

_README

This directory contains the file for the document "Overview of Ground-Water Conditions (Elwha Technical Series PN-95-3) March 1995.

The drawings in this report were superseded by those contained in the document "Water Quality Analyses and Mitigation Alternatives" (Elwha Technical Series PN-95-8) March 1997.

ELWHA RIVER RESTORATION PROJECT, WASHINGTON

Elwha Technical Series
PN-95-3

OVERVIEW OF GROUND WATER CONDITIONS

U.S. Department of Interior
Bureau of Reclamation
Pacific Northwest Region
Boise, Idaho



March 1995

**ELWHA RIVER
ECOSYSTEM AND FISHERIES
RESTORATION PROJECT
Washington**

**OVERVIEW OF
GROUND WATER CONDITIONS**

**Elwha Technical Series
PN-95-3**

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FIGURE 1. General Vicinity and Well Location Map

FIGURE 2. Hydrogeologic Cross-Section

SUMMARY

The geologic setting of the lower Elwha River drainage basin consists of bedrock formations mantled by unconsolidated deposits. The bedrock formations impede ground water flow and define the base of the unconsolidated hydrogeologic system. A sequence of glacial and non-glacial deposits comprise the unconsolidated hydrogeologic system. The Elwha River valley is incised into these deposits, with recently-deposited alluvium partially filling the valley floor. In general, the alluvium and older glacial deposits are aquifers which are relatively coarse-grained and can supply usable quantities of water.

The alluvium within the Elwha River floodplain primarily consists of sand and gravel, and serves as the primary water supply aquifer for the area. Most of the community supply systems are drawing from the alluvial aquifer. The lateral extent of the river-deposited alluvium is restricted to the incised channel bounded by the relatively steep bedrock and glacial-deposit bluffs.

Reported water levels indicate a distinct difference in ground-water occurrence when comparing information from the upland areas with wells completed in the alluvium. Water levels measured in the upland areas are typically 100 to 200 feet higher than the water levels in the alluvial aquifer. The difference in water level elevation between the alluvium and the upland areas indicates that water flowing through the alluvium is not a source of recharge for the upland areas. Fluctuations in river stage should not affect ground-water levels beyond the limits of the river alluvium. Water levels in the alluvium aquifer and the river are generally consistent with one another, indicating that the two systems are likely in hydraulic connection.

The upper river valley (RM 4.0 - 9.7) has had relatively little ground-water development. Most of the water wells are located to the west of and several hundred feet above the river valley, drawing water from elevations above the Elwha River and Lake Aldwell. A few homes and Indian Creek Campground are located near the confluence of Indian Creek and the Elwha River. The water levels in wells completed in the alluvium in this area are probably influenced by the level of Lake Aldwell.

Most of the water use in the Elwha River basin is from the lower valley, below RM 4.0. Several community water systems, industrial supplies, fisheries, and individual homes use the Elwha River for their sole source of water. Current demand, based on permitted capacity for the larger users and estimated consumption for individual users, is approximately 213 cfs.

The surface water and ground water are of excellent chemical quality. Low levels of chloride concentration in well water samples tested in August 1994 show no indication of salt water intrusion into the shallow alluvium aquifer near the shoreline.

INTRODUCTION

The Elwha River Ecosystem and Fisheries Restoration Act (PL 102-495) requires the protection of existing downstream water supplies during removal of the Elwha and Glines Canyon Dams and during restoration of the Elwha River. To this end, studies are underway to identify all water users in the potentially affected area, to describe surface water use and quality, and to develop a conceptual understanding of the occurrence, movement, quality, and use of ground water in the lower Elwha River basin.

This report summarizes the findings of the baseline water resource assessment completed to date. This information and further studies will provide the basis for assessing potential impacts to existing users associated with dam removal and potential mitigation measures to off-set such impacts.

The Elwha River basin is the major drainage on the northern side of the Olympic Mountains, draining an area of approximately 321 square miles, 83 percent of which is located within Olympic National Park. The glaciated valley trends north to northwest from the central Olympic Mountains to Freshwater Bay in the Strait of Juan de Fuca. The river drops nearly 4,500 feet in elevation over its 45-mile length. It is fed by several glaciers, a high quantity of annual precipitation (more than 200 inches) in the upper elevations, and from numerous tributaries within the drainage basin. Average instantaneous discharge is 1,507 cubic feet per second (cfs).

Ground Water Study Area

A preliminary study area was delineated with approximate boundaries running from the mouth of the river on the north, to the Olympic National Park boundary on the south. The city limits of Port Angeles bounded the area on the east, and the edge of the drainage basin defined the study area boundary on the west. (see Figure 1.)

Discussions in this report use a river-mile notation system to identify the locations of pertinent features in the lower Elwha basin. This system begins at the mouth of the Elwha River and increases in one-mile increments moving upstream. The river crosses the Olympic National Park boundary at river-mile (RM) 9.7, measured from the Strait of Juan de Fuca.

Information Sources

This interpretation of hydrogeologic conditions in the lower Elwha basin was developed from published reports, state agency file information, and a limited field reconnaissance. The primary sources of information consisted of:

- The United States Geological Survey (USGS) Geologic Map of the Olympic Peninsula (Map I-994), including unpublished refinements presented in the Port Angeles Regional Watershed report prepared by Clallam County;

- A total of 236 water well logs on file with the Washington State Department of Ecology for the study area;
- Responses to a "Water Use Inventory" developed for this project and sent to all land owners in the study area, including known well owners on the Lower Elwha Reservation; and
- A three-day field reconnaissance which included water level monitoring in 32 wells and the measurement of chloride levels in 12 wells located near the mouth of the river.

GEOLOGIC SETTING

Aquifers are permeable and porous water-bearing areas in the water-saturated zone underground. Aquifers frequently are comprised of sand and gravel (called "unconsolidated materials"); the water flows through the naturally occurring spaces, or pores, around these sand and gravel particles. Sometimes aquifers are found in consolidated rock ("bedrock"); the water flows along interconnected cracks and fractures in the rock.

The geologic setting of the lower Elwha River drainage basin consists of sloping bedrock formations which are locally overlain by younger unconsolidated materials. The bedrock formations impede ground water flow and define the base of the aquifer system, which is the primary area of ground water occurrence. Wells completed within the bedrock formations are typically dependent upon localized fracture zones within the rock to supply usable quantities of water. The bedrock is not generally considered a significant source of water supply in this area.

Bedrock is exposed at the ground surface throughout much of the upper Elwha basin, from the Lake Aldwell area into the upper portions of the drainage. Unconsolidated deposits are exposed at the surface and overlie the bedrock in a majority of the areas north of Lake Aldwell. Projections from well drilling records suggest that the bedrock is covered by about 300 feet of unconsolidated material near the Strait of Juan de Fuca.

The bedrock formations in the lower Elwha basin include basalt (named the Crescent formation), siltstone (Aldwell formation), conglomerate (Lyre formation), and sandstone (Twin River formation). The bedrock formations were folded and faulted during the uplift events which formed the Olympic Mountains. Further detail about the geologic formations and their structures can be found in the USGS Map of the Olympic Peninsula (Map I-994).

BASIN HYDROGEOLOGY

Discussions in this section focus on the unconsolidated units which collectively comprise the lower Elwha basin's hydrogeologic system. This system generally extends from the mouth of the Elwha River to the Indian Creek valley area, located above Lake Aldwell.

Primary Hydrogeologic Units

A sequence of glacial and non-glacial deposits comprise the unconsolidated hydrogeologic system. The older glacial and non-glacial units were deposited first, covering the bedrock surface which slopes downward toward the north. The Elwha River valley is incised into these deposits, with recently deposited alluvium partially filling the valley floor. The present topography of the lower Elwha basin reflects this geologic sequence, with glaciated uplands bounding the deeply-cut channel of the Elwha River. Figure 2 is a cross-sectional drawing which shows the relationship of the alluvium, glacial deposits, and bedrock in the study area.

Alluvium

The alluvium within the Elwha River floodplain primarily consists of sand and gravel with silty zones and it serves as the primary water supply aquifer in this area. Most of the community supply systems are drawing from the alluvial aquifer. These include the Port Angeles Ranney Well and the wells for the Dry Creek Water Association, Elwha Place Homeowners Association, and Lower Elwha Reservation.

The river-deposited alluvium is found only in the incised channel bounded by the relatively steep bedrock and glacial-deposit bluffs. Drilling records indicate that the alluvium is about 55-feet thick at about RM 3.0 and less than 100-feet thick near the mouth of the river.

Glacial Outwash

The glacial outwash consists of sand and gravel and is exposed at the surface on top of the bluffs near the mouth of the Elwha River. The deposits are relatively thin (less than 20 feet) and unsaturated in these areas. The unit does not serve as a water supply source, but is used as a borrow source for several local gravel mining operations.

Glacial Till

Glacial till is exposed at ground surface over a majority of the upland area bounding the Elwha River valley. The till is composed of compacted, non-stratified sand, gravel, and cobbles in a fine-grained matrix. The till was encountered in virtually all upland wells with typical thicknesses ranging from 50 to 150 feet. An excellent exposure of this deposit exists on the west side of the Elwha River, approximately 0.5 mile from the mouth. The bluff is over 100 feet high and stands nearly vertical.

Relatively few wells are completed within the till. Those that are completed in the till (at depths of 150 feet or less) yield small quantities of water when pockets of cleaner sand and gravel are encountered. Reported well yields are typically less than 20 gallons per minute (gpm) and service individual users.

Non-Glacial Deposits

In most areas of the lower Elwha basin, drilling records identified a clayey deposit ranging in thickness from about 20 to 50 feet. The fine-grained, gray material is likely non-glacial in origin; perhaps originating as a marine deposit during a period of time between glacial events. This unit does not yield appreciable quantities of ground water for supply purposes.

Older Glacial Deposits

The deepest glacial unit identified in the lower Elwha basin drilling records is a sequence of sand with silt and gravel that was deposited on top of the bedrock surface in front of the glaciers during an earlier glacial period. The unit was most frequently encountered in the lower portions of the basin, where maximum thicknesses of 100 to 150 feet were identified. The unit apparently pinches out toward the south. Drilling records from wells located in the upland areas around Lake Aldwell either went from glacial till directly into bedrock or penetrated less than 50 feet of the older glacial material.

A number of wells are completed in these glacial deposits, or in the upper portion of the bedrock which is probably hydraulically connected. The wells service individual users and generally have yields of less than 20 gpm.

GROUND WATER FLOW

Variability in composition and origin of the primary hydrogeologic units identified in the lower Elwha basin affects the ability of each unit to transmit ground water. In general, the alluvium and the older glacial deposits are aquifers which are relatively coarse-grained and can supply usable quantities of water. In contrast, the glacial till and the non-glacial deposits are predominantly fine grained, do not readily transmit ground water, and only produce usable quantities of water where localized sandy zones are encountered.

On a regional scale, ground water flow in the lower Elwha basin originates in the higher elevations as precipitation infiltrates into the ground. It flows toward the north through the unconsolidated materials and ultimately discharges to the Strait of Juan de Fuca. Ground water flow through the underlying bedrock is restricted to fractures and joints which are typically local in extent. Water level information provided on well drilling logs enables a qualitative assessment of ground water flow patterns through the unconsolidated deposits.

Inferred Flow Directions

Water levels reported by drillers indicate a distinct difference in ground water occurrence when comparing information from the upland areas with wells completed in the river alluvium. Water levels measured in the upland areas are typically 100 to 200 feet higher than the water levels of the alluvial aquifer. The separation in water levels between these two areas appears to decrease toward the north. These observed water level patterns indicate that a portion of the ground water flowing through the glacial deposits in the uplands discharges to the Elwha River valley, with the remainder of the flow moving toward the north and then discharging to the Strait of Juan de Fuca. The difference in water level elevation between the alluvium and the upland areas indicates that water flowing through the alluvium is not a source of recharge for the upland areas. Fluctuations in river stage should not affect ground water levels beyond the limits of the river alluvium.

Within the alluvium, the general ground water flow direction is toward the north, paralleling the river course. Water levels in the aquifer and the river are generally consistent with one another, indicating that the two systems are probably in hydraulic connection. Surveyed monitoring points have been established to compare hydraulic head measurements in the ground water system with the river stage. Pumping test data indicate that the Port Angeles Ranney Well and other high-yielding community wells draw from ground water levels below the elevation of the river and induce flow toward the wells.

Lake Mills and Lake Aldwell are supplied with water from the Elwha River and other tributaries and from ground water discharge from the surrounding highlands. The incised valley, in which the lakes are located, is partially filled with river alluvium, which is probably hydraulically connected to the surface water. The lakes do not recharge the upland glacial deposits. The water level elevations recorded in wells in the upland areas are significantly higher than water levels in the river alluvium or surface water level. An exception to these conditions is near the Indian Creek confluence, just upstream of Lake

Aldwell. In this area, Lake Aldwell supports a higher ground water level in the lower Indian Creek valley than there would be without the lake.

WATER USE

The Elwha River exits Olympic National Park at about RM 9.7. For study and discussion purposes, the Elwha River valley has been divided into upper and lower sections. The upper valley extends from the park boundary downstream to approximately RM 4.0, where the river emerges from a narrow bedrock canyon below Elwha Dam and where the alluvial floodplain widens and thickens.

Upper Elwha River Valley

The upper river valley has had relatively little ground water development. Most new housing construction and water wells are to the west of the river valley on a remnant glacial outwash terrace at elevations above 400 feet. The wells average less than 200 feet in depth, drawing ground water from elevations above the level of the Elwha River and Lake Aldwell. The water pumped from those wells originated as precipitation which infiltrated into the ground and flowed through the glacial outwash materials.

A few homes and Indian Creek Campground are located near the confluence of Indian Creek and the Elwha River, at the upstream end of Lake Aldwell. Wells in this area, that are completed in the permeable river alluvium, are probably influenced by the level of Lake Aldwell.

Several homes are located on the east side of the Elwha River, south of the Little River tributary. The wells for these homes are shallow and the water levels reflect the fluctuating river level. These wells are not expected to be influenced by the level of Lake Aldwell since the bottom elevations of the wells are above the lake elevation. Some of the wellheads are periodically flooded during high river levels.

A few domestic wells are located on the southeast side of Lake Aldwell. They appear to be completed at a higher elevation than the lake level and draw water from the glacial deposits above the bedrock or from water bearing fractures within the bedrock.

Lower Elwha River Valley

Most of the water use in the Elwha basin is in the lower valley, below RM 4.0. Several community water systems, industrial supplies, and fisheries use the Elwha River for their sole source of water. In addition to the water systems, there are individual users in each sub-basin. Most of the private wells are located in the lower sub-basin on and near the Lower Elwha Reservation. Total water use by all individual well users is estimated at less than 0.2 cfs.

Summary of Water Use

A summary of current water use from the alluvium aquifer in the lower Elwha River valley provides an assessment of water requirements and identifies areas where induced recharge from the river is needed to sustain current demand. The following information, summarized by sub-basin, is as reported in the Washington State Department of Ecology water rights database and the available well log records. This listing includes the permitted capacity for the larger water users and an estimated consumption rate for the individual users who are exempt from the permitting process. In this tabulation, we assume that individual homes use less than 5,000 gallons per day (an average of 3.5 gpm) which is the upper threshold for exemption from water use permitting.

**TABLE 1.— SUMMARY OF WATER USE
Lower Elwha River Valley**

<u>Sub-Basin</u>	<u>Water User</u>	<u>Quantity</u>
	Upper Basin (RM 3.1 - 4.0)	
	Dry Creek Water Association	0.60 cfs
	Other Users	<0.05 cfs
	Middle Basin (RM 2.8 - 3.1)	
	WA Dept of Fisheries Rearing Channel and Industrial Diversions.....	150.0 cfs
	City of Port Angeles.....	50.0 cfs
	Other Users	<0.05 cfs
	Lower Basin (RM 0 - 2.8)	
	Lower Elwha Tribe	0.3 cfs
	Lower Elwha Hatchery.....	11.5 cfs
	Elwha Place Homeowners Assoc.	0.4 cfs
	Other Users	<0.1 cfs
Total Estimated Water Use		213.0 cfs

GROUND WATER QUALITY

Due to the hydraulic connection between the Elwha River and the alluvium aquifer, the quality of surface water and ground water is very similar. The surface water is listed as having excellent quality, and all chemical concentrations meet or exceed requirements of the Washington State Drinking Water regulations.

Water testing conducted in 1977 as part of the USGS study of water resources of the Lower Elwha Reservation indicated the ground water to be of excellent chemical quality¹. The watershed is protected by National Park status in the upper reaches. Most of the remaining basin is rural in character and there are no landfills or industrial discharges. Non-point sources of pollution, such as agricultural and urban run-off, have a very minor influence due to the small number of farm operations or development within the river basin.

All of the homes in the lower basin rely on private septic systems for on-site sewage disposal. At high ground-water levels, the buried perforated drain lines are barely above the water table. The coarse grained alluvium does not provide much filtration to the wastewater before entering the aquifer, and a failed system could be a source of ground-water contamination.

Twelve water samples were tested in August 1994 to determine chloride levels in wells located near the mouth of the river. Eight of the samples were taken from wells on or near the Lower Elwha Reservation; the remaining four were taken from wells on lower Place Road, west of the Elwha River along Freshwater Bay. The maximum chloride concentration tested at 8 milligrams per liter (mg/L), the minimum was less than 1 mg/L, and the average was about 2 mg/L. Washington State Drinking Water Standards require less than 250 mg/L for chloride. The low levels of chloride concentration sampled indicate no salt water intrusion has occurred to-date into the shallow alluvium aquifer near the shoreline.

Further testing of the ground water is not planned as a part of this study since no means or activities that would affect the ground-water quality are anticipated as a result of dam removal. Surface water monitoring is continuing at several USGS data collection stations on the river to provide a record of flow and quality data.

¹ U.S. Geological Survey, 1979. *Water Resources of the Lower Elwha Indian Reservation, Washington*. Water-Resources Investigations Open-File Report 79-82.