For each parcel, the team filled out a "Ski Hill Inventory" form and sketched the site, if appropriate. Information from the landowner surveys and conversations with landowners on-site were recorded on the inventory form by parcel ID number (Appendix A).

Permission to enter property was obtained by telephone by City staff. Properties where permission was either not able to be obtained or was expressly denied were visually observed from public right-of-ways and information was recorded on the inventory form. Field investigators attempted to make contact with property owners who had given advance permission before collecting data on the parcel. If a residential parcel was completely landscaped, only visual observations were made. Working orchards were not field surveyed. Due to time constraints, some parcels were not visited and noted as such. On the first day of fieldwork, the City asked the teams to do a full delineation on one part of Parcel #241701550030 (ID #157y), which adjoins the Club West facility to the north.

Application of Delineation Methodology

The primary goal was to gather data that would allow assessment of each parcel for its likeliness to either contain a wetland or to be all upland. Where it was possible to dig a soil pit, the delineation procedures specified in the *Washington State Wetlands Identification and Delineation Manual* (Appendix Q) were followed and a routine wetland determination data form was completed (Appendix R). Fieldwork was conducted during the growing season.

Vegetation was identified using *Flora of the Pacific Northwest* (Hitchcock and Cronquist, 1981). The April fieldwork for this study was conducted before most plants contained mature reproductive parts; thus identification to species was not possible in most cases. Field investigators identified the dominant plant species at each soil pit to the genus level and a plant was collected if it contained reproductive structures. Botanists were given these plants to identify to species in the lab.

Vegetation was classified per the *USFWS National List of Plant Species that Occur in Wetlands (Biological Report 88 (26.9) and December 1993 Supplement)* with:

- ◆ Obligate Wetland (OBL) species occurring in wetlands 66-99% of the time,
- ◆ Facultative (FAC) species occurring in wetlands 33-66% of the time,
- ◆ Facultative Upland (FACU) species occurring in wetlands 1-33% of the time,
- ◆ Upland (UPL) species occurring in wetlands less than 1% of the time.

A plus sign (+) following the code indicates a greater likelihood for a species to occur in wetlands and a minus sign (-) indicates a lesser likelihood. Hydrophytic vegetation consists of a plant community in which greater than 50% of the dominant species are FAC or a “wetter” code, or any plant community growing on hydric soil and experiencing wetland hydrology.

Soil colors were identified by comparison to the *Munsell Soil Color Charts* (1994). Soils exhibiting matrix chroma values of 1 or less in soils without mottles, chroma values of 2 or less in soils with distinct mottles, or Gley colors were considered hydric, as were soils experiencing wetland hydrology and supporting hydrophytic vegetation.

Wetland hydrology was identified by direct observation on site. Positive wetland hydrology was indicated by visual observation of inundation, soil saturation, or by observation of features identified in the State manual (Appendix Q, pages 31-34).

Mapping

At the end of each two-day fieldwork session, each team compiled a map, including all of the parcels they surveyed. These maps are in the data notebook (Appendix A). The field observations for each parcel were recorded on a Ski Hill Inventory form, on the routine wetland determination data forms, and as sketches.

Selected data for each parcel in the study was entered into a database associated with the Chelan County Assessor's digitized parcel maps. Graphic display of each parcel's identification number, wetlands likeliness code, hydrology, and soil field indicators were then printed out as Geographic Information System (GIS) maps (Figures 5, 6, and 7).

Database Management

All landowner surveys, field forms, data sheets, hand-drawn maps, and slides, are compiled in the data notebook and filed by the parcel's assigned identification number (Appendices A and B). The information gathered for each parcel was transcribed into an Excel database where each parcel is referenced by its assigned identification number (Appendix S).

Some parcel identification numbers are followed by a small letter "b" or "c". In these cases, one landowner owns more than one parcel in a group which was not known when the ID# was first assigned. One parcel, identified as #157, was very large and necessitated subdivision on the study map and in the database into #157, #157x, and #157y. Most of #157 was under cultivation as orchard and was not visited by field teams. #157x, located south of Club West on Titus Road, is not in orchard and field investigators dug 4 soil pits there. In the study, each of these identification numbers are tallied as parcels, even though they are technically all part of one Assessor's parcel.

The City is considering using the land that is identified as parcel #157y for a proposed aquatic center. During the field work, over 20 soil pits were dug on this site and examined. The site proved to be very complex, consisting of a mosaic of uplands and wetlands with signs of being actively drained. A full delineation of this difficult site was not completed. All the data gathered for this land is not included in the study's database. Soil pit data from two representative sites (one upland and one wetland pit) are included in the study data and identified as #157y.

Field data and survey information were used to assign each parcel a “wetlands likelihood” category which was then entered into the database. If a wetland was deemed likely on any part of the parcel, the entire parcel was given the designation. One of four likelihood designations was given to each parcel:

- (1) Wetlands likely present in the parcel;
- (2) Parcel is likely a filled or drained wetland: may or may not be a wetland;
- (3) All of the parcel is uplands, no wetlands likely; or
- (4) Unknown likelihood for wetland presence/absence.

Water Quality Testing

Funding was not available to conduct water quality testing as part of the field component. On June 24, 1998, City staff did collect water samples at three locations in the Ski Hill Basin (Figure 3). Samples were taken to Cascade Analytical Inc., Wenatchee, on that same day for nitrate/nitrite and fecal coliform testing.

Hydrogeology Field Work

Hydrogeologist, Al Wald, Washington State Department of Ecology, conducted independent fieldwork as part of the Leavenworth Water Problems Study, which extended into late summer. He measured stream flows, water level changes in wells, and discharge at storm drains, as well as utilizing well log data and climatic records. The report is presented in the Hydrogeology Report on pages 71-79.

RESULTS

Landowner Survey Results

Eighty-eight of the two hundred sixty-six landowner surveys were returned (33% return rate). The consultant recorded the parcel number represented by the survey on the top of the survey. Surveys are organized by parcel number in the field data notebook (Appendix A), which is available for public viewing at Leavenworth City Hall. Summaries of the landowner comments were typed into the Excel database that contains the field findings (Appendix S).

After reading the surveys, the consultant compiled a list of water problems identified by landowners. The summary list of water problems also includes items of concern identified by City staff (page 40). The following excerpts from eleven of the surveys represent the most serious types of flooding and development problems reported:

...More difficult to use as pasture and for hay in recent years because of more water for longer periods in soil...

Allan K. A. Marson, north side of Poplar Street-western terminus Parcel ID#2

...(During spring runoff), the ditch down Ski Hill (Drive) stops up and floods the whole front of my property..and..a stream flows across Marson property and floods the back yard and two neighbors S(outh) of me...

William R. Garrecht, 515 Ski Hill Drive (south of Pine Street) Parcel ID#10

...I have noticed over the last few years that the surface water on the property has flowed longer and longer...Water normally flows only into late spring, however now we are seeing water spread out and flowing for most of the year...This, I believe, is due to a variety of things such as the Fires of 1994, new development by surrounding landowners, surrounding landowners diverting water from their property, Chelan County not maintaining the road ditches, and us not maintaining the open ditches that annually drained the fields...

Brian Vincent, regarding land owned by Mrs. Janet Moettler,
40 acres around the Wheeler Street area Parcel ID# 13, 13b, 13c, 22, 136

...Water flowed into crawl space 1995/96 and 96/97 winters for the first time since property has been in family (since 1934).... The objective of streets with storm drains is to drain excess water from private property, not the reverse as happens along much of Ski Hill Drive within the City limits...

Kjell M. Bakke, 413 Ski Hill Drive (south of Pine Street) Parcel ID#19

...(Responding to question asking if streams form on property)..our back yard- (has) standing water and in some springs, a running stream...March to early April- last few years, some (water present) all summer...Near FLOOD 2 years ago- water in garage and running down street.

Bill & Sally Bauer, 427 Ski Hill Drive (south of Pine Street) Parcel ID#20

...You dig down 24 inches and you (have) a mini well year around. I have spent over \$30,000 having a special foundation constructed that floats the house... The (previous) old property (house) built in the early 1900's and raised in 1991, was sinking. We had to have the foundation jacked up every other year before we built our new home...We installed approved storm drains (County and City approved in '92) costing over \$8,200 to just barely control water flow...this drainage has saved the Catholic Church from being flooded every year...

John W. McCollum, 12686 Wheeler Street, Parcel ID#23

...In the spring, the water bubbles up in the crawl space and must be pumped out....

Scott Bradshaw, 12754 Ranger Road (north side) Parcel ID# 32

...Here is our new \$16,000 raised septic system...

Phil Bradshaw 12752 Ranger Road (north side), Parcel ID# 33

In conversation with field team on 4/16/98

...High water table making it difficult and costly for sewage disposal...we installed a curtain drain to protect a proposed septic system...A variety of wetland species thrive in the lower 1/3 of our property.

Roy and Jan Wood, 12849 Ranger Road (south side) Parcel ID# 48

...Land is too wet to farm, we believe we can farm again after Tumwater Mountain revegetates...

Gordon Marson, Ranger Rd. (south side) Parcel ID# 52, 52b, 52c

...My basement has water in it all the time. It's unusable..(our) basement walls are destroyed...

Linda Phippen, 10285 Ski Hill Drive (east side, at Village View Drive) Parcel ID#107

Three regions of the UGA initially included in the study area were excluded based on the lack of water problems reported by landowners in these areas. Parcels in the East Leavenworth Road, River Bend Drive, and Varney's Addition areas were taken out of the study, due to lack of reported water problems and the existing intensity of residential development. Figure 2 shows the modified study area map used for the field component.

The water problems identified by landowners and City staff for the Leavenworth Water Problems Study are summarized below.

Development Issues

- ◆ The City of Leavenworth has projected high-density residential development for the Urban Growth Area (UGA). City staff has concerns that parts of the UGA may not be able to support this projected level of density due to surface groundwater conditions and/or the presence of seasonal wetlands.
- ◆ Private landowners and the City of Leavenworth staff need more information about the methods used to identify seasonal wetlands and the laws that regulate wetlands and the use of fill.
- ◆ Landowners in the City and in the UGA are encountering unplanned expenses, time delays, and site work to proceed with building plans or to modify existing structures to cope with seasonal high water tables and seasonal runoff.

Flooding Issues

- ◆ Landowners in the area west of Ski Hill Drive and south of Maple Street have reported longer periods of increased wetness on their land since 1994. Landowners inside the City limits west of Ski Hill Drive have reported recent seasonal problems with high groundwater table, seasonal flooding and sheet flow.
- ◆ The City of Leavenworth stormwater drainage system is servicing both City and Chelan County stormwater from the Ski Hill Basin. During storms and spring run-off, the capacity of the intakes is not adequate. Ponding and sheet flow sometimes occur at the entry points into the City stormwater drainage system at Ski Hill Drive and Pine Street and at Poplar Street. This sheet flow has impacted adjacent private properties.
- ◆ Installation of curtain drains and French drains on private parcels has resulted in concentrated flow down gradient onto adjacent properties.
- ◆ Ski Hill Drive, from Pine Street to West Street, has stormwater entry road drains at a higher elevation than the adjacent properties. Thus, water sometimes sheet flows onto property west of Ski Hill Drive instead of entering the drains.

Water Quality Issues

- ◆ Homes in the Ski Hill Basin primarily utilize on-site septic systems. Few are designed to operate in soils saturated to the surface. Failure of these systems is very likely during months when the groundwater table is at the surface.
- ◆ The creek that flows from Anderson Canyon south along the western edge of Ski Hill Basin is channelized and ditched south to Ranger Road. Riparian vegetation is lacking along most of the waterway. South of Ranger Road, ditching stops and the creek sheet flows southward.
- ◆ Installation of drains has decreased the water quality functions of the wetlands in Ski Hill Basin.

Aerial Photo Record

The available aerial photos series were all taken in mid to late summer, and therefore were not useful in detecting seasonal surface hydrology for this study. However, land use changes over time in the Ski Hill Basin are evident on the photos (Appendix I). In all of the photos, dense residential use inside the Leavenworth City limits fills the southeast portion of the Ski Hill Basin, extending to the Wenatchee River. The 1954 and 1975 photos document the prevalence of irrigated orchards in the north part of the Ski Hill Basin, and pasture/croplands in the middle and southwest parts of the basin. Between 1954 and 1975, the ratio between agricultural and residential uses remained fairly constant for the entire Ski Hill Basin. Comparisons between the 1975 and 1994 photos show a shift in this ratio, specifically in the western third of the basin, where residential use replaces pasture/croplands. A reduction in orchard use and an increase in residential use is also seen in the north part of the basin.

Wetland Determination Results

The three criteria used in wetlands delineation, soils, surface hydrology, and vegetation, will be presented separately in the section that follows. Appendix S contains all the compiled data gathered for the study's 249 parcels for these three criteria. Appendix T contains the summary database displaying wetland likeliness, hydrology criteria and soil criteria results by parcel number and identification code for the 249 parcels.

Soils

Soil series identified as Burch (BuB, BuC) Varelum (VaC, VaD, VaE), and Stemilt (StD) prevail in the northern parts of the Ski Hill Basin study area. Soils in the Peoh (Pe), Peshastin stony loam (PID), and Leavenworth (Lh) series characterize the southern parts of the Ski Hill Basin study area and much of the City. A unit of Cle Elum-rock outcrop (CoF2) is found in the southeastern section of the study site. The eastern edge of the study area includes a corridor of land along Chumstick Creek with soils in the Burch (BuA, BuE, BuC), Brief (BrA, BrB, BsD) and Cashmont (CcB) series. Part of the study area was disjunct from the main study area, and is located on the southwest side of the City, adjacent to Highway 2 at the entrance to Tumwater Canyon. Here, areas of Rock outcrop (Ro) and the Wenatchee soil series (WeB) are found.

Two soils found in the study area, the Leavenworth series (Lh) and the Peoh series (Pe), are listed as hydric in the *Chelan County Area, Washington, Comprehensive Hydric Soils List* (Appendix L). Hydric soils form under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, July 13, 1994).

Peoh silt loam (Pe) is a hydric soil. The soil survey describes Peoh silt loam (Pe) as consisting of poorly drained, medium-textured soils found on terraces and in depressions on uplands, with an average slope of 2%. Included with this soil in mapping were small areas of Burch and Brief soils and some areas that were steeper than this soil. Also included were some areas of soils that have a thin surface layer of muck. The soil permeability is slow and runoff is characterized as ponded to very slow. A seasonal high water table is at a depth of 0-2 feet. The soil survey reports that the soil is mainly used for pasture and hay, and describes it as a Wet Meadow range site not suitable for orchards or woodlands (Appendix L, pgs. 36-37).

Leavenworth fine sandy loam (Lh) itself is not a hydric soil, but has wet spot inclusions. It is found on low terraces and bottomlands adjacent to streams, and slopes average 1%. Permeability is moderate and runoff is very slow. The soil is mainly used for irrigated pastures and/or orchards (Appendix L, pg. 31).

During the field work for the study, soil pits were dug as part of the determination procedure. Table 1 displays the results for the fifty-nine soil pits. Thirty-five pits were found to be hydric, and twenty-four pits were not hydric. Figure 5 displays the soil pit results, showing the presence of hydric soils, presence of non-hydric soils, and presence of both soil types by parcel.

Ron Myhrum, Resource Soil Specialist, Natural Resource Conservation Service, examined soil pits in the study area on April 16-17, 1998, to aid in the field identification of hydric soils. He detailed and confirmed the findings of the soil survey, as described in his report on page 70.

Paste on Figure 5

TABLE 1. Fifty-nine soil pits examined for the Leavenworth Water Problems Study, April 16-17, 23-24, 1998. Parcels identified with ID#, published soil type, and field findings using delineation methodology. Soil pit either met field indicators for the hydric criteria (yes) or did not meet the field indicators for the hydric criteria (no).

Site soils listed as <u>not hydric</u> On Comprehensive Hydric Soils List (NRCS, 1995)				Site soils listed as <u>hydric</u> on Comprehensive Hydric Soils List (NRCS, 1995)			
ID #	Soil Type	yes	no	ID#	Soil Type	yes	no
47	BrC	1		3	Pe	1	
30	BrC	2	3	6	Pe	1	
46	BrC		1	185b	Pe	1	
31	BsD	1		157x	Pe	2	2
50	BuB	1	1	4	Pe	2	
66	BuB		1	17	Pe	2	
174	BuB		1	185	Pe	3	
113	BuB		2	5	Pe	3	
179	BuB		2	18	Pe	4	
182	BuB		2	188	Pe		2
172	BuB		3	51	Pe/BuB	1	
93	BuC		1	157y	Pe/BuB	1	1
148	VaC		1	52	Pe/BuB	7	
149	VaD/VaC		1	29	Pe/PID	1	1

Soils Legend

- BuB: Burch Fine Sandy Loam/0-3% slope
- BuC: Burch Fine Sandy Loam/ 8-15% slope
- VaC: Varelum Silt Loam/ 3-15% slope
- VaD: Varelum Silt Loam/15-20% slope
- BsD: Brief Stony Sandy Loam/0-25% slope
- BrC: Brief Gravelly Sandy Loam/8-15% slope
- PID: Peshastin Stony Loam/0-25% slope
- Pe: PEOH Silt Loam on HYDRIC SOILS LIST

Surface Hydrology

A field indicator for the hydrology criteria is “the visual observation of inundation during the growing season” (Appendix Q, page 32). The photo record documented surface hydrology over time during the growing season, as follows:

- ◆ The photos recorded the presence of water on the ground surface (inundation) or flowing water over time at a series of parcels. Table 2 lists four locations in the study area, visible from a public road, where surface ponded water was observed after the onset of the growing season. Lands north and south of Ranger Road and lands north of Highway 2 (at the junction of Icicle Road) showed surface inundation for a 26 day span and met the field indicators for the hydrology criteria.
- ◆ Table 3 lists eight locations where flowing water in a ditched channel was observed after the onset of the growing season. During the 26-day span (3/19/98-4/14/98), the flow that drained the USFS land containing the ski area north of Titus Road was the only one that became dry. The five flows located near City storm sewer drains flowed for the 26-day span preceding fieldwork. Photo points (P-24, P-25, P-5) document channeled flow from Anderson Canyon for the 26-day span. All of these parcels met the field indicators for the hydrology criteria.

The hydrology results are listed by parcel in the summary database (Appendix T). For the entire study, the summary results are as follows:

<u>Hydrology Criteria Status</u>	<u># of Parcels</u>
Hydrology present: positive field indicator	44
Hydrology absent: no field indicator	63
Riparian corridor present in parcel	9
<u>Hydrology unknown for parcel</u>	<u>133</u>
Total study parcels 249	

The hydrology field indicator results are mapped in Figure 6. Arrows on this map show the observed direction of surface water flow. The map visually shows clustering patterns where hydrology is present in the study area. The largest cluster is found in the western part of the Ski Hill Basin, south of Spring Street to the Wheeler Road area. Other clusters characterize the region adjoining Highway 2 at Icicle Road, the lands north of Pine Street, the land adjoining the west side of Chumstick Highway, and the land adjoining lower Titus Road near the Club West facility.

Figure 6 displays the parcels adjoining Chumstick Creek as a riparian corridor. Riparian areas often function as wetlands. The riparian corridor along Chumstick Creek was not field surveyed.

Paste Figure 6

TABLE 2. Photo documentation of flowing water (+) or absence of flowing water (dry) in ditched channels between 3/19--4/14/98 for the Leavenworth Water Problems Study. Dates where photos were not taken are indicated as N/A. Photo point ID labels correspond to slides filed in the photo point slide series notebook (Appendix B).

Location	Date of Photograph During Growing Season				Photo Point ID label
	3/19	3/27	4/8	4/14	
Southern Ski Hill Basin drainages at entry points in City underground storm sewer					
Corner of Pine Street/Ski Hill Drive Looking North along E. side of Ski Hill Drive on Parcel ID#105b & #106	+	+	+	+	P-11
Looking West from School District Bus Barn entrance, along property line between school (ID#191 and ID #105b)	+	+	+	+	P-21
Looking North from Wheeler Road at property line between Parcel ID #23 and ID #23b	+	+	+	+	P-1
Looking West along the North side of Wheeler Road at Parcel ID #23b	+	+	+	+	P-2a, P-2b
Western part of Poplar St, looking North along property line Between ID#2 and ID#3	N/A	N/A	+	+	P-3
Northern Ski Hill Basin\Chumstick Creek drainage basin					
North part of Ski Hill Basin on the W-E part of Titus Road. Looking South into Parcel ID #142	+	+	N/A	dry	P-23
Anderson Canyon drainage along western Ski Hill Basin Flows to Ranger Road County ditch and into City storm sewer					
Western end of Spring Street, at Cul-de-Sac. Looking North onto Parcel ID#53 & South onto Parcel ID#70	+	+	N/A	+	P-24/P25
North side of Ranger Road at Parcel ID #38 across road from Parcel ID #51	N/A	N/A	+	+	P-5

TABLE 3. Photo documentation of surface ponded water (+) or lack of surface ponded water (-) between 3/19-4/14/98 for the Leavenworth Water Problems Study. Dates where photos were not taken are indicated as N/A. Photo point ID labels correspond to slides filed in the photo point slide series notebook (Appendix B).

Location	Date of Photograph During Growing Season				Photo Point ID Label	Summed # of Days of Inundation
	3/19	3/27	4/8	4/14		
Looking east from the western end of Ranger Road, at Haus Rohrbach cistern: Parcels ID# 48, #49, #47 +	+	+	+		P-8, P-9	26
Looking south at Parcel ID #51, south side of Ranger Road	+	N/A	+	+	P-7	26
Looking north at Parcel ID# 42 & #43, north side of Ranger Road	N/A	N/A	+	+	P-6	7
North side of Hwy 2 at intersection of Icicle Road Parcels ID # 215 & #209	+	+	+	+	P-13, P-15, P-16, P-17	26

Vegetation

The work photo records also serve as a field indicator for the hydrophytic plant criteria. Photos taken in the field on 3/19/98 from photo points 8 & 9 document that the growing season had begun. The photo shows that no snow remained on the ground in the Ranger Road area and green plant growth was visible across a broad mid-section of the Ski Hill Basin (Table 3).

Plants that are actively growing where water is present require hydrophytic adaptations. One of the field indicators for hydrophytic vegetation is “the visual observation of plant species growing in areas of prolonged inundation and/or soil saturation” (Appendix Q, page 16). The manual states that if an area has strong evidence that the hydrology and soil criteria are met, then the vegetation is acting as a hydrophyte and the area is probably a wetland.

Two types of plant communities were represented in the study area. One type of plant community was found on sites identified as “likely uplands” and another type on sites identified as “likely wetlands.”

“Likely Uplands” Plant Community (Represented by Parcel ID #177).

The land has a history of agricultural use for orchards and/or pastureland but is presently not in cultivation. No shrubs or trees are present and cover is comprised of an herbaceous layer of grasses and herbs. Site dominant plants include Canada bluegrass and Kentucky bluegrass (both non-native lawn grasses) and the herbs blue-eyed grass, common dandelion, vetch, and blue-eyed Mary.

“Likely Wetlands” Plant Community (Represented by Parcel ID #52, 52b, 52c)

The land has a history of agricultural use as cultivated hay fields and pastureland. No shrubs or trees are present and cover is comprised of an herbaceous layer of grasses and herbs. Site dominant plants include big leaf lupine, sedges, rushes, and grass species.

Over one hundred individual plants of Wenatchee larkspur (*Delphinium viridescens*), a Washington State Endangered species, was found in the area west of Ski Hill Drive and south of Ranger Road. A report of the population was filed with the Washington Natural Heritage program. A second population is likely nearby in the southeast corner of Ski Hill Drive and Pine Street. Field investigators visually observed the population from Pine St, but could not access the plant to make a positive identification.

Table 4 lists dominant plants present at one or more soil pits in the study area. Thirty-five plants were identified as dominants, having been found at one or more soil pits.

TABLE 4. Plants* identified as community dominants at one or more soil pits during April 16-17, 23-24, 1998, fieldwork.

Genus, species	Common name
<u>Plants keyed to species by botanists, collected at soil pits as dominants:</u>	
<i>Potentilla recta</i>	erect cinquefoil
<i>Delphinium virendenscens</i>	Wenatchee larkspur
<i>Capsella bursa-pastoris</i>	sheperd's purse
<i>Nemophila brevifolia</i>	Great Basin nemophila
<i>Lupinus polyphyllus</i>	big leaf lupine
<i>Floerkea proserpinacoides</i>	false mermaid
<i>Dacytilis glomerata</i>	orchard grass
<u>Plants identified by field investigators, observed at soil pits as dominants:</u>	
<i>Achillea</i> species	yarrow
<i>Carex</i> species	sedge
<i>Centaurea</i> species	knapweed
<i>Cirsium</i> species	thistle
<i>Collinsia</i> species	blue-eyed Mary
<i>Equisetum</i> species	horsetail
<i>Festuca</i> species	fescue
<i>Holcus</i> species	velvet-grass
<i>Juncus</i> species	rush
<i>Lolium</i> species	ryegrass
<i>Medicago</i> species	alfalfa
<i>Phalaris arundinaceae</i>	reed Canarygrass
<i>Plantago</i> species	plantain
<i>Poa</i> species	bluegrass
<i>Poa compressa</i>	Canada bluegrass
<i>Poa pratense</i>	Kentucky bluegrass
<i>Prunus</i> species	wild cherry
<i>Ranunculus</i> species	buttercup
<i>Rumex</i> species	dock, sorrel
<i>Sisyrinchium</i> species	blue-eyed grass
<i>Spirea</i> species	spirea
<i>Symphoricarpos</i> species	snowberry
<i>Taraxacum officinale</i>	common dandelion
<i>Trifolium</i> species	clover
<i>Typha</i> species	cattail
<i>Verbascum</i> species	mullein
<i>Vicia</i> species	vetch
Gramineae family	pasture grasses

*Refer to the field notes for the listing of the USFWS Indicator Status for identified species.

Wetlands Likelihood Category Designation

A wetlands likelihood category was determined for 124 out of the 249 parcels in the study as shown below. 125 parcels have an unknown status (study designation 4) due to lack of access to the site.

<u>Study Designation</u>	<u># of Parcels in Study</u>
(1) Likely wetlands	57
(2) Likely filled or drained wetlands	12
(3) Likely uplands: no wetlands present	55

The likelihood category was assigned after reviewing the hydrology, soils, plant field findings, landowner surveys, and field data, including the photo record. The likelihood category assignment was made using best professional judgement and was heavily based on the findings for the field indicators for hydrology, soils, and plants (Appendix Q). Figure 7 displays the wetlands likelihood category for 249 parcels in the study area. The summary database (Appendix T) lists the category designations by parcel number and parcel ID number.

Wetlands Likelihood Category Comparison to NWI Map Designation

The National Wetlands Inventory classification for each parcel was entered into the study database to allow later comparison between the field findings and the 1987 NWI map (Appendix K). Table 5 summarizes the NWI map wetlands classification by category for all 249 parcels in the study area.

TABLE 5. USFWS National Wetlands Inventory (NWI) map, Leavenworth, 1987; wetland code designations for 249 parcels contained in the Leavenworth Water Problems Study geographic area.

<i>#of parcels</i>	<i>1987 NWI map code designation</i>
58	Total wetland NWI code designations
1	PSSA- Palustrine, Scrub/shrub, temporarily flooded
9	PSSC- Palustrine, Scrub/shrub, seasonally flooded
48	PEMC- Palustrine, emergent, seasonally flooded Includes 1 PEMC/PSSA, and 1 PEMC/POWHx (Palustrine, open water, permanently flooded, excavated)
191	Total uplands, as indicated by NWI map
14	Parcels designated as upland, but directly adjacent to PEMC lands
177	Parcels with no wetland designation, therefore, uplands.
249	Total parcels in Leavenworth Water Problems Study

insert Figure 7

It is important to note that any portion of a parcel that contained a NWI map wetlands code was assigned that designation for the entire parcel. Thus, many parcels with a wetland designation also may include areas of uplands. Parcels without any wetland codes were designated as uplands. Note that in the study area, the designation POWHx was found once, showing an excavated pond (ID #185) that is surrounded by PEMC. In the database, it is categorized as PEMC. Two excavated ponds were observed in the field (ID #42, 49) but were not designated as POWHx on the 1987 NWI Map, suggesting excavation after 1987.

These data enable a comparison between the NWI map classifications with actual findings for study parcels. Tables 6 and 7 compare the study wetland likeliness designation to the NWI map classification for all 249 parcels in the study, of which 58 had NWI wetlands classification and 191 had NWI uplands classification.

Table 6 tabulates findings for parcels designated on the NWI map as wetlands. Twenty-eight parcels were categorized as likely wetlands or filled/drained wetlands and 14 were categorized as likely uplands. Table 7 tabulates findings for parcels designated on the NWI map as uplands. Forty-one parcels were categorized as likely wetlands or filled/drained wetlands and 41 as likely uplands.

TABLE 6. Correlation between the Leavenworth NWI map **wetlands** classifications and field findings, expressed as a wetlands likeliness category, for 58 parcels in the Leavenworth Water Problems Study.

<u>NWI Map</u> <u>Wetland</u> <u>Code</u>	<u>Wetlands likeliness category determined by study</u>			
	<i>Likely</i> <i>Wetland</i> # of parcels	<i>Likely Filled/</i> <i>Drained Wetland</i> # of parcels	<i>Likely</i> <i>Upland</i> # of parcels	<i>Unknown</i> <i>Status</i> # of parcels
PEMC	25	1	14	8
PSSA	1	0	0	0
PSSC	1	0	0	8
58 Total NWI	27	1	14	16
Coded wetlands				
(58 total = 42 parcels given a likeliness category, 16 given an unknown category)				

TABLE 7. Correlation between the Leavenworth NWI map **upland** classifications and field findings, expressed as a wetlands likeliness category, for 191 parcels in the Leavenworth Water Problems Study.

<u>NWI Map</u> Upland <u>Code</u>	<u>Wetlands likeliness category determined by study</u>			
	<i>Likely</i> <i>Wetland</i> # of parcels	<i>Likely Filled/ Drained Wetland</i> # of parcels	<i>Likely</i> <i>Upland</i> # of parcels	<i>Unknown</i> <i>Status</i> # of parcels
Uplands adjacent to PEMC coded land	5	0	1	8
Uplands	25	11	40	101
Total NWI	30	11	41	109
Uplands (191 total = 82 parcels given a likeliness category, 109 given an unknown category)				

Water Quality Testing

Water reports were completed by Cascade Analytical, Inc. on 6/30/98 (Appendix U). Figure 3 identified sample points #1, #2, and #3. Their analysis showed the following results:

<u>Location</u>	<u>Nitrate/Nitrite</u>	<u>Most Probable # Fecal Coliform</u>
#1) W. end of Spring Street, open ditch is culverted under road	0.12 mg/liter	< 1
#2) Junction of Pine and Ski Hill Dr. where open ditch enters stormdrain	0.19 mg/liter	>23*
#3) Junction of Pine and Titus Road, where open ditch enters stormdrain	9.66 mg/liter	>23*
*The MPN analysis method used could not assess levels higher than 23. A more accurate method would be needed for future samples at these sites.		

DISCUSSION

The combined results of the wetland determination fieldwork and the hydrogeology investigation provide new and useful information for long range land use planning in the Ski Hill Basin and adjacent areas.

Change in Land Use

The post-1975 shift in land use to increased residential use in the western part of the Ski Hill Basin has likely affected seasonal surface flows. Increasing residential use results in more impervious surfaces that in turn concentrates seasonal runoff on the surface as the interface with the groundwater is reduced. Many landowners reported on their surveys that they have curtain drains around their building foundations to shift the movement of shallow groundwater down-gradient. These two factors could account for the observed increase in the quantity and duration of surface standing water in lower gradient parts of the basin surrounding Wheeler Street (Landowner comments, pgs 38-39).

Wetland Determination Implications

The Background section of this report discusses the relationship between the NWI maps and our study data. To date, the Leavenworth NWI map is the primary tool used by Chelan County planning staff to identify potential wetlands in the study area. County staff follow a decision-making protocol to field check a parcel for the presence of wetlands when an NWI wetland code is present. This process is used when reviewing a development application.

The study results let us examine the validity of using the NWI map as a credible office tool to predict the presence of wetlands in the Ski Hill Basin. Table 8 compares the 1987 NWI map wetland code designation with actual field findings for 124 out of the study's 249 parcels (50%). The remaining 125 parcels (50%) have an "unknown" likelihood status of containing wetlands due to lack of access to the site.

TABLE 8. Correlation between the Leavenworth NWI Map wetland classification with field findings, expressed as a wetlands likeliness category, for 124 parcels in the Leavenworth Water Problems Study.

<i>NWI Map Code</i>	<i>Wetlands Likelihood Category Determined by Study</i>	
	<i>Likely Wetland or Likely Filled/Drained Wetland</i>	<i>Likely Uplands</i>
	<i># of parcels</i>	<i># of parcels</i>
42 parcels classified as wetlands	28 (28/42 = 66%)	14 (14/42=33%)
82 parcels no classification: uplands	41 (41/82=50%)	41 (41/82=50%)

For the 42 parcels classified on the NWI map as wetlands, two-thirds (66%) were identified as *likely wetlands* or *filled/drained wetlands* in the study. One third (33%) were identified as *likely uplands* in the study. It seems reasonable for County staff to conduct a field check on parcels classified as NWI wetlands since one third of these were found to be uplands.

For the 82 parcels coded as uplands on the NWI maps, 50% were identified as *likely wetlands* or as *filled/drained wetlands*, and 50% as *likely uplands* in the study. For these 82 parcels, about half of them are likely wetlands despite their lack of an NWI wetlands code. Current Chelan County protocol would not require a field check when a building permit is submitted on lands coded as uplands on the NWI map.

This data shows that the 1987 Leavenworth NWI map used alone is not an accurate office predictor of uplands in the Ski Hill Basin. NWI map legends do include a disclosure to this effect. This study provides a greater level of precision than the NWI map as an office tool. A visit to the site to confirm a parcel's upland status is necessary. Permits for development have been issued in the Ski Hill Basin on lands assumed to be uplands, but some residents have experienced unforeseen costs and problems due to high water tables. If the presence of wetlands had been identified earlier during the permitting process, landowners would have been able to modify building plans and avert future costs due to water problems.

Surface Hydrology Implications

The hydrology results (Figure 6) identify several areas within the study boundary that will need to be re-examined to determine whether or not urban densities are appropriate and feasible:

1. The block of land south of Maple Street, west of Ski Hill Drive, extending south to the Wheeler Street vicinity;
2. The block of land north of Hwy. 2 at Icicle Road containing a 2-acre emergent pond and a smaller Scrub-shrub wetland, both identified on the NWI maps and during the study's fieldwork;
3. Lands adjoining the west side of Chumstick Road, where a series of seeps were observed in the roadcuts;
4. Lands containing a riparian corridor of Chumstick Creek;
5. Lands bordering Pine Street; and
6. Lands adjoining lower Titus Road near the Club West facility. Wetlands were present at the base of the hill bisected by Titus Road, and are connected as an east-to-west drainage corridor draining into Chumstick Creek.

Soils Implications

The soil results of the study suggest that the Chelan County hydric soils list and soil survey map could serve as a more accurate office tool than the NWI maps to predict the presence of wetlands in the Ski Hill Basin. Table 9 displays the correlation between the published soil survey list of hydric soils with the actual field findings at each of the 59 soil pits dug during the study. Seventy-nine percent of sites with soils listed in the soil survey as not-hydric did not meet the hydric soil criteria in the field. The remaining 21% (Parcel ID #47, 30, 31, 50) of pits mapped in the soil survey as not hydric were found to meet the hydric soils criteria in the field. These pits were in either Birch or Brief soil series and clustered together at the west end of Ranger Road, adjacent to and just north of a broad expanse of Peoh silt loam which is on the hydric soils list.

For pits dug in soils listed in the soil survey as hydric, field results showed an 83% positive correlation. The 17% (6 out of 35 pits) with non-hydric field findings is misleadingly high. For 4 of the 6 soil pits, 1 or more additional pits were dug on the same parcel and found to be hydric. This illustrates the great importance of field checking the soil survey map when a parcel is under consideration for development.

TABLE 9. Correlation between NRCS published hydric soils designation and soil hydric or non-hydric field findings at 59 soil pits on parcels in the Leavenworth Water Problems Study.

Chelan Co. Comprehensive Hydric Soils List Designation	Field Findings - Hydric Soil Indicator Status	
	<i>Hydric</i>	<i>Non-hydric</i>
24 pits dug in not hydric soils	5 (21%)	19 (79%)
35 pits dug in hydric soils	29 (83%)	6 (17%)

These results suggest that the Chelan County soil survey maps and accompanying hydric soils list have higher prediction accuracy potential for the Ski Hill Basin than do the NWI maps. County planners would have a higher predictive accuracy for the Ski Hill Basin area if the soil survey maps were consulted as the first office tool used to evaluate a development permit. For the 249 parcels in this study, planners can use the information compiled in the study database as an office tool. It is imperative; however, that use of any of these office tools must be accompanied by a field check.

The wetland likeliness code is the most site-specific predictor of wetland presence available to-date for 118 Ski Hill Basin parcels. Sixty-nine parcels are designated as likely wetlands or likely filled or drained wetlands. When a

development proposal is submitted for one of these parcels, planners should conduct a site visit and then decide if a delineation is needed.

Planners also need to evaluate wetland likeliness for all lands under consideration for potential inclusion within an adjusted UGA. Parcels with soils mapped as hydric in the *Chelan County Area, Washington, Comprehensive Hydric Soils List* (Appendix L) would not be good candidates for urban densities. These are soils in the Leavenworth series (Lh) and the Peoh series (Pe).

The soil results suggest a potential option to extend the UGA northward into lands containing no hydric soil classes. For example, some parcels north of Maple Street and the existing UGA northern boundary received a “likely upland” classification and could be used for high-density designation. West of these, the parcels containing the Anderson Canyon drainage were not surveyed so the presence of wetlands is unknown and site inspection for either wetlands or a riparian corridor at their western boundaries is advised.

The block of parcels north of the UGA, between Ski Hill Drive and Chumstick Road contain non-hydric soils and are also potential candidates for UGA inclusion, but need more study. None of the landowners that completed surveys for parcels north of the UGA reported water problems. Due to the presence of working orchards and lack of landowner permission, most of these parcels received the “unknown” wetlands likelihood label. At the top of the Ski Hill Basin, the photo record documented a spring-run off drainage, extending south through the parcel from the USFS land at the developed ski area. This stream dried up by April 14, 1998, but its presence would require delineation if the land were proposed for development and diversion of the spring runoff were necessary.

Vegetation Implications

Ski Hill Basin parcels assigned a positive wetlands likeliness code potentially need a wetlands delineation when development is proposed. In a delineation, several different field indicators of hydrophytic vegetation can be used as evidence that the criteria have been met. One indicator necessitates documentation of hydrology over time during the growing season, as was done in this study. Another field indicator requires accurate plant species identification. This study shows that delineations in the Ski Hill Basin need to be carefully timed to allow for plant identification in May and June. A botanist will be unable to make plant identifications until flowering parts are present on grasses, sedges, and rushes. Landowners needing to have a wetlands delineation done on their parcels need to be informed of these limitations and time requirements.

Findings of a large population of the state endangered species, the Wenatchee larkspur (*Delphinium viridescens*), does not result in legal requirements or conditions for a private landowner. However, the landowner has an opportunity to aid in the protection of this rare species. The Washington Natural Heritage Program offers technical support to private landowners that request it. If the land comes into consideration for a wetland mitigation or reserve site, the presence of this species gives it a high wetlands category ranking. The presence of an endangered plant gives a parcel a high score on the Chelan County Public Benefits Rating System (Appendix V) and benefits a qualifying landowner with a reduction in taxes.

Hydrogeology Implications

The study results suggest that some Ski Hill Basin lands contain wetlands and/or water problems that could impact property owners and adjacent lands. The county and City should consider these findings when designating UGA densities for the Ski Hill Basin. When making adjustments to the UGA, appropriate densities should be developed for two categories of Ski Hill Basin lands:

- ◆ Parcels categorized as *likely wetlands* or *likely filled or drained wetlands*
- ◆ Parcels categorized as *unknown* or parcels adjacent to or surrounded by parcels categorized as *likely wetlands*.

Geographically, clusters of these parcels are displayed on Figure 6. The largest cluster is found in the western part of the Ski Hill Basin, south of Spring Street and extending to the Wheeler Road area. Other clusters characterize the region adjoining Highway 2 at Icicle Road, the lands north of Pine Street, the land adjoining the west side of Chumstick Highway, and the land adjoining lower Titus Road near the Club West facility.

The hydrogeology report and the field findings together explain the nature of the wetlands present in this large region and why current landowners are experiencing water problems. The aquifer underlying the basin is recharged from a large geographic area to the north and west, and responds to annual and multi-year precipitation patterns. Recent years have seen the recharge of groundwater tables with saturation from the surface down over 150 feet to bedrock, reflected in the increased water visible on the land surface from early spring into summer. This type of wetland hydrology fluctuates seasonally and in response to general climate patterns that determine recharge of groundwater.

Overall, water table levels are lower in series of years where the October to March precipitation is below normal. The climate patterns of a series of drought years resulted in a lowered groundwater table for a period of years (Hydrogeology Report Figure 3, page 76). Several Ranger Road landowners reported increased wetness on their land in recent years due to the 1994 fires on Tumwater

Mountain. They believe that the fires removed forest cover and this resulted in higher than normal spring runoff to the basin. Precipitation data, however, suggests instead a climatic explanation for land being wetter. The Hydrogeology Figure 3 shows that from 1983 to 1994, the March to October precipitation levels were below normal, but rose to above normal levels in 1995 through 1998. Increased precipitation allowed gradual recharge of the aquifer after an eleven-year drought cycle, unrelated to the 1994 fires, but occurring at the same time.

A second factor contributing to the increased wetness of this land is the 25-year process of conversion from agricultural land use to single family residential land use in the areas south of Maple Street and north of Wheeler Street, west of Ski Hill Drive. The hydrogeology results note that the increasing amount of impervious surfaces in the basin over time has decreased the capacity of the ground to uptake spring runoff. Thus, during the spring, runoff from the upper basin is ponding in the lower part of the Ski Hill Basin. These are the lands identified in the landowner surveys and in the study results as having water problems.

Many residents who have built homes and on-site septic systems in the Ski Hill Basin use French and curtain drains to shift water off their land. The hydrogeology results demonstrate that natural processes will replace any water artificially drained off a parcel. Realistically, a parcel in this region is “not drainable” when water tables are high due to the interconnected nature of the three wetland systems. Artificial drainage off one parcel impacts parcels located at a lower gradient. One example of this is the increased duration of flooding reported in the surveys by the landowners in the Wheeler/Poplar Streets area, all located at the lowest gradient before water enters the City stormwater drainage system. Included in this area is the home that required special engineering and \$30,000 to build a floating foundation (ID#23), and the farmer who has experienced increased duration and spread of water on farm fields, making them unusable (ID #13, 13b, 13c, 22).

County residents in this area rely on wells for water and have on-site septic systems. The groundwater is connected with the surface system and well contamination from failing on-site septic systems is a potential problem. Recent failure of an existing septic system at Parcel ID#33 resulted in its replacement by an expensive mounded system containing an above-ground drain field. Other landowners of parcels labeled “likely wetlands” may also have been experiencing similar septic problems.

Parcels already inside the City limits in this region are predominantly categorized as “likely wet” in the study results (Figure 7). The City land is situated at the lowest gradient for the Ski Hill Basin and thus is most impacted by up-gradient changes in land use that alter hydrology. These parcels will likely require federal permits to build, which requires a delineation. Once the permit is

granted, landowners may encounter significant expenses both to mitigate the impacts of building and to build.

Water Quality Implications

Nitrogen is a highly mobile nutrient in water and can be found in one of three forms: ammonia, nitrate, and nitrite. High nitrate levels in drinking water can contribute to illness in children and can be toxic to fish. Low levels of nitrate/nitrite at sites #1 and #2 contrast with levels nearly ten times higher (9.66 mg/liter) at site #3. Water with nitrate/nitrite levels that exceed 10 mg/liter is not acceptable for consumption. The surface water flowing at site #3 travels across land used for agriculture and for horse corrals. Water from site #3 is untreated and piped directly to the Wenatchee River. This piped outflow discharges a concentrated flow of nitrate/nitrites into the mainstem Wenatchee River at a point within the Leavenworth City limits. This reach has summer chinook salmon spawning grounds and probable late summer rearing grounds for juvenile spring chinook salmon and steelhead, both listed as endangered under the Federal Endangered Species Act.

Fecal coliform bacteria are present in the feces of mammals, and are used as an indicator of the sanitary quality of water and for the potential presence of other water-borne pathogens. Fecal coliform levels at site #1 were not detectable (<1) but levels at sites #2 and #3 were higher than the analysis test could detect. A more suitable test should be used in the future for these sites. The contrast in fecal coliform levels between site #1 in the upper Ski Hill Basin and sites #2 and #3 in the lower Ski Hill Basin indicate contamination from within the study area. Potential sources include failing on-site septic systems and/or surface flows which come into contact with animal waste.

Evaluation of Wetland Functions for Fish and Wildlife

Development has likely reduced the fish and wildlife functions of the Ski Hill Basin over time, as discussed in the background discussion on fish and wildlife. Loss of shrubs and trees, in addition to loss of emergent vegetation due to draining of wetlands, has reduced the primary productivity and nutrient export. Flood attenuation effectiveness has been reduced by drainage of wetlands into the stormwater system. The high flows during spring runoff would normally flow through the basin at a slower rate than what is seen in the roadside ditches. With this change in flows also comes a loss in groundwater recharge and biofiltration. This latter function has been further influenced by the greater need to filter pollutants associated with human development, such as agricultural fertilizers and pesticides, on-site septic systems, road runoff, and domestic livestock waste.

A quantitative method for measuring historic and current wetland functions has not been developed for this type of wetlands; however, it is clear that there has been some change with human use. There is potential for restoration of some of these functions, and every opportunity to minimize further impacts and to restore lost functions should be encouraged.

CONCLUSIONS

The Leavenworth Water Problems Study can play an important part in future long-range planning for the Ski Hill Basin. It can serve as a tool to address five types of issues affecting the Ski Hill Basin: development, flooding, water quality, wetland improvement, and GMA.

Development Issues

The likely presence of wetlands in the Ski Hill Basin is recognized by the City of Leavenworth and Chelan County. As office tools, City and County staff should consult soils maps and this study's results in addition to NWI maps. Staff should make site visits to determine the need for a delineation before building permits are issued for parcels within the Ski Hill Basin.

Chelan County needs to acknowledge the impact Ski Hill Basin runoff has on the City's stormwater drainage system, pushing it over capacity during snowmelt season. This untreated stormwater is piped directly to the Wenatchee River and may be negatively impacting water quality. The County needs to seek ways to modify the current ditching system to reduce flows entering the City system during spring runoff. Restoring wetlands in order to increase flood storage capacity is one solution. Technical assistance is needed to evaluate the current practice of removing vegetation from County ditches.

The City needs to recognize the presence of wetlands on City parcels. Landowners need to be educated about the identification and functions of wetlands and the legal requirements for delineation, as well as the legal implications of having wetland areas on their property.

Flooding Issues

Enhancement and restoration of wetlands on open space lands would increase spring runoff storage capacity in the lower Ski Hill Basin. This would slow runoff entry into the City's stormwater drainage system and decrease ponding on City parcels which are currently most affected by spring runoff. Enhancement and restoration can be implemented by a combination of private landowners and public agencies with funding from a combination of grants and loans. Enhancement and restoration by private property owners can be funded with grants, free technical support, and utilization of wetlands stewardship strategies (Appendix V).

Water Quality Issues

The water quality for the Ski Hill Basin stormwater should be improved before it is piped untreated into the Wenatchee River. Enhancement and restoration of wetlands on open space lands would increase water quality filtering capacity of County stormwater before it enters the City's stormwater system. Evaluation of on-site septic systems in the Ski Hill Basin is needed to determine failure rates. Education of landowners in order to minimize contact between animal feces and surface water is also important. In areas with wetland hydrology, it would be beneficial to convert on-site sewage systems to City sewers.

Wetland Improvement Issues

One proposed solution to reducing the impact of spring stormwater run-off in the lower Ski Hill Basin is to improve the flood storage functions of the land south of Ranger Road and west of Ski Hill Drive. The hydrogeology report clarifies that the surface and sub-surface flows function as one unit within the Ski Hill Basin. Enhancement of existing wetlands to improve flood storage capacity on land adjacent to runoff entrances to the City storm drainage system would decrease the seasonal surface flooding and high groundwater reported by Poplar and Wheeler Street residents.

Increasing the water quality filtering function of the Ski Hill Basin would have a beneficial effect on the water quality of the Wenatchee River. County residences in the Ski Hill Basin use on-site septic systems, many of which were installed without knowledge of the basin's hydrogeology. The saturated soil conditions observed in parcels along Ranger Road and southward suggest that on-site septic systems are likely inadequate or failing during periods when the groundwater table is at the surface. The Wenatchee River is salmon spawning habitat and the possible nonpoint source pollution coming from the Ski Hill Basin is an important concern. Most of the candidate parcels for wetland restoration are agriculture lands, but have been too wet to crop for several years. Funds are available to both private landowners and municipalities to finance projects. Tables 10, 11 and 12 summarize the funding sources described in Appendix V.

GMA Issues

The study results can be used by planners to identify critical areas and riparian buffers in the study area, and can be used in evaluating the best location of the UGA for Leavenworth, particularly for the Ski Hill Basin area.

Overview of Funding Sources

Five federal or state agencies maintain funding source databases pertaining to projects in Washington. Appendix V contains a complete listing of funding sources. A brief summary of each database follows:

Infrastructure Assistance Directory. Published March, 1998, by the Infrastructure Assistance Coordinating Council. Copies available: telephone 360-586-7656 (leave message). The document lists grants, loans, and other types of assistance available to eligible applicants for eligible projects. Programs seeking assistance are grouped into five categories: Agriculture, Building Efficiency, Community Facility, Comprehensive Planning, and Drinking Water.

Exploring Wetlands Stewardship: A Reference Guide for Assisting Washington Landowners (#96-120). Published October, 1996, by the Department of Ecology. Copies available: telephone the publications office at (360) 407-7472, or access an expanded form of the directory on line at <http://www.wa.gov/ecology/>. The document is written as a desk reference for individuals who provide technical assistance to landowners in the stewardship areas of preservation, conservation, and recovery of wetland and riparian areas. The quick reference guide summarizes the characteristics of each stewardship program offered by many public agencies and private organizations.

Funding Sources Database. Published by the Washington State Department of Transportation, Environmental Affairs Office (contact Heather Roughgarden (360) 705-7132). It is on line at http://www.crab.wa.gov:591/funding_sources/. It is a compilation of loans, grants, and technical assistance programs for restoration, public infrastructure, and recreation that are available for work in Washington State. Information is searchable by eligible entities, program focus, and program type (grant, loan, and technical assistance).

Water Quality Program Financial Assistance for Fiscal Year 1999, Volume 1: Guidelines, Appendix A-Comparison of Eligibility of Costs in the Funding Programs. Published December 1997, by the Department of Ecology. It is available from the Water Quality Program at (360) 407-6400 or on-line at <http://www.wa.gov/ecology/wq/>. This document describes over 100 specific projects and shows grant or loan availability from one of three sources: the Centennial Clean Water Fund, the Washington State Water Pollution Control Revolving Fund, and the Federal Clean Water Act Section 319 Nonpoint Source Fund. These programs are listed in general terms in the other three funding databases described previously.

With the large number of programs listed in these databases, one might assume that there is adequate funding to address the problems identified in this report. However, this is not the case. Funding and program availability changes, many programs have narrow criteria for eligibility, and staff and funds are often inadequate to meet demands, causing backlogs where excellent projects may have to wait several years to begin.

Specific examples from these databases are discussed in Appendix V and applied to potential projects in the Ski Hill Basin. Tables 10, 11, and 12 summarize these potential funds available to private and/or public agencies that would pertain to the Ski Hill Basin. Appendix V lists each of these sources in greater detail and lists local applications as examples, when available.

The cooperative and creative approach used to complete this study can be applied to future efforts to plan, fund, and implement programs that will address the problems researched in this study.

TABLE 10. Summary of selected funding sources for projects conducted by a public agency. Appendix V contains a complete description of funding sources.

<u>Agency</u>	<u>Fund Type</u>	<u>Use</u>
<u>FEDERAL</u>		
EPA	Grants	Support for studies/activities related to Clean Water Act Implementation for wetlands (i.e. partnerships for wetland restoration).
EPA	Grant	Stimulate creation of unique/new approaches to meet storm water requirements
EPA	Grants	Assist states in implementing Section 319 nonpoint source management programs
USDA NRCS	Grants	Assist in planning/implementing watershed projects for flood control, water quality improvement, agriculture water management, habitat development
USDA Rural Development	Grants & Loans	Support water and waste disposal facilities in rural areas. Provide technical support. Can pay fees to connect to development of facilities.
US Fish & Wildlife Service	Grants, technical assistance	The <i>North American Wetlands Conservation Program</i> funds restoration and enhancement of previously impacted wetlands
<u>WASHINGTON STATE</u>		
Dept of Transportation	Technical Assistance	Technical & financial assistance to restore, and enhance wetlands on private lands
Dept of Community, Trade, & Economic Development	Grants, Loans, & Technical Assistance	Assists in growth-related infrastructure projects
Dept of Ecology ³	Grants & Loans	Restoration/enhancement of wetlands/riparian areas, including revegetation. Stormwater quality control, treatment, installation or rehabilitation necessary to protect surface or ground water. Groundwater protection activities and programs. Land acquisition for wetland habitat preservation
State Conservation Commission	Grants, technical assistance	Distribution of funds determined by local conservation district.
<u>OTHER</u>		
National Fish & Wildlife Foundation	Grants (with non- federal funds match)	Support wetland restoration/enhancement projects and acquisition of wetland resources

TABLE 11. Summary of selected funding sources available to a private landowner. Appendix V contains a complete description of funding sources.

Agency	Fund Type	Use
<u>FEDERAL</u>		
USDA NRCS	Grants, Technical Assistance	<i>Wetlands Reserve Program</i> offers landowners opportunity to receive payments for restoring/protecting wetlands. Cost-share funds given for restoration. Landowners paid for granting a conservation easement. New in 1998 is the <i>Conservation Reserve Program</i> (inquire for details)
USDA Farm Service Agency (FSA)	Grants, Technical Assistance	<i>Environmental Quality Incentive Program</i> , the <i>Conservation Reserve Program</i> , and <i>Conservation Easement Program</i> offer private landowners stewardship opportunities.
US Fish & Wildlife Service	Grants, Technical Assistance	The <i>North American Wetlands Conservation Program</i> funds restoration and enhancement of previously impacted wetlands on private lands
<u>WASHINGTON STATE</u>		
Dept. of Transportation	Technical Assistance	Technical & financial assistance to restore, enhance wetlands on private lands
State Conservation Commission	Grants, Technical Assistance	Distribution of funds determined by local conservation district.
<u>OTHER</u>		
Chelan County	Tax reduction	The Public Benefits Rating Systems (PBRs) allows private land to be evaluated by a set criteria. Tax relief can be offered for qualifying properties.
Private Land Trust	Income tax deduction, Reduced estate & property tax	Conservation easements, land donation or bargain sale of land.
National Fish & Wildlife Foundation	Grants (with non- federal funds match)	Support wetland restoration/enhancement projects and acquisition of wetland resources in both fee title & conservation easements

TABLE 12. Washington State Department of Ecology as Funding Source: Selected project descriptions that could apply to the Leavenworth Ski Hill Basin.

Items Description	Centennial		SRF	319
	Grant	Loan	Loan	Grant
Diagnostic studies to assess current water quality	Yes	Yes	Yes	Yes
Facilities: Collection sewers, new, for failing on-site septic systems with a public health emergency or severe public health hazard declared by Washington Department of Health	No	Yes	Yes	No
Facilities: Collection sewers, new, providing the community they will serve was in existence prior to October 18, 1972.	No	Yes	Yes	No
Facilities: Construction of facilities for the control, storage, treatment, disposal, or recycling of domestic wastewater.	Yes	Yes	Yes	No
Facilities: Construction of water pollution control facilities to meet existing need.	Yes	Yes	Yes	No
Facilities: Construction of water pollution control facilities with reserve capacities to accommodate flows associated with 20-year projected growth within defined service areas.	No	No	Yes	No
Groundwater protection activities and Programs	Yes	Yes	Yes	Yes
Land acquisition as an integral part of the treatment process (E.G., land application) or for prevention of water pollution.	No	Yes	Yes	No
Land acquisition for wetland habitat preservation.	No	Yes	Yes	No
Local loan fund establishment for water poll. Control	No	Yes	Yes	No
On-site systems: septic system surveys.	Yes	Yes	Yes	Yes
Planning, comprehensive sewer	Yes	Yes	Yes	No
Planning, comprehensive stormdrain	Yes	Yes	Yes	No
Restoration and enhancement of habitat or riparian and wetlands areas, including revegetation	Yes	Yes	Yes	Yes
Stormwater quality control, treatment, installation or rehabilitation necessary to protect surface and ground water.	Yes	Yes	Yes	Yes

Source: Appendix V: Availability of Funds and Application Cycle Schedule, in *Water Quality Program Financial Assistance For Fiscal Year 1999*, Vol. 1 Guidelines and Vol. 2 Appendices, Dec. 1997, Washington State Department of Ecology.

SOILS REPORT

Authored by Ron Myhrum, Resource Soil Specialist, Natural Resource Conservation Service, after examination of soil pits in the study area on April 16-17, 1998.

To: Susan Ballinger, consultant
Wenatchee, WA

From: Ron Myhrum, Resource Soil Specialist
Natural Resource Conservation Service
Spokane, WA

Subject: Groundwater Study of Leavenworth, WA

At the request of the U.S. Army Corps of Engineers, Seattle District, Andrea Mann-Lower of the Wenatchee NRCS and I provided technical assistance to a groundwater study of the Ski Hill Area of Leavenworth, Washington, on April 16 and 17. I was asked to provide assistance in the identification of hydric soils and Andrea Mann-Lower provided valuable knowledge of the past practices and conditions of the area, as well as gaining experience in hydric soil identification.

During the the course of our visit, we examined soil pits at sites from the bottom to the top of Ski Hill Drive, mainly west of the road. It is apparent that groundwater flow is greatly influenced by the soil type on the site and the location of the site, as well as past drainage modifications. The field work revealed that at the top of Ski Hill Drive, the soils are well drained, moderately permeable and contained no identifiable hydric indicators and no water table within the upper 20 inches of the profile. These soils are identified in the soil survey as Burch soils and Brief soils. In most cases, this area is the conduit for runoff from the canyons above. Because of the slope and the nature of the soils, the water either moves as surface flow along drainageways or is absorbed into the soil and moves horizontally and then laterally, to emerge downslope on the flatter areas. In the lower, flatter areas, the soil pits showed consistent hydric soil indicators, i.e., dark surface layers on top of gleyed or gray subsoil layers. In some pits, the water table was at the surface or within 12 inches, while in other pits, no water table was apparent although the soils did show hydric conditions. Information provided on some of these sites indicated that some drainage modifications had occurred in the past but complete records are unavailable to make accurate predictions. The soil in this area is identified in the soil survey as the Peoh soil and is listed as a hydric soil on the Chelan County hydric soils list.

Finally, it is emphasized that the Soil Survey of Chelan County Area is a good reference for soils information. However, as it is at a scale of 1:20000, it should not be used to identify the soil on a specific site. This requires a site visit. It can be used to compare soils on a site with soils described in the report and contains valuable information to make specific land use interpretations.

Please feel free to contact me if you have any questions. My phone number is 509-323-2982.

Sincerely,

Ron Myhrum
Resource Soil Specialist
cc: Doug Allen, DC, Wenatchee
Shiraz Vira, FSL, Ephrata

HYDROGEOLOGY REPORT

Authored by Alan Wald, Hydrogeologist, WA Dept. of Ecology

Introduction

Hydrogeology is the study of water movement through rocks and soil. It combines hydrology (study of precipitation, evaporation, streamflow, and groundwater) and geology (study of the origin, movement, and weathering of rocks and soil). Hydrology defines the flow of water. Geology defines the physical setting in which that flow occurs. The following discussion considers both.

Little distinction is made between surface water and groundwater for purposes of this report. Spring runoff from snowmelt on Tumwater Mountain infiltrates the ground but reappears as spring flow (surface water discharge) near the base of the mountain. This discharge flows down shallow streams and roadside ditches while infiltrating the alluvial and glacial deposits from Ski Hill to Leavenworth. This infiltration in turn flows beneath the ground beyond the City of Leavenworth and discharges to the Wenatchee River as surface water again. The water in wetlands in the Ski Hill Basin is only a transitional phase of surface and subsurface flow in the watershed from Tumwater Mountain to the Columbia River, and eventually to the sea.

Geology of Ski Hill Basin

The Chumstick Formation, northeast of the Leavenworth Fault and the Ingalls Tectonic Complex to the southwest (Figure 1) characterize the Pre-Pleistocene bedrock geology of the Chiwaukum Graben (see also the general geology description on page 19 of the study). The Chumstick Formation is typically gray sandstone and siltstone of early Cenozoic Age. The Ingalls Complex is typically darker schist and conglomerates of the same age. Depth to bedrock below land surface varies from less than 40 feet to greater than 250 feet in places, but is typically 100 to 150 feet. The Leavenworth Fault on the western boundary of the Chiwaukum Graben (including the Chumstick Formation) is extensively fractured and conveys perennial groundwater discharge to springs at the base of Tumwater Mountain. Surficial geology is predominantly unconsolidated glacial and glaciofluvial sediments in valley fill and terrace deposits. The glacial sediments are frequently compacted and dense where overridden by advancing ice sheets while glaciofluvial sediments typically have a higher permeability due to sorting by fluvial processes. Sediments underlying the study area include water-bearing gravel and occasional granite boulders interbedded with fine-grained lacustrine silts and clays.

FIGURE 1. Generalized Geology of the Chiwaukum Graben. Source: Gresens, Randall L. 1983. *Geology of Wenatchee and Monitor Quadrangles, Chelan and Douglas Counties, Washington*, page 2. Bulletin 75, State Department of Natural Resources, Division of Geology and Earth Resources.

Aquifers of Ski Hill Basin

Bedrock in the study area is not considered an aquifer for purposes of this study. Although wells have been drilled into the sandstone and schist to depths of 200 feet or more below the surface, none have produced significant quantities of water. A review of lithologic descriptions in 30 well logs from the study area (Appendix O) and research on the hydrogeology of nearby areas (Lundquist, 1966; Wildrick, 1979; and Ebbert, 1984) suggest there are three water-bearing zones or aquifers in the study area:

1. A perched, seasonal water table at depths of less than 15 to 20 feet,
2. A middle aquifer of water bearing strata of sufficient permeability to yield water to wells at depths of 20 to 60 feet, and
3. A deep aquifer of sands and gravel overlying bedrock at depths of 100 to 150 feet.

These aquifers are not distinct, separate units across the study area. There is likely hydraulic connection between them even though they may be separated by fine-grained outwash and occasionally dense till of insufficient porosity to yield water to wells. A steep groundwater gradient and proximity to the Wenatchee River suggest aquifer discharge to the river controls groundwater levels in the study area.

A local well log (Bradshaw: Section 2, Township 24 N, Range 17E, Parcel ID # 33) describes interbedded silty clays and gravel, with numerous granite boulders to a depth of 111 feet. The well is finished in water-bearing sands and gravel at a depth of 80 to 111 feet. The static water level after drilling was 17 feet below the top of the well. Another local well log (ID#ACE382: Section 1, Township 24 North, Range 17 E) to the east includes interbedded clay and silty sand to a depth of 110 feet. The well is finished in water-bearing sands and gravel at a depth of 94 to 110 feet. The static water level after drilling was 33.5 feet below the top of the well. As shown in these and other well logs from the study area, the deep aquifer is generally 100 to 120 feet thick, of which 90 feet or more may be saturated. Groundwater levels in the Bradshaw well declined from 6.19 feet below land surface (April, 1998) to 10.60 feet below land surface (September, 1998), as shown in Figure 2.

Groundwater discharge is the upward movement of groundwater in these aquifers under conditions of increasing hydraulic head with depth. Groundwater recharge is the downward movement of groundwater under conditions of decreasing hydraulic head with depth. Most well logs and pump tests in the study area show upward hydrostatic pressure or groundwater discharge from large, upgradient contributing areas. Contributing areas include the Leavenworth Fault and extensive glacial moraines and drift deposits. Some wells have low-pressure, artesian flows at the land surface which may cause

wetlands to form in low-lying areas. When recharge areas are large, these groundwater discharge wetlands persist through the summer in most years. Both surface and shallow subsurface flows follow the local topography and drain southeasterly from the foothills of Tumwater Mountain (elevation 3800 feet mean sea level) to the Wenatchee River (elevation 1100 feet mean sea level). Small streams in the area drain numerous hillside springs and flow generally less than 1 cfs (449 gpm) through the summer months.

FIGURE 2. Groundwater Levels in the Bradshaw Well. April 23– September 16, 1998. Near Leavenworth, WA.

Precipitation Patterns

Precipitation at Leavenworth (elevation 1128 mean sea level) averages 25.17 inches/year for the period 1948-1997 with an average monthly distribution as follows (WRCC, 1998):

Jan	4.66	May	0.81	Sept	0.73
Feb	3.01	Jun	0.90	Oct	2.09
Mar	2.11	Jul	0.33	Nov	4.15
Apr	1.18	Aug	0.49	Dec	4.74

Annual precipitation of more than 31.8 inches or less than 16.2 inches has a probability of 10% (or recurrence interval of 1 year in 10). Snow accumulates from December through March with snowmelt during April and May in the lower elevations. Average seasonal snowfall from October through April for the period 1931 - 1965 was 94.1 inches (about 10 inches water equivalent). The greatest seasonal snowfall was 154.8 inches. The area lies within the Washington Department of Natural Resources "Rain-On-Snow Zone" and rapid snowmelt may occur with rainfall in the early spring in some years. Accumulated precipitation from October through March averages 20.71 inches but varies from less than 9 inches to more than 36 inches per year (Figure 3). Accumulated precipitation from October - March has been above average to average for 1996 - 1998. Spring runoff, particularly during rain-on-snow events, recharges soil moisture deficits by early April. Infiltration and deep percolation of runoff also contribute to groundwater recharge and a rise in the water table. Soil moisture depletion by evapo-transpiration and drainage during summer months causes a soil moisture deficit until recharge by early rains in the fall (Figure 4).

Soil moisture storage capacity varies with organic matter content and the porosity of rock fragments in the soil. Actual storage capacity is determined by experimental methods but, lacking such data, may be assumed to be 6 inches for most soils derived from glacial or glaciofluvial sediments in eastern Washington. Estimated evapo-transpiration for a 6-inch water-storage capacity soil averages 12.5 inches per year (WSU, 1973). Soil moisture recharge occurs in late fall before freeze-up and again in late spring during snowmelt and runoff, as shown in the Figure 4. Precipitation exceeds evapo-transpiration by greater than 10 inches in average years, with a significant water surplus available for runoff, surface storage, and groundwater recharge. Measurements taken in 1998 show maximum water levels in springs, ditches, wetlands, and shallow groundwater during snowmelt followed by gradual declines into the summer.

FIGURE 3. Accumulated Precipitation, October - March, 1949 to 1968 and 1980 to 1997. At Leavenworth, WA.

FIGURE 4. Mean Annual Water Budget. Ski Hill Basin near Leavenworth, WA.

Wetlands of Ski Hill Basin

Water levels in wetlands of the Ski Hill Basin vary seasonally with changes in inflow, outflow, and storage. Inflows include precipitation, spring snowmelt, groundwater discharges, and discharge from hillside springs and roadside ditches. Outflows include evapo-transpiration during summer months, groundwater seepage by deep percolation, additional drainage by curtain drains, agricultural tiles and ditches, and the City stormwater system. Surface water storage is relatively shallow and depths of ponding seldom exceed three feet.

Wetlands in the study area may be classified on the basis of water level changes as short-term seasonal, persistent, or perennial wetlands. Short-term seasonal wetlands are saturated in spring and early summer due to snowmelt runoff and rising groundwater levels. Their water levels decline through the summer due to evapo-transpiration from vegetation or declines in aquifer storage. Wetlands perched above the local water table either on compact tills or silty clay subsoils dry up quickly during the growing season. Wetlands along the roadside ditch on Wheeler Street and behind the Catholic Church had significant flows in April and May but went dry by the end of July, 1998.

Persistent wetlands receive inflows from hillside springs, small streams, or local water tables and may persist until late summer. Their water levels decline by July or August when the springs dry up, groundwater levels decline, or evapo-transpiration depletes soil moisture storage.

Perennial wetlands are saturated all year and are generally found along streams and ditches. Wetlands below the O'Brien Spring (parcel #241702670175, ID#44) at the end of Ranger Road have perennial flow that varied from 126 gpm (April 24, 1998) to 36 gpm (July 23, 1998).

The City of Leavenworth stormwater drainage system collects runoff and subsurface drainage from many of these wetlands and discharges it to the Wenatchee River. The stormwater outfall pipes at 8th Street and below Commercial Street flowed all summer and varied from .2 and 4 cfs in April, 1998, to .02 and 3 cfs, respectively, in August, 1999. Additional development and drainage of wetlands in the Ski Hill Basin will increase the magnitude and duration of this stormwater drainage.

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