# AQUIFER TESTING AND HYDROGEOLOGIC EVALUATION METHOW VALLEY IRRIGATION DISTRICT TWISP, WASHINGTON

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MONTGOMERY
WATER GROUP, INC.
Water Resources Engineering

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# 1.0 INTRODUCTION

HWA conducted a hydrogeologic evaluation of the alluvial aquifer near Twisp, Washington (Figure 1-1), as a subconsultant to Montgomery Water Group, Inc, who held a contract with the Washington State Department of Ecology (Ecology) to investigate and design a new water supply system for the Methow Valley Irrigation District (MVID). The aquifer testing provided hydrogeologic information necessary to evaluate the potential for ground water development and possible transfer of irrigation water rights from surface water withdrawals to ground water withdrawals in the Methow Valley. The testing was completed to evaluate the following conditions at three locations near Twisp, Washington (Figure 1-1):

- Hydrogeologic parameters of the alluvial aquifer.
- The potential influence of ground water withdrawal on ground water levels
- The potential influence of ground water withdrawal on water flow in the Methow River.
- The potential sustainable yield of ground water from the alluvial aquifer.

Three irrigation test wells (PW-1, PW-2, PW-3) and three observation wells (OW-1, OW-2, OW-3) were installed and developed by Holt Drilling, Inc., (Holt), of Puyallup, Washington. HWA performed a step-drawdown test, a constant-rate pumping test, and a recovery test at each test well. During each test, HWA measured water levels in the test and observation wells, nearby domestic wells (if available), and the Methow River (except at PW-2). We also collected ground water and surface water samples for chemical analysis. Based on the results of this investigation, HWA estimated aquifer parameters and optimum pumping rates at the test locations to support decision-making for ground water development and management.

# 2.0 SUMMARY OF HYDROGEOLOGY

## 2.1 Geologic History

The Methow Valley is a fault-bounded bedrock trough filled with Pleistocene to Recent glacial and alluvial sediment. Fault motion during the Pleistocene cut across several thousand feet of Mesozoic-age bedrock creating the Methow-Pasayten Graben and the Methow Valley basin. Pleistocene continental glacial and erosional events deepened and scoured the graben and deposited layers of fine to coarse-grained sediment. Recent fluvial processes have reworked and deposited alluvium within the basin (Waitt, 1972; Barksdale, 1975; McGroder et al, 1990).

## 2.2 Geology of the Methow Valley Alluvial Aquifer

The Methow Valley bedrock consists of faulted, folded, and metamorphosed Mesozoic-age marine, volcanic, and plutonic rocks. These rocks form the side-walls and basement of the Methow Valley. The dense, consolidated rocks contain limited amounts of ground water within fractures, capable of supporting local domestic water supplies (Walters and Kimmel, 1974).

The surface of the Methow Valley slopes gently to the south, from elevation 2,000 feet at Mazama, to 1,600 feet at Twisp, and 1,500 at Carlton (Figure 1-1). Alluvial and glacial sediment fill the valley floor from approximately 5 miles north of Mazama to Carlton, a distance of 30 miles. Smaller sections of alluvium occur along the Twisp and Chewuch River drainages, and along the Methow River from Carlton to Pateros at the confluence with the Columbia River. The maximum width of the alluvium occurs at Winthrop (3 miles), and south of Twisp at the Methow River-Beaver Creek confluence (2.5 miles). Driller's logs for wells installed in the area indicate that the alluvium thickness ranges from a few feet along the valley sidewalls to more than 250 feet along the valley axis. The depth to bedrock along the valley axis may exceed 500 feet (Waitt, 1972).

No studies have correlated local or regional stratigraphic units within the alluvium. The USGS currently is conducting a regional hydrogeologic study of the Methow Valley stream-aquifer system, and expects to issue a report of their investigation in 2003 (USGS, Marijke Van Heeswijk, pers. comm.) In general, the alluvium consists of interbedded layers of sand, gravel and silt, generally becoming finer with lateral distance away from the Methow River, and becoming finer downstream (Waitt, 1972; Walters and Kimmel, 1974; Ecology, Anna Hoselton, pers. comm.) Depositional processes created a heterogeneous stratigraphy consisting of lenses of coarse, permeable gravel (glacial outwash and fluvial stream channel deposits), fine to medium sand (sand bar and overbank deposits), and relatively impermeable silt and clay (glacial till and lacustrine sediment). In the Twisp area, the depth to bedrock exceeds 250 feet, and the alluvium consists of sand and gravel layers, with local lenses of low permeability silt and clay. Figure 2-1 shows a generalized geologic cross-section through the alluvium near Twisp.

## 2.3 Hydrogeology of the Methow Valley Alluvial Aquifer

The unconsolidated alluvial aquifer is interpreted as the ground water-saturated portion of the Methow Valley alluvium. Ground water occurs at depths ranging from 0 to more than 50 feet. The aquifer generally exhibits unconfined conditions at the upper portion of the aquifer and likely exhibits semi-confined conditions with depth due to stratified aquifer heterogeneity.

HWA previously estimated the average hydraulic conductivity of the alluvial aquifer at 1.4 feet/day, based on driller's logs and pumping test information (Montgomery Water Group, 1996). The hydraulic conductivity of the more permeable portions of the aquifer likely exceeds this value by several orders of magnitude. Based on lithologic descriptions in driller's logs of wells installed in the area (Ecology records), HWA estimates a hydraulic conductivity value of 500 to 1,000 ft/day, and a porosity of 25 percent for the permeable sand and gravel portions of the aquifer. Based on the general topography of the valley floor, HWA estimates the average hydraulic gradient of 0.004 ft/ft for the alluvial aquifer near Twisp. Using these parameters, the estimated horizontal ground water velocity in the alluvial aquifer is 8 to 16 feet per day.

Vertical ground water velocity through the aquifer is likely significantly lower than horizontal velocity (10 to more than 100 times) due to low permeability lenses that restrict vertical flow.

## 2.4 Ground Water-Surface Water Interaction

Ground water at shallow aquifer depths (less than 30 feet) below the top of the alluvial aquifer hydraulically interacts with the Methow River. At the top of the aquifer and near the river, the river stage elevation generally coincides with the aquifer head (water table) elevation, and indicates the overall hydraulic head of the aquifer-river system. The Methow River stage fluctuated seasonally in 1999 and 2000 by six feet (USGS WRIS data base [http://water.usgs.gov/wa/nwis/dv/?site_no=12448500 ]; see graph in Appendix A). Based on the stream-aquifer hydraulic connection, seasonal water levels within the alluvial aquifer likely fluctuated across the same range. Water levels in the Methow River fluctuate daily with precipitation, runoff, and surface water diversion events. The regional aquifer head also fluctuates daily, but to a lesser degree due to the greater storage of the aquifer compared to the quantity of water flowing in the river. Water in the river and aquifer likely exchange during the year, depending on relative differences in water levels between the river and aquifer. The magnitude of this exchange is likely greatest during the periods of highest and lowest river stage, where the river recharges the aquifer during the wet season, and the aquifer discharges to the river during the dry season.

## 2.5 Alluvial Aquifer Water Balance

Seasonal infiltration of precipitation and runoff from the Methow Valley watershed during the spring months (March to June) recharge the alluvial aquifer. The central portion of the Methow Valley receives approximately 15 to 20 inches of precipitation per year. Higher upstream in the surrounding mountainous areas, annual precipitation ranges from 40 to 80 inches per year. Most precipitation in the Methow Valley watershed occurs as snowfall, which melts during spring runoff. Most aquifer recharge occurs during this period of maximum river stage, when the Methow River discharges a portion of the spring runoff into the aquifer. Secondary aquifer recharge occurs during the irrigation season (May through September) when surface and ground water obtained from up-valley surface water sources are spread on the valley floor. A portion of this irrigation water infiltrates into the shallow soil and recharges the alluvial aquifer. Unlined irrigation ditches also infiltrate a portion of diverted surface water into shallow soil and alluvial aquifer during irrigation season.

During the warm summer and fall seasons, evapotranspiration from native vegetation and irrigated crops exceeds precipitation, resulting in shallow ground water withdrawal. Melting snow runoff and subsequent aquifer recharge becomes minimal. In the dry season, ground water accumulated and temporarily stored in the alluvial aquifer during the spring months discharges to the Methow River. Throughout the year, wells installed in the aquifer remove ground water, but most ground water withdrawal occurs during the high demand periods of the irrigation season.

Due to the complexity of seasonal recharge and discharge patterns within different areas of the system, no comprehensive water balance for the Methow River-alluvial aquifer system has been completed. The USGS currently is conducting a regional watershed study of the Methow Valley, and expects to complete a report of their investigation in 2001 (USGS, Marijke Van Heeswijk, pers. comm.) Walters and Nassar (1974) prepared the following basic water budget for the alluvial aquifer-Methow River system

- 100 percent enters the system as precipitation and upstream runoff,
- 40 percent discharges out of the system as surface water
- 30 percent is lost through evapotranspiration
- 25 percent leaves the system as subsurface ground water discharge.

## 2.6 Conceptual Model of Ground Water Flow

Previous investigations conducted in the Methow Valley (Walters and Nassar, 1974; Barksdale, 1975) defined the alluvial aquifer as a bedrock-bounded, heterogeneous, unconsolidated, and unconfined aquifer that hydraulically interacts with the Methow River. Seasonal recharge and discharge processes in the river-aquifer system result in a complex intercommunication between river and aquifer flow. In general, much of the water entering the system as surface runoff and precipitation also leaves the system through the Methow River. Approximately one-third of the water entering the basin may be lost through evapotranspiration. Local areas of the system may artificially lose or gain

water via wells or surface infiltration along unlined irrigation ditches. Hydraulic communication between bedrock and the alluvial aquifer likely contributes an insignificant quantity of water to the stream-aquifer system. Data are not yet available to quantify the local or seasonal variations in water balance.

HWA estimated the average ground water flow through the upper portion of the aquifer at Twisp based on the following average aquifer parameters:

- hydraulic conductivity - 500 feet/day
- hydraulic gradient - 0.004 ft/ft
- aquifer thickness - 200 feet
- aquifer width - 8,000 feet

HWA estimates the ground water flux through the aquifer at 3.2 million cubic feet per day, or 37 cubic feet per second (cfs). In comparison, the average Methow River flow at Twisp (estimated from the combined flow of the Methow River at Winthrop plus the flow of the Twisp River at Twisp) for 1999 was approximately 2,100 cubic feet per second (cfs). Appendix A presents a graph and table of Methow River flow at several locations in the Methow Valley, including the Methow River and its tributaries. The graph shows the river flow at Twisp, and the river stage at Winthrop, Washington, approximately 7 miles to the north. (data source: USGS WRIS database).

Ground water within the aquifer generally flows sub-parallel to the river, trending away from the river during spring runoff when the river discharges a portion of its water into the aquifer, and trending towards the river during drier months, when ground water discharges to the river. Previous aquifer testing results in other parts of the Methow Valley (EMCON Northwest, 1993) and water level data in nearby well boring logs indicate that the degree of interaction of ground water in the alluvial aquifer between surface water in the Methow River should vary with depth below the river and distance to the river. The exchange of ground water and surface water, therefore, decreases with distance from the riverbank. Shallow ground water derives from recent surface water infiltration. Deep ground water at the base of the aquifer likely derives from much older water that infiltrated much farther upgradient than local shallow water sources and from surface water that has infiltrated along the valley sidewalls and migrated vertically downward (Figure 2-1).

Layering within the aquifer generally restricts vertical flow within the aquifer, except at areas when significant vertical gradients are created during periods of aquifer stress (e. g., well discharge, and surface infiltration). Most ground water in the aquifer flows horizontally. Maximum pumping rates (1,000 gpm, or 2 cfs) of existing wells is 1,000 times less than the 1999 average river flow (2,100 cfs). Most of the water entering pumping wells derives from ground water flowing horizontally from the aquifer at the depth of the well screen. This ground water ultimately comes from surface infiltration, but may have followed a long flow path (several miles) from multiple points of ground water recharge, depending on the depth of the well (Figure 2-2). HWA estimates the horizontal ground water flow velocity in the alluvial aquifer at a rate of approximately 8

feet per day, or 3,000 feet per year. In order for vertical flow within the aquifer to occur, the vertical gradient must be orders of magnitude greater than horizontal gradient to overcome the lower vertical permeability of the heterogeneous aquifer. At shallow depths and high pumping rates, artificially induced vertical gradients may result in downward vertical flow. At greater depths, however, most ground water flow during pumping likely derives from horizontal flow at the depth of the well screen.

## 2.7 Beneficial Use of Ground Water near Twisp, Washington

The majority of irrigation and domestic ground water wells completed in the alluvial aquifer in the Twisp area obtain water at shallow depths typically ranging from 40 to 100 feet, and installed within 50 feet of the top of the aquifer. Well yields reported on Ecology well records at the time of well completion typically ranged from 10 to 200 gpm, with maximum yields of 1,000 gpm (Ecology well records).

# 3.0 WELL CONSTRUCTION AND DEVELOPMENT

HWA directed the installation of one irrigation supply test well and one observation monitoring well at three separate locations (Figure 1-1) in the area near Twisp, Washington. Figures 3-1, 3-2, and 3-3 present site maps for each location. HWA directed the installation of three 12-inch-diameter test wells (PW-1 through PW-3) and three 6-inch-diameter observation monitoring wells (OW-1 through OW-3). Holt drilled the borings for PW-1 and PW-2 using cable-tool techniques, and drilled the borings for PW-3, OW-1, OW-2, and OW-3 using air rotary techniques. Holt constructed, installed, and developed all wells, and placed bentonite clay seals at each well to a depth of 18 feet below ground surface (bgs). Table 3-1 summarizes drilling and well construction details and Appendix B contains well boring logs.

HWA located the test wells based on property boundaries, property use, access, and maximum expected yield. At HWA's direction, Holt installed the observation monitoring wells approximately 50 feet from the test wells and placed well screens at the same depth as the test wells. HWA observed all test well drilling and installation activities. HWA designed the continuous-wire-wrapped, telescoping, stainless-steel well screens based on sieve analysis results of representative drill cuttings (see Appendix C for sieve results).

## 3.1 PW-1

Holt completed the 200-foot-deep boring for PW-1 on November 11, 1999. HWA identified the following lithology and stratigraphy of unconsolidated alluvium from drill cuttings obtained from PW-1:

- 0 to 12 feet: silty gravel
- 12 to 152 feet: sand with gravel
- 152 to 198 feet: fine sand with silt
- 198 to 200 feet: sandy silt

At the time of drilling, the water table occurred at a depth of 10 feet.

Holt constructed and installed PW-1 on November 15, 1999. The well screen intercepts sand and gravel alluvium at 86 to 156 feet. HWA designed the 12-inch-diameter well as follows:

- 0 to 86 feet: steel casing
- 86 to 96 feet: 0.080-inch-slot well screen (10 feet)
- 96 to 106 feet: 0.060-inch-slot well screen (10 feet)

- 106 to 156 feet: 0.030-inch-slot well screen (50 feet)
- 156 to 161 feet: steel sump.
- 161 to 200 feet: bentonite clay backfill

Holt completed the drilling and installation of observation well OW-1 on November 20, 1999. HWA designed the 6-inch well as follows:

- 0 to 136 feet: steel casing
- 136 to 156 feet: 0.030-inch-slot well screen (20 feet)

## 3.2 PW- 2

Holt completed the 200-foot-deep boring for PW-2 on December 3, 1999. HWA identified the following lithology and stratigraphy of unconsolidated alluvium from drill cuttings obtained from PW-2:

- 0 to 42 feet: sand and sandy gravel
- 42 to 83 feet: fine to coarse sand gravel
- 83 to 200 feet: fine to coarse gravelly sand

At the time of drilling, the water table occurred at a depth of 51 feet.

Holt completed PW-2 on December 5, 1999. The well screens intercept sand and gravel alluvium at 155 to 190 feet. HWA designed the 12-inch-diameter well as follows:

- 0 to 155 feet: steel casing
- 155 to 165 feet: 0.030-inch-slot well screen (10 feet)
- 165 to 190 feet: 0.060-inch-slot well screen (25 feet)
- 190 to 195 feet: steel sump.

Holt completed the drilling and installation of observation well OW-2 on December 10, 1999. HWA designed the 6-inch well as follows:

- 0 to 170 feet: steel casing
- 170 to 190 feet: 0.060-inch-slot well screen (20 feet)

## 3.3 PW-3

Holt initially attempted drilling the boring for PW-3 using cable tool methods. Due to refusal by large boulders encountered in the upper 50 feet of the boring, Holt switched to air rotary drilling methods to complete the 140-foot-deep boring for PW-3 on January 4, 2000. HWA observed drilling activities while Holt advanced the boring from 80 to 140 feet. HWA identified the following lithology and stratigraphy of unconsolidated alluvium from drill cuttings obtained from PW-3:

- 0 to 80 feet: sand and sandy gravel with boulders (based on driller's notes)
- 80 to 91 feet: fine to medium sand
- 91 to 124 feet: gravelly sand and sandy gravel
- 124 to 140 feet: fine to medium sand

At the time of drilling, the water table occurred at a depth of 33 feet.

Holt completed PW-3 on January 6, 2000. The well screens intercepts sand and gravel alluvium at 100 to 135 feet. HWA designed the 12-inch-diameter well as follows:

- 0 to 100 feet: steel casing
- 100 to 110 feet: 0.080-inch-slot well screen (10 feet)
- 110 to 120 feet: 0.060-inch-slot well screen (10 feet)
- 120 to 135 feet: 0.020-inch-slot well screen (15 feet)
- 135 to 140 feet: steel sump.

Holt completed the drilling and installation of observation well OW-3 on January 10, 2000. HWA designed the 6-inch well as follows:

- 0 to 115 feet: steel casing
- 115 to 130 feet: 0.020-inch-slot well screen (20 feet)

## 3.4 Well Development

Holt developed each test well to create a natural filter pack around the well by repeatedly raising and lowering an 8-inch-diameter steel bailer inside the well screen. The surging force of the bailer drew water and fine sediment next to the well screen into the well casing. Holt removed the fine sediment with the sand bailer. Holt completed the well development when sand yield had significantly diminished.

# 4.0 AQUIFER TESTING

HWA conducted the aquifer testing to obtain aquifer parameter data including hydraulic conductivity, specific yield, aquifer transmissivity, water level drawdown, the area of pumping influence around the well, and test well specific capacities. The data were collected to evaluate the hydraulic interaction or communication between the alluvial aquifer and the Methow River during pumping and non-pumping conditions, and to estimate the potential impact of pumping irrigation supply wells on nearby existing water rights.

The scope of work for aquifer testing at PW-1, PW-2, and PW-3 included:

- Background monitoring of ground water and surface water levels
- Step-drawdown testing to determine the optimum constant pumping rate
- Constant-rate testing
- Recovery monitoring

Table 4-1 summarizes the aquifer testing details including rates and duration of pumping at each test location.

Holt provided the submersible pump, diesel-powered electric generator and fuel, discharge hose, pumping well stilling tubes, and an operator. HWA provided the horizontal discharge pipe and flow gauge. HWA and Holt observed all aquifer testing activities and conducted all water elevation measurements. Appendix D summarizes the type and specifications of all testing equipment. The Washington State Department of Fish and Wildlife approved the discharge of all aquifer testing water into an abandoned MVID irrigation ditch (PW-2), or into the Methow River (PW-1 and PW-3). Appendix E summarizes the discharge procedures. Appendix F summarizes pumping rates for the constant-rate portions of the testing. Appendix G contains electronic copies of all transducer data and electronic spreadsheets of water level data.

## 4.1 Background Water Level and Barometric Pressure Monitoring

For a period of several hours to several days before and after the aquifer testing, HWA measured water levels in the Methow River at PW-1 and PW-3, water levels in both the test wells and observation wells at PW-1, PW-2, and PW-3, and water levels at nearby domestic water supply wells at PW-2. HWA used the measurement data to evaluate changes in local ground water and surface water levels before, during, and after the aquifer testing. HWA measured water levels every 10 to 15 minutes using electronic pressure transducers and data loggers. Holt installed stilling tubes consisting of slotted PVC well casing in the PW-1, PW-2, and PW-3, and HWA installed stilling tubes in the

Methow River. HWA placed electronic pressure transducers inside the stilling tubes. HWA also periodically measured water levels by hand using an electric well probe.

HWA recorded all hand measurements on aquifer test report forms (on file) and transferred transducer output to electronic spreadsheets (see Appendix G). While the pump was active, electric current in the pump motor wiring apparently interfered with the electronic transducers placed in the test wells, and the electronically-recorded water level data from the test wells during pumping were too "noisy" for use. Hand-measured data from the test wells were used instead. The background and recovery data which were recorded electronically while the pump was inactive were used in the analysis. HWA obtained barometric pressure readings for April and May 2000 from the closest active National Weather Service weather station, at Omak, Washington, approximately 30 miles east of the test sites (see Appendix H). Section 6 discusses barometric data in conjunction with water level data. Little or no rain fell at any of the test sites during the months of April and May, 2000.

For the period January 1999 to June 2000, HWA obtained Methow River stage and flow data from the USGS for the Methow River at Mazama, Winthrop, and Pateros, and the Twisp River at Twisp. The data are presented in Appendix A.

Following review of the transducer data, HWA determined that one transducer cable was not properly vented to the atmosphere, and therefore the transducer recorded both water levels and atmospheric pressure. The resulting transducer measurements reflect both changes in water levels and changes in barometric pressure. The transducer was used to monitor water levels at the Methow River at PW-1, a domestic background well (airport well) at PW-2, and the test well at PW-3. In subsequent aquifer analysis, HWA used USGS Methow River stage data instead of Methow River transducer measurements at PW-1, and used hand-measured data at PW-3 instead of the transducer measurements at PW-3. At PW-2, the airport well data was not used in the analysis due to the imprecision of the transducer output.

## 4.2 Step Tests

Following background water level measurements, HWA conducted step tests at each well to estimate the maximum yield of ground water from the well and identify a optimum pumping rate for the constant-rate test. Each step test consisted of four periods of pumping for 60 to 130 minutes at pumping rates of approximately 250, 500, 750, and 1,000 gpm. HWA measured water levels at progressively increasing time intervals during each step (e. g., 5 seconds, 10 seconds, 30 seconds, 1 minute, 2 minutes, 5 minutes, etc.)

Figure 4-1 and Table 4-1 summarize results of step testing at PW-1, PW-2, and PW-3. Water elevation changes during the first two steps at each site reached steady state during the first 30 minutes of testing. HWA ran the first two steps for 60 to 90 minutes each, and the third and fourth steps for 80 to 130 minutes each.

## 4.3 Constant-Rate Tests

Static water levels stabilized in the test wells by the start of the constant-rate testing on the day after the step test. HWA directed the constant-rate testing at each location. Each well was pumped continuously for a period of 5 to 6 days at average rates of 1,214 gpm (PW-1), 821 gpm (PW-2), and 1,023 gpm (PW-3). During the constant-rate testing, HWA measured water levels at progressively increasing time intervals throughout the tests. At PW-1 and PW-3, HWA measured water levels at the test well, observation well, and Methow River. At PW-2, HWA measured water levels at the test well, observation well, and four nearby domestic wells. Figures 3-1, 3-2, and 3-3 show the well locations at each site. Table 4-1 summarizes pumping rates and maximum drawdown levels for each site. During the testing, HWA conferred with Anna Hoselton of Ecology to discuss the progress and results of aquifer testing. Section 6 summarizes ground water drawdown and recovery results.

## 4.4 Recovery Monitoring

HWA measured water level recovery at all wells at the conclusion of the constant-rate test. HWA monitored the recovery of water levels for three to eight days at each location. The submersible pump was not equipped with a foot-valve, which would have reduced the maximum pumping during the constant-rate portion of the test. Consequently, the initial portion of the recovery monitoring data at the pumping wells were affected by the return flow of water from the discharge hose into the well. Recovery data from the observation wells, but not the test wells, were used in aquifer analysis.

# 5.0 WATER QUALITY TESTING

## 5.1 Ground Water Sampling Results

HWA collected one ground water discharge sample at the start of the constant-rate test and one sample at the end of the constant-rate test at all three locations. Ground water samples were collected to evaluate the changes in ground water chemistry that may indicate possible sources of ground water entering the well screen during pumping. North Creek Analytical, Inc, of Bothell, Washington, analyzed the samples for total metals (iron, magnesium, manganese, calcium, sodium, potassium) and inorganic parameters (chloride, sulfate, alkalinity, nitrate, and nitrite). Appendix I contains a copy of all laboratory reports. HWA periodically measured pH, specific conductance, and dissolved oxygen (DO) in samples of ground water PW-3. Table 5-1 summarizes sample analytical results.

In general, the analytical results for the ground water samples collected at the start of the constant-rate test were similar to results for the ground water samples collected at the end of the test; metals and inorganic parameter concentrations generally decreased slightly by less than 10 percent. The PW-2 ground water sample contained the lowest analyte concentrations, and the PW-3 sample generally contained analyte concentrations that were 30 to 300 percent greater than at PW-2.

## 5.2 Surface Water Sampling Results

HWA collected surface water samples from the Methow River at the end of the constant-rate test at PW-1 and PW-3. The samples were collected to compare to ground water sample results and evaluate possible contribution of surface water to ground water withdrawn from the aquifer during pumping. The samples were analyzed by NCA for the same parameters as ground water samples. Appendix I and Table 5-1 present the surface water results. The analyte concentrations in the Methow River sample at PW-1 were similar to those in the river sample at PW-3.

## 5.3 Comparison of Ground Water to Surface Water Chemistry

The water quality results indicate high water quality for both ground water and surface water, based on the tested parameters. Neither ground water nor surface water quality data indicate impact from agriculture activities (e. g., elevated nitrate, sulfate, or chloride). The data indicate that the ground water meets irrigation and drinking water quality standards.

The average ground water analyte concentration was two to three times greater than the same analyte concentration in the river sample, with the following exceptions: river and ground water pH values were similar; specific conductance of river water was approximately 2 to 3 times lower than in ground water; and total iron and DO concentrations in surface water samples exceeded the ground water concentrations. The insignificant difference in analyte concentrations between ground water samples collected at the start and end of the tests suggests that ground water extracted during aquifer testing contained an insignificant component of river water. For example, the DO values in ground water at PW-3 decreased during the pumping, and remained lower than surface water DO values at PW-3. If the discharged ground water contained a component of surface water, the DO values would more likely increase, rather than decrease. Only two samples were collected during testing, however, and conclusions drawn from the data are speculative. Assessment of sources of ground water extracted from the aquifer on the basis of chemistry would require additional sampling points distributed vertically and laterally around the wells, and sampling over the long term to evaluate the seasonal variations of surface water –ground water exchange.

# 6.0 AQUIFER TESTING RESULTS

## 6.1 PW-1

Figure 3-1 shows the well locations and Methow River at PW-1. Observation well OW-1 lies 50 feet from PW-1, and both wells were installed approximately 120 feet from the Methow River bank. Figure 6-1 shows relative water levels measured during all testing at PW-1. At the time of aquifer testing, the surface of the Methow River was approximately 10 feet below the surface of the grade at the well installation, and the base of the river was approximately 4 feet below the river surface. The PW-1 well screen lies approximately 86 to 156 feet below grade. The top of the PW-1 well screen, therefore, lies approximately 72 feet below the base of the Methow River. At the time of aquifer testing, the depth to water at PW-1 and OW-1 were approximately 10 feet below grade, corresponding to the river elevation. PW-1 and OW-1 fully penetrate the most permeable portion of the aquifer, but not the entire saturated portion of the aquifer.

The nearest wells to PW-1 occur more than 1,000 feet to the north and east of the test well (Figure 3-1). The eastern well was active during the constant rate test, and water levels in the well fluctuated too frequently for useful comparison to water levels at OW-1 and PW-1. The northern well was not accessible for background monitoring.

### 6.1.1 Background Monitoring Results and Environmental Factors

During the period of water level monitoring (May 3 to May 23, 2000), the Methow River level decreased by 0.8 feet, then rose by approximately 2.4 feet, with a net gain of 1.6 feet. The fluctuations likely occurred due to variable rates of snowpack melt and runoff, and recharge of the alluvial aquifer. During this period, the changes in ground water levels at PW-1 and OW-1 generally correlated with, but did not exactly match, changes in the river level. The vertical separation between the river and the wells, and the stratification of the alluvial aquifer apparently slightly attenuated the hydraulic communication between the river and the aquifer at the depth of PW-1 well screen. Due to this hydraulic communication at PW-1, the regional aquifer head is also expressed in river stage, which can be used to correct pumping test results for regional changes in ground water levels if no other ground water level data are available. Ground water level measurements during long-term (multi-day) pumping would require correction for changes in regional aquifer hydraulic head. Regional changes in aquifer head likely would not significantly affect short-term (e. g., step-testing) results. Ground water level fluctuations did not correlate to, and required no correction for, daily barometric pressure fluctuations (Figure 6-1).

### 6.1.2 Step Testing Results

Figure 6-2 and Table 4-1 summarize step-testing results at PW-1. HWA pumped PW-1 at a maximum rate of 1,200 gpm during the step test. HWA estimates a maximum yield of 2,076 gpm at PW-1 based on the well design and well screen manufacturers specifications. Well performance during step-testing (Figure 4-1) indicates that a

maximum drawdown of 42 feet would occur at the maximum theoretical yield, assuming that well performance remains linear up to the maximum testing rate. The maximum available drawdown, based on the depth of well screen submergence below the static water level, is approximately 76 feet, or 34 feet greater than the estimated drawdown at the theoretical yield.

### 6.1.3 Constant-Rate Testing Results

HWA pumped PW-1 at an average rate of 1,214 gpm for five days (May 10 to May 15, 2000). Appendix F shows pumping rate data for PW-1. During the constant-rate test, the river level decreased by 0.28 feet. The regional aquifer water level likely decreased by a similar amount, which would necessitate a minor correction to the constant-rate water level data. Figure 6-3 shows a semi-log plot of drawdown levels at PW-1 and OW-1, and the change in the Methow River water level during the test. The results show that 90 percent of the maximum drawdown at PW-1 (17.3 feet) and OW-1 (6.0 feet) occurred within the first 10 minutes of the test. Changes in water levels at PW-1 and OW-1 were synchronized during the entire test, indicating good hydraulic connection within the aquifer between the two wells.

Closer observation of the semi-log plot of drawdown versus time for OW-1 (Figure 6-4) suggests three distinct phases of aquifer response to pumping. HWA interprets the first six minutes as a linear, Theis-type, semi-confined aquifer response, influenced by well bore storage and partial well penetration. From 6 to 100 minutes, the drawdown rate decreased, likely due to delayed-yield aquifer drainage release of water from the alluvial aquifer. The third phase, from 100 minutes to the end of the test (5 days), is interpreted as a Theis-type, semi-confined aquifer response as the hydraulic cone of depression expanded outward into the aquifer. The aquifer drawdown continued during the third phase, although river level slightly increased by 0.28 feet during the test . (Figure 6-4).

Based on the water level data at the site, HWA assumes the following conditions for the aquifer, wells, river, and pumping test results at PW-1:

- The saturated thickness of the aquifer exceeds 151 feet
- The river intersects the upper four feet of the aquifer.
- Limited exchange of ground water and surface water occurs between the top of the alluvial aquifer and the river
- The alluvial aquifer is unconfined at shallow depths and trends towards semi-confined conditions at the depth of the well screen, due to aquifer heterogeneity.
- The wells partially penetrate the entire saturated thickness of the aquifer at approximately 72 feet below the base of the river, and approximately 76 feet below the top of the aquifer.
- The wells fully penetrate the most productive zone of the alluvial aquifer.
- The first phase of the test does not provide useful data for determining long-term aquifer response to pumping; the second phase of the test indicates delayed-yield response; the third phase of the test appears most representative of aquifer properties during long-term pumping (Theis-type, semi-confined response).

- A slight correction for regional water level change, but not barometric pressure change is required before analysis.

HWA calculated the transmissivity of the alluvial aquifer assuming that the late-time portion of the OW-1 drawdown curve met the criteria for the Cooper and Jacob (1946) time-drawdown analytical method. HWA used the Aquifer Test® software developed by Waterloo Hydrogeologic, Inc. to evaluate drawdown versus time results for OW-1 (Figure 6-4). The analysis indicates a transmissivity value of 63,500 $ft^2$/day, or 475,000 gpd/ft for the alluvial aquifer at PW-1. At a time of 100 minutes, HWA estimates a 0.0001 value for the well function *u*, which confirms the applicability of the method. Partial penetration effects appear insignificant at long-term pumping rates. This initial estimate assumed no correction for regional water level rise. A corrected transmissivity value would be lower by approximately 3 percent, or 61,000 $ft^2$/day.

For comparison, HWA calculated the transmissivity of the alluvial aquifer assuming that the second phase of the drawdown curve indicates delayed yield conditions, meeting the criteria for the Neuman (1972) analytical method. HWA used the Aquifer Test® software to evaluate drawdown versus time results for OW-1 (Figure 6-5). The analysis indicates a transmissivity value of 16,000 $ft^2$/day, or 118,000 gpd/ft for the alluvial aquifer at PW-1. The Neuman method is sensitive to the early-time data, which was brief for the PW-1 test (less than 6 minutes), and requires sufficient long-term data to provide an accurate match in the analysis. The test would have needed to run for at least another log cycle (10 days) to provide this data. The estimate based on the Neuman method, therefore, is considered less reliable the estimate based on the Cooper-Jacob method.

### 6.1.4 Recovery Monitoring Results

The recovery portion of the test was started at 9AM on May 15, but a technical problem with programming one transducer required re-activating the pump 14 minutes later. PW-1 was pumped for approximately 3 hours until 12:05 PM, when ground water levels had returned to the long-term drawdown levels, and then the recovery portion was re-started. During the recovery portion of the test, the river water level, and therefore, the regional aquifer level, rose by approximately 2.4 feet, and ground water levels in PW-1 and OW-1 rose approximately 2 feet higher than the initial water level at the start of the constant-rate test. Long-term recovery results, therefore, would require correction for regional aquifer water level rise to accurately estimate the recovery-based transmissivity. The recovery test results shows three phases in the semi-log residual recovery time (Figure 6-6). The first phase occurs during the first five minutes of recovery, is too early for use in recovery analysis due to potential effects of return flow into the well from the pump discharge line. The second phase occurs during the first hour of recovery, when delayed yield-type effects likely occurred. The third phase occurs after the first hour of recovery, when the regional aquifer recovered following a Theis-type, semi-confined response with additional rise due to an increase in regional aquifer head to a level higher than the initial level at the start of pumping. The third phase (late-time data) appeared most representative of the aquifer response, after correction for regional water level rise (Figure 6-6).

HWA calculated the transmissivity of the alluvial aquifer assuming that the late-time portion of the OW-1 recovery curve met the criteria for the Theis (1935) recovery analytical method. The analysis indicates an uncorrected transmissivity value of 58,600 $ft^2$/day for the alluvial aquifer at PW-1 (see Appendix J for example calculations). If a correction is applied, then the residual drawdown value ($\Delta s$) would decrease and the transmissivity value would increase by approximately 25 percent. The uncorrected value, therefore, is considered conservative.

### 6.1.5 Summary

HWA also considered the Dietz method (1943) for estimating transmissivity of an aquifer bounded by a recharge boundary (the river). This method does not appear to represent the site conditions, as the Methow River does not fully penetrate the aquifer, and the method, therefore, would underestimate transmissivity values. The Cooper-Jacob methods appear most useful for estimating the aquifer transmissivity. Based on an average of drawdown and recovery data calculations, HWA estimates the average aquifer transmissivity at PW-1 at 60,000 $ft^2$/day (Table 6-1). Assuming an average saturated thickness of 151 feet, HWA estimates the average hydraulic conductivity of the alluvial aquifer at 400 feet per day, or 0.14 centimeters per second (cm/sec). This value compares well with the observed aquifer materials (fine to coarse sand with gravel).

At PW-1, the Methow River hydraulically interacts with the upper portion of the alluvial aquifer; some surface water from the river likely recharges the aquifer during high river stage, and some ground water from the alluvial aquifer discharges to the river during low river stage. The direct exchange of river water and ground water likely occurs only at the uppermost levels of the aquifer; the exchange of surface water and ground water decreases with aquifer depth, as most ground water in the aquifer flows horizontally, rather than vertically due to the stratified aquifer heterogeneity. The majority of ground water entering the well during pumping likely derives from ground water in the aquifer flowing horizontally at the depth of the well screen.

## 6.2 PW-2

Figure 3-2 shows the well locations at PW-2. Observation well OW-2 lies 50 feet from PW-2, and both wells were installed approximately 1,200 feet from the Methow River bank. Figure 6-7 shows relative water levels measured during all testing at PW-2. The PW-2 well screen lies approximately 155 to 190 feet below grade. At the time of aquifer testing, the depth to water at PW-2 and OW-2 was approximately 51 feet below grade, which appears to correspond to the Methow River level. PW-2 and OW-2 fully penetrate the most permeable portion of the aquifer, but not the entire saturated portion of the aquifer.

HWA monitored water levels at four domestic supply wells located at a distance of 500 to 1,100 feet from PW-2 (Figure 3-2). The domestic wells were likely completed at depths ranging from 50 to 100 feet. HWA attempted to determine the depth to the bottom of these wells, but could not due to the presence of pumps, hoses, and wiring in

the wells. None of the owners had a well completion log for the well. Ecology records did not contain copies of the domestic well logs. Other wells in the area were completed at depths ranging from 50 to 150 feet. Based on typical well completions in the area, PW-2 may be completed approximately 50 feet lower than the domestic wells.

### 6.2.1 Background Monitoring Results and Environmental Factors

During the period of water level monitoring (April 14 to May 3, 2000), daily water levels at the Methow River (based on river stage data recorded by the USGS; Appendix A), generally fluctuated by 0.1 feet or less. Fluctuations likely occurred due to variations in snowpack melt, runoff, and aquifer recharge. During this period, the ground water levels at PW-2 also fluctuated, but not concurrently or in the same magnitude or direction as river level fluctuations. The horizontal and vertical separation between the river and the wells, and the stratification of the alluvial aquifer would attenuate the aquifer response to changes in river water levels. The river stage, therefore, appears to have little correlation with aquifer testing water level data. Water levels measured at the South well, 1,100 feet south of PW-2, likely were not influenced by pumping at PW-2 and therefore recorded regional aquifer head at that location. Water levels measured at the airport well were not considered useful, due to the faulty transducer.

Water levels in the domestic wells, were affected by pumping at PW-2, but also appeared to increase by approximately 0.2 feet during the constant-rate portions of the test. Water levels in these wells also apparently increased by 0.3 feet during the recovery portion of the test. Similar increases in water level were apparent at PW-2 and OW-2. These amounts would be used to correct for a rise in aquifer head during the constant-rate and recovery portions of the test.

Ground water level fluctuations did not correlate to, and required no correction for, daily barometric pressure fluctuations (Figure 6-7).

### 6.2.2 Step Testing Results

Figure 6-8 and Table 4-1 summarize step-testing results at PW-2. HWA pumped PW-2 at a maximum rate of 925 gpm during the step test. HWA estimates a maximum yield of 1,284 gpm at PW-2 based on the well design and well screen manufacturers specifications. Well performance during step-testing (Figure 4-1) indicates that a maximum drawdown of 25 feet would occur at the maximum theoretical yield, assuming that well performance remains linear up to the maximum testing rate. The maximum available drawdown, based on the depth of well screen submergence below the static water level, is approximately 104 feet, or 79 feet greater than the estimated drawdown at the theoretical yield. The maximum step-testing discharge rate (925 gpm) exceeded the capacity of the irrigation ditch to transmit water to the Methow River. HWA therefore, selected a lower rate for the constant-rate testing. A higher rate would have resulted in flooding of private property and a public road, and possibly damaged the irrigation ditch.

### 6.2.3 Constant-Rate Testing Results

HWA pumped PW-2 at an average rate of 821 gpm for six days (April 19 to 25, 2000). Appendix F shows pumping rate data for PW-2. During the constant-rate test, ground water levels generally increased by 0.2 feet at the domestic wells.

Figure 6-9 shows a semi-log plot of drawdown levels at PW-2 and OW-2 during the test. The results show that 90 percent of the maximum drawdown at PW-2 (14.9 feet) and OW-2 (2.4 feet) occurred within the first 10 minutes of the test. Approximately 0.25 feet of drawdown (after correcting for regional water level rise) was observed at the two nearest domestic wells as a response to pumping. The water levels in the domestic wells and OW-2 corresponded to drawdown at test well PW-2. This synchronous response suggests good hydraulic communication within the aquifer between all four well locations. HWA could not identify the source for the slight water level fluctuation at OW-2 during the second and third days of the test. The fluctuation did not correspond to any observed changes in water level or barometric pressure. The fluctuation did not appear to correspond to a temporary fluctuation in pumping rate, and HWA observed no fluctuations in pumping rate or the PW-2 drawdown measurements.

Closer observation of the semi-log plot of drawdown versus time (Figure 6-10) suggests three distinct phases of aquifer response to pumping. The first three minutes is interpreted as a linear Theis-type, semi-confined aquifer response. From 3 to approximately 500 minutes, the drawdown rate decreased, likely due to a delayed-yield aquifer drainage release of water from the alluvial aquifer. After 500 minutes, the third phase is interpreted as a Theis-type, semi-confined aquifer response as the hydraulic cone of depression expanded outward into the aquifer. The aquifer drawdown continued during the third phase, although the regional aquifer water level increased by approximately 0.2 feet, which influenced the aquifer response.

Based on the water level results at the site, HWA assumes the following conditions for the aquifer, wells, river, and pumping test results at PW-2:

- The saturated thickness of the aquifer exceeds 144 feet.
- The river intersects the upper four feet of the aquifer.
- Limited exchange of ground water and surface water occurs between the top of the alluvial aquifer and the river
- The alluvial aquifer is unconfined at shallow depths and trends towards semi-confined conditions at the depth of the well screen, due to aquifer heterogeneity.
- The wells partially penetrate the entire saturated thickness of the aquifer at approximately 104 feet below the top of the aquifer.
- The wells fully penetrate the most productive zone of the alluvial aquifer.
- The first three minutes of the test does not provide useful data for determining long-term aquifer response to pumping. The second phase of the test (3 to 500 minutes) indicates influence by delayed yield, and the third phase of the test appears to represent Theis-type, semi-confined aquifer response to pumping.
- Constant-rate data should be corrected for the 0.2-foot increase in regional water levels before analysis

HWA calculated the transmissivity of the alluvial aquifer assuming that the late-time portion of the distance-drawdown curve met the criteria for the Jacob's distance-drawdown method (1935). The distance-drawdown result likely represents general aquifer conditions because it incorporates results from several wells in different directions from the pumping well. HWA used drawdown measured at OW-2 and at two nearest domestic wells, and did not apply a correction for regional water level rise, as all wells apparently were equally affected. Figure 6-11 shows the distance-drawdown curve after 2,500 minutes of pumping. The analysis indicates a transmissivity value of 30,000 $ft^2$/day for the alluvial aquifer at PW-2. HWA considers this result conservative, because the domestic well screens installations are likely higher in the aquifer than the OW-2 well screen. The difference in screen depth potentially would result in head loss due to vertical variations in hydrostratigraphy. The drawdown that occurred at the top of the aquifer may have been lower than the drawdown that occurred in the aquifer at the depth of the PW-2 well screen. If so, then higher drawdown values would have resulted in higher transmissivity estimates. The distance-drawdown result also indicates that the radius of influence of pumping PW-2 at 821 gpm is less than 1,000 feet. No drawdown would have occurred at the airport or south wells due to PW-2 pumping.

HWA also calculated transmissivity using Cooper and Jacob (1935) analytical method to evaluate drawdown results at OW-2. The analysis indicates a transmissivity values of 33,600 to 36,000 $ft^2$/day for the alluvial aquifer at PW-2 (Figure 6-10; Appendix J). These results are similar to the distance-drawdown-based estimate. At a time of 100 minutes, HWA estimates a value of 0.0001 for the well function $u$, which confirms the applicability of the method. Partial penetration effects appear insignificant at long-term pumping rates.

### 6.2.4 Recovery Monitoring Results

During the recovery portion of the test, water levels in all wells at PW-2 increased by approximately 0.3 feet from the time of the end of the constant-rate test, which indicated a regional rise in aquifer water levels. Long-term recovery results required correction for regional aquifer level rise before use. The recovery test results shows three phases in the semi-log residual recovery time (Figure 6-12). The first phase occurs during the first five minutes of recovery, and appears too early for use in recovery analysis. The second phase occurs during the first hour of recovery. The third phase occurs after the first hour of recovery, when the aquifer recovered following a Theis-type, semi-confined response with additional rise due to an increase in regional aquifer head to a level higher than the initial level at the start of pumping. The third phase (late-time data) appeared most representative of the aquifer response, after correction for regional water level rise (Figure 6-12).

HWA calculated the transmissivity of the alluvial aquifer assuming that the late-time portion of the OW-2 recovery curve met the criteria for the Theis (1935) recovery analytical method. HWA calculated an uncorrected transmissivity value of 53,000 $ft^2$/day for the alluvial aquifer at PW-2. A corrected value would result in an

estimated transmissivity value of 96,000 $ft^2$/day, which seems too large compared to drawdown-based estimates.

### 6.2.5 Summary

Based on the drawdown and recovery results, HWA estimates the average aquifer transmissivity at PW-2 at 35,000 $ft^2$/day (Table 6-1). More weight could be given to the distance-drawdown estimate, which incorporates the drawdown observed within a 550-foot radius around the well, resulting in an average value for a relatively large area around the well. Any changes in aquifer water level due to river level changes would likely be attenuated by the distance to the river. Assuming an average saturated thickness of 144 feet, HWA estimates the average hydraulic conductivity of the alluvial aquifer at 243 feet per day, or 0.09 cm/sec. This value compares well with the observed aquifer materials (medium sand with gravel).

At PW-2, as at PW-1, the Methow River hydraulically interacts primarily with the upper portion of the alluvial aquifer. At PW-2, however, this hydraulic interaction between the aquifer at PW-2 and the Methow River is likely attenuated by distance to the river (approximately 1,200 feet). Due to vertical heterogeneity of the stratified aquifer, the majority of ground water entering the well screen during pumping derives primarily from ground water within the aquifer flowing horizontally at the depth of the well screen.

## 6.3 PW-3

Figure 3-3 shows the well locations and Methow River at PW-3. Observation well OW-3 lies 50 feet from PW-3, and both wells were installed approximately 100 feet from the Methow River. Figure 6-13 shows relative water levels measured during all testing at PW-3. At the time of aquifer testing, the surface of the Methow River was approximately 33 feet below the surface of the grade at the well installation, and the base of the river was approximately 4 feet below the river surface. The PW-3 well screen lies 100 to 135 feet below grade. The top of the PW-3 well screen, therefore, lies approximately 63 feet below the base of the Methow River. At the time of aquifer testing, the depth to water at PW-3 and OW-3 were approximately 33 feet below grade, corresponding to the river level. PW-3 and OW-3 fully penetrate the most permeable portion of the aquifer, but not the entire saturated portion of the aquifer. At PW-3, the Methow River hydraulically interacts with the upper portion of the alluvial aquifer. A direct exchange of river water and ground water likely occurs at the uppermost levels of the aquifer, but the exchange decreases with aquifer depth.

HWA measured water levels at one domestic supply well located 300 feet west of PW-3 (Figure 3-3). During the constant rate test, the domestic well was periodically pumped to obtain irrigation water. Water levels in the domestic well, therefore, fluctuated too frequently for useful comparison to water levels at OW-3 and PW-3.

Due to equipment malfunction, river water levels were not measured during the recovery period following the constant-rate test. Instead, USGS data for the Methow River stage (Appendix A) were used for analysis.

### 6.3.1 Background Monitoring Results and Environmental Factors

During the period of river water level monitoring (April 4 to April 13, 2000), the daily water level of the Methow River fluctuated by less than 0.1 foot. During the constant-rate testing period, river water level decreased slightly by 0.3 feet then returned to pre-pumping levels by the end of the constant-rate test. During the recovery testing period, the river level increased steadily by approximately one foot. Changes in water levels at PW-3 and OW-3 during these times generally matched changes in river levels, indicating that the regional aquifer at the depth of the PW-3 well screen hydraulically communicates with the Methow River, with little attenuation. The river stage, therefore, may be used to indicate regional aquifer water levels, if ground water level data are not available. Ground water level fluctuations did not correlate to, and required no correction for, daily barometric pressure fluctuations (Figure 6-13).

### 6.3.2 Step Testing Results

Figure 6-14 and Table 4-1 summarize step-testing results at PW-3. HWA pumped PW-3 at a maximum rate of 1,022 gpm during the step test. HWA estimates a maximum yield of 945 gpm at PW-3 based on the well design and well screen manufacturers specifications. The final step at 1,022 gpm exceeded the theoretical safe yield. Some minor sand pumping occurred during the final step due to high velocity or turbulent flow at the well screen. Well performance during step-testing (Figure 4-1) indicates that a maximum drawdown of four feet would occur at the maximum theoretical yield. The well performance with each step appeared to follow a linear trend, even at a rate exceeding the theoretical safe yield rate. The maximum available drawdown, based on the depth of well screen submergence below the static water level, is approximately 67 feet, or 63 feet greater than the estimated drawdown at the theoretical yield.

### 6.3.3 Constant-Rate Testing Results

HWA pumped PW-3 at an average rate of 1,023 gpm for five days (April 5 to April 10, 2000). Appendix F shows pumping rate data for PW-3. During the constant-rate test, the river level (and therefore the regional aquifer water level) remained generally constant. The river level decreased by 0.3 feet, then returned to pre-pumping levels by the end of the test. No correction for changes in regional aquifer head were required for the constant-rate water level data. Figure 6-15 shows a semi-log plot of drawdown levels at PW-3 and OW-3, and the change in the Methow River water level during the test. The results show that 90 percent of the maximum drawdown at PW-3 (5.18 feet) and OW-3 (2.62 feet) occurred within the first 10 minutes of the test. Changes in water levels at PW-3 matched changes at OW-3, indicating good hydraulic connection within the aquifer between the two wells. The general rise and fall in elevations at the two wells during the last few days of the test appear to match river elevations (and regional aquifer head).

Closer observation of the semi-log plot of drawdown versus time (Figure 6-16) indicates two distinct phases of aquifer response to pumping. The first six minutes is interpreted as a linear Theis-type, semi-confined aquifer response. From 6 to approximately 1,000 minutes, the drawdown rate decreased, due to a delayed-yield aquifer drainage

release of water from the alluvial aquifer. After 1,000 minutes of pumping, water levels continued to decline in a delayed-yield-type response, but with the addition of regional ground water level decline. The response did not appear to change to the Theis-type response that occurred at PW-1 and PW-2. This suggests that semi-confining conditions may not exist at PW-3, that delayed-yield response occurs for a longer period at PW-3 than at the other testing locations, or both. Delayed yield response at PW-3 results from variables such as horizontal and vertical aquifer permeability, lateral extent and thickness of the aquifer, and the transmissivity of the overlying portion of the aquifer. The strong overprint of regional head fluctuations obscured the aquifer response to pumping, but it appears that ground water levels continued to decline relative to the regional aquifer head (see latest portion of drawdown curves on Figure 6-15).

Based on the water level results at the site, HWA assumes the following conditions for the aquifer, wells, river, and pumping test results at PW-3:

- The saturated thickness of the aquifer exceeds 107 feet
- The river intersects the upper four feet of the aquifer.
- Limited exchange of ground water and surface water occurs between the top of the alluvial aquifer and the river
- The alluvial aquifer is unconfined to the depth of the PW-3 well screen (100-135 feet); semi-confined conditions may occur at depths below the well screen, due to aquifer heterogeneity.
- The wells partially penetrate the entire saturated thickness of the aquifer at approximately 63 feet below the base of the river, and approximately 67 feet below the top of the aquifer.
- The wells fully penetrate the most productive zone of the alluvial aquifer.
- The first six minutes of the test does not provide useful data for determining long-term aquifer response to pumping. The second phase of the test appears most representative of aquifer properties.

HWA calculated the transmissivity of the alluvial aquifer assuming that the second phase, of the OW-3 drawdown curve met the criteria for the Neuman (1972) delayed-yield analytical method. HWA used the Aquifer Test® software developed by Waterloo Hydrogeologic, Inc. to evaluate drawdown versus time results for OW-3. The analysis indicates a transmissivity value of 48,000 $ft^2$/day, or 360,000 gpd/ft for the alluvial aquifer at PW-3 (Figure 6-16). This result may underestimate the actual transmissivity, because the data did not indicate a Theis-type response at the end of delayed-yield portion of the aquifer response. The method uses a best-fit method that is most accurate when early-, mid-, and late-time data are available for curve matching.

### 6.3.4 Recovery Monitoring Results

During the recovery portion of the test, river and regional aquifer water levels rose by two feet, exceeding the initial water levels. Long-term recovery results would require correction for river level rise before use. The recovery test results show two phases in the semi-log residual recovery time (Figure 6-17). The first phase occurred during the first five minutes of recovery, and appear too early for use in recovery analysis. The second

phase began during the first hour of recovery and is interpreted as reversible delayed-yield response. After the first day of recovery, regional aquifer head and river water level changes overprinted the recovery response, necessitating a correction for these effects. An accurate correction would require monitoring data from a portion of the aquifer not affected by pumping. No domestic well data near PW-3 were available for monitoring, however, and a correction factor could only be estimated based on river level data. Any correction would result in a flatter recovery curve (less residual drawdown), which would result in a lower value change in residual drawdown ($\Delta s$) and a higher transmissivity value.

HWA calculated the transmissivity of the alluvial aquifer assuming that the second phase of the OW-3 recovery curve met the criteria for the Theis (1935) recovery analytical method. The analysis indicates a transmissivity value of 155,000 $ft^2$/day for the alluvial aquifer at PW-3. This value may overestimate the actual aquifer transmissivity, as the effects of elastic storage may still affect recovery at earlier recovery times, and aquifer response to a rise in river stage may overprint recovery response. See Appendix J for the recovery-based calculation.

**6.3.5 Summary**

At PW-3, The Neuman and Cooper-Jacob methods appear most appropriate for evaluating the drawdown and recovery results, respectively. The regional aquifer head and river stage affect water level in the aquifer at the depth of the PW-3 well screen which complicates analysis of the aquifer response to pumping. Ground water pumping at PW-3 likely did not affect river level changes. The short distance between PW-3 and the river indicate that the aquifer hydraulic head will rapidly change with river stage level.

The soil boring log data indicate higher permeability of the aquifer than at other testing locations. The coarse sand and gravel layer at PW-3, however, may not be extensive. Based on an average between the drawdown and recovery calculation, HWA estimates the average aquifer transmissivity at PW-3 at 96,000 $ft^2$/day (Table 6-1). This value likely decreases with distance from the river as the aquifer becomes finer grained (less transmissive). Assuming an average saturated thickness of 107 feet, HWA estimates the average hydraulic conductivity of the alluvial aquifer at 897 feet per day, or 0.32 cm/sec. This value compares well with the observed aquifer materials (sand and gravel).

At PW-3, similar to PW-1 and PW-2, the Methow River exchanges water according to river stage and regional aquifer water levels. The amount of exchange decreases with aquifer depth. In contrast to the other two locations, the permeability of the aquifer at PW-3 and closer proximity of the well to the river results in greater hydraulic communication (pressure head response) between the river and the aquifer than at PW-1 and PW-2. Change in river stage and aquifer head appear to be synchronous. This does not imply, however, that direct exchange of ground water and surface water occurs at the depth of the PW-3 well screen. The vertical distance between the base of the river and the aquifer at the well depth (100 to 135 feet), and the stratified aquifer heterogeneity,

restrict vertical flow to the well. Most of the ground water entering the well screen likely derives from ground water flowing horizontally in the aquifer at the depth of the well screen.

# 7.0 CONCLUSIONS AND RECOMMENDATIONS

HWA conducted the aquifer testing to evaluate the alluvial aquifer response to ground water pumping and the potential effect on river water levels and nearby domestic ground water wells.

## 7.1 Interaction between the Methow River and the Alluvial Aquifer

The alluvial aquifer hydrostratigraphy observed in well borings and the water level data obtained during the aquifer testing indicated the general hydraulic relationship between surface water the Methow River and ground water in the alluvial aquifer. The stratified alluvial aquifer is ground water-saturated from the elevation of the Methow River to a depth of at least 200 feet. Through this saturated thickness, conditions in the aquifer likely progress from unconfined conditions with direct hydraulic communication with the river water at the uppermost levels of the aquifer, downward to increasingly confined conditions as layers of lower permeability aquifer materials restrict vertical flow within the aquifer. In addition, the degree of hydraulic communication between surface water and ground water decreases with distance from the river.

## 7.2 Aquifer Transmissivity and Flow Estimates

Average alluvial aquifer transmissivity estimates range from 35,000 $ft^2$/day to 96,000 $ft^2$/day (Table 6-1). The estimates were based on average transmissivity values calculated from the best-fit drawdown and recovery data. HWA concludes that the values correlate well with respective aquifer materials observed during drilling. The coarsest-grained alluvium occurs at PW-3, which lies within 100 feet of the river, and finest-grained alluvium occurs at PW-2, which was installed at a distance of 1,200 feet from the river. The coarse-grained deposits and high transmissivity values at PW-3 may indicate a former alluvial channel, which may only exist in a narrow band along the river.

Based on the testing results HWA estimates the average horizontal flow velocity of ground water in the alluvial aquifer during non-pumping conditions at 4 feet per day (average hydraulic conductivity = 250 feet/day; horizontal hydraulic gradient = 0.004 feet/feet; porosity = 25 percent). The average vertical flow velocity under non-pumping conditions would likely be in the range of 100 times lower due to aquifer heterogeneity. During pumping conditions, horizontal velocities near the pumping well would increase, particularly at the depth of the well screen. For pumping conditions, HWA estimates a average vertical velocity of 1.3 feet per day, using the following assumptions:

- vertical gradient - 0.13 feet per foot (drawdown of 10 feet, vertical distance of 75 feet)
- vertical hydraulic conductivity – 2.5 feet/day (one percent of average horizontal hydraulic conductivity)
- porosity – 25 percent

This estimate for the average vertical velocity directly above a pumping well (which would decrease exponentially with distance) is less than the average horizontal velocities during non-pumping conditions. During pumping conditions, the horizontal velocity would be even greater. The vertical flow from shallow portions of the aquifer or the river during pumping at the testing rates at the test wells is likely insignificant.

## 7.3 Optimum Pumping Rates

The amount of available drawdown at each test location appears adequate for maximum sustainable pumping rates. HWA recommends pumping the wells at 75 to 90 percent of the theoretical yield, primarily to avoid turbulent flow, excessive sand pumping, and well screen corrosion during long-term pumping. Table 6-1 summarizes the theoretical yield and recommended rates for each well. HWA estimated the specific capacity for each test well assuming that the constant-rate testing nearly achieved steady-state pumping conditions. Longer term pumping, or pumping at different times of the year when aquifer head decreases, may result in a different specific capacity values for the wells. Long-term pumping rates may also result in the intersection of the drawdown cone of depression with a hydraulic boundary, such as impermeable bedrock or a stratigraphic pinch-out of a transmissive zone. This could lead to increased drawdown at the pumping well.

## 7.4 Aquifer Pumping and Methow River Water Levels

During the period of aquifer testing, the Methow River flowed at a rate of 2,500 to 3,000 cfs, and the average annual flow in 1999 was 2,000 cfs (Appendix A; USGS WRIS database). In comparison, HWA estimated the average ground water flux through the alluvial aquifer at 37 cfs, assuming an average values for aquifer hydraulic gradient and conductivity. The maximum discharge of ground water at PW-1 was 1,214 gpm, or 2.7 cfs, or approximately 0.1 percent of the average river flow. Ground water pumping at 1,000 gpm at any of the three locations, therefore, would have little or no effect on the Methow River water levels.

## 7.5 Aquifer Pumping and Ground Water Levels

The ground water levels in the alluvial aquifer in 1999 and 2000 fluctuated by six feet (Appendix A; USGS WRIS database). Ground water pumping in highly transmissive zones of the alluvial aquifer will cause a widespread but small magnitude drawdown response; the cone of water level depression around the well would be broad and relatively flat. Conversely, the water level cone of depression around wells pumping from lower transmissivity zones would be smaller in area, but steeper.

At PW-2, water levels in the domestic wells within 550 feet of PW-2 drew down by less than 0.5 feet during the constant-rate test. In comparison, pumps operating in the domestic wells during the aquifer testing drew down water levels within the domestic wells by 0.5 to more than 1 foot.

No domestic wells were available to provide water level data to assess the extent of aquifer response to pumping during testing at PW-1 and PW-3. The actual drawdown at specific distances from the irrigation wells may be estimated using the estimated aquifer transmissivity values at each location and the Cooper-Jacob distance-drawdown method of analysis (see Appendix J):

- The drawdown at OW-1, 50 feet distant from PW-1, was 6.0 feet. At 10 times this distance (500 feet), HWA estimates a drawdown of 4.6 feet, assuming a pumping rate of 1,214 gpm.
- The drawdown at OW-2, 50 feet distant from PW-1, was 2.2 feet. At 500 feet, HWA estimates a drawdown of 0.5 feet, assuming a pumping rate of 821 gpm.
- The drawdown at OW-3, 50 feet distant from PW-1, was 2.6 feet. At 500 feet, HWA estimates a drawdown of 1.8 feet, assuming a pumping rate of 1,023 gpm.

These calculations indicate that the alluvial aquifer at PW-2 and PW-3 can be pumped at rates exceeding 1,000 gpm with little effect on surrounding water users. The alluvial aquifer at PW-1 may not be able to sustain high pumping rates without affecting water levels at nearby wells.

## 7.6 Additional Irrigation Supply Wells

The MVID may be served by pressurized irrigation systems supplied by wells including those drilled and tested for this project. Three pressurized systems are currently planned. The service areas for each system are named the East Side, Upper West Side and Lower West Side.

The East Side system would serve an area on the east side of the Methow River between the old mill site (by the Hwy 20 bridge crossing of the Methow River) to property located approximately one-half way between Hwy 20 and Beaver Creek Road. The approximate area that would be served is 356 acres, although more or less acreage could be included depending on the final configuration of the MVID. The demand for the East Side system would be approximately 9 gpm per acre served, or 3204 gpm. Pumping Wells (PW) 1 and 2 are located within the service area of the potential East Side system.

The Upper West Side system would serve an 84-acre area on the west side of the Methow River between the Town of Twisp and Roach Spill on the existing MVID West Canal. The estimated demand for this area is 756 gpm. No test wells were constructed on the west side of the Methow River. However given the proximity to PW-1 and PW-2 along with the alluvial nature of the valley it is likely similar hydrogeologic conditions exist along the west side of the Methow River.

The Lower West Side would serve a 240-acre area on the west side of the Methow River between Alder Creek and just north of the end of the existing MVID system. The estimated demand for this area is approximately 2160 gpm. Pumping Well 3 is located within this service area.

The total estimated well pumping requirement for the MVID is 6120 gpm. That pumping requirement could change depending on the final configuration of the district. This amount appears achievable based on aquifer testing results. The available drawdown at PW-1, PW-2, and PW-3 is four to six times greater than the constant-rate drawdown observed at each test well, indicating that abundant available drawdown exists at each site. HWA recommends careful consideration of the potential influence of a irrigation supply well field on water levels at nearby domestic wells, however. Factors to consider include the distance to domestic wells, domestic well depths and average pumping rates, estimates of the irrigation well and observation well pumping rates, and property boundary locations.

# 8.0 REFERENCES

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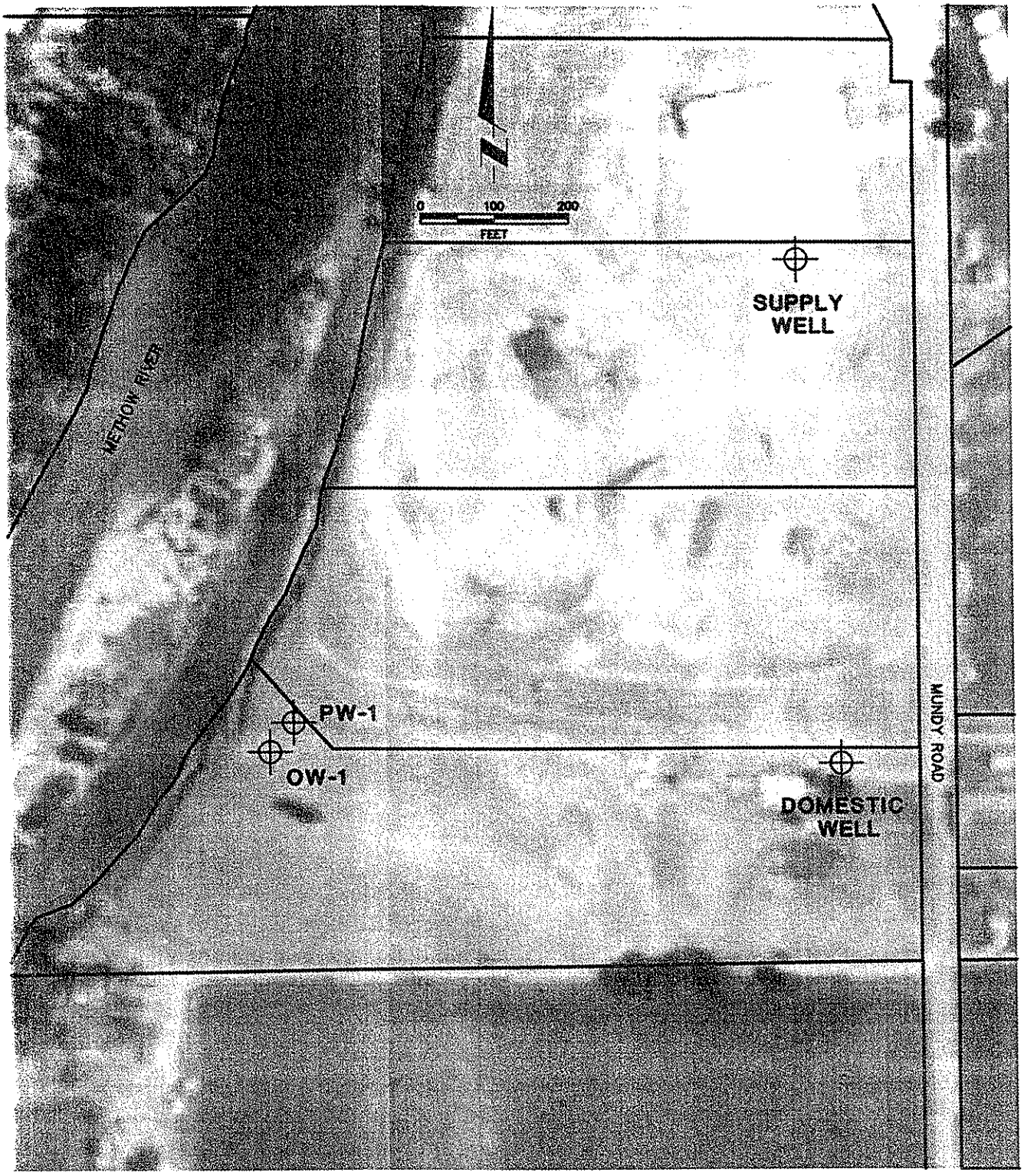
http://water.usgs.gov/wa/nwis/dv/?site_no=12448500




## NOTE

1. Property lines from Okanogan County GIS 1999.
2. Aerial photograph (ortho. quad.) from Okanogan County dated 1994.

REFERENCE: Base map provided by MONTGOMERY WATER GROUP, INC.

HWA GEOSCIENCES INC.

PW-1 LOCATION

METHOW VALLEY IRRIGATION DISTRICT
TWISP, WASHINGTON

| | |
|---|---|
| DRAWN BY HAC | FIGURE NO. 3-1 |
| CHECKED BY SN | |
| DATE 11.07.00 | PROJECT NO. 94054 |

C:\1PROJECTS\94\94054\94054001.DWG


N

0' 200' 400' 800'

SCALE: 1"=400'

## LEGEND

**PW-2** BORING DESIGNATION AND APPROXIMATE LOCATION

## NOTE

1. Property lines from Okanogan County GIS 1999.
2. Aerial photograph (ortho. quad.) from Okanogan County dated 1994.

REFERENCE: Base map provided by MONTGOMERY WATER GROUP, INC.

C:\1PROJECTS\94\94054\94054005.DWG

HWA GEOSCIENCES INC.

METHOW VALLEY IRRIGATION DISTRICT TWISP, WASHINGTON

PW-2 LOCATION

DRAWN BY HAC
CHECKED BY SN
DATE 08.06.01

FIGURE NO. 3-2

PROJECT NO. 94054


## NOTE

1. Property lines from Okanogan County GIS 1999.
2. Aerial photograph (ortho. quad.) from Okanogan County dated 1994.

REFERENCE: Base map provided by MONTGOMERY WATER GROUP, INC.

HWA GEOSCIENCES INC.

PW-3 LOCATION

METHOW VALLEY IRRIGATION DISTRICT
TWISP, WASHINGTON

| | |
|---|---|
| DRAWN BY HAC | FIGURE NO. 3-3 |
| CHECKED BY SN | |
| DATE 08.06.01 | PROJECT NO. 94054 |

C:\1PROJECTS\94\94054\94054003.DWG

**Figure 4-1**
**Step Testing Results and Well Performance**
**Methow Valley Irrigation District**
**Twisp, Washington**

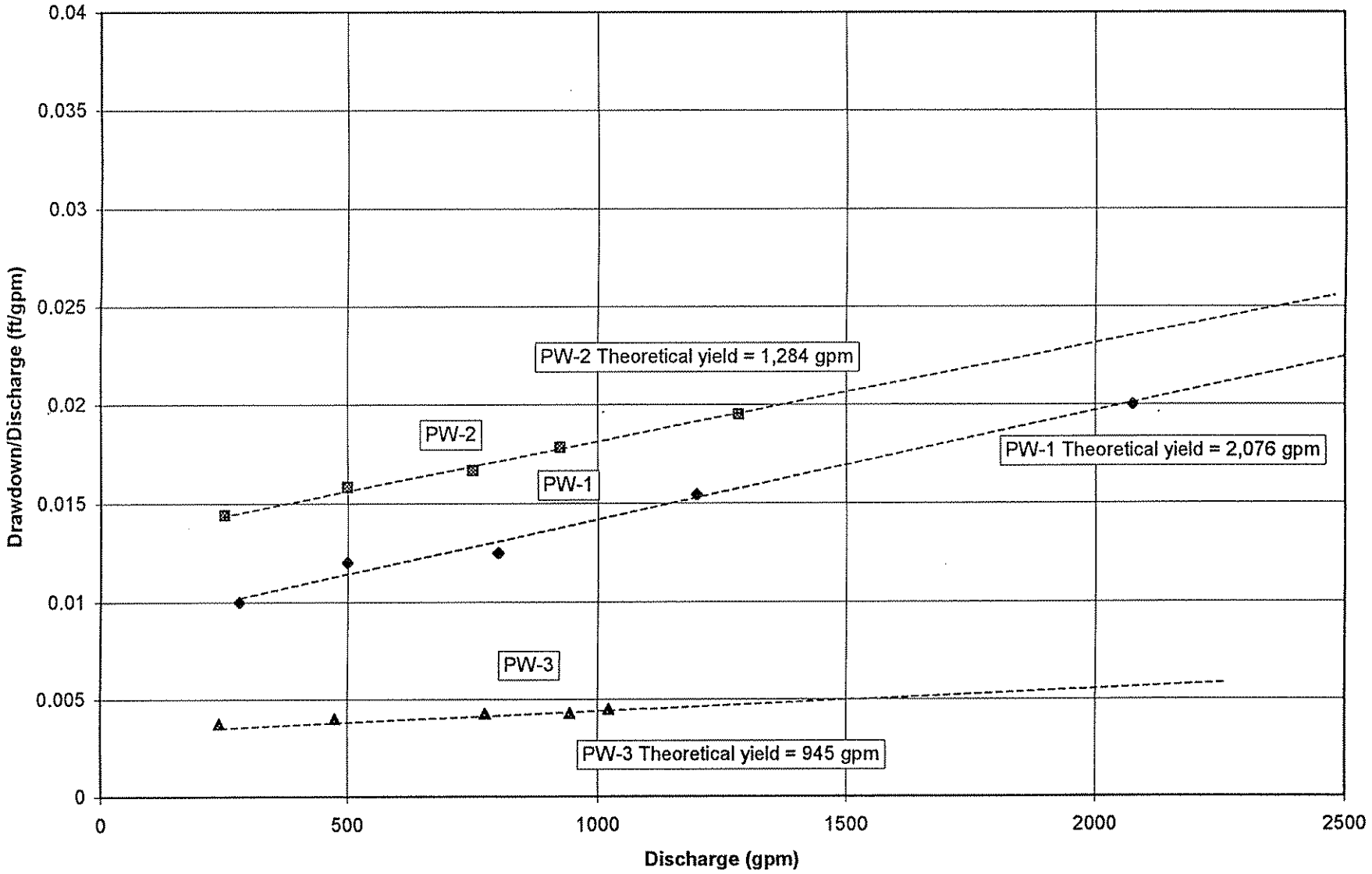


**Figure 6 - 1**
**Water Level Measurements - PW-1**
**May 3 - 23, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**

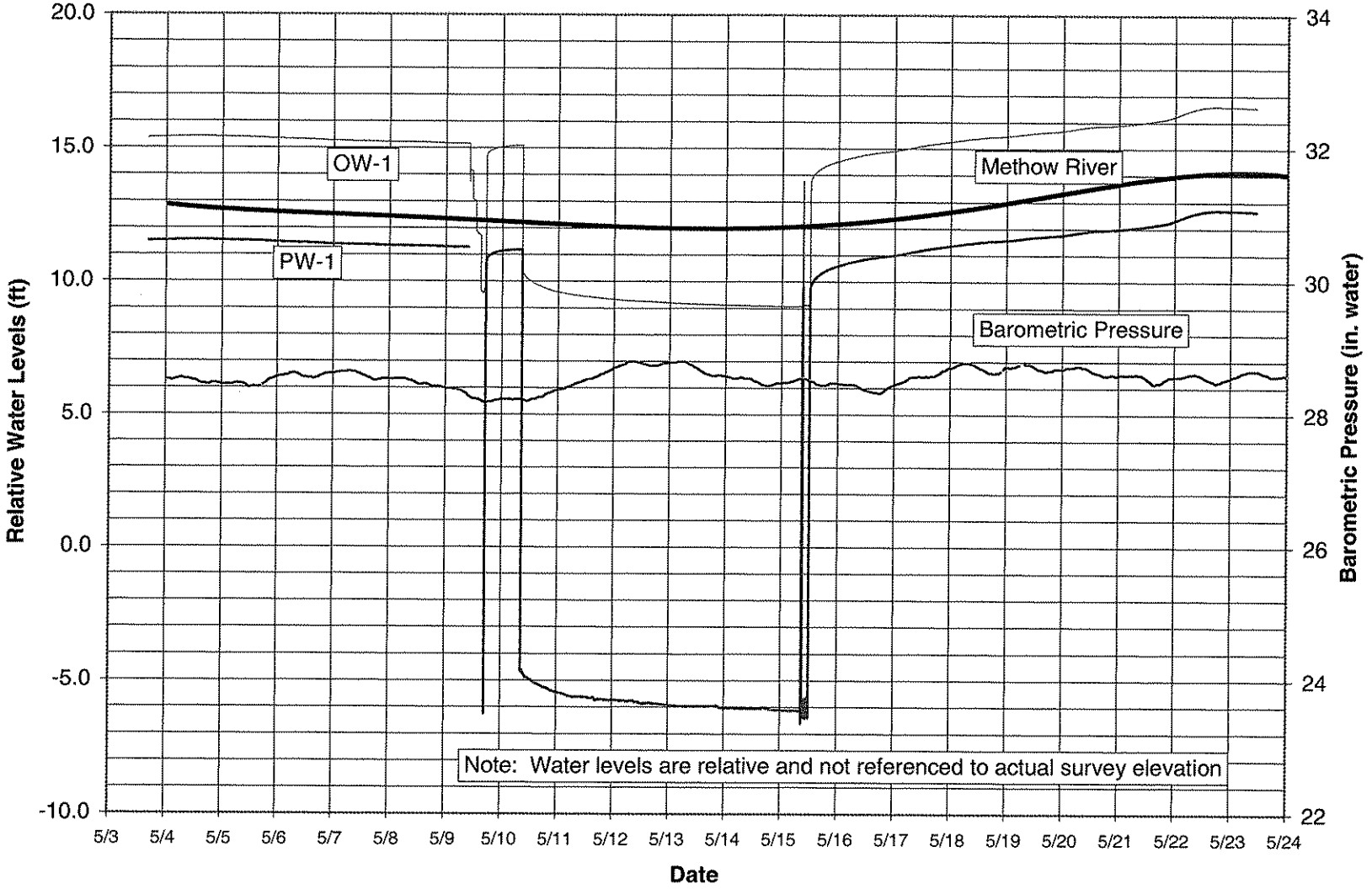


**Figure 6-2**
**Step Test Results - PW-1**
**May 9, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**

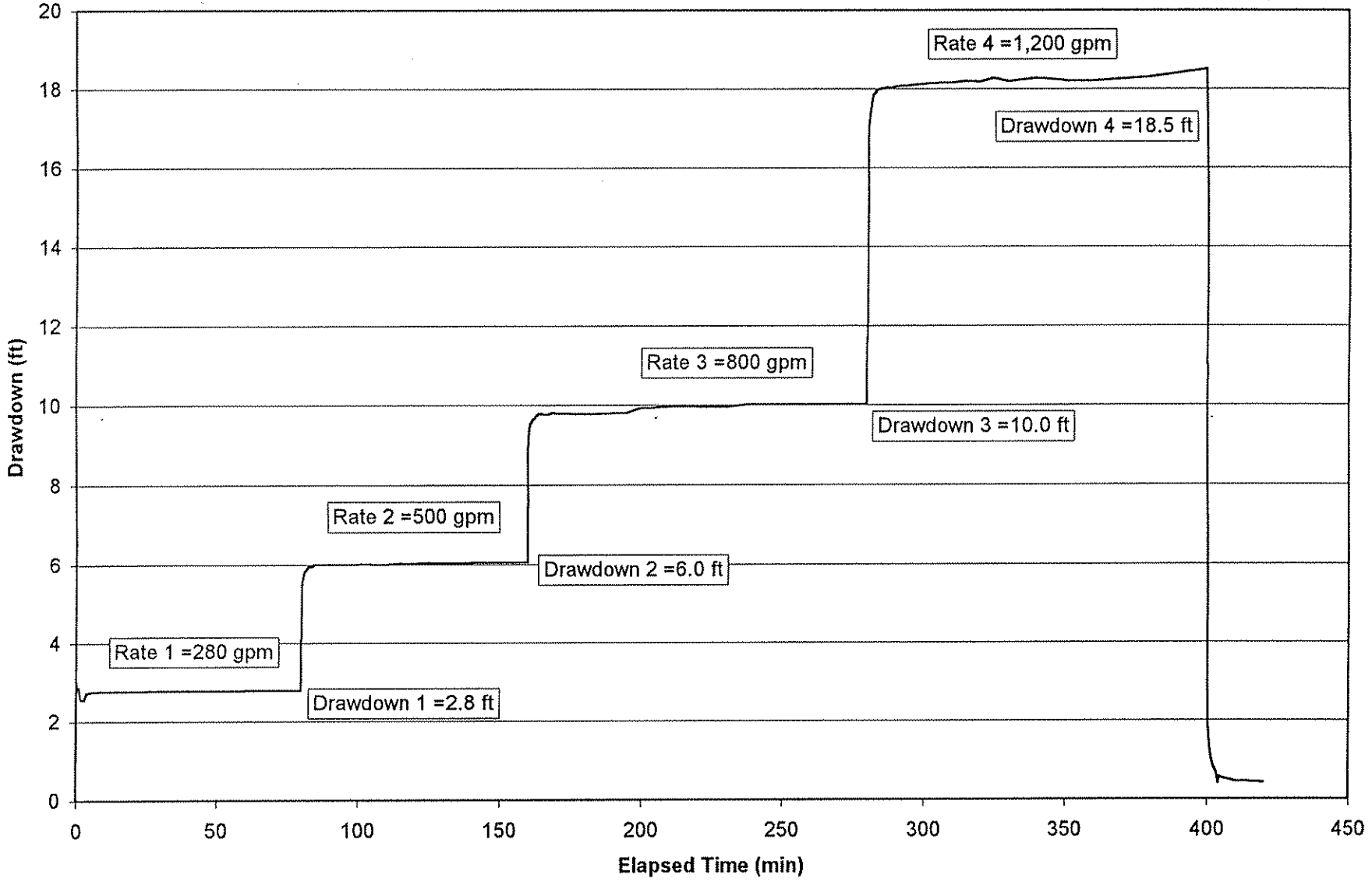
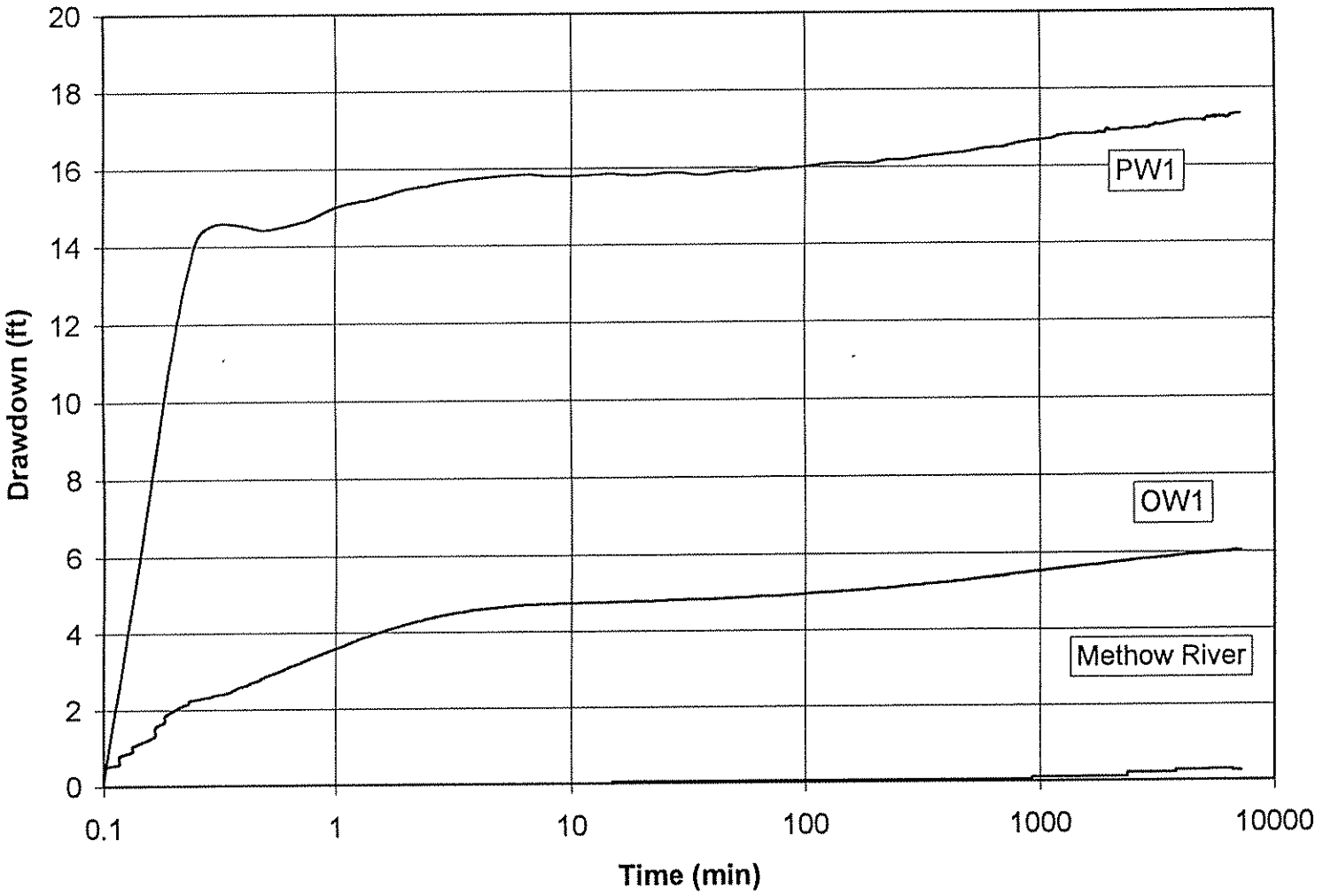
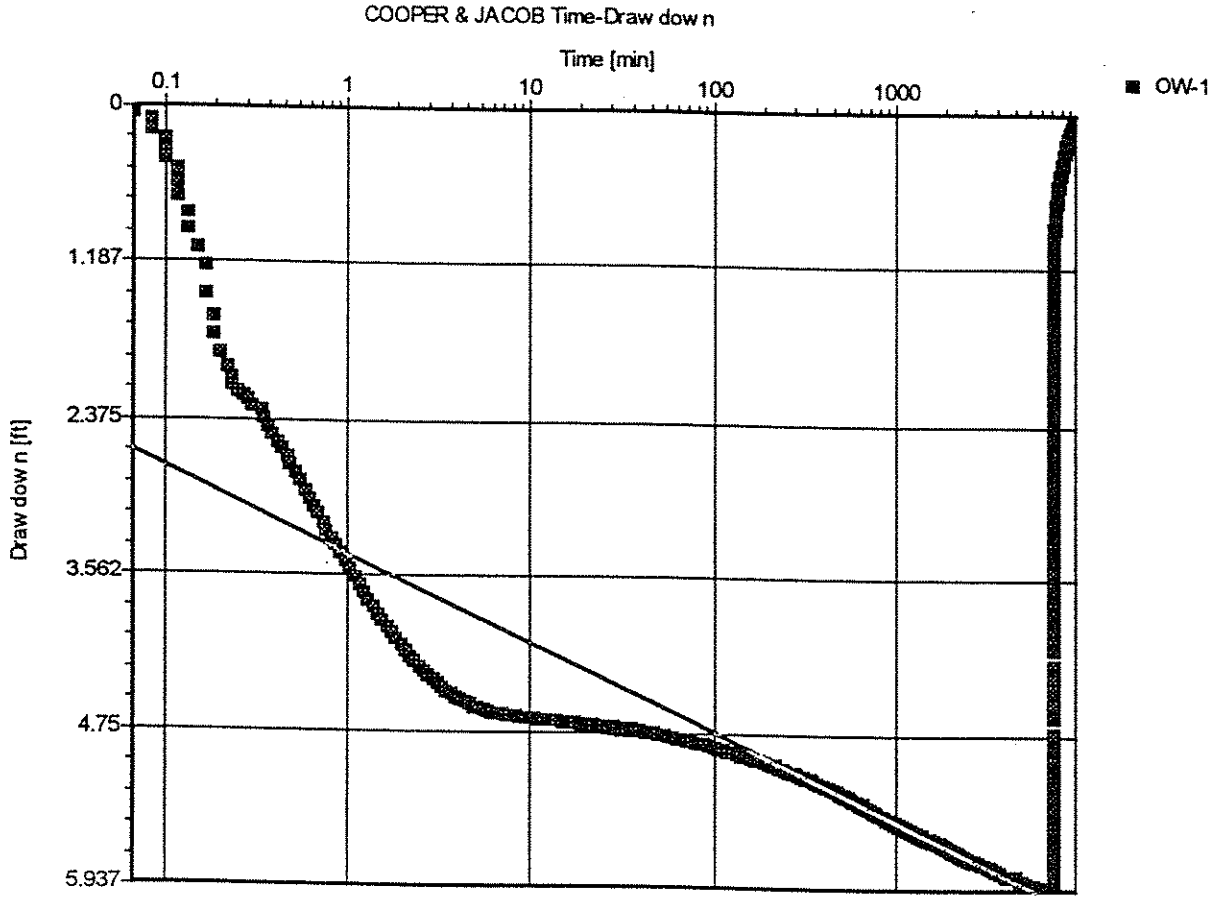


**Figure 6-3**
**Drawdown - PW-1**
**May 10 - 15, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**



| HWA GeoSciences<br>19730 - 64th Ave W, Suite 200<br>Lynnwood, WA 98037<br>(425) 774-0106 | **Pumping test analysis**<br>No: 94054<br>Project: PW-1<br>Client: MVID |
|---|---|

| | | |
|---|---|---|
| Location: Twisp, Washington | Pumping test: PW-1 | Pumping well: PW-1 |
| Test performed by: HWA GeoSciences<br>Test date: 5/22/2000 | Evaluated by:<br>Evaluation date: 7/6/2000 | |
| Analysis method: COOPER & JACOB Time-Drawdown | Aquifer thickness: 151<br>Discharge rate: 1214 [U.S. gal/min] | |



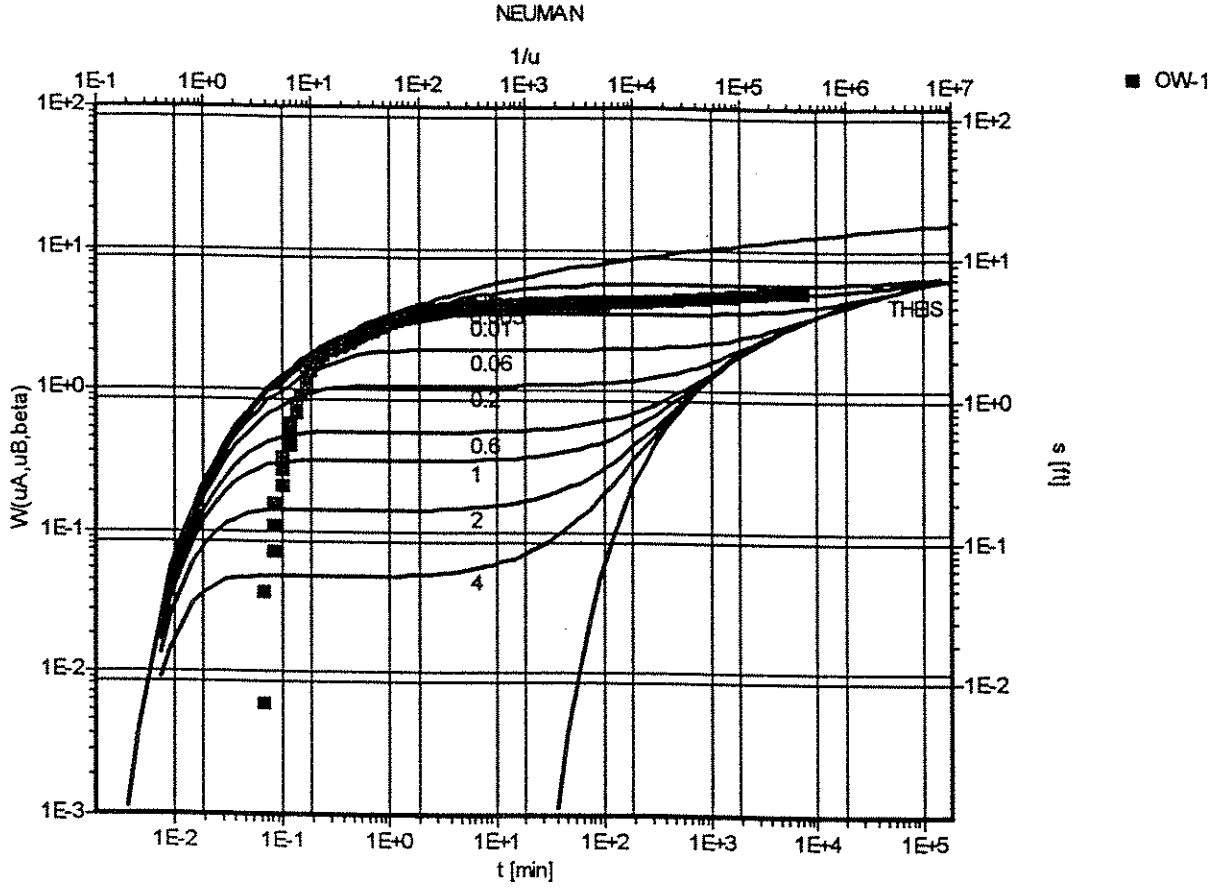

| | |
|---|---|
| Transmissivity: | 6.35×10^+4 [ft²/d] |
| Conductivity: | 4.21×10^+2 [ft/d] |
| Storativity: | 3.63×10^-7 .00000363 ? |

Figure 6-4

| HWA GeoSciences<br>19730 - 64th Ave W, Suite 200<br>Lynnwood, WA 98037<br>(425) 774-0106 | **Pumping test analysis**<br>No: 94054<br>Project: PW-1<br>Client: MVID |
|---|---|

| Location: Twisp, Washington | Pumping test: PW-1 | Pumping well: PW-1 |
|---|---|---|

| | |
|---|---|
| Test performed by: HWA GeoSciences<br>Test date: 5/22/2000 | Evaluated by:<br>Evaluation date: 5/22/2000 |
| Analysis method: NEUMAN | Aquifer thickness: 151<br>Discharge rate: 1214 [U.S. gal/min] |




Transmissivity: 1.59×10^+4 [ft²/d]

Conductivity: 1.05×10^+2 [ft/d]

Storativity: 3.29×10^-4 .00033

Specific yield: 3.29×10^+0

Figure 6-5

**Figure 6 - 6**
**Recovery - OW-1**
**May 15 - 23, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**

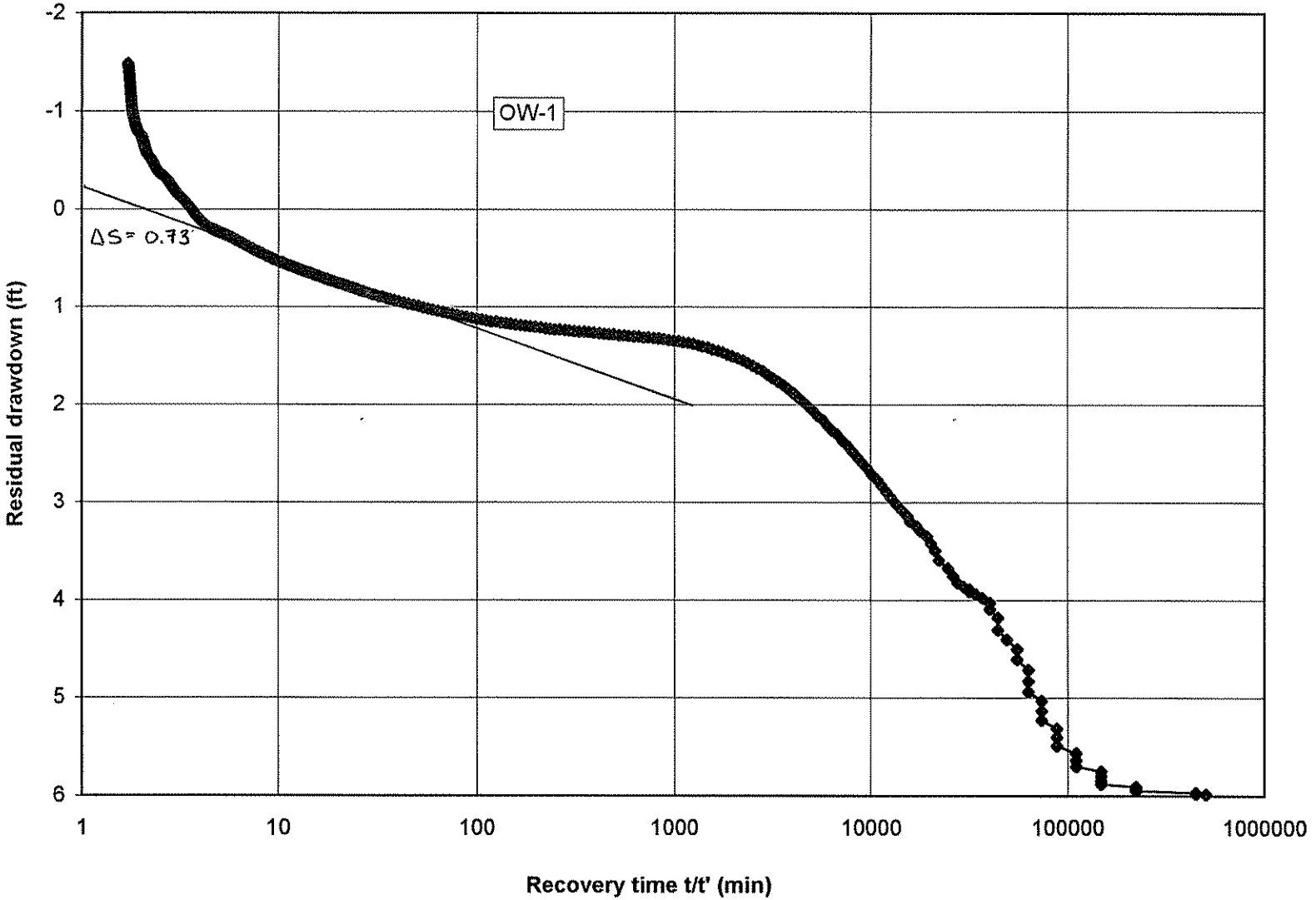


**Figure 6 - 7**
**Water Level Measurements - PW-2**
**April 13 - May 3, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**

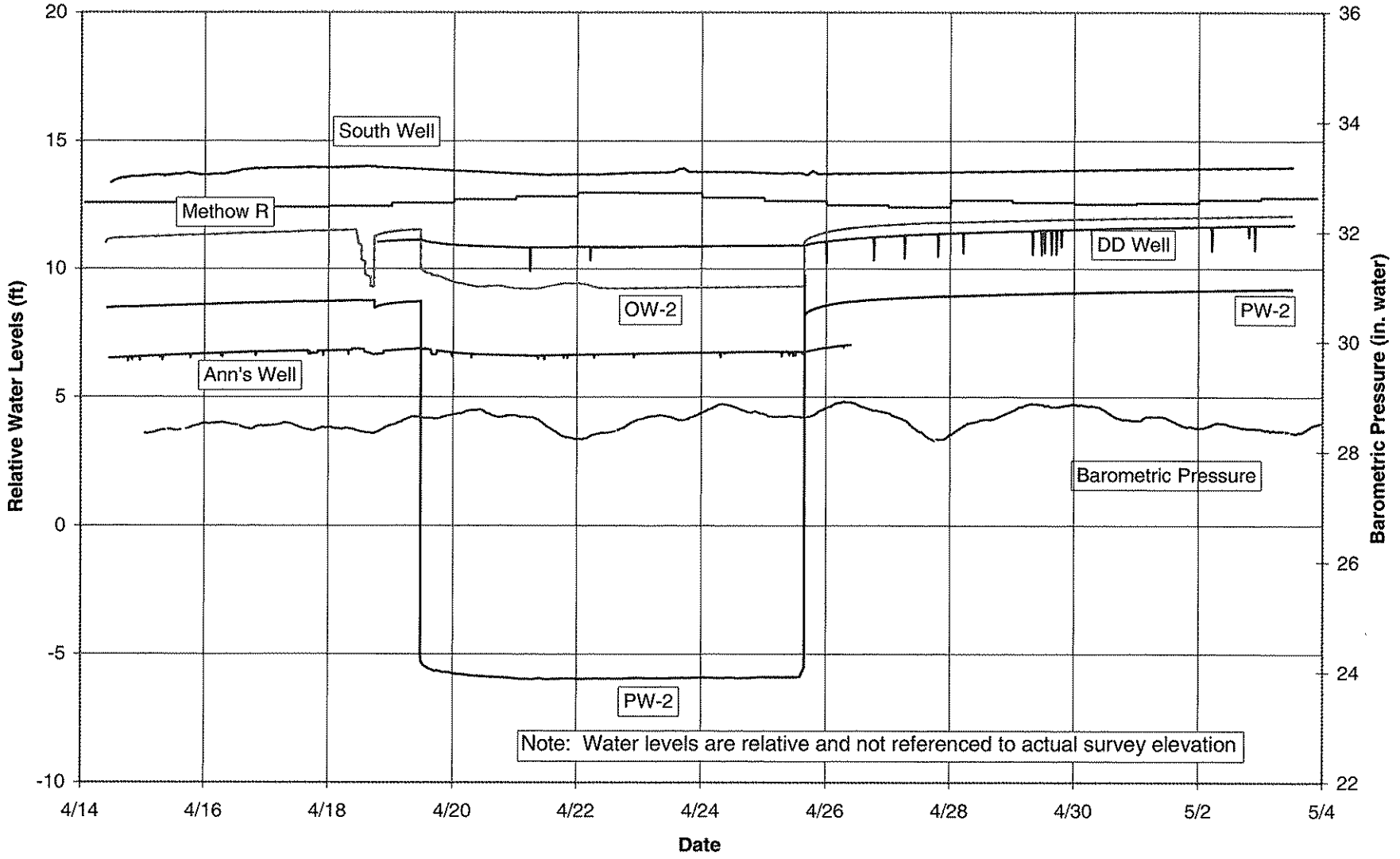


**Figure 6 - 8**
**Step Test Results - PW-2**
**April 18, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**

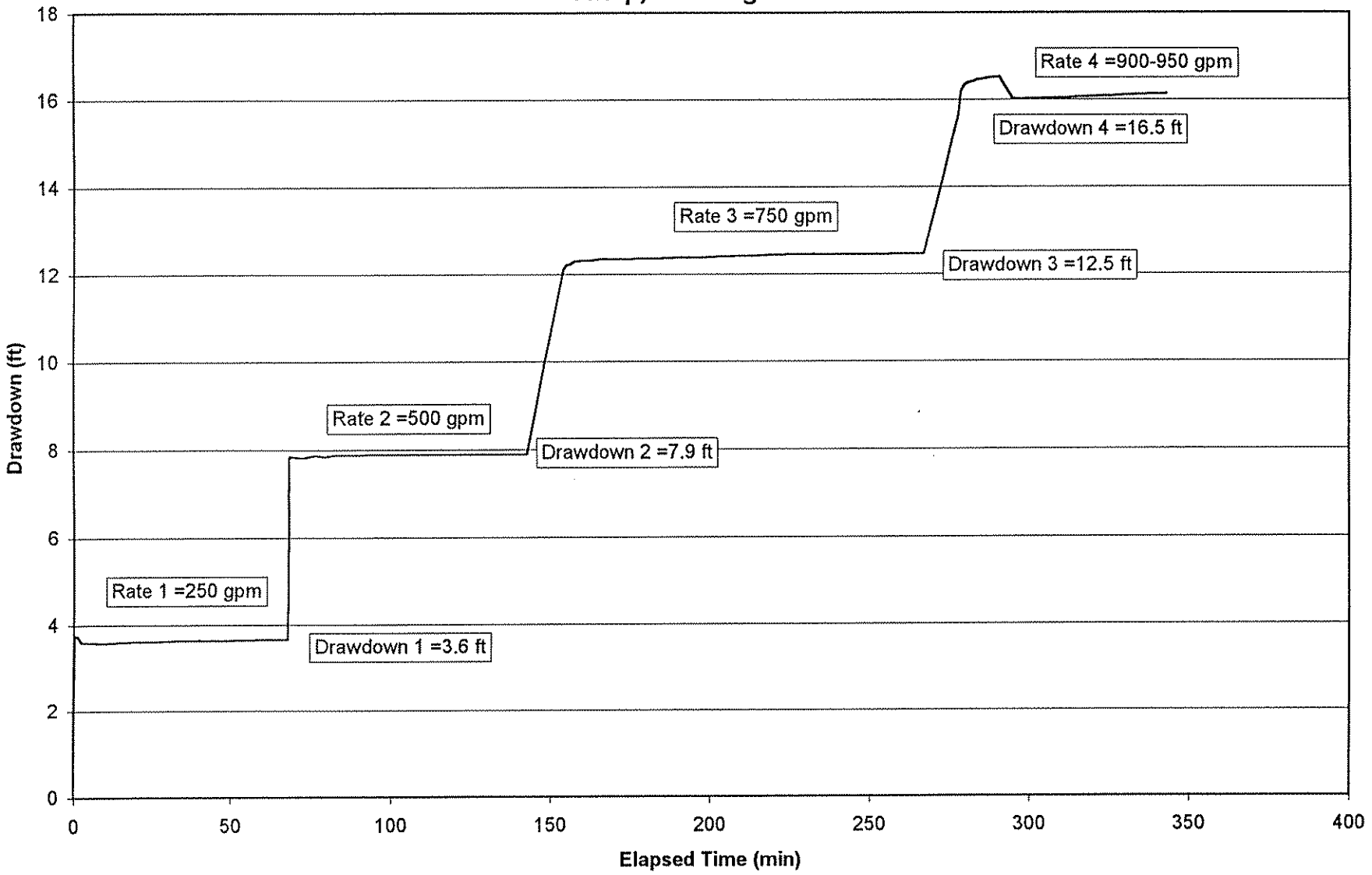
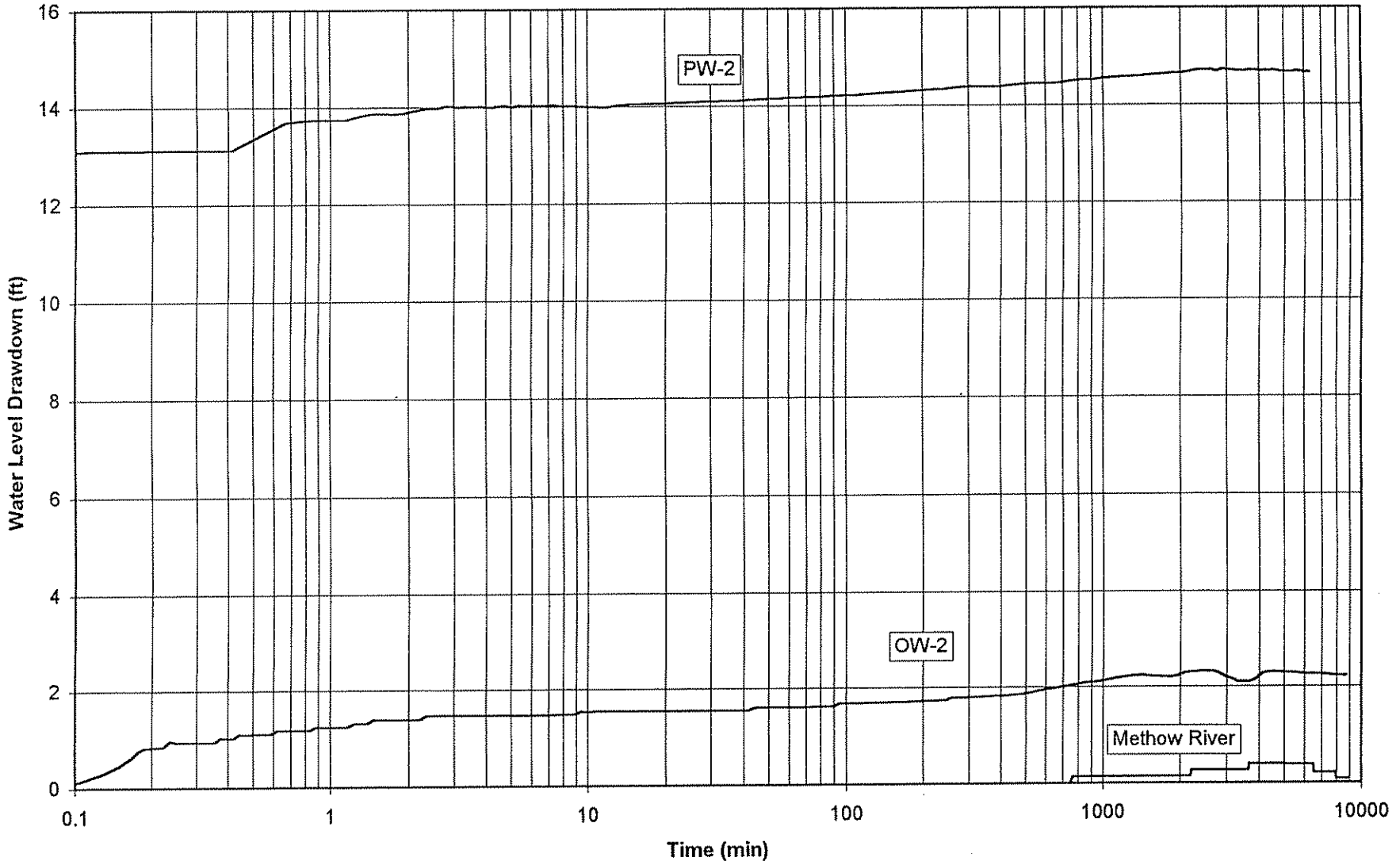


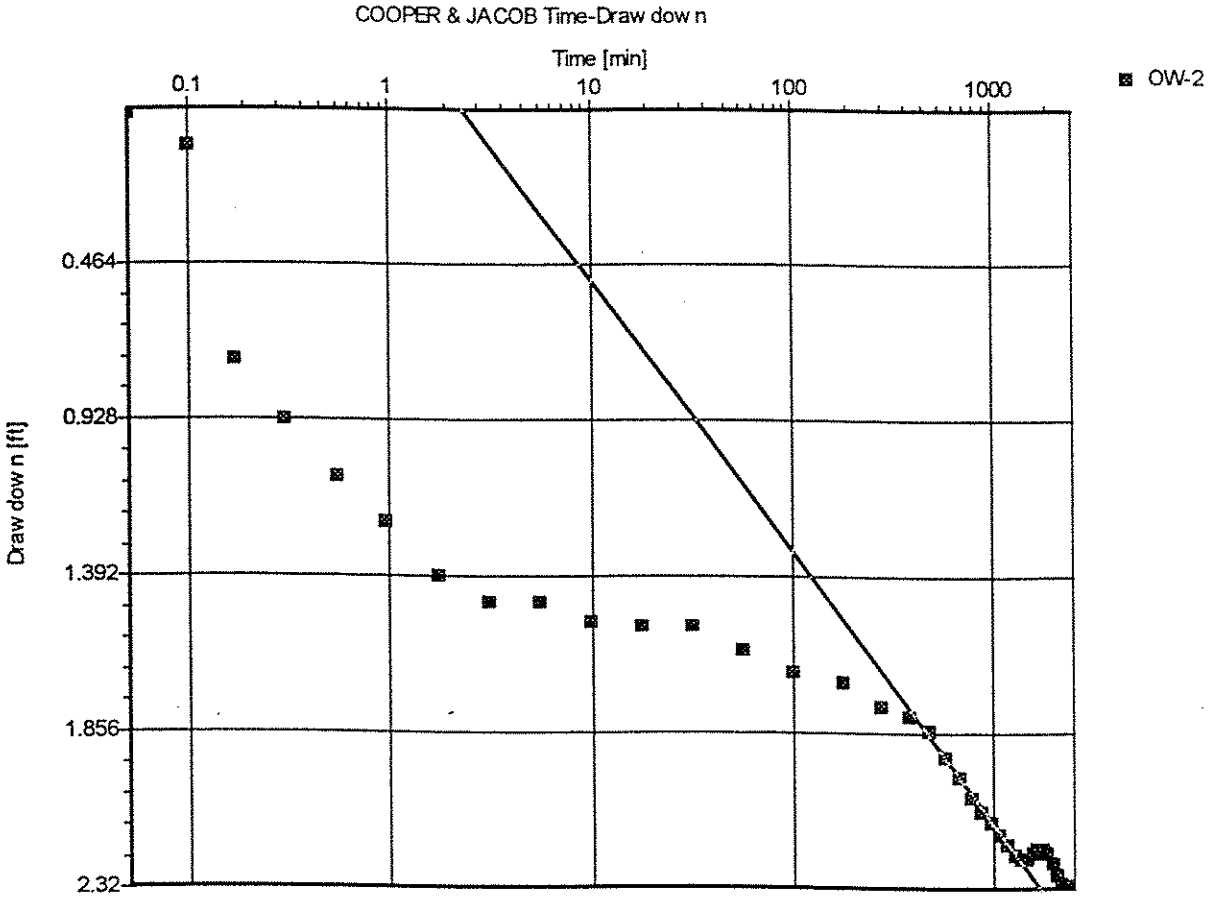
**Figure 6 - 9**
**Drawdown - PW-2**
**April 19 - 25, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**



| HWA GeoSciences<br>19730 - 64th Ave W, Suite 200<br>Lynnwood, WA 98037<br>(425) 774-0106 | **Pumping test analysis**<br>No: 94054<br>Project: PW-2<br>Client: MVID |
|---|---|

| Location: Twisp | Pumping test: PW-2 | Pumping well: PW-2 |
|---|---|---|

| | | | |
|---|---|---|---|
| Test performed by: | HWA GeoSciences | Evaluated by: | HWA GeoSciences |
| Test date: | 5/25/2000 | Evaluation date: | 5/25/2000 |
| Analysis method: | COOPER & JACOB Time-Drawdown | Aquifer thickness: | 144 |
| | | Discharge rate: | 825 [U.S. gal/min] |




| | |
|---|---|
| Transmissivity: | 3.60×10^+4 [ft²/d] |
| Conductivity: | 2.50×10^+2 [ft/d] |
| Storativity: | 7.46×10^-2 .07 |

Figure 6-10

**Figure 6 - 11**
**Distance vs. Drawdown - PW-2**
**April 19 - 25, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**

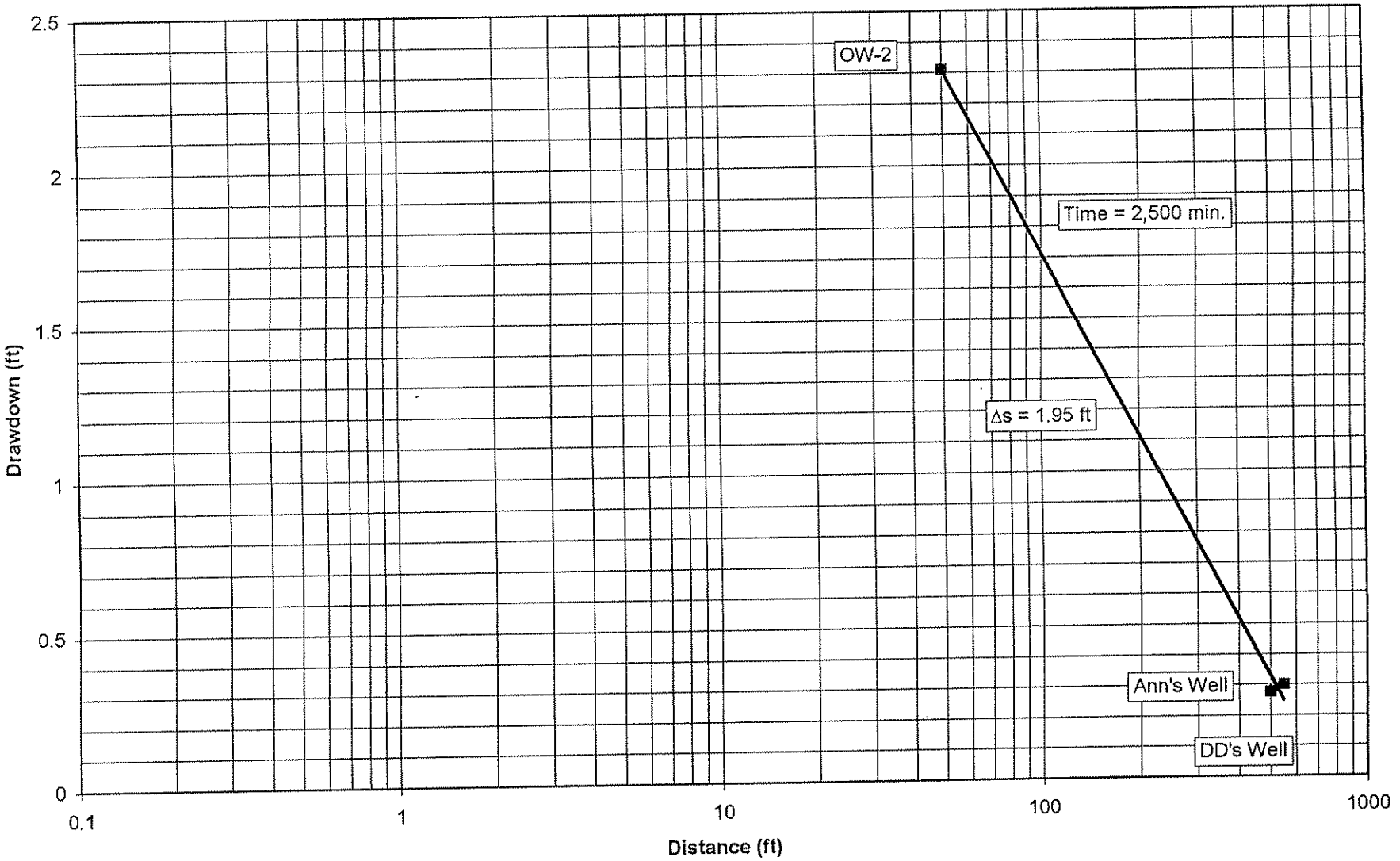


**Figure 6 - 12**
**Recovery - OW-2**
**April 25 - May 3, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**

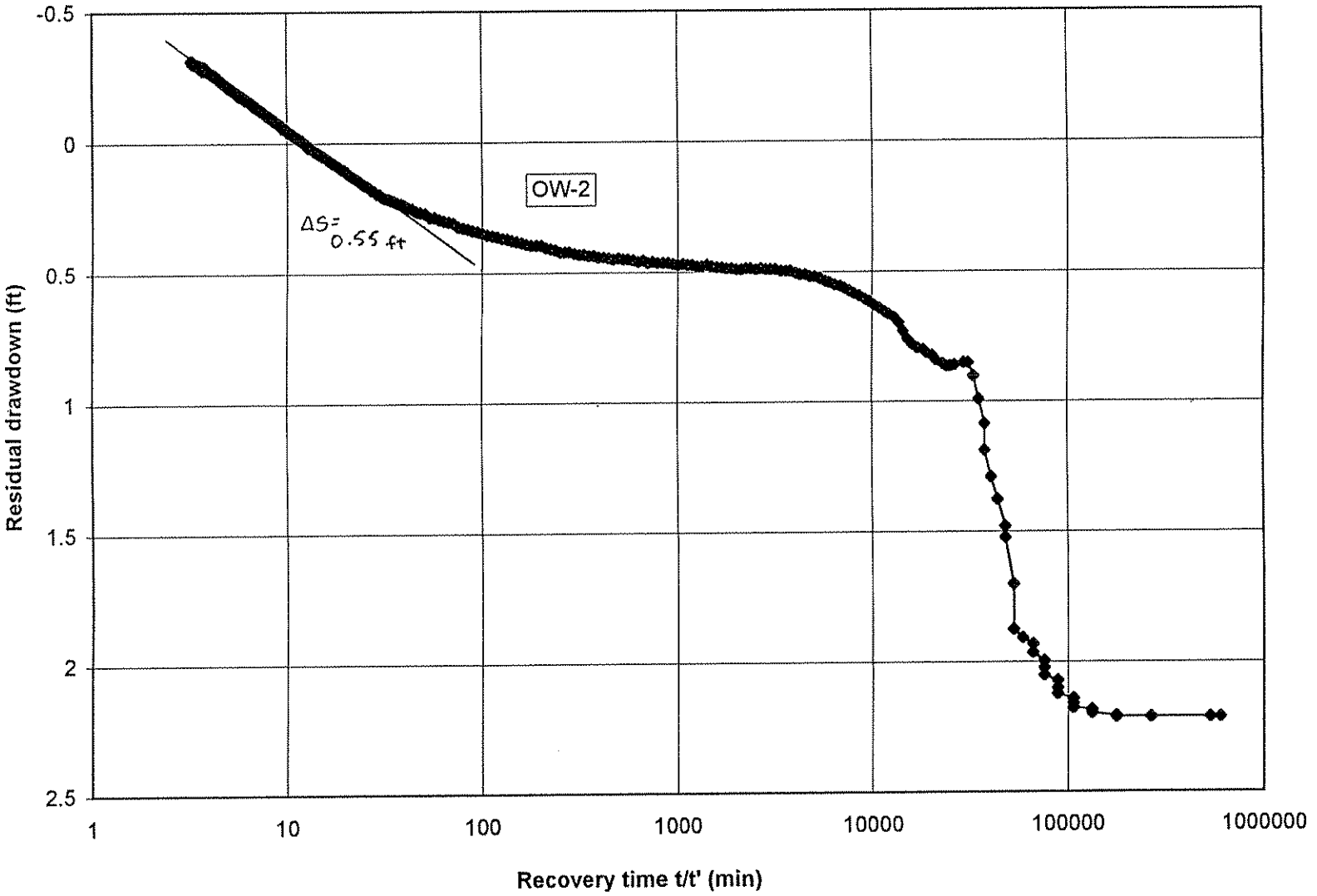
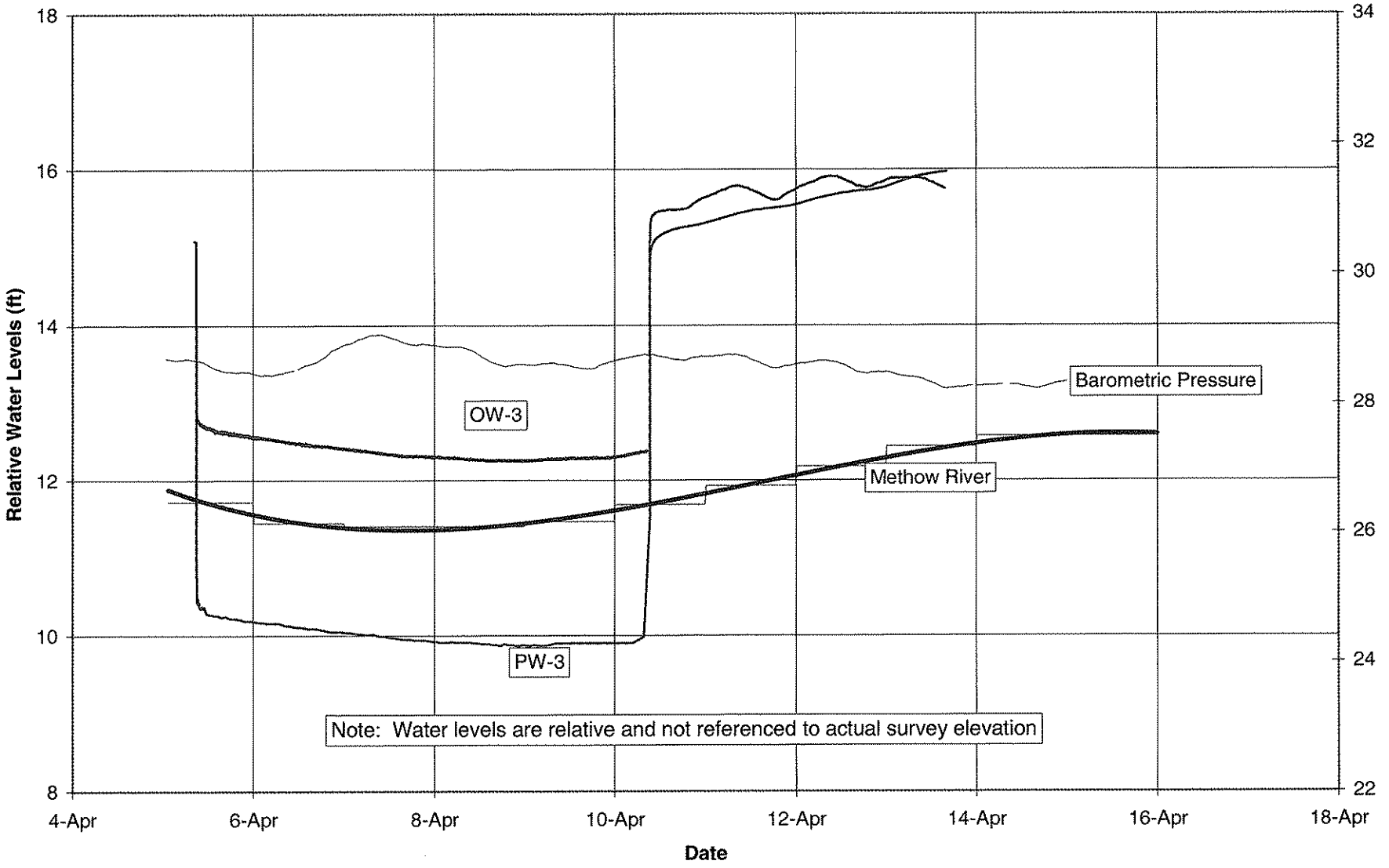


**Figure 6 - 13**
**Water Level Measurements - PW-3**
**April 4 - 13, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**



# Figure 6 - 14
# Step Testing Results - PW-3
# April 4, 2000
# Methow Valley Irrigation District
# Twisp, Washington

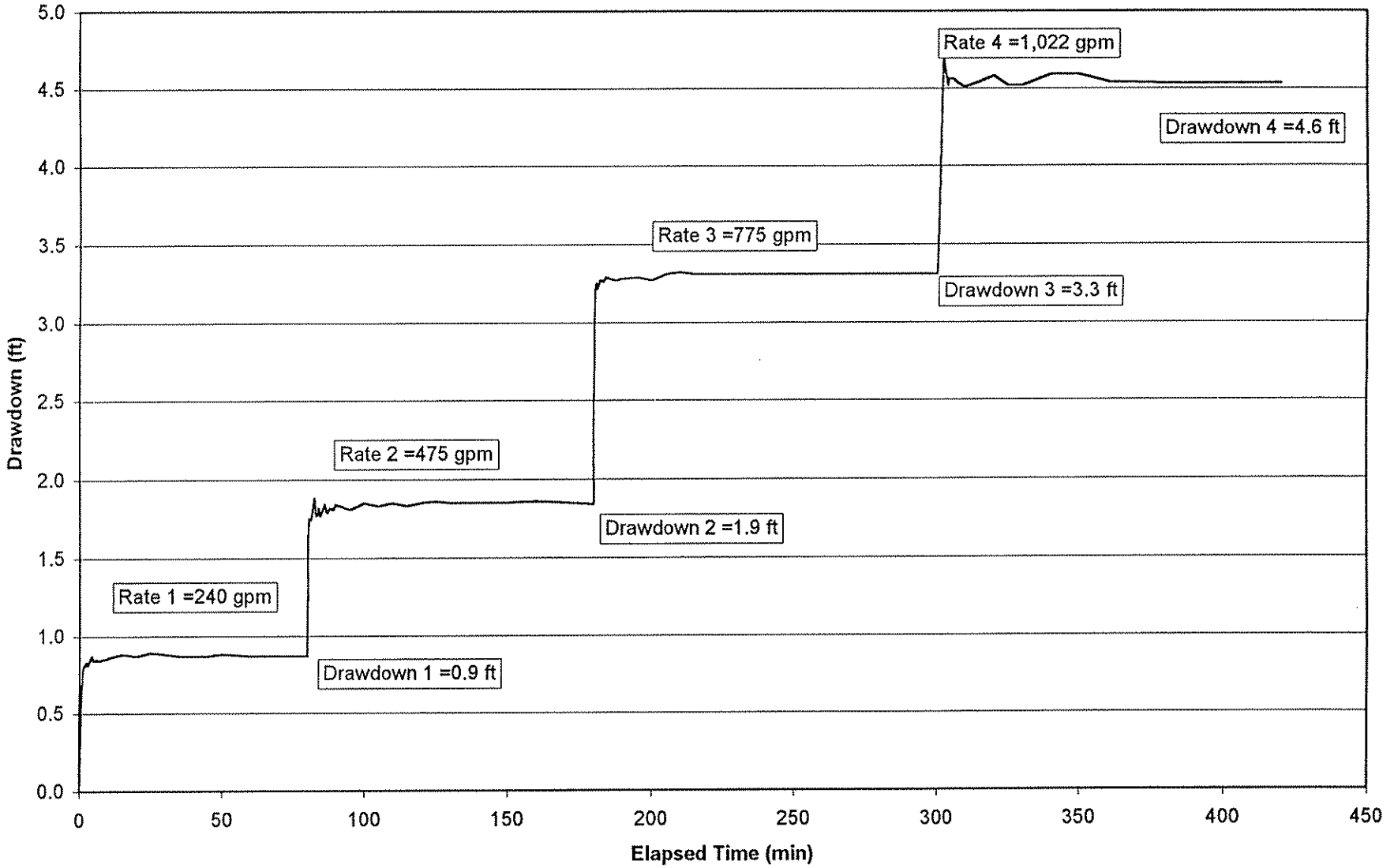
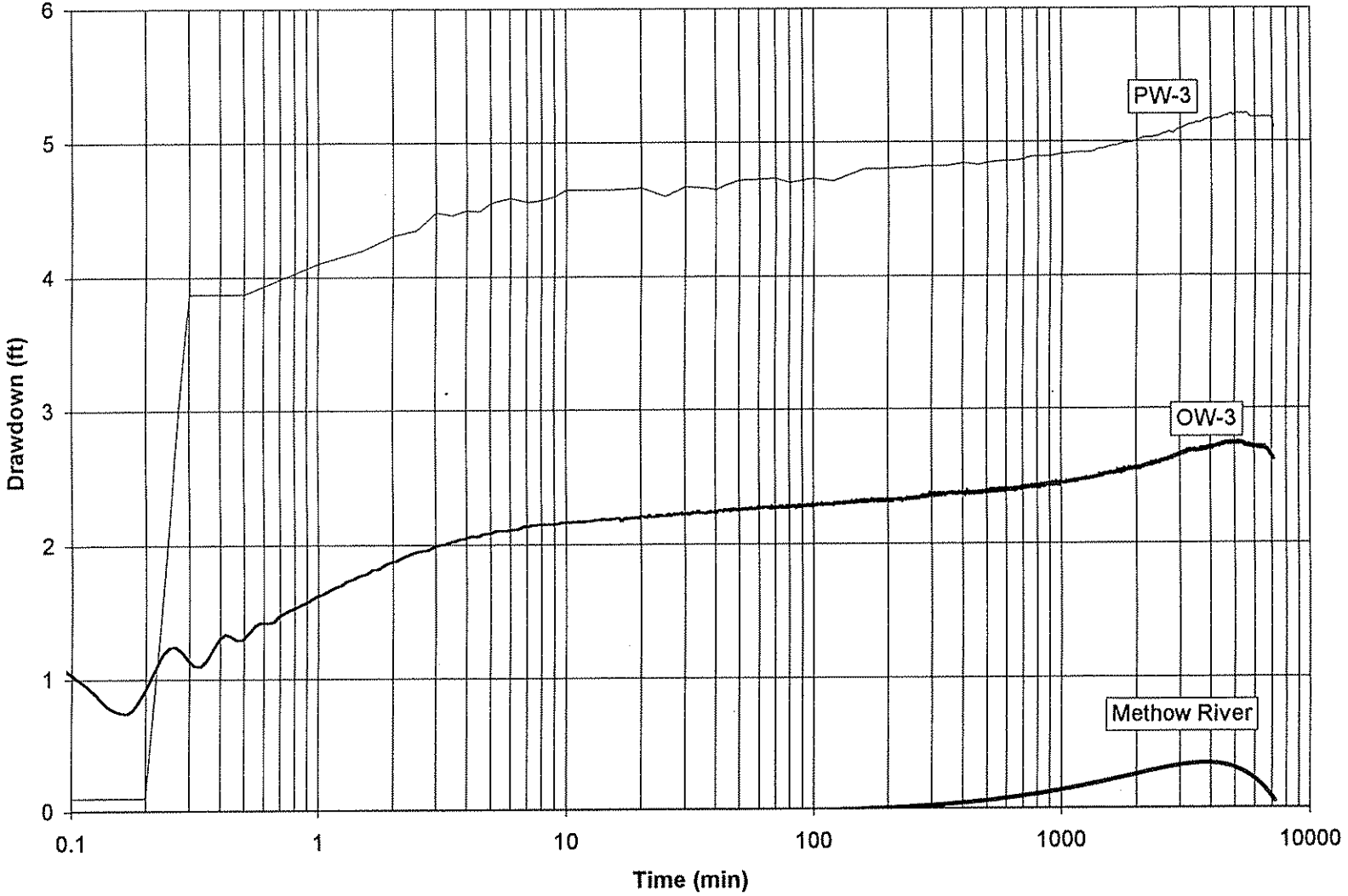
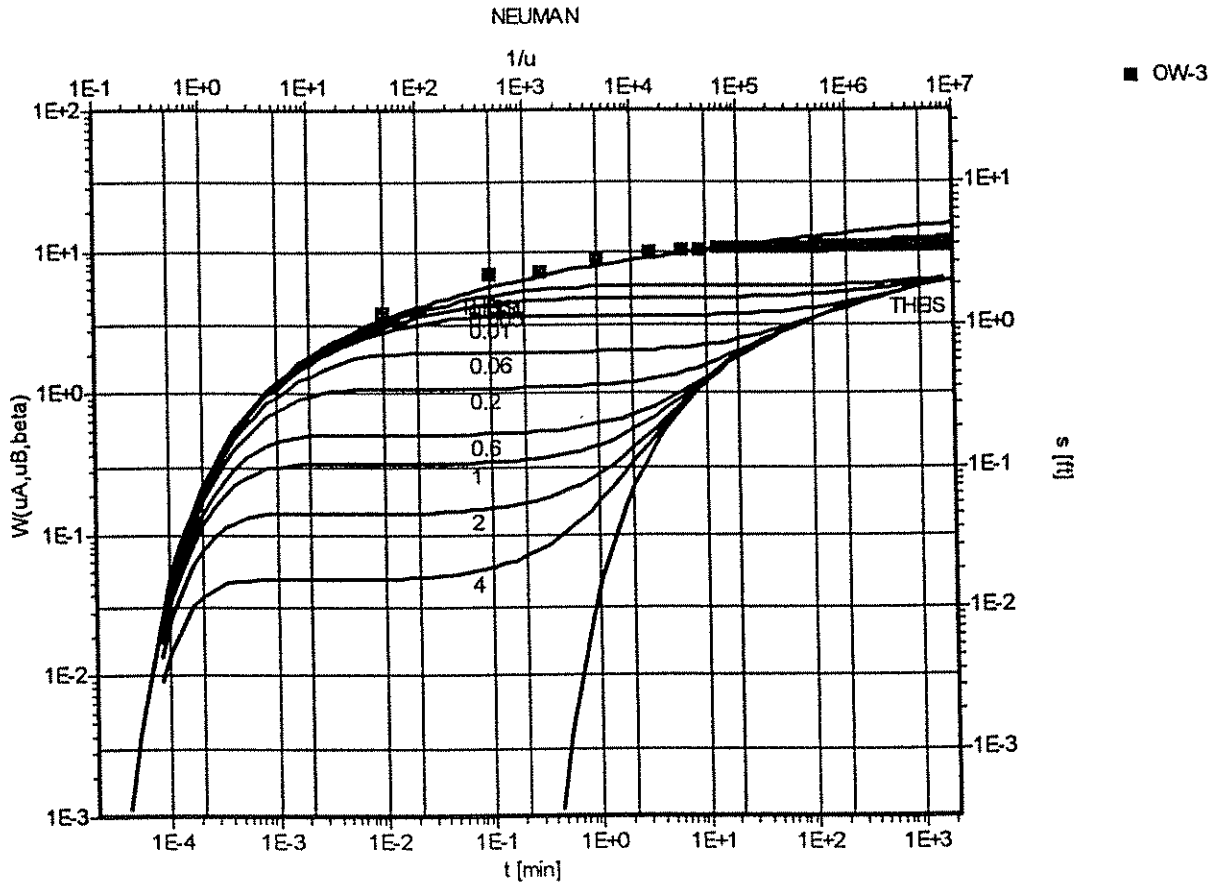


**Figure 6 - 15**
**Drawdown - PW-3**
**April 5, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**



| HWA GeoSciences<br>19730 - 64th Ave W, Suite 200<br>Lynnwood, WA 98037<br>(425) 774-0106 | **Pumping test analysis**<br>No: 94054<br>Project: PW-3<br>Client: MVID | |
|---|---|---|
| Location: Twisp, Washington | Pumping test: PW-3 | Pumping well: PW-3 |
| Test performed by: HWA GeoSciences<br>Test date: 5/26/2000 | Evaluated by:<br>Evaluation date: 7/6/2000 | |
| Analysis method: NEUMAN | Aquifer thickness: 107<br>Discharge rate: 1025 [U.S. gal/min] | |




Transmissivity: 4.78×10^+4 [ft²/d]

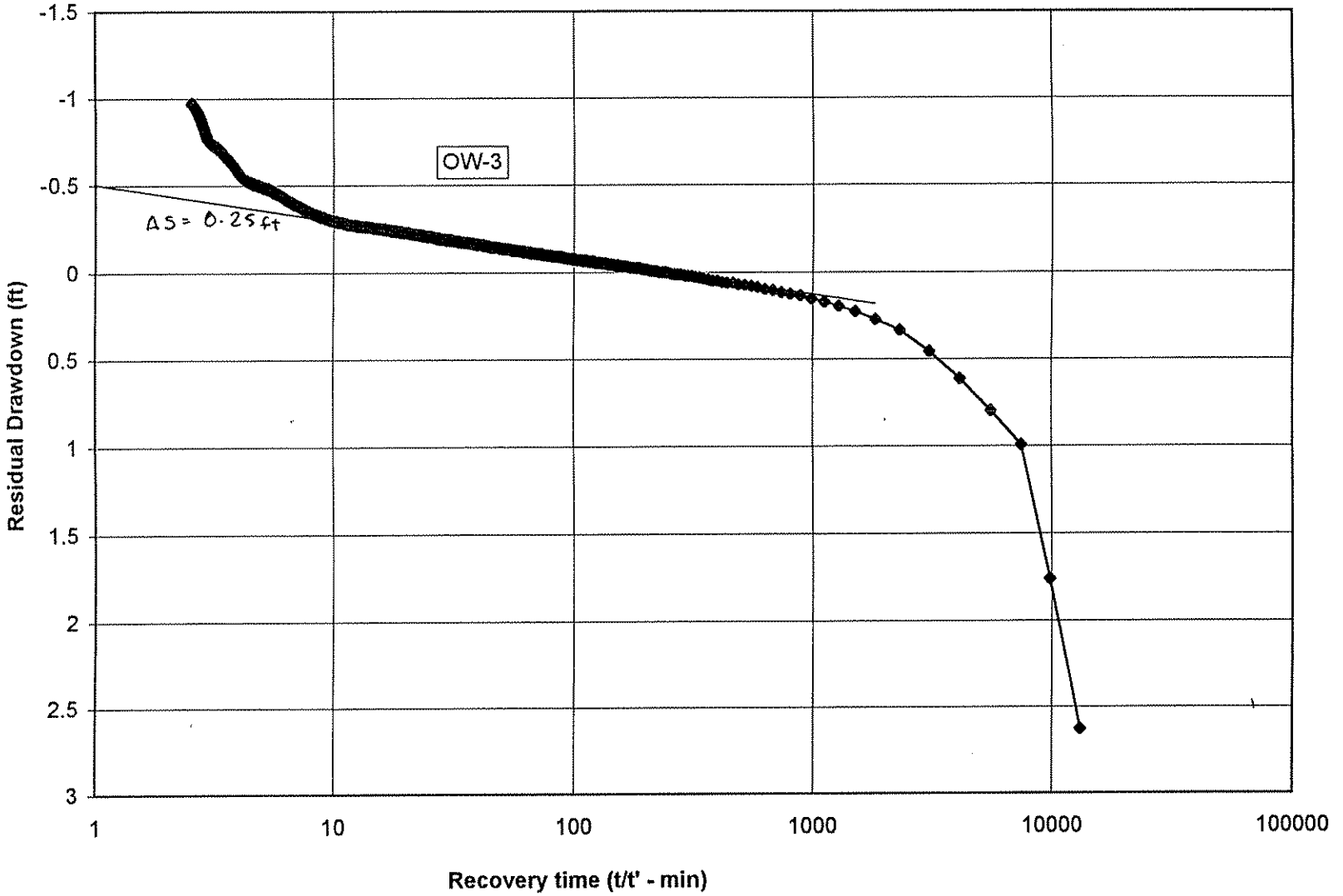
Conductivity: 4.46×10^+2 [ft/d]

Storativity: 1.10×10^-5 .000011

Specific yield: 1.10×10^-1 .11

Figure 6-16

**Figure 6 - 17**
**Recovery - PW-3**
**April 10 - 13, 2000**
**Methow Valley Irrigation District**
**Twisp, Washington**



# Tables

# Table 3-1
## Well Construction Details
## Methow Valley Irrigation District
## Twisp, Washington

| Well | Completion Date | Boring Depth (feet bgs) | Casing Diameter (inch) | Top of Screen (feet bgs) | Base of Screen (feet bgs) | Base of Sump (feet bgs) |
|---|---|---|---|---|---|---|
| Irrigation Supply Wells | | | | | | |
| PW-1 | 11/15/1999 | 200 | 12 | 86 | 156 | 161 |
| PW-2 | 12/5/1999 | 200 | 12 | 155 | 190 | 195 |
| PW-3 | 1/6/2000 | 140 | 12 | 100 | 135 | 140 |
| Observation Wells | | | | | | |
| OW-1 | 11/20/1999 | 200 | 6 | 136 | 156 | -- |
| OW-2 | 12/10/1999 | 200 | 6 | 170 | 190 | -- |
| OW-3 | 1/10/2000 | 140 | 6 | 115 | 135 | -- |

# Table 4-1
## Aquifer Testing Details
## Methow Valley Irrigation District
## Twisp, Washington

| Well Location | PW-1 | PW-2 | PW-3 |
|---|---|---|---|
| Background Elevation Monitoring Start Date | 5/3/2000 | 4/13/2000 | 4/4/2000 |
| Step Testing Date | 5/9/2000 | 4/18/2000 | 4/4/2000 |
| Step 1 Rate (gpm) | 280 | 250 | 240 |
| Step 1 Maximum Drawdown (ft) | 2.8 | 3.6 | 0.9 |
| Step 1 Duration (min) | 80 | 60 | 90 |
| Step 2 Rate (gpm) | 500 | 500 | 475 |
| Step 2 Maximum Drawdown (ft) | 6.0 | 7.9 | 1.9 |
| Step 2 Duration (min) | 90 | 85 | 90 |
| Step 3 Rate (gpm) | 800 | 750 | 775 |
| Step 3 Maximum Drawdown (ft) | 10.0 | 12.5 | 3.3 |
| Step 3 Duration (min) | 120 | 125 | 90 |
| Step 4 Rate (gpm) | 1200 | 925 | 1022 |
| Step 4 Maximum Drawdown (ft) | 18.5 | 16.5 | 4.6 |
| Step 4 Duration (min) | 130 | 80 | 90 |

| | | | |
|---|---|---|---|
| Constant Rate Testing Start Date | 5/10/2000 | 4/19/2000 | 4/5/2000 |
| Constant Rate (gpm) | 1214 | 821 | 1023 |
| Total Time of Constant Rate Testing (min) | 7220 | 8890 | 7220 |
| Total Quantity of Constant Rate Discharge (gal) | 8,765,080 | 7,298,690 | 7,386,060 |
| Maximum Drawdown (ft) - Irrigation Well | 17.3 | 14.9 | 5.18 |
| Maximum Drawdown (ft) - Observation Well | 6.0 | 2.4 | 2.62 |

| | | | |
|---|---|---|---|
| Recovery Test Start Date | 5/15/2000 | 4/25/2000 | 4/10/2000 |
| Recovery Test End Date | 5/23/2000 | 5/3/2000 | 4/13/2000 |

# Table 5-1
# Water Quality Testing Results
# Methow Valley Irrigation District
# Twisp, Washington

| Ground Water - Test Wells | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample | Date | pH | SC | DO | Alkalinity | Chloride | $NO_3/NO_2$-N | Sulfate | Ca | Fe | K | Mg | Mn | Na |
| PW-1 start | 5/10/2000 | -- | 200 | -- | 104 | 0.70 | 0.278 | 12.9 | 34.8 | < 0.15 | 1.01 | 8.37 | < 0.01 | 5.86 |
| PW-1 end | 5/15/2000 | -- | -- | -- | 101 | -- | 0.220 | -- | 32.9 | 0.16 | 0.56 | 7.83 | -- | 5.53 |
| PW-2 start | 4/19/2000 | -- | -- | -- | 92.5 | 0.90 | 0.525 | 10.6 | 36.0 | < 0.15 | 0.95 | 5.81 | < 0.01 | 4.09 |
| PW-2 end | 4/25/2000 | -- | -- | -- | 91.5 | 0.92 | 0.481 | 10.5 | 33.6 | < 0.15 | 0.92 | -- | < 0.02 | 3.71 |
| PW-3 start | 4/6/2000 | 8.0 | 340 | 8.2 | 183 | 2.49 | 0.870 | 18.2 | 51.5 | 0.64 | < 0.5 | -- | < 0.02 | 16.6 |
| PW-3 end | 4/10/2000 | 7.6 | 390 | 7.7 | 168 | 2.09 | 0.783 | 16.0 | 49.6 | < 0.15 | 2.83 | -- | < 0.001 | 14.3 |

| Surface Water - Methow River | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample | Date | pH | SC | DO | Alkalinity | Chloride | $NO_3/NO_2$-N | Sulfate | Ca | Fe | K | Mg | Mn | Na |
| PW-1 | 5/15/2000 | -- | -- | -- | 45.5 | -- | 0.051 | -- | 15.9 | 0.27 | < 0.5 | 2.45 | -- | 2.43 |
| PW-3 | 4/10/2000 | 7.7 | 110 | 9.2 | 57 | 0.475 | 0.188 | 4.64 | 20.2 | 0.18 | 0.664 | -- | 0.00387 | 2.93 |

All results reported in mg/L, equivalent to parts per million (ppm).
-- Not analyzed

# Table 6-1
# Aquifer Testing Summary
# Methow Valley Irrigation District
# Twisp, Washington

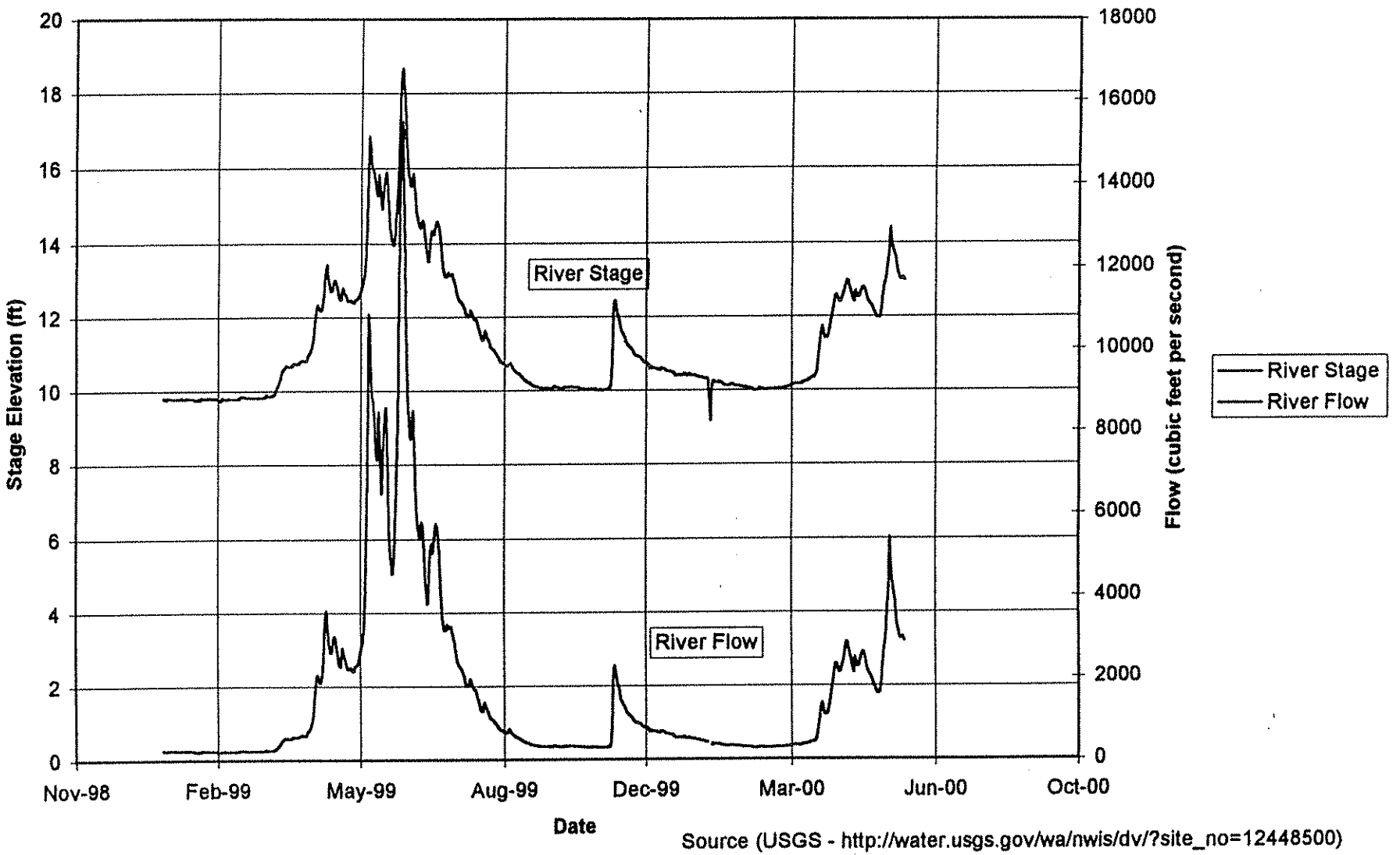
| Well Details | | | |
|---|---|---|---|
| | PW-1 | PW-2 | PW-3 |
| Well depth (ft bgs) | 161 | 195 | 140 |
| Screen top (ft bgs) | 86 | 155 | 100 |
| Screen base (ft bgs) | 156 | 190 | 135 |
| Static water level (ft bgs) | 10 | 51 | 33 |
| Available drawdown (ft) | 76 | 104 | 67 |
| Theoretical yield (gpm) | 2076 | 1284 | 945 |
| Recommended rate (gpm) | 1,500 - 1,800 | 800 - 1,000 | 700 - 900 |
| | | | |
| **Methow River Details** | | | |
| Water Level (ft bgs) | 10 | 51 | 33 |
| Base of River (ft bgs) | 14 | 55 | 37 |
| Minimum Saturated Aquifer Thickness | 151 | 144 | 107 |
| Vertical Separation between Base of Methow River and Top of Well Screen | 72 | 100 | 63 |
| | | | |
| **Pumping Test Results** | | | |
| Constant rate (gpm) | 1214 | 821 | 1023 |
| Maximum drawdown (ft) | 17.3 | 14.9 | 5.2 |
| Estimated yield (gpm/ft) | 70 | 55 | 197 |
| | | | |
| **Transmissivity Estimates ($ft^2$/day)** | | | |
| Cooper/Jacob Drawdown method | 61,000 | 36,000 | - |
| Cooper-Jacob Recovery method | 58,600 | 53,000 | 155,000 |
| Cooper-Jacob Distance-Drawdown method | - | 30,000 | - |
| Neuman Delayed-Yield method | 15,900 | - | 48,000 |
| Average of Drawdown and Recovery ($ft^2$/day) | 60,000 | 35,000 | 96,000 |
| Average of Drawdown and Recovery (gpd/ft) | 448,800 | 261,800 | 718,080 |
| **Hydraulic Conductivity Estimates** | | | |
| ft/day | 400 | 243 | 897 |
| cm/sec | 0.14 | 0.09 | 0.32 |

# Appendices

# Appendix A

# Methow River Stage and Flow
# January 1999 to June 2000

## Methow River Stage and Flow



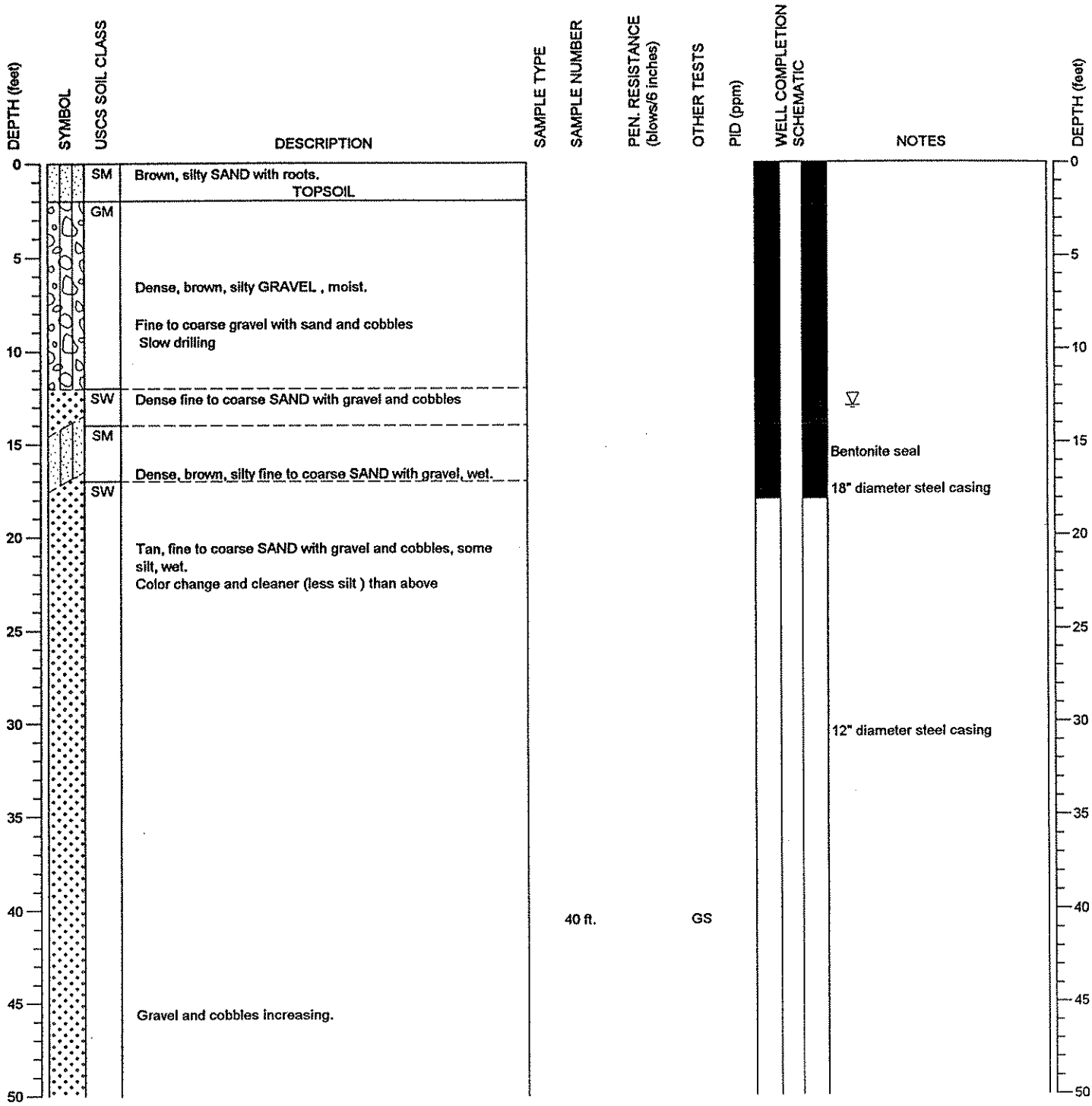

Source (USGS - http://water.usgs.gov/wa/nwis/dv/?site_no=12448500)

# Appendix B

# Well Boring Logs

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Cable tool, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/9/1999
DATE COMPLETED: 11/15/1999
LOGGED BY: Sugar/Higgins




NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
PW-1



PROJECT NO.: 94054 FIGURE: A-2

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Cable tool, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/9/1999
DATE COMPLETED: 11/15/1999
LOGGED BY: Sugar/Higgins

| DEPTH (feet) | SYMBOL | USCS SOIL CLASS | DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | PEN. RESISTANCE (blows/6 inches) | OTHER TESTS | PID (ppm) | WELL COMPLETION SCHEMATIC | NOTES | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | | | Color change to olive gray, gravel and cobbles increasing. | | | | | | | | 50 |
| 55 | | SP SM | Olive gray fine silty SAND, some medium to coarse sand, wet<br>Thin - 1-inch layer of brown plastic SILT at 57 feet. | | | | | | | | 55 |
| 60 | | | | | | | | | | 12" diameter steel casing | 60 |
| 65 | | SW | Olive gray, fine to coarse SAND with gravel, some cobbles, little silt, wet. | | | | | | | | 65 |
| 70 | | | Gravel and cobbles decreasing. | | | | | | | | 70 |
| 75 | | | | | | | | | | | 75 |
| 80 | | | | | 80 ft. | | GS | | | 12" diameter steel casing | 80 |
| 85 | | | Fines increasing. | | | | | | | | 85 |
| 90 | | SW SM | | | | | | | | 12" diameter 0.080" slot stainless steel wire-wrapped screen | 90 |
| 95 | | | Olive gray, fine to coarse SAND with silt, some fine gravel, wet. | | | | | | | | 95 |
| 100 | | | | | | | | | | | 100 |

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

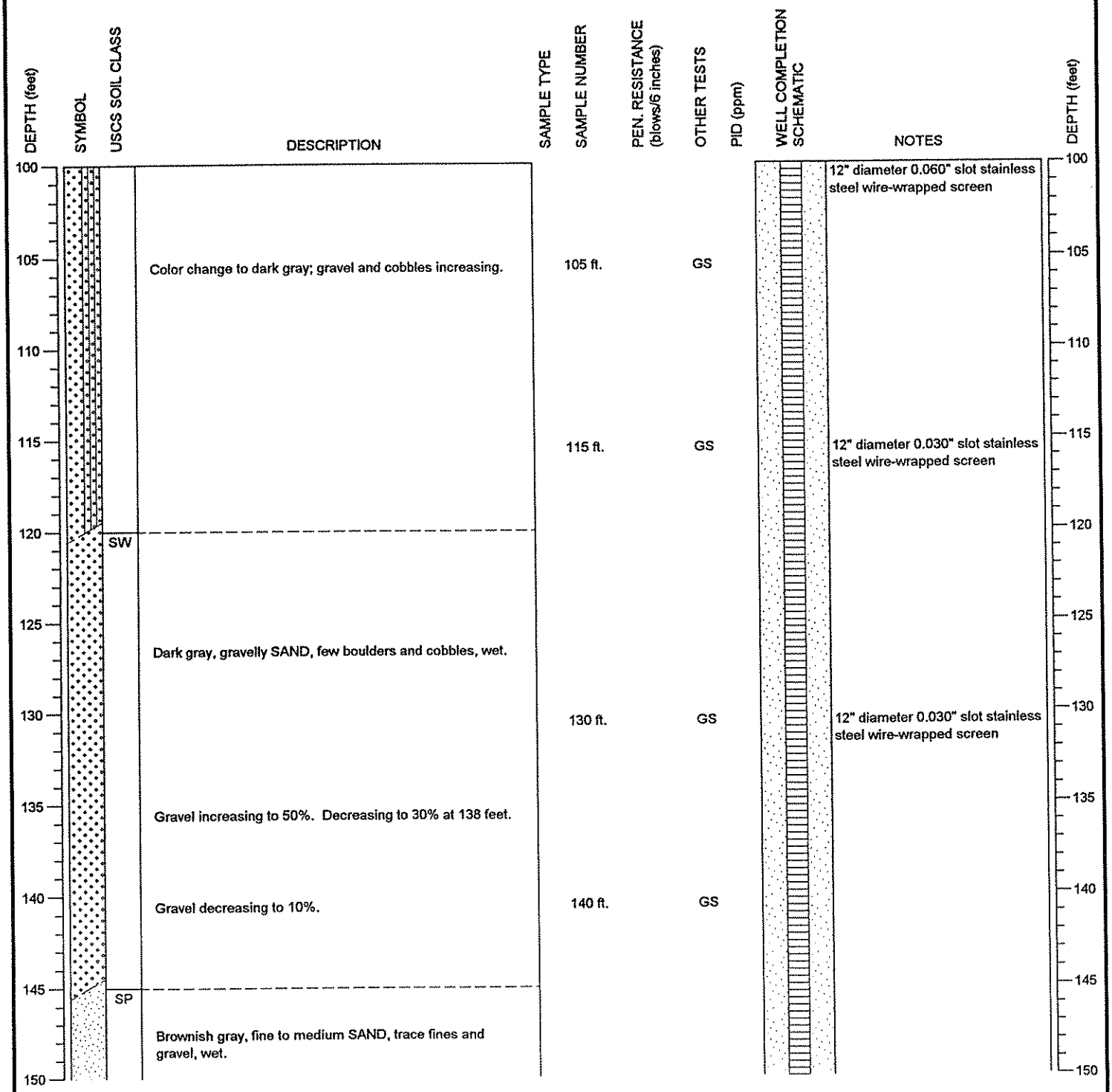
MONITORING WELL:
PW-1



PROJECT NO.: 94054 FIGURE: A-2

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Cable tool, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/9/1999
DATE COMPLETED: 11/15/1999
LOGGED BY: Sugar/Higgins

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
PW-1

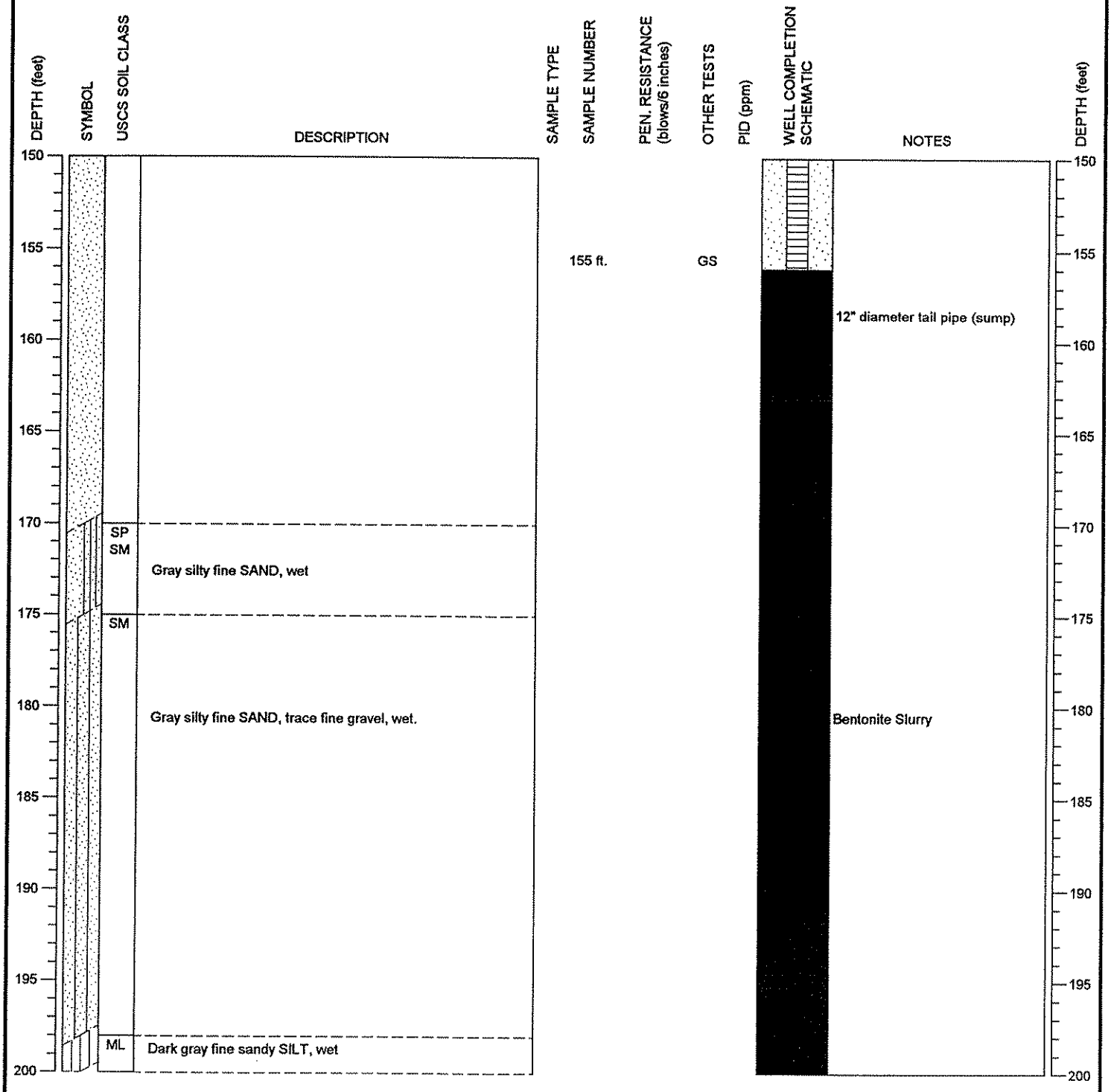


PROJECT NO.: 94054

FIGURE: A-2

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Cable tool, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/9/1999
DATE COMPLETED: 11/15/1999
LOGGED BY: Sugar/Higgins

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
PW-1

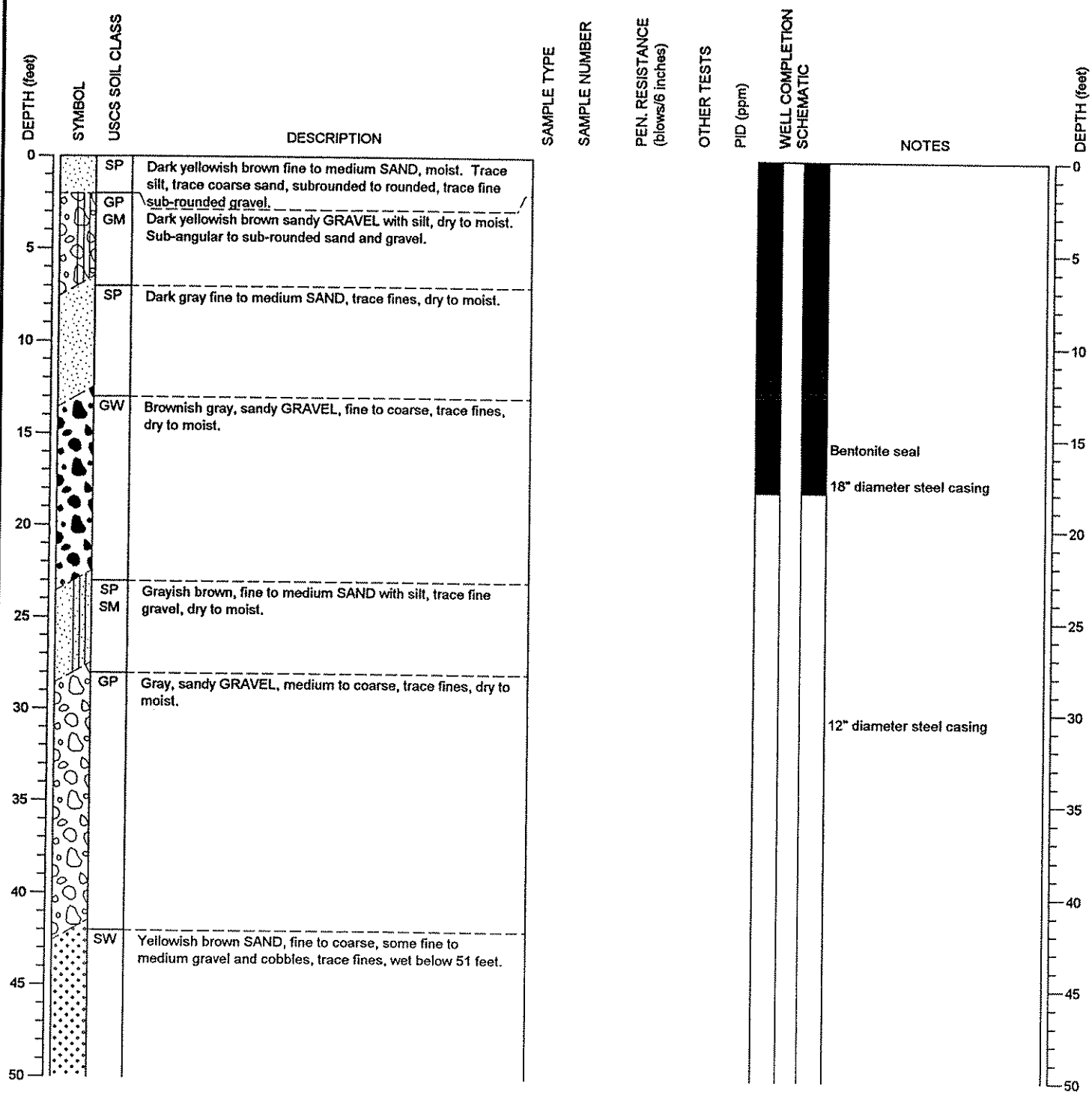


PROJECT NO.: 94054 FIGURE: A-2

MWELL 94054B.GPJ 11/29/00

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Cable tool, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/16/1999
DATE COMPLETED: 12/5/1999
LOGGED BY: Higgins/Hagestedt




NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
PW-2

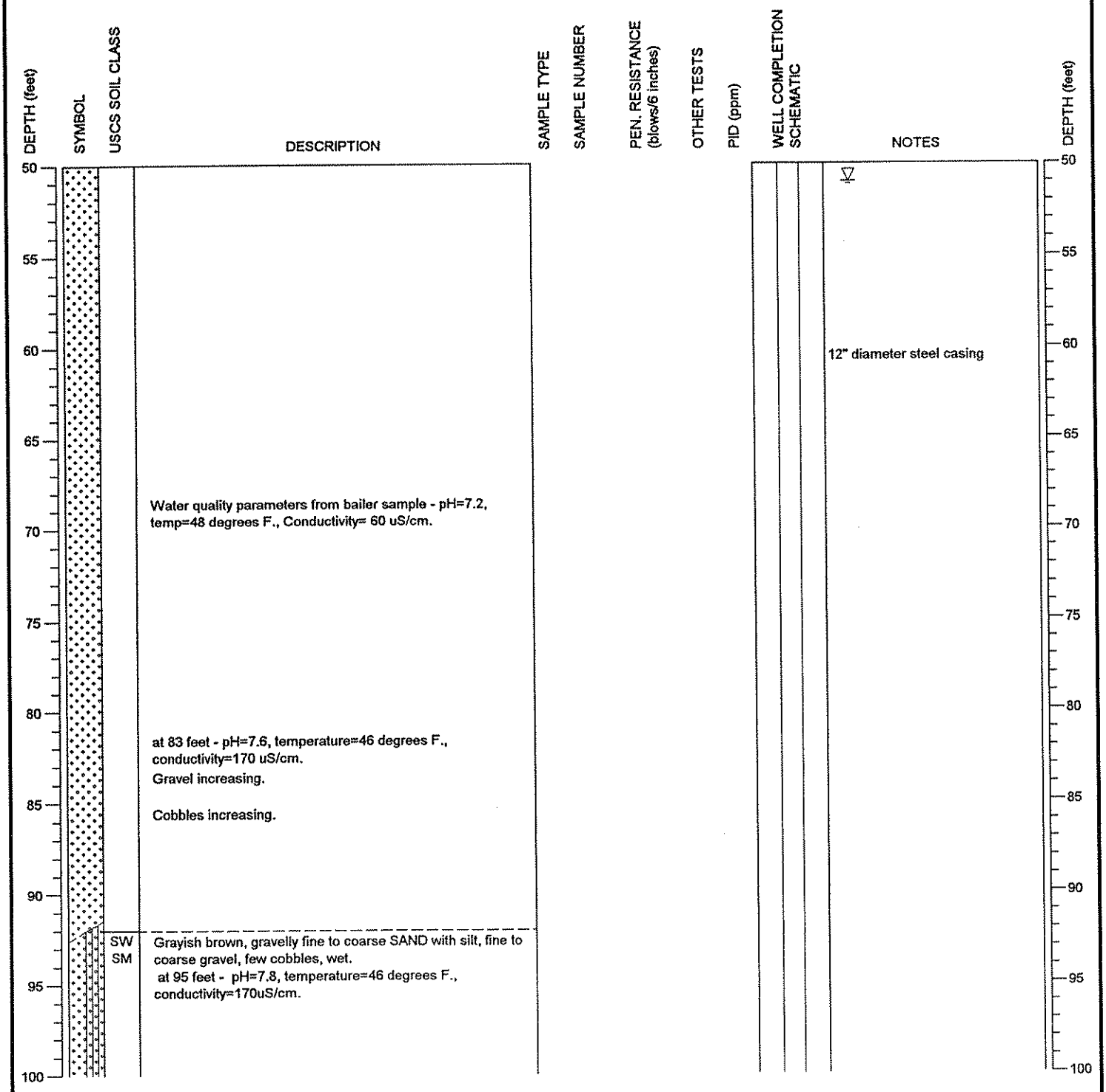


PROJECT NO.: 94054

FIGURE: A-3

DRILLING METHOD: Cable tool, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

DATE STARTED: 11/16/1999
DATE COMPLETED: 12/5/1999
LOGGED BY: Higgins/Hagestedt

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
PW-2



PROJECT NO.: 94054

FIGURE: A-3

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Cable tool, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

DATE STARTED: 11/16/1999
DATE COMPLETED: 12/5/1999
LOGGED BY: Higgins/Hagestedt

| DEPTH (feet) | SYMBOL | USCS SOIL CLASS | DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | PEN. RESISTANCE (blows/6 inches) | OTHER TESTS | PID (ppm) | WELL COMPLETION SCHEMATIC | NOTES | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | | | | | | | | | | 12" diameter steel casing | 100 |
| 105 | | | | | | | | | | | 105 |
| 110 | | | | | | | | | | | 110 |
| 115 | | | | | | | | | | | 115 |
| 120 | | | | | | | | | | | 120 |
| 125 | | | | | | | | | | | 125 |
| 130 | | | | ○ | S-28 | | GS | | | | 130 |
| 135 | | | Gravel and cobbles decreasing. | | | | | | | | 135 |
| 140 | | | Gravel and cobbles increasing. | | | | | | | 12" diameter steel casing | 140 |
| 145 | | | | | | | | | | | 145 |
| 150 | | | | | | | | | | | 150 |

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
PW-2

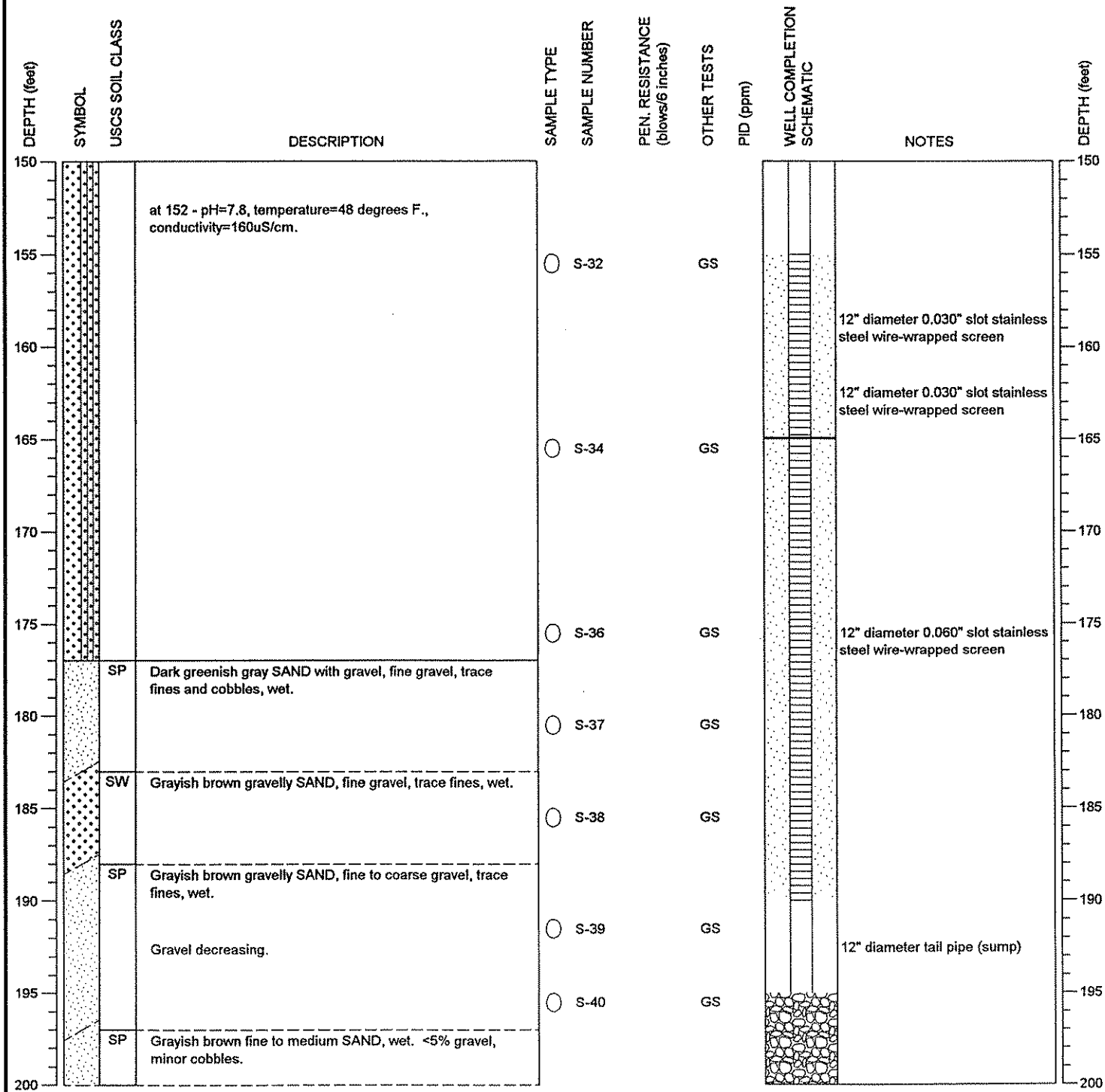


PROJECT NO.: 94054

FIGURE: A-3

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Cable tool, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/16/1999
DATE COMPLETED: 12/5/1999
LOGGED BY: Higgins/Hagestedt

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
PW-2



PROJECT NO.: 94054 FIGURE: A-3

MWELL 94054B.GPJ 11/29/00

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 1/4/2000
DATE COMPLETED: 1/6/2000
LOGGED BY: Higgins

| DEPTH (feet) | SYMBOL | USCS SOIL CLASS | DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | PEN. RESISTANCE (blows/6 inches) | OTHER TESTS | PID (ppm) | WELL COMPLETION SCHEMATIC | NOTES | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | 0 to 85 feet: Sand and gravel, with boulders. (based on driller's notes) | | | | | | | | 0 |
| 5 | | | | | | | | | | | 5 |
| 10 | | | | | | | | | | | 10 |
| 15 | | | | | | | | | | Bentonite seal<br>18" diameter steel casing | 15 |
| 20 | | | | | | | | | | | 20 |
| 25 | | | | | | | | | | | 25 |
| 30 | | | | | | | | | | 12" diameter steel casing | 30 |
| 35 | | | | | | | | | | ▽ | 35 |
| 40 | | | | | | | | | | | 40 |
| 45 | | | | | | | | | | | 45 |
| 50 | | | | | | | | | | | 50 |

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
PW-3

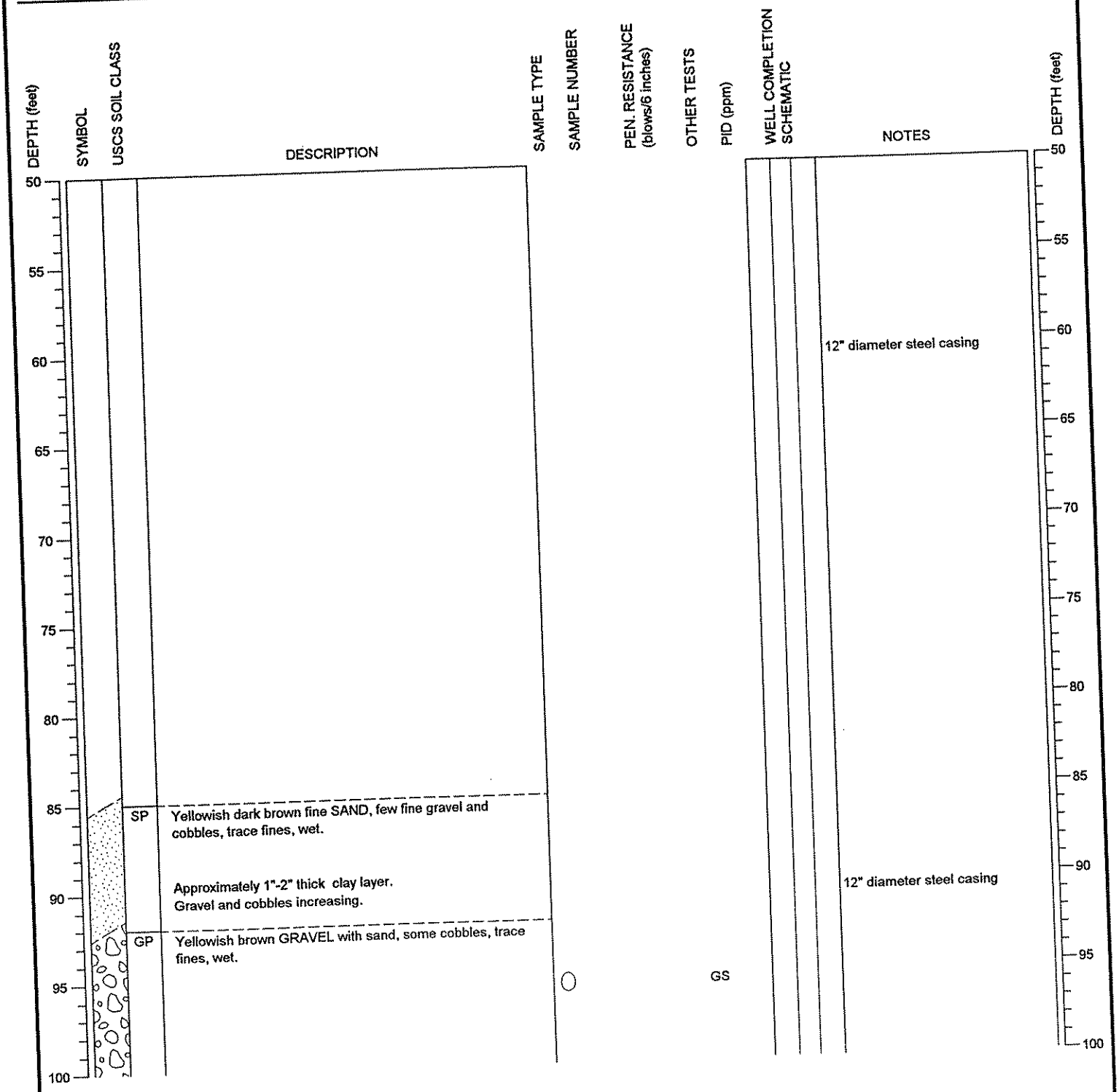


PROJECT NO.: 94054

FIGURE: A-4

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 1/4/2000
DATE COMPLETED: 1/6/2000
LOGGED BY: Higgins

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
PW-3

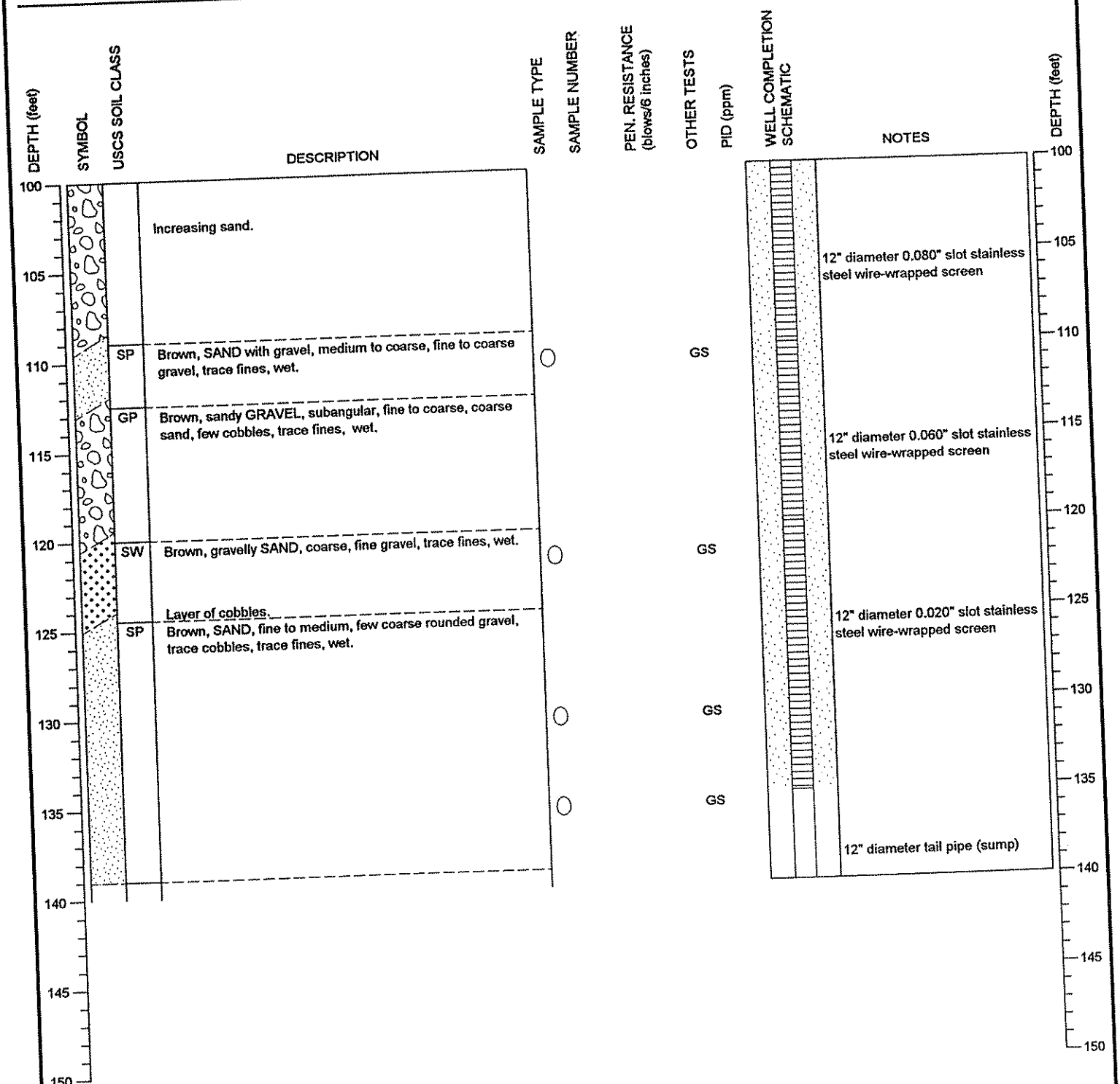


PROJECT NO.: 94054

FIGURE: A-4

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 12" steel casing
SAMPLING METHOD: Bailer
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 1/4/2000
DATE COMPLETED: 1/6/2000
LOGGED BY: Higgins

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL: PW-3



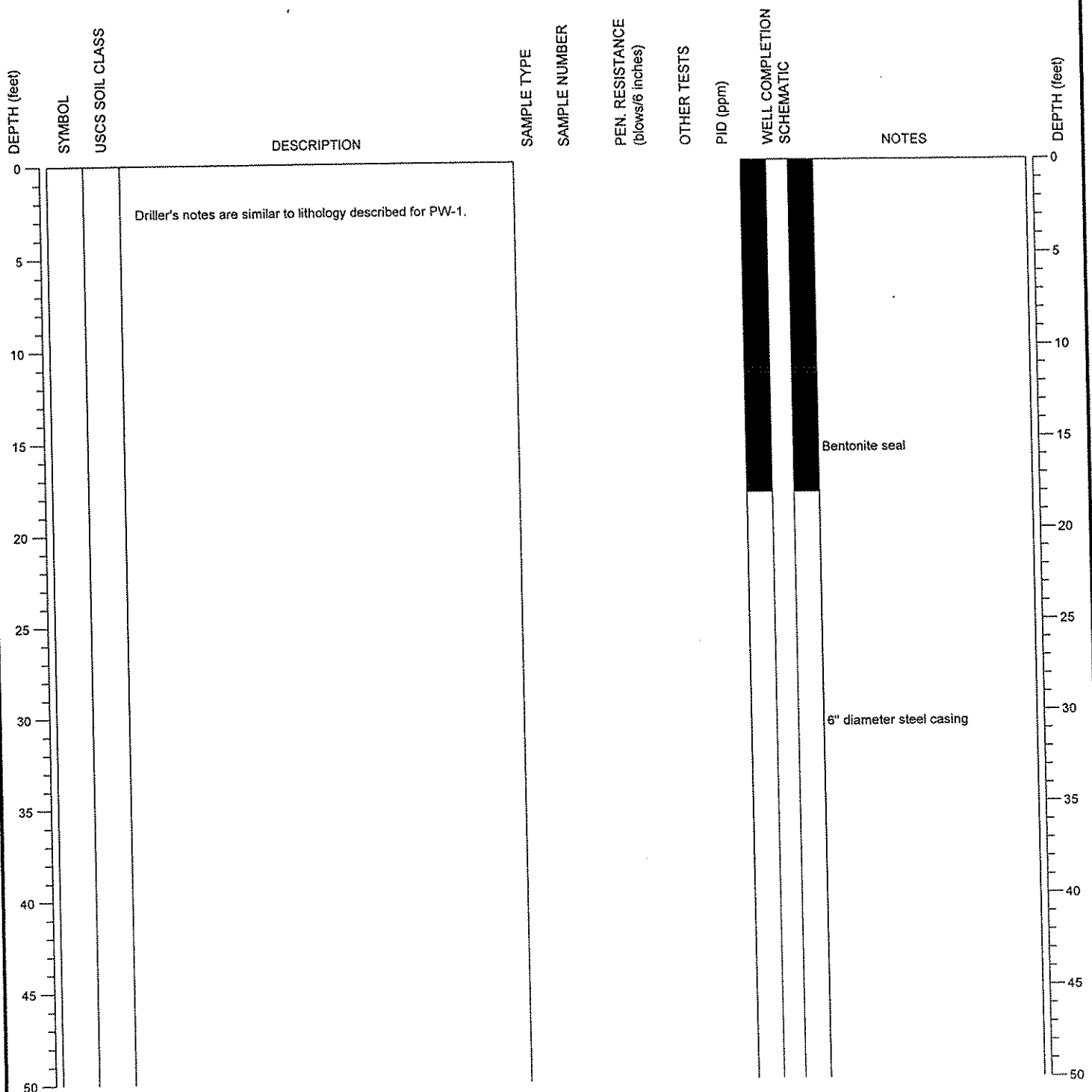
PROJECT NO.: 94054

FIGURE: A-4

MWELL 94054B.GPJ 11/29/00

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/20/1999
DATE COMPLETED: 11/20/1999
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

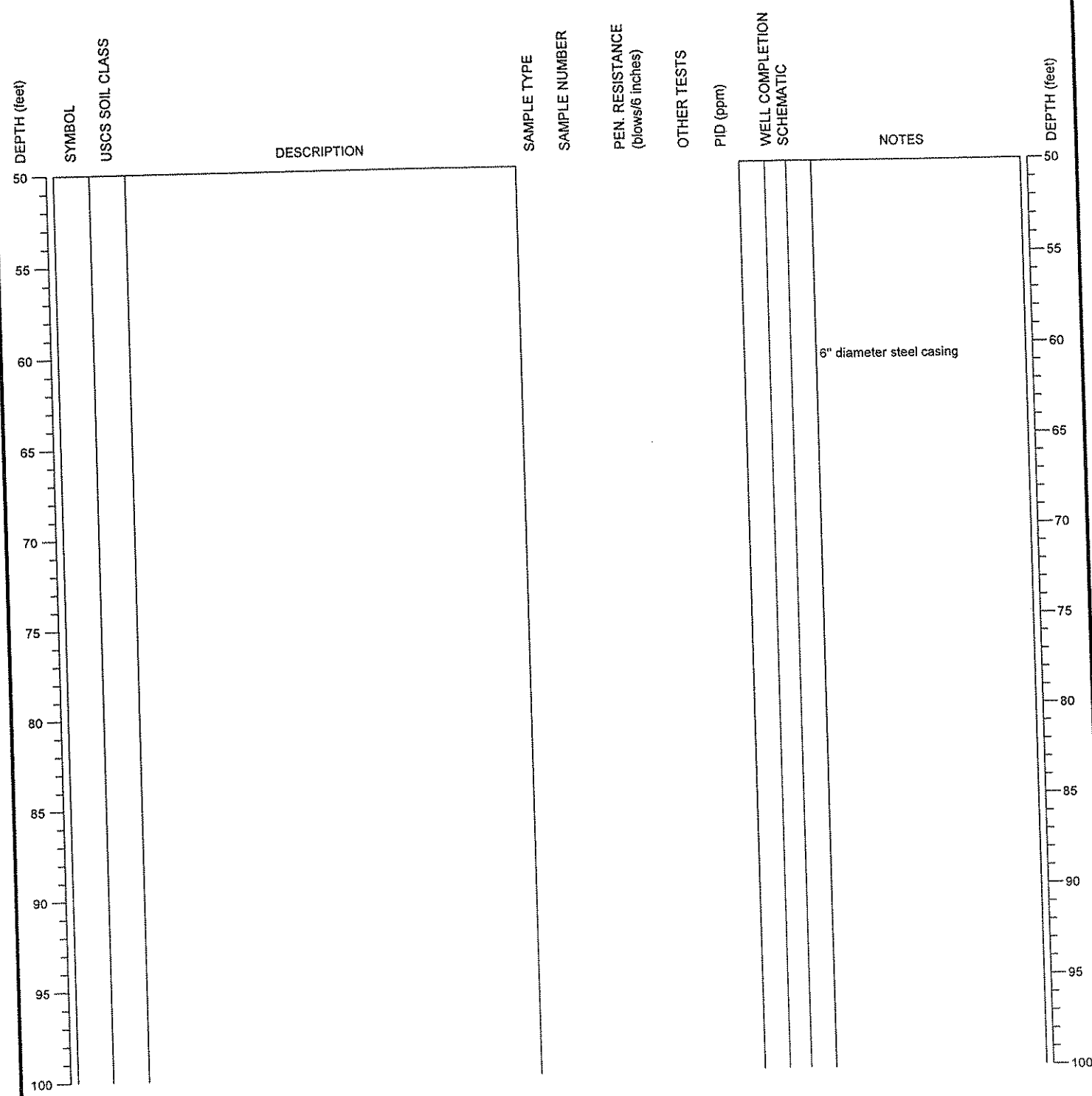
MONITORING WELL:
OW-1



PROJECT NO.: 94054 FIGURE: A-5

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/20/1999
DATE COMPLETED: 11/20/1999
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
OW-1

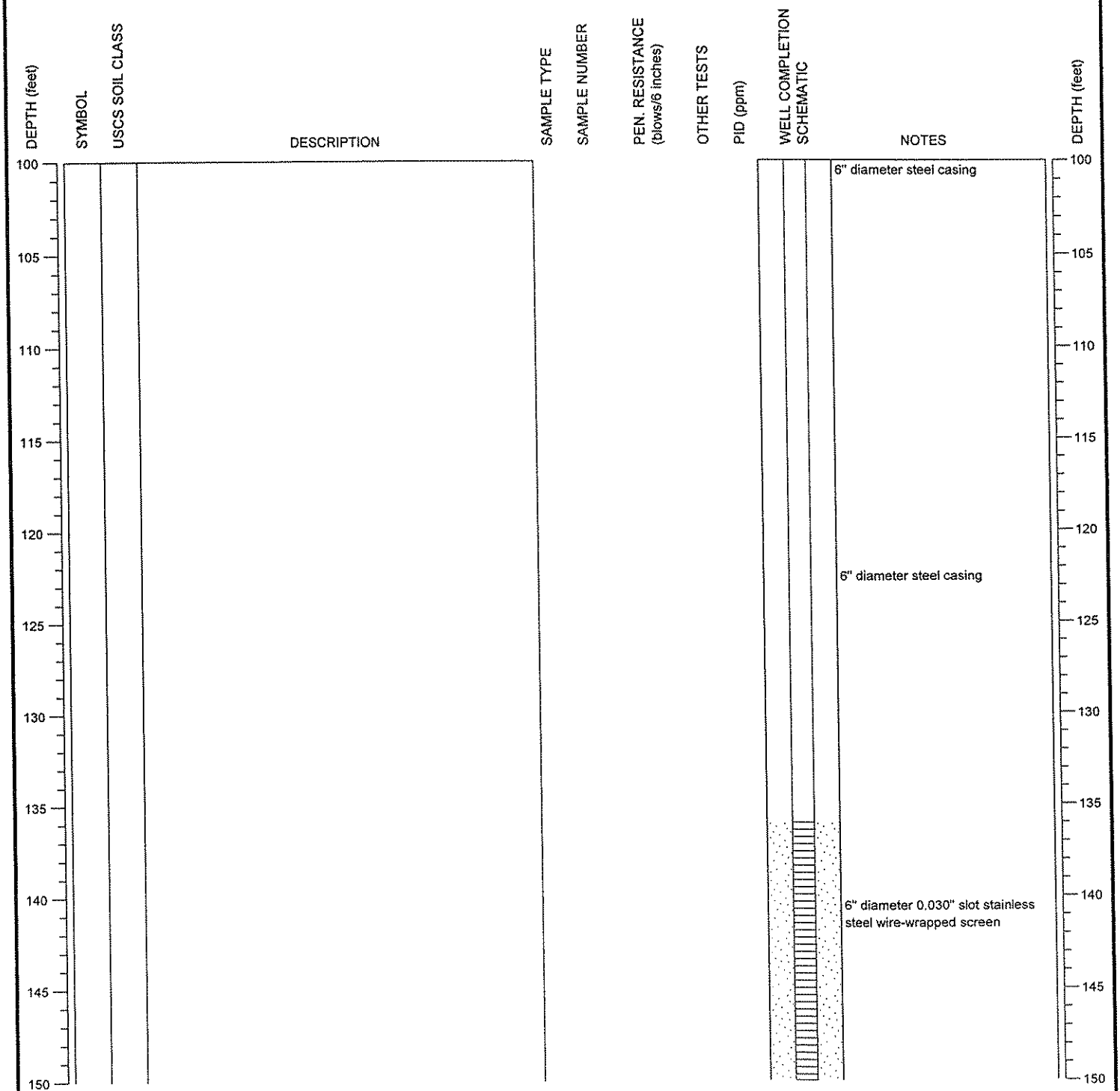


PROJECT NO.: 94054

FIGURE: A-5

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/20/1999
DATE COMPLETED: 11/20/1999
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
OW-1

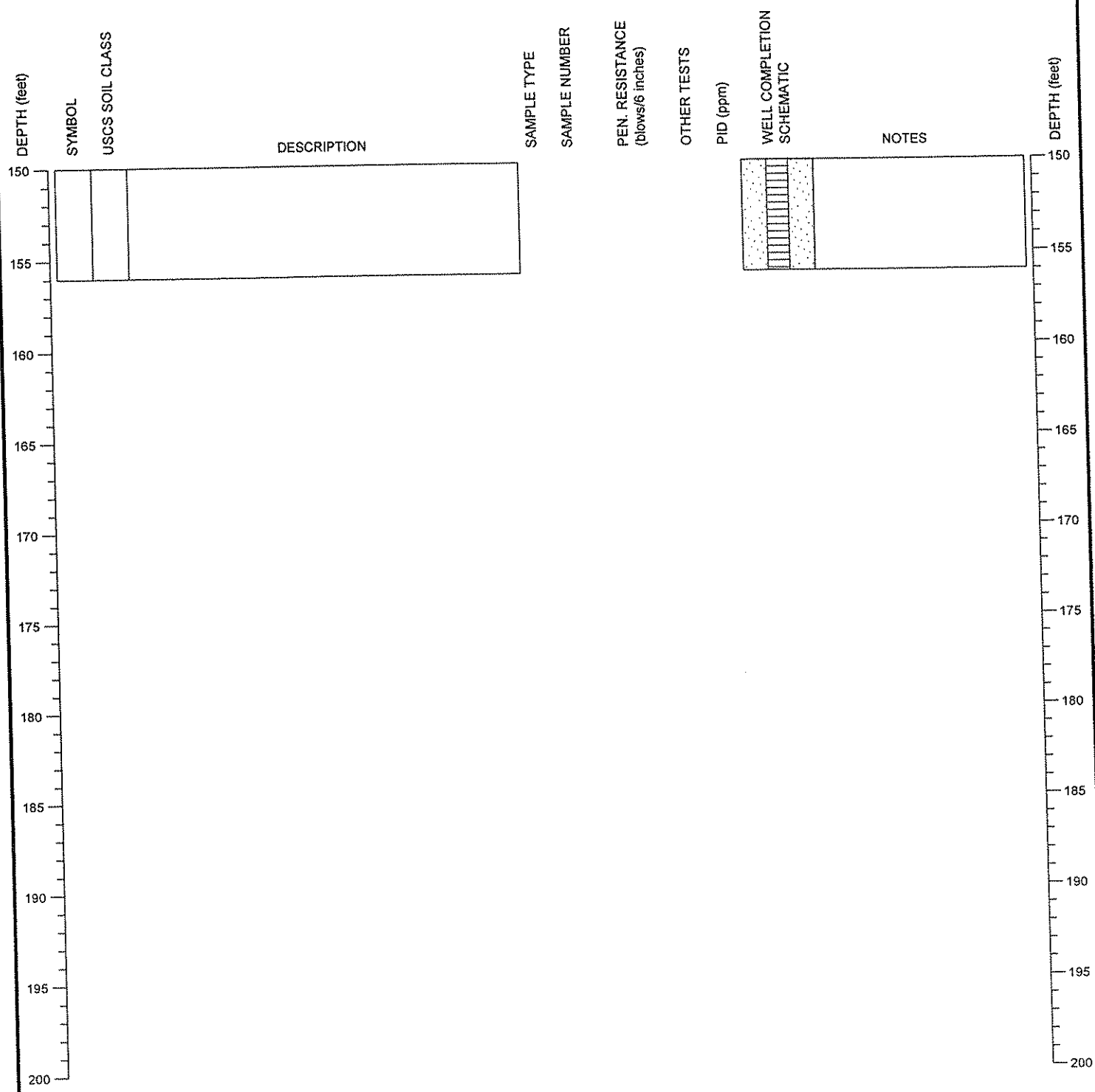


PROJECT NO.: 94054 FIGURE: A-5

MWELL 94054.GPJ 11/17/00

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/20/1999
DATE COMPLETED: 11/20/1999
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
OW-1

PAGE: 4 of 4

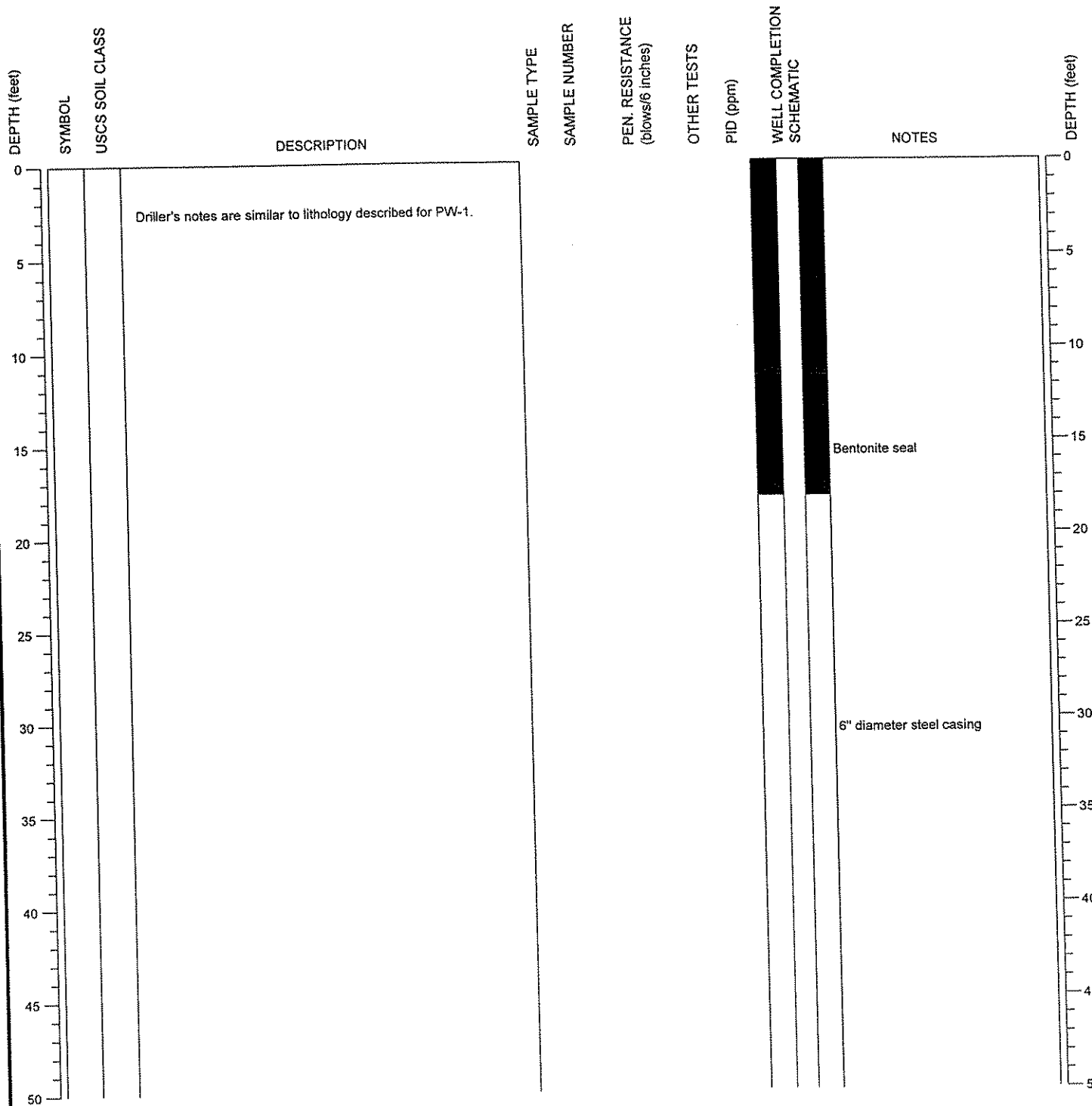
PROJECT NO.: 94054

FIGURE: A-5

MWELL 94054.GPJ 11/17/00

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/10/1999
DATE COMPLETED: 11/10/1999
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
OW-2

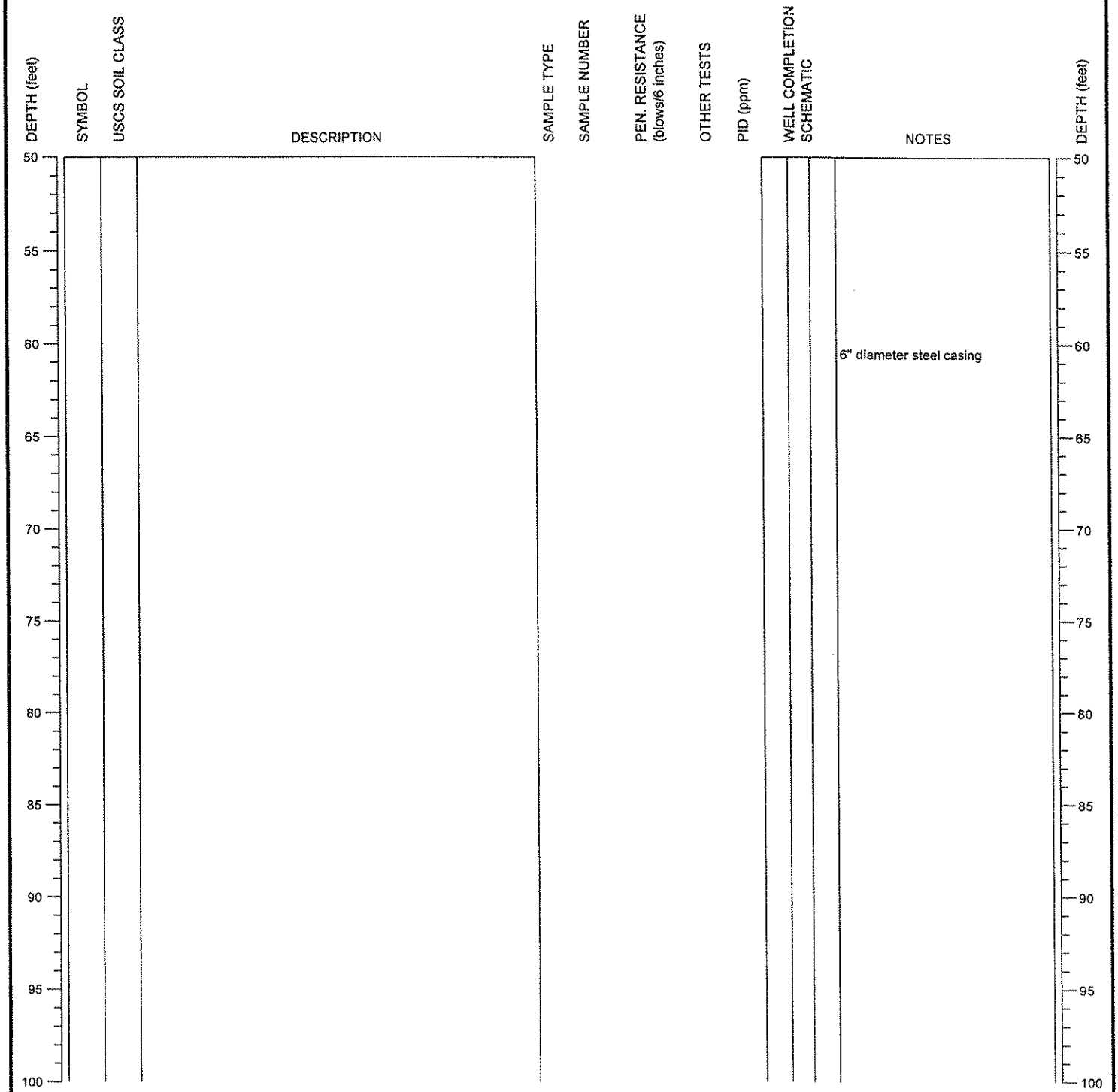


PROJECT NO.: 94054

FIGURE: A-6

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/10/1999
DATE COMPLETED: 11/10/1999
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

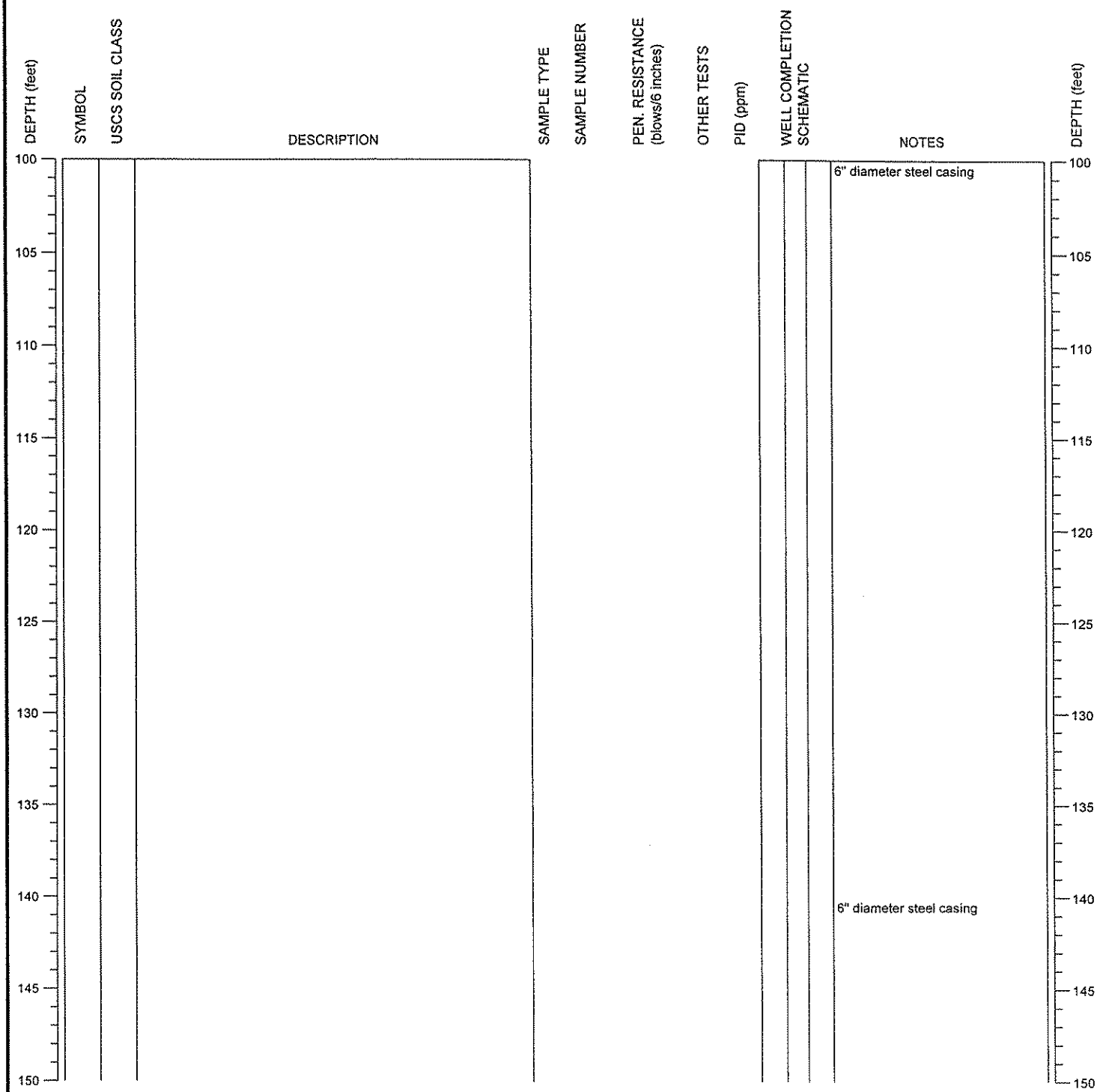
MONITORING WELL:
OW-2



PROJECT NO.: 94054 FIGURE: A-6

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/10/1999
DATE COMPLETED: 11/10/1999
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

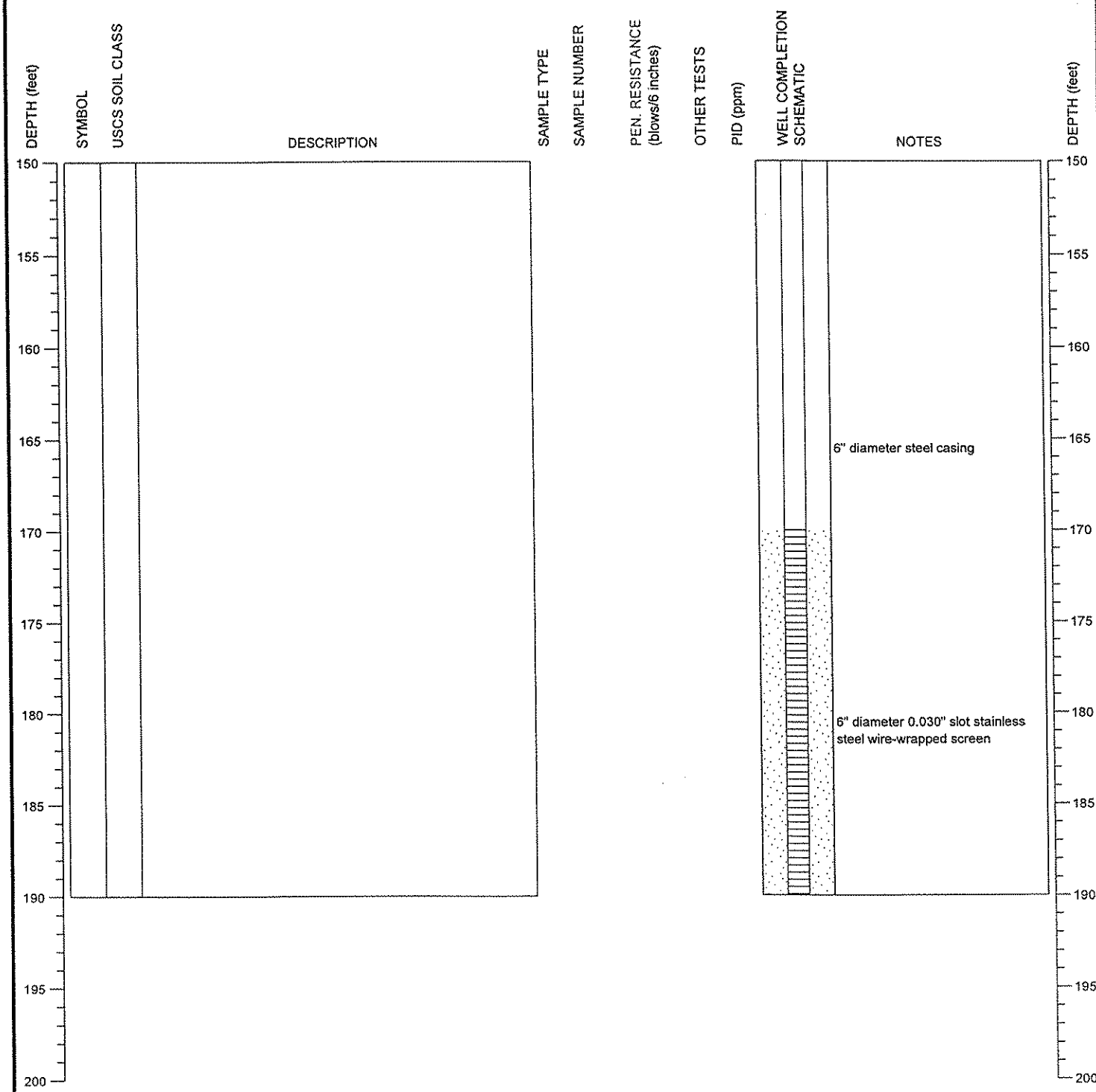
MONITORING WELL:
OW-2



PROJECT NO.: 94054 FIGURE: A-6

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 11/10/1999
DATE COMPLETED: 11/10/1999
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

MONITORING WELL:
OW-2

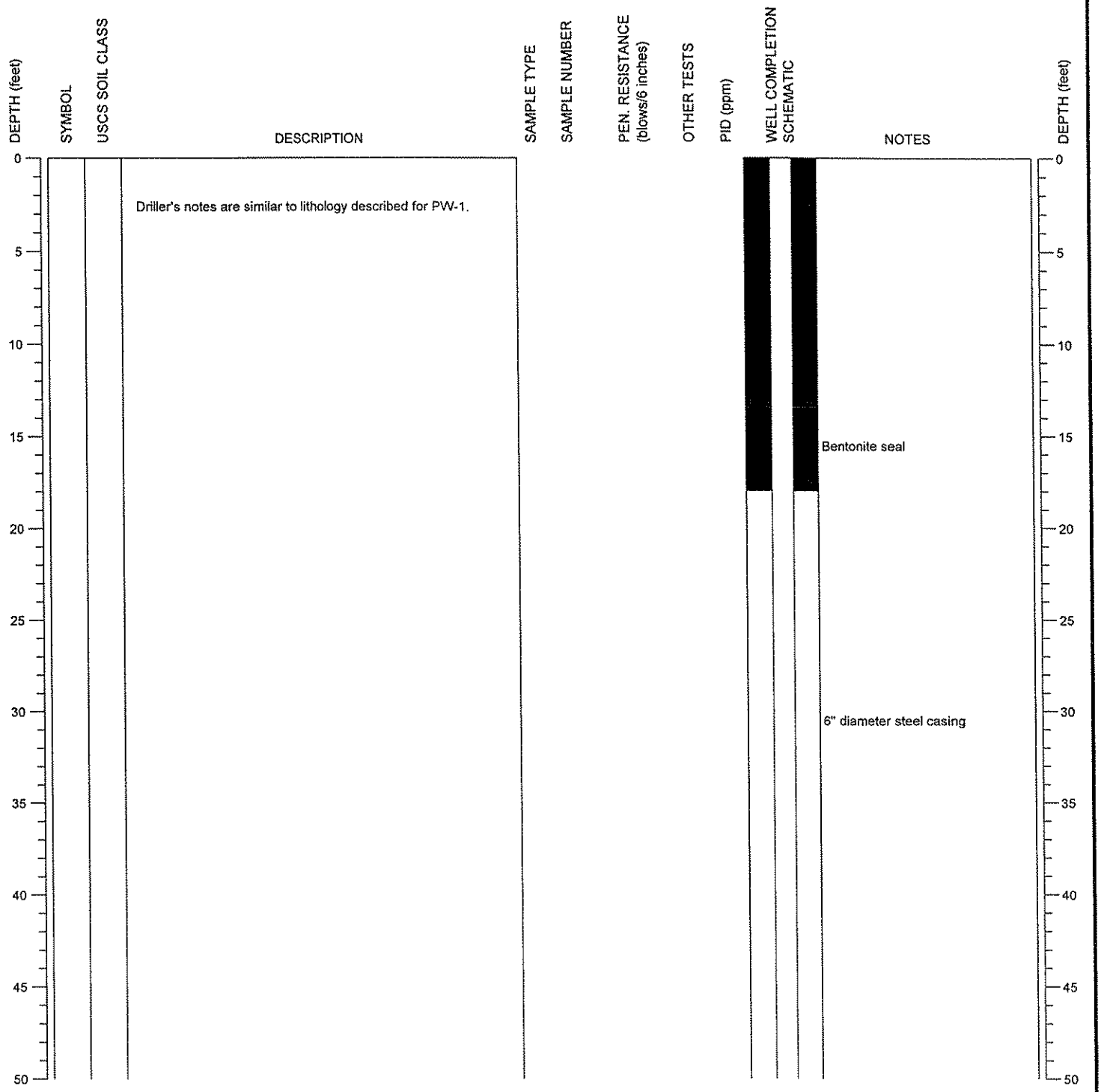


PROJECT NO.: 94054

FIGURE: A-6

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 1/10/2000
DATE COMPLETED: 1/10/2000
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

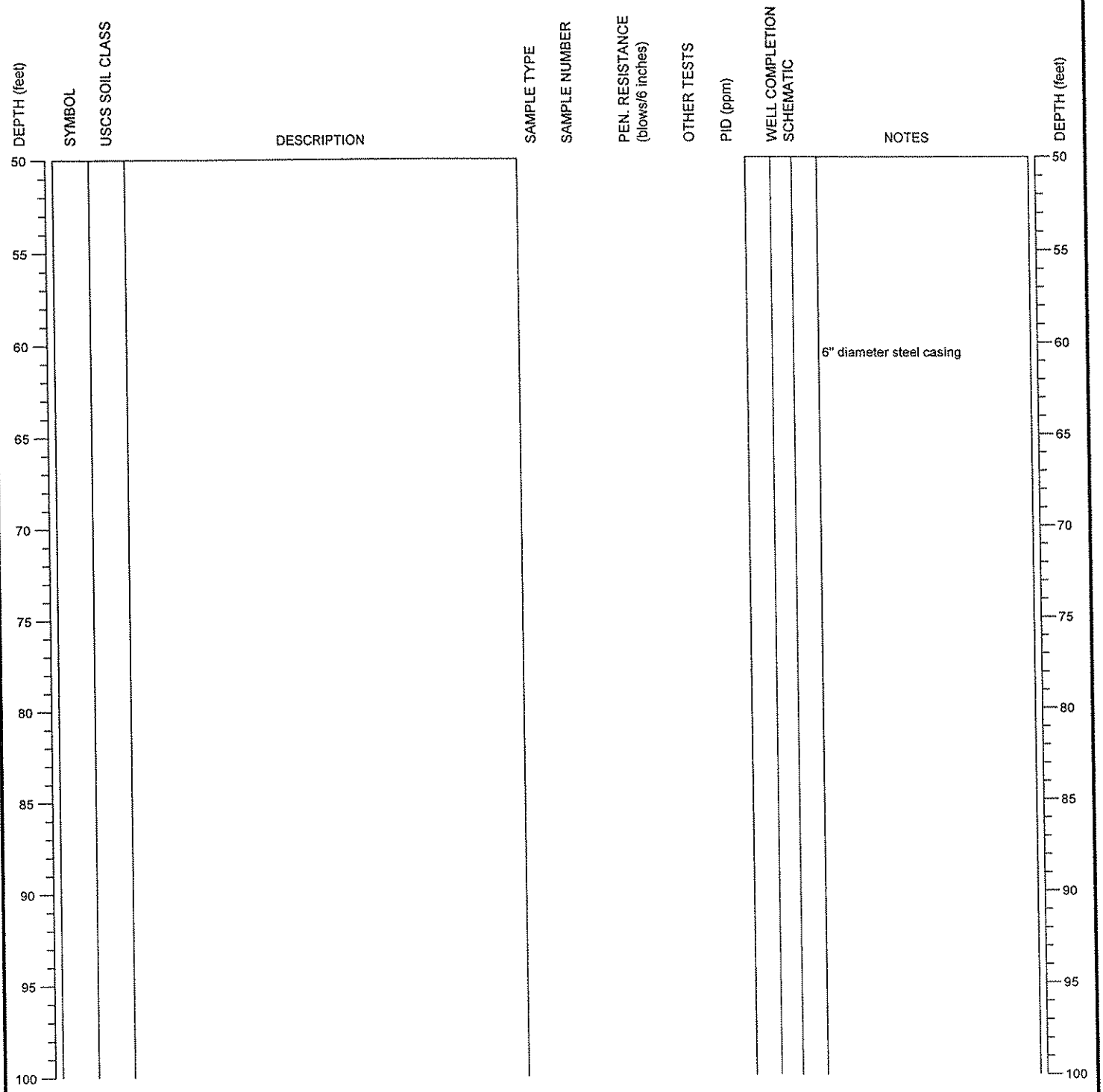
MONITORING WELL:
OW-3



PROJECT NO.: 94054 FIGURE: A-7

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 1/10/2000
DATE COMPLETED: 1/10/2000
LOGGED BY: Holt Drilling, Inc.

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HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

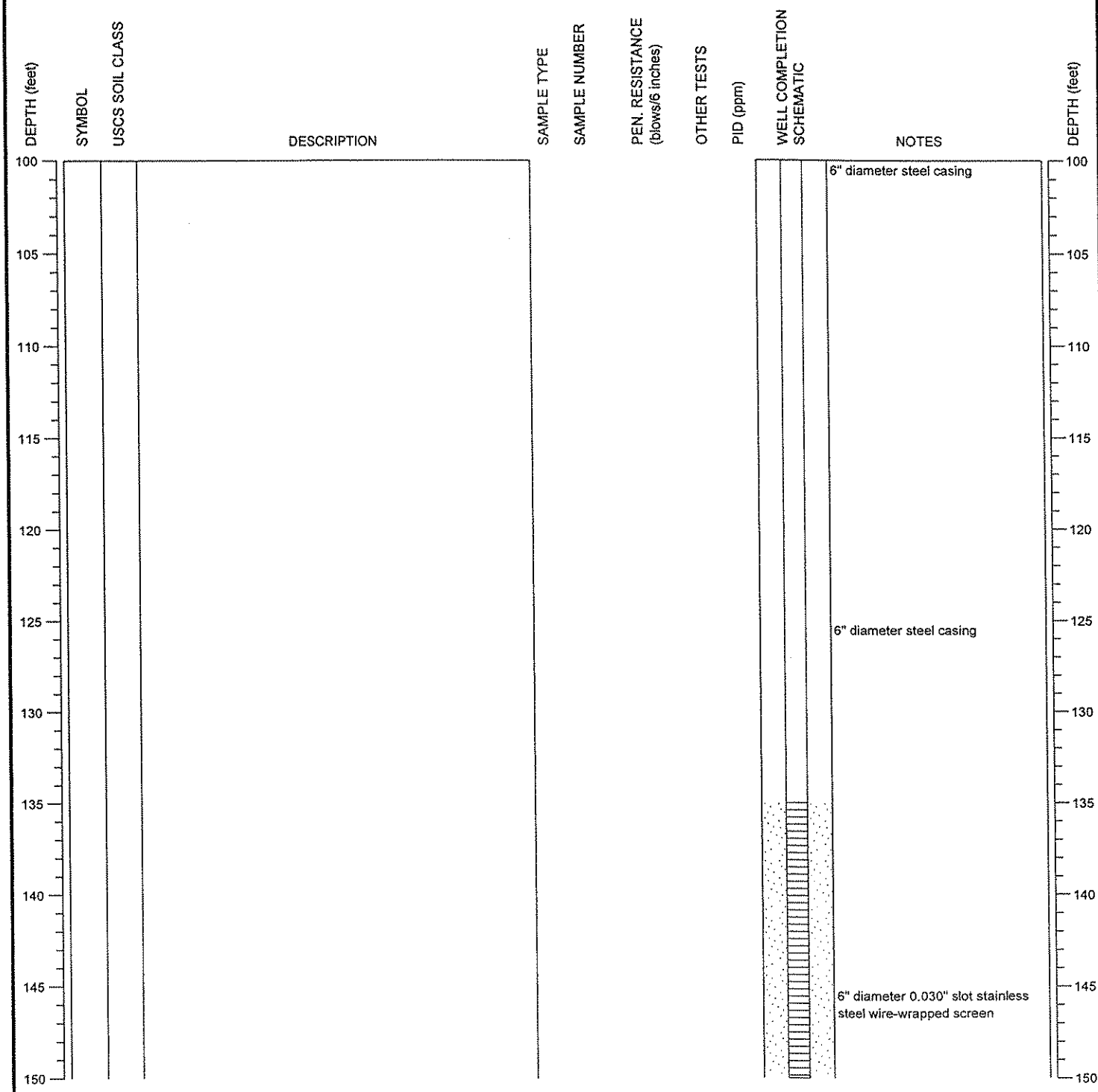
MONITORING WELL:
OW-3



PROJECT NO.: 94054 FIGURE: A-7

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 1/10/2000
DATE COMPLETED: 1/10/2000
LOGGED BY: Holt Drilling, Inc.




NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

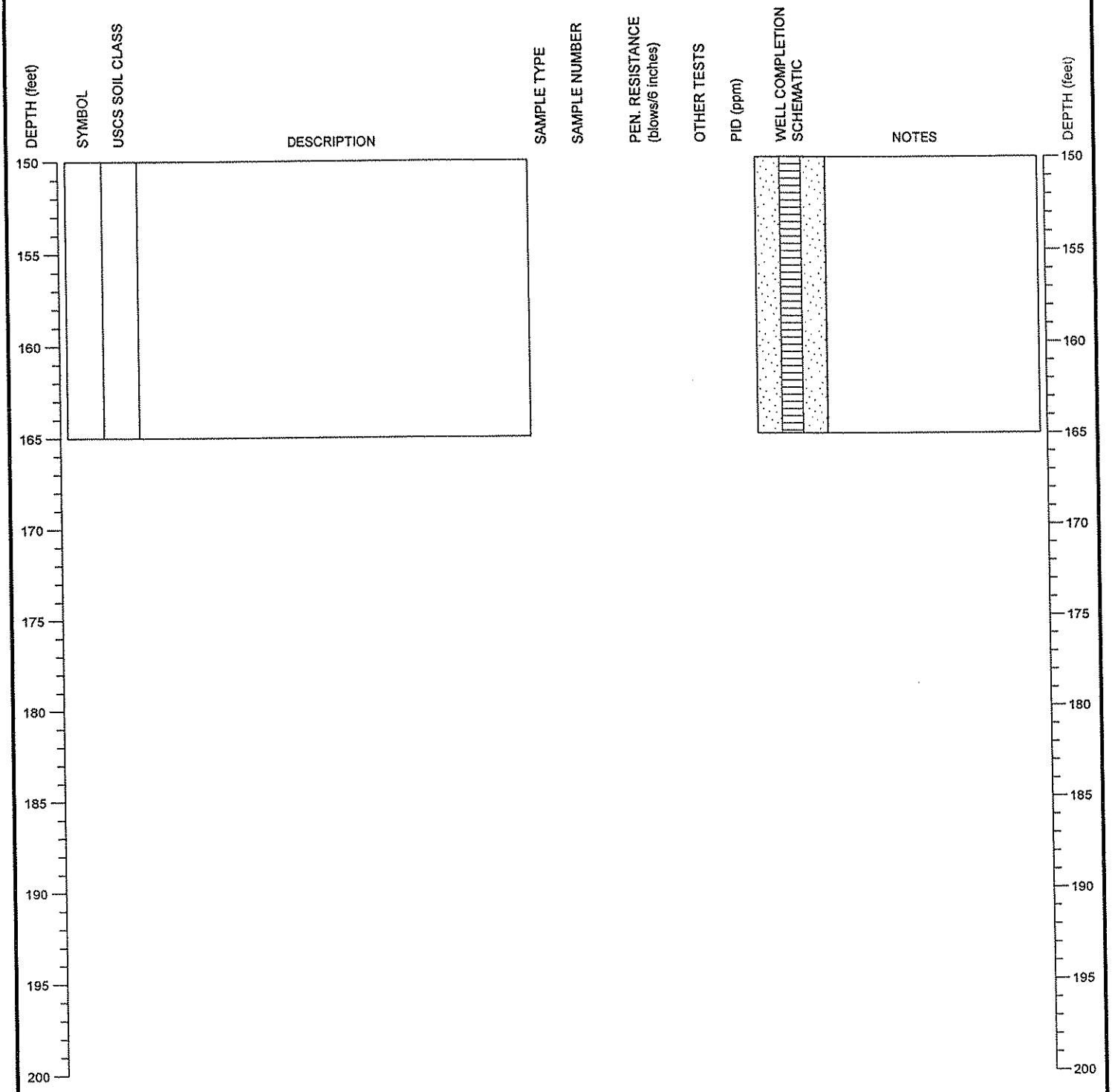
MONITORING WELL:
OW-3



PROJECT NO.: 94054 FIGURE: A-7

DRILLING COMPANY: Holt Drilling, Inc.
DRILLING METHOD: Air Rotary, 6" steel casing
SAMPLING METHOD:
SURFACE ELEVATION: ± feet

LOCATION: Twisp, WA
DATE STARTED: 1/10/2000
DATE COMPLETED: 1/10/2000
LOGGED BY: Holt Drilling, Inc.




NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

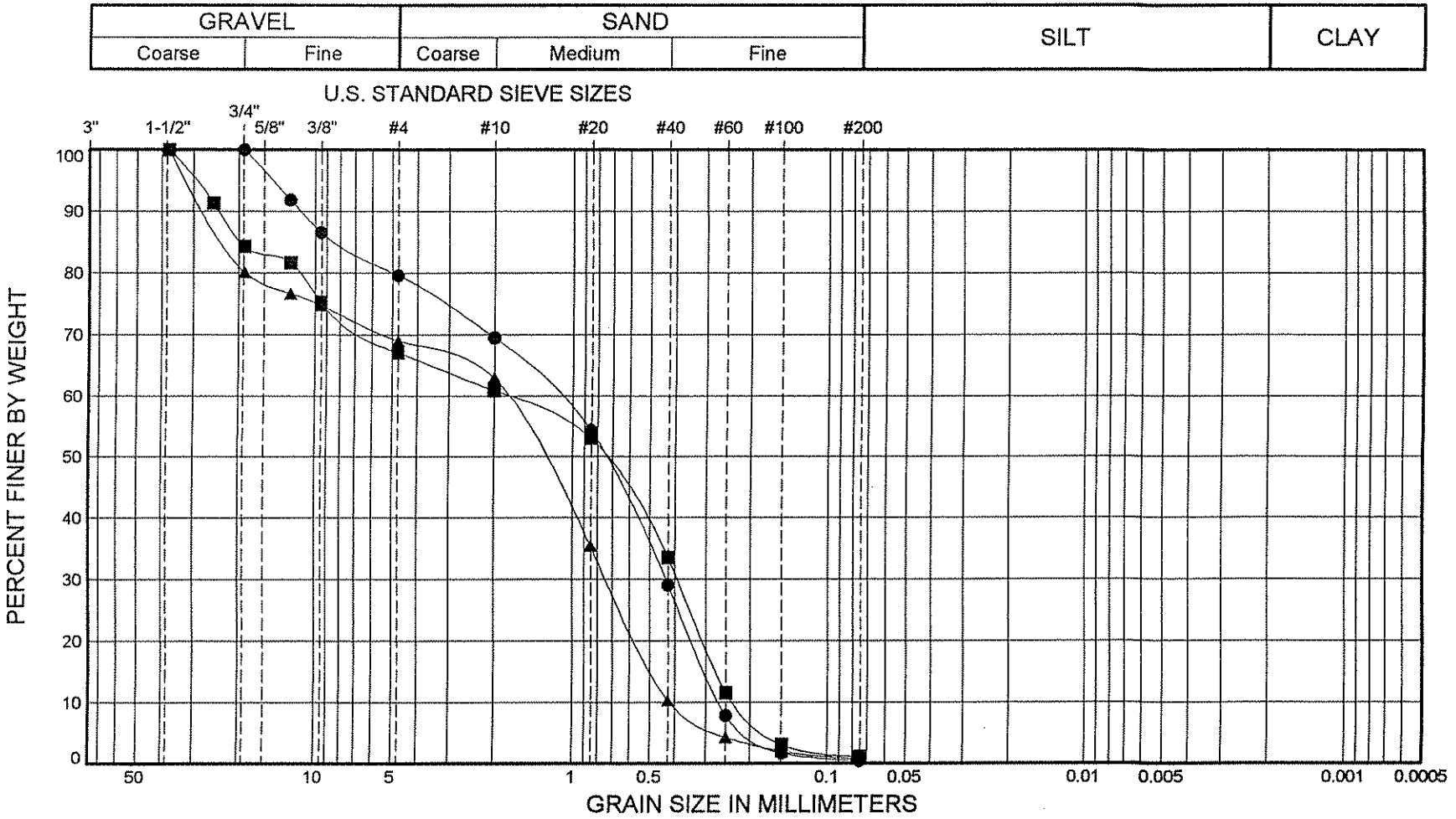
MONITORING WELL:
OW-3



PROJECT NO.: 94054 FIGURE: A-7

# Appendix C

# Sieve Analysis Results



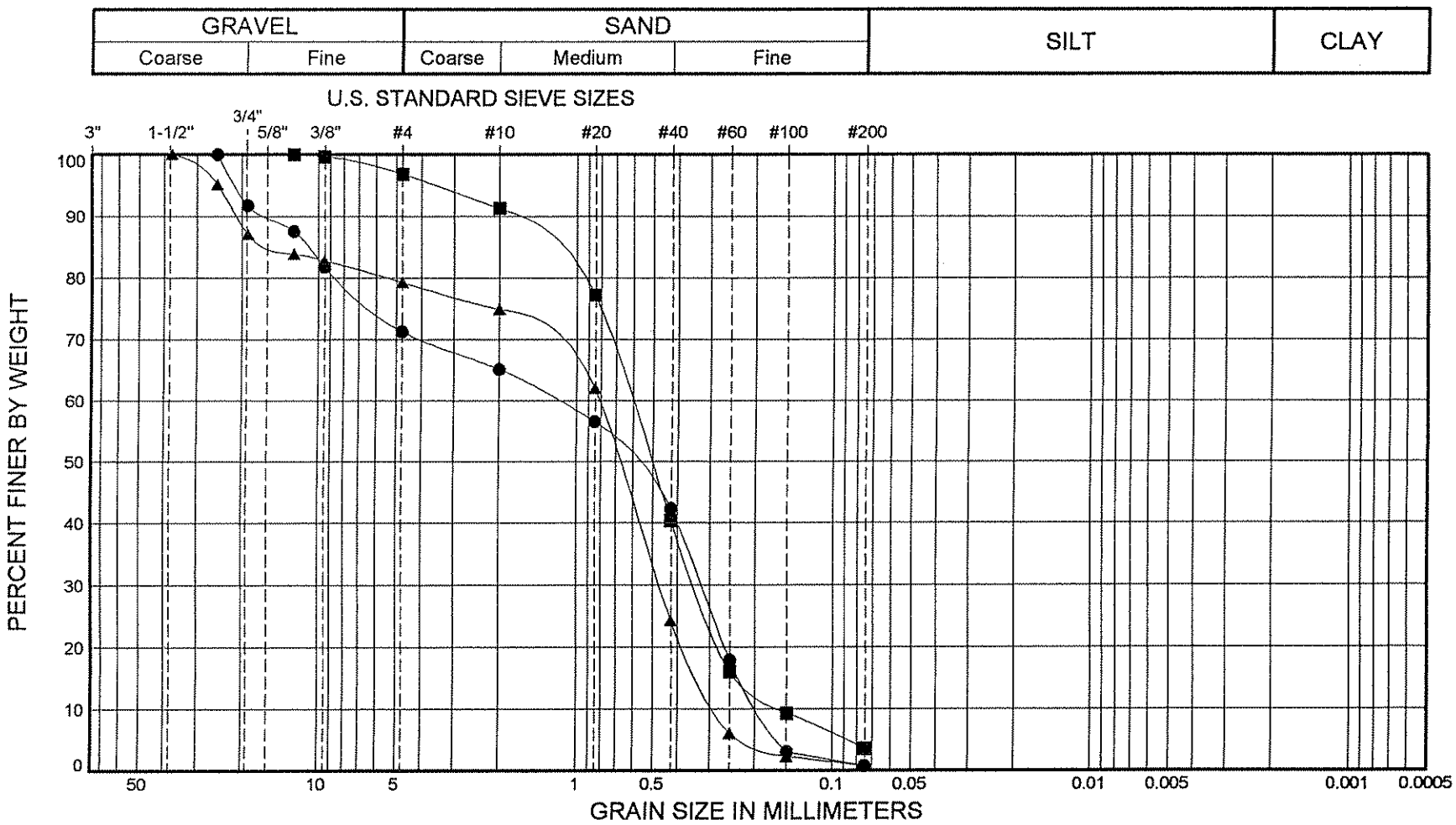

| SYMBOL | SAMPLE | | DEPTH (ft) | CLASSIFICATION | % MC | LL | PL | PI | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | PW-1 | 40 ft. | | (SP) Grayish brown, poorly graded SAND with gravel | 18 | | | | 20.4 | 79.1 | 0.5 |
| ■ | PW-1 | 80 ft. | | (SP) Grayish brown, poorly graded SAND with gravel | 14 | | | | 32.9 | 65.9 | 1.1 |
| ▲ | PW-1 | 105 ft. | | (SP) Grayish brown, poorly graded SAND with gravel | 12 | | | | 31.0 | 68.2 | 0.8 |

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 94054 FIGURE: B-1



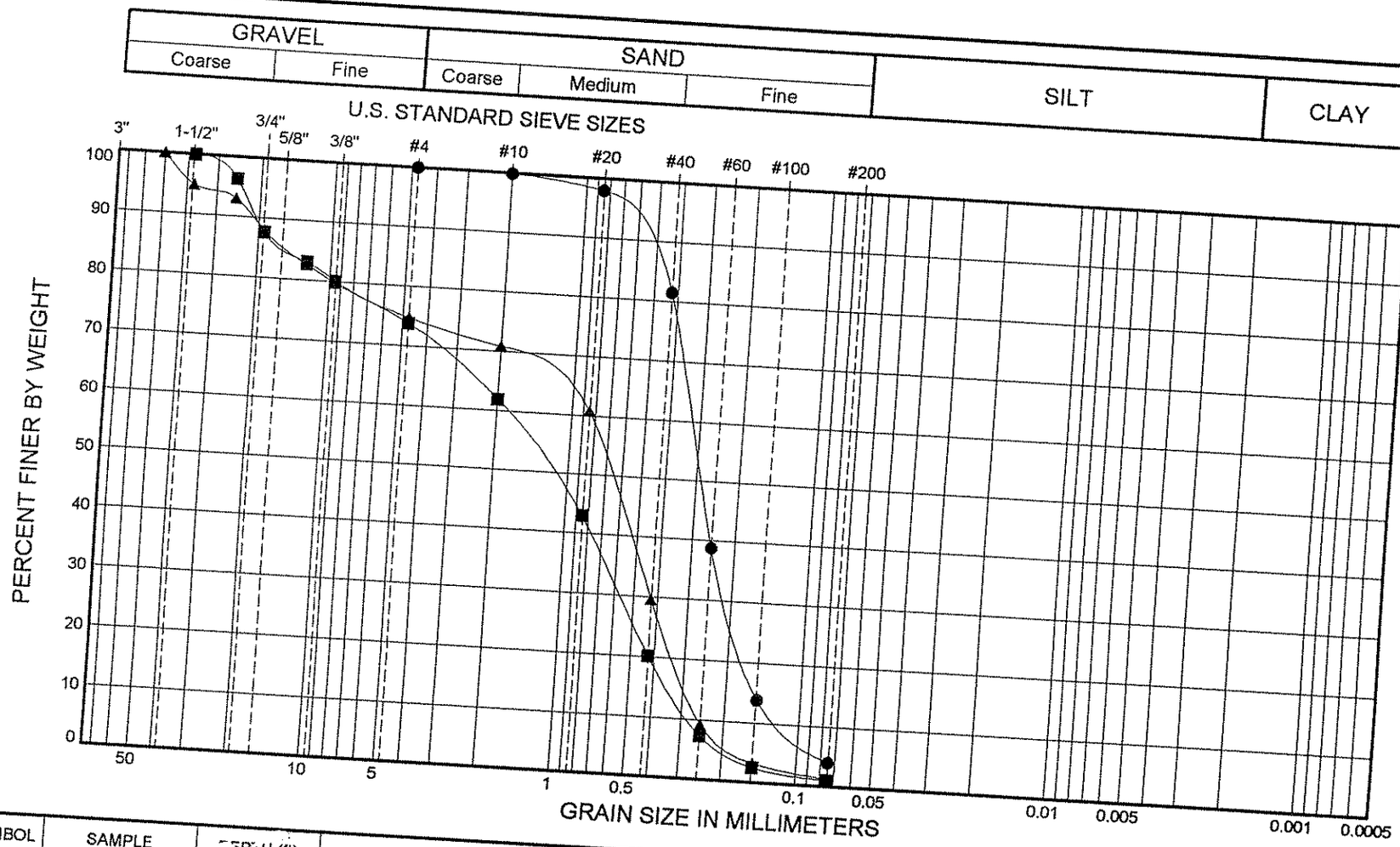

| SYMBOL | SAMPLE | | DEPTH (ft) | CLASSIFICATION | % MC | LL | PL | PI | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | PW-1 | 115 ft. | | (SP) Grayish brown, poorly graded SAND with gravel | 16 | | | | 28.8 | 70.4 | 0.8 |
| ■ | PW-1 | 130 ft. | | (SP) Olive brown, poorly graded SAND | 19 | | | | 3.2 | 93.2 | 3.7 |
| ▲ | PW-1 | 140 ft. | | (SP) Olive gray, poorly graded SAND with gravel | 14 | | | | 20.7 | 78.4 | 0.9 |

HWA GeoSciences Inc.

Methow Valley Irrigation District
Twisp, Washington

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 94054 FIGURE: B-2

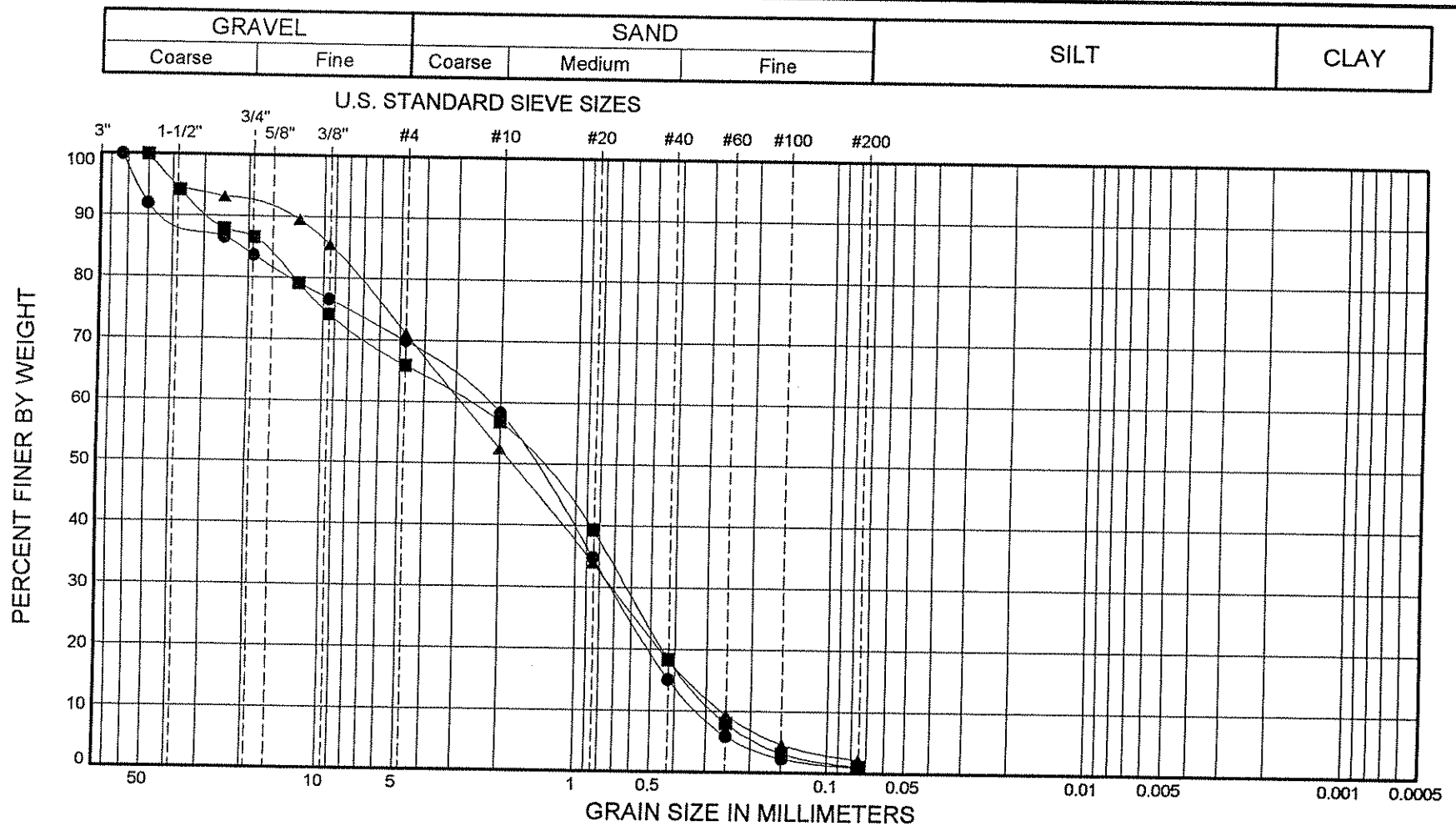



| SYMBOL | SAMPLE | | DEPTH (ft) | CLASSIFICATION | % MC | LL | PL | PI | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | PW-1 | 155 ft. | | (SP) Olive gray, poorly graded SAND | 24 | | | | | 95.9 | 4.1 |
| ■ | PW-2 | S-28 | 130.0 - 131.0 | (SP) Grayish brown, poorly graded SAND with gravel | 11 | | | | 26.3 | 72.7 | 1.1 |
| ▲ | PW-2 | S-32 | 155.0 - 156.0 | (SP) Grayish brown, poorly graded SAND with gravel | | | | | 25.3 | 73.4 | 1.3 |

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

GRAIN SIZE DISTRIBUTION TEST RESULTS



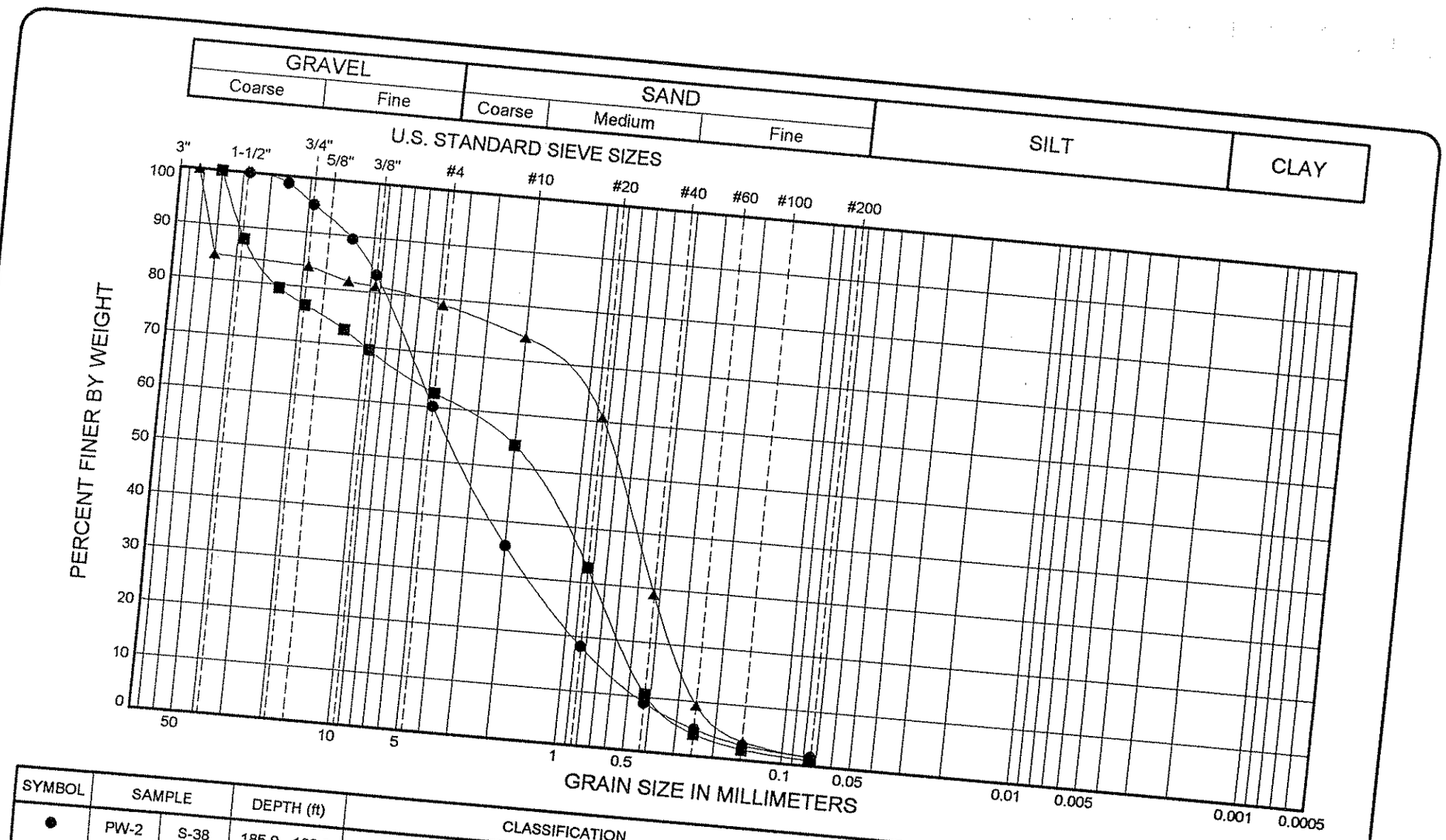

| SYMBOL | SAMPLE | | DEPTH (ft) | CLASSIFICATION | % MC | LL | PL | PI | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | PW-2 | S-34 | 165.0 - 166.0 | (SP) Grayish brown, poorly graded SAND with gravel | | | | | 30.1 | 68.9 | 1.0 |
| ■ | PW-2 | S-36 | 175.0 - 176.0 | (SP) Grayish brown, poorly graded SAND with gravel | | | | | 34.1 | 64.7 | 1.2 |
| ▲ | PW-2 | S-37 | 180.0 - 181.0 | (SP) Grayish brown, poorly graded SAND with gravel | 12 | | | | 28.9 | 68.8 | 2.2 |

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO: 94054 FIGURE B-4




| SYMBOL | SAMPLE | | DEPTH (ft) | CLASSIFICATION | % MC | LL | PL | PI | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | PW-2 | S-38 | 185.0 - 186.0 | (SW) Grayish brown, well graded SAND with gravel | 11 | | | | 39.9 | 58.4 | 1.7 |
| ■ | PW-2 | S-39 | 191.0 - 192.0 | (SP) Grayish brown, poorly graded SAND with gravel | 16 | | | | 37.4 | 61.6 | 1.0 |
| ▲ | PW-2 | S-40 | 195.0 - 196.0 | (SP) Grayish brown, poorly graded SAND with gravel | 20 | | | | 21.1 | 77.3 | 1.6 |

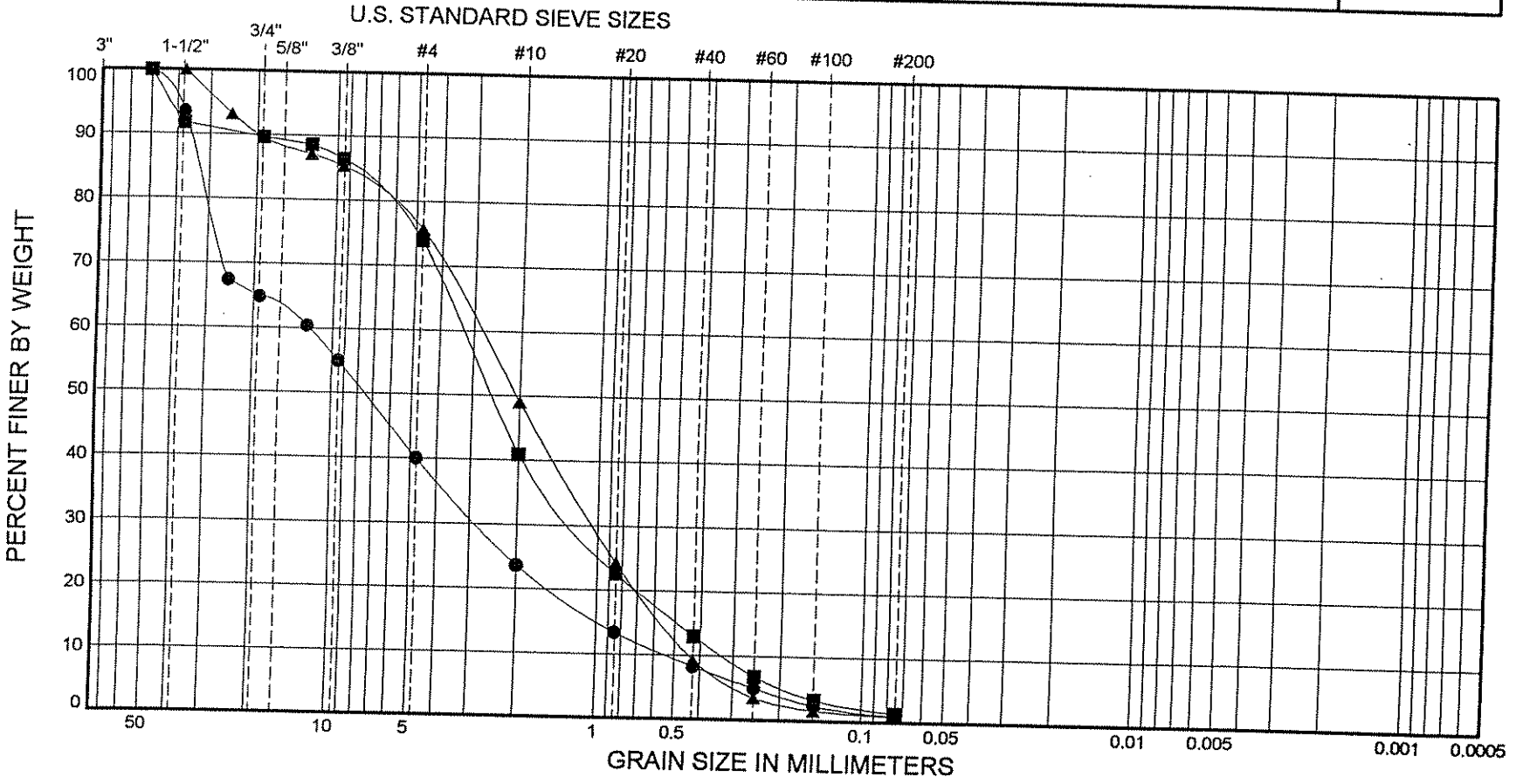
HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

GRAIN SIZE DISTRIBUTION

HWAGRSZ 94054.GPJ 12/6/00

| GRAVEL | | SAND | | | SILT | CLAY |
|---|---|---|---|---|---|---|
| Coarse | Fine | Coarse | Medium | Fine | | |

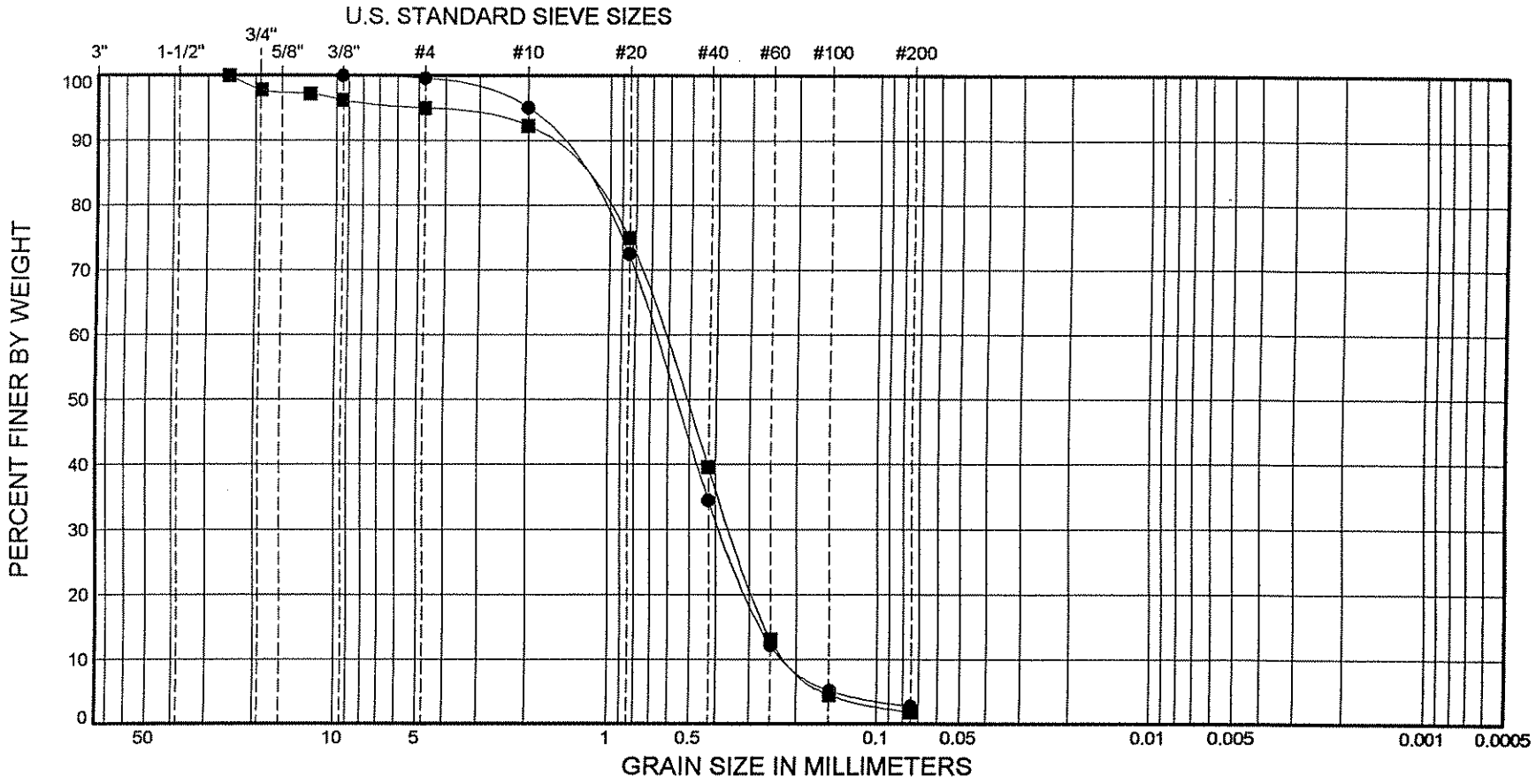



| SYMBOL | SAMPLE | DEPTH (ft) | CLASSIFICATION | % MC | LL | PL | PI | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | PW-3 | 95.0 - 96.0 | (GW) Brownish gray, well graded GRAVEL with sand | 4 | | | | 59.9 | 39.1 | 1.0 |
| ■ | PW-3 | 110.0 - 111.0 | (SW) Brownish gray, well graded SAND with gravel | 5 | | | | 26.1 | 72.5 | 1.4 |
| ▲ | PW-3 | 121.0 - 122.0 | (SP) Brownish gray, poorly graded SAND with gravel | 11 | | | | 24.3 | 74.8 | 0.9 |

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

GRAIN SIZE DISTRIBUTION TEST RESULTS




| SYMBOL | SAMPLE | | DEPTH (ft) | CLASSIFICATION | % MC | LL | PL | PI | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | PW-3 | | 130.0 - 131.0 | (SP) Brownish gray, poorly graded SAND | 27 | | | | 0.4 | 96.8 | 2.7 |
| ■ | PW-3 | | 135.0 - 136.0 | (SP) Brownish gray, poorly graded SAND | 22 | | | | 5.0 | 93.1 | 1.9 |

HWA GEOSCIENCES INC.

Methow Valley Irrigation District
Twisp, Washington

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 94054 FIGURE: B-7

# Appendix D

# Aquifer Testing Equipment List

# METHOW VALLEY IRRIGATION DISTRICT
# AQUIFER TESTING EQUIPMENT LIST

## Provided by HWA GeoSciences

- Troll electronic pressure transducers and data loggers (In-Situ)
- Electronic and suspension cables
- Solinst well probes
- Calibrated flow meters, instantaneous and totalizing
- Orifice plate, 8-inch-diameter with flow measurement table
- Gate valve
- Laptop computer with connections for data loggers, download software, pump test software, power attachments, user manual, discs
- Digital camera
- 5-gallon bucket
- 200-foot tape
- transit, tripod, and stadia rod
- Test forms, write-in-rain (24)
- stopwatch
- Semi-log graph paper

## Provided by Holt Drilling

- Electric submersible pump
- Diesel generator and fuel tanks
- 1,000 feet of 6-inch-diameter discharge pipe and fittings
- Stilling tubes – 200 feet of threaded 2-inch-diameter PVC pipe and 10 feet of slotted screen
- Couplers to attach stilling tube to well casing
- Water discharge dissipation materials – sand bags, plywood sheeting, plastic sheeting

# Appendix E

# Ground Water Discharge Procedures

# Ground Water Discharge Procedures

The pumping tests discharged ground water at rates ranging from 200 to 1,000 gallons per minute (gpm). At the request of the Washington State Department of Ecology and the Washington State Department of Fish and Wildlife, all water from aquifer testing was discharged in a manner that returned the water to the aquifer or Methow River and in a manner that did not disturb slopes, river bottoms, or surface soil.

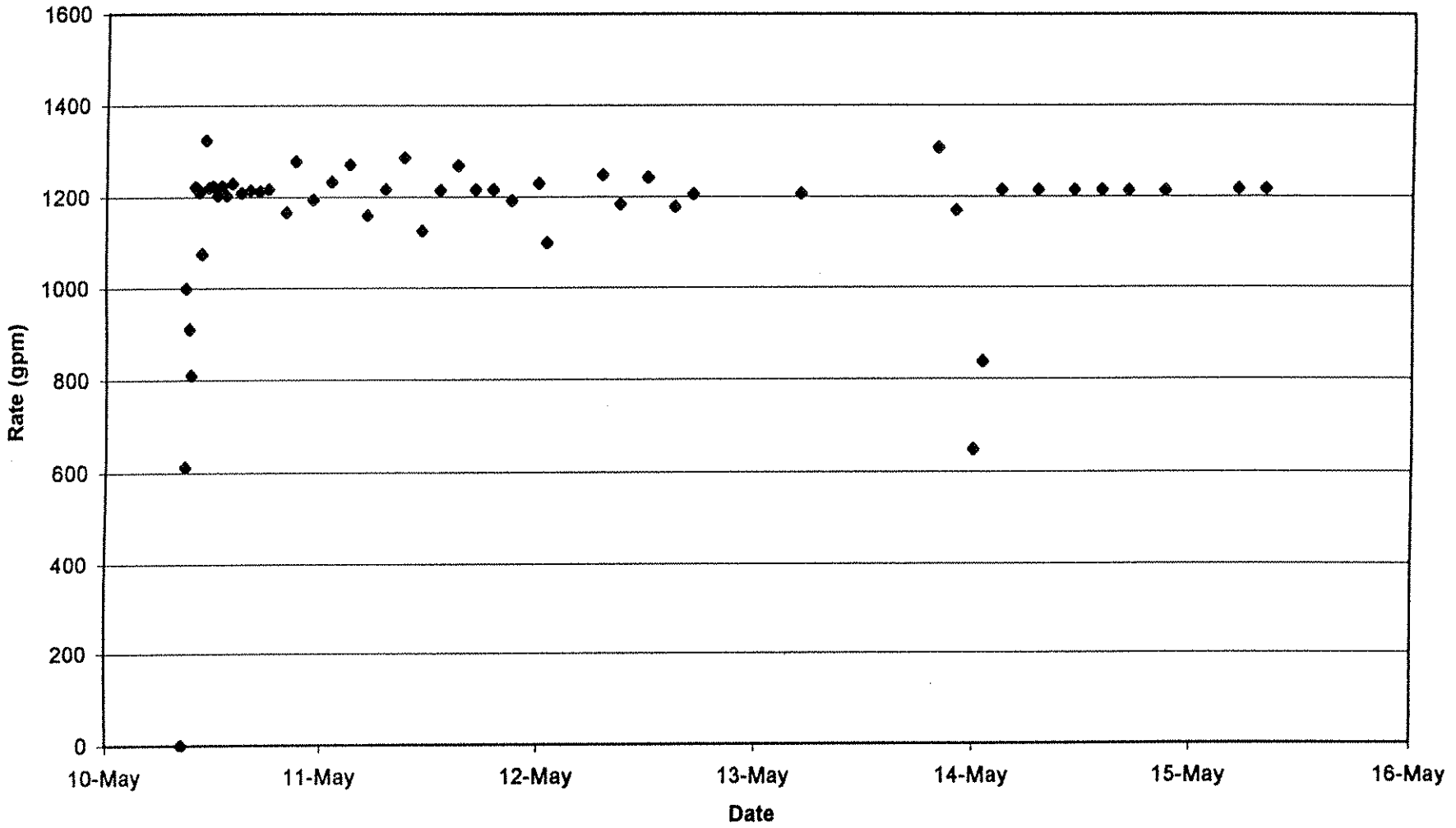
At PW-1 and PW-3, groundwater was discharged into the Methow River. Holt Drilling mitigated the force of the discharge and minimized stream and bank erosion at the edge of the river by constructing a plywood platform that spread out the discharge of water at the river's edge. The platform attenuated the force of the discharge water and prevented water from discharging directly onto the stream bank or into the river.

At PW-2, the water was discharged into an abandoned irrigation channel. The water flowed within the channel, partially infiltrating into the soil, and partially discharging into the Methow River. The abandoned irrigation channel is shown on Figure 3-2.

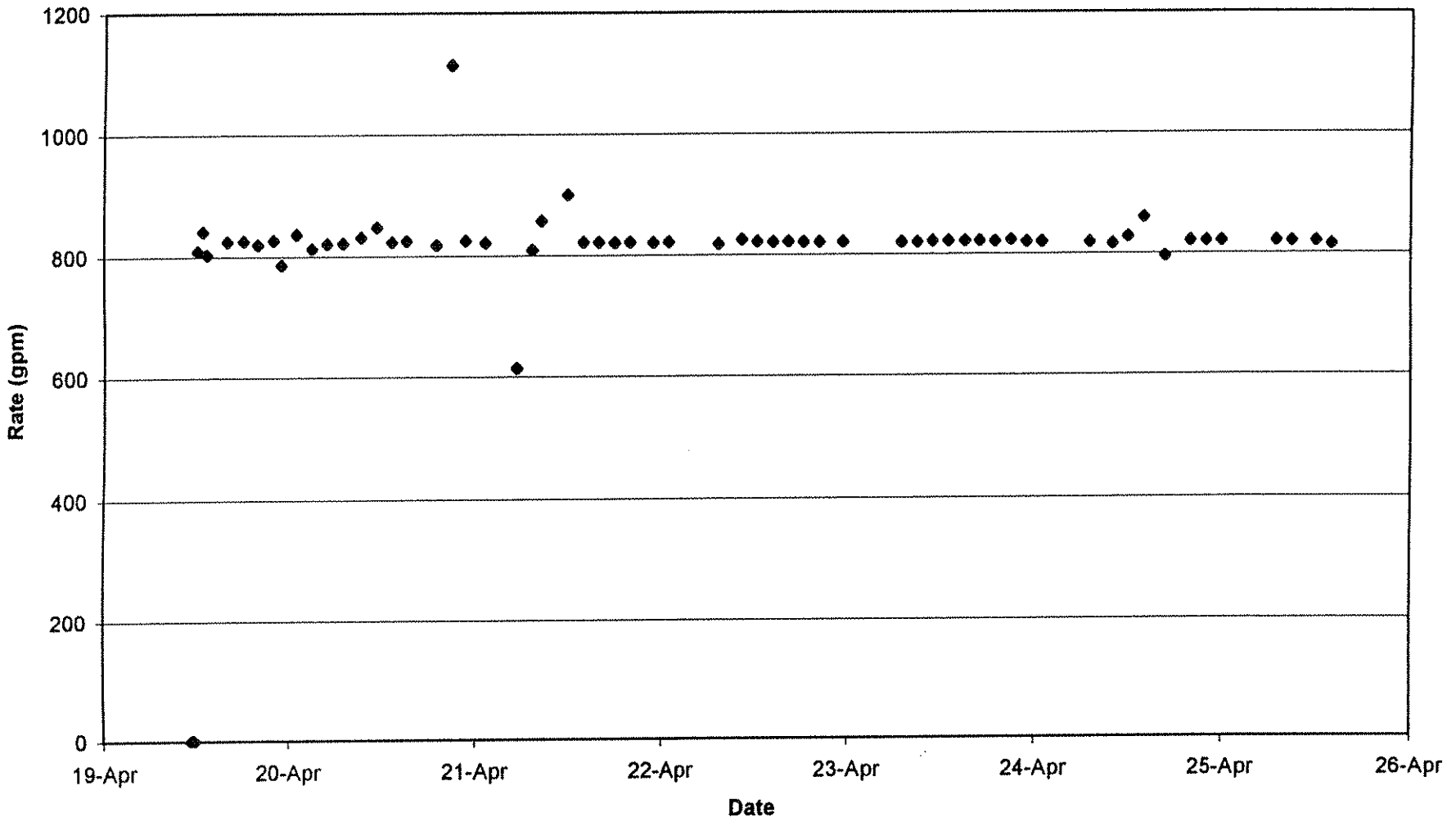
# Appendix F

# Test Well and Pumping Rate Field Data

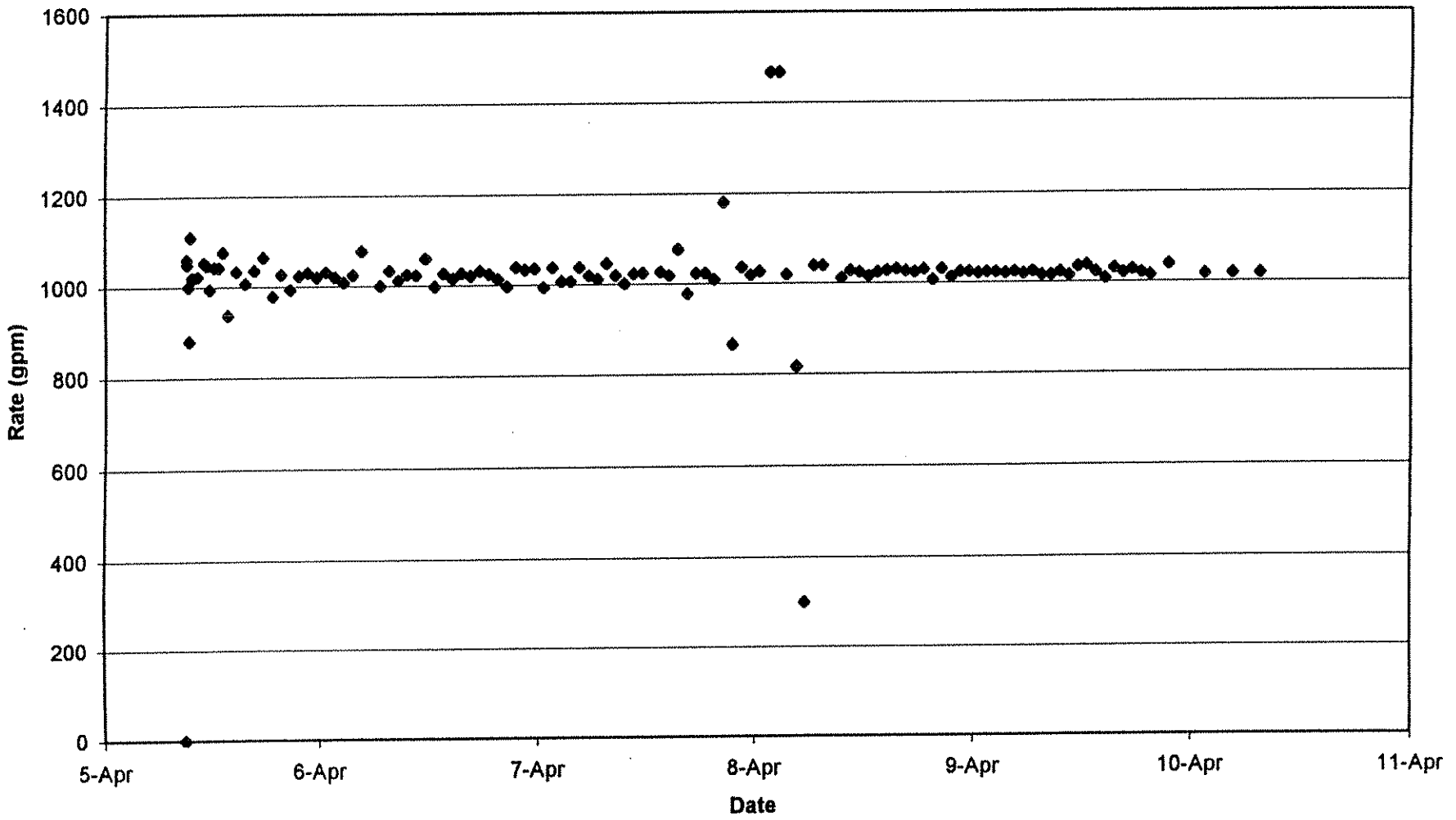
**PW-1 Pumping Rate**
**Methow Valley Irrigation District**
**Twisp, Washington**



**PW-2 Pumping Rate**
**Methow Valley Irrigation District**
**Twisp, Washington**



**PW-3 Pumping Rate**
**Methow Valley Irrigation District**
**Twisp, Washington**



**PW-1 Pumping Rates**
**Methow Valley Irrigation District**
**Twisp, Washington**

| Date/Time | Elapsed Time (min) | Rate (gpm) | Flowmeter (100 gallons) |
|---|---|---|---|
| 5/10/2000 8:40 | 0 | 0 | 266679 |
| 5/10/2000 8:55 | 15 | 613 | 266771 |
| 5/10/2000 9:00 | 20 | 1000 | 266954 |
| 5/10/2000 9:20 | 40 | 910 | 267136 |
| 5/10/2000 9:35 | 55 | 810 | 267258 |
| 5/10/2000 9:55 | 75 | 1222 | 267502 |
| 5/10/2000 10:05 | 85 | 1220 | 267624 |
| 5/10/2000 10:25 | 105 | 1210 | 267866 |
| 5/10/2000 10:45 | 125 | 1075 | 268081 |
| 5/10/2000 11:05 | 145 | 1325 | 268346 |
| 5/10/2000 11:25 | 165 | 1220 | 268590 |
| 5/10/2000 11:55 | 195 | 1223 | 268957 |
| 5/10/2000 12:25 | 225 | 1203 | 269318 |
| 5/10/2000 12:55 | 255 | 1223 | 269685 |
| 5/10/2000 13:25 | 285 | 1203 | 270046 |
| 5/10/2000 14:05 | 325 | 1230 | 270538 |
| 5/10/2000 15:05 | 385 | 1208 | 271263 |
| 5/10/2000 16:05 | 445 | 1215 | 271992 |
| 5/10/2000 17:05 | 505 | 1212 | 272719 |
| 5/10/2000 18:05 | 565 | 1217 | 273449 |
| 5/10/2000 20:05 | 685 | 1166 | 274848 |
| 5/10/2000 21:05 | 745 | 1278 | 275615 |
| 5/10/2000 23:05 | 865 | 1193 | 277047 |
| 5/11/2000 1:05 | 985 | 1233 | 278527 |
| 5/11/2000 3:05 | 1105 | 1272 | 280053 |
| 5/11/2000 5:05 | 1225 | 1159 | 281444 |
| 5/11/2000 7:05 | 1345 | 1217 | 282904 |
| 5/11/2000 9:05 | 1465 | 1287 | 284448 |
| 5/11/2000 11:05 | 1585 | 1125 | 285798 |
| 5/11/2000 13:05 | 1705 | 1215 | 287256 |
| 5/11/2000 15:00 | 1820 | 1269 | 288715 |
| 5/11/2000 17:00 | 1940 | 1215 | 290173.5 |
| 5/11/2000 19:00 | 2060 | 1215 | 291632 |
| 5/11/2000 21:00 | 2180 | 1192 | 293062 |
| 5/12/2000 0:00 | 2360 | 1229 | 295275 |
| 5/12/2000 1:00 | 2420 | 1098 | 295934 |
| 5/12/2000 7:00 | 2780 | 1248 | 300426 |
| 5/12/2000 9:00 | 2900 | 1183 | 301846 |
| 5/12/2000 12:00 | 3080 | 1242 | 304082 |
| 5/12/2000 15:00 | 3260 | 1178 | 306202 |
| 5/12/2000 17:00 | 3380 | 1205 | 307648 |
| 5/13/2000 5:00 | 4100 | 1207 | 316338 |
| 5/13/2000 20:00 | 5000 | 1307 | 328099 |
| 5/13/2000 22:00 | 5120 | 1169 | 329502 |
| 5/14/2000 0:00 | 5240 | 648 | 330280 |
| 5/14/2000 1:00 | 5300 | 837 | 331009 |
| 5/14/2000 3:00 | 5420 | 1214 | 332466 |
| 5/14/2000 7:00 | 5660 | 1214 | 335380 |

**PW-1 Pumping Rates**
**Methow Valley Irrigation District**
**Twisp, Washington**

| Date/Time | Elapsed Time (min) | Rate (gpm) | Flowmeter (100 gallons) |
|---|---|---|---|
| 5/14/2000 11:00 | 5900 | 1214 | 338294 |
| 5/14/2000 14:00 | 6080 | 1215 | 340481 |
| 5/14/2000 17:00 | 6260 | 1213 | 342665 |
| 5/14/2000 21:00 | 6500 | 1214 | 345578 |
| 5/15/2000 5:00 | 6980 | 1217 | 351419 |
| 5/15/2000 8:00 | 7160 | 1217 | 353610 |

**Average** **1214**

**PW-2 Pumping Rates**
**Methow Valley Irrigation District**
**Twisp, Washington**

| Date/Time | Elapsed Time (min) | Rate (gpm) | Flowmeter (100 gallons) |
|---|---|---|---|
| 4/19/2000 11:30 | 0 | 0 | - |
| 4/19/2000 11:50 | 20 | - | 190364 |
| 4/19/2000 12:11 | 41 | 810 | 190534 |
| 4/19/2000 12:52 | 82 | 841 | 190879 |
| 4/19/2000 13:23 | 113 | 803 | 191128 |
| 4/19/2000 16:01 | 271 | 825 | 192432 |
| 4/19/2000 18:07 | 397 | 825 | 193472 |
| 4/19/2000 20:00 | 510 | 819 | 194398 |
| 4/19/2000 22:00 | 630 | 827 | 195390 |
| 4/19/2000 23:02 | 692 | 785 | 195877 |
| 4/20/2000 1:00 | 810 | 836 | 196864 |
| 4/20/2000 3:01 | 931 | 812 | 197847 |
| 4/20/2000 5:01 | 1051 | 821 | 198832 |
| 4/20/2000 7:01 | 1171 | 822 | 199818 |
| 4/20/2000 9:21 | 1311 | 831 | 200981 |
| 4/20/2000 11:22 | 1432 | 847 | 202006 |
| 4/20/2000 13:22 | 1552 | 823 | 202961 |
| 4/20/2000 15:15 | 1665 | 825 | 203893 |
| 4/20/2000 19:09 | 1899 | 818 | 205808 |
| 4/20/2000 20:53 | 2003 | 1114 | 206967 |
| 4/20/2000 22:54 | 2124 | 825 | 207965 |
| 4/21/2000 1:25 | 2275 | 821 | 209205 |
| 4/21/2000 5:23 | 2513 | 614 | 210666 |
| 4/21/2000 7:24 | 2634 | 809 | 211645 |
| 4/21/2000 8:36 | 2706 | 857 | 212262 |
| 4/21/2000 12:01 | 2911 | 900 | 214108 |
| 4/21/2000 14:01 | 3031 | 822 | 215094 |
| 4/21/2000 16:01 | 3151 | 822 | 216080 |
| 4/21/2000 18:01 | 3271 | 821 | 217065 |
| 4/21/2000 20:01 | 3391 | 822 | 218051 |
| 4/21/2000 23:01 | 3571 | 821 | 219528 |
| 4/22/2000 1:01 | 3691 | 822 | 220514 |
| 4/22/2000 7:32 | 4082 | 818 | 223712 |
| 4/22/2000 10:31 | 4261 | 825 | 225189 |
| 4/22/2000 12:31 | 4381 | 822 | 226175 |
| 4/22/2000 14:31 | 4501 | 821 | 227160 |
| 4/22/2000 16:31 | 4621 | 822 | 228146 |
| 4/22/2000 18:31 | 4741 | 821 | 229131 |
| 4/22/2000 20:31 | 4861 | 821 | 230116 |
| 4/22/2000 23:31 | 5041 | 821 | 231593 |
| 4/23/2000 7:01 | 5491 | 820 | 235283 |
| 4/23/2000 9:01 | 5611 | 820 | 236267 |
| 4/23/2000 11:01 | 5731 | 822 | 237253 |
| 4/23/2000 13:01 | 5851 | 822 | 238239 |
| 4/23/2000 15:10 | 5980 | 822 | 239299 |

**PW-2 Pumping Rates**
**Methow Valley Irrigation District**
**Twisp, Washington**

| | | | |
|---|---|---|---|
| 4/23/2000 17:01 | 6091 | 822 | 240211 |
| 4/23/2000 19:01 | 6211 | 821 | 241196 |
| 4/23/2000 21:01 | 6331 | 823 | 242184 |
| 4/23/2000 23:01 | 6451 | 820 | 243168 |
| 4/24/2000 1:01 | 6571 | 820 | 244152 |
| 4/24/2000 7:06 | 6936 | 819 | 247142 |
| 4/24/2000 10:02 | 7112 | 816 | 248579 |
| 4/24/2000 12:01 | 7231 | 828 | 249564 |
| 4/24/2000 14:00 | 7350 | 860 | 250587 |
| 4/24/2000 16:45 | 7515 | 795 | 251899 |
| 4/24/2000 20:01 | 7711 | 821 | 253508 |
| 4/24/2000 22:02 | 7832 | 821 | 254501 |
| 4/25/2000 0:01 | 7951 | 820 | 255477 |
| 4/25/2000 7:01 | 8371 | 820 | 258922 |
| 4/25/2000 9:01 | 8491 | 820 | 259906 |
| 4/25/2000 12:01 | 8671 | 820 | 261382 |
| 4/25/2000 14:02 | 8792 | 815 | 262368 |

**Average** **821**

**PW-3 Pumping Rates**
**Methow Valley Irrigation District**
**Twisp, Washington**

| Date/Time | Elapsed Time (min) | Rate (gpm) | Flowmeter (100 gallons) |
|---|---|---|---|
| 4/5/2000 9:00 | 0 | 0 | 113982 |
| 4/5/2000 9:05 | 5 | 1060 | 114035 |
| 4/5/2000 9:07 | 7 | 1050 | 114056 |
| 4/5/2000 9:15 | 15 | 1000 | 114136 |
| 4/5/2000 9:20 | 20 | 880 | 114180 |
| 4/5/2000 9:30 | 30 | 1110 | 114291 |
| 4/5/2000 9:40 | 40 | 1020 | 114393 |
| 4/5/2000 9:50 | 50 | 1020 | 114495 |
| 4/5/2000 10:20 | 80 | 1023 | 114802 |
| 4/5/2000 11:00 | 120 | 1054 | 115224 |
| 4/5/2000 11:20 | 140 | 1047 | 115433 |
| 4/5/2000 11:40 | 160 | 995 | 115632 |
| 4/5/2000 12:10 | 190 | 1043 | 115945 |
| 4/5/2000 12:40 | 220 | 1043 | 116258 |
| 4/5/2000 13:10 | 250 | 1077 | 116581 |
| 4/5/2000 13:40 | 280 | 937 | 116862 |
| 4/5/2000 14:40 | 340 | 1033 | 117482 |
| 4/5/2000 15:40 | 400 | 1007 | 118086 |
| 4/5/2000 16:40 | 460 | 1037 | 118708 |
| 4/5/2000 17:40 | 520 | 1065 | 119347 |
| 4/5/2000 18:40 | 580 | 978 | 119934 |
| 4/5/2000 19:40 | 640 | 1027 | 120550 |
| 4/5/2000 20:40 | 700 | 993 | 121146 |
| 4/5/2000 21:40 | 760 | 1023 | 121760 |
| 4/5/2000 22:40 | 820 | 1030 | 122378 |
| 4/5/2000 23:40 | 880 | 1020 | 122990 |
| 4/6/2000 0:40 | 940 | 1032 | 123609 |
| 4/6/2000 1:40 | 1000 | 1020 | 124221 |
| 4/6/2000 2:40 | 1060 | 1008 | 124826 |
| 4/6/2000 3:40 | 1120 | 1025 | 125441 |
| 4/6/2000 4:40 | 1180 | 1078 | 126088 |
| 4/6/2000 6:40 | 1300 | 1000 | 127288 |
| 4/6/2000 7:40 | 1360 | 1033 | 127908 |
| 4/6/2000 8:40 | 1420 | 1012 | 128515 |
| 4/6/2000 9:40 | 1480 | 1025 | 129130 |
| 4/6/2000 10:40 | 1540 | 1023 | 129744 |
| 4/6/2000 11:40 | 1600 | 1060 | 130380 |
| 4/6/2000 12:40 | 1660 | 998 | 130979 |
| 4/6/2000 13:40 | 1720 | 1027 | 131595 |
| 4/6/2000 14:40 | 1780 | 1015 | 132204 |
| 4/6/2000 15:40 | 1840 | 1027 | 132820 |
| 4/6/2000 16:40 | 1900 | 1022 | 133433 |
| 4/6/2000 17:40 | 1960 | 1032 | 134052 |
| 4/6/2000 18:40 | 2020 | 1025 | 134667 |
| 4/6/2000 19:40 | 2080 | 1013 | 135275 |

**PW-3 Pumping Rates**
**Methow Valley Irrigation District**
**Twisp, Washington**

| Date/Time | Elapsed Time (min) | Rate (gpm) | Flowmeter (100 gallons) |
|---|---|---|---|
| 4/6/2000 20:40 | 2140 | 997 | 135873 |
| 4/6/2000 21:40 | 2200 | 1040 | 136497 |
| 4/6/2000 22:40 | 2260 | 1033 | 137117 |
| 4/6/2000 23:40 | 2320 | 1037 | 137739 |
| 4/7/2000 0:40 | 2380 | 995 | 138336 |
| 4/7/2000 1:40 | 2440 | 1038 | 138959 |
| 4/7/2000 2:40 | 2500 | 1007 | 139563 |
| 4/7/2000 3:40 | 2560 | 1007 | 140167 |
| 4/7/2000 4:40 | 2620 | 1038 | 140790 |
| 4/7/2000 5:40 | 2680 | 1020 | 141402 |
| 4/7/2000 6:40 | 2740 | 1012 | 142009 |
| 4/7/2000 7:40 | 2800 | 1047 | 142637 |
| 4/7/2000 8:40 | 2860 | 1020 | 143249 |
| 4/7/2000 9:40 | 2920 | 1002 | 143850 |
| 4/7/2000 10:40 | 2980 | 1023 | 144464 |
| 4/7/2000 11:40 | 3040 | 1025 | 145079 |
| 4/7/2000 13:40 | 3160 | 1027 | 146311 |
| 4/7/2000 14:40 | 3220 | 1018 | 146922 |
| 4/7/2000 15:40 | 3280 | 1077 | 147568 |
| 4/7/2000 16:40 | 3340 | 978 | 148155 |
| 4/7/2000 17:40 | 3400 | 1023 | 148769 |
| 4/7/2000 18:40 | 3460 | 1023 | 149383 |
| 4/7/2000 19:40 | 3520 | 1010 | 149989 |
| 4/7/2000 20:40 | 3580 | 1180 | 150697 |
| 4/7/2000 21:40 | 3640 | 865 | 151216 |
| 4/7/2000 22:40 | 3700 | 1037 | 151838 |
| 4/7/2000 23:40 | 3760 | 1018 | 152449 |
| 4/8/2000 0:40 | 3820 | 1027 | 153065 |
| 4/8/2000 1:40 | 3880 | 1467 | 153945 |
| 4/8/2000 2:40 | 3940 | 1467 | 154825 |
| 4/8/2000 3:40 | 4000 | 1020 | 155437 |
| 4/8/2000 4:40 | 4060 | 817 | 155927 |
| 4/8/2000 5:40 | 4120 | 300 | 156107 |
| 4/8/2000 6:40 | 4180 | 1040 | 156731 |
| 4/8/2000 7:40 | 4240 | 1040 | 157355 |
| 4/8/2000 9:40 | 4360 | 1012 | 158569 |
| 4/8/2000 10:40 | 4420 | 1028 | 159186 |
| 4/8/2000 11:40 | 4480 | 1025 | 159801 |
| 4/8/2000 12:40 | 4540 | 1015 | 160410 |
| 4/8/2000 13:40 | 4600 | 1025 | 161025 |
| 4/8/2000 14:40 | 4660 | 1028 | 161642 |
| 4/8/2000 15:40 | 4720 | 1032 | 162261 |
| 4/8/2000 16:40 | 4780 | 1027 | 162877 |
| 4/8/2000 17:40 | 4840 | 1025 | 163492 |
| 4/8/2000 18:40 | 4900 | 1030 | 164110 |

**PW-3 Pumping Rates**
**Methow Valley Irrigation District**
**Twisp, Washington**

| Date/Time | Elapsed Time (min) | Rate (gpm) | Flowmeter (100 gallons) |
|---|---|---|---|
| 4/8/2000 19:40 | 4960 | 1007 | 164714 |
| 4/8/2000 20:40 | 5020 | 1032 | 165333 |
| 4/8/2000 21:40 | 5080 | 1013 | 165941 |
| 4/8/2000 22:40 | 5140 | 1025 | 166556 |
| 4/8/2000 23:40 | 5200 | 1025 | 167171 |
| 4/9/2000 0:40 | 5260 | 1022 | 167784 |
| 4/9/2000 1:40 | 5320 | 1023 | 168398 |
| 4/9/2000 2:40 | 5380 | 1023 | 169012 |
| 4/9/2000 3:40 | 5440 | 1022 | 169625 |
| 4/9/2000 4:40 | 5500 | 1025 | 170240 |
| 4/9/2000 5:40 | 5560 | 1020 | 170852 |
| 4/9/2000 6:40 | 5620 | 1025 | 171467 |
| 4/9/2000 7:40 | 5680 | 1017 | 172077 |
| 4/9/2000 8:40 | 5740 | 1017 | 172687 |
| 4/9/2000 9:40 | 5800 | 1023 | 173301 |
| 4/9/2000 10:40 | 5860 | 1015 | 173910 |
| 4/9/2000 11:40 | 5920 | 1035 | 174531 |
| 4/9/2000 12:40 | 5980 | 1038 | 175154 |
| 4/9/2000 13:40 | 6040 | 1023 | 175768 |
| 4/9/2000 14:40 | 6100 | 1008 | 176373 |
| 4/9/2000 15:40 | 6160 | 1032 | 176992 |
| 4/9/2000 16:40 | 6220 | 1022 | 177605 |
| 4/9/2000 17:40 | 6280 | 1028 | 178222 |
| 4/9/2000 18:40 | 6340 | 1022 | 178835 |
| 4/9/2000 19:40 | 6400 | 1015 | 179444 |
| 4/9/2000 21:40 | 6520 | 1039 | 180691 |
| 4/10/2000 1:40 | 6760 | 1018 | 183134 |
| 4/10/2000 4:40 | 6940 | 1018 | 184967 |
| 4/10/2000 7:40 | 7120 | 1019 | 186801 |

**Average** **1023**

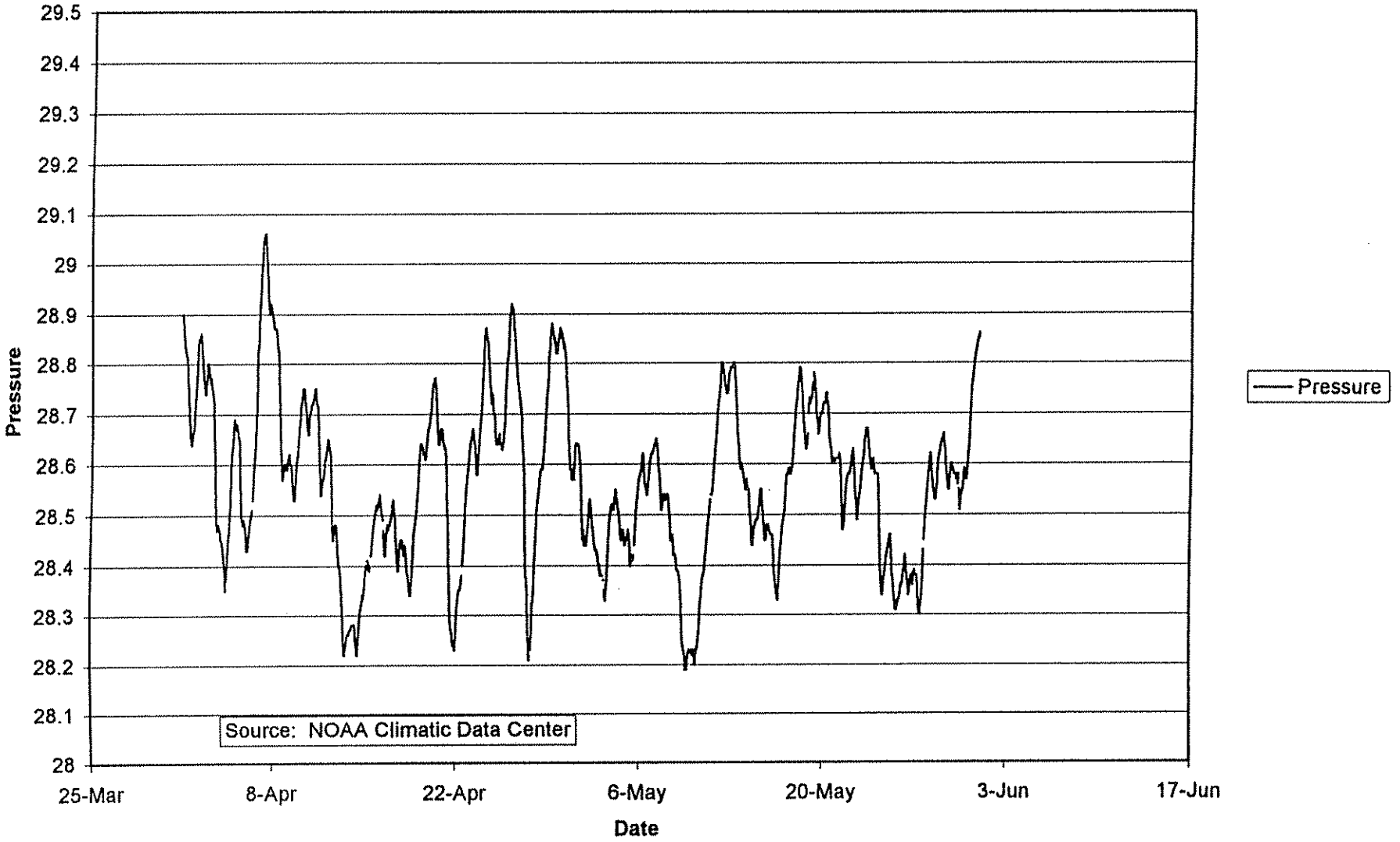
# Appendix G

# Electronic File of Water Level Data
# (in pocket)

# Appendix H

# Barometric Measurements, Omak, Washington

Barometric Pressure - Omak, Washington



# Appendix I

# Laboratory Reports

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Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588

| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/23/00 10:05 |

## ANALYTICAL REPORT FOR SAMPLES

| Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| PW-1A | B0E0206-01 | Water | 05/10/00 10:45 | 05/11/00 18:20 |





Jeanne Thompson, Project Manager

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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/23/00 10:05 |

## Total Metals by EPA 6000/7000 Series Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-1A (B0E0206-01) Water Sampled: 05/10/00 10:45 Received: 05/11/00 18:20** | | | | | | | | | |
| **Calcium** | **34.8** | 0.250 | mg/l | 1 | 0E18037 | 05/18/00 | 05/19/00 | EPA 6010B | |
| Iron | ND | 0.150 | " | " | " | " | " | " | |
| **Potassium** | **1.01** | 0.500 | " | " | " | " | 05/21/00 | " | |
| **Magnesium** | **8.37** | 0.100 | " | " | " | " | 05/19/00 | " | |
| Manganese | ND | 0.0100 | " | " | 0E17006 | 05/17/00 | 05/18/00 | EPA 6020 | |
| **Sodium** | **5.86** | 0.500 | " | " | 0E18037 | 05/18/00 | 05/19/00 | EPA 6010B | |

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541.383.9310 fax 541.382.7588

| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Steve Nelson | **Reported:**<br>05/23/00 10:05 |

## Conventional Chemistry Parameters by APHA/EPA Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-1A (B0E0206-01) Water** | **Sampled: 05/10/00 10:45** | **Received: 05/11/00 18:20** | | | | | | | |
| **Total Alkalinity** | **104** | 5.00 | mg/L as CaCO3 | 1 | 0E13014 | 05/12/00 | 05/13/00 | EPA 310.1 | |
| **Nitrate/Nitrite-Nitrogen** | **278** | 10.0 | ug/l as N | " | 0E19009 | 05/18/00 | 05/18/00 | EPA 353.2 | |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/23/00 10:05 |

## Physical Parameters by APHA/ASTM/EPA Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-1A (B0E0206-01) Water Sampled: 05/10/00 10:45 Received: 05/11/00 18:20** | | | | | | | | | |
| **Specific Conductivity** | **200** | 1.00 | uS/cm | 1 | 0E12020 | 05/12/00 | 05/12/00 | EPA 120.1 | |





JMT

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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/23/00 10:05 |

## Total Metals by EPA 6000/7000 Series Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E17006: Prepared 05/17/00 Using EPA 3020A** | | | | | | | | | | |
| **Blank (0E17006-BLK1)** | | | | | | | | | | |
| Manganese | ND | 0.0100 | mg/l | | | | | | | |
| **LCS (0E17006-BS1)** | | | | | | | | | | |
| Manganese | 0.239 | 0.0100 | mg/l | 0.200 | | 119 | 80-120 | | | |
| **Matrix Spike (0E17006-MS1)** | | | | | **Source: B0E0235-01** | | | | | |
| Manganese | 0.866 | 0.0500 | mg/l | 0.200 | 0.577 | 144 | 75-125 | | | Q-15 |
| **Matrix Spike Dup (0E17006-MSD1)** | | | | | **Source: B0E0235-01** | | | | | |
| Manganese | 0.778 | 0.0200 | mg/l | 0.200 | 0.577 | 100 | 75-125 | 10.7 | 20 | Q-15 |
| **Batch 0E18037: Prepared 05/18/00 Using EPA 3010A** | | | | | | | | | | |
| **Blank (0E18037-BLK1)** | | | | | | | | | | |
| Calcium | 0.717 | 0.250 | mg/l | | | | | | | Q-18 |
| Iron | ND | 0.150 | " | | | | | | | |
| Magnesium | ND | 0.100 | " | | | | | | | |
| Potassium | ND | 0.500 | " | | | | | | | |
| Sodium | ND | 0.500 | " | | | | | | | |
| **LCS (0E18037-BS1)** | | | | | | | | | | |
| Calcium | 10.6 | 0.250 | mg/l | 10.0 | | 106 | 80-120 | | | |
| Iron | 10.7 | 0.150 | " | 10.0 | | 107 | 80-120 | | | |
| Magnesium | 10.5 | 0.100 | " | 10.0 | | 105 | 80-120 | | | |
| Potassium | 51.9 | 0.500 | " | 50.0 | | 104 | 80-120 | | | |
| Sodium | 10.0 | 0.500 | " | 10.0 | | 100 | 80-120 | | | |

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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/23/00 10:05 |

# Total Metals by EPA 6000/7000 Series Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E18037: Prepared 05/18/00 Using EPA 3010A** | | | | | | | | | | |
| **Matrix Spike (0E18037-MS1)** | | | | | **Source: B0E0206-01** | | | | | |
| Calcium | 44.2 | 0.250 | mg/l | 10.0 | 34.8 | 94.0 | 80-120 | | | |
| Iron | 10.6 | 0.150 | " | 10.0 | ND | 105 | 80-120 | | | |
| Magnesium | 18.5 | 0.100 | " | 10.0 | 8.37 | 101 | 80-120 | | | |
| Potassium | 53.5 | 0.500 | " | 50.0 | 1.01 | 105 | 80-120 | | | |
| Sodium | 15.7 | 0.500 | " | 10.0 | 5.86 | 98.4 | 80-120 | | | |
| **Matrix Spike Dup (0E18037-MSD1)** | | | | | **Source: B0E0206-01** | | | | | |
| Calcium | 43.7 | 0.250 | mg/l | 10.0 | 34.8 | 89.0 | 80-120 | 1.14 | 20 | |
| Iron | 10.6 | 0.150 | " | 10.0 | ND | 105 | 80-120 | 0 | 20 | |
| Magnesium | 18.4 | 0.100 | " | 10.0 | 8.37 | 100 | 80-120 | 0.542 | 20 | |
| Potassium | 53.2 | 0.500 | " | 50.0 | 1.01 | 104 | 80-120 | 0.562 | 20 | |
| Sodium | 15.4 | 0.500 | " | 10.0 | 5.86 | 95.4 | 80-120 | 1.93 | 20 | |





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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Steve Nelson | **Reported:**<br>05/23/00 10:05 |

## Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E13014: Prepared 05/12/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0E13014-BLK1)** | | | | | | | | | | |
| Total Alkalinity | ND | 5.00 | mg/L as CaCO3 | | | | | | | |
| **LCS (0E13014-BS1)** | | | | | | | | | | |
| Total Alkalinity | 48.5 | 5.00 | mg/L as CaCO3 | 50.0 | | 97.0 | 90-110 | | | |
| **Duplicate (0E13014-DUP1)** | | | | | **Source: B0E0206-01** | | | | | |
| Total Alkalinity | 105 | 5.00 | mg/L as CaCO3 | | 104 | | | 0.957 | 6 | |
| **Batch 0E19009: Prepared 05/18/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0E19009-BLK1)** | | | | | | | | | | |
| Nitrate/Nitrite-Nitrogen | ND | 10.0 | ug/l as N | | | | | | | |
| **LCS (0E19009-BS1)** | | | | | | | | | | |
| Nitrate/Nitrite-Nitrogen | 1030 | 10.0 | ug/l as N | 1000 | | 103 | 90-110 | | | |
| **Matrix Spike (0E19009-MS1)** | | | | | **Source: B0E0082-09** | | | | | |
| Nitrate/Nitrite-Nitrogen | 630 | 10.0 | ug/l as N | 500 | 138 | 98.4 | 71-128 | | | |
| **Matrix Spike Dup (0E19009-MSD1)** | | | | | **Source: B0E0082-09** | | | | | |
| Nitrate/Nitrite-Nitrogen | 624 | 10.0 | ug/l as N | 500 | 138 | 97.2 | 71-128 | 0.957 | 20 | |

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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/23/00 10:05 |

## Physical Parameters by APHA/ASTM/EPA Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E12020: Prepared 05/12/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0E12020-BLK1)** | | | | | | | | | | |
| Specific Conductivity | ND | 1.00 | uS/cm | | | | | | | |
| **LCS (0E12020-BS1)** | | | | | | | | | | |
| Specific Conductivity | 66.4 | 1.00 | uS/cm | 73.9 | | 89.9 | 85-115 | | | |
| **Duplicate (0E12020-DUP1)** | | | | | **Source: B0E0145-01** | | | | | |
| Specific Conductivity | 24.5 | 1.00 | uS/cm | | 23.1 | | | 5.88 | 20 | |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/23/00 10:05 |

## Notes and Definitions

| | |
|---|---|
| Q-15 | Analyses are not controlled on matrix spike RPD and/or percent recoveries when the sample concentration is significantly higher than the spike level. |
| Q-18 | The method blank contains analyte at a concentration above the MRL. This concentration is less than 5% of the sample result, which is negligible according to method criteria. |
| DET | Analyte DETECTED |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| NR | Not Reported |
| dry | Sample results reported on a dry weight basis |
| RPD | Relative Percent Difference |





Jeanne Thompson, Project Manager

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# CHAIN OF CUSTODY REPORT

**Work Order #:** B0E0206

CLIENT: HWA GeoSciences
REPORT TO: Steve Nelson
ADDRESS:
PHONE: 7740106 FAX: 7742714

INVOICE TO:
P.O. NUMBER: 94054

PROJECT NAME: MUID
PROJECT NUMBER: 94054
SAMPLED BY: Nelson

TURNAROUND REQUEST in Business Days*
Organic & Inorganic Analyses: ~~10~~ STD. | 7 | 5 | 4 | 3 | 2 | 1 | <1
Petroleum Hydrocarbon Analyses: 5 STD. | 4 | 3 | 2 | 1 | <1
OTHER Please Specify
*Turnaround Requests less than standard may incur Rush Charges

| | CLIENT SAMPLE IDENTIFICATION | SAMPLING DATE/TIME | NO3/NO2 | Alkalinity | Ca, Mg, K, Na | Fe, Mn | S.C | MATRIX (W, S, O) | # OF CONT. | COMMENTS | NCA W ID |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | PW-1A | 5-10-00 1045 | | | | | | W | 3 | B0E0206- | 01 |
| 2. | | | | | | | | | | | |
| 3. | | | | | | | | | | | |
| 4. | | | | | | | | | | | |
| 5. | | | | | | | | | | | |
| 6. | | | | | | | | | | | |
| 7. | | | | | | | | | | | |
| 8. | | | | | | | | | | | |
| 9. | | | | | | | | | | | |
| 10. | | | | | | | | | | | |
| 11. | | | | | | | | | | | |
| 12. | | | | | | | | | | | |
| 13. | | | | | | | | | | | |
| 14. | | | | | | | | | | | |
| 15. | | | | | | | | | | | |

REQUESTED ANALYSES

RELINQUISHED BY: PRINT NAME: Steve Nelson FIRM: HWA DATE: 5-11 TIME: 615P
RECEIVED BY: PRINT NAME: PRANY TONTZ FIRM: NCA DATE: 5/11/00 TIME: 1820
RELINQUISHED BY: PRINT NAME: FIRM: DATE: TIME:
RECEIVED BY: PRINT NAME: FIRM: DATE: TIME:

ADDITIONAL REMARKS:
TEMP: 2

REV 3/

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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Steve Nelson | **Reported:**<br>06/05/00 10:52 |

## ANALYTICAL REPORT FOR SAMPLES

| Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| PW-1A | B0E0206-01 | Water | 05/10/00 10:45 | 05/11/00 18:20 |





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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Steve Nelson | **Reported:**<br>06/05/00 10:52 |

## Anions by EPA Method 300.0

## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-1A (B0E0206-01) Water Sampled: 05/10/00 10:45 Received: 05/11/00 18:20** | | | | | | | | | |
| **Chloride** | **0.697** | 0.200 | mg/l | 1 | 0F02003 | 06/01/00 | 06/01/00 | EPA 300.0 | |
| **Sulfate** | **12.9** | 0.200 | " | " | " | " | " | " | |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 06/05/00 10:52 |

## Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0F02003: Prepared 06/01/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0F02003-BLK1)** | | | | | | | | | | |
| Chloride | ND | 0.200 | mg/l | | | | | | | |
| Sulfate | ND | 0.200 | " | | | | | | | |
| **LCS (0F02003-BS1)** | | | | | | | | | | |
| Chloride | 1.89 | 0.200 | mg/l | 2.00 | | 94.5 | 90-110 | | | |
| Sulfate | 5.72 | 0.200 | " | 6.00 | | 95.3 | 90-110 | | | |
| **Duplicate (0F02003-DUP2)** | | | | | **Source: B0E0495-04** | | | | | |
| Chloride | 3010 | 100 | mg/l | | 2990 | | | 0.667 | 25 | |
| **Duplicate (0F02003-DUP3)** | | | | | **Source: B0E0495-04** | | | | | |
| Sulfate | 233 | 20.0 | mg/l | | 237 | | | 1.70 | 25 | |
| **Matrix Spike (0F02003-MS2)** | | | | | **Source: B0E0495-04** | | | | | |
| Chloride | 4090 | 100 | mg/l | 1000 | 2990 | 110 | 80-120 | | | |
| **Matrix Spike (0F02003-MS3)** | | | | | **Source: B0E0495-04** | | | | | |
| Sulfate | 780 | 20.0 | mg/l | 600 | 237 | 90.5 | 80-120 | | | |





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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Steve Nelson | **Reported:**<br>06/05/00 10:52 |

## Notes and Definitions

| | |
|---|---|
| DET | Analyte DETECTED |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| NR | Not Reported |
| dry | Sample results reported on a dry weight basis |
| RPD | Relative Percent Difference |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/31/00 14:24 |

## ANALYTICAL REPORT FOR SAMPLES

| Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| PW-1-B-051500 | B0E0266-01 | Water | 05/15/00 08:00 | 05/16/00 09:00 |
| RW-1-051500 | B0E0266-02 | Water | 05/15/00 08:30 | 05/16/00 09:00 |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/31/00 14:24 |

## Total Metals by EPA 6000/7000 Series Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-1-B-051500 (B0E0266-01) Water** | **Sampled: 05/15/00 08:00** | | **Received: 05/16/00 09:00** | | | | | | |
| **Calcium** | **32.9** | 0.250 | mg/l | 1 | 0E18037 | 05/18/00 | 05/19/00 | EPA 6010B | |
| **Iron** | **0.156** | 0.150 | " | " | " | " | " | " | |
| **Potassium** | **0.555** | 0.500 | " | " | " | " | 05/21/00 | " | |
| **Magnesium** | **7.83** | 0.100 | " | " | " | " | 05/19/00 | " | |
| **Sodium** | **5.53** | 0.500 | " | " | " | " | 05/19/00 | " | |
| **RW-1-051500 (B0E0266-02) Water** | **Sampled: 05/15/00 08:30** | | **Received: 05/16/00 09:00** | | | | | | |
| **Calcium** | **15.9** | 0.250 | mg/l | 1 | 0E18037 | 05/18/00 | 05/19/00 | EPA 6010B | |
| **Iron** | **0.270** | 0.150 | " | " | " | " | " | " | |
| Potassium | ND | 0.500 | " | " | " | " | 05/21/00 | " | |
| **Magnesium** | **2.45** | 0.100 | " | " | " | " | 05/19/00 | " | |
| **Sodium** | **2.43** | 0.500 | " | " | " | " | 05/19/00 | " | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/31/00 14:24 |

## Conventional Chemistry Parameters by APHA/EPA Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-1-B-051500 (B0E0266-01) Water Sampled: 05/15/00 08:00 Received: 05/16/00 09:00** | | | | | | | | | |
| **Total Alkalinity** | **101** | 5.00 | mg/L as CaCO3 | 1 | 0E21004 | 05/21/00 | 05/21/00 | EPA 310.1 | |
| **Nitrate/Nitrite-Nitrogen** | **220** | 10.0 | ug/l as N | " | 0E31004 | 05/30/00 | 05/30/00 | EPA 353.2 | |
| **RW-1-051500 (B0E0266-02) Water Sampled: 05/15/00 08:30 Received: 05/16/00 09:00** | | | | | | | | | |
| **Total Alkalinity** | **45.5** | 5.00 | mg/L as CaCO3 | 1 | 0E21004 | 05/21/00 | 05/21/00 | EPA 310.1 | |
| **Nitrate/Nitrite-Nitrogen** | **50.5** | 10.0 | ug/l as N | " | 0E31004 | 05/30/00 | 05/30/00 | EPA 353.2 | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/31/00 14:24 |

# Total Metals by EPA 6000/7000 Series Methods - Quality Control

## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E18037: Prepared 05/18/00 Using EPA 3010A** | | | | | | | | | | |
| **Blank (0E18037-BLK1)** | | | | | | | | | | |
| Calcium | 0.717 | 0.250 | mg/l | | | | | | | Q-18 |
| Iron | ND | 0.150 | " | | | | | | | |
| Magnesium | ND | 0.100 | " | | | | | | | |
| Potassium | ND | 0.500 | " | | | | | | | |
| Sodium | ND | 0.500 | " | | | | | | | |
| **LCS (0E18037-BS1)** | | | | | | | | | | |
| Calcium | 10.6 | 0.250 | mg/l | 10.0 | | 106 | 80-120 | | | |
| Iron | 10.7 | 0.150 | " | 10.0 | | 107 | 80-120 | | | |
| Magnesium | 10.5 | 0.100 | " | 10.0 | | 105 | 80-120 | | | |
| Potassium | 51.9 | 0.500 | " | 50.0 | | 104 | 80-120 | | | |
| Sodium | 10.0 | 0.500 | " | 10.0 | | 100 | 80-120 | | | |
| **Matrix Spike (0E18037-MS1)** | | | | | **Source: B0E0206-01** | | | | | |
| Calcium | 44.2 | 0.250 | mg/l | 10.0 | 34.8 | 94.0 | 80-120 | | | |
| Iron | 10.6 | 0.150 | " | 10.0 | ND | 105 | 80-120 | | | |
| Magnesium | 18.5 | 0.100 | " | 10.0 | 8.37 | 101 | 80-120 | | | |
| Potassium | 53.5 | 0.500 | " | 50.0 | 1.01 | 105 | 80-120 | | | |
| Sodium | 15.7 | 0.500 | " | 10.0 | 5.86 | 98.4 | 80-120 | | | |
| **Matrix Spike Dup (0E18037-MSD1)** | | | | | **Source: B0E0206-01** | | | | | |
| Calcium | 43.7 | 0.250 | mg/l | 10.0 | 34.8 | 89.0 | 80-120 | 1.14 | 20 | |
| Iron | 10.6 | 0.150 | " | 10.0 | ND | 105 | 80-120 | 0 | 20 | |
| Magnesium | 18.4 | 0.100 | " | 10.0 | 8.37 | 100 | 80-120 | 0.542 | 20 | |
| Potassium | 53.2 | 0.500 | " | 50.0 | 1.01 | 104 | 80-120 | 0.562 | 20 | |
| Sodium | 15.4 | 0.500 | " | 10.0 | 5.86 | 95.4 | 80-120 | 1.93 | 20 | |



*The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.*

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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: Methow Valley Irrigation<br>Project Number: 94054<br>Project Manager: Steve Nelson | **Reported:**<br>05/31/00 14:24 |

## Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E21004: Prepared 05/21/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0E21004-BLK1)** | | | | | | | | | | |
| Total Alkalinity | ND | 5.00 | mg/L as CaCO3 | | | | | | | |
| **LCS (0E21004-BS1)** | | | | | | | | | | |
| Total Alkalinity | 51.0 | 5.00 | mg/L as CaCO3 | 50.0 | | 102 | 90-110 | | | |
| **Duplicate (0E21004-DUP1)** | | | | | **Source: B0E0266-01** | | | | | |
| Total Alkalinity | 100 | 5.00 | mg/L as CaCO3 | | 101 | | | 0.995 | 6 | |
| **Batch 0E31004: Prepared 05/30/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0E31004-BLK1)** | | | | | | | | | | |
| Nitrate/Nitrite-Nitrogen | ND | 10.0 | ug/l as N | | | | | | | |
| **LCS (0E31004-BS1)** | | | | | | | | | | |
| Nitrate/Nitrite-Nitrogen | 1030 | 10.0 | ug/l as N | 1000 | | 103 | 90-110 | | | |
| **Matrix Spike (0E31004-MS1)** | | | | | **Source: B0E0354-03** | | | | | |
| Nitrate/Nitrite-Nitrogen | 538 | 10.0 | ug/l as N | 500 | ND | 107 | 71-128 | | | |
| **Matrix Spike Dup (0E31004-MSD1)** | | | | | **Source: B0E0354-03** | | | | | |
| Nitrate/Nitrite-Nitrogen | 527 | 10.0 | ug/l as N | 500 | ND | 104 | 71-128 | 2.07 | 20 | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/31/00 14:24 |

## Notes and Definitions

| | |
|---|---|
| Q-18 | The method blank contains analyte at a concentration above the MRL. This concentration is less than 5% of the sample result, which is negligible according to method criteria. |
| DET | Analyte DETECTED |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| NR | Not Reported |
| dry | Sample results reported on a dry weight basis |
| RPD | Relative Percent Difference |

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# CHAIN OF CUSTODY REPORT

**Work Order #:** B0E0266

CLIENT:

INVOICE TO:

REPORT TO: STEVE NELSON / HWA GEOSCIENCES
ADDRESS: 19730-64TH AVE. W. SUITE 200
LYNNWOOD WA 98036-5957
PHONE: 425 774 0106 FAX: 425 77 2714

P.O. NUMBER:

PROJECT NAME: METHOW VALLEY
PROJECT NUMBER: 94059
SAMPLED BY: SCOTT ZOEN

**TURNAROUND REQUEST in Business Days***

Organic & Inorganic Analyses: ~~10~~ 7 5 4 3 2 1 <1

STD. Petroleum Hydrocarbon Analyses: 5 4 3 2 1 <1

STD. OTHER Please Specify

*Turnaround Requests less than standard may incur Rush Charges.

REQUESTED ANALYSES

| | CLIENT SAMPLE IDENTIFICATION | SAMPLING DATE/TIME | Ca, Mg, K, NO3 | Alkalinity | NO3, NO2 | Fe, Mg | MATRIX (W, S, O) | # OF CONT. | COMMENTS | NCA W ID |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | PW-1-B-051500 | 5-15-00 0800 | X | X | X | X | W | 3 | | -01 |
| 2. | RW-1-051500 | 5-15-00 0830 | X | X | X | X | W | 3 | | -02 |
| 3. | | | | | | | | | | |
| 4. | | | | | | | | | | |
| 5. | | | | | | | | | | |
| 6. | | | | | | | | | | |
| 7. | | | | | | | | | | |
| 8. | | | | | | | | | | |
| 9. | | | | | | | | | | |
| 10. | | | | | | | | | | |
| 11. | | | | | | | | | | |
| 12. | | | | | | | | | | |
| 13. | | | | | | | | | | |
| 14. | | | | | | | | | | |
| 15. | | | | | | | | | | |

RELINQUISHED BY: Scott Zoen DATE: 5-16-00
PRINT NAME: SCOTT ZOEN FIRM: HWA TIME: 0900

RECEIVED BY: Cathy Nichols DATE: 5/16/
PRINT NAME: C Nichols FIRM: NCA TIME: 9:00

RELINQUISHED BY: DATE:
PRINT NAME: FIRM: TIME:

RECEIVED BY: DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS:

w/o

TEMP: 0.0

COC REV 3/99

PAGE OF

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541.383.9310 fax 541.382.7588

| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

## ANALYTICAL REPORT FOR SAMPLES

| Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| PW-2-1 | B0D0392-01 | Water | 04/19/00 13:45 | 04/21/00 08:00 |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

## Total Metals by EPA 6000/7000 Series Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-2-1 (B0D0392-01) Water Sampled: 04/19/00 13:45 Received: 04/21/00 08:00** | | | | | | | | | |
| **Calcium** | **36.0** | 0.250 | mg/l | 1 | 0E02008 | 05/02/00 | 05/03/00 | EPA 6010B | |
| Iron | ND | 0.150 | " | " | " | " | 05/04/00 | " | |
| **Potassium** | **0.949** | 0.500 | " | " | " | " | 05/04/00 | " | |
| **Magnesium** | **5.81** | 0.100 | " | " | " | " | 05/03/00 | " | |
| Manganese | ND | 0.0200 | " | " | " | " | " | " | |
| **Sodium** | **4.09** | 0.500 | " | " | " | " | 05/03/00 | " | |
| **PW-2-1 (B0D0392-01RE1) Water Sampled: 04/19/00 13:45 Received: 04/21/00 08:00** | | | | | | | | | |
| **Magnesium** | **5.05** | 0.100 | mg/l | 1 | 0E10033 | 05/10/00 | 05/11/00 | EPA 6010B | |



*The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entire.*

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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

## Conventional Chemistry Parameters by APHA/EPA Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-2-1 (B0D0392-01) Water** | **Sampled: 04/19/00 13:45** | **Received: 04/21/00 08:00** | | | | | | | |
| **Total Alkalinity** | **92.5** | 5.00 | mg/L as CaCO3 | 1 | 0E03008 | 05/03/00 | 05/03/00 | EPA 310.1 | |





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541.383.9310 fax 541.382.7588

| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

## Anions by EPA Method 300.0

## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-2-1 (B0D0392-01) Water Sampled: 04/19/00 13:45 Received: 04/21/00 08:00** | | | | | | | | | |
| **Chloride** | **0.899** | 0.200 | mg/l | 1 | 0D24008 | 04/21/00 | 04/21/00 | EPA 300.0 | |
| **Nitrate-Nitrogen** | **0.525** | 0.100 | mg/L as N | " | " | " | " | " | |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | " | " | " | " | " | |
| **Sulfate** | **10.6** | 0.200 | " | " | " | " | " | " | |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

# Total Metals by EPA 6000/7000 Series Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E02008: Prepared 05/02/00 Using EPA 3010A** | | | | | | | | | | |
| **Blank (0E02008-BLK1)** | | | | | | | | | | |
| Calcium | ND | 0.250 | mg/l | | | | | | | |
| Iron | ND | 0.150 | " | | | | | | | |
| Magnesium | ND | 0.100 | " | | | | | | | |
| Manganese | ND | 0.0200 | " | | | | | | | |
| Potassium | ND | 0.500 | " | | | | | | | |
| Sodium | ND | 0.500 | " | | | | | | | |
| **LCS (0E02008-BS1)** | | | | | | | | | | |
| Calcium | 11.1 | 0.250 | mg/l | 10.0 | | 111 | 80-120 | | | |
| Iron | 10.4 | 0.150 | " | 10.0 | | 104 | 80-120 | | | |
| Magnesium | 11.4 | 0.100 | " | 10.0 | | 114 | 80-120 | | | |
| Manganese | 11.0 | 0.0200 | " | 10.0 | | 110 | 80-120 | | | |
| Potassium | 44.4 | 0.500 | " | 50.0 | | 88.8 | 80-120 | | | |
| Sodium | 11.3 | 0.500 | " | 10.0 | | 113 | 80-120 | | | |
| **Matrix Spike (0E02008-MS1)** | | | | | **Source: B0D0483-01** | | | | | |
| Calcium | 48.7 | 0.250 | mg/l | 10.0 | 33.6 | 151 | 80-120 | | | Q-15 |
| Iron | 10.9 | 0.150 | " | 10.0 | ND | 108 | 80-120 | | | |
| Magnesium | 17.8 | 0.100 | " | 10.0 | 5.11 | 127 | 80-120 | | | Q-01 |
| Manganese | 11.4 | 0.0200 | " | 10.0 | ND | 114 | 80-120 | | | |
| Potassium | 47.2 | 0.500 | " | 50.0 | 0.916 | 92.6 | 80-120 | | | |
| Sodium | 16.0 | 0.500 | " | 10.0 | 3.71 | 123 | 80-120 | | | Q-01 |
| **Matrix Spike Dup (0E02008-MSD1)** | | | | | **Source: B0D0483-01** | | | | | |
| Calcium | 47.9 | 0.250 | mg/l | 10.0 | 33.6 | 143 | 80-120 | 1.66 | 20 | Q-15 |
| Iron | 10.3 | 0.150 | " | 10.0 | ND | 102 | 80-120 | 5.66 | 20 | |
| Magnesium | 17.1 | 0.100 | " | 10.0 | 5.11 | 120 | 80-120 | 4.01 | 20 | |
| Manganese | 11.0 | 0.0200 | " | 10.0 | ND | 110 | 80-120 | 3.57 | 20 | |
| Potassium | 45.7 | 0.500 | " | 50.0 | 0.916 | 89.6 | 80-120 | 3.23 | 20 | |
| Sodium | 15.6 | 0.500 | " | 10.0 | 3.71 | 119 | 80-120 | 2.53 | 20 | |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

## Total Metals by EPA 6000/7000 Series Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E10033: Prepared 05/10/00 Using EPA 3010A** | | | | | | | | | | |
| **Blank (0E10033-BLK1)** | | | | | | | | | | |
| Magnesium | ND | 0.100 | mg/l | | | | | | | |
| **LCS (0E10033-BS1)** | | | | | | | | | | |
| Magnesium | 10.5 | 0.100 | mg/l | 10.0 | | 105 | 80-120 | | | |
| **Matrix Spike (0E10033-MS1)** | | | | | **Source: B0D0392-01RE1** | | | | | |
| Magnesium | 15.1 | 0.100 | mg/l | 10.0 | 5.05 | 101 | 80-120 | | | |
| **Matrix Spike Dup (0E10033-MSD1)** | | | | | **Source: B0D0392-01RE1** | | | | | |
| Magnesium | 15.3 | 0.100 | mg/l | 10.0 | 5.05 | 103 | 80-120 | 1.32 | 20 | |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

## Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E03008: Prepared 05/03/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0E03008-BLK1)** | | | | | | | | | | |
| Total Alkalinity | ND | 5.00 | mg/L as CaCO3 | | | | | | | |
| **LCS (0E03008-BS1)** | | | | | | | | | | |
| Total Alkalinity | 49.5 | 5.00 | mg/L as CaCO3 | 50.0 | | 99.0 | 90-110 | | | |
| **Duplicate (0E03008-DUP1)** | | | | | **Source: B0D0483-01** | | | | | |
| Total Alkalinity | 92.5 | 5.00 | mg/L as CaCO3 | | 91.5 | | | 1.09 | 6 | |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

## Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D24008: Prepared 04/21/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0D24008-BLK1)** | | | | | | | | | | |
| Chloride | ND | 0.200 | mg/l | | | | | | | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | | | | | | |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | | | | | | | |
| Sulfate | ND | 0.200 | " | | | | | | | |
| **LCS (0D24008-BS1)** | | | | | | | | | | |
| Chloride | 1.85 | 0.200 | mg/l | 2.00 | | 92.5 | 90-110 | | | |
| Nitrate-Nitrogen | 1.06 | 0.100 | mg/L as N | 1.00 | | 106 | 90-110 | | | |
| Nitrite-Nitrogen | 0.907 | 0.100 | mg/l | 1.00 | | 90.7 | 90-110 | | | |
| Sulfate | 5.98 | 0.200 | " | 6.00 | | 99.7 | 90-110 | | | |
| **Duplicate (0D24008-DUP1)** | | | | | **Source: B0D0373-07** | | | | | |
| Chloride | 5.61 | 0.200 | mg/l | | 5.98 | | | 6.38 | 25 | |
| Nitrate-Nitrogen | 0.108 | 0.100 | mg/L as N | | 0.114 | | | 5.41 | 25 | |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | | ND | | | | 25 | |
| Sulfate | 4.13 | 0.200 | " | | 4.12 | | | 0.242 | 25 | |
| **Duplicate (0D24008-DUP2)** | | | | | **Source: B0D0403-06** | | | | | |
| Chloride | ND | 0.200 | mg/l | | ND | | | | 25 | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | ND | | | | 25 | |
| Sulfate | ND | 0.200 | mg/l | | ND | | | | 25 | |
| **Matrix Spike (0D24008-MS1)** | | | | | **Source: B0D0373-07** | | | | | |
| Chloride | 8.32 | 0.200 | mg/l | 2.00 | 5.98 | 117 | 80-120 | | | |
| Nitrate-Nitrogen | 1.20 | 0.100 | mg/L as N | 1.00 | 0.114 | 109 | 80-120 | | | |
| Nitrite-Nitrogen | 1.04 | 0.100 | mg/l | 1.00 | ND | 104 | 80-120 | | | |
| Sulfate | 10.2 | 0.200 | " | 6.00 | 4.12 | 101 | 80-120 | | | |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

## Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D24008: Prepared 04/21/00 Using General Preparation** | | | | | | | | | | |
| **Matrix Spike (0D24008-MS2)** | | | | | **Source: B0D0403-06** | | | | | |
| Chloride | 1.85 | 0.200 | mg/l | 2.00 | ND | 92.5 | 80-120 | | | |
| Nitrate-Nitrogen | 1.11 | 0.100 | mg/L as N | 1.00 | ND | 111 | 80-120 | | | |
| Sulfate | 5.93 | 0.200 | mg/l | 6.00 | ND | 98.8 | 80-120 | | | |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Steve Nelson | 05/11/00 09:47 |

## Notes and Definitions

| | |
|---|---|
| Q-01 | The spike recovery for this QC sample is outside of established control limits. Review of associated batch QC indicates the recovery for this analyte does not represent an out-of-control condition for the batch. |
| Q-15 | Analyses are not controlled on matrix spike RPD and/or percent recoveries when the sample concentration is significantly higher than the spike level. |
| DET | Analyte DETECTED |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| NR | Not Reported |
| dry | Sample results reported on a dry weight basis |
| RPD | Relative Percent Difference |

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20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711 (541) 383-9310 FAX 382-7588

# CHAIN OF CUSTODY REPORT

**Work Order #:** BOD0392

CLIENT: HWA GeoSciences
REPORT TO: Steve Nelson
ADDRESS: 19730 64th Ave W 200
PHONE: 425 774 0106 FAX: 774 2714

INVOICE TO: Same
P.O. NUMBER: 94054

PROJECT NAME:
PROJECT NUMBER:
SAMPLED BY:

TURNAROUND REQUEST in Business Days*
Organic & Inorganic Analyses: 10 STD. | 7 | 5 | 4 | 3 | 2 | 1 | <1
Petroleum Hydrocarbon Analyses: 5 STD. | 4 | 3 | 2 | 1 | <1
OTHER — Please Specify
*Turnaround Requests less than standard may incur Rush Charges.

| | CLIENT SAMPLE IDENTIFICATION | SAMPLING DATE/TIME | Fe, Mn | Ca, Mg | Na, K | Cl, $SO_4$ | $NO_3$/$NO_2$ | Alkalinity | MATRIX (W, S, O) | # OF CONT. | COMMENTS | NCA WO ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | PW-2-1 | 4-19-00/1345 | X | X | X | X | X | X | W | 4 | BOD0392-01 | |
| 2. | | | | | | | | | | | | |
| 3. | | | | | | | | | | | | |
| 4. | | | | | | | | | | | | |
| 5. | | | | | | | | | | | | |
| 6. | | | | | | | | | | | | |
| 7. | | | | | | | | | | | | |
| 8. | | | | | | | | | | | | |
| 9. | | | | | | | | | | | | |
| 10. | | | | | | | | | | | | |
| 11. | | | | | | | | | | | | |
| 12. | | | | | | | | | | | SAMPLES WERE NOT @ 2-6C UPON RECEIPT | |
| 13. | | | | | | | | | | | | |
| 14. | | | | | | | | | | | | |
| 15. | | | | | | | | | | | | |

REQUESTED ANALYSES

RELINQUISHED BY: Steve Nelson — PRINT NAME: Steve Nelson — FIRM: HWA — DATE: 4-21 — TIME: 800
RECEIVED BY: [signature] — PRINT NAME: Adam [redacted] — FIRM: [redacted] — DATE: [redacted] — TIME: [redacted]
RELINQUISHED BY: — PRINT NAME: — FIRM: — DATE: — TIME:
RECEIVED BY: — PRINT NAME: — FIRM: — DATE: — TIME:

ADDITIONAL REMARKS:

TEMP: 10.1°C

COC REV 3/99

PAGE OF

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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/10/00 14:06 |

## ANALYTICAL REPORT FOR SAMPLES

| Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| PW-2-2 | B0D0483-01 | Water | 04/25/00 15:00 | 04/27/00 11:30 |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/10/00 14:06 |

## Total Metals by EPA 6000/7000 Series Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-2-2 (B0D0483-01) Water Sampled: 04/25/00 15:00 Received: 04/27/00 11:30** | | | | | | | | | |
| **Calcium** | **33.6** | 0.250 | mg/l | 1 | 0E02008 | 05/02/00 | 05/04/00 | EPA 6010B | |
| Iron | ND | 0.150 | " | " | " | " | 05/03/00 | " | |
| **Potassium** | **0.916** | 0.500 | " | " | " | " | 05/04/00 | " | |
| Manganese | ND | 0.0200 | " | " | " | " | 05/10/00 | " | |
| **Sodium** | **3.71** | 0.500 | " | " | " | " | 05/04/00 | " | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/10/00 14:06 |

## Conventional Chemistry Parameters by APHA/EPA Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-2-2 (B0D0483-01) Water** | **Sampled: 04/25/00 15:00** | **Received: 04/27/00 11:30** | | | | | | | |
| **Total Alkalinity** | **91.5** | 5.00 | mg/L as CaCO3 | 1 | 0E03008 | 05/03/00 | 05/03/00 | EPA 310.1 | |
| **Nitrate/Nitrite-Nitrogen** | **481** | 10.0 | ug/l as N | " | 0E08012 | 05/05/00 | 05/05/00 | EPA 353.2 | |





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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: Methow Valley Irrigation<br>Project Number: 94054<br>Project Manager: Jim Bailey | **Reported:**<br>05/10/00 14:06 |

## Anions by EPA Method 300.0

## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **PW-2-2 (B0D0483-01) Water Sampled: 04/25/00 15:00 Received: 04/27/00 11:30** | | | | | | | | | |
| **Chloride** | **0.923** | 0.200 | mg/l | 1 | 0D28005 | 04/27/00 | 04/27/00 | EPA 300.0 | |
| **Sulfate** | **10.5** | 0.200 | " | " | " | " | " | " | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/10/00 14:06 |

## Total Metals by EPA 6000/7000 Series Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E02008: Prepared 05/02/00 Using EPA 3010A** | | | | | | | | | | |
| **Blank (0E02008-BLK1)** | | | | | | | | | | |
| Calcium | ND | 0.250 | mg/l | | | | | | | |
| Iron | ND | 0.150 | " | | | | | | | |
| Manganese | ND | 0.0200 | " | | | | | | | |
| Potassium | ND | 0.500 | " | | | | | | | |
| Sodium | ND | 0.500 | " | | | | | | | |
| **LCS (0E02008-BS1)** | | | | | | | | | | |
| Calcium | 11.1 | 0.250 | mg/l | 10.0 | | 111 | 80-120 | | | |
| Iron | 10.4 | 0.150 | " | 10.0 | | 104 | 80-120 | | | |
| Manganese | 11.0 | 0.0200 | " | 10.0 | | 110 | 80-120 | | | |
| Potassium | 44.4 | 0.500 | " | 50.0 | | 88.8 | 80-120 | | | |
| Sodium | 11.3 | 0.500 | " | 10.0 | | 113 | 80-120 | | | |
| **Matrix Spike (0E02008-MS1)** | | | | | **Source: B0D0483-01** | | | | | |
| Calcium | 48.7 | 0.250 | mg/l | 10.0 | 33.6 | 151 | 80-120 | | | Q-15 |
| Iron | 10.9 | 0.150 | " | 10.0 | ND | 108 | 80-120 | | | |
| Manganese | 11.4 | 0.0200 | " | 10.0 | ND | 114 | 80-120 | | | |
| Potassium | 47.2 | 0.500 | " | 50.0 | 0.916 | 92.6 | 80-120 | | | |
| Sodium | 16.0 | 0.500 | " | 10.0 | 3.71 | 123 | 80-120 | | | Q-01 |
| **Matrix Spike Dup (0E02008-MSD1)** | | | | | **Source: B0D0483-01** | | | | | |
| Calcium | 47.9 | 0.250 | mg/l | 10.0 | 33.6 | 143 | 80-120 | 1.66 | 20 | Q-15 |
| Iron | 10.3 | 0.150 | " | 10.0 | ND | 102 | 80-120 | 5.66 | 20 | |
| Manganese | 11.0 | 0.0200 | " | 10.0 | ND | 110 | 80-120 | 3.57 | 20 | |
| Potassium | 45.7 | 0.500 | " | 50.0 | 0.916 | 89.6 | 80-120 | 3.23 | 20 | |
| Sodium | 15.6 | 0.500 | " | 10.0 | 3.71 | 119 | 80-120 | 2.53 | 20 | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/10/00 14:06 |

## Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0E03008: Prepared 05/03/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0E03008-BLK1)** | | | | | | | | | | |
| Total Alkalinity | ND | 5.00 | mg/L as CaCO3 | | | | | | | |
| **LCS (0E03008-BS1)** | | | | | | | | | | |
| Total Alkalinity | 49.5 | 5.00 | mg/L as CaCO3 | 50.0 | | 99.0 | 90-110 | | | |
| **Duplicate (0E03008-DUP1)** | | | | | **Source: B0D0483-01** | | | | | |
| Total Alkalinity | 92.5 | 5.00 | mg/L as CaCO3 | | 91.5 | | | 1.09 | 6 | |
| **Batch 0E08012: Prepared 05/05/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0E08012-BLK1)** | | | | | | | | | | |
| Nitrate/Nitrite-Nitrogen | ND | 10.0 | ug/l as N | | | | | | | |
| **LCS (0E08012-BS1)** | | | | | | | | | | |
| Nitrate/Nitrite-Nitrogen | 1010 | 10.0 | ug/l as N | 1000 | | 101 | 90-110 | | | |
| **Matrix Spike (0E08012-MS1)** | | | | | **Source: B0D0475-05** | | | | | |
| Nitrate/Nitrite-Nitrogen | 1920 | 10.0 | ug/l as N | 500 | 1510 | 82.0 | 71-128 | | | |
| **Matrix Spike Dup (0E08012-MSD1)** | | | | | **Source: B0D0475-05** | | | | | |
| Nitrate/Nitrite-Nitrogen | 1900 | 10.0 | ug/l as N | 500 | 1510 | 78.0 | 71-128 | 1.05 | 20 | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/10/00 14:06 |

## Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D28005: Prepared 04/27/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0D28005-BLK1)** | | | | | | | | | | |
| Chloride | ND | 0.200 | mg/l | | | | | | | |
| Sulfate | ND | 0.200 | " | | | | | | | |
| **Blank (0D28005-BLK2)** | | | | | | | | | | |
| Chloride | ND | 0.200 | mg/l | | | | | | | |
| **LCS (0D28005-BS1)** | | | | | | | | | | |
| Chloride | 1.88 | 0.200 | mg/l | 2.00 | | 94.0 | 90-110 | | | |
| Sulfate | 5.84 | 0.200 | " | 6.00 | | 97.3 | 90-110 | | | |
| **LCS (0D28005-BS2)** | | | | | | | | | | |
| Chloride | 2.01 | 0.200 | mg/l | 2.00 | | 100 | 90-110 | | | |
| **Duplicate (0D28005-DUP1)** | | | | | **Source: B0D0441-01** | | | | | |
| Chloride | 15.4 | 1.00 | mg/l | | 14.4 | | | 6.71 | 25 | |
| **Duplicate (0D28005-DUP2)** | | | | | **Source: B0D0441-10** | | | | | |
| Chloride | 4.11 | 0.200 | mg/l | | 3.94 | | | 4.22 | 25 | |
| **Duplicate (0D28005-DUP3)** | | | | | **Source: B0D0456-10** | | | | | |
| Chloride | 6.32 | 0.200 | mg/l | | 7.15 | | | 12.3 | 25 | |
| Sulfate | 11.3 | 0.200 | " | | 11.2 | | | 0.889 | 25 | |
| **Matrix Spike (0D28005-MS1)** | | | | | **Source: B0D0441-01** | | | | | |
| Chloride | 26.6 | 1.00 | mg/l | 10.0 | 14.4 | 122 | 80-120 | | | Q-01 |
| **Matrix Spike (0D28005-MS2)** | | | | | **Source: B0D0441-10** | | | | | |
| Chloride | 6.11 | 0.200 | mg/l | 2.00 | 3.94 | 109 | 80-120 | | | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/10/00 14:06 |

## Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D28005: Prepared 04/27/00 Using General Preparation** | | | | | | | | | | |
| **Matrix Spike (0D28005-MS3)** | | | | | **Source: B0D0456-10** | | | | | |
| Chloride | 8.76 | 0.200 | mg/l | 2.00 | 7.15 | 80.5 | 80-120 | | | |
| Sulfate | 17.1 | 0.200 | " | 6.00 | 11.2 | 98.3 | 80-120 | | | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/10/00 14:06 |

## Notes and Definitions

| | |
|---|---|
| Q-01 | The spike recovery for this QC sample is outside of established control limits. Review of associated batch QC indicates the recovery for this analyte does not represent an out-of-control condition for the batch. |
| Q-15 | Analyses are not controlled on matrix spike RPD and/or percent recoveries when the sample concentration is significantly higher than the spike level. |
| DET | Analyte DETECTED |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| NR | Not Reported |
| dry | Sample results reported on a dry weight basis |
| RPD | Relative Percent Difference |





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NORTH CREEK ANALYTICAL
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# CHAIN OF CUSTODY REPORT

**Work Order #** B0D0483 94054

REPORT TO: HWA GeoSciences Inc,
ATTENTION: Jim Bailey
ADDRESS: 19730 64th Ave. West
Lynnwood, WA
PHONE: 425 774-0106 FAX: 774-2714
PROJECT NAME: Methow Valley Irrigation District
PROJECT NUMBER: 94054
SAMPLED BY: R. Dyer

INVOICE TO:
ATTENTION: Same
ADDRESS:
P.O. NUMBER: NCA QUOTE #:

TURNAROUND REQUEST in Business Days *
Organic & Inorganic Analyses: 10 Standard | 7 | 5 | 4 | 3 | 2 | 1 | Same Day
Fuels & Hydrocarbon Analyses: 5 Standard | 3-4 | 2 | 1 | Same Day
OTHER Specify:
* Turnaround Requests less than standard may incur Rush Charges.

| | CLIENT SAMPLE IDENTIFICATION | SAMPLING DATE/TIME | NCA SAMPLE ID (Laboratory Use Only) | Analysis Request: Fe, Mn, Ca, Na, K, Cl, SO4, Alkalinity, Nitrate/N, TDS | MATRIX (W, S, A, O) | # OF CONTAINERS | COMMENTS |
|---|---|---|---|---|---|---|---|
| 1. | PW-2-2 | 4/27/00 13:00 | | X X X X X | W | 3 | |
| 2. | | | | | | | |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

RELINQUISHED BY (Signature): DATE: 4-27-00
PRINT NAME: Steve Nelson FIRM: HWA TIME: 11:30

RECEIVED BY (Signature): Cathy Nichols
PRINT NAME: C. Nichols FIRM: NCA DATE: 4/27/00 TIME: 11:30

RELINQUISHED BY (Signature): DATE:
PRINT NAME: FIRM: TIME:

RECEIVED BY (Signature): DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS:

3.2°

PAGE OF

COC Rev 8, 1/00

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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

## ANALYTICAL REPORT FOR SAMPLES

| Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| 000406PW3A | B0D0154-01 | Water | 04/06/00 14:40 | 04/10/00 12:55 |





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Jeanne Thompson, Project Manager

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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

## Total Metals by EPA 6000/7000 Series Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **000406PW3A (B0D0154-01) Water** | **Sampled: 04/06/00 14:40** | | **Received: 04/10/00 12:55** | | | | | | |
| **Calcium** | **51.5** | 0.250 | mg/l | 1 | 0D13009 | 04/13/00 | 04/22/00 | EPA 6010B | |
| **Iron** | **0.639** | 0.150 | " | " | " | " | 04/23/00 | " | |
| Potassium | ND | 0.500 | " | " | " | " | 04/22/00 | " | |
| Manganese | ND | 0.0200 | " | " | " | " | 04/23/00 | " | |
| **Sodium** | **16.6** | 0.500 | " | " | " | " | 04/22/00 | " | |



*The results in this report apply to the samples analyzed in accordance with the chain custody document. This analytical report must be reproduced in its entir*

JmT

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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

## Conventional Chemistry Parameters by APHA/EPA Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **000406PW3A (B0D0154-01) Water Sampled: 04/06/00 14:40 Received: 04/10/00 12:55** | | | | | | | | | |
| **Total Alkalinity** | **183** | 5.00 | mg/L as CaCO3 | 1 | 0D17029 | 04/17/00 | 04/17/00 | EPA 310.1 | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

## Anions by EPA Method 300.0

## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **000406PW3A (B0D0154-01) Water** | **Sampled: 04/06/00 14:40** | | **Received: 04/10/00 12:55** | | | | | | |
| **Chloride** | **2.49** | 0.200 | mg/l | 1 | 0D19005 | 04/18/00 | 04/18/00 | EPA 300.0 | |
| **Nitrate-Nitrogen** | **0.870** | 0.100 | mg/L as N | " | 0D12010 | 04/11/00 | 04/11/00 | " | A-01 |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | " | " | " | " | " | A-01 |
| **Sulfate** | **18.2** | 0.200 | " | " | 0D19005 | 04/18/00 | 04/18/00 | " | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

# Total Metals by EPA 6000/7000 Series Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D13009: Prepared 04/13/00 Using EPA 3020A** | | | | | | | | | | |
| **Blank (0D13009-BLK1)** | | | | | | | | | | |
| Calcium | ND | 0.250 | mg/l | | | | | | | |
| Iron | ND | 0.150 | " | | | | | | | |
| Manganese | ND | 0.0200 | " | | | | | | | |
| Potassium | ND | 0.500 | " | | | | | | | |
| Sodium | ND | 0.500 | " | | | | | | | |
| **LCS (0D13009-BS1)** | | | | | | | | | | |
| Calcium | 11.5 | 0.250 | mg/l | 10.0 | | 115 | 80-120 | | | |
| Iron | 11.6 | 0.150 | " | 10.0 | | 116 | 80-120 | | | |
| Manganese | 11.3 | 0.0200 | " | 10.0 | | 113 | 80-120 | | | |
| Potassium | 58.8 | 0.500 | " | 50.0 | | 118 | 80-120 | | | |
| Sodium | 10.8 | 0.500 | " | 10.0 | | 108 | 80-120 | | | |
| **Matrix Spike (0D13009-MS1)** | | | | | **Source: B0D0141-01** | | | | | |
| Calcium | 14.6 | 0.250 | mg/l | 10.0 | 3.66 | 109 | 80-120 | | | |
| Iron | 10.6 | 0.150 | " | 10.0 | 0.246 | 104 | 80-120 | | | |
| Manganese | 10.6 | 0.0200 | " | 10.0 | ND | 106 | 80-120 | | | |
| Potassium | 57.0 | 0.500 | " | 50.0 | ND | 114 | 80-120 | | | |
| Sodium | 16.3 | 0.500 | " | 10.0 | 5.79 | 105 | 80-120 | | | |
| **Matrix Spike Dup (0D13009-MSD1)** | | | | | **Source: B0D0141-01** | | | | | |
| Calcium | 12.8 | 0.250 | mg/l | 10.0 | 3.66 | 91.4 | 80-120 | 13.1 | 20 | |
| Iron | 10.8 | 0.150 | " | 10.0 | 0.246 | 106 | 80-120 | 1.87 | 20 | |
| Manganese | 10.7 | 0.0200 | " | 10.0 | ND | 107 | 80-120 | 0.939 | 20 | |
| Potassium | 57.0 | 0.500 | " | 50.0 | ND | 114 | 80-120 | 0 | 20 | |
| Sodium | 16.4 | 0.500 | " | 10.0 | 5.79 | 106 | 80-120 | 0.612 | 20 | |





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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

## Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D17029: Prepared 04/17/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0D17029-BLK1)** | | | | | | | | | | |
| Total Alkalinity | ND | 5.00 | mg/L as CaCO3 | | | | | | | |
| **LCS (0D17029-BS1)** | | | | | | | | | | |
| Total Alkalinity | 48.0 | 5.00 | mg/L as CaCO3 | 50.0 | | 96.0 | 90-110 | | | |
| **Duplicate (0D17029-DUP1)** | | | | | **Source: B0D0087-07** | | | | | |
| Total Alkalinity | 129 | 5.00 | mg/L as CaCO3 | | 130 | | | 0.772 | 6 | |

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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

## Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D12010: Prepared 04/11/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0D12010-BLK1)** | | | | | | | | | | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | | | | | | |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | | | | | | | |
| **LCS (0D12010-BS1)** | | | | | | | | | | |
| Nitrate-Nitrogen | 0.967 | 0.100 | mg/L as N | 1.00 | | 96.7 | 90-110 | | | |
| Nitrite-Nitrogen | 1.00 | 0.100 | mg/l | 1.00 | | 100 | 90-110 | | | |
| **Duplicate (0D12010-DUP1)** | | | | | **Source: B0D0173-07** | | | | | |
| Nitrate-Nitrogen | 0.817 | 0.100 | mg/L as N | | 0.822 | | | 0.610 | 25 | |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | | ND | | | | 25 | |
| **Matrix Spike (0D12010-MS1)** | | | | | **Source: B0D0173-07** | | | | | |
| Nitrate-Nitrogen | 1.69 | 0.100 | mg/L as N | 1.00 | 0.822 | 86.8 | 80-120 | | | |
| Nitrite-Nitrogen | 1.04 | 0.100 | mg/l | 1.00 | ND | 104 | 80-120 | | | |
| **Batch 0D19005: Prepared 04/18/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0D19005-BLK1)** | | | | | | | | | | |
| Chloride | ND | 0.200 | mg/l | | | | | | | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | | | | | | |
| Sulfate | ND | 0.200 | mg/l | | | | | | | |
| **Blank (0D19005-BLK2)** | | | | | | | | | | |
| Chloride | ND | 0.200 | mg/l | | | | | | | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | | | | | | |
| Sulfate | ND | 0.200 | mg/l | | | | | | | |





JMT

Jeanne Thompson, Project Manager

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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

## Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D19005: Prepared 04/18/00 Using General Preparation** | | | | | | | | | | |
| **LCS (0D19005-BS1)** | | | | | | | | | | |
| Chloride | 2.00 | 0.200 | mg/l | 2.00 | | 100 | 90-110 | | | |
| Nitrate-Nitrogen | 1.05 | 0.100 | mg/L as N | 1.00 | | 105 | 90-110 | | | |
| Sulfate | 5.94 | 0.200 | mg/l | 6.00 | | 99.0 | 90-110 | | | |
| **LCS (0D19005-BS2)** | | | | | | | | | | |
| Chloride | 2.04 | 0.200 | mg/l | 2.00 | | 102 | 90-110 | | | |
| Nitrate-Nitrogen | 1.03 | 0.100 | mg/L as N | 1.00 | | 103 | 90-110 | | | |
| Sulfate | 5.98 | 0.200 | mg/l | 6.00 | | 99.7 | 90-110 | | | |
| **Duplicate (0D19005-DUP1)** | | | | | **Source: B0D0305-09** | | | | | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | ND | | | | 25 | |
| **Duplicate (0D19005-DUP2)** | | | | | **Source: B0D0259-03** | | | | | |
| Chloride | 4.77 | 0.200 | mg/l | | 5.14 | | | 7.47 | 25 | |
| Sulfate | 8.26 | 0.200 | " | | 8.30 | | | 0.483 | 25 | |
| **Duplicate (0D19005-DUP3)** | | | | | **Source: B0D0264-04** | | | | | |
| Chloride | 16.5 | 2.00 | mg/l | | 16.5 | | | 0 | 25 | |
| Sulfate | 69.8 | 2.00 | " | | 72.6 | | | 3.93 | 25 | |
| **Duplicate (0D19005-DUP4)** | | | | | **Source: B0D0311-08** | | | | | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | ND | | | | 25 | |
| **Matrix Spike (0D19005-MS1)** | | | | | **Source: B0D0305-09** | | | | | |
| Nitrate-Nitrogen | 1.04 | 0.100 | mg/L as N | 1.00 | ND | 104 | 80-120 | | | |
| **Matrix Spike (0D19005-MS2)** | | | | | **Source: B0D0259-03** | | | | | |
| Chloride | 6.85 | 0.200 | mg/l | 2.00 | 5.14 | 85.5 | 80-120 | | | |
| Sulfate | 14.1 | 0.200 | " | 6.00 | 8.30 | 96.7 | 80-120 | | | |

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| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

## Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D19005: Prepared 04/18/00 Using General Preparation** | | | | | | | | | | |
| **Matrix Spike (0D19005-MS3)** | | | | | **Source: B0D0264-04** | | | | | |
| Chloride | 38.6 | 2.00 | mg/l | 20.0 | 16.5 | 110 | 80-120 | | | |
| Sulfate | 134 | 2.00 | " | 60.0 | 72.6 | 102 | 80-120 | | | |
| **Matrix Spike (0D19005-MS4)** | | | | | **Source: B0D0311-08** | | | | | |
| Nitrate-Nitrogen | 1.04 | 0.100 | mg/L as N | 1.00 | ND | 104 | 80-120 | | | |





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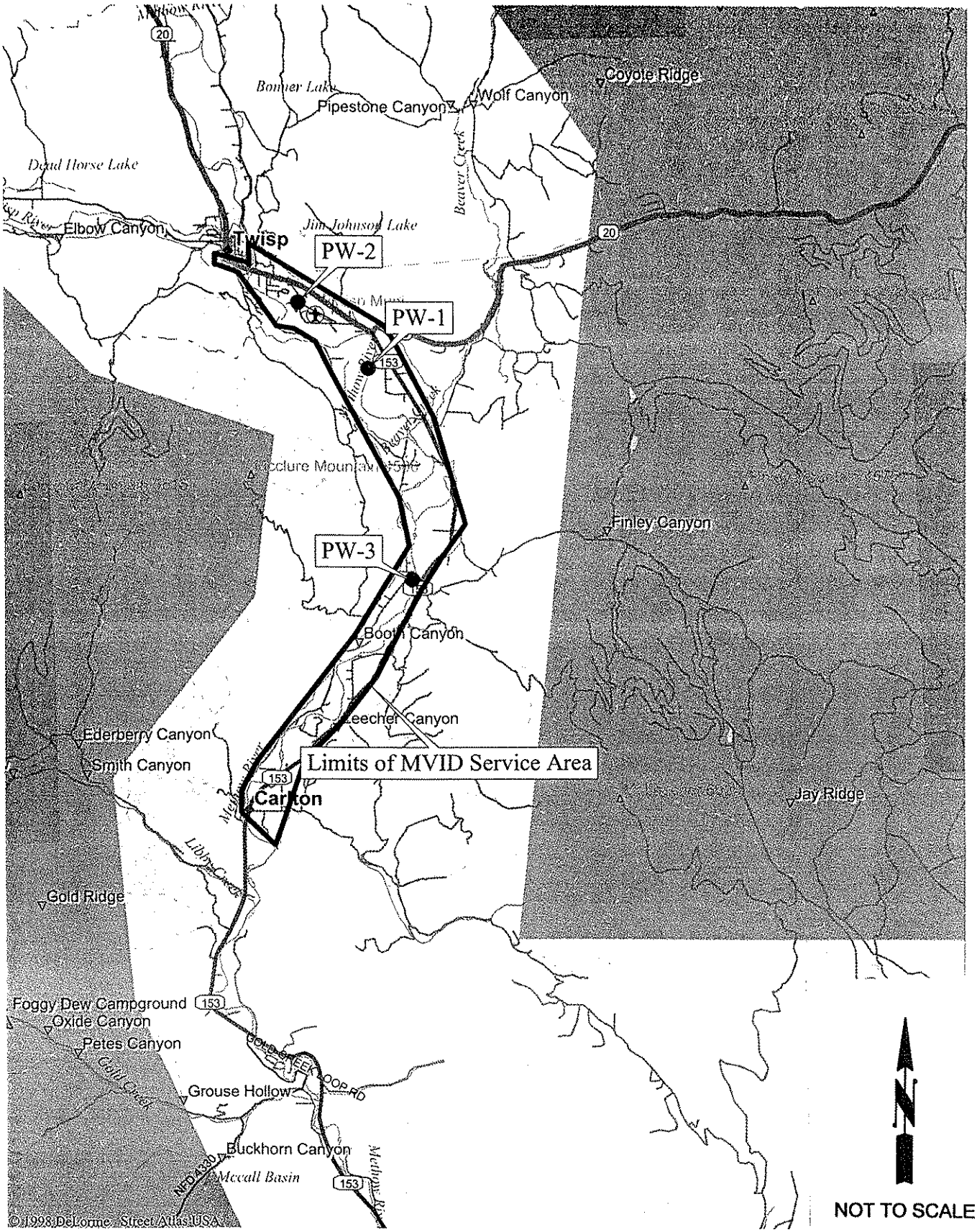
541.383.9310 fax 541.382.7588

| | | |
|---|---|---|
| Hong West | Project: Methow Valley Irrigation | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 05/01/00 15:12 |

## Notes and Definitions

| | |
|---|---|
| A-01 | This sample was received outside of the recommended hold time. |
| DET | Analyte DETECTED |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| NR | Not Reported |
| dry | Sample results reported on a dry weight basis |
| RPD | Relative Percent Difference |

# Figures



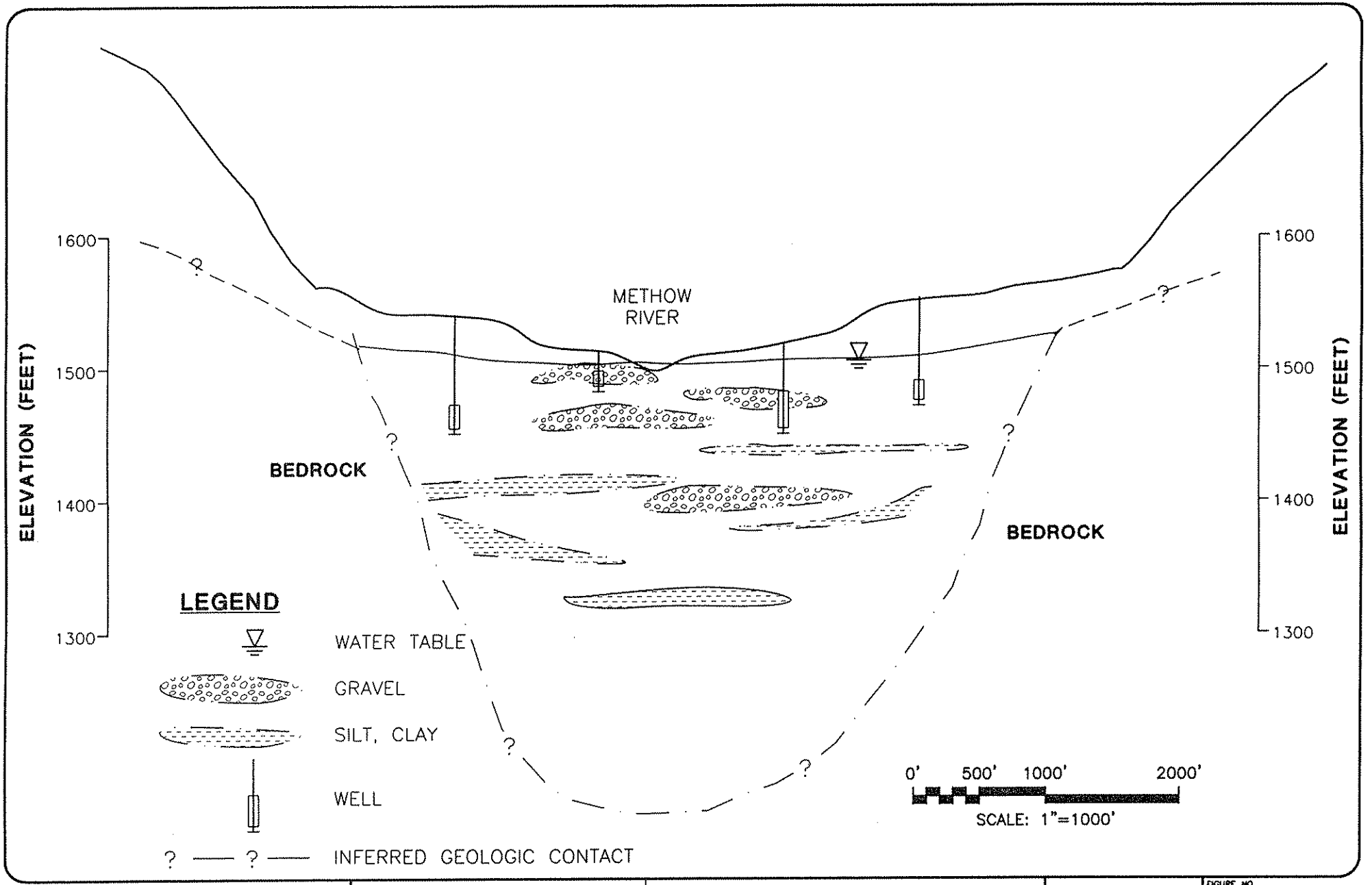

HWA GEOSCIENCES INC.

# SITE LOCATION

METHOW VALLEY IRRIGATION DISTRICT
TWISP, WASHINGTON

| | |
|---|---|
| DRAWN BY | HAC |
| CHECKED BY | SN |
| DATE | 11.20.00 |
| FIGURE NO. | 1-1 |
| PROJECT NO. | 94054 |

C:\1PROJECTS\94\94054\94054001.DWG




HWA GEOSCIENCES INC.

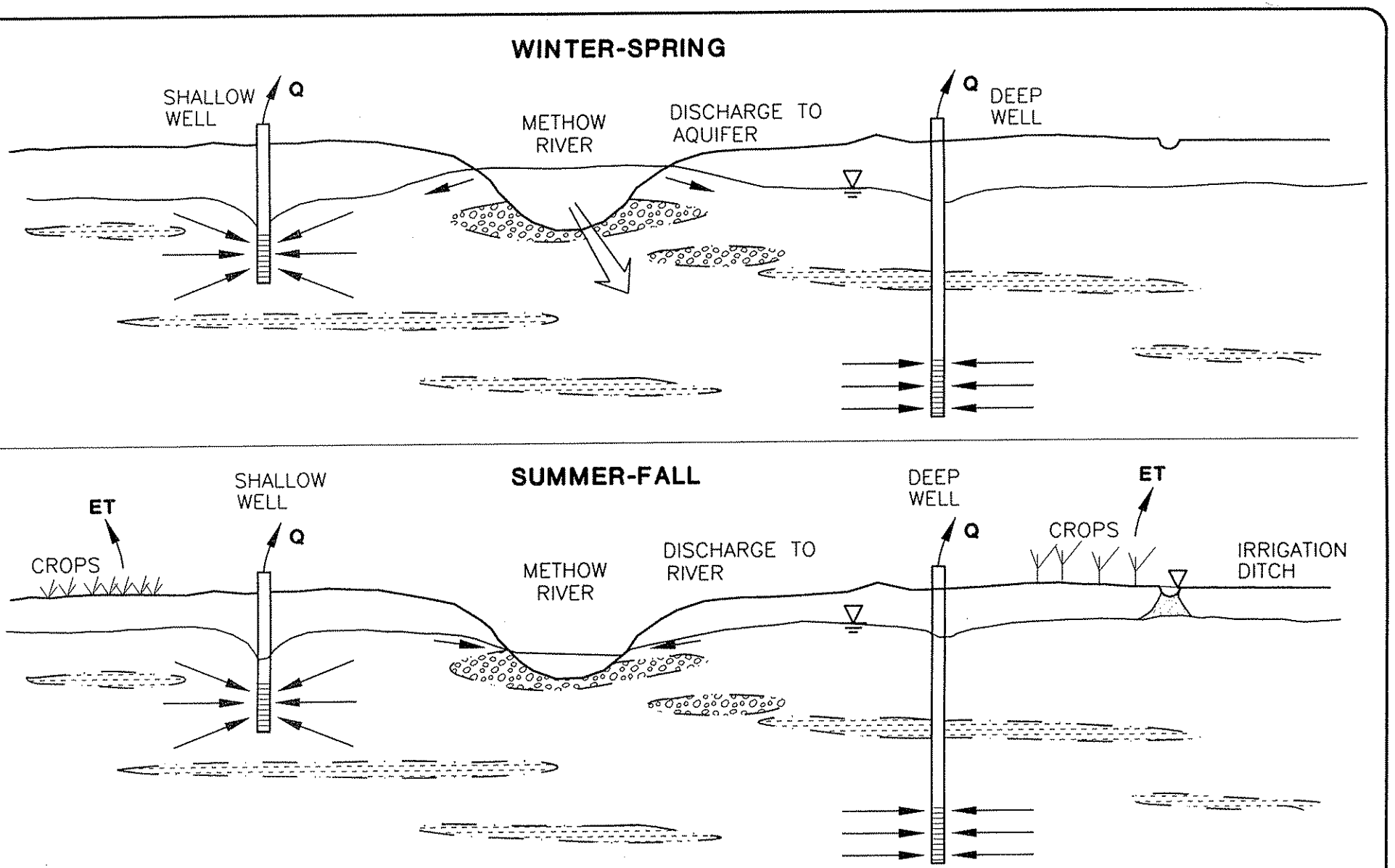
METHOW VALLEY
IRRIGATION DISTRICT
TWISP, WASHINGTON

GENERALIZED GEOLOGIC
CROSS SECTION
THROUGH ALLUVIAL AQUIFER
NEAR TWISP, WASHINGTON

DRAWN BY HAC
CHECKED BY SN
DATE 12.07.00

FIGURE NO. 2-1
PROJECT NO. 94054

C:\1PROJECTS\94\94054\94054002.DWG




HWA GEOSCIENCES INC.

METHOW VALLEY IRRIGATION DISTRICT TWISP, WASHINGTON

CONCEPTUAL MODEL OF GROUND WATER FLOW AND WATER BALANCE

| | |
|---|---|
| DRAWN BY HAC | FIGURE NO. 2-2 |
| CHECKED BY SN | |
| DATE 12.07.00 | PROJECT NO. 94054 |

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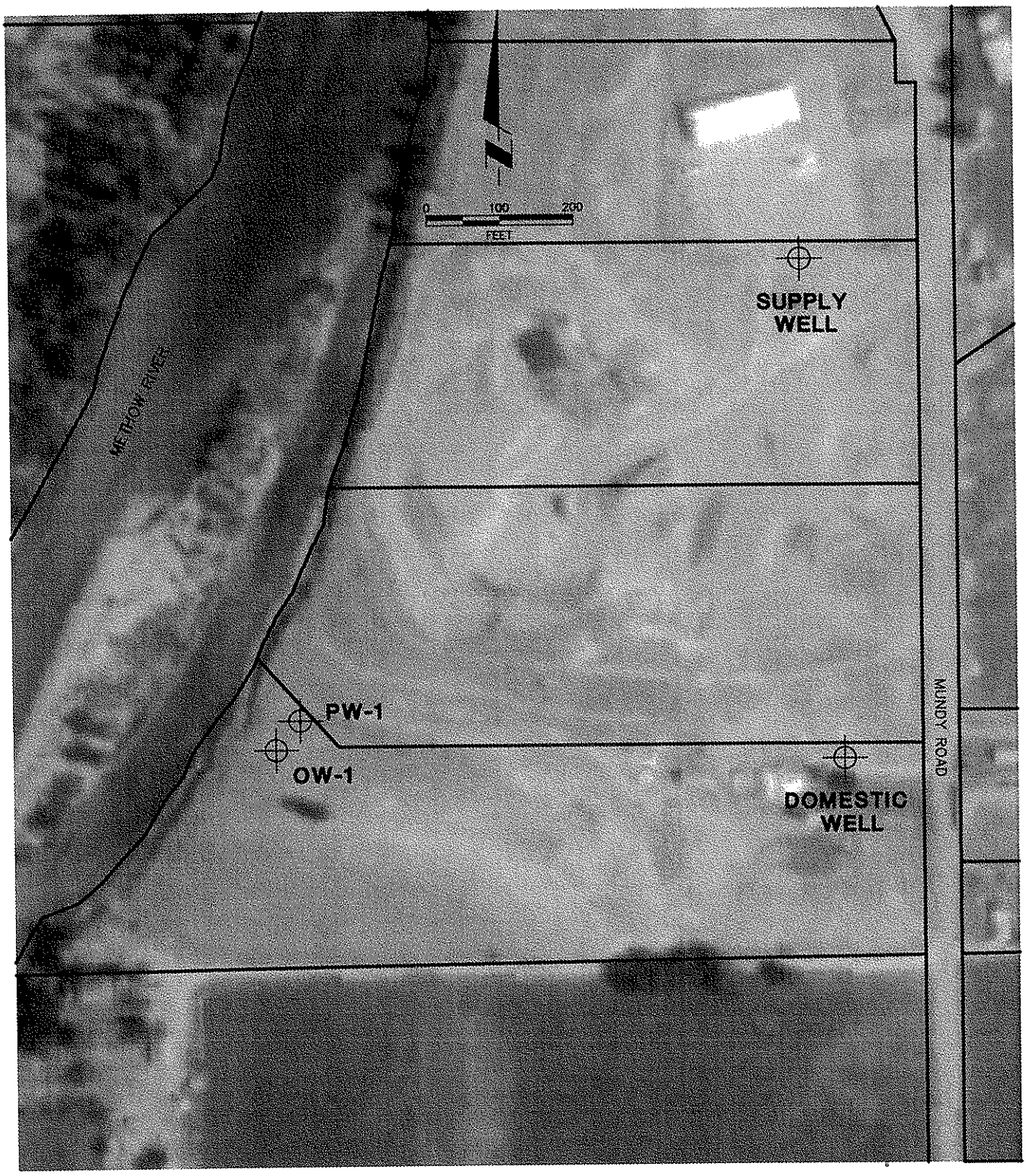


## NOTE

1. Property lines from Okanogan County GIS 1999.
2. Aerial photograph (ortho. quad.) from Okanogan County dated 1994.

REFERENCE: Base map provided by MONTGOMERY WATER GROUP, INC.

HWA GEOSCIENCES INC.

PW-1 LOCATION

METHOW VALLEY IRRIGATION DISTRICT
TWISP, WASHINGTON

| | |
|---|---|
| DRAWN BY HAC | FIGURE NO. 3-1 |
| CHECKED BY SN | |
| DATE 08.06.01 | PROJECT NO. 94054 |

C:\1PROJECTS\94\94054\94054001.DWG

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Environmental Laboratory Network
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# CHAIN OF CUSTODY REPORT

**Work Order #:** B0D0154

CLIENT: HWA Geosciences
REPORT TO: Jim Bailey
ADDRESS: 19730 64th Ave. West #200 Lynnwood, WA
PHONE: 425-774-0106 FAX: 425-774-2714

INVOICE TO:

P.O. NUMBER:

PROJECT NAME: Methow Valley Irrigation
PROJECT NUMBER: 94054
SAMPLED BY: KRK

**TURNAROUND REQUEST in Business Days***
Organic & Inorganic Analyses: 10 | 7 | 5 | 4 | 3 | 2 | 1 | <1
STD. Petroleum Hydrocarbon Analyses: 5 | 4 | 3 | 2 | 1 | <1
STD. OTHER Please Specify
*Turnaround Requests less than standard may incur Rush Charges.

| CLIENT SAMPLE IDENTIFICATION | SAMPLING DATE/TIME | REQUESTED ANALYSES: Ca, Mg, Na, K, Chlor. Sulf. | Alkalinity | Nitrate & Nitrite | MATRIX (W, S, O) | # OF CONT. | COMMENTS | NCA WO ID |
|---|---|---|---|---|---|---|---|---|
| 1. 000406PW3A | 04/06/00 - 1440 | X | X | X | W | 2 | B0D0154 - | 01 |
| 2. | | | | | | | | |
| 3. | | | | | | | | |
| 4. | | | | | | | | |
| 5. | | | | | | | | |
| 6. | | | | | | | | |
| 7. | | | | | | | | |
| 8. | | | | | | | | |
| 9. | | | | | | | | |
| 10. | | | | | | | | |
| 11. | | | | | | | | |
| 12. | | | | | | | | |
| 13. | | | | | | | | |
| 14. | | | | | | | | |
| 15. | | | | | | | | |

SAMPLES WERE NOT @ 2-6C UPON RECEIPT

RELINQUISHED BY: Kevin R. Knapp DATE: 4-7-00
PRINT NAME: Kevin R. Knapp FIRM: HWA Geosciences TIME:

RECEIVED BY: Joanne Tobey DATE: 4/10/0
PRINT NAME: JOANNE TOBEY FIRM: NCA TIME: 125

RELINQUISHED BY: DATE:
PRINT NAME: FIRM: TIME:

RECEIVED BY: DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS: Call Jim Bailey with any questions. 4.0

COC REV 3/99

TEMP: 17.0

PAGE: OF

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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Jim Bailey | **Reported:**<br>04/28/00 10:40 |

## ANALYTICAL REPORT FOR SAMPLES

| Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| 000410 PW3 River | B0D0216-01 | Water | 04/10/00 08:20 | 04/12/00 18:15 |
| 000410 PW3 B | B0D0216-02 | Water | 04/10/00 08:20 | 04/12/00 18:15 |





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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 04/28/00 10:40 |

## Total Metals by EPA 6000/7000 Series Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **000410 PW3 River (B0D0216-01) Water** | **Sampled: 04/10/00 08:20** | | **Received: 04/12/00 18:15** | | | | | | |
| **Calcium** | **20.2** | 0.250 | mg/l | 1 | 0D19007 | 04/19/00 | 04/26/00 | EPA 6010B | |
| **Potassium** | **0.664** | 0.500 | " | " | " | " | 04/26/00 | " | |
| **Manganese** | **0.00387** | 0.00100 | " | " | 0D18002 | 04/18/00 | 04/21/00 | EPA 6020 | |
| **Sodium** | **2.93** | 0.500 | " | " | 0D19007 | 04/19/00 | 04/26/00 | EPA 6010B | |
| **000410 PW3 River (B0D0216-01RE1) Water** | **Sampled: 04/10/00 08:20** | | **Received: 04/12/00 18:15** | | | | | | |
| **Iron** | **0.182** | 0.150 | mg/l | 1 | 0D19007 | 04/19/00 | 04/28/00 | EPA 6010B | |
| **000410 PW3 B (B0D0216-02) Water** | **Sampled: 04/10/00 08:20** | | **Received: 04/12/00 18:15** | | | | | | |
| **Calcium** | **49.6** | 0.250 | mg/l | 1 | 0D19007 | 04/19/00 | 04/26/00 | EPA 6010B | |
| **Potassium** | **2.83** | 0.500 | " | " | " | " | " | " | |
| Manganese | ND | 0.00100 | " | " | 0D18002 | 04/18/00 | 04/21/00 | EPA 6020 | |
| **Sodium** | **14.3** | 0.500 | " | " | 0D19007 | 04/19/00 | 04/26/00 | EPA 6010B | |
| **000410 PW3 B (B0D0216-02RE1) Water** | **Sampled: 04/10/00 08:20** | | **Received: 04/12/00 18:15** | | | | | | |
| Iron | ND | 0.150 | mg/l | 1 | 0D19007 | 04/19/00 | 04/28/00 | EPA 6010B | |





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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Jim Bailey | **Reported:**<br>04/28/00 10:40 |

## Conventional Chemistry Parameters by APHA/EPA Methods
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **000410 PW3 River (B0D0216-01) Water** | **Sampled: 04/10/00 08:20 Received: 04/12/00 18:15** | | | | | | | | |
| **Total Alkalinity** | **57.0** | 5.00 | mg/L as CaCO3 | 1 | 0D17029 | 04/17/00 | 04/17/00 | EPA 310.1 | |
| **000410 PW3 B (B0D0216-02) Water** | **Sampled: 04/10/00 08:20 Received: 04/12/00 18:15** | | | | | | | | |
| **Total Alkalinity** | **168** | 5.00 | mg/L as CaCO3 | 1 | 0D17029 | 04/17/00 | 04/17/00 | EPA 310.1 | |





JMT
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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 04/28/00 10:40 |

## Anions by EPA Method 300.0

## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **000410 PW3 River (B0D0216-01) Water** | **Sampled: 04/10/00 08:20** | | **Received: 04/12/00 18:15** | | | | | | |
| **Chloride** | **0.475** | 0.200 | mg/l | 1 | 0D24013 | 04/23/00 | 04/23/00 | EPA 300.0 | |
| **Nitrate-Nitrogen** | **0.188** | 0.100 | mg/L as N | " | 0D13026 | 04/13/00 | 04/13/00 | " | A-01 |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | " | " | " | " | " | A-01 |
| **Sulfate** | **4.64** | 0.200 | " | " | " | " | " | " | |
| **000410 PW3 B (B0D0216-02) Water** | **Sampled: 04/10/00 08:20** | | **Received: 04/12/00 18:15** | | | | | | |
| **Chloride** | **2.09** | 0.200 | mg/l | 1 | 0D24013 | 04/23/00 | 04/23/00 | EPA 300.0 | |
| **Nitrate-Nitrogen** | **0.783** | 0.100 | mg/L as N | " | 0D13026 | 04/13/00 | 04/13/00 | " | A-01 |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | " | " | " | " | " | A-01 |
| **Sulfate** | **16.0** | 0.200 | " | " | " | " | " | " | |





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541.383.9310 fax 541.382.7588

| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Jim Bailey | **Reported:**<br>04/28/00 10:40 |

# Total Metals by EPA 6000/7000 Series Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D18002: Prepared 04/18/00 Using EPA 3020A** | | | | | | | | | | |
| **Blank (0D18002-BLK1)** | | | | | | | | | | |
| Manganese | ND | 0.00100 | mg/l | | | | | | | |
| **LCS (0D18002-BS1)** | | | | | | | | | | |
| Manganese | 0.196 | 0.00100 | mg/l | 0.200 | | 98.0 | 80-120 | | | |
| **Matrix Spike (0D18002-MS1)** | | | | | Source: B0D0216-01 | | | | | |
| Manganese | 0.192 | 0.00100 | mg/l | 0.200 | 0.00387 | 94.1 | 75-125 | | | |
| **Matrix Spike Dup (0D18002-MSD1)** | | | | | Source: B0D0216-01 | | | | | |
| Manganese | 0.197 | 0.00100 | mg/l | 0.200 | 0.00387 | 96.6 | 75-125 | 2.57 | 20 | |
| **Batch 0D19007: Prepared 04/19/00 Using EPA 3010A** | | | | | | | | | | |
| **Blank (0D19007-BLK1)** | | | | | | | | | | |
| Calcium | ND | 0.250 | mg/l | | | | | | | |
| Iron | 0.368 | 0.150 | " | | | | | | | Q-18 |
| Potassium | ND | 0.500 | " | | | | | | | |
| Sodium | ND | 0.500 | " | | | | | | | |
| **Blank (0D19007-BLK2)** | | | | | | | | | | |
| Iron | ND | 0.150 | mg/l | | | | | | | |
| **LCS (0D19007-BS1)** | | | | | | | | | | |
| Calcium | 10.4 | 0.250 | mg/l | 10.0 | | 104 | 80-120 | | | |
| Iron | 11.4 | 0.150 | " | 10.0 | | 114 | 80-120 | | | |
| Potassium | 53.3 | 0.500 | " | 50.0 | | 107 | 80-120 | | | |
| Sodium | 10.1 | 0.500 | " | 10.0 | | 101 | 80-120 | | | |





Jeanne Thompson, Project Manager

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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Jim Bailey | **Reported:**<br>04/28/00 10:40 |

## Total Metals by EPA 6000/7000 Series Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D19007: Prepared 04/19/00 Using EPA 3010A** | | | | | | | | | | |
| **LCS (0D19007-BS2)** | | | | | | | | | | |
| Iron | 10.5 | 0.150 | mg/l | 10.0 | | 105 | 80-120 | | | |
| **Matrix Spike (0D19007-MS1)** | | | | | **Source: B0D0283-01** | | | | | |
| Calcium | 77.6 | 0.250 | mg/l | 10.0 | 74.2 | 34.0 | 80-120 | | | Q-15 |
| Iron | 18.3 | 0.150 | " | 10.0 | 8.14 | 102 | 80-120 | | | |
| Potassium | 59.0 | 0.500 | " | 50.0 | 8.31 | 101 | 80-120 | | | |
| Sodium | 18.5 | 0.500 | " | 10.0 | 8.72 | 97.8 | 80-120 | | | |
| **Matrix Spike (0D19007-MS2)** | | | | | **Source: B0D0216-01RE1** | | | | | |
| Iron | 10.5 | 0.150 | mg/l | 10.0 | 0.182 | 103 | 80-120 | | | |
| **Matrix Spike Dup (0D19007-MSD1)** | | | | | **Source: B0D0283-01** | | | | | |
| Calcium | 74.6 | 0.250 | mg/l | 10.0 | 74.2 | 4.00 | 80-120 | 3.94 | 20 | Q-15 |
| Iron | 18.2 | 0.150 | " | 10.0 | 8.14 | 101 | 80-120 | 0.548 | 20 | |
| Potassium | 56.9 | 0.500 | " | 50.0 | 8.31 | 97.2 | 80-120 | 3.62 | 20 | |
| Sodium | 18.7 | 0.500 | " | 10.0 | 8.72 | 99.8 | 80-120 | 1.08 | 20 | |
| **Matrix Spike Dup (0D19007-MSD2)** | | | | | **Source: B0D0216-01RE1** | | | | | |
| Iron | 10.4 | 0.150 | mg/l | 10.0 | 0.182 | 102 | 80-120 | 0.957 | 20 | |

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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Jim Bailey | **Reported:**<br>04/28/00 10:40 |

## Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D17029: Prepared 04/17/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0D17029-BLK1)** | | | | | | | | | | |
| Total Alkalinity | ND | 5.00 | mg/L as CaCO3 | | | | | | | |
| **LCS (0D17029-BS1)** | | | | | | | | | | |
| Total Alkalinity | 48.0 | 5.00 | mg/L as CaCO3 | 50.0 | | 96.0 | 90-110 | | | |
| **Duplicate (0D17029-DUP1)** | | | | | **Source: B0D0087-07** | | | | | |
| Total Alkalinity | 129 | 5.00 | mg/L as CaCO3 | | 130 | | | 0.772 | 6 | |

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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 04/28/00 10:40 |

## Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D13026: Prepared 04/13/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0D13026-BLK1)** | | | | | | | | | | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | | | | | | |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | | | | | | | |
| Sulfate | ND | 0.200 | " | | | | | | | |
| **LCS (0D13026-BS1)** | | | | | | | | | | |
| Nitrate-Nitrogen | 0.906 | 0.100 | mg/L as N | 1.00 | | 90.6 | 90-110 | | | |
| Nitrite-Nitrogen | 0.972 | 0.100 | mg/l | 1.00 | | 97.2 | 90-110 | | | |
| Sulfate | 5.74 | 0.200 | " | 6.00 | | 95.7 | 90-110 | | | |
| **Duplicate (0D13026-DUP1)** | | | | | **Source: B0D0209-06** | | | | | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | ND | | | | 25 | |
| Nitrite-Nitrogen | ND | 0.100 | mg/l | | ND | | | | 25 | |
| Sulfate | 2.33 | 0.200 | " | | 2.20 | | | 5.74 | 25 | |
| **Duplicate (0D13026-DUP2)** | | | | | **Source: B0D0226-06** | | | | | |
| Nitrate-Nitrogen | ND | 0.100 | mg/L as N | | ND | | | | 25 | |
| Sulfate | 1.53 | 0.200 | mg/l | | 1.57 | | | 2.58 | 25 | |
| **Matrix Spike (0D13026-MS1)** | | | | | **Source: B0D0209-06** | | | | | |
| Nitrate-Nitrogen | 0.981 | 0.100 | mg/L as N | 1.00 | ND | 98.1 | 80-120 | | | |
| Nitrite-Nitrogen | 0.993 | 0.100 | mg/l | 1.00 | ND | 99.3 | 80-120 | | | |
| Sulfate | 8.05 | 0.200 | " | 6.00 | 2.20 | 97.5 | 80-120 | | | |
| **Matrix Spike (0D13026-MS2)** | | | | | **Source: B0D0226-06** | | | | | |
| Nitrate-Nitrogen | 0.925 | 0.100 | mg/L as N | 1.00 | ND | 92.5 | 80-120 | | | |
| Sulfate | 7.24 | 0.200 | mg/l | 6.00 | 1.57 | 94.5 | 80-120 | | | |





JMT

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| | | |
|---|---|---|
| Hong West<br>19730 64th Ave W., Ste 200<br>Lynnwood WA, 98036 | Project: MUID<br>Project Number: 94054<br>Project Manager: Jim Bailey | **Reported:**<br>04/28/00 10:40 |

# Anions by EPA Method 300.0 - Quality Control
## North Creek Analytical - Bothell

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 0D24013: Prepared 04/23/00 Using General Preparation** | | | | | | | | | | |
| **Blank (0D24013-BLK1)** | | | | | | | | | | |
| Chloride | ND | 0.200 | mg/l | | | | | | | |
| Sulfate | ND | 0.200 | " | | | | | | | |
| **LCS (0D24013-BS1)** | | | | | | | | | | |
| Chloride | 1.95 | 0.200 | mg/l | 2.00 | | 97.5 | 90-110 | | | |
| Sulfate | 5.64 | 0.200 | " | 6.00 | | 94.0 | 90-110 | | | |
| **Duplicate (0D24013-DUP1)** | | | | | **Source: B0D0311-01** | | | | | |
| Chloride | 71.6 | 2.00 | mg/l | | 76.1 | | | 6.09 | 25 | |
| Sulfate | 61.5 | 2.00 | " | | 61.6 | | | 0.162 | 25 | |
| **Duplicate (0D24013-DUP2)** | | | | | **Source: B0D0421-07** | | | | | |
| Chloride | 25.3 | 1.00 | mg/l | | 21.4 | | | 16.7 | 25 | |
| **Matrix Spike (0D24013-MS1)** | | | | | **Source: B0D0311-01** | | | | | |
| Chloride | 98.6 | 2.00 | mg/l | 20.0 | 76.1 | 113 | 80-120 | | | |
| Sulfate | 125 | 2.00 | " | 60.0 | 61.6 | 106 | 80-120 | | | |
| **Matrix Spike (0D24013-MS2)** | | | | | **Source: B0D0421-07** | | | | | |
| Chloride | 30.9 | 1.00 | mg/l | 10.0 | 21.4 | 95.0 | 80-120 | | | |

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| | | |
|---|---|---|
| Hong West | Project: MUID | |
| 19730 64th Ave W., Ste 200 | Project Number: 94054 | **Reported:** |
| Lynnwood WA, 98036 | Project Manager: Jim Bailey | 04/28/00 10:40 |

## Notes and Definitions

| | |
|---|---|
| A-01 | This sample was received outside of the recommended hold time. |
| Q-15 | Analyses are not controlled on matrix spike RPD and/or percent recoveries when the sample concentration is significantly higher than the spike level. |
| Q-18 | The method blank contains analyte at a concentration above the MRL. This concentration is less than 5% of the sample result, which is negligible according to method criteria. |
| DET | Analyte DETECTED |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| NR | Not Reported |
| dry | Sample results reported on a dry weight basis |
| RPD | Relative Percent Difference |

NORTH CREEK ANALYTICAL
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# CHAIN OF CUSTODY REPORT

**Work Order #** B0D0216

| REPORT TO: | INVOICE TO: |
|---|---|
| ATTENTION: Jim Bailey | ATTENTION: Jim Bailey |
| ADDRESS: 19730 64th Ave West Lynnwood WA. 98036 | ADDRESS: |
| PHONE: 425-774 0106 FAX: | P.O. NUMBER: NCA QUOTE #: |
| PROJECT NAME: MUID | |
| PROJECT NUMBER: 94054 | |
| SAMPLED BY: Kevin Lauff | |

**TURNAROUND REQUEST in Business Days ***

Organic & Inorganic Analyses: 10 Standard | 7 | 5 | 4 | 3 | 2 | 1 | Same Day

Fuels & Hydrocarbon Analyses: 5 Standard | 3-4 | 2 | 1 | Same Day

OTHER Specify:

* *Turnaround Requests less than standard may incur Rush Charges.*

| | CLIENT SAMPLE IDENTIFICATION | SAMPLING DATE/TIME | NCA SAMPLE ID (Laboratory Use Only) | Analysis Request: Nitrate | Nitrite | Fe, Mn | Sulfate | Alkalinity | Calcium, K | Na, Cl | MATRIX (W, S, A, O) | # OF CONTAINERS | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 000410 PW3 River | 8:20 | | X | X | X | X | X | X | X | | 1 | B0D0216-01 |
| 2. | 000410 PW3 River | 8:20 | | X | X | X | X | X | X | X | | 1 | -01 |
| 3. | 000410 PW3 B | 8:20 | | X | X | X | X | X | X | X | | 1 | B0D0216-02 |
| 4. | 000410 PW3 B | 8:20 | | X | X | X | X | X | X | X | | 1 | -02 |
| 5. | | | | | | | | | | | | | |
| 6. | | | | | | | | | | | | | |
| 7. | | | | | | | | | | | | | |
| 8. | | | | | | | | | | | | | |
| 9. | | | | | | | | | | | | | |
| 10. | | | | | | | | | | | | | |

| | | | |
|---|---|---|---|
| RELINQUISHED BY (Signature): Jim Bailey | DATE: | RECEIVED BY (Signature): Prany Tonty | DATE: 4/12/00 |
| PRINT NAME: Jim Bailey | FIRM: TIME: 4/12/00 | PRINT NAME: PRANY TONTY | FIRM: NCA TIME: 815 |
| RELINQUISHED BY (Signature): | DATE: 4/12/00 | RECEIVED BY (Signature): | DATE: |
| PRINT NAME: | FIRM: TIME: | PRINT NAME: | FIRM: TIME: |

ADDITIONAL REMARKS:

20.1 W/O

PAGE OF

COC Rev 8, 1/00

# Appendix J

# Transmissivity Calculations

# Pumping Test Evaluation

**Project:** Methow Valley Irrigation District
**Test Site:** PW-3
**Number of observation wells** 1
**Distance from pumping well** 50 feet

**Recovery**

| | |
|---|---|
| Δs (ft) | 0.25 |
| Q(gpm) | 1023 |
| π | 3.14 |

1. Cooper-Jacob's Me

$$Q = \frac{4\pi\Delta s T}{2.3}$$

$$T = \frac{2.3Q}{4\pi\Delta s}$$

**T = 1,079,037 gallons/day/ft**
**144,202 $ft^2$/day**

**Theim Method**

**Key Assumption(s)** Aquifer is confined, wells are fully penetrating, steady state pumping
(the effect of the river is equal upon the pumping well and the observation well - both are the same distance from the river)
(the effect of partial penetration is equal upon the pumping well and the observation well - both are screened at the same depths)

1. Theim's Method

$$Q = \frac{2\pi T(s_w - s_o)}{2.3 \log (r_o/r_w)}$$

$$T = \frac{Q\ 2.3 \log (r_o/r_w)}{2\pi(s_w - s_o)}$$

| | t=500 | t = end | r |
|---|---|---|---|
| PW-2 | 14.44 | 14.62 | 1 |
| OW-2 | 2.2 | 2.366 | 50 |
| Ann's | 0.217 | 0.3 | 500 |
| Dee Dee | 0.126 | 0.266 | 550 |

| T = | gallons/day/ft | $ft^2$/day | |
|---|---|---|---|
| PW2 - O | 74,888 | 10,012 | |
| PW2 - An | 102,380 | 13,687 | |
| PW2 - DD | 103,289 | 13,809 | |
| OW-2 - An | 272,072 | 36,373 | 35,133 |
| OW-2 - D | 270,902 | 36,217 | |
| Ann - DD | 245,408 | 32,809 | |

# Pumping Test Evaluation

**Project:** Methow Valley Irrigation District
**Test Site:** PW-1
**Number of observation wells** 1
**Distance from pumping well** 50 feet

**Constant-Rate** **Cooper-Jacob Method**

**Key Assumption(s):**
Aquifer is confined, wells are fully penetrating, steady state pumping
(the effect of regional water levels is equal upon the pumping well and the observation well)
(the effect of partial penetration is equal upon the pumping well and the observation well - both are screened at the same depths)

**Drawdown**

| | |
|---|---|
| Δs (ft) | 0.63 |
| Q(gpm) | 1214 |
| π | 3.14 |

1. Cooper-Jacob's Metho

$$Q = \frac{4\pi\Delta s T}{2.3}$$

$$T = \frac{2.3Q}{4\pi\Delta s}$$

| u | r | S | t min | t day |
|---|---|---|---|---|
| 0.0001 | 50 | 0.0005 | 100 | 0.07 |

**T = 508,135 gallons/day/ft**
**67,907 $ft^2$/day**

**Recovery** **Cooper-Jacob Method**

**Key Assumption(s):** same as above

| | |
|---|---|
| Δs (ft) | 0.73 |
| Q(gpm) | 1214 |
| π | 3.14 |

1. Cooper-Jacob's Metho

$$Q = \frac{4\pi\Delta s T}{2.3}$$

$$T = \frac{2.3Q}{4\pi\Delta s}$$

| u | r | S | t min | t day |
|---|---|---|---|---|
| 0.0001 | 50 | 0.0005 | 100 | 0.07 |

**T = 438,527 gallons/day/ft**
**58,604 $ft^2$/day**

**Dietz's Method**

$Sm = (Q/2(pi)T)*G(x,y)$

Where:
Sm = Maximum drawdown in observation well (feet)
Q = Pumping rate (gpd)
π = 3.14
T = Transmissivity (ft2/day)
$G(x,y)$ = Greens Function = $\frac{1}{2} \ln [[(X_o+X_w)^2 + (Y_o-Y_w)^2] / [(X_o-X_w)^2 + (Y_o-Y_w)^2]]$
$X_o$ = X-coordinate of observation well OW-1
$Y_o$ = Y-coordinate of observation well OW-1
$X_w$ = X-coordinate of pumping well PW-1
$Y_w$ = Y-coordinate of pumping well PW-1

**Key Assumption(s):** Aquifer is crossed by one straight, fully penetrating recharge boundary with a constant head

| Parameter | Value |
|---|---|
| Observation Well | OW-1 |
| $s_m$ (ft) | 6 |
| Q(gpm) | 1214 |
| π | 3.14 |
| $X_o$(ft) | 130 |
| $X_w$(ft) | 130 |
| $Y_o$(ft) | 50 |
| $Y_w$(ft) | 0 |

**Formula Calculation**

1. Greens Function = G (x,y) =

$$\frac{\frac{1}{2} \ln [(X_o+X_w)^2 + (Y_o-Y_w)^2]}{[(X_o-X_w)^2 + (Y_o-Y_w)^2]}$$

$$\frac{\frac{1}{2} \ln 70100}{2500}$$

$$\frac{1}{2} \ln 28.04$$

Answer = G (x,y) = **1.67**

2. Dietz's Method $s_m = \frac{Q\ G\ (x,y)}{2\pi T}$

$T = \frac{Q\ G\ (x,y)}{2\pi s_m}$

Answer =

**T = 77,332 gallons/day/ft**
**10,335 $ft^2$/day**

**Hantush's Method**

**Key Assumption(s):** Aquifer is crossed by one straight, partially penetrating recharge boundary with a constant head

| | |
|---|---|
| $s_m$ (ft) | 6 |
| $\Delta s_p$ (ft) | 2.15 |
| Q(gpm) | 1214 |
| $\pi$ | 3.14 |

1. Hantush's Method $f(r_r) = \frac{s_m}{\Delta s_p}$

$f(r_r) = 2.79$

from Annex 6.4 $r_r = 23.8$

$s_m = \frac{Q \ln r_r}{2\pi T}$

$T = \frac{Q \ln r_r}{2\pi s_m}$

**T = 147,057 gallons/day/ft**
**19,653 $ft^2$/day**

**Theim Method**

**Key Assumption(s):** Aquifer is confined, wells are fully penetrating, steady state pumping
(the effect of the river is equal upon the pumping well and the observation well - both are the same distance from the river)
(the effect of partial penetration is equal upon the pumping well and the observation well - both are screened at the same depths)

| | adjusted for R | unadjusted |
|---|---|---|
| $s_o$ (ft) | 6.00 | |
| $s_w$ (ft) | 17.3 | |
| $r_o$ (ft) | 50 | |
| $r_w$ (ft) | 0.5 | |
| Q(gpm) | 1214 | |
| $\pi$ | 3.14 | |

1. Theim's Method $Q = \frac{2\pi T(s_w - s_o)}{2.3 \log (r_o/r_w)}$

$T = \frac{Q\ 2.3 \log (r_o/r_w)}{2\pi(s_w - s_o)}$

**T = 113,319 gallons/day/ft**
**15,150 $ft^2$/day**

# Pumping Test Evaluation

**Project:** **Methow Valley Irrigation District**
**Test Site:** **PW-2 (Airport Property)**
**Number of observation wells**

| | OW-2 | Ann's | Dee Dee | Airport | South |
|---|---|---|---|---|---|
| (ft) | 50 | 500 | 550 | 1100 | 1100 |

time = 2500 min

**Jacob's Method:** (Distance-Drawdown)

$$T = \frac{2.3Q}{2\pi\Delta s}$$

Where:
s = Maximum drawdown in observation well (feet)
Q = Pumping rate (gpd)
π = 3.14
T = Transmissivity (ft2/day or gpd/ft)

**Key Assumption(s)** Aquifer is confined, wells are fully penetrating, steady state pumping
(the effect of partial penetration is equal upon the pumping well and the observation well - both are screened at the same depths)

| **Parameter** | | | | **Formula Calculation** |
|---|---|---|---|---|
| Q(gpm) | 821 | | | $T = \frac{2.3Q}{2\pi\Delta s}$ |
| π | 3.14 | | | |
| Observation Well | r (ft) | s at 2500 min | no correction | |
| OW-2 | 50 | 2.311 | required for | |
| Ann's | 500 | 0.278 | regional aquifer | $T = \frac{2719152}{12.246}$ |
| Dee Dee | 550 | 0.30 | level change; all wells | |
| Airport | 1100 | | respond equally | **T = 222,044 gpd/ft** |
| South | 1100 | | | **29,685 $ft^2$/d** |

Δs = (ft) 1.95 (from graph "dist-dwdn")

| u | r | S | T | t | t |
|---|---|---|---|---|---|
| 0.0002 | 50 | 0.0005 | 29,685 | 100 | 0.07 |

No correction was made for regional aquifer level change; all wells responded equally

**Constant-Rate** **Cooper-Jacob Method**

**Key Assumption(s)** Aquifer is confined, wells are fully penetrating, steady state pumping
(the effect of regional water levels is equal upon the pumping well and the observation well)
(the effect of partial penetration is equal upon the pumping well and the observation well - both are screened at the same depths)

**Drawdown**

| | | | |
|---|---|---|---|
| Δs (ft) | 0.86 | 1. Cooper-Jacob's Me | $Q = \frac{4\pi\Delta sT}{2.3}$ |
| Q(gpm) | 821 | | |
| π | 3.14 | | $T = \frac{2.3Q}{4\pi\Delta s}$ |

| u | r | S | t min | t day |
|---|---|---|---|---|
| 0.0134 | 50 | 0.05 | 100 | 0.07 |

**T = 251,736 gallons/day/ft**
**33,655 $ft^2$/day**

**Recovery**

| | | | |
|---|---|---|---|
| Δs (ft) | 0.55 | 1. Cooper-Jacob's Me | $Q = \frac{4\pi\Delta sT}{2.3}$ |
| Q(gpm) | 821 | | |
| π | 3.14 | | $T = \frac{2.3Q}{4\pi\Delta s}$ |

**T = 393,624 gallons/day/ft**
**52,623 $ft^2$/day**

# Pumping Test Evaluation

**Project:** Methow Valley Irrigation District
**Test Site:** PW-3
**Number of observation wells** 1
**Distance from pumping well** 50 feet

Recovery

| | |
|---|---|
| Δs (ft) | 0.25 |
| Q(gpm) | 1023 |
| π | 3.14 |

1. Cooper-Jacob's Me

$$Q = \frac{4\pi\Delta s T}{2.3}$$

$$T = \frac{2.3Q}{4\pi\Delta s}$$

**T = 1,079,037 gallons/day/ft**
**144,202 $ft^2$/day**

**Theim Method**

Key Assumption(s) Aquifer is confined, wells are fully penetrating, steady state pumping
(the effect of the river is equal upon the pumping well and the observation well - both are the same distance from the river)
(the effect of partial penetration is equal upon the pumping well and the observation well - both are screened at the same depths)

1. Theim's Method

$$Q = \frac{2\pi T(s_w - s_o)}{2.3 \log (r_o/r_w)}$$

$$T = \frac{Q\ 2.3 \log (r_o/r_w)}{2\pi(s_w - s_o)}$$

| | t=500 | t = end | r |
|---|---|---|---|
| PW-2 | 14.44 | 14.62 | 1 |
| OW-2 | 2.2 | 2.366 | 50 |
| Ann's | 0.217 | 0.3 | 500 |
| Dee Dee | 0.126 | 0.266 | 550 |

| T = | gallons/day/ft | $ft^2$/day | |
|---|---|---|---|
| PW2 - O | 74,888 | 10,012 | |
| PW2 - An | 102,380 | 13,687 | |
| PW2 - DD | 103,289 | 13,809 | |
| OW-2 - An | 272,072 | 36,373 | 35,133 |
| OW-2 - D | 270,902 | 36,217 | |
| Ann - DD | 245,408 | 32,809 | |