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# QUANTIFYING IMPACTS TO A FLOODPLAIN GROUNDWATER SYSTEM FROM LARGE-SCALE SAND AND GRAVEL MINING

By

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Quantifying the Impacts to a Floodplain Groundwater System From Large-Scale Sand and Gravel Mining

Director: William W. Woessner 5/24/01

In order to satisfy the increasing demands of construction industries, new sources of sand and gravel (aggregate) must be continuously located and developed. Sand and gravel deposits are typically found in flood plains along active river and stream channels. Excavation can and does take place below the water table, leading to concerns about negative effects on groundwater and surface-water resources, particularly from large-scale mining. Local Residents and an adjacent drainage district were concerned that a proposed expansion of an aggregate mine, creating a 360-acre lake in the Columbia River floodplain, would raise the water table over a large area, thereby increasing flooding potential, and drainage pumping costs.

This study characterized groundwater and surface-water conditions in the area of the expansion and reviewed the drainage district's dewatering operations. A MODLFOW (McDonald and Harbaugh, 1988) model was developed and a series of simulations created to replicate existing conditions and to predict the effect of the aggregate mine excavation on the local groundwater flow system. Numerically simulating existing and future groundwater conditions showed that groundwater flow to the aquifer beneath the drainage district would increase by 10 to 17 percent. This increased flow produces additional saturation of a limited area above the current water table, resulting in additional pumpage requirements of five to eighteen gallons per minute. In addition, an increase in flooding potential due to a widespread increase in water table elevation is not predicted.

## TABLES

## FIGURES AND PLATES

## APPENDICES

# CHAPTER 1: INTRODUCTION

According to the USGS, each year in the U.S. over two billion tons of aggregate are produced annually (USGS, 1999). Aggregate consists of sand, gravel and crushed stone that are used in the construction of roads, structures and the manufacturing of cement products. Current projections indicate that the amount of aggregate needed to satisfy demands over the first 25 years of the 21st century will be equal to the total amount of aggregate mined during the entire 20th century (USGS, 1999). In Oregon alone, the Department of Geology and Mineral Industries predicts an increase in aggregate consumption of 0.53% annually over the next 50 years (Whelan, 1995). This means that new sources of aggregate must be located and developed in order to fulfill increasing demands.

Most sand and gravel aggregate was deposited as stream-laden (fluvial) sediments along the course of rivers and streams. These deposits can be found in and near active river channels and within the floodplains of river valleys formed by the erosion, migration and flooding of rivers over thousands of years. In some cases, these sand and gravel deposits are several hundreds of feet thick and cover many acres.

Floodplain mining for aggregate often occurs in areas with shallow water tables. Mining can and does take place within the saturated sediments of unconfined sand and gravel aquifers. Mining within an aquifer can be a source of concern to neighbors and regulatory agencies because its potential to alter the natural groundwater flow system and/or introduce contamination.

Several researchers have examined the flow conditions around lakes, ponds and gravel pits. Many of these studies are associated with contaminants or the potential contamination of public water supplies. However, at least two efforts (Durbec, et al., 1987, and Shope, 1990) include an investigation of the interaction between gravel pits, aquifers and nearby surface waters. These studies examine the characteristics of existing groundwater systems in which mining has occurred and the potential impacts of mining below the water table.

Significant research has been conducted to examine the behavior of lakes and ponds relative to hydraulically connected groundwater flow systems, including techniques of numerical simulation. Cheng and Anderson (1993, 1994) developed a Lake package for MODFLOW, which allows simulation of lakes with variable recharge and boundary conditions within a groundwater flow system. This package has subsequently been modified to include additional boundary conditions (Council, 1998). Baker, et al. (1998) developed a MODFLOW module, PITLAKE, to simulate dewatering and rewatering of mine pits.

Comparison of techniques used to simulate flow-through lakes is reported by several workers. Chung and Anderson (1998) and Nair and Wilsnack (1998) examined the results of using high-hydraulic conductivity (K) zones in MODFLOW compared to the use of the Lake package for various scenarios.

Several researches have examined the techniques used to quantify the parameters and controls that influence lake/groundwater interactions and the uncertainty that may be associated with these parameters (Winter, 1981) (Lee, 1996) (Lee and Swancar, 1996).

## Goals and Objectives

The primary goal of this project was to determine what effect the proposed mine expansion would have on the local groundwater flow system. In order to accomplish this, specific objectives were established. They included:

1) Compiling and reviewing previous work on the hydrogeology of the project area. Tasks included analysis of water well reports filed with Oregon Water Resources Department (WRD).
2) Interviewing individuals familiar with local hydrogeology, mining activities and the SDIC operations. Tasks included reviewing historic mining in the area and detailing past and current SDIC operations.
3) Analyzing the location of project area monitoring wells, piezometers and surface-water gages. Tasks included confirming elevations for measuring points and relating them to a common datum.
4) Estimating the hydraulic characteristics of project-area sediments. Tasks included analyzing previous research and evaluating information on the geologic history of the area.
5) Measuring, documenting and analyzing water-level data collected from piezometers, monitoring wells and surface-water gages to provide basis for a conceptual model. A database of water-level elevations was generated to support this objective.
6) Developing a conceptual model of the local groundwater flow system and surface-water groundwater interaction based on the information gained from Objectives 1 through 5 above.

7) Creating a groundwater flow model that tests and evaluates the conceptual groundwater flow system. Tasks included calibrating the model to match measured water levels.
8) Creating a groundwater flow model to simulate the potential effects of the proposed mine expansion on the local groundwater flow system. Several methodologies were explored.
9) Analyzing flow model results and determination/quantification of actual mining effects.

### Report Organization

The text of this report provides a discussion of the results and conclusions from the background research, field investigations and groundwater modeling. Chapter 2 provides Background information, Chapter 3 describes the Research Methods, and Chapter 4 details the Results of the study. Chapter 5 contains a discussion of Uncertainty and Limitations and Chapter 6 includes Selected References. Figures are included after the text and Appendices A, B C and D contain supporting data.

## CHAPTER 2: BACKGROUND

As shown on Figure 1, the project area is about 2 miles northeast of the town of Scappoose in Columbia County, Oregon. The site is on the western side of the Columbia River valley. Elevations in the valley bottom generally range from about 100 feet Mean Sea Level (MSL) to near sea level. The west side of the river valley is bounded by the Tualatin Hills, which locally extend to more than 1,000 feet MSL in elevation.

The project area includes numerous creeks, sloughs, lakes and wetlands as shown on Plate 1, Project Area Map. Major water bodies in the area include Jackson and Scappoose Creeks, Santosh and Evans Sloughs, Scappoose Bay and the Multnomah Channel, which connects the Willamette and Columbia Rivers. Dense vegetation exists along Jackson Creek, Evans and Santosh Sloughs and scattered small stands of deciduous trees are also present. Most of the area is used for agriculture, including irrigated crops and pasture for cattle.

Sand and gravel mining has been conducted in the Scappoose area for decades. Several active mining operations are located directly north of the expansion area and also to the west. These operations currently mine sand and gravel below the water table, creating open-water lakes and ponds.

The expansion property (referred to as Pit E, see Plate 1) is a 423-acre parcel of relatively flat crop and pastureland that slopes downward gradually from northwest to southeast. The Scappoose Industrial Airpark and rural residential properties border it on the west, Jackson Creek on the east. Residential properties and farmlands exist north and south of the site, respectively. Site elevations range from approximately 50 feet MSL at the western edge near the Scappoose Industrial Airpark to less than 10 feet MSL at the eastern border near Jackson Creek/Santosh Slough. No surface water features are present within the site boundaries.

Native vegetation is largely absent from the site, existing only as individual trees and isolated strips along fences. Elsewhere, pasture and crops cover the site.

The mining is planned to occur in excavated cells. Ponds will naturally form as the excavations extend to about 100 feet below the water table. No offsite surface-water runoff will be allowed to enter future ponds, and water levels within each mining cell will correspond with groundwater elevations in the surrounding area.

## Area Geology

The project area is within the historic floodplain of the Columbia River. Ancient flows of the river deposited gravels, cobbles and boulders on top of basalt bedrock, which is present at depth. Subsequent channel meandering and intermittent flooding over millions of years covered these ancient deposits with layers of coarse-grained materials interspersed with lenses of fine-grained overbank deposits. An overlying soil, consisting of sand, silt, clay and gravel, is from 1- to 20-feet thick in much of the floodplain.

Walker and MacLeod (1991) mapped the finer-grained sediment as Holocene age (about 11,000 years ago and younger) alluvial sediment. The underlying coarse-grained material is interpreted as a combination of Late Pleistocene age (about 1.8 million years ago) catastrophic flood gravels overlying older Miocene-Pliocene age (7 to 26 million years ago) river gravels of the Troutdale Formation (Bet and Rosner, 1993). Rock-type distinctions occur between the unconsolidated gravel and the Troutdale formation, but these are not likely to be noted on drillers' logs (the primary source of geologic information). Figure 3 shows the simplified stratigraphy underlying the project area. Figures 4 and 5 show geologic cross-sections through the project area.

The following paragraphs describe the geologic units in the project area in order of increasing age:

### Fine-Grained Quaternary Flood Deposits

Fluvial sediments occur to depths of 1 to 20 feet below the ground surface. These geologically recent, fine-grained overbank or flood deposits consist primarily of brown cobbly silts with some bouldery cobbly silts with silty sands and cobbly silty sands. The thickness of this unit apparently increases toward the eastern side of the project area. The permeability of this finer-grained material is less than in the underlying sediments.

### Coarse-Grained Quaternary-Tertiary Flood Deposits

Below the fine-grained flood deposits, older, coarse-grained glacio-fluvial flood deposits underlie the area. These sediments, which are Quaternary to Tertiary in age, extend to depths of more than 200 feet below ground surface. The unit consists of poorly graded, rounded gravels and cobbles in a sand matrix. These deposits are the materials that are locally mined for sand and gravel.

The deposits contain scattered boulders larger than 12 inches in diameter. The deposits are locally cemented and can perch groundwater, based on observations of dewatered gravel pits southwest of the site. Groundwater can be locally confined beneath these low-permeability cemented zones. A review of water-well reports for several wells in the project area suggests that these cemented zones are discontinuous and cannot be confirmed over large distances. Hartford and McFarland (1989) report that cementation occurs in both the Quaternary gravels and the deeper Troutdale formation, thereby preventing these criteria from being used as a distinguishing characteristic. A greenish, cemented gravel is present between depths of about 65 to 108 feet below ground surface (bgs), based on site coring data.

### Site Geology

The geology beneath the expansion site is consistent with the units described above, based on the conditions encountered near and below the adjacent GNW Pits A and B (Figure 2). Boring logs for 94B1, 94M1, 94M2, 94M3 and 94M4 (see Appendix C) and Figures 3 and 4 provide details on the subsurface geology.

A discontinuous silt unit was encountered in the upper unconsolidated sand and gravel zones in borings 94M2 and 94M4. The silt unit, where present, appears to be 10- to 15-feet-thick.

Cemented and unconsolidated sand and gravel was encountered in borings 94M1, 94M2 and 94M3. The cemented zone appears to be discontinuous beneath the site, based on the information from these borings. In boring 94M1 (the only boring that extensively explored the vertical thickness of this layer), the cemented zone extended to -200 feet MSL and was more than 90-feet thick. The full thickness of the cemented zone in boring 94M1 is unknown since this boring did not completely penetrate the cemented material. Based on reports by others, it is inferred that unconsolidated silts, sands and gravels are present below the cemented zones.

### Soils

Maps compiled by the U.S.D.A. Soil Conservation Service (SCS) show two soil series exist at the site (SCS, 1986). These series are the Sauvie silty clay loam and the Sifton loam. The Sauvie silty clay loam occurs in the southeastern portion of the property along Jackson Creek and the Sifton loam covers the remainder of the site. Both soils are described as deep to very deep (extending deeper than 60 inches below ground surface). The Sauvie series is described as poorly drained soil formed on recent silty alluvium. The Sifton series are classified as somewhat excessively well-drained soils formed in gravely alluvium mixed with volcanic ash.

**Surface Water**

As previously discussed, the project area is within the historic floodplain of the Columbia River (see Plate 1). In addition to the Columbia River, principal drainages in the area include:

- Multnomah Channel east of the site, which discharges to the Columbia River at Scappoose Bay (south of St. Helens, Oregon);
- Jackson Creek and Santosh Slough immediately east of the site, which discharge either to Evans Slough or to the SDIC tide gate at the north end of Santosh Slough, depending on season; and
- Scappoose Creek west and northwest of the site, which drains to lowlands northwest of the site and eventually Scappoose Bay.

Some of the above features are natural, although the U.S. Army Corps of Engineers (COE) and the SDIC have substantially modified local drainages. The Jackson Creek/Santosh Slough system functions as a drain to collect water from other smaller drainage ditches in the district. This water is directed either to Evans Slough when the Columbia River is high or to the tide gate when the Columbia River is low.

The COE modifications to surface water features are primarily related to flood control and to allow shipping in the Columbia River and related major waterways. The SDIC's improvements control water levels in private farmland within the historic floodplain. The COE assists the SDIC with dewatering system improvements since the COE provides additional flood control structures, such as the dike along the Multnomah Channel.

Other surface-water features within the project area include the numerous channels and ditches within the SDIC, and ponds created by gravel mining operations. These ponds are at Santosh Pits A and B (north of the expansion area), and at the Scappoose Sand and Gravel operation, about ½ mile west of the expansion area. In addition, the area includes a barge canal north of Pit A, and several small seasonal ponds within the SDIC.

Levels and stages of surface-water features in the project area are influenced by regional as well as local conditions. A major regional influence on surface-water elevations is the Columbia River stage, which, in turn, is influenced by conditions such as tidal effects, seasonal precipitation and snowmelt, and the regulation of upstream dams.

Tidal influences, which alter the river stage as much as several feet along this reach of the Columbia River are pronounced during low water periods, but are less significant during high river stages (Helper, 1991). The mean monthly river stage ranges from about 15 feet MSL in January to about 5 feet MSL in September (Helper, 1991). The Barge Canal, north of the site, allows barges to move from the Santosh loading area to the Multnomah Channel. The water level of the Barge Canal is considered to be roughly equal to the Columbia River stage because of its direct connection to the river.

Local controls on surface-water elevations include runoff from precipitation, recharge from groundwater and the pumping schedules of the SDIC.

No natural surface water features or drainages exist on the proposed expansion site, based on aerial photos and site observations. However, farm roads and some irrigation and drainage ditches provide conduits for surface runoff. This runoff collects in low-lying areas and forms intermittent, temporary puddles. Precipitation for this area is estimated to be approximately 40 inches/year, based on data from the collecting station at St. Helens, Oregon.

## Scappoose Drainage Improvement Company Operations

The SDIC (formerly known as the Scappoose Drainage District or SDD) was formed as a drainage district in 1922 to manage water levels in the agricultural lands along the floodplain. Numerous drainage canals, levees, tide gates and pump stations were subsequently constructed between 1926 and 1928. In 1939 and 1940, the COE reinforced the SDIC's levees and upgraded the pumping capacity of the system. Additional improvements were added through the years.

The COE studied other SDIC improvements (described in a June 1971 COE *Design Memorandum*) and subsequently completed further work. This work included removing and replacing major pumping stations and tide gates, upgrading the levee and constructing a sublevee southeast of the barge canal (Ogden Beeman & Associates, 1979). The SDIC tries to maintain water levels within the Jackson Creek and Santosh Slough system at approximately elevation 4 to 4.75 feet MSL during winter and elevation 3 to 3.75 feet MSL during the summer (personal communication, SDIC). The calculated recurrence frequency of the Standard Project Flood is about 1,000 years (COE, 1971).

Dewatering inside the SDIC boundaries is conducted by pumping surface water from drainage canals, which in turn, are connected to numerous ditches. Five pump stations currently exist near the site. Each station is related to a sub-basin within the district. Four of the stations (referred to as the Johnson, Honeyman, Hoven and Smith pump stations) are in the interior of the SDIC and discharge water to Jackson Creek, Santosh Slough or Evans Slough inside the SDIC boundaries. The fifth station, known as the Evans pump station, extracts water from the east end of Evans Slough and discharges it into Multnomah Channel, which is outside the SDIC boundaries. Plate 1 shows the locations of these pumps and features.

The majority of SDIC pumping occurs in the winter when precipitation rates and water levels reach their seasonal highs, although the SDIC also controls creek and slough levels in the summer to maintain water for irrigation. Pumps at each station automatically start when float switches exceed pre-set elevations. The Johnson, Honeyman and Hoven pump stations, which pump in the interior of the SDIC, each have capacities of 3,000 gallons per minute (gpm) and discharge into Jackson Creek/Santosh Slough. The Evans pumping station at the eastern edge of the SDIC has four pumps, each reportedly capable of discharging a maximum of 32,600 gpm at 27 feet of head.

The Smith pump station is nearest the site. This station is also within the lowest elevation and largest subbasin of the SDIC. The Smith station has two pumps with capacities of 3,000 gpm and 6,000 gpm. These pumps extract water from a network of ditches and discharge it to a ditch connected to Jackson Creek/Santosh Slough. From Jackson Creek, the water flows northward into Santosh Slough or enters Evans Slough and is pumped into Multnomah Channel. During low stages on the Columbia River, tide gates at the north end of Santosh Slough allow water to gravity flow out of the SDIC. During high river stages, water flows south from Santosh Slough and north from Jackson Creek into Evans Slough and is eventually pumped into the Multnomah Channel.

### Groundwater

Regional groundwater flow is inferred to be from the highlands west of the project area toward the Multnomah Channel east of the proposed expansion site. The aquifer system in the project area is interpreted to be unconfined, although locally confined conditions appear to exist. The Quaternary-Tertiary fluvial deposits in the area are the principal, uppermost regional water-bearing unit. These deposits are referred to by Swanson, et al. (1993) as the Upper Sedimentary Subsystem of the Portland Basin. This subsystem is described as being composed of two hydrogeologic units, the Unconsolidated Sedimentary Aquifer and the underlying Troutdale (or Consolidated) Gravel Aquifer. This interpretation is consistent with Hartford and McFarland's (1989) Unconsolidated Gravel/Troutdale Gravel Aquifer. Within this subsystem, the two units are not separated by geologic structures or a major change in sediment types, but are commonly distinguished by a change in the amount of cementation.

The referenced authors describe the Unconsolidated Sedimentary Aquifer as being composed of catastrophic flood deposits, and consisting of bouldery gravels to silt. Drillers' logs indicate cemented or clayey gravels mark the transition from the unconsolidated gravels to consolidated gravels. Swanson et al. (1993) shows the Unconsolidated Sedimentary Aquifer to generally be less than 200 feet in thickness. It likely increases up to 400-feet thick along the axis of the Columbia River channel, based on data from wells drilled on Sauvie Island to the south of the project area.

The Troutdale Gravel Aquifer is present in most parts of the Portland Basin. This aquifer occurs within consolidated formations of poorly to moderately cemented conglomerates (consisting of sands, gravels and cobbles), and sandy conglomerates and gravels. The conglomerates are derived from ancestral Columbia River-borne sediments. Gravels in the unit are derived primarily from basalt flows of the Columbia River Basalt Group, although the full range of rock types found in the Columbia River drainage are represented. Lenses of sand, silt and clay are also common in the Troutdale Gravel Aquifer. The aquifer commonly ranges from about 100- to 400-feet thick.

The hydrostratigraphic units underlying the Upper Sedimentary Subsystem of the Portland Basin are described by Swanson et al. (1993) as the Undifferentiated Fine-Grained Sediments and Older Rocks. Neither of these units appears to be penetrated by any wells in the project area and both consist of relatively low permeability formations. These units probably represent the lower boundary of the Portland Basin groundwater system. It is estimated from Swanson et al. (1993) that the top of these units occur at a depth of at least 300 feet below ground surface in the project area.

### Project Area Conditions

Drillers' logs for water wells in the project area were compiled and reviewed. Wells that could be located from the reported information and field observations are shown on Plate 1 and listed in Table 1.

The project area drillers' logs describe cemented zones and layers of fine-grained sediments, with up to 80 feet of confining head in the water-bearing zones. Variations in the reported amount of confining head between wells that are in relatively close proximity provide strong evidence that the cemented zones and fine-grained sediments comprise a system of discontinuous lenses. These lenses tend to locally confine groundwater, but still allow hydraulic communication to occur between different areas of the aquifer. For example, wells 4/1-31dd1 and 4/1-31dd2 have a difference in confining head of 24 feet even though these wells are less than 500 feet apart and are completed at depths of 53 and 60 feet respectively. These conditions are not uncommon in fluvial environments.

Keener (1983) estimated hydraulic parameters in the area using specific capacity test data reported on 39 drillers' logs. Keener reports "the predominant computed permeability coefficient lies between 70 and 580 ft/day. However, there are sufficient wells with computed values ranging up to 1,220 ft/day to force the average computed value to 400 ft/day (with the extremes excluded)." He also reports the results of tests conducted by others. One such test provided a permeability estimate of up to 8,640 ft/day in a large-

# Table 1. Project Area Water-Well Data Summary

| Well Number | Total Depth of Well (ft.) | Screened Interval (ft.) | Depth to First Water (ft.) | Static Depth to Water (ft.) | Completion Date |
|---|---|---|---|---|---|
| 3/1-6ab1 | 79.5 | open casing | | 42 | Mar-61 |
| 3/1-6ab2 | 50 | " " | | 38 | Aug-66 |
| 3/1-6ab3 | 70 | " " | | 39 | Aug-68 |
| 3/1-6bb1 | 80 | " " | | 50 | Aug-58 |
| 3/1-6bb2 | 80 | " " | 60 | 45 | Jun-68 |
| 3/1-6bb3 | 63 | open casing | 18 | 18 | Apr-94 |
| 3/1-6ca | 81 | " " | | 38 | Apr-67 |
| 3/1-7cd | 80 | open casing | 3 | 3 | Dec-94 |
| 3/1-8da | 35 | open casing | 30 | 16 | Sep-92 |
| 3/2-12ad | 138 | " " | 124 | 42 | Jul-74 |
| 3/2-12bb | 94 | " " | 89 | 52 | Jul-74 |
| 3/2-12dc1 | 177 | " " | 85 | 25 | Sep-73 |
| 3/2-12dc2 | 164 | 113-155 | | 39 | Jul-56 |
| 3/2-1aa | 149 | open casing | 70 | 45 | Dec-79 |
| 3/2-1ba | 90 | " " | | 55 | Aug-57 |
| 3/2-1cc | 210 | " " | 56 | 34 | Jul-60 |
| 3/2-1cd | 120 | " " | 97 | 45 | Aug-91 |
| 3/2-1db | 120 | open casing | 10 | 10 | Feb-93 |
| 3/2-2ca | 280 | 260-280 | 265 | 245 | May-89 |
| 3/2-2dd1 | 260 | 165-260 | 246 | 124 | Aug-88 |
| 3/2-2dd2 | 250 | open casing | 65 | 58 | May-92 |
| 4/1-31ad1 | 70 | open casing | | 21 | Jul-69 |
| 4/1-31ad2 | 33 | " " | | 17 | Dec-80 |
| 4/1-31bd | 118 | " " | 25 | 3 | Jun-80 |
| 4/1-31cb | 127 | | | 40 | Aug-51 |
| 4/1-31cd | 85 | open casing | | 48 | Feb-67 |
| 4/1-31da1 | 60 | " " | | 45 | May-85 |
| 4/1-31dd1 | 53 | open casing | | 35 | Oct-82 |
| 4/1-31dd2 | 60 | " " | 60 | 35 | Oct-79 |
| 4/1-32bb | 40 | " " | 20 | 5 | Nov-73 |
| 4/1-32cb | 85 | " " | 32 | 32 | Apr-82 |
| 4/1-33cd | 106 | " " | 80 | 80 | Sep-79 |
| 4/2-36bb | 148 | " " | 110 | 97 | Sep-91 |
| 4/2-36bc | 150 | " " | 120 | 70 | Aug-77 |
| 4/2-36cc | 135 | " " | 120 | 70 | Jul-77 |

Notes:

1) Approximate locations of the above wells to the nearest quarter-quarter section are shown on Plate 1.
2) More wells in project area than shown.
3) Data based on drillers' logs (see Appendix B).
4) Depth to first water not always reported by driller.
5) Well numbers assigned according to the following format:
   - 3 - Township number (north, Willamette Baseline)
   - 1 - Range number (west, Willamette Baseline)
   - 6 - Section number
   - a - quarter section
   - b - quarter quarter section
   - 1 - indicates the number of the well within the quarter-quarter section (if more than 1)

diameter shallow pit in the bottom of Santosh Pit A, but this type of test is considered less reliable than well data.

To summarize, the groundwater system beneath the project area is a single, unconfined aquifer composed of heterogeneous, but predominately coarse-grained fluvial sediments. Lenses of silt locally occur and areas of significant thicknesses of cemented sediments are common, apparently resulting in localized confinement of groundwater.

**Previous Investigations**

Work for this project was initiated in 1993 by David J. Newton Associates, Inc. (DNA) at the request of the property owner, Lone Star Northwest (now known as Glacier Northwest (GNW)). GNW operates sand and gravel mining and processing operations near Scappoose, Oregon and desired to expand mining to adjacent farm property to the south.

A number of technical studies relating to aggregate mining have been conducted in the area. These studies have addressed issues regarding the quantity and quality of aggregate in the area; the presence, quality and use of surface water and groundwater; and environmental concerns (see Appendix A).

Monitoring of groundwater and surface water conditions in the project area began in April 1993. The purpose of the monitoring was to collect water-level data to help characterize existing conditions at the site. Initial groundwater modeling was conducted by others in 1993 (DNA, 1994a) using data available at that time. This initial model simulated a shallower excavation and was designed to estimate only the amount of additional groundwater flow that would result from that excavation. This was done by directing all groundwater discharge in the model to a single point, rather than through a cross section of the aquifer.

Subsequent to the initial modeling effort, significant additional geologic and hydrogeologic data were collected from new borings and water-level measurements. These data provided details into such thins as the nature of the aquifer material and seasonal fluctuations in water-table position. It was determined that modeling efforts could be improved to produce a more realistic simulation of the project-area conditions. This new model uses some of the same data as the previous effort but differs in almost all model design aspects. The modeling effort for this study began in September 1995 and therefore uses data collected up to that time. This report details the results of that work and evaluates the predicted impacts to the floodplain groundwater system. These results are based on:

- Subsurface explorations and field-testing conducted by others prior to this project.
- Subsurface explorations completed in support of the mine expansion project.
- Water-level data and field observations compiled from April 1993 to September 1995.
- Numerical modeling of the groundwater flow conditions that will likely result if the mine is expanded to include a 460-acre excavation.

# CHAPTER 3: RESEARCH METHODS

As discussed earlier in this report, a previous investigation (DNA, 1994a) attempted to model the effects of mining Pit E. This effort relied on less than one year of water-level measurements collected on and around the site and a limited number of shallow borings to characterize the geologic and hydrogeologic conditions beneath the site. In order to account for seasonal fluctuations in groundwater conditions and to more accurately simulate a revised mining plan, an additional data collection effort was deemed necessary.

## Subsurface Investigation

To investigate site conditions, 10 wells on and adjacent to the proposed expansion property were installed (Plate 1, Table 2). Water levels in these and several previously existing wells on and near the site were regularly measured beginning in April 1993. Table 2 lists information on the wells monitored for this investigation. Four surface-water gages placed in Jackson Creek were also used to monitor changes in surface water elevations. The purpose of measuring these water levels was to:

- Document any seasonal changes in groundwater elevations beneath the site.
- Obtain data on groundwater flow directions and gradients, and seasonal fluctuations that may occur.
- Collect data to help define surface water/groundwater relationships.

With the above information, it was possible to compare the model-predicted water levels with those observed.

**Table 2. Well Completion Details**

| Well Number | Total Depth (feet bgs) | Screened Interval Depth (feet bgs) | Casing Diameter (inches) | Date Installed |
|---|---|---|---|---|
| P-1 | 9 | 7-9 | 1 | 3/93 |
| P-2 | 10 | 8-10 | 1 | 3/93 |
| P-3 | 11 | 9-11 | 1 | 3/93 |
| P-4 | 34 | unknown | 2 | unknown |
| P-5 | 9 | 7-9 | 1 | 3/93 |
| P-6 | 20 | 18.5-20 | 2 | 4/93 |
| P-7 | 20 | 18.5-20 | 2 | 4/93 |
| P-8 | 46 | unknown | 2 | unknown |
| MW-1 | 42 | 32-42 | 2 | 4/93 |
| MW-2 | 50 | 35-50 | 4 | 3/94 |
| MW-3 | 55 | 40-55 | 4 | 2/94 |
| MW-4 | 40 | 25-40 | 4 | 2/94 |
| 4/1-31cd (Havlic) | 85 | open casing | 8 | 2/67 |

## Numerical Modeling

To understand how the mine expansion might influence area groundwater levels and flow, a numerical model, of the site and surrounding area was constructed using MODFLOW (McDonald and Harbaugh, 1988). MODFLOW, a three-dimensional, finite-difference groundwater flow model developed by the USGS, was chosen because of its flexibility of application and its widespread use and acceptance among groundwater professionals (Anderson and Woessner, 1992). The modeling was designed to simulate existing surface water and groundwater conditions, and provided predictions of groundwater conditions that may result from the proposed mining. These results were used to estimate changes in groundwater flow directions, gradients and the volume of groundwater that would annually move through a given area, and to and from the SDIC boundaries.

The new model uses some of the same data as a previous effort (DNA, 1994a) but differs in almost all model design aspects.

### Modeling Process

The modeling process began by developing a conceptual visualization (model) of the hydrogeologic system, followed by constructing a corresponding numerical model that incorporates field data (such as water-level measurements), simplified assumptions about the aquifer system and professional judgments of the system's hydraulic parameters. The results obtained from the numerical model are subsequently compared to the conceptual model and field data. This comparison can indicate whether the underlying assumptions and generalized estimates of hydraulic parameters are: 1) reasonable; or 2) should be revised and the numerical model adjusted and reanalyzed. An iterative process of comparing and modifying the conceptual and numerical models typically continues until both models are in general agreement and the water-level conditions produced by the numerical model are reasonably similar to those observed in the field.

This process can also be effective in identifying the need for additional data or directed research. These new requirements are evaluated and, if necessary, completed and incorporated into the model. At this stage, the model is ready for use as a predictive tool to examine how changes in the existing hydrogeologic system will likely influence groundwater elevations and flow.

In fluvial environments, subsurface materials are generally heterogeneous and anisotropic, and hydraulic parameters can be highly variable over short distances. As a result, numerical models in these types of systems are based on best estimates of hydraulic parameters (such as hydraulic conductivity), and a number of model simulations are generally carried out, with a specific set of hydraulic parameters used in each simulation. The parameters can be adjusted until the model results match field-measured conditions according to established criteria. This is the process of model calibration.

Sensitivity analyses were conducted for this study to evaluate how the parameter uncertainties influence the model results (Anderson and Woessner, 1992).

The model parameters used and assumptions made in this project are intended to be as simple as possible. It is important to remember that this model is a design and evaluation tool that is based on these simplifying conditions. As such, the model does not provide a unique solution since other model designs that are consistent with the observed data could be developed. However, the model developed for this project is appropriate for understanding the affect of the mine expansion on the groundwater flow system in the project area. Where assumptions are made, it is with the objective of producing the maximum change to the flow system, and thus provide conservative results.

## CHAPTER 4: RESULTS

### Site Conditions

Tables B1 and B2 in Appendix B summarize water-level data collected during this investigation. Figure 6 is a hydrograph of the same data. One piezometer, P-3, was monitored, but later abandoned due to casing damage. Measurements in well 4/1-31cd were interrupted in August 1994 due to modification to the wellhead, which made access difficult.

As part of this work, surface-water levels were monitored at stream gages on Jackson Creek/Santosh Slough. These gages are designated WL-1, WL-5, SG-1 and SG-2. Plate 1 shows the locations of these stream gages and Figure 6 presents hydrographs of the measurements collected between April 1993 and September 1995. Table B2 summarizes the surface-water data collected for this investigation.

### Groundwater

The average groundwater elevation in the monitored wells ranged from 3.9 feet MSL at P-8 to 4.9 feet MSL at MW-1. Water levels are generally lowest along the eastern margins of the site. Water-level fluctuations in each well averaged approximately 2 feet annually, although P-6 changed by almost 2.7 feet in 1993 (see Table B1). Based on the collected data, the direction of groundwater flow beneath the majority of the site is generally from the northwest to the southeast.

Figures 7 and 8 are water-level maps based on May 15 and September 22, 1995 measurements. These dates were selected as being representative of typical high-water and low-water conditions. As shown in Figure 7, water levels on May 15, 1995 ranged from approximately 5.5 feet MSL on the west side of the site to approximately 5.2 to 5.4 feet MSL along the eastern boundary. For comparison, water levels during the low-water conditions on September 22, 1995 (Figure 8) show water levels ranged from approximately 3.8 feet MSL on the west side of the site to approximately 3.1 to 3.6 feet MSL along the eastern boundary.

As shown on Figures 7 and 8, the inferred direction of groundwater flow beneath the site remains essentially unchanged between the May 15 and September 22 high- and low-water conditions. Although the flow direction is not uniform, (probably due to local variations in sediment composition) the predominant flow direction beneath the majority of the site is inferred to be to the southeast. Furthermore, although the average water-level difference is approximately 2.2 feet for these dates, the inferred groundwater gradients are approximately consistent at 0.0002 to 0.0004 through the majority of the site.

Groundwater mounding is apparent around P-7 during periods of low water conditions, based on water-level measurements. This mound influences the nearby gradients and directions of groundwater movement. For example, groundwater appears to move outward from well P-7 with an apparent maximum gradient of up to 0.0002 based on September 1995 data. It's possible that an upward vertical flow gradient caused by variations in the hydraulic conductivity of the sediments could be a cause of the groundwater mounding, which apparently occurs only during the dry summer months.

### Surface Water

Water levels in Jackson Creek/Santosh Slough remain relatively stable due to continuous recharge to the creek from the Smith pump and other interior SDIC pumping plants (Plate 1).

Measurements collected between May 24, 1993 and September 22, 1995 showed the average annual fluctuation at the stream gages was approximately 1.9 feet, although SG-2 fluctuated almost 3 feet in 1994 (see Table B2). Similarly, the average elevation of Jackson Creek was 3.9 feet MSL. The maximum observed water level on Jackson Creek was 5.8 feet MSL at SG-2 on April 11, 1994 and the minimum observed water level was 2.4 feet

MSL at WL-5 on August 4, 1994. Gage WL-1 was destroyed in September 1993; therefore subsequent measurements are not available for this location.

The relative positions of the water levels at the four Jackson Creek/Santosh Slough gages (SG-1, SG-2, WL-1 and WL-5) indicate a changing direction of flow in these streams, and at times, stagnant conditions. Pumping to the south of SG-1 in the SDIC apparently causes Jackson Creek to sometimes flow to the south. At other times, it flows north to either the Evans pump station (via Evans Slough) or to Santosh Slough and the tide gate.

Stream-stage data are not available for Scappoose Creek. According to the USGS St. Helens, Oregon and Washington quadrangle map, Scappoose Creek flows north between elevations of 0 and 30 feet MSL along its course, which is approximately 2,500 to 4,500 feet west of the proposed expansion.

### Surface Water/Groundwater Relationships

Drillers' logs for water-wells adjacent to Scappoose Creek give an indication of the relationship between the creek and groundwater. Many of these wells (including wells 3/2-1aa, 3/2-1cd, 4/1-31ad1, 4/1-31bd and 4/1-31cb) indicate significantly different static water levels than the apparent elevation of the nearby creek. This difference is attributed to the hydraulic separation of the creek from groundwater. This separation is likely due to deposition of fine-grained sediments along the banks and bed of the creek, and/or cementation of subsurface sediments in the area. Several wells, 3/2-1db and 3/1-6bb3, are reported to have a static water levels apparently consistent with the elevation of the creek at their locations (see Table 1 and Plate 1). However, it is concluded from the majority of the data that Scappoose Creek has limited hydraulic connection with the groundwater in the area west of the project site. This conclusion is supported by the fact that lower Scappoose Creek maintains low-gradient flow in the floodplain throughout the summer, indicating it is not losing significant flow to groundwater.

Stream gages WL-1 and WL-5 on Jackson Creek are sited near wells P-1 and P-5 on the west bank of the Creek (see Plate 1). These monitoring pairs (P-1/WL-1 and P-5/WL-5) provide data on the water-level relationship between surface water and groundwater. The data for both monitoring pairs show similar trends, and in many cases, the measurements differ by only tenths of a foot (see Figure 6 and Tables B1 and B2). These data indicate that Jackson Creek is well connected to the groundwater system, and that groundwater flow is toward the creek in this area. The creek is maintained by the SDIC to receive flow from the subsurface and SDIC pumps, and carry the water to Evans or Santosh Sloughs. Observations indicate this system is operating as intended.

A Corps of Engineers report (COE, 1971) indicates that seepage into the SDIC from Multnomah Channel increases when the Columbia River stage rises. This is logical considering the significant volume of coarse sediments in the area. The SDIC maintains water levels within the district that are substantially less than the river stage during much of the year. This condition likely induces surface water to recharge the groundwater system within the SDIC. It is also likely that the influence of the river stage on surface and groundwater levels decreases with distance from the Multnomah Channel, and that at some point within the SDIC, this influence is offset by the recharge of surface water from the west.

## Overview of Conceptual Model

The conceptual model of the area groundwater flow system is based on the hydrogeology of this part of the Portland Basin as described in Chapter 2 and interpretation of data collected between 1993 and 1995 (see Figure 9).

The uppermost aquifer system underlying the project area is interpreted to be 200 to 400-feet thick, with the thickness increasing toward the Columbia River to the east, and decreasing and eventually terminating against the Tualatin Mountains to the west. The aquifer is underlain by low permeability siltstones, mudstones and claystones as described by Swanson et al. (1993). The aquifer system appears to be laterally extensive along the north-south axis, which is parallel to this reach of the Columbia River.

Recharge to the aquifer underlying the project area occurs from the Columbia River to the north, northwest (via Scappoose Bay wetlands) and east; highlands to the west; and infiltration from precipitation, dry wells, and septic systems both within and upgradient (west) of the project area. Discharge from the aquifer is inferred to occur from the SDIC dewatering system and flow to the Columbia River (via Multnomah Channel) during low river stages.

The predominant directions of groundwater flow appear to be toward the SDIC basin from the Multnomah Channel in the east, north and northwest, and the higher elevations to the west. Groundwater appears to move from northwest to southeast beneath the proposed expansion site. During high-water conditions, shallow groundwater recharges open ditches and is removed to the Multnomah Channel via the network of pumps and canals. During low-water conditions, the direction of groundwater movement and gradient remain unchanged, but water is removed from the SDIC basin via the tide gate at the north end of Santosh Slough and by pumping from the Evans pumps. Flow gradients through the majority of the project area are inferred to be approximately 0.0002 to 0.0004, based on measured water levels on and near the site. Water-level data also show a groundwater mound in the northeast corner of the site as discussed elsewhere in this report, but this is inferred to be localized, based on well measurements and does not appear to have a significant effect on the larger-scale groundwater flow system.

Flow rates and leakage rates of the Multnomah Channel, Scappoose Creek, Barge Canal or Jackson Creek/Santosh Slough, and the volume of water removed from the aquifer by SDIC pumping are unknown. However, as discussed in Chapter 4, there are indications that leakage to or from Scappoose Creek is relatively limited and that Jackson Creek/Santosh Slough is relatively well connected to the aquifer. The Barge Canal is presumed to be an extension of the Multnomah Channel and is likely hydraulically connected with the aquifer, based on the coarse nature of the underlying sediments and the fact that the canal is dredged to maintain its depth.

### Conceptual Model Water Balance

In general, a simple water balance (or hydrologic budget) for a given area of aquifer can be described by the following equation:

Flow in = Flow out +/- (change in aquifer storage)

In the steady-state condition as considered here there is no change in storage, therefore flow in must equal flow out. The components of inflow are recharge from precipitation and recharge from upgradient groundwater flow. Outflow components consist of groundwater discharge and discharge from pumping wells (if any). It is presumed there is no surface water recharge (except leakage from the Barge Canal) or discharge from pumping wells in the conceptual model.

Groundwater inflow can be calculated using Darcy's Law:

$$Q = KiA$$

Where: Q = groundwater flow rate
K = hydraulic conductivity of the aquifer material
i = groundwater flow gradient
A = cross-sectional area through which groundwater is flowing

The length of the cross-sectional flow area (or discharge boundary) is defined by a line drawn to generally connect the SDIC pumps east of the expansion site from about SG-1 on the south to the Barge Canal on the north (see Figure 10). The thickness of the aquifer is about 300 feet (slightly thicker during high-water conditions) and groundwater is flowing generally west to east.

Groundwater flow gradients range from 0.0002 (during low-water conditions) to 0.0004 (during high-water conditions) over the expansion site as discussed previously. Higher gradients likely exist in the northern part of the study area between the Barge Canal on the northwest and the SDIC pumps on southwest due to the Barge Canal level being at a somewhat higher elevation than groundwater. Although no groundwater data exists for this area, the level of the Barge Canal and pumping level in the SDIC are known. These data indicate groundwater flow gradients ranging 0.0003 to 0.001 for high and low water conditions respectively.

The value of hydraulic conductivity used is 1,225 ft/day. The selection of this value is discussed in detail later in this Chapter.

A recharge factor (17 inches/year) is calculated for a surface area that extends from the discharge boundary described above (on the east) westward to approximately Highway 30 and to the Barge Canal in the northwest. The source of this value is described in detail later in this Chapter.

Uncertainty results from errors that can be present in the values of parameters that are measured or calculated. Winter (1981) estimates that errors in annual rainfall estimates and evaporation rates (used in this model as part of estimated recharge) can be as high as 10 to 15%. Calculation of hydraulic gradients and the position and nature of hydrogeologic boundaries may contain errors due to interpretation of drilling and measurement data and placement of piezometers and surface-water gages. In addition, Winter (1981) concludes that it is probably not possible to estimate hydraulic conductivity any closer than 50% and in many cases it may be closer to 100%. Based on these error estimates, and using the method of Lee and Swancar (1996), a maximum probable error for the hydrologic budget is calculated to be ± 52%. Table 3 below contains the results of the calculations and error analysis described above.

**Table 3. Conceptual Water Balance Results.**

| | **Calculated Groundwater Flow ($ft^3$/day)** | **Range Including Error (± 52%) ($ft^3$/day)** |
|---|---|---|
| High Water Conditions | 5,280,000 | 2,534,000 to 8,026,000 |
| Low Water Conditions | 2,380,000 | 1,142,000 to 3,618,000 |

## Model Design

MODFLOW (McDonald and Harbaugh, 1988), a three-dimensional, finite-difference groundwater flow model developed by the USGS, was used to model the project area. MODFLOW was chosen because of its flexibility of application and its wide acceptance among groundwater professionals. The governing equations, solved by finite difference methods, upon which the MODFLOW program is based, and the computer code itself, have been independently verified by other researchers using analytical solutions. The following sections describe the model design elements used for this project and justification for each condition or assumption.

The general approach of the modeling was to develop a model that predicts the maximum water level and flow volume change to the SDIC that may occur in the SDIC during and after mining. Where parameters were estimated or simplifications were made in the model based on a likely range of values, the value was selected to cause the largest increase in the water level or flow volume to the SDIC area. This was done to prevent underestimating the effects of mining, providing a conservative result.

The modeling involved the simulation of: 1) existing hydrogeological conditions (current-conditions model); and 2) hydrogeological conditions resulting from the proposed mining (future-conditions model). The difference between the current-conditions model and the future-conditions model is the insertion of a high conductivity zone that was used to simulate the presence of the completed mine at Pit E that will extend below the water table (see Figures 9 and 10 for details of the model designs). In order to examine the range of potential influences on the groundwater system, two sets of boundary conditions were used for each of the modeled systems: 1) low-water or dry season conditions; and 2) high-water or wet season conditions. The September 22 and May 15, 1995 water-level data were selected to represent the low and high water conditions, respectively, based on analysis of the collected data.

A steady-state model was used due to the limited information on the aquifer storage properties within the project area, and the inherently higher data demands of a transient simulation. A three-dimensional model was selected since this allows for simulating different hydrogeologic units within a thicker aquifer system. The model design presumes that the existing and proposed excavations penetrate only part of the total aquifer thickness.

### Model Grid

A regularly spaced, 250-foot-square grid was horizontally imposed over the project area (see Figures 10 and 11). The two-layer model contained 5,204 active cells. This level of discretization was selected to balance the level of detail needed with the desire to maintain a model of manageable size. Finer and variable nodal spacing was judged unnecessary because of the relatively low and consistent groundwater gradients in the project area.

In the model, the aquifer system is divided into two layers. The position of the boundary between the two layers is intended to approximate the projected maximum excavation depth at the proposed expansion site (see Figure 9). The model allows water to flow freely between the two layers since this boundary does not reflect changes in geology, but is only intended as a means of projecting the proposed excavation. The layer boundary is located at an elevation of -100 feet MSL in the model. Since the water table at the site is typically at an elevation of 5 to 8 feet MSL, the model slightly overestimates the depth of the pit. This overestimation is a conservative simplification since a larger excavation would produce a greater influence to the groundwater flow system.

### Boundary Conditions

Two types of boundaries were used: no-flow and specified-head. The locations of each type of boundary are shown in Figures 10 and 11.

#### No-Flow Boundaries

No-flow boundaries are used to constrain the northeast to southwest groundwater flow. The northern and southern no-flow boundaries are placed roughly parallel to the inferred direction of groundwater flow and, therefore, should not alter the direction of flow. A no-flow boundary is also present between the Barge Canal and the western specified-head boundary, separating the model from the wetlands to the north (which are assumed not to contribute groundwater to the area being modeled). The bottom no-flow boundary simulates the low-permeability, fine-grained sediments that are inferred to exist at an elevation of approximately -300 feet MSL.

### Specified-Head Boundaries

The east and west margins of the model are composed of specified-head boundaries. The western specified-head boundary is composed of two reaches. The northwest reach coincides with the Barge Canal, although limited field data are available to define historic water levels in the Barge Canal. As a result of this limitation, the Columbia River stage recorded at the Vancouver, Washington gage was used. This gage is approximately 15 river miles upstream from the project area and, therefore, should always be somewhat higher than the stage of the river at the Barge Canal. This results in a water level estimate that is slightly high at this boundary (probably ½-foot or less), a conservative assumption because a higher water level results in a greater volume of water entering the model. On May 15, 1995, the average gage reading was 10.2 feet MSL and the average September 22, 1995 gage reading, 4.4 feet MSL.

The west reach of the western specified -head boundary follows a general southwest to northeast line located west of Scappoose Creek. As discussed elsewhere in Chapter 4, Scappoose Creek is considered to have limited connection with groundwater in this area. This boundary, therefore, represents an average groundwater elevation along the line that is not influenced by surface water conditions. High-water conditions are simulated by using a specified-head value of 8.0 feet MSL, which corresponds to May 15, 1995 measurements. Low-water conditions are simulated by using a specified-head value of 6.0 feet MSL, which corresponds to September 15, 1995 measurements. These values were selected to maintain and extend the groundwater gradient that exists beneath the expansion site, and to provide a reasonable match between field measurements and model calculations. The specified-head boundary was placed far enough away from the proposed mining site (over 4,000 feet) to minimize the potential for this boundary to interfere with groundwater conditions beneath the site.

The location of the eastern specified-head boundary in the model follows a line that approximately connects four interior SDIC pumping stations (Johnson, Honeyman, Smith and Hoven, see Figures 10 and 11). This was done to simulate the hydrologic divide likely created by SDIC pumping. Although no field data are available for this part of the project area, information supplied by the SDIC indicates that they attempt to maintain water levels in this area at 3.0 to 4.75 feet MSL. To simulate the high-water conditions occurring on May 15, 1995, this boundary was set at 4.75 feet MSL. To simulate low-water conditions occurring on September 22, 1995, this boundary was set at 3.0 feet MSL. It is inferred that the area east of these four pumping stations is in such close proximity to the Multnomah Channel that the influence of this large, continuous supply of water would tend to dominate any changes in the groundwater system west of the SDIC pumping stations.

### Hydraulic Conductivity

Drilling data reviewed for this project show there is significant variation in the grain size and amount of cementation within the geologic materials underlying the project area. In order to simplify what is a complex system and at the same time maintain conservative overestimation in the model, the largest consistently reported field-measured values of hydraulic conductivity in Keener (1983) were used, except where large-scale excavations are currently located or proposed. This value was 1,225 ft/day. Use of the highest consistently reported value rather than an average is a conservative approach since the higher hydraulic conductivity should result in more water flowing to the district.

Ponds resulting from mining act essentially as flow-through lakes (they neither remove nor add water relative to the groundwater system) since they do not have inlet or outlet streams. Therefore, it was concluded that an accurate way to model these surface-water features was to insert a volume with extremely high values of hydraulic conductivity to simulate open-water conditions.

The existing and proposed excavations (ponds and lakes) were simulated by using a hydraulic conductivity value of 1,000,000 feet/day. This value was selected by creating a generic model of similar size and properties to the project area. A rectangular volume of higher hydraulic conductivity was inserted into the generic model to simulate a quarry excavation. A series of simulations were subsequently conducted in which the hydraulic conductivity of the excavated zone was increased from 1,000 ft/day to 1,000,000 ft/day in order-of-magnitude increments. The resulting flow volume from each simulation was compared to the previous increment and the percentage increase in flow was calculated for each step. The change in flow became smaller with each successive increment, until at 1,000,000 ft/day, the increased flow from the previous increment was less than 0.25%. It was concluded that further increases in the hydraulic conductivity value of the excavated volume would have negligible effect and that 1,000,000 ft/day would be a reasonable value to use in simulating a flow-through lake. This result, using a contrasting hydraulic conductivity value that is three orders of magnitude larger for the lake nodes than the surrounding aquifer, is consistent with work done by Chung (1998). In addition, Chung and

Anderson (1998), and Nair and Wilsnack concluded that representing a flow through lake with a zone of high hydraulic conductivity yields results similar to using the MODFLOW Lake Package (Cheng and Anderson, 1993 and 1994).

### Recharge

According to Snyder et al. (1994), recharge rates in the project area range from 6 to 19 inches/year although precipitation for the area is estimated to be approximately 40 inches/year based on data collected at the St. Helens, Oregon Rural Fire District Station. Based on the recharge estimates, 17 inches/year was selected as the overall estimate for the entire modeled area. The selected recharge rate was applied uniformly at the top of the uppermost layer of the model. The value selected is conservative because using a high volume for recharge should again cause overestimation of the effects that could be caused by mining.

### Model Calibration

Calibrating the model involves comparing model-generated water levels and water balance calculations with actual field-measured data. Adjustments are made to the model design parameters (such as boundary conditions or aquifer characteristics) to bring the model-generated and the field-measured values into closer agreement (for head and for flow). For this modeling effort, emphasis was placed on designing a conservative model that tends to overestimate the results of changes to the groundwater flow system. This strategy should result in a higher overall hydraulic conductivity of certain areas of the model (such as near MW-2), thereby producing a larger volume of water flowing to the SDIC.

Calibration statistics for each model are listed in Table D1 (Appendix D) and summarized in Table 6. The Absolute Residual Mean for the high- and low-water conditions models was 0.55 feet and 0.46 feet respectively. Generally, both the high- and low-water conditions models achieved closer calibration at wells located in the southern and eastern portions of the site, downgradient of the proposed excavation. The largest residual errors occurred at MW-2, in the northeast portion of the site at the apparent location of a groundwater mound. The residual error at MW-2 is a maximum of 2.8 feet.

As shown in Table 4 below, the groundwater output flows generated by both current conditions models are within the error range calculated for the water balance. This indicates reasonably good agreement between the conceptual water balance and the model-generated results.

**Model Results**

To quantify the amount of water-level change and groundwater flow change volume that could result from mining Pit E, the results of the current-conditions models (Figures 12a and 13a) were compared to the results of the future-conditions models for each of the two water-level conditions (May 15, 1995 and September 22, 1995, Figures 12b and 13b). Two MODFLOW-generated criteria were used for comparison: 1) the output flow rate; and 2) the change in head (water-level elevation).

MODFLOW produces a volumetric water budget for each simulation (see Appendix D). This budget includes the output flow rates, which is the rate of groundwater flow that exits the model under steady-state conditions via specified-head boundaries. All of the groundwater in these models discharges to the eastern specified-head boundary. For comparison, the output flow rate produced by the current-conditions model for each date is compared to the output flow rate produced by the corresponding future-conditions model. These comparisons are shown in Table 4 below.

**Table 4. MODFLOW Model Groundwater Flow Output Comparisons.**

| Simulation Date | Output Flow Current Conditions ($ft^3$/day) | Error Range (± 52%) ($ft^3$/day) | Output Flow Future Conditions ($ft^3$/day) | Flow Increase ($ft^3$/day) | Percentage Flow Increase |
|---|---|---|---|---|---|
| May 15, 1995 | 6,048,000 | 2,534,000 to 8,026,000 | 6,674,000 | 625,000 | 10% |
| September 22, 1995 | 2,925,000 | 1,142,000 to 3,618,000 | 3,428,000 | 503,000 | 17% |

The Table 4 model results indicate that the change in groundwater flow to the downgradient boundary (the eastern model boundary) following the completed excavation of Pit E will be an increase of approximately 10% during high-water conditions and an increase of approximately 17% during low- water conditions. This increase in flow occurs throughout the total thickness of the aquifer beneath the project area (estimated to be 300 feet) due to the increased gradient east of the excavation (see Figures 12b and 13b).

### Evaluation of Model Results

The downgradient pumps in the SDIC are designed to lower the water table below natural levels by pumping from the surface. It follows that changes to the flow system that cause the water table to rise will result in increased pumping to maintain the desired elevation for SDIC operations. It also follows that the volume of increased pumping is related to the amount of water table rise that occurs within the drained area. Therefore it is relevant to evaluate the actual volume of water that will need to be pumped as a consequence of the increased flow. This volume should be significantly less than shown in Table 4 since only the uppermost few feet of aquifer are affected by drainage pumping.

MODFLOW computed water-level changes (drawdown), which corresponds to a change in the position of the water table. The values can be positive (water-level rise) or negative (water-level decline). As shown in Figures 12c and 13c, the model predicts a maximum 0.8 feet water-level rise on the downgradient side (east side) of Pit E and a maximum water-level decline of 0.8 feet on the upgradient side (west side) of Pit E. Both of these maximum changes occur within the boundary of Pit E and attenuate rapidly with distance from the site. For example, in the area immediately downgradient (east) of Pit E, an increase of 0.2 feet is predicted at a distance of approximately 1,500 feet east of the site. Correspondingly, a decrease of 0.2 feet is predicted to occur approximately 3,000 feet northeast of the site in the upgradient area.

The maximum predicted change in water level that occurs outside the Pit E boundary is 0.6 feet. This change is predicted as a water-table rise up to 400 feet east of the site boundary, and as a water-table decline occurring up to 300 feet west of the site boundary. The insertion of the excavated area into the model has the effect of flattening the water table across the excavation (which is open water) and increasing the flow gradients both upstream and downstream of the new pit (see Figure 14a).

Only the additional flow volume caused by a water-table rise and saturation of previously dry soil will need to be pumped to maintain the lowered water-table elevation desired by the SDIC. This flow can be estimated by determining the downgradient cross-sectional area that became saturated as the result of mining, and calculating, using Darcy's Law, the groundwater flow rate through this area.

Using the water-table change contours and gradients on Figures 12c and 13c, and the cross-section lines indicated on each Figure, and using and hydraulic conductivity values confirmed by field measurements and numerical modeling, the additional pumpage requirements are calculated and listed in Table 5 below (see also Figure 14b).

With regard to the potential for the mine expansion to cause increased flooding, the limited amount of additional saturation in the downgradient areas is unlikely to increase flooding potential. This conclusion is based on the small increase in pumpage requirements by the SDIC and the small surface area affected by the downgradient water-table rise.

**Table 5. Additional Groundwater Pumpage Requirements**

| Simulation Date | Estimated Cross-Sectional Area ($ft^2$) | Pumpage Rate Increase (gpm) | Error Range (± 52%) (gpm) |
|---|---|---|---|
| May 15, 1995 | 3,030 | 12 | 6 to 18 |
| September 22, 1995 | 2,550 | 10 | 5 to 15 |

### Discussion of Model Results

The results of the work described in this report indicate that the effect of introducing a large-scale mining excavation in the Columbia River floodplain on the local groundwater flow system is limited. The additional pumping required to remove the additional flow created by Pit E is roughly equivalent to the average domestic well (5 to 18 gpm). For the Scappoose Drainage Improvement Company, which operates a system designed to lower the water table beneath agricultural land downgradient from Pit E and maintains a total pumping capacity of over 130,000 gpm, this amount of increased flow is not significant.

### Conclusions

Groundwater occurs in a sand and gravel aquifer that extends to a depth of approximately 300 feet beneath the site. A review of field observations and drillers' logs for area wells indicates the aquifer contains numerous lenses and layers of coarse sand and gravel, and discontinuous cemented zones. Although the cemented zones can perch and locally confine groundwater, the aquifer is considered a single regional groundwater system.

The hydraulic conductivity of the sediments that make up the aquifer varies due to silt and clay content and variable cementation. According to investigations by others, the estimated hydraulic conductivity of the most coarse-grained portions of the aquifer may be as high as 6 ft/minute and the hydraulic conductivity of the fine-grained or cemented material may be as low as 0.05 ft/minute (Keener, 1983).

Groundwater occurrence and movement in the area is primarily influenced by:

- Precipitation in the highlands to the west of the project area and in the project area itself.

- Dewatering pumping in agricultural lands east of the project area.
- Proximity of the extensive groundwater reservoir of the Columbia River system.

It is concluded from data compiled for this project that recharge to the aquifer beneath the site originates primarily in highlands to the west of the site but also occurs from surface infiltration. It is concluded from site data that SDIC pumping operations interfere with the influence of the Columbia River system on groundwater occurrence and movement within the project area. To a large extent, groundwater movement in the project area is influenced by dewatering conducted to allow agriculture in the floodplain. The SDIC pumps water from drainage canals east of Jackson Creek, thereby effectively lowering groundwater elevations on the east side of the creek and creating a relatively constant-head boundary condition at the eastern side of the site. The predominant direction of groundwater movement beneath the site is inferred to be to the southeast toward the SDIC at a gradient of approximately 0.0002 to 0.0004. This gradient remains relatively constant throughout the year, although water levels in site wells fluctuate as much as 2 feet annually. As long as the SDIC continues to dewater farmland east of Jackson Creek, groundwater will likely continue to move towards this area of extraction.

Average groundwater elevations at 11 monitoring points established on and around the Pit E site range from 3.9 to 4.9 feet MSL, based on measurements obtained between April 1993 and September 1995. The average surface water elevation for four stream gages installed in Jackson Creek (south and east of the site) range from 3.7 to 4.0 feet MSL, based on measurements during the same time period.

The mine expansion is expected to create an approximately 100-feet deep, 360-acre pond. A MODFLOW model indicates that groundwater flow within the aquifer beneath the site and the SDIC may be increased by 10 to 17%, based on "before and after" model simulations performed for both high and low water conditions. This increased flow would be distributed throughout the full thickness of the aquifer (estimated to be approximately 300 feet) and would occur gradually over the planned 20-year operational life of the mine. The increased pumping that may be required within the SDIC boundaries as the result of this increased groundwater flow is estimated to be approximately 5 to 18 gallons/minute). Model results predict that the maximum change in water levels resulting from the increase in flow that could occur in the SDIC would be: 1) an increase of approximately 0.8 feet for a limited area on the downgradient (east) side of Pit E; and, 2) a decrease of approximately 0.8 feet for a limited area on the upgradient (west) side of Pit E. The maximum changes in water levels predicted to occur outside the Pit E boundary are predicted by the model to be approximately 0.6 feet. This change, which attenuates with distance from the site boundary, is predicted to occur as a water-table rise up to 400 feet east of the eastern site boundary and as a water-table decline up to 300 feet west of the western site boundary.

## CHAPTER 5: DISCUSSION OF UNCERTAINTY/MODEL LIMITATIONS

Since assumptions are used in estimating the characteristics of aquifer materials, and in simplifying conditions for the model's governing equations, a discussion of uncertainty relative to these assumptions is warranted.

As stated previously, numerical models provide non-unique solutions to groundwater problems. A different set of conditions could be created that would duplicate the results found in this study. Therefore, a sensitivity analysis was conducted on selected hydraulic parameters used in the model. The results of this analysis are summarized in Table 6 and detailed in Appendix D.

**Table 6. Sensitivity Analysis and Calibration Summary**

| Model | Parameter Changed | Flow Increase (%) | Water-Level Change (feet) | ARM (feet) | Results |
|---|---|---|---|---|---|
| | **Final Models** | | | | |
| 15-May | Current Conditions | | | 0.55 | |
| 15-May | Future Conditions | 10 | -0.8 to 0 .8 | | |
| 22-Sep | Current Conditions | | | 0.46 | |
| 22-Sep | Future Conditions | 17 | -0.6 to 0.7 | | |
| | **Model K Increased 1000%** | | | | |
| 15-May | Current Conditions | | | 0.48 | Subsurface flow increases. Change resulting from Pit E approximately the same as Final Models. Slightly closer calibration but less water-level change than Final Models. |
| 15-May | Future Conditions | 10 | -0.7 to 0.7 | | |
| 22-Sep | Current Conditions | | | 0.42 | |
| 22-Sep | Future Conditions | 17 | -0.5 to 0.6 | | |
| | **Model K Decreased 1000%** | | | | |
| 15-May | Current Conditions | | | 1.28 | Subsurface flow decreases. Change in flow resulting from Pit E much less than Final Models. Water-level change for 9/22 model much larger. Calibration error much higher. |
| 15-May | Future Conditions | 1 | -1.1 to 1.0 | | |
| 22-Sep | Current Conditions | | | 1.31 | |
| 22-Sep | Future Conditions | 2 | 3.8 to 6.9 | | |
| | **Gradient Increased by 33%** | | | | |
| 15-May | Current Conditions | | | 1.40 | Subsurface flow increases. Change resulting from Pit E approximately the same as Final Models. Calibration error much higher. |
| 15-May | Future Conditions | 11 | -1.3 to 1.3 | | |
| 22-Sep | Current Conditions | | | 1.01 | |
| 22-Sep | Future Conditions | 17 | -0.5 to 0.6 | | |
| | **Recharge increased by 100%** | | | | |
| 15-May | Current Conditions | | | 0.63 | Subsurface flow increases. Change resulting from Pit E approximately the same as Final Models. |
| 15-May | Future Conditions | 10 | -0.9 to 0.8 | | |
| 22-Sep | Current Conditions | | | 0.45 | |
| 22-Sep | Future Conditions | 16 | -0.6 to 0.7 | | |
| | **Aquifer Thickness 100 feet** | | | | |
| 15-May | Current Conditions | | | 0.60 | Subsurface flow decreases. Change resulting from Pit E approximately the same as Final Models. |
| 15-May | Future Conditions | 11 | -0.8 to 0.8 | | |
| 22-Sep | Current Conditions | | | 0.48 | |
| 22-Sep | Future Conditions | 18 | -0.8 to 0.8 | | |

Notes: 1) Residual Mean based on a comparison of field measured water levels for 5/15/95 and 9/22/95 with MODFLOW generated water-levels from the current-conditions models.

2) Water-level change based on MODFLOW generated drawdown data from future-conditions models.

The sensitivity analysis shows the model to be most sensitive to changes in hydraulic conductivity. The value of hydraulic conductivity selected that resulted in the best fit between model-generated heads and field measurements was 1,225 ft/day. This value was used for subsequent groundwater flow modeling. Morgan and McFarland (1996) estimate the median hydraulic conductivity value (based on an analysis of data from 90 drillers' logs) for the Unconsolidated Sediments aquifer to be 250 ft/day, significantly less than the value used for this study. However, 1,225 ft/day used for this study is within the range examined by the USGS and close to the 75th percentile of all the values. Therefore, the value used for this study is justified, particularly since it is based on actual field data.

The degree of calibration of the current-conditions models to site conditions can be examined in Table 5 Absolute Residual Mean (ARM) and a comparison of the conceptual model water balance with model generated groundwater flows in Table 5. The highest ARM for the final models is 0.55 feet. This is within 10 % of the average field-measured water level.

In Chapter 4 a range of error of ± 52% was determined based on the potential error that exists for each measured parameter (Winter, 1981). This is the range of uncertainty associated with the model results and the estimated effect of the mine expansion. The calculated conceptual groundwater flow rate, including this error range, encompasses the flow rates produced by the current conditions models (see Table 4). This indicates reasonably good agreement between the conceptual water balance and the model-generated results, within the range of uncertainty. Even when this rather large range of uncertainty, the resulting range of impacts is not significant.

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# Project Location and Vicinity Map

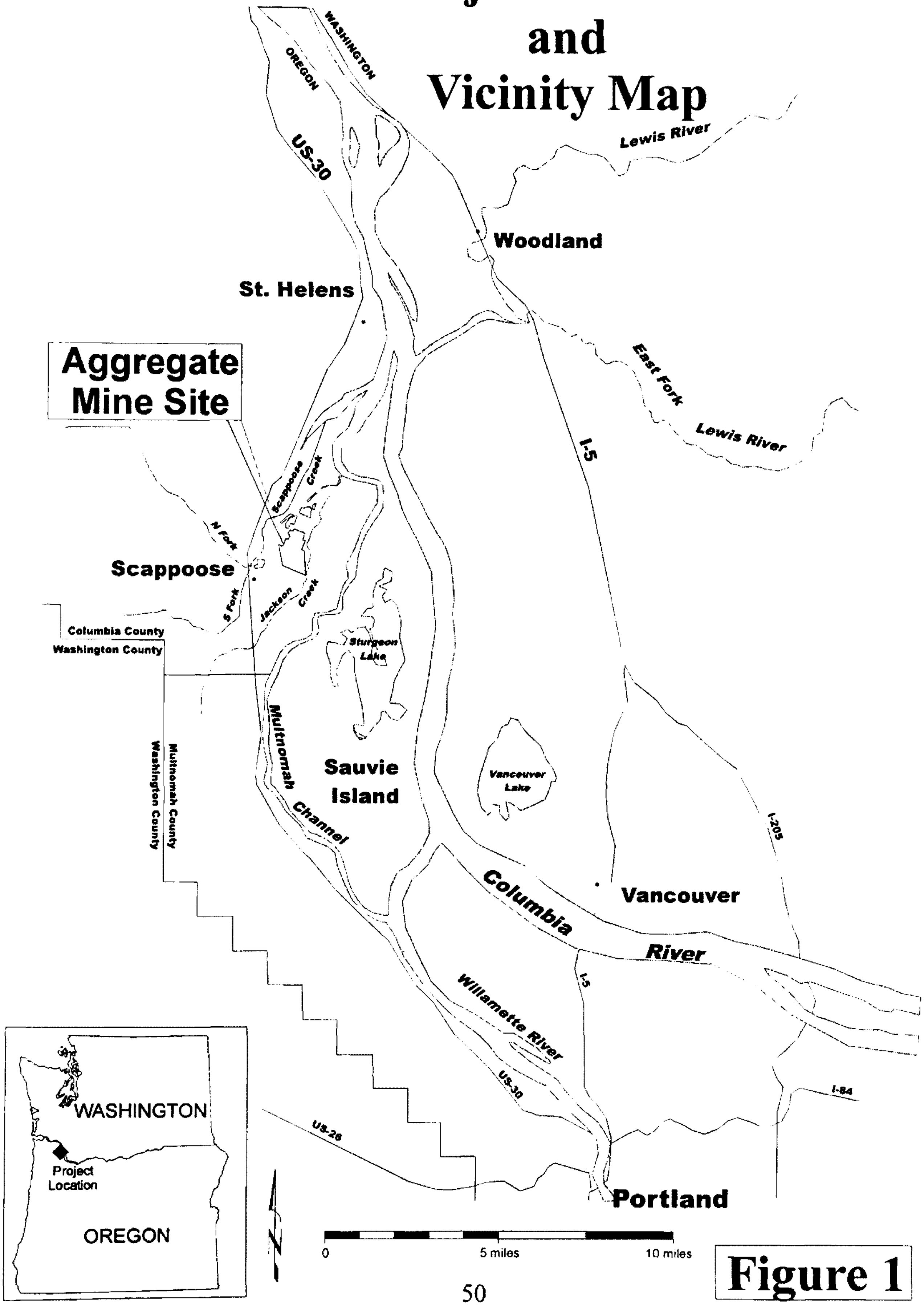


Figure 1

SitePlan

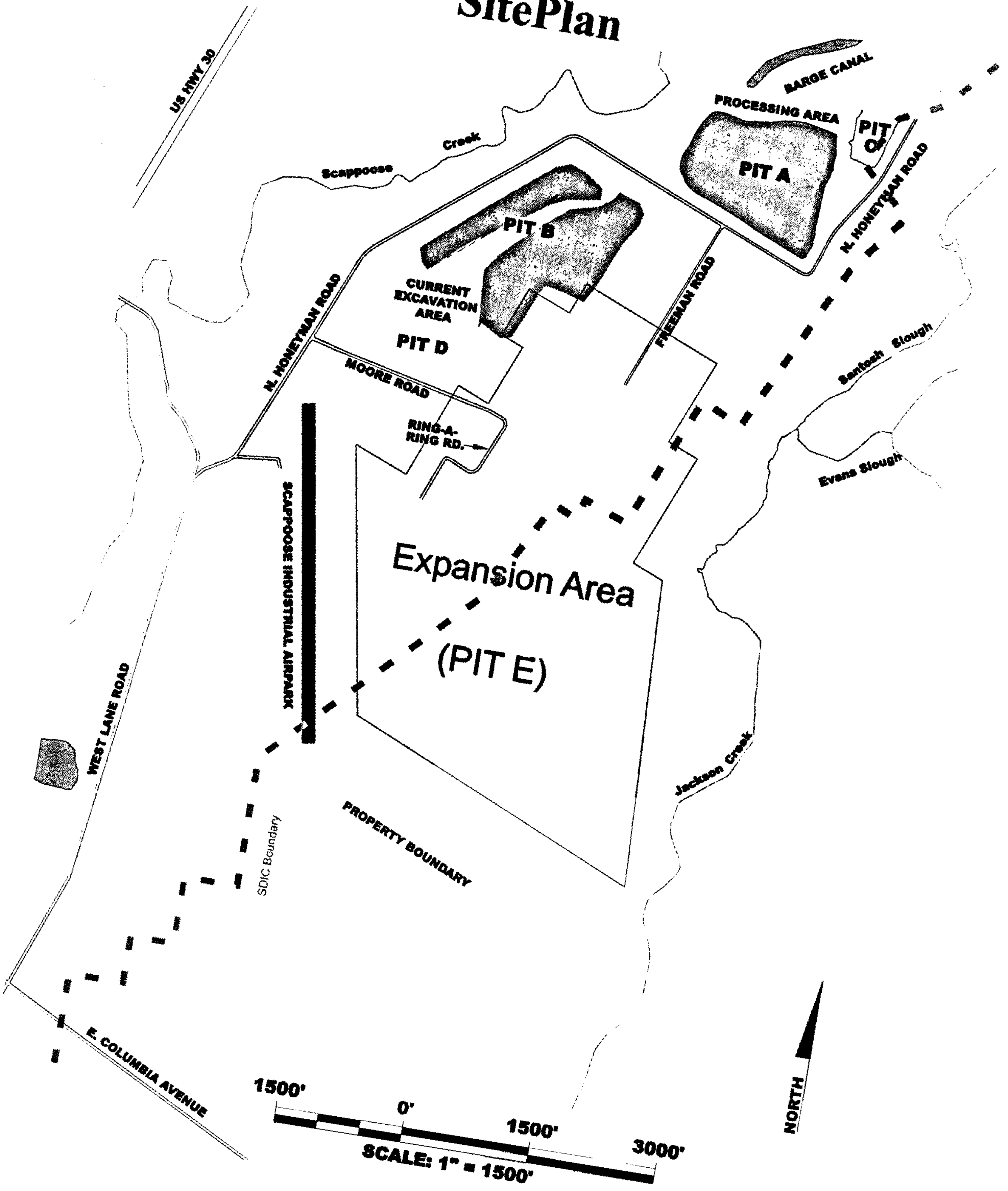
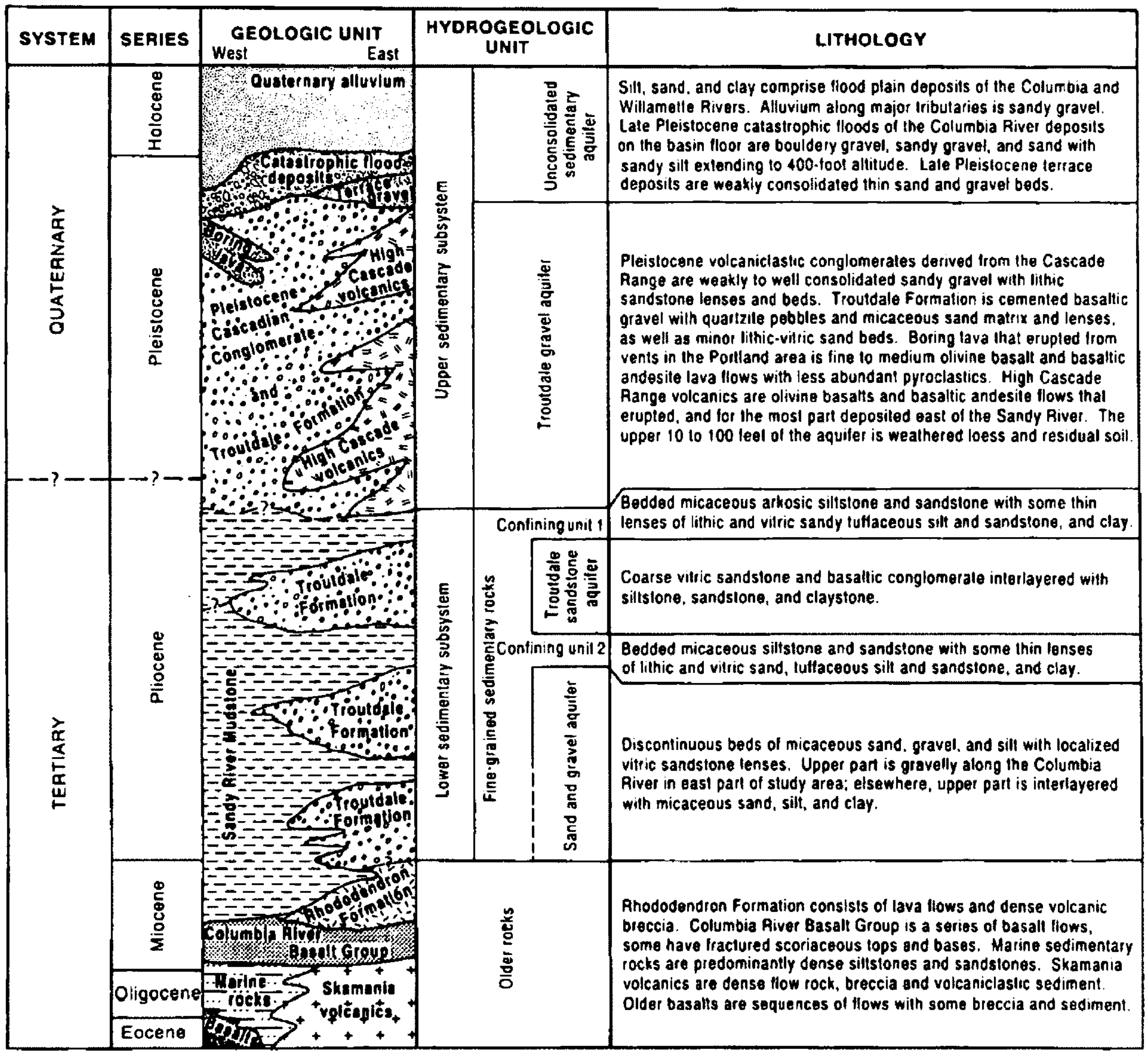


Figure 2

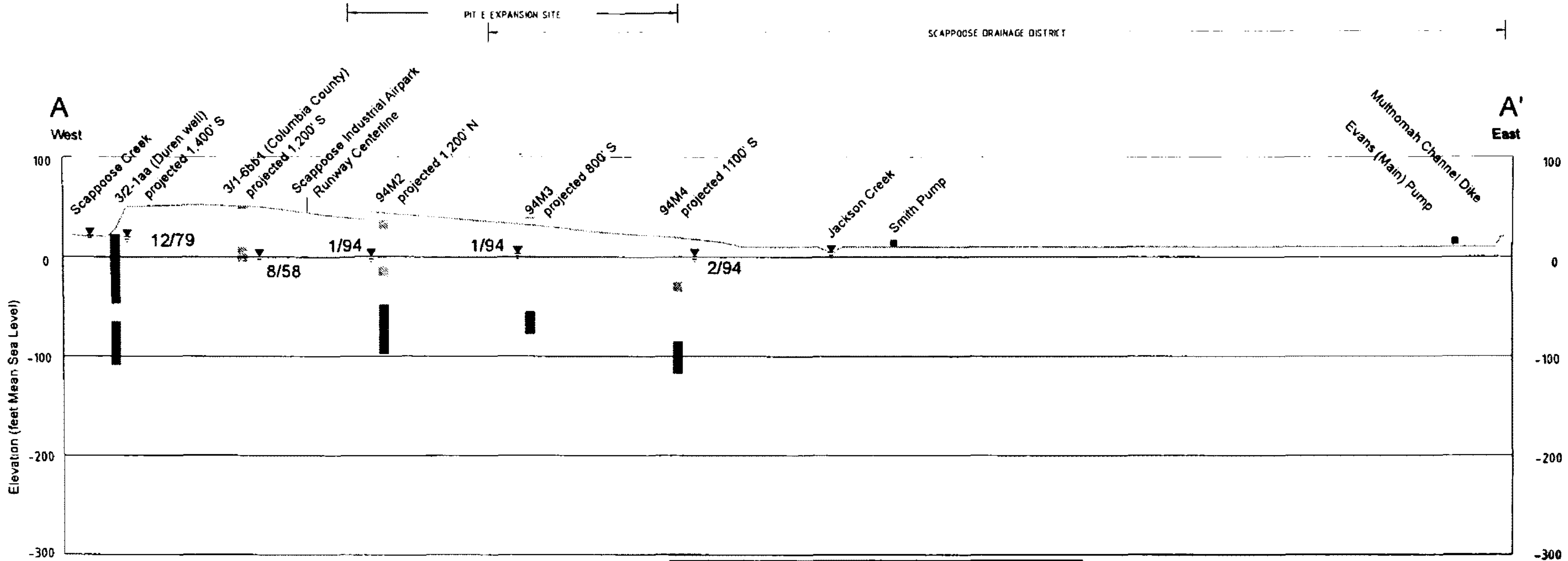
# Portland Basin Stratigraphy



| HYDROGEOLOGIC UNIT | | | LITHOLOGY |
|---|---|---|---|
| Upper sedimentary subsystem | Unconsolidated sedimentary aquifer | | Silt, sand, and clay comprise flood plain deposits of the Columbia and Willamette Rivers. Alluvium along major tributaries is sandy gravel. Late Pleistocene catastrophic floods of the Columbia River deposits on the basin floor are bouldery gravel, sandy gravel, and sand with sandy silt extending to 400-foot altitude. Late Pleistocene terrace deposits are weakly consolidated thin sand and gravel beds. |
| | Troutdale gravel aquifer | | Pleistocene volcaniclastic conglomerates derived from the Cascade Range are weakly to well consolidated sandy gravel with lithic sandstone lenses and beds. Troutdale Formation is cemented basaltic gravel with quartzite pebbles and micaceous sand matrix and lenses, as well as minor lithic-vitric sand beds. Boring lava that erupted from vents in the Portland area is fine to medium olivine basalt and basaltic andesite lava flows with less abundant pyroclastics. High Cascade Range volcanics are olivine basalts and basaltic andesite flows that erupted, and for the most part deposited east of the Sandy River. The upper 10 to 100 feet of the aquifer is weathered loess and residual soil. |
| Lower sedimentary subsystem | Fine-grained sedimentary rocks | Confining unit 1 | Bedded micaceous arkosic siltstone and sandstone with some thin lenses of lithic and vitric sandy tuffaceous silt and sandstone, and clay. |
| | | Troutdale sandstone aquifer | Coarse vitric sandstone and basaltic conglomerate interlayered with siltstone, sandstone, and claystone. |
| | | Confining unit 2 | Bedded micaceous siltstone and sandstone with some thin lenses of lithic and vitric sand, tuffaceous silt and sandstone, and clay. |
| | | Sand and gravel aquifer | Discontinuous beds of micaceous sand, gravel, and silt with localized vitric sandstone lenses. Upper part is gravelly along the Columbia River in east part of study area; elsewhere, upper part is interlayered with micaceous sand, silt, and clay. |
| Older rocks | | | Rhododendron Formation consists of lava flows and dense volcanic breccia. Columbia River Basalt Group is a series of basalt flows, some have fractured scoriaceous tops and bases. Marine sedimentary rocks are predominantly dense siltstones and sandstones. Skamania volcanics are dense flow rock, breccia and volcaniclastic sediment. Older basalts are sequences of flows with some breccia and sediment. |

From: Swanson, R.D., McFarland, W.D., Gonthier, J.B., Wilkinson, J.M., 1993,
*A Description of Hydrogeologic Units in the Portland Basin, Oregon and Washington.*
USGS Water-Resources Investigations Report 90-4196.

**Figure 3**



## EXPLANATION

TOPOGRAPHY FROM U.S.G.S. ST. HELENS 7.5 MINUTE QUAD SHEET

2/93 ▼ WATER LEVEL AND DATE MEASURED

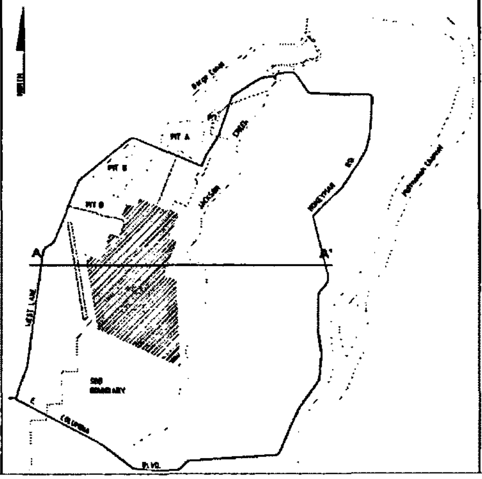
▨ SILT OR CLAY

GRAVEL OR SAND AND GRAVEL

■ CEMENTED GRAVEL OR CEMENTED SAND AND GRAVEL

▨ SAND OR SILTY SAND

**PLAN VIEW OF CROSS-SECTION**



## Notes:

1) Cross-section alignment also shown on Plate 1.

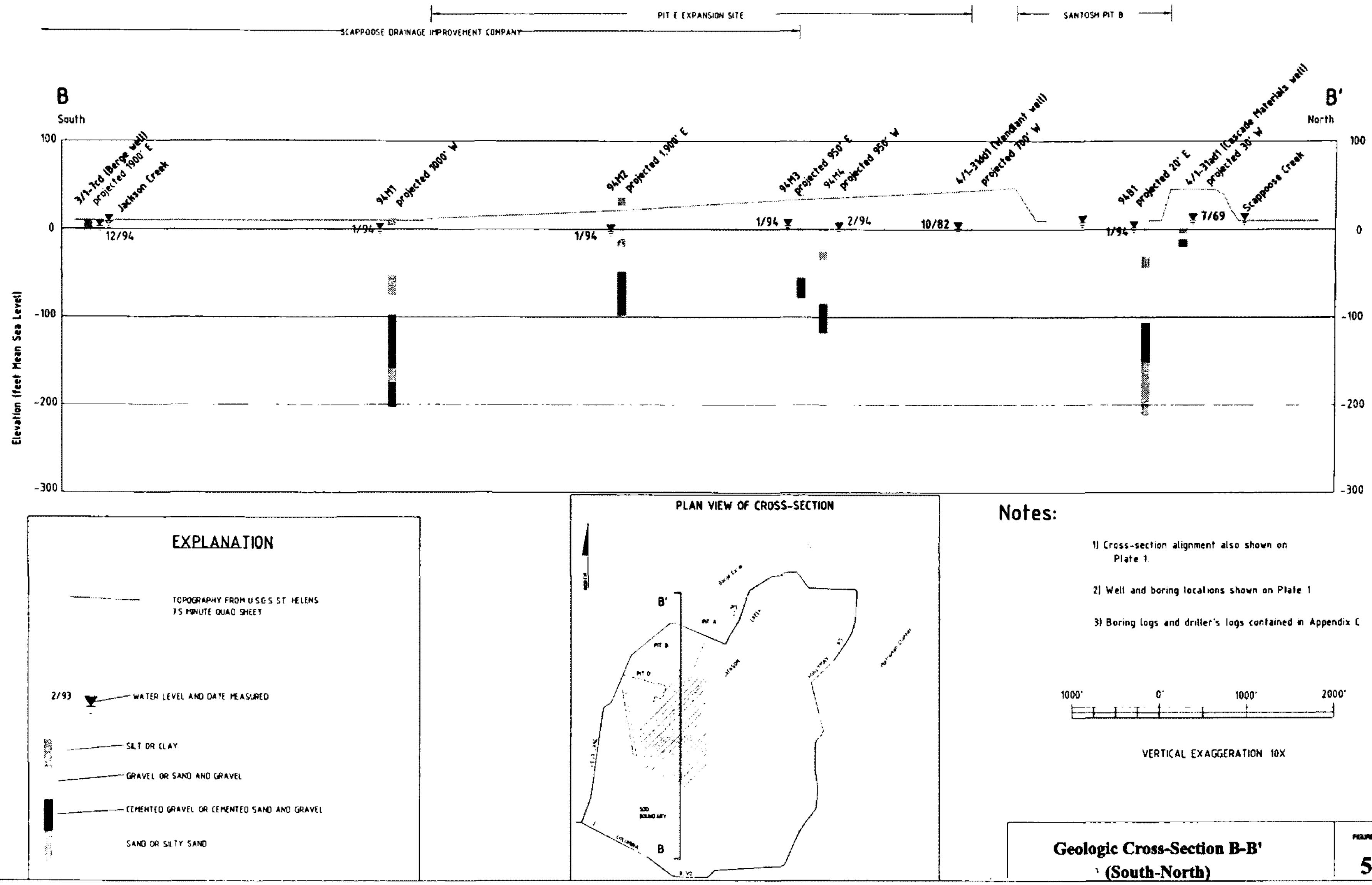
2) Well and boring locations shown on Plate 1.

3) Boring logs and driller's logs contained in Appendix C.

VERTICAL EXAGGERATION: 10X

**Geologic Cross-Section A-A'**
**(West-East)**

4



## Notes:

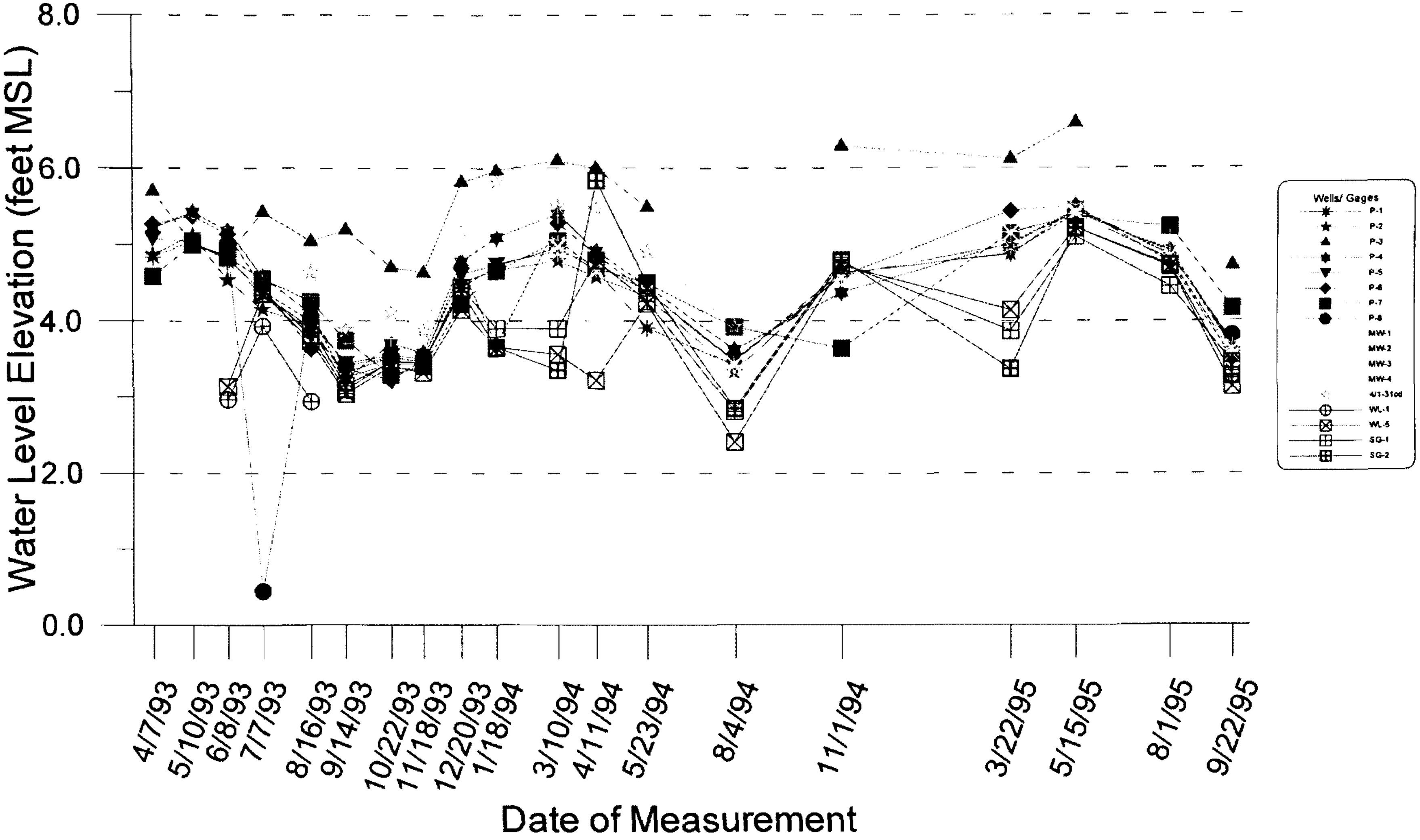
1) Cross-section alignment also shown on Plate 1

2) Well and boring locations shown on Plate 1

3) Boring logs and driller's logs contained in Appendix C

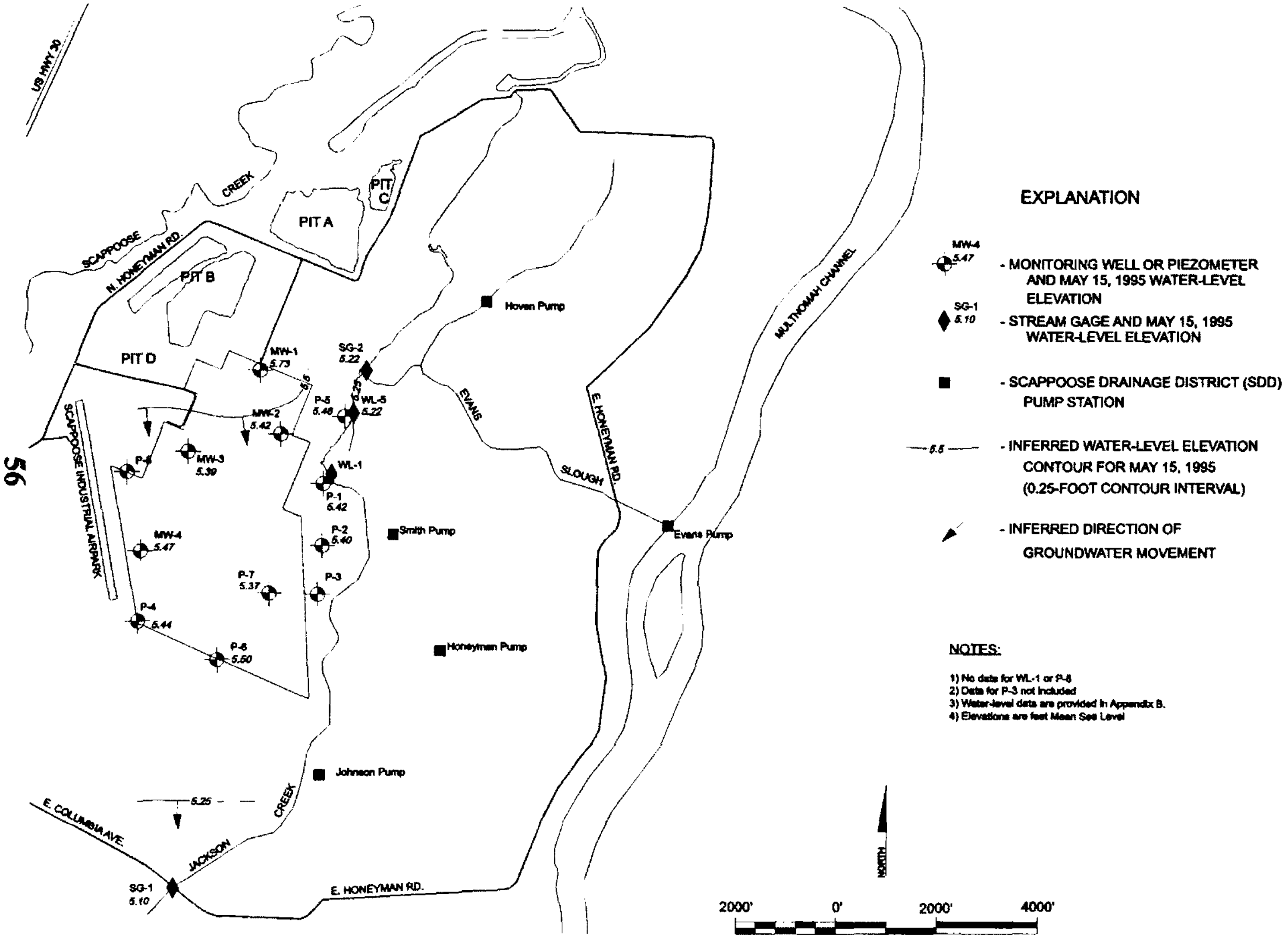
**Geologic Cross-Section B-B'**
**(South-North)**

FIGURE
5



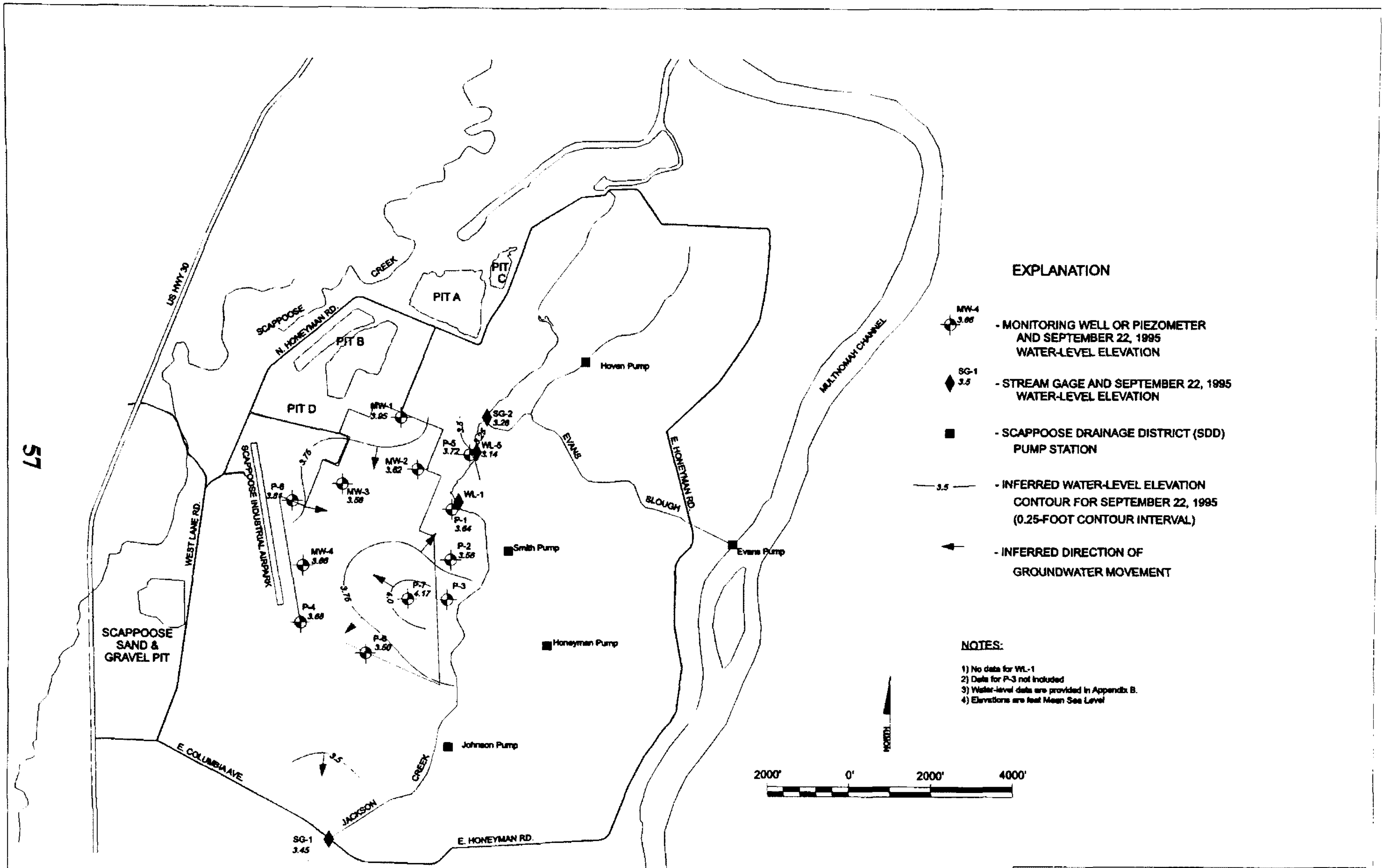
Notes: 1) P3 data not used for analysis.
2) More data than shown on graph. All data listed in Table A1.

**Hydrographs** **Figure 6**



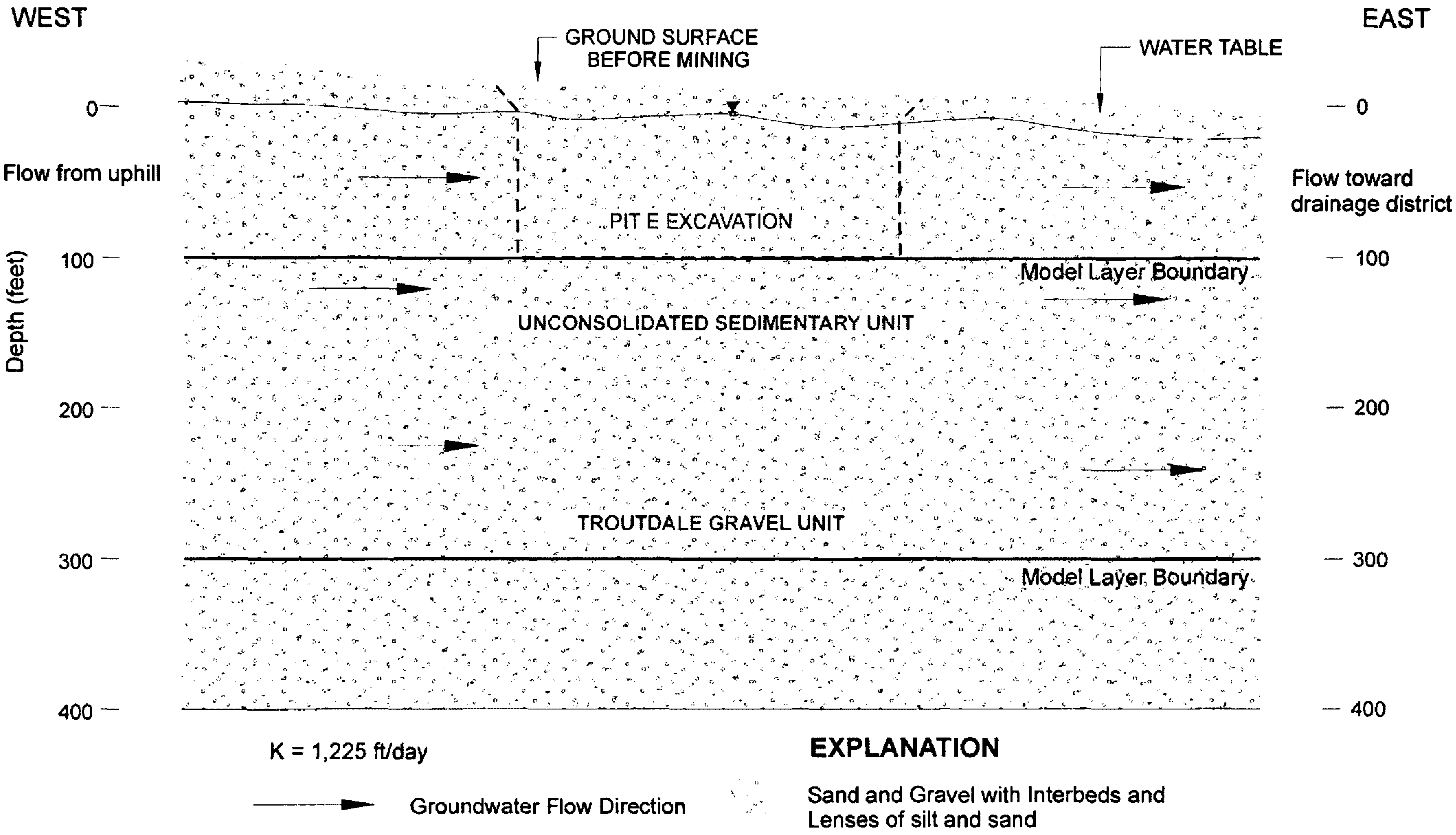
**Water-Level Map**
**for May 15, 1995**

FIGURE
7



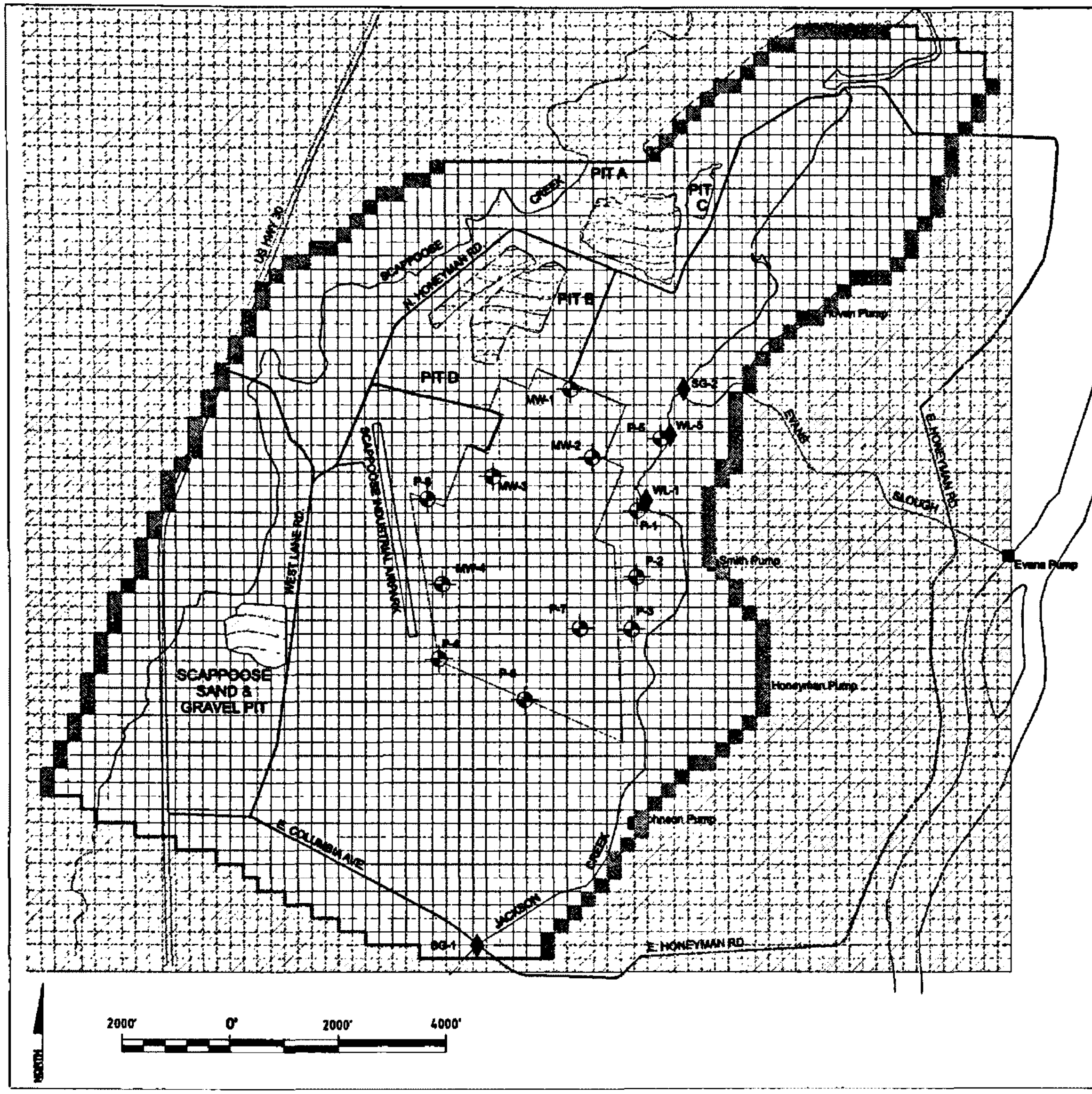
**Water-Level Map**
**for September 22, 1995**

FIGURE 8



Conceptual Model Block Diagram

Figure 9



## EXPLANATION

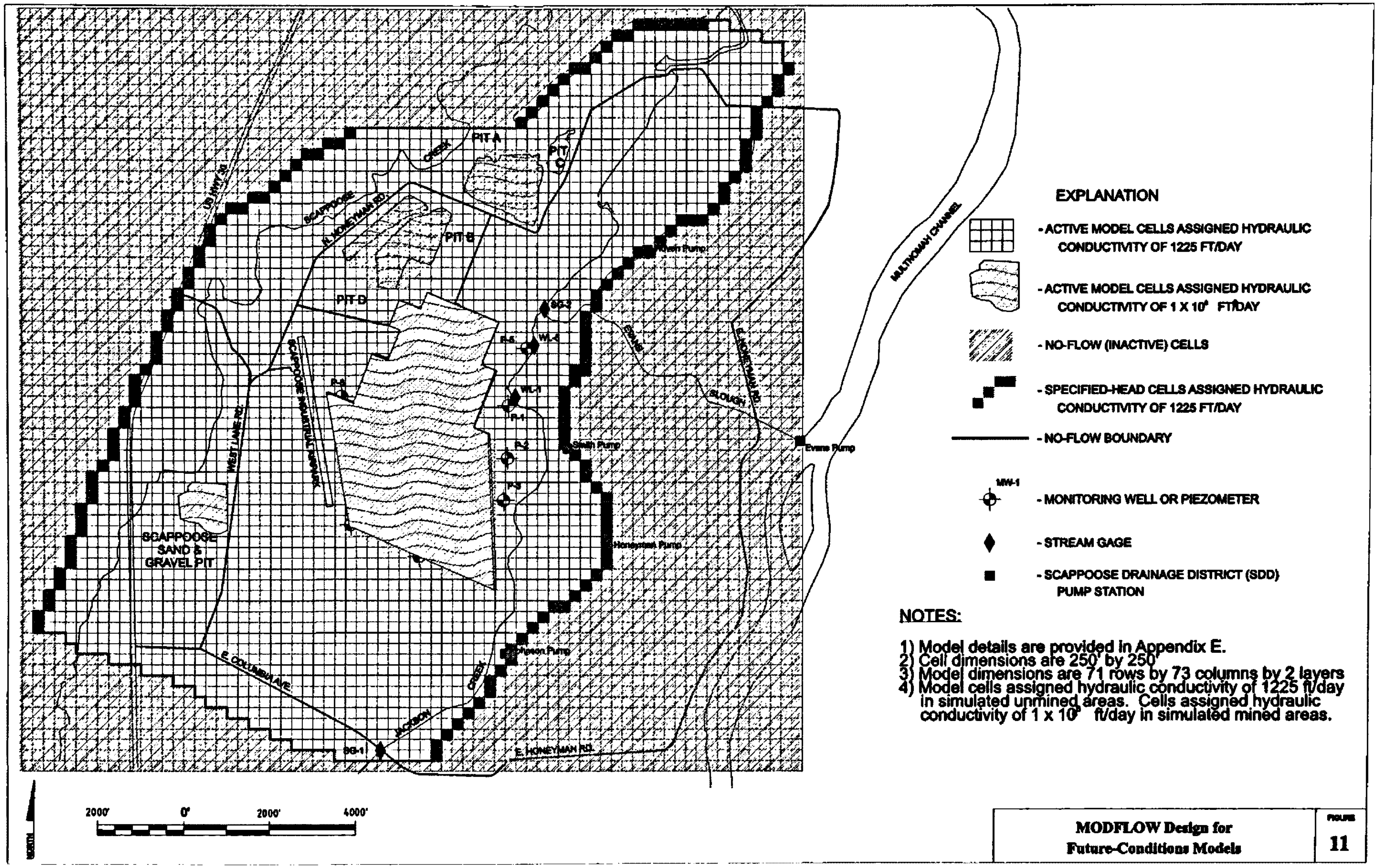
- ▦ - ACTIVE MODEL CELLS ASSIGNED HYDRAULIC CONDUCTIVITY OF 1225 FT/DAY
- ACTIVE MODEL CELLS ASSIGNED HYDRAULIC CONDUCTIVITY OF 1 X 10[illegible] FT/DAY
- ▨ - NO-FLOW (INACTIVE) CELLS
- ■ - SPECIFIED-HEAD CELLS ASSIGNED HYDRAULIC CONDUCTIVITY OF 1225 FT/DAY
- ― - NO-FLOW BOUNDARY
- MW-1 ⌖ - MONITORING WELL OR PIEZOMETER
- ◆ - STREAM GAGE
- ■ - SCAPPOOSE DRAINAGE DISTRICT (SDD) PUMP STATION

**NOTES:**

1) Model details are provided in Appendix E.
2) Cell dimensions are 250' by 250'
3) Model dimensions are 71 rows by 73 columns by 2 layers
4) Model cells assigned hydraulic conductivity of 1225 ft/day in simulated unmined areas. Cells assigned hydraulic conductivity of 1 x 10[illegible] ft/day in simulated mined areas.

**MODFLOW Design for Current-Conditions Models**

FIGURE 10

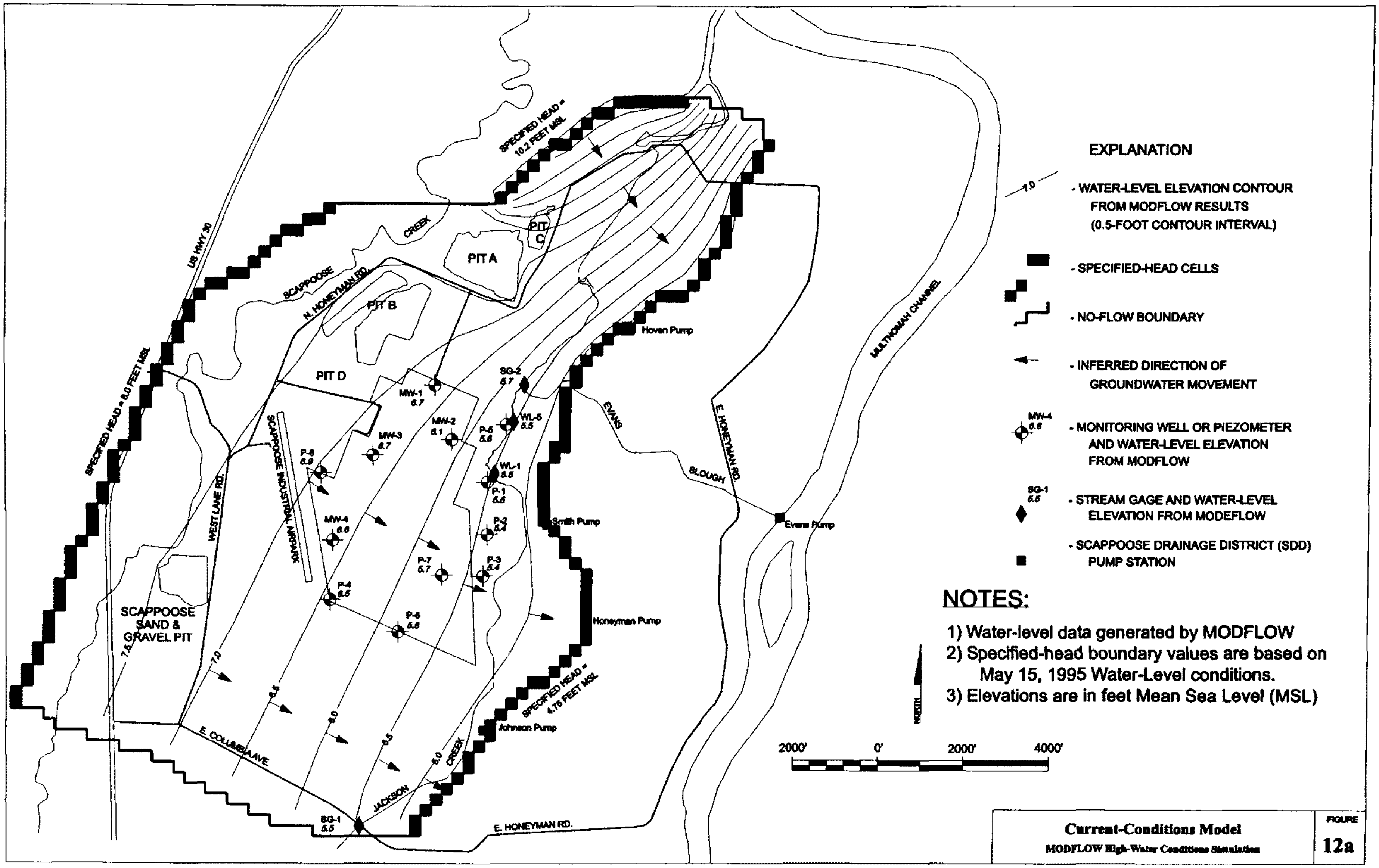


NOTES:

1) Model details are provided in Appendix E.
2) Cell dimensions are 250' by 250'
3) Model dimensions are 71 rows by 73 columns by 2 layers
4) Model cells assigned hydraulic conductivity of 1225 ft/day in simulated unmined areas. Cells assigned hydraulic conductivity of 1 x 10[illegible] ft/day in simulated mined areas.

**MODFLOW Design for Future-Conditions Models**

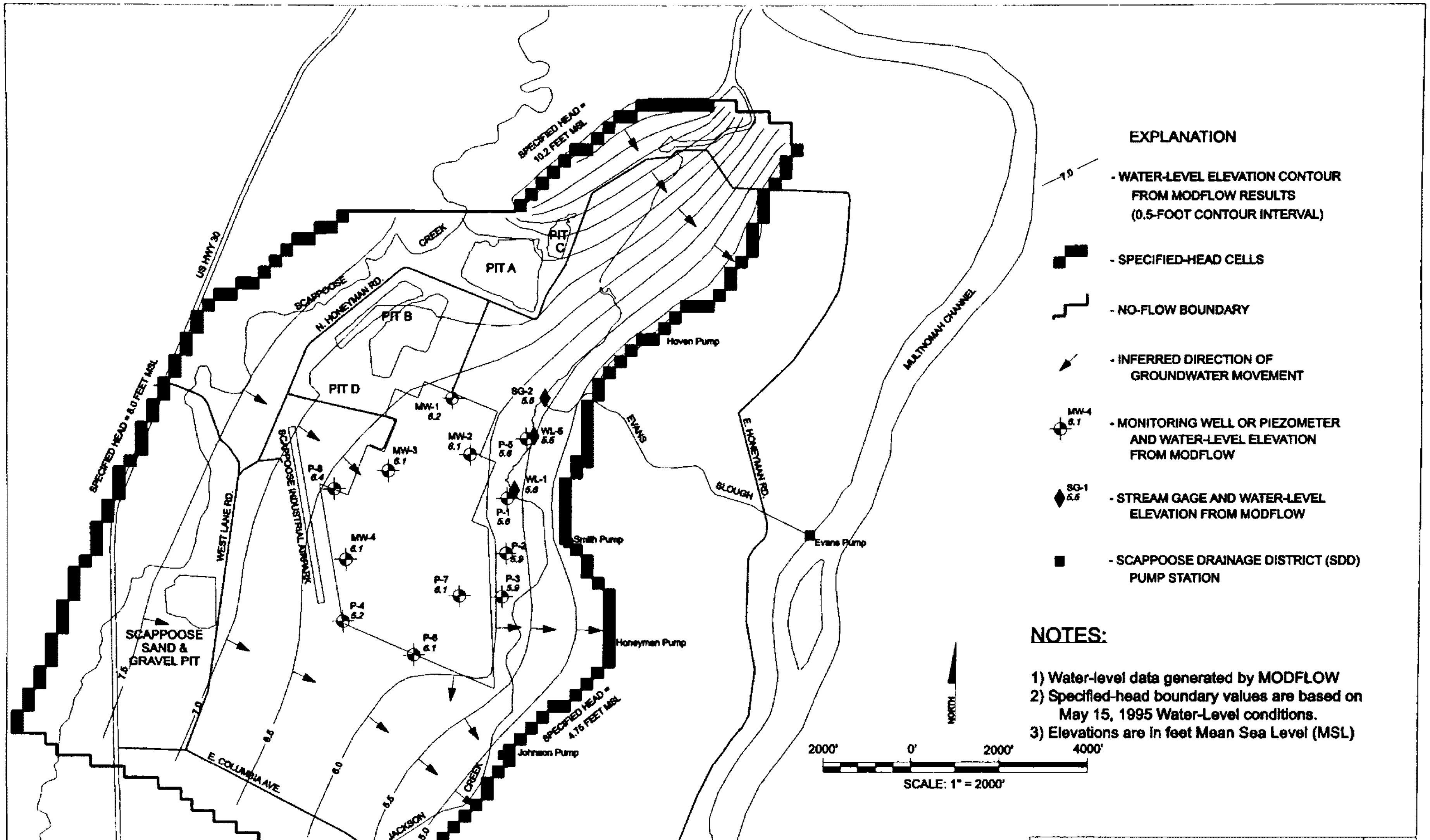
FIGURE 11



**Current-Conditions Model**

MODFLOW High-Water Conditions Simulation

FIGURE 12a



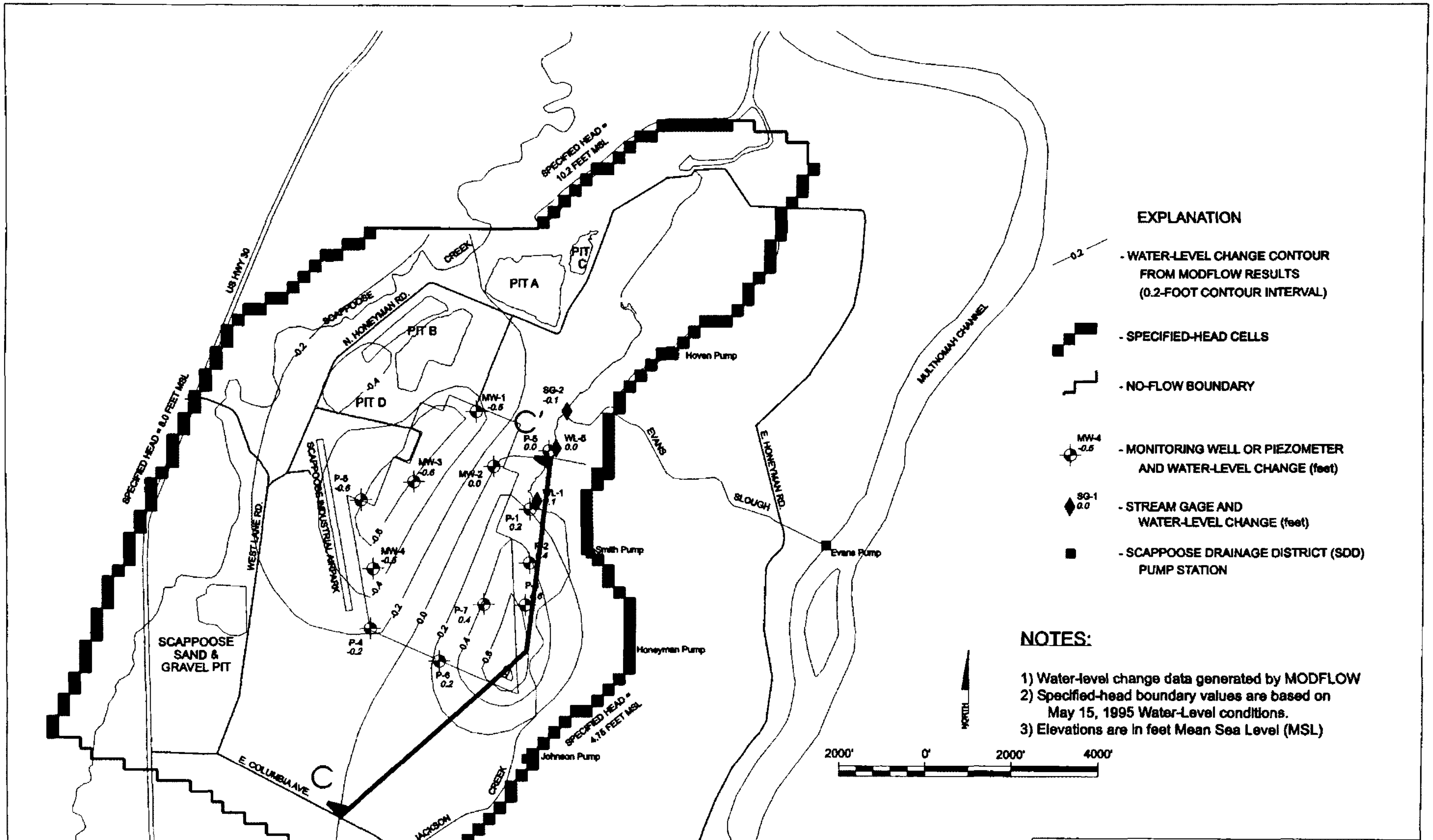
NOTES:

1) Water-level data generated by MODFLOW
2) Specified-head boundary values are based on May 15, 1995 Water-Level conditions.
3) Elevations are in feet Mean Sea Level (MSL)

**Future-Conditions Model**

**MODFLOW High-Water Conditions Simulation**

FIGURE **12b**

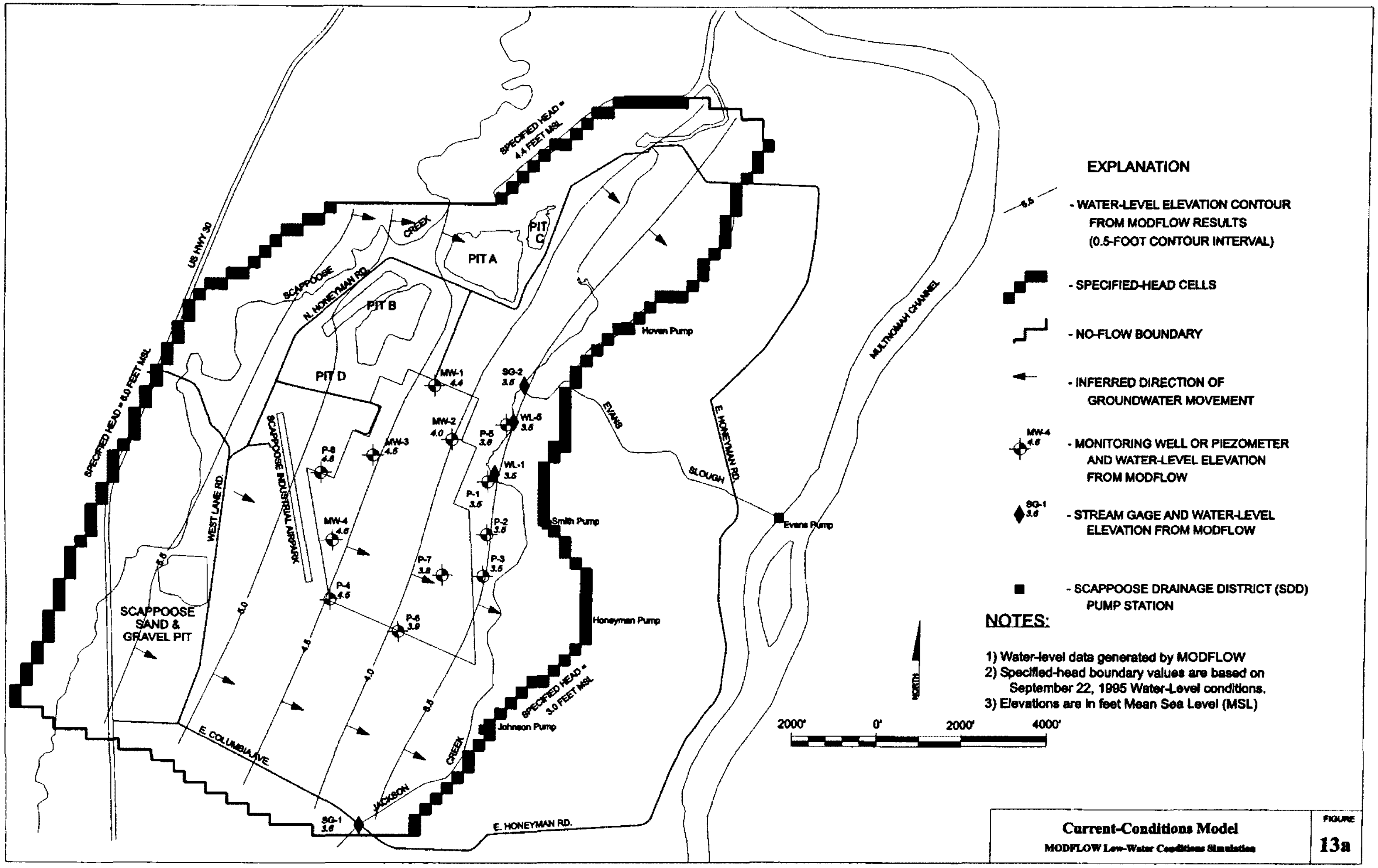


NOTES:

1) Water-level change data generated by MODFLOW
2) Specified-head boundary values are based on May 15, 1995 Water-Level conditions.
3) Elevations are in feet Mean Sea Level (MSL)

**Predicted Water-Level Changes**
MODFLOW High-Water Conditions Simulation

FIGURE 12c



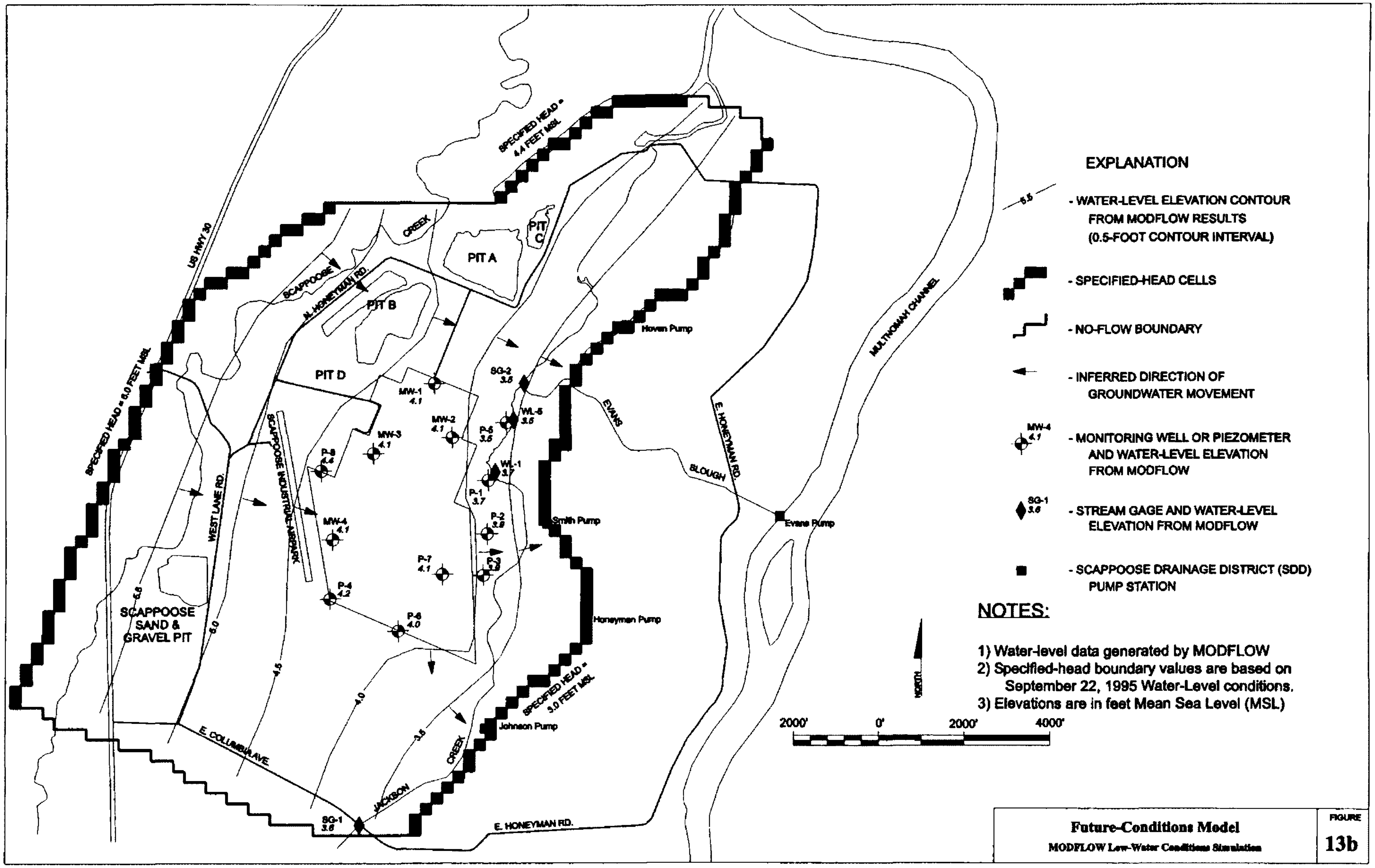
NOTES:

1) Water-level data generated by MODFLOW
2) Specified-head boundary values are based on September 22, 1995 Water-Level conditions.
3) Elevations are in feet Mean Sea Level (MSL)

**Current-Conditions Model**

**MODFLOW Low-Water Conditions Simulation**

FIGURE 13a



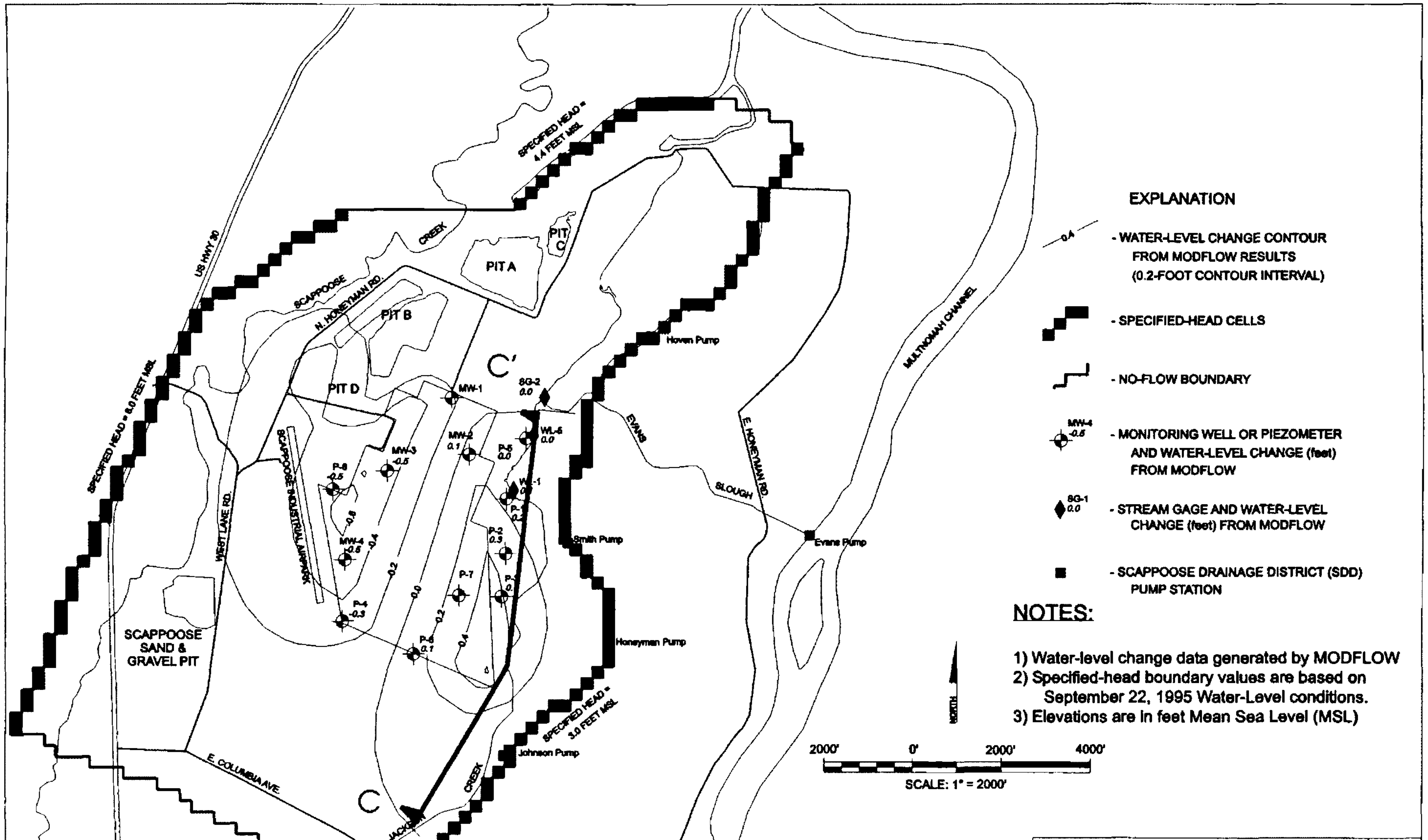
NOTES:

1) Water-level data generated by MODFLOW
2) Specified-head boundary values are based on September 22, 1995 Water-Level conditions.
3) Elevations are in feet Mean Sea Level (MSL)

**Future-Conditions Model**

MODFLOW Low-Water Conditions Simulation

13b



NOTES:

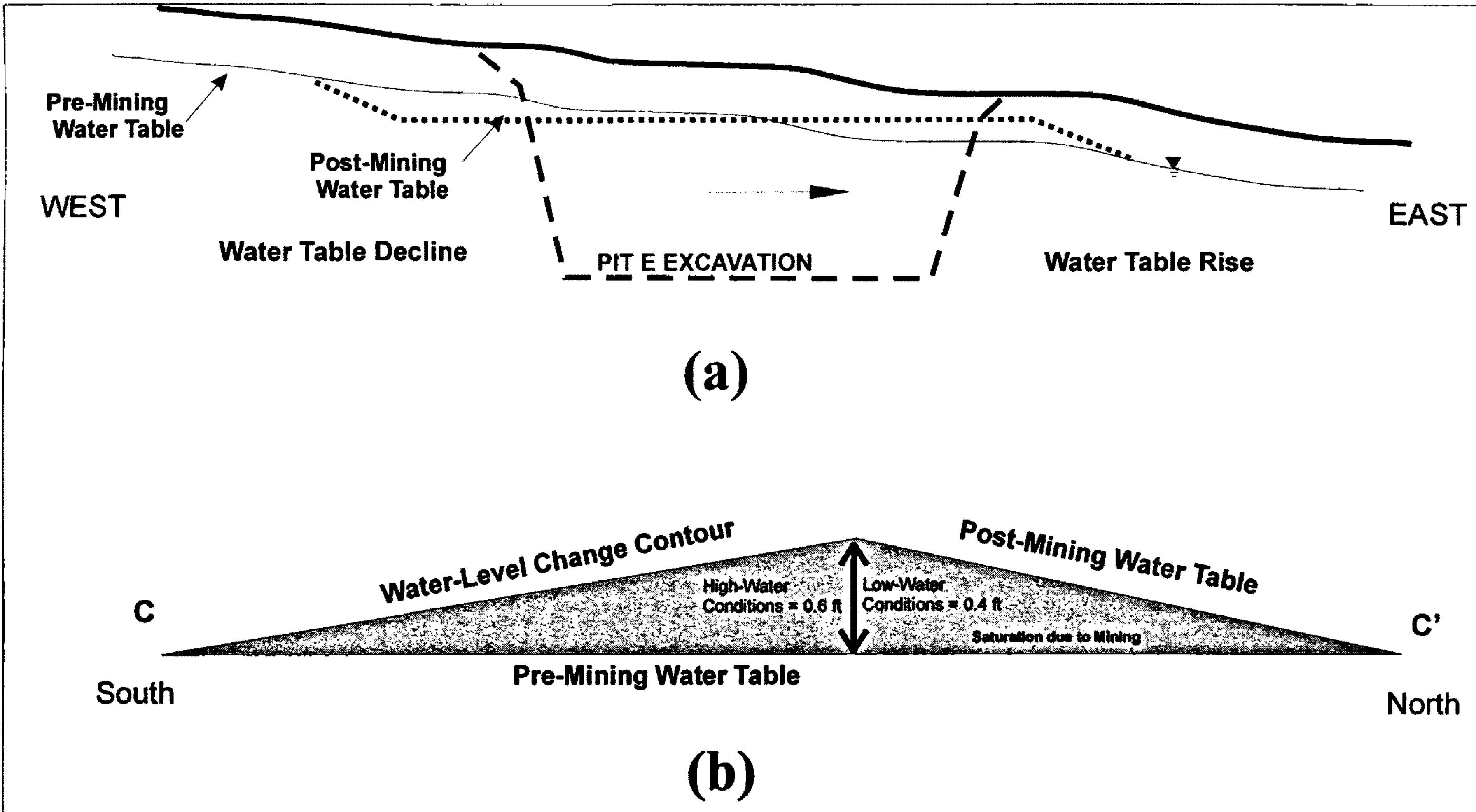
1) Water-level change data generated by MODFLOW
2) Specified-head boundary values are based on September 22, 1995 Water-Level conditions.
3) Elevations are in feet Mean Sea Level (MSL)

**Predicted Water-Level Changes**

MODFLOW Low-Water Conditions Simulation

FIGURE

13c



Evaluation of Future Conditions
Model Results

FIGURE
14

# APPENDIX A

# ANNOTATED BIBLIOGRAPHY

A number of technical studies relating to aggregate mining have been conducted in the study area. These studies have addressed issues regarding the quantity and quality of aggregate in the area; the presence, quality and use of surface water and groundwater; and environmental concerns. Since 1992, DNA produced several reports (published and unpublished) for GNW's existing and planned mining sites in the project area. The following investigations are related to project-area geology and hydrogeology. These references were relied on for this investigation and are listed in the Bibliography section of this report.

In 1980, Northwest Testing Laboratories conducted an aggregate resource evaluation of the Santosh Pits, which were owned at that time by Cascade Aggregate, Inc. The purpose of the study was to investigate the extent of the sand and gravel deposits, and to establish quantitative and qualitative values for the deposits. Borings completed at the site were used to define geologic units beneath the site and quantify the particle-size distribution of the deposits (Northwest Testing Laboratories, 1980).

Geo Recon International completed a geophysical exploration of the proposed expansion property in 1980. They took vertical electrical soundings and placed borings across the site to define the subsurface geologic features (Geo Recon International, 1980).

Quentin R. Keener, a consultant, conducted several analyses of sediment samples in the area of Santosh Pits A and B as part of a preliminary 1983 feasibility study of dewatering Pit B (Keener, 1983).

In 1986, Cascade Aggregate drilled borings on the Pit E property and conducted grain size analyses of selected samples from these borings (Cascade Aggregate, 1986).

Ogden Beeman & Associates conducted a groundwater study prior to excavating Santosh Pit A below the water table (Ogden Beeman & Associates, 1989).

Geotechnical Resources, Incorporated conducted preliminary seepage and water quality studies in 1992. This investigation looked at potential changes to the flow of Jackson Creek as well as impacts to upgradient domestic wells that could result from the excavation of the proposed expansion area (Geotechnical Resources, Inc., 1992).

DNA issued a hydrogeologic report in 1994. This report included evaluations of potential groundwater impacts to the area resulting from the excavation of the proposed expansion area, based on numerical modeling (DNA, 1994a).

In 1994, DNA conducted an aggregate resource investigation in the area of LSNW's existing Pits A through D and the proposed expansion area. This investigation characterized the geology and aggregate reserves encountered, and evaluated the geographic and stratigraphic conditions of cemented gravel encountered at depth in the existing mining pits. A total of 17 Becker Hammer borings were drilled, including four borings within the proposed expansion area (94M1, 94M2, 94M3, 94M4; see Plate 1 and Appendix B).

Laboratory analyses to characterize physical properties were performed on representative formation samples (DNA, 1994b).

In 1995, DNA completed a mineral and aggregate evaluation for the proposed expansion area. This report summarized the results of a geologic investigation and material testing of representative samples from the site. This work by Columbia County regulations in order to have the site listed in the significant resource inventory (DNA, 1995).

In 1996, DNA completed a preliminary geotechnical investigation report for the planned Pit E extension. This report characterized geographic, geologic and hydrologic conditions, evaluated the quantity of mineral resource, and analyzed slope stability (DNA, 1996).

# APPENDIX B

# WATER-LEVEL DATA

## Table B1

### Project Area
### Groundwater Elevation Data

| Date | P-1 | P-2 | P-3 | P-4 | P-5 | P-6 | P-7 | P-8 | MW-1 | MW-2 | MW-3 | MW-4 | 4/1-31cd (Havlic) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Groundwater Elevation (feet MSL) | | | | | | | | | | | | |
| 4/7/93 | 4.84 | 4.87 | 5.70 | 5.22 | 5.08 | 5.27 | 4.59 | | 5.63 | | | | |
| 4/15/93 | 5.14 | 4.87 | 5.10 | 5.72 | 5.08 | 5.87 | 4.99 | | 6.03 | | | | |
| 4/26/93 | 5.04 | 4.87 | 5.00 | 5.62 | 5.08 | 5.57 | 4.99 | | 5.33 | | | | |
| 5/3/93 | 5.04 | 4.77 | 5.00 | 5.22 | 4.98 | 5.47 | 4.89 | | 5.38 | | | | |
| 5/10/93 | 5.04 | 5.12 | 5.00 | 5.42 | 5.03 | 5.37 | 4.99 | | 5.34 | | | | |
| 5/17/93 | 4.84 | 4.77 | 4.70 | 5.12 | 4.88 | 5.07 | 4.84 | | 5.13 | | | | |
| 5/24/93 | 4.90 | 4.85 | 4.91 | 5.23 | 4.94 | 5.18 | 4.95 | 4.94 | 5.23 | | | | |
| 6/1/93 | 5.00 | 4.96 | 5.18 | 5.28 | 5.04 | 5.23 | 4.95 | 5.05 | 5.31 | | | | |
| 6/8/93 | 4.78 | 4.54 | 4.86 | 5.18 | 4.82 | 5.13 | 4.84 | 5.00 | 5.21 | | | | |
| 6/15/93 | 4.66 | 4.63 | 5.49 | 5.02 | 4.74 | 4.93 | 4.89 | 4.59 | 5.06 | | | | |
| 7/7/93 | 4.34 | 4.15 | 5.42 | 4.58 | 4.39 | 4.45 | 4.55 | 0.45 | 4.59 | | | | |
| 8/16/93 | 3.86 | 3.93 | 5.04 | 4.09 | 3.99 | 3.63 | 4.25 | 4.05 | 4.32 | | | | 4.63 |
| 9/14/93 | 3.32 | 3.26 | 5.19 | 3.23 | 3.44 | 3.37 | 3.74 | 3.41 | 3.70 | | | | 3.88 |
| 10/22/93 | 3.52 | 3.43 | 4.70 | 3.70 | 3.54 | 3.22 | 3.29 | 3.52 | 3.77 | | | | 4.11 |
| 11/18/93 | 3.46 | 3.43 | 4.63 | 3.58 | 3.50 | 3.49 | 3.40 | | 3.92 | | | | 3.87 |
| 12/20/93 | 4.44 | 4.51 | 5.82 | 4.78 | 4.61 | 4.70 | 4.22 | | 4.93 | | | | 5.17 |
| 1/18/94 | 4.72 | 4.66 | 5.97 | 5.09 | 4.74 | 3.68 | 4.65 | | 5.17 | | | | 5.82 |
| 3/10/94 | 4.96 | 4.79 | 6.10 | 5.40 | 4.92 | 5.28 | 5.05 | | 5.38 | 4.97 | 4.88 | 5.02 | 5.50 |
| 4/11/94 | 4.67 | 4.58 | 6.00 | 4.92 | 4.74 | 4.87 | 4.69 | | 5.08 | 4.65 | 4.00 | 4.68 | 5.47 |
| 5/23/94 | 3.91 | 4.32 | 5.49 | 4.46 | 4.40 | 4.38 | 4.50 | | 4.71 | 4.39 | 4.30 | 4.34 | 4.91 |
| 8/4/94 | 3.42 | 3.33 | | 3.62 | 3.48 | 3.47 | 3.92 | | 3.76 | 3.43 | 3.34 | 3.42 | 3.92 |
| 11/1/94 | 4.59 | 4.62 | 6.29 | 4.37 | 4.63 | 4.59 | 3.64 | | 4.70 | 4.57 | 4.55 | 4.61 | |
| 3/22/95 | 5.00 | 4.88 | 6.12 | 5.02 | 4.87 | 5.44 | 5.15 | | 5.26 | 5.15 | 5.16 | 4.97 | |
| 5/15/95 | 5.42 | 5.40 | 6.59 | 5.44 | 5.46 | 5.50 | 5.37 | | 5.73 | 5.42 | 5.39 | 5.47 | |
| 8/1/95 | 4.90 | 4.80 | | 4.92 | 4.86 | 4.76 | 5.23 | | 5.08 | 4.85 | 4.84 | 4.90 | |
| 9/22/95 | 3.64 | 3.56 | 4.72 | 3.68 | 3.72 | 3.50 | 4.17 | 3.81 | 3.95 | 3.62 | 3.56 | 3.66 | |

## Table B2

### Project Area
### Surface-Water Elevation Data

| Date | WL-1 | WL-5 | SG-1 | SG-2 |
|---|---|---|---|---|
| | Surface-Water Elevation (feet MSL) | | | |
| 5/24/93 | 3.85 | 4.02 | | |
| 6/1/93 | 4.35 | 4.48 | | |
| 6/8/93 | 2.97 | 3.14 | | |
| 6/15/93 | 3.85 | 4.15 | 4.65 | 4.27 |
| 7/7/93 | 3.93 | 4.36 | 4.35 | 4.40 |
| 8/16/93 | 2.94 | 3.73 | 3.90 | 3.80 |
| 9/14/93 | | 3.04 | 3.15 | 3.09 |
| 10/22/93 | | 3.40 | 3.45 | 3.47 |
| 11/18/93 | | 3.32 | 3.45 | 3.45 |
| 12/20/93 | | 4.15 | 4.44 | 4.39 |
| 1/18/94 | | 3.65 | 3.90 | 3.65 |
| 3/10/94 | | 3.56 | 3.90 | 3.35 |
| 4/11/94 | | 3.22 | 4.80 | 5.84 |
| 5/23/94 | | 4.23 | 4.26 | 4.50 |
| 8/4/94 | | 2.41 | 2.81 | 2.85 |
| 11/1/94 | | 4.73 | 4.76 | 4.80 |
| 3/22/95 | | 4.14 | 3.87 | 3.37 |
| 5/15/95 | | 5.22 | 5.10 | 5.22 |
| 8/1/95 | | 4.71 | 4.45 | 4.73 |
| 9/22/95 | | 3.14 | 3.45 | 3.28 |

Notes: 1) WL-1 (Jackson Creek stream gage) destroyed 9/93.

# APPENDIX C

# WATER WELL REPORTS, BORING LOGS AND WELL CONSTRUCTION LOGS

# WATER WELL REPORTS

RECEIVED
MAR 13 1961
STATE ENGINEER
SALEM, OREGON

3.6451

File Original and First Copy with the STATE ENGINEER, SALEM OREGON

## WATER WELL REPORT
## STATE OF OREGON

State Well No 3N/1W-6
State Permit No

### (1) OWNER:
Name Gerald Widmayer
Address Box 621 Scappoose Ore

### (2) LOCATION OF WELL:
County Col. Owner's number, if any—
¼ ¼ Section 6 T. 3 N. R. 1 W W.M.
Bearing and distance from section or subdivision corner
75 Ft. East Of East Boundary
Of Columbia County Airport

### (3) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

### (4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

### (5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

### (6) CASING INSTALLED:
Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 79 - 6 ft. Gage 17#
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

### (7) PERFORATIONS:
Perforated? ☐ Yes ☒ No
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

### (8) SCREENS:
Well screen installed ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

### (9) CONSTRUCTION:
Was well gravel packed? ☐ Yes ☐ No Size of gravel:
Gravel placed from ft. to ft.
Was a surface seal provided? ☒ Yes ☐ No To what depth? 2-6" ft.
Material used in seal— Cement
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? Depth of strata
Method of sealing strata off

### (10) WATER LEVELS:
Static level 42 ft. below land surface Date
Artesian pressure lbs. per square inch Date

Log Accepted by:
(Signed) G. J. Widmayer (Owner) Date 3-11, 1961

### (11) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal. min. with ft. drawdown after hrs.
" " "
" " "
Bailer test 15 gal./min. with 4" ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

### (12) WELL LOG:
Diameter of well 6 inches
Depth drilled 80 ft. Depth of completed well 80 ft.
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

| MATERIAL | FROM | TO |
|---|---|---|
| Soil & Gravel | 0 | 1[illegible] |
| Gravel | 10 | 60 |
| Course Sand & Fine Gravel | 60 | 8[illegible] |

Work started 1/20/61 Completed 3/5/61 19

### (13) PUMP:
Manufacturer's Name
Type: H.P.

**Well Driller's Statement:**
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Svend A. Hald (Person, firm or corporation) (Type or print)
Address Box 1267 Sta. A. St. Helens, O.
Driller's well number 9
(Signed) Svend A. Hald (Well Driller)
License No. 261 Date 3/5/61 19

3/1-6ab1

3·6ab2

NOTICE TO WATER WELL CONTRACTOR
The original and first copy
of this report are to be
filed with the
TATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date
of well completion

# WATER WELL REPORT
## STATE OF OREGON
(Please type or print)

State Well No 3N/1W-6

State Permit No

## 1) OWNER:
ame [illegible]
dress 5831 N [illegible]

## 2) LOCATION OF WELL:
unty Columbia Driller's well number
NW ¼ NE ¼ Section 38 T. 3N R. 1W W.M.
aring and distance from section or subdivision corner

## 3) TYPE OF WORK (check):
ew Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
donment, describe material and procedure in Item 12.

## 4) PROPOSED USE (check):
omestic ☒ Industrial ☐ Muni al ☐
rigation ☐ Test Well ☐ Other ☐

## (5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

## 6) CASING INSTALLED:
Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 50 ft. Gage 250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

## 7) PERFORATIONS:
Perforated? ☐ Yes ☒ No
ype of perforator used
ize of perforations by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## (8) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Di. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

## 9) CONSTRUCTION:
Well seal—Material used in seal Betonite
Depth of seal 20 ft. Was a packer used? No
Diameter of well bore to bottom of seal 9 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
any strata contain unusable water? ☐ Yes ☒ No
ype of water? depth of strata
Method of sealing strata off

## (10) WATER LEVELS:
Static level 38 ft. below land surface Date 8/2/66

## (11) WELL TESTS:
Drawdown is amount water level is lowered below static level.
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 10 gal./min. with 2 ft. drawdown after 1 hr
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒

## (12) WELL LOG:
Diameter of well below casing 6
Depth drilled 54 ft. Depth of completed well 50 ft.
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

| MATERIAL | FROM | TO |
|---|---|---|
| Sand Brown Fine | 0 | 8 |
| Gravel Multicolor Med | 8 | 54 |

Work started July 25 1966 Completed Aug 1, 196
Date well drilling machine moved off of well Aug 1 196

## (13) PUMP:
Manufacturer's Name No Pump Installed
Type: H.P.

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report true to the best of my knowledge and belief.

NAME F.E. McKnight
(Person, firm or corporation) (Type or print)
Address 840 West St. St. Helens
Drilling Machine Operator's License No. 323
(Signed) F.E. McKnight 3/1-6ab2
(Water Well Contractor)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy
of this report are to be
filed with the
STATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date
of well completion.

RECEIVED
NOV 1 1968
STATE ENGINEER
SALEM, OREGON

# WATER WELL REPORT
## STATE OF OREGON
(Please type or print)
(Do not write above this line)

3/1-6ab3

24

State Well No 3N/1w-6

State Permit No

## (1) OWNER:
Name Clarence B. Quick
Address Box A Scappoose Ore.

## (2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

## (3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

## (4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## (5) CASING INSTALLED:
Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 70 ft. Gage .17
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

## (6) PERFORATIONS:
Perforated? ☐ Yes ☒ No.
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## (7) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

## (8) WATER LEVEL: Completed well.
Static level 39'-6" ft. below land surface Date 8-20-68
Artesian pressure lbs. per square inch Date

## (9) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 30 gal./min. with 10 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No

## (10) CONSTRUCTION:
Well seal—Material used Bentonite
Depth of seal 18' ft.
Diameter of well bore to bottom of seal 12 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:

## (11) LOCATION OF WELL:
County Col. Driller's well number 92
¼ ¼ Section 6 T. 3N R. 1W
Bearing and distance from section or subdivision corner

## (12) WELL LOG:
Diameter of well below casing —
Depth drilled 70 ft. Depth of completed well 70

Formation: Describe color, texture, grain size and structure of materia and show thickness and nature of each stratum and aquifer penetrat with at least one entry for each change of formation. Report each cha in position of Static Water Level as drilling proceeds. Note drilling ra

| MATERIAL | From | To | SW |
|---|---|---|---|
| Black Soil | 0 | 2 | |
| med + Large Gravel | 2 | 16 | |
| med + Large Gravel + br Clay | 16 | 26 | |
| Coarse Gray Sand + fine Gravel | 26 | 70 | 39 |

Work started 8-10-68 19 Completed 8-20-68 19
Date well drilling machine moved off of well 8-22-68 19

**Drilling Machine Operator's Certification:**
This well was constructed under my direct supervision. Ma rials used and information reported above are true to my be knowledge and belief.
[Signed] Svend A. Held Date 8-22, 19
(Drilling Machine Operator)
Drilling Machine Operator's License No. 144

**Water Well Contractor's Certification:**
This well was drilled under my jurisdiction and this repor true to the best of my knowledge and belief.
NAME SVEND A. HELD
(Person, firm or corporation) (Type or print)
Address BOX 1267 St. Helens Ore.
[Signed] Svend A. Held
(Water Well Contractor)
8-22-68

3N/1W-6C
3/1-6bb1

File Original and
First Copy with the
STATE ENGINEER,
SALEM OREGON

# WATER WELL REPORT
## STATE OF OREGON

State Well No. 4
State Permit No [redacted]

### (1) OWNER:
Name Columbia Co. Ore.
Address

### (2) LOCATION OF WELL:
County Col Owner's number, if any—
N.W.¼ N.W.¼ Section 6 T. 3 N R. 1 W W.M.
Bearing and distance from section or subdivision corner
Well is located 268 FT. N 11°00' west
53 FT South 79°00' West from the
S.W. Corner of John McPherson D.
L.C. Section 6 T. 3N Range 1

### (3) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

### (4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☒
Irrigation ☐ Test Well ☐ Other ☐

### (5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

### (6) CASING INSTALLED:
Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 30 ft. Gage 1/4
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

### (7) PERFORATIONS:
Perforated? ☐ Yes ☒ No
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

### (8) SCREENS:
Well screen installed ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

### (9) CONSTRUCTION:
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
Was a surface seal provided? ☒ Yes ☐ No To what depth? 20 ft.
Material used in seal— Drillings
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? Depth of strata
Method of sealing strata off

### (10) WATER LEVELS:
Static level 50 ft. below land surface Date 9 Aug 58
Artesian pressure lbs. per square inch Date

Log Accepted by:
(Signed) Col County (Owner) Date 8/12 1958
By D Johnson

### (11) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after
" " "
" " "
Bailer test 30 gal./min. with 5 ft. drawdown after 2
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒

### (12) WELL LOG:
Diameter of well 6 in.
Depth drilled 80 ft. Depth of completed well 30
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

| MATERIAL | FROM | |
|---|---|---|
| Topsoil + Gravel | 0' | |
| Gravel | 2' | |
| Sand | 40' | |
| Gravel | 53' | |

Work started 4 Aug 1958 Completed 9 Aug

### (13) PUMP:
Manufacturer's Name
Type: H.P.

**Well Driller's Statement:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Guy A. Luttrell (Person, firm, or corporation) (Type or print)
Address Rt 1, Box 430 St. Helens,
Driller's well number 4
(Signed) G. A. Luttrell (Well Driller)
License No. 238 Date 11 Aug 19

(USE ADDITIONAL SHEETS IF NECESSARY)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion

RECEIVED
8 1968
STATE ENGINEER
SALEM, OREGON

# WATER WELL REPORT
## STATE OF OREGON
(Please type or print)
(Do not write above this line)

3/1-6bb2

State Well No 3N/1W-6
State Permit No

## (1) OWNER:
Name Gerold Widmayer
Address Box 621 Scappoose Ore

## (2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

## (3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

## (4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## (5) CASING INSTALLED:
Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 80 ft. Gage 17
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

## PERFORATIONS:
Perforated? ☐ Yes ☒ No.
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## (7) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam Slot size Set from ft. to ft.
Diam Slot size Set from ft. to ft.

## (8) WATER LEVEL: Completed well.
Static level 45'-6" ft. below land surface Date 6-24-68
Artesian pressure lbs. per square inch Date

## (9) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 30 gal./min. with 12 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

## (10) CONSTRUCTION:
Well seal—Material used Bentonite Clay
Depth of seal 18' ft.
Diameter of well bore to bottom of seal 10 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:

## (11) LOCATION OF WELL:
County Col Driller's well number 89
¼ ¼ Section 6 T 3N R 1W
Bearing and distance from section or subdivision corner
North End Col Co. Airport

## (12) WELL LOG:
Diameter of well below casing —
Depth drilled 80 ft. Depth of completed well 80

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level as drilling proceeds. Note drilling ra

| MATERIAL | From | To | S |
|---|---|---|---|
| Br Clay + Large Gravel | 0 | 20 | |
| Mud + Large Gravel | 20 | 52 | |
| Course Br Sand | 52 | 71 | 6 |
| Br Course Sand + Fine Gravel | 71 | 80 | 4 |

Work started 6-13 1968 Completed 6-22 19
Date well drilling machine moved off of well 6-24-68 19

**Drilling Machine Operator's Certification:**
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Svend A. Hall (Drilling Machine Operator) Date 6-24 196

Drilling Machine Operator's License No. 144

**Water Well Contractor's Certification:**
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME SVEND A. HALD (Person, firm or corporation) (Type or print)
Address Box 1267 St Helens Ore.
[Signed] Svend A. Ha (Water Well Contractor)

Colu
819

3/1-6663 3N/1W/6

**STATE OF OREGON**
**WATER WELL REPORT**
(as required by ORS 537.765)

(START CARD) # 51999

Instructions for completing this report are on the last page of this form.

**(1) OWNER:** Well Number
Name [illegible]
Address 54000 West Lane Road
City Scappoose State OR Zip 97056

**(2) TYPE OF WORK**
☒ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

**(3) DRILL METHOD:**
☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger
☐ Other

**(4) PROPOSED USE:**
☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

**(5) BORE HOLE CONSTRUCTION:**
Special Construction approval ☐ Yes ☑ No Depth of Completed Well 63 ft.
Explosives used ☐ Yes ☑ No Type Amount

| HOLE | | | SEAL | | | |
|---|---|---|---|---|---|---|
| Diameter | From | To | Material | From | To | Sacks or pounds |
| 10 | 0 | 20 | Bentonite | 0 | 20 | 16 |
| 6 | 20 | 63 | | | | |
| | | | | | | |
| | | | | | | |

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☑ Other poured
Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

**(6) CASING/LINER:**

| | Diameter | From | To | Gauge | Steel | Plastic | Welded | Threaded |
|---|---|---|---|---|---|---|---|---|
| Casing: | 6 | +1 | 62 | 250 | ☑ | ☐ | ☑ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| Liner: | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |

Final location of shoe(s) 62

**(7) PERFORATIONS/SCREENS:**
☐ Perforations Method
☐ Screens Type Material

| From | To | Slot size | Number | Diameter | Tele/pipe size | Casing | Liner |
|---|---|---|---|---|---|---|---|
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |

**(8) WELL TESTS: Minimum testing time is 1 hour**

☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

| Yield gal/min | Drawdown | Drill stem at | Time |
|---|---|---|---|
| 70 | | 50 | 1 hr. |
| | | | |
| | | | |

Temperature of water 52 Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata

**(9) LOCATION OF WELL by legal description:**
County Columbia Latitude Longitude
Township 3N N or S Range 1W E or W WM
Section 6 [illegible] 1/4 [illegible] 1/4
Tax Lot 200 Lot Block Subdivision
Street Address of Well (or nearest address) Same

**(10) STATIC WATER LEVEL:**
18 ft. below land surface. Date 4-1-94
Artesian pressure lb. per square inch. Date

**(11) WATER BEARING ZONES:**

Depth at which water was first found 18

| From | To | Estimated Flow Rate | SWL |
|---|---|---|---|
| 18 | 63 | 30 | 18 |
| | | | |
| | | | |
| | | | |

**(12) WELL LOG:**
Ground Elevation

| Material | From | To | SWL |
|---|---|---|---|
| Pitrun Fill | 0 | 3 | |
| Brn Silty Sand | 3 | 16 | |
| Brn Silty Sand + Gravel | 16 | 47 | 18 |
| Black Sand + Gravel | 47 | 63 | |

Date started 4-1-94 Completed 4-1-94

**(unbonded) Water Well Constructor Certification:**

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

WWC Number
Signed Date

**(bonded) Water Well Constructor Certification:**

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 215
Signed Date 4-5-94

316ca

(29)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy
of this report are to be
filed with the
STATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date
of well completion.

# WATER WELL REPORT
## STATE OF OREGON
(Please type or print)

State Well No. 3N/1W-6

State Permit No.

## (1) OWNER:
Name Ernest Bailey
Address 9540 North Fillmore

## (2) LOCATION OF WELL:
County Columbia  Driller's well number
SE ¼ SW ¼ Section 6 T. 3N R. 1W W.M.
Bearing and distance from section or subdivision corner

## (3) TYPE OF WORK (check):
Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

## (4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

## (5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

## (6) CASING INSTALLED:
Threaded ☐ Welded ☒
8" Diam. from 0 ft. to 81 ft. Gage 250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

## (7) PERFORATIONS:
Perforated? ☐ Yes ☒ No
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## (8) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

## (9) CONSTRUCTION:
Well seal—Material used in seal Betonite & Puddled Clay
Depth of seal 26 ft. Was a packer used? No
Diameter of well bore to bottom of seal 12 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off

## (10) WATER LEVELS:
Static level 36ft 4in ft. below land surface Date 4/15/57

## (11) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after
Bailer test 60 gal./min. with 8 ft. drawdown after 1½
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒

## (12) WELL LOG:
Diameter of well below casing 8 in
Depth drilled 86 ft. Depth of completed well 81

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

| MATERIAL | FROM | TO |
|---|---|---|
| Soil Brown Med | 0 | 2 |
| Gravel & Bolder Grey Large | 2 | 45 |
| Clay Blue Med | 45 | 53 |
| Bolders & Sand Grey Med | 53 | 86 |

Work started 3/16 1957 Completed 4/11/
Date well drilling machine moved off of well 4/11/

## (13) PUMP:
Manufacturer's Name
Type: H.P.

Water Well Contractor's Certification:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME F. E. McKnight
(Person, firm or corporation) (Type or print)
Address 840 West Street St. Helens
Drilling Machine Operator's License No. 323
[Signed] F. E. Mc
(Water Well Contractor)
3/1-6ca
4/30 19 4/14/

WELL [illegible] REPORT as required by ORS 537.765 Page [illegible] 3/1-7cd Start card # 53600 7cd

JAN - [illegible] 1995
WATER R[illegible] DEPT
SALEM, OREGON

OWNER: Well No. W-1? Col 242
Name TIM DEPGE
Address 34135 E. COLUMBIA AVE
City SCAPPOOSE St OR Zip 97056

TYPE OF WORK: NEW WELL

DRILL METHOD: ROTARY AIR

PROPOSED USE: DOMESTIC

BORE HOLE CONSTRUCTION:
Special Construction Approval: NO Depth of Compl. Well 80 ft
Explosives used: NO Type Amount

| HOLE |  |  | SEAL |  |  |  |
|---|---|---|---|---|---|---|
| Diam. | From | To | Material | From | To | Amount |
| 10 | 0 | 18 | BENTONITE | 0 | 18 | 9 SACKS |
| 6 | 18 | 80 |  |  |  |  |

Seal placement method C
Backfill: from ft to ft Material
Gravel: from ft to ft Size

CASING/LINER:

|  | Diam. | From | To | Gauge | Material | Connection |
|---|---|---|---|---|---|---|
| Casing | 6 | +1 | 80 | 250 | STEEL | WELDED |
| Liner |  |  |  |  |  |  |

Final Location of shoe(s) 80 FT

PERFORATIONS/SCREENS:
☐ Perforations Method
☐ Screens Type Material

| From | To | Slot Size | Number | Diam. | Tele/pipe size | Casing/liner |
|---|---|---|---|---|---|---|

WELL TESTS: Minimum testing time is 1 hour
[illegible] AIR

| Yield [illegible] | Drawdown | Drill stem at | Time |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] |  | [illegible] | [illegible] |

Temperature of water 52 Depth Artesian Flow Found
Was a water analysis done? [illegible] By whom
[illegible] water not suitable for use
Depth of strata [illegible]

LOCATION OF WELL by legal description:
County COLUMBIA Lat. Long.
Township 3 N Range 1 W
Section [illegible] SE 1/4 SW 1/4
Tax Lot Lot Block Subdivision
Street Address of well (or nearest address)
34135 E COLUMBIA AVE SCAPPOOSE, OR 97056

(10) STATIC WATER LEVEL:
3 ft. below land surface. Date 12/23/94
Artesian pressure psi Date

(11) WATER BEARING ZONES:
Depth at which water was first found 3

| From | To | Est Flow Rate | SWL |
|---|---|---|---|
| 3 | 80 | 25 GPM | 3 |

(12) WELL LOG:
Ground elevation

| Material | From | To | SWL |
|---|---|---|---|
| CLAY | 0 | 3 | 3 |
| CLAY GRAVEL | 3 | 10 |  |
| GRAVEL, SAND | 10 | 70 |  |
| GRAVEL CLEAN | 70 | 80 |  |

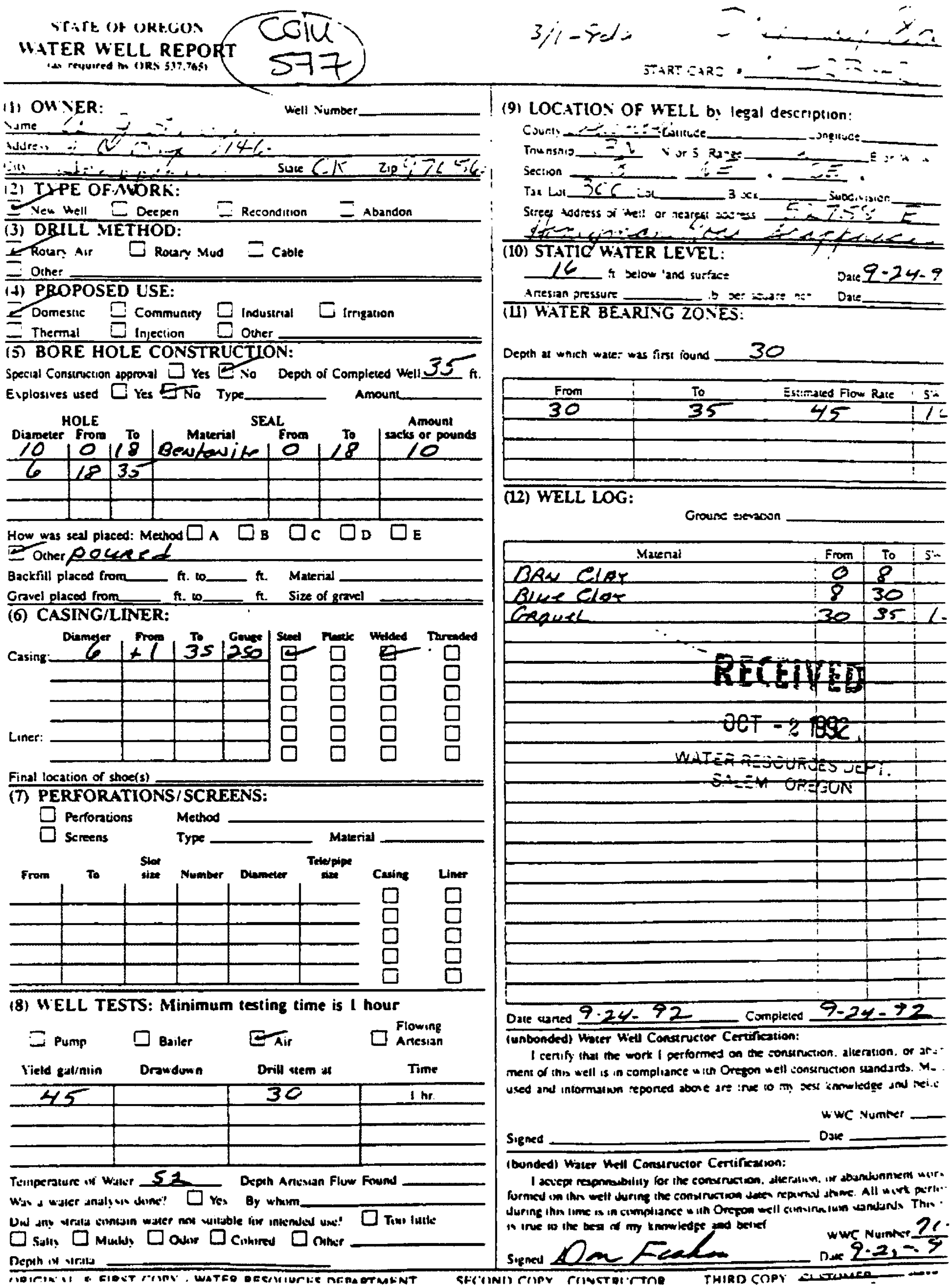
Date started 12/14/94 Completed 12/23/94

(unbonded) Water Well Constructor Certification: I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
WWC Number
Signed Date

(bonded) Water Well Constructor Certification: I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 1480
Signed Date 12/30/94

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 10/9?

3/1 7cd



STATE OF OREGON
**WATER WELL REPORT**
(as required by ORS 537.765)

CGIU
577

3/1-92 [illegible]

START CARD # [illegible]

## (1) OWNER:

Well Number ______

Name [illegible]

Address [illegible] 146

City [illegible] State OR Zip 97756

## (2) TYPE OF WORK:

☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

## (3) DRILL METHOD:

☑ Rotary Air ☐ Rotary Mud ☐ Cable

☐ Other ______

## (4) PROPOSED USE:

☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Other ______

## (5) BORE HOLE CONSTRUCTION:

Special Construction approval ☐ Yes ☑ No Depth of Completed Well 35 ft.

Explosives used ☐ Yes ☑ No Type ______ Amount ______

| HOLE | | | SEAL | | | Amount |
|---|---|---|---|---|---|---|
| Diameter | From | To | Material | From | To | sacks or pounds |
| 10 | 0 | 18 | Bentonite | 0 | 18 | 10 |
| 6 | 18 | 35 | | | | |
| | | | | | | |

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E

☑ Other poured

Backfill placed from ______ ft. to ______ ft. Material ______

Gravel placed from ______ ft. to ______ ft. Size of gravel ______

## (6) CASING/LINER:

| | Diameter | From | To | Gauge | Steel | Plastic | Welded | Threaded |
|---|---|---|---|---|---|---|---|---|
| Casing: | 6 | +1 | 35 | 250 | ☑ | ☐ | ☑ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| Liner: | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |

Final location of shoe(s) ______

## (7) PERFORATIONS/SCREENS:

☐ Perforations Method ______

☐ Screens Type ______ Material ______

| From | To | Slot size | Number | Diameter | Tele/pipe size | Casing | Liner |
|---|---|---|---|---|---|---|---|
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |

## (8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

| Yield gal/min | Drawdown | Drill stem at | Time |
|---|---|---|---|
| 45 | | 30 | 1 hr. |
| | | | |
| | | | |
| | | | |

Temperature of Water 52 Depth Artesian Flow Found ______

Was a water analysis done? ☐ Yes By whom ______

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ______

Depth of strata ______

## (9) LOCATION OF WELL by legal description:

County [illegible] Latitude ______ Longitude ______

Township [illegible] N or S Range [illegible] E or W

Section [illegible] [illegible] 1/4 [illegible] 1/4

Tax Lot 300 Lot ______ Block ______ Subdivision ______

Street Address of Well (or nearest address) [illegible]

[illegible]

## (10) STATIC WATER LEVEL:

16 ft. below land surface Date 9-24-9

Artesian pressure ______ lb. per square inch Date ______

## (11) WATER BEARING ZONES:

Depth at which water was first found 30

| From | To | Estimated Flow Rate | SW |
|---|---|---|---|
| 30 | 35 | 45 | 1 |
| | | | |
| | | | |
| | | | |

## (12) WELL LOG:

Ground elevation ______

| Material | From | To | SW |
|---|---|---|---|
| BRN Clay | 0 | 8 | |
| Blue Clay | 8 | 30 | |
| Gravel | 30 | 35 | 1 |

RECEIVED
OCT - 2 1992
WATER RESOURCES DEPT.
SALEM, OREGON

Date started 9-24-92 Completed 9-24-92

**(unbonded) Water Well Constructor Certification:**

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

WWC Number ______

Signed ______ Date ______

**(bonded) Water Well Constructor Certification:**

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 71

Signed Don Fechn Date 9-2-9

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER

ATER RESOURCES DEPARTMENT
SALEM, OREGON 97310
within 30 days from the date
of well completion

(39)

# WATER WELL REPORT

## STATE OF OREGON

(Please type or print)

(Do not write above this line)

State Well No. 3/2W-
State Permit No.
32

## OWNER:

e Elmer Duren
ress 185 S. 4th Street
St. Helens, Oregon 97051

## TYPE OF WORK (check):

w Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

bandonment, describe material and procedure in Item 12.

## ) TYPE OF WELL:

ary ☒ Driven ☐
e ☐ Jetted ☐
☐ Bored ☐

## (4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## ) CASING INSTALLED:

Threaded ☐ Welded ☒

6 " Diam. from plus 1 ft. to 149 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

## ) PERFORATIONS:

Perforated? ☐ Yes ☒ No.

pe of perforator used
ze of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## ) SCREENS:

Well screen installed? ☐ Yes ☒ No

anufacturer's Name
e Model No.
am. Slot size Set from ft. to ft.
iam. Slot size Set from ft. to ft.

## ) WELL TESTS:

Drawdown is amount water level is lowered below static level

a pump test made? ☐ Yes ☒ No If yes, by whom?
ield: 90 gal./min. with 60 ft. drawdown after 2 hrs.
" 55 " 40 " "
" 20 " 20 " "
iler test gal./min. with ft. drawdown after hrs.
esian flow g.p.m.
Temperature of water 50° Depth artesian flow encountered ft.

## (9) CONSTRUCTION:

Well seal—Material used Cement grout & gel
Well sealed from land surface to 148 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 25 sacks
How was cement grout placed? Bottom seal @ 148' placed w/dump bailer - 5 sacks. Top seal @ 40' tremmied in place to land surface 20 sacks

Was a drive shoe used? ☒ Yes ☐ No Plugs Size location ft.
any strata contain unusable water? ☐ Yes ☒ No
pe of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

## (10) LOCATION OF WELL:

County Columbia Driller's well number
NE ¼ NE ¼ Section 1 T 3 N. R 2 W. W.M.
Bearing and distance from section or subdivision corner

## (11) WATER LEVEL: Completed well.

Depth at which water was first found 70
Static level 45 ft. below land surface. Date 12/21/
Artesian pressure lbs. per square inch. Date

## (12) WELL LOG:

Diameter of well below casing --
Depth drilled 150 ft. Depth of completed well 149 ft.

Formation: Describe color, texture, grain size and structure of materials and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Brown clay & gravel | 0 | 1 | |
| Brown cemented gravel | 1 | 12 | |
| Gray cemented gravel-occ.loose | 12 | 70 | |
| Gray sand & gravel | 70 | 90 | w.b. |
| Gray cemented sand & gravel | 90 | 135 | |
| Gray gravel - waterbearing | 135 | 150 | 90 |
| Elev 41-46? | | | |
| WTR -6' | | | |
| [illegible] | | | |
| (59') | | | |
| -65 (65') | | | |

RECEIVED
DEC 31 1979
WATER RESOURCES DEPT
SALEM, OREGON

Work started 11/16/79 19 Completed 12/26/79 19
Date well drilling machine moved off of well 12/21/79 19

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] (Drilling Machine Operator) Date 12/27/79 19
Drilling Machine Operator's License No. 523

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name A. M. JANNSEN WELL DRILLING CO. INC. (Person, firm or corporation) (Type or print)
Address 21075 SW Tualatin Valley Hwy. Aloha, Or
[Signed] (Water Well Contractor)
Contractor's License No. 79 Date 12/27/79 19

ATE ENGINEER
LEM OREGON

# WATER WELL REPORT
## STATE OF OREGON

State Well No 3N/2w-1C
State Permit No 321ba

## (1) OWNER:
Charles Mutchelknaus
Route 1 Box 242
Scappoose, Oregon

## (2) LOCATION OF WELL:
County Columbia Owner's number, if any—
NE ¼ NW ¼ Section 1 T. 3N R. 2W W.M.
earing and distance from section or subdivision corner

## TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

## (4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
ation ☐ Test Well ☐ Other ☐

## (5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

## (6) CASING INSTALLED:
Threaded ☐ Welded ☒
6" Diam. from -3 ft. to 82'-4" ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

## (7) PERFORATIONS:
Perforated? ☐ Yes ☒ No
ype of perforator used
of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## (8) SCREENS:
Well screen installed ☐ Yes ☒ No
facturer's Name
ype Model No.
iam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

## CONSTRUCTION:
well gravel packed? ☐ Yes ☒ No Size of gravel:
ravel placed from ft. to ft.
as a surface seal provided? ☒ Yes ☐ No To what depth? 40 ft.
aterial used in seal—Drill cuttings
id any strata contain unusable water? ☐ Yes ☒ No
ype of water? Depth of strata
ethod of sealing strata off

## (10) WATER LEVELS:
tatic level 55 ft. below land surface Date 8/30/57
rtesian pressure lbs. per square inch Date

Accepted by:
Mitchelknaus Date , 19
(Owner)

## (11) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield gal. min. with ft. drawdown after hrs.
Bailer test 9 gal. min. with total ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water 54 Was a chemical analysis made? ☐ Yes ☒ No

## (12) WELL LOG:
Diameter of well 6 inches
Depth drilled 90 ft. Depth of completed well 90 ft.

*Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

| MATERIAL | FROM | TO |
|---|---|---|
| Brown clay | 0 | 23 |
| Yellow silt | 23 | 69 |
| Cement gravel | 69 | 90 |

Elev +/-60'
WL +/-5'
Cement = -9' (21')

Work started August 1957 Completed August 1957

## (13) PUMP:
Manufacturer's Name Montgomery Ward
Type: Jet H.P. 1

**Well Driller's Statement:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Steinman Bros.
(Person, firm, or corporation) (Type or print)
Address 15112 S.E. McLoughlin Blvd. Milwaukie, Or
Driller's well number 31-57
(Signed)
(Well Driller)
License No. 1 Date Sept. 3, 1957

(USE ADDITIONAL SHEETS IF NECESSARY)

3/2-1ba

(37)

32

File Original and
First Copy with the
STATE ENGINEER.
SALEM OREGON

## WATER WELL REPORT
## STATE OF OREGON

State Well No [illegible]

State Permit No

### (1) OWNER:

Name Dorothy Huff

Address Vernonia, Oregon

### (2) LOCATION OF WELL:

County Columbia Owner's number, if any—

¼ ¼ Section T. R. [illegible] W.M.

Bearing and distance from section or subdivision corner

[illegible]

### (3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 11.

### (4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐

Irrigation ☐ Test Well ☐ Other ☐

### (5) TYPE OF WELL:

Rotary ☐ Driven ☐

Cable ☒ Jetted ☐

Dug ☐ Bored ☐

### (6) CASING INSTALLED:

Threaded ☐ Welded ☒

6" Diam. from 0 ft. to 157' 10" ft. Gage .280 wall

5" Diam. from 153 ft. to 210 ft. Gage .120

" Diam. from ft. to ft. Gage

### (7) PERFORATIONS:

Perforated? ☒ Yes ☐ No

Type of perforator used torch

SIZE of perforations 1/8 in. by 12 in.

4 per foot perforations from 190 ft. to 210 ft.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

### (8) SCREENS:

Well screen installed ☐ Yes ☒ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

### (9) CONSTRUCTION:

Was well gravel packed? ☐ Yes ☒ No Size of gravel:

Gravel placed from ft. to ft.

Was a surface seal provided? ☐ Yes ☐ No To what depth? ft.

Material used in seal—

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? Depth of strata

Method of sealing strata off

### (10) WATER LEVELS:

Static level 34 ft. below land surface Date 7-25-60

Artesian pressure lbs. per square inch Date

Log Accepted by:

[Signed] Date 19
(Owner)

### (11) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?

Yield gal./min. with ft. drawdown after hrs.

Bailer test 15 gal./min. with 66 ft. drawdown after 2 hrs.

Artesian flow g.p.m. Date

Temperature of water Was a chemical analysis made? ☐ Yes ☐ No

### (12) WELL LOG:

Diameter of well 6 inches

Depth drilled 210 ft. Depth of completed well 210 ft.

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

| MATERIAL | FROM | TO |
|---|---|---|
| clay & sand | 0 | 22 |
| boulders | 22 | 30 |
| cmented gravel | 30 | 56 |
| lots of sand (water bearing) | 56 | 68 |
| hard sand & gravel (water at 92) | 68 | 92 |
| cemented gravel | 92 | 116 |
| loose gravel (no water) | 116 | 123 |
| cemented gravel (water at 129) | 123 | 130 |
| Cemented gravel (water at 189 | 130 | 189 |
| clay | 189 | 200 |
| gray shale | 200 | 210 |
| Elev. +/- 60 | | |
| wtr +/- 26' | | |
| +/- 30 - 4 (26') | | |
| Cement +/- 32 (24') | | |
| +/- -63' (66') | | |

Work started 6-27-60 19 Completed 7-25-60 19

### (13) PUMP:

Manufacturer's Name Pacific Pumping Company

Type: Jet H.P. 2

**Well Driller's Statement:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME A. M. Jannsen Drilling Company
(Person, firm, or corporation) (Type or print)

Address 21075 S. W. Tualatin Highway - Aloha, Or.

Driller's well number:

[Signed] Edward M. Jannsen Partner

License No. 79 Date 7-25-60 19

STATE OF OREGON
# WATER WELL REPORT
(as required by ORS 537.765)

(START CARD) # 9291

## (1) OWNER:
Well Number
Name Robert G. & Gloria A. Wenborn
Address 50825 S.W. Old Portland Rd.
City Scappoose State OR Zip 97056

## (2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

## (3) DRILL METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

## (4) PROPOSED USE:
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

## (5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☑ Depth of Completed Well 295 ft.
Explosives used Yes ☐ No ☑ Type ______ Amount ______

| HOLE | | | SEAL | | | |
|---|---|---|---|---|---|---|
| Diameter | From | To | Material | From | To | Amount sacks or pounds |
| 10 | 0 | 20 | Bentonite | 0 | 20 | 9 |
| 6 | 20 | 295 | | | | |

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☑ Other poured
Backfill placed from ______ ft. to ______ ft. Material ______
Gravel placed from ______ ft. to ______ ft. Size of gravel ______

## (6) CASING/LINER:

| | Diameter | From | To | Gauge | Steel | Plastic | Welded | Threaded |
|---|---|---|---|---|---|---|---|---|
| Casing: | 6 | +1 | 39 | 250 | ☑ | ☐ | ☑ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| Liner: | 4 | 0 | 5 295 | | ☐ | ☑ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |

Final location of shoe(s) none

## (7) PERFORATIONS/SCREENS:
☑ Perforations Method Drill
☐ Screens Type ______ Material ______

| From | To | Slot size | Number | Diameter | Tele/pipe size | Casing | Liner |
|---|---|---|---|---|---|---|---|
| 260 | 280 | | 40 | 5/8 | | ☐ | ☐ |
| | | | | | | ☐ | ☑ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |

## (8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

| Yield gal/min | Drawdown | Drill stem at | Time |
|---|---|---|---|
| 15 | | 295 | 1 hr. |
| | | | |
| | | | |

Temperature of water ______ Depth Artesian Flow Found ______
Was a water analysis done? ☐ Yes By whom ______
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ______
Depth of strata: ______

## (9) LOCATION OF WELL by legal description:
County Columbia Latitude ______ Longitude ______
Township 3N N or S. Range 2W E or W.M.
Section 2 NE ¼ SW ¼
Tax Lot 3001 Lot ______ Block ______ Subdivision ______
Street Address of Well or nearest address Eagle Lane
Scappoose 97056

## (10) STATIC WATER LEVEL:
245 ft. below land surface Date 5-8-
Artesian pressure ______ lb. per square inch Date ______

## (11) WATER BEARING ZONES:
Depth at which water was first found 265

| From | To | Estimated Flow Rate | S |
|---|---|---|---|
| 265 | 290 | 15 | 24 |
| | | | |
| | | | |
| | | | |

## (12) WELL LOG:
Ground elevation ______

| Material | From | To | S |
|---|---|---|---|
| Soil | 0 | 1 | |
| Red Clay | 1 | 13 | |
| Brn Clay | 13 | 32 | |
| Brn Sandstone | 32 | 68 | |
| Grey Sandstone w/layers of Grey Claystone | 68 | 124 | |
| Brn/Green Sandstone | 124 | 145 | |
| Soft Brn Seamy Rock | 145 | 168 | |
| Brn Sandstone | 168 | 218 | |
| Soft Brn Seamy Rock | 218 | 229 | |
| Brn Sandstone | 229 | 265 | |
| Brn Sandstone w/Layers of Broken Rock & Clay | 265 | 295 | 2 |

Date started 5/8 Completed 5-9

**(unbonded) Water Well Constructor Certification:**
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my knowledge and belief.
WWC Number ______
Signed ______ Date ______

**(bonded) Water Well Constructor Certification:**
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 21
Signed Date 5-17-8

322cd

3N/2W 1 Cd

(3-)

STATE OF OREGON
# WATER WELL REPORT
(as required by ORS 537.765)

START CARD # 31383

## (1) OWNER:

Well Number

Name Scappoose Sand + Gravel Co.

Address P. O. Box AF

City Scappoose State OR Zip 97056

## (2) TYPE OF WORK:

☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

## (3) DRILL METHOD

☑ Rotary Air ☐ Rotary Mud ☐ Cable

☐ Other

## (4) PROPOSED USE:

☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Other

## (5) BORE HOLE CONSTRUCTION:

Special Construction approval Yes ☐ No ☑ Depth of Completed Well 120 ft.

Explosives used Yes ☐ No ☑ Type Amount

| HOLE | | | SEAL | | | Amount |
|---|---|---|---|---|---|---|
| Diameter | From | To | Material | From | To | sacks or pounds |
| 10 | 0 | 19 | Bentonite | 0 | 19 | 13 |
| | | | | | | |
| 6 | 19 | 120 | | | | |
| | | | | | | |

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E

☑ Other poured

Backfill placed from ft. to ft. Material

Gravel placed from ft. to ft. Size of gravel

## (6) CASING/LINER:

| | Diameter | From | To | Gauge | Steel | Plastic | Welded | Threaded |
|---|---|---|---|---|---|---|---|---|
| Casing: | 6 | +3 | 120 | .250 | ☑ | ☐ | ☑ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| Liner: | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |

Final location of shoe(s) 120

## (7) PERFORATIONS/SCREENS:

☐ Perforations Method

☐ Screens Type Material

| From | To | Slot size | Number | Diameter | Tele/pipe size | Casing | Liner |
|---|---|---|---|---|---|---|---|
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |

## (8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

| Yield gal/min | Drawdown | Drill stem at | Time |
|---|---|---|---|
| 60 | | 100 | 1 hr |
| | | | |
| | | | |

Temperature of water 52 Depth Artesian Flow Found

Was a water analysis done? ☐ Yes By whom

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other

Depth of strata:

## (9) LOCATION OF WELL by legal description:

County Columbia Latitude Longitude

Township 3N N or S Range 2W E or W WM

Section 1 SE 1/4 SW 1/4

Tax Lot 601 Lot Block Subdivision

Street Address of Well (or nearest address) 33485 E. Crown Zellerbach Rd, Scappoose

## (10) STATIC WATER LEVEL:

45 ft. below land surface Date 8-27-9

Artesian pressure lb. per square inch Date

## (11) WATER BEARING ZONES:

Depth at which water was first found 97

| From | To | Estimated Flow Rate | SWL |
|---|---|---|---|
| 97 | 120 | 60 | 45 |
| | | | |
| | | | |
| | | | |

## (12) WELL LOG:

Ground elevation

| Material | From | To | SWL |
|---|---|---|---|
| Gravel | 0 | 2 | |
| Brn Silty Sand | 2 | 17 | |
| Brn Sand + Gravel | 17 | 34 | |
| Blue Clay + Gravel | 34 | 42 | |
| Fine Blue Sand + Gravel | 42 | 50 | |
| Grey Clay + Gravel | 50 | 67 | |
| Brn/Grey Silty Sand + | | | |
| Gravel | 67 | 79 | |
| Brn Sand + Gravel | 79 | 97 | |
| Brn/Black Sand + Gravel | 97 | 120 | 45 |
| | | | |
| | | | |
| Elev | | | |
| +/-50' | | | |
| WTR | | | |
| +/-5' | | | |
| | | | |
| NC | | | |

Date started 8-26-91 Completed 8-27-91

**(unbonded) Water Well Constructor Certification:**

I certify that the work I performed on the construction, alteration abandonment of this well is in compliance with Oregon well construct. standards. Materials used and information reported above are true to my b- knowledge and belief.

WWC Number

Signed Date

**(bonded) Water Well Constructor Certification:**

I accept responsibility for the construction, alteration, or abandonme: work performed on this well during the construction dates reported above. a work performed during this time is in compliance with Oregon we construction standards. This report is true to the best of my knowledge ar belief

WWC Number 715

Signed Don Feeken Date 8-30-91

STATE OF OREGON
**WATER WELL REPORT**
(as required by ORS 537.765)

6,11

FEB 25 1993
WATER RESOURCES DEPT.
SALEM, OREGON

32/dc
3N 2w 1db

START CARD) # 49533

**(1) OWNER:** Well Number

Name AL GRABHORN
Address 55585 COLUMBIA RIVER HWY
City SCAPPOOSE State OR Zip 97056

**(2) TYPE OF WORK:**
☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

**(3) DRILL METHOD:**
☒ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

**(4) PROPOSED USE:**
☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

**(5) BORE HOLE CONSTRUCTION:**
Special Construction approval ☐ Yes ☒ No Depth of Completed Well 120 ft.
Explosives used ☐ Yes ☒ No Type Amount

| HOLE Diameter | From | To | SEAL Material | From | To | Amount sacks or pounds |
|---|---|---|---|---|---|---|
| 10 | 0 | 20 | CEMENT | 0 | 20 | 10 SACKS |
| 6 | 20 | 120 | | | | |
| | | | | | | |
| | | | | | | |

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☐ Other
Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

**(6) CASING/LINER:**

| | Diameter | From | To | Gauge | Steel | Plastic | Welded | Threaded |
|---|---|---|---|---|---|---|---|---|
| Casing: | 6 | +1 | 120 | 250 | ☒ | ☐ | ☒ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| Liner: | 0 | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |

Final location of shoe(s) 120

**(7) PERFORATIONS/SCREENS:**
☐ Perforations Method NA
☐ Screens Type Material

| From | To | Slot size | Number | Diameter | Tele/pipe size | Casing | Liner |
|---|---|---|---|---|---|---|---|
| 0 | 0 | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |

**(8) WELL TESTS: Minimum testing time is 1 hour**
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

| Yield gal/min | Drawdown | Drill stem at | Time |
|---|---|---|---|
| 80gpm | | 110 | 1 hr. |
| | | | |
| | | | |
| | | | |

Temperature of Water 52 Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

**(9) LOCATION OF WELL by legal description:**
County COLUMBIA Latitude Longitude
Township 3 N N or S Range 2 W E or W WM
Section 1 NW ¼ SE ¼
Tax Lot Lot Block Subdivision
Street Address of Well (or nearest address) 55585 Columbia River HWY Scappoose, Or 97056

**(10) STATIC WATER LEVEL:**
10 ft below land surface Date 2/10/93
Artesian pressure lb. per square inch Date

**(11) WATER BEARING ZONES:**
Depth at which water was first found 10 FT

| From | To | Estimated Flow Rate | SWL |
|---|---|---|---|
| 10 | 120 | 80GPM | 10 |
| | | | |
| | | | |
| | | | |

**(12) WELL LOG:**
Ground elevation

| Material | From | To | SWL |
|---|---|---|---|
| Clay Gravel | 0 | 13 | 10 |
| Gravel ~~Silt,~~ Sand | 13 | 30 | |
| Gravel, Sand | 30 | 120 | |
| | | | |
| | | | |
| | | | |
| ECa: +/- 40-45' | | | |
| | | | |
| [illegible] +/- [illegible] | | | |
| | | | |
| NC | | | |

Date started Feb. 9, 1993 Completed Feb. 10, 199

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 1480
Signed Date 24 Feb 93

STATE OF OREGON

# WATER WELL REPORT

(as required by ORS 537 765)

(36)

3N 2W/2 dd

222

## (1) OWNER:

Well Number: ____

Name CHARLES E. STALLINGS

Address P.O. BOX 338

SCAPPOOSE State OR Zip 97056

## (2) TYPE OF WORK:

☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

## (3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable

☐ Other ____

## (4) PROPOSED USE:

☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Other ____

## (5) BORE HOLE CONSTRUCTION:

Special Construction approval Yes ☐ No ☒ Depth of Completed Well 263 ft.

Explosives used Yes ☐ No ☐ Type ____ Amount ____

| HOLE | | | SEAL | | | Amount |
|---|---|---|---|---|---|---|
| Diameter | From | To | Material | From | To | sacks or pounds |
| 10 | 0 | 174 | CEMENT | 0 | 174 | 49 |
| 6 | 174 | 263 | | | | |
| | | | | | | |
| | | | | | | |

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E

☐ Other ____

Backfill placed from ____ ft. to ____ ft. Material ____

Gravel placed from ____ ft. to ____ ft. Size of gravel ____

## (6) CASING/LINER:

| | Diameter | From | To | Gauge | Steel | Plastic | Welded | Threaded |
|---|---|---|---|---|---|---|---|---|
| Casing: | 6 | +1 | 174 | 250 | ☒ | ☐ | ☒ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | 4½ | 164 | 263 | 190 | ☐ | ☒ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |

Final location of shoe(s) 174

## (7) PERFORATIONS/SCREENS:

☒ Perforations Method DRILL

☐ Screens Type ____ Material ____

| From | To | Slot size | Number | Diameter | Tele/pipe size | Casing | Liner |
|---|---|---|---|---|---|---|---|
| | | | | | | ☐ | ☐ |
| 165 | 260 | | 76 | 7/16 | | ☐ | ☒ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |

## (8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

| Yield gal/min | Drawdown | Drill stem at | Time |
|---|---|---|---|
| 20 | | 248 | 1 hr. |
| | | | |
| | | | |

Temperature of water 51° Depth Artesian Flow Found ____

Was a water analysis done? ☒ Yes By whom DRILLER

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____

Depth of strata: ____

## (9) LOCATION OF WELL by legal description:

County COLUMBIA Latitude ____ Longitude ____

Township 3N N or S Range 2W E or W WM

Section 2 SE ¼ SE ¼

Tax Lot ____ Lot ____ Block ____ Subdivision ____

Street Address of Well (or nearest address) 32776 BOMMAL LOOP SCAPPOOSE, OR 97056

## (10) STATIC WATER LEVEL:

124 ft. below land surface Date 8-5-83

Artesian pressure ____ lb. per square inch Date ____

## (11) WATER BEARING ZONES:

Depth at which water was first found 246

| From | To | Estimated Flow Rate | SWL |
|---|---|---|---|
| 246 | 248 | 20 | 127 |
| | | | |
| | | | |
| | | | |

## (12) WELL LOG:

Ground elevation 45

| Material | From | To | SWL |
|---|---|---|---|
| CLAY LIGHT BROWN | 0 | 57 | |
| CLAY GRAY | 57 | 67 | |
| CLAY LIGHT BROWN | 67 | 79 | |
| CLAYSTONE LIGHT GRAY | 79 | 86 | |
| CLAYSTONE LIGHT BROWN | 86 | 109 | |
| CLAY GRAY | 109 | 168 | |
| SANDSTONE DARK GRAY | 168 | 202 | |
| SANDSTONE BROWN | 202 | 214 | |
| SANDSTONE GREENISH GRAY | 214 | 246 | |
| SANDSTONE WATER BEARING | 246 | 248 | 124 |
| SANDSTONE GREENISH GRAY | 248 | 258 | 124 |
| SANDSTONE DARK GRAY | 258 | 263 | 124 |
| | | | |
| | | | |
| Elev | | | |
| +/- 200 | | | |
| | | | |
| WTR 7/-76' in Basalt? | | | |
| | | | |
| [illegible] SAND/GRAVEL | | | |
| | | | |
| | | | |
| | | | |

Date started 8-1-88 Completed 8-5-88

**(unbonded) Water Well Constructor Certification:**

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

WWC Number ____

Signed ____ Date ____

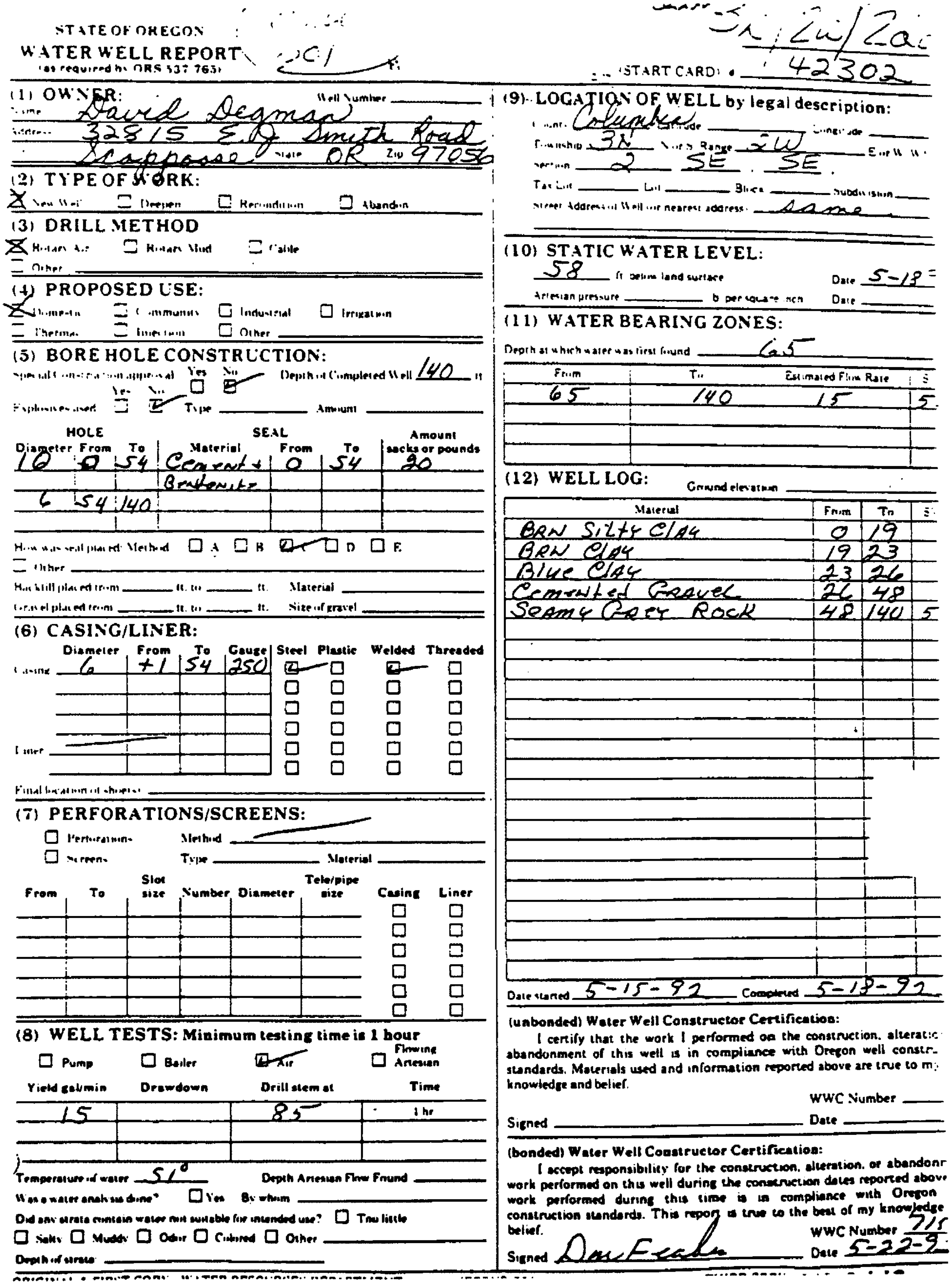
**(bonded) Water Well Constructor Certification:**

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 515

Signed Date 8-10-88

WHITE COPIES - WATER RESOURCES DEPARTMENT YELLOW COPY - CONSTRUCTOR PINK COPY - [illegible]



STATE OF OREGON
**WATER WELL REPORT** 201
(as required by ORS 537.765)

3N/2W/2ac
(START CARD) # 42302

## (1) OWNER:

Well Number
Name David Degman
Address 32815 E.J. Smith Road
Scappoose State OR Zip 97056

## (2) TYPE OF WORK:

☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

## (3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

## (4) PROPOSED USE:

☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

## (5) BORE HOLE CONSTRUCTION:

Special Construction approval Yes ☐ No ☑ Depth of Completed Well 140 ft.
Explosives used Yes ☐ No ☑ Type Amount

| HOLE | | | SEAL | | | Amount |
|---|---|---|---|---|---|---|
| Diameter | From | To | Material | From | To | sacks or pounds |
| 10 | 0 | 54 | Cement + | 0 | 54 | 20 |
| | | | Bentonite | | | |
| 6 | 54 | 140 | | | | |
| | | | | | | |

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

## (6) CASING/LINER:

| | Diameter | From | To | Gauge | Steel | Plastic | Welded | Threaded |
|---|---|---|---|---|---|---|---|---|
| Casing | 6 | +1 | 54 | 250 | ☑ | ☐ | ☑ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| Liner | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |

Final location of shoe(s)

## (7) PERFORATIONS/SCREENS:

☐ Perforations Method
☐ Screens Type Material

| From | To | Slot size | Number | Diameter | Tele/pipe size | Casing | Liner |
|---|---|---|---|---|---|---|---|
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |

## (8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

| Yield gal/min | Drawdown | Drill stem at | Time |
|---|---|---|---|
| 15 | | 85 | 1 hr |
| | | | |
| | | | |

Temperature of water 51° Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

## (9) LOCATION OF WELL by legal description:

County Columbia Latitude Longitude
Township 3N N or S Range 2W E or W. WM.
Section 2 SE ¼ SE ¼
Tax Lot Lot Block Subdivision
Street Address of Well (or nearest address) same

## (10) STATIC WATER LEVEL:

58 ft. below land surface Date 5-18
Artesian pressure lb. per square inch Date

## (11) WATER BEARING ZONES:

Depth at which water was first found 65

| From | To | Estimated Flow Rate | S |
|---|---|---|---|
| 65 | 140 | 15 | 5 |
| | | | |
| | | | |
| | | | |

## (12) WELL LOG:

Ground elevation

| Material | From | To | S |
|---|---|---|---|
| BRN Silty Clay | 0 | 19 | |
| BRN Clay | 19 | 23 | |
| Blue Clay | 23 | 26 | |
| Cemented Gravel | 26 | 48 | |
| Seamy Grey Rock | 48 | 140 | 5 |

Date started 5-15-92 Completed 5-18-92

**(unbonded) Water Well Constructor Certification:**

I certify that the work I performed on the construction, alteratio abandonment of this well is in compliance with Oregon well constr. standards. Materials used and information reported above are true to my knowledge and belief.

WWC Number
Signed Date

**(bonded) Water Well Constructor Certification:**

I accept responsibility for the construction, alteration, or abandonr work performed on this well during the construction dates reported above work performed during this time is in compliance with Oregon construction standards. This report is true to the best of my knowledge belief.

WWC Number 715
Signed Date 5-22-9

Th... ... and ... copies of this report are to be filed with the
...E ENGINEER, SALEM, OREGON 9731...
within 30 days from the date of well completion

RECEIVED FEB ... 1975
STATE ENGINEER
SALEM, OREGON

## ... WELL REPORT
## STATE OF OREGON
(Please type or print)
(Do not write above this line)

STATE ENGINEER
SALEM, OREGON

State Well No. ... 3/2-12 ... 21
State Permit No. 3212ad

WNER:
Gus H. Wagner
...ess 7320 N. E. Sacramento
Portland, Oregon

**TYPE OF WORK (check):**
...w Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
...bandonment, describe material and procedure in Item 12.

**TYPE OF WELL:**
...ary ☐ Driven ☐
...le ☒ Jetted ☐
... ☐ Bored ☐

**(4) PROPOSED USE (check):**
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

**CASING INSTALLED:** Threaded ☐ Welded ☒
8 " Diam. from +1 ft. to 137½ ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

**PERFORATIONS:** Perforated? ☒ Yes ☐ No.
...pe of perforator used Mills Knife
...e of perforations 1/4 in. by 2 in.
60 perforations from 126 ft. to 136 ft.
perforations from ft. to ft.
perforations from ft. to ft.

**) SCREENS:** Well screen installed? ☐ Yes ☒ No
...nufacturer's Name
Model No.
...am. Slot size Set from ft. to ft.
...am. Slot size Set from ft. to ft.

**) WELL TESTS:** Drawdown is amount water level is lowered below static level
...s a pump test made? ☐ Yes ☒ No If yes, by whom?
...eld: gal./min. with ft. drawdown after hrs.
...ailer test 100 gal./min. with 0 ft. drawdown after 2 hrs.
...tesian flow g.p.m.
...mperature of water Depth artesian flow encountered ft.

**) CONSTRUCTION:**
...ell seal—Material used Bentonite
...ell sealed from land surface to 20 ft.
...ameter of well bore to bottom of seal 12 in.
...ameter of well bore below seal 8 in.
...umber of sacks of cement used in well seal 0 sacks
...umber of sacks of bentonite used in well seal 4 sacks
...rand name of bentonite International Gel
...umber of pounds of bentonite per 100 gallons
...f water 50 lbs./100 gals.
...as a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
...ny strata contain unusable water? ☐ Yes ☒ No
...ype of water? depth of strata
...ethod of sealing strata off
...as well gravel packed? ☐ Yes ☒ No Size of gravel:
...ravel placed from ft. to ft.

**(10) LOCATION OF WELL:**
County Columbia Driller's well number
SE ¼ NE ¼ Section 12 T. 3N R. 2 W. W.M.
Bearing and distance from section or subdivision corner

**(11) WATER LEVEL: Completed well.**
Depth at which water was first found 124 ft.
Static level 42 ft. below land surface. Date 5/2/74
Artesian pressure lbs. per square inch. Date

**(12) WELL LOG:** Diameter of well below casing 8"
Depth drilled 138 ft. Depth of completed well 138 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata.*

| +/-45' MATERIAL UTK +/- 3' | From | To | SWL |
|---|---|---|---|
| Topsoil mixed w/coarse gravel | 0 | 1 | |
| Muddy coarse gravel w/some cobble | 1 | 13 | |
| Muddy brown sand & med.coarse gravel | 13 | 28 | |
| Fine gravel | 28 | 30 | |
| Muddy, med.coarse gravel | 30 | 34 | |
| Med.fine to fine gravel | 34 | 52 | |
| Fine to coarse brown sand | 52 | 57 | |
| Med.fine to med.coarse gravel | 57 | 73 | |
| Cemented gravel | 73 | 79 | -28( |
| Coarse sand & fine gravel | 79 | 83 | |
| Cemented gravel | 83 | 86 | -39( |
| Coarse sand & fine gravel | 86 | 89 | |
| Med.fine to coarse gray sand | 89 | 101 | |
| Muddy coarse gray sand | 101 | 111 | |
| Muddy sand & gravel mix | 111 | 115 | |
| Fine to med. coarse gravel | 115 | 117 | |
| Cemented gravel | 117 | 119 | |

Work started 4/4/74 19 Completed 5/2/74 19
Date well drilling machine moved off of well 5/2/74 19

**Drilling Machine Operator's Certification:**
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] (Drilling Machine Operator) Date 5/6/7...
Drilling Machine Operator's License No. 751

**Water Well Contractor's Certification:**
This well was drilled under my jurisdiction and this re... true to the best of my knowledge and belief.
Name A. M. Jannsen Drilling Co. (Person, firm or corporation) (Type or print)
Address 21075 S.W. Tualatin Valley Hwy, Aloha, Or.
[Signed] (Water Well Contractor)
Contractor's License No. 79 Date 5/6/74, 19

(USE ADDITIONAL SHEETS IF NECESSARY)

3/2-12ad

if this report are to be
filed with the
ATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date
of well completion

# WATER WELL REPORT

STATE OF OREGON
(Please type or print)
(Do not write above this line)

State Well No 3/2w-12
State Permit No

## OWNER:

e Gus H. Wagner Page 2

dress

## 2) TYPE OF WORK (check):

ew Well ☐ Deepening ☐ Reconditioning ☐ Abandon ☐

abandonment, describe material and procedure in Item 12.

## 3) TYPE OF WELL:

ary ☐ Driven ☐
able ☐ Jetted ☐
g ☐ Bored ☐

## (4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## CASING INSTALLED:

Threaded ☐ Welded ☐

" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

## PERFORATIONS:

Perforated? ☐ Yes ☐ No.

Type of perforator used

Size of perforations in. by in.

perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## (7) SCREENS:

Well screen installed? ☐ Yes ☐ No

Manufacturer's Name

Model No.

Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

## (8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☐ No If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

Bailer test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m.

emperature of water Depth artesian flow encountered ft.

## (9) CONSTRUCTION:

Well seal—Material used

Well sealed from land surface to ft.

Diameter of well bore to bottom of seal in.

Diameter of well bore below seal in.

Number of sacks of cement used in well seal sacks

Number of sacks of bentonite used in well seal sacks

Brand name of bentonite

Number of pounds of bentonite per 100 gallons of water lbs./100 gals.

Was a drive shoe used? ☐ Yes ☐ No Plugs Size: location ft.

any strata contain unusable water? ☐ Yes ☐ No

pe of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☐ No Size of gravel:

Gravel placed from ft. to ft.

## (10) LOCATION OF WELL:

County Driller's well number

¼ ¼ Section T R W.M.

Bearing and distance from section or subdivision corner

## (11) WATER LEVEL: Completed well.

Depth at which water was first found ft.

Static level ft. below land surface. Date

Artesian pressure lbs. per square inch. Date

## (12) WELL LOG:

Diameter of well below casing

Depth drilled ft. Depth of completed well ft.

Formation: Describe color, texture, grain size and structure of materials and show thickness and nature of each stratum and aquifer penetrated with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata.*

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Fine to med. coarse gravel | 119 | 123 | |
| Muddy gray sand | 123 | 124 | |
| Med fine to coarse gravel | 124 | 138 | 100 |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Work started 19 Completed 19

Date well drilling machine moved off of well 19

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Date 19
(Drilling Machine Operator)

Drilling Machine Operator's License No.

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name
(Person, firm or corporation) (Type or print)

Address

[Signed]
(Water Well Contractor)

Contractor's License No. Date 19

(USE ADDITIONAL SHEETS IF NECESSARY)

3/2-12ad

TE TO WATER WELL CONTRACTOR
The original and first copy
of this report are to be
filed with the
TATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date
of well completion

## WATER WELL REPORT
## STATE OF OREGON
(Please type or print)
(Do not write above this line)

3212cc
State Well No 3N|2W-12
State Permit No

**OWNER:**
me Jean Hebeisen
ress Shoemaker Rd, Scappoose, Oregon

**2) TYPE OF WORK (check):**
ew Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
abandonment, describe material and procedure in Item 12.

**3) TYPE OF WELL:**
Rotary ☒ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

**(4) PROPOSED USE (check):**
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

**CASING INSTALLED:** Threaded ☐ Welded ☒
6 " Diam. from 0 ft. to 94 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

**PERFORATIONS:** Perforated? ☒ Yes ☐ No.
Type of perforator used Burning Torch
Size of perforations 1/4 in. by 6 in.
12 perforations from ~~94~~ 84 ft. to 94 ft.
perforations from ft. to ft.
perforations from ft. to ft.

**(7) SCREENS:** Well screen installed? ☐ Yes ☒ No
nufacturer's Name
e Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

**(8) WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 20 gal./min. with 38 ft. drawdown after 1 hrs.
Artesian flow g.p.m.
perature of water Depth artesian flow encountered ft.

**(9) CONSTRUCTION:**
Well seal—Material used Bentonite
Well sealed from land surface to 20 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal sacks
Number of sacks of bentonite used in well seal 4 sacks
Brand name of bentonite Yellowstone-Western
Number of pounds of bentonite per 100 gallons of water lbs./100 gals.
s a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

**(10) LOCATION OF WELL:**
County Columbia Driller's well number
¼ ¼ Section 12 T 3N R 2 W W.M.
Bearing and distance from section or subdivision corner

**(11) WATER LEVEL: Completed well.**
Depth at which water was first found 89 ft.
Static level 52 ft. below land surface Date 7-3-7
Artesian pressure lbs. per square inch. Date

**(12) WELL LOG:** Diameter of well below casing
Depth drilled 94 ft. Depth of completed well 94 ft.

Formation: Describe color, texture, grain size and structure of materials and show thickness and nature of each stratum and aquifer penetrated with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata*

| MATERIAL | From | To | XXX |
|---|---|---|---|
| Topsoil | 0 | | 2 |
| Clay, red | 2 | | 25 |
| Clay, silty | 25 | | 40 |
| Clay, blue | 40 | | 60 |
| Gravel, cemented | 60 | | 90 |
| Gravel, candy | 90 | | 94 |

Work started 7-2-74 19 Completed 7-3-74 19
Date well drilling machine moved off of well 7-3-74 19

**Drilling Machine Operator's Certification:**
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Eugene (Drilling Machine Operator) Date 7-3-74 19
Drilling Machine Operator's License No. 007

**Water Well Contractor's Certification:**
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name Farrel McGhee Well Drilling (Person, firm or corporation) (Type or print)
Address 1020 Industrial Way, Longview, Wa.
[Signed] Farrel McGhee (Water Well Contractor)
Contractor's License No. 438 Date 7-3-74 19

TO THE WATER WELL CONTRACTOR
The original and first copy
of this report are to be
filed with the
STATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date
of well completion

# WATER WELL REPORT

STATE OF OREGON STATE ENGINEER
(Please type or print) SALEM, OREGON
(Do not write above this line)

SEP 2 1973

State Well No. 3 . . . -12

State Permit No.

## (1) OWNER:

Name SCAPOOSE HIGH SCHOOL

Address SCAPOOSE, OREGON

## (2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

## (3) TYPE OF WELL:

Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

## (4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

## (5) CASING INSTALLED: Threaded ☐ Welded ☒

12" Diam. from +1 ft. to 177 ft. Gage .330

" Diam. from ft. to ft. Gage

" Diam. from ft. to ft. Gage

## (6) PERFORATIONS: Perforated? ☒ Yes ☐ No.

Type of perforator used STAR

Size of perforations 3/8 in. by 1 1/4 in.

720 perforations from 137 ft. to 157 ft.

840 perforations from 157 ft. to 172 ft.

perforations from ft. to ft.

## (7) SCREENS: Well screen installed? ☐ Yes ☒ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

## (8) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☒ Yes ☐ No If yes, by whom? STRASSER

Yield: 450 gal./min. with 107 ft. drawdown after 6 hrs.

390 " 85 " 7 "

" 340 " 73 " 8 "

Bailer test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m.

Temperature of water 51 Depth artesian flow encountered ft.

## (9) CONSTRUCTION:

Well seal—Material used CEMENT GROUT

Well sealed from land surface to 22 ft.

Diameter of well bore to bottom of seal 16 in.

Diameter of well bore below seal 12 in.

Number of sacks of cement used in well seal 17 sacks

Number of sacks of bentonite used in well seal sacks

Brand name of bentonite

Number of pounds of bentonite per 100 gallons of water lbs./100 gals.

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☒ No Size of gravel:

Gravel placed from ft. to ft.

## (10) LOCATION OF WELL:

County COLUMBIA Driller's well number 5454

SW ¼ SE ¼ Section 12 T. 3N R. 2W W.M.

Bearing and distance from section or subdivision corner

## (11) WATER LEVEL: Completed well.

Depth at which water was first found 85 ft.

Static level 25 ft. below land surface Date 9/10/73

Artesian pressure lbs. per square inch Date

## (12) WELL LOG: Diameter of well below casing —

Depth drilled 177 ft. Depth of completed well 177 ft.

Formation: Describe color, texture, grain size and structure of materials and show thickness and nature of each stratum and aquifer penetrated with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata*

| MATERIAL | From | To | SWL |
|---|---|---|---|
| TOP SOIL | 0 | 1 | |
| GRAVEL AND BOULDERS | 1 | 14 | |
| CEMENTED GRAVEL | 14 | 27 | |
| BROWN CLAY AND GRAVEL | 27 | 80 | |
| BROWN SAND | 80 | 85 | |
| SAND AND GRAVEL | 85 | 90 | |
| FINE GREEN SAND | 90 | 96 | |
| BLUE CLAY AND GRAVEL | 96 | 125 | -51 |
| GRAVEL AND BROWN SAND | 125 | 133 | |
| TIGHT SAND AND GRAVEL | 133 | 172 | |
| STICKY BLUE CLAY | 172 | 177 | |

Elev 'L 45

WTR 20'

CMT 31-~~21~~ 19' = 12

BLUE CLAY/GR -~~25~~ 51'

Work started AUG 9 1973 Completed SEPT 12 1973

Date well drilling machine moved off of well SEPT 13 1973

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] ...... (Drilling Machine Operator) Date 9/20, 1973

Drilling Machine Operator's License No. 175

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name R.J. STRASSER DRILLING CO (Person, firm or corporation) (Type or print)

Address 8110 SE SUNSET LANE PORTLAND O.

[Signed] Robert L Strasser (Water Well Contractor)

Contractor's License No. 10 Date SEPT 20 1973

ATE ENGINEER
LEM OREGON

# WATER WELL DRILLERS REPORT
## STATE OF OREGON

3N/2W-12Q1

State Permit No. 3/12dc2

**1) OWNER:**

me Steinfeld Pickle Co.

ress P.O.Box 2589 Portland,3,Oregon.

**2) LOCATION OF WELL:**

nty Columbia Owner's number, if any—

F D or Street No. Scappoose,Oregon.

earing and distance from section or subdivision corner

Well on the south City limits of Scappoose,Oregon.

433'E & 894'N from S¼ corner

Section 12 T3N R2W

**3) TYPE OF WORK (check):**

ew well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

bandonment, describe material and procedure in Item 11.

**4) PROPOSED USE (check):**

...estic ☐ Industrial ☒ Municipal ☐

rrigation ☐ Test Well ☐ Other ☐

**(5) EQUIPMENT:**

Rotary ☐

Cable ☒

Dug Well ☐

**) CASING INSTALLED:**

hreaded ☐ Welded ☒

| ROM | ft. to | ft. Diam. | Gage or Wall |
|---|---|---|---|
| 0 | ~~xxxx~~ 164 | 8 | .280 |

**If gravel packed**

| Diameter of Bore | from ft. | to ft. |
|---|---|---|
| none | | |

Size of gravel:

and size of shoe or well ring

ibe joint Welded-Steel Shoe

**7) PERFORATIONS:**

ype of perforator used Mills Knife

ZE of perforations 1½ in., length, by ¼ in.

| M | ft. to | ft. | perf per foot | No. of rows |
|---|---|---|---|---|
| 113 | 155 | | 4 | 1 foot Apart |

**SCREENS:**

Give Manufacturer's Name, Model No. and Size

none

**8) CONSTRUCTION:**

as a surface sanitary seal provided? ☐ Yes ☒ No To what depth ft.

ere any strata sealed against pollution? ☒ Yes ☐ No

yes, note depth of strata

ROM 0 ft. to Abt.30 ft.

with cuttings

ETHOD OF SEALING filled around pipe

**9) WATER LEVELS:**

[illegible] ft.

[illegible] Static 39 ft.

[illegible] ft.

ccepted by:

Signed] ........ Dated ........, 19......

Owner

**(10) WELL TESTS:** Steinman Bros. Pacific Pumping Co's Pum

Was a pump test made? ☒ Yes ☐ No If yes, by whom?

Yield 300 gal./min. with to 54 ft. draw down after hrs.

" 400 to 70 from top

" 435 77 " "

Artesian flow g.p.m.

Shut-in pressure lbs. per square inch.

Bailer test g.p.m. with ft. drawdown

Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

Was electric log made of well? ☐ Yes ☒ No

**(11) WELL LOG:**

Diameter of well 8 inches

Total depth 16X4 ft. Depth of completed well 164 ft.

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

| ft. | to ft. | |
|---|---|---|
| 0 | 5 | Gravel fill material |
| 5 | 11 | large gravel & boulders |
| 11 | 16 | cement gravel |
| 16 | 29 | loose gravel |
| 29 | 35 | cement gravel |
| 35 | 40 | loose grey gravel |
| 40 | 45 | loose sand & gravel,brown |
| 45 | 57 | brown cemented gravel |
| 57 | 59 | cemented gravel |
| 59 | 70 | fine brown sand & gravel |
| 70 | 80 | cemented gravel |
| 80 | 83 | loose gravel. 25 G.P.M. |
| 83 | 91 | green sand,silt & grav |
| 91 | 98 | 3" cemented with sand, |
| 98 | 101 | loose gravel & sand |
| 101 | 132 | cemented gravel,50 G.P. |
| 132 | 136 | loose gravel |
| 136 | 148 | cemented gravel,3" minus |
| 148 | 151 | looser gravel |
| 151 | 159 | cemented gravel |
| 159 | 164 | sand & gravel. |
| | | [illegible] |
| | | [illegible] |
| | | [illegible] +/- 7 (14') |
| | | [illegible] |

Ground elevation at well site ........ feet above mean sea level.

Work started June 19 1956 Completed July 20 1956

**Well Driller's Statement:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Steinman Bros.
(Person, firm, or corporation) (Typed or printed)

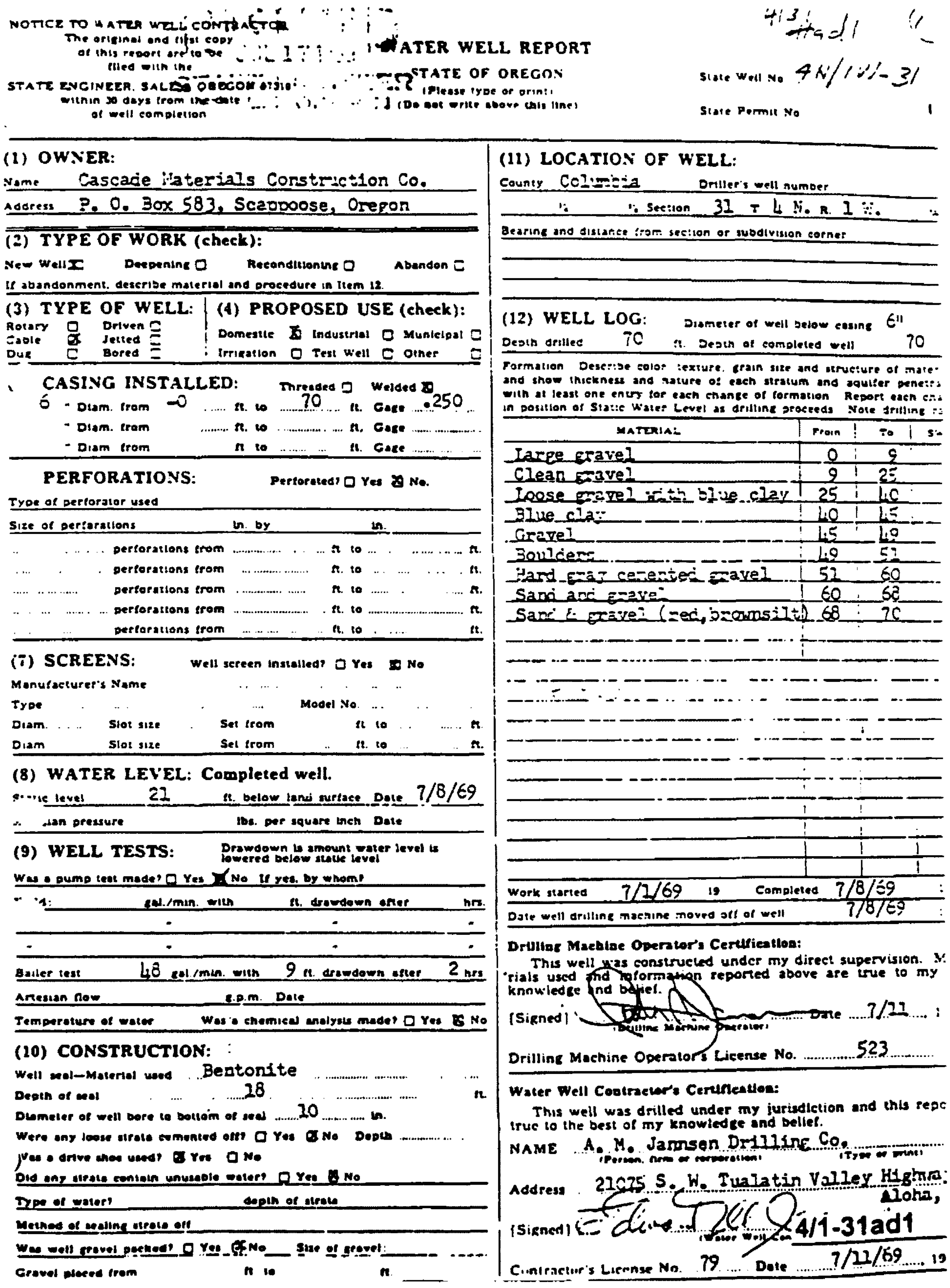
Address 8332,S.E.16th.Ave.Portland 2.

Driller's well number 1556

[Signed] Ed Steinman
(Well Driller)

License No. 1 Dated Sept. 12, 1956

3/2-12dc2



NOTICE TO WATER WELL CONTRACTOR
The original and first copy
of this report are to be
filed with the
STATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date
of well completion

## WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

4/3 #ad11

State Well No 4N/1W-31
State Permit No

### (1) OWNER:
Name Cascade Materials Construction Co.
Address P. O. Box 583, Scappoose, Oregon

### (2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

### (3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

### (4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

### CASING INSTALLED:
Threaded ☐ Welded ☒
6 " Diam. from -0 ft. to 70 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

### PERFORATIONS:
Perforated? ☐ Yes ☒ No.
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

### (7) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

### (8) WATER LEVEL: Completed well.
Static level 21 ft. below land surface Date 7/8/69
Artesian pressure lbs. per square inch Date

### (9) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 48 gal./min. with 9 ft. drawdown after 2 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

### (10) CONSTRUCTION:
Well seal—Material used Bentonite
Depth of seal 18 ft.
Diameter of well bore to bottom of seal 10 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

### (11) LOCATION OF WELL:
County Columbia Driller's well number
¼ ¼ Section 31 T 4 N. R. 1 W.
Bearing and distance from section or subdivision corner

### (12) WELL LOG:
Diameter of well below casing 6"
Depth drilled 70 ft. Depth of completed well 70

Formation: Describe color, texture, grain size and structure of mate and show thickness and nature of each stratum and aquifer penetra with at least one entry for each change of formation. Report each cha in position of Static Water Level as drilling proceeds. Note drilling ra

| MATERIAL | From | To | S |
|---|---|---|---|
| Large gravel | 0 | 9 | |
| Clean gravel | 9 | 25 | |
| Loose gravel with blue clay | 25 | 40 | |
| Blue clay | 40 | 45 | |
| Gravel | 45 | 49 | |
| Boulders | 49 | 51 | |
| Hard gray cemented gravel | 51 | 60 | |
| Sand and gravel | 60 | 68 | |
| Sand & gravel (red, brownsilt) | 68 | 70 | |

Work started 7/1/69 19 Completed 7/8/69
Date well drilling machine moved off of well 7/8/69

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my knowledge and belief.

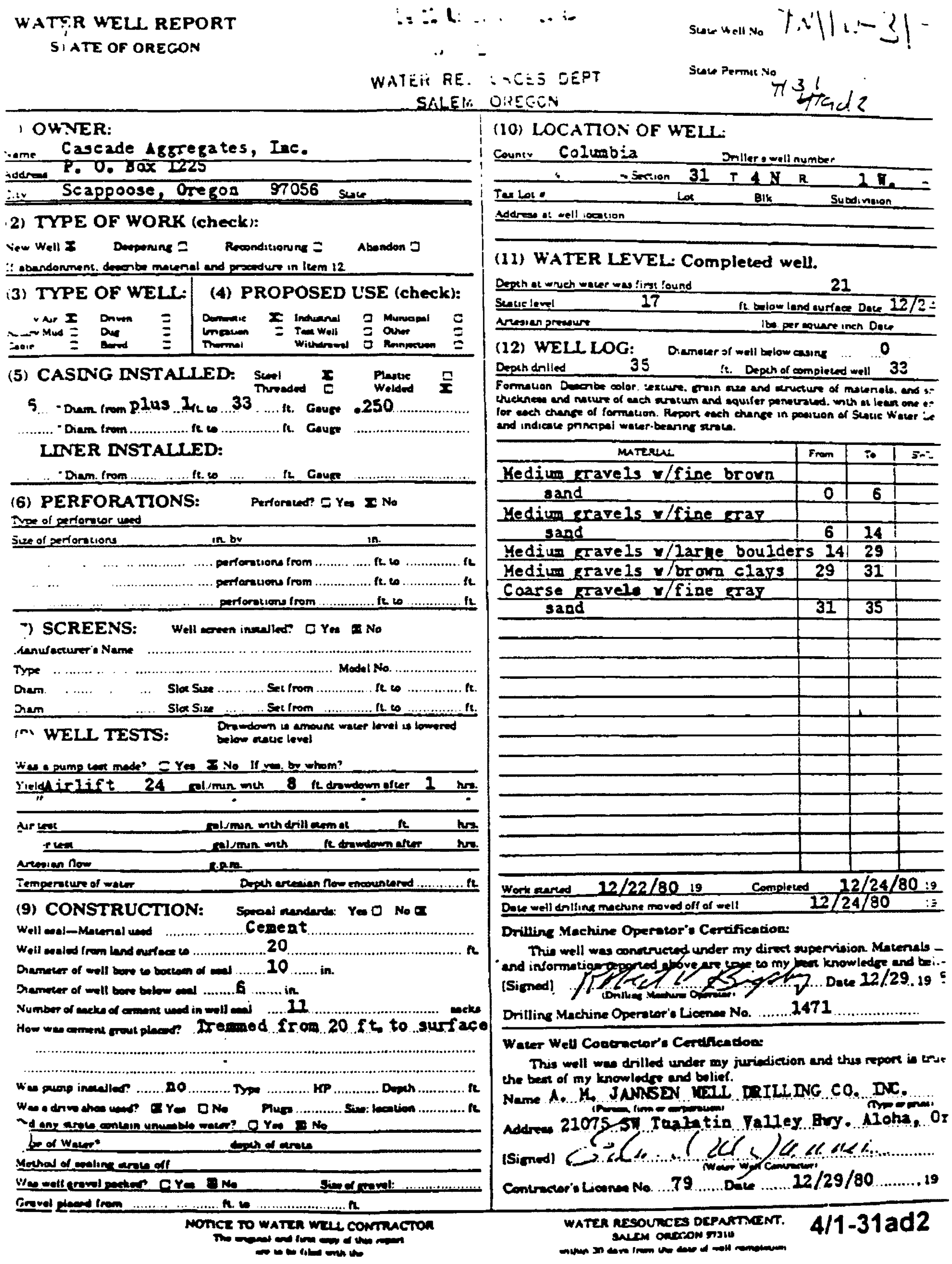
[Signed] (Drilling Machine Operator) Date 7/11

Drilling Machine Operator's License No. 523

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this repo true to the best of my knowledge and belief.

NAME A. M. Jannsen Drilling Co.
(Person, firm or corporation) (Type or print)
Address 21075 S. W. Tualatin Valley Highwa
Aloha,
[Signed] (Water Well Con
4/1-31ad1
Contractor's License No. 79 Date 7/11/69 19



**WATER WELL REPORT**
**STATE OF OREGON**

WATER RE[illegible]CES DEPT
SALEM OREGON

State Well No T4N/1W-31-

State Permit No 4/1-31ad2

**(1) OWNER:**

Name Cascade Aggregates, Inc.
Address P. O. Box 1225
City Scappoose, Oregon 97056 State

**(2) TYPE OF WORK (check):**

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

**(3) TYPE OF WELL:**

Rotary Air ☒ Driven ☐
Rotary Mud ☐ Dug ☐
Cable ☐ Bored ☐

**(4) PROPOSED USE (check):**

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐
Thermal Withdrawal ☐ Reinjection ☐

**(5) CASING INSTALLED:** Steel ☒ Plastic ☐ Threaded ☐ Welded ☒

6 " Diam. from plus 1 ft. to 33 ft. Gauge .250
" Diam. from ft. to ft. Gauge

**LINER INSTALLED:**

" Diam. from ft. to ft. Gauge

**(6) PERFORATIONS:** Perforated? ☐ Yes ☒ No

Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

**(7) SCREENS:** Well screen installed? ☐ Yes ☒ No

Manufacturer's Name
Type Model No.
Diam. Slot Size Set from ft. to ft.
Diam. Slot Size Set from ft. to ft.

**(8) WELL TESTS:** Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield Airlift 24 gal./min. with 8 ft. drawdown after 1 hrs.
Air test gal./min. with drill stem at ft. hrs.
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

**(9) CONSTRUCTION:** Special standards: Yes ☐ No ☒

Well seal—Material used Cement
Well sealed from land surface to 20 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 11 sacks
How was cement grout placed? Tremmed from 20 ft. to surface

Was pump installed? no Type HP Depth ft.
Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of Water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

**(10) LOCATION OF WELL:**

County Columbia Driller's well number
¼ ¼ Section 31 T 4 N R 1 W.
Tax Lot # Lot Blk Subdivision
Address at well location

**(11) WATER LEVEL: Completed well.**

Depth at which water was first found 21
Static level 17 ft. below land surface Date 12/24
Artesian pressure lbs. per square inch Date

**(12) WELL LOG:** Diameter of well below casing 0

Depth drilled 35 ft. Depth of completed well 33

Formation: Describe color, texture, grain size and structure of materials, and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Medium gravels w/fine brown sand | 0 | 6 | |
| Medium gravels w/fine gray sand | 6 | 14 | |
| Medium gravels w/large boulders | 14 | 29 | |
| Medium gravels w/brown clays | 29 | 31 | |
| Coarse gravels w/fine gray sand | 31 | 35 | |

Work started 12/22/80 19 Completed 12/24/80 19
Date well drilling machine moved off of well 12/24/80 19

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Robert V. Bigsby (Drilling Machine Operator) Date 12/29, 19

Drilling Machine Operator's License No. 1471

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name A. M. JANNSEN WELL DRILLING CO. INC. (Person, firm or corporation) (Type or print)
Address 21075 SW Tualatin Valley Hwy. Aloha, Or

[Signed] (Water Well Contractor)

Contractor's License No. 79 Date 12/29/80 19

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
WATER RESOURCES DEPARTMENT, SALEM, OREGON 97310
within 30 days from the date of well completion.

4/1-31ad2

The original and first copy of this report
are to be filed with the
WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310
within 30 days from the date
of well completion.

# WATER WELL REPORT

## STATE OF OREGON

(Please type or print)

(Do not write above this line)

State Well No

State Permit No 4n

## (1) OWNER:

Name Tony Irving
Address Route 3, Box 258 X B
Scappoose, Oregon 97056

## (2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in item 12.

## (3) TYPE OF WELL:

Rotary ☒ Driven ☐
☐ Jetted ☐
☐ Bored ☐

## (4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## (5) CASING INSTALLED:

Threaded ☐ Welded ☒

6" Diam. from plus 1 ft. to 117 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

## (6) PERFORATIONS:

Perforated? ☐ Yes ☒ No.

Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## (7) SCREENS:

Well screen installed? ☐ Yes ☒ No

Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

## (8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?

Yield: 100 gal./min. with 97 ft. drawdown after 1 hrs.
" 50 " 48' " "
" " " "

Bailer test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m.

Temperature of water Depth artesian flow encountered ft.

## (9) CONSTRUCTION:

Well seal—Material used Cement grout & 5% gel
Well sealed from land surface to 20' ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 6 sacks
How was cement grout placed? Tremmed into dry annular bore - 20' to land surface

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

## (10) LOCATION OF WELL:

County Columbia Driller's well number
¼ ¼ Section 31 T. 3 N R. 1 W.
Bearing and distance from section or subdivision corner

## (11) WATER LEVEL: Completed well.

Depth at which water was first found 25'
Static level 3 ft. below land surface. Date 6/4/80
Artesian pressure lbs. per square inch. Date

## (12) WELL LOG:

Diameter of well below casing 6"
Depth drilled 120 ft. Depth of completed well 118

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Brown silty clay w/sand layers | 0 | 15 | |
| Gray silty sandy clays | 15 | 23 | |
| Coarse gravels w/cemented layers | 23 | 29 | w |
| Brown sandy clays w/gravel layers | 29 | 53 | |
| Coarse gravels w/brown sand and cemented layers | 53 | 86 | w |
| Brown sand w/coarse gravels | 86 | 97 | w |
| Coarse gravels w/muddy gravel layers | 97 | 112 | w |
| Coarse gravels w/little sand-(brown) | 112 | 120 | w |
| | | | 100 |

RECEIVED
WATER RESOURCES DEPT
SALEM, OREGON

Work started 6/2/80 19 Completed 6/4/80 19
Date well drilling machine moved off of well 6/4/80 19

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

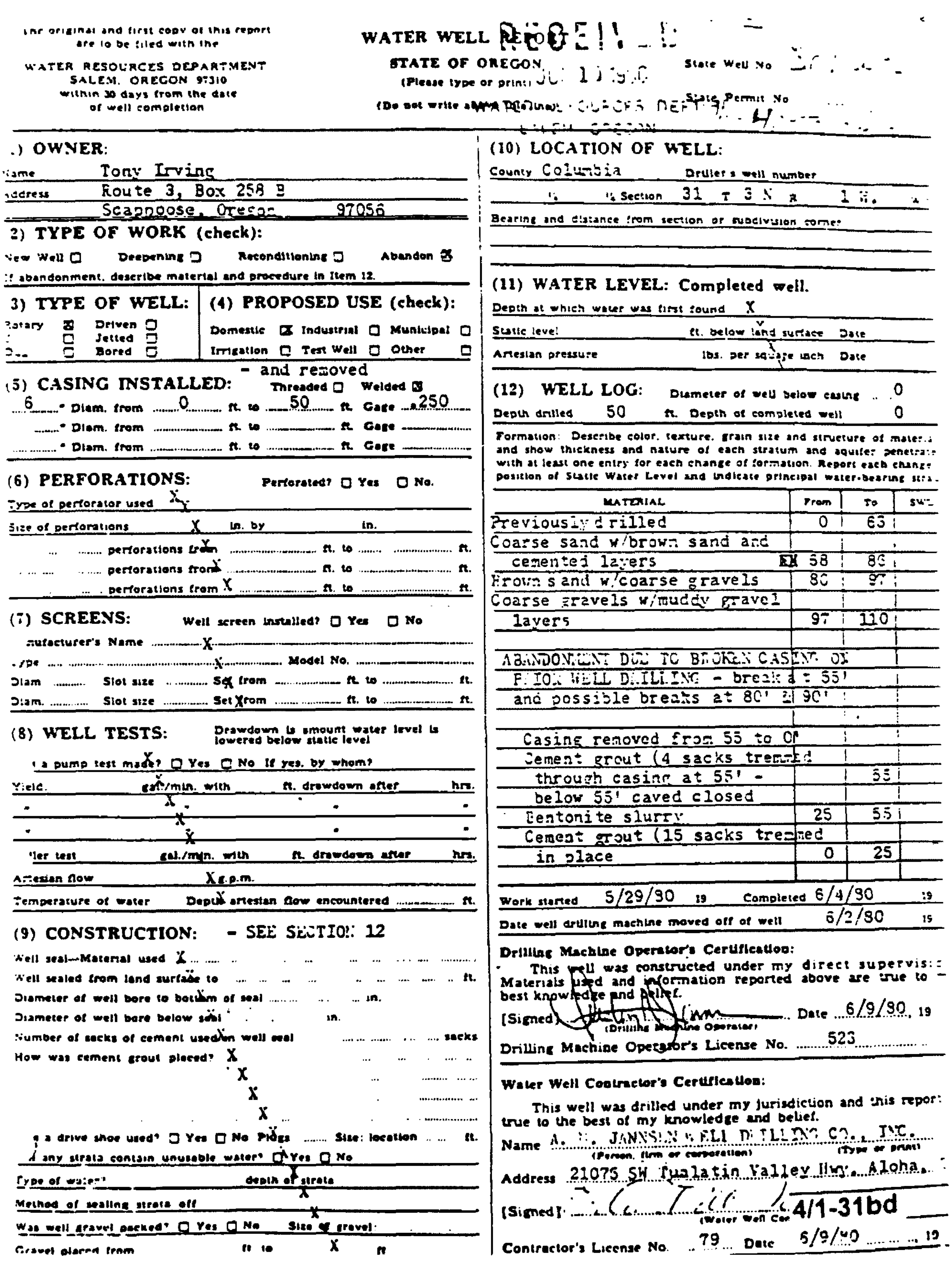
[Signed] Date 6/9/80 19
(Drilling Machine Operator)

Drilling Machine Operator's License No. 523

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name A. M. JANNSEN WELL DRILLING CO., INC.
(Person, firm or corporation) (Type or print)
Address 21075 SW Tualatin Valley Hwy. Aloha, O
[Signed] 4/1-31bd
(Water Well Contractor)
Contractor's License No. 79 Date 6/9/80 19



The original and first copy of this report are to be filed with the
WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310
within 30 days from the date of well completion

## WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

RECEIVED
JUL 1 1980
WATER RESOURCES DEPT
SALEM, OREGON

State Well No
State Permit No

### (1) OWNER:
Name Tony Irving
Address Route 3, Box 258 B
Scappoose, Oregon 97056

### (2) TYPE OF WORK (check):
New Well ☐ Deepening ☐ Reconditioning ☐ Abandon ☒
If abandonment, describe material and procedure in Item 12.

### (3) TYPE OF WELL:
Rotary ☒ Driven ☐
☐ Jetted ☐
☐ Bored ☐

### (4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

### (5) CASING INSTALLED:
- and removed
Threaded ☐ Welded ☒
6 " Diam. from 0 ft. to 50 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

### (6) PERFORATIONS:
Perforated? ☐ Yes ☐ No.
Type of perforator used X
Size of perforations X in. by in.
perforations from X ft. to ft.
perforations from X ft. to ft.
perforations from X ft. to ft.

### (7) SCREENS:
Well screen installed? ☐ Yes ☐ No
Manufacturer's Name X
Type X Model No.
Diam Slot size Set from X ft. to ft.
Diam. Slot size Set X from ft. to ft.

### (8) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? X ☐ Yes ☐ No If yes, by whom?
Yield: X gal./min. with ft. drawdown after hrs.
X
X
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow X g.p.m.
Temperature of water Depth X artesian flow encountered ft.

### (9) CONSTRUCTION: - SEE SECTION 12
Well seal—Material used X
Well sealed from land surface to ft.
Diameter of well bore to bottom X of seal in.
Diameter of well bore below seal in.
Number of sacks of cement used X in well seal sacks
How was cement grout placed? X
X
X
X
Was a drive shoe used? ☐ Yes ☐ No Plugs X Size: location ft.
Did any strata contain unusable water? ☐ X Yes ☐ No
Type of water? depth of strata X
Method of sealing strata off X
Was well gravel packed? ☐ Yes ☐ No Size of gravel: X
Gravel placed from ft. to X ft.

### (10) LOCATION OF WELL:
County Columbia Driller's well number
¼ ¼ Section 31 T 3 N R 1 W. W.M.
Bearing and distance from section or subdivision corner

### (11) WATER LEVEL: Completed well.
Depth at which water was first found X
Static level X ft. below land surface Date
Artesian pressure X lbs. per square inch Date

### (12) WELL LOG:
Diameter of well below casing 0
Depth drilled 50 ft. Depth of completed well 0

Formation: Describe color, texture, grain size and structure of materials and show thickness and nature of each stratum and aquifer penetrated with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Previously drilled | 0 | 63 | |
| Coarse sand w/brown sand and | | | |
| cemented layers | 58 | 80 | |
| Brown sand w/coarse gravels | 80 | 97 | |
| Coarse gravels w/muddy gravel | | | |
| layers | 97 | 110 | |
| | | | |
| ABANDONMENT DUE TO BROKEN CASING ON | | | |
| PRIOR WELL DRILLING - break at 55' | | | |
| and possible breaks at 80' & 90' | | | |
| | | | |
| Casing removed from 55 to 0' | | | |
| Cement grout (4 sacks tremmed | | | |
| through casing at 55' - | | 55 | |
| below 55' caved closed | | | |
| Bentonite slurry | 25 | 55 | |
| Cement grout (15 sacks tremmed | | | |
| in place | 0 | 25 | |
| | | | |

Work started 5/29/80 19 Completed 6/4/80 19
Date well drilling machine moved off of well 6/2/80 19

**Drilling Machine Operator's Certification:**
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] (Drilling Machine Operator) Date 6/9/80, 19
Drilling Machine Operator's License No. 523

**Water Well Contractor's Certification:**
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name A. H. JANNSEN WELL DRILLING CO., INC. (Person, firm or corporation) (Type or print)
Address 21075 SW Tualatin Valley Hwy., Aloha,
[Signed] (Water Well Contractor) 4/1-31bd
Contractor's License No. 79 Date 6/9/80 19

**STATE ENGINEER**
**Salem, Oregon**

# Well Record

(/-
STATE WELL NO. 4N/1W-31
COUNTY Columbia
APPLICATION NO. GR-511

4/31cb

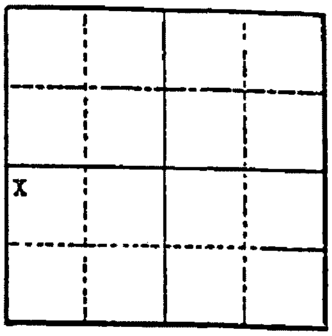
OWNER: Walter & Marjorie Erickson MAILING ADDRESS:

LOCATION OF WELL: Owner's No. 2 CITY AND STATE: Warren, Oregon

NW ¼ SW ¼ Sec. 31 T. 4 N. ~~S~~, R. 1 ~~E~~ W., W.M.

Bearing and distance from section or subdivision corner Tax lot 25

Altitude at well



Section 31

TYPE OF WELL: drilled Date Constructed 8/10/51

Depth drilled 127 ft. Depth cased 127 ft.

CASING RECORD: 10 inch

FINISH:

AQUIFERS:

WATER LEVEL: 40 ft.

PUMPING EQUIPMENT: Type Pacific H.P. 5
Capacity 48 G.P.M.

WELL TESTS:
Drawdown 20 ft. after hours 50 G.
Drawdown ft. after hours G.

USE OF WATER Irrigation - 8 ac. Temp. °F. 19

SOURCE OF INFORMATION GR-511

DRILLER or DIGGER McKnight

ADDITIONAL DATA:
Log Water Level Measurements Chemical Analysis Aquifer Test

REMARKS:

4/1-31cb

State Printing

OBSERVATION WELL

4131

31F

NOTICE TO WATER WELL CONTRACTOR
The original and first copy
of this report are to be
filed with the
ATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date
of well completion

# WATER WELL REPORT
## STATE OF OREGON
(Please type or print)

State Well No. 4N/1W-

State Permit No.

### 1) OWNER:

ame Mr. John Havlic
ddress Scappoose Ore

### (2) LOCATION OF WELL:

County Columbia Driller's well number
SE ¼ SW ¼ Section 45 T. 1W R. 4N W.M.
Bearing and distance from section or subdivision corner
Sec 31

### (3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
andonment, describe material and procedure in Item 12.

### (4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

### (5) TYPE OF WELL:

Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

### (6) CASING INSTALLED:

Threaded ☐ Welded ☒
8" Diam. from 0 ft. to 85 ft. Gage 250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

### (7) PERFORATIONS:

Perforated? ☐ Yes ☒ No
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

### (8) SCREENS:

Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

### (9) CONSTRUCTION:

Well seal—Material used in seal Betonite
Depth of seal 18 ft. Was a packer used? No
Diameter of well bore to bottom of seal 12 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off

### (10) WATER LEVELS:

Static level 48 ft. below land surface Date 2/15/62

### (11) WELL TESTS:

Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? Havlic
Yield: 240 gal./min. with 20 ft. drawdown after 5 hrs.
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

### (12) WELL LOG:

Diameter of well below casing 5
Depth drilled 92 ft. Depth of completed well 85 ft.

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

| MATERIAL | | | FROM | TO |
|---|---|---|---|---|
| Soil | Brown | Med | 0 | 3 |
| Gravel | Grey | Large | 3 | 50 |
| Clay | Blue | Med | 50 | 60 |
| Gravel & | Grey | Med | 60 | 92 |

Work started 1/10 1966 Completed 2/14 19
Date well drilling machine moved off of well 2/16 19

### (13) PUMP:

Manufacturer's Name Bingham
Type: Turbin H.P. 15

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME F.E. McKnight
(Person, firm or corporation) (Type or print)
Address 840 West St. St Helens O
Drilling Machine Operator's License No. 323
[Signed] F E McK
(Water Well Contractor)

4/1-31cd

STATE OF OREGON
**WATER WELL REPORT**
(as required by ORS 537.765)

RECEIVED
MAY 2 1985
WATER RESOURCES DEPT
SALEM, OREGON

Please TYPE or PRINT IN INK

4.31da
(for official use only)

## (1) OWNER:

Name Harold T Good Rich
Address 54455 Freeman Rd
City Scappoose State Ore

## (2) TYPE OF WORK (check):

New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

## (3) TYPE OF WELL:

Rotary Air ☑ Driven ☐
Rotary Mud ☐ Dug ☐
Cable ☐ Bored ☐

## (4) PROPOSED USE (check):

Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Thermal Withdrawal ☐ Reinjection ☐
Other Piezometric ☐ Grounding ☐ Test ☐

## (5) CASING INSTALLED:

Steel ☑ Plastic ☐
Threaded ☐ Welded ☑

6 " Diam. from +1 ft. to 60 ft. Gauge .250
" Diam. from ft. to ft. Gauge

**LINER INSTALLED:**

Steel ☐ Plastic ☐
Threaded ☐ Welded ☐

" Diam. from ft. to ft. Gauge

## (6) PERFORATIONS:

Perforated? ☐ Yes ☑ No
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## (7) SCREENS:

Well screen installed? ☐ Yes ☑ No
Manufacturer's Name
Type Model No.
Diam. Slot Size Set from ft. to ft.
Diam. Slot Size Set from ft. to ft.

## (8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☑ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Air test 20 gal./min. with drill stem at 45 ft. 1 hrs.
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

## (9) CONSTRUCTION:

Special standards Yes ☐ No ☑
Well seal - Material used Cement + 5% Bentonite
Well sealed from land surface to 15 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Amount of sealing material 14 sacks ☑ pounds ☐
How was cement grout placed? pumped

Was pump installed? Type HP Depth ft.
Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☑ No Size of gravel
Gravel placed from ft. to ft.

## (10) LOCATION OF WELL by legal description:

County Columbia ¼ ¼ of Section 31
Township 4N (Township is North or South) Range 1W (Range is East or West)
Tax Lot Lot Block Subdivision
MAILING ADDRESS OF WELL (or nearest address) Same As #1

## (11) WATER LEVEL of COMPLETED WELL:

Depth at which water was first found 46
Static level 40 ft. below land surface Date 5-2
Artesian pressure lbs. per square inch Date

## (12) WELL LOG:

Diameter of well below casing 6
Depth drilled 60 ft. Depth of completed well 60

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Brn Sand- Silt + Boulders | 0 | 19 | |
| Blue/Grey Sand + Boulders | 19 | 60 | |

Date work started 5-18 /completed 5-20
Date well drilling machine moved off of well 5-20 19

**(unbonded) Water Well Constructor Certification (if applicable)**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Date , 19

**(bonded) Water Well Constructor Certification:**

Bond 140878 (number) Issued by: Ore Auto Ins Co (Surety Company Name)
On behalf of Dan Fenkin (type or print name of Water Well Constructor)

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief:

(Signed) Don Fenkin (Water Well Constructor)
(Dated) 5-22-85

NOTICE TO WATER WELL CONSTRUCTOR
The original and first copy of this report are to be filed with the

WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310
within 30 days from the date of well completion.

4/1-31da1

## WATER WELL REPORT
STATE OF OREGON

RECEIVED
NOV 8 1982
WATER RESOURCES DEPT.
SALEM, OREGON

State Well No 4N/1W-31

State Permit No

**OWNER:**

Name Allan WendLandt
Address Rt 3 Box 217
City Scappoose State Ore

**(2) TYPE OF WORK (check):**

New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12

**(3) TYPE OF WELL:**

Rotary Air ☑ Driven ☐
Rotary Mud ☐ Dug ☐
Cable ☐ Bored ☐

**(4) PROPOSED USE (check):**

Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐
Thermal ☐ Withdrawal ☐ Reinjection ☐

**(5) CASING INSTALLED:** Steel ☑ Plastic ☐ Threaded ☐ Welded ☑

6 " Diam. from +2 ft. to 53 ft. Gauge .250
" Diam. from ft. to ft. Gauge

**LINER INSTALLED:**

" Diam. from ft. to ft. Gauge

**(6) PERFORATIONS:** Perforated? ☐ Yes ☑ No

Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

**SCREENS:** Well screen installed? ☐ Yes ☑ No

Manufacturer's Name
Type Model No.
Diam. Slot Size Set from ft. to ft.
Diam. Slot Size Set from ft. to ft.

**(8) WELL TESTS:** Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☑ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Air test 50 gal./min. with drill stem at 45 ft. 1 hrs.
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

**(9) CONSTRUCTION:** Special standards: Yes ☐ No ☑

Well seal—Material used Cement + 5% Bentonite
Well sealed from land surface to 18 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 7 sacks
How was cement grout placed? pumped

Was pump installed? Type HP Depth ft.
Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☑ No
Type of Water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☑ No Size of gravel:
Gravel placed from ft. to ft.

**(10) LOCATION OF WELL:**

County Columbia Driller's well number
Section 31 T 4N R 1W
Tax Lot # 0AC-0C1200 Blk Subdivision
Address at well location Same as # 1

**(11) WATER LEVEL: Completed well.**

Depth at which water was first found 36
Static level 35 ft. below land surface Date 10-26
Artesian pressure lbs. per square inch Date

**(12) WELL LOG:** Diameter of well below casing 6

Depth drilled 53 ft. Depth of completed well 53

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Brown Sand Gravel + Boulders | 0 | 53 | |

Work started 10-25 1982 Completed 10-26 1982
Date well drilling machine moved off of well 10-26 1982

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Don Feakin (Drilling Machine Operator) Date 10-27 1982

Drilling Machine Operator's License No.

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name Turner Drilling Co (Person, firm or corporation) (Type or print)
Address Rt 1 Box 522 Portland 97231
[Signed] Don Feakin (Water Well Contractor)
Contractor's License No. Date 10-27 1982

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report

WATER RESOURCES DEPARTMENT, SALEM, OREGON 97310

4/1-31dd1

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report
are to be filed with the

WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310
within 30 days from the date
of well completion

# WATER WELL REPORT

## STATE OF OREGON

(Please type or print)

(Do not write above this line)

State Well No

State Permit No

## (1) OWNER:

Name Mike Wehage

Address Freeman Rd. Scappoose, Oregon

## (2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

## (3) TYPE OF WELL:

Rotary ☐ Driven ☐
☒ Jetted ☐
☐ Bored ☐

## (4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## (5) CASING INSTALLED:

Threaded ☐ Welded ☒

6" Diam. from 0 ft. to 60 ft. Gage .250

" Diam. from ft. to ft. Gage

" Diam. from ft. to ft. Gage

## (6) PERFORATIONS:

Perforated? ☐ Yes ☒ No.

Type of perforator used

Size of perforations in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

## ) SCREENS:

Well screen installed? ☐ Yes ☒ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

## (8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

Bailer test 30 gal./min. with 5 ft. drawdown after 1 hrs.

Artesian flow g.p.m.

Temperature of water 50 Depth artesian flow encountered ft.

## (9) CONSTRUCTION:

Well seal—Material used cement

Well sealed from land surface to 20 ft.

Diameter of well bore to bottom of seal 10 in.

Diameter of well bore below seal 6 in.

Number of sacks of cement used in well seal 6½ sacks

How was cement grout placed? pumped

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☒ No Size of gravel

## (10) LOCATION OF WELL:

County Columbia Driller's well number

¼ ¼ Section 31 T. 4N R. 1 W

Bearing and distance from section or subdivision corner

## (11) WATER LEVEL: Completed well.

Depth at which water was first found 60

Static level 22 ft. below land surface. Date 10/2

Artesian pressure lbs. per square inch. Date

## (12) WELL LOG:

Diameter of well below casing 6

Depth drilled 60 ft. Depth of completed well 60

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| soil brown sandy | 0 | 1 | |
| clay brown sandy small | | | |
| boulders | 1 | 19 | |
| graval med. sandy | 19 | 33 | |
| sand fine | 33 | 49 | |
| graval med. | 49 | 60 | 22 |

Work started 10/2 1979 Completed 10/8 19

Date well drilling machine moved off of well 10/8 19

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Bryant C. Luttrell Date 10/8, 19
(Drilling Machine Operator)

Drilling Machine Operator's License No. 1074

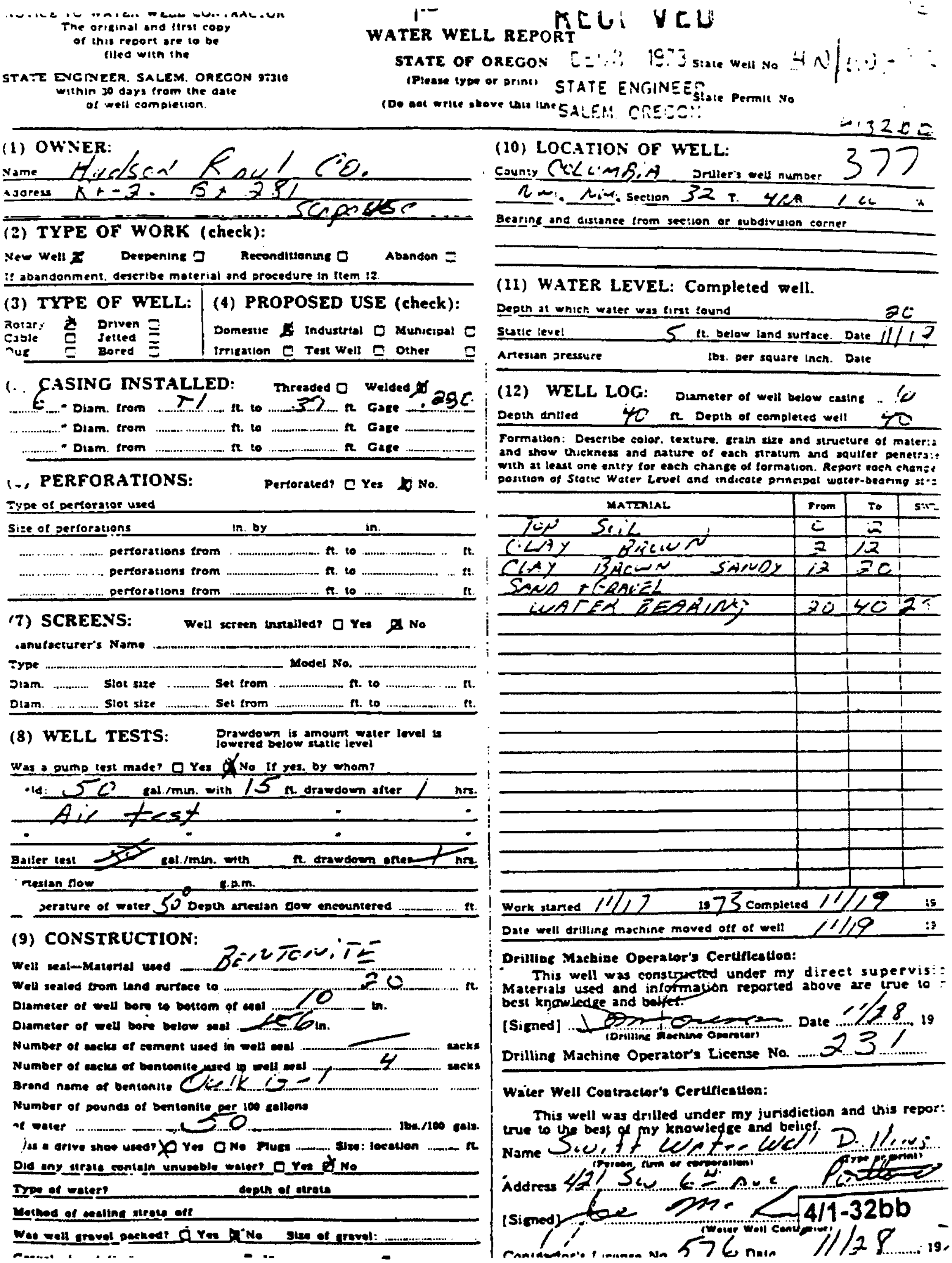
**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name Guy A. Luttrell Well Drilling
(Person, firm or corporation) (Type or print)

Address Rt. 1 Box 1630 St. Helens, Oregon

[Signed] G. A. L (Water Well Contractor) 4/1-31dd2



NOTICE TO WATER WELL CONTRACTOR
The original and first copy
of this report are to be
filed with the
STATE ENGINEER, SALEM, OREGON 97310
within 30 days from the date
of well completion.

## WATER WELL REPORT

STATE OF OREGON
(Please type or print)
(Do not write above this line)

RECEIVED
DEC 3 1973
STATE ENGINEER
SALEM, OREGON

State Well No 4N/
State Permit No
13200

**(1) OWNER:**

Name Hudson Raul Co.
Address Rt-2. Bx 281
Scappoose

**(2) TYPE OF WORK (check):**

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

**(3) TYPE OF WELL:**

Rotary ☒ Driven ☐
Cable ☐ Jetted ☐
Dug ☐ Bored ☐

**(4) PROPOSED USE (check):**

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

**(5) CASING INSTALLED:** Threaded ☐ Welded ☒

6" Diam. from +1 ft. to 32 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

**(6) PERFORATIONS:** Perforated? ☐ Yes ☒ No.

Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

**(7) SCREENS:** Well screen installed? ☐ Yes ☒ No

Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

**(8) WELL TESTS:** Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: 50 gal./min. with 15 ft. drawdown after 1 hrs.
Air test
Bailer test ~~50~~ gal./min. with ft. drawdown after ~~1~~ hrs.
Artesian flow g.p.m.
Temperature of water 50° Depth artesian flow encountered ft.

**(9) CONSTRUCTION:**

Well seal—Material used Bentonite
Well sealed from land surface to 20 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal — sacks
Number of sacks of bentonite used in well seal 4 sacks
Brand name of bentonite Quik Gel
Number of pounds of bentonite per 100 gallons of water 50 lbs./100 gals.
Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:

**(10) LOCATION OF WELL:**

County Columbia Driller's well number 377
NW ¼ NW ¼ Section 32 T. 4N R 1 W W.M.
Bearing and distance from section or subdivision corner

**(11) WATER LEVEL:** Completed well.

Depth at which water was first found 20
Static level 5 ft. below land surface. Date 11/17
Artesian pressure lbs. per square inch. Date

**(12) WELL LOG:** Diameter of well below casing 6
Depth drilled 40 ft. Depth of completed well 40

Formation: Describe color, texture, grain size and structure of materia and show thickness and nature of each stratum and aquifer penetrate with at least one entry for each change of formation. Report each change position of *Static Water Level* and indicate principal water-bearing st

| MATERIAL | From | To | S |
|---|---|---|---|
| Top Soil | 0 | 2 | |
| Clay Brown | 2 | 12 | |
| Clay Brown Sandy | 12 | 20 | |
| Sand & Gravel | | | |
| Water Bearing | 20 | 40 | 2 |

Work started 11/17 1973 Completed 11/19 19
Date well drilling machine moved off of well 11/19 19

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervis Materials used and information reported above are true to best knowledge and belief.

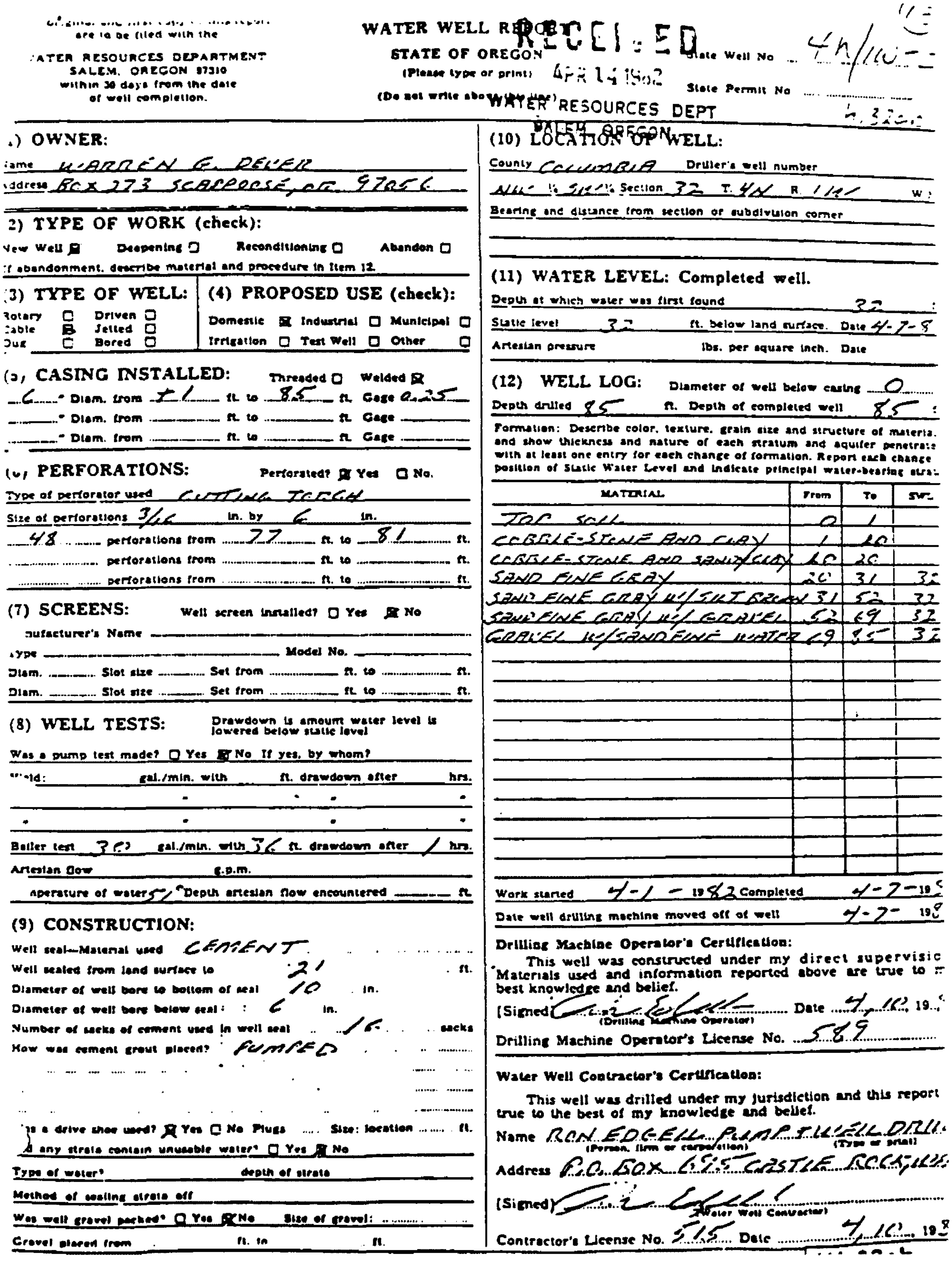
[Signed] (Drilling Machine Operator) Date 11/28, 19
Drilling Machine Operator's License No. 231

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this repor true to the best of my knowledge and belief.

Name Swift Water Well Drilling (Person, firm or corporation) (Type or print)
Address 421 SW 6th Ave Portland
[Signed] (Water Well Contractor)
Contractor's License No. 576 Date 11/28 19

4/1-32bb



Original and first copy of this report are to be filed with the
WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310
within 30 days from the date
of well completion.

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

RECEIVED
APR 14 1982
WATER RESOURCES DEPT
SALEM, OREGON

State Well No 4N/1W-32
State Permit No
4-32

**(1) OWNER:**

Name WARREN G. DEVER
Address BOX 273 SCAPPOOSE, OR. 97056

**(2) TYPE OF WORK (check):**

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

**(3) TYPE OF WELL:**

Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

**(4) PROPOSED USE (check):**

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

**(5) CASING INSTALLED:** Threaded ☐ Welded ☒

6" Diam. from +1 ft. to 85 ft. Gage 0.25
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

**(6) PERFORATIONS:** Perforated? ☒ Yes ☐ No.

Type of perforator used CUTTING TORCH
Size of perforations 3/16 in. by 6 in.
48 perforations from 77 ft. to 81 ft.
perforations from ft. to ft.
perforations from ft. to ft.

**(7) SCREENS:** Well screen installed? ☐ Yes ☒ No

Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

**(8) WELL TESTS:** Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 30 gal./min. with 36 ft. drawdown after 1 hrs.
Artesian flow g.p.m.
Temperature of water 57° Depth artesian flow encountered ft.

**(9) CONSTRUCTION:**

Well seal—Material used CEMENT
Well sealed from land surface to 21 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 16 sacks
How was cement grout placed? PUMPED

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

**(10) LOCATION OF WELL:**

County COLUMBIA Driller's well number
NW ¼ SW ¼ Section 32 T. 4N R. 1W W.M.
Bearing and distance from section or subdivision corner

**(11) WATER LEVEL: Completed well.**

Depth at which water was first found 32
Static level 32 ft. below land surface. Date 4-7-82
Artesian pressure lbs. per square inch. Date

**(12) WELL LOG:** Diameter of well below casing 0

Depth drilled 85 ft. Depth of completed well 85

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| TOP SOIL | 0 | 1 | |
| COBBLE-STONE AND CLAY | 1 | 10 | |
| COBBLE-STONE AND SAND/CLAY | 10 | 20 | |
| SAND FINE GRAY | 20 | 31 | 32 |
| SAND FINE GRAY W/SILT BROWN | 31 | 52 | 32 |
| SAND FINE GRAY W/GRAVEL | 52 | 69 | 32 |
| GRAVEL W/SAND FINE WATER | 69 | 85 | 32 |

Work started 4-1-1982 Completed 4-7-1982
Date well drilling machine moved off of well 4-7-1982

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] (Drilling Machine Operator) Date 4-10, 1982
Drilling Machine Operator's License No. 589

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name RON EDGELL PUMP & WELL DRILLING (Person, firm or corporation) (Type or print)
Address P.O. BOX 695 CASTLE ROCK, WA.
[Signed] (Water Well Contractor)
Contractor's License No. 515 Date 4-10, 1982

Notice to Water Well Contractor: The original and first copy of this report are to be filed with the

WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310
within 30 days from the date
of well completion.

# WATER WELL REPORT
## STATE OF OREGON

(Please type or print)

(Do not write above this line)

State Well No 4N\1W-33

State Permit No

## (1) OWNER:

Name Reichold Chemical, Inc.

Address P. O. Box 810

St. Helens, Oregon 97051

## (2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

## (3) TYPE OF WELL:

Rotary ☒ Driven ☐
Cable ☐ Jetted ☐
☐ Bored ☐

## (4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## (5) CASING INSTALLED:

Threaded ☐ Welded ☒

6-5/8" Diam. from plus 1½ ft. to 106 ft. Gage .250

" Diam. from ft. to ft. Gage

" Diam. from ft. to ft. Gage

## (6) PERFORATIONS:

Perforated? ☐ Yes ☒ No.

Type of perforator used

Size of perforations in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

## (7) SCREENS:

Well screen installed? ☐ Yes ☒ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

## (8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?

Yield: 50 gal./min. with ft. drawdown after 2 hrs.

35 " " " "

" " "

Bailer test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m.

Temperature of water Depth artesian flow encountered ft.

## (9) CONSTRUCTION:

Well seal—Material used Cement grout & gel

Well sealed from land surface to 60 ft.

Diameter of well bore to bottom of seal 10 in.

Diameter of well bore below seal 6 in.

Number of sacks of cement used in well seal 15 sacks

How was cement grout placed? Tremied into annular bore 60 ft. to ground level.

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☒ No Size of gravel:

Gravel placed from ft. to ft

## (10) LOCATION OF WELL:

County Columbia Driller's well number

SE ¼ SW ¼ Section 33 T. 4 N. R. 1 W. W.M.

Bearing and distance from section or subdivision corner

## (11) WATER LEVEL: Completed well.

Depth at which water was first found 80 ft.

Static level 80 ft. below land surface. Date 9/13/79

Artesian pressure lbs. per square inch. Date

## (12) WELL LOG:

Diameter of well below casing 0

Depth drilled 109 ft. Depth of completed well 106 ft.

Formation: Describe color, texture, grain size and structure of materials and show thickness and nature of each stratum and aquifer penetrated with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Brown clay w/gravel | 0 | 9 | |
| Med. gravel-occ.coarse w/some | | | |
| brown sandy clay | 9 | 14 | |
| Fine to coarse gravel-occ. | | | |
| boulder (dry) | 14 | 32 | |
| Med. to coarse gravel w/fine | | | |
| brown sand | 32 | 46 | |
| Med.gravel w/some fines-clay | 46 | 65 | |
| Brown silty sand-occ. clay | 65 | 72 | |
| Tight brown sand & gravel-occ. | | | |
| silty | 72 | 98 | |
| Brown sand & gravel | 98 | 108 | 50gpm |
| Brown silty sand & gravel | 108 | 109 | |
| | | | |
| WELL COMPLETED TO 106 FT. | | | |

RECEIVED
SEP 1 1979
WATER RESOURCES DEPT
SALEM, OREGON

Work started 8/6/79 19 Completed 9/13/79 19

Date well drilling machine moved off of well 9/13/79 19

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] (Drilling Machine Operator) Date 9/14/79, 19

Drilling Machine Operator's License No. 523

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name A. M.JANNSEN WELL DRILLING CO. INC. (Person, firm or corporation) (Type or print)

Address 21075 S.W. Tualatin Valley Hwy. Aloha, Or.

[Signed] (Water Well Contractor)

4/1-33cd

6.

The original and first copy of this report are to be filed with the

WATER RESOURCES DEPARTMENT.
SALEM, OREGON 97310
within 30 days from the date of well completion.

# WATER WELL REPORT
## STATE OF OREGON
(Please type or print)

(Do not write above this line)

State Well No. 4N/1W-33

State Permit No

## (1) OWNER:
Name Reichold Chemical , Inc.
Address P. O. Box 810
St. Helens, Oregon 97051

## (2) TYPE OF WORK (check):
New Well ☐ Deepening ☐ Reconditioning ☐ Abandon ☒

If abandonment, describe material and procedure in Item 12.

## (3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☐ Jetted ☐
☐ Bored ☐

## (4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## (5) CASING INSTALLED:
Threaded ☐ Welded ☐

" Diam. from X ft. to ft. Gage
" Diam. from X ft. to ft. Gage
" Diam. from X ft. to ft. Gage

## (6) PERFORATIONS:
Perforated? ☐ Yes ☐ No.

Type of perforator used X
Size of perforations X in. by in.
perforations from X ft. to ft.
perforations from X ft. to ft.
perforations from X ft. to ft.

## (7) SCREENS:
Well screen installed? ☐ Yes ☐ No

Manufacturer's Name X
Type X Model No.
Diam. Slot size Set X from ft. to ft.
Diam. Slot size Set X from ft. to ft.

## (8) WELL TESTS:
Drawdown is amount water level is lowered below static level

Was a pump test made? X ☐ Yes ☐ No If yes, by whom?
Yield: gal./min. X with ft. drawdown after hrs.
" X " "
" X " "
Bailer test gal./min. X with ft. drawdown after hrs.
Artesian flow X g.p.m.
Temperature of water Depth X artesian flow encountered ft.

## (9) CONSTRUCTION:
Well seal—Material used See (12)
Well sealed from land surface to ft.
Diameter of well bore to bottom of seal in.
Diameter of well bore below seal in.
Number of sacks of cement used in well seal 6 sacks
How was cement grout placed? Tremied in place and pressurized

X

X

Was a drive shoe used? ☐ Yes X ☐ No Plugs Size: location ft.
Did any strata contain unusable water? X ☐ Yes ☐ No
Type of water? X depth of strata
Method of sealing strata off X
Was well gravel packed? ☐ Yes ☐ No X Size of gravel:
Gravel placed from ft. to X

## (10) LOCATION OF WELL:
County Columbia Driller's well number
SE ¼ SW ¼ Section 33 T. 4 N R. 1 W.
Bearing and distance from section or subdivision corner

## (11) WATER LEVEL: Completed well.
Depth at which water was first found
Static level ft. below land surface. Date
Artesian pressure lbs. per square inch. Date

## (12) WELL LOG:
Diameter of well below casing
Depth drilled ft. Depth of completed well

Formation: Describe color, texture, grain size and structure of materials and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| ABANDONMENT PROCEDURE | | | |
| | | | |
| Cement Grout 80' 70' | | | |
| Bentonite X70' 60' | | | |
| Cement Grout 60' 40' | | | |
| Bentonite 40' 20' | | | |
| Cement Grout 20' 0' | | | |

RECEIVED
SEP 1[illegible] 1979
WATER RESOURCES DEPT
SALEM, OREGON

Work started 9/12/79 19 Completed 9/12/79 19
Date well drilling machine moved off of well --- 19

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

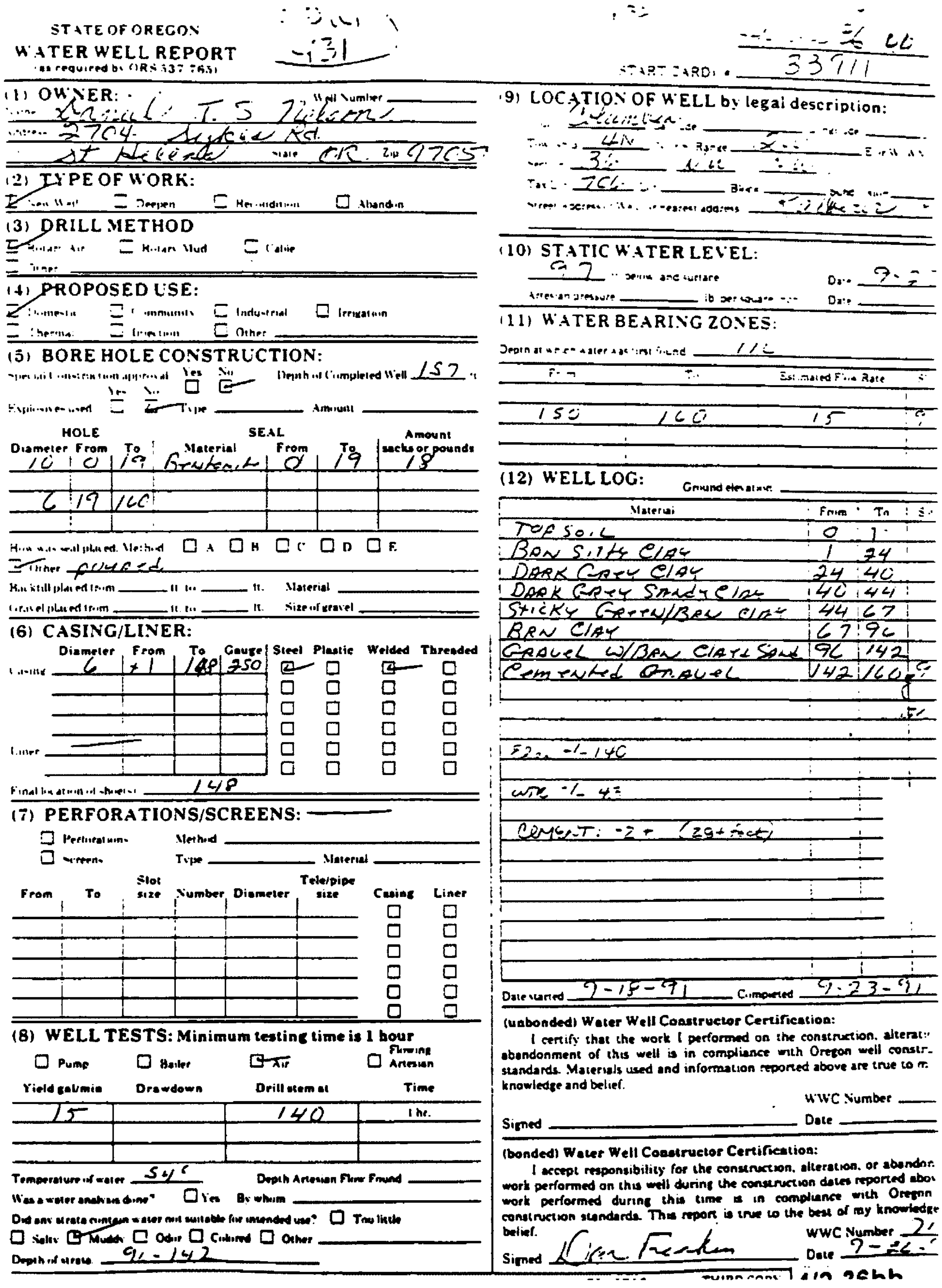
[Signed] (Drilling Machine Operator) Date 9/14/79 19
Drilling Machine Operator's License No. 523

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name A. H. JANNSEN WELL DRILLING CO. INC. (Person, firm or corporation) (Type or print)
Address 21075 SW Tualatin Valley Hwy, Aloha, Or.
[Signed] (Water Well Contractor)

4/1-33cd



STATE OF OREGON
**WATER WELL REPORT**
(as required by ORS 537.765)

131

[illegible] cc

START CARD) # 33711

**(1) OWNER:**
Well Number
Name [illegible] T. S [illegible]
Address 2704 Sykes Rd.
City St Helens State OR Zip 9705

**(2) TYPE OF WORK:**
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

**(3) DRILL METHOD**
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

**(4) PROPOSED USE:**
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

**(5) BORE HOLE CONSTRUCTION:**
Special Construction approval Yes ☐ No ☑ Depth of Completed Well 157 ft.
Explosives used Yes ☐ No ☑ Type Amount

| HOLE | | | SEAL | | | Amount |
|---|---|---|---|---|---|---|
| Diameter | From | To | Material | From | To | sacks or pounds |
| 10 | 0 | 19 | Bentonite | 0 | 19 | 18 |
| | | | | | | |
| 6 | 19 | 160 | | | | |

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☑ Other poured
Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

**(6) CASING/LINER:**

| | Diameter | From | To | Gauge | Steel | Plastic | Welded | Threaded |
|---|---|---|---|---|---|---|---|---|
| Casing | 6 | +1 | 148 | .250 | ☑ | ☐ | ☑ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |
| Liner | | | | | ☐ | ☐ | ☐ | ☐ |
| | | | | | ☐ | ☐ | ☐ | ☐ |

Final location of shoe(s) 148

**(7) PERFORATIONS/SCREENS:**
☐ Perforations Method
☐ Screens Type Material

| From | To | Slot size | Number | Diameter | Tele/pipe size | Casing | Liner |
|---|---|---|---|---|---|---|---|
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |
| | | | | | | ☐ | ☐ |

**(8) WELL TESTS: Minimum testing time is 1 hour**
☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

| Yield gal/min | Drawdown | Drill stem at | Time |
|---|---|---|---|
| 15 | | 140 | 1 hr. |
| | | | |
| | | | |

Temperature of water 54 Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☑ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata 91-142

**(9) LOCATION OF WELL by legal description:**
County Columbia Latitude Longitude
Township 4N N or S Range 2W E or W of WM
Section 34 [illegible] 1/4 [illegible] 1/4
Tax Lot 700 Lot Block Subdivision
Street Address of Well (or nearest address) [illegible]

**(10) STATIC WATER LEVEL:**
97 ft. below land surface Date 9-2
Artesian pressure lb. per square inch Date

**(11) WATER BEARING ZONES:**
Depth at which water was first found 112

| From | To | Estimated Flow Rate | SWL |
|---|---|---|---|
| | | | |
| 150 | 160 | 15 | 9 |
| | | | |

**(12) WELL LOG:**
Ground elevation

| Material | From | To | SWL |
|---|---|---|---|
| Top Soil | 0 | 1 | |
| Brn Silty Clay | 1 | 24 | |
| Dark Gray Clay | 24 | 40 | |
| Dark Grey Sandy Clay | 40 | 44 | |
| Sticky Green/Brn Clay | 44 | 67 | |
| Brn Clay | 67 | 96 | |
| Gravel w/Brn Clay & Sand | 96 | 142 | |
| Cemented Gravel | 142 | 160 | 9 |

[illegible] -/- 140

WTR -/- 42

CEMENT: -2 + (29+ feet)

Date started 9-18-91 Completed 9-23-91

**(unbonded) Water Well Constructor Certification:**
I certify that the work I performed on the construction, alterat[…] abandonment of this well is in compliance with Oregon well constr[…] standards. Materials used and information reported above are true to m[…] knowledge and belief.
WWC Number
Signed Date

**(bonded) Water Well Constructor Certification:**
I accept responsibility for the construction, alteration, or abandon[…] work performed on this well during the construction dates reported abo[…] work performed during this time is in compliance with Oregon construction standards. This report is true to the best of my knowledge belief.
WWC Number 21
Signed Date 9-26-

THIRD COPY 410 26bb

The original and first copy of this report are to be filed with the
·TE ENGINEER, SALEM, OREGON 97310
within 30 days from the date of well completion.

RECEIVED
OCT 13 1977
WATER RESOURCES DEPT.
SALEM, OREGON

## WATER WELL REPORT
## STATE OF OREGON

(Please type or print)
(Do not write above this line)

State Well No. 4/2-W-36cb
State Permit No
-236bc

## OWNER:

·e Victor Von Elsten
·ress Scappoose Ore

## ) TYPE OF WORK (check):

·w Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
·bandonment, describe material and procedure in Item 12.

## ) TYPE OF WELL:

·ary ☐ Driven ☐
·le ☒ Jetted ☐
· ☐ Bored ☐

## (4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## ) CASING INSTALLED:

Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 150 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

## ·) PERFORATIONS:

Perforated? ☐ Yes ☒ No.
·pe of perforator used
·e of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

## ) SCREENS:

Well screen installed? ☐ Yes ☒ No
·anufacturer's Name
Model No.
·am. Slot size Set from ft. to ft.
·am. Slot size Set from ft. to ft.

## 3) WELL TESTS:

Drawdown is amount water level is lowered below static level

·as a pump test made? ☒ Yes ☒ No If yes, by whom?
·ld. gal./min. with ft. drawdown after hrs.
·ailer test 15 gal./min. with 15 ft. drawdown after 1 hrs.
·tesian flow g.p.m.
·nperature of water Depth artesian flow encountered ft.

## 9) CONSTRUCTION:

·ell seal—Material used Cement
·ell sealed from land surface to 25 ft.
·ameter of well bore to bottom of seal 10 in.
·ameter of well bore below seal 6 in.
·umber of sacks of cement used in well seal 8 sacks
·umber of sacks of bentonite used in well seal sacks
·rand name of bentonite
·umber of pounds of bentonite per 100 gallons
· water lbs./100 gals.
·as a drive shoe used? ☒ Yes ☒ No Plugs Size: location ft.
·y strata contain unusable water? ☐ Yes ☒ No
·ype of water? depth of strata
·ethod of sealing strata off
·as well gravel packed? ☐ Yes ☒ No Size of gravel:
·ravel placed from ft. to ft.

## (10) LOCATION OF WELL:

County Columbia Driller's well number
SW ¼ NW ¼ Section 36 T 4N R 2W W.M.
Bearing and distance from section or subdivision corner

## (11) WATER LEVEL: Completed well.

Depth at which water was first found 120 ft.
Static level 70 ft. below land surface Date 8/8/77
Artesian pressure lbs. per square inch. Date

## (12) WELL LOG:

Diameter of well below casing 6"
Depth drilled 150 ft. Depth of completed well 150 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Top Soil | 0 | 5 | |
| Yellow Clay | 5 | 25 | |
| Water Bearing Sand | 25 | 40 | |
| Blue Clay | 40 | 50 | |
| Brown Clay | 50 | 90 | |
| Cement Gravel | 90 | 110 | |
| Med Brown Sand | 110 | 135 | 70 |
| Sand Gravel | 135 | 145 | 70 |
| Gravel | 145 | 150 | 70 |

Work started 7/12 1977 Completed 8/4 1977
Date well drilling machine moved off of well 8/5 1977

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Marwin McMullen Date 8/22, 1977
(Drilling Machine Operator)
Drilling Machine Operator's License No. 508

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name Merwin McMullen
(Person, firm or corporation) (Type or print)
Address RT2 Box 2094A Deer Island
[Signed] Marwin McMullen
(Water Well Contractor)
Contractor's License No. 660 Date 8/27, 1977

(USE ADDITIONAL SHEETS IF NECESSARY)

4/2-36bc

110

The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion

RECEIVED
AUG 8 1977
WATER RESOURCES DEPT.
SALEM, OREGON

# WATER WELL REPORT
## STATE OF OREGON
(Please type or print)
(Do not write above this line)

State Well No 4N-2W-36
State Permit No
423 6cc

**(1) OWNER:**

Name Darrell ~~[illegible]~~ Tucker
Address Scappoose Oregon

**(2) TYPE OF WORK (check):**

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

**(3) TYPE OF WELL:**

Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

**(4) PROPOSED USE (check):**

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

**CASING INSTALLED:** Threaded ☐ Welded ☒

6" Diam. from 0 ft. to 135 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

**PERFORATIONS:** Perforated? ☐ Yes ☒ No.

Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

**(7) SCREENS:** Well screen installed? ☐ Yes ☒ No

Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

**(8) WELL TESTS:** Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 18 gal./min. with 10 ft. drawdown after 1 hrs.
Artesian flow g.p.m.
Temperature of water Depth artesian flow encountered ft.

**(9) CONSTRUCTION:**

Well seal—Material used Cement
Well sealed from land surface to 20 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 5 sacks
Number of sacks of bentonite used in well seal sacks
Brand name of bentonite
Number of pounds of bentonite per 100 gallons of water lbs./100 gals.
Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

**(10) LOCATION OF WELL:**

County Columbia Driller's well number
SW ¼ SW ¼ Section 36 T 4N R 2W W.M.
Bearing and distance from section or subdivision corner

**(11) WATER LEVEL: Completed well.**

Depth at which water was first found 120 ft.
Static level 70 ft. below land surface. Date 7/11/7
Artesian pressure lbs. per square inch. Date

**(12) WELL LOG:** Diameter of well below casing 6"

Depth drilled 135 ft. Depth of completed well 135 ft.

Formation: Describe color, texture, grain size and structure of materials and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| Top soil | 0 | 5 | |
| Yellow clay | 5 | 40 | |
| Blue clay | 40 | 80 | |
| Cement Gravel | 80 | 95 | |
| Brown Sand Bed | 95 | 121 | |
| Sand & Gravel | 121 | 130 | 70 |
| Gravel | 130 | 135 | 70 |

[illegible]
[illegible]

Work started 6/30 1977 Completed 7/11 1977
Date well drilling machine moved off of well 7/12 1977

**Drilling Machine Operator's Certification:**

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] McMullen (Drilling Machine Operator) Date 7/11, 1977

Drilling Machine Operator's License No. 808

**Water Well Contractor's Certification:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name Mervin McMullen (Person, firm or corporation) (Type or print)
Address RT2 Box 2094A Deer Island 97

[Signed] W McMullen (Water Well Contractor)

Contractor's License No. 660 Date 7/11, 1977

(USE ADDITIONAL SHEETS IF NECESSARY)

4/2-36CC

# BORING LOGS

# *KEY TO BORING LOGS*

BORING LOGS

**DAVID J. NEWTON** ASSOCIATES INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE SUITE 400 503 226-7718
PORTLAND OREGON 97205 FAX 503 226 7181

**PROJECT NUMBER:** 420-106
**BORING LOG:** **LEGEND**
**PROJECT:** Lone Star - Santosh
**LOCATION:** Approx. location of boring
**TOTAL DEPTH:** depth to bottom hole
**DIAMETER:** OD. drillpipe
**ELEVATION:** feet above MSL
**DRILLING CONTRACTOR:** Beck Environmental Contracting
**METHOD:** type of drill
**START DATE:** on site drilling
**FINISH DATE:** off site
**WATER LEVEL AND TIME:** feet below surface, time, date
**LOGGED BY:** on-site geologist/geotech

| SAMPLE | | SYMBOL | GRAPHIC LOG | DESCRIPTION | | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | | | | Blow Count |
| 1 | | | ▨ | Well Graded Gravels, Gravel - Sand Mixtures | Clean gravels with little or no fines | Gravels (>50% coarse fraction larger than #4 sieve size (¼") | Coarse Grained Soils | |
| 2 | | GW | | | | | | |
| 3 | | | ▨ | Poorly Graded Gravels, Gravel-Sand Mixtures | | | | Hammer blows used to drive drillpipe into soil a distance of one foot |
| 4 | | GP | | | | | | |
| 5 | | | ▨ | Silty Gravels, Poorly Graded Gravel-Sand Silt Mixtures | Gravels w/ >15% fines | | | |
| 6 | | | | | | | | |
| 7 | | GM | | | | | | |
| 8 | | | ▨ | Well Graded Sands, Gravelly Sands | Clean sands with little or no fines | Sands (>50% coarse fraction smaller than #4 sieve size (¼") | | |
| 9 | | SW | | | | | | Blow counts higher than 190 blows per foot are recorded as 180 blows per foot. |
| 10 | | | ▨ | Poorly Graded Sands, Gravelly Sands | | | | |
| 11 | | SP | | | | | | |
| 12 | | | ▨ | Silty Sands, Poorly Graded Sand - Silt Mix | Sands with over 15% fines | | | |
| 13 | | SM | | | | | | |
| 14 | | | ▤ | Inorganic Silts, | Silts and Clays Liquid Limit < 50% | | Fine Grained | |
| 15 | | ML | | | | | | |
| 16 | | | ▤ | Inorganic Clays of low to med. plasticity, Lean Clays | | | | |
| 17 | | | | | | | | |
| 18 | | CL | | | | | | In soft or loose soils, drillpipe may be advanced without hammering - the distance pushed is shown with a bold border as at <—- left |
| 19 | | | ▧ | Cemented sand and gravel: gravel framework bound together with sand and silica cement | | | Cemented Soils | |
| 20 | | | | | | | | |
| 21 | | | | | | | | |
| 22 | | | ▧ | Strongly cemented sand and gravel: similar but harder than cemented sand and gravel | | | | |
| 23 | | | | | | | | |
| 24 | | | | | | | | |
| 25 | | | | | | | | |
| 26 | | | | | | | | |
| 27 | | ▽ | Groundwater level at time of exploration or as noted | | | | | |
| 28 | | | | | | | | |
| 29 | | Sample number | | | | | | |
| 30 | 94X1 | Sample depth interval | | | | | | |
| 31 | 0-100' | Bulk sample location, obtained by collecting soil cuttings in a plastic bag or fiberglass sack | | | | | | |
| 32 | SK | | | | | | | |
| 33 | | Sample type | | | | | | |
| 34 | | | | | | | | |
| 35 | | | | | | | | |
| 36 | | | | | | | | |
| 37 | | | | | | | | |
| 38 | | | | | | | | |
| 39 | | | | | | | | |
| 40 | | | | | | | | |

SAMPLE TYPES: B = BAG SAMPLE ST = SHELBY TUBE SS = SPLIT SPOON SK = BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

## *BORING LOG*

**DAVID J. NEWTON** ASSOCIATES, INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE, SUITE 400 503 226-1118
PORTLAND, OREGON 97205 FAX 503 226-1191

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94B1
**PROJECT:** Lone Star - Santosh
**LOCATION:** N. ctr Pit B
**TOTAL DEPTH:** 219 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** 9.58 ft. MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/6/94
**FINISH DATE:** 1/6/94
**WATER LEVEL AND TIME:** ~ 5 ft @ 850 1/6
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 1 | | 842 | | WELL-GRADED GRAVEL w\ SAND (GW), grey-brown, | 39 |
| 2 | | | | damp to wet, med. dense, occ. loose, rounded gravels | 49 |
| 3 | | | | to >4 in. max. dimensions | 55 |
| 4 | | | | | 46 |
| 5 | | 846 | | | 34 |
| 6 | | | | | 43 |
| 7 | | ▽ | | | 23 |
| 8 | | | | | 15 |
| 9 | | | | | 17 |
| 10 | | 852 | | | 32 |
| 11 | | | | | 30 |
| 12 | | | | | 10 |
| 13 | | | | | 5 |
| 14 | | | | | 32 |
| 15 | | 854 | | | 33 |
| 16 | | | | | 34 |
| 17 | | | | | 36 |
| 18 | | | | | 35 |
| 19 | | | | | 37 |
| 20 | | 901 | | becomes grey, slightly sandier | 27 |
| 21 | | | | | 24 |
| 22 | | | | | 24 |
| 23 | | | | | 34 |
| 24 | | | | | |
| 25 | | 902 | | | 7 |
| 26 | | | | | 11 |
| 27 | | | | | 11 |
| 28 | | | | | 23 |
| 29 | | | | | 15 |
| 30 | | 908 | | | 11 |
| 31 | | | | | 3 |
| 32 | | | | | 17 |
| 33 | | | | tr. silt | 12 |
| 34 | | | | | 15 |
| 35 | | 912 | | becoming silty, water return dark grey | 7 |
| 36 | | | | | 14 |
| 37 | | | | | 25 |
| 38 | | | | SILT w\ GRAVEL (ML), dark grey, wet, soft to firm, tr. sand | 4 |
| 39 | | | | | 8 |
| 40 | | 918 | | | 22 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

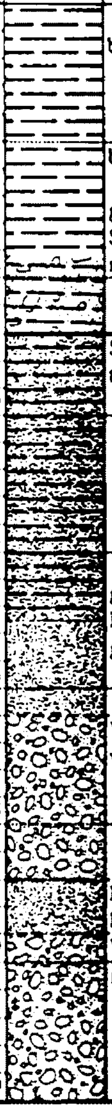
Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

**Page 1 of 6**

*BORING LOG*

**DAVID J. NEWTON ASSOCIATES, INC**
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE, SUITE 400 503 [illegible]
PORTLAND, OREGON 97205 FAX 503 [illegible]

| | | | |
|---|---|---|---|
| **PROJECT NUMBER:** 420-106 | | **BORING NUMBER:** 94B1 | |
| **PROJECT:** | Lone Star - Santosh | | |
| **LOCATION:** | N. ctr Pit B | **TOTAL DEPTH:** 219 ft. | **DIAMETER:** 6 5/8 in. |
| **ELEVATION:** | 9.58 ft. MSL | **DRILLING CONTRACTOR:** | Beck Environmental |
| **METHOD:** | Becker hammer drill | **START DATE:** 1/6/94 | **FINISH DATE:** 1/6/94 |
| **WATER LEVEL AND TIME:** | 7.5 ft. @ 850 1/6 | **LOGGED BY:** | J. Lawes |

| **SAMPLE** | | | | **DESCRIPTION** | **COMMENTS** |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | TIME | GRAPHIC LOG | | Blow Counts |
| 41 | | |  | | 11 |
| 42 | | | | becomes black, 90% silt | 8 |
| 43 | | | | | 6 |
| 44 | | | | | 14 |
| 45 | | 918 | | | 5 |
| 46 | | | | becoming sandier, more gravelly | 12 |
| 47 | | | | | 3 |
| 48 | | | | grades to | 11 |
| 49 | | | | SANDY SILT w\ GRAVEL (ML), black to dark grey, wet, soft | |
| 50 | | 928 | | rounded gravels to 3-4 in. max. | 13 |
| 51 | | | | | 9 |
| 52 | | | | | 14 |
| 53 | | | | SILTY SAND (SM), dark grey, wet, loose, rounded gravels | 8 |
| 54 | | | | to >4 in. max. | 2 |
| 55 | | 929 | | pushed 3 feet ——> | 2 |
| 56 | | | | | 2 |
| 57 | | | | | 19 |
| 58 | | | | | |
| 59 | | | | | 25 |
| 60 | | 934 | | | 20 |
| 61 | | | | | 9 |
| 62 | | | | grades to | 5 |
| 63 | | | | POORLY-GRADED SAND w/GRAVEL (SP), grey, occ. grey- | 18 |
| 64 | | | | green, wet, med. dense, tr. silt | 28 |
| 65 | | 935 | | | 24 |
| 66 | | | | | 22 |
| 67 | | | | WELL-GRADED GRAVEL w\ SAND (GW), dark grey-green, | 37 |
| 68 | | | | wet, med. dense, tr. silt | 36 |
| 69 | | | | | 35 |
| 70 | | 945 | | | 59 |
| 71 | | | | | 65 |
| 72 | | | | | 69 |
| 73 | | | | POORLY-GRADED SAND (SP), grey, to grey-green, wet, | 12 |
| 74 | | | | loose, tr. gravel | 15 |
| 75 | | 949 | | WELL-GRADED GRAVEL w\ SAND (GW), dark grey, wet, | 12 |
| 76 | | | | med. dense, tr. silt | 56 |
| 77 | | | | | 119 |
| 78 | | | | | 15 |
| 79 | | | | | 15 |
| 80 | | 959 | | | 17 |

SAMPLE TYPES: B = BAG SAMPLE ST = SHELBY TUBE SS = SPLIT SPOON SK = BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

Page 2 of 6

# *BORING LOG*

DAVID J. NEWTON ASSOCIATES INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE, SUITE 400
PORTLAND, OREGON 97205

**PROJECT NUMBER: 420-106**
**BORING NUMBER: 94B1**
**PROJECT:** Lone Star - Santosh

| | | | | | |
|---|---|---|---|---|---|
| **LOCATION:** | N. ctr Pit B | **TOTAL DEPTH:** | 219 ft. | **DIAMETER:** | 6 5/8 in. |
| **ELEVATION:** | 9.58 ft. MSL | **DRILLING CONTRACTOR:** | | | Beck Environmental |
| **METHOD:** | Becker hammer drill | **START DATE:** | 1/6/94 | **FINISH DATE:** | 1/6/94 |
| **WATER LEVEL AND TIME:** | 7.5 ft. @ 850 1/6 | **LOGGED BY:** | J. Lawes | | |

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 81 | | |  | | |
| 82 | | | | | 19 |
| 83 | | | | | 63 |
| 84 | | | | | 35 |
| 85 | | 1002 | | | 43 |
| 86 | | | | | 55 |
| 87 | | | | | 50 |
| 88 | | | | | 30 |
| 89 | | | | occ. boulders, appx. 40% sand | 20 |
| 90 | | 1010 | | | 40 |
| 91 | | | | | 70 |
| 92 | | | | | 55 |
| 93 | | | | | 38 |
| 94 | | | | | 59 |
| 95 | | 1014 | | | 100 |
| 96 | | | | very sandy (50%?), boulders | 39 |
| 97 | | | | | 45 |
| 98 | | | | | 31 |
| 99 | | | | | 35 |
| 100 | | 1026 | | | 36 |
| 101 | | | | | 35 |
| 102 | | | | | 46 |
| 103 | | | | grades to | 97 |
| 104 | | | | WELL-GRADED SAND w\ GRAVEL (SW), grey to green, wet, | 68 |
| 105 | | 1030 | | med. dense to dense | 35 |
| 106 | | | | | 115 |
| 107 | | | | water return green | 79 |
| 108 | | | | | 65 |
| 109 | | | | more gravelly | 90 |
| 110 | | 1042 | | | 70 |
| 111 | | | | | 81 |
| 112 | | | | | 91 |
| 113 | | | | CEMENTED, WELL-GRADED GRAVEL w\ SAND (GW), | 130 |
| 114 | | | | dark green, wet, very dense, occ. boulders > 10 in. max. | 127 |
| 115 | | 1055 | | | 119 |
| 116 | | | | POORLY-GRADED SAND (SP), green, wet, loose to med. | 124 |
| 117 | | | | dense, very fine sand w\ tr. gravels | 52 |
| 118 | | | | | 22 |
| 119 | | | | | 23 |
| 120 | | 1107 | | | 25 |

**SAMPLE TYPES:** B - BAG SAMPLE  ST - SHELBY TUBE  SS - SPLIT SPOON  SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

**Page 3 of 6**

# *BORING LOG*

DAVID J. NEWTON ASSOCIATES, INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE, SUITE 400 503 228-7718
PORTLAND, OREGON 97205 FAX 503 228-7781

**PROJECT NUMBER: 420-106**
**BORING NUMBER: 94B1**
**PROJECT:** Lone Star - Santosh
**LOCATION:** N. ctr Pit B
**TOTAL DEPTH:** 219 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** 9.58 ft. MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/6/94
**FINISH DATE:** 1/6/94
**WATER LEVEL AND TIME:** 7.5 ft. @ 850 1/6
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 121 | | | | CEMENTED, WELL-GRADED GRAVEL w\ SAND (GW), | 90 |
| 122 | | | | green, wet, very dense, cemented | 119 |
| 123 | | | | | 113 |
| 124 | | | | | 117 |
| 125 | | 1118 | | large boulders | 178 |
| 126 | | | | | 177 |
| 127 | | | | becomes very well cemented, extremely dense | 180 |
| 128 | | | | | 180 |
| 129 | | | | very gravelly, large boulders | 180 |
| 130 | | 1202 | | | 149 |
| 131 | | | | | 180 |
| 132 | | | | | 180 |
| 133 | | | | | 189 |
| 134 | | | | | 180 |
| 135 | | 1221 | | | 180 |
| 136 | | | | | 180 |
| 137 | | | | | 180 |
| 138 | | | | | 180 |
| 139 | | | | | 135 |
| 140 | | 1244 | | | 180 |
| 141 | | | | | 180 |
| 142 | | | | | 180 |
| 143 | | | | | 125 |
| 144 | | | | | 131 |
| 145 | | 1259 | | | 145 |
| 146 | | | | | 172 |
| 147 | | | | | 111 |
| 148 | | | | | 140 |
| 149 | | | | | 180 |
| 150 | | 1325 | | | 180 |
| 151 | | | | | 180 |
| 152 | | | | | 180 |
| 153 | | | | | 107 |
| 154 | | | | | 79 |
| 155 | | 1338 | | | 68 |
| 156 | | | | | 180 |
| 157 | | | | becomes sandier | 63 |
| 158 | | | | POORLY-GRADED SAND (SP), green, wet, med. dense | 20 |
| 159 | | | | to loose, tr. gravel | 15 |
| 160 | | 1352 | | | |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

**Page 4 of 6**

## *BORING LOG*

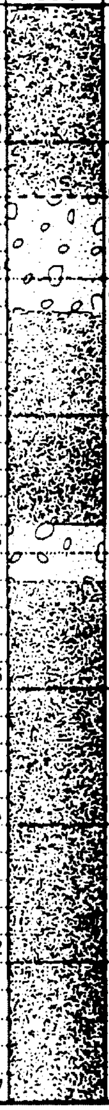
**DAVID J. NEWTON** ASSOCIATES, INC.
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE SUITE 400 503 [illegible]
PORTLAND OREGON [illegible] FAX 503 [illegible]

**PROJECT NUMBER:** 420-106

**BORING NUMBER:** 94B1

**PROJECT:** Lone Star - Santosh

| | | | |
|---|---|---|---|
| **LOCATION:** | N. ctr Pit B | **TOTAL DEPTH:** 219 ft. | **DIAMETER:** 6 5/8 in. |
| **ELEVATION:** | 9.58 ft. MSL | **DRILLING CONTRACTOR:** | Beck Environmental |
| **METHOD:** | Becker hammer drill | **START DATE:** 1/6/94 | **FINISH DATE:** 1/6/94 |
| **WATER LEVEL AND TIME:** | ~5 ft @ 850 1/6 | **LOGGED BY:** | J. Lawes |



| SAMPLE DEPTH (ft) | SAMPLE NO. AND TYPE | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS Blow Counts |
|---|---|---|---|---|---|
| 161 | | | | | 26 |
| 162 | | | | | 22 |
| 163 | | | | | 25 |
| 164 | | | | | 26 |
| 165 | | 1400 | | | 29 |
| 166 | | | | tr. silt, more gravelly | 86 |
| 167 | | | | grades to | 66 |
| 168 | | | | POORLY GRADED SAND w\ GRAVEL (SP), green, wet, med. | 66 |
| 169 | | | | dense to loose, wood chips - interbedded with | 79 |
| 170 | | 1413 | | WELL-GRADED SAND w\ GRAVEL (SW), green, wet, med. | 20 |
| 171 | | | | dense, tr. silt | 37 |
| 172 | | | | | 20 |
| 173 | | | | | 19 |
| 174 | | | | | 19 |
| 175 | | 1415 | | | 21 |
| 176 | | | | | 17 |
| 177 | | | | | 23 |
| 178 | | | | | 15 |
| 179 | | | | | 23 |
| 180 | | 1423 | | | 31 |
| 181 | | | | | 43 |
| 182 | | | | | 18 |
| 183 | | | | | 21 |
| 184 | | | | | 23 |
| 185 | | 1425 | | | 21 |
| 186 | | | | | 19 |
| 187 | | | | | 21 |
| 188 | | | | | 22 |
| 189 | | | | | |
| 190 | | 1431 | | less gravelly | 35 |
| 191 | | | | | 21 |
| 192 | | | | | 28 |
| 193 | | | | | 43 |
| 194 | | | | | 21 |
| 195 | | 1432 | | | 26 |
| 196 | | | | | 17 |
| 197 | | | | | 17 |
| 198 | | | | | 18 |
| 199 | | | | | 18 |
| 200 | | 1437 | | | 12 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

Page 5 of 6

## BORING LOG

**DAVID J. NEWTON** ASSOCIATES, INC.
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE, SUITE 400 [illegible]
PORTLAND, OREGON [illegible] FAX [illegible]

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94B1
**PROJECT:** Lone Star - Santosh
**LOCATION:** N. ctr Pit B
**TOTAL DEPTH:** 219 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** 9.58 ft. MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/6/94
**FINISH DATE:** 1/6/94
**WATER LEVEL AND TIME:** 7.5 ft. @ 850 1/6
**LOGGED BY:** J. Lawes

| SAMPLE | | | | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | TIME | GRAPHIC LOG | | Blow Counts |
| 201 | | | ▨ | | 13 |
| 202 | | | ▨ | | 15 |
| 203 | | | ▨ | < 20%(?) gravel | 12 |
| 204 | | | ▨ | | 17 |
| 205 | | 1438 | ▨ | | 18 |
| 206 | | | ▨ | | 21 |
| 207 | | | ▨ | | 18 |
| 208 | | | ▨ | | 15 |
| 209 | | | ▨ | grades to | 11 |
| 210 | | 1445 | ▨ | POORLY-GRADED SAND (SP), grey-green, wet, loose, | 12 |
| 211 | | | ▨ | tr. gravel | 15 |
| 212 | | | ▨ | | 16 |
| 213 | | | ▨ | | 12 |
| 214 | | | ▨ | | 16 |
| 215 | | 1446 | ▨ | | 16 |
| 216 | | | ▨ | | 16 |
| 217 | | | ▨ | | 16 |
| 218 | | | ▨ | | 17 |
| 219 | | | ▨ | | 17 |
| 220 | | | | TD @ 219 ft. at 1447 | |
| 221 | | | | 1/6/94 | |
| 222 | | | | | |
| 223 | | | | | |
| 224 | | | | | |
| 225 | | | | | |
| 226 | | | | | |
| 227 | | | | | |
| 228 | | | | | |
| 229 | | | | | |
| 230 | | | | | |
| 231 | | | | | |
| 232 | | | | | |
| 233 | | | | | |
| 234 | | | | | |
| 235 | | | | | |
| 236 | | | | | |
| 237 | | | | | |
| 238 | | | | | |
| 239 | | | | | |
| 240 | | | | | |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

Page 6 of 6

## *BORING LOG*

| | | |
|---|---|---|
| **DAVID J. NEWTON** ASSOCIATES, INC<br>CIVIL & GEOLOGICAL ENGINEERING SERVICES | **PROJECT NUMBER:** 420-106 | **BORING NUMBER:** 94M1 |
| | **PROJECT:** Lone Star - Meier Property | |
| **LOCATION:** SE portion Meier prop | **TOTAL DEPTH:** 215 ft. | **DIAMETER:** 6 5/8 in. |
| **ELEVATION:** appx. 13 ft. MSL | **DRILLING CONTRACTOR:** | Beck Environmental |
| **METHOD:** Becker hammer drill | **START DATE:** 1/25/94 | **FINISH DATE:** 1/27/94 |
| **WATER LEVEL AND TIME:** | 17 ft. @ 1125 1/25 | **LOGGED BY:** J. Lawes |

| SAMPLE | | | | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | TIME | GRAPHIC LOG | | Blow Counts |
| 1 | | 1102 | | SILT (ML) with some ELASTIC SILT (ML), brown, moist | 2 |
| 2 | | | | soft, tr. sand, with roots and plant fragments in upper 6 in. | 2 |
| 3 | | | | plastic to very plastic (topsoil) | 2 |
| 4 | | | | pushed 7.5 feet ———> | 2 |
| 5 | | 1102 | | | 2 |
| 6 | | | | | 2 |
| 7 | | | | | 2 |
| 8 | | | | | 6 |
| 9 | | | | WELL-GRADED GRAVEL w\ SILT (GW-GM), brown, moist | 17 |
| 10 | 94M1 | 1116 | | med. dense | 39 |
| 11 | 0'-20' | | | | 41 |
| 12 | SK | | | | 42 |
| 13 | | ▽ | | | 47 |
| 14 | | | | | 50 |
| 15 | | 1119 | | | 44 |
| 16 | | | | | 39 |
| 17 | | | | becomes wet | 40 |
| 18 | | | | | 67 |
| 19 | | | | | 49 |
| 20 | | 1148 | | | 50 |
| 21 | | | | | 86 |
| 22 | | | | | 93 |
| 23 | | | | | 55 |
| 24 | | | | | 21 |
| 25 | | 1153 | | | 83 |
| 26 | | | | | 60 |
| 27 | | | | | 21 |
| 28 | 94M1 | | | | 19 |
| 29 | 20-40' | | | | 18 |
| 30 | SK | 1208 | | | 31 |
| 31 | | | | | 17 |
| 32 | | | | | 38 |
| 33 | | | | | 60 |
| 34 | | | | | 53 |
| 35 | | 1210 | | SILTY SAND w\ GRAVEL (SM), brown, moist to wet, med. | 38 |
| 36 | | | | dense to loose, occ. gravels or cobbles to >4 in. max. | 30 |
| 37 | | | | | 15 |
| 38 | | | | | 16 |
| 39 | | | | | 18 |
| 40 | | 1223 | | | 25 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

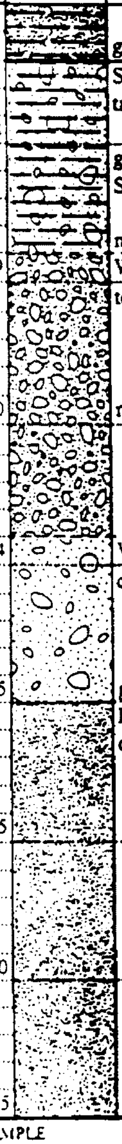
Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

**Page 1 of 6**

## *BORING LOG*

DAVID J. NEWTON ASSOCIATES, INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
[illegible]
PORTLAND OREGON [illegible]

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M1
**PROJECT:** Lone Star - Meier Property
**LOCATION:** SE portion Meier prop
**TOTAL DEPTH:** 215 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 13 ft. MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/25/94
**FINISH DATE:** 1/27/94
**WATER LEVEL AND TIME:** 17 ft. @ 1125 1/25
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 41 | | |  | | 14 |
| 42 | | | | grades to | 12 |
| 43 | | | | SILTY GRAVEL (GM), brown, wet, med. dense to dense, | 29 |
| 44 | | | | tr. sand | 31 |
| 45 | | 1228 | | | 93 |
| 46 | | | | grades to | 103 |
| 47 | | | | SILTY GRAVEL w\ SAND (GM) as above, sandier | 45 |
| 48 | | | | | 97 |
| 49 | | | | many large cobbles & boulders | 155 |
| 50 | | 1239 | | WELL-GRADED GRAVEL w\ SAND (GW), grey, wet, dense | 180 |
| 51 | | | | to very dense, tr. silt | 72 |
| 52 | | | | | 65 |
| 53 | | | | | 122 |
| 54 | | | | | 64 |
| 55 | | 1250 | | much sand - about 50% sand | 62 |
| 56 | | | | | 53 |
| 57 | | | | | 166 |
| 58 | | | | | 70 |
| 59 | 94M1 | | | | 50 |
| 60 | 40-90' | 1304 | | WELL-GRADED SAND w\ GRAVEL (SW), grey, wet, med. | 47 |
| 61 | SK | | | dense to dense, tr. silt | 23 |
| 62 | | | | | 19 |
| 63 | | | | | 31 |
| 64 | | | | | 23 |
| 65 | | 1305 | | grades to | 21 |
| 66 | | | | POORLY-GRADED SAND w\ GRAVEL (SP), grey, wet, med. | 89 |
| 67 | | | | dense to dense, occ. boulders | 64 |
| 68 | | | | | 52 |
| 69 | | | | | 47 |
| 70 | | 1315 | | | 56 |
| 71 | | | | | 85 |
| 72 | | | | | 71 |
| 73 | | | | | 64 |
| 74 | | | | | 38 |
| 75 | | 1320 | | | 129 |
| 76 | | | | | 72 |
| 77 | | | | | 63 |
| 78 | | | | | 117 |
| 79 | | | | | 38 |
| 80 | | 1335 | | | 40 |

SAMPLE TYPES: B = BAG SAMPLE ST = SHELBY TUBE SS = SPLIT SPOON SK = BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

**Page 2 of 6**

## *BORING LOG*

| | | |
|---|---|---|
| **DAVID J. NEWTON** ASSOCIATES INC<br>CIVIL & GEOLOGICAL ENGINEERING SERVICES<br>1201 SW 12TH AVENUE, SUITE 400 503 228-7718<br>PORTLAND OREGON 97205 FAX 503 228-7791 | **PROJECT NUMBER:** 420-106 | **BORING NUMBER:** 94M1 |
| | **PROJECT:** Lone Star - Meier Property | |
| **LOCATION:** SE portion Meier prop | **TOTAL DEPTH:** 215 ft. | **DIAMETER:** 6 5/8 in. |
| **ELEVATION:** appx. 13 ft MSL | **DRILLING CONTRACTOR:** | Beck Environmental |
| **METHOD:** Becker hammer drill | **START DATE:** 1/25/94 | **FINISH DATE:** 1/27/94 |
| **WATER LEVEL AND TIME:** | 17 ft. @ 1125 1/25 | **LOGGED BY:** J. Lawes |

| SAMPLE | | | | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | TIME | GRAPHIC LOG | | Blow Counts |
| 81 | | |  | | 43 |
| 82 | | | | very dark brown | 90 |
| 83 | | | | | 183 |
| 84 | 94M1 | | | | 75 |
| 85 | 40-90' | 1342 | | | 57 |
| 86 | SK | | | more gravelly | 50 |
| 87 | | | | | 32 |
| 88 | | | | grades to | 34 |
| 89 | | | | WELL-GRADED GRAVEL w\ SILT & SAND (GW-GM), | 60 |
| 90 | | 1350 | | brown, wet to moist, med. dense to dense | 61 |
| 91 | | | | | 162 |
| 92 | | | | becomes green to green-brown, cemented | 115 |
| 93 | | | | | 178 |
| 94 | 94M1 | | | | 188 |
| 95 | 90-100' | 1417 | | | 180 |
| 96 | SK | | | | 104 |
| 97 | | | | WELL-GRADED GRAVEL w\ SAND (GW), brown to grey- | 32 |
| 98 | | | | brown, wet, med. dense to loose | 19 |
| 99 | | | | | 34 |
| 100 | | 1427 | | | 47 |
| 101 | | | | | 64 |
| 102 | | | | | 35 |
| 103 | | | | | 39 |
| 104 | 94M1 | | | sandier, grades to | 47 |
| 105 | 100-110' | 1439 | | WELL-GRADED SAND w\ GRAVEL (SW), dark gold-brown, | 81 |
| 106 | SK | | | wet, dense to med. dense, tr. silt | 42 |
| 107 | | | | | 55 |
| 108 | | | | | 88 |
| 109 | | | | | 60 |
| 110 | | 1458 | | | 109 |
| 111 | | | | CEMENTED, WELL-GRADED GRAVEL w\ SAND (GW), | 123 |
| 112 | | | | v. dark green, wet, very dense, cemented to well cemented | 180 |
| 113 | | | | Shut down @ 1512 1/25 Drilling @ 1220 1/26 | 180 |
| 114 | | | | | 189 |
| 115 | 94M1 | 1243 | | | 147 |
| 116 | 110-215' | | | | 180 |
| 117 | SK | | | | 127 |
| 118 | | | | | 138 |
| 119 | | | | | 104 |
| 120 | | 1257 | | | 100 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

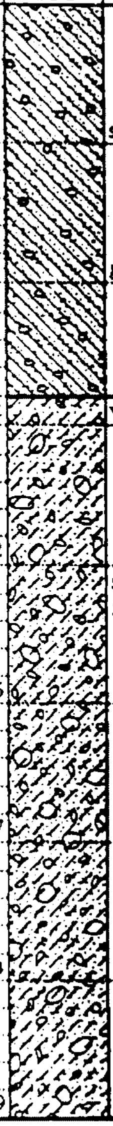
Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

**Page 3 of 6**

## *BORING LOG*

**DAVID J. NEWTON** ASSOCIATES, INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
[illegible] SW 13TH AVENUE SUITE 400 503 [illegible]
PORTLAND OREGON [illegible] FAX 503 [illegible]

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M1
**PROJECT:** Lone Star - Meier Property
**LOCATION:** SE portion Meier prop
**TOTAL DEPTH:** 215 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 13 ft MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/25/94
**FINISH DATE:** 1/27/94
**WATER LEVEL AND TIME:** 17 ft. @ 1125 1/25
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 121 | | |  | | 103 |
| 122 | | | | | 124 |
| 123 | | | | | 180 |
| 124 | | | | | 121 |
| 125 | | 1303 | | sandier, less well cemented | 104 |
| 126 | | | | | 85 |
| 127 | | | | | 95 |
| 128 | | | | | 98 |
| 129 | | | | | 69 |
| 130 | | 1315 | | gravelly | 93 |
| 131 | | | | | 115 |
| 132 | | | | | 89 |
| 133 | | | | | 75 |
| 134 | | | | | 82 |
| 135 | | 1322 | | very well cemented, dark grey-green | 124 |
| 136 | | | | | 180 |
| 137 | | | | | 180 |
| 138 | | | | | 180 |
| 139 | 94M1 | | | | 185 |
| 140 | 110-215' | 1352 | | | 180 |
| 141 | SK | | | single large (1.5-2 ft. min. dimensions) vesicular basalt boulder | 180 |
| 142 | | | | 500+ blows per foot from 140 to 142 ft. | 180 |
| 143 | | | | | 183 |
| 144 | | | | | 111 |
| 145 | | 1446 | | | 122 |
| 146 | | | | | 148 |
| 147 | | | | | 180 |
| 148 | | | | | 180 |
| 149 | | | | | 165 |
| 150 | | 1507 | | | 89 |
| 151 | | | | | 132 |
| 152 | | | | | 180 |
| 153 | | | | | 163 |
| 154 | | | | | 184 |
| 155 | | 1534 | | | 140 |
| 156 | | | | | 177 |
| 157 | | | | | 187 |
| 158 | | | | Shut down @ 1600 1/26 Drilling @ 903 1/27 | 180 |
| 159 | | | | | 180 |
| 160 | | 909 | | | 169 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

# *BORING LOG*

DAVID J. NEWTON ASSOCIATES INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
[illegible] 12TH AVENUE, SUITE [illegible] [illegible]
PORTLAND, OREGON [illegible] FAX [illegible]

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M1
**PROJECT:** Lone Sater - Meier Property
**LOCATION:** SE portion Meier prop
**TOTAL DEPTH:** 215 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 13 ft MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/25/94
**FINISH DATE:** 1/27/94
**WATER LEVEL AND TIME:** 17 ft. @ 1125 1/25
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 161 | | |  | | 180 |
| 162 | | | | sandy, greyer, weakly cemented | 53 |
| 163 | | | | | 49 |
| 164 | | | | | 105 |
| 165 | | 922 | | | 134 |
| 166 | | | | grey-green to dark green, well cemented | 155 |
| 167 | | | | | 180 |
| 168 | | | | | 180 |
| 169 | | | | | 91 |
| 170 | | 943 | | weakly cemented | 93 |
| 171 | | | | | 104 |
| 172 | | | | POORLY-GRADED SAND w\ GRAVEL (SP), very dark green, | 55 |
| 173 | | | | wet, med. dense fine to very fine sand | 57 |
| 174 | | | | | 37 |
| 175 | | 1006 | | making great amounts of water - sand washing out of sample | 46 |
| 176 | | | | | 42 |
| 177 | | | | | 57 |
| 178 | | | | | 34 |
| 179 | 94M1 | | | | 36 |
| 180 | 110-215' | 1014 | | | 40 |
| 181 | SK | | | | 28 |
| 182 | | | | | 27 |
| 183 | | | | | 54 |
| 184 | | | | | 41 |
| 185 | | 1018 | | | 72 |
| 186 | | | | | 41 |
| 187 | | | | | 76 |
| 188 | | | | | 81 |
| 189 | | | | CEMENTED, WELL-GRADED SAND w\ GRAVEL (GW), | 140 |
| 190 | | 1034 | | very dark green, wet, very dense, tr. silt, well cemented, | 184 |
| 191 | | | | less water | 180 |
| 192 | | | | | 180 |
| 193 | | | | | 180 |
| 194 | | | | | 180 |
| 195 | | 1058 | | | 180 |
| 196 | | | | | 125 |
| 197 | | | | | 180 |
| 198 | | | | | 180 |
| 199 | | | | | 180 |
| 200 | | 1126 | | | 94 |

SAMPLE TYPES: B = BAG SAMPLE ST = SHELBY TUBE SS = SPLIT SPOON SK = BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

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## *BORING LOG*

**DAVID J. NEWTON** ASSOCIATES, INC.
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE SUITE 400 [illegible]
PORTLAND, OREGON [illegible] FAX [illegible]

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M1
**PROJECT:** Lone Star - Meier Property
**LOCATION:** SE portion Meier prop.
**TOTAL DEPTH:** 215 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 13 ft. MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/25/94
**FINISH DATE:** 1/27/94
**WATER LEVEL AND TIME:** 17 ft. @ 1125 1/25
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 201 | | | | WELL-GRADED GRAVEL w\ SILT & SAND (GW-GM), dark green, med. dense to very dense, tr. cement, hard silt chunks | 58 |
| 202 | | | | | 61 |
| 203 | | | | | 49 |
| 204 | | | | | 180 |
| 205 | | 1137 | | | 156 |
| 206 | 94M1 | | | CEMENTED, WELL-GRADED SAND w\GRAVEL (SW), dark green, wet, med. dense to dense, cemented: very gravelly, grades between (SW ) and WELL-GRADED GRAVEL w\ SAND (GW), as above but dense to very dense | 45 |
| 207 | 110-215' | | | | 50 |
| 208 | SK | | | | 48 |
| 209 | | | | | 78 |
| 210 | | 1147 | | | 126 |
| 211 | | | | | 180 |
| 212 | | | | | 135 |
| 213 | | | | | 127 |
| 214 | | | | | 180 |
| 215 | | | | | 180 |
| 216 | | | | TD @ 215 ft. at 1204 | |
| 217 | | | | 1/27/94 | |
| 218 | | | | | |
| 219 | | | | | |
| 220 | | | | | |
| 221 | | | | | |
| 222 | | | | | |
| 223 | | | | | |
| 224 | | | | | |
| 225 | | | | | |
| 226 | | | | | |
| 227 | | | | | |
| 228 | | | | | |
| 229 | | | | | |
| 230 | | | | | |
| 231 | | | | | |
| 232 | | | | | |
| 233 | | | | | |
| 234 | | | | | |
| 235 | | | | | |
| 236 | | | | | |
| 237 | | | | | |
| 238 | | | | | |
| 239 | | | | | |
| 240 | | | | | |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

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## BORING LOG

**DAVID J. NEWTON** ASSOCIATES, INC.
CIVIL & GEOLOGICAL ENGINEERING SERVICES

| | | |
|---|---|---|
| **PROJECT NUMBER:** 420-106 | | **BORING NUMBER:** 94M2 |
| **PROJECT:** | Lone Star - Meier Property | |
| **LOCATION:** SW portion Meier prop | **TOTAL DEPTH:** 135 ft | **DIAMETER:** 6 5/8 in. |
| **ELEVATION:** appx. 36 ft MSL | **DRILLING CONTRACTOR:** | Beck Environmental |
| **METHOD:** Becker hammer drill | **START DATE:** 1/28/94 | **FINISH DATE:** 1/31/94 |
| **WATER LEVEL AND TIME:** 37 ft @ | 1038 1/28 **LOGGED BY:** | J. Lawes |

| SAMPLE | | | | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | TIME | GRAPHIC LOG | | Blow Counts |
| 1 | | 949 | | SILT w\ GRAVEL (ML), brown, moist, hard, tr. sand, low plasticity, subangular to rounded gravels to 3 in. max. (upper 6 in. topsoil) | 2 |
| 2 | | | | | 18 |
| 3 | | | | | 65 |
| 4 | | | | | 44 |
| 5 | | 951 | | | 63 |
| 6 | | | | | 46 |
| 7 | | | | | 59 |
| 8 | | | | | 69 |
| 9 | | | | | 74 |
| 10 | | 1005 | | | 91 |
| 11 | | | | WELL-GRADED GRAVEL w SILT & SAND (GW-GM), brow damp, med. dense to dense, occ. boulders to >10 in. max. | 45 |
| 12 | | | | | 53 |
| 13 | | | | | 38 |
| 14 | | | | | 57 |
| 15 | | 1007 | | | 92 |
| 16 | | | | | 41 |
| 17 | | | | | 50 |
| 18 | | | | | 84 |
| 19 | 94M2 | | | | 93 |
| 20 | 0-50'/60-80' | 1016 | | | 50 |
| 21 | SK | | | | 78 |
| 22 | | | | | 91 |
| 23 | | | | | 63 |
| 24 | | | | | 27 |
| 25 | | 1022 | | | 161 |
| 26 | | | | | 107 |
| 27 | | | | | 58 |
| 28 | | | | | 51 |
| 29 | | | | less silt - trace | 82 |
| 30 | | 1033 | | | 85 |
| 31 | | | | | 99 |
| 32 | | | | | 47 |
| 33 | | | | WELL-GRADED GRAVEL w\ SAND (GW), brown, moist, med. dense, much pea gravel, occ. cobbles to 8 in. max, tr. silt | 29 |
| 34 | | | | | 43 |
| 35 | | 1036 | | | 26 |
| 36 | | | | | 17 |
| 37 | | ▽ | | becomes wet | 15 |
| 38 | | | | | 8 |
| 39 | | | | | 64 |
| 40 | | 1044 | | | 51 |

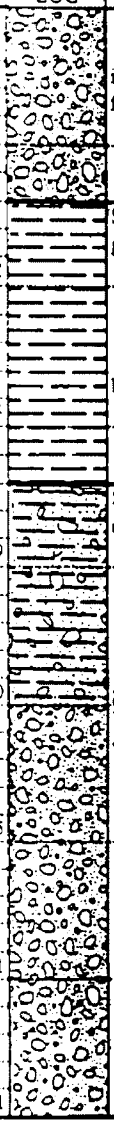
SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

## *BORING LOG*

**DAVID J. NEWTON ASSOCIATES, INC.**
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE, SUITE 400
PORTLAND OREGON 97205

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M2
**PROJECT:** Lone Star - Meier Property
**LOCATION:** SW portion Meier prop
**TOTAL DEPTH:** 135 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 36 ft MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/28/94
**FINISH DATE:** 1/31/94
**WATER LEVEL AND TIME:** 37 ft. @ 1038 1/28
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 41 | | |  | | 35 |
| 42 | | | | | 24 |
| 43 | | | | interbeds of SILT (ML) or SILT w\ GRAVEL (ML), grey, moist firm to hard, mod. plasticity, tr. sand | 19 |
| 44 | 94M2 | | | | 8 |
| 45 | 0-50'/60-80' | 1045 | | | 16 |
| 46 | SK | | | | 41 |
| 47 | | | | | 46 |
| 48 | | | | SILT (ML), grey, moist to wet, hard, mod. plasticity, occ. gravel, tr. sand | 17 |
| 49 | | | | | 14 |
| 50 | | 1052 | | | 6 |
| 51 | | | | | 5 |
| 52 | | | | | 7 |
| 53 | | | | | 7 |
| 54 | 94M2 | | | becomes damp | 16 |
| 55 | 50-60' | 1053 | | | 14 |
| 56 | SK | | | | 12 |
| 57 | | | | | 29 |
| 58 | | | | SILTY GRAVEL w\ SAND (GM), grey, damp to wet, med. dense to dense | 72 |
| 59 | | | | | 80 |
| 60 | | 1059 | | | 49 |
| 61 | | | | | 105 |
| 62 | | | | | 180 |
| 63 | | | | | 86 |
| 64 | | | | | 180 |
| 65 | | 1120 | | grades to | 180 |
| 66 | | | | WELL-GRADED GRAVEL w\ SAND (GW), bronze-brown, wet, dense to very dense, tr. silt | 28 |
| 67 | | | | | 37 |
| 68 | | | | | 60 |
| 69 | 94M2 | | | | 145 |
| 70 | 0-50'/60-80' | 1135 | | | 125 |
| 71 | SK | | | | 65 |
| 72 | | | | | 59 |
| 73 | | | | | 50 |
| 74 | | | | | 78 |
| 75 | | 1141 | | | 102 |
| 76 | | | | | 70 |
| 77 | | | | | 63 |
| 78 | | | | | 77 |
| 79 | | | | | 92 |
| 80 | | 1151 | | | 31 |

SAMPLE TYPES: B = BAG SAMPLE ST = SHELBY TUBE SS = SPLIT SPOON SK = BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

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## *BORING LOG*

**DAVID J. NEWTON** ASSOCIATES INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE SUITE 400 [illegible]
PORTLAND OREGON [illegible] FAX [illegible]

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M2
**PROJECT:** Lone Star - Meier Property
**LOCATION:** SW portion Meier prop
**TOTAL DEPTH:** 135 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 36 ft. MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/28/94
**FINISH DATE:** 1/31/94
**WATER LEVEL AND TIME:** 37 ft @ 1038 1/28
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 81 | | | | | 18 |
| 82 | | | | traces of brown (weathered?) cement | 23 |
| 83 | | | | | 31 |
| 84 | | | | | 96 |
| 85 | | 1155 | | becomes weakly cemented, brown | 85 |
| 86 | | | | | 57 |
| 87 | | | | | 116 |
| 88 | | | | | 180 |
| 89 | | | | | 74 |
| 90 | | 1235 | | | 118 |
| 91 | | | | | 103 |
| 92 | | | | Shut down@ 1239 1/28 Drilling @ 925 1/31 | 77 |
| 93 | | | | | 154 |
| 94 | | | | CEMENTED, WELL-GRADED SAND w\ GRAVEL (SW), | 180 |
| 95 | | 945 | | brown to bronze-brown, wet, very dense, well cemented, tr. silt | 180 |
| 96 | | | | | 180 |
| 97 | | | | | 180 |
| 98 | | | | | 180 |
| 99 | 94M2 | | | | 180 |
| 100 | 80-135' | 1009 | | | 120 |
| 101 | SK | | | | 180 |
| 102 | | | | becomes less well cemented | 180 |
| 103 | | | | | 134 |
| 104 | | | | | 147 |
| 105 | | 1026 | | | 85 |
| 106 | | | | | 121 |
| 107 | | | | | 178 |
| 108 | | | | | 116 |
| 109 | | | | POORLY-GRADED SAND w\ GRAVEL (SP), bronze-brown, | 33 |
| 110 | | 1039 | | wet, med. dense to dense, tr silt, occ. cement | 31 |
| 111 | | | | | 165 |
| 112 | | | | | 22 |
| 113 | | | | | 23 |
| 114 | | | | | 17 |
| 115 | | 1042 | | CEMENTED, WELL-GRADED SAND w\ GRAVEL (SW), | 90 |
| 116 | | | | brown, occ. grey-brown, wet, dense to very dense, cemented | 102 |
| 117 | | | | | 126 |
| 118 | | | | | 67 |
| 119 | | | | very sandy | 162 |
| 120 | | 1057 | | | 180 |

SAMPLE TYPES: B = BAG SAMPLE ST = SHELBY TUBE SS = SPLIT SPOON SK = BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

## BORING LOG

**DAVID J. NEWTON ASSOCIATES, INC.**
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE, SUITE 400 503 228-7718
PORTLAND OREGON 97205 FAX 503 228-7781

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M2
**PROJECT:** Lone Star - Meier Property
**LOCATION:** SW portion Meier prop.
**TOTAL DEPTH:** 135 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 36 ft. MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/28/94
**FINISH DATE:** 1/31/94
**WATER LEVEL AND TIME:** 37 ft. @ 1038 1/28
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 121 | | |  | | 48 |
| 122 | | | | | 67 |
| 123 | | | | | 148 |
| 124 | | | | well cemented, very dense | 163 |
| 125 | | 1106 | | | 191 |
| 126 | | | | | 188 |
| 127 | 94M2 | | | | 123 |
| 128 | 80-140' | | | | 97 |
| 129 | SK | | | | 180 |
| 130 | | 1124 | | | 122 |
| 131 | | | | | 180 |
| 132 | | | | | 180 |
| 133 | | | | | 141 |
| 134 | | | | | 180 |
| 135 | | | | | 183 |
| 136 | | | | TD @ 135 ft. at 1142 | |
| 137 | | | | 1/31/94 | |
| 138 | | | | | |
| 139 | | | | | |
| 140 | | | | | |
| 141 | | | | | |
| 142 | | | | | |
| 143 | | | | | |
| 144 | | | | | |
| 145 | | | | | |
| 146 | | | | | |
| 147 | | | | | |
| 148 | | | | | |
| 149 | | | | | |
| 150 | | | | | |
| 151 | | | | | |
| 152 | | | | | |
| 153 | | | | | |
| 154 | | | | | |
| 155 | | | | | |
| 156 | | | | | |
| 157 | | | | | |
| 158 | | | | | |
| 159 | | | | | |
| 160 | | | | | |

SAMPLE TYPES: B = BAG SAMPLE ST = SHELBY TUBE SS = SPLIT SPOON SK = BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

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# BORING LOG

DAVID J. NEWTON ASSOCIATES, INC.
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE SUITE 400 [illegible]
PORTLAND, OREGON [illegible] FAX [illegible]

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M3
**PROJECT:** Lone Star - Meier Property
**LOCATION:** W side Meier prop
**TOTAL DEPTH:** 118 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 39 ft MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/31/94
**FINISH DATE:** 2/1/94
**WATER LEVEL AND TIME:** 37 ft. @ 1521 1/31
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 1 | | 1447 | | SILT (ML), black, moist, soft, root hairs (topsoil) | 2 |
| 2 | | | | WELL-GRADED GRAVEL w\ SAND & SILT (GW-GM), grey-brown, damp, med. dense to dense | 12 |
| 3 | | | | | 48 |
| 4 | | | | | 55 |
| 5 | | 1451 | | | 67 |
| 6 | | | | | 67 |
| 7 | | | | | 74 |
| 8 | | | | | 106 |
| 9 | | | | | 105 |
| 10 | | 1504 | | | 58 |
| 11 | | | | | 73 |
| 12 | | | | less silt | 52 |
| 13 | | | | | 49 |
| 14 | | | | | 52 |
| 15 | | 1507 | | | 58 |
| 16 | | | | | 58 |
| 17 | | | | | 54 |
| 18 | | | | | 43 |
| 19 | 94M3 | | | | 43 |
| 20 | 0-50' | 1513 | | | 45 |
| 21 | SK | | | | 54 |
| 22 | | | | | 33 |
| 23 | | | | | 25 |
| 24 | | | | | 32 |
| 25 | | 1515 | | | 25 |
| 26 | | | | | 24 |
| 27 | | | | | 18 |
| 28 | | | | | 15 |
| 29 | | | | | 16 |
| 30 | | 1420 | | | 22 |
| 31 | | | | | 35 |
| 32 | | | | | 8 |
| 33 | | | | pea gravel, very silty | 16 |
| 34 | | | | | 13 |
| 35 | | 1521 | | | 16 |
| 36 | | | | | 10 |
| 37 | | ▽ | | becomes wet | 12 |
| 38 | | | | | 10 |
| 39 | | | | | 9 |
| 40 | | 1526 | | | 14 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

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# *BORING LOG*

DAVID J. NEWTON ASSOCIATES, INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE SUITE 400
PORTLAND OREGON 97205

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M3
**PROJECT:** Lone Star - Meier Property
**LOCATION:** W side Meier prop
**TOTAL DEPTH:** 118 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 39 ft MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/31/94
**FINISH DATE:** 2/1/94
**WATER LEVEL AND TIME:** 37 ft @ 1521 1/31
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 41 | | | | | 15 |
| 42 | | | | | 33 |
| 43 | | | | POORLY-GRADED GRAVEL w\ SAND (GP) grey-brown | 25 |
| 44 | 94M3 | | | wet, loose to med. dense, much pea gravel, occ. gravel | 4 |
| 45 | 0-50' | 1527 | | >4 in. max. dimension | 8 |
| 46 | SK | | | | 9 |
| 47 | | | | | 8 |
| 48 | | | | | 21 |
| 49 | | | | | 17 |
| 50 | | 1531 | | | 20 |
| 51 | | | | | 15 |
| 52 | | | | | 24 |
| 53 | | | | Shut down @ 1533 1/31 Drilling @ 851 2/1 | 23 |
| 54 | | | | | 13 |
| 55 | | 900 | | | 16 |
| 56 | | | | | 30 |
| 57 | | | | | 27 |
| 58 | | | | | 23 |
| 59 | | | | WELL-GRADED GRAVEL w\ SAND & SILT (GW-GM), | 20 |
| 60 | | 916 | | brown to grey-brown, wet, med. dense to dense | 60 |
| 61 | | | | | 180 |
| 62 | | | | | 180 |
| 63 | | | | | 112 |
| 64 | 94M3 | | | | 14 |
| 65 | 50-100' | 947 | | | 34 |
| 66 | SK | | | | 33 |
| 67 | | | | | 145 |
| 68 | | | | | 52 |
| 69 | | | | | 31 |
| 70 | | 1005 | | | 83 |
| 71 | | | | | 115 |
| 72 | | | | | 70 |
| 73 | | | | | 71 |
| 74 | | | | | 47 |
| 75 | | 1010 | | | 74 |
| 76 | | | | | 45 |
| 77 | | | | | 56 |
| 78 | | | | | 54 |
| 79 | | | | | 61 |
| 80 | | 1020 | | | 65 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

## BORING LOG

DAVID J. NEWTON ASSOCIATES INC
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1301 SW 12TH AVENUE SUITE 400 503 226-1118
PORTLAND OREGON 97205 FAX 503 226-7791

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M3
**PROJECT:** Lone Star - Meier Property
**LOCATION:** W side Meier prop
**TOTAL DEPTH:** 118 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 39 ft MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 1/31/94
**FINISH DATE:** 2/1/94
**WATER LEVEL AND TIME:** 37 ft @ 1521 1/31
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 81 | | | | much sand - almost WELL-GRADED SAND w\ GRAVEL (SW), similar to above | 135 |
| 82 | | | | | 54 |
| 83 | | | | | 50 |
| 84 | | | | | 60 |
| 85 | | 1024 | | | 64 |
| 86 | | | | | 52 |
| 87 | | | | | 68 |
| 88 | | | | | 77 |
| 89 | 94M3 | | | | 114 |
| 90 | 50-100' | 1034 | | | 58 |
| 91 | SK | | | | 35 |
| 92 | | | | | 36 |
| 93 | | | | | 24 |
| 94 | | | | | 59 |
| 95 | | 1037 | | | 69 |
| 96 | | | | CEMENTED, WELL-GRADED SAND w\ GRAVEL (SW), grey to grey-brown, wet, dense to very dense, cemented to weakly cemented | 141 |
| 97 | | | | | 78 |
| 98 | | | | | 104 |
| 99 | | | | | 53 |
| 100 | | 1052 | | | 119 |
| 101 | | | | | 85 |
| 102 | | | | | 70 |
| 103 | | | | | 11 |
| 104 | | | | becomes green to grey-green | 76 |
| 105 | | 1059 | | | 73 |
| 106 | | | | very green | 88 |
| 107 | | | | | 73 |
| 108 | 94M3 | | | | 69 |
| 109 | 100-118' | | | | 78 |
| 110 | SK | 1113 | | | 84 |
| 111 | | | | well cemented | 111 |
| 112 | | | | | 78 |
| 113 | | | | | 156 |
| 114 | | | | | 87 |
| 115 | | 1126 | | | 121 |
| 116 | | | | | 110 |
| 117 | | | | | 87 |
| 118 | | | | | 188 |
| 119 | | | | TD @ 188ft. at 1133 | |
| 120 | | | | 2/1/94 | |

SAMPLE TYPES: B = BAG SAMPLE ST = SHELBY TUBE SS = SPLIT SPOON SK = BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

Page 3 of 3

# BORING LOG

| | | |
|---|---|---|
| DAVID J. NEWTON ASSOCIATES, INC<br>CIVIL & GEOLOGICAL ENGINEERING SERVICES | **PROJECT NUMBER:** 420-106 | **BORING NUMBER:** 94M4 |
| | **PROJECT:** Lone Star - Meier Property | |
| **LOCATION:** NE portion Meier prop | **TOTAL DEPTH:** 145 ft | **DIAMETER:** 6 5/8 in. |
| **ELEVATION:** appx. 27 ft MSL | **DRILLING CONTRACTOR:** | Beck Environmental |
| **METHOD:** Becker hammer drill | **START DATE:** 2/1/94 | **FINISH DATE:** 2/2/94 |
| **WATER LEVEL AND TIME:** 27 ft @ | 1507 2/1/94 **LOGGED BY:** | J. Lawes |

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 1 | | 1432 |  | WELL-GRADED GRAVEL w\ SAND (GW), brown, moist, | 4 |
| 2 | | | | loose to med. dense, tr. silt, rounded gravels to > 4 in. max. | 37 |
| 3 | | | | dimensions | 22 |
| 4 | | | | | 17 |
| 5 | | 1436 | | | 12 |
| 6 | | | | | 10 |
| 7 | | | | | 18 |
| 8 | | | | | 37 |
| 9 | | | | | 49 |
| 10 | | 1443 | | | 48 |
| 11 | | | | becomes grey-brown | 58 |
| 12 | | | | | 57 |
| 13 | | | | | 63 |
| 14 | | | | | 59 |
| 15 | | 1446 | | | 47 |
| 16 | | | | | 43 |
| 17 | | | | | 44 |
| 18 | | | | | 56 |
| 19 | 94M4 | 1500 | | | 56 |
| 20 | 0-50' | | | | 48 |
| 21 | SK | | | | 81 |
| 22 | | | | sandier | 52 |
| 23 | | | | | 58 |
| 24 | | 1503 | | | 59 |
| 25 | | | | | 67 |
| 26 | | | | grades to | 38 |
| 27 | | ∇ | | SILTY GRAVEL w\ SAND (GM), brown, wet, loose to med. | 31 |
| 28 | | | | dense | 12 |
| 29 | | | | | 11 |
| 30 | | 1508 | | | 9 |
| 31 | | | | | 10 |
| 32 | | | | | 22 |
| 33 | | | | | 29 |
| 34 | | | | | 21 |
| 35 | | 1509 | | | 8 |
| 36 | | | | | 7 |
| 37 | | | | | 12 |
| 38 | | | | | 15 |
| 39 | | | | | 7 |
| 40 | | 1513 | | | 7 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

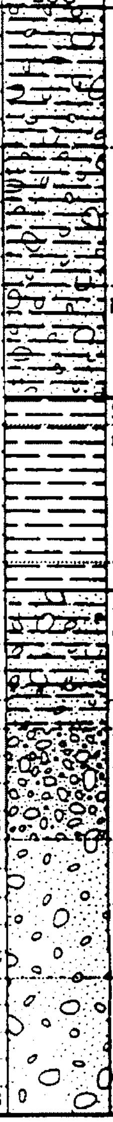
Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

Page 1 of 4

## *BORING LOG*

**DAVID J. NEWTON ASSOCIATES, INC.**
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE SUITE 400
PORTLAND OREGON 97205

**PROJECT NUMBER:** 420-106
**BORING NUMBER:** 94M4
**PROJECT:** Lone Star - Meier Property
**LOCATION:** NE portion Meier prop
**TOTAL DEPTH:** 145 ft.
**DIAMETER:** 6 5/8 in.
**ELEVATION:** appx. 27 ft MSL
**DRILLING CONTRACTOR:** Beck Environmental
**METHOD:** Becker hammer drill
**START DATE:** 2/1/94
**FINISH DATE:** 2/2/94
**WATER LEVEL AND TIME:** 27 ft. @ 1507 2/1/94
**LOGGED BY:** J. Lawes

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 41 | | |  | | 10 |
| 42 | | | | | 9 |
| 43 | | | | | 7 |
| 44 | 94M4 | | | | 6 |
| 45 | 0-50' | 1514 | | | 8 |
| 46 | SK | | | | 8 |
| 47 | | | | | 15 |
| 48 | | | | | 12 |
| 49 | | | | | 10 |
| 50 | | 1521 | | | 13 |
| 51 | | | | pea gravels | 33 |
| 52 | | | | | 30 |
| 53 | | | | | 33 |
| 54 | | | | | 12 |
| 55 | | 1526 | | SILT (ML) light grey w\ brown mottling, wet, soft, tr. sand, low mod. plasticity | 5 |
| 56 | | | | | 4 |
| 57 | | | | | 5 |
| 58 | | | | | 5 |
| 59 | 94M4 | | | | 10 |
| 60 | 50-70' | 1529 | | | 7 |
| 61 | SK | | | | 8 |
| 62 | | | | SILTY GRAVEL w\ SAND(GM), grey, wet, loose to med. dense | 15 |
| 63 | | | | | 21 |
| 64 | | | | | 18 |
| 65 | | 1531 | | | 14 |
| 66 | | | | | 19 |
| 67 | | | | WELL-GRADED GRAVEL w\ SAND (GW), grey-brown, wet, med. dense to dense, tr. silt - almost 50% sand | 24 |
| 68 | | | | | 22 |
| 69 | | | | | 56 |
| 70 | | 1538 | | | 52 |
| 71 | | | | very sandy, grades to WELL-GRADED SAND w\ GRAVEL (SW), grey to grey-brown, wet, med. dense, tr. silt | 31 |
| 72 | | | | | 30 |
| 73 | | | | | 37 |
| 74 | 94M4 | | | | 39 |
| 75 | 70-120' | 1547 | | | 39 |
| 76 | SK | | | | 27 |
| 77 | | | | | 28 |
| 78 | | | | | 24 |
| 79 | | | | | 19 |
| 80 | | 1553 | | | 30 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

**Page 2 of 4**

## BORING LOG

**DAVID J. NEWTON ASSOCIATES INC**
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE, SUITE 400
PORTLAND OREGON 97205

| | | | |
|---|---|---|---|
| **PROJECT NUMBER:** 420-106 | | **BORING NUMBER:** 94M4 | |
| **PROJECT:** | Lone Star - Meier Property | | |
| **LOCATION:** | NE portion Meier prop | **TOTAL DEPTH:** | 145 ft. |
| | | **DIAMETER:** | 6 5/8 in. |
| **ELEVATION:** | appx. 27 ft MSL | **DRILLING CONTRACTOR:** | Beck Environmental |
| **METHOD:** | Becker hammer drill | **START DATE:** | 2/1/94 |
| | | **FINISH DATE:** | 2/2/94 |
| **WATER LEVEL AND TIME:** | 27 ft @ 1507 2/1/94 | **LOGGED BY:** | J. Lawes |

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 81 | | | | POORLY-GRADED SAND w\ GRAVEL (SP), grey to grey- | 23 |
| 82 | | | | brown, wet, med. dense, tr. silt, much gravel (40-50%) | 22 |
| 83 | | | | | 20 |
| 84 | | | | Shut down @ 1556 2/1 Drilling @ 834 2/2 | 47 |
| 85 | | 834 | | | 35 |
| 86 | | | | | 57 |
| 87 | | | | | 68 |
| 88 | | | | | 50 |
| 89 | | | | very dark brown, < 30% gravel | 38 |
| 90 | | 851 | | | 75 |
| 91 | | | | | 96 |
| 92 | | | | | 55 |
| 93 | | | | | 87 |
| 94 | | | | | 13 |
| 95 | | 859 | | | 26 |
| 96 | | | | | 86 |
| 97 | | | | | 112 |
| 98 | | | | | 47 |
| 99 | 94M4 | | | | 71 |
| 100 | 70-120' | 922 | | | 175 |
| 101 | SK | | | | 118 |
| 102 | | | | large boulders | 180 |
| 103 | | | | | 180 |
| 104 | | | | | 180 |
| 105 | | 940 | | | 180 |
| 106 | | | | | 147 |
| 107 | | | | | 180 |
| 108 | | | | | 97 |
| 109 | | | | | 29 |
| 110 | | 1019 | | | 46 |
| 111 | | | | | 78 |
| 112 | | | | | 117 |
| 113 | | | | traces of cement, brown (weathered?) | 180 |
| 114 | | | | | 180 |
| 115 | | 1027 | | | 141 |
| 116 | | | | | 126 |
| 117 | | | | | 180 |
| 118 | | | | | 162 |
| 119 | | | | | 124 |
| 120 | | 1047 | | | 65 |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

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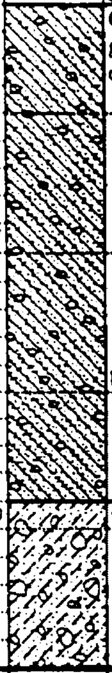
## *BORING LOG*

| | | |
|---|---|---|
| DAVID J. NEWTON ASSOCIATES, INC<br>CIVIL & GEOLOGICAL ENGINEERING SERVICES<br>1201 SW 12TH AVENUE SUITE 400 503 228-7718<br>PORTLAND OREGON 97205 FAX 503 228-7761 | **PROJECT NUMBER: 420-106**<br>**PROJECT:** Lone Star - Meier Property | **BORING NUMBER: 94M4** |
| **LOCATION:** NE portion Meier prop | **TOTAL DEPTH:** 145 ft. | **DIAMETER:** 6 5/8 in. |
| **ELEVATION:** appx. 27 ft MSL | **DRILLING CONTRACTOR:** | Beck Environmental |
| **METHOD:** Becker hammer drill | **START DATE:** 2/1/94 | **FINISH DATE:** 2/2/94 |
| **WATER LEVEL AND TIME:** 27 ft. @ | 1507 2/1/94 **LOGGED BY:** | J. Lawes |

| SAMPLE | | TIME | GRAPHIC LOG | DESCRIPTION | COMMENTS |
|---|---|---|---|---|---|
| DEPTH (ft) | NO. AND TYPE | | | | Blow Counts |
| 121 | | | | grades to | 22 |
| 122 | | |  | CEMENTED, WELL-GRADED GRAVEL w\ SAND (GW), | 31 |
| 123 | | | | grey-brown, wet, med. dense, weak cement, much pea gravel, | 35 |
| 124 | | | | occ. boulder | 39 |
| 125 | | 1048 | | | 30 |
| 126 | | | | | 30 |
| 127 | | | | | 47 |
| 128 | | | | | 42 |
| 129 | 94M4 | | | | 92 |
| 130 | 120-145' | 1057 | | | 46 |
| 131 | SK | | | | 75 |
| 132 | | | | | 42 |
| 133 | | | | | 82 |
| 134 | | | | | 73 |
| 135 | | 1101 | | better cemented, dense | 78 |
| 136 | | | | | 95 |
| 137 | | | | | 94 |
| 138 | | | | | 46 |
| 139 | | | | | 97 |
| 140 | | 1119 | | well cemented, very dense | 180 |
| 141 | | | | | 180 |
| 142 | | | | | 180 |
| 143 | | | | | 180 |
| 144 | | | | | 180 |
| 145 | | | | | 180 |
| 146 | | | | TD @ 145 ft. at 1256 | |
| 147 | | | | 2/2/94 | |
| 148 | | | | | |
| 149 | | | | | |
| 150 | | | | | |
| 151 | | | | | |
| 152 | | | | | |
| 153 | | | | | |
| 154 | | | | | |
| 155 | | | | | |
| 156 | | | | | |
| 157 | | | | | |
| 158 | | | | | |
| 159 | | | | | |
| 160 | | | | | |

SAMPLE TYPES: B - BAG SAMPLE ST - SHELBY TUBE SS - SPLIT SPOON SK - BULK SAMPLE

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

**Page 4 of 4**

# WELL CONSTRUCTION LOGS

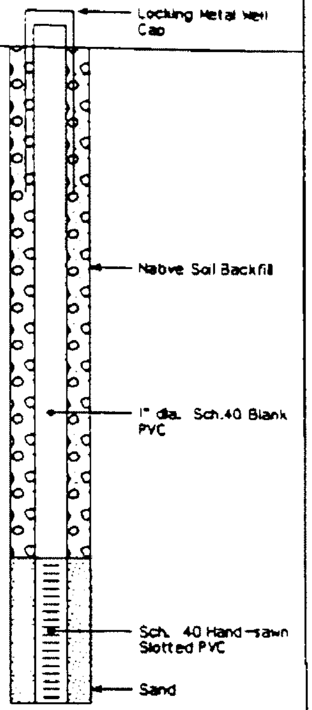
# WELL CONSTRUCTION LOGS

## Monitoring Well No. P-1

| | | |
|---|---|---|
| **PROJECT:** Lone Star Northwest Pit E | **DATE:** 3-31-93 | **LOGGED BY:** John Lawes |
| **EQUIPMENT:** Mitsubishi tracked excavator | **HOLE DIA.:** 48 in. | **SAMPLER:** none |
| **INITIAL GW DEPTH:** 4 ft. | **FINAL GW:** 4 ft. | **HOLE ELEV.:** 9.2 ft. MSL |

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. |
|---|---|---|---|---|---|
| POORLY-GRADED GRAVEL with S[illegible] COBBLY SILTY SAND, brown, loose to medium dense, moist to wet. Cobbles to 10 inches maximum dimension | GP<br>SP | | 0 – 9 | | |
| Bottom of Hole at 9 feet | | | 9 – 15 | | |

WELL CONSTRUCTION DETAIL



**DAVID J. NEWTON ASSOCIATES INCORPORATED**

*Notes:*

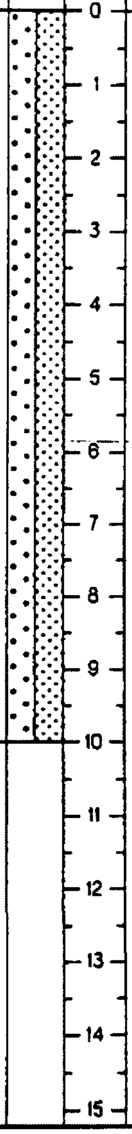
Project No. 420-101

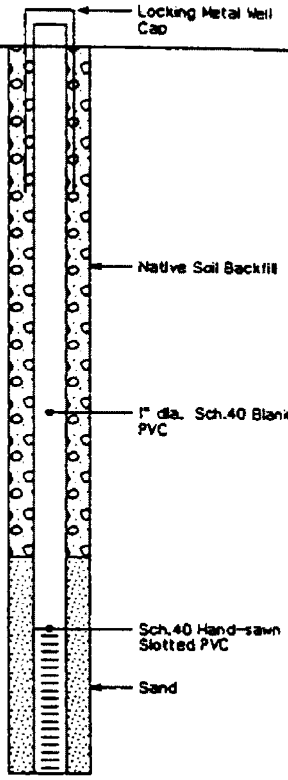
*Page 1 of 1*

# Monitoring Well No. P-2

**PROJECT:** Lone Star Northwest Pit E
**DATE:** 3-31-93
**LOGGED BY:** John Lawes
**EQUIPMENT:** Mitsubishi tracked excavator
**HOLE DIA.:** 48 in.
**SAMPLER:** none
**INITIAL GW DEPTH:** 5 ft.
**FINAL GW:** 5 ft.
**HOLE ELEV.:** 8.4 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | WELL CONSTRUCTION DETAIL |
|---|---|---|---|---|---|---|---|
| POORLY-GRADED GRAVEL with SILT to COBBLY SILTY SAND, brown, loose to medium dense, moist to wet. Cobbles to 12 inches maximum dimension | GP<br>SP | | | | | | |
| Bottom of Hole at 10 feet | | | | | | | |





**DAVID J. NEWTON ASSOCIATES**
INCORPORATED

*Notes:*

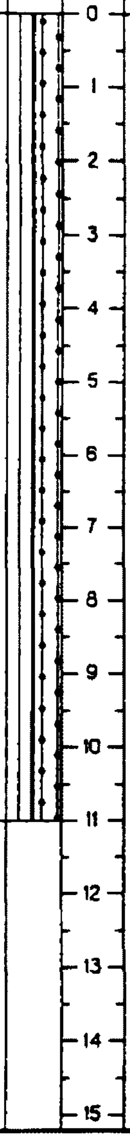
Project No.
420-101

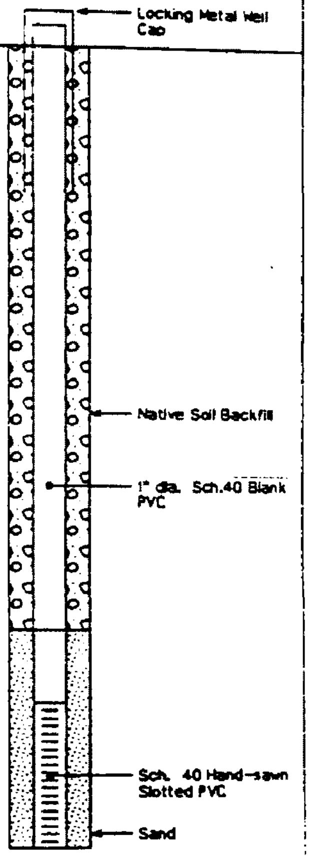
*Page 1 of 1*

# Monitoring Well No. P-3

**PROJECT:** Lone Star Northwest Pit E
**DATE:** 3-31-93
**LOGGED BY:** John Lawes
**EQUIPMENT:** Mitsubishi tracked excavator
**HOLE DIA.:** 48 in.
**SAMPLER:** none
**INITIAL GW DEPTH:** 11 ft.
**FINAL GW:** 11 ft.
**HOLE ELEV.:** 8.0 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | WELL CONSTRUCTION DETAIL |
|---|---|---|---|---|---|---|---|
| SILT with COBBLES AND BOULDERS to SILTY GRAVEL, brown, loose to medium dense, moist to wet. Boulders to 7 feet maximum dimension | ML<br>GM | | 0–11 | | | | |
| Bottom of Hole at 11 feet | | | 11–15 | | | | |





**DAVID J. NEWTON ASSOCIATES INCORPORATED**

*Notes:*

Project No. 420-101

*Page 1 of 1*

# Boring Log No. P-4

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** unknown
**INITIAL GW DEPTH:** 21 ft.

**DATE:** located 3-31-93
**HOLE DIA.:** unknown
**FINAL GW:** 21 ft.

**LOGGED BY:**
**SAMPLER:** none
**HOLE ELEV.:** 27.0 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | REMARKS |
|---|---|---|---|---|---|---|---|
| This piezometer was located by DNA on March 31, 1993. No exploratory boring or piezometer construction details are known | | | 0 | | | | |
| | | | 5 | | | | 2-in. diam. PVC - no well details known |
| | | | 10 | | | | |
| | | | 15 | | | | |
| | | | 20 | | | | |
| | | | 25 | | | | |
| | | | 30 | | | | |
| Bottom of Piezometer at 34 feet | | | 35 | | | | |
| | | | 40 | | | | |
| | | | 45 | | | | |
| | | | 50 | | | | |

**DAVID J. NEWTON ASSOCIATES**
**INCORPORATED**

*Notes:*

Project No.
420-101

*Page 1 of 1*

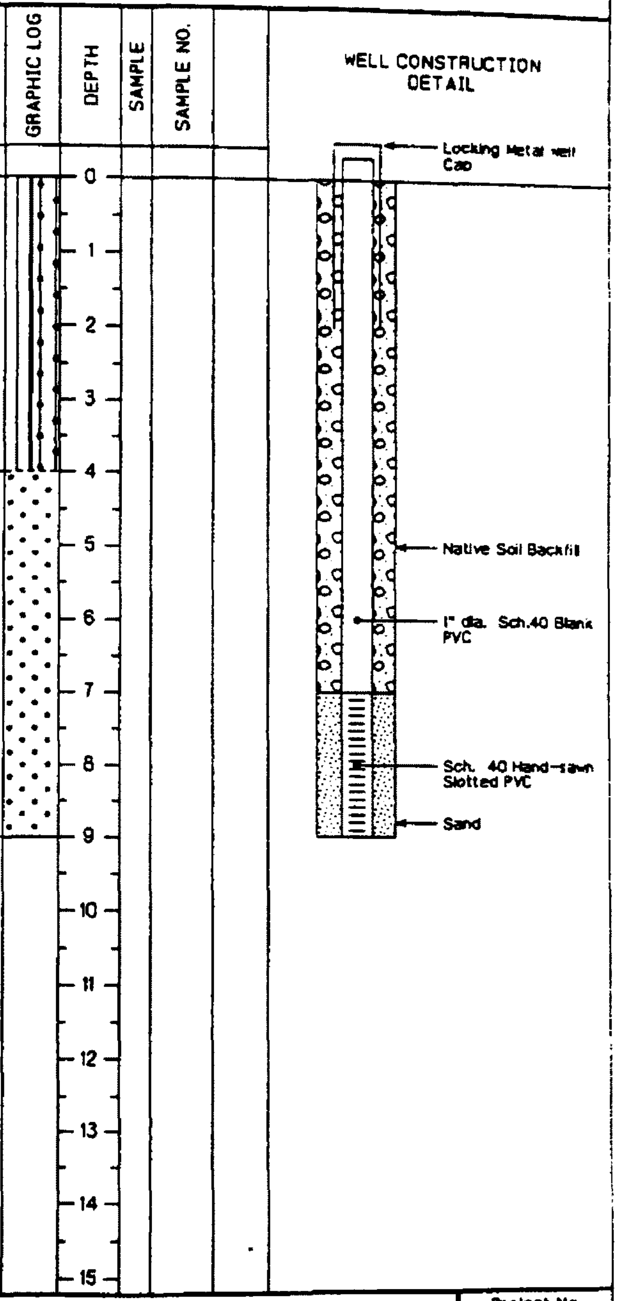
# Monitoring Well No. P-5

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Mitsubishi tracked excavator
**INITIAL GW DEPTH:** 5 ft.

**DATE:** 3-31-93
**HOLE DIA.:** 48 in.
**FINAL GW:** 5 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** 7.2 ft. MSL

| DESCRIPTION | USCS CLASS |
|---|---|
| SILT with COBBLES AND BOULDERS to SILTY GRAVEL, medium brown, loose to medium dense, moist. Cobbles to 8 inches maximum dimension | ML<br>GM |
| POORLY-GRADED GRAVEL, medium brown to medium gray, loose, wet, sides caving below 4 feet. Cobbles to 8 inches max. dimension | GP |
| Bottom of Hole at 9 feet | |



**DAVID J. NEWTON ASSOCIATES INCORPORATED**

*Notes:*

Project No. 420-101

*Page 1 of 1*

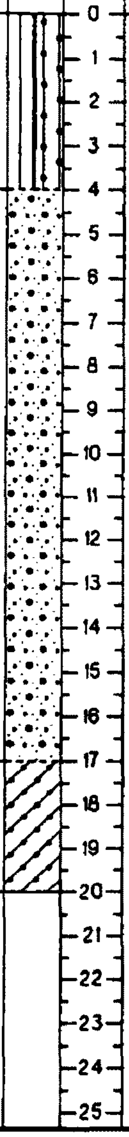
# Monitoring Well No. P-6

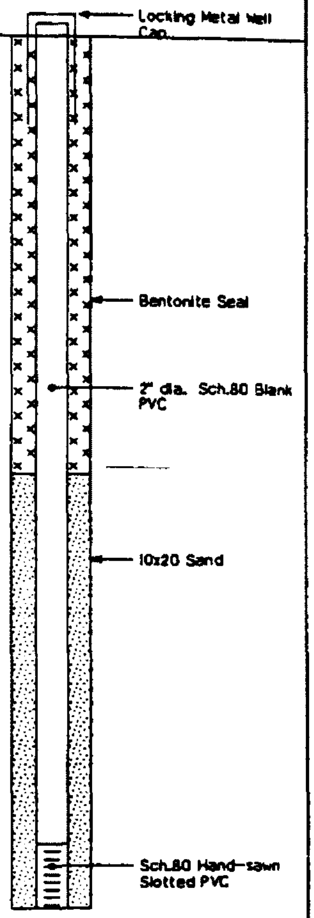
**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Truck-mounted Hollow-stem Auger
**INITIAL GW DEPTH:** 10 ft.

**DATE:** 4-5-93
**HOLE DIA.:** 10 in.
**FINAL GW:** 10 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** 10.0 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | WELL CONSTRUCTION DETAIL |
|---|---|---|---|---|---|---|---|
| SILT with GRAVEL, dark brown, moist, firm to stiff, roots and rounded gravels and cobbles to 4 inches maximum dimension | ML<br>GM | | | | | | |
| WELL-GRADED GRAVEL with SILT, brown, moist to wet, medium dense | GW | | | | | | |
| CLAYEY GRAVEL, grey-brown, wet, medium dense | GC | | | | | | |
| Bottom of Hole at 20 feet | | | | | | | |





**DAVID J. NEWTON ASSOCIATES INCORPORATED**

*Notes:*

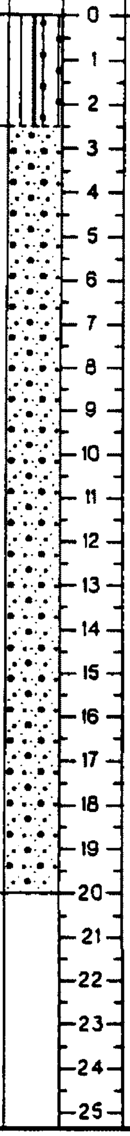
Project No. 420-101

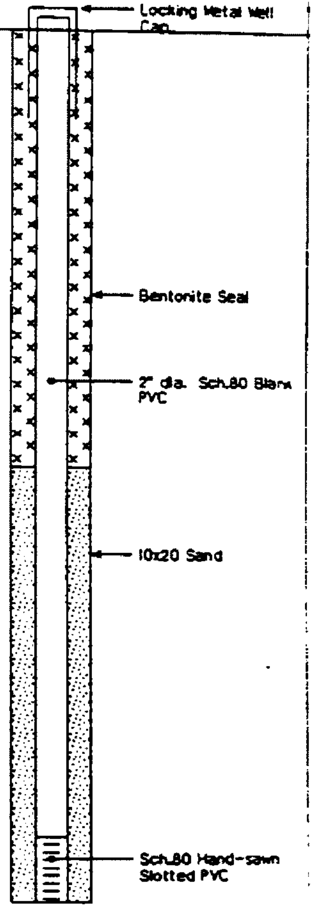
*Page 1 of 1*

# Monitoring Well No. P-7

| | | |
|---|---|---|
| **PROJECT:** Lone Star Northwest Pit E | **DATE:** 4-5-93 | **LOGGED BY:** John Lawes |
| **EQUIPMENT:** Truck-mounted Hollow-stem Auger | **HOLE DIA.:** 10 in. | **SAMPLER:** none |
| **INITIAL GW DEPTH:** 10 ft. | **FINAL GW:** 10 ft. | **HOLE ELEV.:** 11.7 ft. MSL |

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | WELL CONSTRUCTION DETAIL |
|---|---|---|---|---|---|---|---|
| SILT with GRAVEL, dark brown, moist, firm to stiff, roots and rounded gravels and cobbles to 4 inches maximum dimension | ML<br>GM | | | | | | |
| WELL-GRADED GRAVEL with SILT, brown, moist to wet, medium dense | GW | | | | | | |
| Bottom of Hole at 20 feet | | | | | | | |





**DAVID J. NEWTON ASSOCIATES INCORPORATED**

*Notes:*

Project No. 420-101

*Page 1 of 1*

# Boring Log No. P-8

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** unknown
**INITIAL GW DEPTH:** 43 ft.

**DATE:** located 8/93
**HOLE DIA.:** unknown
**FINAL GW:** 43 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** unknown

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. |  | REMARKS |
|---|---|---|---|---|---|---|---|
| This piezometer was located by DNA in August, 1993. No exploratory boring or piezometer construction details are known |  |  | 0 |  |  |  |  |
|  |  |  | 5 |  |  |  | No well details known |
|  |  |  | 10 |  |  |  |  |
|  |  |  | 15 |  |  |  |  |
|  |  |  | 20 |  |  |  |  |
|  |  |  | 25 |  |  |  |  |
|  |  |  | 30 |  |  |  |  |
|  |  |  | 35 |  |  |  |  |
|  |  |  | 40 |  |  |  |  |
|  |  |  | 45 |  |  |  |  |
| Bottom of Piezometer at 46 feet |  |  |  |  |  |  |  |
|  |  |  | 50 |  |  |  |  |

**DAVID J. NEWTON**
**ASSOCIATES**
INCORPORATED

*Notes:*
*Groundwater at 41 feet when found August 1993*

Project No.
420-101

*Page 1 of 1*

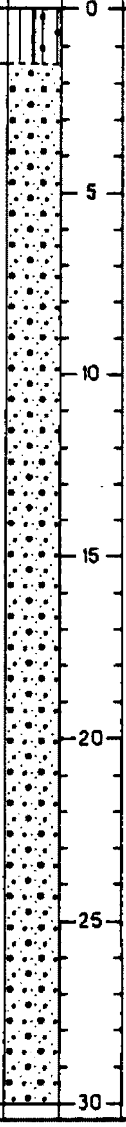
# Monitoring Well No. MW-1

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Truck-mounted Hollow-stem Auger
**INITIAL GW DEPTH:** 31 ft.

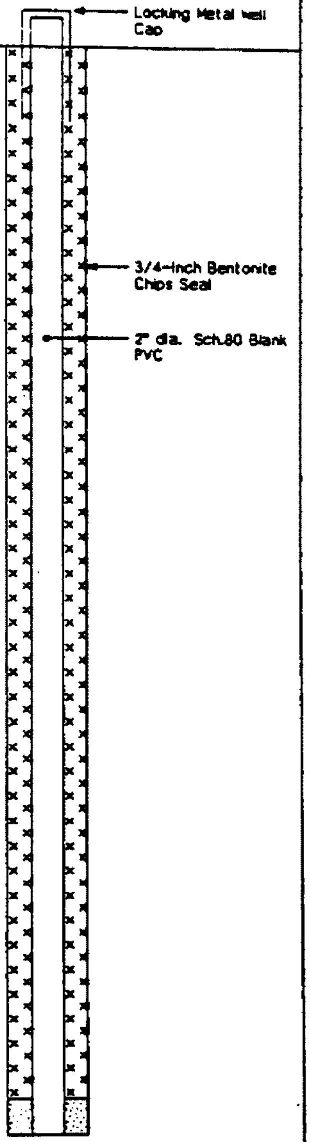
**DATE:** 4-8-93
**HOLE DIA.:** 10 in.
**FINAL GW:** 31 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** approx. 38 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. |
|---|---|---|---|---|---|
| SILT with GRAVEL, black, moist, firm to stiff, roots and rounded gravels and cobbles to 4 inches maximum dimension | ML<br>GM | | 0 | | |
| WELL-GRADED GRAVEL with SILT, brown, moist to wet, medium dense | GW | | | | |



**WELL CONSTRUCTION DETAIL**



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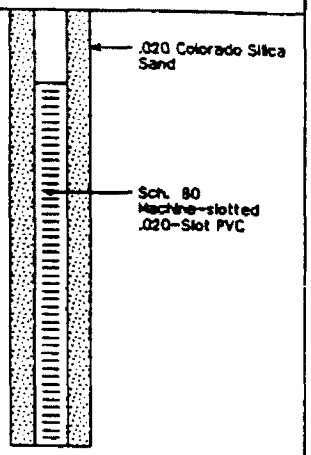
# Monitoring Well No. MW-1

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Truck-mounted Hollow-stem Auger
**INITIAL GW DEPTH:** 31 ft.

**DATE:** 4-8-93
**HOLE DIA.:** 10 in.
**FINAL GW:** 31 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** approx. 38 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | WELL CONSTRUCTION DETAIL |
|---|---|---|---|---|---|---|---|
| (con't)<br>WELL-GRADED GRAVEL with SILT, brown, moist to wet, medium dense | GW | | 30<br>35<br>40 | | | |  |
| Bottom of Hole at 42.5 feet | | | 45<br>50<br>55<br>60 | | | | |

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# Monitoring Well No. MW-2

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Truck-mounted Becker Hammer Drill
**INITIAL GW DEPTH:** 30 ft.

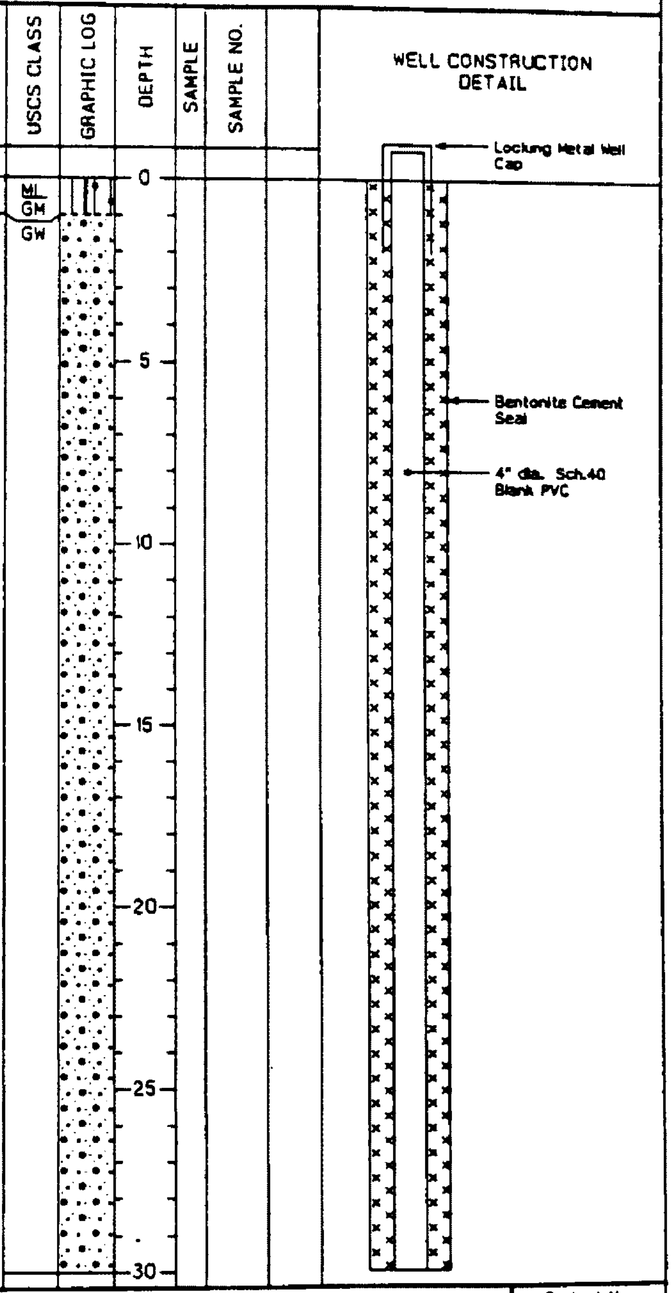
**DATE:** 3-2-94
**HOLE DIA.:** 8 5/8 in.
**FINAL GW:** 30 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** approx. 28 ft. MSL

DESCRIPTION

SILT with GRAVEL, black, moist, firm to stiff, roots and rounded gravels and cobbles to 4 inches maximum dimension

WELL-GRADED GRAVEL with SILT AND SAND, brown, moist to wet, medium dense, cobbles to 10 inches max. dimension



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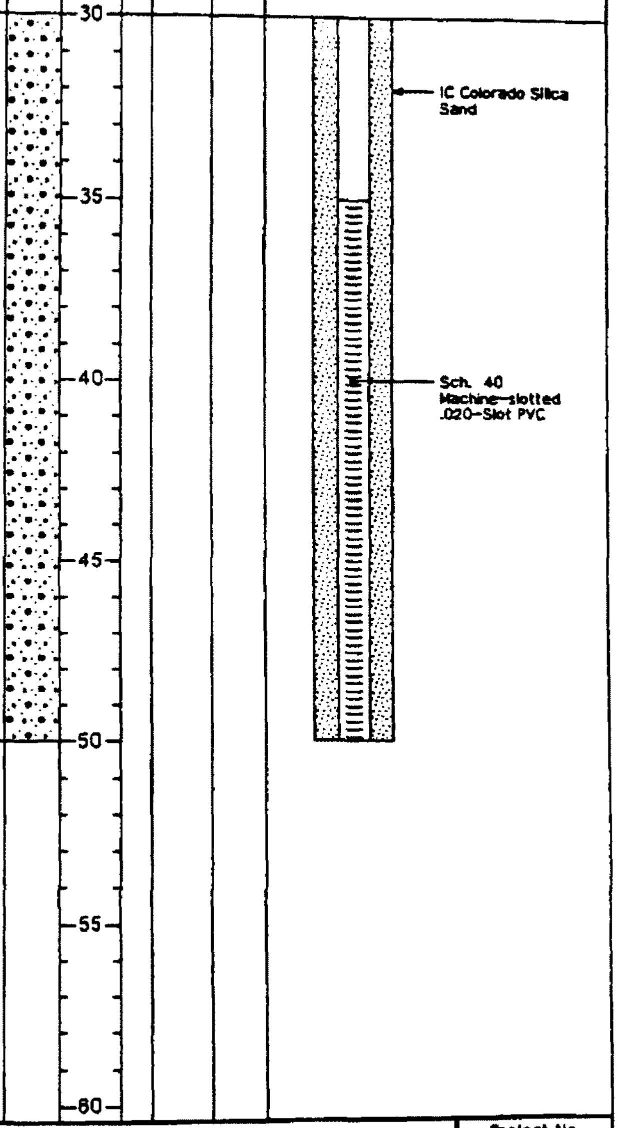
# Monitoring Well No. MW-2

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Truck-mounted Becker Hammer Drill
**INITIAL GW DEPTH:** 30 ft.

**DATE:** 3-2-94
**HOLE DIA.:** 8 5/8 in.
**FINAL GW:** 30 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** approx. 28 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | WELL CONSTRUCTION DETAIL |
|---|---|---|---|---|---|---|---|
| (con't)<br>WELL-GRADED GRAVEL with SILT AND SAND, brown, moist to wet, medium dense, cobbles to 10 inches max. dimension | GW | | 30 | | | | |
| Bottom of Hole at 50 feet | | | 50 | | | | |



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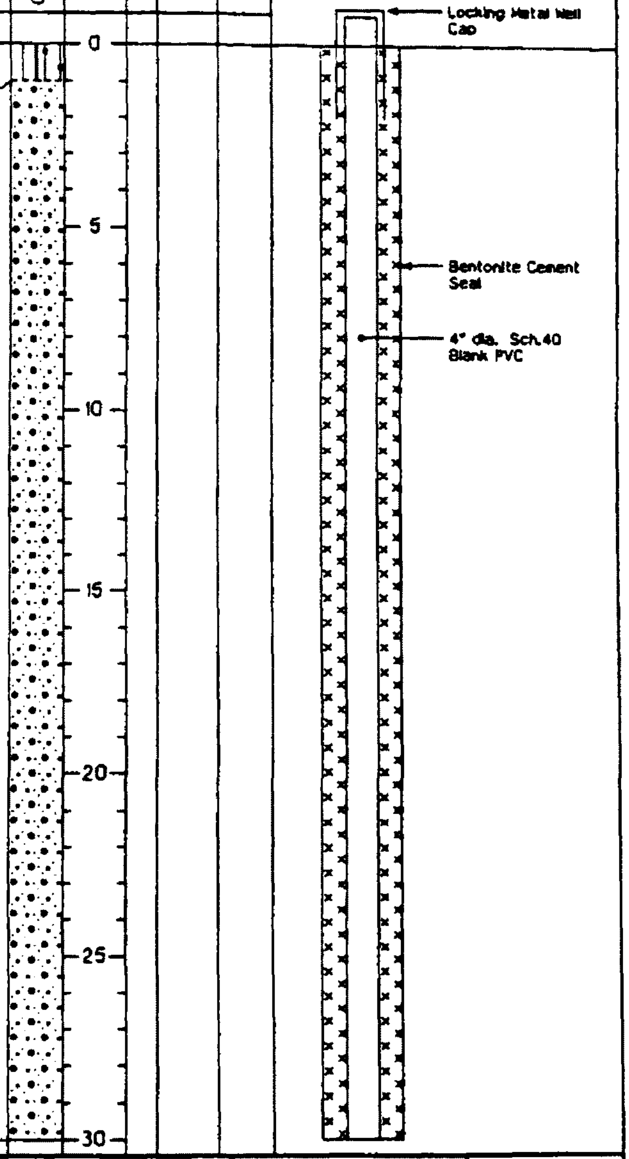
# Monitoring Well No. MW-3

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Truck-mounted Becker Hammer Drill
**INITIAL GW DEPTH:** 30 ft.

**DATE:** 2-28-94
**HOLE DIA.:** 8 5/8 in.
**FINAL GW:** 30 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** approx. 38 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | WELL CONSTRUCTION DETAIL |
|---|---|---|---|---|---|---|---|
| SILT with GRAVEL, black, moist, firm to stiff, roots and rounded gravels and cobbles to 4 inches maximum dimension | ML<br>GM | | | | | | |
| WELL-GRADED GRAVEL with SILT AND SAND, brown, moist to wet, medium dense, cobbles to 10 inches max. dimension | GW | | | | | | |



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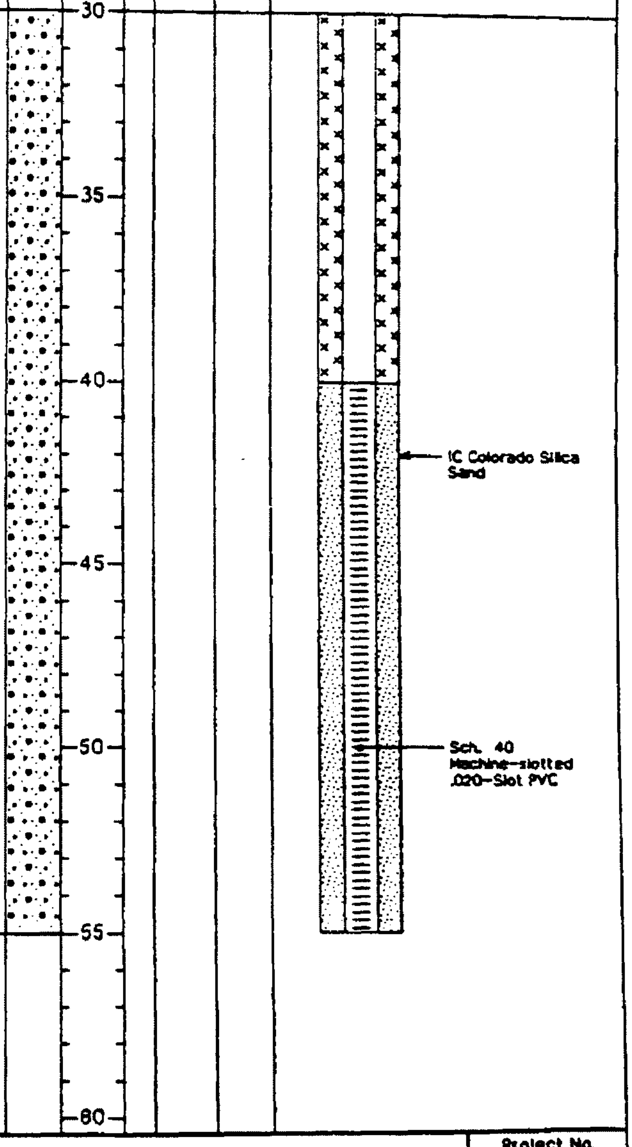
## Monitoring Well No. MW-3

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Truck-mounted Becker Hammer Drill
**INITIAL GW DEPTH:** 30 ft.

**DATE:** 2-28-94
**HOLE DIA.:** 6 5/8 in.
**FINAL GW:** 30 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** approx. 38 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | WELL CONSTRUCTION DETAIL |
|---|---|---|---|---|---|---|---|
| (con't)<br>WELL GRADED GRAVEL with SILT AND SAND, brown, wet, medium dense, cobbles to 10 inches max. dimension | GW | | 30–55 | | | | |
| Bottom of Hole at 55 feet | | | 55–60 | | | | |



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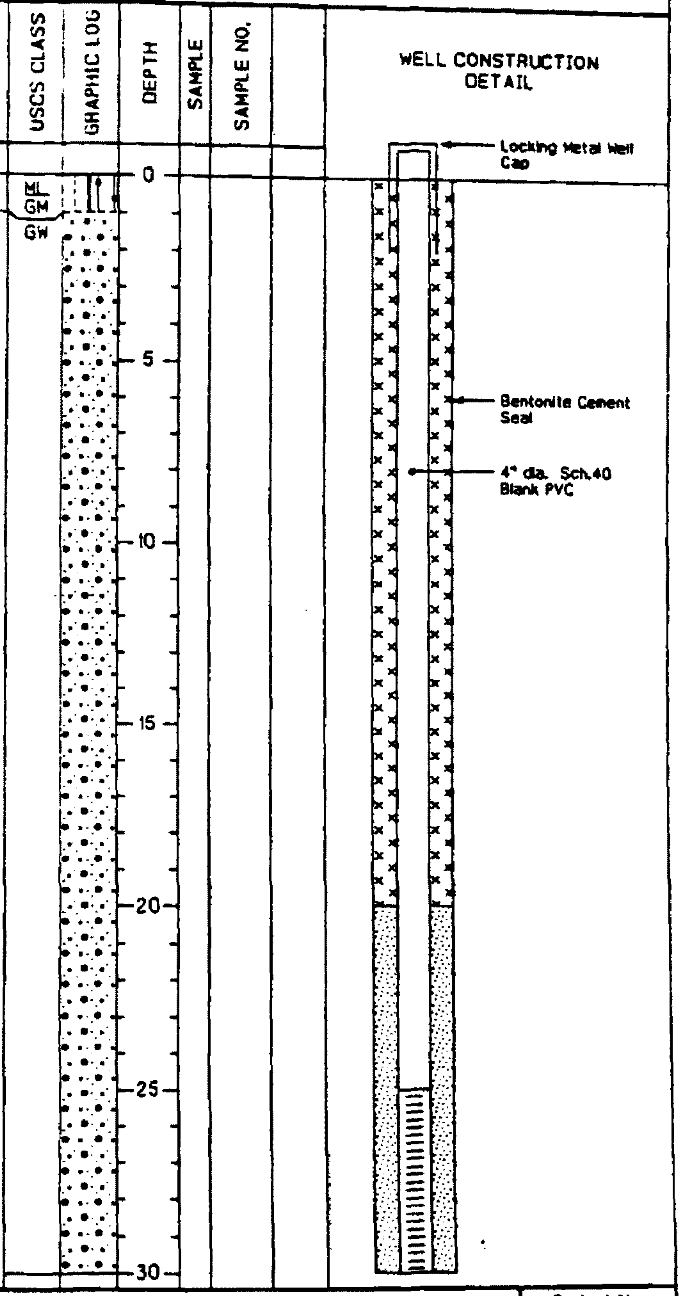
# Monitoring Well No. MW-4

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Truck-mounted Becker Hammer Drill
**INITIAL GW DEPTH:** 30 ft.
**DATE:** 2-25-94
**HOLE DIA.:** 8 5/8 in.
**FINAL GW:** 30 ft.
**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** approx. 38 ft. MSL

DESCRIPTION

SILT with GRAVEL, black, moist, firm to stiff, roots and rounded gravels and cobbles to 4 inches maximum dimension

WELL-GRADED GRAVEL with SILT AND SAND, brown, moist to wet, medium dense, cobbles to 10 inches max. dimension



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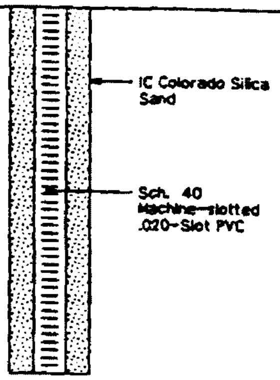
# Monitoring Well No. MW-4

**PROJECT:** Lone Star Northwest Pit E
**EQUIPMENT:** Truck-mounted Becker Hammer Drill
**INITIAL GW DEPTH:** 30 ft.

**DATE:** 2-25-94
**HOLE DIA.:** 6 5/8 in.
**FINAL GW:** 30 ft.

**LOGGED BY:** John Lawes
**SAMPLER:** none
**HOLE ELEV.:** approx. 38 ft. MSL

| DESCRIPTION | USCS CLASS | GRAPHIC LOG | DEPTH | SAMPLE | SAMPLE NO. | | WELL CONSTRUCTION DETAIL |
|---|---|---|---|---|---|---|---|
| (con't)<br>WELL-GRADED GRAVEL with SILT AND SAND, brown, moist to wet, medium dense, cobbles to 10 inches max. dimension | GW | | 30 | | | |  |
| | | | 35 | | | | |
| Bottom of Hole at 40 feet | | | 40 | | | | |
| | | | 45 | | | | |
| | | | 50 | | | | |
| | | | 55 | | | | |
| | | | 60 | | | | |

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# APPENDIX D

# MODFLOW MODEL DETAILS

Disc in Pocket
Disc contains final model MODFLOW design and output files

### MODLFOW Model Results and Comparisons

The following charts contain the results of the MODFLOW models. Each table compares the model output volume from the current-conditions model and the future-conditions model for each simulation date. Sensitivity Analysis was performed by adjusting selected parameters individually in the model. Certain parameters, such as hydraulic conductivity, have a significant impact on the total amount of water which flows through the model. Therefore, the sensitivity of the model to each parameter was analyzed on the basis of it's impact on the percent increase in flow for each current/future model pair. A summary of the sensivity analysis results is given inTable D1, Sensitivity Analysis and Calibration Statistics at the end of this appendix.

### Final Models

15-May-95

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 515c | 6,048,400 | 139 | 50,688 |
| 515f | 6,673,600 | 153 | 55,927 |
| Increase | 625,200 | 14 | 5,239 |
| % Increase | 10.34 | | |

East CH boundary= 4.75
Barge Canal=10.24
Western gw level =8.0
Surface recharge=17 in/yr

22-Sep-95

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 922c | 2,925,400 | 67 | 24,516 |
| 922f | 3,428,500 | 79 | 28,732 |
| Increase | 503,100 | 12 | 4,216 |
| % Increase | 17.20 | | |

East CH boundary= 3.0
Barge Canal=4.37
Western gw level =6.0
Surface recharge=17 in/yr

### Sensivity Analysis Results

15-May-95
**Increased Hydraulic Conductivity**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 515chik | 57,663,000 | 1,324 | 483,239 |
| 515fhik | 63,259,000 | 1,452 | 530,136 |
| Increase | 5,596,000 | 128 | 46,897 |
| % Increase | 9.70 | | |

East CH boundary= 4.75
Barge Canal=10.24
Western gw level =8.0
Surface recharge=17 in/yr
K1 = 12,250

22-Sep-95
**Increased Hydraulic Conductivity**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 922chik | 26,503,000 | 609 | 222,106 |
| 922fhik | 31,031,000 | 712 | 260,052 |
| Increase | 4,528,000 | 104 | 37,946 |
| % Increase | 17.08 | | |

East CH boundary= 3.0
Barge Canal=4.37
Western gw level =6.0
Surface recharge=17 in/yr
K1 = 12,250

15-May-95

**Decreased Hydraulic Conductivity**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 515clok | 976,490 | 22 | 8,183 |
| 515flok | 984,460 | 23 | 8,250 |
| Increase | 7,970 | 0.18 | 67 |
| % Increase | 0.82 | | |

East CH boundary= 4.75
Barge Canal=10.24
Western gw level =8.0
Surface recharge=17 in/yr
K1 = 122.5

22-Sep-95

**Decreased Hydraulic Conductivity**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 922clok | 659,610 | 15 | 5,528 |
| 922flok | 671,250 | 15 | 5,625 |
| Increase | 11,640 | 0.27 | 98 |
| % Increase | 1.76 | | |

East CH boundary= 3.0
Barge Canal=4.37
Western gw level =6.0
Surface recharge=17 in/yr
K1 = 122.5

15-May-95

**Increased Gradient**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 515chig | 10,255,000 | 235 | 85,941 |
| 515fhig | 11,360,000 | 261 | 95,201 |
| Increase | 1,105,000 | 25 | 9,260 |
| % Increase | 10.78 | | |

East CH boundary= 4.75
Barge Canal=13.6
Western gw level =10.6
Surface recharge=17 in/yr

22-Sep-95

**Increased Gradient**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 922chig | 5,057,200 | 116 | 42,381 |
| 922fhig | 5,903,100 | 136 | 49,470 |
| Increase | 845,900 | 19 | 7,089 |
| % Increase | 16.73 | | |

East CH boundary= 3.0
Barge Canal=5.8
Western gw level =8.0
Surface recharge=17 in/yr

15-May-95

**Increased Recharge**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 515chir | 6,343,600 | 146 | 53,162 |
| 515fhir | 6,982,700 | 160 | 58,518 |
| Increase | 639,100 | 15 | 5,356 |
| % Increase | 10.07 | | |

East CH boundary= 4.75
Barge Canal=10.24
Western gw level =8.0
Surface recharge=34 in/yr

22-Sep-95

**Increased Recharge**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 922chir | 3,221,200 | 74 | 26,995 |
| 922fhir | 3,737,600 | 86 | 31,323 |
| Increase | 516,400 | 12 | 4,328 |
| % Increase | 16.03 | | |

East CH boundary= 3.0
Barge Canal=4.37
Western gw level =6.0
Surface recharge=34 in/yr

15-May-95
**Aquifer bottom at -200 ft**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 515c200 | 4,195,500 | 96 | 35,160 |
| 515f200 | 4,655,500 | 107 | 39,015 |
| Increase | 460,000 | 11 | 3,855 |
| % Increase | 10.96 | | |

East CH boundary= 4.75
Barge Canal=10.24
Western gw level =8.0
Surface recharge=17 in/yr

22-Sep-95
**Aquifer bottom at -200 ft**

| Model Root Name | Output Volume ft3/day | Output Volume ac-ft/day | Output Volume ac-ft/year |
|---|---|---|---|
| 922c200 | 2,070,900 | 48 | 17,355 |
| 922f200 | 2,437,200 | 56 | 20,425 |
| Increase | 366,300 | 8 | 3,070 |
| % Increase | 17.69 | | |

East CH boundary= 3.0
Barge Canal=4.37
Western gw level =6.0
Surface recharge=17 in/yr

**Table D1. Sensitivity Analysis and Calibration Statistics**

| Model Root Name | Parameter and Amount Changed | Output Volume (ft$^3$/day) | Volume Increase (%) | Water-Level Change (feet) | Absolute Residual Mean | Results |
|---|---|---|---|---|---|---|
| 515c | Final Model | 6,048,400 | | | 0.55 | |
| 515f | | 6,673,600 | 10.34 | -0.8 to 0 .8 | | |
| 922c | Final Model | 2,925,400 | | | 0.46 | |
| 922f | | 3,428,500 | 17.2 | -0.6 to 0.7 | | |
| 515chik | Hydraulic Conductivity Increased 1000% | 57,663,000 | | | 0.48 | Subsurface flow increases. Percentage change resulting from Pit E approximately the same as Final Models. Slightly closer calibration but less water-level change than Final Models. |
| 515fhik | | 63,259,000 | 9.7 | -0.7 to 0.7 | | |
| 922chik | Hydraulic Conductivity Increased 1000% | 26,503,000 | | | 0.42 | |
| 922fhik | | 31,031,000 | 17.08 | -0.5 to 0.6 | | |
| 515clok | Hydraulic Conductivity Decreased 1000% | 976,490 | | | 1.28 | Subsurface flow decreases. Percentage change in flow resulting from Pit E much less than Final Models. Water-level change for 9/22 model much larger. Calibration error much higher. |
| 515flok | | 984,460 | 0.82 | -1.1 to 1.0 | | |
| 922clok | Hydraulic Conductivity Decreased 1000% | 659,610 | | | 1.31 | |
| 922flok | | 671,250 | 1.76 | 3.8 to 6.9 | | |
| 515chig | Gradient Increased by 33% | 10,255,000 | | | 1.40 | Subsurface flow increases. Percentage change resulting from Pit E approximately the same as Final Models. Calibration error much higher |
| 515fhig | | 11,360,000 | 10.78 | -1.3 to 1.3 | | |
| 922chig | Gradient Increased by 33% | 5,057,200 | | | 1.01 | |
| 922fhig | | 5,903,100 | 16.73 | -0.5 to 0.6 | | |
| 515chir | Recharge increased by 100% | 6,343,600 | | | 0.63 | Subsurface flow increases. Percentage change resulting from Pit E approximately the same as Final Models. |
| 515fhir | | 6,982,700 | 10.07 | -0.9 to 0.8 | | |
| 922chir | Recharge increased by 100% | 3,221,200 | | | 0.45 | |
| 922fhir | | 3,434,600 | 16.03 | -0.6 to 0.7 | | |
| 515c200 | Decrease Aquifer Thickness by 100 feet | 4,195,500 | | | 0.60 | Subsurface flow decreases. Percentage change resulting from Pit E approximately the same as Final Models. |
| 515f200 | | 4,655,500 | 10.96 | -0.8 to 0.8 | | |
| 922c200 | Decrease Aquifer Thickness by 100 feet | 2,070,900 | | | 0.48 | |
| 922f200 | | 2,437,200 | 17.69 | -0.8 to 0.8 | | |

*Notes:*

1) *Residual Mean based on a comparison of field measured* water levels for 5/15/95 and 9/22/95 with MODFLOW generated water-levels from the current-conditions models.
2) Water-level change based on MODFLOW generated drawdown data from future-conditions models.
3) Model root name prefixes: 515 = 5/15/95 conditions
   922 = 9/22/95 conditions
   c = current-conditions model
   f = future-conditions model

MODFLOW design listings and output files for the final models are on the disk in pocket.