PRELIMINARY DESIGN REPORT
FOR THE
DISPOSAL CELL AT THE SEQUOYAH FUELS CORPORATION FACILITY

Prepared For:

Sequoyah Fuels Corporation
I-40 & Highway 10
Gore, Oklahoma 74435

Prepared By:

consulting
scientists and
engineers

3801 Automation Way, Suite 100
Fort Collins, Colorado 80525

December 2002

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Prepared For:
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1.0 INTRODUCTION

This report presents the preliminary engineering design of the on-site disposal cell associated with reclamation of the Sequoyah Fuels Corporation (SFC) facility in Sequoyah County, Oklahoma. The preliminary engineering design has been conducted for SFC by MFG, Inc. (formerly Shepherd Miller), according to the work scope outlined in the May 7, 2002 Shepherd Miller proposal. The disposal cell design is a component of the overall site reclamation plan for the facility.

The on-site disposal cell design is an update of the conceptual disposal cell design documented in Morrison Knudson (M-K, 1996), ESCI (1996) and ESCI (1998). This update is based on (1) additional site characterization data (including SFC, 1998 and SM, 2001), (2) modifications in disposal cell construction strategy by SFC, and (3) a disposal cell cover design incorporating a store-and-deplete infiltration control strategy with a vegetated surface. The disposal cell has been designed to meet the performance criteria for 11e.(2) byproduct material reclamation outlined in Appendix A of 10 CFR 40 and administered by the U.S. Nuclear Regulatory Commission (NRC). The technical analysis of the design has followed procedures outlined in NRC (1990) for long-term stability of 11e.(2) byproduct material sites. This report has been structured to present the updated disposal cell design and supporting technical analyses in a format and level of detail consistent with technical guidelines in NRC (1990), as well as reclamation plan review guidelines in NRC (2002).

2.0 SITE CONDITIONS

Site conditions pertinent to the disposal cell design are outlined in the following subsections.

2.1 Location and Climate

The SFC site is located in north-central Oklahoma, northeast of the confluence of the Illinois River with the Arkansas River (tributaries of the Robert S. Kerr Reservoir). The site encompasses approximately 600 acres on the east bank of the Illinois River, north of Interstate Highway 40 and west of Oklahoma State Highway 10 (shown on Drawing 1). The SFC facilities (shown on Drawing 2) are primarily located within the 85-acre Process Area.

The site is in an area of warm, temperate, continental climate (RSA, 1991). Annual precipitation averages 39 to 45 inches, depending on nearby climatological station location. Precipitation is fairly evenly distributed throughout the year, with more intense precipitation in the spring (ESCI, 1996). For extreme storm events, the probable maximum precipitation events are 29 inches in 6 hours and 19 inches in one hour (Appendix B). Annual evaporation averages approximately 70 inches (for Class A pan data) and 50 inches (for shallow lake data) (Linsley and others, 1975).

2.2 Geologic Setting

As described in RSA (1991), SFC (1998) and SM (2001), the site is located on a ridge or upland area above the Illinois River. The site is underlain by the Pennsylvanian Atoka Formation sequence of sandstone, siltstone and shale. The bedding of these units is nearly horizontal, with varying depths of weathering and erosion. These units are mantled at varying depths with Pleistocene terrace deposits. The underlying soils and sedimentary rocks at the site have been investigated with regional geologic data and over 500 drill holes on site (SFC, 1998).

The site is located on the southwest flank of the Ozark Uplift, a regional structural feature. The site is in an area of low to moderate seismicity with no active structural features or zones of measured seismic activity in the immediate area (as described in Appendix C).

The Atoka Formation sedimentary rocks beneath the site consist of alternating shale and sandstone layers, extending to depths of several hundred feet (SFC, 1998 and SM, 2001). Groundwater levels and water quality have been evaluated from over 300 wells that have been completed on site. This information is presented in other documents (SM, 2001 and MFG, 2002) and not repeated here. These shale and sandstone units are both of relatively low hydraulic conductivity, so that although groundwater is present in these units, groundwater yield is low. The uppermost groundwater beneath the site is within the uppermost shale layer. A limited, transient amount of groundwater is perched on the uppermost shale within the terrace deposits (SFC, 1998 and SM, 2001).

Soils investigated from drilling on site consist of these terrace deposits and weathered zones of the Atoka Formation. The locations of selected drill holes pertinent to borrow area and disposal cell foundation conditions are shown on Drawing 3. The logs of these selected drill holes are presented in Appendix A. These soils range from sandy, clayey gravels to silty clays. The materials are classified (according to the Unified Soil Classification System) as a low to moderate plasticity silt and clay as well as clayey sand and gravel (CL, ML, CH, MH, SC and GC).

2.3 Construction Materials

Potential construction materials for disposal cell cover system, fill, and liner materials include soils and weathered sedimentary rock from on-site sources, and rock from off-site sources. These materials are discussed in Appendix A and summarized below.

Cover Material. Cover material would be obtained from on-site terrace deposit soils and weathered Atoka Formation shale and sandstone. From material balance calculations in Appendix A, there is significantly more material available for cover material than required volume of material. If the sources of cover material are prioritized by proximity to the disposal cell, the existing berm materials and subsoils in the process area are the preferred cover construction materials. These are the tornado berm and settling pond berm materials shown on Drawing 3.

Liner material. As described in subsequent sections, a liner is proposed in a portion of the disposal cell. If a compacted clay is used for this liner, the material would be obtained from the soil borrow area at the south end of the site (Drawing 3).

Topsoil. Topsoil for the surface of the disposal cell and surrounding areas to be vegetated would be obtained from the agland area on the west side of the site (Drawing 1). As discussed in Appendix A, there is sufficient topsoil available in the agland area for the disposal cell cover system and surrounding areas.

Rock mulch. As described in subsequent sections, a layer of rock mulch is planned as an erosion protection zone on the side slopes and perimeter apron of the disposal cell. Although on-site sedimentary rock is available, the preferred sources of rock are nearby commercial sources of limestone or alluvial gravel and cobbles (discussed in Appendix A).

2.4 Disposed Materials

The materials to be placed in the disposal cell consist of process waste materials, structural debris, and underlying liner materials and subsoils from planned site cleanup and reclamation activities. The results of previous characterization of the chemical, radiological and physical properties of these materials are presented in RSA (1991) and SFC (1997). The most current information is compiled in the 1998 Site Characterization Report (SFC, 1998). The characterization data in SFC (1998) is presented in terms of site characterization units (SCUs), representing specific processing areas or facilities on site. The locations of the SCUs are shown on Drawing 2 and pertinent data for each SCU are summarized in Appendix A.

In the preliminary disposal cell design, SFC has grouped similar materials from individual SCUs together for disposal sequencing. Due to the planned placement of these materials in layers in the cell, these groups are referred to as Layers A through D. The correlations between the SCU numbers and Layer numbers are presented in Appendix A, along with estimated volumes of these materials. The four layers are described below.

Layer A. Layer A materials consist of five components: (1) raffinate sludge, (2) Pond 2 residual materials, (3) Emergency Basin sediment, (4) North Ditch sediment, and (5) Sanitary Lagoon sediment. The locations of these materials are shown on Drawing 2.

Due to the relatively high activity concentration of radionuclides in Layer A materials, these materials would be the lowest layer in the disposal cell profile and would be placed over a prepared liner. The volumes and key radionuclide activity concentrations for Layer A materials are presented in Appendix A. In terms of estimated volume, raffinate sludge comprises most of the of Layer A materials (60 percent), followed by Pond 2 residual materials (36 percent), and the remaining sediments (totaling 4 percent).

Layer B. Layer B materials consist of soil liner and subsoil materials beneath the clarifier, the calcium fluoride basin, Pond 3E, the Emergency Basin, the North Ditch and the Sanitary Lagoon, as well as Pond 1 spoils pile material. The Layer B materials (primarily contaminated soils) are listed second in the order, since they would be excavated after removal of Layer A materials and placed directly on top of Layer A materials in the disposal cell profile. The locations of these materials are shown on Drawing 2. The volumes and key radionuclide activity concentrations for Layer B materials are presented in Appendix A. In terms of estimated volume, the Pond 1 spoils pile (35 percent), clarifier liners (26 percent), and Emergency Basin soils (13 percent) comprise approximately 74 percent of the Layer B materials.

Layer C. Layer C materials consist of structural materials, concrete and asphalt, calcium fluoride basin materials, calcium fluoride sediments, and on-site buried materials. These materials would be placed above the Layer B materials, and covered with contaminated soils (Layer D materials). The locations of these materials are shown on Drawing 2. The volumes and key radionuclide activity concentrations for Layer C materials are presented in Appendix A. In terms of estimated volume, the calcium fluoride sediments (44 percent), structural materials (38 percent) and concrete and asphalt (15 percent) comprise approximately 97 percent of the Layer C materials.

Layer D. Layer D materials consist of contaminated soils and sedimentary rock that require cleanup. The cleanup level used for the estimated volume in Appendix A is a natural uranium

activity concentration of 27 pCi/g. The approximate area of material cleanup is shown on Drawing 2.

The total layer material volumes from the estimates from Appendix A are presented in Table 2.1 below, in order of placement from bottom to top within the cell.

Table 2.1 Disposed Material Summary

Layer	Description	Estimated Volume (cu ft)	Fraction of Total Volume (%)	Natural Uranium (pCi/g)	Radium-226 (pCi/g)	Thorium-230 (pCi/g)
A	Sludge and sediment	1,744,735	21.0	357-12100	6-332	211-16300
B	Liner soils and subsoils	1,262,673	15.1	5-95	0.5-2.1	47-70
C	Calcium fluoride sediments, debris	1,764,067	21.1	168-520	0.2-0.8	2.1-4.8
D	Contaminated site soils	3,574,000	42.8	250	--	--
Totals		8,345,475	100.0	--	--	--

3.0 PRELIMINARY DESIGN STRATEGY

3.1 Site Classification

Based on discussions between SFC and NRC personnel, the SFC site is planned for reclamation as an 11e.(2) byproduct material site under performance standards administered by the NRC. All of the waste materials will be disposed on site. Upon successful demonstration to NRC of meeting these performance standards, the site will be transferred to the U.S. Department of Energy for long-term care and maintenance. The proposed boundary of the area to be transferred to the Department of Energy is the institutional control boundary shown on Drawings 1 and 2.

3.2 Design Criteria

The key design criteria for the disposal cell are to: (1) meet the performance standards for reclamation outlined in Appendix A of 10 CFR 40, (2) provide sufficient capacity for disposal of on-site materials, (3) result in a facility that blends in with the surrounding area (from a visual, hydrologic and vegetative standpoint), (4) have a negligible effect on underlying groundwater, and (5) facilitate site cleanup and reclamation activity. These criteria are outlined below.

Performance standards. The performance standards in Appendix A of 10 CFR 40 include: (1) isolation of the 11e.(2) material, (2) reduction of the rate of radon emanation from the cover to an average of 20 pCi/square meter-second, (3) having the reclamation be effective for a long period of time (200 to 1,000 years), and (4) minimizing reliance on active maintenance.

Disposal cell capacity. The disposal cell has been designed to have sufficient capacity for the on-site materials described in Section 2.4. The estimated volumes listed in Table 2.1 total 8.6 million cubic feet. The disposal cell layout shown in Drawing 5 has been sized for a capacity (beneath the cover system) of approximately 9 million cubic feet.

The actual capacity required for the disposal cell depends on the volume of material excavated during site soil cleanup and the density of the material after placement in the cell. From the material volume estimates in Table 2.1, the materials with the largest potential variability are the contaminated soils (Layer D). Due to this variability, the preliminary disposal cell design has

incorporated a range of volumes (from 5 million to 12 million cubic feet). The geometric limits on the disposal cell are: (1) a maximum top surface elevation of approximately 590 feet (to minimize visual impact), and (2) the location of the north and west sides of the cell being fixed. The variability in disposed material volume is accommodated by reducing or extending the locations of the south and east sides of the cell.

Surrounding area impact. As mentioned above, the top surface of the cell will be limited to an elevation of approximately 590 feet to minimize the visual impact of the disposal cell from surrounding areas. In addition, the side slopes of the cell will be at 5:1 (horizontal:vertical) or less, with the corners of the cell rounded to create a topographic feature that is visually similar to the surrounding area. The surface of the complete cell will be vegetated with natural species similar to surrounding areas.

Effect on groundwater. The disposal cell cover design strategy includes minimizing infiltration of meteoric water. This is consistent with Appendix A of 10 CFR 40 as well as the conceptual design (M-K, 1996 and ESCI, 1996). The cover design has been changed from a layered system with a low-permeability compacted clay zone to a uniform zone that promotes evapotranspiration from vegetation (as discussed in Section 4).

Facilitation of site cleanup. The siting and layout of the cell has been designed to accommodate stormwater management and construction activity during site cleanup, as described in more detail in Section 5.

3.3 Site Selection and Layout

The disposal cell was sited to be over the major areas of contamination at the facility, similar to the conceptual design in M-K (1996) and ESCI (1996). The disposal cell was also sited to be close to materials to be placed in the cell, but also out of the way of areas of major building demolition or soil washing. The disposal cell layout has a similar shape and area to the design in M-K (1996) and ESCI (1996), but with the following modifications.

1. The layout incorporates rounded corners to facilitate earthmoving construction techniques as well as produce a feature that blends in with surrounding topography.

2. The facility was moved to the north to utilize the emergency basin for disposal cell stormwater collection during construction.

3. The facility was moved to the east, with the west side angled to reduce the length of slope and area draining into the gully west of the emergency basin.

4. The layout was adjusted to tie into natural ground or anticipated post-reclamation contours to provide drainage away from the toe of the slopes along the perimeter of the cell.

5. Replacement of the diversion channel on the east side of the cell with an apron that drains away from the cell.

6. Changing the top surface of the cell to drain to the southeast at a slope of one percent (with a top elevation of approximately 590 feet). This allows runoff to flow over the side slope on the sides with the shortest slope lengths.

3.4 Institutional Control

As described above, the disposal cell design is based on the site being transferred to the U.S. Department of Energy for long-term care and maintenance. As with other 11e.(2) byproduct material sites, the U.S. Department of Energy will exercise institutional control of the site. This means that the site is fenced to limit unauthorized access. Activities within the institutional control boundary are only those authorized by the U.S. Department of Energy or its contractors, such as monitoring or maintenance. The proposed institutional control boundary for the SFC facility after reclamation is shown on Drawings 1 and 2.

4.0 DISPOSAL CELL DESCRIPTION

The preliminary disposal cell design is shown on Drawings 5, 6 and 7, based on the design criteria and strategy outlined in Section 4. This design is described in the following subsections.

4.1 Layout and Capacity

The disposal cell layout consists of a four-sided domed structure to contain the disposed materials beneath a soil cover. The top surface of the structure drains to the southeast (the corner with the highest ground surface elevation) at a one-percent slope. The direction of top surface drainage was chosen to be toward the highest ground elevation and away from the west side of the cell. The side slopes of the cell are at 5:1 (20 percent), the maximum slope under NRC reclamation criteria.

The disposal cell layout for the estimated volume of disposed materials in Table 2.1 (8.4 million cubic feet) is shown in the drawings, and on Figure 4.1. Due to the variability in disposed material density, the amount of stabilizing additives that may be added to some materials, and the amount of Layer D soils that may actually be excavated, the disposal cell location and layout has been planned to accommodate a range of disposed material volumes (from 5 million to 12 million cubic feet). The cell layouts that would accommodate this range in volumes are shown in Figures 4.2 and 4.3, for capacities of 5 and 12 million cubic feet, respectively. For these cell layouts, the north and west sides remain in the same location and with the same height, while the location of the south and east sides are adjusted. A typical cross section through the disposal cell (for any of these volumes) is shown in Figure 4.4. The key volume relationships for the range of cell layouts are shown in Figure 4.5.

4.2 Cover System

The cover system over the disposal cell consists of a 10-foot thick soil cover on both the top surface and side slopes of the cell. This cover system is shown in cross section and detail on Drawing 7, and is summarized in Figure 4.4.

The upper 18 inches of the cover system consists of an erosion protection and vegetation zone. On the top surface, the upper 18 inches of the cover thickness consists of a topsoil layer. On the side slopes, the upper 18 inches consists of a 12-inch thick topsoil layer above a six-inch thick rock mulch layer. The cover surface will be vegetated, with the long-term vegetation being a native grassland and forest system. The remaining 8.5-foot thickness of the cover system will consist of on-site soils to provide a root zone and moisture retention zone for infiltrating meteoric water.

4.3 Perimeter Area

The disposal cell perimeter will transition into the surrounding reclaimed site topography such that drainage from the toe of the side slopes is conveyed away from the cell. Outside the toe of the side slopes will be a 20-foot wide perimeter apron, consisting of the same topsoil and rock mulch layers as on the side slopes (Drawing 7).

4.4 Erosional Stability

The erosional stability of the disposal cell design was evaluated according to procedures outlined in NRC (1990) and NRC (1999). The evaluation methods and results are outlined in Appendix B. The disposal cell surface was evaluated for peak runoff from the Probable Maximum Precipitation (PMP) event. The calculated velocity from the peak runoff was compared with acceptable, non-erosive velocities on the top surface and side slopes of the disposal cell.

On the top surface of the disposal cell, the one-percent slope with vegetated surface conditions provides sufficient resistance to erosion, even under conservative, poor vegetation conditions. On the side slopes of the disposal cell, flow velocities down the 5:1 slopes require rock for erosion protection from PMP runoff. The selected protection is a layer of rock mulch with a median particle size of 3.2 inches (sized for the peak flow from the PMP). In order to promote vegetative growth on the side slopes, the rock mulch layer will be at the base of the topsoil layer (shown in Figure 4.4). The same protective layer will be extended 20 feet from the toe of the side slopes for a perimeter apron (shown in Figure 4.4).

4.5 Slope Stability

The slope stability of the disposal cell was evaluated under static and seismic conditions according to standard criteria outlined in NRC (2002). The stability evaluation results and selection of seismic parameters are outlined in Appendix C.

The stability analysis results are presented as calculated factors of safety, which are compared with accepted minimum factors of safety. The analysis results under static conditions show that calculated factors of safety are higher than the minimum long-term value of 1.5. The analysis results under seismic conditions (represented by pseudostatic analyses) show that calculated factors of safety are higher than the minimum value of 1.1. The stability analyses were conducted using conservative input values for material shear strength and density (as described in Appendix C).

4.6 Radon Emanation

The reduction in emanation of radon-222 from disposed materials by the cover system was evaluated using calculation procedures outlined in NRC (1989). The evaluation input parameters and results are presented in Appendix D. The evaluation results show that the cover system and sequence of disposed material placement in the cell reduces the average rate of radon-222 emanation to below the limit of 20 pCi/square meter-second (from Appendix A of 10 CFR 40).

The radon emanation calculations used the RADON model (NRC, 1989), with conservative parameters for the cover system and disposed materials. Maximum ingrowth from thorium-230 to radium-226 under long-term conditions was included as input for the disposed materials in the calculations.

4.7 Meteoric Water Infiltration

Infiltration of meteoric water and moisture migration through the cover system was evaluated using two applicable moisture tracking models. The modeling method and results are presented in Appendix E.

The first model used was the HELP model (Schroeder and others, 1994), selected as an accepted infiltration model and for comparison with the modeling of the cover system in the preliminary design (ESCI, 1996). Modeling was conducted using average climatic conditions over a simulation period of 100 years. Typical soil properties were used with a fully developed vegetative cover. The average rate of migration of meteoric water through the bottom of the cover was calculated to be approximately 0.92 inches/year, or 2.3 percent of annual precipitation. This rate of migration is higher than that calculated for the layered cover system in ESCI (1996), ranging from 0.78 to 0.01 inches/year.

The second model used was the TerreSIM model, an MFG model used for land use and ecosystem evaluation (described in Appendix E). The TerreSIM model uses a detailed method of tracking evapotranspiration and plant canopy evaporation, based on specific plant communities. Modeling was conducted under average climatic conditions for a simulation period of 200 years. The same soil properties as those in the HELP modeling were used, with more detailed characterization of the native plant community used for revegetation. The average rate of migration of meteoric water through the bottom of the cover was calculated to be approximately 7.8 inches/year or 17 percent of annual precipitation, for the first 45 years of simulation. For the next 155 years of simulation (after full development of the plant community), the calculated rate of migration through the cover was zero.

As described in Section 5, the synthetic liner materials in ponds on site are planned for re-use by placement within the layers of disposed materials in the disposal cell. The synthetic liner will be spread, overlapped, and covered to provide a liner system to intercept downward-migrating moisture from the cover system. Therefore for short-term conditions, the synthetic liner would limit moisture migration through the disposed materials. For long-term conditions (after establishment of mature vegetation on the cover), moisture migration from the bottom of the cover is limited by the cover itself. From the modeling under long-term conditions described above, the rate of moisture migration out of the cover is negligible (Appendix E).

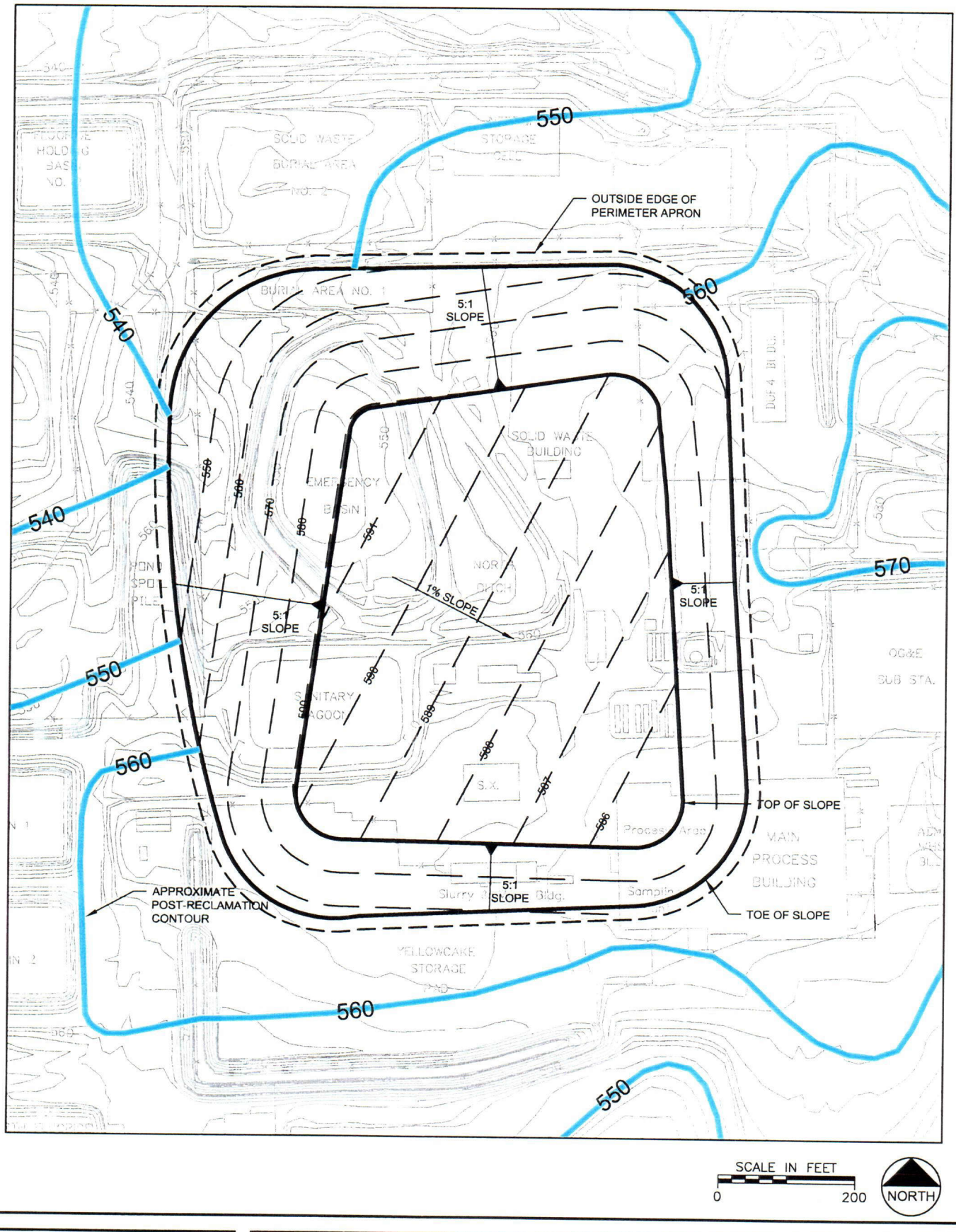

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FIGURE 4.1
DISPOSAL CELL LAYOUT FOR
9 MILLION CUBIC FOOT CAPACITY

Date:	DECEMBER 2002
Project:	180734
File:	SITE-FIGS-01

C01

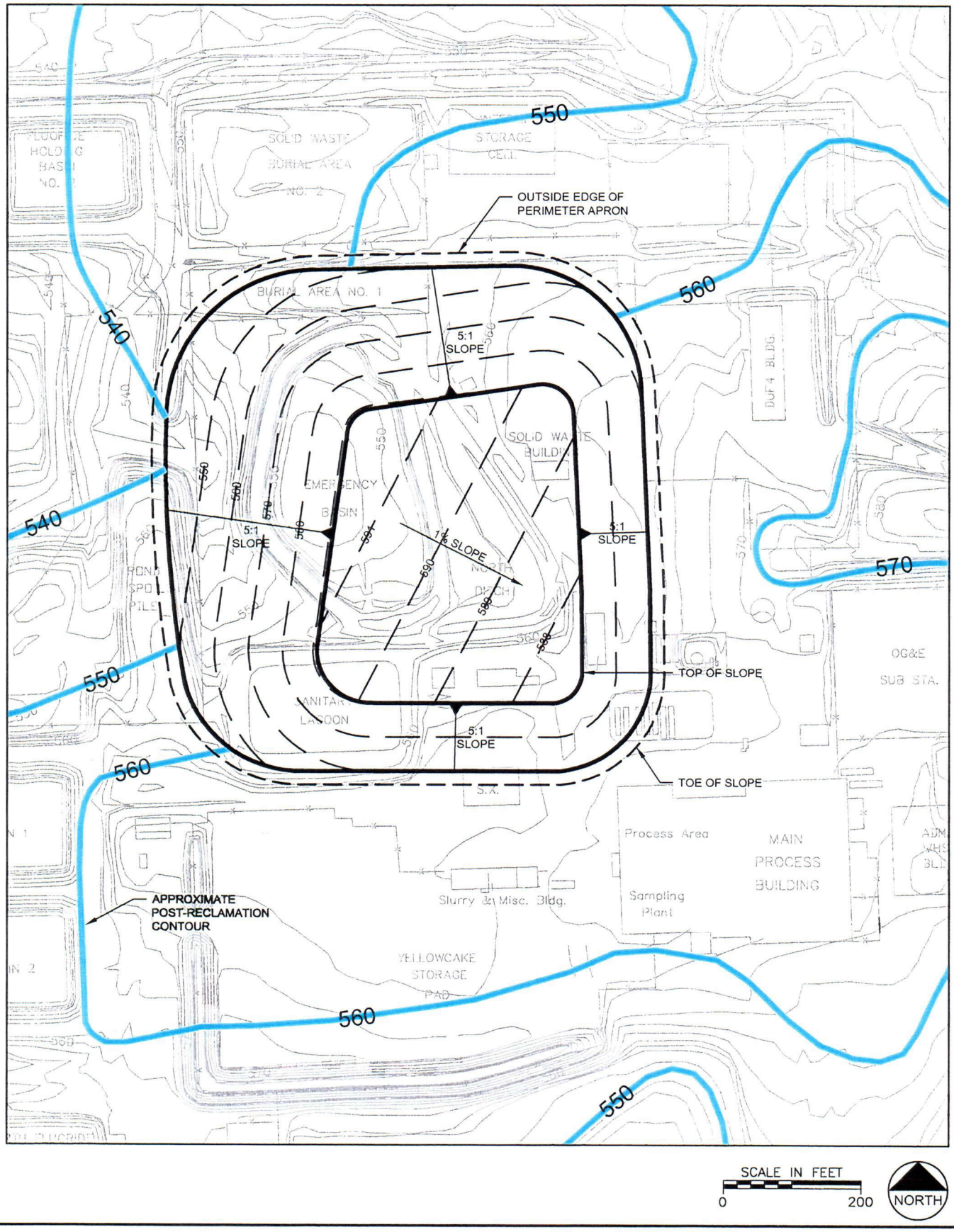

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FIGURE 4.2
DISPOSAL CELL LAYOUT FOR 5 MILLION CUBIC FOOT CAPACITY

Date:	DECEMBER 2002
Project:	180734
File:	SITE-FIGS-01

C02

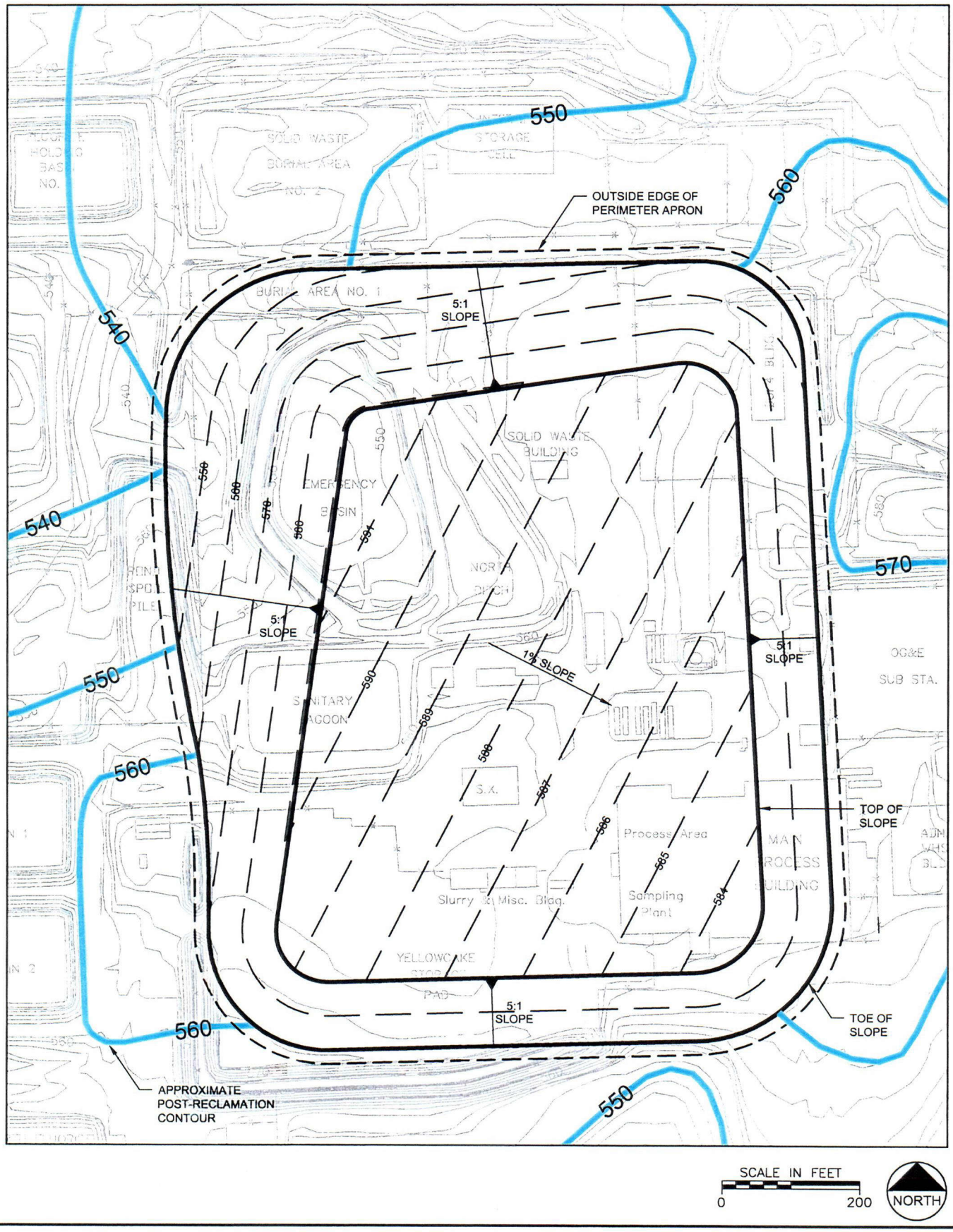

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FIGURE 4.3
DISPOSAL CELL LAYOUT FOR 12 MILLION CUBIC FOOT CAPACITY

Date:	DECEMBER 2002
Project:	180734
File:	SITE-FIGS-01

C03

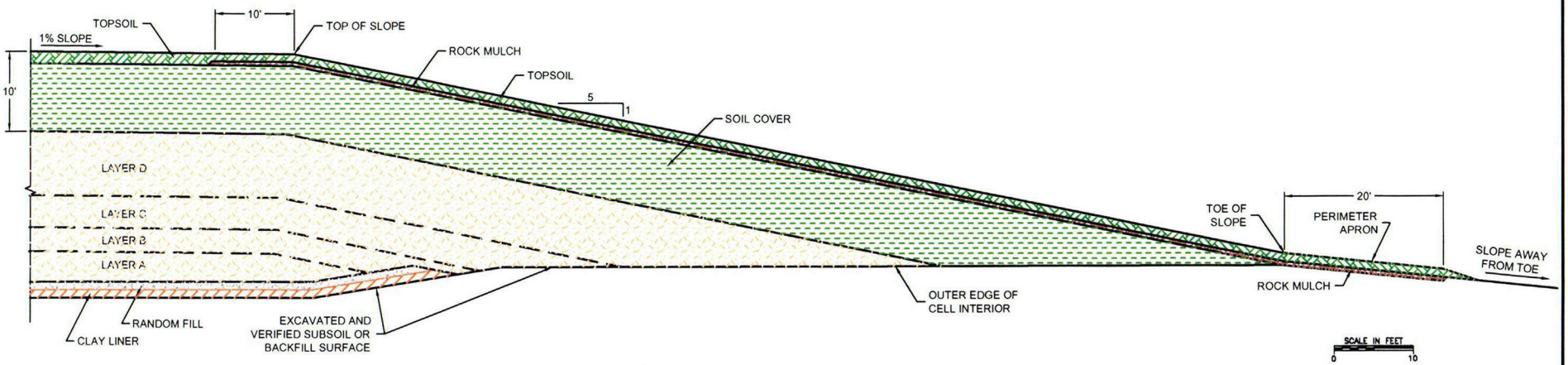

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FIGURE 4.4
TYPICAL CROSS SECTION ON EAST SIDE OF DISPOSAL CELL

Date:	DECEMBER 2002
Project:	180734
File:	SITE-FIGS-01

C04

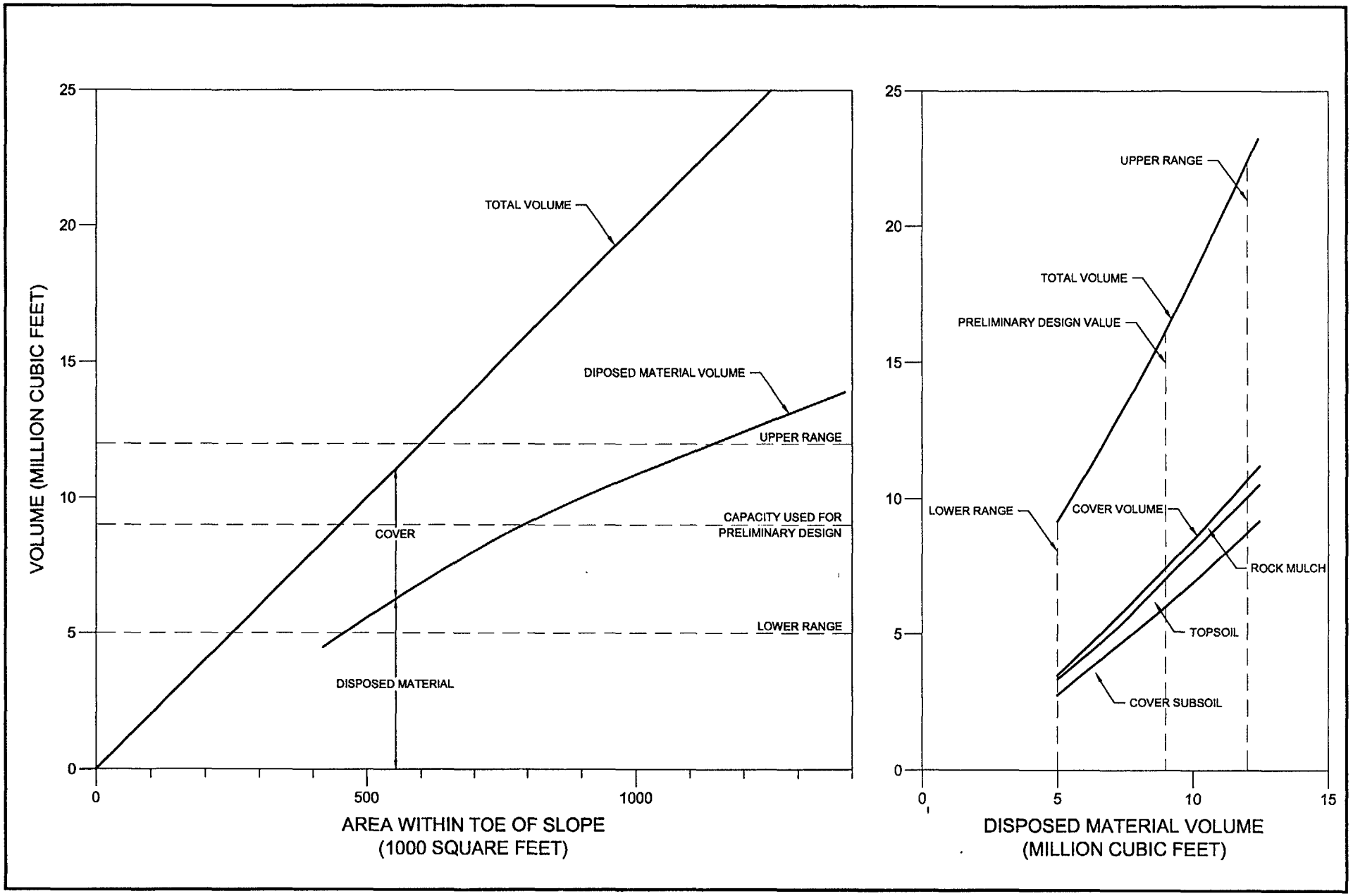

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FIGURE 4.5
DISPOSAL CELL VOLUME RELATIONSHIPS

Date:	DECEMBER 2002
Project:	180734
File:	SITE-FIGS-01

5.0 DISPOSAL CELL CONSTRUCTION

The anticipated strategy for disposal cell construction (from the base of the facility to the bottom of the cover system) is outlined in the following subsections.

5.1 Overall Sequence

As mentioned in Section 2.4, the materials to be disposed have been grouped by radionuclide activity concentration. These groups or layers are summarized in Table 2.1. The sequence of placement in the disposal cell is by these layers (as shown in Figure 4.4).

As mentioned in Section 4.7, the synthetic liner material from the ponds on site will be removed and incorporated into the disposal material layer sequence. The liner material placement will be above the Layer B materials, within the Layer C or D materials.

5.2 Water Management

Water management during disposal cell construction will include the elements listed below:

1. Removal, treatment and permitted discharge of water in existing ponds (primarily Layer A material ponds).
2. Diversion of clean area stormwater runoff from work areas (where material excavation will take place) and from the disposal cell footprint.
3. Collection of stormwater runoff from work area and the disposal cell footprint for treatment and permitted discharge or use for disposed material compaction or dust control.
4. Isolation of water used for processing operations (such as soil washing or leaching) from stormwater runoff.

5.3 Construction Sequence

In conjunction with the overall sequence and water management strategy above, the anticipated construction sequence for the disposal is outlined below.

1. Setup of the soil stockpiling and washing or leaching area in the yellowcake storage pad.

2. Removal of sediment and underlying subsoils from the emergency basin, north ditch, and sanitary lagoon (Layer A and Layer B materials). These materials would require temporary stockpiling.

3. Removal of contaminated soils from the footprint of the disposal cell,-particularly where the lined area will be (shown on Drawing 6). This will include excavation of utility trenches and removal of piping and conduit within the cell footprint. These materials would require temporary stockpiling.

4. Backfilling and compaction of excavated areas within the cell footprint.

5. Preparation of the lined area within the disposal cell (Drawing 6).

6. Placement of Layer A materials within the lined area of the disposal cell. This would include the stockpiled materials from the emergency basin, north ditch, and sanitary lagoon, as well as Pond 2 residual material and raffinate sludge.

7. Removal of and temporary stockpiling of synthetic liners.

8. Excavation of remaining liner soils and subsoils from Layer A ponds and Pond Spoils Pile materials, and placement in Layer B (on top of Layer A materials) in the disposal cell. Excavation of materials from the interim soil storage cell and the area west of the storage cell, and placement in Layer B.

9. Preparation of remaining areas of the disposal cell for fill placement.

10. Excavation of remaining Layer B and C materials and placement in the disposal cell.

11. Removal of structural materials, and placement in the disposal cell (in Layer C).

12. Excavation of remaining contaminated soils (Layer D materials), with disposal cell footprint adjusted to the east and south as necessary (based on contaminated soil volume).

13. Cover construction (described in Section 6).

6.0 COVER CONSTRUCTION

As previously discussed, the disposal cell cover has been modified from the layered system in ESCI (1996) to a homogeneous, (store-and-deplete) cover with a vegetated surface. The cover is designed to promote long-term vegetative growth that optimizes evapotranspiration and subsequently minimizes infiltration. Based on preliminary analyses, this homogeneous cover would be ten feet thick for optimal root zone development and sufficient for radon attenuation. A ten-foot thickness was used for volume estimates, and is shown in the cross sections and details on the Drawings. This ten-foot thickness includes an 18-inch thick topsoil and rock mulch zone at the cover surface.

6.1 Construction Materials

The disposal cell cover construction materials are discussed in Section 2.3 and Appendix A. The material quantities (for the preliminary design cell disposal capacity of approximately 9 million cubic feet) are outlined below.

Cover system materials. The cover material volume (for the 10-foot thick cover) totals approximately 258,700 cubic yards. As discussed in Appendix A, significantly more material is available on site than is required for the cover material.

Topsoil. As mentioned above, approximately 35,400 cubic yards of topsoil would be required for the cover, and 4,000 cubic yards for the perimeter apron. Sufficient topsoil is available for this volume (and additional volume) from the agland area.

Rock mulch. The rock mulch volume totals 8,000 cubic yards for the cell cover and 2,000 cubic yards for the perimeter apron. Rock mulch material would be obtained from off-site sources.

Cover subsoil materials. The remaining cover material volume (subtracting the topsoil and rock mulch) is approximately 215,300 cubic yards, for the layout shown on the drawings. The likely sources of this material would be the tornado berm and settling pond berm materials.

6.2 Construction Sequence

The anticipated construction sequence for the disposal cell cover is outlined below.

1. Construction of the cover on the north and west sides of the disposal cell. The cover material could be placed in horizontal lifts or lifts parallel to the outside 5:1 slopes. The rock mulch and topsoil would be placed as cover areas are completed to final elevations and grades.

2. Cover material placement is planned to minimize voids and future differential settlement. Placement in lifts with a method compaction specification is planned, based on the anticipated type of construction equipment.

3. Construction of the cover over completed areas of the cell, with the south and east sides of the cell established after the volume of contaminated soils has been established.

4. Transition of the perimeter apron of the disposal cell with surrounding reclaimed topography to promote runoff away from the disposal cell.

5. Establishment of vegetation on the disposal cell surface, consistent with the overall plan for mature vegetation development.

7.0 PERFORMANCE MONITORING AND VERIFICATION

The performance monitoring and verification tasks for the disposal cell are consistent with plans for overall site reclamation and review guidelines in NRC (2002). Key tasks are outlined in the following subsections, and address the period of time from site reclamation until property transfer to the U.S. Department of Energy.

7.1 Settlement

Since the soil-like disposal materials will be placed in lifts and compacted to minimize void spaces (as described in Section 5) and sludges will be dewatered or solidified, cover settlement will not be as critical an issue as for uranium tailings impoundments. However, settlement will be monitored with survey monuments installed on a grid system on the cover surface. The monuments will be surveyed on a quarterly basis until four quarters of stable conditions (less than 0.1 foot of settlement) are measured.

7.2 Vegetative Cover

A vegetation plan will be prepared for the disposal cell surface outlining the initial and mature species desired for the cell and the schedule and methods planned for achieving the mature vegetation (such as transplanting of seedlings and institution of weed control). After establishment of the initial vegetation on the cover surface, the condition of the initial vegetation will be monitored for comparison with the schedule in the vegetation plan. The vegetation performance will be monitored by SFC until that responsibility is changed with property transfer to the U.S. Department of Energy.

7.3 Erosional Stability

The erosional stability of the cover surface will be monitored on a semi-annual basis, most likely at the same time as vegetation monitoring. Elements of the erosional stability monitoring are degree of vegetation cover (in terms of surface coverage), identification of settled or ponded areas (such as on the top surface), and identification of rills, gullys, or other areas of runoff concentration. Areas that are identified will be monitored to determine if corrective action is

necessary. Corrective action would include fill placement with topsoil or placement of erosion-resistant materials on the surface, such as rock mulch.

7.4 Groundwater Protection

The strategy for a groundwater protection plan will be developed under NRC guidelines as the result of a Corrective Action Assessment for the site. This will be developed independently of the disposal cell design.

8.0 REFERENCES

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DRAWINGS

SITE LOCATION MAP

US HWY 64

MISSOURI PACIFIC RAILROAD

PROPOSED INSTITUTIONAL CONTROL BOUNDARY

ILLINOIS RIVER

HEADWATERS OF ROBERT S. KERR RESERVOIR

CURRENT FACILITY BOUNDARY

AGLAND

FERTILIZER POND AREA

ROBERT S. KERR RESERVOIR

INTERSTATE 40

N

SCALE IN FEET

300 0 600

NOTE: TOPOGRAPHY AND SITE FACILITIES FROM SEQUOYAH FUELS CORPORATION DATA AND REPORTS

REVISIONS	No.	DESCRIPTION	BY	CHKD.	APPROVED		DATE
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DESIGNERS	ENGINEERING RECORD	BY	DATE
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consulting scientists and engineers

Fort Collins, CO
970 223-9600

PREPARED FOR

SEQUOYAH FUELS
A GENERAL ATOMICS COMPANY

TITLE

SITE LOCATION AND CURRENT SITE LAYOUT

PROJECT	100734	DATE	DECEMBER 2002	DRAWING	REVISION
SCALE	AS SHOWN	ACAD FILE	SITE-01.DWG	1	A

C05

SITE CHARACTERIZATION UNIT LIST
(from SFC, 1998)

1. Main Process Building area
2. Solvent Extraction Building area
3. Initial lime neutralization unit
5. Solid Waste Burial area (south)
6. Emergency Basin
7. Sanitary Lagoon
8. Pond 1 Spoils Pile
9. North Ditch
10. Contaminated equipment area
11. Drainage areas around Emergency Basin and north ditch
12. Fluoride Holding Basin No. 2
13. Fluoride Holding Basin No. 1
14. Fluoride Clarifier and Settling Basins
15. Fluoride Sludge Burial area
16. South Yellowcake Sump
17. Clarifier A Basin area
18. Pond 2
19. Area west of Pond 2
20. Solid Waste Burial Area No. 2 (north)
21. Yellowcake Storage Pad
22. East perimeter area (northern section)
23. 1986 incident soil storage area
24. FertilizerPond area
25. Former raffinate treatment area
26. Decorative Pond area
27. Combination stream
28. Present Lime Neutralization Area
29. DUF_4 Building area
30. Tank farm and cylinder storage area
31. Front lawn area
32. South perimeter area
33. Northeast perimeter area
34. Drainage/runoff areas
35. Scrap metal storage area and interim storage cell
50. 1986 incident plume area
52. Northeast perimeter area
53. Northwest perimeter area
54. Southwest perimeter area
55. Southeast perimeter area

ILLINOIS RIVER

CURRENT FACILITY BOUNDARY

DISPOSAL CELL OUTLINE

CUT AREA

SETTLING POND BERMS

TORNADO BERM

STORMWATER RESERVOIR EMBANKMENT

FERTILIZER POND BERMS

FERTILIZER POND AREA

SOIL BORROW AREA

HWY 10

LEGEND

14 SITE CHARACTERIZATION UNIT NUMBER OUTLINED IN TABLE ABOVE (FROM SFC, 1998)

PERIMETER OF POTENTIAL SOIL BORROW AREA

PROPOSED INSTITUTIONAL CONTROL BOUNDARY

LAYER A MATERIALS

LAYER C CALCIUM FLUORIDE SEDIMENTS AND BURIED MATERIALS

LAYER C STRUCTURAL MATERIALS

LAYER C CONCRETE AND ASPHALT

LAYER B MATERIALS

APPROX. PERIMETER OF LAYER D CONTAMINATED SOIL AND ROCK

SCALE IN FEET
200 0 400

NOTE: TOPOGRAPHY AND SITE FACILITIES FROM SEQUOYAH FUELS CORPORATION DATA AND REPORTS

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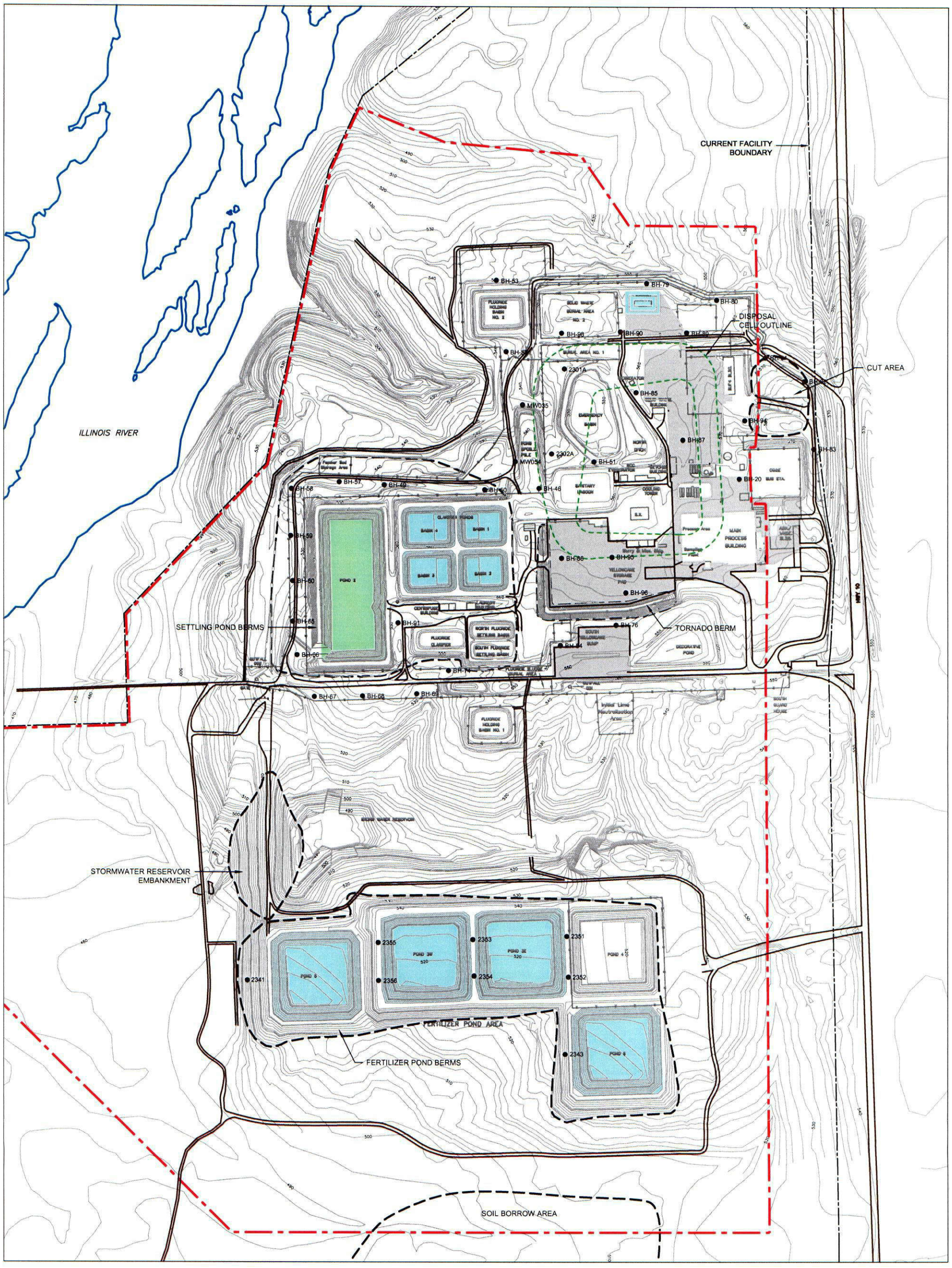
CURRENT SITE LAYOUT AND FACILITIES

PROJECT	100734	DATE	DECEMBER 2002	DRAWING	REVISION
SCALE	AS SHOWN	ACAD FILE	SITE-01.DWG	2	A

C06



LEGEND

- CURRENT HDPE-LINED AREA
- CURRENT HYPALON-LINED AREA
- MAJOR CONCRETE PAD AREAS
- ● SELECTED DRILL HOLE LOCATION
- PERIMETER OF POTENTIAL SOIL BORROW AREA
- PROPOSED INSTITUTIONAL CONTROL BOUNDARY

SCALE IN FEET

200 0 400

NOTE: TOPOGRAPHY AND SITE FACILITIES FROM SEQUOYAH FUELS CORPORATION DATA AND REPORTS

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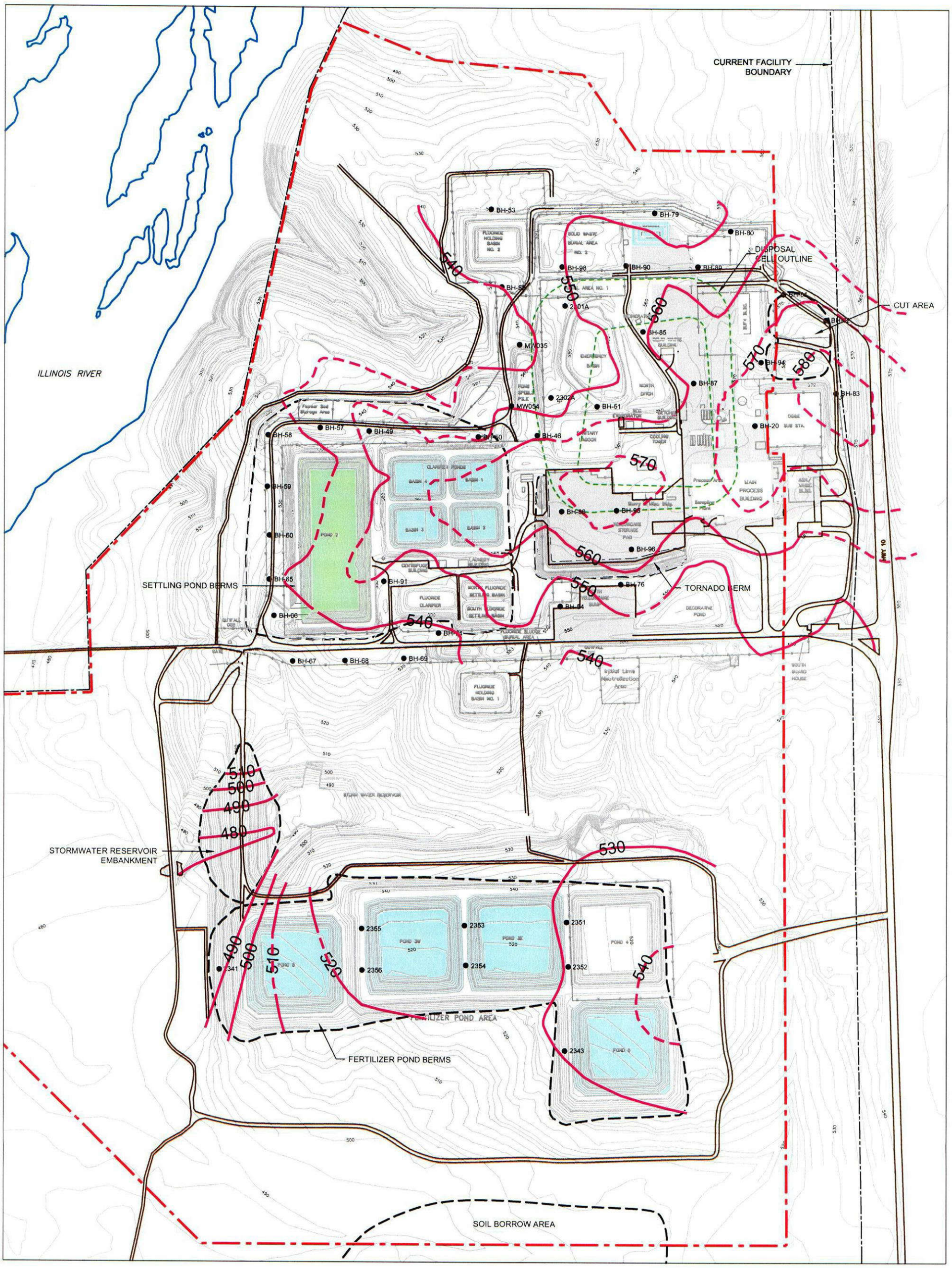
CURRENT SITE LAYOUT WITH LINER AND PAD AREAS AND POTENTIAL BORROW AREAS

PROJECT	100734	DATE	DECEMBER 2002	DRAWING	REVISION
SCALE	AS SHOWN	ACAD FILE	SITE-01.DWG	3	A

C07



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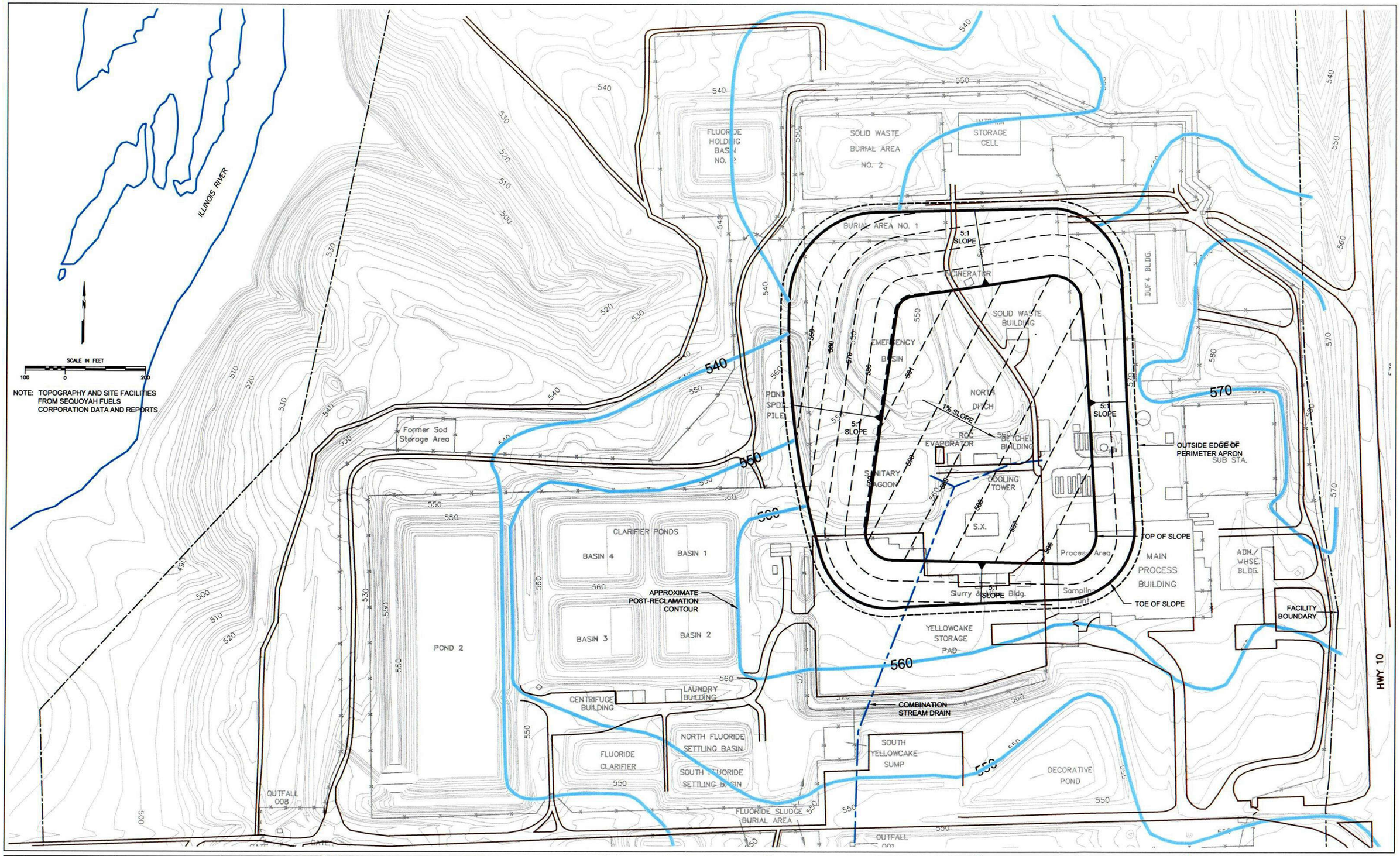
CURRENT SITE LAYOUT WITH ORIGINAL GROUND CONTOURS

PROJECT	100734	DATE	DECEMBER 2002	DRAWING	REVISION
SCALE	AS SHOWN	ACAD FILE	SITE-01.DWG	4	A

C08



REVISIONS	No.	DESCRIPTION	BY	CHKD.	APPROVED		DATE
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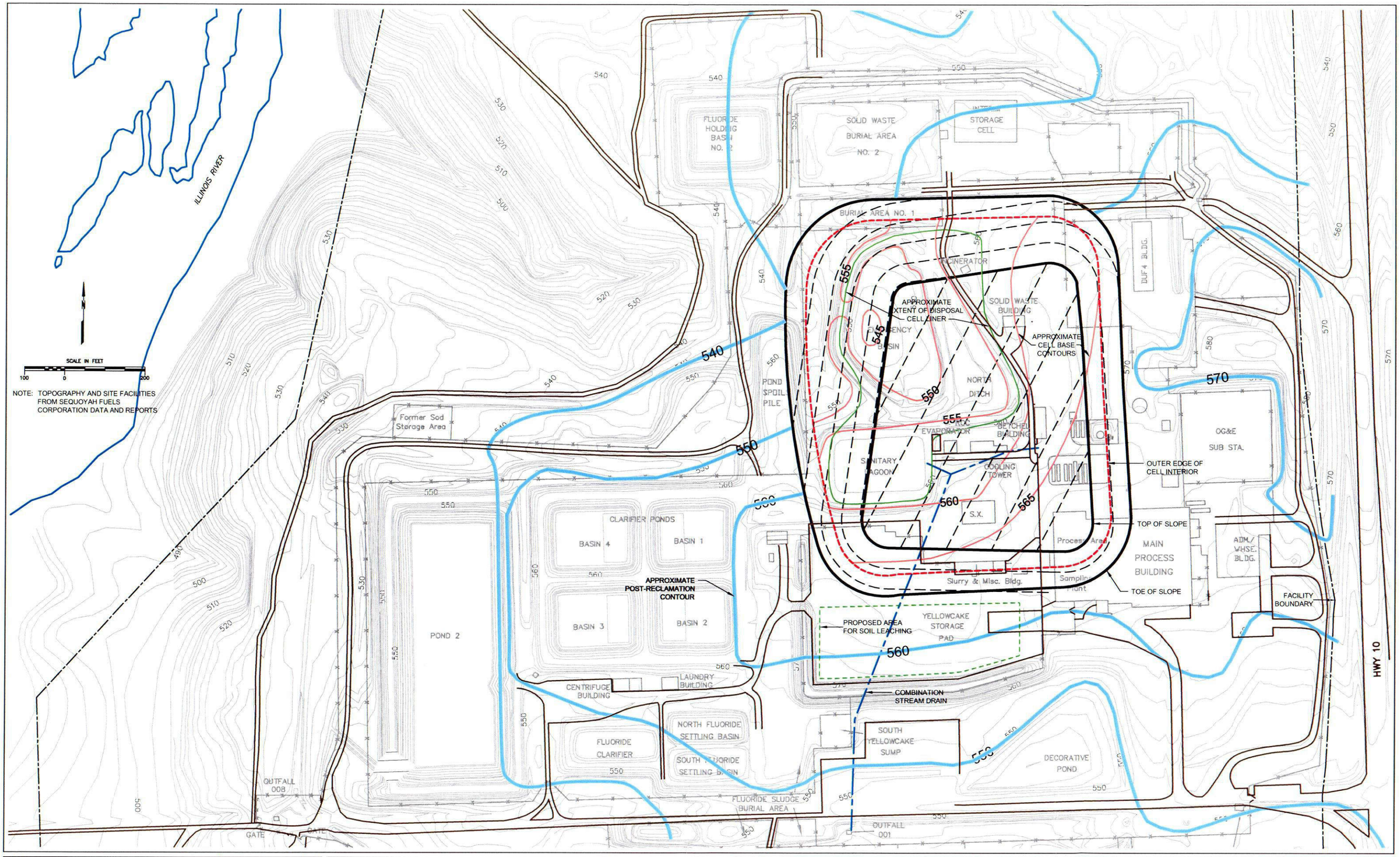
CURRENT FACILITIES AND DISPOSAL CELL LAYOUT

PROJECT	100734	DATE	DECEMBER 2002	DRAWING	REVISION
SCALE	AS SHOWN	ACAD FILE	SITE-01.DWG	5	1

C09



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DISPOSAL CELL INTERIOR PLAN

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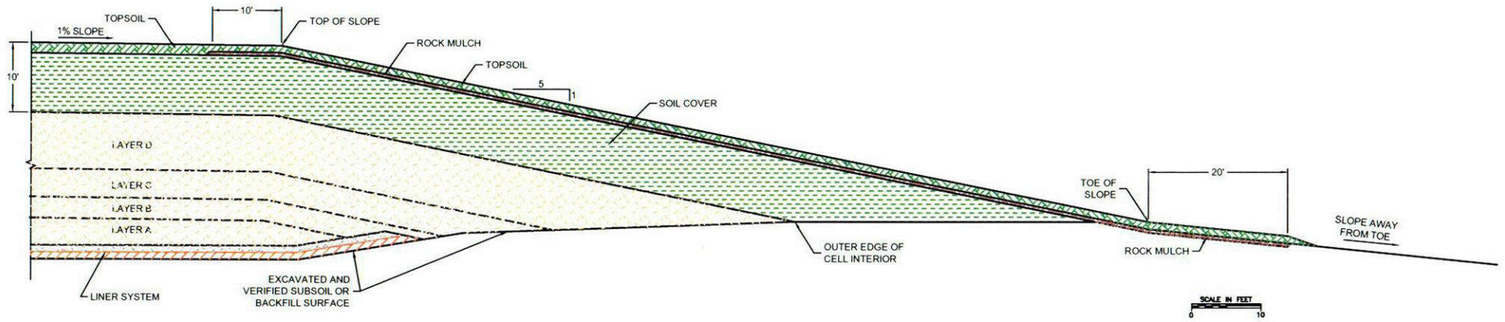
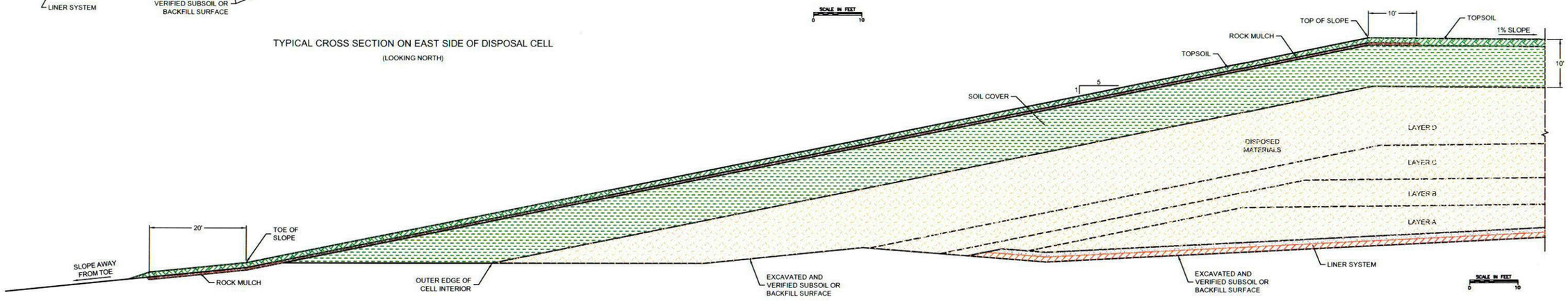
C10



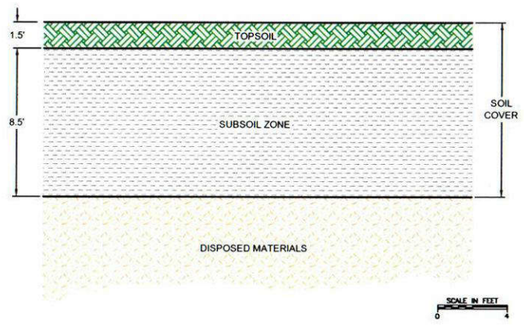
TYPICAL CROSS SECTION ON EAST SIDE OF DISPOSAL CELL

(LOOKING NORTH)

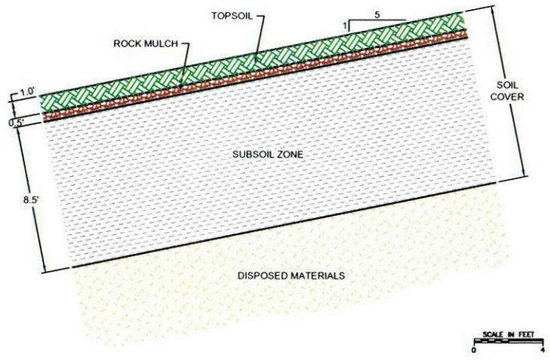


TYPICAL CROSS SECTION ON WEST SIDE OF DISPOSAL CELL

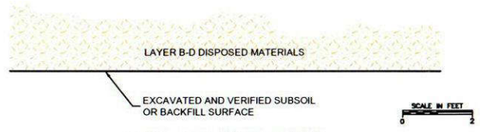
(LOOKING NORTH)



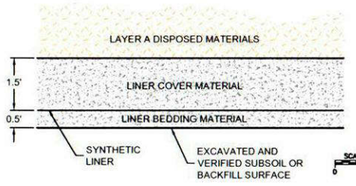
TYPICAL COVER SYSTEM DETAIL, TOP OF CELL



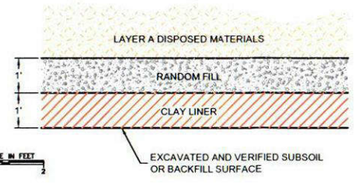
TYPICAL COVER SYSTEM DETAIL, CELL SIDE SLOPES



TYPICAL CELL BOTTOM DETAIL
BENEATH LAYER B-D MATERIALS



TYPICAL LINER SYSTEM DETAIL
(BENEATH LAYER A MATERIALS)
FOR SYNTHETIC LINER ALTERNATIVE



TYPICAL LINER SYSTEM DETAIL
(BENEATH LAYER A MATERIALS)
FOR CLAY LINER ALTERNATIVE

NOTES:

1. ROCK MULCH - Rock mulch with median particle size of 3.2 inches, and layer thickness of 6 inches.
2. TOPSOIL - Approved material obtained from within facility boundary.
3. SOIL COVER - Gravelly clay to silty clay obtained from within facility boundary.
4. SALVAGED SYNTHETIC LINER - Hypalon or HDPE from stockpiles on site or removed from existing closed ponds. Liner material lapped in shingled manner (minimum overlap of 12 inches) prior to covering with disposed material.
5. RANDOM FILL - Material from site cleanup operations, top surface rolled with vibratory roller or compactor.
6. DISPOSED MATERIALS - Materials from site cleanup operations, placed in lifts to minimize void spaces and rolled (where necessary) with vibratory roller or compactor.
7. CLAY LINER - Silty clay compacted to 95 percent of Standard Proctor density and within 2 percent of Standard Proctor optimum moisture content. Material obtained from within facility boundary.
8. SYNTHETIC LINER - 60-mil nominal thickness HDPE, seamed and tested to form continuous liner.
9. LINER BEDDING MATERIAL - Granular material with maximum particle size of 1.0 inches.
10. LINER COVER MATERIAL - Granular material with maximum particle size of 1.0 inches.

REVISIONS

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TYPICAL DISPOSAL CELL CROSS SECTIONS AND DETAILS

PROJECT	100734	DATE	DECEMBER 2002	DRAWING	REVISION
SCALE	AS SHOWN	ACAD FILE	SITE-01.DWG	7	0

C11

APPENDIX A

MATERIAL CHARACTERIZATION

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ATTACHMENTS

A.1 INTRODUCTION

This appendix summarizes available material characterization data for (1) the materials to be placed in the disposal cell, and (2) materials to be used for the disposal cell cover system. This data is discussed in the following sections, and is used in subsequent appendices of this report to analyze key aspects of the preliminary disposal cell design.

A.2 DISPOSED MATERIALS

The materials to be placed in the disposal cell consist of process waste materials, structural debris, and underlying liner materials and subsoils from planned site cleanup and reclamation activities. The results of previous characterization of the chemical, radiological and physical properties of these materials are presented in the 1998 Site Characterization Report (SFC, 1998). The characterization data is presented in terms of site characterization units (SCUs), representing specific areas or facilities on site. The locations of the SCUs are shown on Drawing 2 and pertinent data for each SCU are summarized in Attachment A.1.

In the conceptual disposal cell design, SFC has grouped similar materials from individual SCUs together for disposal sequencing. Due to the planned placement of these materials in layers in the cell, these groups are referred to in this report as Layers A through D. The correlations between the SCU numbers and Layer numbers are presented in Attachment A.1. The estimated volumes of these materials are also included in Attachment A.1, based on calculations by SFC documented in SFC (1998), as well as recent updated estimates by SFC. The four layers are described below.

Layer A. Layer A materials consist of five components: (1) raffinate sludge, (2) Pond 2 residual materials, (3) Emergency Basin sediment, (4) North Ditch sediment, and (5) Sanitary Lagoon sediment. The locations of these materials are shown on Drawing 2.

Due to the relatively high activity concentration of radionuclides in Layer A materials, these materials would be the lowest layer in the disposal cell profile and would be placed over a prepared liner. The volumes and key radionuclide activity concentrations for Layer A materials

are summarized in Table A.1. In terms of estimated volume, raffinate sludge comprises most of the of Layer A materials (60 percent), followed by Pond 2 residual materials (36 percent), and the remaining sediments (totaling 4 percent).

The radionuclide concentrations for Layer A materials are presented in Table A.1 as mean values and in Table A.2 as 95 percent upper confidence-interval values, based on statistical analysis of Layer A material data. This analysis was conducted by SFC and summarized at the end of Attachment A.1.

Layer B. Layer B materials consist of soil liner and subsoil materials beneath the clarifier, highly contaminated soils, the calcium fluoride basin, Pond 3E, the Emergency Basin, the North Ditch and the Sanitary Lagoon, as well as Pond 1 spoils pile and interim soil storage cell material. The Layer B materials (primarily contaminated soils) are listed second in the order, since they would be excavated after removal of Layer A materials and placed directly on top of Layer A materials in the disposal cell profile. The locations of these materials are shown on Drawing 2. The volumes and key radionuclide activity concentrations for Layer B materials are summarized in Table A.3. In terms of estimated volume, the Pond 1 spoils pile (35 percent), clarifier liners (26 percent), and Emergency Basin soils (13 percent) comprise approximately 74 percent of the Layer B materials.

Layer C. Layer C materials consist of structural materials, concrete and asphalt, calcium fluoride basin materials, calcium fluoride sediments, and on-site buried materials. These materials would be placed above the Layer B materials, and covered with contaminated soils (Layer D materials). The locations of these materials are shown on Drawing 2. The volumes and key radionuclide activity concentrations for Layer C materials are summarized in Table A.4. In terms of estimated volume, the calcium fluoride sediments (31 percent), structural materials (28 percent) and concrete and asphalt (25 percent) comprise approximately 84 percent of the Layer C materials.

Layer D. Layer D materials consist of contaminated soils and sedimentary rock that require cleanup. The cleanup level used for the estimated volume in Table A.5 is a natural uranium

activity concentration of 27 pCi/g. The approximate area of material cleanup is shown on Drawing 2.

The total layer material volumes from the estimates in Tables A.1 through A.5 are summarized below.

Layer	Estimated Volume (cu ft)	Fraction of Total Volume (%)
A	1,744,735	21.0
B	1,262,673	15.1
C	1,764,067	21.1
D	3,574,000	42.8
Totals	8,345,475	100.0

A.3 COVER MATERIAL

The planned disposal cell cover system consists of a 10-foot thick zone, comprised of an 8.5 foot thick zone of soil cover (subsoil) material beneath a 1.5-foot thick layer of rock mulch and topsoil. The soil cover will be constructed with on-site soils and shallow sedimentary rocks. Characterization of these materials is based on drill hole logs from previous subsoil investigation and well installation work. The locations of selected drill holes pertinent to borrow area and disposal cell foundation conditions are shown on Drawing 3. The logs of these selected drill holes are presented in Attachment A.2.

As described in SMI (2001) and SFC (1998), the site is located on a ridge or upland area above the Illinois River. The site is underlain by the Pennsylvanian Atoka Formation sequence of sandstone, siltstone, and shale. The bedding of these units is nearly horizontal, with varying depths of weathering and erosion. These units are mantled at varying depths with Pleistone terrace deposits. Soils investigated from drilling on site consist of these terrace deposits and weathered zones of the Atoka Formation. These soils range from sandy, clayey gravels to silty clays. The materials are classified (according to the Unified Soil Classification System) as a low to moderate plasticity silt and clay as well as clayey sand and gravel (CL, ML, CH, MH, SC, and GC). The range in soil particle size distribution from the drill hole logs is shown in Figure A.1.

For infiltration and radon attenuation modeling (Appendices B and D), the coarse limit from the range of these materials was conservatively used.

The potential sources of soil cover materials are existing berms, embankments and fill areas as well as natural deposits. The most likely sources (shown on Drawing 3) are: (1) the tornado berm, (2) settling pond berm and foundation materials, (3) natural materials east of the DUF_4 building, (4) fertilizer pond berms, (5) the stormwater reservoir embankment, and (6) the soil borrow area south of the fertilizer ponds. Based on the borrow area limits shown on Drawing 3, the estimated volumes of material available in these areas are summarized in the table below.

Potential Borrow Area[a]	Estimated Available Volume (cy)[a]	Borrow Material Description	Reference Drill Holes[b]
1. Tornado berm	12,000	Berm material	--
2. Settling pond berm and foundation	241,000	Berm and foundation materials (sandy, silty clay)	BH 49-50, 57-60, 65-66, 91
3. Materials east of DUF_4 building	15,000	Natural soils (silty clay)	BH-82
4. Fertilizer pond berms	155,000	Berm material (gravelly, sandy, silty clay)	2341, 2343, 2351-2355
5. Stormwater reservoir embankment	84,000	Embankment material	--
6. South soil borrow area	207,000	Natural soils (silty clay)	--

a Shown on Drawing 3
b Locations shown on Drawing 3, with logs in Attachment A.2

For the disposal cell footprint shown on Drawing 3, the estimated total cover volume is approximately 258,700 cubic yards. Subtracting the estimated topsoil volume (35,400 cubic yards) and rock mulch volume (8,000 cubic yards) to be included in the cover system, the remaining volume of cover material (from the borrow areas listed above) totals 215,300 cubic yards. Comparison with the volumes in the table above shows that the tornado berm and most of the settling pond berm material alone could comprise the required cover volume.

A.4 COVER SURFACE MATERIALS

The materials comprising the near-surface materials on the cover are topsoil and rock mulch, as outlined below.

Topsoil. The on-site source of topsoil for reclamation is the agland area (shown in Drawing 1), which contains areas of topsoil several feet thick. The estimated volume of topsoil on the cover surface (for the disposal cell footprint on Drawing 3) is approximately 19,100 cubic yards on the top surface (18 inches thick), 16,300 cubic yards in the side slopes (12 inches thick), and 4,000 cubic yards on the perimeter apron (12 inches thick). These volumes total 39,400 cubic yards, which is equivalent to removing 12 inches of topsoil from an area of the agland covering approximately 25 acres.

Rock mulch. The requiring volume of rock mulch includes approximately 8,000 cubic yards on the side slopes and 2,000 cubic yards on the perimeter apron. As shown in Drawing 6, the rock mulch will be in a six-inch thick lift between the cover material and topsoil. From the erosional stability calculations in Appendix B, a rock mulch with a median size of 3.2 inches and a maximum size of 6 inches is required.

The potential sources of rock mulch are: (1) alluvial sandy gravel and cobbles from nearby off-site gravel pits, (2) blasted or crushed limestone from off-site limestone quarries, and (3) indurated sandstone from on-site excavated areas. The potential off-site sources are the preferred sources of rock mulch material due to the relatively small required quantity and nearby location of available gravel pits or quarries.

On-site sandstone was tested on a preliminary basis for durability in 2002. The test results indicated that the rock is marginally acceptable, based on NRC durability criteria (NRC, 1990). The durability test results from these preliminary tests are provided in Attachment A.3. Use of on-site sandstone would require: (1) selective excavation for more indurated or harder units, and (2) using slightly larger sized rock (oversizing) according to criteria in NRC (1990).

A.5 REFERENCES

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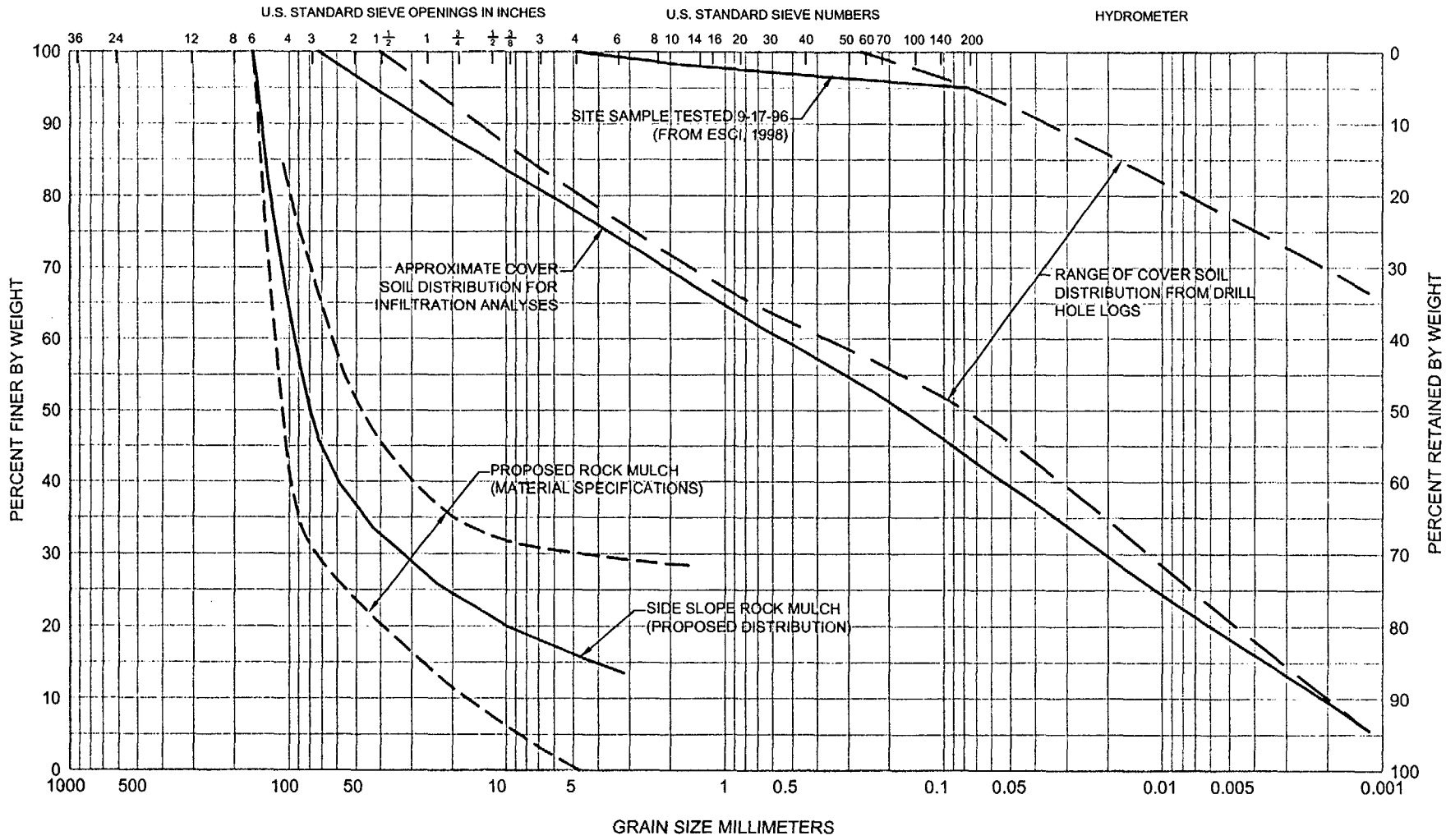


consulting scientists and engineers

FIGURE A.1
COVER MATERIAL PARTICLE-SIZE DISTRIBUTION SUMMARY

Date:	DECEMBER 2002
Project:	180734-13
File:	GSD-01.DWG

Table A.1 Layer A Mean Source Term Values

Material	Volume (cu ft)	Weight (10^9 g)	Nat. Uranium (pCi/g)	Radium-226 (pCi/g)	Thorium-230 (pCi/g)
Raffinate sludge	1,064,000	6.76	5720	157	9560
Pond 2 residual materials	635,000	17.8	357	49.9	1440
Emergency basin sediment	14,600	0.129	4210	332	16300
North ditch sediment	20,770	0.198	8430	7.18	211
Sanitary Lagoon sediments	10,365	0.099	12100	5.8	276
Totals	1,744,735	24.986	--	--	--
Weighted average	--	--	--	80	--

Table A.2 Layer A 95 Percent Upper Confidence-Interval Source Term Values

Material	Volume (cu ft)	Weight (10^9 g)	Nat. Uranium (pCi/g)	Radium-226 (pCi/g)	Thorium-230 (pCi/g)
Raffinate sludge	1,064,000	6.76	7500	218	15100
Pond 2 residual materials	635,000	17.8	472	67	1284
Emergency basin sediment	14,600	0.129	6030	508	29100
North ditch sediment	20,770	0.198	19500	13.9	499
Sanitary Lagoon sediments	10,365	0.099	18500	19.7	1120
Totals	1,744,735	24.986	--	--	--
Weighted average	--	--	--	110	--

Table A.3 Layer B Mean Source Term Values

Material	Volume (cu ft)	Weight (10^9g)	Nat. Uranium (pCi/g)	Radium-226 (pCi/g)	Thorium-230 (pCi/g)
Pond 1 spoils pile	437,400	21.8	4.8	2.1	47
Clarifier liners	332,400	16.6	28	0.5	70
Calcium fluoride basin liner	95,285	4.76	13.3	--	--
Pond 3E clay liner	88,232	4.41	4.9	--	--
Emergency basin soils	162,500	8.12	95	--	--
North ditch soils	87,500	4.37	68	--	--
Sanitary lagoon liner	56,356	2.81	28	0.5	70
Chipped pallets	3,000	--	--	--	--
Totals	1,262,673	62.87	--	--	--
Weighted average	--	--	--	0.9	--

Table A.4 Layer C Mean Source Term Values

Material	Volume (cu ft)	Weight (10^9g)	Nat. Uranium (pCi/g)	Radium-226 (pCi/g)	Thorium-230 (pCi/g)
Structural materials	568,550	51.6	168	--	--
Concrete and asphalt	256,000	23.3	168	--	--
Scrap metal	100,000	--	--	--	--
Fluoride holding basin #1	171,400	2.62	311	0.8	4.8
Fluoride holding basin #2	186,000	2.85	356	0.8	4.8
Fluoride settling basins and clarifier	114,300	1.79	520	0.8	4.8
Buried calcium fluoride	96,380	--	--	--	--
Buried fluoride holding basin #1	57,200	0.875	313	0.8	4.8
Interim storage cell	154,887	7.74	373	0.21	2.1
Solid waste burials	51,100	--	--	--	--
DUF_4 drummed contaminated trash	2,200	--	--	--	--
Other drummed contaminated trash	4,050	--	--	--	--
Empty contaminated drums	2,000	--	--	--	--
Totals	1,764,067	--	--	--	--
Weighted average	--	--	--	0.3	--

Table A.5 Layer D Mean Source Term Values

Material	Volume (cu ft)	Weight (10^9g)	Nat. Uranium (pCi/g)	Radium-226 (pCi/g)	Thorium-230 (pCi/g)
Contaminated soils and sedimentary rock*	3,574,000	178.5	250	--	--

* Estimated by SFC for materials above 27 pCi/g natural uranium

ATTACHMENT A.1

DISPOSED MATERIAL CHARACTERIZATION SUMMARY

Site Characterization Unit Summary[a]

Site Characterization Unit	History	1995 Sampling and Analysis	Analysis Results	Comments
1. Main Process Building area	Operated 1970-1992	57 soil sample locations to 79 ft depth, 851 analyses	Max U 7,100 pCi/g; 89% of samples <35 pCi/g, 92% <110 pCi/g	Impacted soils to 15-ft depth
2. Solvent Extraction Building area	Operated 1970-1992	61 soil sample locations to 79 ft depth; 426 analyses	Max U 7,500 pCi/g; 74% of samples <35 pCi/g U; 82% < 110 pCi/g	Impacted soils to 30-ft depth; Ra-226 and Th-230 present
3. Initial lime neutralization unit	Operated 1970-1971, material removed in 1992	Residual soils sampled to 2-ft depth, 82 analyses	Max U 61 pCi/g; 96% of samples <35 pCi/g U; 100% <110 pCi/g	Limestone excavated and moved to interim storage cell in 1992
5. Solid Waste Burial area (south)	Operated from 1970-1981, covered	25 soil sample locations to 34 ft depth; 85 analyses	43,000 cu ft containing 0.64 Ci U	51,115 cu ft of total waste buried; cover soil impacted
6. Emergency Basin	Constructed in 1969	12 sediment samples; 19 soil sample locations to 4.5 ft depth; 75 analyses	Max soil U 3,500 pCi/g; 67% of soil samples <35 pCi/g U, 88% <110 pCi/g; 14,600 cu ft of sediment containing 0.54 Ci U	Sediments 1 to 8 in. thick, impacted soils to 5 ft depth
7. Sanitary Lagoon	Constructed in 1971, later drained and lined	6 sludge probe locations; 9 sludge samples; 14 soil sample locations to 29 ft depth	Max soil U 6,200 pCi/g; 85% of soil samples <35 pCi/g; 92% <110 pCi/g	Sludge 4 to 12 in. thick, 10,400 cu ft containing 1.28 Ci U; impacted soil <5 ft depth
8. Pond 1 Spoils Pile	Placed in 1980, clays from old raffinate pond	10 spoils pile locations, 9 soil sample locations to 38 ft depth; 75 soil analyses	Max soil U 15 pCi/g, Th-230 2.6 pCi/g, Ra-226 0.4 pCi/g; Spoil pile (1987): U 0.4 - 12.9 pCi/g, Th-230 0.11 to 155 pCi/g, Ra-226 0.72 – 4.32 pCi/g	437,000 cu ft of material containing 0.1 Cu U; impacted soil <5 ft depth; 59 spoil pile samples in 1987
9. North Ditch	Constructed in 1972; drains to Emergency Basin	7 sediment locations; 14 soil sample locations; 62 soil analyses	Max soil U 510 pCi/g; 60% of soil U <35 pCi/g; 77% <110 pCi/g	20,770 cu ft of sediment (10 to 40 in thick) containing 0.77 Ci U; impacted soils <5 ft
10. Contaminated equipment area	Incinerator and solid waste management (SWM) building	21 soil sample locations to 40 ft depth; 119 analyses	Max soil U 12,200 pCi/g; 72% of samples <35 pCi/g U; 83% <110 pCi/g	Impacted soils <5 ft depth deeper impacted soils southeast of SWM building
11. Drainage areas around Emergency Basin and north ditch	Sampled in 1985 and 1990	33 soil sample locations to 38 ft depth; 167 analyses	Max soil U 6,200 pCi/g; 76% of samples <35 pCi/g U; 90% <110 pCi/g	Impacted soils <5 ft depth

[a] From Section 4 of SCR (SFC, 1998)

Site Characterization Unit Summary[a] (continued)

Site Characterization Unit	History	1995 Sampling and Analysis	Analysis Results	Comments
12. Fluoride Holding Basin No. 2	Clay lined basin constructed in 1985	155 soil sample locations to 30 ft depth; 121 analyses	99% of soil sample <35 pCi/g U; 100% <110 pCi/g; Th-230 1.8 pCi/g, Ra-226 1.4 pCi/g	Contains 186,000 cu ft of calcium fluoride sludge containing 1.02 Ci U; yellowcake drums crushed north of basin; surface soil impact
13. Fluoride Holding Basin No. 1	Clay-lined basin constructed in 1981	5 soil sample locations to 28 ft depth; 52 analyses	79% of soil samples <35 pCi/g	Contains 171,400 cu ft. of calcium fluoride sludge containing 0.82 Ci U; surface soil impact
14. Fluoride Clarifier and Settling Basins	3 soil-lined basins constructed in 1971	8 solids sample locations; 3 soil sample locations to 32 ft depth; 28 analyses	Solids: U 56-1,100 pCi/g, Th-230 4.8 pCi/g, Ra-226 0.8 pCi/g; Soils: 96% <35 pCi/g U, 100% <110 pCi/g, Th-230 0.8 pCi/g, Ra-226 1.6 pCi/g	Basins contain 114,300 cu ft of calcium fluoride sludge containing 0.92 Ci U; surface soil impact
15. Fluoride Sludge Burial area	Used for burial of sludge prior to 1981	6 soil sample locations to 26 ft depth; 44 analyses	100% of soil samples <35 pCi/g	Contains 96,380 cu ft of buried sludge containing 1.52 Ci U, and 57,200 cu ft of stored sludge containing 1.55 Ci U
16. South Yellowcake Sump	Concrete sump constructed in 1980	3 soil sample locations to 25-ft depth; 21 analyses	Max soil U 160 pCi/g; 95% of soil samples <35 pCi/g and 95% <100 pCi/g U; Th-230 0.6 pCi/g, Ra-226 1.2 pCi/g	Sediment removed in 1995 and placed in 2A clarifier; surface soil impact
17. Clarifier A Basin area	Four clay and hypalon-lined ponds and two buildings	11 sludge sample locations; 13 soil sample locations to 44 ft depth; 104 analyses	Sludge: U 2,500 – 19,200 pCi/g; Th-230 2,930 – 48,200 pCi/g; Ra-226 14 – 190 pCi/g; Soil: Max U 210 pCi/g, 97% <35 pCi/g, 98% <110 pCi/g, Th-230 1.6 – 790 pCi/g, Ra-226 0.1 – 4.6 pCi/g	Contains 1,064,000 cu ft of sludge, containing 37.1 Ci U; hypalon liners damaged; surrounding soils and clay liner impacted
18. Pond 2	Operated 1971 – 1980; remediated and lined in 1992 with HDPE	21 sludge sample locations; 24 soil sample locations to 40 ft depth; 218 analyses	Sludge: U 3.4 – 2,060 pCi/g, Th-230 1.8 – 6,800 pCi/g, Ra-226 0.4 – 230 pCi/g; Soil: Max U 49 pCi/g, 99% <35 pCi/g, Th-230 0.6 – 14 pCi/g, Ra-226 0.7 – 2.8 pCi/g	Clay liner and sludge 635,000 cu ft containing 10.8 Ci U, no surrounding soil impact
19. Area west of Pond 2	Drainage area backfilled as french drain with concrete tank	11 soil sample locations to 46 ft depth; 118 analyses	Max soil U 3.9 pCi/g	No impacted soil

Site Characterization Unit Summary[a] (continued)

Site Characterization Unit	History	1995 Sampling and Analysis	Analysis Results	Comments
20. Solid Waste Burial Area No. 2 (north)	Operated 1979 – 1980	21 soil sample locations to 40 ft depth; 132 analyses	Max soil U 5,060 pCi/g; 86% of samples <35 pCi/g U, 89% <110 pCi/g	Contains 8,100 cu ft of waste containing 0.04 Ci U, limited impacted soil
21. Yellowcake Storage Pad	Used since 1970, concrete pad constructed 1979; includes building and sump	18 soil sample locations to 44 ft depth; 234 analyses	Max soil U 1,070 pCi/g; 90% of samples <35 pCi/g U, 95% <110 pCi/g	100,000 cu ft of equipment containing 0.15 Ci U stored on pad and 2,000 cu ft in drums; soil beneath pad impacted
22. East perimeter area (northern section)	Part of area remediated in 1992	47 soil sample locations to 52 ft depth; 239 analyses	Max soil U 37 pCi/g; 97% of samples <35 pCi/g U	Limited impacted soil in southwest portion of area
23. 1986 incident soil storage area	Material placed in 1986 and removed in 1992	42 soil sample locations to 22 ft depth; 110 analyses	Max soil U 38 pCi/g; 99% of samples <35 pCi/g U; Th-230 3.1 – 19 pCi/g; Ra-226 1.6 – 1.7 pCi/g	Impacted sod placed in 1986 and removed to interim soil storage cell in 1992; soil impacted in isolated spots
24. Fertilizer Pond area	Clay and hypalon lined ponds constructed 1978-1985	58 soil sample locations to 6 ft depth; 94 analyses	Max soil U 39 pCi/g; 99% of samples <35 pCi/g U; Th-230 0 – 206 pCi/g, Ra-226 0.6 – 3.4 pCi/g	Pond 4 used to store raffinate sludge, liner cleaned in 1995, liner removed in 1998; ponds 3E, 3W, 5 and 6 used to store ammonium nitrate; limited impacted soil
25. Former raffinate treatment area	Operated 1970 – mid 1980s; contains tanks and building	8 soil sample locations to 4.5 ft depth; 20 analyses	Max soil U 25 pCi/g; 95% of samples <35 pCi/g and 95% <110 pCi/g	Soils impacted
26. Decorative Pond area	Area constructed around 1970	30 soil sample locations to 44 ft depth; 268 analyses	Max soil U 1,300 pCi/g; 94% of samples <35 pCi/g U, 99% <110 pCi/g; Th-230 0.6 pCi/g, Ra-226 1.2 pCi/g	Area affected by 1986 incident, sod removed in 1992; U in pond sediment 12.2 – 17.1 pCi/g
27. Combination stream	Reinforced concrete pipe installed 5-30 ft below ground	21 soil sample locations to 32.5 ft depth; 79 analyses	Max soil U 510 pCi/g; 87% of samples <35 pCi/g U; 94% <110 pCi/g; Th-230 1.0 – 3.6 pCi/g; Ra-226 0.8 – 1.8 pCi/g	Trench backfill impacted
28. Present Lime Neutralization Area	Constructed in 1970; four tanks	3 soil sample locations to 2 ft depth; 6 analyses	Max soil U 350 pCi/g; 17% of samples <35 pCi/g U; 17% <110 pCi/g	Soils impacted
29. DUF_4 Building area	Operated 1986 – 1993	17 soil sample locations to 45 ft depth; 103 analyses	Max soil U 68 pCi/g; 98% of samples <35 pCi/g	Soils in area and beneath building and concrete pad impacted

Site Characterization Unit Summary[a] (continued)

Site Characterization Unit	History	1995 Sampling and Analysis	Analysis Results	Comments
30. Tank farm and cylinder storage area	South tank farm constructed 1969; North tank farm constructed 1975	13 soil sample locations to 45 ft depth; 171 analyses	Max soil U 650 pCi/g; 95% of samples <35 pCi/g U; 97% <110 pCi/g	Soils north of Main Process Building and beneath concrete pads impacted
31. Front lawn area	Lawns, access roads and parking lot	16 soil sample locations to 37.5 ft depth; 147 analyses	Max soil U 1,550 pCi/g; 99% of samples <35 pCi/g U; Th-230 0.5 – 1.2 pCi/g; Ra-226 0.1 – 2.3 pCi/g	Soils impacted in limited areas
32. South perimeter area	Stormwater reservoir constructed in 1991	40 soil sample locations to 30 ft depth; 168 analyses, 7 sediment samples	Max soil U 120 pCi/g; 99% of samples <35 pCi/g U; Th-230 0.8 – 910 pCi/g; Ra-226 1.2 to 4.7 pCi/g; Sediments: U 4.5 – 43 pCi/g, Th-230 1.0 – 1.3 pCi/g, Ra-226 0.1 pCi/g	Soil impacted near lime neutralization area and north of Pond 4
33. Northeast perimeter area	--	6 soil sample locations to 29 ft depth; 32 analyses	Max soil U 6.8 pCi/g	No impact on soils
34. Drainage/runoff areas	--	Sediment samples collected from each drainage	005: Max U 520 pCi/g, Th-230 1.7 – 354 pCi/g, Ra-226 0.5 – 3.7 pCi/g, 007: Max U 80 pCi/g, Th-230 1.8 – 3.4 pCi/g, Ra-226 0.8 – 2.2 pCi/g	Impact in 005 and 007 drainages
35. Scrap metal storage area and interim storage cell	Material storage area since 1975; interim soil storage area since 1991	14 soil sample locations to 36-ft depth; 75 analyses	Max soil U 1,560 pCi/g; 91% of samples <35 pCi/g U; 93% <110 pCi/g	Interim storage cell contains 154,800 cu ft of soils containing 2.84 Ci U on synthetic liner over concrete pad
50. 1986 incident plume area	Area of downwind plume from tank rupture in 1986	23 soil sample locations to 2 ft depth; 23 analyses	Max soil U 200 pCi/g; 96% of samples <35 pCi/g and 110 pCi/g U; Th-230 0.5 – 2.0 pCi/g, Ra-226 1.3 – 3.1 pCi/g	No current impact east of Highway 10; impacted soils in limited areas west of Highway 10
52. Northeast perimeter area	Areas treated with SFC ammonium nitrate fertilizer	9 soil sample locations to 0.5 ft depth; 9 analyses	Max soil U 1.3 pCi/g	No soil impact
53. Northwest perimeter area	--	19 soil sample locations to 46 ft depth; 148 analyses	Max soil U 13 pCi/g	Soil impact at one surface location
54. Southwest perimeter area	--	32 soil sample locations to 40 ft depth; 64 analyses	Max soil U 30 pCi/g	Soil impact at surface south and west of fertilizer ponds
55. Southeast perimeter area	--	9 soil sample locations to 0.5 ft depth; 9 analyses	Max soil U 1.7 pCi/g	No soil impact

Disposal Material Characterization Summary

Material	SCU No.[a]	Item No.[b]	Layer No.[c]	Volume (cu ft)[d]	Weight (10^9 g)	Nat. Uranium		Thorium-230		Radium -226	
						pCi/g	Ci	pCi/g	Ci	pCi/g	Ci
SLUDGES & SEDIMENTS											
Raffinate sludge	17	5	A	1,064,000	6.76	5914	37.14	9611.1	60.4	118.1	0.7
Pond 2 residual materials	18	8	A	635,000	17.8	288	10.77	1284	48.03	43.0	1.61
Emergency basin sediment	6	11	A	14,600	0.139	3864	0.54	33,900	4.71	885	0.123
North ditch sediment	9	11	A	20,770	0.198	3865	0.77	698	0.137	170	0.033
Sanitary lagoon sediment	7	10	A	10,365	0.099	12,884	1.28	276	0.50	5.8	0.008
Fluoride holding basin #1	13	7	C	171,400	2.62	311	0.82	4.8	0.013	0.8	0.002
Fluoride holding basin #2	12	7	C	186,000	2.85	356	1.02	4.8	0.014	0.8	0.002
Fluoride settling basins & clarifier	14	7	C	114,300	1.79	520	0.92	4.8	0.008	0.8	0.001
Buried calcium fluoride	15	7	C	96,380	--	--	1.52	--	--	--	--
Buried fluoride holding basin #1	15	7	C	57,200	0.875	313	0.27	4.8	0.004	0.8	0.001
LINER SOILS & SUBSOILS											
Clarifier liners	17	8	B	332,400	16.6	28	0.47	70	1.16	0.5	0.008
Calcium fluoride basin liner	12, 13, 14	8	B	95,285	4.76	13.3	0.064	--	--	--	--
Pond 3E clay liner	24	8	B	88,232	4.41	4.9	0.02	--	--	--	--
Emergency basin soils	6	11	B	162,500	8.12	95	0.78	--	--	--	--
North ditch soils	9	11	B	87,500	4.37	68	0.30	--	--	--	--
Sanitary lagoon liner	7	10	B	56,356	2.81	28	0.08	70	0.20	0.5	0.001
BURIED MATERIALS & DRUMS											
Pond 1 spoils pile	8	8	B	437,400	21.8	4.8	0.11	47	1.02	2.1	0.046
Interim storage cell	9	35	C	154,887	7.74	373	2.89	2.1	0.016	0.21	0.0016
Solid waste burials	5	12	C	51,100	--	--	0.681	--	--	--	--
DUF_4 drummed contam. trash	--	2	C	2,200	--	--	0.37[e]	--	--	--	--
Other drummed contam. trash	--	6	C	4,050	--	--	0.015	--	--	--	--
Empty contam. drums	--	3	C	2,000	--	--	0.015	--	--	--	--

Disposal Material Characterization Summary (continued)

Material	SCU No.[a]	Item No.[b]	Layer No.[c]	Volume (cu ft)[d]	Weight (10^9 g)	Nat. Uranium		Thorium-230		Radium -226	
						pCi/g	Ci	pCi/g	Ci	pCi/g	Ci
STRUCTURAL MATERIALS	(see below)	(see below)		568,550	51.6	168	8.67	--	--	--	--
Main plant building	1	13	C	[2,178,000]							
Solvent Extraction Building	2	13	C	[180,000]							
DUF_4 Building	29	13	C	[281,000]							
ADU/Misc. digestion building	21	13	C	[75,000]							
Laundry building	17	13	C	[12,500]							
Centrifuge building	17	13	C	[15,000]							
Bechtel building	30	13	C	[27,000]							
Solid waste building	10	13	C	[18,000]							
Cooling tower	2	13	C	[30,000]							
RCC evaporator	2	13	C	[18,750]							
Incinerator	10	13	C	[7,500]							
Concrete and asphalt	Various	13	C	256,000	23.3	168	3.91				
Scrap metal	--	4	C	100,000	--	--	0.15	--	--	--	--
Chipped pallets	--	--	B	3,000	--	--	--	--	--	--	--
SUBSOILS & BEDROCK											
Contaminated materials[f]	Various	14	D	3,574,000	178.5	250	44.8	--	--	--	--

a Site characterization unit number from Section 4 of SCR (SFC, 1998).
b Calculation item number in Attachment III of SCR.
c Layer number in disposal cell sequence.
d Values are from Attachment III of SCR; values in brackets are calculated building volumes from floor area and building height; disposal volume is 20 percent of building volume.
e Depleted uranium value
f Materials above 27 pCi/g natural uranium

Statistical Summary of Layer A Materials

Emergency Basin

	U-nat	Th-230	Ra-226
Number of values	8	5	5
Minimum	1590	3790	186
25% Percentile	2670		
Median	3720	17100	276
75% Percentile	5440		
Maximum	8400	30000	534
Mean	4210	16300	332
Std. Deviation	2180	10300	142
Std. Error	770	4610	63.5
Lower 95% CI	2380	3540	156
Upper 95% CI	6030	29100	508

Raffinate Sludge

	U-nat	Th-230	Ra-226
Number of values	20	19	20
Minimum	1440	305	13.7
25% Percentile	3510	3360	61.1
Median	4820	5420	140
75% Percentile	6250	17400	183
Maximum	19200	48200	535
Mean	5720	9560	157
Std. Deviation	3800	11600	130
Std. Error	850	2650	29.2
Lower 95% CI	3950	3980	95.6
Upper 95% CI	7500	15100	218

North Ditch

	U-nat	Th-230	Ra-226
Number of values	5	5	5
Minimum	2200	12.8	1.4
25% Percentile			
Median	3020	90.5	6
75% Percentile			
Maximum	22300	475	16
Mean	8430	211	7.18
Std. Deviation	8880	232	5.41
Std. Error	3970	104	2.42
Lower 95% CI	-2590	-77.2	0.466
Upper 95% CI	19500	499	13.9

Sanitary Lagoon

	U-nat	Th-230	Ra-226
Number of values	9	3	3
Minimum	2300	8.2	0.9
25% Percentile	4530		
Median	12200	163	4.5
75% Percentile	19000		
Maximum	26100	656	11.9
Mean	12100	276	5.77
Std. Deviation	8270	338	5.61
Std. Error	2760	195	3.24
Lower 95% CI	5780	-565	-8.17
Upper 95% CI	18500	1120	19.7

Pond 2 Residual

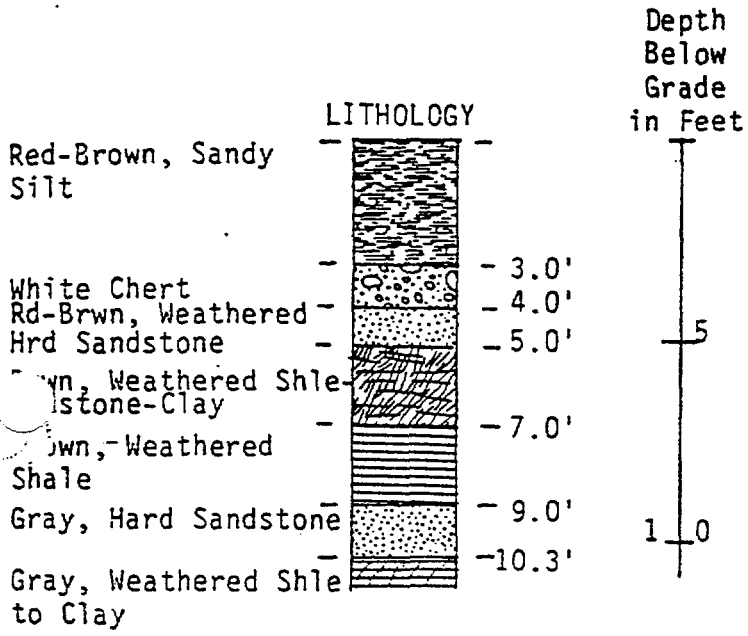
	U-nat	Th-230	Ra-226
Number of values	67	63	63
Minimum	3.4	1.8	0.4
25% Percentile	15.3	32	2
Median	143	280	18
75% Percentile	510	2600	70.5
Maximum	2060	6820	230
Mean	357	1440	49.9
Std. Deviation	472	2070	66.4
Std. Error	57.7	261	8.37
Lower 95% CI	241	918	33.1
Upper 95% CI	472	1960	66.6

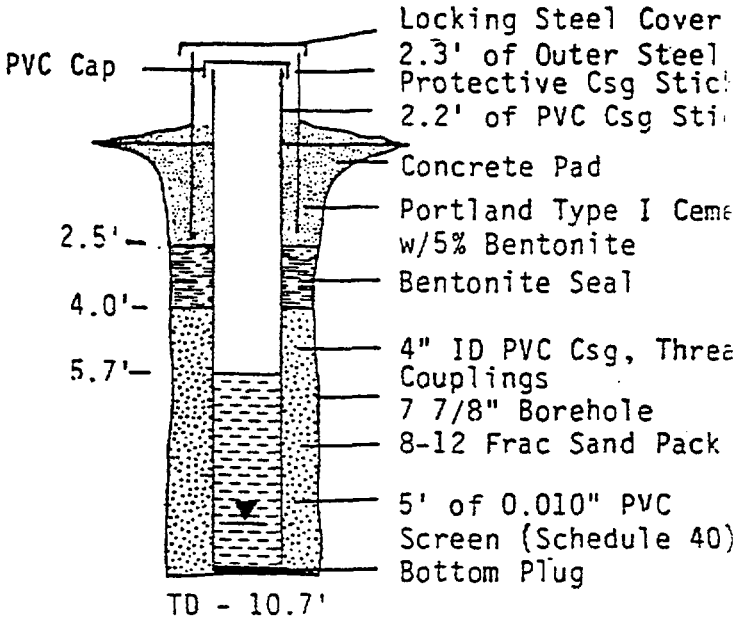
Values are in pCi/g; CI - confidence interval.

ATTACHMENT A.2

SELECTED DRILL HOLE LOGS

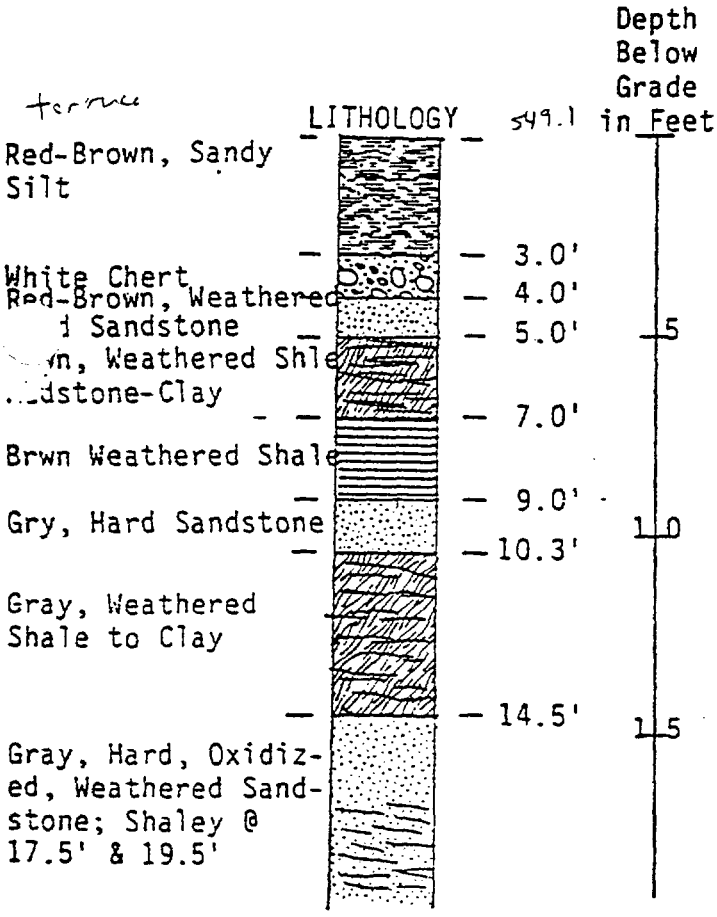
MONITOR WELL 2301A
NORTH OF EMERGENCY BASIN #1
SEQUOYAH FUELS CORPORATION
GORE, OK

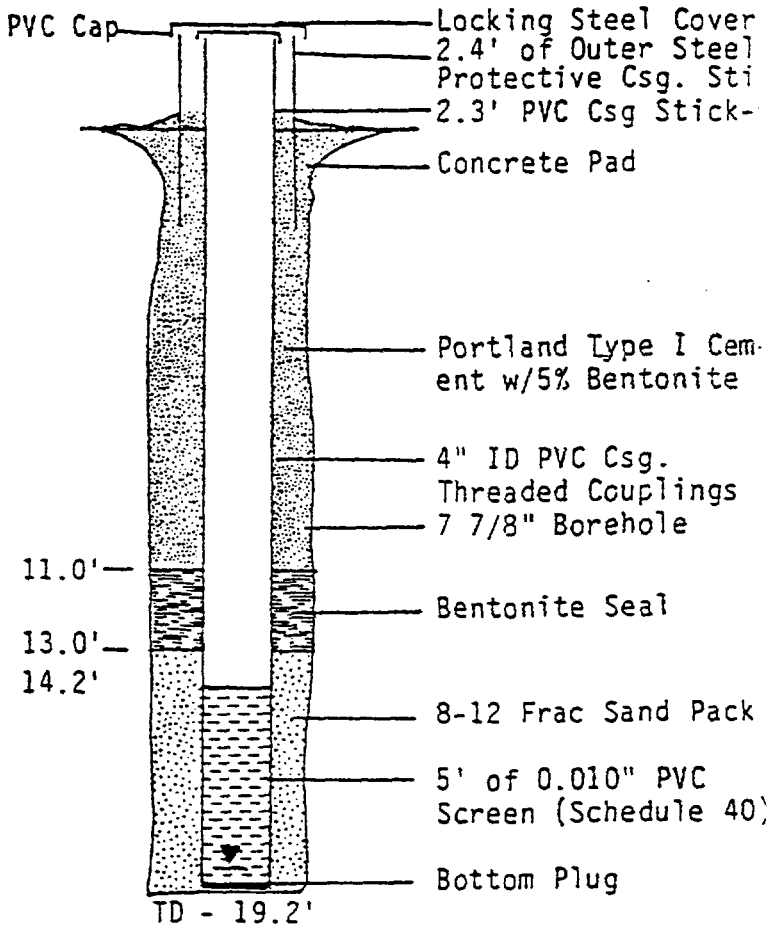




Well Installed: November 25, 1986
Water Level Taken on November 26, 1986
Logged By: R. K. Widmann

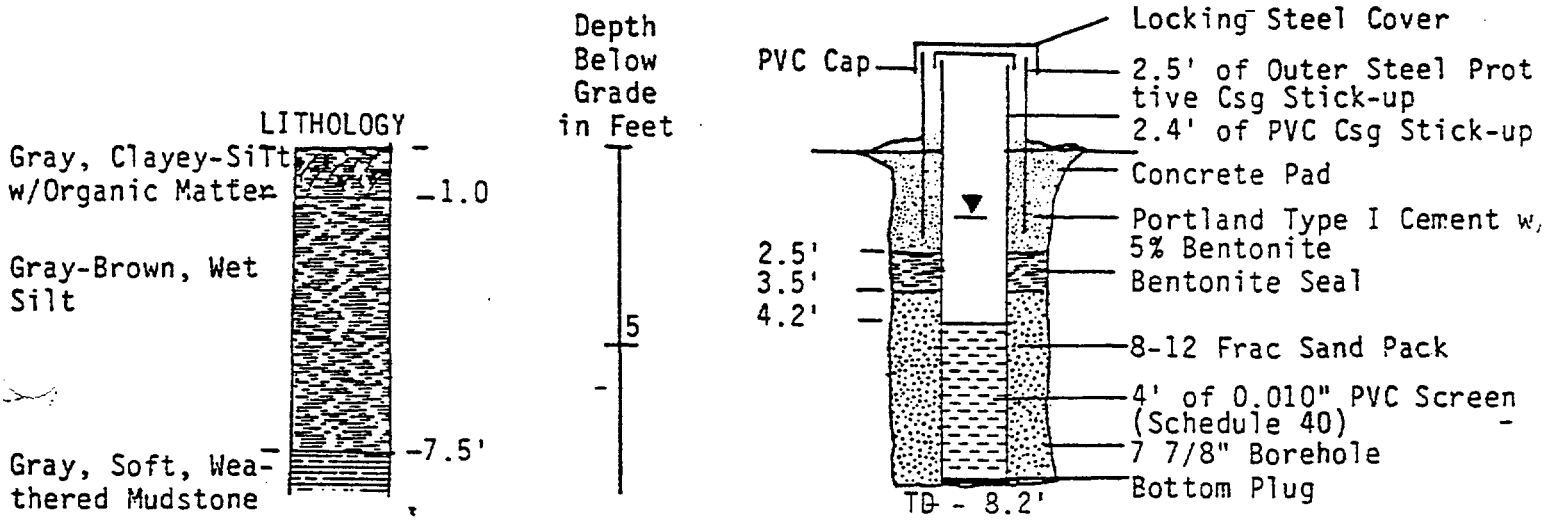
MONITOR WELL 2301B
NORTH OF EMERGENCY BASIN #1
SEQUOYAH FUELS CORPORATION
GORE, OK





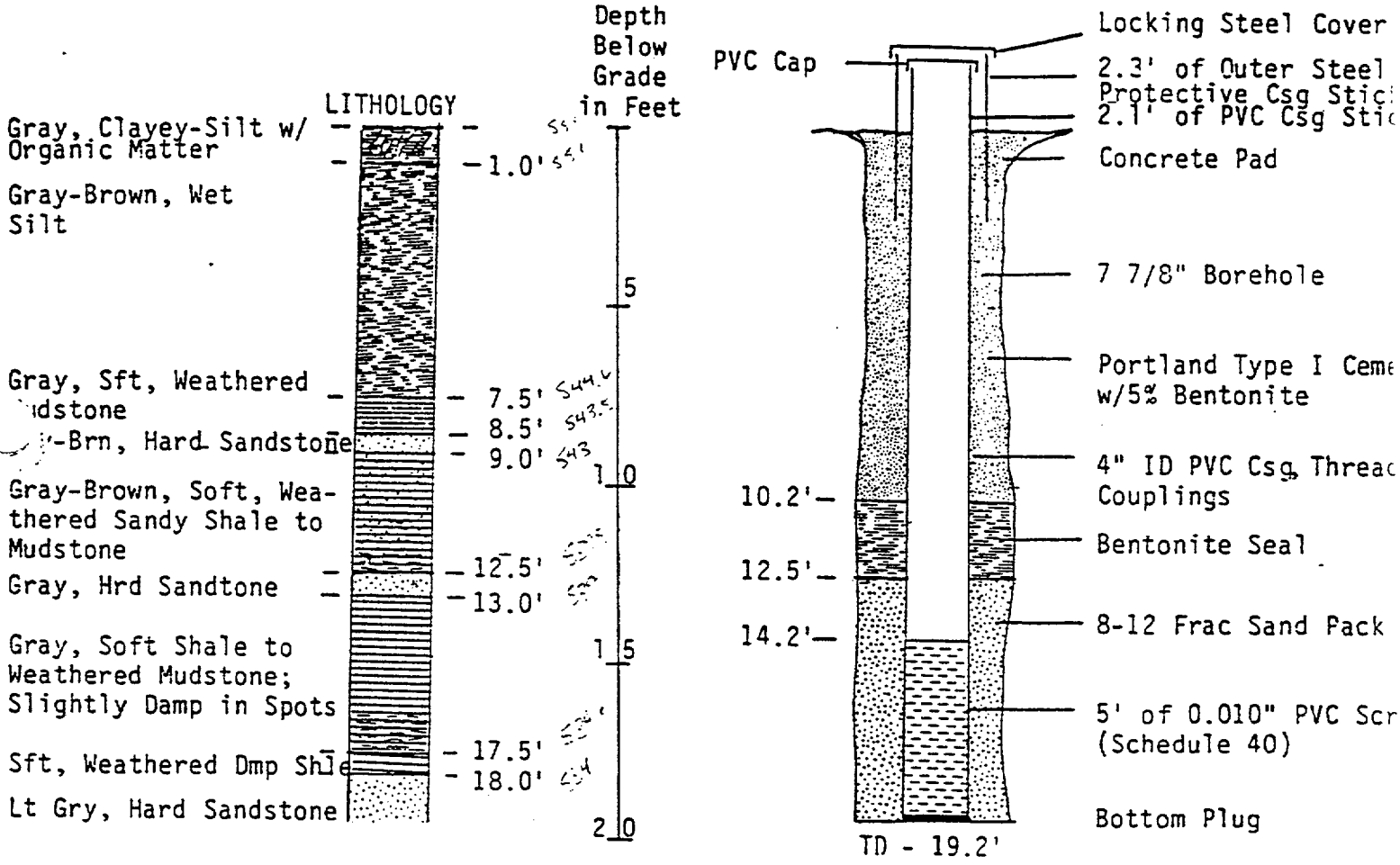
Well Installed: November 25, 1986
Water Level Taken on November 26, 1986
Logged By: R. K. Widmann

MONITOR WELL 2302A
WEST OF SANITARY LAGOON
SEQUOYAH FUELS CORPORATION
GORE, OK



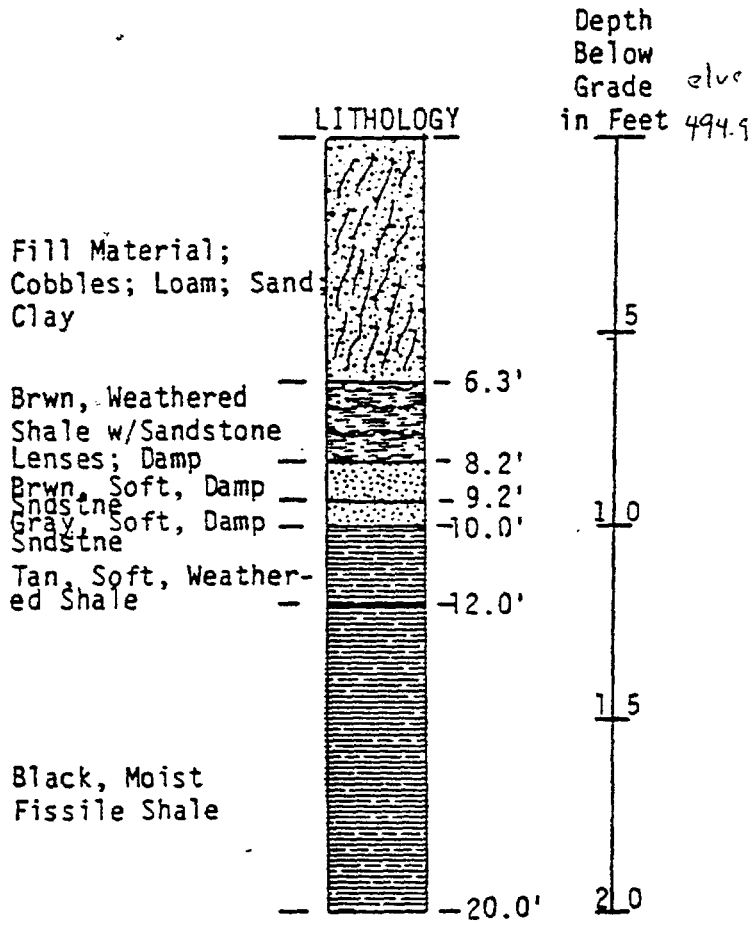
Well Installed: November 18, 1986 by Jim Winnek, Inc.
Water Level Taken on November 26, 1986
Logged By: R. K. Widmann

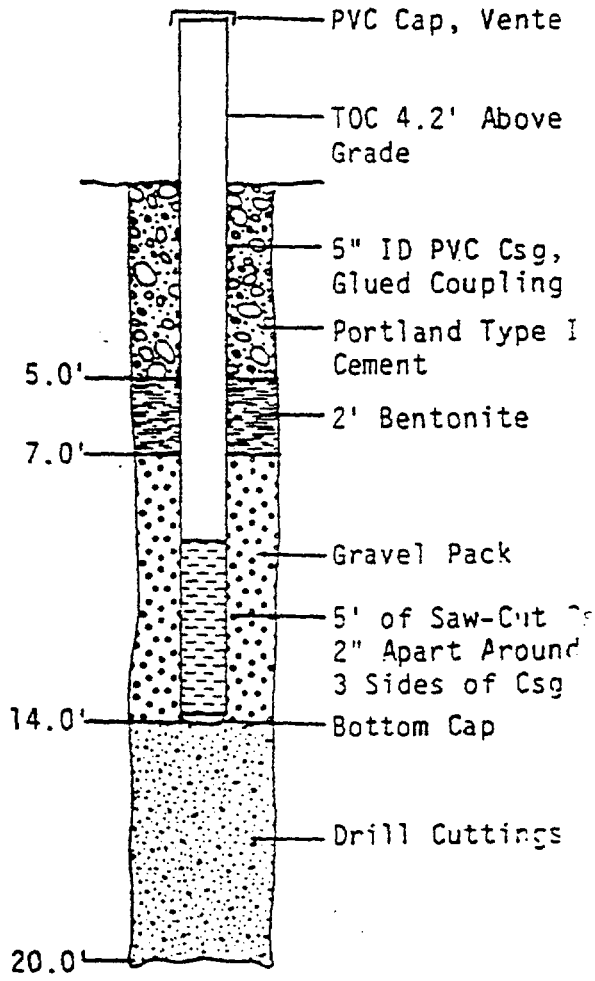
MONITOR WELL 2302B
WEST OF SANITARY LAGOON
SEQUOYAH FUELS CORPORATION
GORE, OK



Well Installed: November 19, 1986 by Jim Winnek, Inc.
Water Level at Top of PVC Csg on November 26, 1986
Logged By: R. K. Widmann

MONITOR WELL 2341
WEST OF POND #5
SEQUOYAH FUELS CORPORATION
GORE, OK.





Well Installed: 4-4-85 By Hemphill Corporation

CLIENT Sequoyah Fuel Corporation — PROJECT Observation Well — WELL NO 2343

BORING LOCATION Coodinates 10937N + 8625E — DATE 6/13-14/85 — SHEET 1 OF 1

ELEV.	DEPTH AND SCALE	DESCRIPTION OF MATERIAL (TYPE, COLOR, TEXTURE, CONSISTENCY)
		4-3/4" TEST HOLE
539.4	0.0	Ground Level
		CLAY, Silty, Sandy, Red-Brown, Moist
534.4	5.0	
532.4	7.0	CLAY, Silty, Sandy, Multicolored, Moist
		CLAY, Sandy, Shaley, Tan-Brown
524.4	15.0	
524.1	15.3	SANDSTONE, Firm, Tan
		SHALE, Clayey, Tan-Gray
517.4	22.0	
		SANDSTONE, Hard, Tan-Gray
510.4	29.0	
		SANDSTONE, Soft, Shaley Gray
506.4	33.0	
		SANDSTONE, Hard, Gray
502.9	36.5	
		SHALE, Firm, Gray
499.4	40.0	
		Bottom of Hole

WELL CONSTRUCTION

7-7/8" OBSERVATION WELL

ELEV.	DEPTH AND SCALE
539.4	0.0
533.4	6.0
520.4	19.0
518.4	21.0
515.4	24.0
502.9	36.5
499.4	40.0

- 5" PVC - VENTED PIPE CAP
- 12" HOLE
- 8" PVC PIPE (0.0' to 6.0')
- 8" HOLE
- NEAT CEMENT GROUT (0.0' to 19.0')
- 5" PVC PIPE (0.0' to 36.5') WITH 4.0' STICKUP
- BENTONITE SEAL (19.0' to 21.0')
- GRAVEL PACK (19.0' to 36.5')
- SAW SLOTTED (24.0' to 36.5') 2" O.C. - 3 SIDES
- 5" PVC CAP
- 7-7/8" HOLE PLUGGED WITH DRILL CUTTINGS

GENERAL INFORMATION

GR. ELEV. 539.4
ELEV = 514.1
WATER TABLE 25.3
BORED BY Cooper
LOGGED BY Cooper
CHECKED BY Hemphill

CASING INFORMATION

SIZE	FT-RUN	PULLED	LEFT
8" PVC	6.0	0.0	6.0
5" PVC	40.0	0.0	40.0

DRILLING MUD

TYPE New Gel NO. SACKS 1

PENETRATION TESTS

FROM	TO	BLOWS/6"

SHELBY TUBE SAMPLES

FROM	TO	FROM	TO

CORING

FROM	TO	RECOVERY

WATER LOSS

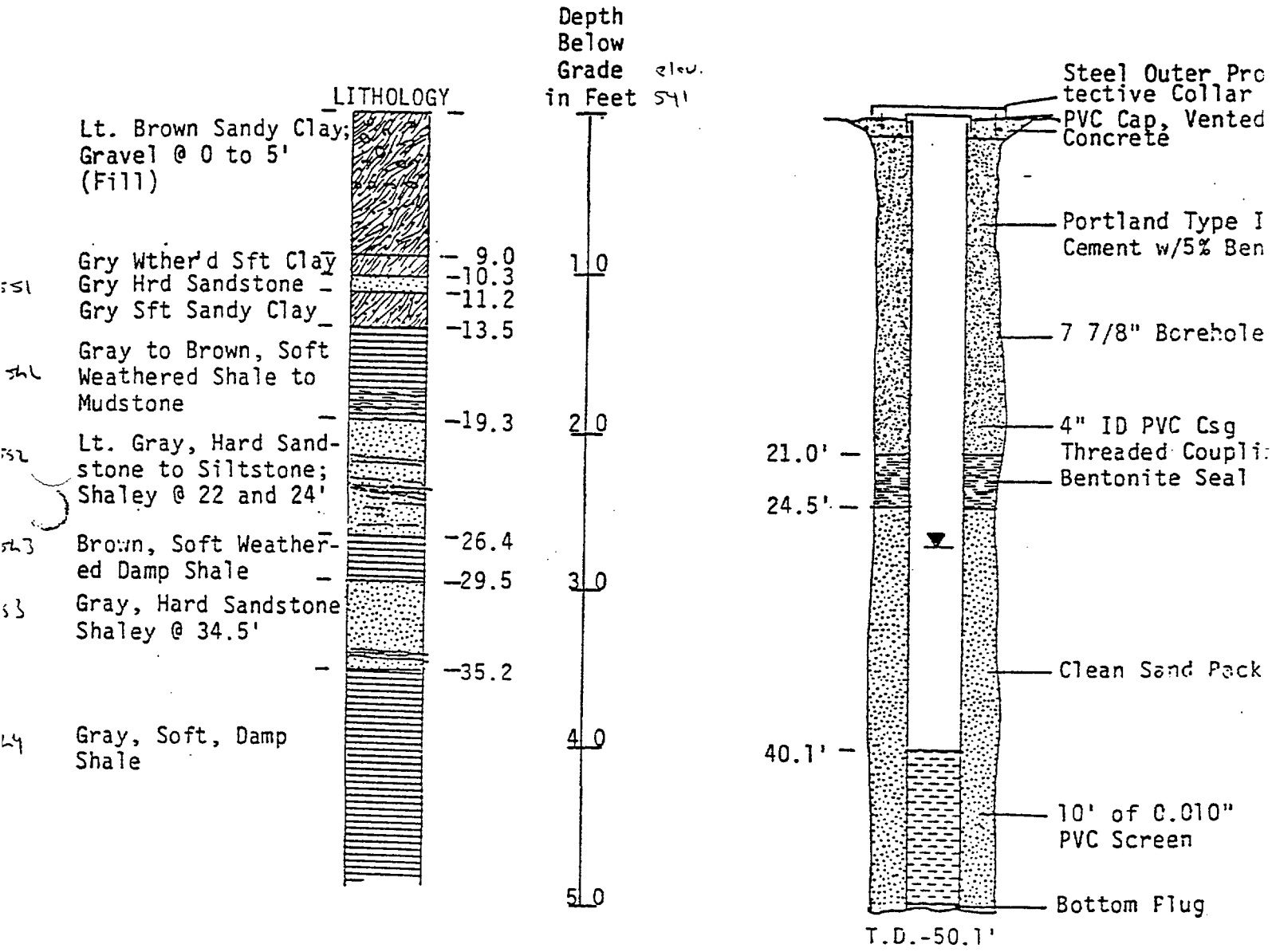
CEMENT (NO. SACKS) 5.0

REMARKS

HEMPHILL CORPORATION
4634 South 83rd East Avenue
TULSA, OKLAHOMA 74145

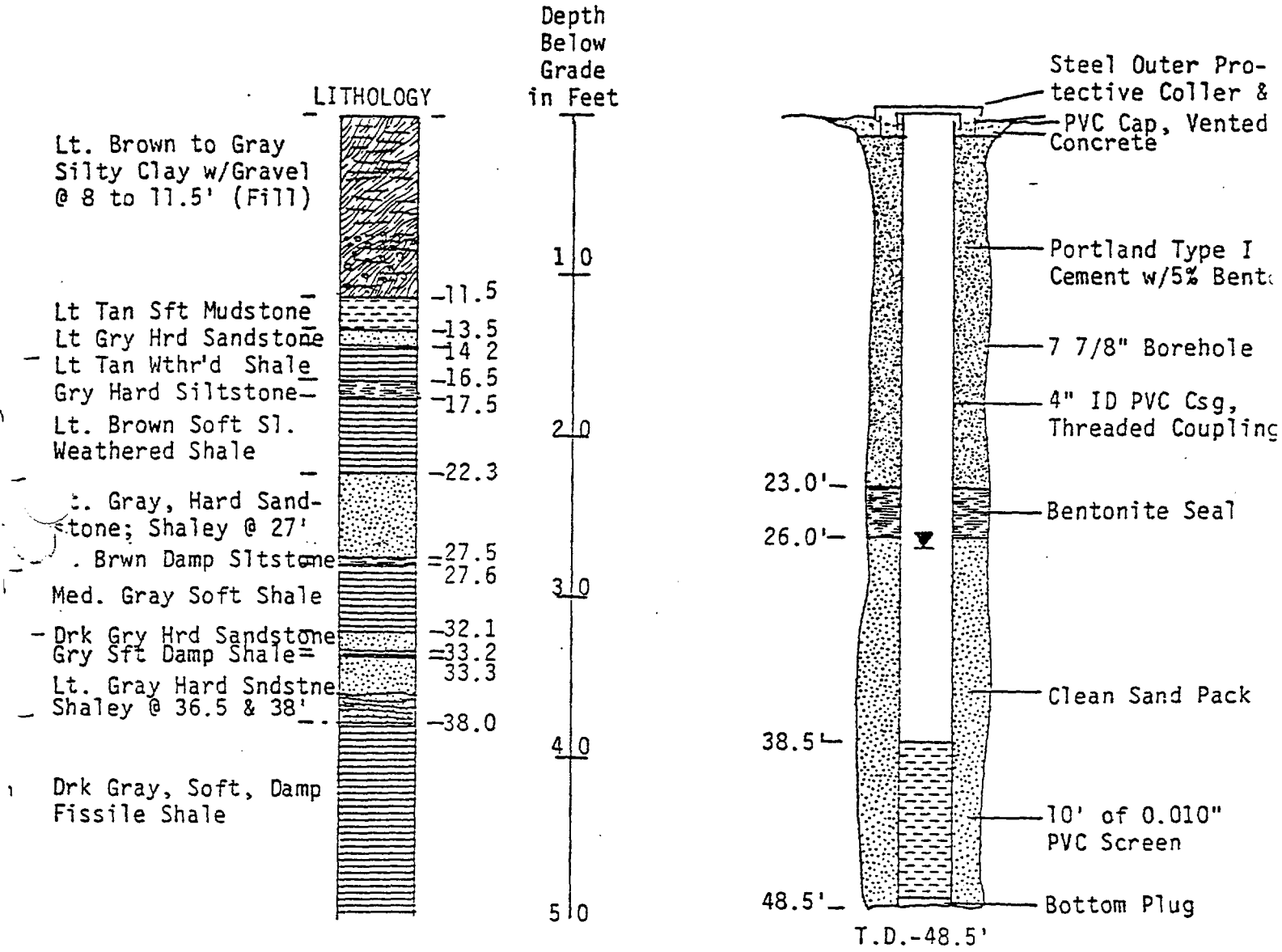
OBSERVATION WELL

MONITOR WELL 2351
BETWEEN PONDS 3E AND 4
SEQUOYAH FUELS CORPORATION
GORE, OK



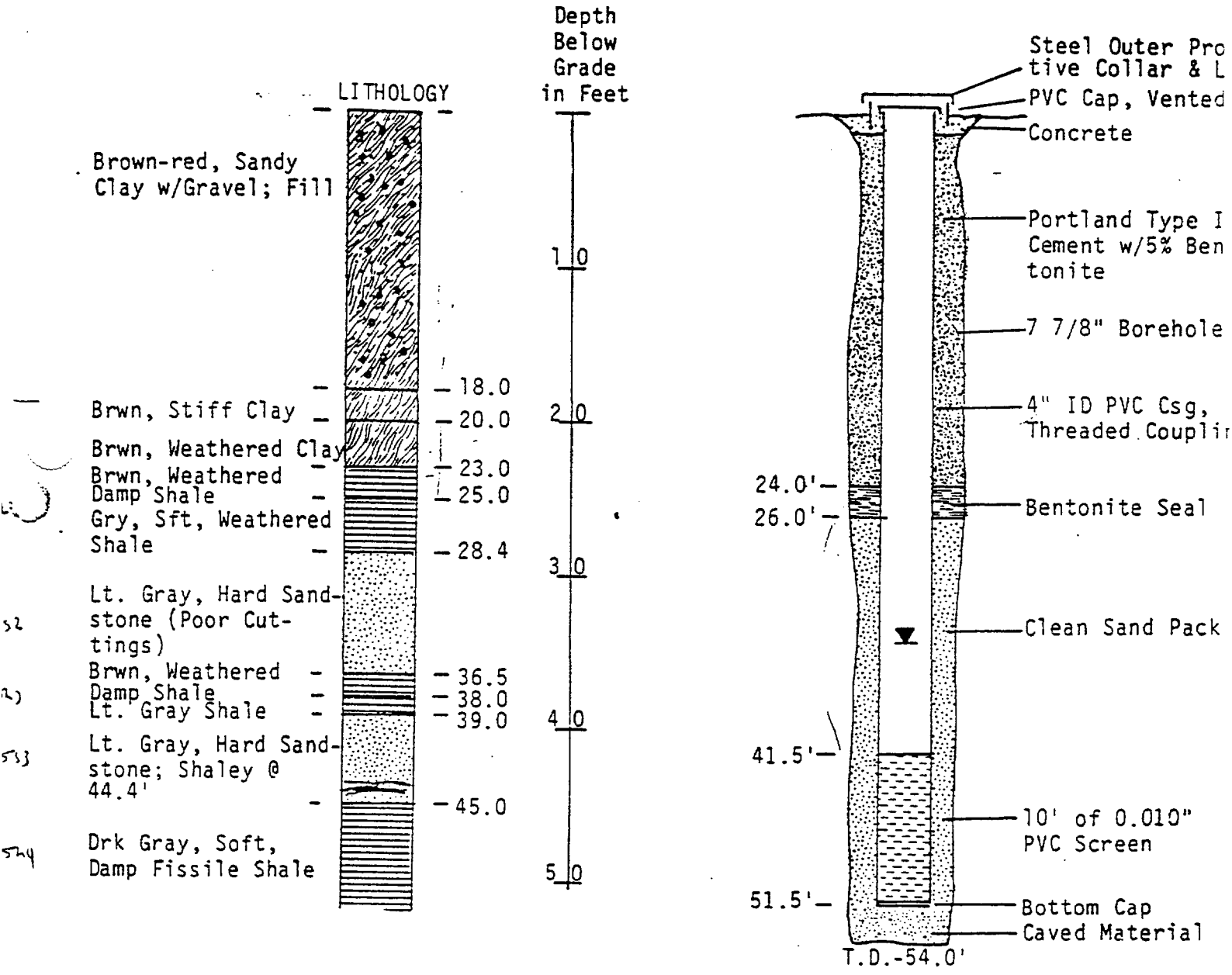
Well Installed: June 17, 1986 by Jim Winnek, Inc.
Water Level on June 23, 1986 - 27.04' Below Top of PVC Casing
Logged by: R. K. Widmann

MONITOR WELL 2352
BETWEEN PONDS 3E and 4
SEQUOYAH FUELS CORPORATION
GORE, OK



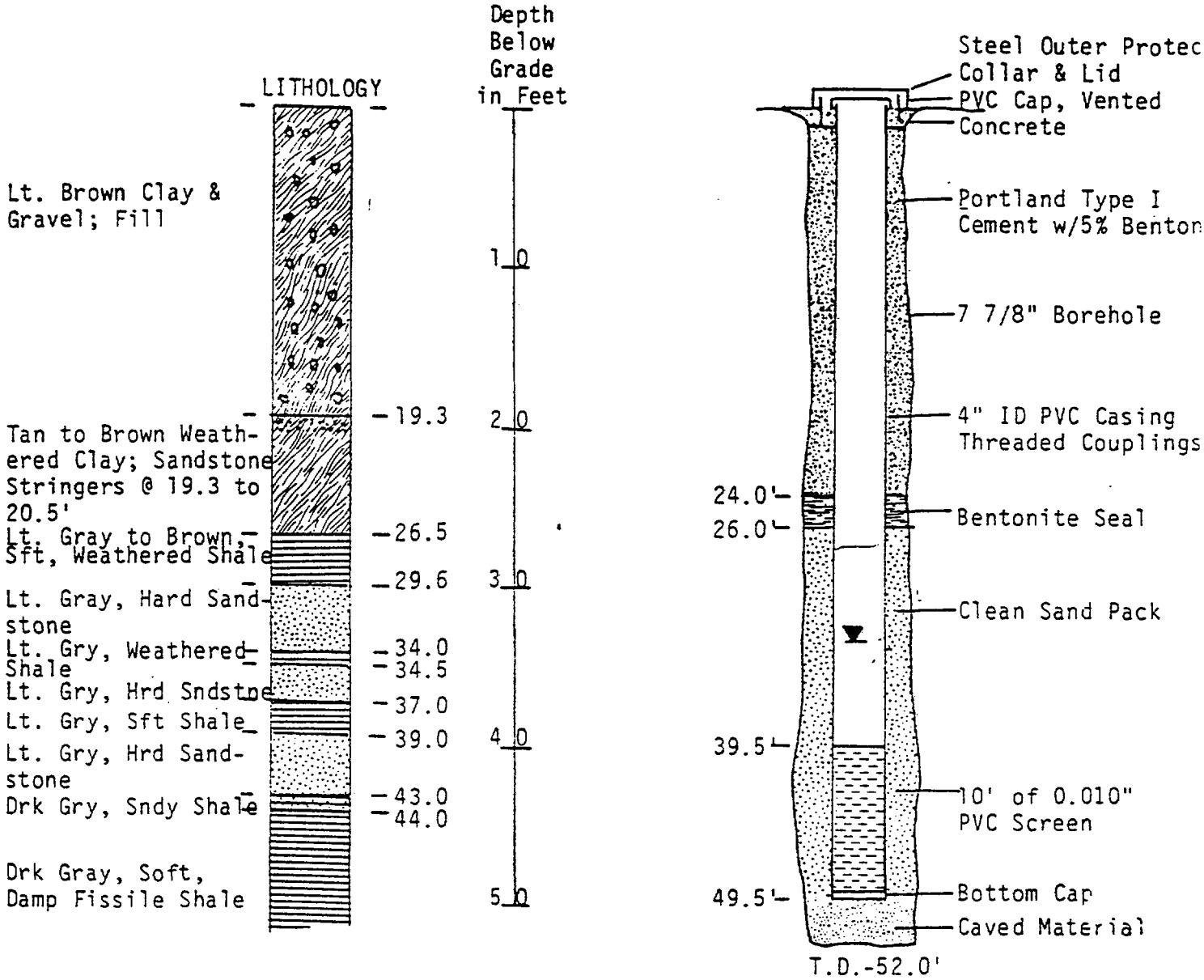
Well Installed: June 16, 1986 by Jim Winnek, Inc.
Water Level on June 23, 1986 - 26.64' Below Top of PVC Casing
Logged by: R. K. Widmann

MONITOR WELL 2353
BETWEEN PONDS 3E AND 3W
SEQUOYAH FUELS CORPORATION
GORE, OK



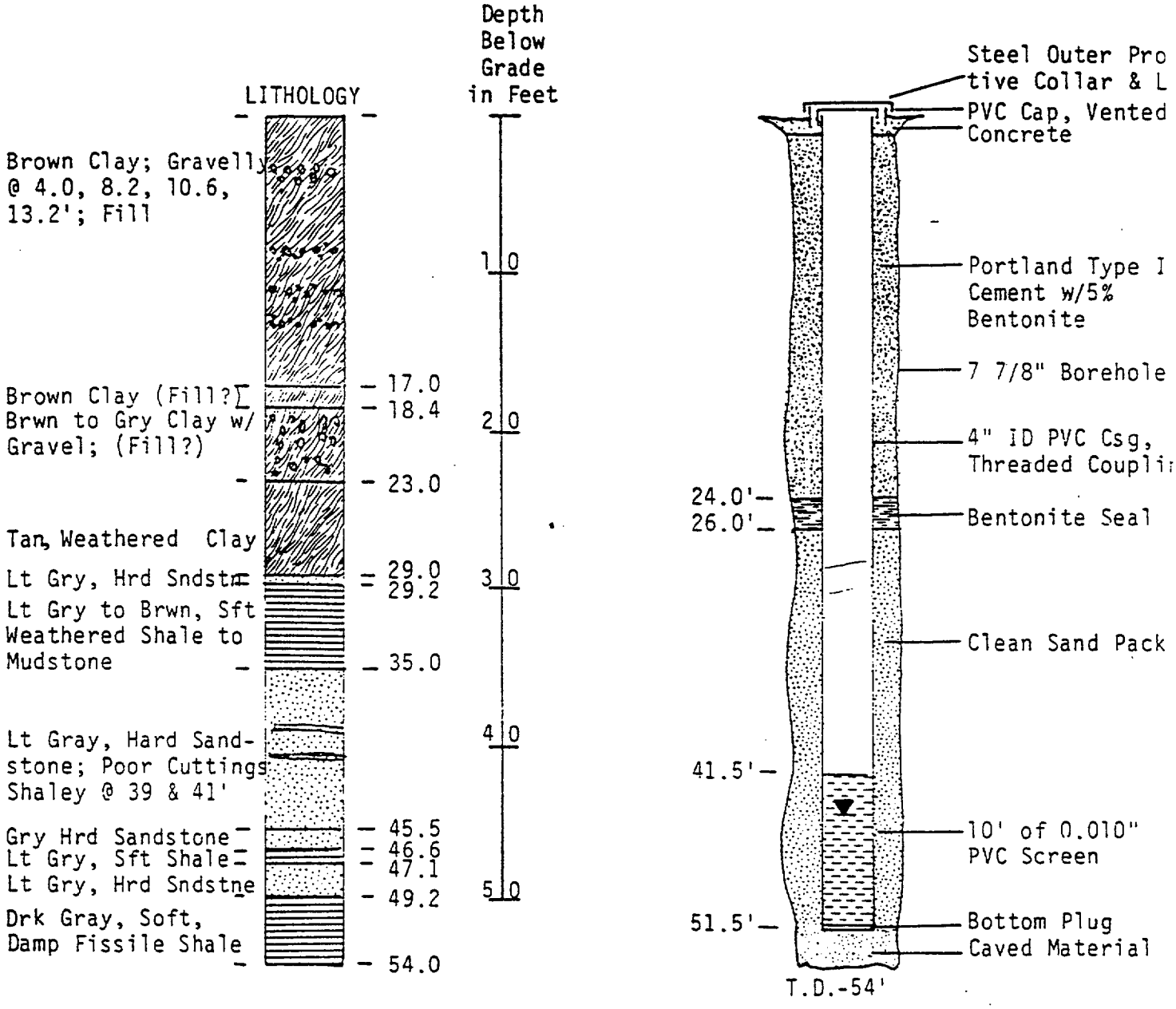
Well Installed: June 12, 1986 by Jim Winnek, Inc.
Water Level on June 23, 1986 - 33.92' Below Top of PVC Casing
Logged by: R. K. Widmann

MONITOR WELL 2354
BETWEEN PONDS 3E AND 3W
SEQUOYAH FUELS CORPORATION
GORE, OK



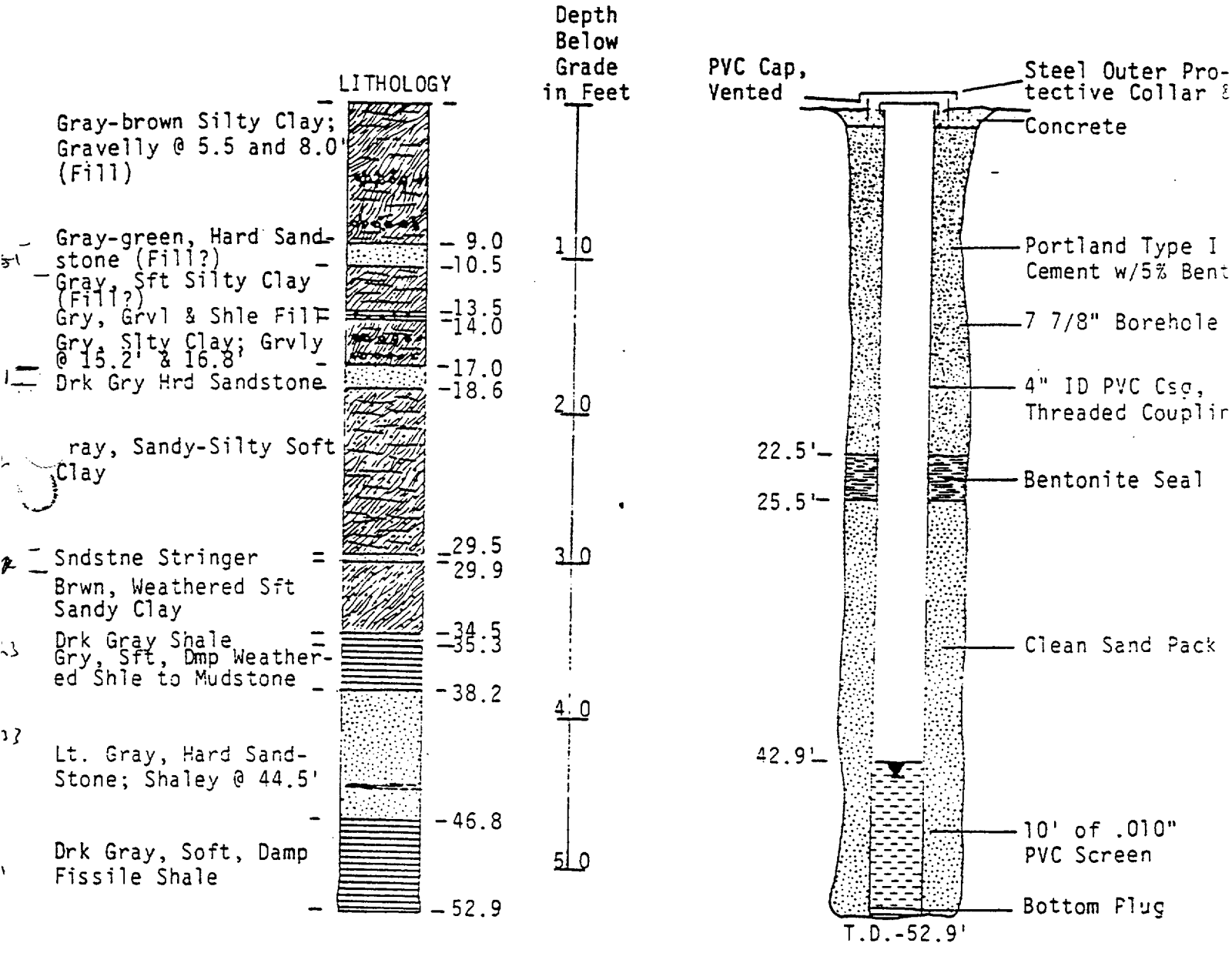
Well Installed: June 12, 1986 by Jim Winnek, Inc.
Water Level on June 23, 1986 - 33.20' Below Top of PVC Casing
Logged by: W. Goodman

MONITOR WELL 2355
BETWEEN PONDS 3W AND 5
SEQUOYAH FUELS CORPORATION
GORE, OK

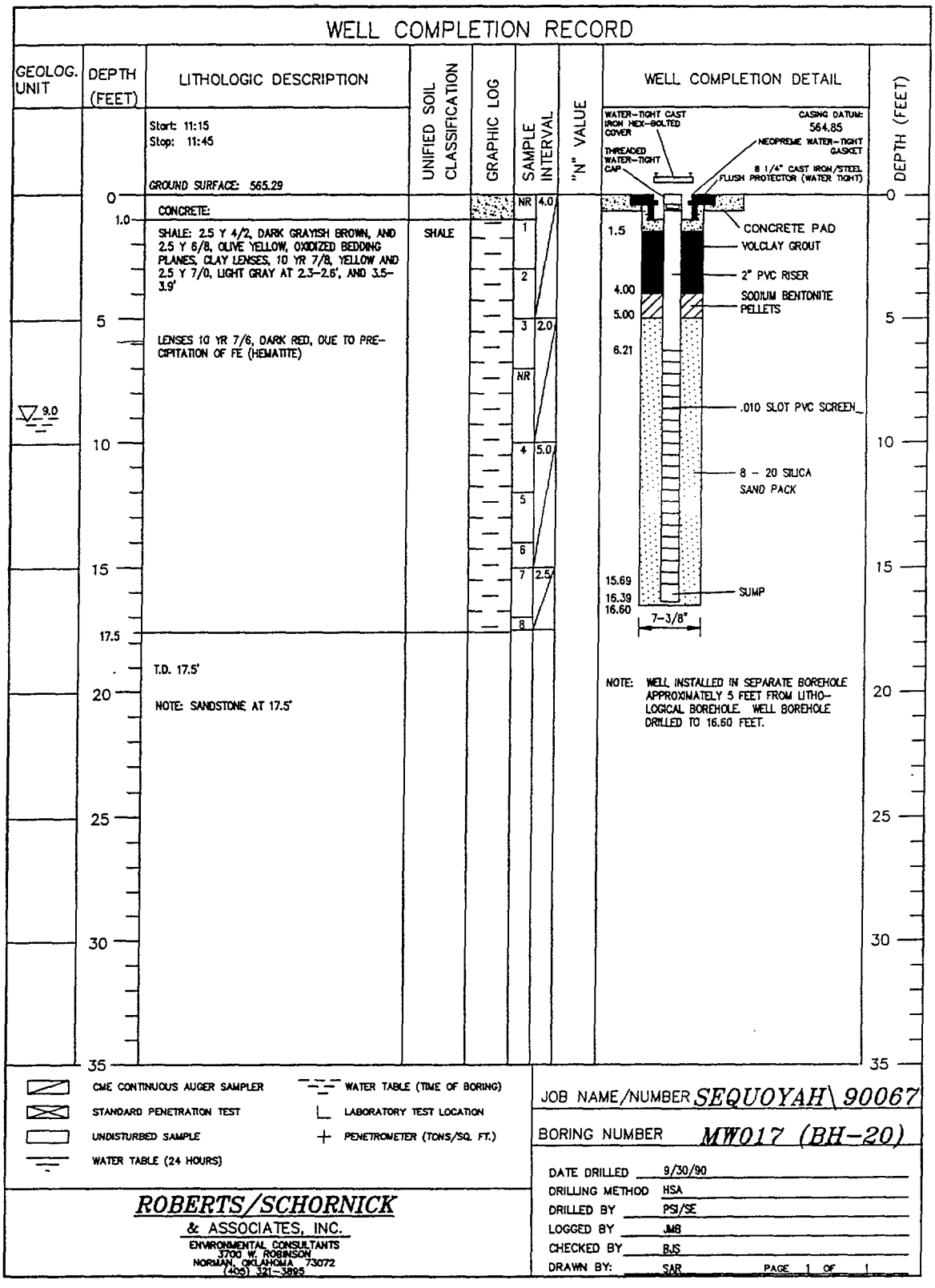


Well Installed: June 11, 1986 by Jim Winnek, Inc.
Water Level on June 23, 1986 - 44.70' Below Top of PVC Csg.
Logged by: R. K. Widmann

MONITOR WELL 2356
BETWEEN PONDS 3W AND 5
SEQUOYAH FUELS CORPORATION
GORE, OK



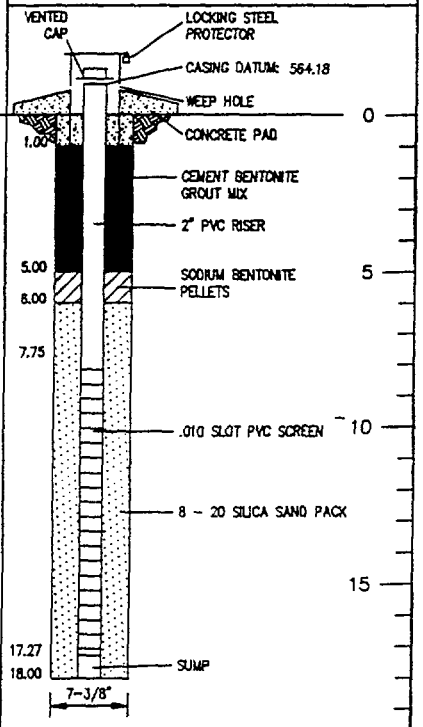
Well Installed: June 10, 1986 by Jim Winnek, Inc.
Water Level on June 23, 1986 - 43.60' Below Top of PVC Csg
ogged by : R. K. Widmann


WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
DEPTH (FEET)
Start: 11:15
Stop: 11:45
GROUND SURFACE: 565.29
CONCRETE:
SHALE: 2.5 Y 4/2, DARK GRAYISH BROWN, AND 2.5 Y 6/8, OLIVE YELLOW, OXIDIZED BEDDING PLANES, CLAY LENSES, 10 YR 7/8, YELLOW AND 2.5 Y 7/0, LIGHT GRAY AT 2.3–2.6', AND 3.5–3.9'
SHALE
LENSES 10 YR 7/6, DARK RED, DUE TO PRECIPITATION OF FE (HEMATITE)
T.D. 17.5'
NOTE: SANDSTONE AT 17.5'
WATER-TIGHT CAST IRON HEX-BOLTED COVER
CASING DATUM: 564.85
NEOPRENE WATER-TIGHT GASKET
THREADED WATER-TIGHT CAP
8 1/4" CAST IRON/STEEL FLUSH PROTECTOR (WATER TIGHT)
CONCRETE PAD
VOLCLAY GROUT
2" PVC RISER
SODIUM BENTONITE PELLETS
.010 SLOT PVC SCREEN
8 – 20 SILICA SAND PACK
SUMP
7-3/8"
NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGICAL BOREHOLE. WELL BOREHOLE DRILLED TO 16.60 FEET.
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW017 (BH-20)
DATE DRILLED 9/30/90
DRILLING METHOD HSA
DRILLED BY PSI/SE
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
ROBERTS/SCHORNICK & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS
3700 W. ROBINSON
NORMAN, OKLAHOMA 73072
(405) 321-3895

WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	SAMPLE INTERVAL	"N" VALUE
		GROUND SURFACE: 561.70				
	0	SILTY TOP SOIL: ROOTS, 2.5 YR 2.5/2 BLACK			1 1.0	
	1.0	GRAVELLY CLAYEY SILT: 2.5 YR 5/4, SOFT, MOIST, NON-STRAT., 10% QUARTZ GRAVEL, 3-15 MM, 20% CLAY, 70% SILT	ML		NR	
	5 5.4	GRAVELLY SILTY CLAY: 7.5 YR 6/6, REDDISH YELLOW, MOIST, SOFT, NON-STRAT., MOTTLED, 20% QUART GRAVEL 3-25 MM, 30% SILT, 50% CLAY (CLAY M-H PLAST.)	CL		2 2.5	
					NR	
	9.5 10	CLAY: 10 YR 7/6 TO 7/2, YELLOW IT LIGHT GRAY, FIRM TO CRUMBLY, ZONE 10.2-11.3' (SLIGHTLY BLOCKY STRUCTURE), GRADES TO WEATHERED SHALE AT 14.5'	CL TO CH		3 3.0	
					4	
					NR	
	14.3 15	SHALE: WEATHERED, 10 YR 7/3, VERY PALE BROWN THINLY BEDDED, ROOT TRACES TO 15.0', MOTTLED LIGHT BROWN, GRAY, MOIST	SHALE		5 3.5	
shl					6	
					NR	
	19.4 20	AUGER REFUSAL 19.4' SANDSTONE ENCOUNTERED				
	25					
	30					
	35					

WELL COMPLETION DETAIL



NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 18.0 FEET.

CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW036 (BH-46)*

DATE DRILLED 10/31/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR PAGE 1 OF 1

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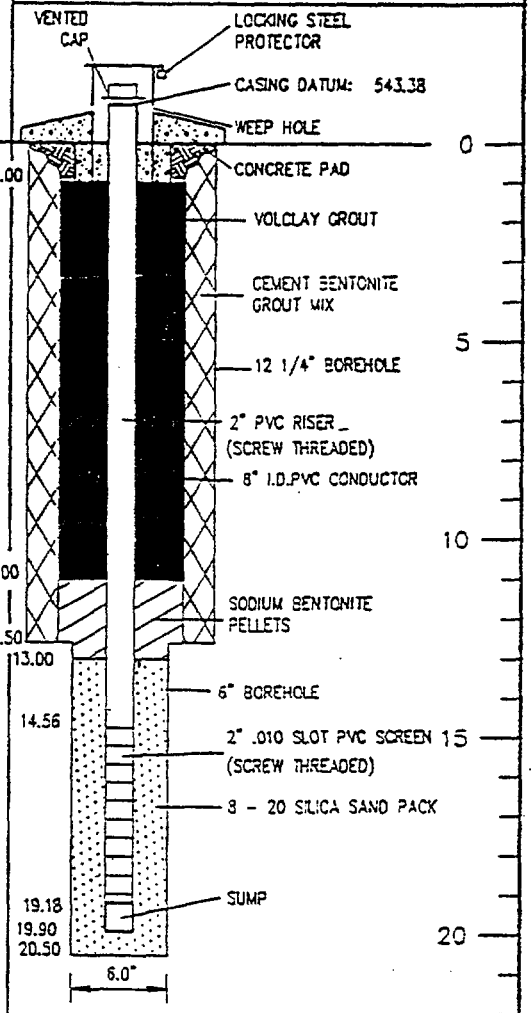
NORMAN, OKLAHOMA 73072
(405) 321-3895

WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION
		GROUND SURFACE: 541.10	
	0 – 0.4	WEATHERED SANDSTONE GRAVEL: SILT, ROUND FILL	CH
	0.4 – 2.0	CLAY: 10 YR 6/8 TO 7/1, BROWNISH YELLOW TO LIGHT GRAY, MOIST, H-PLAST., MOTTLED, FIRM, VERY HIGHLY ORGANIC LENSE 1.6-1.8' (ODOR), ROTTS, ETC.	
	2.0 – 6.5	CLAYEY SILT: 7.5 YR 4/2, DARK BROWN, MOIST TO WET, M-PLAST., ROOTS, TRACE GRAVEL, 40% CLAY, 60% SILT, GRADES TO SILTY CLAY 6.5'	ML
	6.5 – 8.4	SILTY CLAY: 7.5 YR 4/2, DARK BROWN, WET TO SATURATED, SOFT-FIRM, H-PLAST., 70% CLAY, 30% SILT	CH
	8.4 – 10	SANDSTONE, SILTY CLAY: 10 YR 6/6, BROWNISH YELLOW, WET, SOFT, 20% WEATHERED SANDSTONE, 10 YR 3/1, VERY DARK GRAY, 30% SILT, 50% CLAY, M-H PLAST.	CH
	10 – 12.5	SANDSTONE: CONDUCTOR CASING:	SANDSTONE
	12.5 – 15.5	SANDSTONE: 2.5 Y 6/1, GRAY TO LIGHT GRAY, MASSIVE, FINE GRAIN, DRY TO SLIGHTLY MOIST, HIGHLY CEMENTED, HARD	SANDSTONE
	15.5 – 18.5	SHALE: 2.5 Y 2/0 (N2/), BLACK, FISSILE, WET, HIGHLY ORGANIC, SOFT	SHALE
	18.5 – 20.5	SANDSTONE: 2.5 Y 7/1 (N7/), LIGHT GRAY, HIGHLY CEMENTED, HARD, FINE GRAINED	SANDSTONE
	20.5	T.D. 20.5'	

SAMPLE INTERVAL	"N" VALUE
1	2.0
NR	
2	4.5
3	
NR	
1	
2	
3	



WELL COMPLETION DETAIL

8.0'

15.5'

SSL

SSL

SSL

CUE CONTINUOUS AUGER SAMPLER

STANDARD PENETRATION TEST

UNDISTURBED SAMPLE

WATER TABLE (24 HOURS)

WATER TABLE (TIME OF BORING)

LABORATORY TEST LOCATION

PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW-35A (BH-47)*

DATE DRILLED 11/12/90

DRILLING METHOD AIR ROTARY

DRILLED BY POOL

LOGGED BY JAB

CHECKED BY BJS

ROBERTS/SCHORNICK

& ASSOCIATES, INC.

ENVIRONMENTAL CONSULTANTS

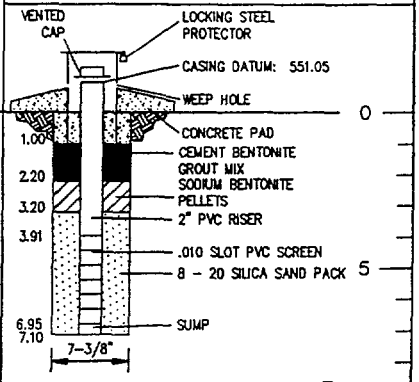
3700 W. ROBINSON

NORMAN, OKLAHOMA 73072

WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	SAMPLE INTERVAL	"N" VALUE
		GROUND SURFACE: 548.40				
	0	TOPSOIL: SILTY LOAM			1 2.8	
	0.8	SANDY CLAYEY SILT: 5 YR 5/4, REDDISH BROWN, MOIST, LOW-PLAST., SLIGHLY MOTTLED, SOFT-FIRM, 15% SAND, VERY FINE-FINE GRAIN, RND-SUBRND., 30% CLAY, 55% SILT	ML			
▽2.3'	1.6	GRAVELLY SANDY SILT: 5 YR 4/4, REDDISH BROWN, SOFT-FIRM, MOIST TO WET TO SAT., SOME GRAVEL AT BASE, 10% GRAVEL, 30% SAND, VF-F GRAIN, RND-SUBRND, 60% SILT	ML		2 NR	
	5 5.1	CLAY: 5 YR 6/6 TO 6/1, REDDISH YELLOW TO GRAY, MOTTLED, FIRM, MOIST TO WET, H-PLAST., NON-STRAT. TO SLIGHTLY BLOCKY STRUCTURE	CH		3 2.1	
	7.1	T.D. 7.1' SANDSTONE ENCOUNTERED AUGER REFUSAL 7.1'				
551	10					
	15					
	20					
	25					
	30					
	35					

WELL COMPLETION DETAIL



NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 7.1 FEET.

CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW040 (BH-50)*

DATE DRILLED 10/31/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR

PAGE 1 OF 1

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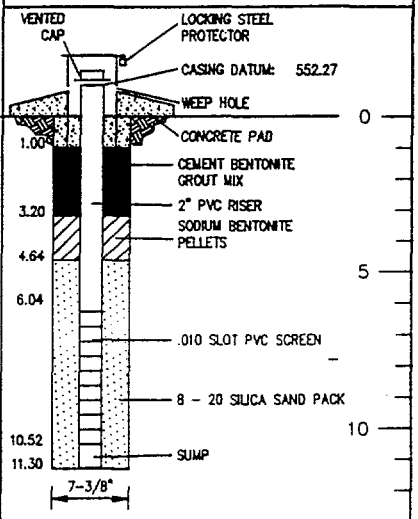
NORMAN, OKLAHOMA 73072
(405) 321-3895

WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	SAMPLE INTERVAL	"N" VALUE
		GROUND SURFACE: 550.0				
	0 – 0.3	TOPSOIL:			1	7.8
		CLAYEY SANDY SILT: 2.5 YR 7/6, REDDISH YELLOW FILL MATERIAL, SOFT, NON-STRAT., MOIST, 70% CLAY, 30% SAND, M-C GRAIN, RND-SUBRND., 50% TRACE GRAVEL THROUGHOUT	ML			
	2.0		ML		2	2.8
		CLAYEY SILT: 7.5 YR 4/4, BROWN, MOIST, SOFT, 40% CLAY, 60% SILT, NON-STRAT., H-PLAST.			NR	
	5.0'					
	5 – 5.5	SILTY CLAY: 5 YR 5/3 TO 2.5 YR 4/8, REDDISH BROWN TO RED, MOIST, FIRM, H-PLAST., MOTTLED, 30% SILT, 70% CLAY	CH		3	5.0
					4	
	8.9					
		WEATHERED SHALE: 7.5 YR 6/2 TO 4/0, PINKISH GRAY TO DARK GRAY	SHALE		5	
Sh2	10				6	3.5
		T.D. 11.3'				
	15					
	20					
	25					
	30					
	35					

WELL COMPLETION DETAIL



NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 11.3' FEET.

CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW054 (BH-62)*

DATE DRILLED 11/19/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR PAGE 1 OF 1

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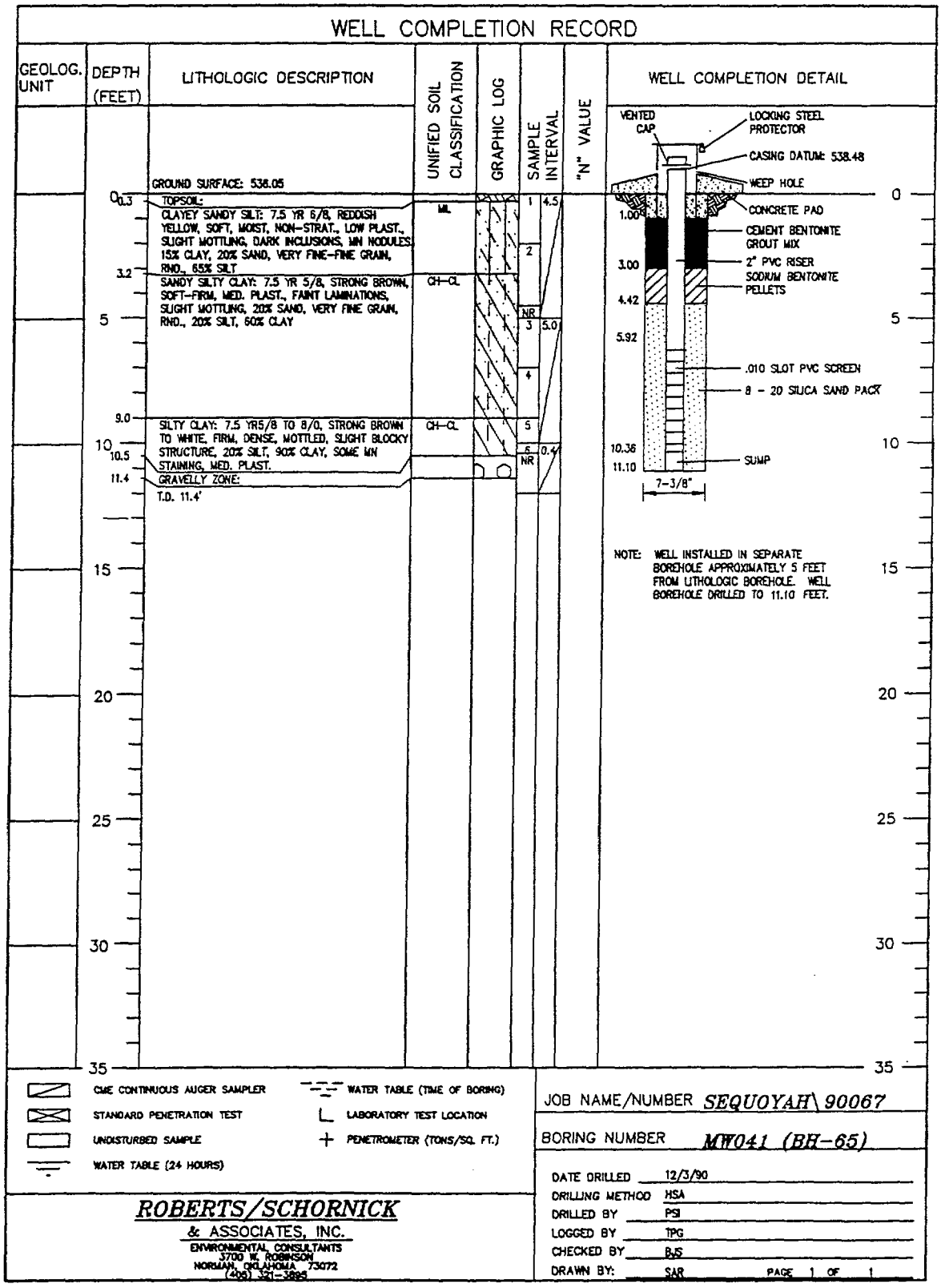
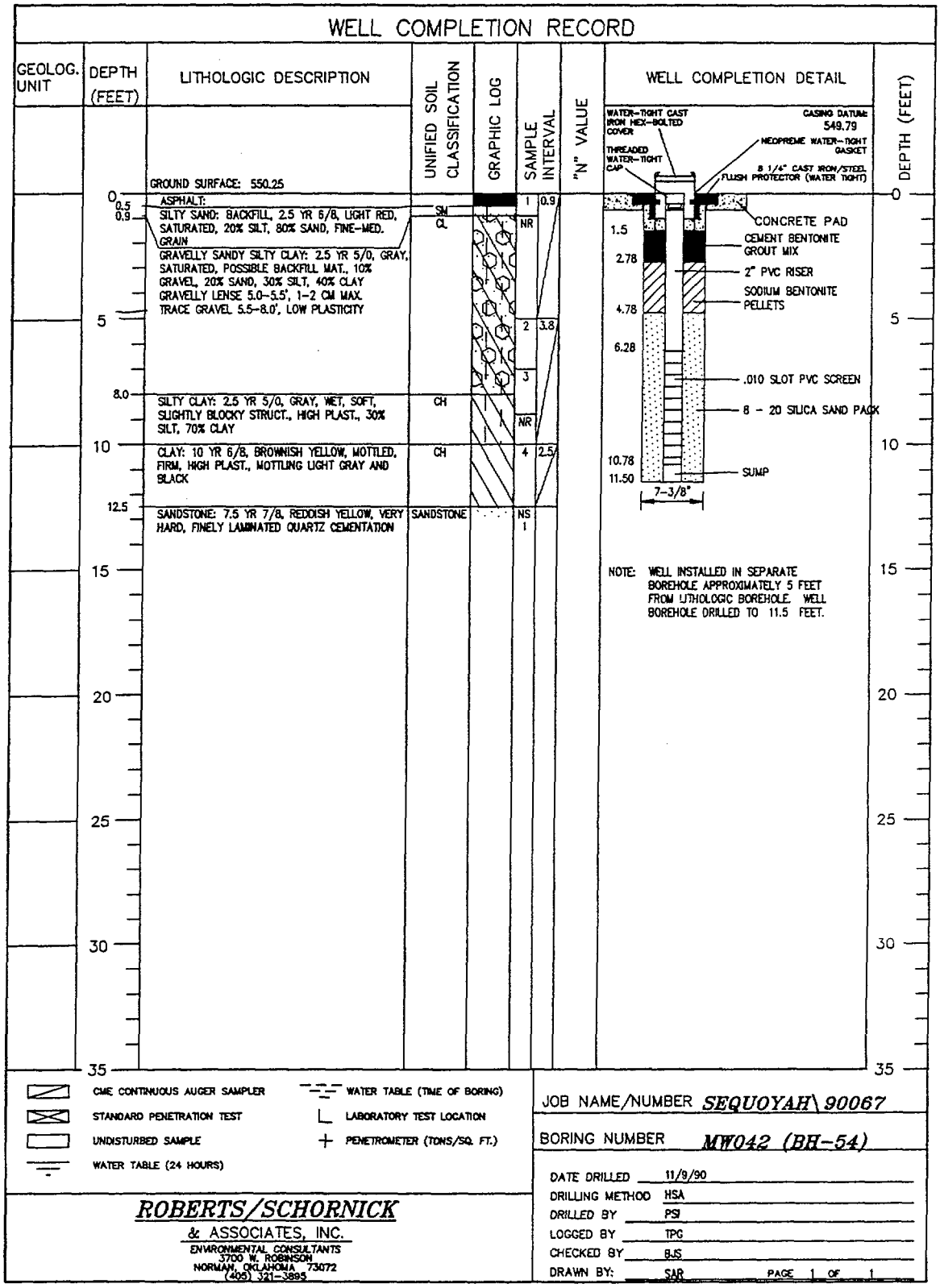

WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 538.05
TOPSOIL:
CLAYEY SANDY SILT: 7.5 YR 6/8, REDDISH YELLOW, SOFT, MOIST, NON-STRAT., LOW PLAST., SLIGHT MOTTLING, DARK INCLUSIONS, MN NODULES, 15% CLAY, 20% SAND, VERY FINE-FINE GRAIN, RND., 65% SILT
SANDY SILTY CLAY: 7.5 YR 5/8, STRONG BROWN, SOFT-FIRM, MED. PLAST., FAINT LAMINATIONS, SLIGHT MOTTLING, 20% SAND, VERY FINE GRAIN, RND., 20% SILT, 60% CLAY
SILTY CLAY: 7.5 YR5/8 TO 8/0, STRONG BROWN TO WHITE, FIRM, DENSE, MOTTLED, SLIGHT BLOCKY STRUCTURE, 20% SILT, 90% CLAY, SOME MN STAINING, MED. PLAST.
GRAVELLY ZONE:
T.D. 11.4'
ML
CH-CL
CH-CL
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 538.48
WEEP HOLE
CONCRETE PAD
CEMENT BENTONITE GROUT MIX
2" PVC RISER
SODIUM BENTONITE PELLETS
.010 SLOT PVC SCREEN
8 - 20 SILICA SAND PACK
SUMP
7-3/8"
NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 11.10 FEET.
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW041 (BH-65)
DATE DRILLED 12/3/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
ROBERTS/SCHORNICK & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS
3700 W. ROBINSON
NORMAN, OKLAHOMA 73072
(405) 321-3895


WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
DEPTH (FEET)
GROUND SURFACE: 550.25
ASPHALT:
SILTY SAND: BACKFILL, 2.5 YR 6/8, LIGHT RED, SATURATED, 20% SILT, 80% SAND, FINE-MED. GRAIN
GRAVELLY SANDY SILTY CLAY: 2.5 YR 5/0, GRAY, SATURATED, POSSIBLE BACKFILL MAT., 10% GRAVEL, 20% SAND, 30% SILT, 40% CLAY GRAVELLY LENSE 5.0-5.5', 1-2 CM MAX. TRACE GRAVEL 5.5-8.0', LOW PLASTICITY
SILTY CLAY: 2.5 YR 5/0, GRAY, WET, SOFT, SLIGHTLY BLOCKY STRUCT., HIGH PLAST., 30% SILT, 70% CLAY
CLAY: 10 YR 6/8, BROWNISH YELLOW, MOTTLED, FIRM, HIGH PLAST., MOTTLING LIGHT GRAY AND BLACK
SANDSTONE: 7.5 YR 7/8, REDDISH YELLOW, VERY HARD, FINELY LAMINATED QUARTZ CEMENTATION
SM
CL
CH
CH
SANDSTONE
0
0.5
0.9
5
8.0
10
12.5
15
20
25
30
35
1
2
3
4
NS
1
0.9
3.8
2.5
NR
NR
WATER-TIGHT CAST IRON HEX-BOLTED COVER
CASING DATUM: 549.79
NEOPRENE WATER-TIGHT GASKET
THREADED WATER-TIGHT CAP
8 1/4" CAST IRON/STEEL FLUSH PROTECTOR (WATER TIGHT)
CONCRETE PAD
CEMENT BENTONITE GROUT MIX
2" PVC RISER
SODIUM BENTONITE PELLETS
.010 SLOT PVC SCREEN
8 - 20 SILICA SAND PACK
SUMP
1.5
2.78
4.78
6.28
10.78
11.50
7-3/8"
NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 11.5 FEET.
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW042 (BH-54)
DATE DRILLED 11/9/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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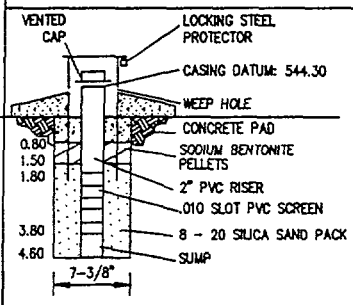
NORMAN, OKLAHOMA 73072
(405) 321-3895

WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	SAMPLE INTERVAL	"N" VALUE
	0	GROUND SURFACE: 541.60				
	0.9	SANDY CLAYEY SILT: 7.5 YR 7/6, REDDISH YELLOW, MOIST, MOTTLED WITH 7.5 YR 7/0, LIGHT GRAY, 15% SAND, VERY FINE-FINE GRAIN, RND-SUBRND., 30% CLAY, 55% SILT, FIRM, ROOTS GRADES TO SILTY CLAY AT 0.9'	ML		1 4.0	
		SILTY CLAY: 7.5 YR 7/6 TO 7/0, REDDISH YELLOW TO LIGHT GRAY, MOIST, MOTTLED, FIRM, M-L PLAST., NON-STRAT. TO 1.7-2.9', LENS BLOCKY TO THINLY BEDDED, ALSO SAND PRESENT IN THIS ZONE 20% VERY FINE-FINE GRAIN, RND-SUBRND., TURNS FROM FIRM TO HARD AT 4.5', INCREASE IN SAND AT 4.5' TO 20%	CH		2 NR	
	4.5 5.2	SANDY SILTY WEATHERED SHALE: 7.5 YR 7/6 TO 7/0, REDDISH YELLOW TO LIGHT GRAY, HARD DRY	SHALE		3 0.7'	
		T.D. 5.2' SANDSTONE ENCOUNTERED				

WELL COMPLETION DETAIL



NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 4.60 FEET.

0 5 10 15 20 25 30 35

CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW045 (BH-49)*

DATE DRILLED 11/1/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR PAGE 1 OF 1

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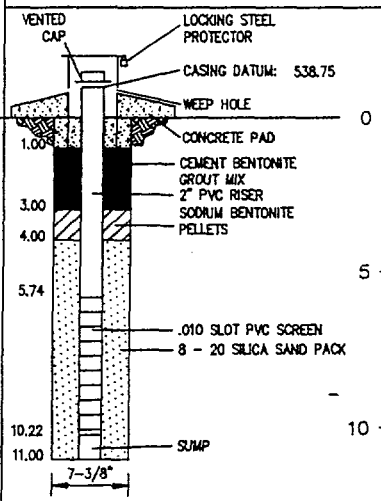
cj of
3/19/01

WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	SAMPLE INTERVAL	"N" VALUE
		GROUND SURFACE: 536.51				
	0	TOPSOIL:			1	3.8
	0.8	CLAY: 7.5 YR 6/4, LIGHT BROWN, FIRM, HIGH PLAST., MOIST, MOTTLED, NON-STRAT.	CH			
	1.3	SANDY SILTY CLAY: 10 YR 8/8, YELLOW, FIRM-HARD, SLIGHTLY LAMINATED TO SLIGHTLY BLOCKY STRUCT., MOTTLED, DRY-MOIST, 10-20% SILT, 60-70% CLAY	CL		2	
	3.7	WEATHERED SANDSTONE LENSE: 10 YR 6/1, GRAY, VERY HARD, VERY FINE GRAIN, SILICA CEMENTATION	SANDSTONE		NR	
	5				3	3.0
Sh2	6.0	WEATHERED SHALE: SILTY AND SANDY TO 7.0', 10 YR 7/4 TO 7/8, NON-STRAT., VERY PALE BROWN TO YELLOW, THEN TO 10 YR 3/1, VERY DARK GRAY, THINLY LAMINATED, SANDSTONE LENSE 6.0-6.2', 6.5-6.7'	SHALE		4	
					NR	
	10				5	0.5
	10.5	SANDSTONE: VERY DENSE, VERY HARD	SANDSTONE			
	15					
	20					
	25					
	30					
	35					

WELL COMPLETION DETAIL



NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 11.0 FEET.

CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW046 (BH-57)*

DATE DRILLED 11/9/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR PAGE 1 OF 1

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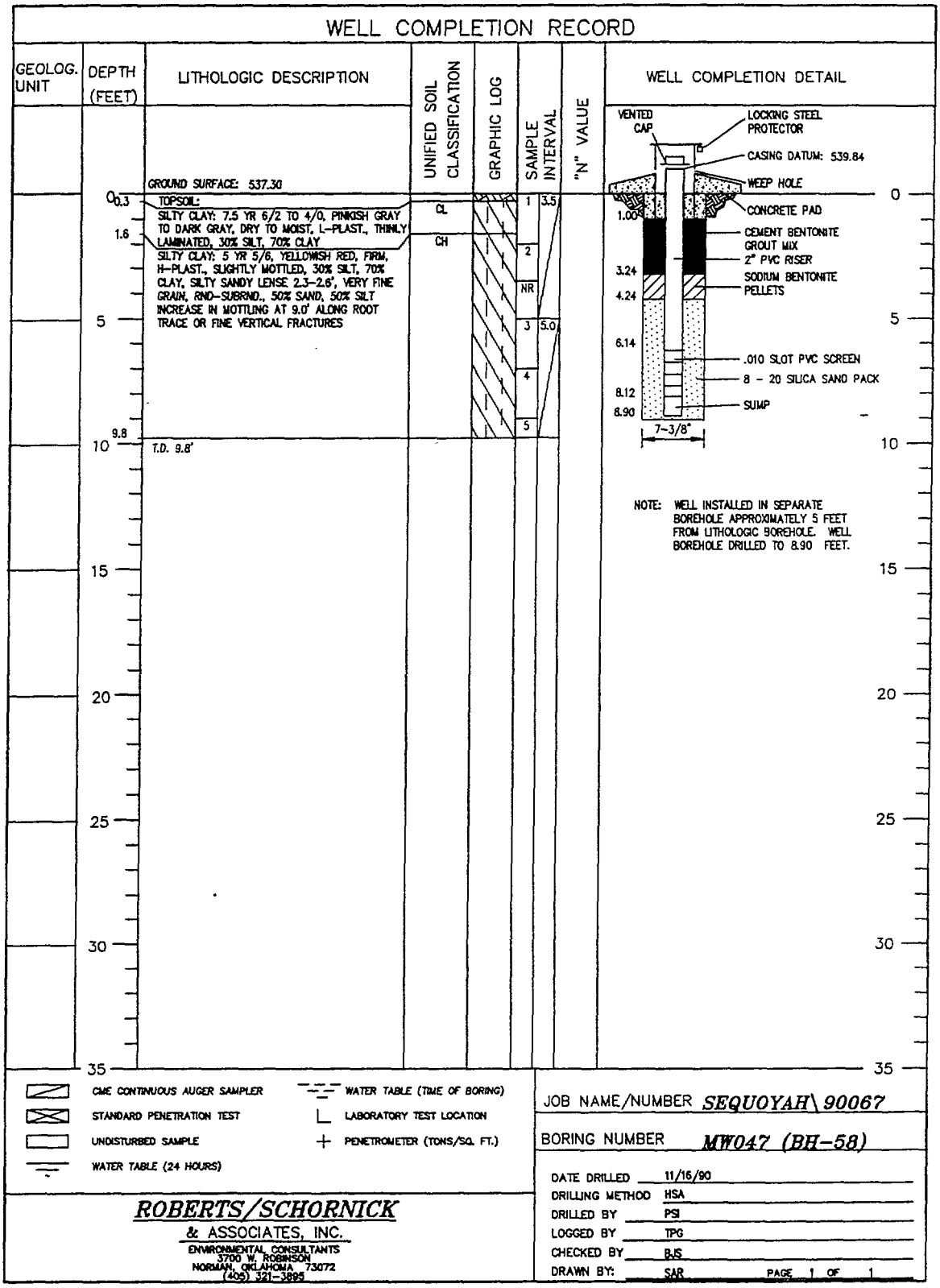
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 537.30
Qo
0.3
TOPSOIL:
SILTY CLAY: 7.5 YR 6/2 TO 4/0, PINKISH GRAY TO DARK GRAY, DRY TO MOIST, L-PLAST., THINLY LAMINATED, 30% SILT, 70% CLAY
CL
1.6
SILTY CLAY: 5 YR 5/6, YELLOWISH RED, FIRM, H-PLAST., SLIGHTLY MOTTLED, 30% SILT, 70% CLAY, SILTY SANDY LENSE 2.3-2.6', VERY FINE GRAIN, RND-SUBRND., 50% SAND, 50% SILT INCREASE IN MOTTLING AT 9.0' ALONG ROOT TRACE OR FINE VERTICAL FRACTURES
CH
9.8
T.D. 9.8'
1
3.5
2
NR
3
5.0
4
5
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 539.84
WEEP HOLE
CONCRETE PAD
1.00
CEMENT BENTONITE GROUT MIX
2" PVC RISER
3.24
SODIUM BENTONITE PELLETS
4.24
6.14
.010 SLOT PVC SCREEN
8 - 20 SILICA SAND PACK
8.12
8.90
SUMP
7-3/8"
NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 8.90 FEET.
0
5
10
15
20
25
30
35
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW047 (BH-58)
DATE DRILLED 11/16/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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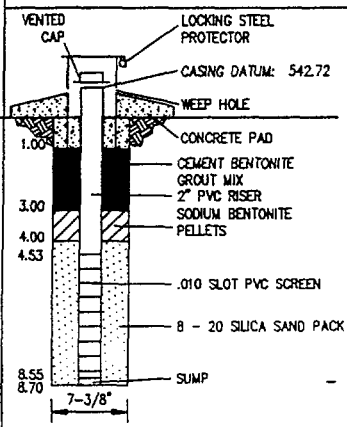
WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	SAMPLE INTERVAL	"N" VALUE
		GROUND SURFACE: 540.14				
	0	TOPSOIL:			1	2.0
	0.6	SILTY SAND: 5 YR 5/3 TO 4/2, REDDISH BROWN TO DARK REDDISH GRAY, MOIST, SOFT, NON-STRAT., 45% SILT, 55% SAND, VERY FINE GRAIN, RND-SUBRND., ROCK LAYER 1.5-1.7', WEATHERED SANDSTONE 5 YR 5/8, YELLOWISH RED TO 3/2 DARK REDDISH BROWN, CONCRETIONS	SP			
	1.7	GRAVELLY SILTY SANDY CLAY: 10 YR 7/4 TO 7/8, VERY PALE BROWN TO YELLOW, DRY TO MOIST, L-PLAST., SANDY GRAVELLY LAYER 1.7-5.0', CLAY 5.0-6.0', SANDY LAYER 6.0-6.5', GRAVEL WEATHERED SANDSTONE 10%, SILT 20%, SAND 30%, VERY FINE-FINE GRAIN, RND-SUBRND., 40% CLAY	CL			NR
	5				2	4.5
	6.5	WEATHERED SHALE: 7.5 YR 4/0, DARK GRAY	SHALE		3	
Sh2	9.5					NR
	10	T.D. 9.5'				
	15					
	20					
	25					
	30					
	35					

WELL COMPLETION DETAIL



NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 8.7 FEET.

CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW049 (BH-52)*

DATE DRILLED 11/1/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR

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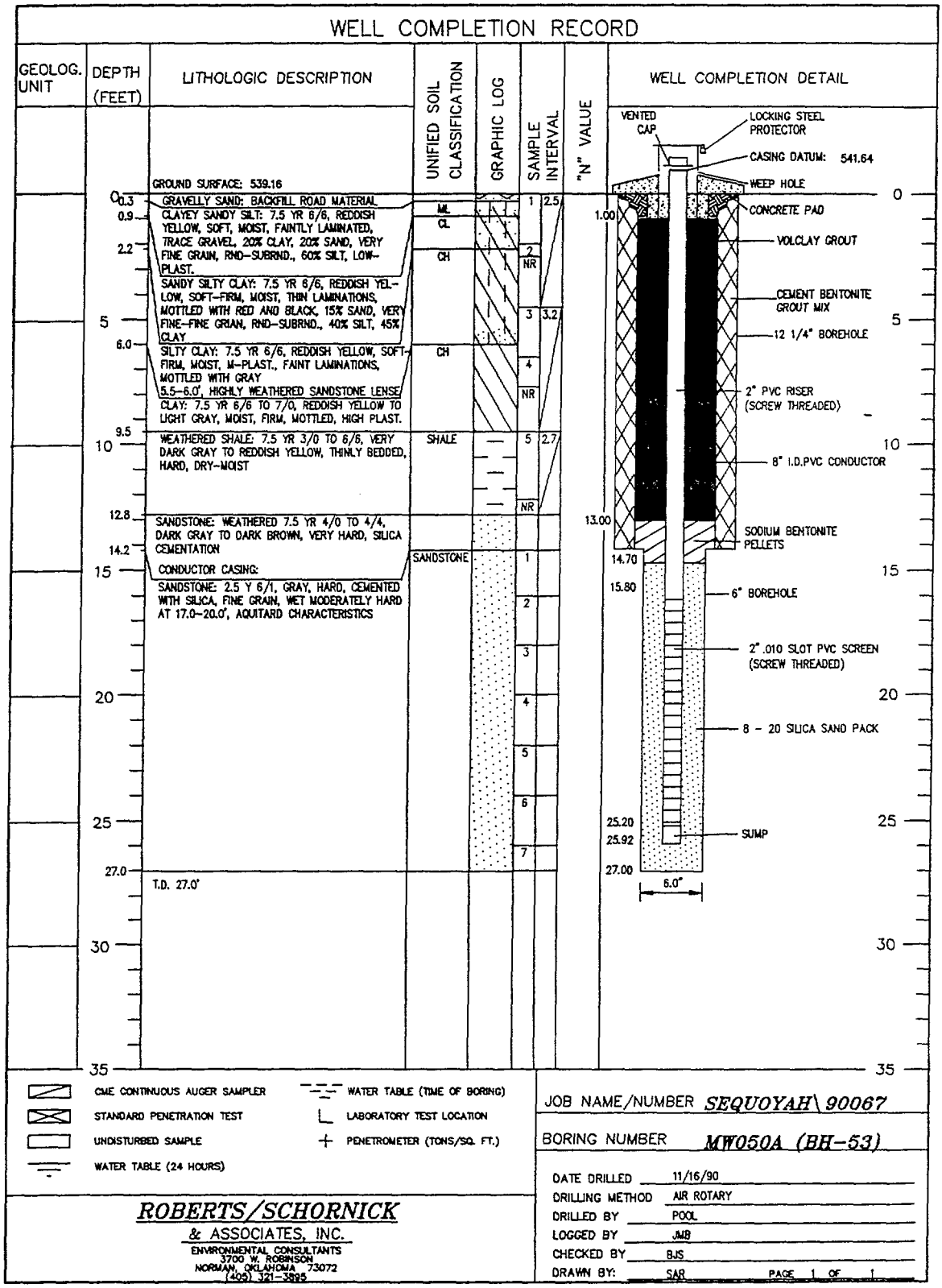
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 539.16
Q 0.3 GRAVELLY SAND: BACKFILL ROAD MATERIAL
0.9 CLAYEY SANDY SILT: 7.5 YR 6/6, REDDISH YELLOW, SOFT, MOIST, FAINTLY LAMINATED, TRACE GRAVEL, 20% CLAY, 20% SAND, VERY FINE GRAIN, RND–SUBRND., 60% SILT, LOW–PLAST.
ML
CL
2.2
CH
SANDY SILTY CLAY: 7.5 YR 6/6, REDDISH YELLOW, SOFT–FIRM, MOIST, THIN LAMINATIONS, MOTTLED WITH RED AND BLACK, 15% SAND, VERY FINE–FINE GRAIN, RND–SUBRND., 40% SILT, 45% CLAY
5
6.0
CH
SILTY CLAY: 7.5 YR 6/6, REDDISH YELLOW, SOFT–FIRM, MOIST, M–PLAST., FAINT LAMINATIONS, MOTTLED WITH GRAY
5.5–6.0', HIGHLY WEATHERED SANDSTONE LENSE
CLAY: 7.5 YR 6/6 TO 7/0, REDDISH YELLOW TO LIGHT GRAY, MOIST, FIRM, MOTTLED, HIGH PLAST.
9.5
10
WEATHERED SHALE: 7.5 YR 3/0 TO 6/6, VERY DARK GRAY TO REDDISH YELLOW, THINLY BEDDED, HARD, DRY–MOIST
SHALE
12.8
SANDSTONE: WEATHERED 7.5 YR 4/0 TO 4/4, DARK GRAY TO DARK BROWN, VERY HARD, SILICA CEMENTATION
14.2
15
CONDUCTOR CASING:
SANDSTONE
SANDSTONE: 2.5 Y 6/1, GRAY, HARD, CEMENTED WITH SILICA, FINE GRAIN, WET MODERATELY HARD AT 17.0–20.0', AQUITARD CHARACTERISTICS
20
25
27.0
T.D. 27.0'
30
35
1 2.5
2 NR
3 3.2
4 NR
5 2.7
NR
1
2
3
4
5
6
7
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 541.64
WEEP HOLE
1.00
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D.PVC CONDUCTOR
13.00
SODIUM BENTONITE PELLETS
14.70
15.80
6" BOREHOLE
2" .010 SLOT PVC SCREEN (SCREW THREADED)
8 – 20 SILICA SAND PACK
25.20
25.92
SUMP
27.00
6.0"
0
5
10
15
20
25
30
35
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW050A (BH–53)
DATE DRILLED 11/16/90
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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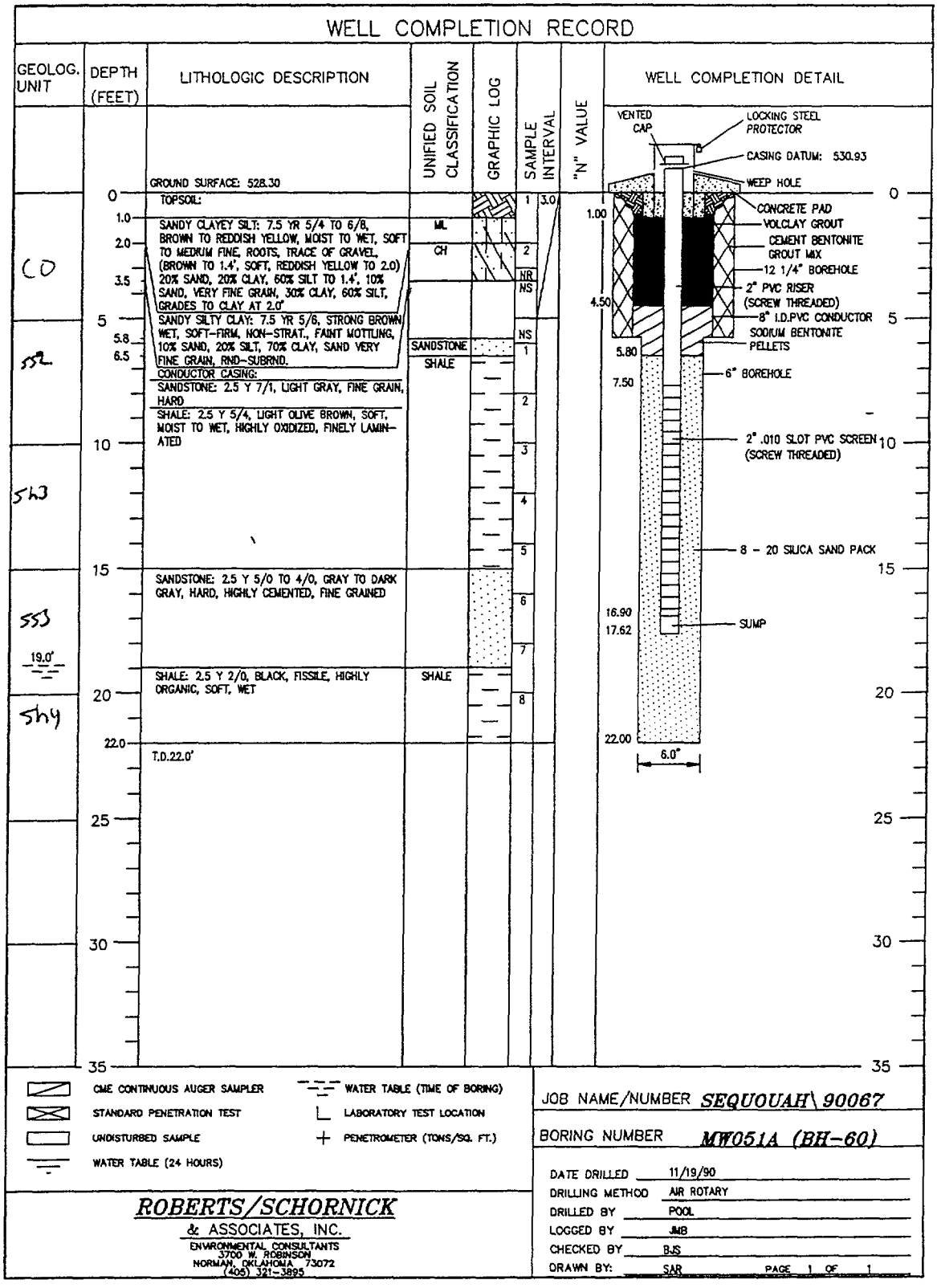
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 528.30
TOPSOIL:
SANDY CLAYEY SILT: 7.5 YR 5/4 TO 6/8, BROWN TO REDDISH YELLOW, MOIST TO WET, SOFT TO MEDIUM FINE, ROOTS, TRACE OF GRAVEL, (BROWN TO 1.4', SOFT, REDDISH YELLOW TO 2.0) 20% SAND, 20% CLAY, 60% SILT TO 1.4', 10% SAND, VERY FINE GRAIN, 30% CLAY, 60% SILT, GRADES TO CLAY AT 2.0'
SANDY SILTY CLAY: 7.5 YR 5/6, STRONG BROWN WET, SOFT-FIRM, NON-STRAT., FAINT MOTTLING, 10% SAND, 20% SILT, 70% CLAY, SAND VERY FINE GRAIN, RND-SUBRND.
CONDUCTOR CASING:
SANDSTONE: 2.5 Y 7/1, LIGHT GRAY, FINE GRAIN, HARD
SHALE: 2.5 Y 5/4, LIGHT OLIVE BROWN, SOFT, MOIST TO WET, HIGHLY OXIDIZED, FINELY LAMINATED
SANDSTONE: 2.5 Y 5/0 TO 4/0, GRAY TO DARK GRAY, HARD, HIGHLY CEMENTED, FINE GRAINED
SHALE: 2.5 Y 2/0, BLACK, FISSILE, HIGHLY ORGANIC, SOFT, WET
T.D.22.0'
ML
CH
SANDSTONE
SHALE
SHALE
CO
552
543
553
554
19.0'
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 530.93
WEEP HOLE
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2" .010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
1.00
4.50
5.80
7.50
16.90
17.62
22.00
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOUAH\ 90067
BORING NUMBER MW051A (BH-60)
DATE DRILLED 11/19/90
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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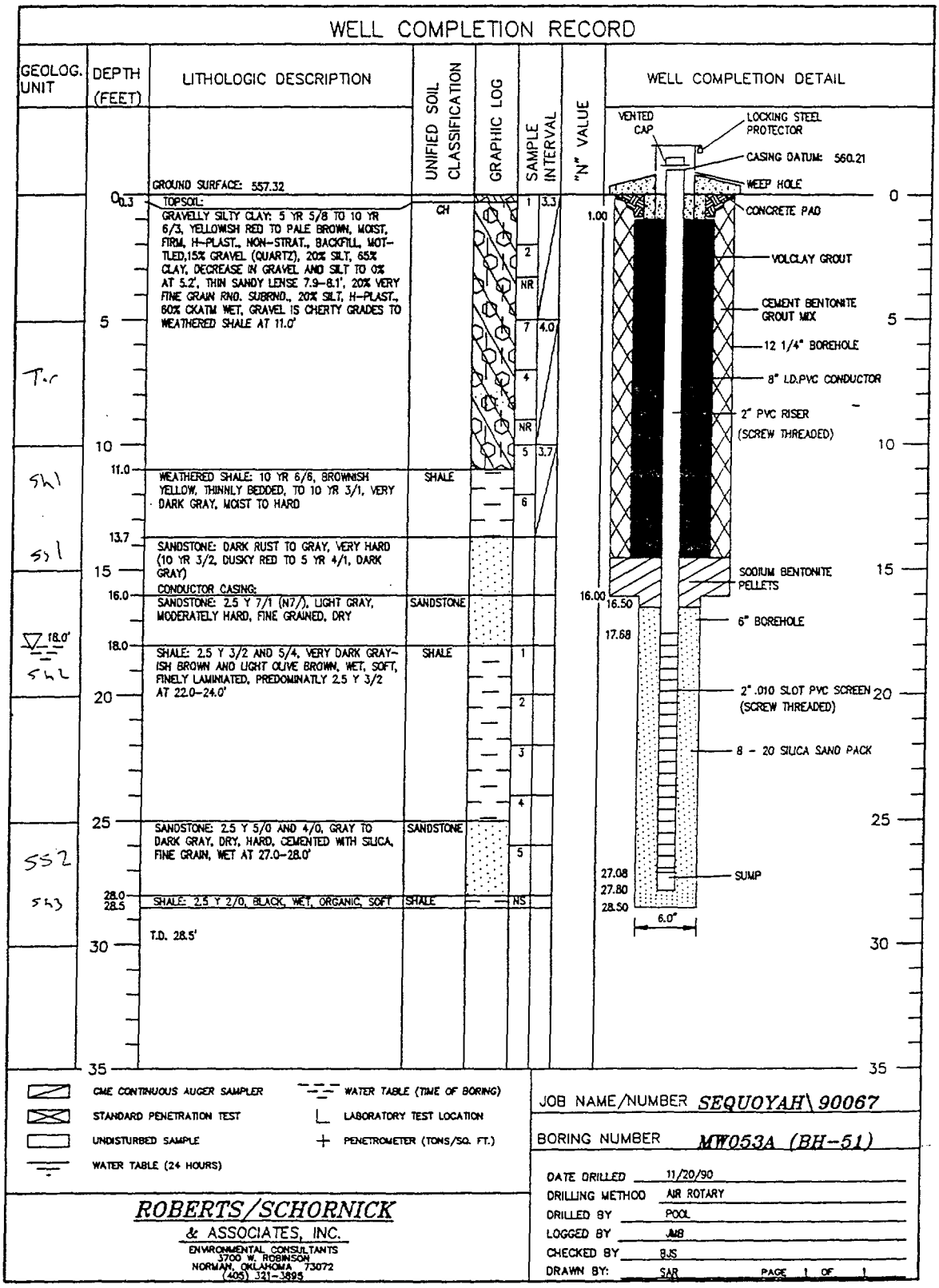
WELL COMPLETION RECORD



JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW053A (BH-51)*

DATE DRILLED 11/20/90

DRILLING METHOD AIR ROTARY

DRILLED BY POOL

LOGGED BY JMB

CHECKED BY BJS

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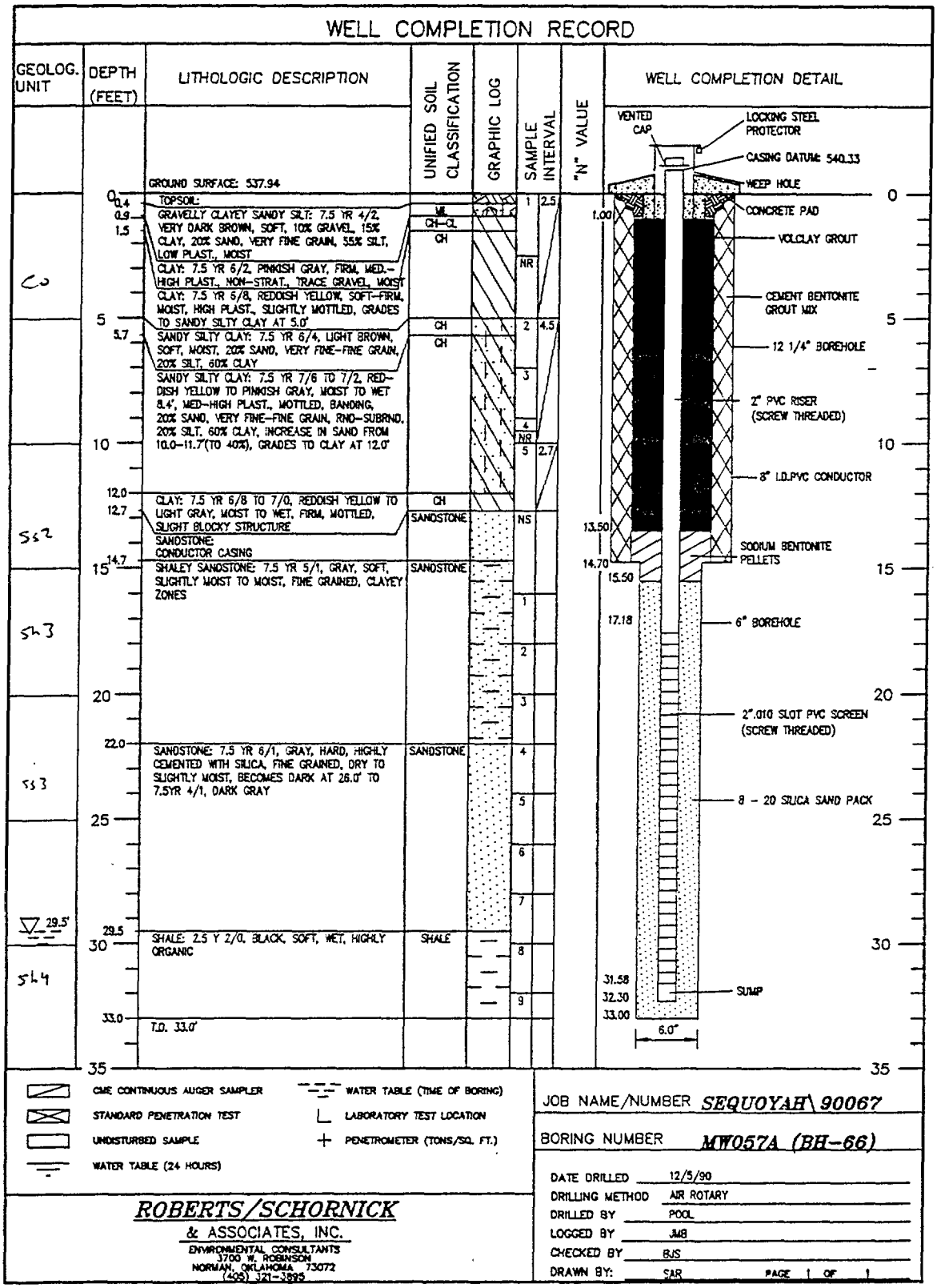
WELL COMPLETION RECORD



JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW057A (BH-66)*

DATE DRILLED 12/5/90
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR PAGE 1 OF 1

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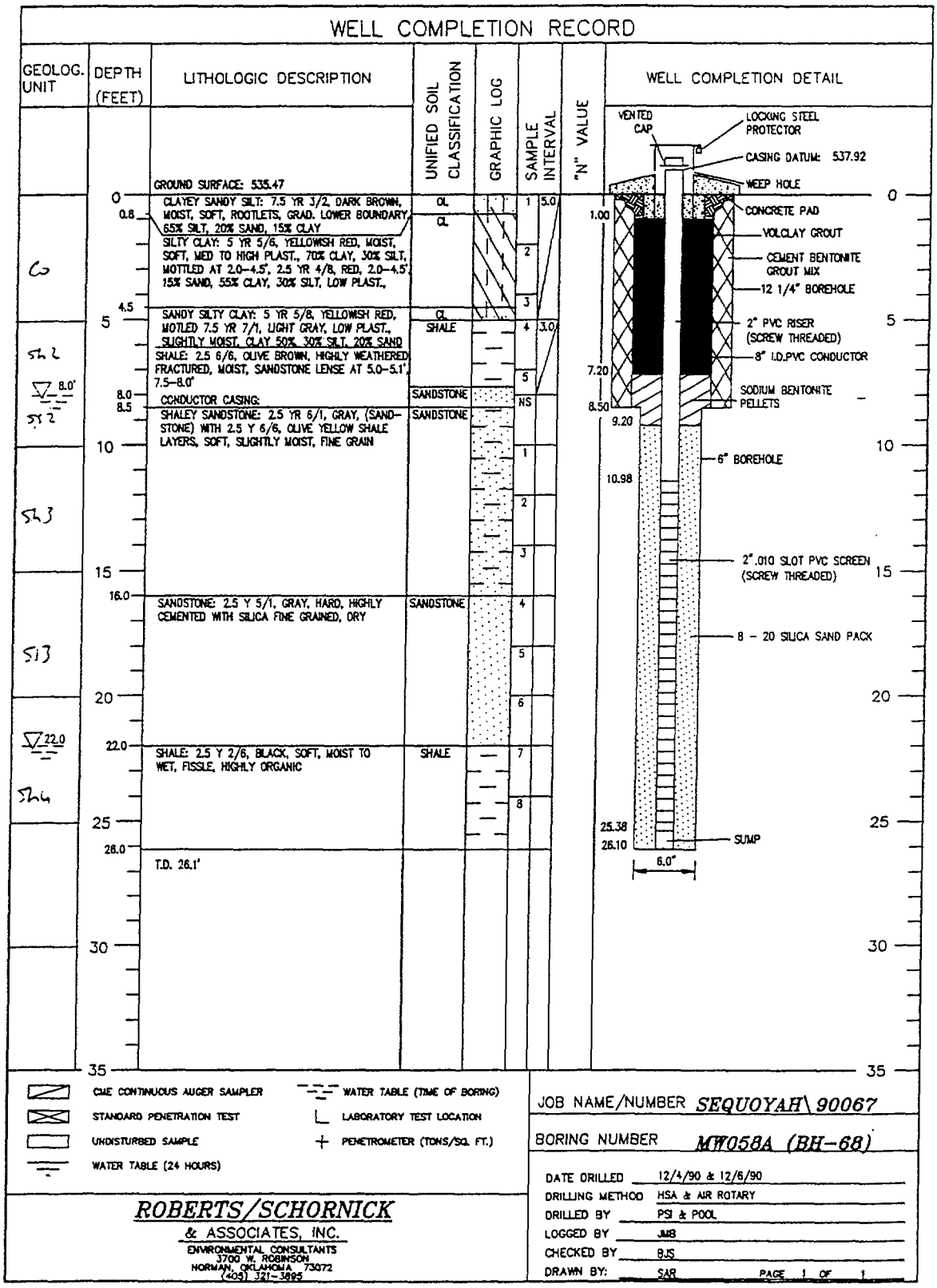
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 535.47
CLAYEY SANDY SILT: 7.5 YR 3/2, DARK BROWN, MOIST, SOFT, ROOTLETS, GRAD. LOWER BOUNDARY, 65% SILT, 20% SAND, 15% CLAY
SILTY CLAY: 5 YR 5/6, YELLOWISH RED, MOIST, SOFT, MED TO HIGH PLAST., 70% CLAY, 30% SILT, MOTTLED AT 2.0–4.5', 2.5 YR 4/8, RED, 2.0–4.5' 15% SAND, 55% CLAY, 30% SILT, LOW PLAST.,
SANDY SILTY CLAY: 5 YR 5/8, YELLOWISH RED, MOTLED 7.5 YR 7/1, LIGHT GRAY, LOW PLAST., SLIGHTLY MOIST, CLAY 50%, 30% SILT, 20% SAND
SHALE: 2.5 6/6, OLIVE BROWN, HIGHLY WEATHERED FRACTURED, MOIST, SANDSTONE LENSE AT 5.0–5.1', 7.5–8.0'
CONDUCTOR CASING:
SHALEY SANDSTONE: 2.5 YR 6/1, GRAY, (SAND-STONE) WITH 2.5 Y 6/6, OLIVE YELLOW SHALE LAYERS, SOFT, SLIGHTLY MOIST, FINE GRAIN
SANDSTONE: 2.5 Y 5/1, GRAY, HARD, HIGHLY CEMENTED WITH SILICA FINE GRAINED, DRY
SHALE: 2.5 Y 2/6, BLACK, SOFT, MOIST TO WET, FISSLE, HIGHLY ORGANIC
T.D. 26.1'
CL
SHALE
SANDSTONE
NS
8.0'
22.0'
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 537.92
WEEP HOLE
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 – 20 SILICA SAND PACK
SUMP
1.00
7.20
8.50
9.20
10.98
25.38
26.10
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW058A (BH-68)
DATE DRILLED 12/4/90 & 12/6/90
DRILLING METHOD HSA & AIR ROTARY
DRILLED BY PSI & POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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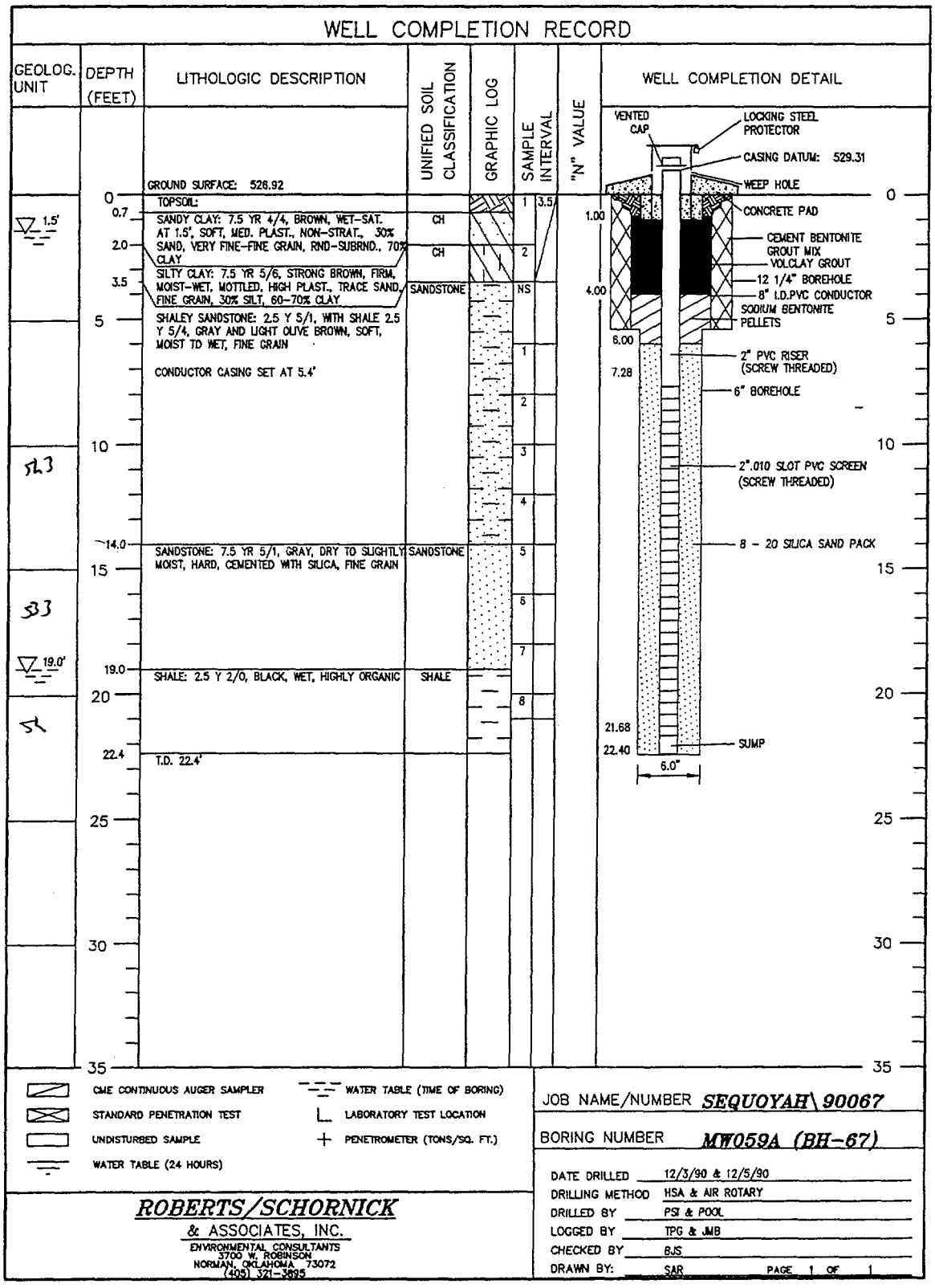
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 526.92
TOPSOIL:
SANDY CLAY: 7.5 YR 4/4, BROWN, WET-SAT. AT 1.5', SOFT, MED. PLAST., NON-STRAT., 30% SAND, VERY FINE-FINE GRAIN, RND-SUBRND., 70% CLAY
CH
SILTY CLAY: 7.5 YR 5/6, STRONG BROWN, FIRM, MOIST-WET, MOTTLED, HIGH PLAST., TRACE SAND, FINE GRAIN, 30% SILT, 60-70% CLAY
CH
SHALEY SANDSTONE: 2.5 Y 5/1, WITH SHALE 2.5 Y 5/4, GRAY AND LIGHT OLIVE BROWN, SOFT, MOIST TO WET, FINE GRAIN
SANDSTONE
CONDUCTOR CASING SET AT 5.4'
SANDSTONE: 7.5 YR 5/1, GRAY, DRY TO SLIGHTLY MOIST, HARD, CEMENTED WITH SILICA, FINE GRAIN
SANDSTONE
SHALE: 2.5 Y 2/0, BLACK, WET, HIGHLY ORGANIC
SHALE
T.D. 22.4'
1.5'
19.0'
52.3
33
51
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 529.31
WEEP HOLE
CONCRETE PAD
CEMENT BENTONITE GROUT MIX
VOLCLAY GROUT
12 1/4" BOREHOLE
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
2" PVC RISER (SCREW THREADED)
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
1.00
4.00
6.00
7.28
21.68
22.40
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
ROBERTS/SCHORNICK
& ASSOCIATES, INC.
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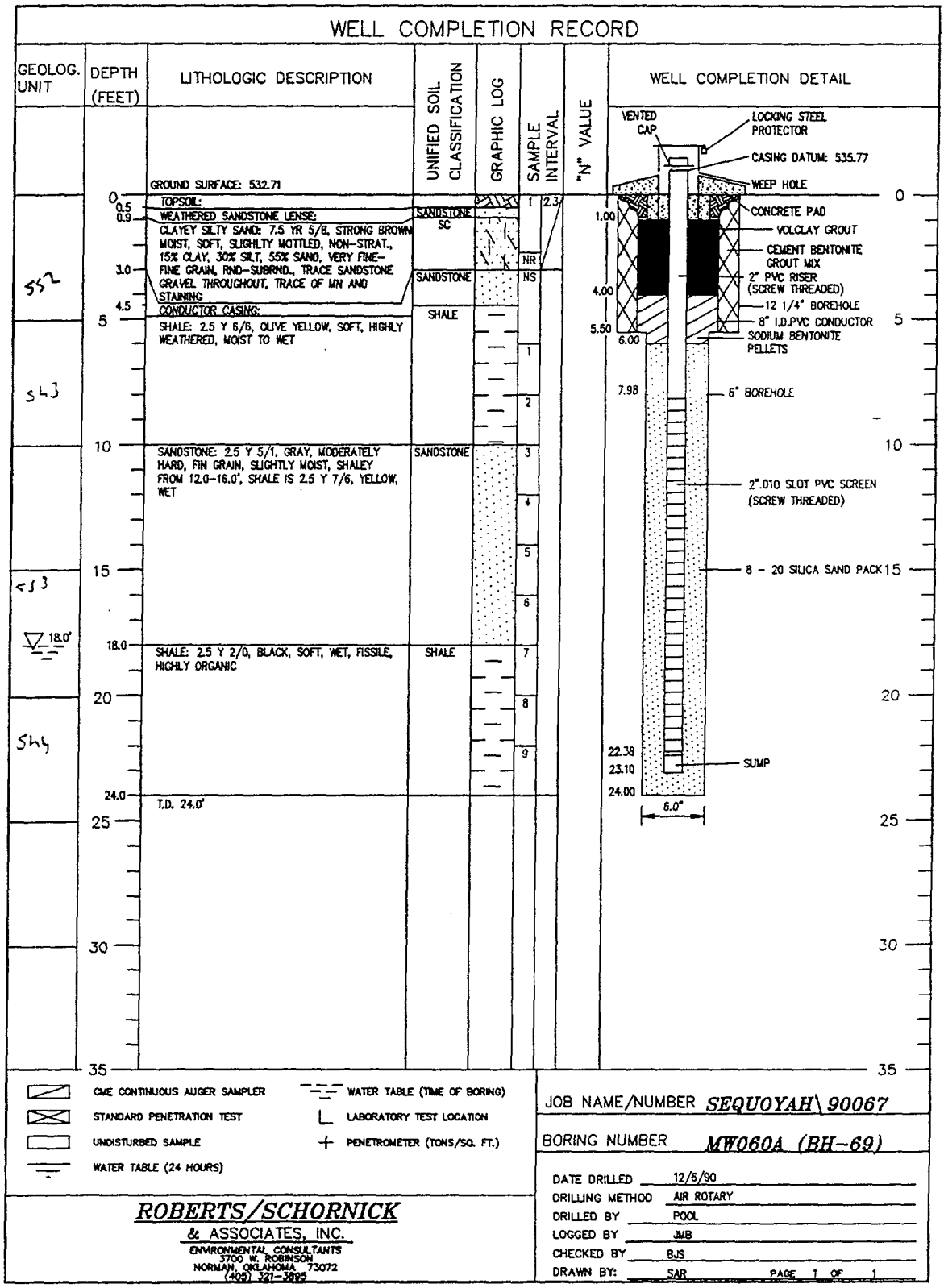
3700 W. ROBINSON
NORMAN, OKLAHOMA 73072
(405) 321-3695
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW059A (BH-67)
DATE DRILLED 12/3/90 & 12/5/90
DRILLING METHOD HSA & AIR ROTARY
DRILLED BY PSI & POOL
LOGGED BY TPG & JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1


WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 532.71
TOPSOIL:
WEATHERED SANDSTONE LENSE:
CLAYEY SILTY SAND: 7.5 YR 5/8, STRONG BROWN MOIST, SOFT, SLIGHLTY MOTTLED, NON-STRAT., 15% CLAY, 30% SILT, 55% SAND, VERY FINE-FINE GRAIN, RND-SUBRND., TRACE SANDSTONE GRAVEL THROUGHOUT, TRACE OF MN AND STAINING
CONDUCTOR CASING:
SHALE: 2.5 Y 6/6, OLIVE YELLOW, SOFT, HIGHLY WEATHERED, MOIST TO WET
SANDSTONE: 2.5 Y 5/1, GRAY, MODERATELY HARD, FIN GRAIN, SLIGHTLY MOIST, SHALEY FROM 12.0-16.0', SHALE IS 2.5 Y 7/6, YELLOW, WET
SHALE: 2.5 Y 2/0, BLACK, SOFT, WET, FISSILE, HIGHLY ORGANIC
T.D. 24.0'
SANDSTONE
SC
SHALE
NR
NS
2.3
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 535.77
WEEP HOLE
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
2" PVC RISER (SCREW THREADED)
12 1/4" BOREHOLE
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
1.00
4.00
5.50
6.00
7.98
22.38
23.10
24.00
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW060A (BH-69)
DATE DRILLED 12/6/90
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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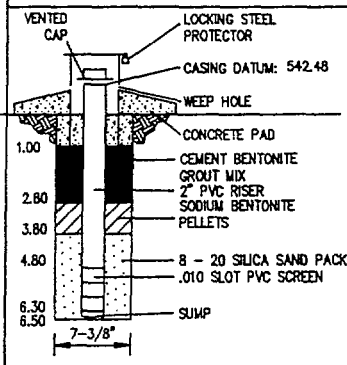
(405) 321-3825

WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	SAMPLE INTERVAL	"N" VALUE
		GROUND SURFACE: 540.07				
	0 – 0.4	TOPSOIL:				
		SILTY CLAY: BACKFILL, 7.5 YR 5/4, BROWN, MOIST, FIRM, MOTTLED, TRACE GRAVEL, (SANDSTONE), NON-STRAT., HIGH PLAST., 20% SILT, 80% CLAY, SILTY SANDY LENSE 1.3-1.6' 7.5 YR 3/4, DARK BROWN, SOFT, WET. GRADES TO 10 YR 6/8 TO 7/1, BROWNISH YELLOW TO LIGHT GRAY, FIRM, MOIST	CH		1 2.0 NR 2 1.0	
	5.5	T.D. 5.5'				



WELL COMPLETION DETAIL

NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 6.50 FEET.

0 5 10 15 20 25 30 35

CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\90067*

BORING NUMBER *MW065 (BH-74)*

DATE DRILLED 12/6/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR PAGE 1 OF 1

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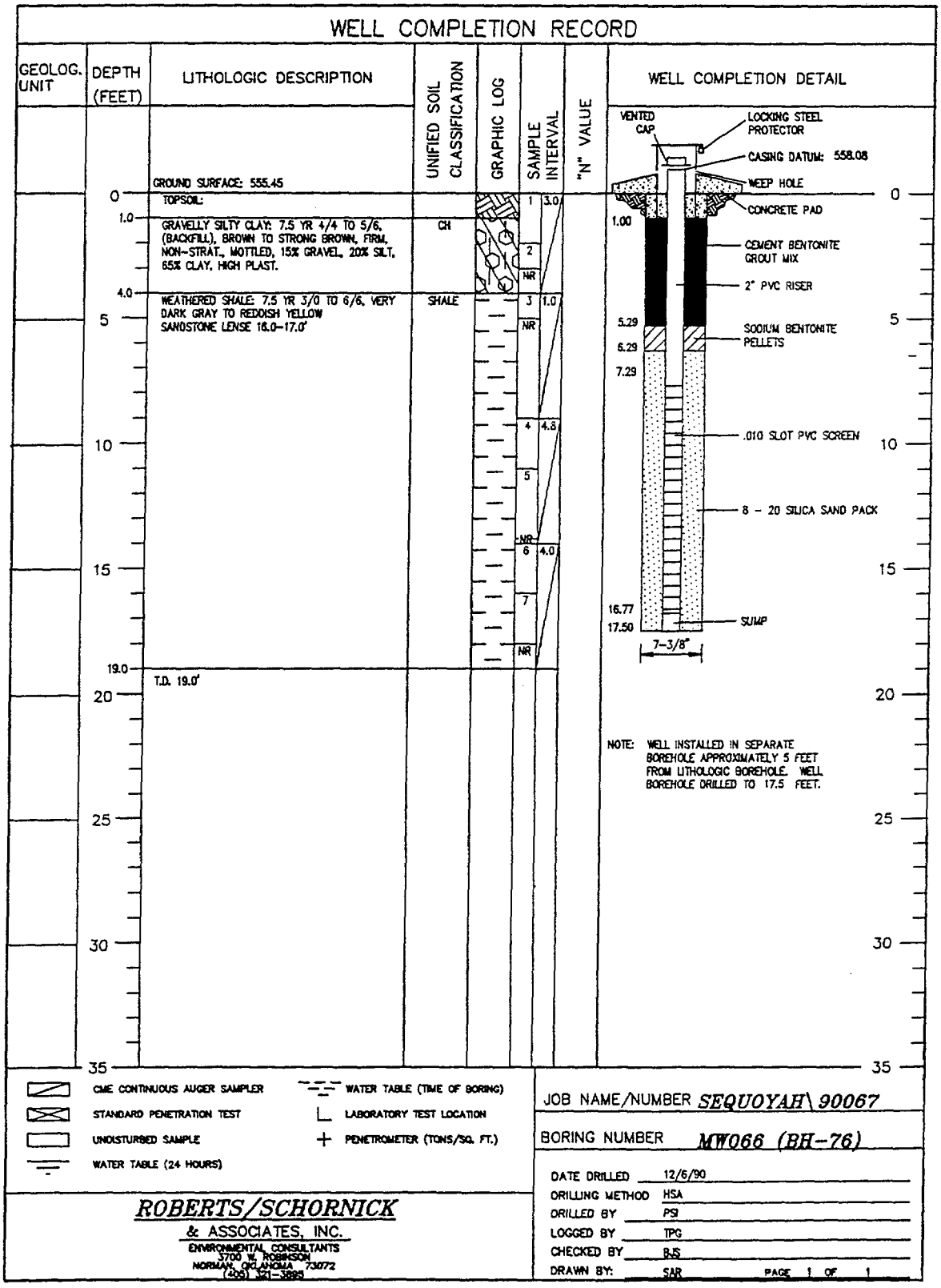
WELL COMPLETION RECORD



JOB NAME/NUMBER *SEQUOYAH\90067*

BORING NUMBER *MW066 (BH-76)*

DATE DRILLED 12/6/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR PAGE 1 OF 1

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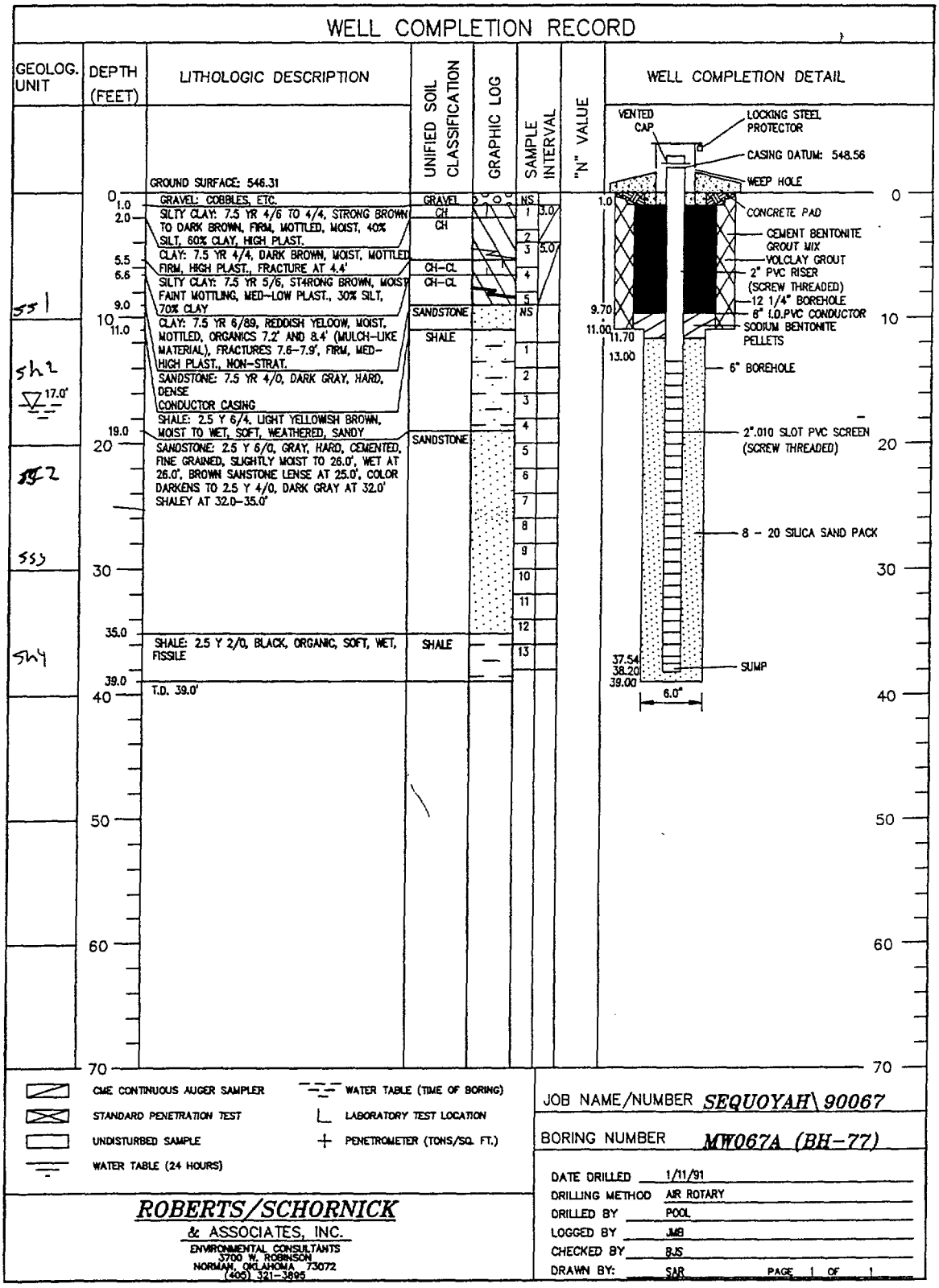
555.45
-17.50
537.95

-6.29
549.16


WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 546.31
GRAVEL: COBBLES, ETC.
SILTY CLAY: 7.5 YR 4/6 TO 4/4, STRONG BROWN TO DARK BROWN, FIRM, MOTTLED, MOIST, 40% SILT, 60% CLAY, HIGH PLAST.
CLAY: 7.5 YR 4/4, DARK BROWN, MOIST, MOTTLED FIRM, HIGH PLAST., FRACTURE AT 4.4'
SILTY CLAY: 7.5 YR 5/6, STRONG BROWN, MOIST FAINT MOTTLING, MED-LOW PLAST., 30% SILT, 70% CLAY
CLAY: 7.5 YR 6/8, REDDISH YELOOW, MOIST, MOTTLED, ORGANICS 7.2' AND 8.4' (MULCH-LIKE MATERIAL), FRACTURES 7.6-7.9', FIRM, MED-HIGH PLAST., NON-STRAT.
SANDSTONE: 7.5 YR 4/0, DARK GRAY, HARD, DENSE
CONDUCTOR CASING
SHALE: 2.5 Y 6/4, LIGHT YELLOWISH BROWN, MOIST TO WET, SOFT, WEATHERED, SANDY
SANDSTONE: 2.5 Y 6/0, GRAY, HARD, CEMENTED, FINE GRAINED, SLIGHTLY MOIST TO 26.0', WET AT 26.0', BROWN SANSTONE LENSE AT 25.0', COLOR DARKENS TO 2.5 Y 4/0, DARK GRAY AT 32.0' SHALEY AT 32.0-35.0'
SHALE: 2.5 Y 2/0, BLACK, ORGANIC, SOFT, WET, FISSILE
T.D. 39.0'
GRAVEL
CH
CH
CH-CL
CH-CL
SANDSTONE
SHALE
SANDSTONE
SHALE
17.0'
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 548.56
WEEP HOLE
CONCRETE PAD
CEMENT BENTONITE GROUT MIX
VOLCLAY GROUT
2" PVC RISER (SCREW THREADED)
12 1/4" BOREHOLE
6" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW067A (BH-77)
DATE DRILLED 1/11/91
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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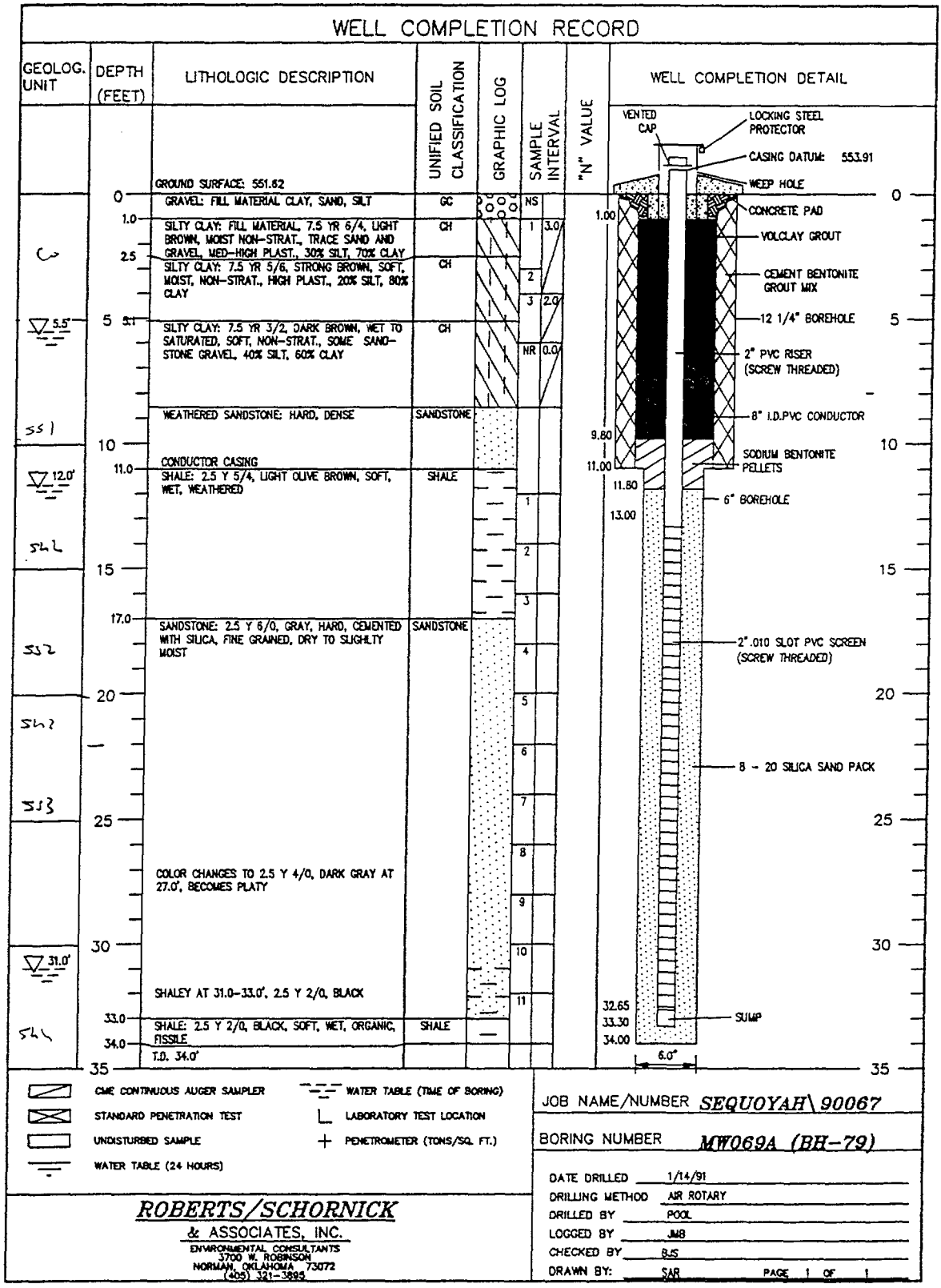
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 551.62
GRAVEL: FILL MATERIAL CLAY, SAND, SILT
GC
SILTY CLAY: FILL MATERIAL, 7.5 YR 6/4, LIGHT BROWN, MOIST NON-STRAT., TRACE SAND AND GRAVEL, MED-HIGH PLAST., 30% SILT, 70% CLAY
CH
SILTY CLAY: 7.5 YR 5/6, STRONG BROWN, SOFT, MOIST, NON-STRAT., HIGH PLAST., 20% SILT, 80% CLAY
CH
SILTY CLAY: 7.5 YR 3/2, DARK BROWN, WET TO SATURATED, SOFT, NON-STRAT., SOME SAND-STONE GRAVEL, 40% SILT, 60% CLAY
CH
WEATHERED SANDSTONE: HARD, DENSE
SANDSTONE
CONDUCTOR CASING
SHALE: 2.5 Y 5/4, LIGHT OLIVE BROWN, SOFT, WET, WEATHERED
SHALE
SANDSTONE: 2.5 Y 6/0, GRAY, HARD, CEMENTED WITH SILICA, FINE GRAINED, DRY TO SLIGHLTY MOIST
SANDSTONE
COLOR CHANGES TO 2.5 Y 4/0, DARK GRAY AT 27.0', BECOMES PLATY
SHALEY AT 31.0-33.0', 2.5 Y 2/0, BLACK
SHALE: 2.5 Y 2/0, BLACK, SOFT, WET, ORGANIC, FISSILE
SHALE
T.D. 34.0'
NS
NR
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 553.91
WEEP HOLE
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW069A (BH-79)
DATE DRILLED 1/14/91
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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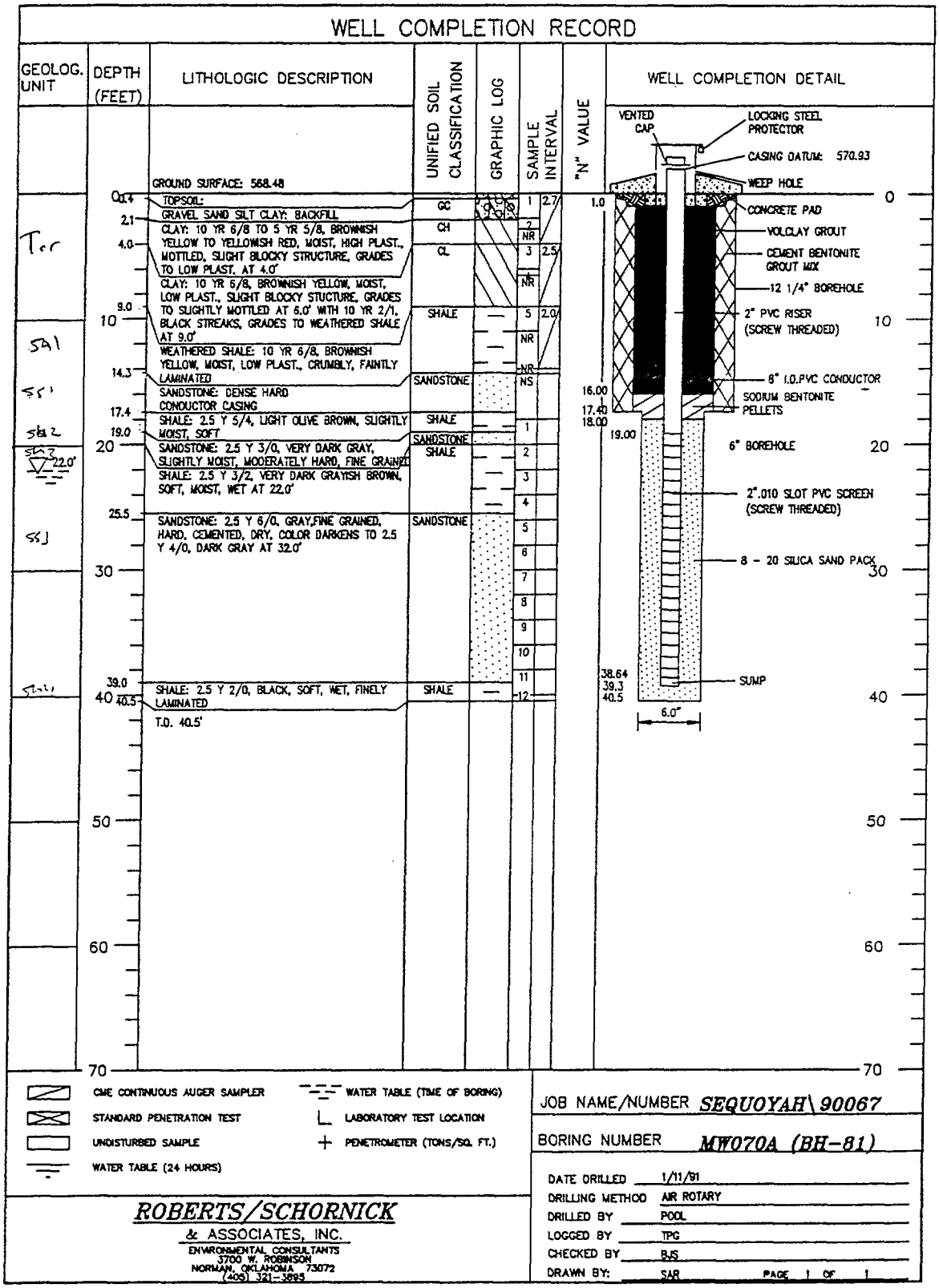
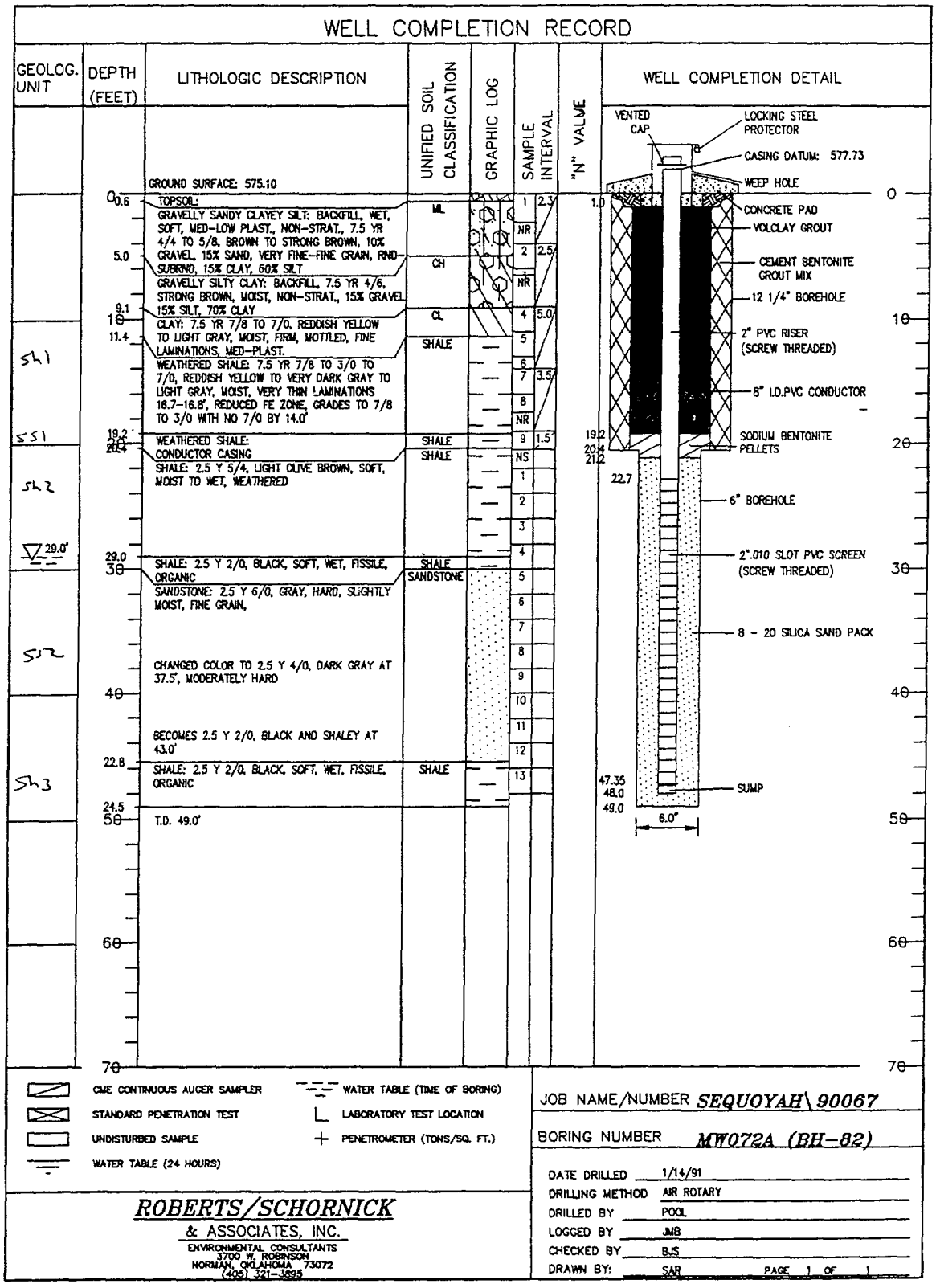

WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 568.48
TOPSOIL
GRAVEL SAND SILT CLAY: BACKFILL
CLAY: 10 YR 6/8 TO 5 YR 5/8, BROWNISH YELLOW TO YELLOWISH RED, MOIST, HIGH PLAST., MOTTLED, SLIGHT BLOCKY STRUCTURE, GRADES TO LOW PLAST. AT 4.0'
CLAY: 10 YR 6/8, BROWNISH YELLOW, MOIST, LOW PLAST., SLIGHT BLOCKY STUCTURE, GRADES TO SLIGHTLY MOTTLED AT 6.0' WITH 10 YR 2/1, BLACK STREAKS, GRADES TO WEATHERED SHALE AT 9.0'
WEATHERED SHALE: 10 YR 6/8, BROWNISH YELLOW, MOIST, LOW PLAST., CRUMBLY, FAINTLY LAMINATED
SANDSTONE: DENSE HARD CONDUCTOR CASING
SHALE: 2.5 Y 5/4, LIGHT OLIVE BROWN, SLIGHTLY MOIST, SOFT
SANDSTONE: 2.5 Y 3/0, VERY DARK GRAY, SLIGHTLY MOIST, MODERATELY HARD, FINE GRAINED
SHALE: 2.5 Y 3/2, VERY DARK GRAYISH BROWN, SOFT, MOIST, WET AT 22.0'
SANDSTONE: 2.5 Y 6/0, GRAY, FINE GRAINED, HARD, CEMENTED, DRY, COLOR DARKENS TO 2.5 Y 4/0, DARK GRAY AT 32.0'
SHALE: 2.5 Y 2/0, BLACK, SOFT, WET, FINELY LAMINATED
T.D. 40.5'
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 570.93
WEEP HOLE
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D. PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
ROBERTS/SCHORNICK & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS
3700 W. ROBINSON
NORMAN, OKLAHOMA 73072
(405) 321-3695
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW070A (BH-81)
DATE DRILLED 1/11/91
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1


WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 575.10
0.6 TOPSOIL: GRAVELLY SANDY CLAYEY SILT: BACKFILL, WET, SOFT, MED-LOW PLAST., NON-STRAT., 7.5 YR 4/4 TO 5/8, BROWN TO STRONG BROWN, 10% GRAVEL, 15% SAND, VERY FINE-FINE GRAIN, RND-SUBRND, 15% CLAY, 60% SILT
ML
5.0 GRAVELLY SILTY CLAY: BACKFILL, 7.5 YR 4/6, STRONG BROWN, MOIST, NON-STRAT., 15% GRAVEL 15% SILT, 70% CLAY
CH
9.1 CLAY: 7.5 YR 7/8 TO 7/0, REDDISH YELLOW TO LIGHT GRAY, MOIST, FIRM, MOTTLED, FINE LAMINATIONS, MED-PLAST.
CL
11.4 WEATHERED SHALE: 7.5 YR 7/8 TO 3/0 TO 7/0, REDDISH YELLOW TO VERY DARK GRAY TO LIGHT GRAY, MOIST, VERY THIN LAMINATIONS 16.7-16.8', REDUCED FE ZONE, GRADES TO 7/8 TO 3/0 WITH NO 7/0 BY 14.0'
SHALE
19.2 WEATHERED SHALE: CONDUCTOR CASING
SHALE
SHALE: 2.5 Y 5/4, LIGHT OLIVE BROWN, SOFT, MOIST TO WET, WEATHERED
29.0 SHALE: 2.5 Y 2/0, BLACK, SOFT, WET, FISSILE, ORGANIC
SHALE
SANDSTONE: 2.5 Y 6/0, GRAY, HARD, SLIGHTLY MOIST, FINE GRAIN,
CHANGED COLOR TO 2.5 Y 4/0, DARK GRAY AT 37.5', MODERATELY HARD
BECOMES 2.5 Y 2/0, BLACK AND SHALEY AT 43.0'
22.8 SHALE: 2.5 Y 2/0, BLACK, SOFT, WET, FISSILE, ORGANIC
SHALE
24.5 T.D. 49.0'
Sh1
Ss1
Sh2
Ss2
Sh3
29.0'
SAMPLE INTERVAL: 1 2.3, NR, 2 2.5, NR, 4 5.0, 5, 6, 7 3.5, 8, NR, 9 1.5, NS, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
"N" VALUE: 1.0, 19.2, 20.4, 21.2, 22.7, 47.35, 48.0, 49.0
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 577.73
WEEP HOLE
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
6.0"
0
10
20
30
40
50
60
70
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW072A (BH-82)
DATE DRILLED 1/14/91
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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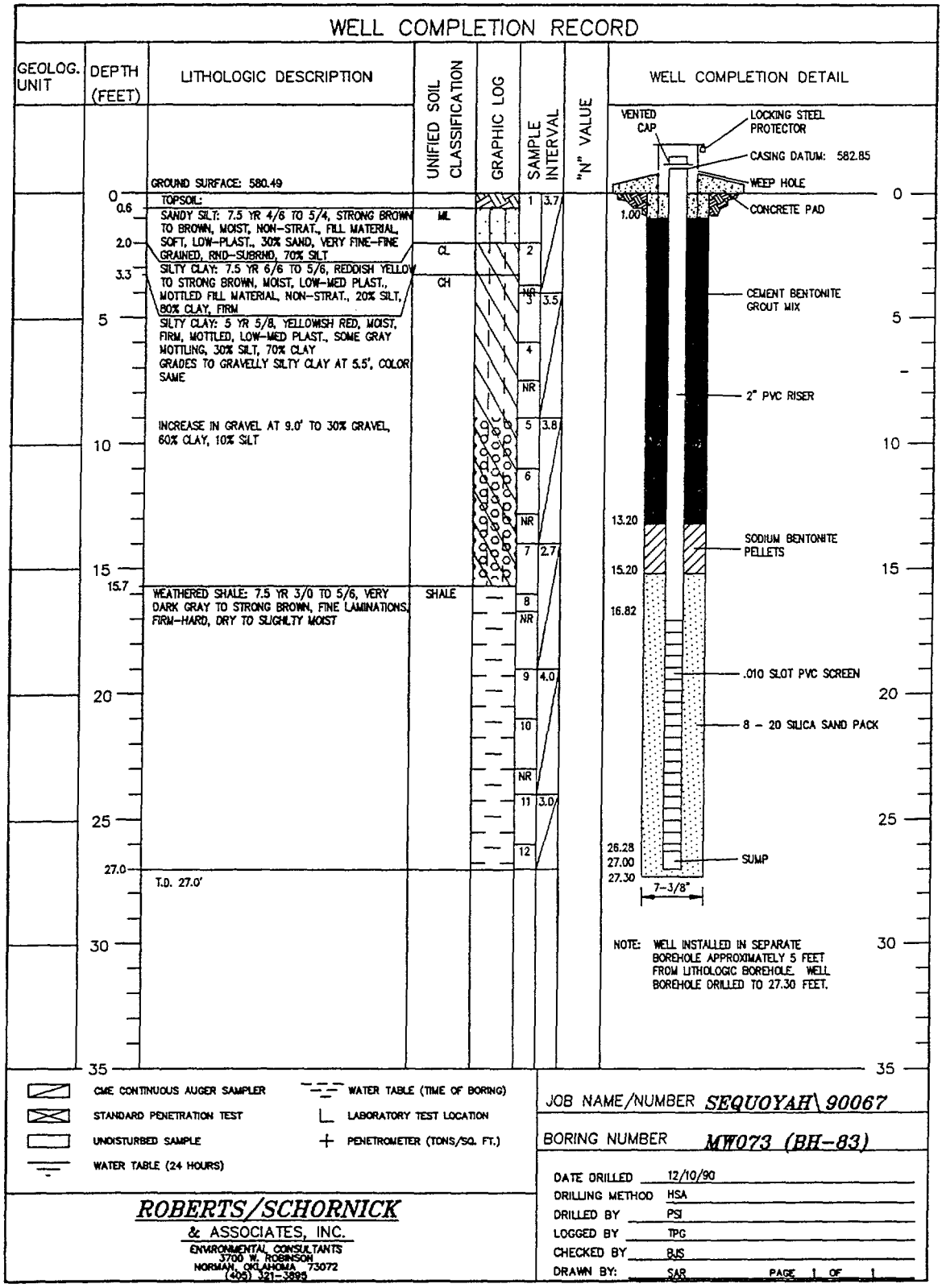
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 580.49
TOPSOIL:
SANDY SILT: 7.5 YR 4/6 TO 5/4, STRONG BROWN TO BROWN, MOIST, NON-STRAT., FILL MATERIAL, SOFT, LOW-PLAST., 30% SAND, VERY FINE-FINE GRAINED, RND-SUBRND, 70% SILT
ML
SILTY CLAY: 7.5 YR 6/6 TO 5/6, REDDISH YELLOW TO STRONG BROWN, MOIST, LOW-MED PLAST., MOTTLED FILL MATERIAL, NON-STRAT., 20% SILT, 80% CLAY, FIRM
CL
CH
SILTY CLAY: 5 YR 5/8, YELLOWISH RED, MOIST, FIRM, MOTTLED, LOW-MED PLAST., SOME GRAY MOTTLING, 30% SILT, 70% CLAY
GRADES TO GRAVELLY SILTY CLAY AT 5.5', COLOR SAME
INCREASE IN GRAVEL AT 9.0' TO 30% GRAVEL, 60% CLAY, 10% SILT
WEATHERED SHALE: 7.5 YR 3/0 TO 5/6, VERY DARK GRAY TO STRONG BROWN, FINE LAMINATIONS, FIRM-HARD, DRY TO SLIGHLTY MOIST
SHALE
T.D. 27.0'
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 582.85
WEEP HOLE
CONCRETE PAD
CEMENT BENTONITE GROUT MIX
2" PVC RISER
SODIUM BENTONITE PELLETS
.010 SLOT PVC SCREEN
8 - 20 SILICA SAND PACK
SUMP
7-3/8"
NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 27.30 FEET.
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW073 (BH-83)
DATE DRILLED 12/10/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
ROBERTS/SCHORNICK & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS
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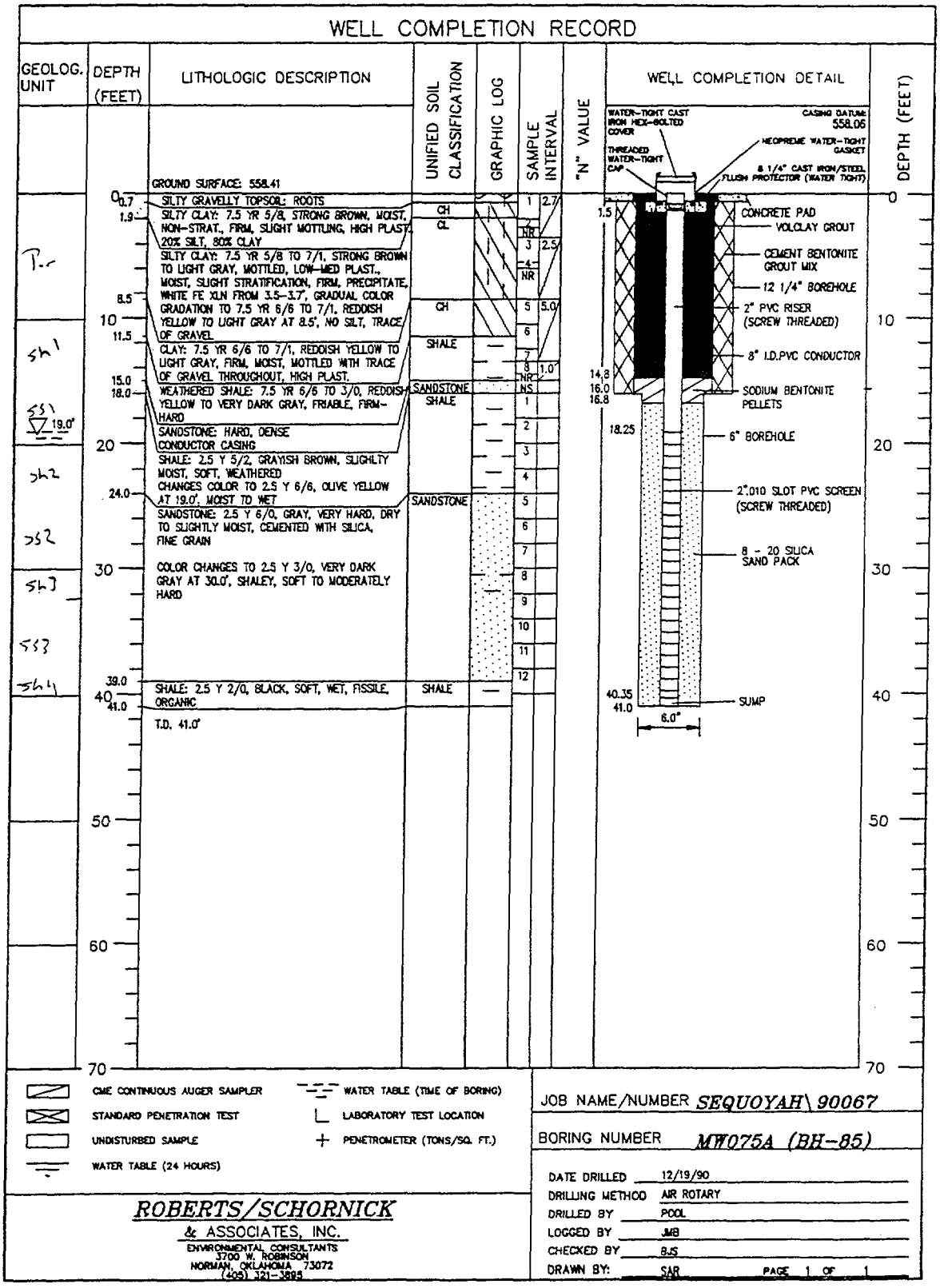
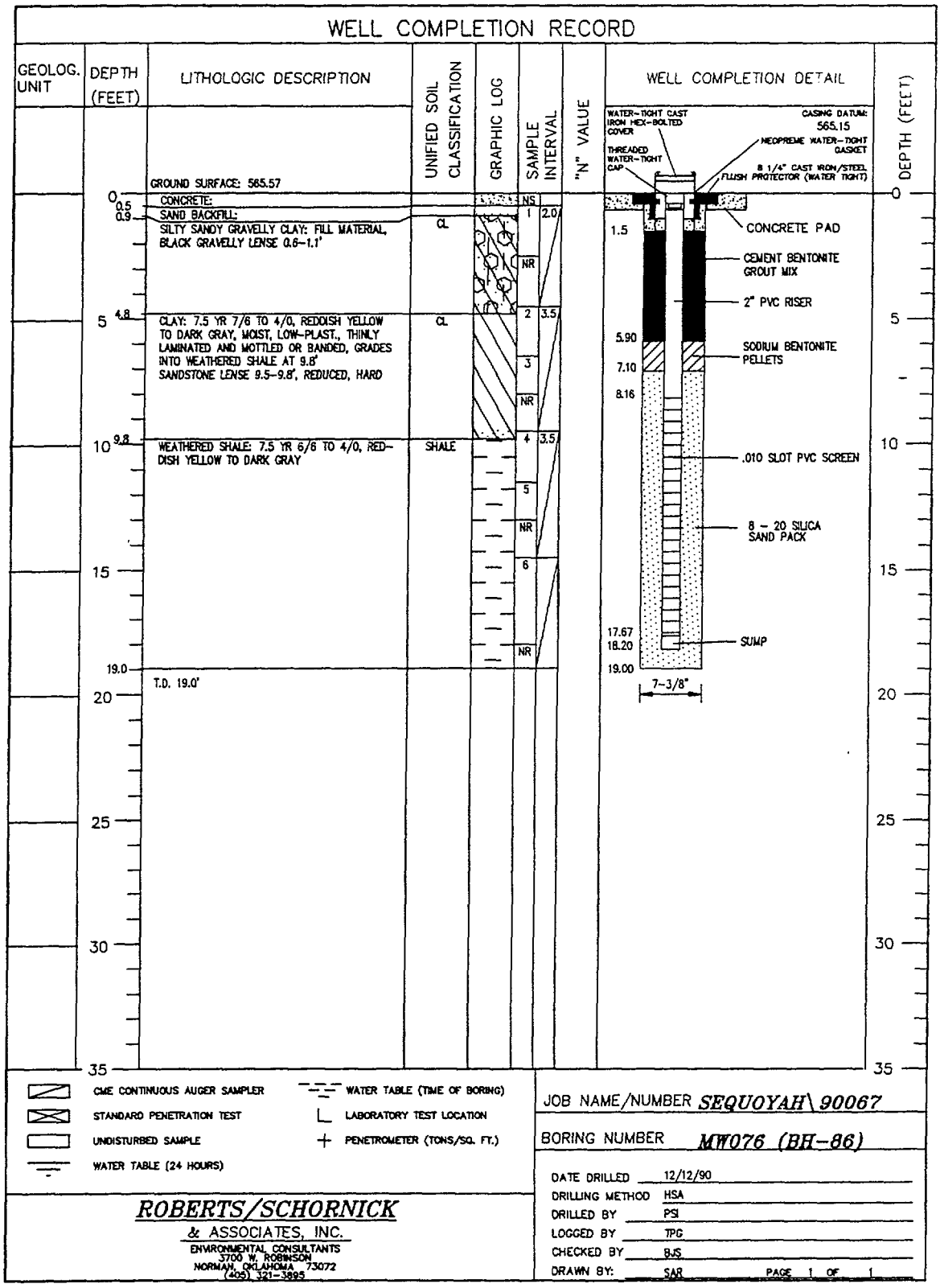
(405) 321-3895

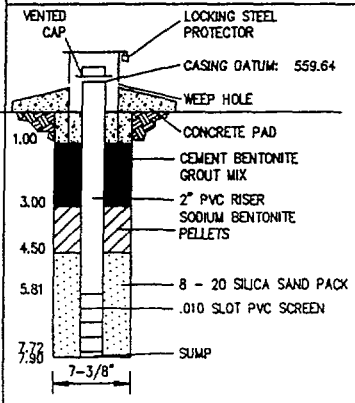

WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
DEPTH (FEET)
GROUND SURFACE: 558.41
SILTY GRAVELLY TOPSOIL; ROOTS
SILTY CLAY: 7.5 YR 5/8, STRONG BROWN, MOIST, NON-STRAT., FIRM, SLIGHT MOTTLING, HIGH PLAST, 20% SILT, 80% CLAY
SILTY CLAY: 7.5 YR 5/8 TO 7/1, STRONG BROWN TO LIGHT GRAY, MOTTLED, LOW-MED PLAST., MOIST, SLIGHT STRATIFICATION, FIRM, PRECIPITATE, WHITE FE XLN FROM 3.5-3.7', GRADUAL COLOR GRADATION TO 7.5 YR 6/6 TO 7/1, REDDISH YELLOW TO LIGHT GRAY AT 8.5', NO SILT, TRACE OF GRAVEL
CLAY: 7.5 YR 6/6 TO 7/1, REDDISH YELLOW TO LIGHT GRAY, FIRM, MOIST, MOTTLED WITH TRACE OF GRAVEL THROUGHOUT, HIGH PLAST.
WEATHERED SHALE: 7.5 YR 6/6 TO 3/0, REDDISH YELLOW TO VERY DARK GRAY, FRIABLE, FIRM-HARD
SANDSTONE: HARD, DENSE
CONDUCTOR CASING
SHALE: 2.5 Y 5/2, GRAYISH BROWN, SLIGHLTY MOIST, SOFT, WEATHERED
CHANGES COLOR TO 2.5 Y 6/6, OLIVE YELLOW AT 19.0', MOIST TO WET
SANDSTONE: 2.5 Y 6/0, GRAY, VERY HARD, DRY TO SLIGHTLY MOIST, CEMENTED WITH SILICA, FINE GRAIN
COLOR CHANGES TO 2.5 Y 3/0, VERY DARK GRAY AT 30.0', SHALEY, SOFT TO MODERATELY HARD
SHALE: 2.5 Y 2/0, BLACK, SOFT, WET, FISSILE, ORGANIC
T.D. 41.0'
CH
CL
SHALE
SANDSTONE
WATER-TIGHT CAST IRON HEX-BOLTED COVER
CASING DATUM 558.06
NEOPRENE WATER-TIGHT GASKET
THREADED WATER-TIGHT CAP
8 1/4" CAST IRON/STEEL FLUSH PROTECTOR (WATER TIGHT)
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
ROBERTS/SCHORNICK & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS
3700 W. ROBINSON
NORMAN, OKLAHOMA 73072
(405) 321-3895
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW075A (BH-85)
DATE DRILLED 12/19/90
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1


WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 565.57
CONCRETE:
SAND BACKFILL:
SILTY SANDY GRAVELLY CLAY: FILL MATERIAL, BLACK GRAVELLY LENSE 0.6–1.1'
CL
CLAY: 7.5 YR 7/6 TO 4/0, REDDISH YELLOW TO DARK GRAY, MOIST, LOW-PLAST., THINLY LAMINATED AND MOTTLED OR BANDED, GRADES INTO WEATHERED SHALE AT 9.8'
SANDSTONE LENSE 9.5–9.8', REDUCED, HARD
WEATHERED SHALE: 7.5 YR 6/6 TO 4/0, REDDISH YELLOW TO DARK GRAY
SHALE
T.D. 19.0'
WATER-TIGHT CAST IRON HEX-BOLTED COVER
CASING DATUM: 565.15
NEOPRENE WATER-TIGHT GASKET
THREADED WATER-TIGHT CAP
8 1/4" CAST IRON/STEEL FLUSH PROTECTOR (WATER TIGHT)
CONCRETE PAD
CEMENT BENTONITE GROUT MIX
2" PVC RISER
SODIUM BENTONITE PELLETS
.010 SLOT PVC SCREEN
8 – 20 SILICA SAND PACK
SUMP
7-3/8"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
ROBERTS/SCHORNICK & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS
3700 W. ROBINSON
NORMAN, OKLAHOMA 73072
(405) 321-3895
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW076 (BH-86)
DATE DRILLED 12/12/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1

WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	SAMPLE INTERVAL	"N" VALUE
		GROUND SURFACE: 557.87				
	0	SANDY SILTY GRAVEL: ROAD FILL	GC		NS	
	1.0	GRAVELLY SILTY CLAY: FILL MATERIAL, 7.5 YR 6/8, REDDISH YELLOW, SOFT, 20% GRAVE, 25% SILT, 55% CLAY	CL		1	3.0
	3.2	SILTY CLAY: 7.5 YR 5/2, BROWN, SOFT-FIRM, MOIST, SLIGHT MOTTLING, MED. PLAST., TRACE FINE GRAIN SAND, 40% SILT, 60% CLAY, GRADES TO CLAYEY SILT AT 4.5'	CL-CH		2	
	4.5				NR	
	5	CLAYEY SILT: 7.5 YR 5/2, BROWN, SOFT, MOIST, SLIGHTLY MOTTLED, 40% CLAY, 60% SILT	ML		3	1.0
SS1	6.7	SANDSTONE:	SANDSTONE			
	10					
	15					
	20					
	25					
	30					
	35					

WELL COMPLETION DETAIL



NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 7.90 FEET.

CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW077 (BH-89)*

DATE DRILLED 12/13/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR PAGE 1 OF 1

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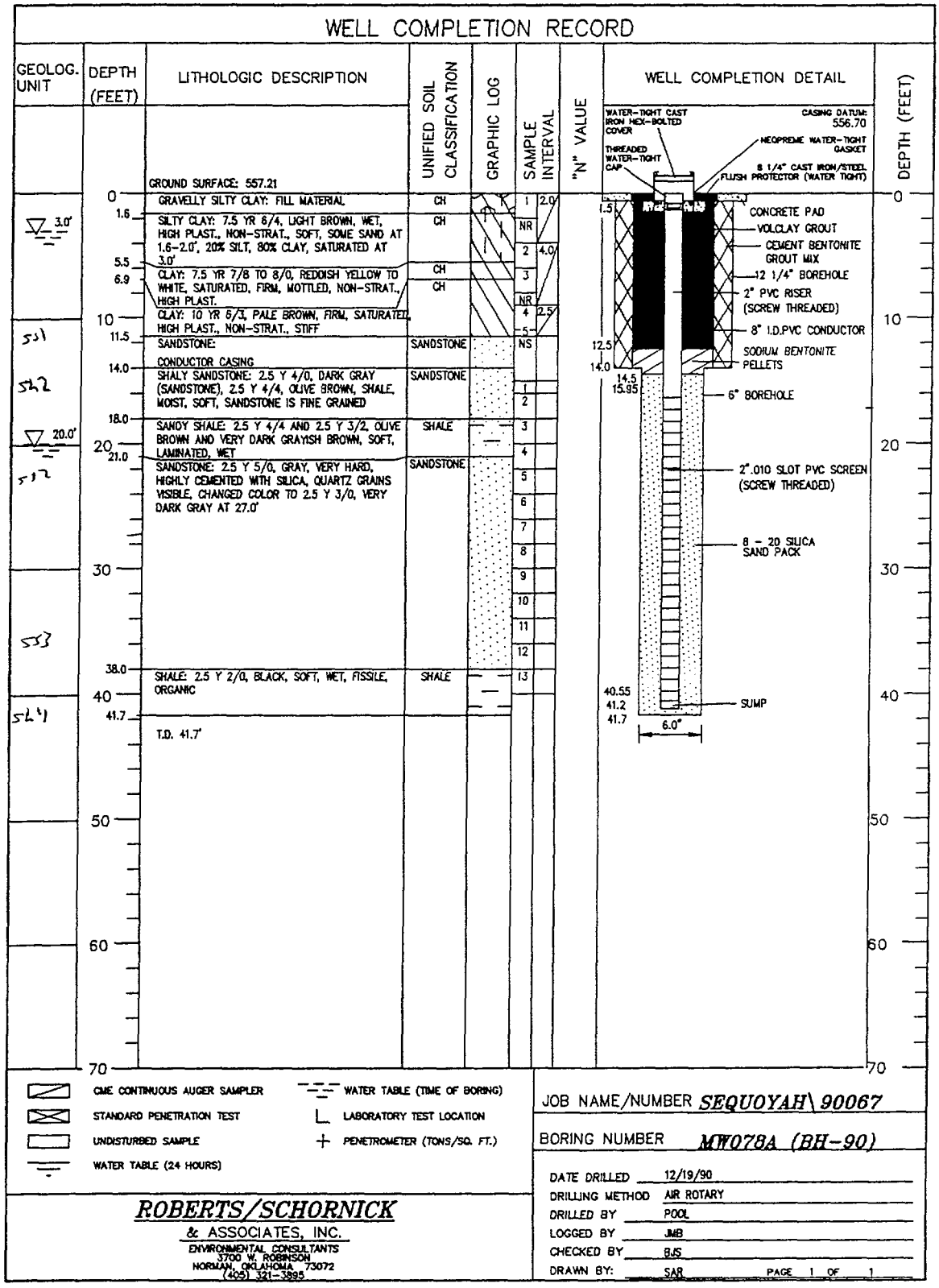
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
DEPTH (FEET)
GROUND SURFACE: 557.21
GRAVELLY SILTY CLAY: FILL MATERIAL
SILTY CLAY: 7.5 YR 6/4, LIGHT BROWN, WET, HIGH PLAST., NON-STRAT., SOFT, SOME SAND AT 1.6-2.0', 20% SILT, 80% CLAY, SATURATED AT 3.0'
CLAY: 7.5 YR 7/8 TO 8/0, REDDISH YELLOW TO WHITE, SATURATED, FIRM, MOTTLED, NON-STRAT., HIGH PLAST.
CLAY: 10 YR 6/3, PALE BROWN, FIRM, SATURATED, HIGH PLAST., NON-STRAT., STIFF
SANDSTONE:
CONDUCTOR CASING
SHALY SANDSTONE: 2.5 Y 4/0, DARK GRAY (SANDSTONE), 2.5 Y 4/4, OLIVE BROWN, SHALE, MOIST, SOFT, SANDSTONE IS FINE GRAINED
SANDY SHALE: 2.5 Y 4/4 AND 2.5 Y 3/2, OLIVE BROWN AND VERY DARK GRAYISH BROWN, SOFT, LAMINATED, WET
SANDSTONE: 2.5 Y 5/0, GRAY, VERY HARD, HIGHLY CEMENTED WITH SILICA, QUARTZ GRAINS VISIBLE, CHANGED COLOR TO 2.5 Y 3/0, VERY DARK GRAY AT 27.0'
SHALE: 2.5 Y 2/0, BLACK, SOFT, WET, FISSILE, ORGANIC
T.D. 41.7'
WATER-TIGHT CAST IRON HEX-BOLTED COVER
CASING DATUM: 556.70
NEOPRENE WATER-TIGHT GASKET
THREADED WATER-TIGHT CAP
8 1/4" CAST IRON/STEEL FLUSH PROTECTOR (WATER TIGHT)
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW078A (BH-90)
DATE DRILLED 12/19/90
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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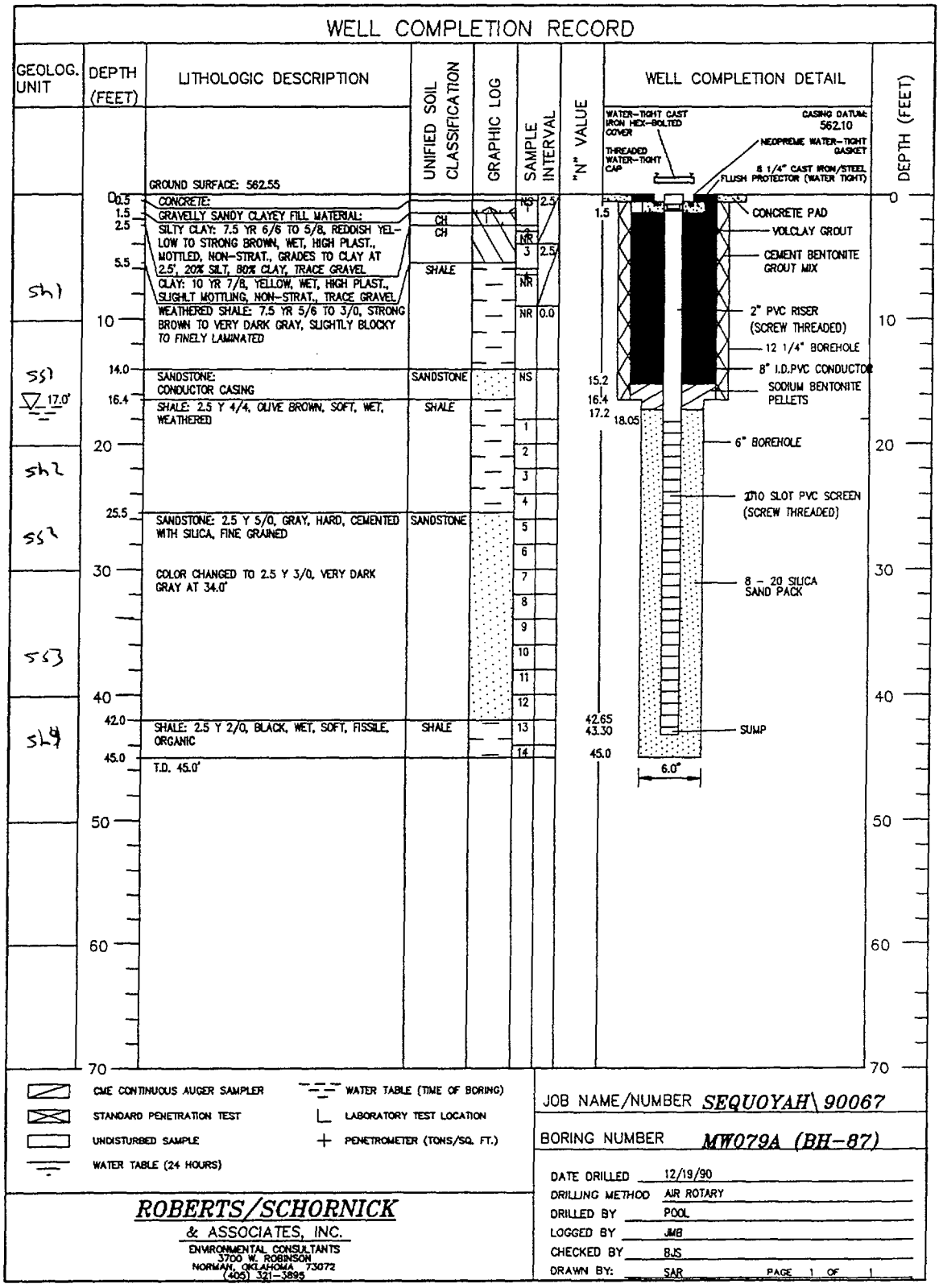
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
DEPTH (FEET)
GROUND SURFACE: 562.55
CONCRETE:
GRAVELLY SANDY CLAYEY FILL MATERIAL:
SILTY CLAY: 7.5 YR 6/6 TO 5/8, REDDISH YELLOW TO STRONG BROWN, WET, HIGH PLAST., MOTTLED, NON-STRAT., GRADES TO CLAY AT 2.5', 20% SILT, 80% CLAY, TRACE GRAVEL
CLAY: 10 YR 7/8, YELLOW, WET, HIGH PLAST., SLIGHLT MOTTLING, NON-STRAT., TRACE GRAVEL
WEATHERED SHALE: 7.5 YR 5/6 TO 3/0, STRONG BROWN TO VERY DARK GRAY, SLIGHTLY BLOCKY TO FINELY LAMINATED
SANDSTONE: CONDUCTOR CASING
SHALE: 2.5 Y 4/4, OLIVE BROWN, SOFT, WET, WEATHERED
SANDSTONE: 2.5 Y 5/0, GRAY, HARD, CEMENTED WITH SILICA, FINE GRAINED
COLOR CHANGED TO 2.5 Y 3/0, VERY DARK GRAY AT 34.0'
SHALE: 2.5 Y 2/0, BLACK, WET, SOFT, FISSILE, ORGANIC
T.D. 45.0'
WATER-TIGHT CAST IRON HEX-BOLTED COVER
CASING DATUM: 562.10
THREADED WATER-TIGHT CAP
NEOPRENE WATER-TIGHT GASKET
8 1/4" CAST IRON/STEEL FLUSH PROTECTOR (WATER TIGHT)
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
2" PVC RISER (SCREW THREADED)
12 1/4" BOREHOLE
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
.010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW079A (BH-87)
DATE DRILLED 12/19/90
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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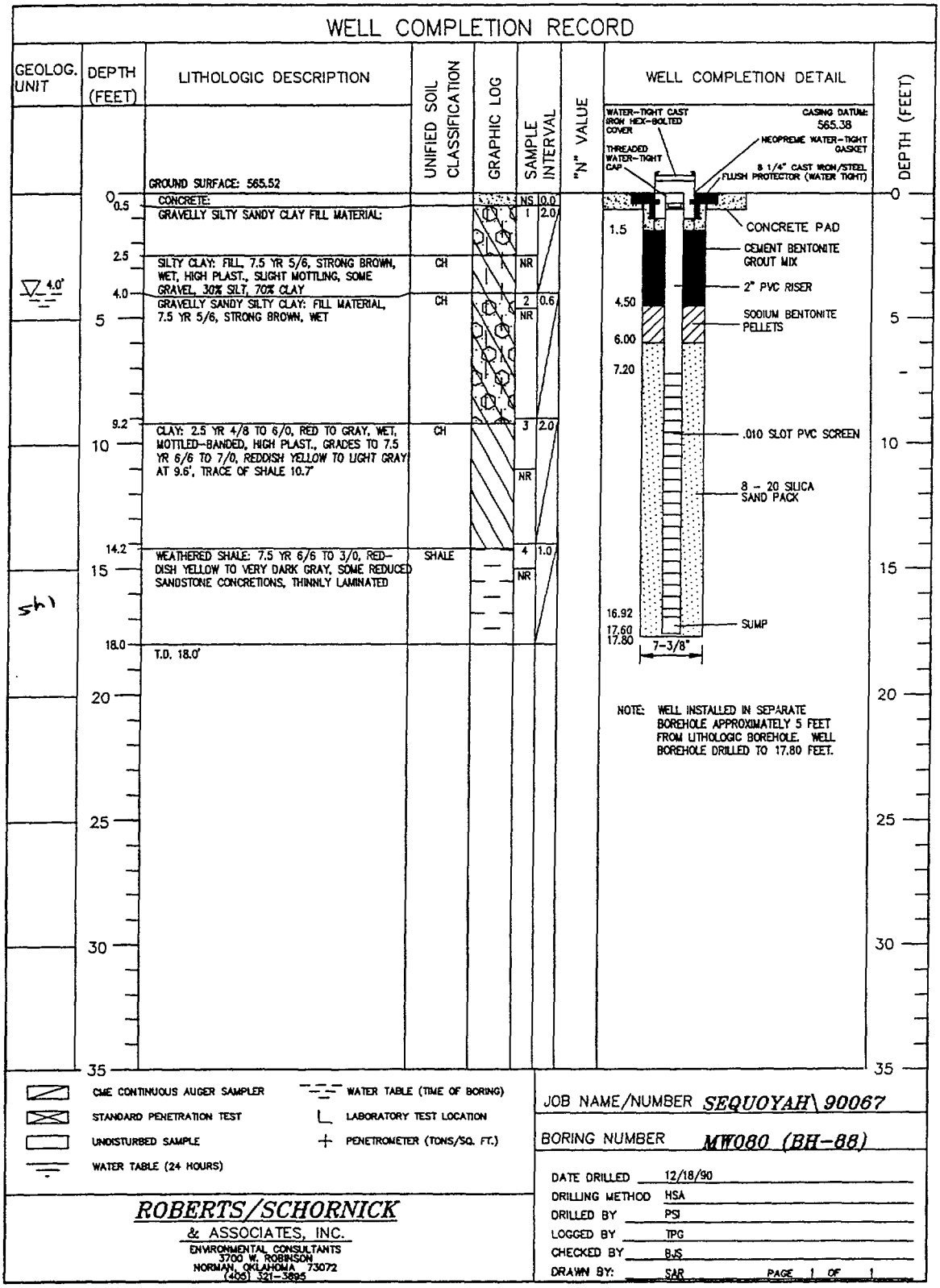
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 565.52
CONCRETE:
GRAVELLY SILTY SANDY CLAY FILL MATERIAL:
SILTY CLAY: FILL, 7.5 YR 5/6, STRONG BROWN, WET, HIGH PLAST., SLIGHT MOTTLING, SOME GRAVEL, 30% SILT, 70% CLAY
GRAVELLY SANDY SILTY CLAY: FILL MATERIAL, 7.5 YR 5/6, STRONG BROWN, WET
CLAY: 2.5 YR 4/8 TO 6/0, RED TO GRAY, WET, MOTTLED-BANDED, HIGH PLAST., GRADES TO 7.5 YR 6/6 TO 7/0, REDDISH YELLOW TO LIGHT GRAY AT 9.6', TRACE OF SHALE 10.7'
WEATHERED SHALE: 7.5 YR 6/6 TO 3/0, REDDISH YELLOW TO VERY DARK GRAY, SOME REDUCED SANDSTONE CONCRETIONS, THINNLY LAMINATED
T.D. 18.0'
CH
CH
CH
SHALE
WATER-TIGHT CAST IRON HEX-BOLTED COVER
CASING DATUM: 565.38
NEOPRENE WATER-TIGHT GASKET
THREADED WATER-TIGHT CAP
8 1/4" CAST IRON/STEEL FLUSH PROTECTOR (WATER TIGHT)
CONCRETE PAD
CEMENT BENTONITE GROUT MIX
2" PVC RISER
SODIUM BENTONITE PELLETS
.010 SLOT PVC SCREEN
8 - 20 SILICA SAND PACK
SUMP
7-3/8"
NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 17.80 FEET.
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW080 (BH-88)
DATE DRILLED 12/18/90
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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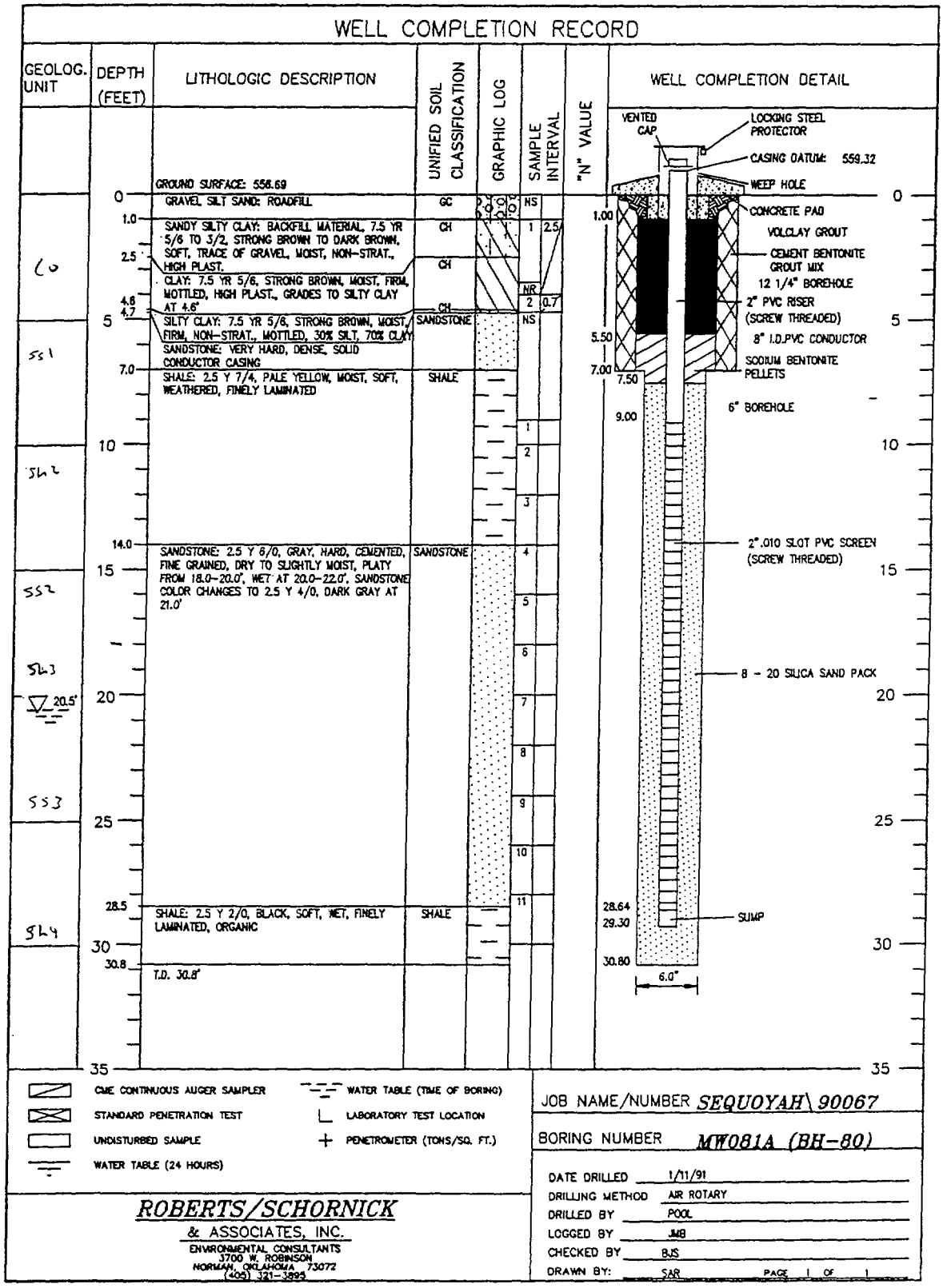
WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 556.69
GRAVEL, SILT SAND: ROADFILL
SANDY SILTY CLAY: BACKFILL MATERIAL, 7.5 YR 5/6 TO 3/2, STRONG BROWN TO DARK BROWN, SOFT, TRACE OF GRAVEL, MOIST, NON-STRAT., HIGH PLAST.
CLAY: 7.5 YR 5/6, STRONG BROWN, MOIST, FIRM, MOTTLED, HIGH PLAST., GRADES TO SILTY CLAY AT 4.6'
SILTY CLAY: 7.5 YR 5/6, STRONG BROWN, MOIST, FIRM, NON-STRAT., MOTTLED, 30% SILT, 70% CLAY
SANDSTONE: VERY HARD, DENSE, SOLID CONDUCTOR CASING
SHALE: 2.5 Y 7/4, PALE YELLOW, MOIST, SOFT, WEATHERED, FINELY LAMINATED
SANDSTONE: 2.5 Y 8/0, GRAY, HARD, CEMENTED, FINE GRAINED, DRY TO SLIGHTLY MOIST, PLATY FROM 18.0-20.0', WET AT 20.0-22.0', SANDSTONE COLOR CHANGES TO 2.5 Y 4/0, DARK GRAY AT 21.0'
SHALE: 2.5 Y 2/0, BLACK, SOFT, WET, FINELY LAMINATED, ORGANIC
T.D. 30.8'
GC
CH
SANDSTONE
SHALE
NS
NR
2.5
0.7
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 559.32
WEEP HOLE
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
1.00
5.50
7.00
7.50
9.00
28.64
29.30
30.80
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW081A (BH-80)
DATE DRILLED 1/11/91
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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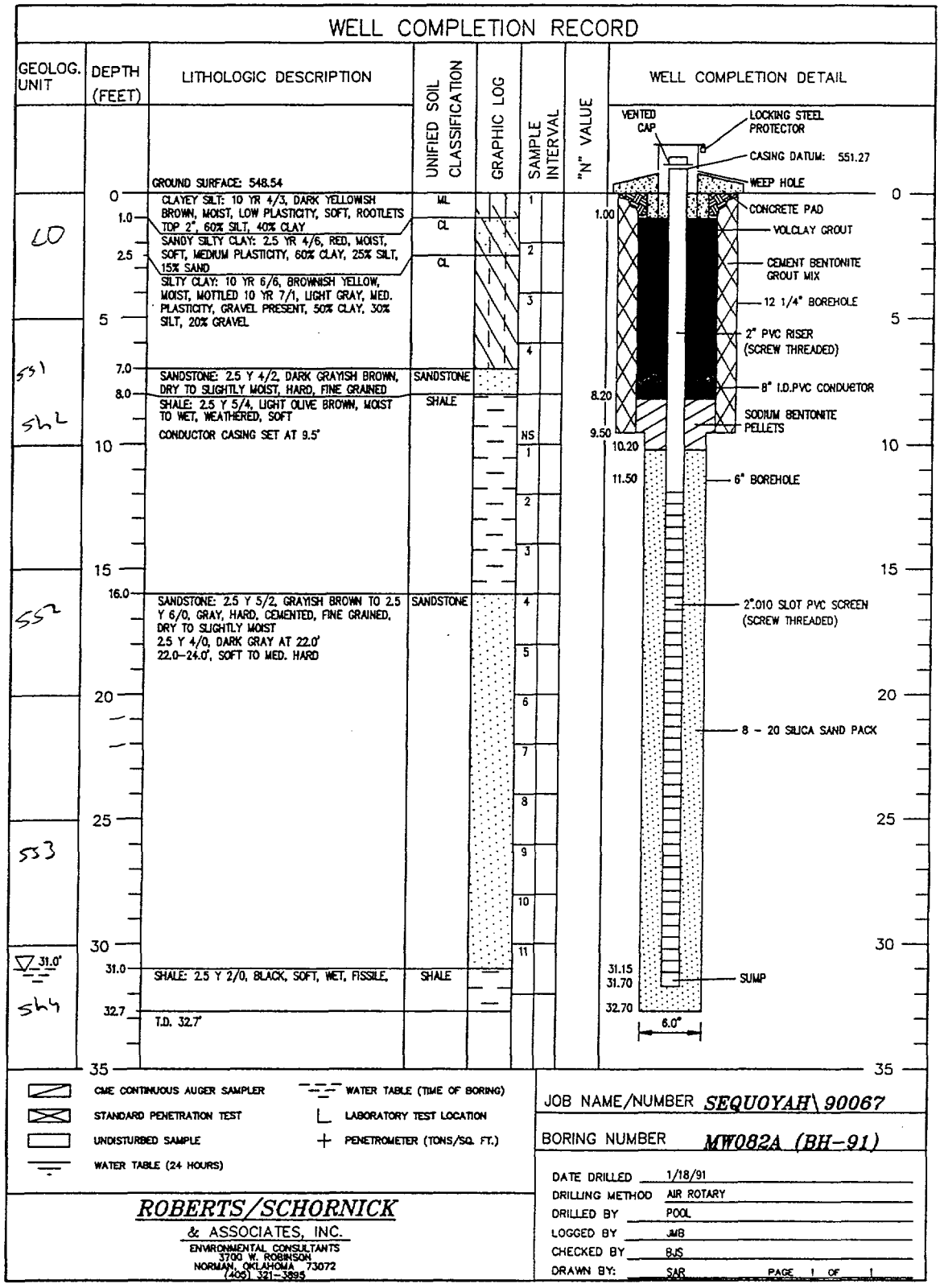
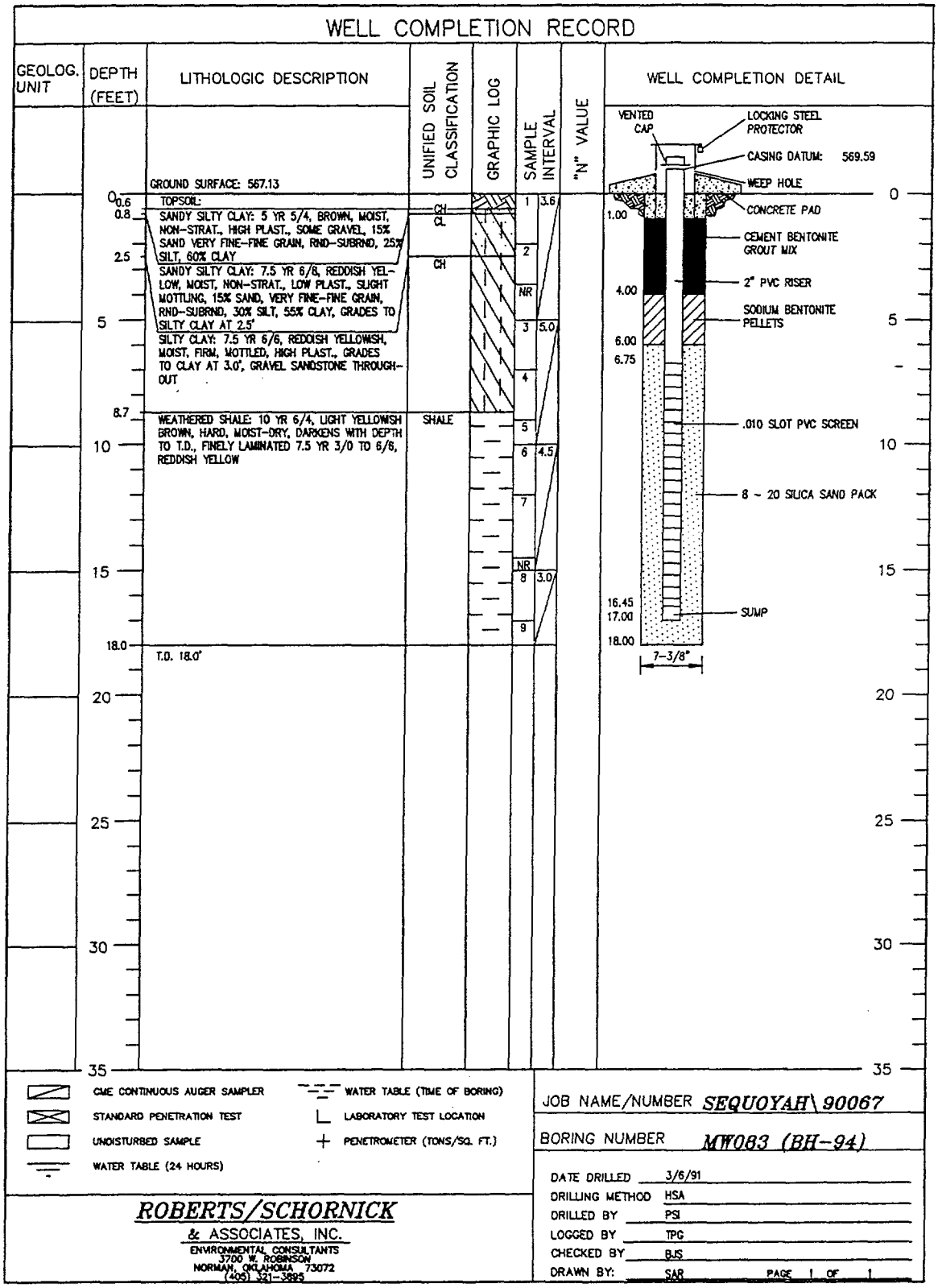

WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 548.54
CLAYEY SILT: 10 YR 4/3, DARK YELLOWISH BROWN, MOIST, LOW PLASTICITY, SOFT, ROOTLETS TOP 2", 60% SILT, 40% CLAY
SANDY SILTY CLAY: 2.5 YR 4/6, RED, MOIST, SOFT, MEDIUM PLASTICITY, 60% CLAY, 25% SILT, 15% SAND
SILTY CLAY: 10 YR 6/6, BROWNISH YELLOW, MOIST, MOTTLED 10 YR 7/1, LIGHT GRAY, MED. PLASTICITY, GRAVEL PRESENT, 50% CLAY, 30% SILT, 20% GRAVEL
SANDSTONE: 2.5 Y 4/2, DARK GRAYISH BROWN, DRY TO SLIGHTLY MOIST, HARD, FINE GRAINED
SHALE: 2.5 Y 5/4, LIGHT OLIVE BROWN, MOIST TO WET, WEATHERED, SOFT
CONDUCTOR CASING SET AT 9.5'
SANDSTONE: 2.5 Y 5/2, GRAYISH BROWN TO 2.5 Y 6/0, GRAY, HARD, CEMENTED, FINE GRAINED, DRY TO SLIGHTLY MOIST
2.5 Y 4/0, DARK GRAY AT 22.0'
22.0–24.0', SOFT TO MED. HARD
SHALE: 2.5 Y 2/0, BLACK, SOFT, WET, FISSILE,
T.D. 32.7'
ML
CL
CL
SANDSTONE
SHALE
SANDSTONE
SHALE
NS
0
1.0
2.5
5
7.0
8.0
10
15
16.0
20
25
30
31.0
32.7
35
LO
SS1
SH2
SS2
SS3
SH4
31.0'
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 551.27
WEEP HOLE
CONCRETE PAD
VOLCLAY GROUT
CEMENT BENTONITE GROUT MIX
12 1/4" BOREHOLE
2" PVC RISER (SCREW THREADED)
8" I.D.PVC CONDUCTOR
SODIUM BENTONITE PELLETS
6" BOREHOLE
2".010 SLOT PVC SCREEN (SCREW THREADED)
8 - 20 SILICA SAND PACK
SUMP
1.00
8.20
9.50
10.20
11.50
31.15
31.70
32.70
6.0"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW082A (BH-91)
DATE DRILLED 1/18/91
DRILLING METHOD AIR ROTARY
DRILLED BY POOL
LOGGED BY JMB
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
ROBERTS/SCHORNICK
& ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS
3700 W. ROBINSON
NORMAN, OKLAHOMA 73072
(405) 321-3895


WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 567.13
0
0.6
TOPSOIL:
0.8
SANDY SILTY CLAY: 5 YR 5/4, BROWN, MOIST, NON-STRAT., HIGH PLAST., SOME GRAVEL, 15% SAND VERY FINE-FINE GRAIN, RND-SUBRND, 25% SILT, 60% CLAY
CH
CL
2.5
SANDY SILTY CLAY: 7.5 YR 6/8, REDDISH YELLOW, MOIST, NON-STRAT., LOW PLAST., SLIGHT MOTTLING, 15% SAND, VERY FINE-FINE GRAIN, RND-SUBRND, 30% SILT, 55% CLAY, GRADES TO SILTY CLAY AT 2.5'
CH
5
SILTY CLAY: 7.5 YR 6/6, REDDISH YELLOWISH, MOIST, FIRM, MOTTLED, HIGH PLAST., GRADES TO CLAY AT 3.0', GRAVEL SANDSTONE THROUGHOUT
8.7
WEATHERED SHALE: 10 YR 6/4, LIGHT YELLOWISH BROWN, HARD, MOIST-DRY, DARKENS WITH DEPTH TO T.D., FINELY LAMINATED 7.5 YR 3/0 TO 6/6, REDDISH YELLOW
SHALE
10
15
18.0
T.D. 18.0'
20
25
30
35
1
2
NR
3
4
5
6
7
NR
8
9
3.6
5.0
4.5
3.0
VENTED CAP
LOCKING STEEL PROTECTOR
CASING DATUM: 569.59
WEEP HOLE
CONCRETE PAD
1.00
CEMENT BENTONITE GROUT MIX
2" PVC RISER
4.00
SODIUM BENTONITE PELLETS
6.00
6.75
.010 SLOT PVC SCREEN
8 ~ 20 SILICA SAND PACK
16.45
17.00
18.00
SUMP
7-3/8"
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\90067
BORING NUMBER MW083 (BH-94)
DATE DRILLED 3/6/91
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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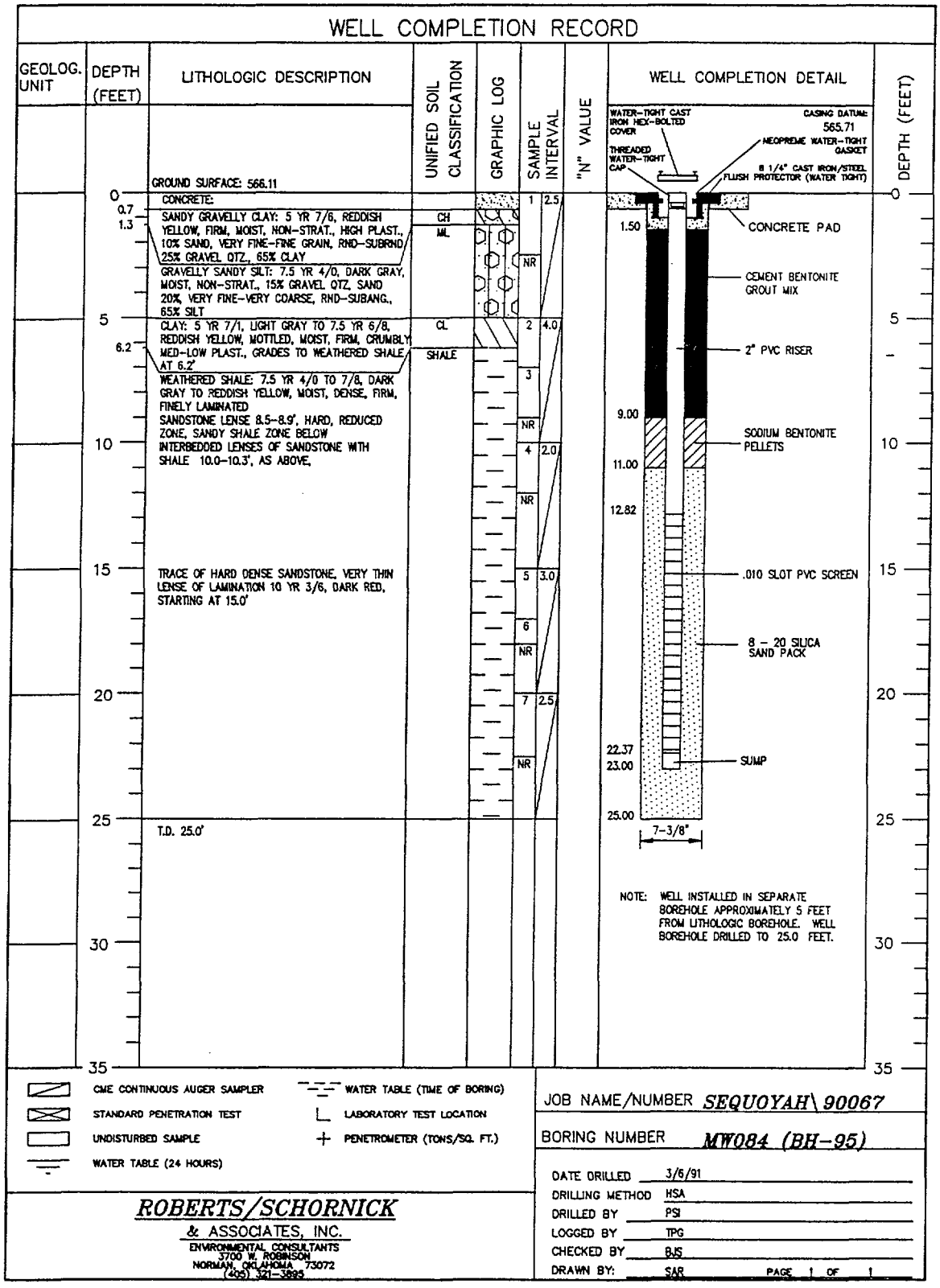
NORMAN, OKLAHOMA 73072
(405) 321-3895


WELL COMPLETION RECORD
GEOLOG. UNIT
DEPTH (FEET)
LITHOLOGIC DESCRIPTION
UNIFIED SOIL CLASSIFICATION
GRAPHIC LOG
SAMPLE INTERVAL
"N" VALUE
WELL COMPLETION DETAIL
GROUND SURFACE: 566.11
CONCRETE:
SANDY GRAVELLY CLAY: 5 YR 7/6, REDDISH YELLOW, FIRM, MOIST, NON-STRAT., HIGH PLAST., 10% SAND, VERY FINE-FINE GRAIN, RND-SUBRND 25% GRAVEL QTZ., 65% CLAY
GRAVELLY SANDY SILT: 7.5 YR 4/0, DARK GRAY, MOIST, NON-STRAT., 15% GRAVEL QTZ, SAND 20%, VERY FINE-VERY COARSE, RND-SUBANG., 65% SILT
CLAY: 5 YR 7/1, LIGHT GRAY TO 7.5 YR 6/8, REDDISH YELLOW, MOTTLED, MOIST, FIRM, CRUMBLY MED-LOW PLAST., GRADES TO WEATHERED SHALE AT 6.2'
WEATHERED SHALE: 7.5 YR 4/0 TO 7/8, DARK GRAY TO REDDISH YELLOW, MOIST, DENSE, FIRM, FINELY LAMINATED
SANDSTONE LENSE 8.5-8.9', HARD, REDUCED ZONE, SANDY SHALE ZONE BELOW
INTERBEDDED LENSES OF SANDSTONE WITH SHALE 10.0-10.3', AS ABOVE,
TRACE OF HARD DENSE SANDSTONE, VERY THIN LENSE OF LAMINATION 10 YR 3/6, DARK RED, STARTING AT 15.0'
T.D. 25.0'
CH
ML
CL
SHALE
WATER-TIGHT CAST IRON HEX-BOLTED COVER
CASING DATUM: 565.71
NEOPRENE WATER-TIGHT GASKET
THREADED WATER-TIGHT CAP
8 1/4" CAST IRON/STEEL FLUSH PROTECTOR (WATER TIGHT)
CONCRETE PAD
CEMENT BENTONITE GROUT MIX
2" PVC RISER
SODIUM BENTONITE PELLETS
.010 SLOT PVC SCREEN
8 - 20 SILICA SAND PACK
SUMP
7-3/8"
NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 25.0 FEET.
CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)
JOB NAME/NUMBER SEQUOYAH\ 90067
BORING NUMBER MW084 (BH-95)
DATE DRILLED 3/6/91
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR
PAGE 1 OF 1
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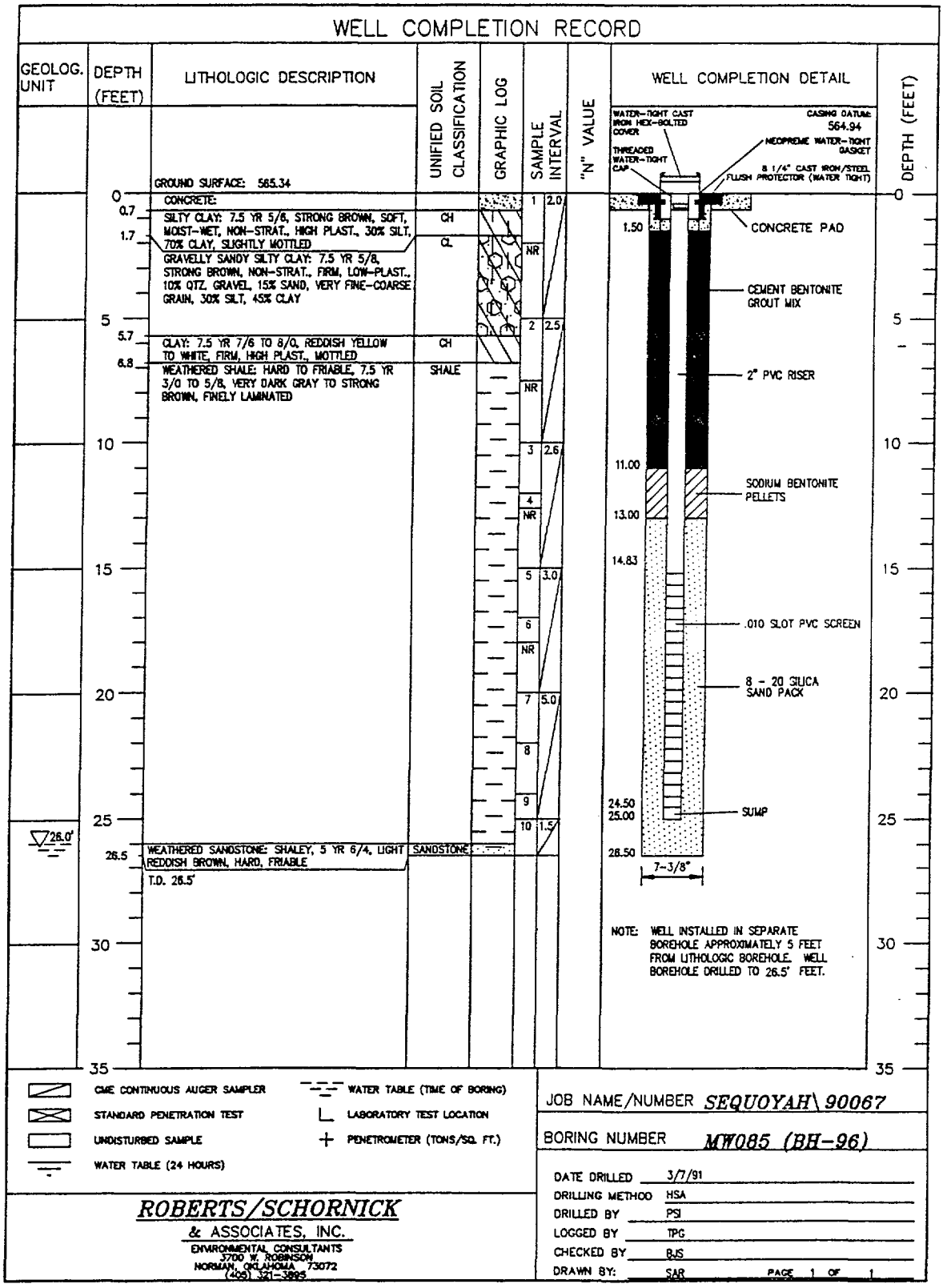
3700 W. ROBINSON
NORMAN, OKLAHOMA 73072
(405) 321-3895



565.34
26.5
538.84

565.34
13
552.34

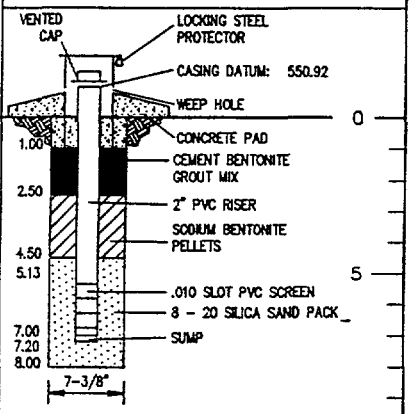
WELL COMPLETION RECORD

GEOLOG. UNIT	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	UNIFIED SOIL CLASSIFICATION
		GROUND SURFACE: 549.88	
	0	GRAVELLY SANDY SILTY CLAY: 5 YR 5/6, YELLOWISH RED, MOIST, FIRM, NON-STRAT., HIGH PLAST., 15% GRAVEL, 3MM-3CM QTZ., 15% SAND, VERY FINE-VERY COARSE GRAIN, RND-SUBANG, 20% SILT, 50% CLAY	CH
	2.8	SANDY SILT: 5 YR 7/8, REDDISH YELLOW, SOFT, NON-STRAT., GRADES TO SILTY CLAY BY 5.8', 30% SAND, VERY FINE-FINE GRAIN, RND-SUBRND, 70% SILT	ML
	5		
	5.8	SILTY CLAY: 5 YR 5/8, YELLOWISH RED, MOIST, FIRM, MED-HIGH PLAST., MOTTLED, NON-STRAT., 20% SILT, 80% CLAY	CH
	6.2		CH
	8.0	CLAY: 5 YR 7/1 TO 6/8, LIGHT GRAY TO REDDISH YELLOW, MOIST, FIRM, MOTTLED, HIGH PLAST.	
		T.D. 8.0'	
	10	NO SAMPLES TAKEN FOR RSA	
	15		
	20		
	25		
	30		
	35		

GRAPHIC LOG

SAMPLE INTERVAL	"N" VALUE
1	3.5
2	
NR	
3	3.0
4	0.0

WELL COMPLETION DETAIL



NOTE: WELL INSTALLED IN SEPARATE BOREHOLE APPROXIMATELY 5 FEET FROM LITHOLOGIC BOREHOLE. WELL BOREHOLE DRILLED TO 8.0 FEET.

CME CONTINUOUS AUGER SAMPLER
STANDARD PENETRATION TEST
UNDISTURBED SAMPLE
WATER TABLE (24 HOURS)
WATER TABLE (TIME OF BORING)
LABORATORY TEST LOCATION
PENETROMETER (TONS/SQ. FT.)

JOB NAME/NUMBER *SEQUOYAH\ 90067*

BORING NUMBER *MW087 (BH-98)*

DATE DRILLED 3/12/91
DRILLING METHOD HSA
DRILLED BY PSI
LOGGED BY TPG
CHECKED BY BJS
DRAWN BY: SAR PAGE 1 OF 1

ROBERTS/SCHORNICK
& ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS
3700 W. ROBINSON
NORMAN, OKLAHOMA 73072
(405) 321-3895

ATTACHMENT A.3

DURABILITY TESTING OF ON-SITE RIPRAP

SHEPHERD MILLER
Environmental and Engineering Consultants

TECHNICAL MEMORANDUM

DATE: May 20, 2002 **SMI # 180734**

TO: Craig Harlin

FROM: Clint Strachan

SUBJECT: Sequoyah Fuels Corporation
Facility Potential Riprap Materials
Durability Testing

COPY: Toby Wright
File

This memorandum presents the results of durability testing of two on-site sources of potential riprap for disposal cell and channel surface erosion protection (if needed). This evaluation was conducted for Sequoyah Fuels Corporation (SFC) by Shepherd Miller. The durability test results are evaluated in terms of criteria used by the U.S. Nuclear Regulatory Commission (NRC) in assessing long-term riprap durability (NRC, 1990).

DURABILITY BACKGROUND

Several physical and chemical tests have been selected by NRC to represent long-term weathering of rock in evaluation of its suitability for erosion protection material, based on review work documented in Lindsey and others (1982) and DePuy (1965). The test results for a particular test are scored (on a scale between one and ten). This score is multiplied by a weighting factor based on general rock type. The products from each test are added to yield a rock quality score. The actual rock quality score is compared with the maximum possible score to determine the rock quality designation. A designation above 80 percent indicates acceptable durability. A designation between 60 and 80 percent indicates acceptable durability (but with oversizing), and a designation below 60 percent indicates unacceptable results.

SAMPLE DESCRIPTION AND TESTING

Two on-site rock sources were sampled by SFC for durability testing: (1) a laminated gray sandy limestone, and (2) a light brown sandstone. The samples were selected to represent the likely range of rock conditions (not best-case conditions).

The limestone samples were tested primarily by the Oklahoma Department of Transportation Materials Division in Oklahoma City (under the direction of SFC). The remaining tests were conducted under the direction of Shepherd Miller by Terracon in Fort Collins, Colorado.

TEST RESULTS

The test results for the sandstone sample are summarized in Table 1 below.

Table 1 Sandstone Sample Test Results

Test	Value	Score	Weighting Factor[a]	Test Score[b]	Max. Score[c]
Specific gravity	2.54	5.8	6	34.8	60
Absorption (%)	2.58	1.8	5	9.0	50
Sodium Sulfate soundness (%)	0.2	10.0	3	30.0	30
Schmidt hammer rebound (%)	38	4.8	13	62.4	130
Freeze-thaw (%)	-	-	2	-	-
L.A. abrasion	10.0	5.0	8	40.0	50
Test Score Total				**176.2**	**320**
Rock Quality Designation (%)				**55**	-

[a] Weighting factors from NRC (1990) for sandstone
[b] Product of score and weighting factor
[c] Product of maximum score (10) and weighting factor

The test results indicate that the sandstone does not meet long-term NRC durability criteria (being less than 60 percent). Based on inspection of the sample received from SFC, some of the sandstone was very hard and competent, and some of the sandstone was weathered and more easily broken. Selective excavation of the sandstone may produce a riprap product that meets durability criteria.

Test results for the limestone sample are summarized in Table 2.

Table 2 Limestone Sample Test Results

Test	Value	Score	Weighting Factor[a]	Test Score[b]	Max. Score[c]
Specific gravity	2.64	7.8	12	93.6	120
Absorption (%)	0.4	8.5	13	110.5	130
Sodium Sulfate soundness (%)	0.2	10.0	4	40.0	40
Schmidt hammer rebound (%)	17	2.1	11	23.1	110
Freeze-thaw (%)	0.2	9	7	63	70
L.A. abrasion	35.6	0	1	0	10
Test Score Total				**330.2**	**480**
Rock Quality Designation (%)				**69**	-

[a] Weighting factors from NRC (1990) for limestone
[b] Product of score and weighting factor
[c] Product of maximum score (10) and weighting factor

The rock quality designation of 69 percent from Table 2 means that the limestone is acceptable (since the score was above 60 percent) but requires oversizing (since the score was less than 80 percent). The oversizing amount is 11 percent (80 – 69 percent). Therefore, if a riprap with a median size of six inches is required, the specific median rock would be approximately 6.7 inches.

The limestone sample tests were conducted under Oklahoma state highways (CRD) standards, and may differ from the ASTM standards (used for the tests conducted on the sandstone sample) that are the basis for the NRC scoring criteria. In Table 2, the LA abrasion test results (in terms of percent loss) appear high, and may be from 500 revolutions. The NRC criteria is 100 revolutions. Therefore, comparison of the CRD standards with ASTM standards would be made to verify the test results on the limestone sample (except for the Schmidt hammer test).

The test results on the two rock samples are consistent with visual inspection of the materials. The potential riprap material is marginally durable for long-term erosion protection applications, and would most likely require some oversizing.

REFERENCES

DuPuy, G., 1965. "Petrographic Investigations of Rock Durability and Comparisons of Various Test Procedures." *Engineering Geology*, Vol. 2, No 2, pp 31-46. July.

Lindsey, C., L. Long, and C. Begej, 1982. "Long-Term Survivability of Riprap for Armoring Uranium Mill Tailings and Covers: A Literature Review." *NUREG/CR-2642*, prepared for NRC, April.

U.S. Nuclear Regulatory Commission (NRC), 1990. "Final Staff Technical Position, Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites." April.

May 16, 2002

Terracon
301 N. Howes • P.O. Box 503
Fort Collins, Colorado 80521-0503
(970) 484-0359 Fax: (970) 484-0454

Mr. Clint Strachan
Shepherd Miller, Inc.
3801 Automation Way, Suite 100
Fort Collins, CO 80525

Re: **Shepherd Miller**
Miscellaneous Laboratory Testing
Fort Collins, Colorado
Project No. 20026313

We are transmitting:
- ☒ herewith
- ☐ under separate cover

☐ Field Data ☒ Laboratory Data ☐ Report ☐ Revised Report

Regarding:

- ☐ Compacted Fills
- ☐ Footings
- ☐ Concrete
- ☐ Asphalt
- ☒ Aggregate
- ☐ Non-Destructive Testing of Steel
- ☐ Permeability Test
- ☐ Location Diagram
- ☐ Soil Samples
- ☐ Construction Material Samples
- ☐ Moisture-Density
- ☐ Grain Size Analysis
- ☐ Masonry
- ☐ R-Value
- ☐ General Information
  - ☐ Certifications
  - ☐ Resumes
  - ☐ Other
- ☐ Report will follow under separate cover

On-site observation services were provided ☐ Full Time ☐ Part Time ☒ Not Applicable

Remarks:

Sincerely,
TERRACON

Mike L. Walker, CET
Manager of Construction Services

Enc/Copies to: (2) Addressee

Terracon

Physical Properties of Aggregates

301 North Howes
Fort Collins, Colorado 80521
(970) 484 - 0359
(970) 484 - 0454

Client Name: Shepard Miller Inc.
Address: 3801 Automation Way, Ste. 100
Fort Collins, CO 80525
Attn: Clint Strachan
Project Name: Durability Testing
Location: Not Reported

Project No.: 20026313 **Date of Report:** 13-May-02
Sample I.D.# or Description:
Client classificaton/I.D.: Sandstone

Aggregate Source:
On-Site
Aggregate Type:
Coarse Aggregate

Sampled By: Client **Date:** 18-Apr-02
Submitted By: Client **Date:** 18-Apr-02
Reviewed By: Mike L. Walker

Sieve Analysis, ASTM C136 — Test Standards are ASTM unless otherwise indicated

Sieve Size	X Passing Retained % Accumulative	Specification Min.	Specification Max.
6"			
5"			
4"			
3"			
2-1/2"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#8			
#10			
#16			
#20			
#30			
#40			
#50			
#80			
#100			
#200			

Test		Standard	Results	Specification
Fineness Modulus		C125		
Dry Rodded Unit Wt, pcf		C29		
Lightweight Pieces, %		C123		
Clay Lumps & Friable, %		C142		
Organic Impurities		C40		
Sand Equivalent Value		C2419		
LA Abrasion, % (100 Rev) Grade 1		C535	10	
Soundness-Mg ,%loss		C88		
Soundness-Na, %loss		C88	0.2	
Fractured Face, % by Wt.				
One or more				
Two or more				
Liquid Limit		D4318		
Plasticity Index		D4318		
Schmidt Hammer Rebound		C805	38	
Specific Gravity	Absorption, %	C127	2.58	
	Bulk (Dry)	C127	2.38	
	Bulk (SSD)	C127	2.44	
	Apparent	C127	2.54	

Comments:

Copies to:

STATE:	OK	INDEX NO.:	RIPRAP	TESTED BY:	CEWES-SC-E
LAT:	35	LONG.: 95	DATA SHEET	DATE:	Jul 88
MATERIAL:	Limestone			LAB ID:	880307

LOCATION: Sec 21, T 13 N, R 21 E, Sequoyah County, OK, Brazil Creek Minerals, Inc.

PRODUCER: Souter Construction Company, Conway, AR

SAMPLED BY: CESWT-EC-DT

TESTED FOR: Hideaway Cove, Eufaula Lake, OK

USED AT:

PROCESSING BEFORE TESTING:

GEOLOGICAL FORMATION AND AGE:

TEST METHOD	RESULTS
BULK SPECIFIC GRAVITY, SSD, (CRD-C 107)	2.64
ABSORPTION, %, (CRD-C 107)	0.4
DENSITY, LB/CU FT, (CRD-C 107)	165
SULFATE SOUNDNESS, % LOSS, (CRD-C 137)	0.2
FREEZING & THAWING, % LOSS, (CRD-C 144)	0.2
LOS ANGELES ABRASION, % LOSS, (CRD-C 145)	35.6
ETHYLENE GLYCOL, % LOSS, (CRD-C 148)	
WETTING & DRYING, % LOSS, (CRD-C 169)	0.0

PETROGRAPHIC REPORT (CRD-C 127)

The sample is a light gray (N7) to pale red (10R 6/2) bedded coarse grain dolomitic limestone. The gray fraction is more dolomitic and contain some quartz where the reddish rock is a pure limestone with only a slight amount of dolomite. The rock is bedded but the transition between the different rock types is tight and should not pose a problem where the rock is used as slope protection stone.

REMARKS

The rock from this quarry should perform satisfactorily as slope protection material.

ENG 8012R

Encl 1

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL # of pages ▶ 1

To Dani White	From Frank Oler
Dept./Agency Souter Const	Phone # 918-669-7533
Fax # 918-489-5591	Fax # 918-669-1526

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

AUG 04 1997

OKLAHOMA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

DATE SAMPLED: 7-31-97 LAB NO. 1 -4070- 17351

PRODUCER: Souter Const. Co. LOCATION: Gore, Okla.
COUNTY: SEQUOYAH LEGAL DISCRIPTION: W½ Sec. 21, T13N, R21E
DIVISION: 1 PIT NUMBER: 6801

METHOD OF TESTING STONE FOR RESTISTANCE
TO FREEZING AND THAWING

Standard Specifications for Highway Construction
1986 EDITION
Section 713 / Corps of Engineers/CRD-C 144

	FOUND	REQUIRED
SPECIFIC GRAVITY (bulk):	2.695	
UNIT WEIGHT (min.):	168.138	140 LB.
ABSORPTION (max.):	0.146	6 %

DESCRIPTION:
RAN No. 2
(A) Supports

INTIAL DRY WEIGHT (grms): 7723 g 2311 g 1288 g

QUALITATIVE ANALYSIS (during testing)

FRAGMENT CONCLUSION:

Number of fragments	Weight	Percent %
1	7692 g	99.6

REQUIRED(20 cycle/15% max.) FOUND: 0.4 %

REMARKS;

Okla. Dept. of Transportation
MATERIALS DIVISION
200 N.E. 21st Street
Oklahoma City, OK 73105

MEETS SPECIFICATION REQUIREMENTS

SEP 29 1997

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Distributed by _____