RAPID INFILTRATION BASIN EVALUATION REPORT
COLD SPRING VALLEY WASTE WATER TREATMENT FACILITY
WASHOE COUNTY, NEVADA

DRAFT

Prepared for:

Kennedy/Jenks Consultants
5190 Neil Road, Suite 210
Reno, NV 89502

Prepared by:

BROADBENT & ASSOCIATES, INC.
2000 Kirman Avenue
Reno, Nevada 89502
(775) 322-7969

July, 2003

Project No. 03-02-116

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL

July 25, 2003

Project No. 03-02-116

Kennedy/Jenks Consultants
5190 Neil Road, Suite 210
Reno, NV 89502

Attn: Mrs. Lynn Orphan, P.E.

RE: Rapid Infiltration Basin (RIB) Evaluation Report, Cold Spring Valley Waste Water Treatment Facility, Washoe County, NV.

Dear Mrs. Orphan:

Broadbent & Associates, Inc. (BAI) is pleased to present this *Rapid Infiltration Basin (RIB) Evaluation Report* for the Cold Spring Valley Waste Water Treatment Facility located in northern Cold Spring Valley, Washoe County, NV. BAI conducted activities documented herein as a sub-consultant to Kennedy/Jenks Consultants (K/J), while K/J is contracting directly with the Washoe County Department of Water Resources (DWR). Conducted activities included three basic tasks: 1) Evaluation of the existing RIBs; 2) Evaluation and siting of potential new RIB locations; and 3) preparation of the enclosed report. Details of conducted activities, results, and conclusions are provided within the report.

Should you have questions or require additional information, please do not hesitate to contact us.

Sincerely,
BROADBENT & ASSOCIATES, INC.

Lee W. Williams,
Senior Staff Geologist

DRAFT

Douglas G. Guerrant, R.G., C.HG., C.E.M.
Principal Hydrogeologist

Enclosure: *Rapid Infiltration Basin Evaluation Report, Cold Spring Valley Waste Water Treatment Facility, Washoe County, Nevada*

TABLE OF CONTENTS

TABLES

DRAWINGS

FIGURES

APPENDICES

1.0 INTRODUCTION/PURPOSE

Based upon on-going residential growth in the north Cold Spring Valley area, the existing Cold Spring Valley Waste Water Treatment Facility (CSWWTF) will need to be expanded to accommodate the increased loading associated with continued growth. The current facility has six rapid infiltration basins (RIBs) that are utilized to infiltrate treated waster water effluent. Furthermore, it has been reported that the existing RIBs are not performing as originally anticipated, in that they are not capable of transmitting/infiltrating at the design capacity. Given this information, it is likely that additional RIBs will be needed and that additional locations may be required to better accommodate future anticipated flows.

The purpose of this investigation was to evaluate the existing RIBs and then re-rate their infiltration capacities, to evaluate and test additional areas as potential new RIB locations for Treatment Facility expansion, and to incorporate the new infiltration and flow information into the existing ground-water flow and solute transport model for this area to determine if there will be any significant impacts to the long term water resources of northern Cold Spring Valley.

2.0 EXISTING RIB EVALUATION ACTIVITIES

2.1 CURRENT TREATMENT FACILITY OPERATIONS

As indicated above, the CSWWTF, in its current state, consists of six RIBs. In general, only one RIB receives discharge at any given time. Since the facility was opened in late-1997, discharge flows have increased from approximately 10,000 gallons per day (gpd) to approximately 120,000 gpd.

Drawing 1 (a geologic map of the area discussed below) depicts the current plant configuration. The RIBs are numbered 1 – 6. The rotation pattern for use of the RIBs is as follows: #1, #4, #5, #2, #3, and then #6. Personnel from SPB utilities (the CSWWTF operation and maintenance contractor) have indicated that RIBs #1 and #2 perform poorly, while RIBs #5 and #6 perform the best. Furthermore, they have indicated that RIBs #1 and #2 take about one week to load and about one month to dry up, while RIBs #5 and #6 take about one month to load and about one week to dry up. RIBs #3 and #4 perform somewhere in between.

Unfortunately, specific flow data is readily not available on a per RIB basis. However, SPB Utilities was able to provide a schedule of time periods when each RIB was being loaded for the period of July, 1999 – June, 2003. Table 1 provides a tabulation of estimated flows and resulting estimated infiltration rates per RIB for the last two loading events for each RIB (covering the period of September, 2002 through June, 2003). Review of Table 2 indicates that average infiltration rates range from 0.022 inches/hour (~17,700 gpd) to 0.031 inches/hour (~28,000 gpd) for RIBs #1 and #2, respectively. Average infiltration rates for RIBs #3 and #4 are 0.082 inches/hour (~71,300 gpd) and 0.072 inches/hour (~75,000 gpd), respectively. Average infiltration rates for RIBs #5 and #6 were 0.101 inches/hour (~87,000 gpd) and 0.107 inches/hour (~91,600 gpd), respectively.

Review of the Dewante and Stowell 1991 report entitled *Proposed Wastewater Facilities, Cold Spring Valley* (Dewante and Stowell, 1991) indicates that the design loading rate for the existing RIBs was approximately 40,000 gpd/acre, or 0.06 inches/hr. This design rate was derived from double ring infiltrometer test results for tests conducted by Pezonella Associates, Inc. in 1991 in the area of the CSWWTP (Pezonella, 1991). The design rate was derived by taking 4.5% of the actual double ring test results, as suggested in the US EPA process design manual entitled *Land Treatment of Municipal Wastewater* (October, 1981).

As a means of evaluating actual performance rates versus the design rate, Table 1 was complied. Review of Table 1 indicates that there is a range in the level of actual RIB performance of 36% to 157% relative to the design rate, with RIB #1 being the worst performer and RIB #6 being the best.

2.2 DOUBLE RING INFILTROMETER TESTING ACTIVITIES

BAI personnel conducted an investigation of the existing RIBs to evaluate their current performance on June 25 and 26, 2003. Two double ring infiltrometer tests were conducted in both RIB #2 and RIB #6: one at the current RIB surface and one at a depth of approximately 4.0 – 5.0 below the current surface. Each test area was set up with a four-foot diameter outer ring and a two-foot diameter inner ring. The outer rings for the at-depth tests were constructed by excavating an approximate four-foot diameter pit to the test depth. Excavated materials were used to construct berms to act as outer rings for the surface tests. A two-foot diameter steel inner ring was driven approximately two inches into the test surface. Yardsticks were driven into the surface within the inner rings in order to facilitate water level measurements within the inner rings.

Lithology encountered during construction of the rings in RIBs #2 and #6 generally consisted of a brown silty sand of medium density. However, in RIB #2 the upper 1.5 feet consisted of a dark brown dense silt-clay mix with a trace of sand. A one-inch thick lens of red clayey silt with a trace of sand was also observed at a depth of 2.75 feet in RIB #2. The silt-clay mix observed in RIB #2 exhibited desiccation cracks that were expressed at the surface. The surface of RIBs #1, #2 and #3 exhibited similar desiccation cracks and silt-clay mix. RIBs #4 and #5 were covered with water as well as aquatic plants, and therefore, could not be observed. The surface of RIB #6 consisted of the brown silty sand encountered during ring construction, however, the desiccation cracking but was not as pronounced as the cracks in the silt-clay mix found in RIB #2.

Once each ring was constructed, it was pre-soaked and then a six-hour infiltration test was conducted for each area. Water used for the test was effluent pumped from the CSWWTF. Water levels between the inner and outer ring were kept similar by adding water to the outer ring when necessary. Water was maintained in both rings for the duration of each test. Collected infiltration data for these tests is provided in Table 1. Additionally, the field data sheets for these tests are provided in Appendix A.

Results from the double ring infiltrometer tests discussed above were compared with actual operation flow data provided by SPB Utilities, as presented in Table 1. Review of Table 1 indicates that the estimated operational infiltration rate for the current surface of RIB #2 is 42% of the rate estimated by the double ring infiltrometer test (0.03"/hr ÷ 0.07"/hr). The estimated operational infiltration rate for RIB #2 at a depth of 4.5 feet below the current surface is only 0.4% of the rate estimated by the double ring infiltrometer test (.03"/hr ÷ 7.15"/hr), meaning the at depth double ring test rate is much greater than the current operational rate at the surface. Therefore, it seems clear that the infiltration rate for RIB #2 (and likely RIB #1) could be significantly enhanced by excavating the top 2.0 – 3.0 feet of this RIB to remove the fine textured materials (to a depth below the thin red clay lens, where present) and to expose the underlying more course textured sands.

Review of Table 1 relative to RIB #6 indicates that the estimated operational infiltration rate for the current surface of RIB #6 is 11% of the rate estimated by the double ring infiltrometer test, while the estimated operational infiltration rate for RIB #6 at a depth of 4.0 feet below the current surface is 19.0% of the rate estimated by the double ring infiltrometer test. Accordingly, there does not appear to be a significant difference between the two tests conducted on RIB #6.

2.3 DISCUSSION

Based upon the above information, it appears that, in general, the existing RIBs are performing at rates similar to the design rates of 40,000 gpd (0.06"/hr), but that RIBs #1 and #2 rates could be significantly increased by removing the top 2.0 – 3.0 of overburden to expose some underlying coarser materials. Re-rated information for each RIB, based upon actual operation data, is provided in Table 1, both in gallons per day (gpd) and gpd/acre, and as listed below:

Basin	Gpd/acre	acres	gpd
RIB #1	14,500	1.22	17,690
RIB #2	20,138	1.40	28,193
RIB #3	53,665	1.33	71,374
RIB #4	47,090	1.58	74,402
RIB #5	66,097	1.33	87,909
RIB #6	62,935	1.45	91,256

As indicated above, if the top 2.0 - 3.0 feet of overburden were removed from RIB #1 and #2, infiltration rates would likely significantly increase. Infiltration test results suggest that an infiltration rate of approximately 7.0 inches/hr might be possible. However, the long term rate would likely be significantly less, as suggested in the previously mentioned US EPA document that indicates that 4.5% of test results should be utilized as a design rate. However, that suggested rate is based upon a short term (30 minute test) utilizing clean water for the test. In this case, a six-hour test was conducted utilizing actual effluent water. Accordingly, a higher percentage would be reasonable to assume (i.e., 10%). If 10% of the infiltration test rate were assumed to be reasonable in this case, then one might expect an infiltration rate of approximately

0.7"/hr (10% of 7.0 inches/hr) to be experienced in RIB #1 and #2, if the overburden were removed. To be even more conservative, a 4.5% rate could be utilized, which would result in an estimated rate of 0.315 inches/hr.

3.0 NEW RIB LOCATIONS

3.1 PURPOSE

Based upon current information and planned growth for the area, it appears that the existing RIBs will not be capable of accommodating future anticipated flows. Given this information, it is likely that additional RIBs will be needed and that a different location will be required to better accommodate future anticipated flows. The purpose of this portion of the investigation documented herein is to locate potential new sites for additional RIBs. To do so, existing lithologic information for the area was reviewed and additional drilling and lithologic logging was conducted, the details of which are discussed below.

3.2 SUBSURFACE LITHOLOGY

There have been several investigations conducted in this area of Cold Spring Valley over the years, with some drilling and some test pit excavations. These investigations include Van Denburgh, 1981 and Pezonella, 1991. Both of these reports were reviewed prior to BAI selecting possible drilling locations for additional drilling and lithologic logging.

Drawing 1 is a geologic map of northern Cold Spring Valley (adapted from Van Denburgh, 1981), specifically depicting the area around and north of the CSWWTF. Review of Drawing 1 indicates that there exists a surface expression of a rather large beach and delta deposit (as described by Van Denburgh, 1981) located in the middle of the extreme northern portion of the valley in an arched shaped pattern to the north and east of the CSWWTF. The presence of this coarse grained (sand) deposit was confirmed by review of lithologic logs provided in the Pezonella, 1991 report and upon field inspection. Furthermore, this sand deposit is believed to exist throughout the northern portion of the valley at varying depths, depending upon your location. To further investigate this sand body as well as lithology in general in this area, three new borings were drilled by Broadbent & Associates, Inc. (BAI), as documented below.

Drawing 1 depicts several boring locations identified as PB- and BB-. The PB- locations were drilled and logged by Pezonella in 1991 and the BB- locations were drilled and logged by Broadbent & Associates, Inc. in 2003. The PMW-1 location is a monitor well location drilled, logged, and constructed by Pezonella in 1991.

The above mentioned Pezonella borings were drilled with a truck mounted hollow stem auger drill rig with split spoon sampling equipment. Samples were collected on a five-foot interval. The BAI borings were also drilled with a hollow stem auger rig but sampling was conducted via the continuous core Moss sampling system which facilitated more accurate description of subsurface lithologic conditions, relative to the split spoon sampling technique.

Lithologic boring logs for both the Pezonella, 1991 work and the BAI 2003 work were utilized to build two geologic cross-sections (A-A' and B-B') provided herein as Figures 1 and 2 (see Drawing 1 or cross-section transects). Copies of the utilized boring logs utilized are provided in Appendix B. In both cases, the lithology was logged utilizing the universal soil classification system.

Review of these two cross-sections indicates that for the area investigated, in general, the sand deposit is present from land surface to a depth ranging from approximately 20 feet below land surface (bls) to the total depth investigated (55 feet bls). This sand is underlain by a clay unit with variable thickness. Depths and thicknesses of each unit vary depending upon your location, and the clay layer is not found to be laterally continuous. Additionally, there was clay material present at the surface in the area of BB3, which is located out in the flood plain area in the extreme northern portion of the valley. Ground water was only encountered in BB3 at a depth of approximately 39 feet bls.

The presence of the sand deposit appears to offer a good opportunity for placement of additional RIBs. This sand appears to be relatively clean with some silts and some gravels. While there is underlying clay present, it does not appear to be laterally continuous such that infiltrated water should be able to work its way vertically downward, over time, and not remain perched above the clay.

3.3 DOUBLE RING INFILTROMETER TESTING

To further investigate the potential for new RIB locations discussed above, BAI personnel conducted three double ring infiltrometer tests (BR-1, BR-2, and BR-3), one each at the three BAI drilling locations (BB1, BB2, and BB3, respectively) discussed above. Testing activities were conducted on July 16 and 17, 2003. Each test was conducted at a depth of approximately 5.0 – 6.0 feet bls. Each test area was set up with a four-foot diameter outer ring and a two-foot diameter inner ring. The outer ring for the at-depth tests were constructed by excavating an approximate four-foot diameter pit to the test depth. Lithology encountered during the excavation of the outer ring was consistent with the soil boring lithology discussed above. A two-foot diameter steel inner ring was driven approximately two inches into the test surface. Yardsticks were driven into the surface within the inner rings in order to facilitate water level measurements within the inner rings.

Subsequent to construction, each ring was pre-soaked and then a six-hour test was conducted for each area. Clean water was used for these tests which was provided by the Lifestyle Homes construction crew (via the Utilities, Inc. water supply well known as the Sweger Well). Water levels between the inner and outer ring were kept similar by adding water to the outer ring when necessary. Water was maintained in both rings for the duration of each test. Collected infiltration data for these tests (as well as the early tests) is provided in Table 2. Additionally, the field data sheets for these tests are provided in Appendix A.

Review of Table 2 indicates that the average infiltration rate for BR-1, measured at a depth of 5.5 feet below the existing land surface, is 4.44 inches/hour. The average infiltration rate for BR-2, measured at a depth of 5.5 feet below the existing land surface, is 6.55 inches/hour. The average infiltration rate for BR-3, measured at a depth of 5.0 feet below the existing land surface, is 1.15 inches/hour.

3.4 DISCUSSION

Based upon the above information, it appears that the area to the northeast of the existing RIBs has potential for successful installation and operation of future RIBs. Lithologic logging and infiltration testing activities suggest that two of the three areas tested (BR-1 and BR-2) offer good potential for infiltration (test rates of 4.44 "/hr and 6.55 "/hr, respectively), while the BR-3 test area was found to be of less potential (1.15 "/hr).

As discussed above, design rates for land application of treated effluent are generally a percentage of test rates. In the case of the original design for the CSWWTF, a 4.5% rate of infiltration test rates was utilized, where testing activities were short duration (30 minutes) and clean water was utilized for the test. In the case of the BR-1 and BR-2 tests, clean water was used for the test, but a much longer test was conducted (6 hours). However, to be consistent with previous design criteria for the CSWWTF, a design rate equal to 4.5% of the infiltration test result is recommended. Therefore, the design rate for infiltration for the BR-1 test area would be approximately 0.2"/hr (130,349 gpd/acre), while the design rate for infiltration for the BR-2 test area would be approximately 0.3"/hr (195,523 gpd/acre).

4.0 GROUND-WATER FLOW & SOLUTE TRANSPORT MODEL UP-DATE

BAI previously prepared (Broadbent & Associates, 2002) a ground-water flow and solute transport model as part of waste water facility planning activities for the CSWWTP conducted by the Washoe County Department of Water Resources. As part of the investigation documented herein, any new information developed in terms of infiltration rates was to be incorporated into the flow model to see if there were to be any resulting impacts to the local water resources. Review of the model input parameter data reveals that the input flows to the RIBs for 2003 were estimated at approximately 129,000 gpd. Current actual discharge is approximately 120,000 gpd, therefore, there is a minor discrepancy and little influence within the model.

Additional review of model parameter data reveals that the vertical hydraulic conductivities utilized in the model for the area under and around the current RIB locations ranged from 0.05 – 0.5 inches/hr. These rates are similar to those developed from the operation and test data for the RIBs. Therefore, there does not appear to be any new information that would significantly affect the ground-water flow model at this time.

5.0 SUMMARY/DISCUSSION

The existing CSWWTF will require expansion in order to accommodate the planned residential growth for north Cold Spring Valley. Existing RIBs are capable of handling current loads and they are operating at or above the original design rating of 0.06"/hr, with the exception of RIBs #1 and #2. However, infiltration rates for both RIB #1 and #2 can likely be significantly increased by removing the top 2.0 – 3.0 feet of overburden to expose underlying sands. If this overburden were to be removed, the infiltration rate for these basins might be expected to increase from ~0.03"/hr to 0.315"/hr or greater. Infiltration rates for RIB #3, 4, 5, and 6 range from 0.072 – 0.101"/hr, based upon estimated operation data.

Several potential new RIB locations were investigated to the northeast of the existing CSWWTF. Available literature was reviewed and three new soil borings were drilled to assess the subsurface lithology in this area. A large sand body is found to be present, both exposed at the surface as well as at depth. This sand is underlain by non-continuous clay layer of variable thickness. Double ring infiltrometer tests were conducted at all three drill locations. Two of the three test areas (BR-1 and BR-2) were found to possess good infiltration rates (4.44 and 6.55"/hr, respectively). Applying the EPA recommended standard of 4.5% of the test rate for a design rate, the estimated design rates are 0.2"/hr and 0.3"/hr for BR-1 and BR-2, respectively.

BAI previously prepared a ground-water flow and solute transport model as part of waste water facility planning activities for the CSWWTP conducted by the Washoe County Department of Water Resources. Review of the model input parameter data reveals that the input flows to the RIBs for 2003 were estimated at approximately 129,000 gpd. Current actual discharge is approximately 120,000 gpd, therefore, there is a minor discrepancy and little influence within the model. Additionally, the vertical hydraulic conductivities utilized in the model are similar to those developed from the operation and test data for the RIBs. Therefore, there does not appear to be any new information that would significantly affect the ground-water flow model at this time.

It should be noted that during review of CSWWTF operation data, it was observed that water levels are rising in existing shallow monitor wells (MW-1S, 2S, 3S, and 4S). These wells were installed by the Washoe County Department of Water Resources (WCDWR) and they are monitored on a quarterly basis by the WCDWR. Monitoring data for 1997 – 2003 are provided on Figure 3 for these four wells. Review of Figure 3 demonstrates this rising trend. It was further noted that water levels in the deeper monitor wells (MW-2D, 3D, and 4D) are slowly declining and that there appears to be a direct influence on water levels in these deeper wells as a result of pumping from the nearby Sweger Well. Figure 4 depicts the declining water level trend, while Figure 5 depicts the influence of the Sweger Well on water levels in these monitor wells. While these results are not unexpected, it noted here as something that should be monitored over time, especially as the residential growth of the valley continues to increase and as water supply demand and CSWWTF discharges continue to increase.

6.0 CONCLUSIONS

General conclusions are as follows:

- The current RIBs are operating at or above the original design rating of 0.06"/hr, with the exception of RIBs #1 and #2. Infiltration rates for RIB #3, 4, 5, and 6 range from 0.072 – 0.101"/hr, based upon estimated operation data.
- Infiltration rates for both RIB #1 and #2 can likely be significantly increased by removing the top 2.0 – 3.0 feet of overburden to expose underlying sands. Expected infiltration rates would be approximately 0.315"/hr or greater.
- There is a sand deposit present at the surface or just below the surface throughout a large portion of the area to the northeast of the CSWWTF that offers good potential for future RIB locations.
- Estimated design infiltration rates for two tested areas (BR-1 and BR-2) are approximately 0.2"/hr and 0.3"/hr, respectively.
- Review of the ground-water flow and solute transport model reveals that the model was constructed with information that still appears to be representative of known conditions, and therefore, no modifications were necessary.
- Water levels in existing shallow monitor wells located in direct proximity to the CSWWTF are increasing while water levels in deeper monitor wells are slowly declining (apparently due to Sweger Well pumping). These water level changes were anticipated but should be closely monitoired as growth in the valley continues.

7.0 REFERENCES

Broadbent & Associates, Inc., 2002, Ground-Water Flow and Salute Transport Model, North Cold Spring Valley, Washoe County, Nevada.

Dewante & Stowell, 1991, Proposed Wastewater Facilities, Cold Spring Valley, Crystal Canyon Corporation, Washoe County, Nevada.

Pezonella Associates, Inc., 1997, Geotechnical Investigation, Proposed Woodland Park, Washoe County, Nevada.

SEA Engineers/Planners, Inc., 1985, Soils Investigation, Sweger Estate, Cold Springs Valley, Washoe County, Nevada.

Van Denburgh, A.S., 1981, Water Resources of Cold Spring Valley, A Growing Urban Area Northwest of Reno, Nevada, USG Open File Report 80-1287.

TABLES

Table 1: RIB Operation and Testing Data for the Cold Spring Valley Waste Water Treatment Facility, Cold Spring Valley, Washoe County, Nevada.

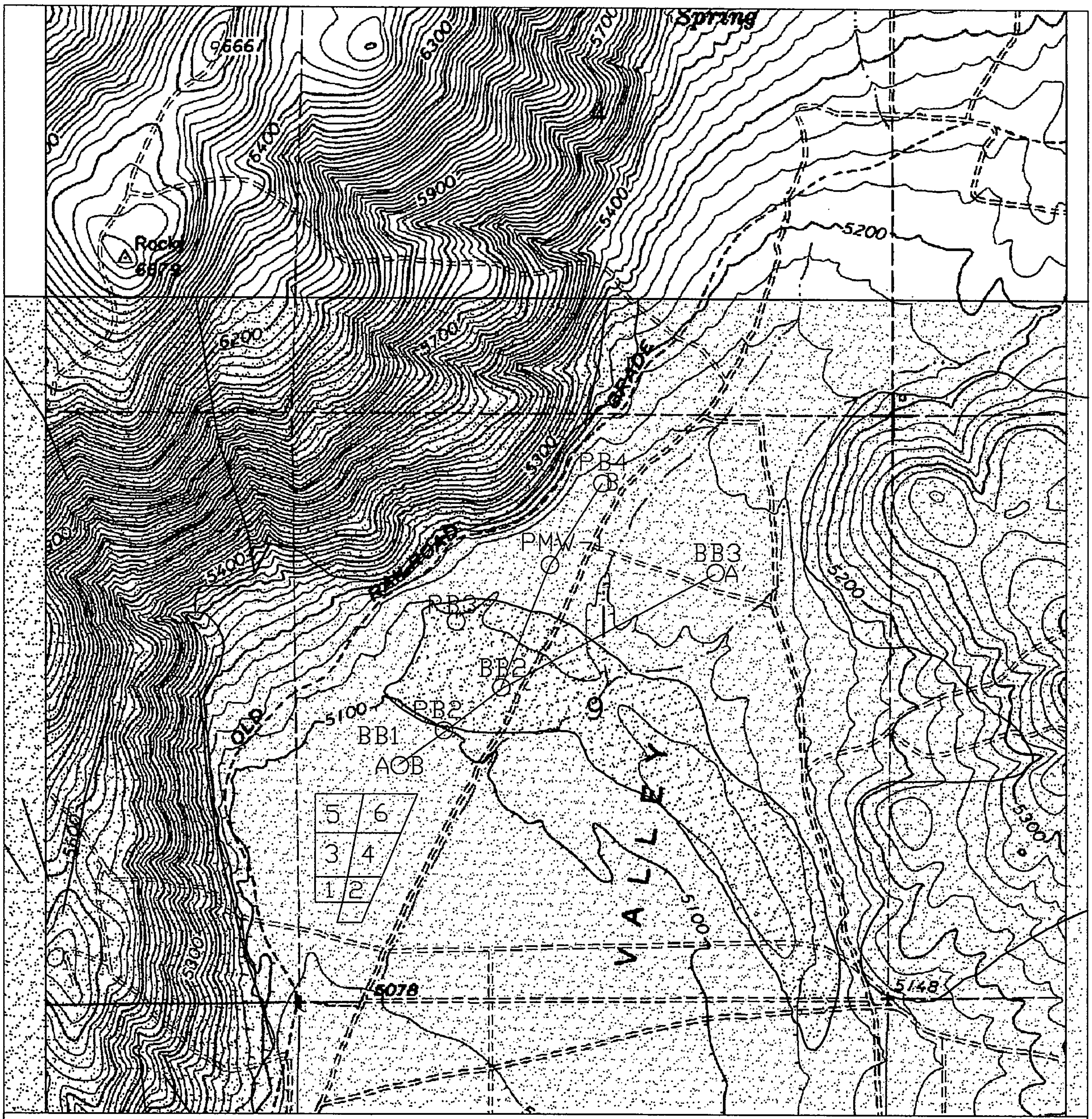
CSWWTP RIB No.	Days Loaded (days)	Loading Rate (gal/day)	Volume Loaded (gal)	Volume Loaded (ft3)	Time to Dissipate (days)	Basin Area (ft2)	Basin Area (Acres)	Infiltration Rate (ft/day)	Infiltration Rate (gpd/acre)	Infiltration Rate (in/hr)	Loading Time Period	Double Ring Test Results (in/hr)	Ring Test Depth From Surface (ft)	RIB Performance	
														Percent of Ring Test Rate	Percent of Design Rate*
1	5	107,000	535,000	71,515	30	53,000	1.22	0.039	12,563	0.019	1/16/03 - 1/21/03	Not Tested	Not Tested	Not Tested	36%
1	6	120,000	720,000	96,244	30	53,000	1.22	0.050	16,438	0.025	5/15/03 - 5/21/03				
							Average:	*0.044*	*14,500*	*0.022*					
2	13	88,000	1,144,000	152,921	30	60,950	1.40	0.058	19,014	0.029	9/17/02 - 9/30/02	0.07	Surface	42%	50%
2	10	119,000	1,190,000	159,070	30	60,950	1.40	0.065	21,262	0.033	3/10/03 - 3/20/03	7.15	4.5	0.4%	
							Average:	*0.062*	*20,138*	*0.031*					
3	36	100,000	3,600,000	481,219	14	57,750	1.33	0.167	54,309	0.083	9/30/02 - 11/5/02	Not Tested	Not Tested	Not Tested	134%
3	20	119,500	2,390,000	319,476	14	57,750	1.33	0.163	53,022	0.081	3/20/03 - 4/9/03				
							Average:	*0.165*	*53,665*	*0.082*					
4	22	112,500	2,475,000	330,838	14	68,800	1.58	0.134	43,528	0.067	1/21/03 - 2/12/03	Not Tested	Not Tested	Not Tested	118%
4	28	120,000	3,360,000	449,138	14	68,800	1.58	0.155	50,651	0.078	5/21/03 - 6/18/03				
							Average:	*0.145*	*47,090*	*0.072*					
5	36	98,000	3,528,000	471,595	7	57,800	1.33	0.190	61,833	0.095	12/11/02 - 1/16/03	Not Tested	Not Tested	Not Tested	165%
5	26	118,500	3,081,000	411,843	7	57,800	1.33	0.216	70,362	0.108	2/12/03 - 3/10/03				
							Average:	*0.203*	*66,097*	*0.101*					
6	31	100,000	3,100,000	414,383	7	63,000	1.45	0.173	56,406	0.087	11/5/02 - 12/6/02	0.88	Surface	11%	157%
6	36	120,000	4,320,000	577,463	7	63,000	1.45	0.213	69,464	0.107	4/9/03 - 5/15/03	0.50	4.0	19%	
							Average:	*0.193*	*62,935*	*0.097*					

* *The design rate for the RIBs was 40,000 gpd (0.06"/hr), as derived by Dewante and Stowell (1991) and Pezonella (1991).*

Table 2: Double Ring Infiltrometer Test Results, Cold Spring Valley, Washoe County, Nevada.

Ring Test Number	Date	Infiltration Rate (in/hr)	Depth Below Surface (ft)
RIB2-S	6/26/2003	0.074	0.0
RIB2-D	6/26/2003	7.15	4.5
RIB6-S	6/26/2003	0.88	0.0
RIB6-D	6/26/2003	0.50	4.0
BR-1	7/17/2003	4.44	5.5
BR-2	7/17/2003	6.55	5.5
BR-3	7/17/2003	1.15	5.0

DRAWINGS



EXPLANATION

Quaternary geology modified from E.C. Bingler (Bingler and Trexler, 1975). Bedrock geology modified from R.L. Nielsen (unpublished Nev. Bur. Mines and Geology map, 1965).

Adapted from Van Denburgh, 1980

Base from U.S. Geological Survey 1:24,000
Reno NW, 1967 (photorevised 1974)

0 0.5 1 MILE

0 0.5 1 KILOMETER

CONTOUR INTERVAL 20 FEET

DATUM IS SEA LEVEL

QUATERNARY
- ▨ Beach and delta deposits
- ▨ Fan, sheetwash, and flood-plain alluvial deposits

JURASSIC(?) AND TRIASSIC
- ▨ Metavolcanic and metasedimentary rocks

—— - - - .... Fault. Dashed where approximately located; dotted where buried

A' ———— Cross Section Lines

Existing Waste Water Treatment Facility

BB1 ○ Borehole and/or test pit location

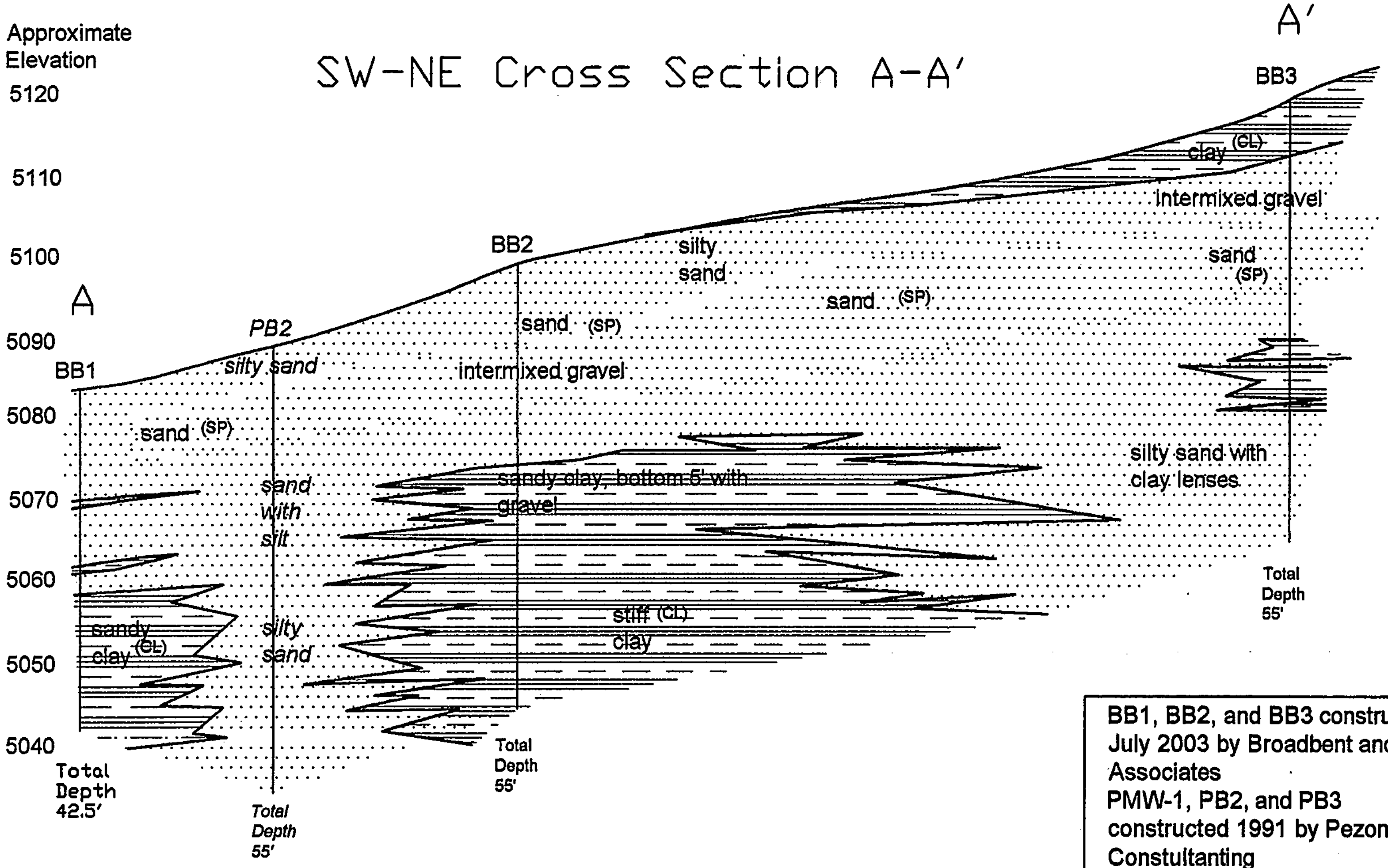
BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL
2000 Kirman Avenue
Reno, Nevada 89502

North Cold Spring Valley Geologic Map,
Cold Spring Valley, Nevada

Drawn July 21, 2003 by M. Gerlinger
Approved July 22, 2003 by D. Guerrant

Drawing 1

FIGURES



BB1, BB2, and BB3 constructed July 2003 by Broadbent and Associates
PMW-1, PB2, and PB3 constructed 1991 by Pezonella Constultanting

LEGEND:
Approximate Horizontal Scale 1" = 425'   Approximate Vertical Scale 1" = 20'

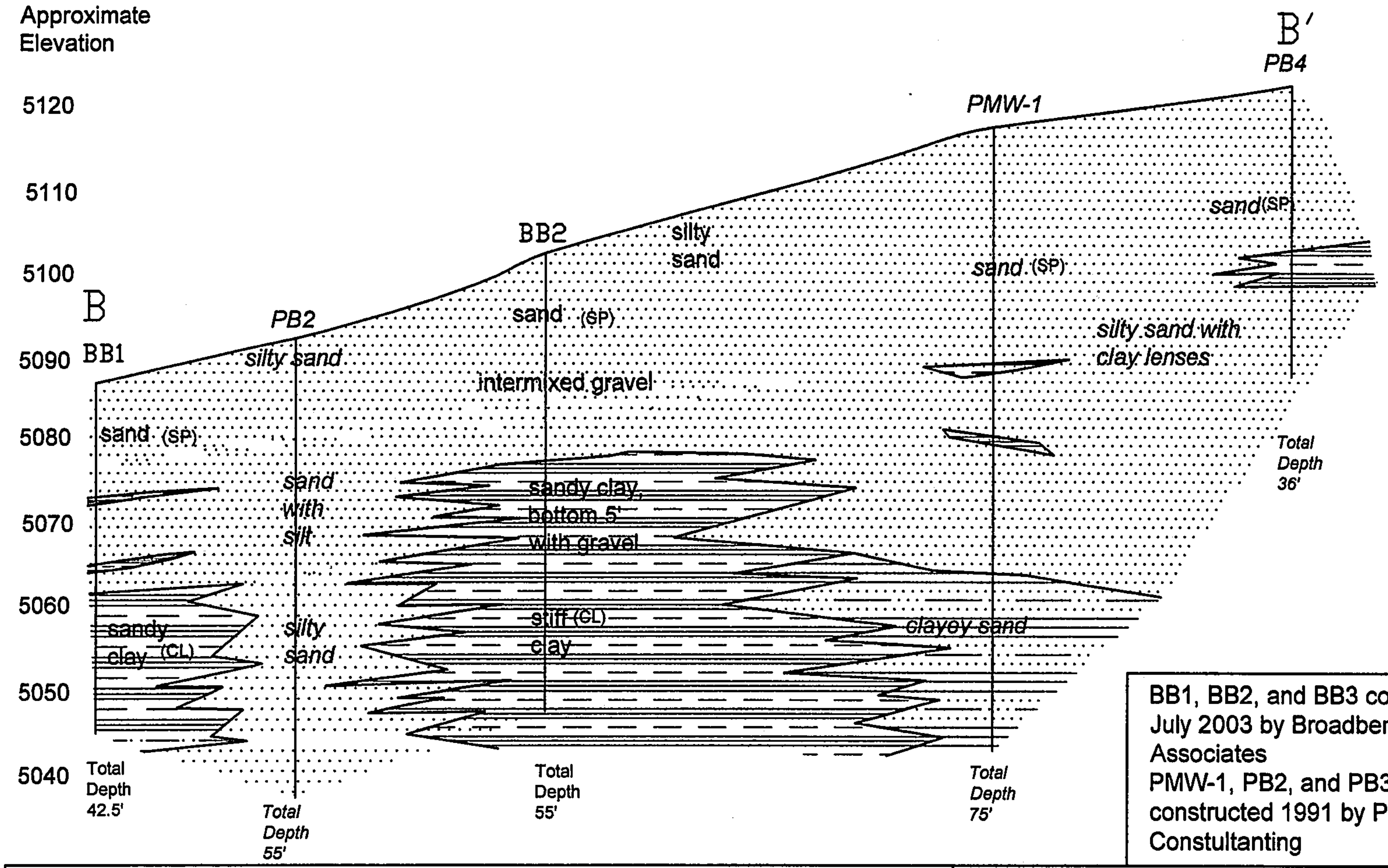
- ▦ Sand
- ▤ Clay
- | Soil Boring
- ≷ Approximate Contact

Drawn July 17, 2003 by M. Gerlinger
Approved July 18, 2003 by D. Guerrant

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL
2000 Kirman Avenue
Reno, Nevada 89502

Figure 1

S-N Cross Section B-B′



BB1, BB2, and BB3 constructed July 2003 by Broadbent and Associates
PMW-1, PB2, and PB3 constructed 1991 by Pezonella Constultanting

LEGEND:

Approximate Horizontal Scale 1" = 425′ Approximate Vertical Scale 1" = 20′

- ▨ Sand
- ▤ Clay
- | Soil Boring
- ≷ Approximate Contact

Drawn July 17, 2003 by M. Gerlinger
Approved July 18, 2003 by D. Guerrant

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL
2000 Kirman Avenue
Reno Nevada 89502

Figure 2

Figure 3: Depth to Water versus Time for MW-1S, 2S, 3S, and 4S, Cold SpringValley, Washoe County, Nevada.

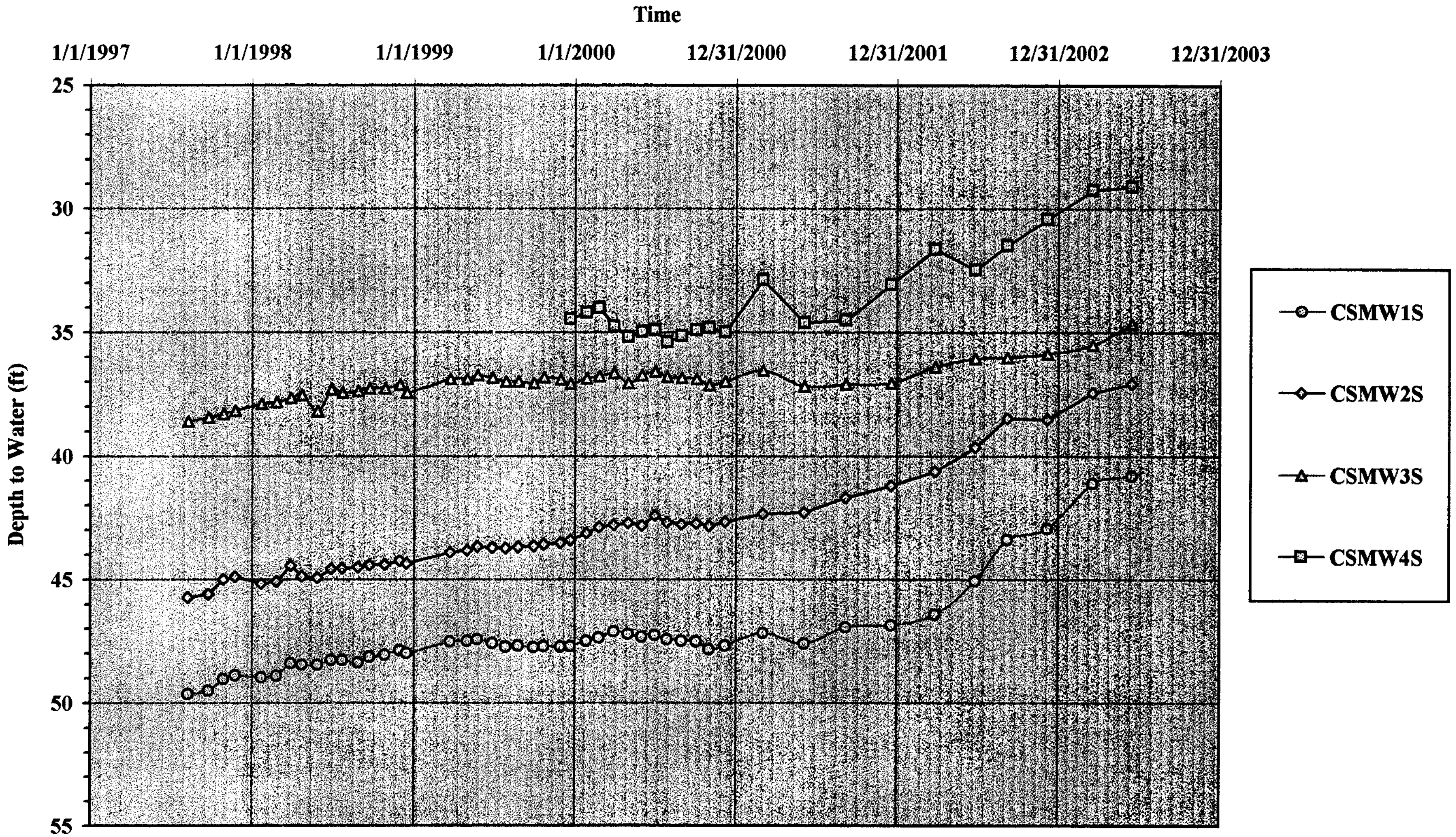


Figure 4: Depth to Water versus Time for Monitor Wells MW-2D, 3D, and 4D, Cold Spring Valley, Washoe County, Nevada.

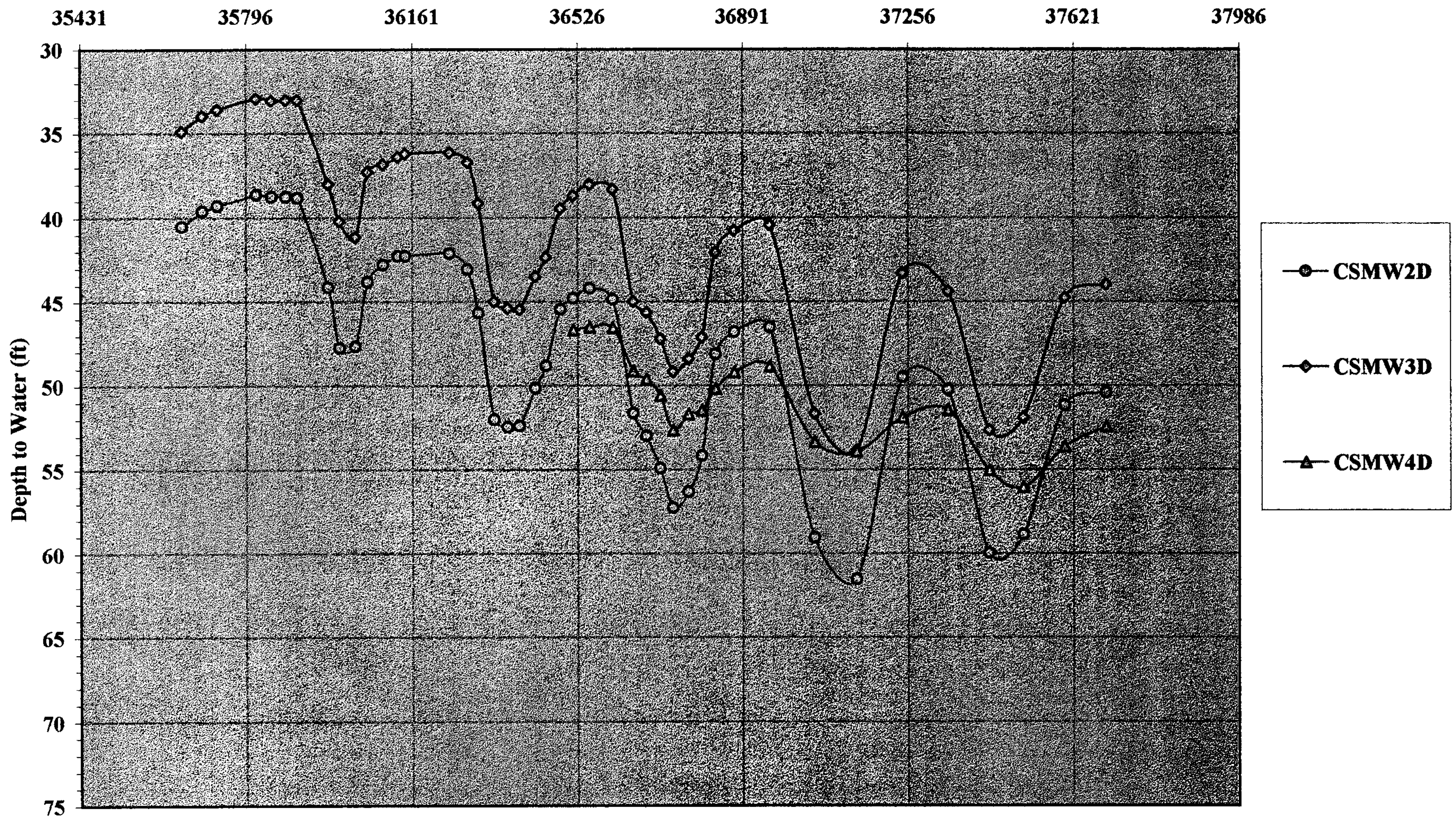
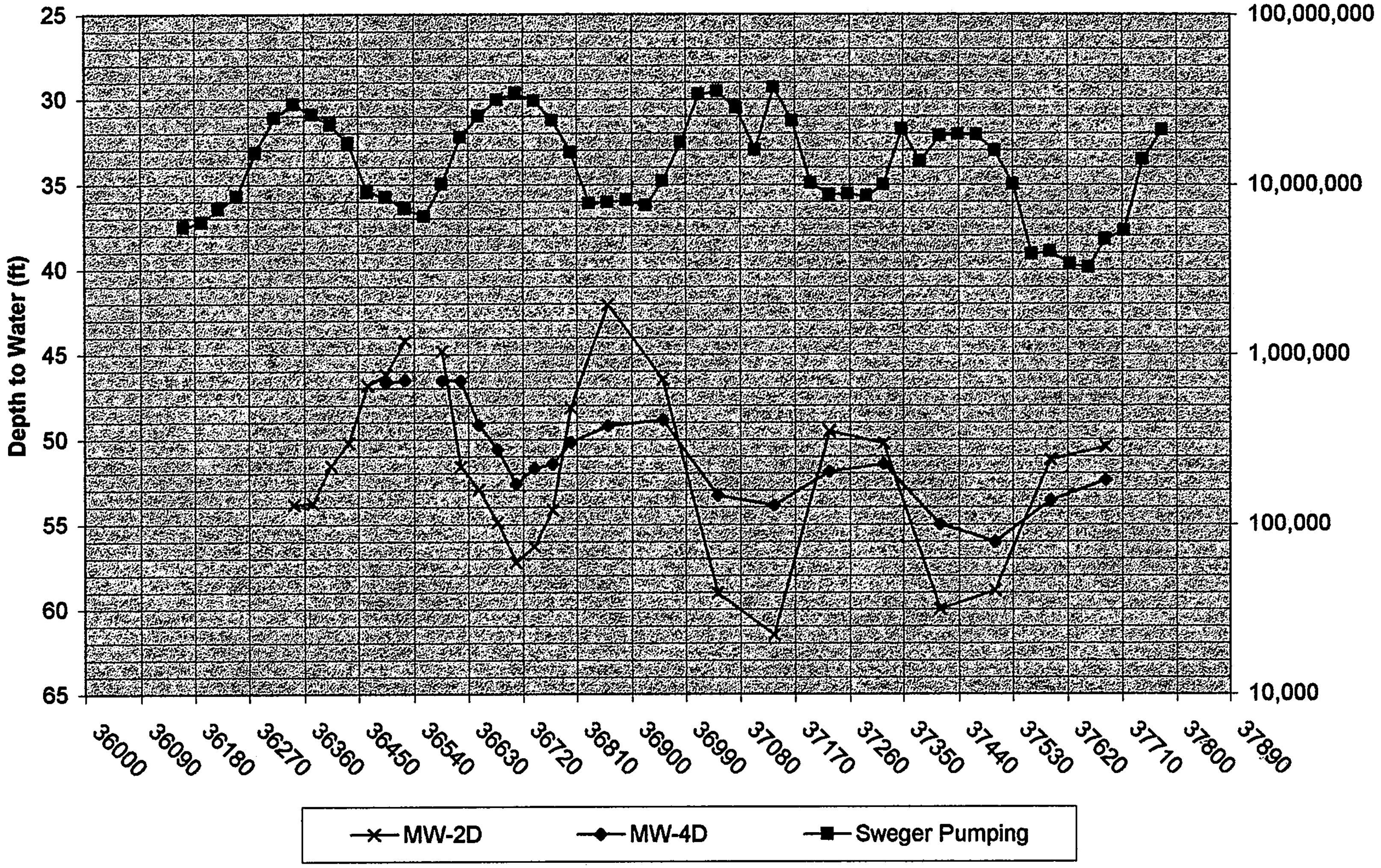


Figure 5: Depth to Water & Sweger Well Pumping Data versus Time for MW-2D & 4D, Cold Spring Valley, Nevada.



APPENDIX A

RIB TEST DATA SHEETS

Infiltration Test Data Sheet
Cold Springs RIB's, Cold Springs, Nevada

Date: 6/26/2003

Test Location: RIB2-S

Test Depth: Surface

Time	Water Level Reading (Inches)		Elapsed Time (Minutes)	Infiltration (Inches)	Infiltration Rate (Inches/Hour)	Notes
	Before Filling	After Filling				
11:00	2.75	2.75	▨	▨	▨	Still full from 6/25/03, outer ring dry
			61	0.13	0.12	
12:01	2.88	2.88				Not Filled (NF)
			116	0.00	0.00	
13:57	2.88	2.88				NF
			114	0.13	0.07	
15:51	3.00	3.00				NF
			69	0.13	0.11	
17:00	3.13	End				End of test
				Average	0.074	

Infiltration Test Data Sheet
Cold Springs RIB's, Cold Springs, Nevada

Date: 6/26/2003

Test Location: RIB2-D

Test Depth: 4.5 Feet

Time	Water Level Reading (Inches)		Elapsed Time (Minutes)	Infiltration (Inches)	Infiltration Rate (Inches/Hour)	Notes
	Before Filling	After Filling				
11:27	Dry	3.50				Infiltration is very fast
			23	3.38	8.80	
11:44	6.88	6.88				Not Filled (NF)
			10	1.13	6.75	
11:54	8.00	0.50				
			57	7.25	7.63	
12:51	7.75	7.75				NF
			16	1.75	6.56	
13:07	9.50	0.50				
			67	7.88	7.05	
14:14	8.38	0.50				
			72	7.25	6.04	
15:26	7.75	0.50				
			75	8.13	6.50	
16:41	8.63	0.50				
			46	6.00	7.83	
17:27	6.50	End				End of Test
				Average	7.15	

Infiltration Test Data Sheet
Cold Springs RIB's, Cold Springs, Nevada

Date: 6/26/2003

Test Location: RIB6-S

Test Depth: Surface

Time	Water Level Reading (Inches)		Elapsed Time (Minutes)	Infiltration (Inches)	Infiltration Rate (Inches/Hour)	Notes
	Before Filling	After Filling				
10:26	Dry	4.00				
			68	0.88	0.77	
11:34	4.88	4.88				Not Filled (NF)
			55	0.75	0.82	
12:29	5.63	5.63				NF
			80	1.13	0.84	
13:49	6.75	6.75				NF
			52	0.75	0.87	
14:41	7.50	2.50				
			105	1.63	0.93	
16:26	4.13	End				End of test
				Average	0.88	

Infiltration Test Data Sheet
Cold Springs RIB's, Cold Springs, Nevada

Date: 6/26/2003

Test Location: RIB6-D

Test Depth: 4.0 Feet

Time	Water Level Reading (Inches)		Elapsed Time (Minutes)	Infiltration (Inches)	Infiltration Rate (Inches/Hour)	Notes
	Before Filling	After Filling				
10:29	Dry	4.00	▨	▨	▨	
			68	0.50	0.44	
11:37	4.50	4.50				Not Filled (NF)
			53	0.38	0.42	
12:30	4.88	4.88				NF
			80	0.63	0.47	
13:50	5.50	5.50				NF
			62	0.75	0.73	
14:52	6.25	3.00				
			97	0.75	0.46	
16:29	3.75	End				End of test
				Average	0.50	

Infiltration Test Data Sheet
Cold Springs RIB's, Cold Springs, Nevada

Date: 7/17/2003

Test Location: BR-1

Test Depth: 5.5 Feet

Time	Water Level Reading (Inches)		Elapsed Time (Minutes)	Infiltration (Inches)	Infiltration Rate (Inches/Hour)	Notes
	Before Filling	After Filling				
10:15	NA	1.00				Infiltration is fast
			37	2.88	4.66	
10:52	3.88	1.00				
			95	7.38	4.66	
12:27	8.38	1.00				
			61	4.38	4.30	
13:28	5.38	1.00				
			94	6.88	4.39	
15:02	7.88	1.00				
			73	5.13	4.21	
16:15	6.13	End				End of Test
				Average	4.44	

Infiltration Test Data Sheet
Cold Springs RIB's, Cold Springs, Nevada

Date: 7/17/2003

Test Location: BR-2

Test Depth: 5.5 Feet

Time	Water Level Reading (Inches)		Elapsed Time (Minutes)	Infiltration (Inches)	Infiltration Rate (Inches/Hour)	Notes
	Before Filling	After Filling				
10:05	NA	0.50	▨	▨	▨	Infiltration is very fast
10:26	3.13	0.50	21	2.63	7.50	
11:08	5.00	0.50	42	4.50	6.43	
11:35	3.38	0.50	27	2.88	6.39	
12:03	3.63	0.50	28	3.13	6.70	
12:37	4.25	0.50	34	3.75	6.62	
12:58	2.88	0.50	21	2.38	6.79	
13:38	4.75	0.50	40	4.25	6.38	
14:15	4.25	0.50	37	3.75	6.08	
14:42	3.50	0.50	27	3.00	6.67	
15:24	4.88	0.50	42	4.38	6.25	
16:05	4.75	End	41	4.25	6.22	End of Test
				Average	6.55	

Infiltration Test Data Sheet
Cold Springs RIB's, Cold Springs, Nevada

Date: 7/17/2003

Test Location: BR-3

Test Depth: 5.0 Feet

Time	Water Level Reading (Inches)		Elapsed Time (Minutes)	Infiltration (Inches)	Infiltration Rate (Inches/Hour)	Notes
	Before Filling	After Filling				
10:32	Dry	0.63				Infiltration is very slow
			103	2.13	1.24	
12:15	2.75	2.75				Not Filled
			94	1.88	1.20	
13:49	4.63	0.50				
			133	2.25	1.02	
16:02	2.75	End				End of Test
				Average	1.15	

APPENDIX B

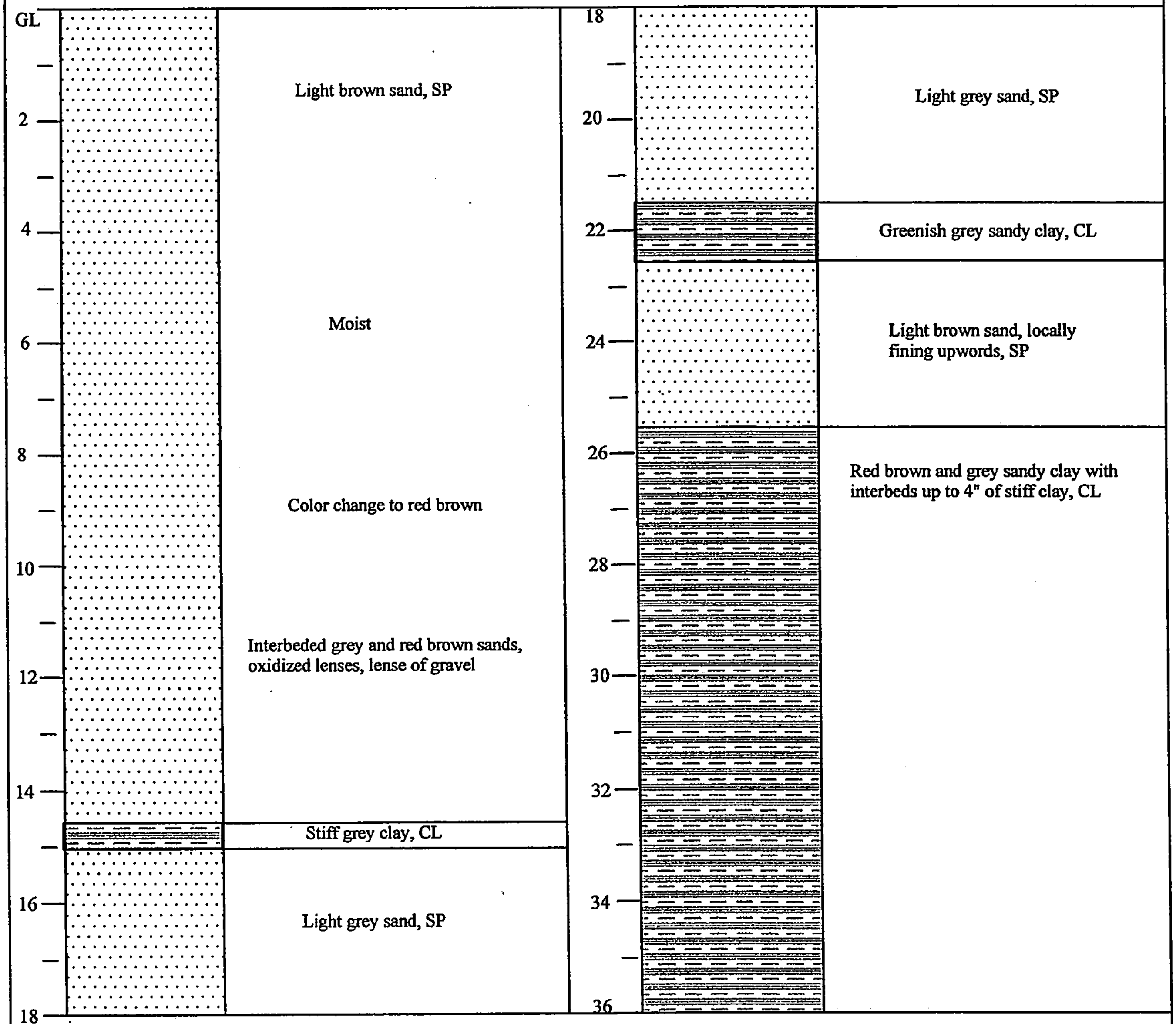
BORING LOGS

LITHOLOGIC LOG OF BORING BB1

CLIENT: Kennedy Jenks Consultants
PROJECT NUMBER: 03-02-116
ADDRESS: 5053 Mud Springs Rd, Cold Springs NV
DATE: 7/14/03
DRILLING CO/METH: WESTEX/Hollow Stem Auger with MOSS sampler
START: 14:20
LOGGED BY: M. E. GERLINGER DESCRIPTION:
STOP: 18:35
COODINATES: NORTHING: 39 42 49.33432 EASTING: 119 58 19.86020 BORING ELEVATION: 5088.3'

LITHOLOGIC DESCRIPTION

LITHOLOGIC DESCRIPTION



Light brown sand, SP

Moist

Color change to red brown

Interbedded grey and red brown sands, oxidized lenses, lense of gravel

Stiff grey clay, CL

Light grey sand, SP

Light grey sand, SP

Greenish grey sandy clay, CL

Light brown sand, locally fining upwords, SP

Red brown and grey sandy clay with interbeds up to 4" of stiff clay, CL

Prepared by: M. Gerlinger Approved by: D. Guerrant Page No.: 1 of 2

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL

LITHOLOGIC LOG OF BORING BB1

CLIENT: Kennedy Jenks Consultants

PROJECT NUMBER: 03-02-116

ADDRESS: 5053 Mud Springs Rd, Cold Springs NV

DATE: 7/14/03

DRILLING CO/METH: WESTEX/Hollow Stem Auger with MOSS sampler

START: 14:20

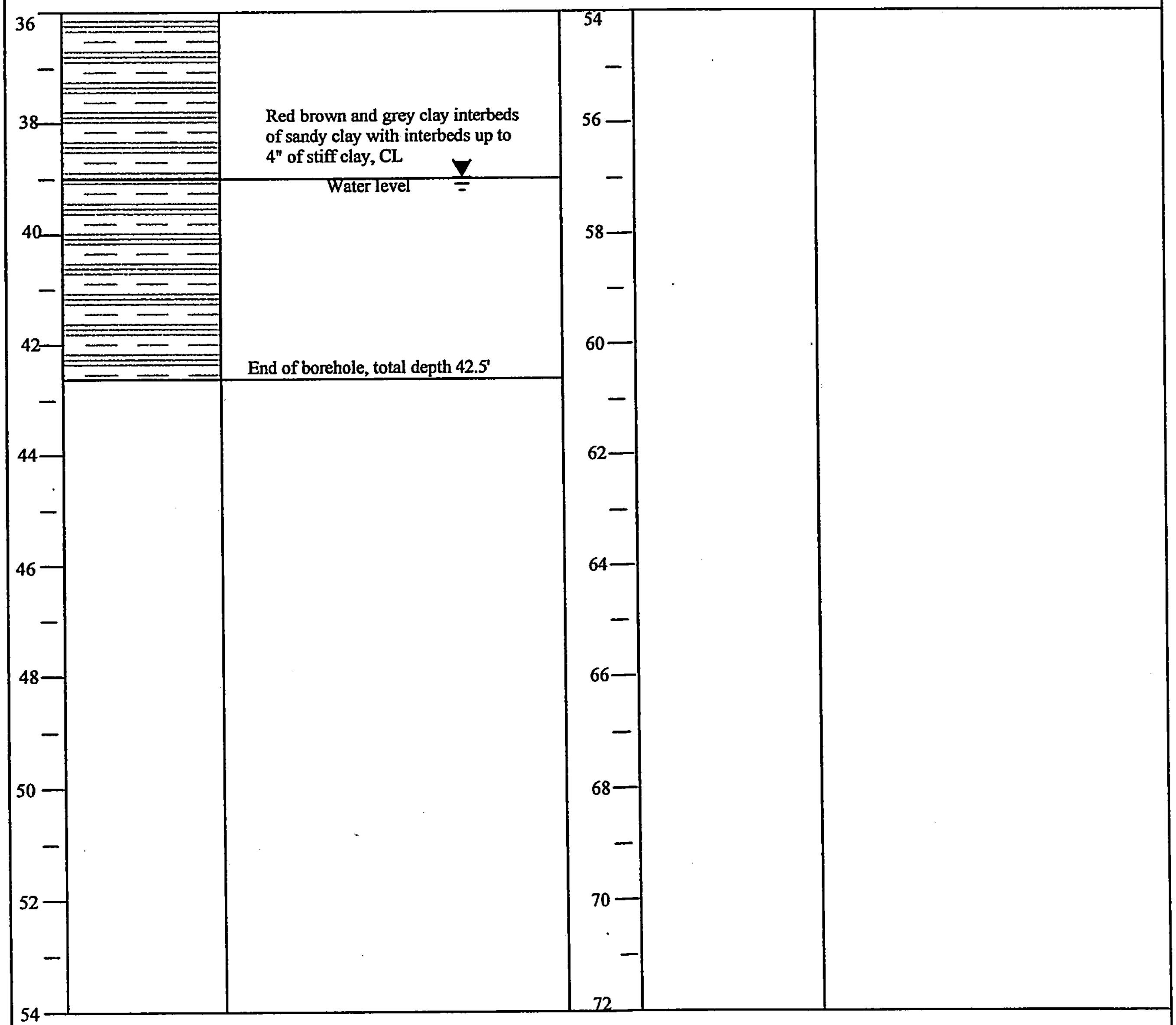
LOGGED BY: M. E. GERLINGER DESCRIPTION:

STOP: 18:35

COODINATES: NORTHING: 39 42 49.33432 EASTING: 119 58 19.86020 BORING ELEVATION: 5088.3'

LITHOLOGIC DESCRIPTION

LITHOLOGIC DESCRIPTION



Red brown and grey clay interbeds of sandy clay with interbeds up to 4" of stiff clay, CL

Water level

End of borehole, total depth 42.5'

Total Depth: 42.5'

Prepared by: M. Gerlinger Approved by: D. Guerrant Page No.: 2 of 2

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL

LITHOLOGIC LOG OF BORING BB2

CLIENT: Kennedy Jenks Consultants

PROJECT NUMBER: 03-02-116

ADDRESS: 5053 Mud Springs Rd, Cold Springs NV

DATE: 7/15/03

DRILLING CO/METH: WESTEX/Hollow Stem Auger with MOSS sampler

START: 09:30

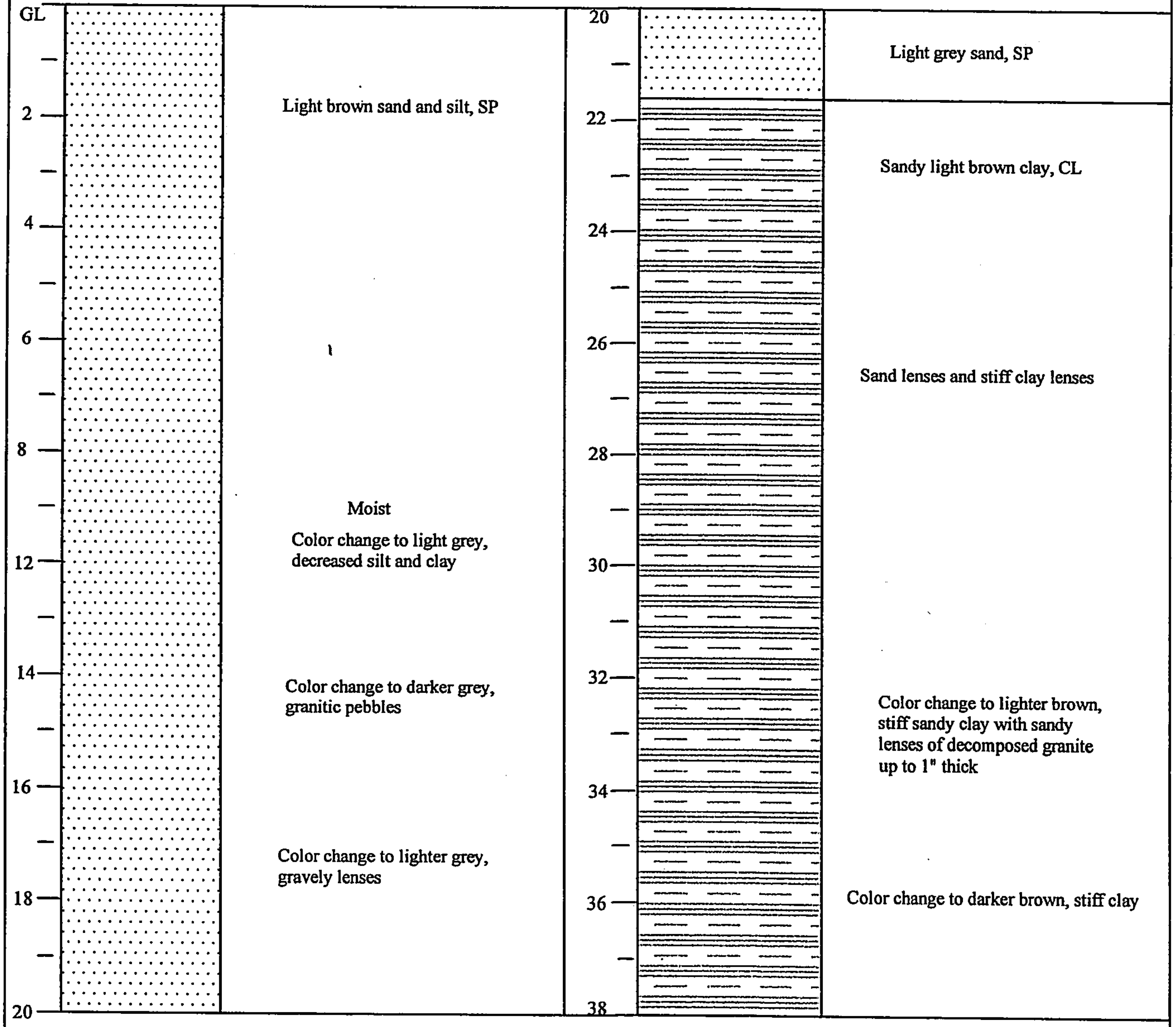
LOGGED BY: M. E. GERLINGER DESCRIPTION:

STOP: 13:30

COODINATES: NORTHING: 39 42 53.02909 EASTING: 119 58 09.45844 BORING ELEVATION: 5097.1'

LITHOLOGIC DESCRIPTION

LITHOLOGIC DESCRIPTION



Light brown sand and silt, SP

Moist

Color change to light grey, decreased silt and clay

Color change to darker grey, granitic pebbles

Color change to lighter grey, gravely lenses

Light grey sand, SP

Sandy light brown clay, CL

Sand lenses and stiff clay lenses

Color change to lighter brown, stiff sandy clay with sandy lenses of decomposed granite up to 1" thick

Color change to darker brown, stiff clay

Prepared by: M. Gerlinger Approved by: D. Guerrant Page No.: 1 of 2

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL

LITHOLOGIC LOG OF BORING BB2

CLIENT: Kennedy Jenks Consultants

PROJECT NUMBER: 03-02-116

ADDRESS: 5053 Mud Springs Rd, Cold Springs NV

DATE: 7/15/03

DRILLING CO/METH: WESTEX/Hollow Stem Auger with MOSS sampler

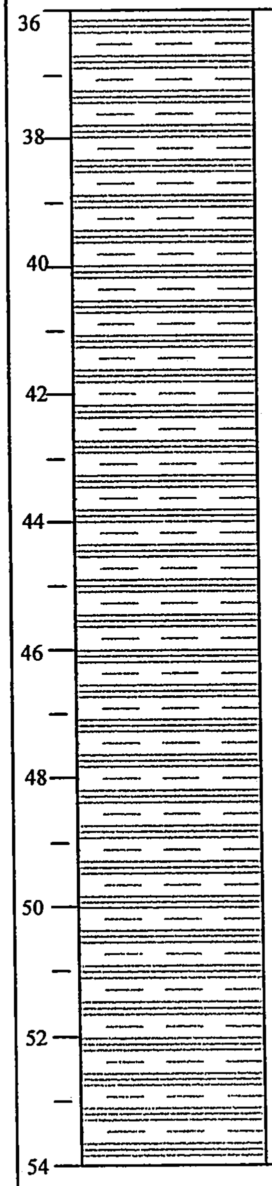
START: 09:30

LOGGED BY: M. E. GERLINGER DESCRIPTION:

STOP: 13:30

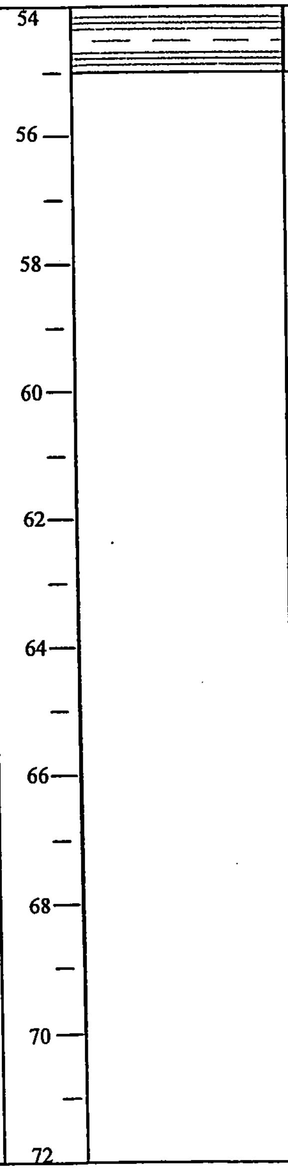
COODINATES: NORTHING: 39 42 53.02909 EASTING: 119 58 09.45844 BORING ELEVATION: 5097.1'

LITHOLOGIC DESCRIPTION



Sandy light brown clay, CL

LITHOLOGIC DESCRIPTION



End of borehole, total depth 55'

Water not encountered

Total Depth: 55'

Prepared by: M. Gerlinger Approved by: D. Guerrant Page No.: 2 of 2

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL

LITHOLOGIC LOG OF BORING BB3

CLIENT: Kennedy Jenks Consultants

PROJECT NUMBER: 03-02-116

ADDRESS: 5053 Mud Springs Rd, Cold Springs NV

DATE: 7/15/03

DRILLING CO/METH: WESTEX/Hollow Stem Auger with MOSS sampler

START: 15:10

LOGGED BY: M. E. GERLINGER

DESCRIPTION:

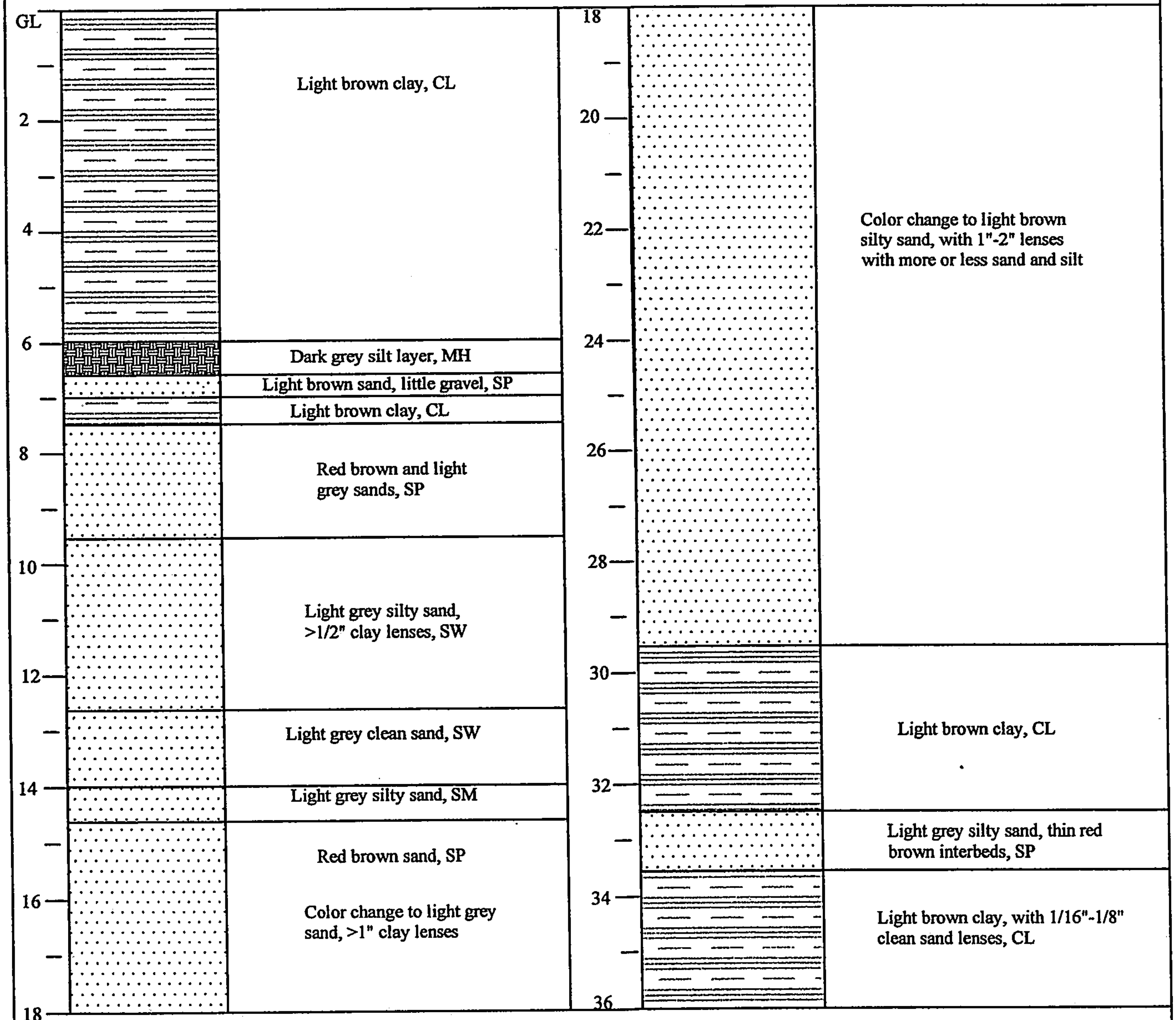
STOP: 18:45

COODINATES: NORTHING: 39 43 05.42701 EASTING: 119 58 55.01557

BORING ELEVATION: 5115.0'

LITHOLOGIC DESCRIPTION

LITHOLOGIC DESCRIPTION



Light brown clay, CL

Dark grey silt layer, MH

Light brown sand, little gravel, SP

Light brown clay, CL

Red brown and light grey sands, SP

Light grey silty sand, >1/2" clay lenses, SW

Light grey clean sand, SW

Light grey silty sand, SM

Red brown sand, SP

Color change to light grey sand, >1" clay lenses

Color change to light brown silty sand, with 1"-2" lenses with more or less sand and silt

Light brown clay, CL

Light grey silty sand, thin red brown interbeds, SP

Light brown clay, with 1/16"-1/8" clean sand lenses, CL

Prepared by: M. Gerlinger Approved by: D. Guerrant Page No.: 1 of 2

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL

LITHOLOGIC LOG OF BORING BB3

CLIENT: Kennedy Jenks Consultants

PROJECT NUMBER: 03-02-116

ADDRESS: 5053 Mud Springs Rd, Cold Springs NV

DATE: 7/15/03

DRILLING CO/METH: WESTEX/Hollow Stem Auger with MOSS sampler

START: 15:10

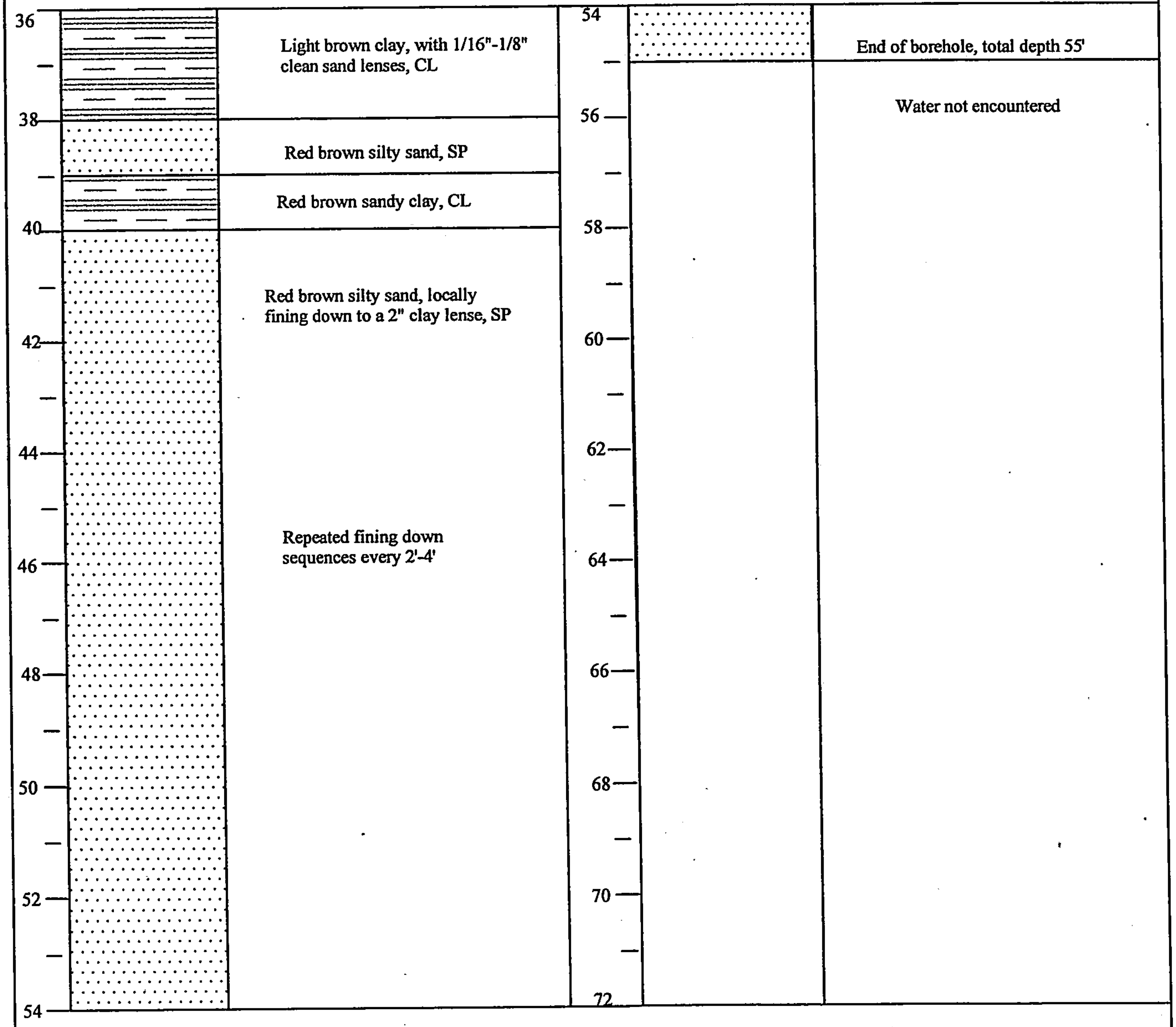
LOGGED BY: M. E. GERLINGER DESCRIPTION:

STOP: 18:45

COODINATES: NORTHING: 39 43 05.42701 EASTING: 119 58 55.01557 BORING ELEVATION: 5115.0'

LITHOLOGIC DESCRIPTION

LITHOLOGIC DESCRIPTION



Light brown clay, with 1/16"-1/8" clean sand lenses, CL

Red brown silty sand, SP

Red brown sandy clay, CL

Red brown silty sand, locally fining down to a 2" clay lense, SP

Repeated fining down sequences every 2'-4'

End of borehole, total depth 55'

Water not encountered

Total Depth: 55'

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL

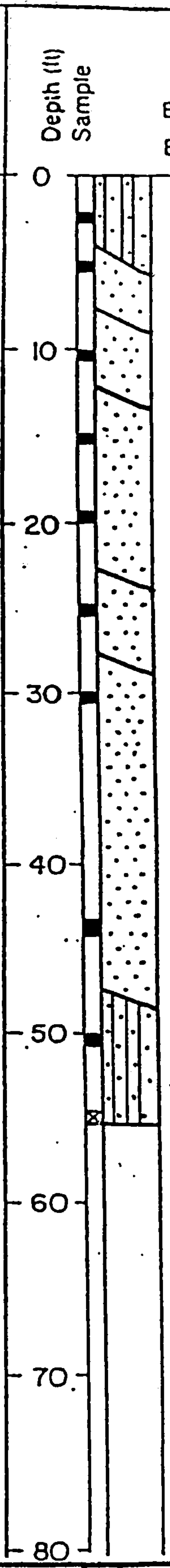
Prepared by: M. Gerlinger Approved by: D. Guerrant Page No.: 2 of 2

LOG OF BORING B-2

Equipment CME 55, Hollow Stem Auger

Elevation ________ Date 10/9/91

Laboratory Tests (and other information)	Driving Resistance Blows/Ft	Moisture Content (%)	Dry Density (pcf)	Well Construction
	7			
	6			
	19			
	18			
	31			
	29			
	36			
	26			
	22			
	26			



BROWN SILTY SAND (SM)
loose, dry

BROWN SAND (SP)
loose, dry

ORANGE BROWN SAND (SW)
with gravel, medium dense, dry

ORANGE BROWN SAND (SP)
medium dense, dry
Color Change to Gray Brown Below 15.5 Feet
Becoming Dense and Moist Below 18.0 Feet
Color Change to Orange Brown Below 19.5 Feet

GREY GREEN SAND (SW)
with gravel, medium dense, dry

GREY BROWN SAND (SP)
dense, dry

With Silt and Becoming Moist Below 39.0 Feet

BROWN SILTY SAND (SM)
medium dense, moist

No Free Water Encountered

Elevation Reference:

See Log of Boring
-1

Pezonella Associates, Inc.
Consulting Engineers and Geologists

Job No. 3072.01N
Appr. /11m
Date 10/23/91

LOG OF BORING B-2

CRYSTAL CANYON WASTEWATER FACILITY
Washoe County, Nevada

PLATE
13

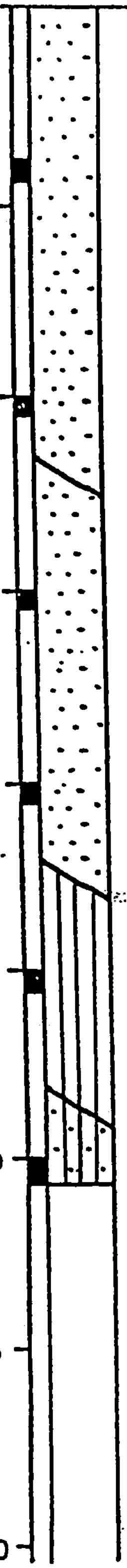
LOG OF BORING B-3

Equipment CME 55, Hollow Stem Auger

Elevation ______ Date 10/10/91

Laboratory Tests (and other information)	Driving Resistance Blows/Ft	Moisture Content (%)	Dry Density (pcf)	Depth (ft)
	12			
				5
	46			10
	36			15
	28			20
	14			25
	36			30
				35
				40

Sample



BROWN SAND (SP-SM)
with silt, medium dense, dry

Color Change to Light Brown, Increasing Silt Content and Becoming Dense Below 10.5 Feet

GREY BROWN SAND (SP)
dense, dry with red staining

GREY GREEN SILT (ML)
with sand, very stiff, moist
with red staining

GREY BROWN SILTY SAND (SM)
dense, moist with red staining

No Free Water Encountered

Elevation Reference:
See Log of Boring B-1

Pezonella Associates, Inc.
Consulting Engineers and Geologists

Job No. 3072.01N
Appr. /11m
Date 10/23/91

LOG OF BORING B-3
CRYSTAL CANYON WASTEWATER FACILITY
Washoe County, Nevada

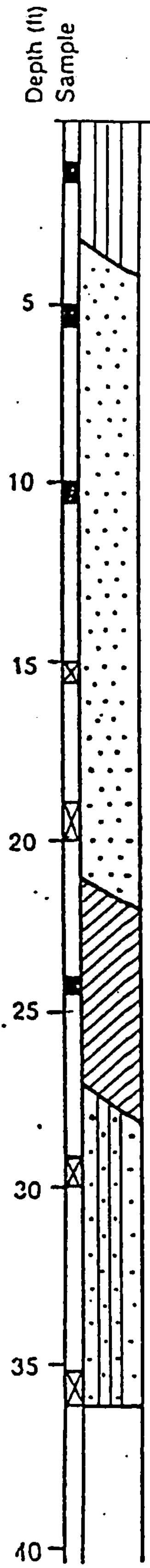
PLATE
14

LOG OF BORING B-4

Equipment CME 55, Hollow Stem Auger

Elevation ____________ Date 10/11/91

Laboratory Tests (and other information)	Driving Resistance Blows/Ft	Moisture Content (%)	Dry Density (pcf)
	17		
	21		
	20		
	28		
	54		
	45		
	23		



DARK BROWN SILT (ML)
with sand, very stiff, dry, with organics

BROWN SAND (SP)
medium dense, dry

Color Change to Red Brown Below 10.0 Feet

Color Change to Brown Below 12.0 Feet

Becoming Dense Below 17.0 Feet

DARK BROWN SANDY CLAY (CH)
very stiff, moist

BROWN SILTY SAND (SM)
medium dense, dry

No Free Water Encountered

Elevation Reference:

See Log of Boring B-1

Pezonella Associates, Inc.
Consulting Engineers and Geologists

Job No. 3072.01N
Appr. /11m
Date 10/23/91

LOG OF BORING B-4
CRYSTAL CANYON WASTEWATER FACILITY
Washoe County, Nevada

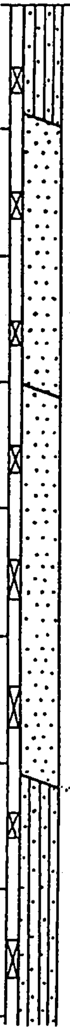
PLATE
15

LOG OF BORING MW-1

Equipment CME 55, Hollow Stem Auger

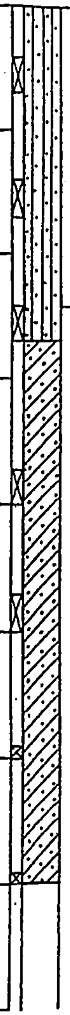
Elevation ______ Date 10/28/91

Laboratory Tests (and other information)	Driving Resistance Blows/ft	Moisture Content	Dry Density	Depth (ft)	
				0	BROWN SILTY SAND (SM) medium dense, dry
	19				
				5	BROWN SAND (SP-SM) medium dense, dry
	26				
				10	
					Color Change to Orange Brown and Becoming dense Below 10.0
	31				
				15	BROWN SAND (SP) medium dense, moist
	22				
				20	
					Color Change to Grey Brown Below 21.0 Feet
	28				
				25	
					Color Change to Orange Brown and Becoming Dense Below 26.0 Feet
	44				
				30	
					BROWN SILTY SAND (SM) medium dense, moist
	18				
				35	With Clay Lenses Below 36.0 Feet
	19				
				40	



Elevation Reference:

Laboratory Tests (and other information)	Driving Resistance Blows/ft	Moisture Content	Dry Density	Depth (ft)	
				40	
					Decreasing Clay Content Below 42.0 Feet
	37				
				45	
	40				
				50	
					▽ WATER LEVEL 10/29/91 - Not Stabilized With Clay Becoming Wet Below 50.0 Feet
	18				
					BROWN CLAYEY SAND (SC) medium dense, wet
				55	
	19				
	20				
				60	
				65	
				70	
				75	
				80	



Pezonella Associates, Inc.
Consulting Engineers and Geologists

Job No. 3072.02
Appr /11m
Date 11/8/91

LOG OF BORING MW-1
CRYSTAL CANYON WASTEWATER FACILITY
Washoe County, Nevada

PLATE
16